ELECTRONIC DESIGN

Internal

Rod Magnets Shrink

Size and Cost of New Type

Beam Switching Tube

page 42

COVER: A complete redesign of the beam switching tube makes the new "Beam-X" practical in many switching applications. The cover looks through the eyes of our artist at the cathode-to-collector current flow in the tube.

Selected Topics In This Issue

How Good Is Inertial Guidance?

System designers of outer space vehicles are scrutinizing closely the capabilities of inertial guidance devices. Accuracies needed and problems presented once the vehicle leaves the earth's gravitational field pose real difficulties. This is one aspect of guidance and navigation problems faced by space vehicle designers.

Aware that inertial guidance systems would have to be supplemented by additional approaches to meet outer space vehicle demands, *ELECTRONIC DESIGN* queried the experts as to where we are going. Bob DeFloria, leading the investigation, assisted by Alan Corneretto and Tom Mount, talked to no less than 23 leaders in the field. Result: Deep differences of opinion but an interesting story. Read it on page 4.

Coming Next Issue

Controlling RFI

Radio frequency interference (RFI) has been responsible for missile failures, communication jamming and radar screen blackouts. Our Feb. 3 issue features a special Staff Report with a thorough up-to-date survey of latest developments on this critical subject. Specialists in the field have prepared over a dozen articles on prediction techniques, methods of measurement, trouble shooting procedures and design criteria for interference suppression; several will appear with the Special Report—others will be included in subsequent issues.

First Practical, Tunnel Diode Circuits

The literature abounds with descriptions of tunnel diodes and the promise they hold. *ELECTRONIC DESIGN* is pleased and proud to bring you, next issue, the first article on designing with tunnel diodes. Authors are U. S. Davidsohn, Y. C. Hwang, and G. B. Ober of General Electric Co. General Electric has been producing small sample quantities since the third quarter of 1959.

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Occulation tracking, a new, high-accuracy twist on an old navigating technique.

Guidance and Navigation Designers Scramble to Meet Space Needs

To extend the usefulness of inertial systems, designers are improving the components. This Honeywell gyro uses a beryllium ball electrostatically suspended to cut down bearing friction.

WHILE MAN is getting ready to find his way in space, the navigation designers expected to guide him there are themselves groping for direction in the twisting currents of new requirements.

A survey of navigation design indicates that supporters of many philosophies are scrambling to find a place in space travel for their methods.

Some groups believe their systems will be adequate with relatively minor design improvements. Others see a need for breakthroughs. Some designers believe navigation philosophies must be grouped into composite systems. Still others foresee a greatly limited role for their speciality.

Disagreement is common not only among experts in different areas but among designers in the same speciality. Even workers in the same specialty in the same company disagree. The result is parallel effort in developing space travel guidance and navigation equipment, lack of strong direction and nearly as many approaches to navigation as there are space missions.

Here is where the industry stands in the four main areas of navigation: inertial, celestial, radio and Doppler.

Inertial—Dominant but Straining Hard

Inertial guidance, though still dominant in controlling advanced missiles, is generally conceded to have serious disadvantages in space travel. The drawbacks are fundamental—gravity, for example, which is used to monitor and limit errors in Schuler-tuned earthbound inertial sys-

tions, is not available in space. Also accelerations, the basic inputs of an inertial navigation system, are completely absent after thrust cutoff. An inertial system in space therefore becomes merely an extrapolative device, which determines the dead-reckoning position of the space vehicle on the basis of conditions existing at cut-off.

One advantage often quoted for the inertial acceleration-sensing method of navigation, is that no delay is required for data smoothing because accelerations themselves are sensed as soon as they occur. This advantage is offset in space by the planetary gravitational fields. A vehicle can be deflected from its trajectory by the gravitational field of a planet, with none of the deflection being recorded in an inertial system.

The second advantage claimed for inertial guidance systems is their immunity to jamming. This attribute is not very significant in peaceful space missions and can be provided by celestial navigation systems as well.

To offset these drawbacks in the inertial principle, designers are improving the components. This effort to squeeze the utmost from the systems is resulting in some exotic designs.

General Electric and Jet Propulsion Laboratory have announced cryogenic, electromagnetically supported gyroscopic rotors, which are virtually friction-free. GE reports that it expects to reduce uncorrected drift in its new gyroscope to 0.0001 of a degree per hour, better than any accuracy available now.

Minneapolis-Honeywell has announced an electrostatically supported gyroscope with relatively low friction values. Kearfott is working on a ferrite rotor for similar results. Since one large source of error in gyroscopes is the drift of the rotor itself, which in turn is largely caused by friction, the performance of these systems under development is reported to be at least an order of magnitude better than any system now in existence.

Ford Instrument Co. and Chance Vought have both announced work on gimble-less inertial "platforms." In these systems the single-degree-of-freedom gyroscopes are strapped down to the vehicle frame, instead of mounted on a platform suspended in a gimbal system. Eliminating the complicated and close-tolerance gimbal structure simplifies the attainment of very precise gyroscopic action. Memory of space orientation is provided by a digital computer, which has an accuracy theoretically limited only by size.

C. L. Davis of Minneapolis-Honeywell has said: "The electrically suspended gyroscope has the potential of far greater accuracy than present forms of gyroscopes and is a distinct advance in the state of the art.

"Naval vessels and space missiles of the future will require guidance so precise that even the ex-

NEWS

tremely accurate gyros of today may be inadequate. Answers to these problems of ultra accuracy are being found in virtually friction-free electrically suspended gyros."

Despite the efforts to break through present machining limits of inertial components, many designers feel that inertial systems will not be able to perform their space navigation function without monitoring by other devices.

According to H. A. Grant of North American's Autonetics Division: "There is no controversy between inertial and other kinds of guidance. As soon as a vehicle gets out of the earth's gravitational field, the inertial guidance system loses its Schuler-tuning and all errors propagate at one half AT^2. Obviously in this case it is necessary to have passive navigation systems to take fixes periodically and reduce the error."

In contrast, R. B. Horsfall, also of Autonetics, says: "Once a vehicle is in interplanetary space, it is free from sudden random disturbing influences of large magnitude, such as wind gusts; particularly if it is in free motion, it may be a good stable platform in itself. Possibly the use of gyroscopes can be dispensed with entirely for this situation."

And yet, in the Centaur space vehicle, designed to soft-land an instrument package on the moon, the opposite approach is taken. Centaur will carry an all-inertial guidance system. The vehicle's burning time will be so long that the craft will travel beyond the earth's horizon and out of range of Cape Canaveral's radio-tracking system before cutoff. The Centaur's Convair designers apparently feel that neither radio nor celestial monitoring is necessary for the vehicle's mission.

Celestial—Rising Star in Space

The view that inertial components may be excess baggage for certain space applications is also backed up by proposed systems designed by celestial guidance groups. At Perkin-Elmer Corp. two satellite programs, a true satellite and a high-altitude balloon, are in the study phase. Both designs call for no gyros aboard at all. Attitude control is attained completely by the use of optical devices. Because no disturbing forces come into play on the satellites, the complexity and interactions connected with inertial components are felt to be an unnecessary burden with no compensating gain. The satellite's attitude would be controlled by slaving the vehicle to the outputs of the optical devices through a reaction sphere.

In a similar application, a star tracker developed by Librascope aided balloonists who studied and

photographed Venus through a 16-inch Schmidt telescope last November. When pointed at a star or planet, the star tracker locks on then tracks the astral body, reflecting light from the target to a half-millimeter slit in the spectrograph. The telescope is "fixed" on the target to within 3 sec of arc. This positioning is comparable to an accuracy of one part in 432,000 parts, Librascope reports.

Attitude control of two recent satellites was actually attained by means of a Barnes infrared sensing unit. This device was used to control the attitude of the satellite closely enough to allow sharp photographs of the earth to be taken. Sperry Gyroscope Co. is proposing optical infrared and even millimetric waves to sense the horizon and establish the vertical direction around the earth or other planets. Such a system, using millimetric radiation, would be especially useful around Venus, where dense clouds make it difficult to sight on the horizon. A by-product of such a vertical sensor obtained almost without cost, according to Earl McCartney of Sperry Gyroscope, is a geometrical determination of range from the center of the planet. This quantity is unobtainable from any inertial device.

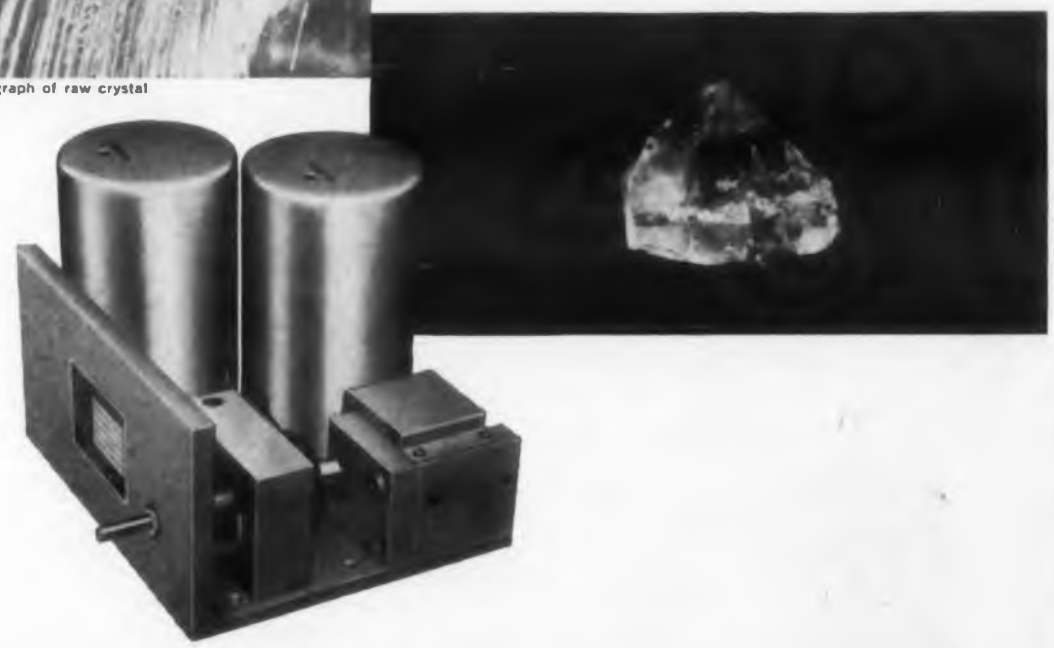
The launch vehicle necessary to get a true space craft off the earth and into orbit will probably still require an inertial system to overcome the violent turbulence of the power phase of the flight. The payload stage of the vehicle, while orbiting in space, is perpetually free from such disturbances and can possibly do without the costly and heavy inertial components.

As far back as 1952, North American's XN-2 experimental stellar-inertial autonavigator tracked stars automatically in broad daylight to supervise its three-gyrostabilized platform. Subsequent XN-2 flights established the ability of stellar-inertial systems to operate accurately in either the atmosphere or outer space at any time of day or night. The XN-2 system's significant contributions to the advancement of automatic navigation were achieved in a test program extending over a period of three years and two months.

Kollsman Instrument Corp. produces the celestial tracking sub-system for the B-58 Hustler navigation system, as well as several other high flying vehicles. Northrup's Snark also uses this "conventional" form of celestial-monitored inertial guidance system.

One of the limits in this type of system, however, is the requirement to measure a very small angle, in the order of seconds, in a large total angle. The percentage of tracking accuracy required from the pick-off devices for a usable navigational accuracy is excessive in this arrangement.

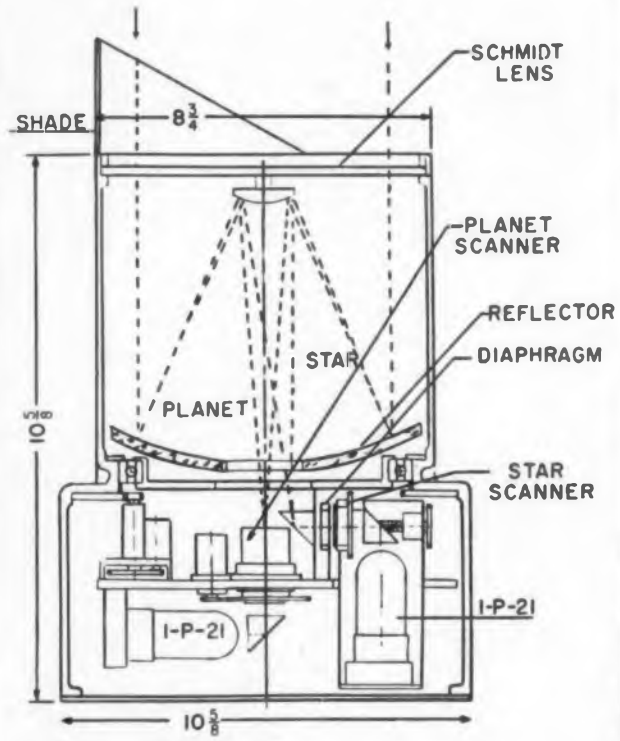
Enlarged photograph of raw crystal



NEWS

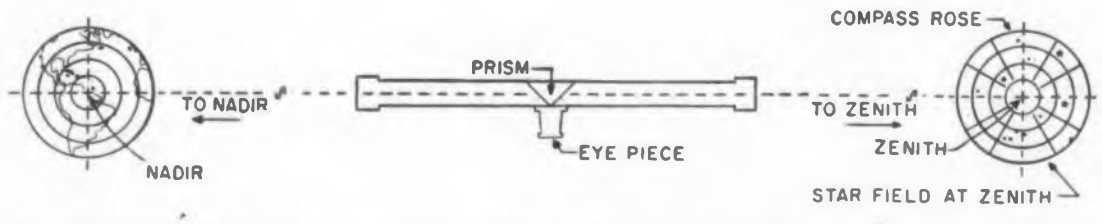
Of more recent interest for this reason, are occu - lation trackers. In these devices the lines of pos - tion in space are established by the planet positio n against a star background. The percentage of a - curacy of the required measurement is reduce , since it is only necessary to determine the planet position with respect to the stars in the local are . With a reference star half a degree away, one se - ond of arc is only one part in 2,000, which is easil obtainable. According to American Bosch Arm , the occulation type of star tracker provides sul - stantial advantages over the conventional sta tracker even though it may be heavier. This is be- cause the accuracy gain more than makes up fo the large price paid in excess weight. The erro accuracy of the occulation method is easily paid for in terms of fuel saving, even at the expense of added guidance weight, which seems unlikely.

The Weems' System of Navigation, Inc., is working with Kearfott on such a method, which "uses a minimum of electronic and minimum of inertial equipment at the start."



Occulation tracker focuses stars and planet on scanners, and determines relative displacement.

Stellar autonavigator designed by North American, flew in 1952 and tracked stars in broad daylight to monitor its inertial platform.



Astral determination of nadir point allows celestial navigation in absence of gravity.

This replaces the gravity vertical with an optically or infrared-derived vertical in the conventional celestial navigation geometry. Inertial components are used, when necessary, only for attitude stabilization to permit accurate sighting of the stars. The absence of gravity in orbital flight has been a barrier to the celestial type of navigation in this situation.

Radio—Accuracy Tops but Range a Problem

Ground-based radio guidance has been used on all advanced ballistic missiles. This type of system uses a very large array of antennas and complex computers on the ground, with little more than a transponder in the vehicle itself. Such systems have been refined to where the accuracies attained are presently superior to those of any other method of guidance in the launch phase. The adaptability of such a system to true space navigation, again, involves differences of opinion. According to Mr. Grant of Autonetics:

"Radio link may be the way the Russians hit the moon. A stellar-monitored inertial system would be much more accurate than any radio link system.

"Radio-control-type navigation is crude and inaccurate compared with most passive systems. Ballistic missiles, up to and including Centaur, use radio control."

American Bosch Arma Corp. says:

"Radio techniques have already played and will continue to play an important role in space navigation. Obviously their prime suitability is for the case when the vehicle is near the earth. However, they are not limited to this region. It has been reported that the Russians have used these techniques in their recent highly accurate shot around the moon.

"Jet Propulsion Laboratory has reported communication with the Pioneer space shot to a range in excess of 400,000 miles, and this would radiate power of one-quarter watt. Theoretically this range can be extended indefinitely."

However, in comparing radio and celestial systems in navigation to Mars, the company says:

"When one turns to the problem of photographic graze and return to earth, the margin of advantage is in the celestial guidance system, primarily because the scale errors in the radio systems are too large to provide sufficient accuracy for the mission."

In contrast, a spokesman for Convair Astronautics, designer of the Azusa radio guidance system, states: "For flights to reasonably close planets, such as Venus or Mars, a radio-inertial guidance system is probably superior at first. For points beyond Venus and Mars, probably optical is superior."

(continued on p. 10)

NEWS

Doppler—A Must in Terminal Phase

In the terminal phase of interplanetary missions Doppler systems come in for consideration. According to M. Y. Silverberg and J. P. Campbell of General Precision Laboratory:

"For the achievement of soft landings or precise satellite orbits after destination, some form of terminal guidance will be required. Terminal guidance appears to be the most appropriate application for Doppler radar.

"An important phase in the operation of many space vehicles will be the establishment of a carefully chosen orbit around the earth, moon, or nearby planets. The guidance system must again include sensors of velocity, altitude and attitude. Self-contained Doppler radar is well-suited for velocity measurement in low-altitude orbit. Doppler output can be used directly in the trajectory program if expressed in terms of a reference frame fixed to the target surface.

"It will be necessary to control the orientation of the vehicle, or at least for the breaking thrust, during descent to the surface, and to reduce the velocity of the vehicle to a safe value at touchdown accelerations. Crucial quantities involved in terminal guidance are, therefore, velocity with respect to the target surface, altitude above the surface, and attitude. A Doppler radar measures directly the first of these and so provides, at its output, signals useful for controlling the breaking rockets."

Composite Systems The Answer?

As is usually the case when requirements exceed the capabilities of any single system, combinations are being pursued. Which composite system will eventually exhibit superior performance is not yet clear. Both Doppler-monitored and celestial-monitored inertial systems have been used successfully. More recent systems have been both Doppler and inertial-monitored. This is the approach taken with the guidance system of the B-58 Hustler, as well as in GPL's AID system (Astral-Inertial-Doppler). Perhaps the last word on composites will be "RAID systems" (Radio, Astral, Inertial, Doppler). Such a composite would be a designer's hedge, insuring that he was with the "winning" system, at a cost of additional system weight.

A look at the fundamental advantages and disadvantages of each approach to guidance in the light of the space environment may shed some light on how the guidance issues might be resolved.

Inertial systems offer the advantages of inherent stability in the presence of disturbing forces, and the ability to sense applied accelerations as they occur. They are jam-proof and interference-free. They suffer from a determination of accuracy with

time, from the total insensitivity to force-field accelerations, and perform no active navigation function during free fall. Equipment is generally complex and heavy.

Ground-based radio devices probably require the least equipment in the vehicle, and yield unequalled positional and velocity accuracy within relatively close range. They suffer from loss of accuracy with range and from the complication of a moving (earth) coordinate reference as well as from signal-to-noise problems. Inertial or celestial space orientation is required.

Celestial navigation equipment, especially occulation types, offer high accuracy independent of time and position anywhere within the solar system, and are jam-proof and relatively interference-free. Equipment is generally complex and fairly heavy. Inertial stabilization is required in the presence of turbulence or large applied thrust.

Doppler systems provide direct velocity measurement with respect to a nearby planet, and provide excellent terminal guidance with accuracy improving as the target planet is approached. Self-contained Doppler systems do not function in midcourse, and when in use, require inertial stabilization, which need be highly accurate only for a three-dimensional solution.

From these characteristics, some designers conclude that:

- Inertial guidance will continue to be necessary for the launching booster, because of inherent vehicle instability during thrust. The need exists for the fast action of accelerometers which sense disturbing forces as they occur. A stable platform is needed to orient any external correcting signals.
- In the space-shuttle or permanently orbiting vehicle, inertial devices might be dispensed with if the vehicle itself has sufficient inertia and if correcting thrusts are rather small.
- For terminal guidance of a grazing vehicle, Doppler radar offers distinct advantages. An associated celestial stabilization might be sufficient if thrust is kept low enough, or relatively low-quality inertial stabilization will suffice if altitude is obtained optically.
- For soft landings, where considerable thrust is involved, inertial stabilization is again a must.

Hence the choice of system and system composites will be dictated by the mission of the vehicle, as well as by the thrust reserve. In all cases, as long as propulsion capacity is marginal, complex and highly accurate sensing and computing devices will be required. As Capt. Thompson, U. S. Naval Academy, states it: "The first space vehicle will be like a battleship with an outboard motor." However, with time, adequate power should be provided, otherwise navigation in the real sense cannot be done. ■ ■

NEWS

A new black body with potential as a standard for ultraviolet radiation has been developed at the National Bureau of Standards. It consists of a graphite core packed in boron nitride powder in a glass-fiber-wrapped porcelain container. Here, the black body is being inserted into an induction coil operated by a high-frequency induction generator. The body's radiant-energy output corresponds closely to that theoretically predicted for an ideal radiator, NBS reports.

Design News in Photos

High-powered modulator used by Sperry Gyroscope to test klystrons generates peak powers of 100-mw video and 3-mw rf. The modulator can be operated on single or dual channel, and alternately on parallel or delayed firings.

Human-engineered experimental cockpit control was designed by Bendix Radio to permit a pilot to operate his radio equipment without looking at the control panel. All switching functions for communications gear of a high-performance aircraft have been integrated into the 12-key panel.

Gallium-phosphide diode operates at 1500 F, reports the Signal Corps, which developed the device for space applications. The Army hopes to use gallium phosphide in solar-cell power supplies and other high-temperature environments.

Design of high-power, gridded traveling-wave tube combnies a periodic focused permanent magnet with a gridded gun to avoid the modulation problems resulting from the high-pulse levels of pulsed-cathode, magnetically focused tubes. Hughes Aircraft reports that the 1-kw, S-band twt has "very fast response and low power consumption."

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NEWS

Insulation Conference Told of High-Heat Advances

A trend toward electrical insulations capable of withstanding higher and higher temperatures was reported at the Second National Conference on the Application of Electrical Insulation.

The meeting, in Washington, held sessions in three general categories: electronics, distribution equipment and rotating machinery. About 1000 engineers heard more than 80 papers.

Among the highlights was a report of wire insulated with resin that endured temperatures of 842 F and above for short periods. Another paper told of the role of ceramics in insulating wire at temperatures from +85 to 1500 F.

Spirited discussions from the floor followed the presentation of many papers, adding to information given by the speakers and updating much of it.

Resin Covering Described

The resin-insulated wire, said to withstand temperatures of 842 F and above for short periods, was described in a paper by J. J. Casey of the Navy Bureau of Ships and J. P. Shoffner of the Polychemicals Dept. of E. I. DuPont de Nemours & Co., Wilmington, Del. Such wires have a survival capability of four to six hours, they said, and are "of significance in 'one-shot' applications, such as missile launchings and transient overloads."

In a paper on ceramics for high-temperature electrical applications, Jesse D. Walton Jr. and Joe N. Harris of the Engineering Experiment Station, Georgia Institute of Technology, described some of their work in a project for the Air Force. Insulation was specified, they reported, to function at temperatures from −85 F to 1500 F with minimum weight and a life expectancy of at least 10,000 hours.

Military Specifications Met

Meeting military specifications for airborne transformers is much easier today than it was two years ago because of progress in the development of the flexible epoxy resins, according to Ward M. Hanson and Jack R. Tuzinski of the Minnesota Mining and Manufacturing Co., St. Paul, Minn.

"Since their introduction a few short years ago," the authors reported, "the flexible epoxy resins have played a heroic role in the field of electronics. Airborne military transformers and high-voltage ignition coils for outboard motors typify the units which have been produced in large volume using this new approach to resin technology."

Paper Stirs Rebuttal

One paper that provoked lively comment from the floor was by L. W. Kirkwood and R. S. Key of Bell Telephone Laboratories. They described alumina powder as a potting material for transformers. This is a refractory material, aluminum oxide, originally developed as a fluid catalyst. It comes in the form of white, spherical particles about 15 mm in diameter. An important advantage of the powder over other impregnants is that it can be removed from the case should the transformer require repair.

In the discussion following the paper, engineers from Hughes pointed out that they had adopted a flat-particle powder rather than the globular-shaped pieces recommended by Bell, because flat particles afforded better particle-to-particle contact. Tests show that heat transfer characteristics are much improved, the Hughes engineers reported.

In the other papers, silicone gel was described as a new potting compound by D. F. Christiansen of Dow Corning Corp. (ED, Sept. 3, 1958, p. 28). The material is self-sealing and sets into a transparent jelly-like substance.

One advantage of the silicone gel is its transparency, which permits the individual components inside the case to be seen after potting. Color codes are easy to read. In checking an assembly, the test prods can be inserted into the compound.

In all, six sessions were devoted to problems of insulation in electronics equipment.

Potting with powdered alumina offers several advantages, Bell Laboratories researchers reported at the national insulation conference: damaged components can be depotted by cutting open the can and pouring out the dry powder; the potting compound will not overheat (the melting point of alumina is well above the possible operating temperatures of electronic components), and the pot's airtight seal will not be threatened by expansion or contraction of the potting compound.

Digital Instruments Stressed In Environmental Testing

The increasing role of digital instruments in environmental testing was explored at a symposium of the New York Metropolitan Chapter of the Institute of Environmental Science.

Two factors are forcing electronics companies to take a hard look at their instrumentation in environmental testing: a great deal of money and energy are now going into establishing high orders of reliability of components, equipment and circuits; and budget restrictions are limiting military financing of testing programs.

Why United States Testing Co., Inc., switched to digital test equipment was explained by Richard F. Hahn, engineer. One reason, he said, is that "a few years ago a qualification test on capacitors to the requirements of MIL-C-25 required 27 parts to be tested."

"Today, he went on, a similar specification, MIL-C-26244, requires that 100 parts be tested and also that they be tested under more severe conditions. We now have 1000 and 2000-hour-life tests, where before, a 500-hour-life test served the industry's need."

Mr. Hahn outlined some advantages of digital systems. He said they improved accuracy by eliminating human errors in making connections and in reading and recording data. Reading, he said, constitutes the largest single source of error in the laboratory.

"Automatic cycling or automatic programing of environmental test equipment is increasingly common," said Wayne Tustin, manager of service and technical training at MB Electronics. "Recently," he said, "more laboratories have seen that automatic programing does a better job than the most conscientious operator, does it cheaper and will work twenty-four hours per day if needed."

A paper that Mr. Tustin delivered described a completely automatic system for controlling random-motion vibration tests. The system provides an instantaneous display of vibratory energy vs. frequency.

Computers Design Circuits

The use of computers in electronic circuit design was described in a paper by Herbert A. Seidman and Philip L. Hillman of General Precision Laboratory, Inc. To improve the reliability of their circuit designs and to reduce the many man-hours demanded by a manual operation, the company has set up a digital computer to analyze circuits already designed and to redesign the circuits when necessary—either to improve their performance or to alter their input and output specifications.

NEWS BRIEFS . . .

. . . **THERMOPLASTIC** visual recording technique being developed by General Electric differs from the Swiss Eidophor color TV system in that it uses a special three-layer film to record the rippling of an electron beam. The Swiss system employs an oil-emulsion record. GE's wide-band, high density recording process could have application in video recording, movie-making, data processing and display.

. . . **EXTENDING ALLOCATIONS** of frequencies to 50 kmc, the International Telecommunications Union at its recently concluded Geneva meeting set aside the band between 19,990 and 20,010 mc for international space research. The ITU also allocated the 15-mc, 150-to-15-mc, 250-mc, and 31,500-to-31,800-mc bands principally to space-space and space-earth communications.

. . . **FCC's TECHNICAL** research division has suggested that a non-FCC organization be asked to research a new system for commercial TV. According to the division, developments of the past 20 years have resulted in: channels that are too wide for the service they provide, excessive power requirements for synchronization signals and audio, and distortion caused by use of vestigial sideband.

PRICES AND AVAILABILITY . . .

. . . **PNP FUSED-JUNCTION TRANSISTORS** have been cut in price by up to 10 per cent by Hughes Aircraft Co. The reduction affects all transistors of the 2N1228-1234 line, and transistors of the 2N1238-1244 line.

. . . **ALUMINUM SHEET, COIL AND PLATE** have been raised in price by about 5 per cent by Olin Mathieson Chemical Corp. The price of electrical conductor will be raised about 2 cents per pound, based on aluminum content, the company reports.

. . . **TEFLON FEP-FLUOROCARBON FILM** 2 or more mils thick has been reduced in price by nearly half by E. I. DuPont de Nemours and Co.—from $29 per pound to $15 per pound. The price of one-mil film has been cut to $16.50 per pound; one-half mil film has been cut to $20 per pound.

Is your company making changes in prices or availability of its products? Send the details to *ELECTRONIC DESIGN*, 830 Third Ave., New York 22, N.Y.

WASHINGTON REPORT

Ephraim Kahn

. . . **MILITARY BUDGET** presents a priorities challenge to the Pentagon. Starting January 18, Congress will examine in a series of hearings the defense posture of the U.S. Prominent issue will be the "missile gap," but odds are against any substantial reductions in ICBM programs. Military men who testify before Congressional groups will be hard put to give unqualified support to the budget they are supposed to support. It is believed that the final figure presented to Congress slashed by about 30 per cent the demands originally made by the military—even after orders were passed to hold essential requests to 90 per cent of fiscal 1960 sums and to add new items sparingly.

. . . **TRANSISTOR IMPORTS** from Japan probably will not be curbed by the Office of Civil and Defense Mobilization, according to some well-placed government experts. Evidence of big expansion plans by U.S. semi-conductor makers, the tendency for benefits from military research to flow toward civilian applications, and the fact that imports are used almost exclusively in non-military items—all given in detail in the Japanese brief to OCDM—are believed to have been particularly impressive. Rejection of the EIA-sponsored import control petition would not foreclose a plea by U.S. industry before the Tariff Commission. Industry spokesmen, however, think that it would be impossible for tariffs to be hiked enough to offset Japan's price advantage.

. . . **PRIORITIES** and allocations authority of the Defense Department, slated to expire on June 30, is expected to be continued by Congress for at least two more years. Efforts will be made by Office of Civil and Defense Mobilization to have Congress broaden stockpiling objectives to encompass the "essential needs of the nation in the event of nuclear attack (including reconstruction)." Until some way is found of assessing what these needs might be, the government suggests that "the maximum objective shall be not less than six months' usage by industry" during a period of active demand.

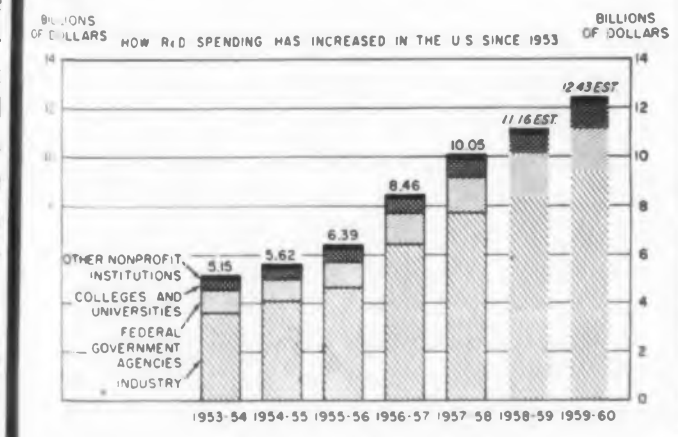
. . . **MORE SHIFTS**—some of them sudden—in military dealings with business can be expected in

the light of an Air Force decision to re-evaluate, on a continuing basis, the utility of America's military forces. This is said to be "a precaution against the wasteful use of national resources or costly errors of judgment, either of which might prejudice the welfare of the nation." Especially likely to be affected are "the nature and priorities of research and development programs bearing on forces and weapons systems." Basic Air Force attitude is the belief that "the best preparation for limited war is proper preparation for general war."

. . . **SOLUTION TO PROBLEMS** of this nature can be reached in other ways, states the Deputy General Counsel of the General Accounting Office. J. Edward Welch asserts that desirable results could be achieved if the Armed Services "increase their in-house capabilities to a point where they will be able to control the design of their weapon systems, develop such systems, and procure a substantial amount of system subassemblies and component parts by separate prime contracts." Congress, of course, is not likely to go along with such a plan, which would seem to relegate industry and its vast know-how to second-class status.

. . . **MISSILE SYSTEMS** may benefit from reductions in jet aircraft purchases that are planned by the military. It is believed that some jet bomber buying will be slashed by 33 per cent or so—about $200 million, at least. This will reduce the need for jet tankers, resulting in a further substantial saving. Funds freed in this manner are to be used in this fiscal year and the next to augment the amount that can be devoted to advanced weapons.

. . . **TOTAL R&D FUNDS** rose from about $5 billion in 1953-54 to over $12 billion in 1959-60, the National Science Foundation says. In the current year, performance of R&D by industry and related organizations will cost $9.4 billion. Note, however, that more than half of the R&D money to be spent by industry comes from the federal government. Over a seven-year period, government agencies' R&D funds went up 83 per cent, industry's rose 159 per cent, the share of colleges and universities climbed 126 per cent, while other non-profit institutions enjoyed a gain of 140 per cent.



MEETINGS

Calendar of Events

January

25-27 28th Annual Meeting of the Institute of the Aeronautical Sciences, Hotel Astor, New York, N.Y.

25-29 Stress Measurement Symposium, Arizona State University, Tempe, Ariz.

31-2/5 Winter General Meeting of the American Institute of Electrical Engineers, AIEE, Statler Hilton Hotel, New York, N.Y.

February

*1-4 ISA Winter Instrument-Automation Conference & Exhibit, Rice Hotel and Sam Houston Coliseum, Houston, Tex.

2-4 15th SPI Reinforced Plastics Division Conference, Edgewater Beach Hotel, Chicago, Ill.

*3-5 1960 Winter Convention on Military Electronics, PGME, Ambassador Hotel, Los Angeles, Calif.

10-12 7th Annual Solid-State Circuits Conference, IRE, AIEE, Hotel Sheraton, Philadelphia, Pa.

11-12 7th Annual Cleveland Electronics Conference, IRE, ISA, AIEE, Engineering and Scientific Center, Cleveland, Ohio.

11-13 1st Annual Electronics Representatives Association, Drake Hotel, Chicago, Ill.

16-18 1st National Symposium on Nondestructive Testing of Aircraft & Missile Components, SRI, Hilton Hotel, San Antonio, Tex.

*19-23 3rd International Electronic Parts Show, Paris, France.

25-26 Scintillation Counter Symposium, PGNS, AIEE, AEC, NBS, Washington, D. C.

*Includes meetings described herewith

AIEE Winter General Meeting, January 31-February 5

One hundred and twenty-one sessions are being organized and 218 formal papers have been submitted for consideration for the AIEE Winter General Meeting. A panel discussion will be held Thursday, Feb. 4, beginning at 9 A.M., on "New Challenges to Electrical Engineers from Medical and Biological Problems." Dr. A. Eckels, chairman of the electrical engineering department of the University of Vermont, will be the moderator. A program of inspection trips has also been prepared. Committee chairman is R. T. Weil, Jr.

Instrument-Automation Conference and Exhibit ISA, Houston, Tex., February 1-4

The theme of the winter Instrument-Automation Conference and Exhibit will be "Process Control in the Electronic Era."

The Conference Sessions will be held Feb. 1-4 at the Rice Hotel, while the Exhibit will be staged in the Sam Houston Coliseum, Feb. 2-4. For additional information write to: Instrument Society of America, 313 Sixth Ave., Pittsburgh 22, Pa.

1960 Winter Convention on Military Electronics, IRE-PGME, February 3-5

Tours to the Pacific Missile Range and Naval Ordnance Laboratories, Corona, are among the many field trips offered to visitors at the 1960 Winter Convention on Military Electronics. The field trips are expected to offer a cross section view of the missile, defense and electronic industries in Southern California.

A visit to Space Technology Labs, Inc., will be held Wednesday, Feb. 3. Visitors will be shown a film on current space probe activities and the company's Space Communications and Navigation Network (SpaN Net), headquarters for a vast intercontinental tracking station network.

Feb. 3, from 7:30 to 10:00, an evening trip to the System Development Corp. of Santa Monica will be featured. Two tours will be offered Feb. 5 to include a visit to the Pacific Missile Range, Point Mugu, Calif., to view a Regulus test launch and a tour to Consolidated Electrodynamics Corp.

The convention to be held at the Biltmore Hotel, Los Angeles, Calif., is sponsored by the Institute of Radio Engineers Professional Group of Military Electronics. Chairman: Dr. Lester C. Van Atta, Hughes Aircraft Co., Los Angeles, Calif.

7th Annual Solid-State Circuits Conference, February 10-12

The 1960 Solid-State Circuits Conference will feature eight sessions devoted to broad advances in the field of solid-state device applications and circuits. Papers will be offered covering new magnetic and semiconductor devices and circuits for digital storage and logic. A number of survey reports on tunnel diodes, thin magnetic films and microwave properties of semiconductors will be presented.

Informal discussion sessions, conducted by leaders in the solid-state field, will be held on Wednesday and Thursday evenings to provide registrants an opportunity to discuss tunnel diodes and their applications, storage techniques, reliability, noise theory, logic circuits, microelectronics, parametric applications and energy conversion. For further information write to: Lewis Winner, 152 West 42nd St., New York 36, N.Y.

3rd International Electronic Parts Show, February 19-23, Paris, France

The 3rd International Electronic Parts Show, for electronics specialists, will present a full range of elements used in the construction of radio-electrical and electronic appliances. Many new exhibitors from all countries will be taking part alongside the larger international firms. The show is organized by the National Federation of French Electronics Industries, 23 rue de Lubeck, Paris 16, France.

NEW

General Electric High-voltage Tantalytic* Capacitors

RATINGS TO 300 VOLTS

General Electric announces a new high-voltage foil Tantalytic capacitor—rated to 300 volts at 85C and to 250 volts at 125C —in both polar and non-polar designs.

SMALLER IN SIZE than any previously available capacitor with similar voltage ratings, these new General Electric capacitors also provide size advantages over series arrangements of lower voltage units.

GREATER CAPACITANCE STABILITY, achieved over the entire temperature range, is provided by these new high-voltage Tantalytic capacitors. An 8 percent maximum capacitance increase at high temperatures and a 20 percent maximum capacitance loss at −55C are specified.

CLOSER CAPACITANCE TOLERANCE of ±15 percent is standard. This represents a significant improvement over the ±20 percent or −15 +75 percent initial tolerances characteristic of lower voltage capacitors.

SUPERIOR LIFE PERFORMANCE during 2000 hours under maximum rated conditions is realized, with a maximum capacitance change not exceeding 10 percent.

FOR COMPLETE INFORMATION on this significant breakthrough in Tantalytic capacitor design, contact your General Electric Sales Representative, or write Section 449-15, General Electric Co., Schenectady 5, N. Y.

*Registered trademark of General Electric Co.

TYPICAL OF THE WIDE RANGE OF RATINGS AVAILABLE WITH THE NEW G-E HIGH-VOLTAGE FOIL TANTALYTIC CAPACITORS

Cat. No.	Volts	Temp.	Capacitance (uf)	Polarity	Max. Leakage at Rated Temp. (ua)	Max. Imp. −55C 120 CPS (Ohms)	Diam.	Length
29F2200	200	85C	0.35	P	32	5715	3/16"	11/16"
29F2105	300	85C	25.0	P	500	82	17/32"	2 3/4"
29F2108	300	85C	2.0	NP	150	1010	3/8"	2 1/8"
29F2207	200	85C	0.15	NP	32	13330	3/16"	11/16"
29F2161	250	125C	2.5	P	100	830	3/8"	1 7/16"
29F2164	250	125C	13.0	P	325	160	15/32"	2 3/4"

These units are supplied in tubular form, in lightweight aluminum cases, with axial leads, and are available with insulating sleeve in 7 case sizes.

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EDITORIAL

Engineering Feat of Past Decade Was Engineering Human Understanding

Not withstanding impressive technical strides, the greatest engineering achievement in the last decade may well be the improvement of human understanding on an international scale.

The co-operation of 30,000 engineers and scientists from 66 nations in carrying out the International Geophysical Year crossed many political, economic, language, ethnic, and racial barriers.

IGY amassed a wealth of data to add to man's storehouse of knowledge. The chief value obtained, however, was not so much in the exchange of impersonal facts as in the interchange of personal thoughts no more profound than, "Good Morning," "I hope you are fine," "Can we do this this way?", and "Au Revoir." Genuine friendliness can dispel unfounded distrust.

Unfortunately not all international technical meetings are successful. The continuing failure of Soviet and American scientists at Geneva to agree on some method of detecting underground atomic explosions is discouraging. It appears, that official instructions from heads of governments however determine what is permissible discussion and what is not. Therefore, free and frank discussion and unfettered experimentation cannot take place.

It may be too much to hope for co-operation and understanding from purely national committees and official international bodies. Proponents for the immediate creation of space law, for example, feel such groups cannot reach a synoptic view and that nongovernmental international organizations must lead the way.

Although more forward-looking co-operative ventures with humanitarian purposes in mind are needed, we can be justifiably proud of simple efforts on the part of our various professional societies to invite foreign guests to our conferences. We, in turn, should attend as many international conferences as we can. The presence of informed and intelligent engineers who also zealously believe in the supreme worth of the individual and the right of political self-determinism will do much to bring about understanding of our human values.

James G. Kupfer

Magnetic Cores Play Many Roles

Irving L. Wieselman and William S. Knowles

Telemeter Magnetics, Inc.

Los Angeles, Calif.

Though their work concerns divergent aspects of data-processor design, Bill Knowles (top) and Irv Wieselman meet on common ground in this paper. Knowles analyzes new designs for data-handling devices and systems using magnetic cores. Wieselman translates systems' requirements into logical designs.

Knowles has done more than work his way from the ground up. He started below ground with development work on sondes for oil well logging and surveying. He has worked in radio telemetry and has two patents for a ground station he invented. He also helped develop the first commercial, large-scale core memory ever to be used in a computer.

Wieselman has designed logic for a Russian-English translator using a photoscopic store with a capacity of 30 million bits on a 16-inch glass disc. He's also worked on converters which would translate one computer code and format into another.

APPLICATIONS of magnetic core circuits have been extended. Where, traditionally, cores have made their most significant contributions as memory elements, today they can be used in all-magnetic flip-flops, gates, counters, adders, programmers, shift registers, and even in all-magnetic digital computers for special applications.

The reliability of cores under adverse environmental conditions—extremes of shock, vibration, temperature—makes them well suited to computing requirements of missiles, spacecraft, and a wide range of industrial process control systems.

Cores—For High Reliability

Previously, magnetic core devices depended on semiconductors and vacuum tubes for logical operations. This resulted in the reliability of the core device being restricted by the reliability of the semiconductors and vacuum tubes. Core reliability is of a much higher order, especially at elevated temperatures and under other environmental hazards. Ferrite cores are available that can be operated reliably at 100 C, and experimental cores have been operated continuously at temperatures as high as 200 C.

Core assemblies, coated with a thin layer of rubber-like material, and using an aluminum-plate heat sink, offer packages which operate at great extremes of temperature, shock, and vibration. This environmental protection offers the computer designer a most reliable electronic element. The predicted reliability of these packages is so high that equipment can be built with the core packages permanently wired in without connectors, further increasing reliability of the overall system.

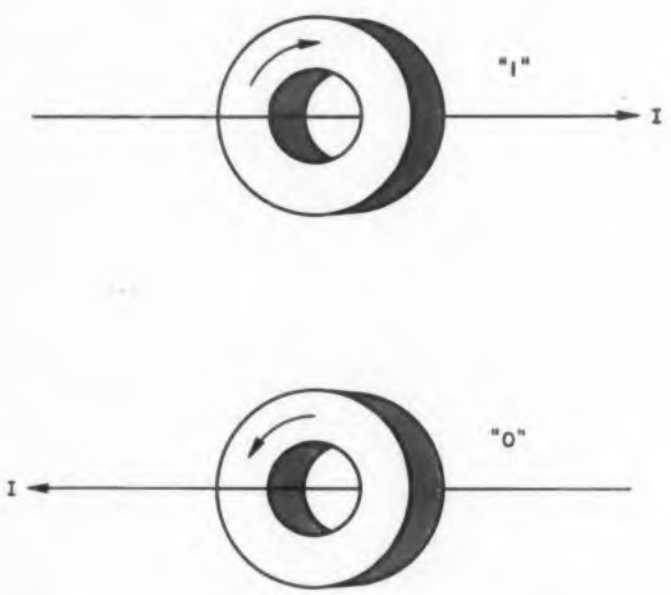


Fig. 1. Direction of current flow determines the binary state of a core.

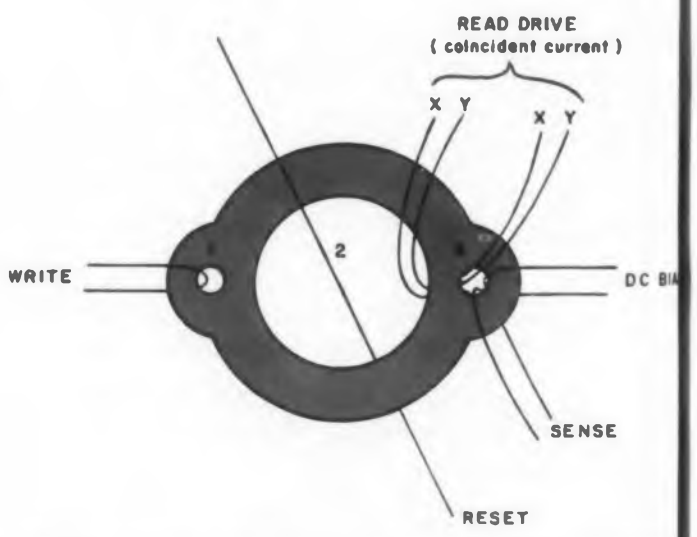


Fig. 2. The basic multiaperture device (*MAD*) is a magnetic core with two apertures in its wall.

The development of core devices to perform active computing functions in addition to the storage function permits the design of all-magnetic computers.

Cores For Memories

The basic phenomenon underlying the use of magnetic cores is retention of a direction of magnetization. The square hysteresis characteristics of the ferrite core material permits it to take on either of two stable states of magnetization. The particular direction of the magnetization is determined by the direction of the current through the activating wire (Fig. 1). One direction of core magnetization is then defined as binary *ONE* and the other as binary *ZERO*.

The binary condition of the core is detected during readout by a sense winding. For the readout operation, a current pulse is passed through the activating line. If the current direction during readout is the same as that which was required to "set" the core, the core state remains unchanged and there is no major flux change to induce a voltage in the sense winding.

However, if the readout current pulse is in the opposite direction, the core changes state and the resulting flux change induces a detectable voltage pulse in the sense winding. The amplitude of this voltage pulse indicates the original binary state of the core.

This readout method is inherently destructive in that the sense of the core is changed. When it is necessary to retain the original sense of the information stored in the core, a "rewrite" circuit resets the core to the original state when the readout action has been completed.

Cores For Logic

Recent developments in the use of multiaperture devices (*MAD*) have not only led to nondestructive readout, but have also permitted use of magnetic devices in logical operations such as *AND-OR* and *NOT* circuits. Fig. 2 shows the basic *MAD* which can be considered as a magnetic core with two apertures cut in the wall, an input and an output aperture.

MAD can provide certain logical functions such as the *OR* and the *AND* functions. Elements with more complex aperture configurations can yield more complex logical functions.

Coincident Current Selection

The principle of coincident-currents is used to select individual cores within a large array of magnetic cores. When a current of magnitude I is required to set a core to one of its two states, a current of magnitude $I/2$ will not cause a change of state.

Therefore, a single core can be selected from an array of cores by activating two wires, each carrying a current pulse of magnitude $I/2$. Fig. 3 shows this technique applied to a core array. Only the core which simultaneously receives the current pulses from both of the activated lines will be set. All the other cores in the array will retain their original settings.

Current Steering

Current steering techniques, which provide the coincident half currents for storage systems and core arrays, permit scanning of core arrays in a desired order. Fig. 4 shows a section of a current distributor designed to scan memory cores in a predetermined order.

An all-magnetic biphase driver alternately activates lines *A* and *B* to provide the input signals to the distributor. The loads designate particular memory cores.

With switch core *X* initially set, the first pulse from Drive *A* resets switch core *X*. This reset action steers a current pulse to load cores on the *X* line. This same reset action also sets switch core $X + 1$ by means of the winding which links core *X* with core $X + 1$.

The succeeding current pulse of line *B* resets $X + 1$. This action steers a pulse to the load on line $X + 1$ and, by means of a linking winding, sets $X + 2$. Alternate pulses on the two driving lines repeat these actions and continue them through the distributor matrix.

In general, the currents steered to the load cores are half-select currents with the other coincident half currents generated by a similar distributor or as the result of some other logical action within the computer.

Cores For Computing

Basic to the new all-magnetic computing devices is the accumulator. It sets an additional storage core for each incremental input. Fig. 5 shows an

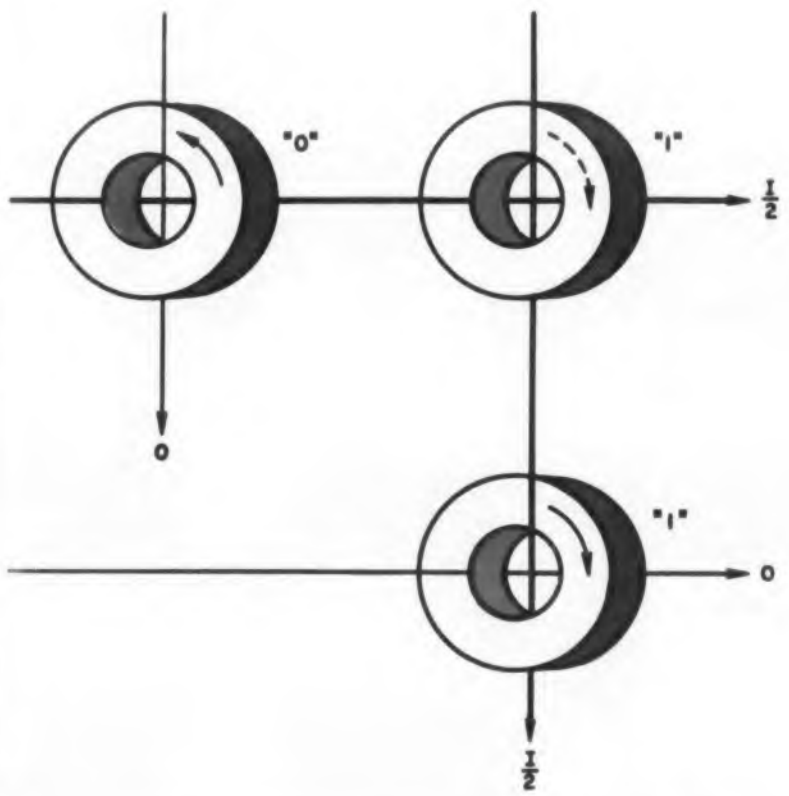


Fig. 3. Coincident half-currents are used to select an indiviual core in an array.

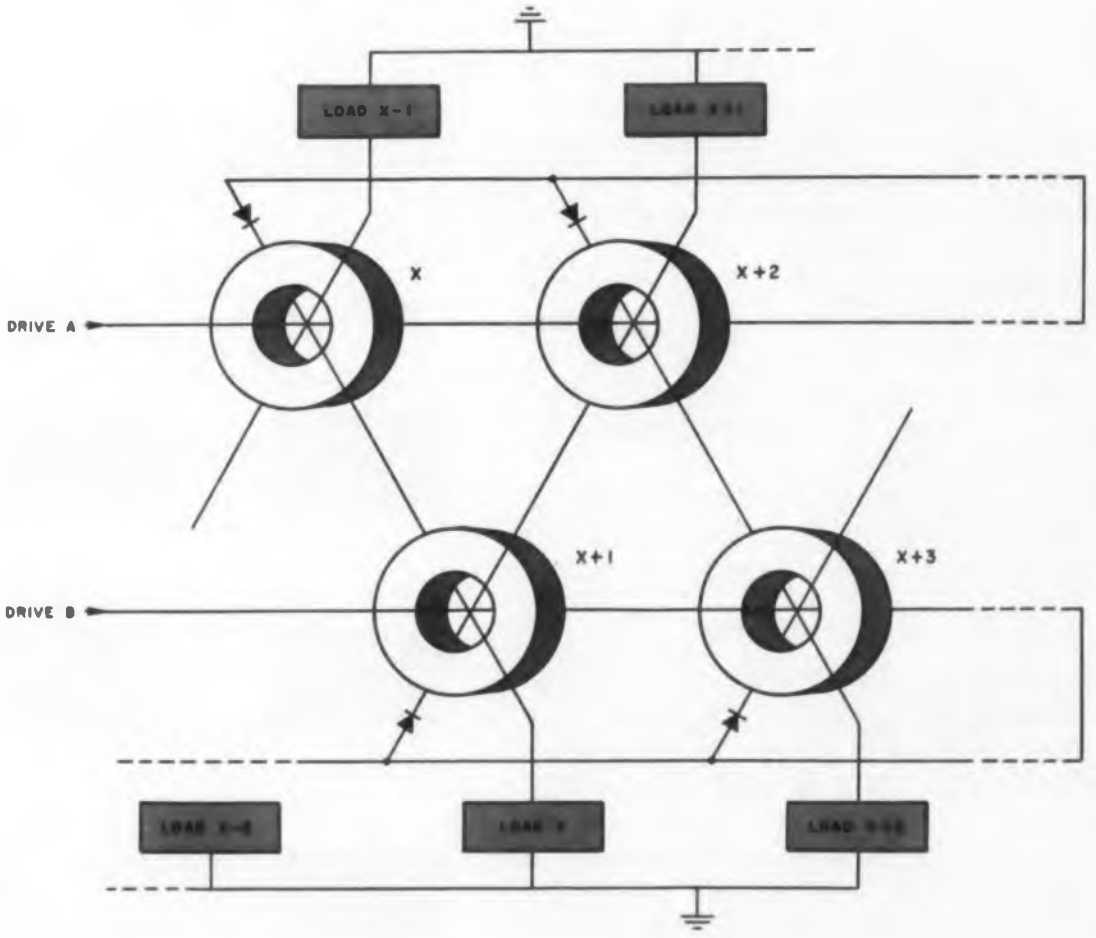


Fig. 4. Section of a current distributor designed to scan memory cores in a predetermined order.

accumulator which has stored *n-1* pulses. To add an additional increment, the *select* line is activated and the current distributor sequenced through the cores which constitute the accumulator.

The combined action of pulses on the *select* line and the line from the current distributor drives the cores in the *set* direction. Those cores that have already been set afford no flux change, and no output appears on the sense winding.

However, the first unset core (core "*n*" in this case) which sets, adds an increment, and produces a pulse on the *sense* line. This output pulse inhibits the *select* line pulses so no additional cores are set.

Cores For Adding

This incremental adding operation is extended to form the basis for adding the contents of two accumulators in a summing function. Consider two accumulators, each containing an accumulated value with a corresponding number of cores set.

The sum of the two values is formed by adding increments to one of the accumulators from the other until the number added to the first equals the number contained in the other. This is done by counting or accumulating the contents of one accumulator in an external accumulator-register and then counting this register back into the other accumulator.

The number of increments added to the accumulator holding the sum is controlled by gating the *select* line "off" when the external register has been emptied.

This summing technique requires that the accumulator used to form the sum have a capacity equal to or greater than the largest sum to be formed. While, at first, this type of summing might seem to have limited usefulness, there are several applications where it can be used to simplify a computing system.

The technique is ideal for cases where the accumulators must be monitored and actions taken when a certain level is reached. This condition, common in many process control systems, requires that only one core (showing the accumulated sum) be monitored.

When the count reaches the critical level and the monitored core is set, the output pulse on the *sense* line starts the necessary control procedure.

Cores For Comparison

A slightly altered configuration makes it possible to compare the contents of two accumulators so as to choose the accumulator with the larger or smaller number in it. If the *select* lines of both accumulators are activated concurrently, the accumulator with the smaller number generates a *sense* pulse first. This technique may be extended to several accumulators so the maximum value of a desired quantity may be determined for a given time interval or for consecutive, overlapping time intervals.

An arrangement of accumulators similar to a series of decade counters can count and perform summing operations on large numbers. For example, counts up to 10^n are represented by *n* accumulators of 10 cores each. An overflow in a least-significant-digit counter causes an increment to be added to the next higher significant-digit counter and also clears the counter for the next incremental input.

Fig. 6 shows the representation of two numbers in terms of decimal coefficients. Each coefficient is contained in a ten-core accumulator. The block diagram indicates the sequence of steps in the summing operation, including consideration of sign.

Fig. 7 shows the steps taken in adding the corresponding decimal coefficients of each number. In the example shown, the subscript "*i*" refers to the digit position starting with *0* for the least significant digit, and *2* represents the most significant digit. Subtraction, of course, involves taking the complement of one of the coefficients stored in the accumulators. Conveniently, the comple-

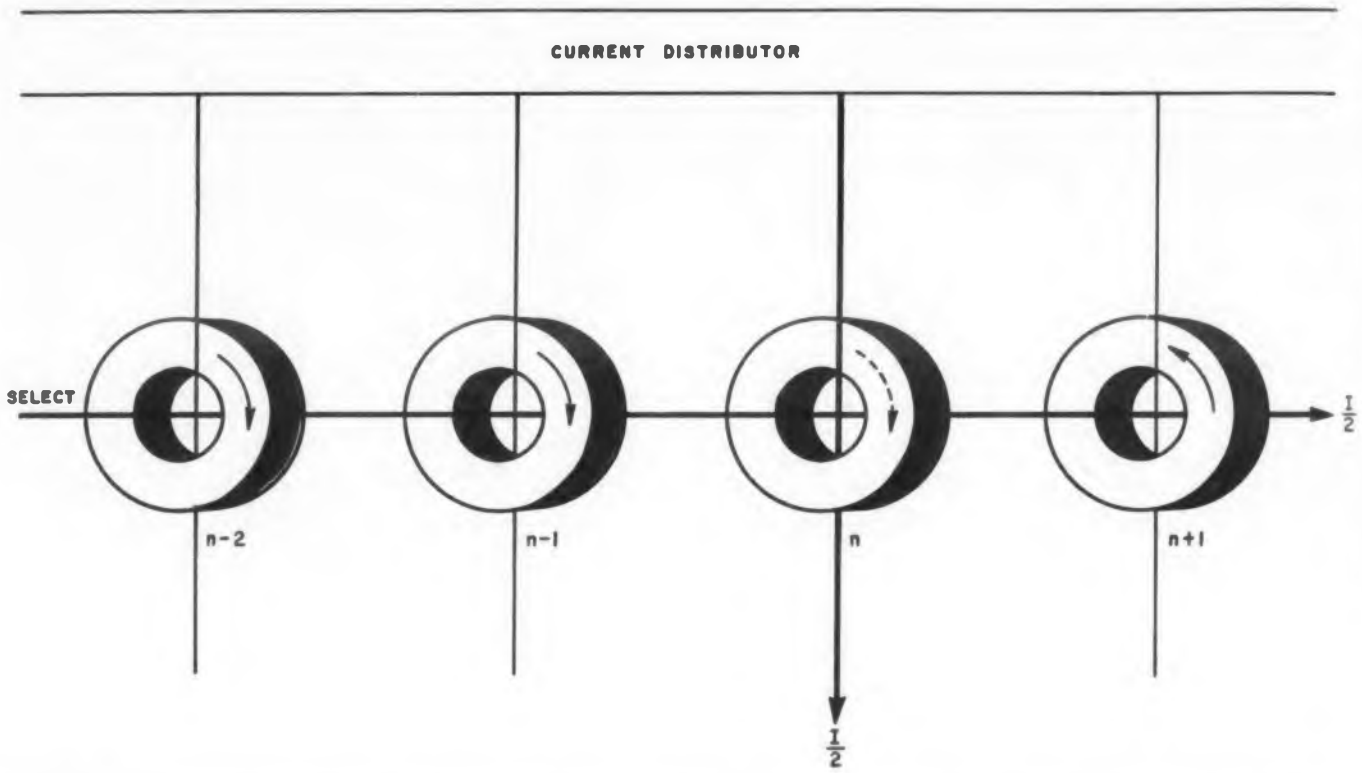


Fig. 5. An accumulator which has stored *n-1* pulses. To add an increment, the select line is activated and the current distributor sequenced through the cores which constitute the accumulator.

$$X = \pm(X_2 \cdot 10^2 + X_1 \cdot 10^1 + X_0 \cdot 10^0)$$
$$y = \pm(y_2 \cdot 10^2 + y_1 \cdot 10^1 + y_0 \cdot 10^0)$$

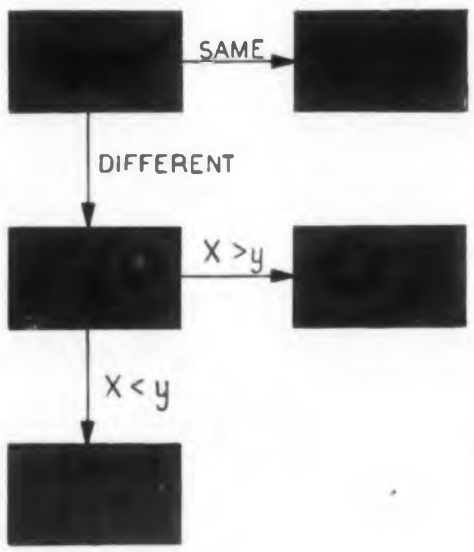


Fig. 6. (left) The sequence of steps used in summing the two numbers shown. Each decimal coefficient is stored in a ten-core accumulator.

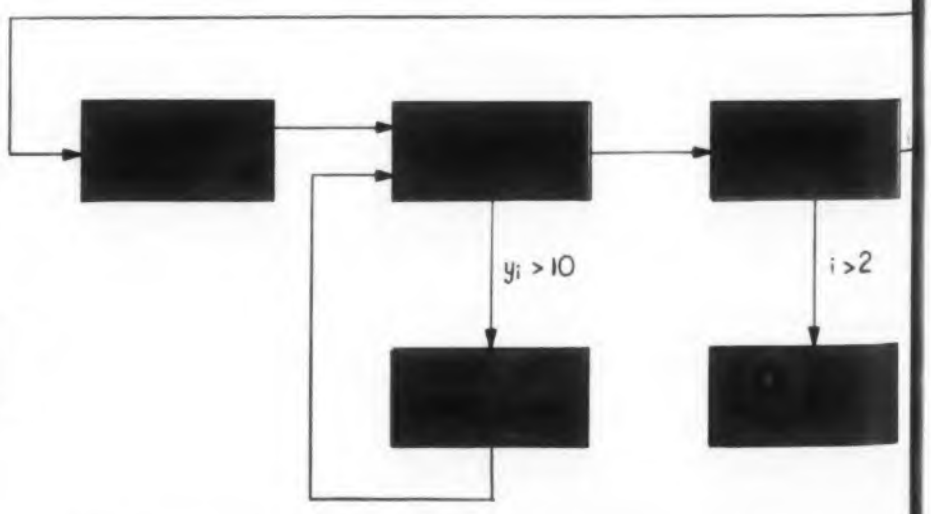


Fig. 7. The steps taken in adding the decimal coefficients of the two numbers shown in Fig. 6. The subscript "*i*" refers to the digit position starting with O for the least significant digit; 2 represents the most significant digit.

ment of the number stored is equal to the number of unset cores in the accumulator.

The use of accumulators containing less cores than the current distributor provides a versatile method of scaling. For example, assume that a time input of one pulse per second is to be processed to generate pulse rates of one pulse per minute. If the current distributor has 10 positions, the first accumulator will be of length *10* and the second of length *6*.

Carries from the first accumulator will appear at six pulses per minute. Carries from the second accumulator will appear at one pulse per minute. In general, the carry output rate of an accumulator used as a scaler is R/n where R is the output rate, and n is the length of the accumulator.

Cores For Amplifying

Until recently, most amplifying actions within computers and data processors were carried out by vacuum tube or semiconductor devices. However, amplification can be carried out by all-magnetic core devices with a large increase in reliability.

Fig. 8 shows a three stage amplifier consisting of three cores. The original signal sets the first core. A clock pulse applied to this core resets the core and generates a pulse in the winding which links the first core with the second core. The second core is either a physically larger core or such a combination of standard size cores that the pulse produces a greater amount of flux than existed in the first core.

A second clock pulse resets the second core and generates a setting pulse for the third core. Again, an increase in actual core size, or in the number of cores combined to form the third core, results in a higher flux in the third core.

A third clock pulse resets the third core and generates an output pulse which is larger than the initial low-level signal pulse by a factor equal to the product of the gains obtained in each core. In these "flux pumps" the energy delivered by the clock pulse is analogous to the dc energy supplied to conventional vacuum tube amplifiers.

These "flux pumps" deliver power gains in the neighborhood of four per stage with outputs of twenty volts at several hundred milliamperes. This is more than enough to drive a large core-storage array.

Efficiency of each stage is computed by dividing the energy in the output pulse by the energy required to set and reset the core. For example, Fig. 9 shows a single stage core amplifier where the input, clock, and output windings have the ratio of 1:5:4.

The input winding sets the core with an energy of one unit. The clock winding resets the core with an energy input of five units, and the output winding delivers four units. This results in an overall efficiency of two-thirds and a gain of four.

Cores With Feedback

An interesting combination of core amplifiers and feedback forms the basis of the biphase driver of Fig. 10. This all-magnetic device behaves much like a conventional triggered flip-flop. Under repetitive driving signals from clock pulses, the biphase driver alternately activates one of two lines driving separate loads. This is comparable to a flip-flop receiving repetitive impulses and alternately assuming one of its two stable states.

Each core in Fig. 10 represents a core amplifier. The winding matrix is designed so that core *A1* can activate core *A2*, core *A2* can activate *A3* and the output signal from core *A3* drives the load on phase *A* and also activates core *B1*.

The relationships between the *B* cores are the same as those between the *A* cores. The output of core *B3* is fed back to activate core *A1*. Phase *1*, *2*, and *3* clock pulses are supplied in repeating sequences. Each sequence of three clock pulses results in an output pulse imposed alternately on each of the two output lines. ■ ■

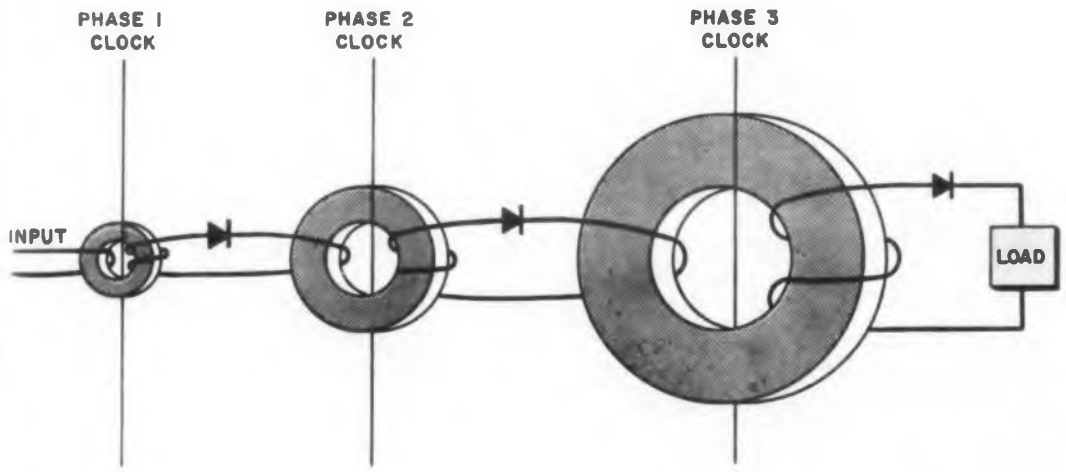


Fig. 8. (above) A three-stage core amplifier.

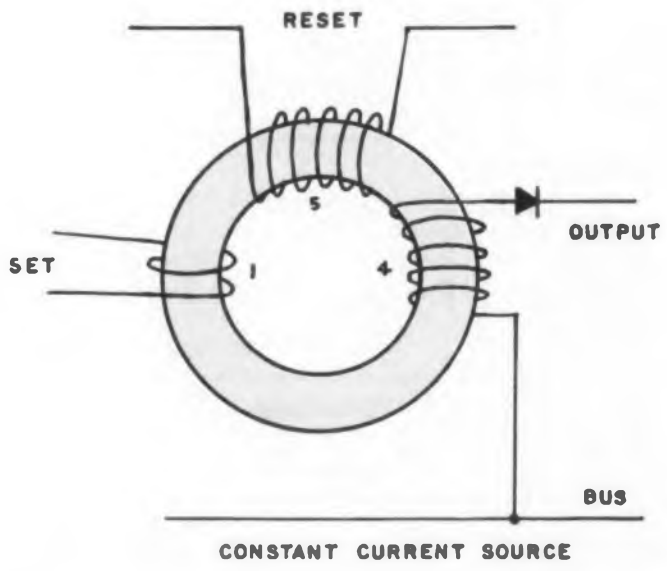


Fig. 9. (right) A single-stage core amplifier.

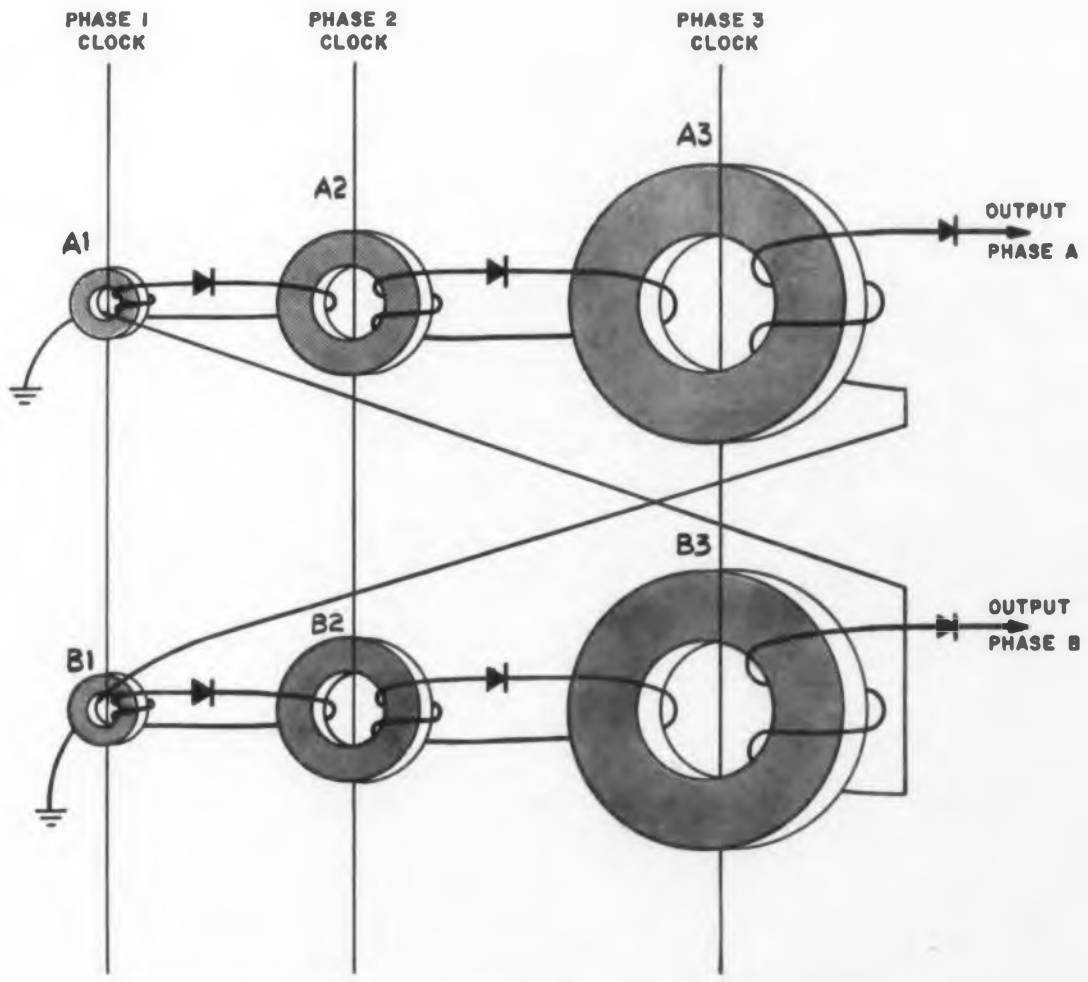
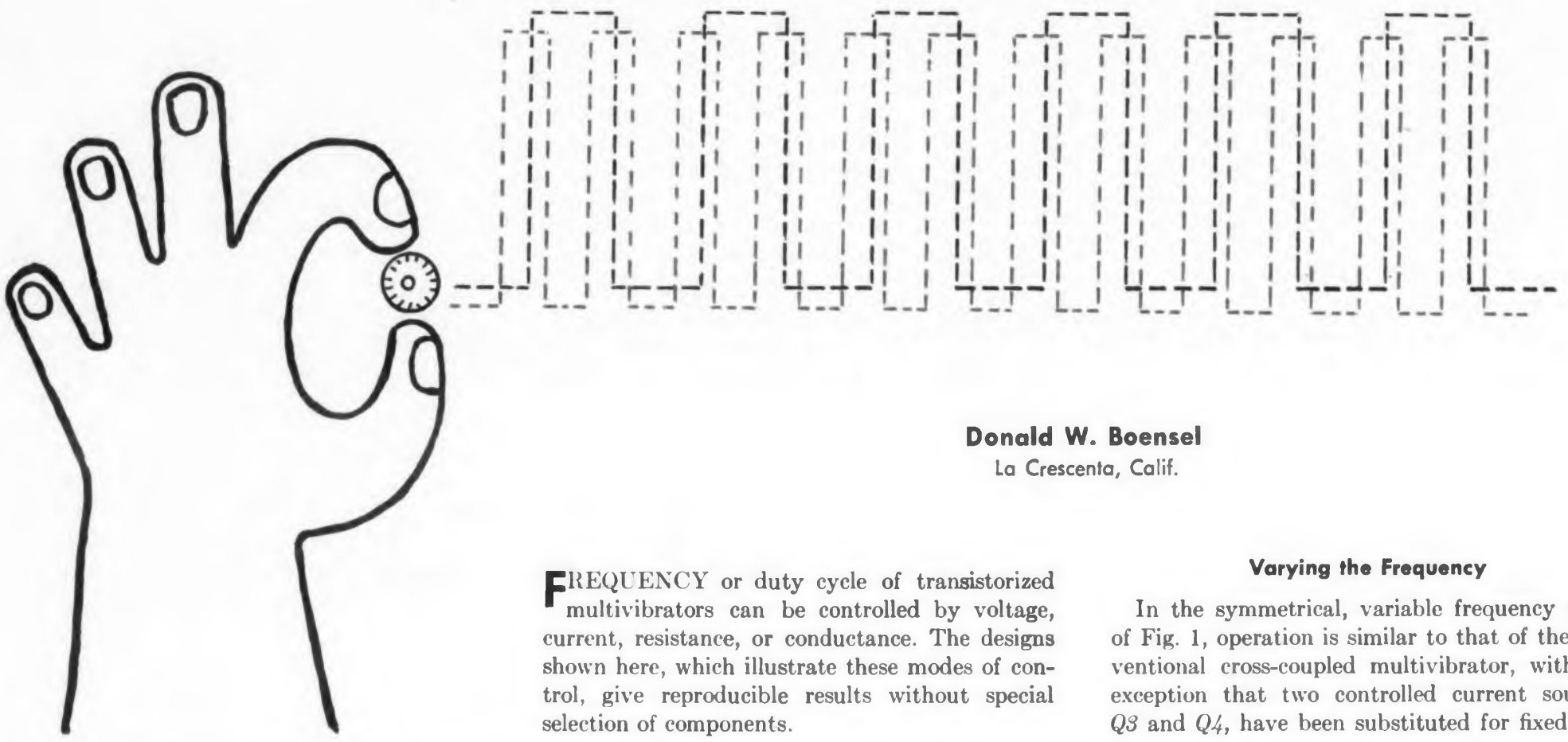


Fig. 10. An all-magnetic counterpart of a conventional triggered flip-flop.

How to Control Transistorized Multivibrators



There's more than one way to control a multi. Author Boensel shows the basic methods here.

Donald W. Boensel
La Crescenta, Calif.

FREQUENCY or duty cycle of transistorized multivibrators can be controlled by voltage, current, resistance, or conductance. The designs shown here, which illustrate these modes of control, give reproducible results without special selection of components.

Varying the Frequency

In the symmetrical, variable frequency multi of Fig. 1, operation is similar to that of the conventional cross-coupled multivibrator, with the exception that two controlled current sources, *Q3* and *Q4*, have been substituted for fixed base

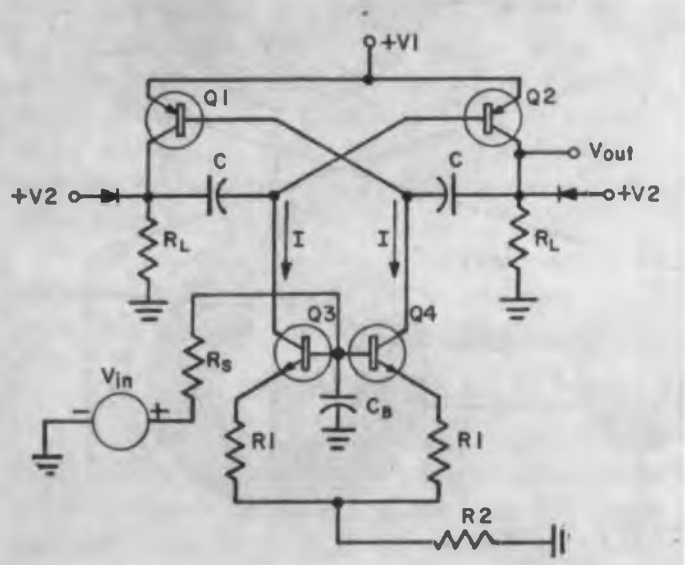
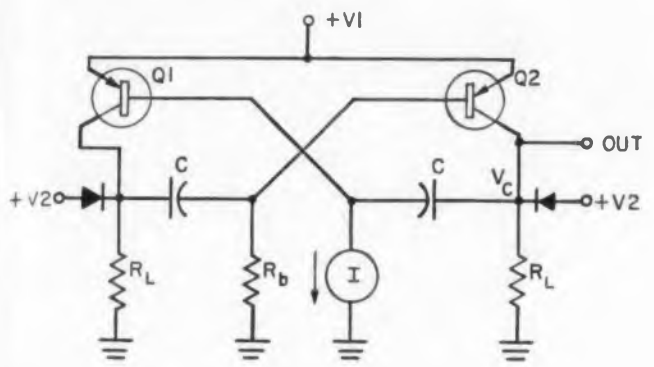


Fig. 1. Frequency of this multivibrator is controlled by two controlled current sources, *Q3* and *Q4*.

Table 1. Multivibrator Frequency Control With Circuit of Fig. 1.

		Type of Control			
		Voltage	**Current***	**Resistance**	**Conductance**
Duty-Cycle		$\frac{1}{2} - \Delta V_{IN}\left(\frac{R2}{4\ R1\ V_{CR2}}\right)$	$\frac{1}{2} - \frac{\Delta V_0}{2\ R1\ I_{IN}}$	$\frac{1}{2} - R\left(\frac{\Delta V_0}{4\ R1\ V_{CR2}}\right)$	$\frac{1}{2} - G\left(\frac{\Delta V_0\ R2}{4\ V_{CR2}}\right)$
Possible Parameter Constraints	V_{IN}	Variable	Fixed $V_{IN} = V_{REF} + \Delta V_0$	Fixed $V_{IN} = V_{REF} + \Delta V_0$	Fixed $V_{IN} = V_{REF} + \Delta V_0$
	R_S	$<< \beta_3\ (2R1)$ $<< \beta_4\ 2R1)$	≅ Zero	≅ Zero	≅ Zero
	R1	Fixed	Fixed	Fixed	1/G
	R2	Fixed	Essentially Infinite*	R	Fixed

* I_{in} is injected at the junction of the two *R1* resistors. Bases of Q3 and Q4 are grounded.



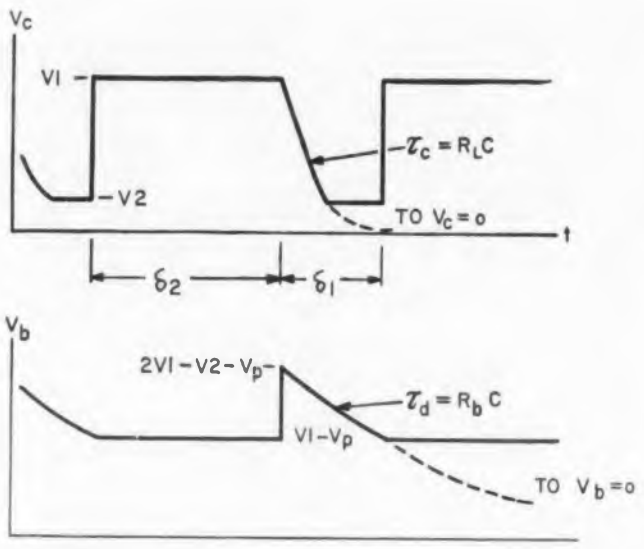


Fig. 2. Circuit and waveforms of a basic variable duty cycle multivibrator. (A) (above) Control of one base current sources varies the duty cycle of this multi. (B) (right) Collector and base voltage waveforms.

return resistors. Transistors *Q3* and *Q4* are operated in common base connections with respect to the bases of the multivibrator transistors *Q1* and *Q2*.

This mode of operation is satisfied for transient as well as static conditions when source resistance R_s fulfills the requirement:

$$R_s \begin{cases} << \beta_3 (R1 + R2) \\ << \beta_4 (R1 + R2) \end{cases}$$

and the value of by-pass capacitor C_B is much greater than the collector to base capacitance of *Q3* or *Q4*.

The four general possibilities for control in this type of circuit are listed in Table 1, with appropriate constraints on parameters, and with the frequency relationships to be expected in each case. Note that the relation is essentially independent of transistor parameters because the oscillator transistors work as switches and the control transistors function as stable common-base current amplifiers.

Varying the Duty Cycles

The general method of control can also be applied to the variable duty cycle circuit of Fig. 2. The constraints for the four control variables are identical to those given in Table 1, except that they apply to only one control transistor rather than two.

More interesting from a design standpoint is the circuitry of the linear duty cycle circuit in

Table 2. Multivibrator Duty-Cycle Control With Circuit of Fig 3.

		Type of Control			
		Voltage	**Current***	**Resistance**	**Conductance**
Frequency		$\frac{V_{IN}}{2C\,(V1-V2)\,(R1+2R2)}$	$\frac{I_{IN}}{4C\,(V1-V2)}$	$\frac{KR}{2C\,(V1-V2)\,(R1+2R2)}$	$\frac{G\,V_0}{2C\,(V1-V2)}$
Possible Parameter Constraints	V_{IN}	V_{IN} (Variable)	Zero	$V_{IN} = KR$ (Potentiometer Type)	Fixed at V_0
	R_S	$<< \beta_3 (R1+R2)$ $<< \beta_4 (R1+R2)$	Zero	$\cong R << \beta_3 (R_1+R_2)$ $\cong R << \beta_4 (R_1+R_2)$	$\cong$ Zero
	R1	Fixed	Fixed (Equalizing)†	Fixed	Fixed R1 << R2
	R2	Fixed	Essentially Infinite	Fixed	1/G

* Transistor Q5 and its associated circuitry are replaced by I_{in} which is injected at the junction of the two *R1* resistors.
† Equalizing emitter resistors split I_{in} equally between Q3 and Q4.

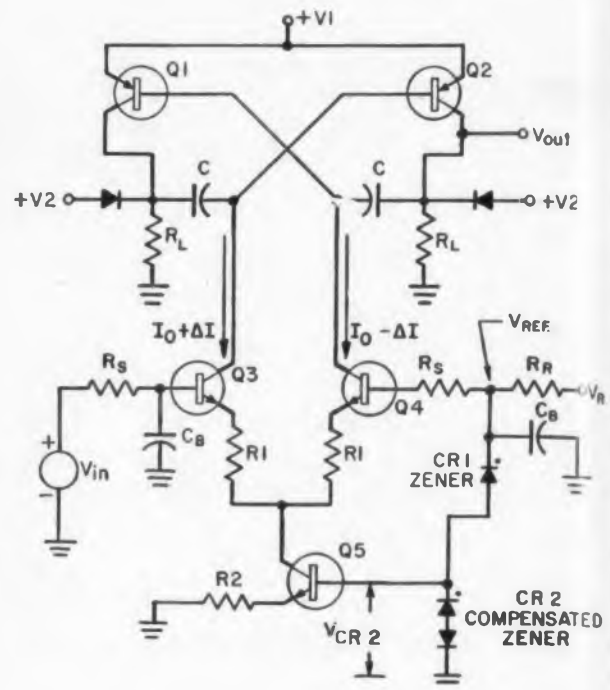


Fig. 3. A differential amplifier controls this linear duty cycle multi.

Fig. 3. Again the basic circuit is similar to Fig. 1, except for the differential method of control current injection. The differential amplifier uses *R1* for emitter degeneration, and a regulated current source return consisting of *R2*, reference Zener *CR2*, and *Q5*, at the differential current node. In addition, an equalizing resistor R_s, equal to the source resistance, is included in the base of reference transistor *Q4*. As before, both bases are bypassed to assure common-base operation for transients. To ensure this condition for static operation as well:

$$R_s \begin{cases} << \beta_3 (2\,R1) \\ << \beta_4 (2\,R1) \end{cases}$$

in which case the differential output current is given by:

$$\Delta I = \frac{\Delta V_{in}}{2\,R1}$$

and the duty cycle is:

$$\Delta = \frac{1}{2} - \frac{\Delta V_{in}}{4\,I_0\,R1}$$

Where I_0 is determined by the relation

$$I_0 = \frac{V_{CR2}}{R2}$$

Table 2 gives circuit constraints and duty cycle relations for the circuit of Fig. 3.

Conductance Control in a Telemetering Oscillator

The telemetering oscillator in Fig. 4 has an output frequency directly proportional to tempera-

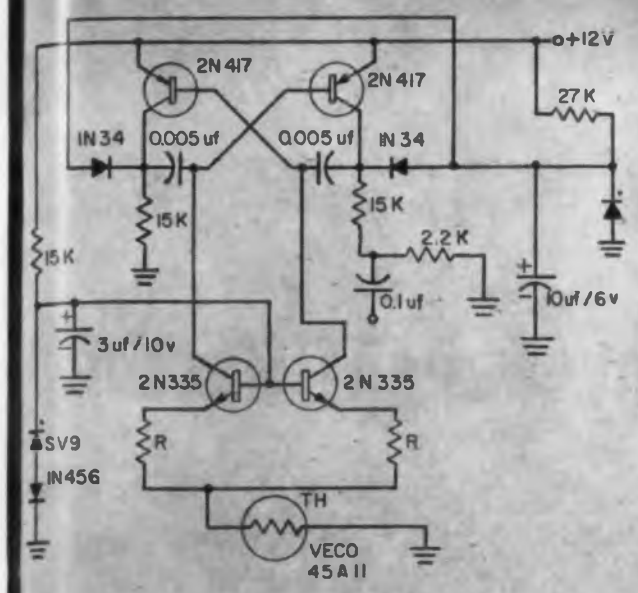


Fig. 4. Output frequency is proportional to temperature in this telemetering oscillator. Resistance *R* is made twice the value of the thermistor resistance at 25 C.

ture. Its linearity stems from the series thermistor-resistance network having a conductance which varies linearly with temperature over a reasonable range. This circuit changes frequency from about 550 cps at −5 deg C to approximately 1300 cps at + 35 deg C, with combined linearity and stability of less than one per cent.

Since this oscillator is required to operate from −10 to +40 deg C, the only compensation necessary is the 1N456 silicon diode in the reference supply. It compensates for changes in the emitter-base voltages of the 2N335 current source transistors.

For operation at temperatures above 40 C, drift can be minimized by the use of low temperature coefficient Zeners, by compensating for clamp diode drift, and by using silicon transistors throughout. The transistors should be operated with minimum control currents much greater than the maximum expected leakage currents.

If it is necessary to use germanium transistors, low leakage can be assured by placing silicon diodes in series with the transistor emitters.

The high frequency limitation of this circuit is imposed primarily by the switching speed of the oscillator transistors. A frequency of 15 kc can be obtained with no degradation in performance by changing only the cross-coupling capacitors. ■■

Acknowledgment

I would like to convey my thanks to members of the Lytech Corporation, Inglewood, Calif., for assisting and supporting the work described in this paper.

Designing Waveguides for Investment Casting

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What the Investment Casting Process Is . . .

Investment casting . . . the "lost wax" process . . . precision casting . . . are different ways of describing the same process, with investment casting the most commonly used name. It is a process whereby wax patterns are joined together in clusters, dipped into a slurry-like refractory material, and placed in a flask. The flask is then filled with additional refractory material and baked in an oven. This hardens the refractory material and melts out the wax, leaving a cavity. Next step is to fill this cavity with molten metal in whatever composition is desired. Chief advantages of the process are design flexibility, better tolerances than other casting methods, and the ability to make shapes that are too complex to be machined, and in materials that are too tough to be machined.

THE CLOSEST practical tolerance a competent investment caster can hold is ±0.005-in. per inch, and a tolerance of plus or minus 0.010-in. per inch is even better and more economical. However, if a waveguide is extremely small, it often can be held to finer tolerances in one or several dimensions. The normal limit is plus or minus 0.004-in. on the waveguide opening.

If closer tolerances are needed, it is possible, if they are in a spot which can be machined, to finish-machine them to the exact dimensions specified.

Frequently, though, in the case of waveguides, these surfaces may be in areas which are impossible to machine. In this case it is quite conceivable that the desired electrical properties can be obtained without the need for such fine tolerances.

It is especially important to remember that the finer the tolerances the greater the cost per part, so it is just common sense to call for extremely close dimensions only on those surfaces which require them.

Investment casting foundries do not request wider tolerances to make the job easier for themselves. Rather, they have realistically analyzed the basic nature of the casting process . . . the inherent shrinkage factor in the expendable patterns and the cast metal itself . . . the differences caused by the slightest changes in pouring temperature or oven position, as well as other factors. Having analyzed all these, the caster tries to arrive at a compromise between close tolerances and low cost.

While it's true that these variables can be controlled to a very great extent, the price of perfect control would be exorbitant, for each variation accounts for some little bit of the total tolerance. Fig. 1 illustrates some limits to be observed when designing for investment casting.

Radii

Where necessary, as it usually is in investment castings, the foundry can produce sharper corners by investment casting than it is possible to get by bending. To equal or exceed the 0.005 to 0.010 deg radii that can be achieved, it would be necessary to go to an expensive broaching process. However, where sharp corners are not strictly necessary, best results and lowest cost can be obtained by specifying as generous a radius as possible.

Straightness

Long, thin parts must be mechanically straightened to obtain a high degree of straightness. Table 1 shows both the as-cast and straightened tolerances you can expect for varying lengths and thicknesses.

Flatness

It takes mechanical straightening to get rid of bow, twist and waviness in typical flat sections. While the tolerances in Table 2 are for flat rectangular castings, they can be applied to any flat waveguide dimension regardless of its irregular shape.

Concentricity

In general, the larger the outside diameter the closer to concentric the foundry can cast an inside diameter. In addition, this makes the part easier to straighten mechanically even though the walls may be heavier. Table 3 gives the amount of eccentricity you can normally expect between I.D.'s and O.D.'s of as-cast parts.

Roundness

The plus or minus 0.005-in. per inch general linear tolerance holds for diameters, but it is possible to do better than this on hollow tubular shapes that can be straightened mechanically after casting.

Angles

As a general rule a designer shouldn't call for angular tolerances finer than plus or minus 1/2 sec of arc. However, if a closer tolerance than this is needed, you may be able to achieve it by mechanical straightening.

Waveguides, the "plumbing" of electronics, are really still very much in the process of development. Investment casting, as a method of producing wave guides, offers certain advantages to the designer. But like the guides themselves, it is fairly new as an industrial process, and many of the techniques of designing waveguides for this process are not familiar to electronic engineers. Hence this article by W. O. Sweeny, on some of the do's and don'ts of designing waveguides for investment casting.

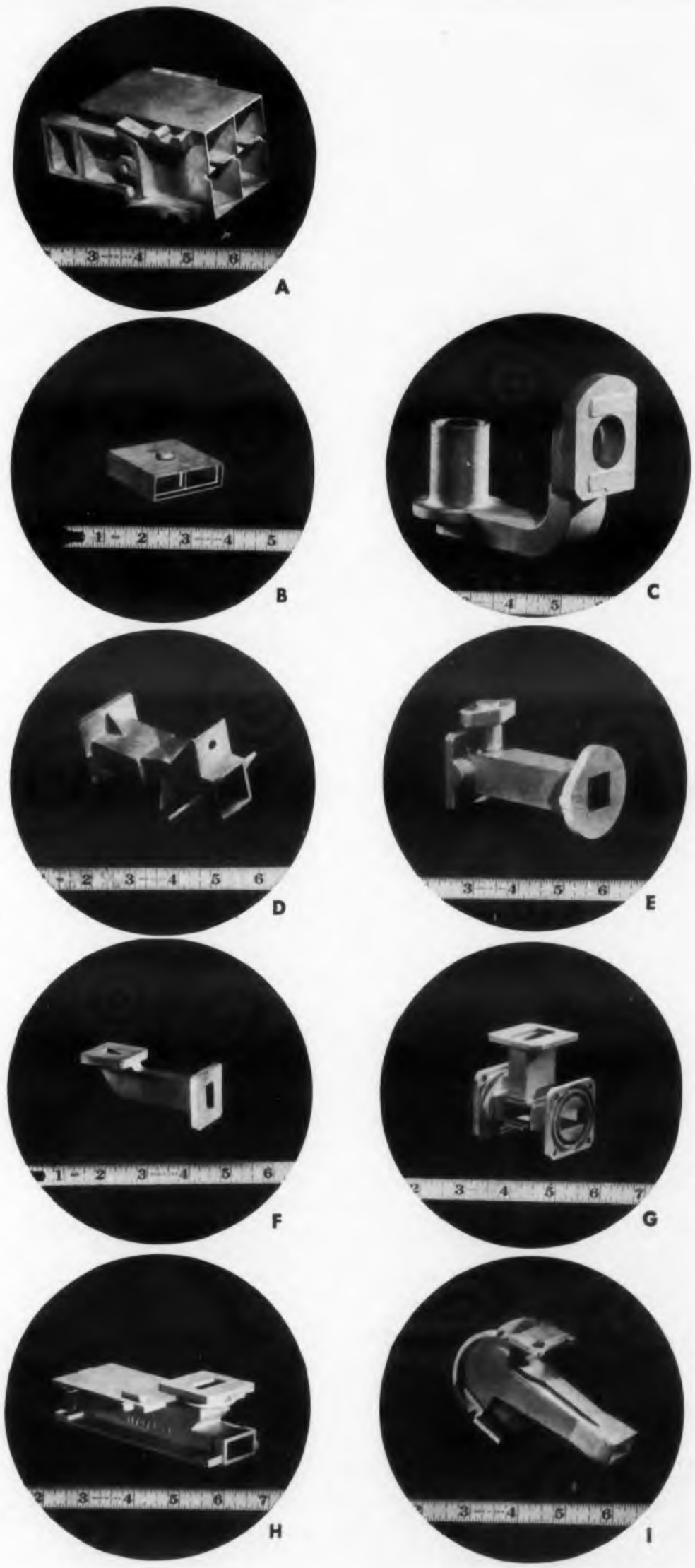


Fig. 1. Design characteristics of investment cast parts.

A. Not a waveguide, but actually a brass tuning mechanism, this part nevertheless demonstrates a basic advantage of the investment casting process as well as a few disadvantages. The part was originally made in three pieces, which were then brazed together. It was then redesigned as an integral unit. Parallelism and straightness of the internal walls were critical, as was the slot. Holding the tolerance on the slot was so unnecessarily costly that the foundry recommended it be machined rather than cast.

B. This is a patented waveguide design perfected by Micro-Wave Development Laboratories, Inc., Babson Park, Mass. Its design is such that it will not lend itself readily to any other means of manufacture because of the complexity of its internal configuration.

C. The gate stubs remaining on the flange of the waveguide indicate that the flange is machined after casting. The thickness of the flange, however, adds distortion, making it difficult to hold tolerances on the waveguide opening. Specifying a thinner walled flange would help improve tolerances and lower machining costs.

D. This is a horn assembly for an antenna on the B-52, and more complex than it looks because, when finished, it contained within it two strips of plastic, which required some unusual production and assembly techniques. The "ribs" are added by the designer because the part has structural as well as electronic functions.

E. The heavy concentration of metal at the end of the casting makes it difficult for the foundry to control the dimension of the opening. This, in turn, makes it difficult to mate flanged parts. Best design practice, where possible, is to keep the mass of metal at a minimum at the ends of the casting.

F. This part was formerly made in five separate pieces and then brazed to form the complete unit. The designer then redesigned the part for investment casting, making it possible to cast the part as a single unit, thus eliminating a number of costly assembly operations.

G. Here is a case where the design of the flanges was thin and simple. This made it possible to lower the cost of the investment casting, which, in turn, made it practical to allow precise machining of the choke grooves and drilling of the bolt holes in the flange.

H. This part was cast in a type 40-E aluminum for ease in brazing, as the design called for it to be brazed to another.

I. Note the complexity of this part. By using the investment casting process to produce it the designer was able to get greater freedom in his design.

Parallel Sections

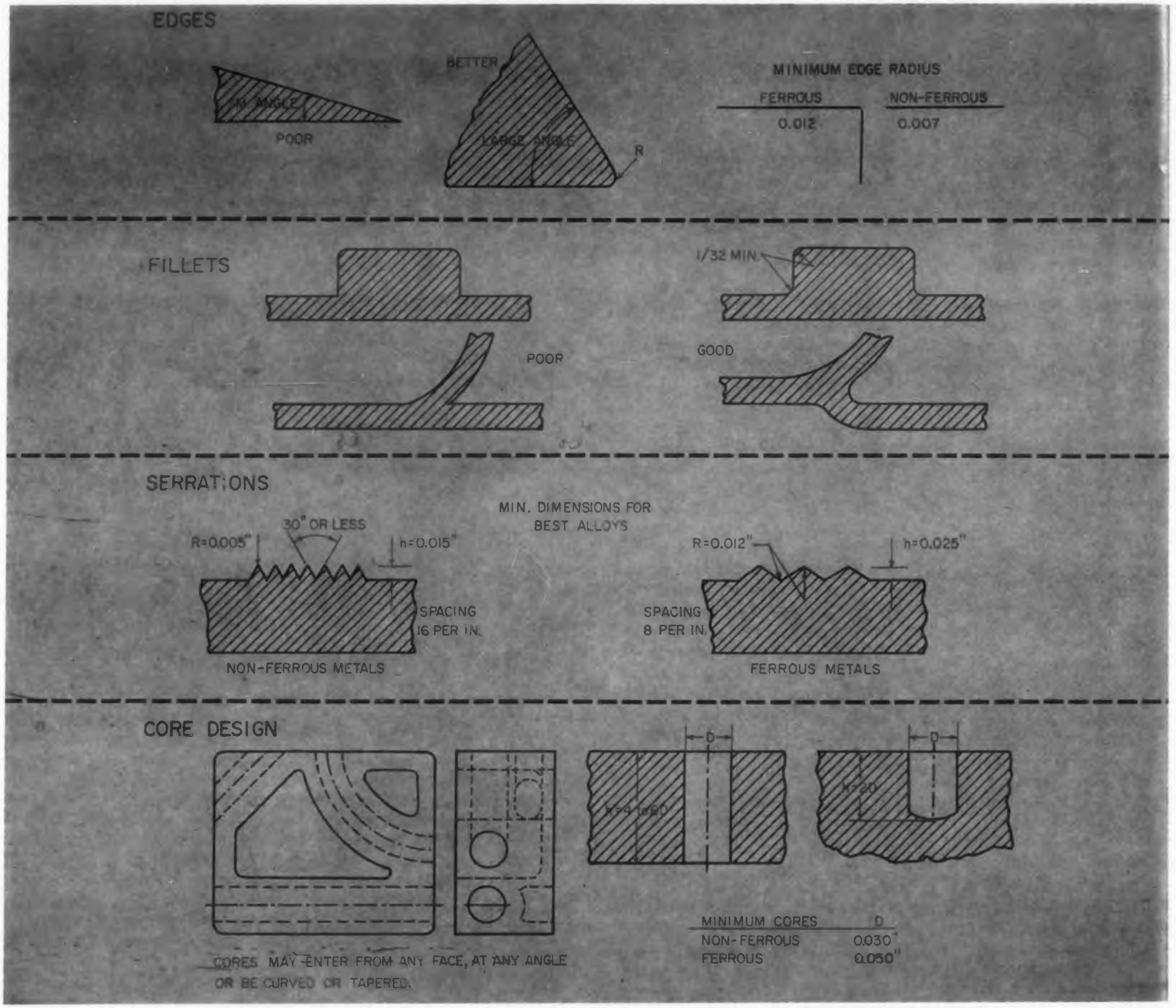
Parts shaped like a tuning fork, with two parallel sections connected at one end, can be cast to within 0.005-in. per inch of parallel. However, if these yoke-shapes are very long, the foundry may have to resort to mechanical straightening to get the tolerance needed. Of course, this tolerance will also depend to a certain extent on the alloy used in the casting—springy and brittle alloys are hard to work. Table 4 shows the actual tolerances that can be achieved.

Holes

The standard dimensional tolerances apply generally to holes. As a matter of fact, investment casting can do a lot of things with holes, up to and including the casting of holes that have greater diameters inside than at their mouths. If a design calls for intersecting holes, we can do this, too, but more easily and cheaply if the design is worked out so that the cores can be withdrawn.

Minimum Section Thickness

The "geometry" of the piece is the determining



factor, of course, but these limits give you a good "rule of thumb":

- limited or tapered areas of low-melting-point alloys can be cast to a thinness of 0.020-in.
- limited or tapered areas of high-melting-point alloys can be cast to a thinness of 0.030-in.
- large areas of low-melting-point alloys can be cast to a thinness of 0.040-in.
- large areas of high-melting-point alloys can be cast to a thinness of 0.060-in.

Surface Finish

This ranges from 63 and 100 rms for nonferrous castings.

Parting Line and Gating

For most applications, the small, fine parting line is not objectionable. However, if it is, let the foundry know about it. It can usually be moved to another area of the casting. The same can be done with gates, although sometimes good casting design makes it necessary to put the gates in certain specific areas. As a general rule, though, they can be shifted to a surface that will ultimately be machined.

Draft

An advantage of the investment casting process is its ability to produce most parts without any draft allowance, although a small amount is desirable for long, extended surfaces to facilitate removal from the die.

Fillets

As generous a fillet as can be granted is desirable. A minimum of 1/32-in. is recommended.

A knowledge of these factors and the effects they have on costs can help the designer of wave guides to use the investment casting process to its fullest and most economical degree.

A wise designer will hold tolerances to plus or minus 0.005-in. per inch only where necessary, opening up these tolerances wherever they are not needed. This permits the foundry to do a really precision job in those areas that are critical.

Frequently, cost savings can be realized and greater accuracy achieved by finish machining a part to very close tolerances.

Perhaps most important of all to a waveguide designer, however, is this: The wise designer of investment cast waveguides will call upon the casting foundry's knowledge and experience. For if the foundry knows what surfaces will be machine finished, what dimensions are critical and other important facts, it can usually produce a better wave guide at less cost to the user.

Following are a group of waveguide parts made by the investment casting process. Making these pieces by methods other than investment casting would have been impractical. ■ ■

Table 1. As Cast and Straightened Tolerances

Length	F. I. R.* as Cast	F. I. R.* Functional
2″ long or less	±.010	±.005
2″ - 4″ long	±.015	±.010
4″ - 6″ long	±.020	±.010
over 6″ long	±.030	±.015

* Full indicator reading.

Table 2. Flatness Tolerances

Length	As Cast	Functional
1″	±.008	±.004
2″	±.016	±.006
4″	±.030	±.010
6″	±.045	±.015

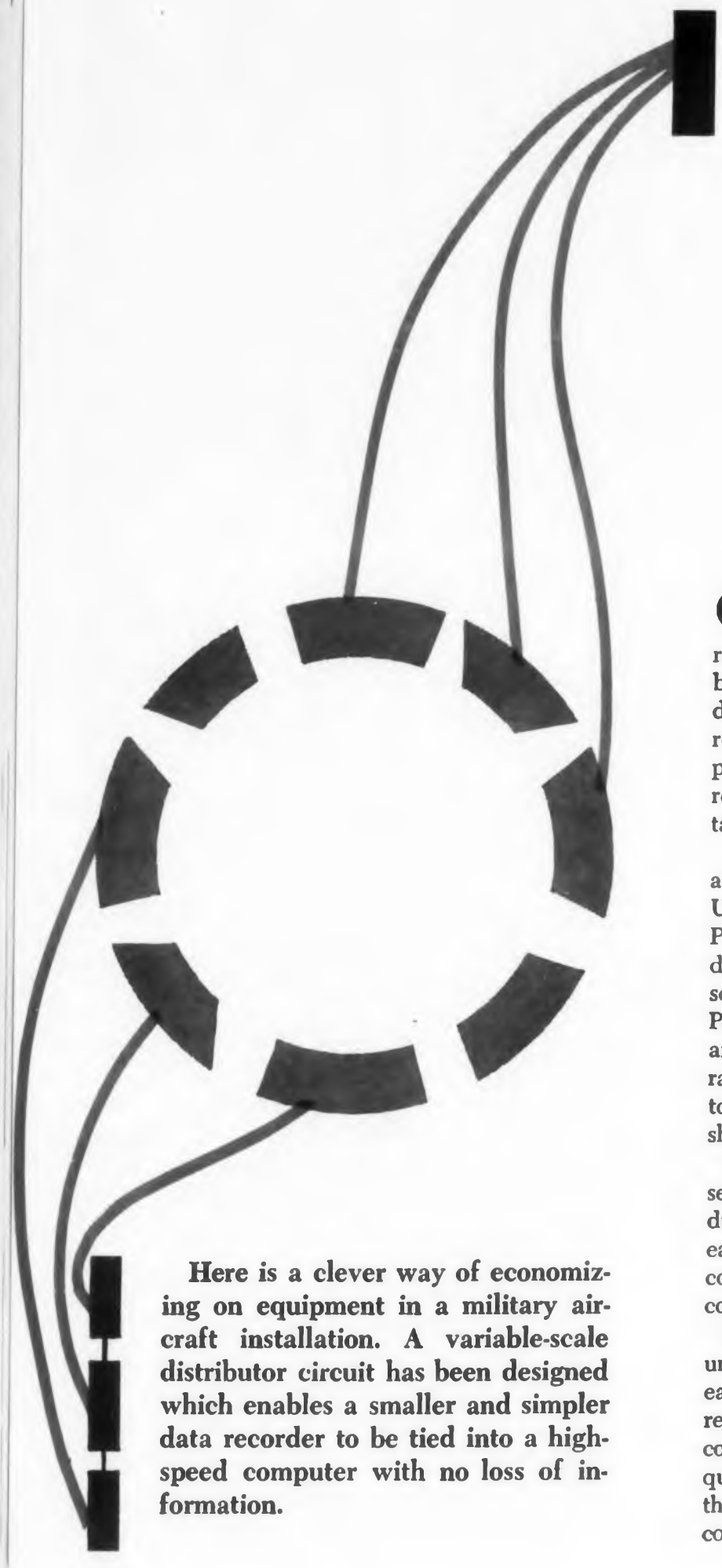
Table 3. Concentricity Tolerances

Outside Diameter	Inside Diameter	F. I. R.* as Cast	F. I. R.* Functional
¾″	¼″	.004	.004
1″	½″	.005	.005
1½″	¾″	.008	.005
2″	1″	.010	.008

* Full indicator reading.

Table 4. Tolerances in Parallel Sections

Distance Between Sections	As Cast	Functional
1/16″	±.003	±.003
⅛″	±.003	±.003
¼″	±.003	±.003
½″	±.005	±.004
¾″	±.006	±.004
1″	±.007	±.005
1½″	±.010	±.007



Sequential Output Selector . . .

Slows Data Transmission

T. J. Boyce
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Here is a clever way of economizing on equipment in a military aircraft installation. A variable-scale distributor circuit has been designed which enables a smaller and simpler data recorder to be tied into a high-speed computer with no loss of information.

GIVEN the problem of recording data transmitted from a high-speed computer into a recorder of limited capabilities, something must be done to reduce speed of transmission of the data to the recorder. The most logical way is to record only one pulse train, or computer word, per computation cycle. Successive pulse trains are recorded one at a time during successive computation cycles.

As part of a project to design and develop an airborne instrumentation system, engineers at the U. S. Naval Air Development Center, Johnsville, Pa., designed an 18 position "distributor." The device consists of logical circuitry that selects sequentially the digital inputs and outputs of a Philco Transac computer. These selected outputs are then presented to the recorder at a reduced rate, that is, well within the recorders capability to receive them. A block diagram of the unit is shown in Fig. 1.

In effect, the distributor, or sequential output selector, blocks all but one of the data pulses during each computation cycle. Thus, during each cycle the computer receives only one digital computer word. During the next cycle, the next computer word is fed to the recorder.

Data pulses are transferred from the computer under the control of the computer program once each cycle, or every 1/30 sec. Binary numbers are recorded sequentially in parallel form, one each computer cycle, by (1) setting the selector to require one pulse more to complete its cycle than the number of data pulses transferred from the computer each cycle, and (2) using coincidence between the selector position and the data position to gate the number into the recorder. The data rate is then reduced by a factor dependent upon the number of data pulses. Fifteen data pulses will result in a 2-cycle output for each bit of information, while 10 data pulses would give a 3-cycle output.

Beam Switching Tubes Used

The sequential selector consists of two magnetron beam-switching tubes connected as an 18-position distributor. A beam-switching tube contains 10 identical arrays of spades, targets, and grids symmetrically located around a central oxide-coated cathode. The spades form and sustain the electron beam, the targets produce a functional pentode-like output, and the grids switch the beam from array to array.

Normally, when the tube is turned on by applying B+ voltage, it will, after warmup, remain in its clear state and there will be no beam formed. The beam may be formed from the cleared condition to any one of the tube's 10 positions by lowering the potential of the respective spade. Spade *1* of tube *1* (Fig. 2) and spade *0* of tube 2 are held at a low potential by *K1* when B+ voltage is applied. Thus, the beam in tube *1* is set in its No. 1 position, which is also the system's No. 1 position, and tube *2* is set in its 0 position.

In the magnetron beam-switching tubes (Burroughs Type 6701) used in this circuit, the odd-numbered grids are internally connected and brought out to an external connection termed

"odd grids." Even-numbered grids are also internally connected and brought out to an external connection termed "even grids." The zero grid of the tube is brought out to an individual terminal.

How It Switches

Assume that the pulse input selector is switched to position 17 and pulses are applied to all grids in parallel except the zero grids. The beam in tube 2 will remain fixed. The beam in tube *1*, however, advances sequentially until it arrives in its 0 position. As the beam in tube *1* moves from position 9 to position 0, the target voltage will rise. This rising voltage triggers transistor *Q-6* (connected to position 9 target), which in turn lowers the zero grid voltage of tube 2 and causes the beam to advance into the system's No. 10 position, which is the No. 1 position of tube 2. As pulses continue, tube 2 is now counting and tube *1* is held in its 0 position. When tube 2 arrives

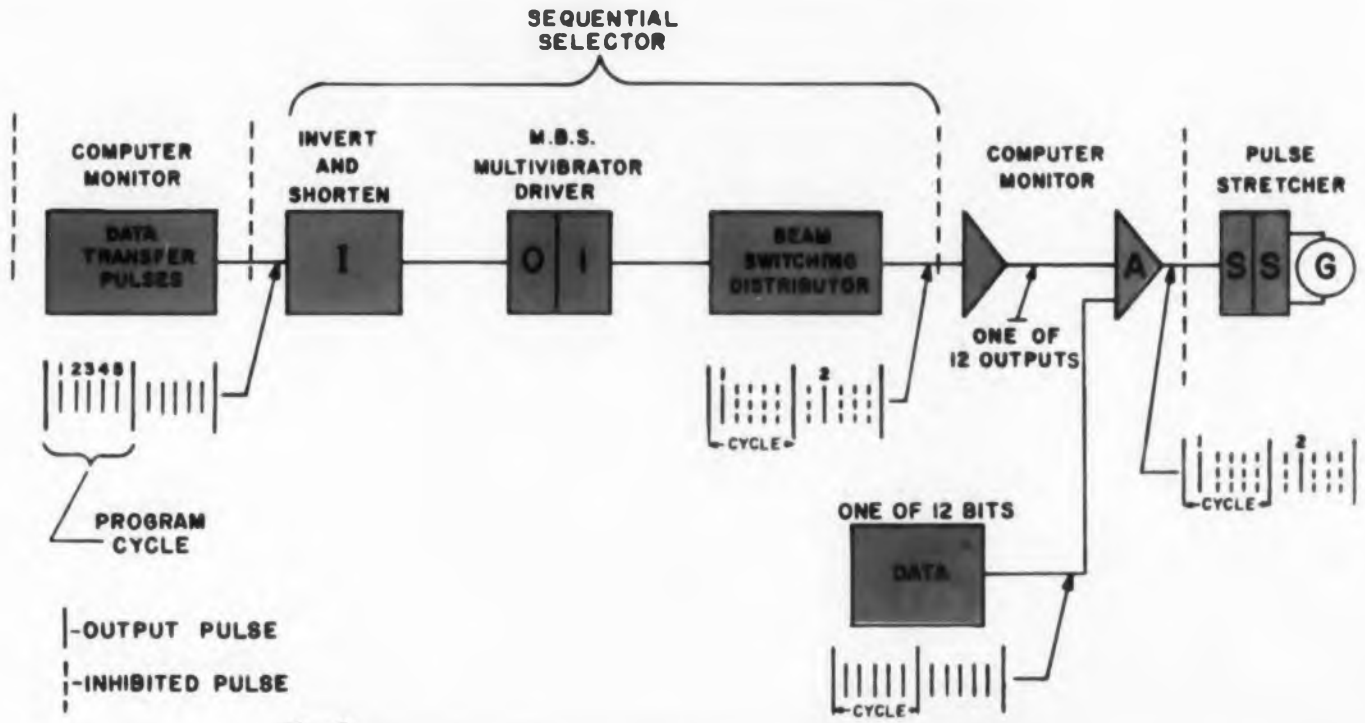

Fig. 1. Operation of the sequential selector designed for military use.

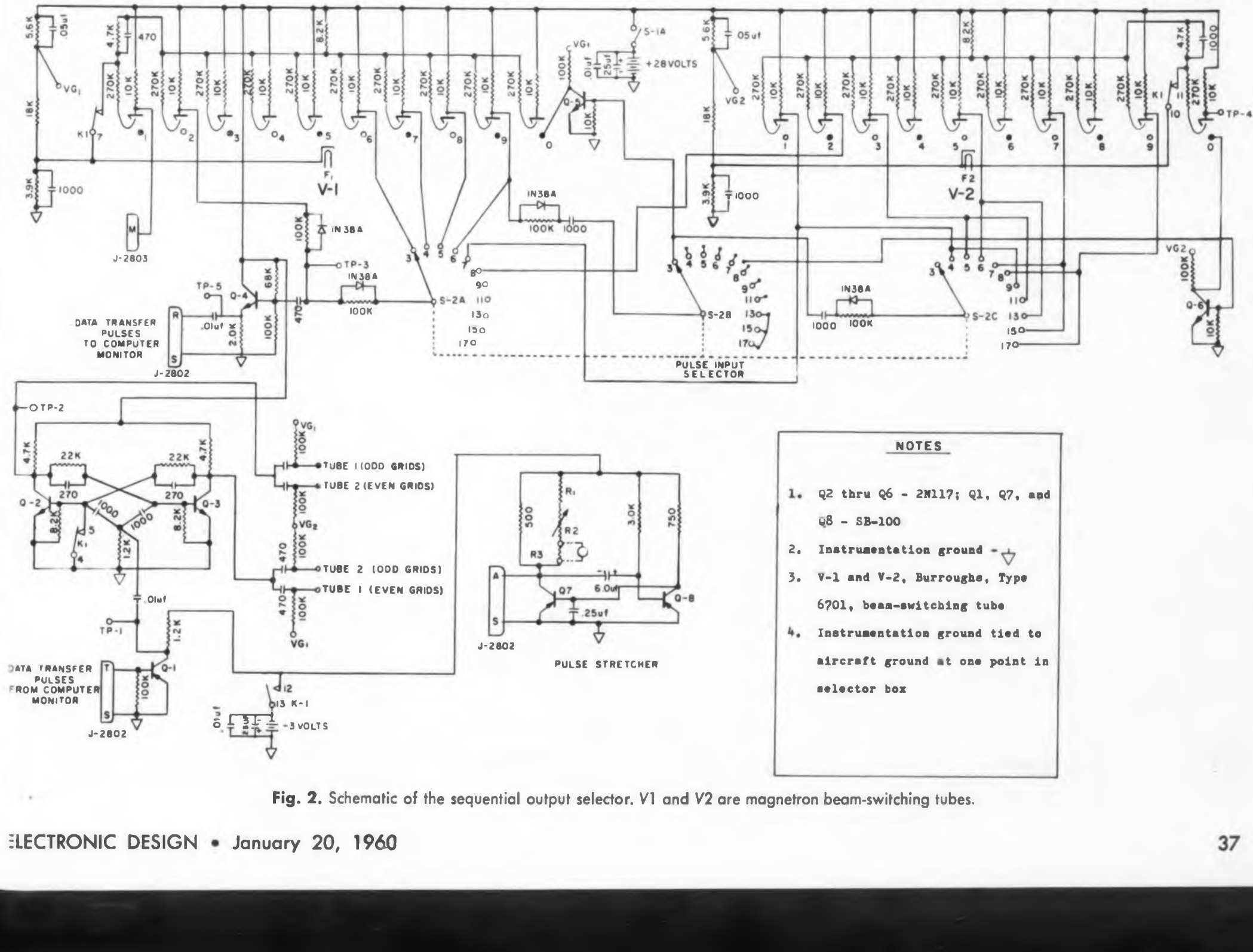

Fig. 2. Schematic of the sequential output selector. *V1* and *V2* are magnetron beam-switching tubes.

at its 0 position, a pulse is developed as before from the rising voltage of position 9 target of tube *2* (the system's No. 18 Position) and is fed back to the zero grid of tube *1* by the action of transistor *Q-5*. This action continues, permitting an 18-position distributor operation.

Any of the targets of the distributor will provide a pulse output as the beam moves through its position. With the pulse input selector on position 17, a buffer amplifier connected to the system's position 2 target, as indicated in Fig. 2, and no other targets connected, 1 pulse out of each 18 provides a pulse output.

If the computer is set to gate out 17 words in each program drum cycle, the distributor pulse input selector switch is set to 17. The data transfer pulses are applied to the distributor input terminals, and the output of the distributor is connected to the coincidence gates which control computer monitor output.

On the first cycle of the program drum, the data transfer pulse associated with the first of the 17 words will move the beam into position 2, the target voltage will drop due to current flow through the target resistor, and a negative pulse will appear at the base of the buffer amplifier, *Q-4*. The negative pulse at the base of *Q-4* decreases the voltage across the emitter-follower output, and a negative output pulse is obtained. This pulse will open the coincidence gates in the computer monitor and permit the first word to be gated out. The distributor is set to require one more pulse to complete its cycle than the number of data transfer pulses transferred from the computer each cycle; therefore, the first data pulse in the second program drum cycle will appear in the first position, and the second data pulse will provide an output at position 2 target. Thus, the distributor is selecting data transfer pulses in sequence, 1 each computer cycle. The computer monitor will then have 17 words gated out to the record equipment in sequence, 1 each computer cycle.

Pulses Are Stretched

The 1-word-per-program cycle gated out of the computer in parallel form is present for only 15 microseconds. Therefore, a single shot multivibrator will be connected to each of 11 lines at the computer output to stretch the word for recording purposes.

Fig. 2 shows a typical 10-millisecond pulse stretcher. In the pulse stretcher circuit, *Q-8* is normally maintained in the saturated state by the base current supplied through the 3 K resistor. The collector of *Q-7* is connected to the collector of the final output transistor in the computer monitor section and is normally near supply voltage. In the computer, a 15-microsecond pulse, representing a binary 1, will trigger the base of

the final output transistor, bringing its collector and the collector of *Q-7* to ground. At this instant the 3 K resistor has impressed across it the sum of the stored voltage in the 6-μf capacitor and the supply voltage. The resultant current through the 3 K resistor commences to discharge the capacitor. The discharge continues until the actual voltage at the base of *Q-8* drops through zero volts to a negative value, thereby turning *Q-8* on again. *Q-7* is held at ground by the base current supplied through the 750-ohm resistor until *Q-8* is again turned on. The collector of *Q-7* is thus at ground for a time determined by the discharge rate of the capacitor through the 3 K resistor. This time is approximately 10 milliseconds, during which current flows through *Q-7* and its associated galvanometer circuit.

A twelfth single-shot multivibrator will be connected to the monitor subprogram output to record the pulse for recorded word identification. If the computer program is set to gate out 15 words per computer cycle, the pulse input selector would be set to 15. The input to tube *1*, zero grid transistor circuit (*Q-5*), is thus transferred to the system's 16th position, and the selector is now a 16-position distributor. In this manner, the selector can be made variable-scale from 18 positions down to 10 positions by selecting the appropriate position on the pulse input selector switch. The effect of a 9-position distributor is achieved by setting the pulse input selector to 8, which converts the sequential selector to an 18-position distributor again with outputs taken from system positions No. 2 and 11. Any number of pulses from 7 through *4* can be accommodated in this manner. When the pulse input selector is at 3, the zero grid transistor circuit of tube *1* is triggered by target 9 of tube *1*. This switches the beam through the 0 position into position 1; since position 1 grid voltage is down, the beam moves into position 2. The result is an 8-position distributor with 2 outputs, which will record 3 words per cycle in sequence.

Other Applications

Circuits and techniques developed on this project should prove useful in other applications. For example, the device could be used to select and gate any one of a series of events, functions, or other data for display and monitoring or for data reduction purposes. The system can be expanded from its present 18-position maxima by adding beam-switch tubes. It can be modified to repeat a selected pulse in a group rather than sequencing the pulses. At present, the system will operate at a pulse repetition rate of 7000 pulses per second with a pulse of 15 microseconds duration. By improving the multivibrator and buffer amplifier circuits, the selector's range could be extended beyond these limits. ■ ■

Some Basic Rules

Handling Nodes And Loops

Two-Port Networks, The Topology Equation

Interpretations And Examples

4

Visual Engineering Mathematics

A Self-Contained Course

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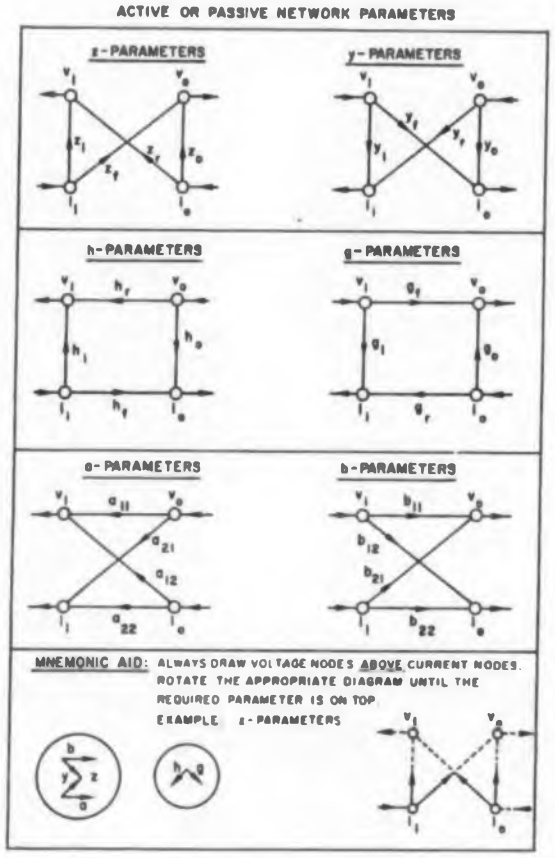
This is the last of four parts on flow graph analysis, a visual form of engineering mathematics. It provides interpretations and examples. The first three parts appeared, respectively, in the December 9, 1959, December 23, 1959, and January 6, 1960, issues of ELECTRONIC DESIGN.

Table 3
ACTIVE OR PASSIVE NETWORK PARAMETERS



HOW DOES one read a flow graph that is given? Take, as an example, the flow graph in Eq. 48 below. It is a two-port network consisting of various nodes and transmittances; this gives the general picture. What does the output current consist of? The flow graph shows, qualitatively, that it consists of a contribution from the output voltage, v_{oe}, and from the input current, i_{ie}. If more detail is required, we can write the equation for the output current by using Rule 6, Table 2.

$$i_{oe} = \frac{v_{oe} \cdot h_{ob}}{\Sigma L} + i_{ie}\left[\frac{-h_{fb}\,(1-h_{rb}) - h_{ib} \cdot h_{ob}}{\Sigma L}\right] \quad (38)$$

where the sum of the loops

$$\Sigma L = 1 - h_{rb} - (-h_{ib} \cdot h_{ob}) - (-h_{fb}) + (h_{rb})\,(-h_{fb}) \quad (39)$$

Instead of looking at the output current, we may wish to examine the input impedance of the network. To do this, we must hold constant the unused independent variable, v_{oe}, and using Rule 6, Table 2,

$$\left.\frac{v_{ie}}{i_{ie}}\right|_{v_{oe}=0} = \frac{h_{ib}}{\Sigma L} \quad (40)$$

The expression on the left is that for the input h-parameter of the overall network and ΣL is the same as before in Eq. 39. Thus, Eq. 40 becomes

$$h_{ie} = \frac{h_{ib}}{1 - h_{rb} + h_{fb} + h_{ib} \cdot h_{ob} - h_{rb} \cdot h_{fb}}. \quad (41)$$

Reading a given flow graph is thereafter like reading a map or examining a large photograph. We can appreciate the broad intent, seeing in a general way how things are shaped. Or we can look more closely at individual areas, one at a time, to see how they fit together and contribute to the whole. Whenever we want, we can examine specific details minutely and precisely. Moreover, if the flow graph does not show the particular view we require, we can manipulate it by simple rules into a form which is more suitable. As mentioned earlier, this is the kind of facility that, in other forms of mathematics, comes only after long familiarity with the equations of one particular system.

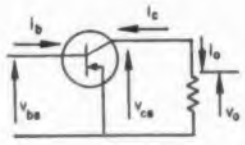
Network Examples

All the standard parameters of two-port networks are shown in flow graph form in Table 3.

From this table the various definitions can be seen at once. One parameter can be expressed in terms of another, external components such as load and generator impedances can be added, and so on. In a passive network, the forward transmittance equals the reverse transmittance in each case.

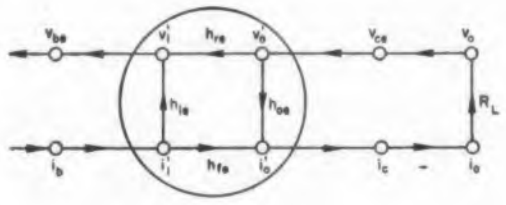
Though many types of network can be described and analyzed by the use of flow graphs, the only types used as examples in this article are those of transistors. This is because, partly, transistors lend themselves ideally to flow graph analysis; partly, it is to leave the main body of the article free to deal in terms which are equally applicable to all subjects, and, in so doing, to provide an introductory treatment of flow graphs not available elsewhere in today's technical literature.

Example. Evaluation of transistor input impedance, common emitter, in terms of *h*-parameters. Circuit:



(42)

Flow graph (with *h*-parameters taken from Table 3):



(43)

The required input impedance is:

$$Z_i = \frac{v_{be}}{i_b} = \frac{h_{ie}\,(\Sigma L) + h_{fe}\,(-1)\,R_L \cdot h_{re}}{\Sigma\, L} \tag{44}$$

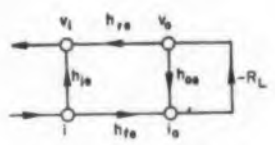
$$\text{where } \Sigma L = 1 - (-1)\,R_L \cdot h_{oe} \tag{45}$$

This simplifies to:

$$Z_i = h_{ie} - \frac{h_{fe} \cdot h_{re} \cdot R_L}{1 + h_{oe} \cdot R_L} \tag{46}$$

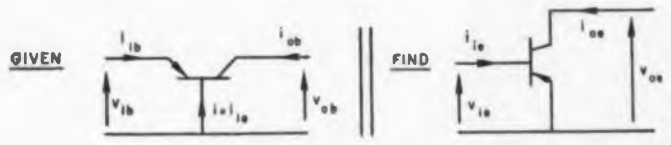
Note the negative unit transmittance which links i_c and i_o.

There are more nodes than are necessary in Eq. 43 to help illustrate the constructional moves. The flow graph would ordinarily be shown simply as

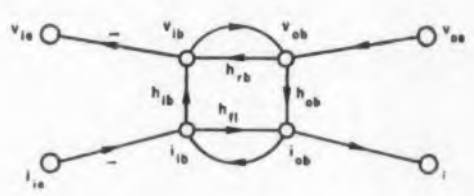


(47)

Example. Derivation of common emitter from common base *h*-parameters.



Method. The h-parameters of the given circuit (which are found in Table 3) are placed in the center, and around the perimeter are placed the nodes of the required network. The circuit equations are examined one at a time and inserted as the interconnecting transmittances in the flow graph.



(48)

Circuit equations

$$v_{ie} = -v_{ib} \tag{49}$$

$$i_{ie} + i_{ib} + i_{ob} = 0 \tag{50}$$

$$\text{Thus: } i_{ib} = -i_{ie} - i_{ob} \tag{51}$$

$$i_{oe} = i_{ob} \tag{52}$$

$$v_{oc} = v_{ob} - v_{ib} \tag{53}$$

$$\text{Thus: } v_{ob} = v_{oe} + v_{ib} \tag{54}$$

Care should be taken in selecting dependent and independent variables. For example, i_{ie} is itself to be an independent variable, so Eq. 51 should not be written with i_{ie} as a dependent variable. Otherwise, an illogical flow graph result, with two transmittances entering the node i_{ie}.

The required *h*-parameters can be written down from inspection of the flow graph. For example, h_{ie} is the ratio of v_{ie} to i_{ie}, with v_{oe} held constant, and is found by tracing the path from i_{ie} to v_{ie} in accordance with flow graph rules. This calculation was carried out earlier (Eq. 41) where the flow graph of Eq. 48 was examined without the benefit of any prior knowledge of its construction. ■ ■

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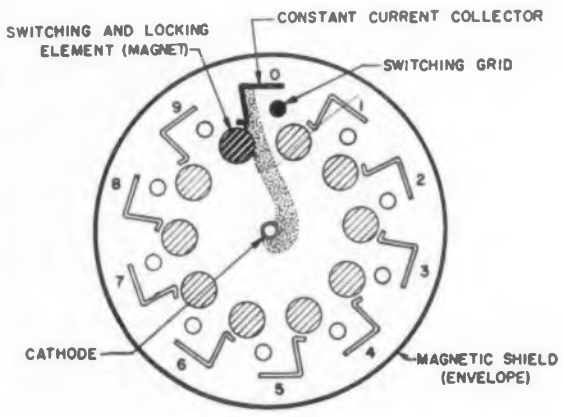
Small Low-Cost Decimal Switch Simplifies Many Circuits



Internal arrangement of the elements in the Beam-X.

THOUGH in function the Beam-X is like its predecessor, the beam-switching tube, its design makes it a completely new product. Designers of the new tube have made it five times smaller and ten times lighter than the old one, and they've cut the price in half.

Developed by the Electronic Tube Div. of Burroughs Corp., Plainfield, N. J., the Beam-X uses small, internal, rod-like magnets as switching and locking elements. The magnets replace heavy, hard-to-align, external magnets and large, external, magnetic shields. Thus, they eliminate expensive potting compounds, extend operating

Beam-X and its Ancestors

Approx.	Beam-X	Type 6700	Type BD-301
Length	3.0 in.	3.5 in.	3.5 in.
Diameter	1.0 in.	1.75 in.	2.26 in.
Weight	1.5 oz.	7.5 oz.	16 oz.
Volume	3.0 cu.in.	8.4 cu.in.	14 cu.in.
Price	$25	$40	$50

Complete decimal counter using the Beam-X and a transistorized driver.

ranges, and improve uniformity of characteristics.

Like its predecessor, the Beam-X can be used for counting, distributing, programming, sampling, frequency-dividing, gating, and timing. In these, and in other applications, its circuitry is simple.

In a decimal counter, for example, a beam switching tube needs 90 fewer components than does a conventional transistorized decimal counter. Before the advent of the Beam-X, an engineer faced a difficult choice between a transistorized counter and one with a beam-switching tube—despite the saving in components that the latter could provide.

For about $40, an engineer considering beam-switching tubes could have used the unshielded type 6700. But to mount more than one, he would have needed a 4-in. center-to-center spacing to avoid magnetic interaction.

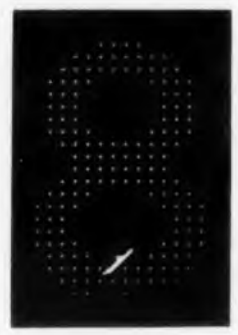
If he could not afford the space, he could have used 2-1/4 in. centers with the shielded type BD-301—a bulky component. It would have cost $50.

Now, he can mount the Beam-X on approximately 1-in. centers—without fear of magnetic interaction—and for only $25.

This decimal switch can provide as many as 10 individual constant-current outputs at better than a 4 mc rate. It can be preset to any position and can switch sequentially or at random.

Sample quantities of the Beam-X are for sale now. Production quantities will be available in March.

For more information on this decimal switch, turn to the Reader-Service Card and circle 102.

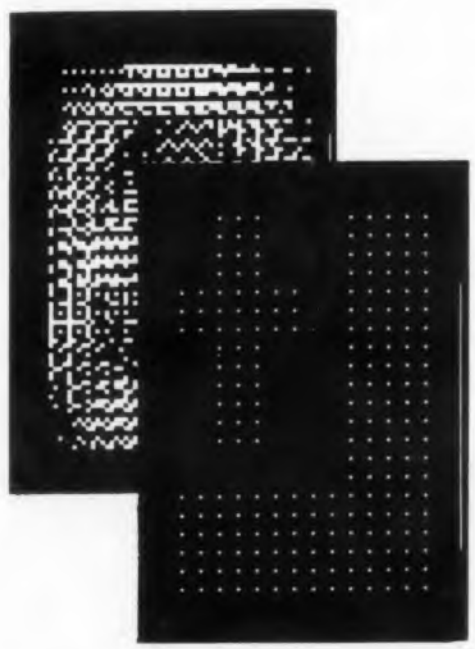


Readout Combines Converter and Display Operations

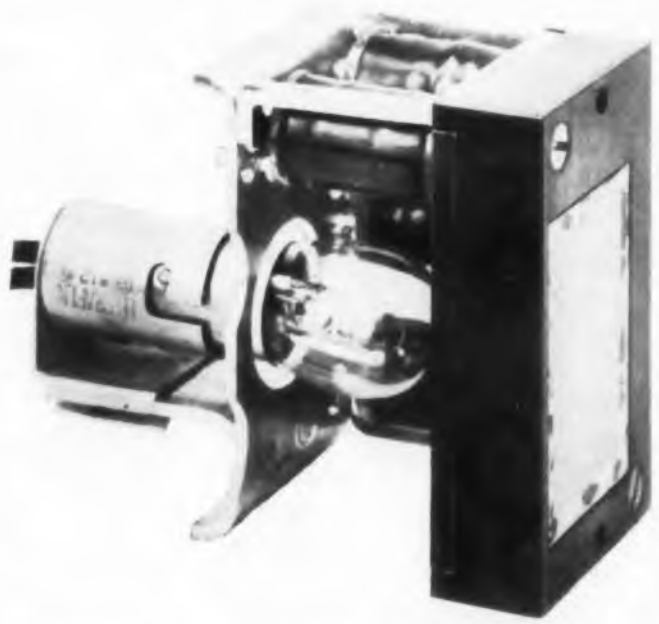
A UNIQUE readout device decodes binary information directly and displays it in alphanumerical form in one operation. Up to sixteen different characters are displayed by each unit in any sequence within a maximum operating time of 100 msec.

Characters or numbers are formed by light passing through holes in two plates. When the plates are moved relative to each other, various prearranged holes line up. Light from a rear-mounted lamp shows through in the shape of the desired character.

With this method, the readout needs no converters, tape cables or high-voltage supplies to present binary information in decimal form. The unit is small (10-3/4 cu in.) and not expensive ($68). It was designed and is being manufactured by Genesys Corp., 10131 National Blvd., Los Angeles, Calif.



Movement of plates relative to each other puts prearranged holes in coincidence, blacks others out. Each plate moves one short step in either x or y direction—a natural for 0,1 type of information input.



Coincident point readout uses only one bulb, translates binary to decimal information directly. Four voice coils move two plates in x and y planes.

Up to 64 Characters Possible

Each plate of the readout is movable in both x and y planes, giving 2^4 possible positions. The front plate consists of regularly spaced holes, like a pegboard; the pattern of holes on the rear plate has a random appearance. Genesys' standard Model CPR 16 decade displays the following numerals and characters: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, −, +, AC Ω, KΩ, MΩ.

Any other configuration of characters is possible on order. Through the use of six input wires instead of four, 64 different alphanumeric characters can be displayed. Or, since operation time is less than 100 msec and there is not waiting out a series to get from one character to the next, animation is possible. This is a new concept in readouts.

The clarity and visibility of readout compare very favorably with other common kinds. The characters are 1.2 in. high and 0.78 in. wide, with a 6 w bulb behind them. The characters are distinct from a distance of 15 or 20 feet. Illumination is fairly even over all parts of the character—a translucent window in front of the bulb disperses the light over the plates.

Parts Protected From Environment

All moving parts are enclosed in a two-piece structure to prevent dust and moisture from entering. No tools are needed to change bulbs; an unskilled worker can do the job in a few seconds without the danger of altering any adjustments. Actuation of the plates is by four voice coils, which have a long life in this application, and a good frequency response. Drive power is 12 v, 150 ma per binary bit.

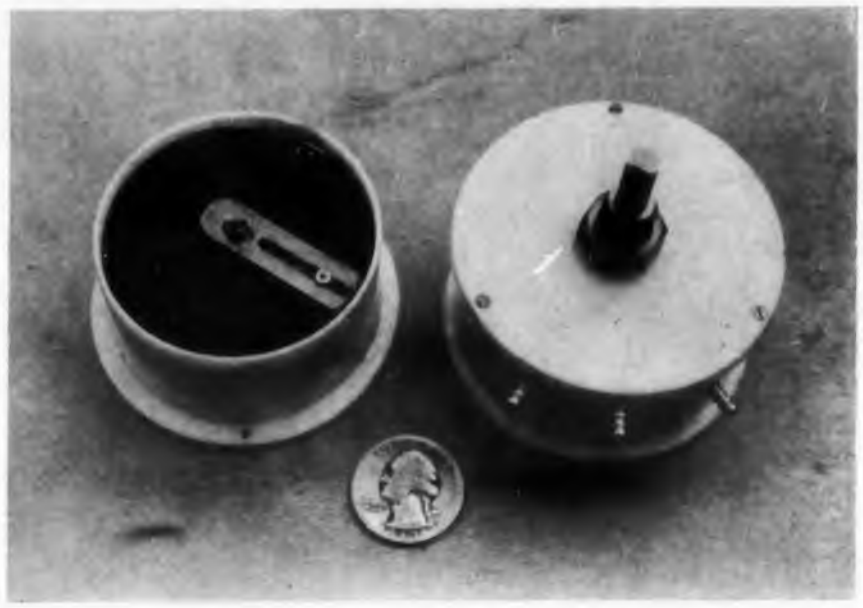
The CPR 16 is 2.5 in. high, 1.5 in. wide and 2-7/8 in. deep.

Future models may have two bulbs instead of one, the company says. In the event of bulb failure, the brightness of the characters would diminish, but use of the readout could continue until the end of a shift, when the bulb could be conveniently replaced. With a two-bulb readout, a colored bulb could be used. A "danger" signal might then turn off the white bulb and turn on a red one, giving immediate sight of trouble somewhere in the system.

The present model will not retain the last reading when power is shut off since the plates return to zero under this condition. Future models will be designed to hold the last reading before power cutoff.

Coincident point readouts can be made almost any size. Genesys Corp. is investigating the possibility of wall-size panels for air-traffic control and other large-scale systems.

For further information on this direct binary coincident point readout, turn to the Reader-Service Card and circle **101**.



Spiral mandrel and linear windings are used in this ten-turn nonlinear potentiometer, about three times the size of a 25-cent piece. Winding the mandrel in a concentric spiral saves potentiometer length.

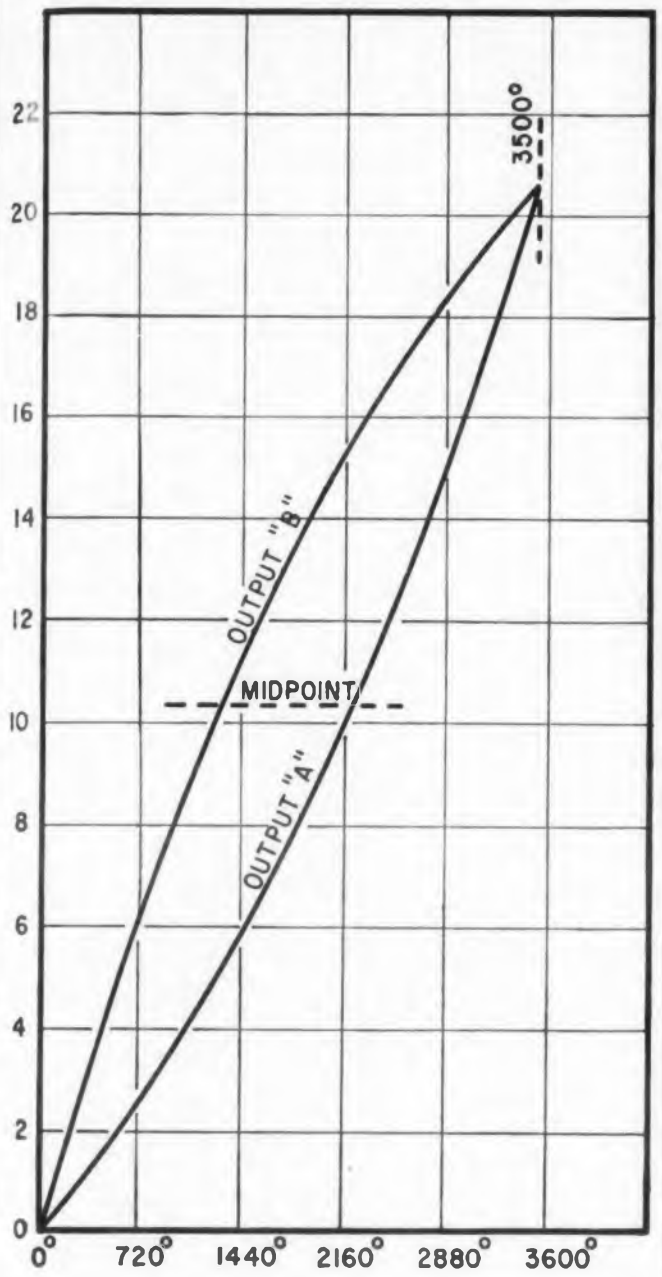
Spiral Windings Give Smooth Nonlinearities In Multiturn Potentiometer

CONTINUOUS nonlinearities in a new multiturn potentiometer are obtained by winding uniform wire on long mandrels and then spiraling the mandrels themselves. A contact rides along the edge of the wirewound card, moving radially as well as circumferentially.

Designed by Harlan Bowitz of Bowitz Electronics, 1341 W. Woodcrest Ave., Fullerton, Calif., the potentiometer is about 2-1/2 in. in diameter.

The uniform windings on the spiraled mandrels provide sine, cosine and square law and tangent output curves, with a resolution said to be superior to present nonlinear potentiometers of the same size. The only discontinuities in the output curve are the small ones caused by the jump from one winding to the next.

Spirals can be wound to suit a variety of different curves. No tapered cards, padding resistors or



Outputs A and B were recorded measuring resistance between the center tap and either of the terminals of the nonlinear potentiometer. Curve is the result of using an Archimedes spiral (mandrel wound tight on itself from center out).

varying wire sizes are needed. Winding and spacing of the wire is simplified, and a greater length of wire per unit volume is possible.

An Archimedes spiral was used to build the potentiometer in the photo. Output resistance for ten turns (9.7 turns—3500 degrees) is recorded in the curve. This prototype was made using No. 28 copper wire, wound helically on a mandrel three-quarters of an inch deep, about 42 inches long.

To make a linear potentiometer using the same technique, Mr. Bowitz says, the card-mandrel can be tapered from the center out. A cube-law output potentiometer is currently in the works. Each spiral nonlinear device is designed to order.

For further information about this spiral nonlinear potentiometer, turn to the Reader-Service Card and circle **100.**

NEW PRODUCTS

Covering all new products that might generally be specified by an electronics engineer engaged in the design of original equipment.

Price and Availability

PRICE AND AVAILABILITY data is now being added, whenever possible, to the New Product descriptions that appear in *ELECTRONIC DESIGN*. This data will help you to:

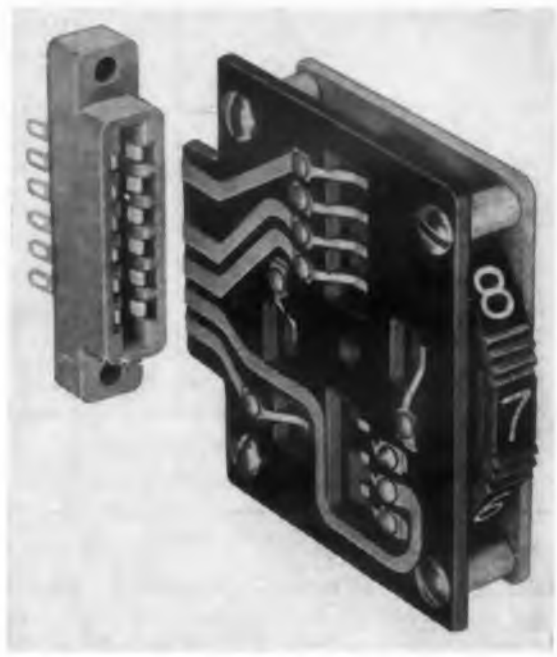
—Evaluate the products more intelligently.
—Decide which products to buy now and which to wait for.
—Schedule your orders wisely.
—Get an insight into prices and savings for similar products.

Most manufacturers have been very cooperative in providing us with *Price and Availability* data. Since some of the data arrived after our deadlines, it was impossible to add it to all of the products. The data represents the latest information at the time of publication.

1000-Mc Tunnel Diode Samples Available 472

Rated at 1000 mc, the type ZJ-56A tunnel diode has a minimum peak-to-valley current ratio of 5 to 1. Characteristics include a typical peak-point current rating of 1 ma which is held to ±10%, and a typical negative conductance of 0.065 mho. Packaged in a TO-18 standard transistor housing, the unit is rated for an operating junction temperature of −55 to +100 C.

General Electric Co., Semiconductor Products Department, Dept. ED, Syracuse, N.Y.
Price & Availability: *Sample quantities available. Price is $60*



Binary Thumbwheel Switch Requires 1/2-in. Panel Space 473

This modular 10-position binary thumbwheel switch requires 1/2-in. of panel space. Only one number at a time is exposed through the bezel window. The series TSB unit is available with wafers that are replaceable in 10 sec, or with fixed wafers if the removable feature is not needed. The removable type unit plugs into fixed printed circuit receptacles and the fixed unit is designed with soldering terminals. Three or four bit binary and complementary outputs can be furnished, and the units can be stacked either horizontally or vertically.

Chicago Dynamic Industries, Inc., Precision Products Div., Dept. ED, 1725 Diversey Blvd., Chicago 14, Ill.
Price & Availability: *Available from stock by end of January. Price on request.*

Flexible Ceramic Makes Ultramin Capacitor

INTENSIVE research and new techniques have resulted in a rolled ceramic capacitor in the high capacity range. Much smaller in size than paper and plastic film capacitors, this new capacitor is known as "Cerol."

Made by Aerovox Corp., Hi-Q Div., Olean, N.Y., the Cerol capacitor is produced by rolling an extremely thin ceramic dielectric film upon which a precious metal is deposited. The rolled ceramic film is then fired. Upon completion of the process, the capacitor becomes a compact and monolithic structure capable of withstanding severe environmental conditions.

Standard Cerol capacitors range in size from 0.2 in. in diameter by 0.65 in. long for a 0.1-mfd unit to 0.4 in. in diameter by 1.4 in. for the 2-mfd unit. The table shows dimensions for some typical units. The units are rated at 100 vdc at temperatures between—55 to 85 C and at 50 v up to 125 C. Higher voltages will be available.

Power factor is 2 per cent maximum at 1 kc. Capacitance variation with temperature is +15 per cent, —25 per cent over the —55 C to 125 C temperature range.

Applications include decoupling and pulse circuits where low series resistance at high frequencies combined with extremely miniature sizes are required.

Prototype quantities of Cerol capacitors are immediately available. Volume quantities can be supplied in three or four weeks. Prices on request.

For further information on this new ceramic capacitor, turn to Reader-Service Card and circle 99.

Typical Cerol Capacitor Sizes

Cap. Mfd	D Max in.	L Max in.
0.1	0.210	0.690
0.25	0.260	0.690
0.5	0.350	0.690
1.0	0.480	0.690
2.0	0.400	1.44

NEW PRODUCTS

Amplifier-Demodulator 494

For use with carrier frequencies of 3 to 30 kc

Designed for applications requiring a phase-sensitive dc output voltage for an ac input signal, model S-40004-P plug-in amplifier-demodulator can be used with carrier frequencies of 3 to 30 kc. Completely transistorized, the unit provides output currents of ±15 ma or greater into a 50-ohm load. It requires 40 ma of −24-v dc power. The linearity of the circuit is better than ±1%; over-all gain is about 4.5. The demodulator is essentially free of zero drift.

Plug-In Instruments, Inc., Dept. ED, 1416 Lebanon Road, Nashville, Tenn.

DC Voltage Sensor 491

Has 10 msec response time

This dc voltage sensor has a response time of less than 10 msec and senses voltages from 3 v dc and up. Each unit is supplied with a preset signal level marked on the nameplate. Accuracy is within ±5% of the calibrated signal level. A typical model, including a 2pdt crystal case relay output, measures 1 x 1-9/16 x 1-3/4 in. and weighs less than 3 oz. This device can also be used as a voltage comparator.

Tempo Instrument, Inc., Dept. ED, Box 338, Hicksville, N.Y.

Price & Availability: *Units available from stock and can be delivered 3 to 4 weeks after order received. Price of 1 to 9 units is $240; $198 for quantities of 100 and up.*

Transistorized, Self-Powered Oscillators 488

Distortion is less than 0.1%

Models 210 and 211 transistorized, self-powered oscillators offer a reliable and isolated source of high purity sine waves. The output distortion is less than 0.1%. Frequencies of 1 to 100,000 cps are selected by decade steps. The maximum output is 5 v rms, open-circuit, or 2.5 into a 600-ohm load. Several models can be furnished to provide either single ended or balanced 600-ohm output; other models have a calibrated output attenuator and level meter.

Burr-Brown Research Corp., Dept. ED, Box 6444, Tucson, Ariz.

Price & Availability: *Prices range from $345 to $445, depending on the unit, with discounts for quantity orders. Units are normally available from stock.*

Silicon Diffused-Junction Rectifiers 489

Are rated at 6 and 12 amp

Designed to meet Mil specs, these silicon diffused-junction rectifiers are capable of operating to base temperatures of 190 C. The 6-amp series is designated as types 1N1341 through 1N1347, and the 12-amp series, types 1N1199 through 1N1205. The piv range is 50 to 500 v for both series. Each diode is nickel-plated for minimum contact resistance and to prevent corrosion.

International Rectifier Corp., Dept. ED, 5121 E. Grand Ave., El Segundo, Calif.

Price & Availability: *In quantities of 1 to 99, the 6-amp units are $3.95 to $16.65 ea; the 12-amp units are $4 to $17.60 ea. Delivery is from stock.*

NEW PRODUCTS

Tape Reader 511

Reads up to 1000 characters per sec

Reading speeds up to 100 characters per sec are possible with model 909 punched tape reader. When used with a companion spooler mechanism, model 3299, reading speeds up to 200 characters per sec are possible. The spooler accommodates paper or mylar tape up to 1 in. in width on 8 in. diam reels.

Potter Instrument Co., Inc., Dept. ED, Plainview, Long Island, N.Y.

Price & Availability: *Delivery is 7 to 9 weeks after order received. Prices vary from $2575 to $3100.*

Compact Interval Timer 493

Has a five-decade display

Model WE-220 compact interval timer has a five-decade display with crystal-controlled time base frequencies of 100, 10, and 1 kc. Maximum indicated times are 1, 10, and 100 sec, in increments of 10 μsec, 100 μsec, and 1 msec, respectively. The inputs may be paralleled for making period or pulse duration measurements. Glow transfer tubes are used for indication of up to 100,000 units. Automatic resetting provides a variable display period of 0.5 to 5 sec; the unit also has controls for manual reset. Applications include measuring the operating times of relays, controls, valves, and motors.

Westport Electric, Dept. ED, 149 Lomita St., El Segundo, Calif.

Radiation Thermometer 500

For remote temperature control

Using infrared detection, model TD-3 radiation thermometer automatically measures and controls the temperature of moving or stationary objects without physical contact. The range can be as low as 400 F and as high as 2000 F in standard units; higher ranges can be furnished for special applications. The unit is unaffected by ambient temperature variations from 20 to 120 F. Its uses include non-destructive testing, assembly-line inspection, and others. Units are furnished with indicators or recording potentiometers.

Radiation Electronics Co., Dept. ED, 5600 W. Jarvis Ave., Chicago 48, Ill.

Price & Availability: *Price quotation will be supplied on request. Units can be delivered 45 days after order is received.*

Multi-Tester Kit 505

DC accuracy is 3% of full scale

Type TE-139 multitester kit has an over-all accuracy of 3% of full scale on dc ranges and 5% of full scale on ac ranges. The ranges are: 0 to 10, 50, 250, 500, and 1000 v ac and dc; dc current, 0 to 500 μa and 0 to 10 and 250 ma; resistance, 0 to 10 K, 100 K, and 1 meg; decibels, −20 to +36 db; capacitance, 250 μμf to 0.02 μf; and inductance, 0 to 5000 h. The input resistance is 20,000 ohms per v dc and 10,000 ohms per v ac. The kit furnishes test leads, battery, and all parts; only the wiring has to be done.

Olson Radio Corp., Dept. ED, 260 S. Forge St., Akron, Ohio.

Price & Availability: *The kits are immediately available from stock at $13.91 ea, three for $40.*

NEW PRODUCTS

Ultrasonic Cleaner 479

Has 7-gal tank

Model 140 ultrasonic cleaner has a 7-gal heavy-gage stainless steel tank measuring 14-3/4 x 11-3/4 x 10 in. The corners are rounded to facilitate rinsing out the contaminants. Actual radiating surface is 48 sq in. The 115 v ac, 60 cps, single-phase generator delivers an average output of 250 w and produces a peak of 1000 w. The unit includes a one-tube oscillator, front panel switching, forced-air cooling, and three-wire ground protection.

National Ultrasonic Corp., Dept. ED, 111 Montgomery Ave., Irvington 11, N.J.

Price & Availability: *Available from stock, the unit is priced at $745.*

Multitester 480

Has a sensitivity of 20,000 ohms per v

Model TS-60H multitester has a sensitivity of 20,000 ohms per v in the dc ranges of 5, 25, 250, 500, and 2500, and 10,000 ohms per v in the ac range of 10, 50, 100, 500, and 1000 v. The dc current ranges are to 50 μa, 25 ma, and 250 ma; resistance ranges are 0 to 6000 ohms and 0 to 60,000 ohms. The decibel range is −20 to +22 db. Furnished in a bakelite cabinet, the instrument measures 3-1/4 x 4-1/2 x 1-1/16 in.

Alco Electronics Manufacturing Co., Dept. ED, 3 Wolcott Ave., Lawrence, Mass.

Price & Availability: *Available from stock, the unit is priced at $16.95. For 2 to 9 units, the price is $11.87; for 10 to 24, $11.30; and for 25 to 49, $10.17.*

Silvered-Mica Dielectric Capacitors 481

Dissipation factor is less than 0.1% at 1 kc

Type CPM silvered-mica dielectric capacitors have a dissipation factor of less than 0.1% at 1 kc. The standard voltage rating is 500 wvdc; other ratings can be furnished on

◀ CIRCLE 41 ON READER-SERVICE CARD

request. Units operate over the temperature range of −55 to +125 C without derating. The temperature coefficient is +40 ±15 ppm per deg C. Tolerance is ±0.1% and the range of capacitances is 0.01 to 0.5 μf.

Arco Electronics, Inc., Dept. ED, 64 White St., New York 13, N.Y.

Price & Availability: *Units are made on order; list prices range from $23.40 to $190.*

Miniature Toggle Switches 482

Are rated at 5 amp

These miniature toggle switches are rated at 5 amp and 125 v ac. The contact resistance is 1 to 3 microohm, the insulation resistance is over 100,000 meg, and the voltage breakdown is at 1000 v ac. Rated for a life of over 100,000 operations, they stand an overload of 150%. Both spdt and dpdt types are offered.

Alco Electronics Manufacturing Co., Dept. ED, 3 Wolcott Ave., Lawrence, Mass.

Price & Availability: *Delivery is from stock. For single orders, the prices are $1.65 for spdt type and $2.15 for dpdt type; for orders of 2 to 14, $1.12 and $1.43; and for 25 to 49, $.99 and $1.29.*

Thermocouple Probe 484

Operates at 1800 F

This thermocouple probe measures liquid and gas temperatures in the range of 1800 F at pressures in excess of 2000 psig. Constructed of chromel-alumel or chromel-constantan, they are suitable for connection to low temperature Teflon or high temperature cables. They may have stainless steel sheaths and either covered or exposed probes, or ceramic sheaths.

Technical Industries Corp., Dept. ED, 389 N. Fair Oaks Ave., Pasadena, Calif.

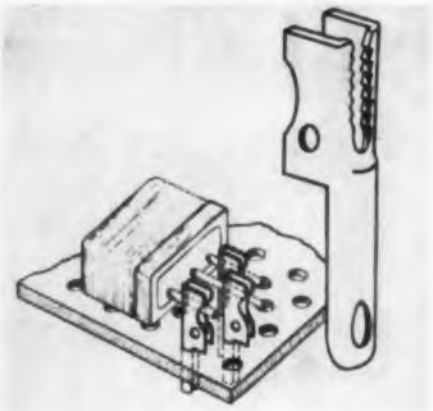
Price & Availability: *The price is about $95 ea; in quantities up to 50, about $80; and in quantities to 100, about $55.*

CIRCLE 42 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Push-In Terminal 490

For miniature circuitry



Type T28 push-in terminal is for holes 1/16-in. in diam. Serrations in the main slot which grips small component leads make the terminal suitable for experimental breadboarding. It can also be used in printed circuits and other product applications. Made of heat-treated beryllium copper, it has a fused tin finish for soldering.

Vector Electronic Co., Dept. ED, 1100 Flower St., Glendale 1, Calif.

Price & Availability: *Priced at $1.55 per package of 100 terminals, they are available for immediate delivery.*

Analog-to-Digital Converter 499

Direct reading

Type 423341 direct reading analog-to-digital converter transmits coded signals to remote locations for use as input to such devices as computers, tape punch recorders, and servo mechanisms. In typical use, the shaft is rotated by a temperature-controlled servo. When the full range is 100 C, visual and electrical readouts are to the nearest 0.01 C. The input driving torque is 2 oz-in., the input shaft rotation is 250 rpm max, the operating temperature range is −80 to +350 F, and the vibration range is 5 to 50 cps at ±10 g. Resolution is 1 bit per 10,000 and readout is to 9999. The unit can be supplied in a servo package to suit the user's requirements.

Kearfott Co., Inc., Dept. ED, 1500 Main Ave., Clifton, N.J.

5 EXCITING NEW SILICON TRANSISTOR

HI-POWER STUD-MOUNTED SILICON TRANSISTOR

A rugged package — easier to mount, with greater strength and lower thermal resistance. Has good beta linearity and switching characteristics good high frequency betas , low saturation voltage. Ratings up to 100 volts available.

Type	V_{cb} Max. Volts	I_c max. Amps	B Typical	R_{cs} Typical (Ohms)
2N1208	60	5	35	1.5
2N1209	45	5	40	1.5
2N1212	60	5	25	2.5

APPLICATIONS Regulated Power Supplies . . . High Current Switching . . . High Frequency Power Amplifiers

Circle 146

CORE SWITCH

Improved switching speed and input characteristics. High-current capabilities with good power handling ability (5w @ 100°c). Rated and tested at 60v.

Type	V_{cb} Max. Volts	(β) Min.	Typ. Input Voltage (Volts)	Typ. Saturation Resistance (Ohms)	Switching Characteristics (μsec)
ST4100	60	15	2.5	10	t_r .2
					t_s .2
					t_f .2

APPLICATIONS . . . magnetic core memory . . . high level multivibrators . . . buffer amplifiers . . . clock source

Circle 147

150mc VERY HIGH FREQUENCY TRANSISTOR

New silicon logic transistor with speed surpassing the fastest silicon types, plus unusual power handling ability. Technical breakthrough now provides minimum and typical DC current gains of 20 and 40 respectively.

TYPE 2N1139

		Min.	Typical	Max.	Test Conditions
D.C. Current Gain	h_{FE}	20	40	—	I_C = 10ma, V_{CE} =10V
D.C. Collector Saturation Voltage	V_{CE}	—	.5	0.7V	I_C = 10ma, I_B = 1ma
Collector Cutoff Current	I_{CO}	—	2	5 μa	V_{CB} = Rating
Output Capacitance	C_{ob}	—	8	12 μμf	V_{CB} =10V, I_E = 0 mA
High Frequency Current Gain	h_{fe}	5	7.5	—	F = 20mc, V_{CE} =10V I_E = 10 mA
Delay Time	t_d	—	6		mμsec.
Rise Time	t_r	—	12		mμsec.
Fall Time	t_f	—	10		mμsec.

Circle 148

UNIVERSAL 50mc LOGIC TRANSISTOR

This transistor features universal application (replaces 2N337, 2N338, 2N1005, 2N1006) and high frequency response, with low saturation resistance, low input impedance, low capacitance.

Type	Typ. Alpha Cutoff (Mc)	Beta Typical	C_o (Typical) (μμf)	Max. (Volts)	Typ. Saturation Resistance (ohms)
ST3031	70	50	2	20	40

APPLICATIONS . . . flip-flops . . . IF and video amplifiers . . . transistor logic . . . pulse amplifiers

Circle 149

STABISTOR COUPLED LOGIC TRANSISTOR

Designed to provide minimum storage times under severe base overdrive conditions in transistor logic circuitry. Tightly controlled input characteristics provide interchangeability; low R_{cs} assures reliable operation at high temperature.

Type	Beta Typical	V_c max. (Volts)	Typical Saturation Resistance (ohms)	Typ. Alpha Cutoff (Mc)	Switching Characteristics (μsec)
ST3030	12	15	40	50	t_r .05
					t_s .20
					t_f .10

APPLICATIONS . . . designed specifically for SCTL and DCTL circuits (write for descriptive paper on SCTL)

CIRCLE 43 ON READER-SERVICE CARD

NEW PRODUCTS

Operational Amplifiers 503

Transistorized

Series 1300 operational amplifiers feature gains of 10,000 and an input impedance of 100 K. Outputs of ±10 v at 200 ma are available. The basic units are differential dc amplifiers designed to be used with external feedback. Typical applications include dc and ac amplifiers, integrators, current and voltage regulators, preamplifiers, and selective filters. The case for germanium or silicon units measures 1 x 2.5 x 3.5 in.

Burr-Brown Research Corp., Dept. ED, Box 6444, Tucson, Ariz.

Price & Availability: *Prices range from $65 to $98 for germanium, and to $310 for silicon. Delivery is from stock to 30 days after receipt of order.*

Portable Recorders 504

For strain gage or thermocouple monitoring

Developed for such applications as strain gage or thermocouple monitoring, models 10 and 20 portable potentiometer recorders are one and two-channel units, respectively. They have a selectable 9 to 120-mv span, gear shift selection of chart speeds, and 0.8 sec balance time. The sensitivity of the units is 0.25%. Suitable for rack mounting as well as portable use, the units weigh 15 lb.

Systron Corp., Dept. ED, 950 Galindo St., Concord, Calif.

Price & Availability: *Model 10 is priced at $435 and model 20, $850. At certain times, a delivery time of 10 to 30 days should be allowed for.*

Countermeasures Receiver 507

Covers 20 to 260 mc

Designed for critical applications in countermeasures and intercept work, type 16A1 receiver has a basic tuning head which covers the frequency range of 30 to 260 mc. One band covers 30 to 60 mc and another covers 55 to 260 mc. The range can be extended to 1000 mc by replacing the tuning head. The receiver has simultaneous am and fm detection with if bandwidths of 10 kc, 300 kc, and 1 mc. The noise figure is less than 4 db for the first band and less than 6 db for the second. Oscillator radiation is 90 db below 1 mw. Power requirements are 190 w at 115 v ac, 50 to 60 cps.

General Electronic Labs., Inc., Dept. ED, 8521 Second Ave., Silver Spring, Md.

Price & Availability: *For small quantities, the price is $3900. Delivery time is 90 days.*

Power Supplies 506

Regulation is 0.1% or 0.01%

The DME line of transistorized power supplies includes four units with outputs of 0 to 18, 0 to 36, 0 to 60, and 0 to 100 v dc; a fifth unit provides 0 to 36 and 0 to 100 v dc. The output current is 0 to 1 amp in the 100-v units, and 0 to 2.5 amp in the lower voltage models. Regulation of 0.1% or 0.01% may be specified. The line regulation is 0.05%, ripple is less than 0.01%, and the recovery time does not exceed 50 μsec. Overshoot is less than 1% at full current and voltage. These units are capable of continuous duty at up to 120% of rated current.

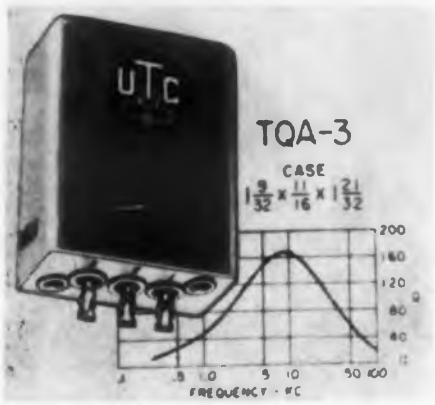
Mid-Eastern Electronics, Inc., Dept. ED, 32 Commerce St., Springfield, N.J.

Price & Availability: *The prices range from $795 to $1395 fob Springfield, N.J. For the model with 0.1% regulation. Delivery time is 60 days.*

NEW PRODUCTS

Toroidal Center-Tapped Inductors 513

For stable oscillators



Type TQA toroidal inductors are for stable oscillators with frequencies of 400 cps to 75 kc. They are center-tapped and have a stabilized core for maximum temperature stability. Available in 19 inductance values from 7 mh to 22 h, they are laboratory adjusted to 1% accuracy. The maximum Q is about 160 at 7.5 kc, 20 at 400 cps, and 30 at 75 kc. The hum pickup is very low due to a uniform toroid winding plus the high-permeability outer case, providing 80 db at coupling attenuation. Hermetically sealed to meet MIL-T-27A, they have the military identification TF4RX20YY. The case measures 11/16 x 1-9/32 x 1-21/23 in. and the weight is 4 oz.

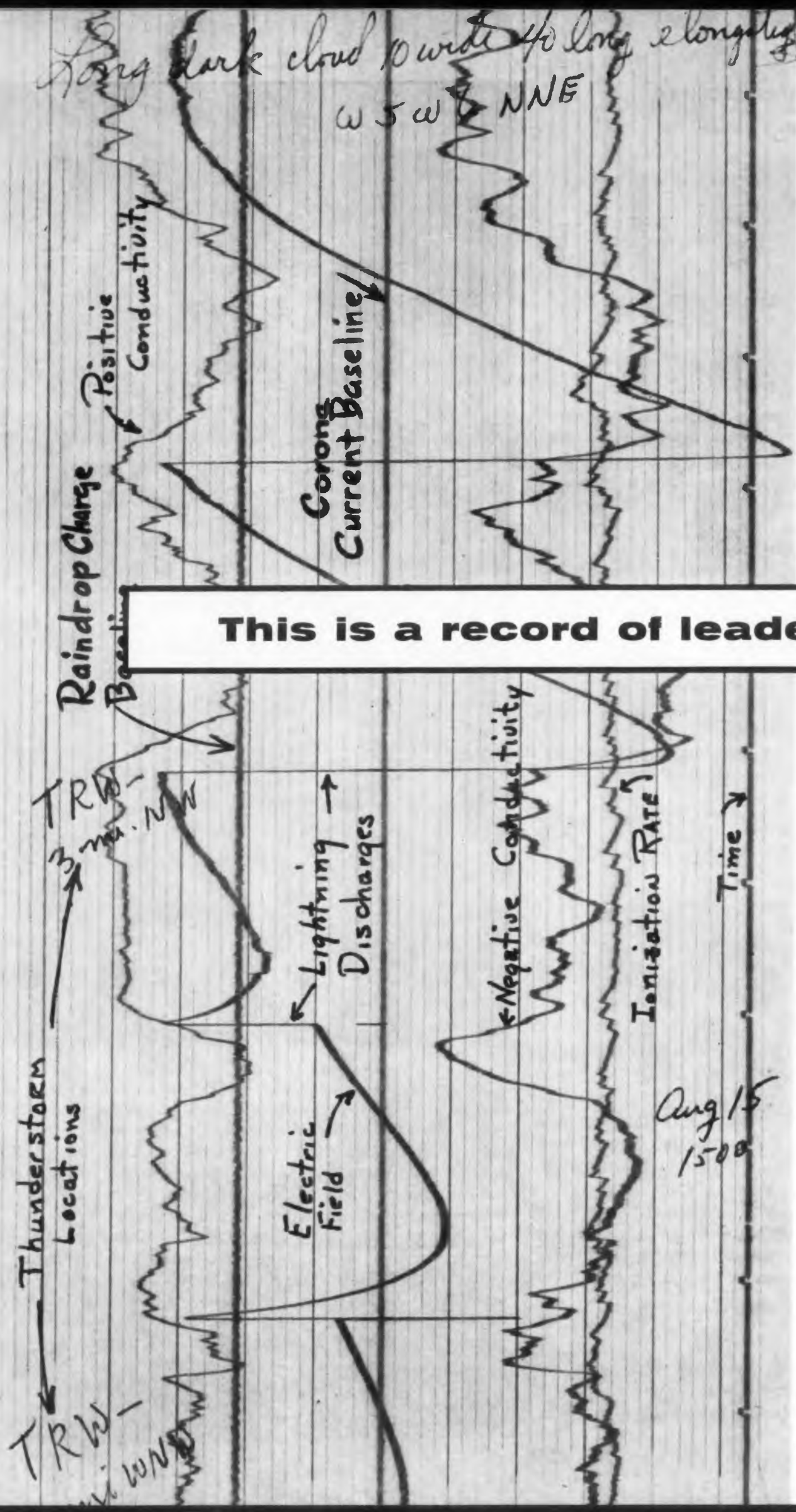
United Transformer Corp., Dept. ED, 150 Varick St., New York 13, N.Y.

Price & Availability: *Price is $9 to $21 ea; quantity discounts are offered. Units are available from stock.*

Crystal Can Solderer 509

Automatic, miniature

This automatic, miniature crystal can solderer is for use in the manufacturing of crystals. The equipment consists of a one-kw induction generator with special tooling. The generator is mounted on a motor-driven, variable speed, 16-station turntable. The crystals are assembled and



This is a record of leadership

Honeywell 906A Visicorder record, actual size. Note longitudinal grid lines

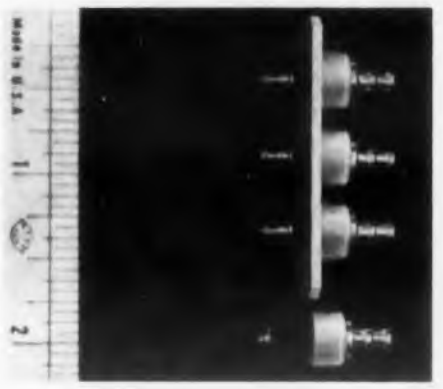
held in spring-loaded jigs. The required input is 120 or 240 v, single-phase.

Reeve Electronics, Inc., Dept. ED, 609 W. Lake St., Chicago 6, Ill.

Price & Availability: *The basic unit is priced at $2150. Additional equipment, such as the holding jigs, is furnished separately at additional cost. Delivery is four to five weeks after receipt of order.*

Hermetic Terminal 510

For 1500 v operating components



Designed for use with electronic components in the intermediate operating voltage range of 1500 v, model 599 nonturning hermetic terminal is a single unit assembly with no loose parts. It meets the requirements of MIL-T-27A.

Lundey Assoc., Dept. ED, 694 Main St., Waltham 54, Mass.

Price & Availability: *Available from stock. Price is $0.049 per unit in quantities of 500,000; $0.065 when less than 1000.*

Frequency Meter 492

Uses no magnetic components

This all-semiconductor frequency meter uses no magnetic components. Either 396-404 or 360-440 cps can be read from the meter which is accurate to 0.1% over a temperature range from −55 to +65 C. The meter measures 3-1/2 in. in diam, and the box is 1-3/4 x 3-1/4 x 5 in. Weight of both units is less than 2 lb.

Vidar Corp., Dept. ED, 2107 El Camino Real, Palo Alto, Calif.

Price & Availability: *Delivery 60 days after order received. Price is $250 per unit when ordered in quantities of 1 to 10. Quantity discounts available.*

◀ CIRCLE 47 ON READER-SERVICE CARD

NEW PRODUCTS

Telemetry Test Set 447

Covers 18 channels

This fm-fm telemetry test set covers 18 IRIG channels. It has facilities for performance check-out of the following: over-all filter discriminator systems, individual discriminator linearity, magnetic data recording systems, oscillographic data recording systems, individual filter characteristics, sub-carrier generators and reference oscillators. The sub-carrier generators allow all 18 frequencies to be modulated to ±7.5%. The highest frequencies may also be modulated to ±15%. Outputs are available individually or as a composite. The video generator has a drift of less than ±2% of design bandwidth for 8 hr. Both the video generator and the audio oscillator have a total harmonic distortion of less than 0.75%. Input power is 110 v, 60 cps, single-phase.

Dynatronics, Inc., Dept. ED, Box 2566, Orlando, Fla.

Punched Tape Reader 470

Reads 1000 characters per sec

Model 3500 photoelectric punched tape reader is a completely solid state unit which stops before the next character at reading speeds of 1000 characters per sec. The design of this unit essentially eliminates the mechanical motion involved in stopping the tape. All standard 5, 6, 7, and 8-level tapes plus sprocket may be handled interchangeably. Both dual and single speed units operating at 100 to 1500 characters per sec can be furnished.

The unit meets the requirements of accuracy, reliability, and speed for digital computer input, machine tool control, and ground support equipment. Modular construction enables the user to specify requirements. The power needed is 115 v, 60 cps, 180 w. The unit mounts on a standard 19-in. rack.

Digitronics Corp., Dept. ED, Albertson, L.I., N.Y.

Price & Availability: Price quoted on request. Delivery time is 60 days.

Motor-Generator for Computers 495

Is rated at 7.5 kw

This 400 cps, brushless motor-generator serves as the power supply for computers. It is rated at 7.5 kw at 1714 rpm with a three-phase, 208 v output. Silicon diodes and an ac exciter replace commutator and brushes.

Electric Machinery Manufacturing Co., Dept. ED, Minneapolis 13, Minn.

Analog-to-Digital Converter 501

Servo type

Type A1503-11 servo analog-to-digital converter consists of an amplifier, a servo motor or tachometer generator, the analog-to-digital converter, and appropriate gearing. Contacts and brushes for each binary bit are capable of carrying a load current of 20 ma at 10 v dc. Having 16 bits per revolution, the system provides an accuracy of 1 bit per 4096. Resolution for the total range is 256.

Kearfott Co., Inc., Dept. ED, 1500 Main Ave., Clifton, N.J.

NEW PRODUCTS

Modular Power Supply 514

Delivers 6 amp from 26 to 30 v dc

This modular power supply delivers 6 amp over the range of 26 to 30 v dc. Regulation is better than 0.2% and ripple is less than 10 mv. Constructed according to MIL-E-4158B, the unit is completely transistorized. Dimensions are 6-1/2 x 6-1/16 x 19-1/4 in.

Invar Electronics Corp., Dept. ED, 323 W. Washington Blvd., Pasadena, Calif.

Modular Oscillograph 474

For rack mounting

Designed for a standard 19-in. rack, type 5-123 oscillograph can be built to a variety of configurations by assembling a combination of modules: record transport, optical, drive, and front controls. Although 36 to 50 channels are basic, other sizes are possible by changing magnet blocks in the optical module. Recording speeds to 160 in. per sec are provided. Either slot-exit or record take-up is available in the record transport without change of hardware. Direct viewing is possible at all times. For use with paper 12 in. wide, the unit holds 475 ft of thin base paper.

Consolidated Electrodynamics Corp., Electro Mechanical Instrument Div., Dept. ED, 360 Sierra Madre Villa, Pasadena, Calif.

Ceramic Foams 487

Three materials available

For use in microwave components such as attenuators, terminations, and loads, this ceramic foam, called Eccosorb, is available in three materials: BR 240, 250, and 260. Their dielectric constants at 10^{10} cps are 15, 7, and 3, respectively. The materials come in sheet form and are readily machined.

Emerson & Cuming, Inc., Dept. ED, Canton, Mass.

Price & Availability: *Available from stock. Price is about $20 per 12 x 12 x 1/4 in. thickness sheet.*

Temperature Controller 475

Regulates within 1 deg F up to 600 F

Type PC electronic temperature controller provides temperature regulation to within 1 deg F up to 600 F. The stainless steel sensing element is a small bullet-probe 1 in. long and 1/4 in. in diameter. The pre-aged thermistor probe may be placed as far as 100 ft from the amplifier-relay cabinet. Loads up to 10 kw can be controlled without a separate magnetic contactor. The dual scale covers from 25 to 225 F and from 200 to 600 F.

Edwin L. Wiegand Co., Dept. ED, 7500 Thomas Blvd., Pittsburgh 8, Pa.

Acceleration Transducer 476

Potentiometric type

Model 400 potentiometric type acceleration transducer offers low static friction and infinite resolution. Having a broadband width sensor, the unit is for use in control, telemetry, and guidance systems; from 0 to 10 g, the response is flat to 50 cps. Dimensions are 1-1/8 x 1-1/8 x 2-1/4 in. and the weight is 5 oz.

White Avionics Corp., Dept. ED, Terminal Road, Plainview, L.I., N.Y.

Limit Switches 477

Yoke-actuator type

Suitable for applications requiring automatic reversal on reciprocating mechanisms, types 206LS1 and 6LS1 yoke-actuator limit switches have an electrical capacity of 10 amp, 120, 240, or 480 v ac. When moved from either extreme position toward the other, the actuator causes the internal switching unit to transfer and maintain the circuit. The actuator heads may be mounted in four positions, 90 deg apart. The yoke actuator may be rotated 360 deg, locking positively in any position.

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

◀ CIRCLE 50 ON READER-SERVICE CARD

NEW PRODUCTS

Power Supply 516

Output is 6 to 30 v dc

Model D-1480 power supply has an output of 6 to 30 v dc continuously variable with 500 ma full load output current. The dynamic output impedance is less than 0.05 ohms at 25 cps and 0.25 ohms at 10 kc. Ripple and noise are less than 500 μv rms. Static load regulation from no load to full load is less than ±0.3% or ±30 mv. A change in the nominal line voltage of ±10% causes a change of less than ±0.1% or ±10 mv. The load current limiting is continuously adjustable from 50 to 500 ma and the unit will hold its specified voltage regulation to load currents within 1% of the overload current setting. Applications of the unit are with all types of transistor circuitry.

D & R Ltd., Dept. ED, 402 E. Gutierrez, P.O. Box 1500, Santa Barbara, Calif.

Telemetering Analyzer 498

Has logarithmic and linear display

Model TA-100L-120L telemetering analyzer has automatic logarithmic display of subcarrier channels and simultaneous linear display of individual channels. Frequency ranges are 350 cps to 85 kc or 120 kv logarithmic display and 13 cps to 85 kc or 120 kc linear display. The sweep width is 150 cps to 22 kc. The unit has a 60-db dynamic range and a 500-mv sensitivity.

Probescope Co., Inc., Dept. ED, 8 Sagamore Hill Drive, Port Washington, N.Y.

Power Switch 440

Electrically-tripped

This manual power switch can be electrically tripped by almost any type of power from a remotely-located control or a safety device. The device is an adaptation of the hydraulic-magnetic circuit breaker, but has the breaker contacts electrically isolated from the coil. A limit control, timer, malfunction detector, or overload condition in one circuit can cause tripping in another interlocked control circuit. The interrupting capacity is 2000 amp at 125 v ac. Either a current or a voltage sensing coil is available.

Heinemann Electric Co., Dept. ED, Plum St., Trenton, N.J.

Price & Availability: Price is on quotation only. Delivery time is 4 to 5 weeks for 25 units or less; for more than 25 units, delivery time is 7 to 8 weeks.

Proportional Temperature Controllers 496

Over-all efficiency is better than 94%

The TC200 proportional temperature controllers provide close control of floated gyroscope and accelerometers. Using semiconductor switching techniques, the units have an output of 100 w or more at an over-all efficiency of better than 94%. Completely solid state, the controllers are furnished in a hermetically sealed enclosure with a seven-pin terminal header. Mil specs are met.

Harrel, Inc., Dept. ED, 1788 First Ave., New York 28, N.Y.

NEW PRODUCTS

Frequency Signal Generator 497

Has local and remote controls

Model FA-5111 dial-controlled spot frequency signal generator has both local and remote controls. Ten present frequencies in the range of 108 to 136 mc are provided. The device is crystal-controlled, using crystals from 18 to 22.6666 mc; stability is ±0.0025% over an ambient temperature range of −10 to +60 C. The output can be cw or 50% modulated by 1000 cps audio. The output varies less than ±10%. A load of 51 ohms is recommended, with a nominal power output of 115 mw. The power requirements are 105 to 130 v ac, 50 to 60 cps. The unit measures 8-23/32 x 19 x 9-1/2 in. and weighs 24 lb.

Telectro Industries Corp., Dept. ED, Long Island City, N.Y.

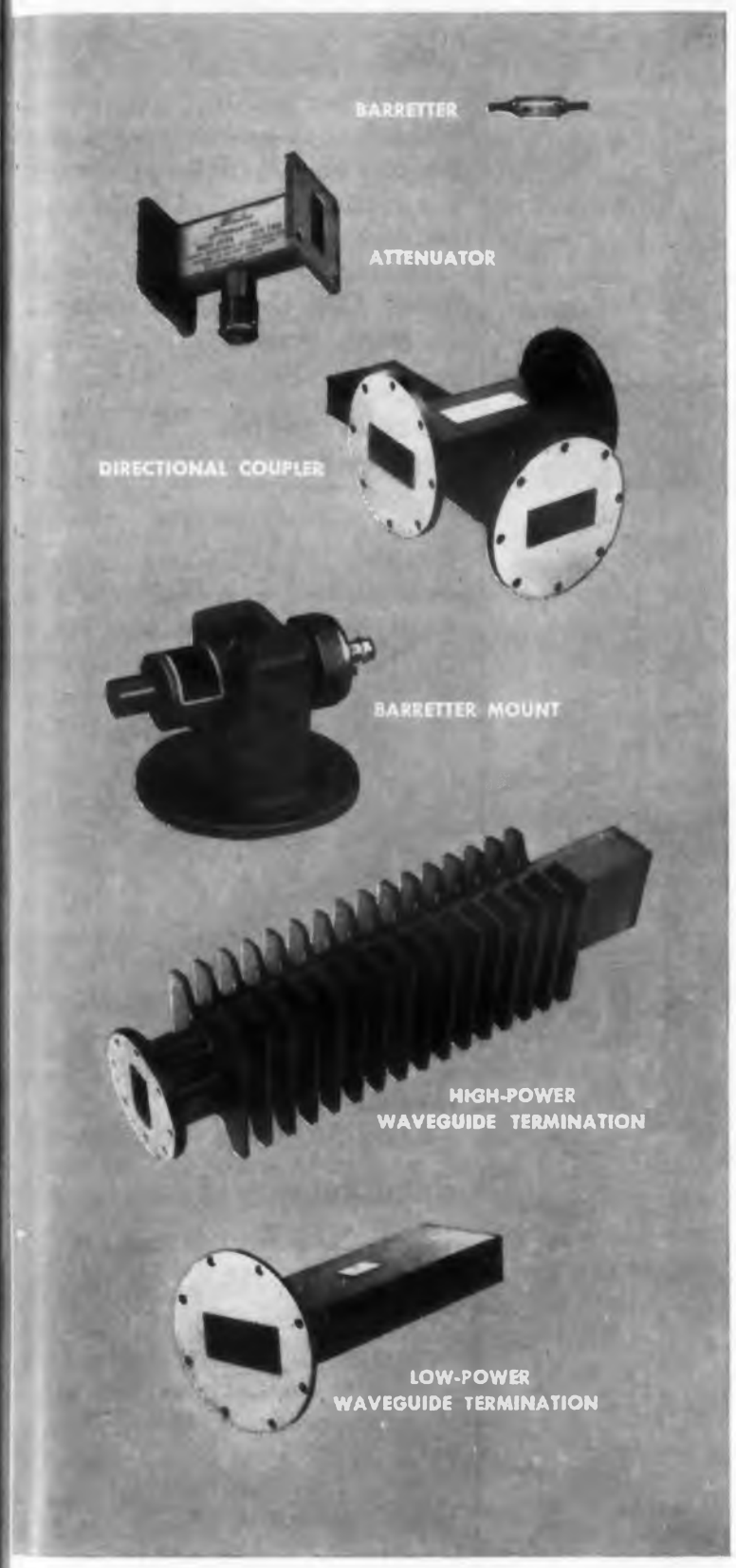
Composition Variable Resistor 471

Has 9/32-in. diam

Designed for miniature communication and test equipment, industrial applications, and micromodular applications, series M250 composition variable resistor has a 9/32-in. diam. Units come in sizes of 500 ohms to 10 meg, the power rating is 0.1 w at 40 C for linear taper, and the angle of rotation is 250 deg.

CTS of Asheville, Inc., Dept. ED, Skyland, N.C. ***Price & Availability:*** *in quantities of 1 to 499, $4.50 ea; 500 to 999, $3.50 ea; 1000 to 2499, $3.00; 2500 to 4900, $2.85; and 5000 and over, $2.75. Units are currently available in sample or production quantities.*

ect
:RMEASUREMENTS



BARRETTERS

Model	Nominal Resistance (ohms)	Price
825	200 for Peak Power Measurements	$ 14.
823	200 for Peak Power Measurements	14

ATTENUATORS

Model	Description	Frequency Range-kmc	Attenuation Range-db	Waveguide Size	Fittings	Price
134	Calibrated ± .5db	8.5-9.6	2-45	1"x½"	UG-39/U	$220
152A	Variable	8.1-12.4	0.5-20	1"x½"	UG-39/U	45
375A	Variable	12.4-18.0	1-15	0.702"x0.391"	UG-419/U	75
374A	Variable	26.5-40	1-20	0.360"x0.220"	UG-599/U	60

DIRECTIONAL COUPLERS

Model	Description	Frequency Range	Attenuation-db	Fittings	Price
517	⅞" Coaxial	.240-.480	30	UG-45/U*	$150
519	⅞" Coaxial	.480-.960	30	UG-46/U*	150
467	⅞" Coaxial	1.99-4.0	20-30-40	UG-45/U*	150
306	3"x1½" Waveguide	2.6-4.0	30	UG-214/U	100
544	3"x1½" Waveguide	2.6-4.0	40	UG-214/U	150
545	3"x1½" Waveguide	2.6-4.0	50	UG-214/U	150
233	2"x1" Waveguide	4.0-6.0	24	UG-149A/U	85
321	2"x1" Waveguide	4.0-6.0	30	UG-149A/U	125
322	2"x1" Waveguide	4.0-6.0	40	UG-149A/U	125
209	1½"x¾" Waveguide	5.3-8.1	24	UG-344/U	75
237	1½"x¾" Waveguide	5.3-8.1	30	UG-344/U	85
546	1¼"x⅝" Waveguide	7-10	30	UG-51/U	85
547	1¼"x⅝" Waveguide	7-10	40	UG-51/U	85
235	1"x1½" Waveguide	8.1-12.4	20	UG-39/U	65
419	1"x½" Waveguide	8.1-12.4	30	UG-39/U	65
234	1"x½" Waveguide	8.1-12.4	40	UG-39/U	65
388	0.702"x0.390" Waveguide	12.4-18.0	20	UG-419/U	65
413A	½"x¼" Waveguide	18.0-26.5	20	UG-595/U	65
414A	½"x¼" Waveguide	18.0-26.5	30	UG-595/U	65
405A	0.360"x0.220" Waveguide	26.5-36.0	20	UG-599/U	80
429A	0.360"x0.220" Waveguide	26.5-40.0	10	UG-599/U	85

*Input fitting. Main line output UG-45/U. Secondary line output, UG-46/U. Adapters (Models 352A and 217) convert these units to Type N.

BARRETTER MOUNTS

Model	Line Size	Barretter Type*	Frequency Range-kmc	Max. VSWR	Fittings Input	Fittings Output	Price
554	⅞" Coax.	811B/550T	.82-2.0	1.8/1.5	UG-46/U	BNC	$175
245	2"x1"	821B	3.7-4.5	1.5	UG-149A/U	UHF	35
184	1"x½"	821B	8.5-9.6	1.5	UG-39/U	UHF	70
423A	2"x1"	543T	5.0-5.9	1.5	UG-149/U	BNC	135
219C	1"x½"	—T	8.5-9.6	1.5	UG-39/U	BNC	130

*B-Barretter, T-Thermistor

HIGH-POWER WAVEGUIDE TERMINATIONS

Model	Size	Frequency (kmc)	Power Capacity Av. (w)	Power Capacity Peak (kw)	Max. VSWR	Fittings	Price
563	3"x½"	2.6-4.0	2200	2200	1.15	UG-534/U	$150
564	2"x1"	3.95-6.0	1500	1500	1.15	UG-407/U	140
565	1¼"x⅝"	7.0-10.0	350	350	1.15	UG-138/U	100
566	1"x½"	8.1-12.4	300	300	1.15	UG-135/U	85

LOW-POWER WAVEGUIDE TERMINATIONS

Model	Size	Frequency Range-kmc	Power Capacity	Max. VSWR	Fittings	Price
308	3"x1½"	2.6-4.0	1	1.04	UG-214/U	$ 40
370	0.702"x0.391"	12.4-18.0	0.5	1.05	UG-419/U	25
418A	½"x¼"	18.0-26.5	0.5	1.07	UG-595/U	30
369A	0.360"x0.220"	26.5-40.0	0.5	1.10	UG-599/U	35
637	⅞" Coaxial	.65-3.5	12	1.4	UG-46/U	55

SPERRY

CLEARWATER, FLORIDA • DIVISION OF SPERRY RAND CORPORATION

CIRCLE 53 ON READER-SERVICE CARD

Carrier Amplifier System 469

Designed for 20 kc

This transistorized 20-kc carrier amplifier system is for use with strain gages, reluctance pick-ups, and differential transformers. The modulated frequency response is flat within ±1% from dc to 3 kc, the over-all sensitivity is better than 1 mv, and the input impedance is about 450 ohms. Depending on the model, the output may be ±15 ma or 50 ma into a 50 ohm load. The linearity is better than 1%. The temperature range is 30 to 125 F. Adjustments are provided for calibration, attenuation, resistive and reactance balance, and gain and reference balance. Units can be furnished with a self-contained power supply.

Plug-In Instruments, Inc., Dept. ED, 1416 Lebanon Road, Nashville, Tenn.

Magnetic Multiplier 456

Miniature

Model MCM 515-1 magnetic multiplier is a miniature modulator made to deliver an analog ouput voltage which is the continuous product of two variable input voltages. One of these is the excitation voltage which varies from 0 to 1 v rms at 400 cps; the other is dc which varies between 0 and ±400 μa. The output voltage is 400 cps and is always in phase or 180 deg out of phase with the variable excitation or fixed reference. The output impedance is 3500 ohms, hysteresis is a maximum of 0.5% input control signal, and the suggested external load is about 25 K. There is less than 5% harmonic distortion in the output ac modulated envelope. The device weighs about 1 oz.

General Magnetics, Inc., Dept. ED, Bloomfield, N.J.

Price & Availability: *Price furnished on request; delivery is in 3 to 4 weeks.*

NEW PRODUCTS

Flow Control Transducer 513

Weighs 5 oz

Model 25 flow control transducer weighs 5 oz and is less than 1-1/2 in. high. Designed for high performance control systems operating within the range of 0.5 to 1 g per min, the unit has an operating pressure range to 4000 psi and a temperature range to 450 F. Hysteresis is a maximum of 3%. Parallel magnet design is used.

Hydraulic Research and Manufacturing Co., Dept. ED, 2835 N. Naomi St., Burbank, Calif.

Accelerometer Calibrator 486

Pendulum type

Model 160 pendulum calibrates accelerometers in the range of 1 to 4 g up to 5 lb with an accuracy of 1%. The instrument consists of a steel bar to be swung freely in a vertical plane about a horizontal shaft through the upper end, and mounts on a wall or any rigid upright member. Overall length of the calibrator is 48 in.

Instruments Div. of W. L. Maxson Corp., Dept. ED, 475 10th Ave., New York 18, N.Y.

Price & Availability: *Unit made on order only. Can be delivered 30 days after order is received. Price is $675 per unit.*

Reed Relays 566

1 to 2500-ohm coil resistance

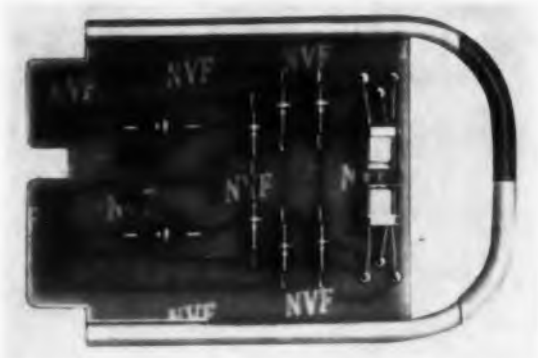
Available in frequencies from 20 to 1600 cps, model J-500 relay can be supplied in coil resistances from 1 to 2500 ohms. These units use a zero temperature coefficient reed to provide operation over a range of —40 to +85 C within 0.005% of design frequency. A magnet structure employs a ceramic ferromagnetic material to eliminate aging effects.

Security Devices Lab. Div of Sargent & Greenleaf, Inc., Dept. ED, Rochester 21, N.Y.

CIRCLE 54 ON READER-SERVICE CARD

Digital Module 356

Contains two inverter circuits



This dc inverter amplifier, model DI-101, contains two identical circuits with independent inputs and outputs. Each inverter circuit will drive up to 5 gate legs. Both input and output are direct-coupled, allowing cascading of the gates. With the input at ground, the output is about +15 v, depending on the load. When the input is +6 v or greater, the output goes to ground. Power requirements are −90 v, 0.5 ma, and +20 v, 1.5 ma.

Computer Control Co. Inc., Dept. ED, 983 Concord St., Framingham, Mass.

Environmental Chamber 466

Temperature range is −125 to +350 F

Model AF-1.5 −125 +350 mobile environmental chamber has a temperature range of −125 to +350 F. Temperatures can be lowered from +350 F down to −100 F in 50 min, and raised from −100 F to +350 F in 30 min. For use in research, testing and conditioning parts, the unit has an accuracy of ±2 deg F. Entrance ports at the door for instrument cables eliminate feed-through ports and terminal panels. Power requirements are 220 v, 60 cps, single-phase; or 220 or 440 v, three-phase. Included with the unit are: a 24 hr recording chart, interior lighting, multi-pane thermal glass assembly in the door, hermetically sealed heating elements, and safety controls. Interior dimensions are 14 x 14 x 14 in.; the unit needs 26 x 32 in. of floor space.

Webber Mfg. Co., Inc., Dept. ED. P.O. Box 217, Indianapolis 6, Ind.

NEW PRODUCTS

Flight Simulation Table 485

Tests missile or air-space craft systems

Flight testing of complete missile or air-space craft stabilization and control systems on the ground is possible with model 17A flight simulation table. Having 2 free axes, the table is also used for angularly displacing gyros and accelerometers in pitch and roll, either statically or dynamically. The natural frequency of each axis is more than 15 cps. Adjustable damping is provided and the threshold of each axis is less than 0.005 deg.

Micro Gee Products, Inc., Dept. ED, 6319 W. Slauson Ave., Culver City, Calif.

Price & Availability: *Unit available from stock and can be delivered less than 30 days after order is received. Price is $33,000.*

Comparators 555

Modular in construction

Called the Comparatron, this device performs continuous digital comparison of command and feedback signals and produces an analog drive signal. Two models are offered: one accepts up to two 24-bit parallel binary numbers, and the other up to two 24-bit parallel binary-coded decimal digits. Input data may be presented from a storage register, handset switches, or a shaft encoder. The output signal is 60 to 1000 cps error-modulated ac having an amplitude of 23 mv peak-to-peak per unit of error for the binary model and 15 mv peak-to-peak per unit of error for the binary-coded decimal model. Either model can be furnished with an integral power supply. Uses include inspection operations, and military areas such as fire control and navigation.

United Aircraft Corp., Norden Div., Dept. ED, 58 Commerce Rd., Stamford, Conn.

Price & Availability: *The price is $2000 fob Gardena, Calif. Delivery time is 90 days.*

CIRCLE 56 ON READER-SERVICE CARD

DU PONT
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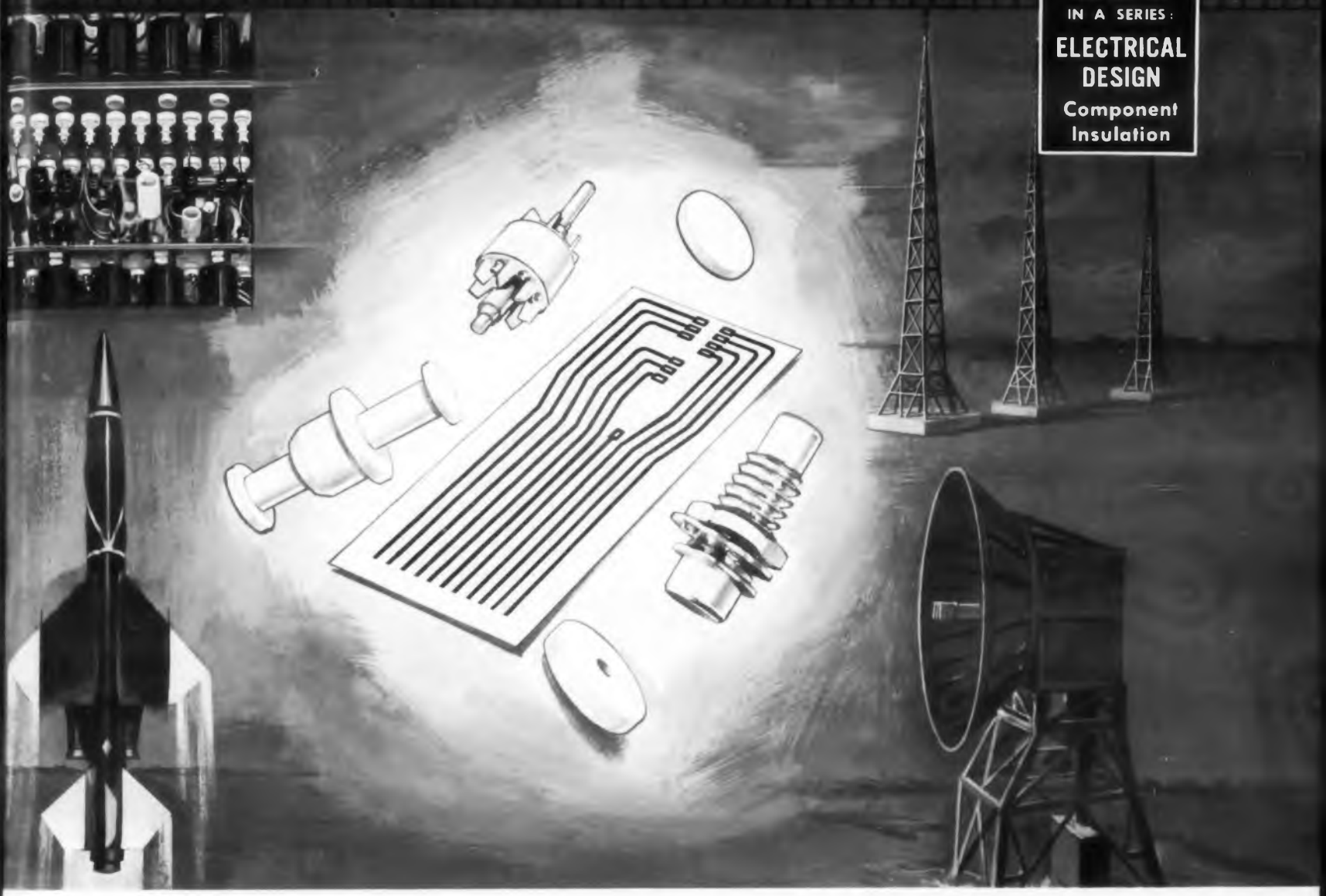
ENGINEERING FACTS ABOUT

TEFLON®

FLUOROCARBON RESINS

NUMBER E-7
IN A SERIES:
ELECTRICAL DESIGN
Component Insulation



TEFLON FEP resins open new avenues for electrical design

With the commercial availability of TEFLON 100 FEP resin —a new, melt-processible fluorocarbon resin—the family of TEFLON resins now offers electronic designers new opportunities for improved component design. Wherever outstanding electrical properties, exceptional thermal stability, savings in size and weight, and utmost safety and reliability in performance are called for, TEFLON fluorocarbon resins are the first choice of the designer. TFE-fluorocarbon resins are rated for continuous service at temperatures up to 500°F. For all operating temperatures between -200°F. and 400°F., FEP-fluorocarbon resins are suitable for continuous service. And because FEP resins can be molded and extruded by techniques commonly used with thermoplastic polymers, they extend the range of practical applications of TEFLON resins. FEP resins not only make possible the rapid fabrication of complex components, but also permit the melt extrusion of jackets for wire and cable and long, continuous lengths of wire insulation.

Electronic designers now have a wider opportunity than ever for miniaturizing components . . . simplifying assembly operations . . . reducing or eliminating maintenance costs . . . by use of TEFLON resins—the most dependable organic insulating materials known.

TEFLON is Du Pont's registered trademark for its family of fluorocarbon resins, including TFE (tetrafluoroethylene) resins and FEP (fluorinated ethylene propylene) resins.

OVER

TFE and FEP resins in a variety of forms offer utmost reliability under exacting conditions

The insulating spacers in coaxial couplers which sample RF in radar-jamming equipment must meet stringent requirements of performance and reliability. The spacers must have a low dielectric constant and low dissipation factor over an extreme range of frequencies, including the microwave region. They must withstand severe vibration without cracking. They must not absorb moisture. They must withstand high temperatures...and must be unaffected by aging. Du Pont TEFLON TFE resins meet all these requirements and were the natural choice for this exacting application.

Because FEP resins are heat-bondable to themselves and to many other materials, including TFE resins and copper, they now make possible improved design of printed circuits, both flexible and rigid. Film of FEP resin is an excellent cement for bonding copper to TFE resins and other materials because laminates so bonded will have the excellent surface electrical properties of the FEP resins plus the special properties – such as rigidity or economy–of the base material. And both the dielectric constant and dissipation factor of FEP and TFE resins are essentially invariant over the widest ranges of temperature and frequency.

The inherent properties of TEFLON fluorocarbon resins have firmly established them as outstanding materials in electrical design, whenever maximum reliability is important, and service conditions are demanding. These resins make possible savings during the manufacture of components, reduced inspection costs, fewer rejects, fewer service failures and lower maintenance costs. Even when ambient conditions are not extreme, the non-aging characteristics of TEFLON resins assure longer service and storage life of equipment.

Today, the unique properties of TEFLON resins are available to the designer in a wide variety of forms. Stock shapes of TEFLON fluorocarbon resins can be readily cut or machined. Fluidized bed coatings and rapid injection molding of complex shapes to close tolerances open new opportunities for the use of TEFLON FEP resins. Primary insulation and jacketing of TEFLON FEP resins for wire and cable can now be extruded in any desired length by standard melt extruders. With the availability of a family of TEFLON fluorocarbon resins, including new TEFLON FEP fluorocarbon resins, designers of electronic equipment are now free to take advantage of the unique properties offered by these resins in a wider variety of useful applications.

SEND FOR MORE INFORMATION

about the properties and applications of TEFLON resins, including additional data on the characteristics of the new FEP resin! Mention your area of interest. Address: E. I. du Pont de Nemours & Co. (Inc.) Polychemicals Dept. T-161, Room 2526, Wilmington 98, Delaware.

In Canada: Du Pont of Canada Limited, P. O. Box 660, Montreal, Quebec.

A variety of tiny electronic components such as feed-throughs, stand-offs, tube and diode sockets, and terminations like the missile connector above utilize the unsurpassed dielectric properties of both TFE-and FEP-fluorocarbon resins. The insulation resistance of all these resins is higher than that of any other solid insulation. Over a measured temperature range from −40°F. to 450°F., their volume resistivity is 10^{18} ohm-cm, surface resistivity is 10^{14} ohms/sq., over the widest range of frequencies.

Powder sintering of FEP resins now makes possible corrosion-resistant coatings in such applications as this rotor, encapsulation of diodes, slot liners, pump impellers, valves and other motor hardware. These fluidized bed coatings offer high-temperature resistance and a smooth, non-stick surface.

TEFLON

TFE-FLUROCARBON RESINS

DU PONT

REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

PC Connector 387

With wire wrap termination

This printed circuit connector with wire wrap termination maintains a positive contact with the printed circuit board over a dimensional range of 0.057 to 0.072 in. The 44 contacts are phosphor bronze with a silver plate of 0.0002 and 0.00003 gold plate finish. The connector can be polarized in any position by inserting the plastic polarizing key.

Cinch Manufacturing Co., Dept. ED, 1926 S. Homan Ave., Chicago 24, Ill.

Silicon Controlled Rectifiers 459

For applications requiring to 16 amp load current

Silicon controlled rectifiers, types X16RC2 through X16RC20, are for applications requiring load currents to 16 amp and blocking voltages from 20 to 200 v. They can be used for static switching, dc motor control, variable and regulated dc power supplies, welding control, ignitron firing, and other switching applications. They switch rapidly to a conducting state either when a signal is applied to the gate terminal or when the critical break-over voltage is exceeded. All units are hermetically sealed and have an all-over height of 1.615 in.

International Rectifier Corp., Dept. ED, 1521 E. Grand Ave., El Segundo, Calif.

Price & Availability: The approximate price range is $38 to $80 per unit, when ordered in quantities of 1 to 50. Delivery is in 6 to 8 weeks.

CIRCLE 850 ON READER-SERVICE CARD

CIRCLE 57 ON READER-SERVICE CARD

NEW PRODUCTS

Analog Computer 442

Solves Fourier integrals

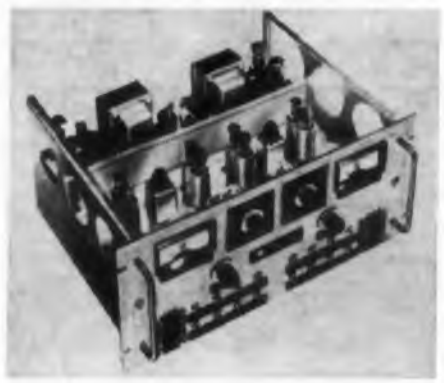
Model CF-1 analog computer is designed to solve Fourier integrals. It can be used to determine the far fields of aperture antennas from the distribution of the field in the aperture, the frequency spectra of voltage pulses, and other physical problems involving Fourier transforms and their inverse transforms over finite limits. Integration may be observed on a dc oscilloscope for interpretation or visual readout. In typical operation, a main lobe and four side lobes can be computed and recorded in 15 min. The unit weighs 325 lb and measures 46 x 25 x 22 in.

Scientific-Atlanta, Inc., Dept. ED, 2162 Piedmont Road, N.E., Atlanta 9, Ga.

Price & Availability: *Price is $9000 fob Atlanta, Ga. Units ordered now will be delivered by about April 1st. After April 1st, units will be produced in limited quantities and can be delivered in 6 to 8 weeks.*

Servo Controller 450

Has controller, servo amplifier and power supply



Comprised of a controller, servo amplifier and power supply, the series 800 servo controller performs summation, integration, and differentiation. The unit is adaptable to any form of start-up, operational and shut-down programming, and includes automatic, automatic balance, manual balance, and manual mode selections.

Compudyne Corp., Dept. ED, S. Warminster Rd., Hatboro, Pa.

Price & Availability: *Delivery within 60 to 90 days. Price on request.*

X-Y Recorder 455

Has built-in X-axis time base

Model 2D X-Y recorder has an integral ac-dc input and a built-in X-axis time base. Eliminating the need for an extra ac converter, it operates directly from a transducer. The dc ranges provide accuracy and resolution better than 0.2%. The input range is 7.5 mv to 150 v on the X-axis and 5 mv to 100 v on the Y-axis. The X-axis time base is 7.5 to 750 in five steps. The input resistance is 200,000 ohms per v. The pen speed for each axis is 20 in. per sec. The following accessories are available for use with the recorder: a digital character printer, a curve follower, a continuous roll chart transport, and a pull-through, tear-off chart transport.

F. L. Moseley Co., Dept. ED, 409 N. Fair Oaks Ave., Pasadena, Calif.

Price & Availability: *Price is $2350. Delivery time is 12 weeks.*

DC Power Supplies 616

Provide 0 to 36 v at up to 50 amp

These Magitran transistor-magnetic power supplies provide regulated outputs in the range of 0 to 36 v dc with current ratings up to 30 amp for model TR36-30M and up to 50 amp for model TR36-50M. For both units, the input is 105 to 125 v ac at 60 cps, line regulation is within ±0.05%, load regulation is less than 0.1%, and ripple is less than 2 mv. They have automatic protection against short circuits or transients either on an intermittent or continuous basis, and recover instantaneously without resetting of relays or changing of fuses.

Electronic Research Associates, Inc., Dept. ED, 67 Factory Place, Cedar Grove, N.J.

NEW PRODUCTS

Character Generator 393

Writes up to 40,000 characters per sec

Able to write up to 40,000 characters per sec, the transistorized Alphadyne character generator measures 6 x 6 x 6 in., and needs 5 w operating power. Its applications include electronic readout of navigational computers or other critical information concerning aircraft movements, in electronic conversion of mechanical readout devices, and in telemetry.

Skiatron Electronics and Television Corp., Dept. ED, 180 Varick St., New York 14, N.Y.

Miniature Speed Reducers 454

Maximum output torque is 35 oz-in.

Type U1 miniature precision speed reducers have a maximum rated output torque of 35 oz-in. The backlash through the entire train is less than 30 min, measured at the output shaft. These units have a diameter of about 15/16 in. Made to meet Mil specs, they have a size 10 frame and are offered with ratios of 9:1 to 3000:1. Ball bearings are used throughout.

PIC Design Corp., Dept. ED, 477 Atlantic Ave., E. Rockaway, L.I., N.Y.

Price & Availability: *Price range for types U1-1 to U1-15 is $66.60 to $125.10. Individual units are available from stock. When larger quantities are ordered, there is a reduction in price and 10 days to two weeks delivery time should be allowed.*

◀ CIRCLE 59 ON READER-SERVICE CARD

Legend Light Assembly 380

For airborne or ground support equipment

For use in airborne or ground support equipment, this legend light assembly can be mounted flush with the panel (allowing tandem arrangements), or it can be stacked vertically in rows to conserve space. It contains two MS 327 lamps and can be sealed against moisture. Lens faces are available in the following sizes (inches): 1-1/4 x 0.375; 1-11/16 x 0.425; 2-1/8 x 0.375.

Radar Relay Inc., Dept. ED, Santa Monica, Calif.

Frame Grid Pentodes 381

For TV applications

Designed for if amplification in TV circuits, these frame grid pentodes, types 6EH7/EF183 and 6EJ7/EF184, have high transconductance, low capacity and low feedback capacity. Transconductance of the 6EH7 is 125 μmho when the grid voltage is —19.5 v. With grid voltage at —2.5 v, transconductance of the 6EJ7 is 15,000 μmho. The gain-bandwidth product of these tubes measures 55% higher than conventional if tubes. Glass envelopes are used on both.

Amperex Electronics Corp., Dept. ED, 230 Duffy Ave., Hicksville, L.I., N.Y.

Altitude Test Chamber 393

Has 27 cu ft of test space

Model FH-27 temperature and altitude test chamber offers 27 cu ft of test space. Temperature ranges are —100 to +300 F and —100 to +500 F. The test chamber cools to —70 F in 38 min. It heats from —70 F to ambient temperature in 14 min, from ambient to +300 F in 20 min, and to +500 F in 45 min. It has hydraulic-action positive-vacuum door locks and strip-chart recording control of temperature. Applications include testing aircraft and missile components in actual flight simulation.

Conrad, Inc., Dept. ED, 141 Jefferson St., Holland, Mich.

CIRCLE 60 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Foot Switch 394

Is 1-3/4 in. high

Model CM6A footswitch measures 1-3/4 in. high, widens from 2-1/4 in. at the rear of the pedal to 3-1/2 in. in the front for the foot rest, and is 4-1/2 in. long. The standard housing is cast iron in a black wrinkle finish which can be modified to meet customer requirements. A sponge rubber base pad is used. The unit can have maintained or momentary action and cord-sets are assembled to meet individual specifications.

Vemaline Products Co., Dept. ED, P.O. Box 222, Hawthorne, N.J.

High Speed Printer 436

For computers and electronic data processing systems

Model 190-120 high-speed printer, for computers and electronic data processing systems, can operate at a speed of 900 lines per min with 120 characters to the line. It has 64 alpha-numeric characters. Containing its own firing circuits, it also has a magnetic drum. Able to make up to six carbon copies, the printer produces more than 250,000 lines per day without deterioration in quality.

Shepard Labs., Inc., Dept. ED, Summit, N.J.

Price & Availability: Price is $39,750 for each unit; a reduction is made when purchased in quantities. Delivery time is 120 days.

Readout Device 392

For use with multichannel analyzer

For use with the model 34 multichannel analyzer, model 44-7 add-punch offers punched paper and standard adding machine tape readouts of stored data. The system can be programmed for any computer code and the code may be easily altered.

Radiation Instrument Development Lab, Inc., Dept. ED, 5737 S. Halstead St., Chicago 21, Ill.

Strain Gage Control 398

Has 5 to 15 v dc output

Type PB-280 strain gage control is a combination power supply and bridge control. The power supply furnishes 5 to 15 v dc with a regulation of less than 0.05% for a 10% line change. The output impedance is less than 0.2 ohms. Ripple is less than 1 mv peak-to-peak. Bridge balance is by means of a high-resolution locking potentiometer. A rotary selector switch provides for shunt calibration at four points. The unit measures 2-3/4 x 4-3/8 x 15-1/4 in.

Owen Labs, Ind., Dept. ED, 55 Beacon Place, Pasadena, Calif.

Jerkmeter 433

Measures rate of change of acceleration

Designed to measure the rate of change of acceleration, model 4405 jerkmeter has principal applications related to missile and aircraft flight dynamics. The system consists of a transistorized accelerometer with integrator inserted into the servo loop in order to generate a jerk signal. Resolution and linearity at full scale are 0.1%. The unit weighs 3.5 oz. Dimensions are 3 x 1-1/2 x 1-5/8 in.

Donner Scientific Co., Dept. ED, Concord, Calif.

Price & Availability: Available from stock designs. Delivery 8 to 12 weeks after order received. Approximate price: $750.

Test Bench 377

To calibrate vacuum gages

Model 904 test bench is used to calibrate vacuum gages with ranges from atmosphere down to 10^{-5} mm Hg pressure. The apparatus consists of a 2 in. high vacuum pumping system complete with air drying column, pressure regulating needle valve, and liquid nitrogen traps; a vertical manifold with individually valved gage ports; a 3-range McLeod gage with associated CO_2 driven mercury system; and a precision manometer.

NRC Equipment Corp., Dept. ED, 160 Charlemont St., Newton 61, Mass.

CIRCLE 62 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Microwave Amplifier 461

Output is 10 mw from 10.5 to 16 mc

Model 549 microwave amplifier has broadband amplification with a gain of 30 db and a 10-mw output from 10.5 to 16 mc. In addition to am applications such as gating and pulsing, the grid may be used in agc circuits to level power output. Phase modulation may be accomplished through a front panel connector capacitively coupled to the TW tube helix. The unit weighs 33 lb and may be bench or rack mounted.

Alfred Electronics, Dept. ED, 897 Commercial St., Palo Alto, Calif.

Price & Availability: *Available within 30 days. Price is $3550, fob Palo Alto.*

DC Signal Amplifier 448

Output is 0 to 5 v dc

Model 1201 low level dc signal amplifier incorporates an adjustable network to adapt it to a range of sensor voltages and impedances. For all sensors, the output of the amplifier is 0 to 5 v dc. The output impedance is 1000 ohms max, the output linearity is ±1% of full scale ±50 mv, and the output ripple is 50 mv rms max. Zero drift is ±1% of full scale ±50 mv and the frequency response is 2 cps. The excitation voltage is 28 v dc; amplifier input impedance is 100 ohms per 1 mv input signal.

Lumen, Inc., Dept. ED, Moen Ave., P.O. Box 905, Joliet, Ill.

Price & Availability: *Price is by quotation only. Up to 100 units can be supplied in 6 weeks.*

Q Meter 620

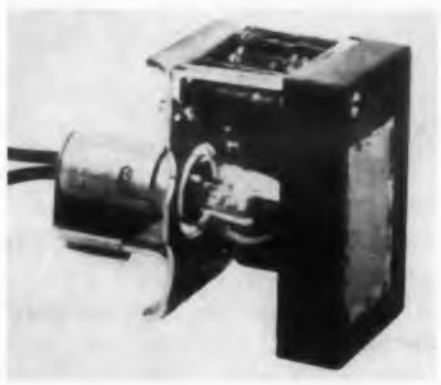
Measurements are read directly

Model VA-260 measures Q, capacitance and inductance over the range from 100 kc to 100 mc. All measurements are read directly and require no computation. A 5-in. mirrored scale meter, calibrated in Q values, covers the range 10 to 400, with accuracy to ±5% up to 50 mc. Test frequencies are covered in six steps with ±1% accuracy at all settings. Incremental capacitance range is 30 to 460 μμf to ±1%. Inductance measurements are made to a tolerance of ±5%, with residual inductance less than 0.03 μh. Self-contained in a slope front case, the unit measures 12-1/2 x 20 x 8-1/2 in. and weighs approximately 40 lb.

Republic Electronics Corp., Dept. ED, 111 Gazza Blvd., Farmingdale, L.I., N.Y.

Coincident Point Readout 352

Displays 16 characters per decade



This miniaturized coincident point readout, model CPR-16, is a direct binary-to-decimal decoding device which displays 16 individual illuminating intelligence characters per decade. Accepting voltage signals of a computer or similar device in the form of a four level binary code, the readout electromechanically converts these signals into decimal numbers or other intelligence characters. A single standard lamp illuminates the readout plates. All moving parts are enclosed in a dust and moisture free two-piece structure which measures 2.5 x 1.5 x 2-7/8 in. Readout characters are 1.2 in. high. Operation time is less than 100 msec.

Genesys Corp., Dept. ED, 10131 National Blvd., Los Angeles 34, Calif.

NEW PRODUCTS

Power Supplies 623

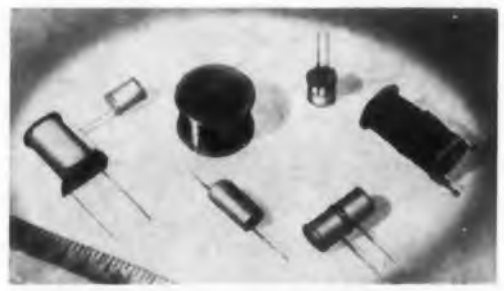
Provide from 5 to 50 v dc

As many as six of these transistor-regulated power supplies can be mounted on a standard 3.5-in. relay-rack panel. Sixteen different models are offered, covering from 5 to 50 v dc. Designed for supplying multiple strain gage or other transducer systems, these power supplies are individually isolated from ground and have outputs individually adjustable over a range of about 15%. The temperature coefficient for the output voltage is less than 0.02% per deg F and the leakage resistance to ground is greater than 100,000 meg.

Elcor, Inc., Dept. ED, 1225 W. Broad St., Falls Church, Va.

Coils 619

To satisfy customer specifications



This line of standard and miniature coils is manufactured to meet customer specifications. Included are relay coils, solenoid coils, precision chokes, MIL types, toroids, high temperature and fine wire coils.

Preferred Coils Inc., Box 14, Dept. ED, Highland Station, Springfield 9, Mass.

Digital Clock 615

For programming system functions

Type DY-2508A 24-hr digital clock is for programming system functions and for adding time information to data recording and processing. Time data for each second is supplied through

multiple relay contacts which can be wired to produce several staircase and decimal outputs simultaneously, or a binary-coded decimal output. The unit also presents a 24-hr in-line display with a resolution of 1 sec. Time information is supplied continuously. A memory circuit holds the time display up to 0.9 sec for completion of the external recording or processing function. The unit operates from an external 1-sec pulse train, an optional internal line-frequency divider, or a crystal-controlled time base.

Dymec, Div. of Hewlitt-Packard Co., 395 Page Mill Road, Palo Alto, Calif.

Generators 618

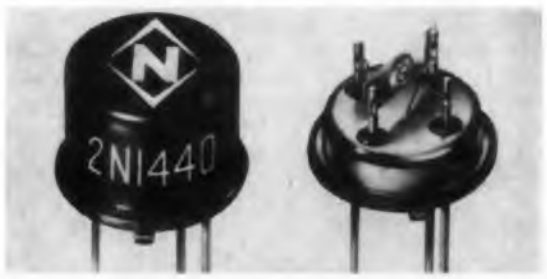
Operate from −55 to +125 C

These tachometer generators, type 6204-01, operate from −55 to +125 C. Rotor moment of inertia is 0.65. The continuous duty motor has 0.2 oz-in. minimum stall torque with approximately 5 w total input, 6000 rpm speed at no load, 26 v (fixed phase) and 40 v (control phase) rated voltage. The units have 26 v rms, 400 cps rated input voltage and 0.26 v rms output voltage at 1000 rpm.

John Oster Manufacturing Co., Avionic Div., Dept. ED, 1 Main St., Racine, Wis.

Silicon Transistors 363

Designed for small signal applications



Silicon transistors 2N1440, 2N1441, and 2N1442 are designed for small signal applications. Dissipation at 125 C in free air is 100 mw. For increased mechanical strength, wafer mounting tabs are welded to supports on both sides. The transistors are hermetically sealed and solderless in design. They exceed the requirements of MIL-T-19500 A.

National Semiconductor Corp., Dept. ED, Danbury, Conn.

NEW PRODUCTS

Microwave Absorber 351

For airborne applications

Eccosorb AN-W is a weatherproof, fuelproof, flexible foam microwave absorber for use outdoors or in situations where the absorber will be in contact with fuel, lubricants, or other hydraulic fluids. The material is extremely light making it suitable for airborne applications. Several absorbers are available in the range from L band through K band with maximum power reflections of 1% or 20 db down.

Emerson & Cuming Inc., Dept. ED, Canton, Mass.

Resistors 617

Are ceramic-encased

These ceramic-encased bathtub resistors are available in 5-w sizes of 5 to 6000 ohms and in 10-w sizes of 5 to 1500 ohms. Resistors having 4, 7, 15, and 20-w capacity are available on special order for original equipment manufacturers. All units have waterproof encapsulation.

Milwaukee Resistor Co., Dept. ED, 700 W. Virginia St., Milwaukee 4, Wis..

Delay Line 446

Ratio of rise time to total delay is less than 0.02

The 10T series delay line has a ratio of rise time to total delay of less than 0.02:1. Attenuation is less than 0.02 db for a 10-μsec delay. Two or more units can be connected in tandem when they have identical impedances. The temperature coefficient is less than 50 ppm per deg C. The

time delay per 10 sections ranges from 0.25 to 5 msec, the accuracy of delay is less than ±1.5%, and the characteristic impedances is 50 to 1000 ohms. All units meet Mil specs.

Ad-Yu Electronics Lab., Inc., Dept. ED, 249-259 Terhune Ave., Passaic, N.J.

Price & Availability: *Price ranges from $77 for a 20-section line to $277 for a 120-section line. Delivery is about two weeks after order.*

Motor Generator 420

Size 8

Type M863-05 size 8 integrating motor generator measures 2.5 in. in length. Thermistor-compensated, it provides an output of 0.5 v per 1000 rpm. Linearity is 0.06% from 0 to 3600 rpm. The no-load speed is 5500 rpm. Able to operate over the temperature range of −54 to +105 C, this compact unit is suitable for missile applications.

Kearfott Co., Inc., Dept. ED, 1500 Main Ave., Clifton, N.J.

Semiconductor Radiators 621

Have dissipation ratings of 5 to 100 w

For use wherever semiconductors require heat dissipators, the R-5000 series semiconductor radiators have a dissipation rating range from 5 to 100 w, with forced convection. The series is available in copper and aluminum. A surface machined flat to within 0.0002 in. is provided for mounting the semiconductors: transistors, rectifiers, or Zener diodes. Plastic shoulder washers are furnished for insulating the heat sink from its mounting.

Wakefield Engineering, Inc., Dept. ED, 11 Broadway, Wakefield, Mass.

NEW PRODUCTS

Tantalum Slug Capacitors 630

Are 15/32-in. long

Type SUB tantalum slug capacitors are 15/32-in. long and 3/16 in. in diam. These wet electrolytic capacitors have a range of capacitances from 1.75 to 30 μf and a work voltage range to 125 v. They have close tolerances and are made to stand extreme conditions of vibration, shock, and acceleration.

Ohmite Manufacturing Co., Dept. ED, 3667 W. Howard St., Skokie, Ill.

Differential Transducer 357

Has full range nonlinearity of 1%

Having a full range nonlinearity of 1%, this variable differential transducer operates at a frequency of 400 cps with repeatability of 0.01%. Type G series includes six models with 1/2-in. diameters and lengths of 1-1/2 to 17 in. Input voltage is 6.3 v to 24 v, depending on the model. The device is used for precision measurement and control in missiles, ground support equipment, aircraft, automation and laboratory applications.

Pacific ElectroKinetics, Dept. ED, 329 S. Vermont Ave., Glendora, Calif.

Rectilinear Transducer 361

Withstands rapid environmental changes

Developed for missiles engine testing and to withstand rapid temperature changes, this type KB rectilinear transducer is also adaptable to general aircraft, automation and industrial applications. Nonlinearity is 0.5% max or less in the rated range of 0.25 in. to 4 in. for the five models that measure from about 2 to 9-1/2 in. in length. Phaseshift is less than 10 deg with a 3 kc carrier.

The coils are encapsulated with an inert epoxy resin which seals the unit.

Crescent Engineering & Research Co., Dept. ED, 5440 N. Peck Rd., El Monte, Calif.

Pulse Delay 354

For use in sensing memory plains

Capable of driving the bases of three other transistors, this Delay B unit's applications are sensing memory plains, changing logical timing in a system and other uses where short delays are desired. The unit has a −4 v, 0.1 μsec pulse for both input and output. The delay increments are at 0.03 μsec each, and the 10 taps provide up to 0.3 μsec delay.

Harvey-Wells Electronics, Research and Development Div., Dept. ED, E. Natick Industrial Park, E. Natick, Mass.

Rate Integrating Gyro 452

Capable of high torquing rates

Designed for use as a control gyro in fire control or autopilot systems in missiles or supersonic aircraft, model M2514-01 rate integrating gyro has a maximum torquing rate of 54,000 deg per hr. A high viscosity damping fluid permits low temperature storage without detrimental effects to pig-tails. Short term vertical and azimuth drifts are 0.03 and 0.05 deg per hr, respectively.

Kearfott Co., Inc., Dept. ED, Little Falls, N.J. *Price & Availability: Available 90 days after order is received. Price on request.*

NEW PRODUCTS

Polystyrene Capacitors 592

Range is 0.001 to 0.68 mf

Type 820-UB polystyrene dielectric capacitors are rated at 100, 200, 400, and 600 v and from 0.001 to 0.68 μf. The temperature coefficient is less than 125 ppm per deg C. Having low dielectric absorption, a low dissipation factor and a high insulation resistance, the units are packaged in a case of phenolic molding with an endfill of moisture-tight epoxy compound. Applications are in computer and timing circuits as well as in precision test equipment.

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

Crimping Tool 402

For hand or bench operation

Designed to handle pins and sockets used in the firm's DS series miniatures, this pneumatic crimping tool may be used for hand or bench operations. Contacts are provided in disposable plastic cartridges which snap in or snap out of the tool. Two series of four indents are provided by the crimping action.

Deutsch Co., Dept. ED, Municipal Airport, Banning, Calif.

IF Bandpass Filter 614

Center frequency is 40 kc

Designed for video if strip applications, type BF-121 bandpass filter has a center frequency of 40 kc, a 1-db bandwidth of 3.4 kc, and a 50-db bandwidth of 22 kc. The input impedance is 51 K and the output is to the grid of the next strip stage. Special 1900-v dc terminals are used. Ripple in the passband is held to less than 0.5 db. Case dimensions are 1.5 x 2 x 4 in.

Control Electronics Co., Inc., Dept. ED, 10 Stepar Place, Huntington Station, L.I., N.Y.

Potentiometer 362

Available in ranges from 50 to 400 K ohms

This 1-13/16 in. ten-turn wirewound potentiometer, model 860, is available in ranges from 50 to 400 K, and up to 1 meg on request. Designed to operate over a temperature range of —55 to +105 C, the potentiometer has a standard linearity tolerance of ±0.25% with tolerances of ±0.020 on special order. Sleeve bearings at both shaft ends are standard. Shaft diameter is 1/4 in.

Spectrol Electronics Corp., Dept. ED, 1710 S. Del Mar Ave., San Gabriel, Calif.

Magnetic Splicing Tape 400

Has a Mylar film backing

Combining nonbleed characteristics with good holding qualities, this magnetic splicing tape has a Mylar film backing 1.5-mil thick. Tensile strength is 25 lb per in. width with adhesion at 35 to 40 oz per in.

Post Designs, Inc., Dept. ED, 7 Chester Drive, Great Neck, N.Y.

Power Supplies 613

Have outputs from 0 to 30 v dc

Transistorized power supplies series 200 and 300 are available with outputs from 0 to 30 v. They operate on 117 v (95-135), 60 cps, over an ambient temperature range of +10 to +140 F. Regulated for line, load and temperature variation, the supplies are short circuit proof with each channel independently fused. Internal impedance is 0.02 ohm to 15 v, and 0.04 ohm to 30 v dc. They are 3-1/2 in. high and are built for rack mounting with 6 units in a standard 19 in. rack.

Computer Engineering Associates, Inc., Dept. ED, 350 N. Halstead, Pasadena, Calif.

NEW PRODUCTS

Digital Circuit Kit 388

Has vibration and moisture resistant circuits

Type TDC transistor digital circuit kit has encapsulated, vibration and moisture resistant circuits that have high loading capabilities and low power requirements. Included are: gating circuits, signal forming circuits, a delay multivibrator, a flip-flop, and a lamp driver for indicating purposes. Applications of the kit are shift registers, binary counters, forward-backward binary counters, and half-adders. Easily accessible test points and in-line or tube-socket mounting are optional with the kit.

Epsco, Inc., Dept. ED, 275 Massachusetts Ave., Cambridge, Mass.

Differential Amplifier 364

Has remote differential input

This broadband dc amplifier, model 603, has 10^{14} ohms input impedance and a remote differential input. Its separate input head may be operated up to 24 ft from the amplifier or plugged directly onto the panel. Bandwidth is dc to 10 kc on the 2.5 mv range, rising to 50 kc on the 1000 mv range. There are nine ranges from 2.5 to 1000 mv, with precise gains up to 4000 and a 10 v output at 10 ma for full scale meter deflections.

Keithley Instruments, Inc., Dept. ED, 12415 Euclid Ave., Cleveland 6, Ohio.

Analog-to-Digital Converter 386

Translates data into cyclic binary form

Model S-G-500-1 servoed analog-to-digital converter translates latitude and longitude data into cyclic binary form. Each latitude and longitude section contains two 2-speed synchro transmitters, a 2^{15} analog-to-digital converter, and appropriate gearing. For applications not requiring 2^{15} resolution, the least significant tracks can be rendered inoperative. Resolution for latitude is one part in 16,384 with a total count of 8192. For longitude, it is one part in 16,384 with a total count of 16,384.

Kearfott Co. Inc., Dept. ED, Little Falls, N.J.

Cover 391

For open type relays

For use with class 66 relays, this dust cover is held in place around the relay and against the mounting strip, panel, or chassis by a rigid steel frame secured by screws. The cover measures about 1-7/8 x 2-1/8 x 2-21/32 in.

Magnecraft Electric Co., Dept. ED, 3350 W. Grand Ave., Chicago 51, Ill.

Desk Top Console 379

Front angled 15 deg from vertical

Measuring 13-5/8 or 18-7/8 in. in height and 21-7/8 in. in length, this console may be set up on a desk, cabinet or counter. The front is angled 15 deg from vertical; front to back base depth is 12-1/4 or 15-3/4 in., depending on panel height. Standard construction is steel; aluminum is available.

Western Devices, Inc., Dept. ED, 600 W. Florence Ave., Inglewood 1, Calif.

Wire Markers 376

For bundles 0.125 to over 0.5 in. diam

Made of polyvinyl chloride, type S and Z markers come in six standard colors and have a complete alphabetical and numerical range. Type Z markers are used for 0.125 in. diam bundles. Diameters over 0.5 in. will use type S. The markers comply with MIL-E-5400B and MIL-E-4158A.

Electrovert Inc., Dept. ED, 124 E. 40th St., New York 16, N.Y.

Foot Switches 371

Spdt and dpdt models

Model HT-52-D foot switch has a spdt action with a 20 amp rating at 125, 250, and 460 v ac. The HT-54-D has a dpdt operation with a 10-amp rating at 125 v ac and 5 amp at 250 v ac. Both models measure 3-1/2 x 2-1/2 x 1-1/4 in., have a steel housing and a skidproof sponge rubber base pad.

Linemaster Switch Corp., Dept. ED, 432 Woodstock Terrace, Woodstock, Conn.

CIRCLE 74 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Dielectric Coolant Pump 373

Weighs 21 oz

Designed for liquid cooling of electronic instrumentation and able to pump any dielectric fluid, this pump weighs 21 oz and has a 2 in. diam. Other applications include use as fuel transfer or booster fuel pump. It has carbon bearings and can run dry.

Task Corp., Dept. ED, 1009 E. Vermont Ave., Anaheim, Calif.

Panel Console 374

Has a 22-1/2 deg inclined panel

This 22-1/2 deg inclined panel console has ball cornered, aluminum casting joints. Sides, top and bottom, are made of 1/8-in. aluminum alloy, and structural members are of aluminum extrusions. Top, front and panel are drilled and tapped to accept standard rack panels. A reinforced rear door will support heavy components. The console is available in four sizes.

Bud Radio, Inc., Dept. ED, 2118 E. 55th St., Cleveland 3, Ohio.

Silicone Varnish 375

Cures in six hours at 150 C

This class H silicone dipping and impregnating varnish cures in six hours at 150 C. Supplied as 59% solids in diacetone alcohol, type 980 varnish has a higher flash point than xylene or toluene impregnating solutions. It meets AIEE requirements for use in 220 C systems.

Dow Corning Corp., Dept. ED, Midland, Mich.

Electrical Thermometer 435

Has accuracy of ±1 to 1.5 C

Suitable for laboratory or production line applications, the model T-1 electrical thermometer has a range of −20 to +180 C and is accurate to ±1 to 1.5 C. It operates through a probe 1/2 in. in diam

◀ CIRCLE 75 ON READER-SERVICE CARD

and 7 in. long that is connected to the instrument body by a 5 conductor cable approximately 30 in. long. Applications include measurement of electronic components surface temperatures.

Ameresco Inc., Dept. ED, 7 Center Ave., Little Falls, N.J.

Price & Availability: Units available from stock. Contact firm for price.

Fhp Motors 383

Are 2.2 in. wide and 2.66 in. high

Designated type KSB33-frame, these motors are rated from 1 to 20 mhp. They are single-phase, 115 v, 60 cps, 3000 rpm units and can be open or enclosed. The motors measure 2.2 in. in width and 2.66 in. in height. They may be used in electronic equipment fans, and other small fhp motor applications.

General Electric, Dept. ED, Schenectady 5, N.Y.

Silicone Rubber 382

Insulate cable and wire

Silicone rubber compounds K-1347 and K-1357 are low-shrink insulators for use with cable and wire. Both compounds are white, and can be color coded to desired shades. Type K-1347 is available in sheet form in 25 and 50 pound cartons. Type K-1357 comes in coiled strips for direct feed to the extruder.

Union Carbide Corp., Silicones Div., Dept. ED, 30 E. 42nd St., New York 17, N.Y.

Silicon Diodes 384

Maximum power rating is 300 mw

These diodes, designated MA-450A through MA-450E, feature reversible polarity by means of a base adaptor supplied with each diode. Cartridge shunt capacitance at 100 kc is about 0.4 μμf. Series lead inductance is less than 10^{-9} h. Power dissipation rating ranges between 300 mw for lowest cut-off types to 150 mw for highest cut-off types.

Microwave Assoc., Dept. ED, N.W. Industrial Park, Burlington, Mass.

CIRCLE 76 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Power Amplifier 462

For telemetry applications

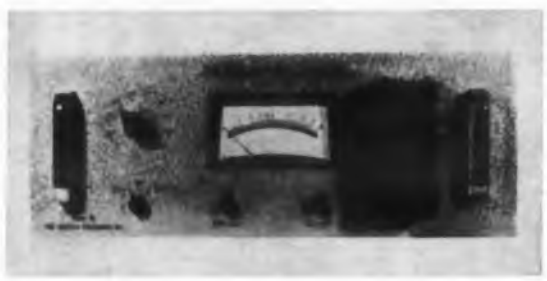
This 10-w amplifier withstands operating temperatures up to 200 F, an acceleration of 10 g, and a shock of 120 g. Designed for use in telemetry applications, it operates at all altitudes and exceeds MIL specifications for salt spray and dust. The amplifier uses low filament power, and has a push-pull grounded grid configuration. Its dimensions are 2 x 1-9/16 x 3 in. Weight is 9 oz.

United ElectroDynamics, Dept. ED, 200 Allendale Road, Pasadena, Calif.

Price & Availability: *Delivery is 30 to 45 days; price is $475 when ordered in quantities of 1 to 9.*

Wide Range Ohmmeter 368

For semiconductor testing



This rack-mounted wide range ohmmeter is especially suited to the measurement of semiconductors because of the low test potential applied to the specimen being tested. At one ohm, the power dissipated is 0.036 mw, and at 500 K it is 0.0004 μw. The self-heating phenomenon that is usual with thermistors is eliminated. The instrument has a range of 50 milliohms to 5000 meg, with center scale ranges of 0.5, 5, 50, and 500 ohms; 5, 50, and 500 K; and 5, 50, and 500 meg. Accuracy is about ±3% of scale length. The voltage applied to the sample is 30 mv at infinity, 15 mv at center scale, and 7.5 mv at quarter scale. The instrument can also be used for determining the resistance in moving coils of electrical indicating devices and for detecting low resistance copper paths, insulation leakage, and similar applications.

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

Power Supply 355

Current capacity is 0 to 25 amp

This transistorized power supply, model LQ5-32-25, has a voltage range of 5 to 32 v dc, and a current capacity of 0 to 25 amp. Line or load voltage regulation is within 50 mv, and ripple voltage is less than 2 mv. The output impedance of the power supply is less than 0.005 ohm. Dimensions for rack mounting are 12-1/4 x 19 x 14-3/4 in.

Universal Electronics Co., Dept. ED, 1720 22nd St., Santa Monica, Calif.

Rotary Switch 399

Used in counters

Model J low force rotary switch is suitable for installations requiring sensitive snap action operation such as in counters or coin-operated devices. It is rated at 5 amp, 120 to 240 v ac. The brass actuating shaft is drilled and slotted to accept the actuator wire.

Robertshaw-Fulton Controls Co., Dept. ED, Box 449, Columbus 16, Ohio.

Synchro Repeaters 358

Are mechanically damped

Units R925-1 and R925-21 are mechanically damped synchro repeaters that provide a line to line output voltage of 11.8 v. Designed to resist corrosion, the housing, shaft and ball bearings are stainless steel, and laminations are corrosion resistant nickel steel. The stainless steel housing also provides mechanical stability, positive grounding, and shielding. A variety of shaft configurations are available to suit desired applications.

Kearfott Co. Inc., Dept. ED, Little Falls, N.J.

NEW PRODUCTS

Subcarrier Oscillator 467

Weight is 2-1/2 oz

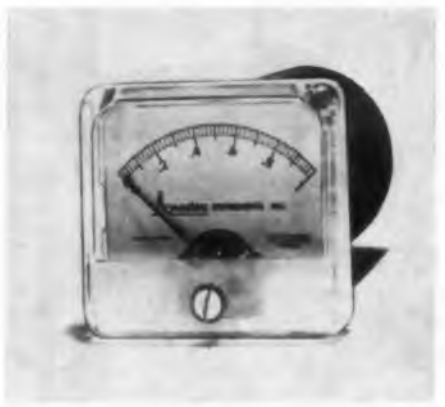
Measuring less than 3 cu in., and weighing 2-1/2 oz, model VC-11 RC phase-shift transistorized oscillator supplies an output of 3 v rms min into a 10-K load with 5 ma current drain at 20 v supply voltage. The unit operates over a temperature range of 32 to 160 F, and withstands shock and acceleration of 200 g. It is supplied for MIL-STD-442 bands 7 through 18.

United ElectroDynamics, Dept. ED, 200 Allendale Road, Pasadena, Calif.

Price & Availability: *90-day delivery. Price of unit with channels 7 to 17 is $240; with channel 18 it is $350.*

Pulse Rate Integrator 367

Output is a function of frequency only



Model PI-100 transistorized pulse rate integrator indicates the frequency or pulse rate from transducers such as flowmeters, tachometers, and similar frequency signal sources. The output is a function of frequency alone and does not vary with the amplitude of the input signal. Input sensitivity is 0.005 to 30 v rms with an input impedance of 20,000 ohms. The unit is small and combined with an integrally mounted 2.5-in. indicator. It operates with a high accuracy. Additional outputs can be furnished for remote meter indications, counters, and a 0 to 50-mv output with 0.25% accuracy.

Anadex Instruments, Inc., Dept. ED, 13758 Victory Blvd., Van Nuys, Calif.

Silicon Diodes 385

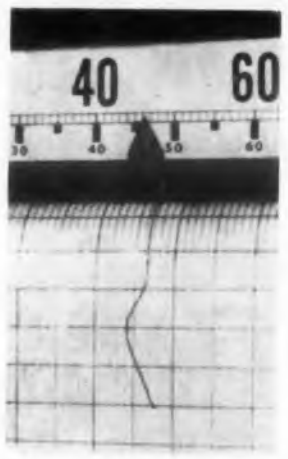
Rated at 600 mw

Fused silicon diodes 1N645 through 1N649 have a power dissipation rating at 25 C of 600 mw. Peak inverse voltage, at —65 to + 150 C, varies from 225 v for type 1N645 up to 600 v for type 1N649. The remaining types are rated at 100 v intervals. The units are designed for use in missile telemetering links, airborne radar, and communications gear.

Hughes Aircraft Co., Dept. ED, Newport Beach, Calif.

Pen 612

For recording and controlling instruments



This ball-point pen is designed for use with the Dynamaster electronic recording and controlling instruments. It can be used at chart speeds from 3/4 in. per hr to 240 in. per min, with instrument balancing speeds from 0.4 to 24 sec. The ink used can be reproduced on all standard office copying machines.

The Bristol Co., Dept. ED, Waterbury 20, Conn.

Galvanometer 389

Has 15 cm scale

The Scalamp portable galvanometer comes with a projection system and has a 15-cm scale. An automatic short circuit foot locks the coil when the instrument is lifted. Floating, shock-resistant mountings eliminate the need for critical leveling. The unit is enclosed in a dustproof case.

The Ealing Corp., Dept. ED, 33 University Road, Cambridge 38, Mass.

CIRCLE 811, 812 ON READER-SERVICE CARD ➤
CIRCLE 347 ON READER-SERVICE CARD

NEW PRODUCTS

Stepping Motor 483

Accuracy is 99.9999%

This stepping motor has a special clutch mechanism which permits the translation of pulses to incremental shaft positions with 99.9999% accuracy. The unit is available in uni-directional and bi-directional models having angular increments of 36 deg per pulse, up to 15 steps per sec, and a load capacity up to 2 lb-in. starting torque. Weight of the units is from 4 to 13 oz. They are used to rotate potentiometers, counters, rotary switches, tape advances, and control mechanisms.

G. H. Leland, Inc., Dept. ED, 123 Webster St., Dayton 2, Ohio.

Interval Timers 401

Push button, motor driven device

Series AT-36 push-button actuated, motor-driven interval timer has a housing of molded phenolic. All terminal and blade configurations are of heavy gage spring steel without welded or staked joints. The switch is rated at 28 amp or 1 hp at 250 v ac. The timer is available for 120 or 240 v operation at 50 or 60 cps with intervals of 30 sec and 1, 5, 10, 30, 60, or 120 min.

Haydon Div. of General Time Corp., Dept. ED, 245 E. Elm St., Torrington, Conn.

Power Supply 366

Output is 100 to 200 v dc

Designed to have excellent regulation characteristics and low thermal drift, model PS4023 power supply has an output of 100 to 200 v dc at up to 400 ma load current. The output voltage is selectable by a six-step range switch; a vernier potentiometer provides for the exact adjustment.

The input is 105 to 125 v at 57 to 63 cps or 380 to 420 cps. Regulation provides less than 0.03% change in the set output for any combination of input voltage or load current conditions. Thermal drift is held to less than 0.006% per deg C change in output voltage. Ripple and noise are less than 2.5 mv rms. Recovery time with the vernier set at the low end of the range is 20 msec; with the vernier at the high end, recovery time is 150 msec.

Power Sources, Inc., Dept. ED, Burlington, Mass.

Pilot Light 360

Measures 2-9/16 in. long, 1 in. in diam

Made of stainless steel and phenolic with an acrylic lens which provides side vision up to 180 deg, this tricolor pilot light measures 2-9/16 in. in length and 1 in. in diam. It uses three MS-25237, 327, or 328 lamps, 28 or 6 v. Each lamp may be wired individually. The light is completely enclosed and may be mounted on 1-1/8 in. centers.

Ronan Panel Co., Dept. ED, 8156 Orion Ave., Van Nuys, Calif.

Metallized Film 353

Is 0.000375 in. thick

Type CM cast Teflon film comes in a full range of thicknesses from 0.000375 in. to 0.004 in. True margins eliminate flash-overs which result from jagged margins or left-over deposits. The film can be metallized on one or both surfaces. Areas of application include transformers, reflectors, antenna circuitry, and high temperature electrostatic shielding.

Dilectrix Corp., Dept. ED, Allen Blvd. & Grand Ave., Farmingdale, N.Y.

NEW PRODUCTS

Miniature Connectors 363

Available in seven sizes

Available in square flange or bulkhead mounting receptacles, these miniature connectors with insertable or removable contacts come in 3, 7, 12, 19, 27, 37, and 61 shell sizes. Current rating is 7.5 amp for each contact. The connectors can be used at altitudes up to 110,000 ft and at temperatures from −67 to +300 F.

Deutsch Co., Dept. ED, Municipal Airport, Banning, Calif.

Connectors 503

For rf coaxial cable

For all standard sizes and types of coaxial cable, the Kellems spiral-wire cable grip gets tighter the more the cable is pulled. The woven wire retains complete flexibility of the cable to prevent excessive stress at the point where clamping stops. Pull is uniformly distributed. These light weight connectors are designed not to change the vswr.

Gremar Manufacturing Co., Inc., Dept. ED, 9 N. Wakefield Ave., Wakefield, Mass.

Electrometer 403

Full scale sensitivity is 10^{-12} amp

Accurate to 2% full scale from 10^{-3} to 10^{-7}, model E-105 electrometer has a full scale sensi-

vity of 10^{-12} amp. The unit uses double filament regulation to obtain long term stability. Some of its uses are back current measurement in silicon transistors, static discharge levels, and insulator and conductor leakage levels. Two of these instruments can be mounted in 3-1/2 in. on a standard relay rack.

Gyra Electronics Corp., Dept. ED, Box 184, LaGrange, Ill.

Price & Availability: Orders filled in 30 to 45 days. Price is $350 fob, LaGrange, Ill.

Cathode Ray Tube 405

Has 1 mil spot size

This 5-in. cathode ray tube, type 5CKP, has a 1 mil spot size, small-particle-size phosphor screen, and a precision ground and polished flat face-plate. Its molded accelerator lead permits use of 20 kv and operation at high altitudes. The tube weighs about 2 lb and uses conventional deflection and focus coils.

Allen B. DuMont Labs, Inc., Dept. ED, Clifton, N.J.

Price & Availability: Available from stock. Price is $400. Quantity discounts available.

Code and Switching Drums 369

Have imbedded circuitry

These code and switching drums are designed for use in automation, telemetering, and control devices in aerial and missile research. The process of imbedding circuitry conforms to and exceeds many Mil specs. The standard telemetering code drum has a code pattern capable of 207 character combinations. Also furnished are sequential code drums, cycle drums for aerial research, code character drums and special drums for individual requirements.

Beck's, Inc., Dept. ED, 300 E. Fifth St., St. Paul 1, Minn.

NEW LITERATURE

Transistorized Power Inverter 90

Transistorized power inverter model TPI-3, designed for power inversion in any airborne environment, is described in this two-page data sheet. Specifications, features, and a simplified circuit diagram are included. Southwestern Industrial Electronics Co., 10201 Westheimer Road, Box 22187, Houston 27, Tex.

Solenoid-Lock Mechanism 91

Application of a solenoid locking mechanism to the firm's standard rotary switches is described in one-page bulletin No. 18. Dimension drawings, photographs of a typical installation, and data on solenoid ratings are included. Electro Switch Corp., King Ave., Weymouth, Boston 88, Mass.

Choppers 92

Bulletin C-43 describes types 600 and 800 dpdt choppers for 400 and 60 cps operation. It illustrates typical circuit applications, internal construction, and terminal connections. The two-page bulletin includes dimensional data. Airpax Electronics, Inc., Cambridge Div., Cambridge, Md.

Power Connectors 93

This six-page, illustrated brochure gives specifications, outline dimensions, and general information on series 1900 miniature power connectors with center screwlock. This series has closed ring entry design contacts. Types include 152, 104, 78, and 34 contacts with a choice of solderless taper pin, solder cup, and solderless wire wrap terminations. Electronic Sales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N.Y.

Inverters 94

Information on the company's models 4309, 4311, and 4312 single and three-phase transistor inverters is contained in this 12-page booklet. Voltage regulation and frequency control under varied environmental conditions are discussed. In addition to an introduction into the theory of static inverters, diagrams and application notes are provided. Specifications include dimensions, weight, and efficiency at full load. Varo Manufacturing Co., Inc., 2201 Walnut St., Garland, Tex.

Annunciators 103

This 36-page, illustrated catalog provides data on the operation and application of annunciator systems for fields involving automation of automatic control. Photographs, diagrams, tabular data, and dimensional informations are included. The Scam Instrument Corp., 1811 W. Irving Park Road, Chicago 13, Ill.

Power Supplies 104

This four-page bulletin, GEA-6926, gives information on the firm's complete line of dc power supplies. Tube and semiconductor supplies, rated from 10 to 1000 kv, dc, and from milliampere values to 250 amp, are described. Data on silicon rectifier power supplies for electrostatic precipitation are included. Photographs are provided. General Electric Co., Schenectady 5, N.Y.

Vibration Meter 105

Designed for accurate measurement of velocity, displacement amplitude and acceleration of vibration, Model T-1A vibration meter is described and illustrated in this two-page data sheet. Included are the unit's specifications and applications. Southwestern Industrial Electronics Co., 10201 Westheimer, Box 22187, Houston, Tex.

Fluxes and Solders 106

Catalog C-1 contains a description of fluxes, solders and supplies for all soldering applications. Technical data and photographs of available products are included. Johnson Manufacturing Co., Inc., Mt. Vernon, Iowa.

Transducer Equipment 107

Strain gage and transducer input conditioning equipment is described and illustrated in this six-page, two-color folder. The conditioning equipment is designed for front-end use on multichannel data acquisition systems to convert the output of variable resistance transducers from a variable resistance to a controlled and calibrated millivolt signal. Bulletin BBUC959 also describes a line of models with provisions incorporated to form resistance bridges, apply measured voltage to each bridge, initially balance each bridge to zero and to calibrate and standardize the entire channel. The basic features of the fifteen standard models are shown on a two-page chart complete with specific notes keyed into the text. Input wiring techniques are explained and diagrammed. B & F Instruments, Inc., 3644 N. Lawrence St., Philadelphia 40, Pa.

NEW LITERATURE

Tantalum Slug Capacitors 113

Series TS wet electrolytic, tantalum slug capacitors are described in bulletin No. 1004, a one-page data sheet. Specifications are listed for capacitances ranging from 1.75 to 30 μf. Operating temperature range of the capacitors is −55 to +85 C. Ohmite Manufacturing Co., 3601 Howard St., Skokie, Ill.

Sensitive Relays 114

Bulletins 100 and 150, four-pages, illustrate and describe sensitive relays. Relays described range upward from 1 mw with contact arrangements from 1 Form C through 4 Form C. Input powers, contact ratings, coil resistance, enclosure dimensions, mounting arrangement, terminal styles, and weight are included. Photographs of the relays appear in the literature. General Automatic Corp., 12 Carlton Ave., Mountain View, Wayne, N.J.

Relays 115

General purpose and plate circuit relays are described in this two-page data sheet. Models RG and PC weigh 1-3/4 oz; models RGP and PCP weigh 2-1/2 oz. Coil and contact ratings are given. Bulletin No. 99 contains wiring diagrams and outline drawings. Artisan Electronics Corp., 171 Ridgedale Ave., Morristown, N.J.

Magnetic Memory Stacks 116

Bulletin 59-L, two-pages, describes the series 3000 apertured ferrite plate memory stacks, a line of miniature plug-in magnetic storage modules for use in high-speed, coincident current, random access memories and serial buffers. Capacity is from 356 to 4096 words and 4 to 16 bits per word. Complete specifications include the 150 ma half current drive and switching time of 1.75 μsec. Rese Engineering, Inc., 731 Arch St., Philadelphia 6, Pa.

Drafting Equipment 117

This 32-page book, "Functional Drafting" Supplement No. 2, deals with precision drafting equipment. Section headings include: The Drafting Table, Drafting Machines, Floor Space, Cost Reduction Factors, and Using A Drafting Machine. The illustrated book contains statistics on drafting efficiency and fatigue as affected by various types of equipment. Kuhlmann Straube Co., Ltd., Box 358, Oakville, Ont., Canada.

Electron Tube Directory

This 1960 edition lists tubes made by American firms. Receiving, television and special purpose tubes are listed by type number. Many discontinued tubes are included. *Write on company letterhead to Metropolitan Supply Co., Dept. ED, 1133 Broadway, New York 10, N.Y.*

Gasketing and Sealing Folder 121

"When You Need A Material With Extra Advantages" summarizes design and application data on the company's materials for high temperature, electrical and electronic insulation, and gasketing and sealing requirements. Rogers Corp., Rogers, Conn.

Video Tape 122

Bulletin No. 1, two pages, is the first in a monthly series involved with video tape. Storage and handling precautions, and physical and magnetic properties of tape No. 179 are covered. The tape is splice-free up to 5400 ft. Longer, special, or non-standard lengths have one splice per reel. A folder for file purposes is included. Minnesota Mining & Manufacturing Co., 900 Bush Ave., St. Paul 6, Minn.

Predetermining Counters 123

Several types of mechanical, electromagnetic, and photoelectric predetermining counters are described in this illustrated, four-page, two-color folder. The counters will register units and objects, linear lengths, angular movement, and other values. Outputs may be in the form of mechanical motion or an electrical impulse. Veeder-Root Inc., Hartford 2, Conn.

Transducer 124

Model 717 absolute pressure transducer is described in this two-page data sheet that includes specifications and dimensional information. The instrument employs a Bourdon tube design that eliminates mechanical linkage, bearings, and multiplication. Bourns Inc., 6135 Magnolia Ave., Riverside, Calif.

Relays

Folder No. R-200 contains 13 data sheets describing the firm's line of relays. Schematics and dimension drawings of the 5 and 10 amp relay series have been designed to meet one or more of the MIL-R-5757C, MIL-R-6106C, and MIL-R-25018 specifications. *Write on company letterhead to the Relay Div., Dept. ED, Electronic Specialty Co., Los Angeles 39, Calif.*

NEW LITERATURE

Servomotors 133

The firm's entire line of size 11 servomotors are described in this 16-page catalog. Units described include 115 v, 400 cps servomotors, adjustable velocity-damp and inertia-damp servomotors, and servomotor-rate generators. Electrical and mechanical specifications are outlined. Individual schematics and torque speed curves are included. Helipot Div., Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif.

Electronic Tachometer 134

A self-contained tachometer with an accuracy of better than 0.25% is described in bulletin No. F-53, two pages. The unit employs a combination of transistor and magnetic circuits that convert a signal input from a magnetic pickup into a current output which can be read directly on a meter scale calibrated in rpm. Airpax Electronics, Inc., Seminole Div., Fort Lauderdale, Fla.

Electronic Instruments

Instruments for electronic measurement and control are described in this illustrated 32-page catalog. Specifications and performance data are included for the firm's complete line. Schematic diagrams and application circuits, as well as information on electrometers and micromicroammeters, are also included. *Write on company letterhead to Keithley Instruments, Inc., Dept. ED, 12415 Euclid Ave., Cleveland 6, Ohio.*

Electronic Housings 135

The firm's line of modular electronic housings is described in this illustrated eight-page catalog, No. 100. Among the housings listed are: cabinet racks; sloping front consoles; instrument and turret cabinets; and equipment such as casters and sliding drawers. Complete dimensional descriptions and ordering charts are included in the booklet. Stantron Div., Wyco Metal Products, 6914 Beck Ave., N. Hollywood, Calif.

Magnetic Modulators 136

Seven models of miniaturized magnetic modulators are described in an illustrated six-page brochure. The units are designed for subminiature circuit assemblies and printed circuit card configurations. Specifications are presented in table form, and amplitude response curves for all models are included. General Magnetics, Inc., 135 Bloomfield Ave., Bloomfield, N.J.

Military Quartz Crystals 143

More than 50 military and scientific quartz crystals in all desired frequency ranges are listed in this four-page, illustrated catalog. In addition to such specifications as tolerances, temperature ranges, static capacity and resonance, diagrams and photographs of holder types are also shown. Scientific Radio Products, Inc., 2303 W. 8 St., Loveland, Colo.

Electric Ovens 144

This four-page, two-color brochure covers recirculating, miniature batch, mechanical convection, and other electric ovens made by the firm. Specifications for individual units include temperature ranges and control points. The ovens are for applications requiring temperatures to 1300 F. Blue M Electric Co., 138th & Chatham St., Blue Island, Ill.

Potentiometer Pressure Pickup 145

Bulletin 1604, two pages, describes and illustrates the firm's potentiometer pressure pickup for missile applications. Design features, specifications, a general description and dimensional diagram are included. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

Microwave Test Equipment 146

Attenuators, power bridges, frequency meters, power supplies, slotted sections, spectrum analyzers and dry calorimeters are described in four-page bulletin No. 300. A photograph of each unit is included. The last page categorizes microwave test equipment. Polytechnic Research and Development Co., 202 Tillary St., Brooklyn 1, N.Y.

Magnetic Tape Eraser 147

Designed to provide clean demagnetization of either direct or fm recorded tapes, this magnetic tape eraser is described and illustrated in the firm's one-page bulletin. Specifications are included. Southwestern Industrial Electronics Co., Div. of Dresser Industries, Inc., P. O. Box 22187, Houston 27, Tex.

Soldering Irons 148

Bulletin GED-3553, eight pages, describes and illustrates a line of soldering irons. Specific models (75-300 w, 60 w, 25 w and 12 w) are discussed. A table shows the results of high-speed melt tests on the firm's soldering irons and those of other manufacturers. General Electric Co., Schenectady 5, N.Y.

NEW LITERATURE

Limit Switches 154

This two-page data sheet, No. 166, describes two oil-tight maintained-contact yoke-actuator switches, types 206LS1 and 6LS1. Actuator heads of these switches may be mounted in four positions, 90 deg apart. The yoke actuator may be rotated 360 deg, positively locking in any position. Photographs, dimension drawings, mechanical characteristics, and electrical ratings are included in the data sheet. Micro Switch, Freeport, Ill.

Signal Generator 155

A description of model 238 pulsed signal generator appears in this two-page data sheet. The instrument produces pulse modulated signals of known levels and frequency in the 2160 to 2400 mc range. Its uses include testing of tropospheric scatter receivers, local oscillators for receivers, and drivers for transmitters. The bulletin contains specifications and a block diagram. General Measurements Co., Inc., 1108 Beacon St., Newton Highlands 61, Mass.

Power Transistors 156

Series 2N1031,A,B,C Power Transistors are described in this four-page data sheet that includes electrical characteristics, performance curves, and dimension outlines. The transistors constitute a series of 12 power transistors with a typical current gain of 40 at 10 amp dc and a maximum current rating of 15 amp dc. They are designed as high current switching transistors for dc-dc converter and dc-ac inverter circuits. Bendix Semiconductor Products, Long Branch, N.J.

Electronic High-Vacuum Pump 157

New leaflet describes a small permanent-appendage, electronic, high-vacuum pump identified as the UlteVac Series 110. Described with the pump is the model PS4 Ultek Power Supply designed to operate it. Specifications and a pressure vs. current chart are included. Literature is identified as Form 110-859. Ultek Corp., 920 Commercial St., Palo Alto, Calif.

Test Equipment 163

This 36-page catalog describes the company's complete line of equipment which measures the electrical characteristics of control synchros, torque synchros, and computing resolvers. The theory of operation, operating procedure, and specifications for each item of equipment are described in detail. Photographs and outline drawings are included. Theta Instrument Corp., 520 Victor St., Saddle Brook, N.J.

Motor and Actuator Catalog 164

Ac and dc motors, linear and rotary actuators, gear boxes, turbine controls and electro-mechanical systems are covered in this 36-page catalog, No. EE-100. Included are descriptions of specific applications of these devices on aircraft and missiles, as well as a complete section detailing the firm's motor frame sizes. Photographs and outline drawings for all units are included. *Write on company letterhead to EEMCO Div. of Electronic Specialty Co., Dept. ED, Los Angeles, Calif.*

Assembly Fasteners 165

The company's line of self-retaining assembly fasteners is described in this eight-page booklet. Included are fasteners for use in the installation of tubing and wiring. The booklet contains photographs. Robin Products, 27027 Groesbeck Highway, Warren, Mich.

Line Clamp 166

Engineering drawings and other illustrations appear in bulletin No. TA209G, a two-page data sheet that describes two models of the firm's hinged line clamps. They may be applied to electrical lines of 1/4 to 6 in. in diam. TA Manufacturing Corp., 4607 Alger St., Los Angeles, Calif.

Trimming Potentiometers 167

Test data of the series 50 ceramic metal trimming potentiometer appears in this 16-page booklet. Test results appear in tables. Among the tests are acceleration, altitude, fungus, humidity, and load life. Helipot Div. of Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif.

NEW LITERATURE

Connectors 173

This two-page catalog illustrates and lists connectors now in production for delivery of 18, 20 and 22 shell size configurations. Features, materials, contacts and ordering information are included. Burndy Corp., H. H. Buggie Div., Toledo 1, Ohio.

Electronic Control Unit 174

An electronic control unit that automatically stops injection molding machines when molds are closing improperly is described in this two-page bulletin. The device does not slow the normal molding cycle. After installation, no settings or adjustments are required. Wintriss, Inc., 20 Vandam St., New York 13, N.Y.

Power Packs 175

A description, illustration and features of high voltage, miniaturized, solid state power packs appear in one-page catalog No. 116. The sheet lists available model types with their specifications and current prices. Electronic Research Associates, Inc., 67 Factory Place, Cedar Grove, N.J.

Temperature Indicators 176

Crayon, liquid, and pellet temperature indicators are described in this five-page folder, No. 5905. Temperature ranges for each type of indicator are given in Fahrenheit and Centigrade equivalent tables. Accuracy of ±1% is possible with the indicators. Tempil Corp., 132 W. 22nd St., New York 11, N.Y.

Power Supply 177

Model PS4000C transistorized power supply for general purpose use is described in this one-page data sheet. The unit has silicon rectifiers, a transistor regulator requiring no dc fuse, and a temperature-compensated silicon diode voltage reference. The sheet contains electrical and mechanical specifications. Power Sources, Inc., Burlington, Mass.

Magnetic Clutches 178

This 18-page booklet presents information on design, applications, and technical and testing specifications for magnetic clutches. PIC Design Corp., Subsidiary of Benrus Watch Co., Inc., 477 Atlantic Ave., E. Rockaway, N.Y.

Time Delay Relays 183

Eighteen standard electronic time delay relays including factory preset, internally adjustable and externally adjustable units are covered in this eight-page, illustrated bulletin. Delayed pull-in, delayed drop-out maintained and delayed drop-out momentary operation are discussed. Specifications and dimensional diagrams also appear. Master Specialties Co., 956 E. 108 St., Los Angeles 59, Calif.

Silver Zinc Battery System 184

This six-page, illustrated brochure describes a silver-zinc battery system which combines the features of primary and secondary battery types. Electrical and physical characteristics, construction and application data for the reusable primary batteries are given. Graphs and charts contrast the performance of this system with other battery systems. Yardney Electric Corp., 40-50 Leonard St., New York 13, N.Y.

Pressure Cut-off 185

Operation, maintenance, specifications and a description of the firm's pressure cut-off for simultaneous control of up to 30 pressure lines appear in two-page, illustrated bulletin 103. Dimensional diagrams and a wiring diagram are included. An external dc power supply and a suppression circuit are also covered. Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.

Servo Construction System 186

A servo breadboarding system that reduces production time is described in this 12-page, illustrated brochure. Basic components, stock parts, system kits, a schematic diagram and a grid layout are included. Specifications and dimensional diagrams for step motors and transmitters also appear. Gap Instrument Corp., 116 Merrick Road, Freeport, N.Y.

Fasteners 187

Self-locking fasteners are described and illustrated in this 20-page catalog. Dimensional diagrams, uses and coding for heavy-duty, light-duty and double-ended spacer nut plates are included. In addition to diagrams of typical equipment installations, the catalog also provides vibration test data, strength and weight data and drafting templates for the fasteners. Advantages, applications, installation tools and photographs of nylon flip grommets also appear. Western Sky Industries, 21301 Cloud Way, Hayward, Calif.

NEW LITERATURE

Resin Selector Charts 192

Selector charts for potting compounds, coatings, foams and bonding agents appear in bulletin No. 121, four-pages. The charts show hard, semi-rigid, and flexible formulations for various processing applications. Illustration and coating are provided. Plastic Assoc., 185 Mountain Road, Laguna Beach, Calif.

Frequency Meters 193

Miniature, switchboard, and portable type frequency meters are described in bulletin No. 32-99, 20-pages. The meters are available in various ranges between 10 and 1700 cps and signal voltages from millivolts upwards. They are designed for continuous operation and are independent of waveform and exact input voltage. Specifications of each meter are given. Dimensions are shown in outline drawings. Photographs are included. James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa.

Plastic Fabrication 194

Machining of plastic sheets, rods and tubes for electronic equipment is illustrated in this four-page folder. Sanding, milling, and inspection operations are shown through photographs. Insulating Fabricators Inc., 150 Union Ave., E. Rutherford, N.J.

Laminated Plastic 195

Available grades and properties of a variety of laminated plastic sheets, rods and tubes are listed in this 20-page catalog. Typical applications are illustrated, and fabricating and finishing information is included. Some of the laminate grades described are: phenolics, melamines, epoxies and silicones with paper, asbestos, canvas, cotton, nylon, and glass fabric bases. Copper-clad laminates for printed circuits are included. Physical and electrical characteristics are given in tabulated form. The catalog contains photographs. Cadillac Plastic & Chemical Co., 15111 Second Ave., Detroit 3, Mich.

Magnetic Shielding 202

Data sheet No. 151 explains how magnetic shield enclosures simplify the evaluation of test data by eliminating factors introduced by magnetic fields radiated by vibration exciter units. The data sheet provides photographs and an outline drawing. Magnetic Shield Div., Perfection Mica Co., 1322 N. Elston Ave., Chicago 22, Ill.

Control Devices 203

Wiring diagrams, dimension and application information for the company's complete line of control devices appear in this 72-page catalog. The illustrated book contains hp selection charts for motors from 1/4 through 200 hp, providing quick selection of starters, heaters and push button stations necessary for control of these motors. Included are complete product description of motor starters (both manual and magnetic), contactors, relays, solenoids, limit switches, push buttons, static control and pilot devices. Pricing tables are included in catalog No. GEC-1260D. General Electric Co., Schenectady 5, N.Y.

Test Equipment 204

Bulletin 500-T, four-pages with five individual flyers, describes transistorized test equipment, power measuring equipment and microwave instrumentation. The catalog gives brief descriptions and the individual specification sheets give complete data on the following instruments: model 500 waveform generator; model 504 transistor curve tracer; model 701-B klystron power supply; model 100-X peak power test set; and model MC-1B calorimetric wattmeter. Cubic Corp., 5575 Kearney Villa Road, San Diego 11, Calif.

Transducers 205

Model 304 gage pressure transducer is described in this two-page data sheet. The unit uses a Bourdon tube as the pressure sensing element and offers a selection of beryllium copper, stainless steel, and Ni-Span-C assemblies. Uses include control, telemetering or remote recording circuits. The data sheet contains specifications, outline drawings, and performance curves. Bourns, Inc., 6135 Magnolia Ave., Riverside, Calif.

NEW LITERATURE

Electroforming 213

This one-page technical newsletter published "on occasion" by the firm discusses developments in the field of electroforming–the process of building structural parts of electro-deposition. Issue No. 1 describes electroforming as a method of fabrication for antenna components. Allied Record Manufacturing Co., Research and Engineering Div., 6916 Santa Monica Blvd., Los Angeles 38, Calif.

Relays 214

Operating characteristics of the firm's complete line of relays are given in this four-page folder. The listings itemize data of varied types of relays –sensitive, antenna, medium power, hermetically sealed, telephone and microminiature. Photographs are included. Kurman Electric Co., 191 Newel St., Brooklyn, N.Y.

Magnetic Tape Recorder 215

Details of an airborne and mobile tape recorder are presented in this four-page illustrated bulletin, No. 1607. The recorder, which comes in 7 or 14 track models, is designed for high-altitude operation and a temperature range from −54 to +71 C. Specifications and operating description are included. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

Mechanical Fasteners 216

This 12-page, two-color brochure describes the complete company line of mechanical fasteners and special cold headed parts. Illustrations of lockbolts, fasteners, tubular and blind rivets, setting machines, and a variety of solid rivets are included. The brochure contains photographs. Townsend Co., Engineered Fasteners Div., Box 71-Z, Ellwood City, Pa.

Germanium Diodes 217

The company's complete line of germanium gold bonded diodes is described in this 10-page brochure, GD-40. They have a permanent weld-bonded solid gold whisker, germanium crystal, and flexible tinned leads. Specifications and characteristic forward and reverse curves are included. A guide to the use of the specifications and suggestions on the selection of diodes are contained in the brochure. Photographs are also included. General Transistor Corp., 91-27 138th Place, Jamaica 35, N.Y.

CIRCLE 222 ON READER-SERVICE CARD

Batteries for Transistor Applications 223

Technical data on single and multiple-voltage type batteries for transistor applications appear in this 12-page booklet, No. TBA-107A. Tabulated material includes voltage, dimensions, weight, number and type of cells. The batteries are designed for use in compact portable radio receivers, communications equipment, and other applications utilizing transistors. In addition to performance curves, terminal and socket patterns are illustrated. Radio Corp. of America, Semiconductor and Materials Div., Somerville, N.J.

Wide-Band Transformers 224

Illustrated bulletin 64-A, 19 pages, covers wide-band transistor transformers which are designed for use as coupling and impedance matching transformers. Features, dimensional diagrams and turns ratios for the 58-series, one-watt; the 65-series, half-watt; and the 70-series, half-watt units are included. Power ratings, operating temperature range, frequency response and distortion are discussed. Aladdin Electronics, Div. of Aladdin Industries, Inc., Nashville 10, Tenn.

Encoders 225

This two-page data sheet, No. 001, contains information on the firm's line of encoders. Arabic decimal to cyclic decimal conversion and binary coding are discussed and illustrated. Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.

Backward Wave Oscillators 226

Voltage and modulation requirements needed to power backward wave oscillators are discussed in this eight-page booklet, entitled "Power Supply Requirements of BWO Tubes." The book describes theory and operation of M and O type tubes. Relationships between power output, frequency shift, and delay line current are graphically presented. Included is a discussion of the model 813 BWO/TWT power supply. Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N.Y.

Microwave Couplers 227

Thirty types of microwave directional couplers are illustrated in this six-page brochure. In addition to mechanical dimensions for each of the units, their design and electrical performance data are discussed. Custom designed types are displayed and their functions outlined together with suggestions for submitting specification data for special assemblies. Waveline Inc., Caldwell, N.J.

CIRCLE 228 ON READER-SERVICE CARD

High Differential Monitor Detects Out-of-Bounds Voltage

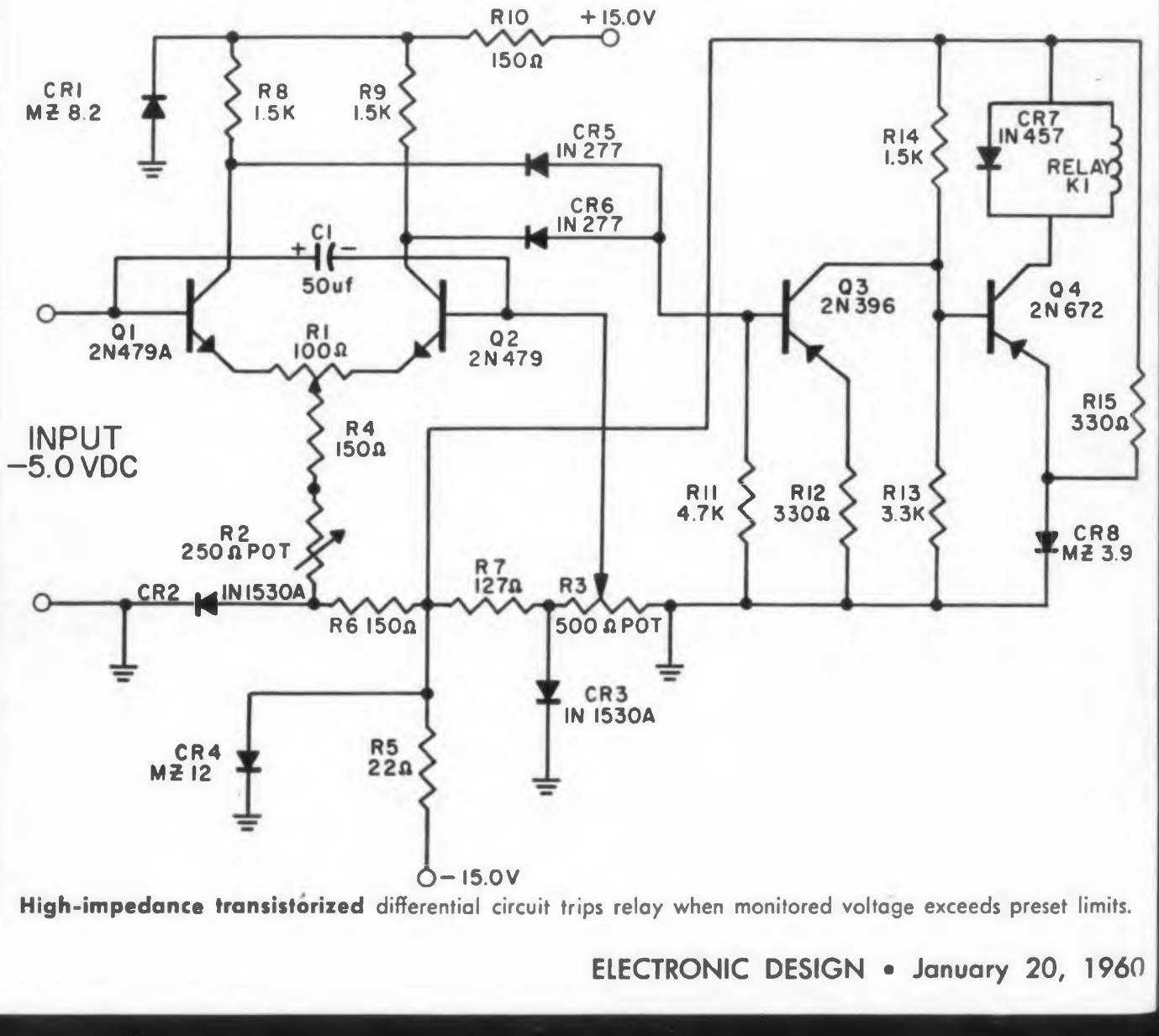
A VOLTAGE sensing circuit was desired to sense an error voltage of either polarity and give an indication that the voltage had surpassed pre-established limits. In addition, the circuit had to be:

1. Small size
2. Reliable
3. Fail-safe
4. Temperature stabilized
5. Low drift sensitive
6. Fairly high in its input impedance.

Circuits of this type are used in monitoring circuit faults, or as part of automatic checkout equipment. Many types of circuits were investigated, but the differential type consistently satisfied the above criteria.

The basic differential monitor consists of a differential stage followed by a two-stage relay driver. The diagram illustrates a circuit intended to monitor negative input voltages. Transistors *Q*1 and *Q*2 are npn types while *Q*3 and *Q*4 are pnp types. A negative reference is provided by *CR*3.

A revised version of this circuit can be used to



High-impedance transistorized differential circuit trips relay when monitored voltage exceeds preset limits.

monitor positive input voltages. In this circuit, $Q1$ and $Q2$ are pnp types, and $Q3$ and $Q4$ are npn types. In addition, all power supplies and diodes are reversed, resulting in a positive reference at $CR3$. Otherwise, the differences between the two circuits are insignificant.

The circuit as shown is designed to monitor a minimum voltage of —5 v to a tolerance of ±5 per cent with an accuracy of 25 mv. The input impedance of the monitor is approximately 50 K. For this reason, it should not be used to monitor a circuit with less than a 5 K impedance.

If the nominal voltage to be monitored is larger than 5 v, then it is necessary to use a voltage divider, as the circuits are designed to work with a nominal input of 5 v dc. Inputs with higher or lower output impedance than that recommended may be monitored at the discretion of the user. However, it must be remembered that due to the bootstrapping from $Q1$ to $Q2$, approximately 3.9 v are present at base of $Q1$ when there is no input.

The input impedance varies as follows:

Circuit	Input Voltage	Input Impedance
negative monitor (shown)	—4.75 v	50 K
	—5.00 v	170 K
	—5.25 v	175 K
positive monitor	+4.75 v	82 K
	+5.00 v	139 K
	+5.25 v	350 K

Null Stability is held to a level no greater than 25 mv between 10 deg C and 40 deg C with power supply variations of ±5 per cent. Component interchangeability is achieved by means of double regulation of the critical reference voltage and the choice of temperature stable complementary diodes throughout. Changes due to h_{FE} and I_{CO} are substantially nullified by the common mode rejection of $Q1$ and $Q2$ as well as by the complementary symmetry arrangement of the circuitry.

Operating points of the circuit are set by the three potentiometers, R_1, R_2 and R_3. To set these adjustments, all three are set to mid-range and an input voltage of —4 v dc or less is applied. R_3 is adjusted for —5.25 v dc at its wiper. When the input voltage is raised to —5 v dc, relay K_1 will pick up. The lower drop-out voltage is then set to —4.75 v dc by means of R_1 and the upper drop-out voltage to —5.25 v dc by means of R_2.

Joseph T. Moses, Specialist, General Electric Co., Syracuse, N. Y.

IDEAS FOR DESIGN

Zener Provides Initial Sweep Step

In many sweep circuit applications, there is a need for an initial jump, or pedestal, along with a linear sweep. The usual circuit to obtain such a waveform includes a resistor in series with a timing capacitor. The disadvantage of this arrangement is a longer flyback time. The discharge time constant, τ_d, is increased by the added resistor, Fig. 1.

A circuit which eliminates this increased flyback time but provides an initial step is illustrated in Fig. 2. The flyback time constant is $\tau_d = (R_{SW} + R_Z)\, C_T$ but in most cases, $R_Z \ll R_{SW}$ [or at least $R_Z \ll R_{STEP}$] so $\tau \cong R_{SW}$. The initial step is now equal to the Zener diode breakdown voltage.

Joseph R. Kotlarski, Electrical Engineer, Hughes Aircraft Co., Bldg. 12, M.S. 1323, Culver City, Calif.

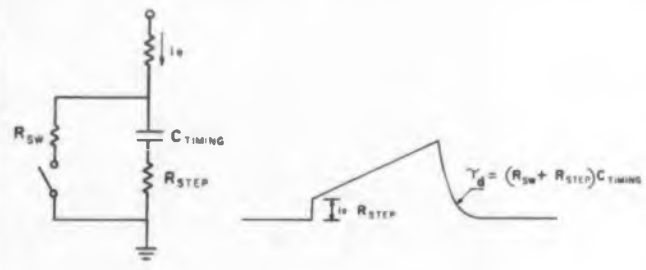


Fig. 1. Usual sweep circuit, with initial step resistor, has increased flyback time.

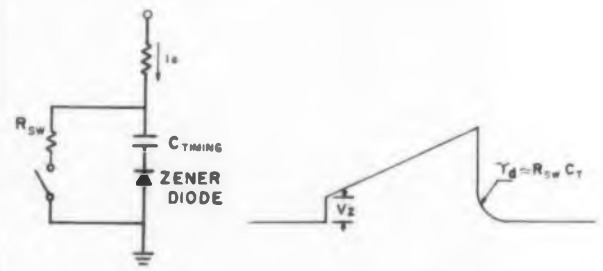


Fig. 2. Zener diode produces initial step with decreased flyback time.

Rotate Waveforms for Effective Values

The effective value, I_E, of a waveform $i(t)$ over a period T is given by the formula

$$I_E{}^2 = \frac{1}{T}\int_o^T i^2(t)\, dt \qquad (1)$$

Multiplying both sides by the product of the period by π yields:

$$\pi\, I_E{}^2\, T = \int_o^T \pi\, i^2(t)\, dt. \qquad (2)$$

As shown in Fig. 1, the right-hand side of Eq. (2) is the volume obtained by rotating the waveform $i(t)$ about the time axis. The left-hand side of Eq. (2) is the volume of a cylinder of radius 'I_E' and height 'T'. This principle is put to use in the following example, where the effective value of the waveform shown in Fig. 2 is calculated.

The waveform is first divided into the four sections shown. It is seen that upon rotation, Sections I, III, and IV yield right circular cones, while Section II yields a right circular cylinder. The respective volumes are:

$$V_I = \frac{1}{3}\pi\,(2)^2\,(2), \quad V_{II} = \pi\,(2)^2\,(3),$$

$$V_{III} = \frac{1}{3}\pi\,(2)^2\,(3), \quad V_{IV} = \frac{1}{3}\pi\left(\frac{2}{3}\right)^2 (1)$$

The total volume is:

$$\frac{8}{3}\pi + 12\,\pi + 4\,\pi = \frac{4}{27}\pi = 18\frac{22}{27}\pi$$

Therefore

$$\pi\,I_E{}^2\,(9) = 18\frac{22}{27}\pi$$

$$I_E{}^2 = 2.09, \; I_E = 1.44$$

It is noted that π need not always be multiplied into the calculation, since it often cancels out, as in the given example.

If portions of the waveform do not yield an easily recognized rotated volume, the volumes may be determined by calculus methods. The result is then substituted in the total volume expression.

Saul Silven, Engineer, Hughes Aircraft, Bldg. 5, M.S. 2390, Culver City, Calif.

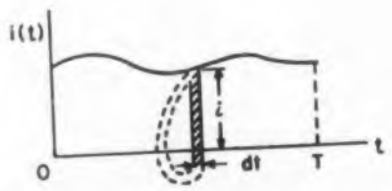


Fig. 1. The waveform is rotated about the time axis.

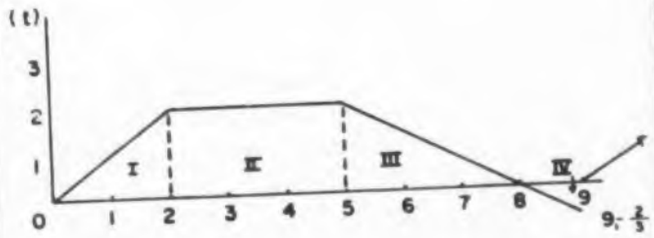


Fig. 2. The waveform is first broken up into segments, then rotated.

IDEAS FOR DESIGN

Prevent Transient Damage

Power transformers deliver a husky transient "kick" when the primary current switch is turned "on" or "off." In many cases this can be costly. Two specific cases are:

(1) When using semiconductor rectifiers the transient voltage must be considered. This means higher rectifier cost, especially in the case of three phase full wave circuits.

(2) When a transformer-rectifier supply is used to power transistor circuitry, the transient is likely to exceed the transistor voltage rating, causing transistor failure.

Both of these conditions can be remedied in new or existing equipment by placing a small cover over the primary power switch. The cover is hinged, and must be lifted to operate the power switch. Lifting the cover operates a push button or microswitch, which disconnects the transformer from the rectifier in the first example—or disconnects the external load in the second case.

In one application, a high voltage supply, the cover switch operated an inexpensive relay, which disconnected the rectifiers. The relay cost $12, the rectifier saving was $180, a net gain of $168!

Bernard Daien, Bogue Electric Co., Paterson, N.J.

An Uncomplementary, Exclusive OR Circuit

The Exlusive-OR circuit published in Ideas for Design (*ED*, July 22, 1959, p84) brought to mind the circuit shown below. This circuit, for two inputs only, uses no diodes and identical, rather than complementary, transistors. Compared to a pure diode equivalent, it may be slightly more expensive, but it delivers more current to the output, at a lower impedance level, and it does not require complemented inputs.

In operation, if the inputs are either both negative or both positive, both transistors are cut-off and the output is negative. If only one input is negative, then the other (positive) input supplies the emitter current, and the output is positive. Symbolically:

$$C = A\cdot\bar{B} + \bar{A}\cdot B$$

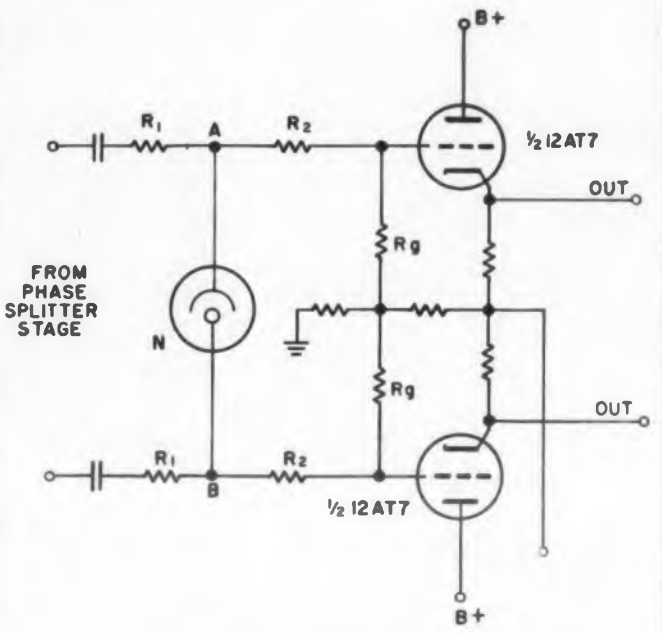
Use of npn transistors and reversal of power supply polarities gives the complemented function:

$$C = A\cdot B + \bar{A}\cdot\bar{B}$$

Lansing E. Tryon, Senior Engineer, Stromberg-Carlson Co., Rochester, N. Y.

Neon Tube Lights And Limits

A cheap, commercial type neon tube can limit signals and, at the same time, provide a visual indication of its limiting operation. In the particular circuit shown, a signal limiter was required for a class B push-pull servo amplifier to prevent the output stage from being overdriven. Resistor R_2 is chosen so that, with the neon tube ignited, the



Neon tube limits symmetrical input to Class-B push-pull stage.

voltage difference across AB produces the maximum acceptable signal to the output stage grids. The waveform across AB is a clipped sinusoid, with its plateau at the neon tube conduction potential. The initial pip which is also present was, in this application, unimportant.

Andrew S. Williams, Senior Electronics Engineer, Stromberg Carlson Co., 1400 N. Goodman St., Rochester 9, N.Y.

Coiled Power Cord Eliminates Pickup

A sensitive vtvm was being plagued by undesired pickup from a nearby source of rf. The usual shielding methods proved ineffective, so it was decided that the spurious signals were coming in through the common power line. Wrapping several turns of the vtvm power cord around the palm of the hand provided the amount of inductance necessary to filter out the radio frequency energy. The exact number of turns was determined by trial and error, after which the cord was taped together to hold the coil shape.

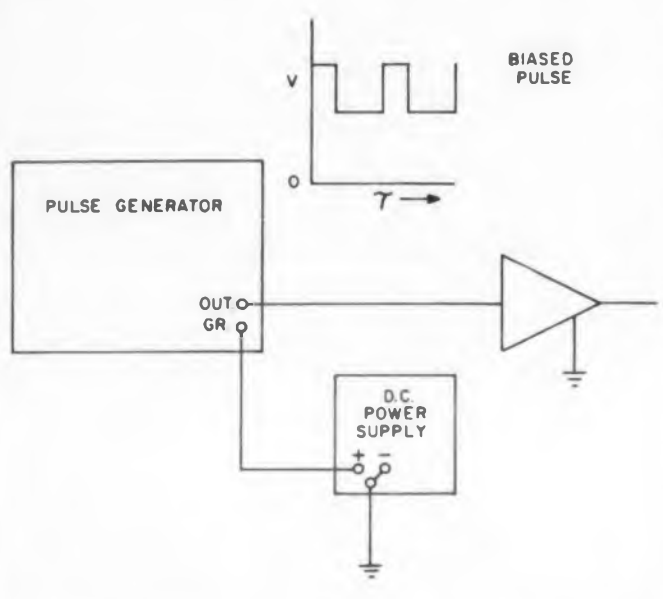
Joseph Leeb, Project Engineer, Bulova Watch Co., Jackson Heights, N.Y.

IDEAS FOR DESIGN

Generator is Biased, But So is Pulse

A biased pulse was needed for test purposes which would not be distorted, or otherwise disturbed, by the biasing method.

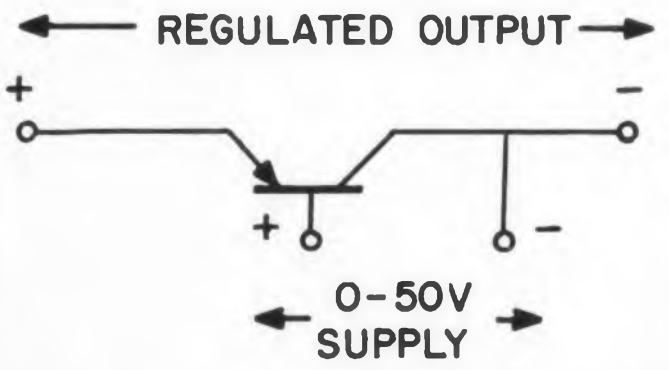
The bias was introduced by connecting the ground terminal on the pulse generator to an external dc source. The generator was left floating, but it should be noted that the ground terminal on the dc source had to be suitably grounded to the system under test.



Morris Suntop, Development Engineer, Remington Rand, Utica, N. Y.

Power Transistor Substitutes For a Series of Zener Diodes

During breadboarding trial and error, setting up a series of regulated power supplies with a range of output voltages can be time-consuming. What is more, the proper Zener diodes may not be readily available. This handy circuit is often



Power transistor substitutes for a series of Zener diodes in this variable voltage regulated power supply.

found useful to simulate a series of 50-w Zener diodes rapidly with available materials.

An 80-v 50 w power transistor, wired as shown, permits a small laboratory supply (or battery) 0-50 v to simulate a regulated variable voltage at currents up to 3/4 amp. When the correct voltage is found, the proper Zener diode may be substituted.

John T. Lamb, Research Engineer, The Tappan Co., Mansfield, Ohio.

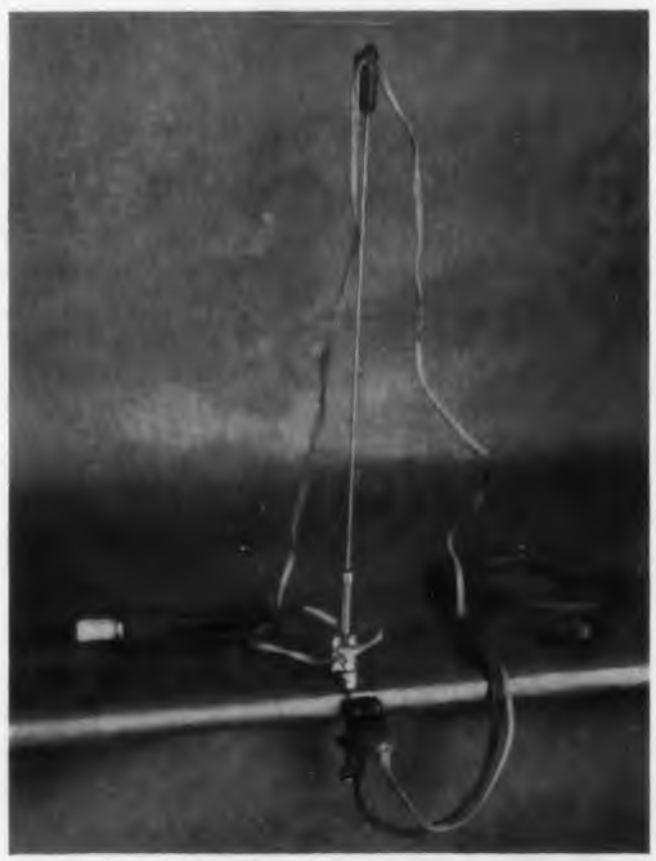
Hang Your Cord High

The photograph illustrates an idea which can prevent your soldering iron from burning its own cord. In addition, the cord is prevented from tangling, and interfering with, components on the bench.

The soldering iron cord is suspended from an easily purchased ironing cord holder. This holder is fastened to a metal rod which, in turn, is attached to a spring. The spring can bend in any direction with very little effort.

Another advantage of this holder is that when soldering in delicate areas, the cord does not drag upon the iron and prevent its free movement.

Ralph Rinaldi, Theta Instrument Corp., Saddle Brook, N.J.



A common ironing cord holder clamps the soldering iron cord and keeps it from tangling with components on the bench.

IDEAS FOR DESIGN

Low Current Steps High Current Stepping Switch

In operating large stepping type switches a large current is often required, particularly for low voltage units. Furthermore, if the stepper must be operated from a remote location, there may be an objectionable voltage drop in the connecting wires.

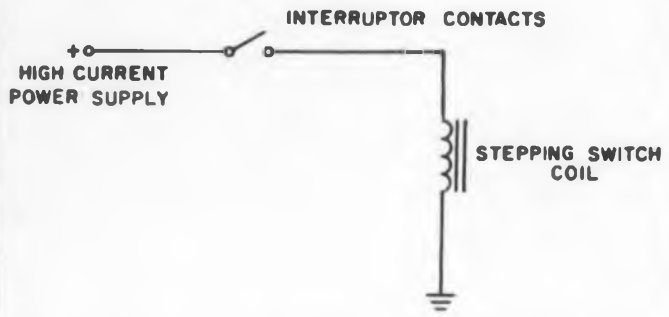


Fig. 1. "Old" circuit requires a high current power supply to directly feed the stepping switch coil.

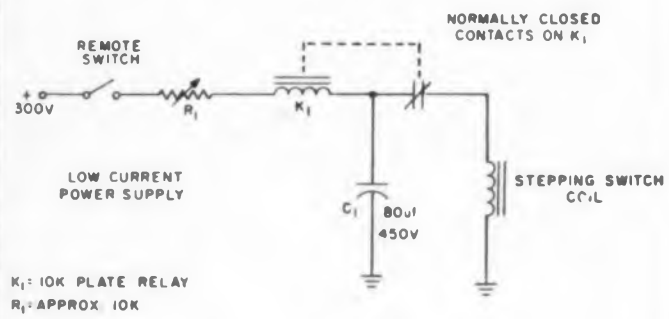


Fig. 2. The stepping switch is operated by the discharge current of capacitor C, in this "new" circuit. Hence, only a relatively low current supply is required.

The current shown in Fig. 2 does away with the need for a high current power supply, and uses relatively small cable wire between the control and operating switch positions.

When the remote switch is closed, the charging current capacitor C_1 is large enough to cause relay K_1 to operate. As C_1 charges, the current will decrease until the fall-out point of K_1 is reached. The relay again operates, closing the normally closed contacts. This causes C_1 to discharge through the stepper coil, advancing it one position. The time required for the operation is determined by the values of R_1, the dc resistance of K_1, C_1 and the pull-in, drop-out characteristics of K_1. It is possible to make the time constant variable according to a pre-arranged program by inserting the proper values of R_1 in one bank of the stepping switch, and stepping to a different value during each operation.

W. E. Barker, Jr., Systems Engineer, Systems Incorporated, Orlando, Fla.

A Feedback Design Chart

A nonlinear amplifier can be made more linear by inserting degenerative feedback. Unfortunately, a loss in gain is associated with the improved linearity. A handy relationship between the achievable linearity and the inherent gain reduction is derived here. Also, a design chart depicting this relationship is presented.

In the region of interest, the maximum and minimum values of gain are defined as A_2 and A_1 respectively.

When a constant feedback coefficient, B, is placed around the amplifier, the new limits of gain are

$$A_{fb_1} = \frac{A_1}{1 + A_1 B}$$

$$A_{fb_2} = \frac{A_2}{1 + A_2 B}$$

$$A_{fb_1} < A_{fb} < A_{fb_2}$$

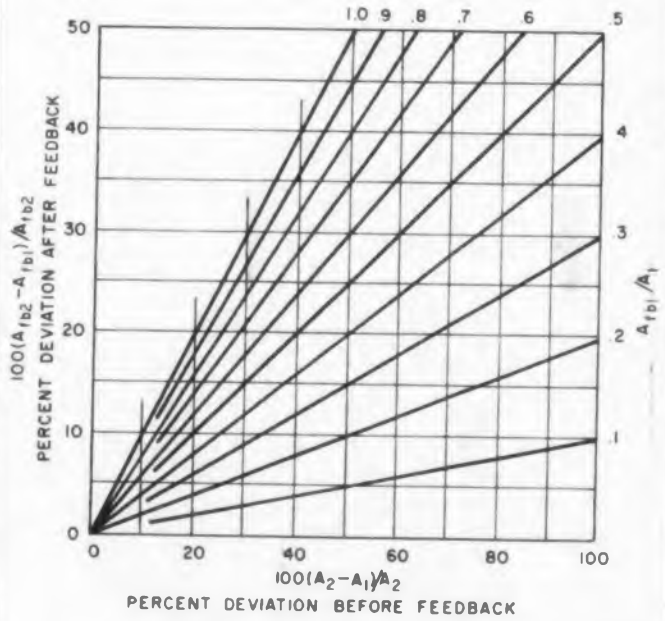
In terms of A_{fb_1} and A_1 or A_{fb_2} and A_2, it can easily be shown that

$$B = \frac{1}{A_{fb_1}} - \frac{1}{A_1} = \frac{1}{A_{fb_2}} - \frac{1}{A_2}$$

Rearranging the preceding equation produces the following desired relationship. It states that a reduction in the gain deviation by a factor of x can be accomplished by decreasing the lower gain limit with degenerative feedback by the same x factor.

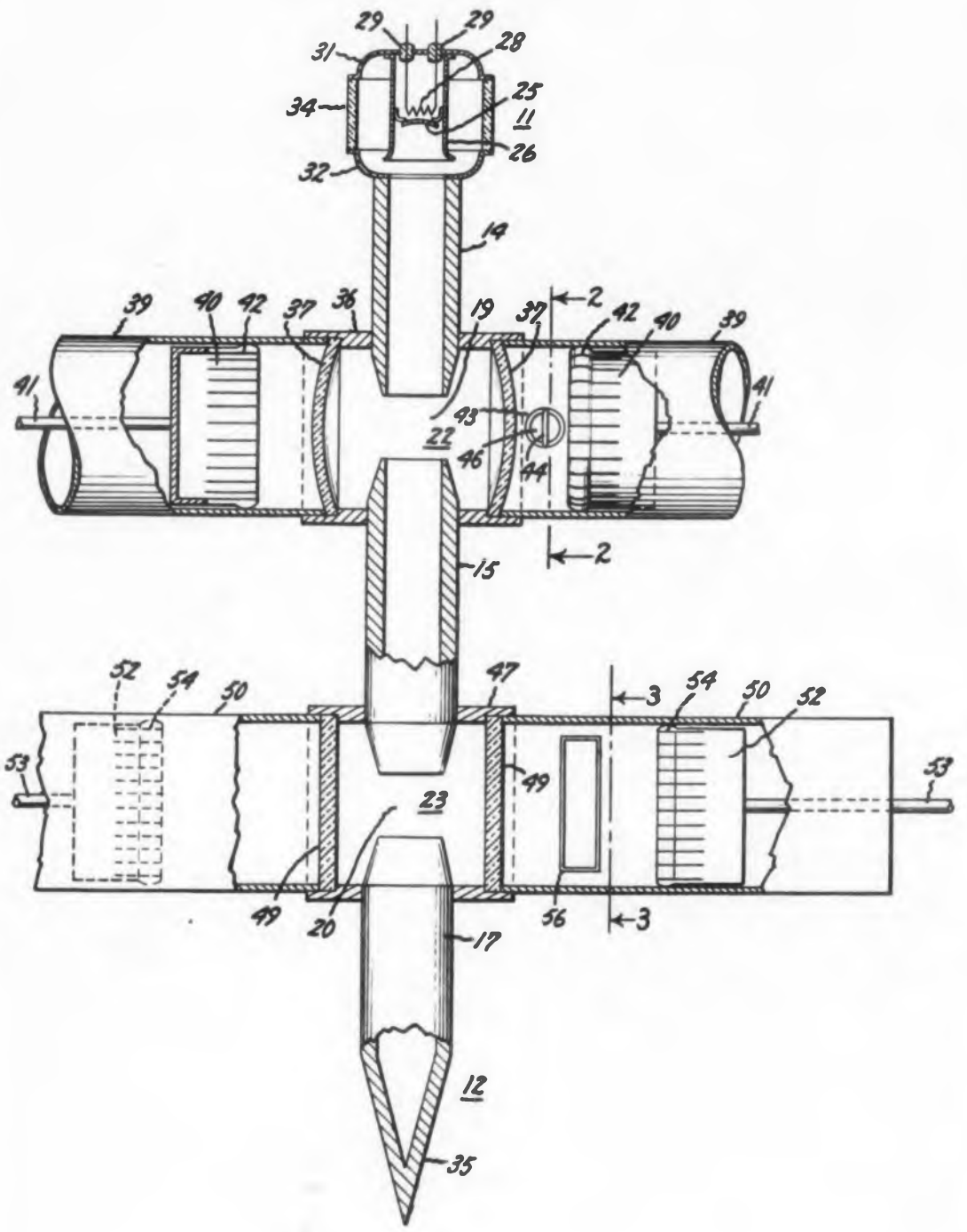
$$\frac{(A_{fb_2} - A_{fb_1})}{A_{fb_2}} = \frac{(A_{fb_1})}{A_1} \cdot \frac{(A_2 - A_1)}{A_2}$$

The design chart below plots this equation in percentage of gain deviation before and after feedback, with the ratio A_{fb_1}/A_1 as a parameter.



D. A. Pierre, Member of the Technical Staff, Hughes Aircraft Co., Los Angeles, Calif.

PATENTS

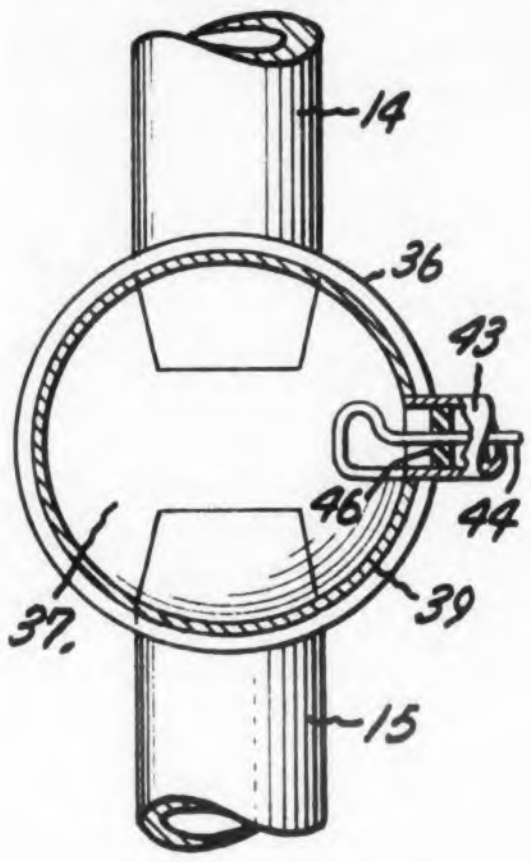


External Resonant Section Tubes

Patent No. 2,910,614. Ralph J. Bondley (Assigned to General Electric Co.)

The klystron tuning means is external to the tube and isolated from the electron beam by dielectric windows. This arrangement allows the window to be made thinner than is usual. Failure of the window due to heating is eliminated and the capacity loading is reduced. The structure is stronger since the window merely

serves as an insulated air seal and is not required to support the tube elements.

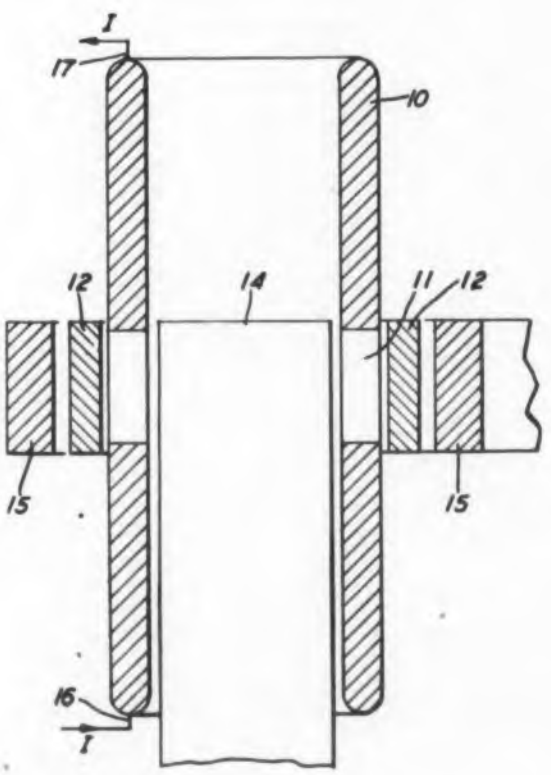


Electromagnetic Stirring Method

Patent No. 2,890,940. William G. Pfann. (Assigned to Bell Telephone Labs).

In zone melting, the liquid is stirred due to the circumferential force created by passing an electric current through the liquid at right angle to the direction of the magnetic field. This increases the efficiency of both zone leveling and zone refining since the freezing rate increases and, in addition, the concentration of minor ingredient is made uniform.

The material is contained in hollow body *10* wherein region *11* is a molten zone in the presence of heater *12*. Magnet *14* and ring *15* generate a radial field which reacts with the longitudinal current flow introduced by electrodes *16* and *17*. Turbulent flow results in region *11*, which, for example, is shown to correspond to a Reynold's number of 20,000.

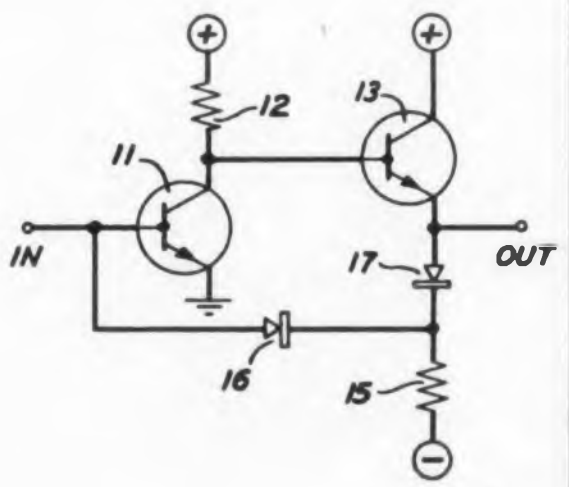


Non-Saturation Junction Transistor Circuits

Patent No. 2,887,542. R. R. Blair and J. R. Harris. (Assigned to Bell Telephone Labs.)

A common emitter transistor stage achieves a high switching rate by combining it with an emitter follower amplifier and a diode. This combination prevents saturation of the switched stage. The arrangement avoids the carrier storage effect which causes the turn-off of a saturated transistor to lag the control signal.

In the configuration shown, a small, positive going input signal to transistor



11 directly couples to emitter follower transistor *13*. This drives the latter stage toward cut-off. Diode *16* is still reverse biased. As signal strength increases, transistor *13* goes to cut-off and diode *16* becomes forward biased, coupling the applied signal directly to load resistor *15*. Diode *17* precisely sets the level above which diode *16* conducts to prevent saturation of transistor *11*.

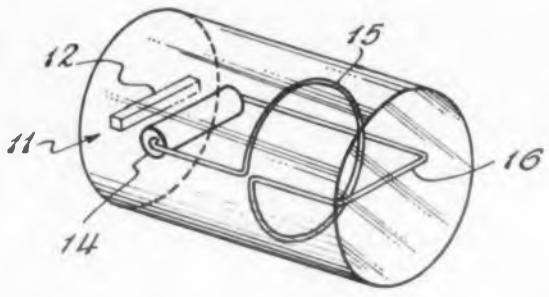
PATENTS

Decoupling Means for Electrical Circuits

Patent No. 2,908,858. Forrest A. Nelson. (Assigned to Varian Associates)

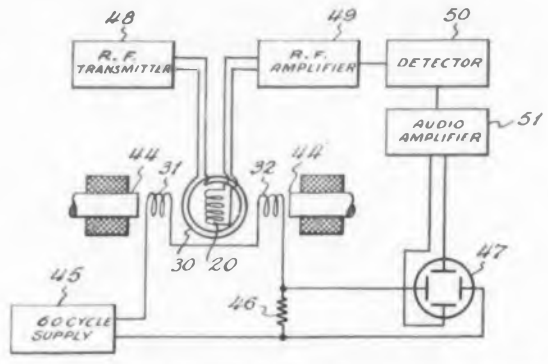
In a microwave spectrometer, the direct leakage from the transmitter to the receiver is cancelled by coupling an out-of-phase portion of the transmitted signal to the receiver through a high resistance loop.

Gyromagnetic resonance in the test sample is generated by a magnetic field



produced by pole pieces *44*. These poles are spaced between the sample and oriented perpendicular to the rf field set up by transmitter coil *30*. A visual display on crt *47* is produced by slightly wobbling the magnetic field by means of 60-cps coils *31* and *32*. These coils drive the sample periodically through resonance. The vertical plates of the oscilloscope are driven by receiver coil *20* oriented normal to transmitter coil *30*.

However, due to the proximity of coils *30* and *20*, there is, induced in the latter, a residual, out-of-phase, component. This is cancelled by coupling loop *15* to coil *30*. The voltage induced in loop *16*, loaded by resistor *14*, produces a field which cancels the direct leakage from the transmitter coil *30* to receiver coil *20*.



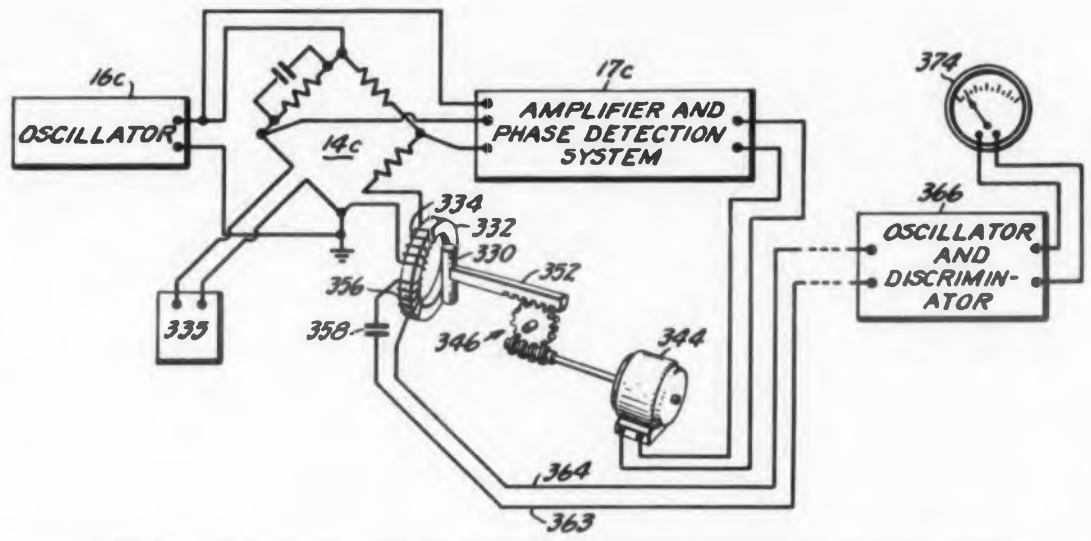
Ferrite Stabilizing System

Patent No. 2,891,158. William D. Gabor. (Assigned to C.G.S. Labs, Inc.).

An oscillator contains a winding on a ferrite core; a second winding on this core is a component of a bridge circuit. External means unbalance the bridge and the permeability of the core is adjusted to restore balance. The resultant change in inductance of the first winding changes the oscillator frequency.

In the system shown, the oscillator, *366*, has its coil, *356*, wound on ferrite core, *332*. A second winding, *334*, is connected in bridge *14c*. Element *335*, a variable resistor, for example, disturbs the bridge balance and the detection system *17c* responds to cause motor *344* to position magnet *330* with core *332* to restore balance. This changes the inductance of coil *356* so that oscillator *366* is set at a different frequency.

A ferrite core is used particularly since the inductor has high Q (low loss) and the incremental permeability is greatly affected by a small change in the degree of magnetic saturation.



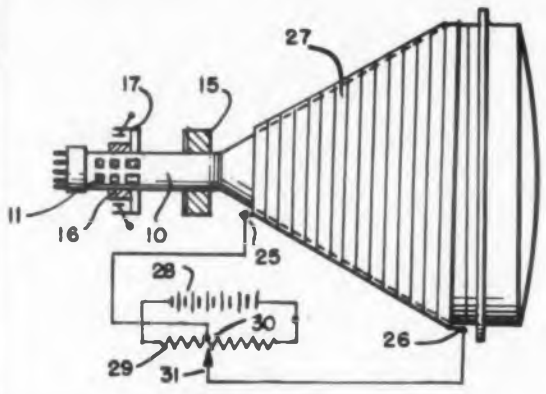
PATENTS

Electrically Energized Magnetic Shield

Patent No. 2,907,914. H. R. Brownell. (Assigned to Magnetic Metals Co.)

The magnetic shielding in a Langworthy strip-wound shield for a color TV tube is improved by passing a dc current through the helix. This increases the permeability of the shield in both magnitude and polarity.

Conical shield 27 is formed by wrapping annealed strips of high silicon steel, separated by asbestos paper, and shaped to the contour of the picture tube bulb. Potentiometer *30* is set for the desired magnetic field strength.

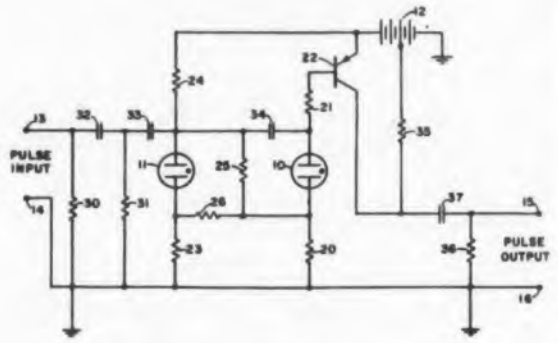


Three State Electronic Circuit

Patent No. 2,901,641. Edward L. Wolf. (Assigned to General Dynamic Corp.)

A simple gas tube circuit indicates or counts pulses scaled down by a factor of three.

Initially if both diodes are cut off, the voltage across diode *10* is higher. A first



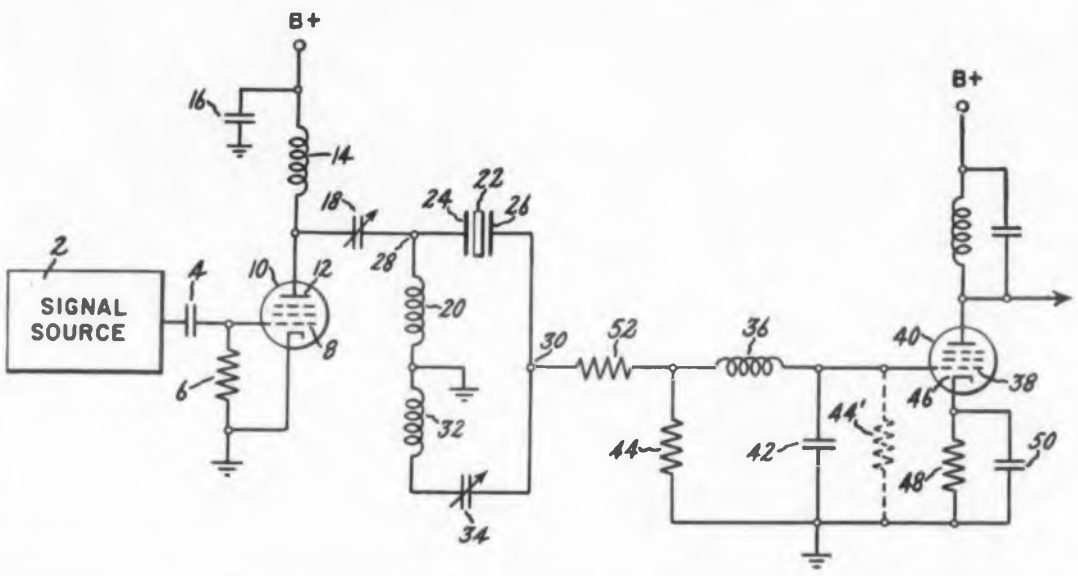
pulse is differentiated by capacitor *32* and resistor *31* to drive diode *10* to conduction and the transistor *22* couples a pulse to the output. The second pulse causes diode *11* to conduct and a pulse couples through capacitor *34* to cut off diode *10*. Finally, the third pulse differentiated causes diode *11* to cut off. The cycle thereby repeats. Typical circuit components are suggested.

Crystal Filter

Patent No. 2,908,877. Thomas T. True (Assigned to General Electric Co.)

Grid current loading of a series resonant circuit changes the bandwidth of a color TV crystal filter according to signal strength. This novel device uses a high resistance in shunt with a capacitor in the form of its analog, which is a low resistance in series with the capacitor.

In the schematic, crystal *22* is driven by tube *10* and its *Q* is conveniently preadjusted by resistor *52* in cascade with the series tuned network, inductance *36* and capacitor *42*. When the strength of signal source *2* is low, the grid-cathode resistance of tube *40* is high and, in effect, the crystal is in series solely with resistor *52*. However, when the signal strength increases, the grid of tube *40* draws current, reducing the grid-cathode resistance in shunt with capacitor *42*. This, by equivalence, corresponds to a high resistance in series with resistor *52* and the crystal *Q* is reduced.

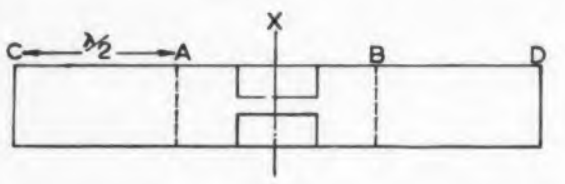


PATENTS

Electron Discharge Devices and Electric Resonators Therefor

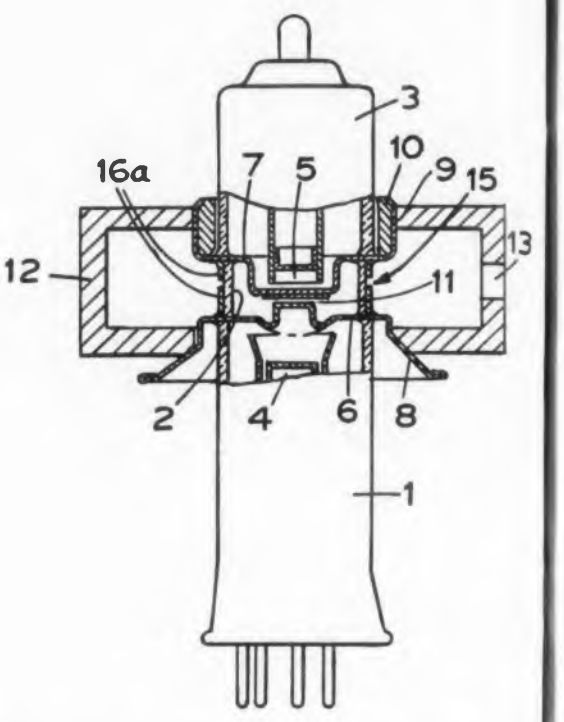
Patent No. 2,904,719. A. F. Pearce, G. Cross and K. H. Kreuchen. (Assigned to EMI Ltd.)

In a reflex klystron operating in a harmonic mode, the electronic tuning range is doubled by capacitive loading of the



cavity outside the voltage nodal surface. The loading appears as an inductance across the capacity gap of the resonator and extends the frequency range.

Normally, the external cavity *12* is dimensioned so that the nodal surface *A* corresponds to the radius of the tube envelope. Silver may be evaporated on the outside of the tube to form a capacitor comprising sections *16a*. At 9200 mc, the tuning range of 40-50 mc corresponds to a change in reflector voltage of 20-30 v.

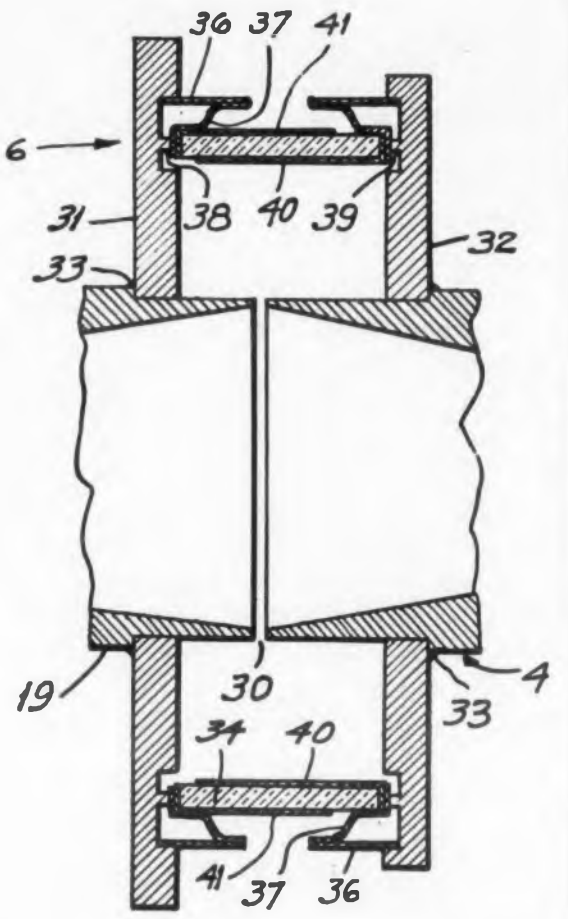


Electron Tube

Patent No. 2,910,613. G. M. W. Badger. (Assigned to Eitel-McCullough, Inc.)

In a klystron amplifier, the collector is insulated by a ceramic section from the tube body. This enables the dc collector current to be separately metered in tuning the cavities and in setting the magnetic focusing. Since all of the rf energy is not taken out of the final cavity, the collector radiates back some of the rf voltage and the device becomes unstable. The solution is to metalize the inner and outer walls of the ceramic to produce, in effect, a capacitor which filters the collector rf signal to the grounded tube body.

Ceramic section *34* is metalized at the ends and brazed to discs *31* and *32*. The capacitor is formed by continuing the metalizing on the surfaces of the ceramic to form metal walls *40* and *41*, suitably gapped at the opposite ends.



BOOKS

Transformers: For the Electric Power Industry

R. L. Bean, N. Chackan, Jr., H. R. Moore, and E. C. Wentz, McGraw Hill Book Co., 327 W. 41st St., New York 36, N. Y., 426 pp, $12.50.

This book is a practical manual on electric power transformers—giving ground work in transformer design, construction, application, operation, and maintenance.

Besides empirical equations, tables, and other up-to-date reference data, the book includes new material on the economics of transformer design and application. It also covers recent advances in methods of temperature calculation; testing techniques; estimation of eddy and stray losses; gauging the transformer's life span; insulation materials and methods; and fault detection.

A chapter on "Insulating the Windings" shows what is actually going on within the insulation during transformer service. It coordinates the problem of voltages which appear in various parts of the winding with the types of structures which are used, their strengths, and characteristics of the materials. The section on "Maintenance, Detection of Faults, and Protection" is based on recent researches reported to the AIEE.

Extensive bibliographies and appendices, plus 277 photographs and drawings, are used to clarify both basic fundamentals and such practical matters as impulse testing, connections, oil deterioration,

lightning protection, corona detection, magnetic principles, heat dissipation, and others. The book interprets much of the ASA Test Code governing transformers into less technical language and also includes a chapter on best shipping methods for transformers.

Problems in Information Storage and Retrieval (Journal)

Pergamon Press, Inc., 122 E. 55th St., New York 22, N. Y., 400 pp per year. Subscription Rates are $20.00 per volume to multiple reader organizations, $15.00 per annum to private individuals.

This is a new international journal which hopes to establish a medium for the rapid publication of original work on the techniques and theory of information storage and retrieval, emphasizing scientific information and the intellectual problems involved.

On the theoretical side, papers will discuss new departures in indexing, classification and notation, recording and disseminating information, and the application of such disciplines as experimental psychology, semantics, linguistics, logic and information theory. Reports on techniques will include transmission of information, punched card methods, mechanical and electronic selectors, and mechanical translation. Articles will be concise, with a minimum of specialist terminology, and news items of international interest on meetings, symposia and specialized educational courses will be given. Letters to the Editor commenting on previous articles will also be published.

The publication will maintain a staff of regional editors located in Moscow, Tokyo, Paris, Milan, Frankfurt, New York and London.

BOOKS

The Servo Engineer's Handbook

Daystrom Transicoil, Div. of Daystrom, Inc., Worcester, Montgomery County, Pa., 128 pp, $3.00.

This book, the author feels, is the first engineering text devoted primarily to the more practical aspects of servo system design, rather than to the theoretical concepts of system parameters and dynamic analysis. It is aimed at the practicing servo engineer instead of the control circuit scientist. Hence, rigorous mathematical derivations have been avoided wherever possible, and practical component information has been assembled in a way which permits the servo designer to apply it immediately. The handbook covers instrument type servomechanisms only. These are considered to be servomechanisms which operate at a load power of less than twenty-five watts. The first chapter serves as an introduction, showing how the different components are related, and as a foundation for the ive succeeding chapters dealing individu lly with motors, rate generators, synch os, gear trains, and amplifiers. A sepa ate chapter describes how these are ass m-bled into a coordinated system for o pti-mum control. The final chapter d als with methods of environmental testing for completed control units.

Plastics Safety Handbook

The Society of the Plastics Industry, Inc., 250 Park Ave., N. Y. 17, N. Y., $5.00

This accident prevention handbook has been prepared by The Society of the Plastics Industry, Inc., in cooperation with the National Safety Council. It is devoted entirely to safety methods applicable to the plastics processing industry. Many processes are specifically treated with the latest safety methods and practices ex-

planned in detail. Processes covered include calendering, coating, casting, compression and transfer molding, extruding, injection molding, thermal forming, and tool and die making. There are also chapters detailing the planning for safety, maintaining of personnel's interest in safety, analysis of the cause of accidents, the keeping of accident records, and the economic and sociological reason for accident prevention programs. Included are 128 photographs, charts, diagrams, tables and report forms illustrated throughout the text, as well as numerous suggestions on ways and means of promoting greater safety in the plastics industry.

Introduction to Matrix Analysis
Richard Bellman, McGraw-Hill Book Co., Inc., 327 W. 41st St., New York 36, N. Y., 331 pp, $10.00.

Three basic fields in the analysis of matrices are covered in this newly published book. They are symmetric matrices and quadratic forms, matrices and differential equations, and positive matrices and their use in probability theory and mathematical economics. The book also presents part of the theoretical treatment of the use of matrices in the computation solution of ordinary and partial differential equations by means of digital computers.

Emphasizing the parts of matrix theory that occur in analysis and application, the contents of this book are specifically slanted toward the needs of analysts, statisticians, mathematicians, mathematical physicists, engineers, and mathematical economists. Each part is motivated with a discussion of the mathematical, physical, and economic background of the matrix theory introduced. Important chapters are included on dynamic programming and stochastic matrices.

Many references are given to original research papers containing further results. The material presented in this volume should enable the reader to make more complete use of current research papers.

IMPULSE

A DIGEST OF NEW DEVELOPMENTS IN ELECTRONICS AND AUTOMATION

PUBLISHED BY ROME CABLE DIV. OF ALCOA, ROME, N. Y.

PIONEERS IN INSTRUMENTATION CABLE ENGINEERING

MAN AND THE MOON. Was Lunik's photo of the moon's backside merely the first step in a larger Russian plan? Speculation since the October 4 moon shot has it that a special moon "package" may have been dropped from the Russian moon station—capable of relaying data continually back to the satellite and then back to earth. This possibility has not yet been verified as this column goes to press. Nonetheless, the general implications are evident: the Russians fully intend to explore the planets and may be beginning now. Can they do it? Well . . . moon rocket control, according to the Reds' own opinion, requires 10 times greater precision than that needed to orbit an earth satellite. This seems to indicate a tremendous rate of achievement for the Russians—improving the precision of rocket control by at least 10 times in the last two years!

SMALL MATTER LOOMS BIG. Little things are becoming a bigger and bigger problem to the aerospace industries. The fact is, measurement techniques are not keeping up with the requirements of advance space projects. Aerospace equipment manufacturers lack the means of measuring, for example, 1/1,000,000 of an inch. Several manufacturers have entered a joint program designed to solve the problem and provide the answers that stand in the way of better calibration and improved standards. Any ideas?

HOW TO BE A CABLE EXPERT. Part of being an expert is knowing where to look for knowledgeable advice. When your problem is cable design or selection of cable materials, you can qualify as "expert" by calling on Rome Cable's specialists to solve your problem for you. In addition to solving the electrical problems inherent in the design of instrumentation and telemetering cables, Rome Cable engineers can also help you overcome certain environmental and physical handicaps under which your system must operate. *You* become the expert because you're *backed* by experts! Get acquainted with what Rome has to offer you by sending for the free booklet "Instrumentation Cables." Address IMPULSE, c/o Rome Cable Corporation, Dept. 1110, Rome, N. Y.

HOW MUCH FOR DEFENSE IN 1960? The Khrushchev visit of 1959 may cause reduced spending for defense in 1960. Speculators looked upon his visit to the U.S. early last fall as a turning point in the cold war. If predictions hold true, then the big electronic stock boom of 1959 will be over by 1960. As yet, there has been no indication of what this might mean to the large number of small firms that depend on R&D.

CABLEMAN'S CORNER. The subject of cable testing is an important one. This is the phase of production that determines whether or not the cable you are purchasing is in accordance with your standards and requirements. In the field of electronics and automation, cables are required to suit various stringent electrical, mechanical, and/or chemical environments. Many years of study and testing have gone into the design of test equipment to be used for these critical tests. It is not enough to know that a cable has been tested in a manner that is "essentially" the same as the required standard. Slight variations in equipment design or methods of tests can mean the difference between conformance and non-conformance. Make sure the test data you receive gives a true picture of the performance of your cable. When you need cable, call on a cable specialist. Our number is Rome 3000.

These news items represent a digest of information found in many of the publications and periodicals of the electronics industry or related industries. They appear in brief here for easy and concentrated reading. Further information on each can be found in the original source material. Sources will be forwarded on request. (14)

BOOKS

Advances in Electronics and Electron Physics

Edited by L. Marton, Academic Press Inc., 111 Fifth Ave., New York 3, N. Y., 523 pp, $15.00.

This volume is the latest in the series which was devised to review the latest developments in the general fields of electronics and electron physics. The topics dealt with in this eleventh volume are best described in the section headings: Recents Advances in Photoemission, Parity Nonconservation in Weak Interactions, Quantum Efficiency of Detectors for Visible and Infrared Radiation, Automatic Data Processing in the Physical Sciences, Operational Amplifiers, Radio Telemetering, Electron Diffraction Structure Analysis and the Investigation of Semiconducting Materials, and Secondary Electron Emission from Solids.

Incidentally, this volume includes for the first time sections written by scientists from the Communist countries. The chapter on photoemission has been written by P. Gorlich of the Friedrich-Schiller University, Jena, Germany and the chapter on electron diffraction was written by Z. G. Pinsker of the Institute of Crystallography, Academy of Sciences of the USSR, Moscow.

Electronic Switching, Timing, And Pulse Circuits

Joseph M. Pettit, McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y., 267 pp, $7.50.

The aim of this book is to promote both physical understanding and analytical techniques for dealing with several important classes of electronic circuits. Tubes and transistors are used primarily as switches in these circuits and the resulting waveforms of current or voltage may be rectangular, triangular, or a suc-

cession of short pulses, but in almost no case will they be sine waves.

The basic analytical techniques presented are based upon the graphical representation of the tube or transistor characteristics, and approximate these by linear segments.

This book is unique in that it integrates the numerous circuits which were devised during the 1940's in connection with radar, nuclear instrumentation, and television, into a unified analytical framework. Vacuum tubes and transistors are treated in parallel fashion, in contrast to the common process whereby a section on transistors has been added to books previously devoted solely to vacuum tubes. The author emphasizes the similarities between the two types of devices, but is careful not to obscure their relative advantages. Among the recent advances covered are: the newer types of npn transistors and special circuits such as the sanatron. The numerous problems and numerical examples in this book are based on practical contemporary circuits and components, including both tubes and transistors.

True Position Dimensioning

D. Bibeau and D. Sweet, Bendix Aviation Corp., Scintilla Div., Sidney, N. Y., 28 pp, $3.00 per copy in lots of 1 to 10; $2.50 per copy lots of 10 or more.

A well illustrated, 28-page booklet presenting a step-by-step explanation of True Position Dimensioning and Tolerance Principles. It is desigend to allow the reader to interpret more readily the drawings of various agencies and companies throughout the country, and in particular, the standard documents: MIL-STD-8, ASA Y14.5, and SAE Dimensioning Standard.

BOOKS

Resistance and Resistors

Charles L. Wellard, McGraw-Hill Book Co., 327 W. 41st St., New York 36, N. Y., 272 pp, $8.50.

This newly published reference and guidebook presents groundwork in the basic aspects of resistance and detailed descriptions of the characteristics of each type of resistor, and the materials used in its manufacture.

Tables in the book include most manufacturers' data on given resistor types. Thus, it is possible to compare at a glance in one common table the full technical scope of available resistors. Charts and graphs also present useful information regarding power and voltage ratings of resistors, varieties of material used in their construction, and applications. Attention is given to such matters as reliability in resistors, measurement, etc. Precision films as replacements for wirewound resistors are treated in detail including information on the preparation of precision films by pyrolysis, evaporation, and reduction of oxides.

The Radio-Electronic Master

United Catalog Publishers, Inc., 60 Madison Ave., Hempstead, N. Y., 1551 pp, $3.50.

The new 1960 (24th) edition of The Radio-Electronic Master is now available from local electronic distributors. Containing 1551 pages, it provides detailed descriptions, specifications, and prices of over 170,000 standard stock electronic items. The products of 330 manufacturers are catalogued and more than 12,500 illustrations are shown.

The Master is divided into 28 product sections, with manufacturers arranged alphabetically in each section. A detailed index pinpoints the thousands of products which include: tubes, transistors, printed circuit components, automatic equipment

miniature and subminiature components, transformers, communication receivers, wire and cable, speakers, volume controls and components and equipment for microwave and telemetering. It is a valuable reference volume for those who buy, sell, specify, design, manufacture, and service electronic parts and equipment.

Information Transmission, Modulation, and Noise

Mischa Schwartz, McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y., 461 pp, $11.00.

This senior or first-year graduate level text stresses the basic unity inherent in modern information transmission systems. Emphasis is placed on the two fundamental limitations to the transmission of information: non-zero time response, and finite bandwidth and noise. The significance of these two limitations is explored in a representative group of modulation systems.

Much of the book's material is devoted to pulse modulation and pulse code modulation systems. Am and fm systems are treated in a more unified way than is customary. Among the recent advances and special topics included in the text are: the relation between time and frequency response of networks using Fourier series and integrals; choppers as examples of balanced modulators, and the phase coherence necessary in suppressed carrier demodulators; sampling theory, time multiplexing, and pulse modulation systems; the concepts of power spectrum, autocorrelation function, and matched filters; noise reduction of fm pre-emphasis and de-emphasis networks; probability and its application to problems in noise phenomena, analysis of pcm systems, radar signals, etc.

Reference is made to practical systems wherever possible and mathematical topics are included when necessary.

Engineering notes from the

SMI REPORTER

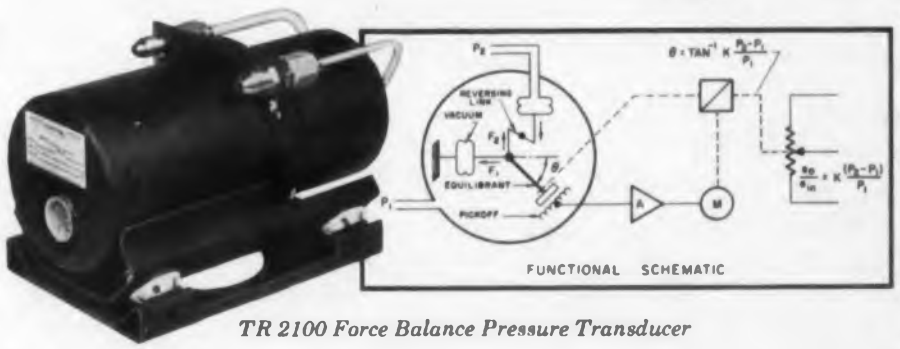
BY STANLEY M. INGERSOLL, *Capabilities Engineer*

Report No. 3
TR 2100 Force Balance Pressure Transducer

SMI is now producing a new, unusually flexible Force Balance Pressure Transducer that features both electrical and mechanical output capabilities. Extreme sensitivity and accuracy is combined with unique flexibility in the TR 2100. It is available in ten models and the functional "Mechatronics" packaging philosophy permits prompt delivery of standard transducers covering a wide range of applications: from subsonic to supersonic aircraft, drones and missiles, to ground support, and test equipment. The functional schematic, shown below, illustrates the basic force balance principle. The transducer measures 3¾" dia. x 7" long, weighs 3.25 lbs., without shockmount, and conforms to MIL-E 5400 and 5272.

Typical Performance Specifications

Type No.	Inputs Physical	Computation	Output Range	Output Form	Accuracy	Threshold
TR 2100	Total & Static Pressure	Mach No.	$0.1 \leq M \leq 1.0$ $-1000 \leq$ Alt. $\leq$ 100,000 ft.	Pot. or Synchro	± 0.001 M	0.0001 M
TR 2100-2	Total & Static Pressure	Mach No.	$0.12 \leq M \leq 3.0$ $-1000 \leq$ Alt. $\leq$ 100,000 ft.	Pot. or Synchro	$0.003 \leq M \leq 0.015$	0.0002 M
TR 2100-5	Static Pressure	Altitude Deviation	± 500 ft. From −1000 to + 80,000 ft.	Pot. or Synchro	—	2 ft.
TR 2100-6	Static Pressure	Pressure Altitude	−1000 to + 100,000 ft.	Dual Speed Synchro	± (25 ft. + 0.25%) −1000 to 5000 ft. ± (40 ft. + 0.25%) 5000 to 80,000 ft. ± 0.5% to 100,000 ft.	2 ft. to 40,000 ft.
TR 2100-7	Turbine Outlet (P_7) And Compressor Inlet (P_2) Pressures	Engine Pressure Ratio (E.P.R.)	$1 \leq$ E.P.R. ≤ 4	Pot. or Synchro	$7 \text{ in.} \leq P_2 \leq 30 \text{ in.}$ $1.9 \leq$ E.P.R. ≤ 2.6 ± 0.010 E.P.R. $3 \text{ in.} \leq P_2 \leq 40 \text{ in.}$ $1.0 \leq$ E.P.R. ≤ 4.0 ± 0.020 E.P.R.	0.0005 E.P.R.



TR 2100 Force Balance Pressure Transducer

For more information and complete operating specifications on the TR 2100 Force Balance Pressure Transducer, write or wire today. Address your inquiries to Stanley M. Ingersoll, Capabilities Engineer.

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CIRCLE 280 ON READER-SERVICE CARD

RUSSIAN TRANSLATIONS

J. George Adashko

The Transistorized Schmidt Trigger

G. P. Petin

A GROUNDED-emitter junction transistor has a voltage and current amplification factor much greater than unity. Thus, it can be used as a substitute in many vacuum tube circuits, including the Schmidt trigger. The Schmidt trigger is used as a voltage discriminator[1, 2] to shape a rectangular voltage from a sinusoidal one,[3, 4] and to generate periodic and aperiodic, rectangular and triangular voltage pulses.

A Schmidt trigger circuit using junction transistors (Fig. 1), is an exact duplicate of the vacuum-tube circuit and has analogous properties: it has two threshold values of input voltage, U_1 and U_2, such that when $U > U_1$, transistor *T1* conducts and *T2* is cut off.

When $U < U_2$, *T1* is cut off, and T2 conducts. When $U_2 < U < U_1$, the circuit has two stable states, with *T1* conducting and *T2* cut off, or vice versa. When $U_2 < U < U_1$ the circuit can be flipped from one state to another by means of a short external pulse, applied to the collector of *T1*.

A characteristic of junction transistors is a very slight dependence of the electrode voltages and currents on the collector voltage. Therefore, the

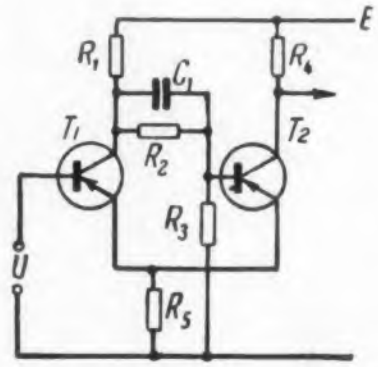

Fig. 1. The basic Schmidt trigger.

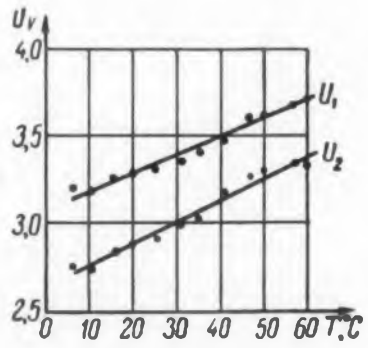

Fig. 2. Temperature dependence of the two threshold values of the input voltage to the Schmidt trigger of Fig. 1.

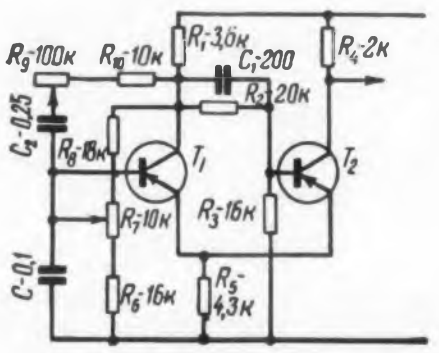

Fig. 3. This shaping circuit changes a sinusoid to a rectangular voltage.

Soviets Expand Research

Thermoelectric elements, semiconductors, and ferrites are due to receive more intensive study in the USSR. The August 1959 issue of the Soviet journal *Vestnik Akademii Nauk SSR*° reports that the presidium of the Soviet Academy of Sciences resolved to expand research activity in these three areas.

The presidium stressed the importance of further research on thermoelectric conversion and of developing higher-efficiency, cascade-type thermoelectric devices.

In the semiconductor field, the presidium urged research on complex-composition semiconductors as well as further work on the usual, crystal semiconductor types.

Regarding ferrites as a "cardinal" problem in solid-state physics, the presidium said that ferrites have contributed to important progress in some of the most important fields of technology (computers, electrical acoustics, radioastronomy, radiospectroscopy, etc.), and without them, the progress would have been impossible. The presidium pointed to an interesting scientific sidelight: ferrite phenomena lie on the borderline between semiconductor physics and the physics of magnetic phenomena.

(Vestnik Akademii Nauk SSR *is one of the many scientific journals abstracted semimonthly in the Central Intelligence Agency's* Scientific Information Report. *This is distributed by the U.S. Dept. of Commerce, Office of Technical Services, Washington 25, D. C. for an annual subscription rate of $28.00.)*

characteristics of junction transistors can be linearized as follows

$$U_1 = h_{11}\, I_e$$

$$I_c = h_{21}\, I_e$$

A transistorized Schmidt trigger with linear characteristics should switch at the instant the cut-off transistor conducts, i.e., when the emitter voltage of the cut-off transistor equals zero. Taking this into account, two sets of Kirchhoff equations can be written for the circuit of Fig. 1, for the two possible states of the circuit. The solutions of these systems give the following approximate values of U_1 and U_2:

$$U_1 = E \times \frac{R_3\, R_5}{(R_1+R_2+R_3)\,(R_5+h^0{}_{11}) + (1+h_{21})\,(R_1+R_2)\,R_3} \qquad (1)$$

$$U_2 = \frac{R_3\,(R_5+h^0{}_{11})}{(R_1+R_2+R_3)\,R_5 - R_1\,R_3\,h_{21}}\, E \qquad (2)$$

In these formulas, $h^0{}_{11}$ is the total input impedance of the transistor, $h^0{}_{11} = U_e\, I_e$; h_{21} is the current amplification factor of the transistor taken with a minus sign, i.e., $h_{21} = -\alpha$.

A great shortcoming of transistors is the strong dependence of their parameters on temperature. The temperature dependence of U_1 and U_2 shown in Fig. 2, was obtained for the following parameters of P1Zh transistors: $E = 9$ v, $R_1 = 3.67$ K, $R_2 = 19.7$ K, $R_3 = 15.45$ K, $R_4 = 2$ K, $R_5 = 4.22$ K. Assuming for these transistors $h^0{}_{11} = 30$ ohms and $h_{21} = 0.95$, we obtain, from Eqs. (1) and (2), $U_1 = 3.21$ v and $U_2 = 2.75$ v.

Fig. 2 shows that, at low temperatures, there is a rather good agreement between the theoretical temperature dependence of U [it is calculated from Eqs. (1) and (2)] and the experimental ones. The temperature coefficients for the voltages U_1 and U_2 in this circuit are about 0.003 to 0.004 parts per degree.

By substituting for R_3 a combination of several

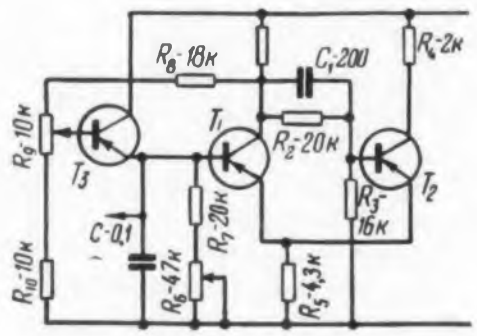

Fig. 4. A rectangular voltage generator.

resistors and a thermistor with a negative temperature coefficient one can reduce the influence of the temperature. For temperature stabilization of U_1 or U_2, the resultant resistance should have a magnitude R_3 and a temperature coefficient

$$\gamma_1 = \frac{1}{R'_3}\frac{dR'_3}{dT} \qquad (2)$$

$$= -\frac{1}{U_1}\frac{dU_1}{dT} \times$$

$$\frac{(R_1+R_2+R_3)\,(R_5+h^0{}_{11}) + (1+h_{21})\,(R_1+R_2)\,R_3}{(R_1+R_2)\,(R_5+h^0{}_{11})}$$

The values of

$$\frac{1}{U_1}\frac{dU_1}{dT} \quad \text{and} \quad \frac{1}{U_2}\frac{dU_2}{dT}$$

must be determined experimentally since they can be computed only if the dependence of the transistor parameters on the temperature is known exactly.

It is impossible to stabilize U_1 and U_2 simultaneously, since the lines in Fig. 2 for U_1 and U_2 have different slopes. However, if one threshold voltage is stabilized, the dependence of the second threshold voltage on the temperature is also reduced. This is because γ_1 and γ_2 have the same sign and are nearly equal.

As long as *T1* is cut off, the input resistance of the circuit is approximately equal to the reciprocal of the junction diode resistance, i.e., several hundred thousand ohms. When *T1* conducts, the resistance is reduced to approximately the magnitude of the input resistance of the circuit with the collector grounded

$$R_{in} \approx \frac{R_5 + h_{11}}{1 + h_{21}} = \frac{R_5 + h_{11}}{1 - \alpha}$$

The switching time in a transistorized Schmidt trigger is determined essentially by the time constant of the transistors themselves,[5] which is about several microseconds.

Applications of the Schmidt Trigger

Reliable operation of Schmidt-trigger circuits with junction transistors is possible through the use of temperature stabilization or through manual adjustment of the operating threshold. We describe here, circuits with manual adjustment.

1. A circuit for shaping a rectangular voltage from a sinusoidal one is shown in Fig. 3. The voltage produced has good waveform, with a rise time of about 2 or 3 microseconds. Consequently the voltage remains rectangular up to 50 kc.

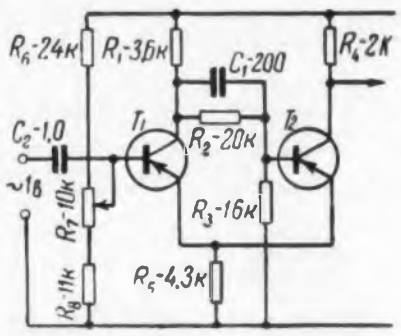

Fig. 5. A sawtooth generator.

If an alternating voltage of approximately one volt is applied to the circuit, there is no need for temperature stabilization, for in this case the amplitude of the applied voltage is much greater than the possible temperature drift of the discrimination voltages U_1 and U_2.

2. The circuit of Fig. 4 can generate rectangular voltages. The operating principle of this circuit, as well as the one that follows, is well analyzed,[6] for ordinary vacuum tube circuits. The duration of the front of the generated rectangular pulses is about 5 microseconds. Depending on the capacitance C, it is possible to obtain rectangular voltages up to 30 kc.

The frequency is continuously varied by means of resistor R_9. By a suitable setting of potentiometer R_7, it is possible to establish such an operating condition, that when a short pulse is applied to the collector of *T1* the circuit generates a single rectangular pulse of constant duration and amplitude.

3. Satisfactory sawtooth waveform can obtain up to approximately 30 kc with the circuit of Fig. 5. The frequency can be continuously varied by resistor R_6, and ranges can be changed by changing the charging capacitor C. The amplitude of the generated voltage is $U_1 - U_2$, i.e., about 0.5 v. By setting potentiometer R_9, one can place this circuit in a slaved mode, at which it generates sawtooth pulses after a brief negative pulse is applied to the collector of *T1*.

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(*Translated from Schmidt Trigger Employing Junction Transistors, in the September 1959 issue of* Radiotekhnika.)

RUSSIAN TRANSLATIONS

Electronic Control of Triggered Multivibrators

A. F. Ivanov and M. L. Tsetlin
Moscow State University
U. S. S. R.

IN THE CONSTRUCTION of computers it is frequently necessary to delay pulses by an interval which is adjustable over a wide range. The adjustment must have a low time-lag, and if possible, little power should be required for the adjustment.

The circuits of this type heretofore known in the literature, permit only mechanical adjustment of the delay, and this imposes many limitations. The system shown in Fig. 1 has electronic adjustment, insuring sufficient speed, sensitivity, and flexibility of control.

This circuit differs from that of an ordinary triggered multivibrator with cathode coupling, in the presence of a cathode follower *T3* and a control tube *T4*. In the absence of a triggering pulse, *T2* is blocked by the plate current of *T1*.

When a negative triggering pulse is applied, the charging current of the capacitor *C* produces a voltage drop for *T4*, which results in the positive potential on the grid of the cathode follower *T3*, and consequently on the grid of *T2*, connected with the cathode follower. The charging time of capacitor *C* is determined by the current through *T4*, which in turn is regulated by the potential on its grid.

The use of a cathode follower makes it possible to exclude the shunting action of the grid-cathode

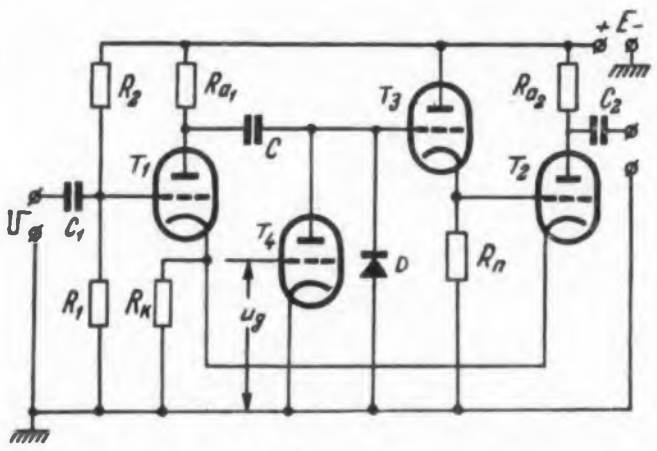

Fig. 1. A triggered multivibrator with a cathode follower and a control tube for varying the delay.

Fig. 2. Pulse duration of the multivibrator can be varied by changing the grid voltage on the control tube.

resistance of tube *T2*. The diode *D* serves to reduce the reset time of the circuit.

The dependence of the duration T of the output pulse on the voltage u_g on the grid of tube *T4* is linear over a rather broad range. Here T changes from

$$T_{min} = (R_{a1} + R_i)\, C\, In\, (u_1/u_2)$$

when $u_g = 0$

to $T_{max} = R_b\, C\, In\, (\Delta_{ua1}/u_2)$

when $| u_g | \geqslant u_{tr}$.

In these formulas R_i is the internal resistance of tube *T4* when $u_g = 0$, R_b is the inverse resistance of the diode, Δu_{a1} is the jump in the plate voltage when *T1* is cut off, u_1 is the initial voltage drop across *T4* when $u_g = 0$, and the voltage across *T4* at the instant *T1* conducts (*T1*'s cutoff voltage) is

$$u/g \approx R_1\, E/(R_1 + R_2) + | E_{tr} |$$

The values of Δu_{a1} and u_1 can be found graphically.

In our experiments we used type 6N1R tubes. The parameters of the circuit were: $E = 300$ v, $R_{a1} = 1000$ ohms, $R_{a2} = R_K = 3.4$ K, $R_m = 47$ K, $R_1 = 18$ K, $R_2 = 110$ K, $C = 100$ μμf, $R_b = 41$ meg (for silicon diode D 204). Here the duration of the multivibrator pulse changes from three μsec to four μsec while u_g changes from 0 to −6 v (See Fig. 2).

Electronic adjustment of pulse duration makes it possible to control the time lag in servomechanisms. In a breadboard of such a model, the duration of the lag, which varied during the time of operation of the system, was compared with the duration T_0, of a reference pulse.

In conclusion, we note that it is possible to generate a sequence of pulses of specified durations by using a scaler in conjunction with the circuit described here.

(*Translated from* Izevestiya Vysshykh Uchebnykh Zavedeniy (News of the Higher Institutions of Learning), *Radiophysics Section, Vol. II, No. 1 1959.*)

GERMAN ABSTRACTS

E. Brenner

Frequency Stability of Astable Transistor Multivibrator

THE ASTABLE multivibrator, when designed symmetrically (Fig. 1 with $R_1 = R_2 = R$; $R_{C1} = R_{C2} = R$; $C_1 = C_2 = C$) generates a square waveform with the nominal repetition frequency $f = 1/2\,RC1n2$. The actual frequency of the output depends on the supply voltage, temperature and component variations and tolerances.

The influence of supply voltage variation on frequency can be calculated but leads to a complicated expression. Using instead typical values, for example

V_{CE} for $I_B \approx V_o/R = 0.1$

V_{BE} for $I_B \approx V_o/R = 0.1$ to 0.3

$I_{CBO} = 3\ \mu a$ at 20 C

base-emitter voltage when loop gain reaches unity so that transition occurs = 0.04 to 0.2 v

one can show that a 10-per-cent variation in supply voltage results in the frequency change

$$\frac{\Delta f}{f} \approx \frac{1.12}{V_o - 0.175}\ \% \qquad (1)$$

where in addition to the above assumptions, the values $R = 16$ K, $R_C = 1$ K and transistor types OC602 spec are used.

Eq. 1 is verified experimentally as shown in Fig. 2.

Similar calculation for temperature variation

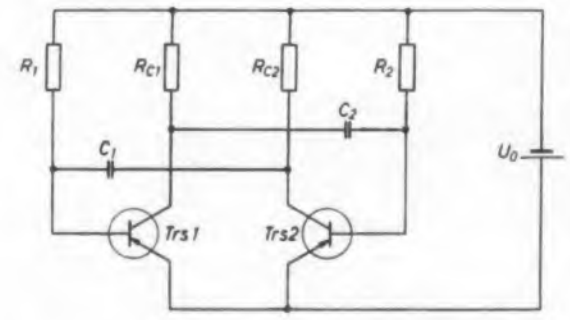

Fig. 1. Astable transistor multivibrator.

shows the dependence depicted in Fig. 3.

Abstracted from an article by E. Brueckner, Nachrichtentechnische Zeitschrift, *Vol. 12, No. 10, October 1959, pp 509-513.*

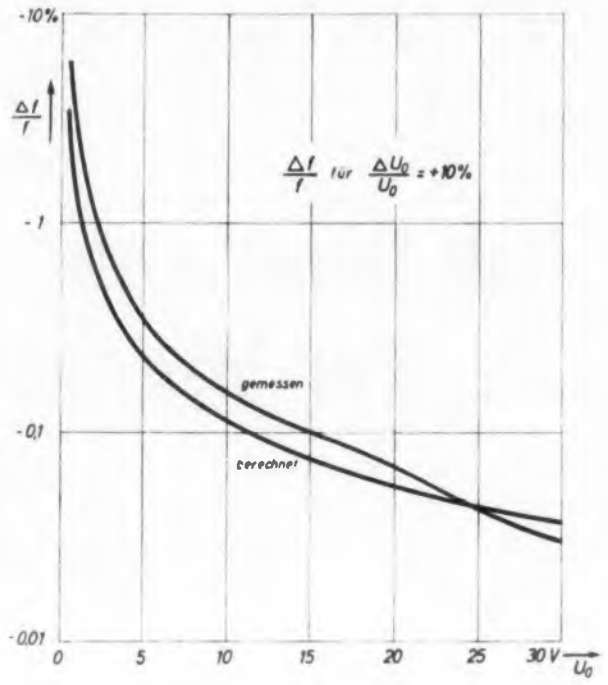

Fig. 2. Calculated and measured curve of frequency dependence on supply voltage for 10 per cent variation in supply voltage using OC 602 spec germanium transistors.

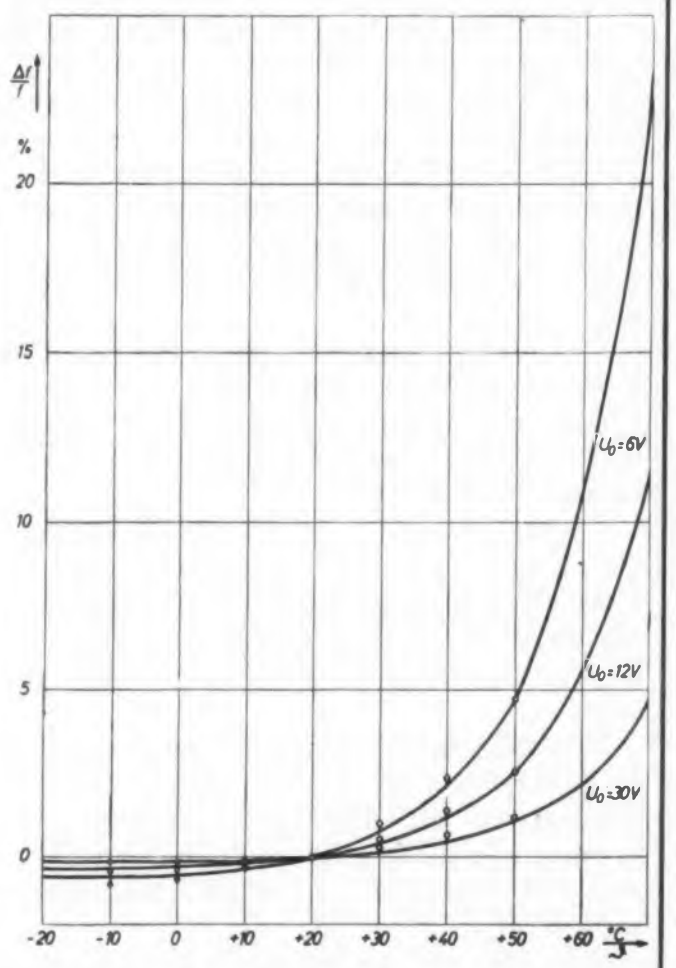

Fig. 3. Temperature dependence of frequency. The small circles indicate measured points, the curves are calculated.

GERMAN ABSTRACT

Hall Generators For Magnetic

HALL GENERATORS can be used in reproducing heads of magnetic tape devices to avoid the following four disadvantages associated with conventional electromagnetic induction transducers:

1. The output voltage, v, Fig. 1, is proportional to frequency. As a consequence, comparatively elaborate compensating schemes must be used in the amplifiers.

2. The output voltage is proportional to the recorded trace thickness, s, so that the storage capacity of a tape is limited since s cannot be reduced without adversely affecting signal-to-noise relations.

3. Increasing storage capacity by reducing tape speed and slit reluctance is possible only in a very limited sense because reduction of slit thickness leads eventually to excessive magnetic decoupling between tape and pickup.

4. The inductance of commercial induction units is so large (0.1 to several henries) that complete transistorizing is difficult since the low-input impedance of transistors in conjunction with this large inductance give rise to excessive time constants.

The Hall-effect transducer arrangement shown in Fig. 2 has much less frequency dependence than the conventional head and requires less elaborate equalizers. Down to recording trade thickness s of 1 mm, the output amplitude is independent of s.

Completely transistorized electronic circuitry can be used with the Hall transducer since the output impedance of Hall generators is purely resistive. In addition, slit thickness and speed

Tape Recorders

reduction is possible without decrease in output voltage.

Because indium antimonide has the largest electron mobility of the known semiconductors, it is best suited for the attainment of large power capability. In addition, indium antimonide has only pure Nyquist noise while other semiconductors exhibit additional noise which varies inversely with frequency.

Abstracted from an article by F. Kuhrt, G. Stark and F. Wolf, Elektronische Rundschau, *Vol. 13, No. 11, November 1959, pp. 407-408.*

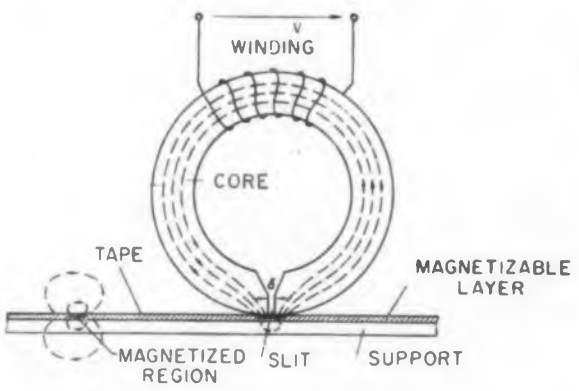

Fig. 1. Induction reproducing head.

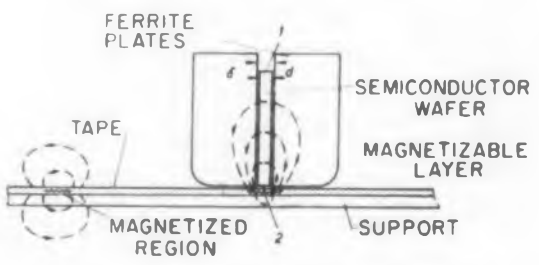

Fig. 2. Hall-effect reproducing head.

CIRCLE 294 ON READER-SERVICE CARD

Aluminum Strip Cuts Voids

BECAUSE ALUMINUM has less conductivity than copper, a greater cross section is needed to provide the same conductance. The actual cross-sectional area occupied by an aluminum conductor must therefore be greater than that of a comparable copper conductor.

If an aluminum conductor is in the same form as conventional insulated copper magnet wire, then a coil of it will occupy more space than a coil of copper and may require enlarging the magnetic circuit of iron and other components of the enclosure in which it is to be housed.

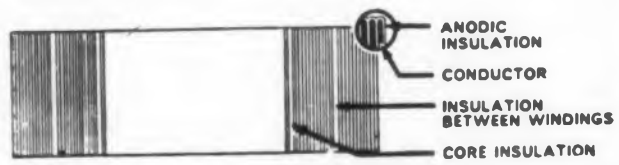

Fig. 1a. Transformer coil using anodized aluminum strip has a conductor space factor up to 30% of window opening.

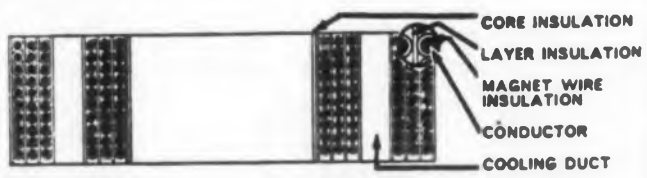

Fig. 1b. Conventional copper magnet wire coil has a conductor space factor approximately 25 to 35% of window opening.

trip Conductor
oids And Costs

However, a coil wound with aluminum strip can be designed so it will occupy no more space than a comparable coil wound with copper magnet wire. This is because the cross-sectional area of a coil includes the conductor itself, the electrical insulation, and any voids in between.

Advantages

With aluminum strip conductor, it is possible to eliminate some of the space required by the insulation and to greatly reduce the voids.

Basically, a strip wound coil consists of a number of turns of aluminum strip with an exceptionally thin layer of insulation between each turn. The number of layers is equal to the number of turns, and the layer-to-layer voltage is equal to the turn-to-turn voltage. This eliminates the high layer-to-layer voltage common in magnet wire coils wound with round copper magnet wire:

The result is a compact coil with practically no voids and a minimum of insulation. The contrast between strip wound coils and those wound with conventional copper magnet wire is illustrated in Fig. 1.

In addition, aluminum strip wound coils have a number of other advantages over comparable coils wound with round copper magnet wire. Among these are:

- Winding problems are simplified. Traversing

mechanisms of conventional winding equipment are not needed. Bobbins and flanges can often be eliminated.

- Layer-to-layer voltage is reduced, eliminating the need for additional insulation required for wire wound coils.
- Heat transfer characteristics are better, and hot spots are eliminated. Since hot-spot temperature determines allowable current densities, it is often possible to use higher currents or a lower equivalent conductor cross section.
- It is practical to use the excellent insulating properties of anodic films for turn insulation.
- With anodized strip conductors, impregnation of coils is usually unnecessary. If it is the practice to impregnate, however, less material is required because voids are at an absolute minimum.
- Joining and insulating of taps and terminals are simplified.

Insulation for strip wound coils may be provided by an anodized film on the surface of the strip, or by a thin ribbon of insulating material interleaved between turns as the coil is wound.

It is possible also that adherent materials such as organic resins or enamels may sometimes be

Fig. 2. Aluminum strip wound coil and the conventional copper wire coil it replaced.

used. The type preferred will depend upon coil operating temperatures and upon relative costs; available thicknesses; electrical, mechanical, and physical properties of the insulating material.

Anodized Aluminum Strip

Aluminum oxide exists on all aluminum in the form of a microscopically thin layer. This provides aluminum with its excellent corrosion resistance. By the use of anodizing techniques, this thin layer is built up to a hard, inelastic, and

highly insulating film approximately 0.00022-inch thick.

Anodized films have certain properties that make them ideal for coil insulation. They are very thin; they are very hard and resistant to abrasion; they have a high breakdown voltage (good dielectric strength) for a given thickness (about 550 volts for 0.00022-inch film); they are inorganic and chemically inert; and, above all, they withstand extremely high temperatures without distress of any kind. Aluminum oxide has a melting temperature which is actually much higher than that of the aluminum itself.

The greatest single problem in the development of a practical anodized strip conductor was to obtain a satisfactory film on the edge of the strip. When a wide sheet is slit into narrower strips, the slit edges are ragged and may have slight burrs.

Such irregularities cause no trouble in most applications, but it is impossible to get a uniform anodized coating over such a configuration. The problem was overcome by a combination of chemical and mechanical processes which give the edge a smooth contour that can be anodized adequately. It is around these edge conditioning processes that the major claims of patent application are based.

Systems using bare strip conductor are quite flexible, since many arrangements of strip widths and thicknesses may be used, and a number of excellent interleaving materials are available. Materials for interleaving may be any of the conventional insulating materials such as paper, Mylar, Teflon, glass, mica, or others depending upon operating temperature requirements, relative cost, available thicknesses, electrical, mechanical, and physical properties. The excellent heat transfer characteristics of strip wound coils result in lower average operating temperatures and in much lower hot spot temperatures than in wire wound coils. These reductions are significant when the choice of interleaving materials is considered.

Abstracted from Reynolds Metals Company Product Description, "Aluminum Strip Conductor," No. 11c-2, August 20, 1959.

Editor's note: Recently, the first large-scale application of aluminum foil strip conductor was announced. The Sparton Automotive Division of Sparton Corp., Jackson, Mich. switched from copper and aluminum magnet wire coils to interleaved aluminum strip conductor coil units for its line of automobile horns. Fig. 2 shows the strip wound coil and the conventional copper wire coil it replaced. The sizes of the two coils are about the same but in switching to the strip coil, 12 bulky parts were eliminated from the old style, copper wire coil horn. ■ ■

Pedestal-Free Switches

SEVERAL of the common switching devices have the disadvantage of causing a pedestal, or step function, to be transferred to the load by the switching signal. This pedestal can be very undesirable, particularly in the case where the switching frequency falls in the signal frequency band, and this paper describes several circuits which produce pedestal-free switching.

A two-diode type pedestal-free switch is shown in Fig. 1. It uses a transformer with a bifilar wound primary and a single secondary. When the switching current turns on diode D_1, diode D_2 is turned off and the signal can be transferred to the load simultaneously with the switching current. During the interval when D_1 is turned off and D_2 on, the signal cannot reach the load and another switching current is passed through D_2 and the load. When the switching potentials are balanced around ground it is possible to obtain equal switching currents which then would maintain a constant current through the load. The load will then be pedestal free. When any distortion of the switching signal occurs in the transformer it will be found difficult to completely balance the two switching currents. Note that the switching signal has to be larger than the largest information signal in order to keep the diode D_1 properly biased.

A pedestal-free transistor switch is shown in Fig. 2.

An alloyed junction transistor of either the pnp or the npn type can be used depending on the switching voltage polarity. In Fig. 2 when the switching voltage is positive the emitter-to-base junction of the transistor is biased in the forward direction and the transistor will present a very low impedance from collector to emitter. The signal now finds a return path to ground and the transformer passes the information to the load. When the switching voltage is negative, the emitter to base junction is back biased and the tran-

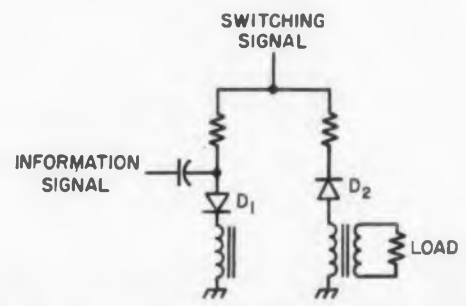

Fig. 1. Two-diode type pedestal-free switch.

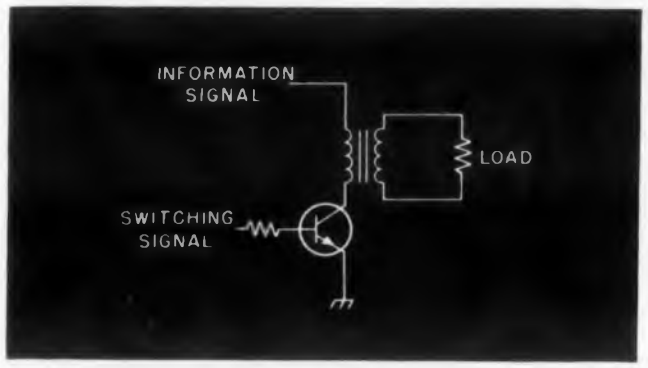

Fig. 2. Transistor type pedestal-free switch.

sistor will present a high impedance in the signal return path. Nearly all of the signal is then developed across the transistor and very little is reflected to the load. The transformed load impedance must be carefully selected to obtain useful efficiency in the "ON-time" and good isolation in the "OFF-time." The resistance of the collector to emitter junction will be in the order of several ohms, while several hundred kilohms can be obtained in the "OFF-time" with germanium transistors. Efficiencies of 95% with an isolation of 60 db can be obtained this way.

The transistor should have bilateral characteristics. This means that the collector and emitter of the transistor can be reversed in a circuit without a change in performance. As can be seen from Fig. 2, when the transistor is turned on, signal current through the collector to emitter junction should be able to flow in both directions.

During the off time, it is imperative to have the switching voltage larger than the largest signal voltage; otherwise, the collector to base junction would be forward biased and another return path is established.

The base current drive has to be larger than the largest signal current in the base in order to maintain the transistor in the "ON-state" and to produce a low impedance from collector to emitter. Therefore, the required switching power is a function to both the maximum signal and the transistor dc gain. *(continued on following page)*

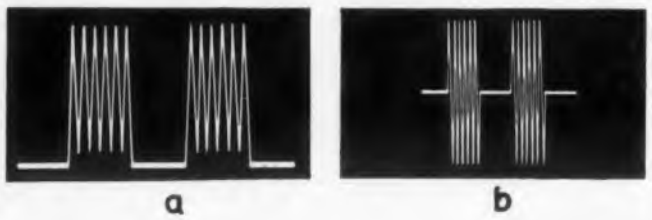

Fig. 3a. Typical voltage wave shape with signal voltage transmitted to load. **b.** Typical voltage wave shape obtained with pedestal-free switch.

The signal source should be at dc ground potential to avoid any dc current from the signal source through the load (and transistor) during the "ON-time." Having established this condition the switch operates as a true impedance switch and will cause no pedestal across the load. A typical voltage waveform is given in Fig. 3b. The maximum frequency that can be used is considerably higher than that of mechanically driven switches as the relay or commutator types.

Although the switch described above requires a floating load, it has the advantage over a parallel switch that the signal source is not shorted during the "OFF-cycle." Instead, the load is disconnected from the source and during this time another load could be connected by means of an additional switch.

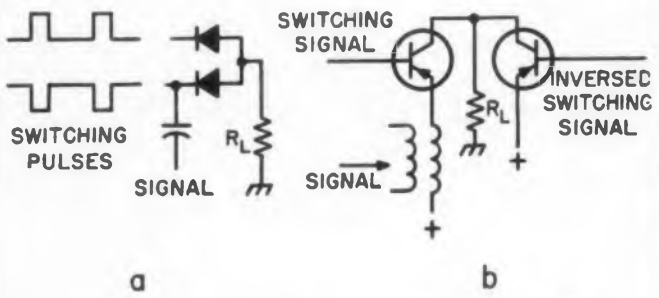

Fig. 4. Pedestal-free switches using two inversed switching signals.

Another form of a pedestal free switch can be used when two switching signals are available which are identical except for polarity. In Fig. 4a and b are given two types. Fig. 4a shows a two diode switch, turned on and off alternately and simultaneously, causing a continuous switching current to flow through the load, which does not produce a pedestal. The signal is only passed

through during the "ON-state" of transistor Q_1. Both transistors alternately contribute to a steady switching current through the load, providing that sufficient drive is applied to the bases of both transistors to produce saturation current independent of transistor gain.

Digested from Pedestal Free Switches *by Sybrand L. Anema, presented at the Sixth Annual East Coast Conference on Aeronautical and Navigational Electronics, Oct. 26-28, 1959, Baltimore, Md.*

Metallized Capacitors

METALLIZED capacitor developments, usage, and reliability have been of considerable interest to the Signal Corps, primarily for their improved volumetric efficiency. In 1952, the Signal Corps initiated a specification engineering program to better understand the relatively new metallized capacitor.

The results of this program showed, essentially, that the environmental and mechanical characteristics of hermetically sealed, metal-encased metallized paper capacitors were equal to the accepted conventional foil styles. In addition to standard climatic and vibration tests specified in MIL-C-25A, the program included high frequency vibration, shock, and acceleration tests now specified in the high reliability specification, MIL-C-14157, covering the foil styles. Electrically, approximately 99% of the specimens had dissipation factors of less than 1%, the limit specified in the foil specifications. The insulation resistance values, however, were lower than those found in conventional styles, quite unpredictable, and marginal with respect to MIL-C-25A requirements. It was found that the effect of the intermittent breakdown on the capacitance and dissipation factor, before the repetitive sparking point, is not significant, although the insulation resistance deteriorated with increasing numbers of sparks. In one test group,

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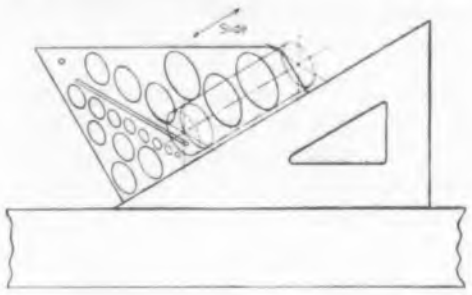
Specialized template applications

A list showing the growing application for templates includes templates for: Electronic Symbols, Electrical Wiring, Landscaping, Screw Heads, House Plans, Nuts and Bolts, Screw Threads, Tooling, Windows, Plumbing, Mathematical Symbols, Map Planning, and many "all-purpose" templates for circles, ellipses, triangles, and other shapes.

Isometric ellipse template is a big timesaver



An isometric ellipse template may be more useful if it is cut in half to provide edges parallel to the minor axes of the ellipses. Halves of the template may then be moved along a 30-60 degree triangle so that ends of a shaft or any cylindrical shape can be drawn in a minimum of time and in perfect alignment.

A selection of 52 popular templates is illustrated and described in a special six page brochure, "Drafting Templates" recently published by Frederick Post Company. *For your copy, write Frederick Post Company, 3644 N. Avondale Ave., Chicago, Illinois.*

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DIGEST

for example, insulation resistance of representative specimens dropped from approximately 20,000 megohm/μf initially to 50 megohm/μf after only 14 breakdowns. One important observation, which is of added significance today since emphasis is being placed on low voltage ratings for transistor circuitry, is that no "self-clearing" was detected when the capacitors were derated to 90% of their nominal rating. Establishing a derating where no breakdowns are encountered is of importance when considering the use of metallized capacitors in circuits which cannot tolerate intermittent sparking and pulses.

Since this study was made, there has been a general evolution of metallized capacitor design, manufacturing and quality control procedures.

Concurrent with this study, a number of events took place which further influenced Signal Corps thinking and added to their confidence in metallized capacitors. One factor has been the general evolution of metallized capacitor design, manufacturing, and quality control procedures. A principal design advance has been the use of metallized paper-metallized mylar combinations. These capacitors have proved themselves, under laboratory tests, to be capable of meeting the requirements of MIL-C-25A covering standard foil designs. They also demonstrated higher orders of insulation resistance values and insulation resistance stability than earlier metallized paper capacitor designs.

Also, the Signal Corps developed a miniature 0.2-mil, 50-volt metallized paper capacitor. Three large Signal Corps Industrial Studies established facilities for evaluating this miniature capacitor. From these programs, large quantities of valuable test data resulted which are presently being analyzed.

Perhaps the most influential event affecting Signal Corps thinking has been the development and acceptance of transistors. These devices, together with the many microminiaturized circuit projects underway, have changed capacitor voltage requirements and placed added emphasis on capacitor miniaturization. Military equipments are being transistorized, wherever possible, and capacitor voltage ratings of less than 50 volts are more the rule. In the near future, it is expected that almost 90% of capacitor needs could be serv-

iced with low voltage ratings. Fortunately, this trend is in line with the recommended voltage derating of metallized capacitors mentioned earlier, and certainly is in the safe direction. The engineer gains added confidence in the use of metallized capacitors when these capacitors are applied in 20,- 35,- and 50-volt circuits.

From a development viewpoint, the metallized electrode for capacitors is an important tool. Denied this, capacitor thin-film development programs would be seriously handicapped. The Army micromodule program, printed circuitry, and solid state circuitry require utmost miniaturization, and all, in some measure, depend on metallized electrode capacitors. A number of low voltage capacitor developments and production development programs employing metallized electrodes are underway at the Signal Corps. These developments are summarized briefly and the volumetric efficiencies of the metallized capacitors are compared with conventional foil-paper capacitor construction. For convenience of comparison, all capacitors are 1 μf and hermetically sealed. Using the 100-volt conventional capacitor as a reference, the following is noted:

a. The 0.2 mil metallized paper capacitor mentioned earlier is approximately 25% the volume of the reference capacitor.

b. The Bell Telephone Laboratories 0.1 mil stripped lacquer metallized capacitor, presently under Signal Corps Industrial Study contract, reduces capacitor volumes to approximately 17%.

c. A novel, thin film Signal Corps development is presently underway for rolled, micron-thick teflon capacitors. Briefly, in this process, uniform, substantially pinhole-free teflon is discharged on a 0.25 mil metallized mylar substrate, and counter-electroded. Capacitors have been made in the laboratory in sizes approximately 12% of the conventional capacitor. With further development effort, and with dielectric thicknesses reduced and tailored to 10- and 25-volt applications, this percentage could be considerably reduced.

In view of the progress made since the early metallized paper capacitor production, the new styles available, and the engineering and production test information made available, the Signal Corps has, today, increased confidence in metallized capacitors.

(*Digested from* The Metallized Electrode Approach To Capacitor Miniaturization, *a paper by Albert Lunchick, U.S. Army Signal Research & Development Laboratory, Fort Monmouth, N. J., delivered to a recent meeting of the New York Metropolitan Chapter of the IRE's Professional Group On Component Parts.*)

REPORT BRIEFS

Transistor Alpha

Effect of ambient temperature on the transistor parameters alpha and alpha cut-off at various bias conditions, is studied in this report. The alpha decreases and the alpha-cut-off frequency increases with a lowering of the ambient temperature. *Effect of Temperature on Alpha and Alpha Cut-off, Edwin Hirshmann, Diamond Ordnance Fuze Labs, Washington, D.C., April 17, 1959, 25 pp, Microfilm $2.70, Photocopy $4.80. Order PB 142852 from Library of Congress, Washington 25, D.C.*

High-Temperature Insulation

Aluminum was plated and subsequently anodized on substrates of copper, chrome, iron and Inconel. Efforts to anodize aluminum plated over various layer metals on copper were unsuccessful. Frit-silicone resin compositions were applied to anodized wire in separate steps, and electrical properties of frit-resin coatings applied to anodized wire were determined. Colloidal silica was deposited electrophoretically on anodized aluminum as a possible substitute for frit-resin coatings. Work on a "one time at temperature coating" showed possibilities of continuous operation to 900 deg F. *High-Temperature Insulation for Wire, J. N. Harris and J. D. Walton, Georgia Institute of Technology, Engineering Experiment Sta., Atlanta, July 1959, 43 pp, $1.25. Order PB 151944 from OTS, Washington 25, D. C.*

Nonlinear Elements and Circuits

Two methods of obtaining the response of an rlc circuit, containing a nonlinear inductor, to an arbitrary applied voltage are discussed. One method makes use of the phase portrait of the circuit; the other, of the phase-current relationship for the inductor. A method of evaluating the coefficients in a polynominal approximation to the two paths of a hysteresis loop is presented. This evaluation is made from a set of tuned voltmeter readings. An rlc circuit with nonlinear resistance is analyzed in a novel manner. A bibliography of material related to nonlinear circuits is presented. *Analysis of Electrical Nonlinear Elements and Circuits, Harold E. Ellithorn and Robert C. McCollum, Notre Dame University, South Bend, Ind., April, 1959, 96 pp, $2.25. Order PB 151916 from OTS, Washington 25, D.C.*

Frequency Control Systems

A general analysis of the phase loop is made for a system employing division of the locked oscillator frequency. The analysis includes the effect of an external signal introduced to frequency-modulate the locked oscillator. The results of the phase loop analysis are then used to establish certain design criteria for various loop components, and to set limitations on the frequency of the external modulating signal. General problems associated with the introduction of frequency modulation in the system are discussed, and ways of using the frequency synthesizer to control a separate fm modulator are briefly considered. *Frequency Control Systems, R. W. Stuart, General Radio Co., Cambridge, Mass., Feb. 1954, 23 pp, Microfilm $2.70, Photocopy $4.80. Order PB 142534 from Library of Congress, Washington 25, D. C.*

Spurious Radar Echoes

Radar echoes that are received from a sensibly clear atmosphere are commonly called "angels." In this paper the various types are described and the probable causes discussed. Also considered is the nature of signals from extra-terrestrial sources. *Spurious Echoes on Radar, A Survey, Vernon G. Plank, Air Force Cambridge Research Center, Bedford, Mass., May, 1959, 61 pp, $1.75. Order PB 151952 from OTS, Washington 25, D.C.*

Variable Capacitor Diodes

Alternative processes for the n and $p+$ regions of the hypersensitive type voltage variable capacitor are discussed. Units fabricated using one such process have shown hypersensitivity between -7 and -10 volts. Based on the improvement of capacitance range, nominal capacitance, and figure of merit, the abrupt junction device having $V^{-\frac{1}{2}}$ voltage sensitivity of capacitance is proposed as the best candidate for satisfaction of electronic tuning requirements. Characteristics of sample units produced to date are presented. Progress in characterization and measurement is outlined. Next quarter's activities are to be aimed at further device and process improvement in terms of electronic tuning, and the fabrication of "developmental model" units. *Variable Capacitor Diodes, L. S. Chase and H. D. Frazier, Pacific Semiconductors, Inc., Culver City, Calif., Oct. 1-Dec. 31, 1958, 32 pp, Microfilm $3.00, Photocopy $6.30. Order PB 142771 from Library of Congress, Washington 25, D. C.*

REPORT BRIEFS

Nickel-Cadmium Batteries

The experimental program was divided into two main tasks. The first task includes a development and evaluation of Sonotone hermetically sealed nickel-cadmium batteries. The second task includes a study of the reaction mechanism and kinetics of a hermetically sealed cell. Experiments have been designed and initiated for two phases of Task 1 and also for Task 2. A cycling panel was constructed for life cycling studies on hermetically sealed cells. A reaction chamber was designed for the reaction mechanism study. Preliminary investigations were made at 1/2 atmosphere and 1 atmosphere pressures on the effects of the variations of volume and concentration of electrolyte on cell performance. This work indicates that an increase in electrolyte concentration gives increased capacity and decreased voltage level. *Study of Sealed Nickel-Cadmium Batteries, Irwin M. Schulman, Sonotone Corp., Elmsford, N. Y., Dec. 1, 1958-Feb. 28, 1959, 48 pp, Microfilm $3.30, Photocopy $7.80. Order PB 142721 from Library of Congress, Washington 25, D. C.*

Thermoelectric Generators

This project covered experimental engineering investigation leading to the construction of five breadboard thermoelectric generators. The maximum efficiency achieved was 1.47 per cent at a load of 2.6 v with a 10 watt-15 cc heat source. A method of improving commercial insulating materials was found. The design parameters governing the choice of the number of junctions, apportionment of heat flow, temperature difference, and internal resistance in their relation to efficiency was also studied. *Thermoelectric Generators, Lloyd Owens, Horizons, Inc., Cleveland, Ohio, Feb. 7-Dec. 1, 1957, 65 pp, Microfilm $3.90, Photocopy $10.80. Order PB 142578 from Library of Congress, Washington 25, D.C.*

Four-Level Masers

A new application of the push-pull pumping scheme is proposed, leading to maser operation with a signal frequency higher than pump frequency. Conditions are indicated under which such operation is possible, and a simple theory is developed. Experimental results obtained with a ruby maser are quoted. *A Possible New Mode of Operation for Four-Level Masers, George Makhov, Willow Run Laboratories, University of*

Michigan, Ann Arbor, Mich., June 1959, 8 pp, Microfilm $1.80, Photocopy $1.80. Order PB 142782 from Library of Congress, Washington 25, D. C.

Antenna Beam Scanning

A brief outline is presented of some of the factors that affect radar range. A reduction in the noise figure of the radar receiver can greatly increase the radar range, especially if the antenna is pointing at the cold sky. An analysis is also presented of the diode up-converter, a new type of low-noise solid-state amplifier that converts upward in frequency and that is particularly suitable for use with electronic scanning antennae. The gain of the three-frequency up-converter is considerably greater than that of the two-frequency up-converter, while its noise figure is only slightly higher. When the three-frequency up-converter is connected in series with a down-converter in the usual fashion, the over-all noise figure of the combination can be lower than if a two-frequency up-converter were used. *Investigation of Methods of Scanning the Beam of Large Antennae, E. M. T. Jones and J. S. Honda, Stanford Research Institute, Menlo Park, Calif., Mar. 1959, 32 pp, Microfilm $3.00, Photocopy $6.30. Order PB 142468 from Library of Congress, Washington 25, D. C.*

Transistor Environmental Testing

This standardization study is concerned with evaluating the effects of the following combined environments on the physical and electrical properties of four specified types of transistors: (1) high temperature vibration, (2) high temperature shock, (3) high temperature acceleration, (4) low temperature vibration, (5) low temperature shock, and (6) low temperature acceleration. In order to accomplish this objective, the study was divided into five phases of work. This report covers all phases of the study. During the task assignment, 600 transistors were procured and subjected to evaluation tests in accordance with a test procedure approved by USASESA. A summary of the results of each test is included and forms Appendix A of this report. As a result of this study program, recommendations have been prepared for including combined environmental testing in the applicable military specification. *Effects of Combined Environmental Exposures On Transistors, Bernard T. Marren, Inland Testing Laboratories, Morton Grove, Ill., Jan. 1-Apr. 30, 1958, 39 pp, Microfilm $3.00, Photocopy $6.30. Order PB 142461 from Library of Congress, Washington 25, D. C.*

REPORT BRIEFS

Transverse Field TWT's

Efforts were directed toward improving the over-all performance of earlier transverse field TWT's by reducing their noise figure and increasing their gain to meet specifications. The rf matching of the input and output to the helices was improved by changing their electrostatic focusing field pattern. Instabilities, present because of wall charges, were eliminated. Mechanical instabilities, caused by heating effects, are still present. An attempt was made to decrease the width of a beam crossover, found to exist in the electron gun used in the earlier tubes, in order to reduce the noise contributed by the initial transverse velocities. When mechanically accurate helices were used, noise figures in the region of 5 to 6 db were measured. A search was made for a material on which longer helices could be wound to obtain additional gain. Alsimag 243 (Forsterite) was very satisfactory. Tubes were built with helices twice as long as the originals; their gains were in excess of 20 db and their noise figures were in the region of 7.5 db. An impedance matching device and a package amplifier were constructed. *Transverse Field Traveling Wave Tube, Robert Adler and George W. Hrbek, Zenith Radio Corp., Chicago, Ill., Nov. 25, 1957, 66 pp, Microfilm $3.90, Photocopy $10.80. Order PB 142577 from Library of Congress, Washington 25, D. C.*

Communications Systems Reliability

This report presents a new method of analysis of the reliability of a communications system. The method makes use of the matrix method of the theory of the linear graphs. The system under consideration consists of a number of communication stations connected by links. Associated with each link is a probability of failure. The problem is to express the probability of failure of the overall system in terms of some of the topological properties of the graph which represents the system. In this way, a connection is established between some quantitative measure on one hand and the structure of the graph on the other. To this end, a new matrix in the theory of linear graphs has to be introduced and its properties studied. These properties are derived and given in terms of a number of theorems. They include (1) a relation between the path matrix and the vertex matrix, (2) the rank of the path matrix, and (3) the correspondence of non-singular submatrices in the path matrix and the path cut sets. The probability of failure then is expressed in terms of the path matrix and is in fact given by the probability of the union of the "basic-cut-set products." *Reliability Study of Communication*

Systems, Omar Wing, Columbia University, School of Engineering, New York, Sept. 15, 1958, 24 pp, Microfilm $2.70, Photocopy $4.80. Order PB 139409 from Library of Congress, Washington 25, D. C.

Broadband Recording Equipment

The Factual Data Section of this report is divided into two parts, one treating the work done on the equipment to improve it mechanically, the other part covers the work done in the attempt to make the required tests. The mechanical changes that were made were necessary in order to improve the tape tracking, to reduce tape flutter, to reduce the excessive noise of the rotor, and to provide protection to the operator from the rapidly moving parts. New tape guides, pressure pads, and pressure roller assemblies, were constructed. The electronics of the motor speed control system which maintains the lateral position of the tape on playback in synchronism with its position on recording were studied and improvements were made. A study was made of the effect of wear of the contact surface of the rotor signal heads. Tests were also made on the operation of the slip ring system which feeds the signal from the rotating heads to the amplifiers. *Broadband Recording Equipment, R. A. Bierwirth, C. M. Minor and T. P. Cooper, Shoup Engineering Co., Chicago, Ill., Oct. 1, 1954-June 15, 1956, 36 pp, Microfilm $3.00, Photocopy $6.30. Order PB142744 from Library of Congress, Washington 25, D. C.*

Sampled-Data Systems

The major purpose of this study has been to attempt to solve some of the problems which arise in the analysis of nonlinear sampled-data systems. In particular, attention was centered on relay systems and saturating systems because these two nonlinearities are often encountered in sampled-data systems and the methods which appear to be applicable to the analysis of these systems were studied. The method used to analyze the relay system was different from that developed to analyze saturating systems: the only feature common to both was that the starting point in each case was the difference equation which described the system. Since this is the fundamental description of the system, it is felt that this is the logical starting point in the analysis of nonlinear sampled-data systems. *The Analysis and Compensation of Nonlinear Sampled-Data Feedback Systems, F. J. Mullin, Electronics Research Laboratory, University of California, Berkeley, Calif. Aug. 22, 1959, 132 pp, Microfilm $6.90, Photocopy $21.30. Order PB 142560 from Library of Congress, Washington 25, D. C.*

Two New Measurement Techniques Spotlight National Bureau of Standards Expansion

In an effort to meet the urgent need for standards and calibration services in the radio-electronics field, the National Bureau of Standards is expanding the facilities of its Radio Standards Laboratory in Boulder, Colo.

Concurrent with this expansion, comes the announcement of two important new measurement techniques perfected by the Bureau. The first technique provides an alternate basis for the determination of the basic electrical standards, and the second describes an ultra-precise calibration method for microwave attenuators.

1. New Basis For Electrical Standard

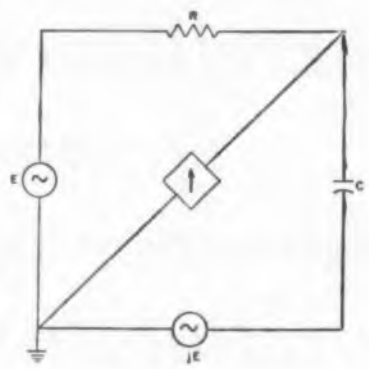

Fig. 1. Diagram showing the principle involved in the National Bureau of Standards' determination of resistance in terms of capacitance. The two-voltage sources are equal in magnitude but 90 degrees out of phase, and the capacitance is adjusted so that no current flows through the detector. At this balance $R = 1/\omega C$, so that the resistance can be determined directly in terms of the capacitance at the frequency of measurement.

IN ATTEMPTING to improve the values assigned to the electrical standards, the Bureau has devised an alternate basis for absolute determinations. Based on a calculable capacitance standards and a highly accurate capacitance bridge, this alternate approach determines the electrical quantites of resistance and voltage, and provides a check on the ohm and the volt as currently maintained by the Bureau.

There are many interactions between electrical and mechanical phenomena which offer possible methods for realizing electrical units by means of mechanical measurements. However, until recently only one relation could be exploited with the required accuracy. This is the dependence of the inductance of a circuit on its geometric size and shape. The Bureau has therefore been using this relation to realize the basic units of electrical measurements: the ohm, the ampere, and, from

Ohm's law, the volt. The absolute ohm is based on a computable self or mutual inductor and the absolute ampere is based on the calculated force between two carefully constructed current-carrying coils.

The development of the computable cylindrical cross-section capacitor and the high-accuracy transformer-type capacitance bridge have changed this situation materially. The computable capacitor can now be used to provide an alternate and probably a more accurate basis for the electrical standards.

The realization of the ohm in terms of the computable capacitor involves comparing a resistive impedance with a capacitive impedance. The capacitance is adjusted until the current through it balances the current through the resistor when the two impedances are connected to voltage sources equal in magnitude but differing in phase by 90 degrees. This allows a value to be assigned to the resistor in terms of the known capacitance and the frequency of measurement.

However, the resistors used in maintaining the ohm are not suitable for use with alternating current. A critical part of the new determination is therefore the construction of a comparison resistor which will have the same value at the comparison frequency as when used with direct current. A resistor which is expected to meet this requirement has been designed and is now undergoing final adjustment.

A realization of the absolute volt through capacitance measurements is also being considered. This determination, like that of the ampere, will be based on a force measurement. Here the force between plates of the capacitor is proportional to the square of the impressed voltage and to the

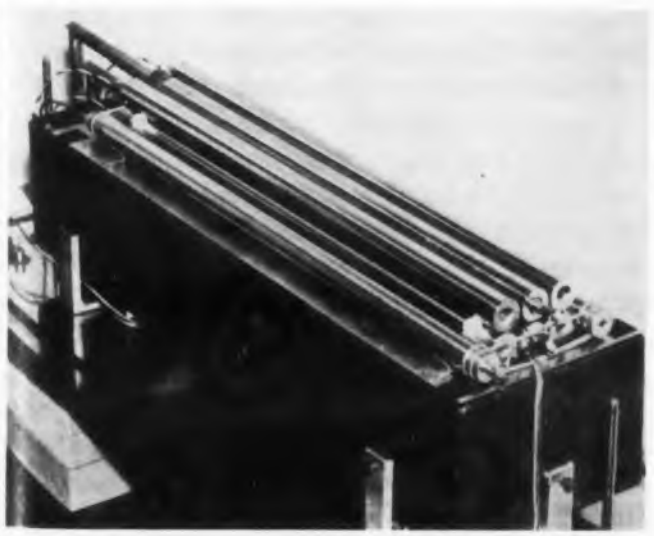

Fig. 2. Calculable capacitance standard on which the National Bureau of of Standards is basing a new realization of the ohm and the volt. The capacitor, computable in terms of length, is being used in conjunction with an accurate capacitance measuring bridge to provide an alternate and probably a more accurate basis for the electrical Standards.

rate of change of capacitance with displacement. It is expected that measuring this force will provide a realization of the volt with an accuracy at least as high as, and probably higher than, present absolute-ampere determinations.

2.
Ultra-Precise Microwave Attenuation Measurement

A METHOD has been developed by the National Bureau of Standards for calibrating the lower ranges of a microwave variable attenuator to accuracies better than 0.0001 decibel (10 microbels). This accuracy exceeds the precision to which available attenuators can be set and read, and is the most accurate measurement of microwave attenuation yet made at the Bureau's Radio Standards Laboratory.

The work was done in connection with the Bureau's program to develop microwave standards and precision measurement methods at microwave frequencies. Calibrated microwave attenuators and directional couplers are used in such instruments as field strength meters and signal generators, and in alignment of radar transmitters and receivers. The use of attenuators for power measurements reduces high power outputs by a known amount to a level that can be conveniently measured with milliwatt instruments. Manufacturers of microwave equipment need their transfer standards calibrated against a national standard to insure the accuracy of attenuators made for industry, the military and the government. This present development provides the required accuracy in the lower ranges.

The improved accuracy was made possible by adapting a very stable power measurement system to attenuation measurements. The resulting calibration system (Fig. 1) consists of an amplitude-stabilized microwave signal source and a

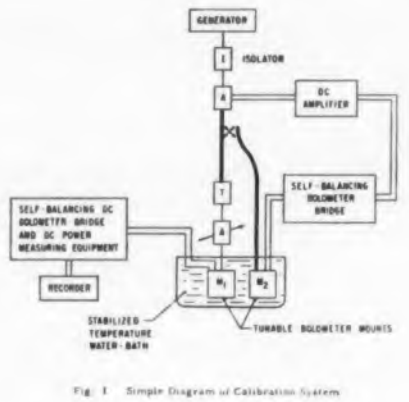

Fig. 1. Block diagram of the calibration system developed at the National Bureau of Standards for precisely measuring very small attenuations.

bolometer detector operated in a temperature-stabilized water bath. There are provisions for "tuning out" the reflections of the system at the place where the test attenuator is inserted, and for accurately measuring the dc power supplied to the bolometer detector. A second bolometer detector forms part of the amplitude stabilization loop.

The change in attenuation as the attenuator dial is moved from the zero position to some other position changes the microwave power input to the bolometer mount from P_1 to P_2. The measured attenuation is given by the expression $A = 10 \log_{10} P_1/P_2$. The microwave power as measured by the bolometer technique is proportional to the amount of dc power withdrawn in order to keep the bolometer resistance constant. The constant of proportionality is the "effective efficiency" of the bolometer mount. This factor cancels out in the expression for attenuation, provided that it is independent of power level, which previous experiments have verified.

The bolometric measurements are made through use of a self-balancing dc bridge, a constant current generator, and associated dc measurement apparatus. This instrumentation provides a direct indication of changes in the microwave power input, which makes possible the determination of small attenuation values.

The attenuation of a rotary vane type of variable attenuator was measured by this method. To obtain an indication of the repeatability of setting the attenuator, the results of three independent settings were recorded. Although the main interest was originally in the lower ranges, the full range of the attenuator was measured.

Two sources of error were considered in estimating the limits of error in the resulting data. These were the mismatch error and the error aris-

ing from the uncertainty in measuring the dc differences. Calculations of the limits of mismatch error are based upon system reflections corresponding to a VSWR less than 1.005 and on changes in the attenuator characteristics as determined from separate measurements. The error in measuring dc power differences is estimated to be less than 0.1 per cent ±0.1 microwatt.

A statistical analysis of the data indicates that the accuracy of the measurements exceeds the precision with which the attenuator can be set and read. This finding suggests that variable microwave attenuators with expanded scales and precise gears are needed if full advantage is to be taken of this calibration accuracy.

Radio Standards Research and Calibration Services Expanded

AS INDICATED by the recent Aerospace Industries Association Survey, the precision needs of the military services and industry are now outstripping the availability of standards and calibration services in the radio-electronics field. Although manufacturers have attempted to fill the gap by establishing procedures to calibrate their own working standards, these standards lose much of their value if they are not calibrated in terms of the national standards.

In an effort to meet these urgent needs, the National Bureau of Standard's Radio Standards Laboratory in Boulder, Colo., is expanding its program of radio standards research and calibration services. Within the limits of its facilities and staff, the Laboratory is seeking to provide the improved standards, measurement techniques, and associated instrumentation that are needed for all radio frequency and microwave quantities. At the present time, standards are being established or improved for frequency, power, attenuation, voltage, impedance, noise, field strength, interference, conductivity, dielectrics, and magnetics. In addition, a new laboratory has recently been activated to use advanced techniques to study radio properties of materials.

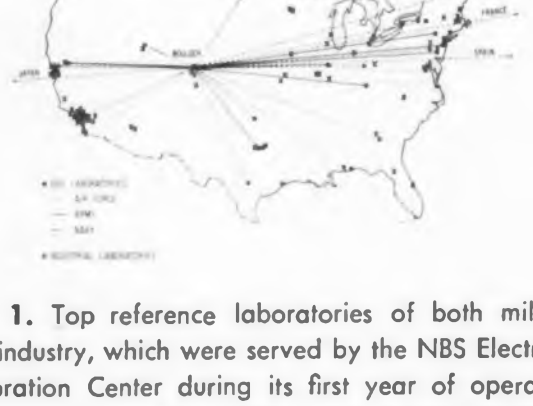

Fig. 1. Top reference laboratories of both military and industry, which were served by the NBS Electronic Calibration Center during its first year of operation. Most of these in turn calibrate lower-level standards.

Microwave Impedance

Impedance measurements play an essential role in the design, production, and evaluation of electronic equipment. However, impedance is one of the most difficult quantities to measure accurately. Recently the Radio Standards Laboratory significantly improved impedance standards and measurement techniques in the microwave range.

Three types of fixed impedance (or reflection) standards have been developed: an adjustable sliding termination for rectangular waveguide, which can be arranged to have practically no reflection; very precise short-circuited sections having almost total reflection; and half-round obstacles whose reflections can be calculated from

the dimensions and wavelengths.

The adjustable sliding termination has a voltage standing-wave ratio of less than 1.0002 or a return loss greater than 80 db. Extremely fine mechanical tolerances and controls provide a fine adjustment and minimum variation in reflection.

In the short-circuited sections of waveguide the input flange is a quarter wavelength from the short circuit. In a typical example, a short-circuited section of X-band electroformed silver waveguide has a calculated VSWR at 10 kmc of approximately 5140, corresponding to a voltage reflection coefficient of approximately 0.99961.

To test these short-circuited sections it was necessary to know the effective conductivity of the metal. This conductivity was obtained by making attenuation measurements of the sections. In these measurements, an attenuator was calibrated by modifying a system used in microwave power research. The lower range of the microwave variable attenuator was calibrated at approximately 9.4 kmc to accuracies exceeding 0.0001 decibel. Such accuracy exceeds that to which fine attenuators can be read. This development illustrates the interdependence of basic measurements. In this case, the need to evaluate impedance standards revealed a need for attenuation measurements that was met by a modification of a power measurement system.

From a theoretical analysis, inductive half-round obstacles have been built for use as impedance standards over a wide range of reflections. Measurements of these reflections have agreed with calculated values to better than 0.1 per cent in VSWR.

The calibration and use of these standards required improvement in the measurement of microwave impedance. Accuracies of 0.1 per cent in VSWR to 2.0 were achieved by using magnified response and modified reflectometer techniques. The development of the latter technique included a rigorous analysis of the microwave reflectometer. This analysis describes the correct adjustment of auxiliary tuners, and provides quantitative values for errors resulting from incorrect adjustments. Work is in progress on the extension of these impedance measuring techniques to other sizes of rectangular waveguide and to coaxial systems.

The above description of recent research and development in microwave impedance illustrates advances in a specific area of standardization. Progress is also being achieved in other basic quantities throughout the radio frequency range.

Atomic Frequency Standards

The physical quantity most important to the electronic field is frequency. To make the national standards of frequency and time intervals readily available, radio broadcasts are made con-

tinuously from WWV, in Beltsville, Md., and from WWVH in Maui, Hawaii. In addition, a 60-kc experimental station broadcasts from Boulder, Colo.

The Radio Standards Laboratory monitors WWV continuously. Its frequency is measured daily in terms of extremely accurate atomic standards. With recent improvements in techniques, comparisons can now be made to a part in 100 billion.

Experiments in the search for more accurate standards of time and frequency have shown that standards based on varying properties of atoms are more precise than astronomical or quartz crystal standards. Atomic standards are also simpler and more completely understood. They do not have secular variations inherent in astronomical time, nor do they suffer from the aging effects of quartz. In addition, they measure time and frequency very quickly, in contrast to delays of months or years necessary for evaluation of other systems.

Recent Improvements

Recent improvements in atomic frequency standards are opening up new possibilities in science and engineering. For example, atomic clocks provide high-resolution spectroscopic techniques that can be used to probe deeper into the molecule, atom, and nucleus. Also, more accurate time measurement will permit a closer study of the effect of land tides, sea tides, and the motion of air masses upon the rotation of the earth. It may even provide a means of detecting the effect of rarified gases and magnetic fields on the motion of planets or satellites. Another government agency is now planning to use atomic clocks in an experimental test of the special and general theories of relativity.

The atomic beam frequency standards under development in the Radio Standards Laboratory depend upon the transistions of cesium atoms from one energy state to another. These transitions can occur by the absorption or emission of an electromagnetic wave of a very definite frequency. This frequency is determined by the difference in energy of the two states involved in the transition. For an isolated atom the energy difference of these states—and consequently the emitted or absorbed frequency—is invariant. Of course, the apparatus used to observe the transition disturbs the atoms, and they can then no longer be considered isolated. However, the atomic beam technique creates the least such disturbance of all current methods. For this reason, it is thought to

provide the most accurate frequency standard, although perhaps not the most precise.

During the past 18 months a cesium beam atomic standard has been almost completely remodeled so that it now has a precision and accuracy of about 7 parts in 100 billion. A new cesium beam standard, designed to have a somewhat higher precision, has just been completed. These two cesium standards, an Atomicron, and an extremely stable crystal oscillator, are now being intercompared on a regular basis.

The new atomic beam is designed to use thallium as well as cesium (thallium has certain important advantages over cesium). Initially, however, cesium is being used and preliminary results (as of October 1, 1959) indicate that its precision and accuracy is 6 parts in 100 billion.

Two ammonia masers (microwave amplification through stimulated emission of radiation) are being used to study the character of the radiation which excites the cesium transition. At the same time they provide separate standards for frequency comparison. Frequency comparisons with atomic standards in other parts of the world are also made on a regular basis.

Electronic Calibration Center

For quantities other than frequency, the Radio Standards Laboratory disseminates its standards and measurement techniques to the Nation mainly through its Electronic Calibration Center, established in 1958. The primary mission of the

Fig. 2. David Russell adjusts the "magic T" input to the detector of the new NBS high-frequency piston attenuator developed by the Radio Standards Laboratory. The attenuator itself is in the Electronic Calibration Center. On the right is the large trombone phase shifter used in this dual-channel system.

STANDARDS AND SPECS

Center is to calibrate inter-laboratory standards for such quantities as voltage, power, and impedance in terms of the national standards maintained by NBS. These interlaboratory standards, in turn, are used to assure the accuracy of reference and working standards.

Although the Center was established primarily to meet critical needs within the Department of Defense, it is also designed to meet the needs of the electronics industry. Efforts are under way to increase the capacity of the Center to provide a larger number of individual calibrations each year.

Its calibration activities are divided into three units covering low, high, and microwave frequency measurements. Instrumentation is still incomplete but interim steps are used when necessary to help meet the calibration demand.

Low frequency (zero to 30 kc) instrumentation now provides for the calibration of resistors, bridges, potentiometers, capacitors, inductors, standard cells, electrical instruments, ratio devices, and instrument transformers. Within recent months the Center has received a transformer-type capacitance bridge, constructed by the Electricity and Electronics Division, that will extend the capacitance calibration range, for low frequencies, downward to 1 micro-pico-farad. By modifying existing ratio sets and associated equipment, it is expected that the frequency range of current and potential transformer calibrations will be extended, within the year, from 60 to 400 cps.

To date, the saturated cells used by the low frequency unit to maintain the volt have been kept at a reasonably constant temperature in an air bath. A new oil bath that is now being completed should increase certified accuracies five times over the current accuracy of 0.001 per cent.

The high frequency unit (30 kc to 300 mc) is now equipped to calibrate standards of voltage (unbalanced), power, impedance, attenuation, and field strength. At the present time, these standards are limited to cw measurements. Calibration services for most quantities are at the fixed frequencies of 30, 100, and 300 kc, and 1, 3, 10, 30, 100, and 300 mc. Continuous frequency coverage is being provided, however, as rapidly as stable and accurate equipment can be devised.

A new precision piston attenuator to operate at 30 mc has just been completed by the Laboratory. This attenuator will measure a change in attenuation of less than 0.001 db, and will allow calibration accuracies of 0.01 db. These same accuracies are expected to be offered within the next year at 100 and 300 mc.

High frequency voltage is now being calibrated

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CAREER BROCHURES

Convair-Pomona

The purpose of this brochure, "Engineering Opportunities For You," is to acquaint the applicant with Convair-Pomona—its history, its corporate structure, and the opportunities available. Convair-Pomona, a division of General Dynamics Corp., is engaged in research, development, engineering, and production in the field of electronics and complex weapons systems.

Brief descriptions of various job opportunities are listed and include mechanical design, electromechanical design, dynamics, aerodynamics, operations research, thermodynamics, electronic systems, hydraulic design, flight analysis, test engineering, microwave and antenna design and engineering writing.

Engineering Personnel, Convair-Pomona, Div. of General Dynamics Corp., Dept. ED, Pomona, Calif.

CIRCLE 872 ON READER-SERVICE CARD

RCA

A comprehensive digest of RCA's West Coast Missile and Surface Department is presented to scientists and engineers in this illustrated brochure. Highlights include systems engineering, projects engineering and projects management, design and development engineering, electronic countermeasures and airborne equipment, data processing and computers, displays and weapon control, missile automatic checkout and missile ground support systems, and light radar.

Radio Corporation of America, Dept. ED, Missile and Surface Radar Dept., Employment Div., Van Nuys, Calif.

CIRCLE 873 ON READER-SERVICE CARD

YOUR CAREER

NEWS AND NOTES

Labor turnover is causing splitting headaches in many engineering companies. If only there were some blueprint that all managements could follow to cut the rate. Unfortunately there isn't, says Dr. Frederick J. Gaudet, director of the Lab of Psychological Studies at Stevens Institute of Technology, Hoboken, N.J. His study of the subject has just been published by the American Management Assoc.

One company's successful technique in checking labor turnover may be another's failure, he has found. But some approaches to solutions have been successful so often that they warrant consideration, he says.

Among these, Dr. Gaudet lists employe screening devices, such as the weighted application form and psychological testing; on-the-job methods, such as improved training and better communication; and, finally, devices aimed at finding out why employes leave a company.

One company, for example, noted a high turnover rate during the employes' first three months on the job. Analysis showed that new employes had no way of knowing how well they were advancing; they were told only that they were expected to reach a standard after a certain number of weeks. Setting weekly goals slashed the turnover more than 50 per cent, Dr. Gaudet reported.

Another concern traced a turnover problem to poor downward communication of company policy on merit raises. An investment of a few hundred dollars in a new pamphlet describing the policy solved the problem, Dr. Gaudet said.

One of the hardest undertakings, he says, is to find out why employes leave. Some company's use the "exit interview," with only spotty success. It has two objectives: to reclaim some of those who intend to quit and to gather information for management as a basis for corrective action.

Human nature being what it is, though, Dr. Gaudet notes that employes tend to give socially acceptable replies to the exit interviewer rather than risk "tattling" or receiving a bad reference.

A relatively new technique, he reports, is the "post-terminal interview." This sounds out the employes with a questionnaire after they have left. The findings are sometimes eye-openers. One company found that at the exit interview changes in jobs were attributed to such external factors as "other employment," "leaving state," "military service." But the post-terminal questionnaire turned up such internal complaints as "poor pay," "bad supervision," "slow advancement."

ENGINEER-IMPROVEMENT COURSES AND SEMINARS

Below are courses and seminars intended to provide the engineer with a better knowledge of various specialties. Our grouping includes several different types of meetings: National Courses—those held on consecutive days and intended to draw attendees from all geographical areas; One-Day Seminars—one-day intensive seminars which move from city to city; and Regional Lectures—regional symposia or lecture series which generally run one night a week for several weeks.

Regional Lecture Series

Managing Engineering Services Workshop Seminar, IEI, January 25-27, New York

This seminar will be of interest to engineers who are dependent upon service functions for the successful execution of their assigned tasks. It will also be of interest to those who are responsible for the supervision of engineering services themselves. Beyond these two groups the seminar will be of value to those who are interested in studying ways in which the effectiveness of engineering services can be utilized within the organization to increase the output from the engineering organization. Subjects to be covered will include basic concept of an engineering service, scope of responsibility, organizing the service function, staffing the service functions, establishment of working relationships with departments served and evaluating performance. For additional information on this seminar and the following four write to: Industrial Education Institute, 25 Huntington Ave., Boston 16, Mass.

PAPER DEADLINES

Convention Program Chairmen have issued the following deadlines to authors wishing to have their papers considered for presentation.

February 1: Deadline for 3 copies of a 250-word unclassified abstract for the 4th National Convention on Military Electronics (MIL-E-CON) to be held June 27-29 at the Sheraton-Park Hotel, Washington, D. C. Suggested topics include, but are not limited to the following: current problems of space technology, space electronics, ranging and tracking, electronic propulsion, data handling systems, guidance and control, inertial systems, reconnaissance systems, communication systems and operation analysis. Send abstracts to: Dr. Craig M. Crenshaw, Department of Army, Office of the Chief Signal Officer, R&D Div., SIGRD-2, Washington 25, D. C.

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Dual pulse presentation on hp 185A. Top trace shows pulse from mercury pulser applied to 2N1385 mesa transistor. Bottom trace shows responding turn-on of transistor. Dip in bottom trace at start of turn-on results from capacitance. Scope sweep speed 1 millimicrosecond/cm.

This new-concept hp 500 MC oscilloscope

can help you now... and here's how!

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. . . here, now is the convenience of conventional pulse measurement in the millimicrosecond region.

The hp 185A 500 MC Oscilloscope is a completely new instrument that is virtually as simple, convenient and easy to read as conventional broadband oscilloscopes, yet provides a wealth of fast-circuit information never before available.

In such fields as computer and radar research and design, and semiconductor research, the Model 185A is the first practical, available answer to the pressing need for measuring and viewing millimicrosecond phenomena.

It should be emphasized that the 185A is an existing instrument—ready for you now, with bright, clear 5″ scope traces that are totally comparable in information, clarity and usefulness with presentations you associate with much lower frequencies.

Sampling oscilloscope

hp 185A is a sampling oscilloscope, whereas most previous oscilloscopes have been broadband instruments. The sampling technique avoids several inherent limitations of the broadband approach which arise in the millimicrosecond region. One of these is the intrinsic sensitivity-bandwidth-display-size limitation of cathode ray tubes; another is the characteristic gain-bandwidth limitation of associated amplifiers.

A third critical problem with the broadband approach in the 500 MC band pass area is that, frequently, fast pulses or occurrences happen at low repetition rates. This means that the writing rate is not sufficient to provide a bright trace on the cathode ray tube.

hp 185A adroitly sidesteps all these roadblocks by immediately translating the input signal to a much lower frequency, through the sampling technique, then proceeding with more conventional signal processing to provide standard oscilloscope operating ease and bright, clear, large-screen presentation.

"Sampling" in this application is analogous to stroboscopic light methodology in that both techniques simulate slowing down the "motion" for better visual study—and both depend on repetition to build a faithful image.

Operation described

In the case of the hp 185A, the sampling approach applied in the following manner.

The first step in building 185A's cathode ray tube picture is to apply a staircase voltage to step the beam across the CRT face. (Figure 1.)

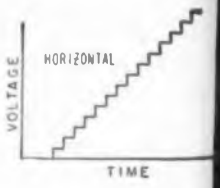

Figure 1

Next, input voltage samples, each taken from a differing point on the waveform, are fed through the vertical amplifier to the scope face.

Now, between the staircase steps, the beam is blanked so that the signal becomes a series of dots. In operation, many dots are present, and the pattern appears continuous. (Figure 2.)

Figure 2

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