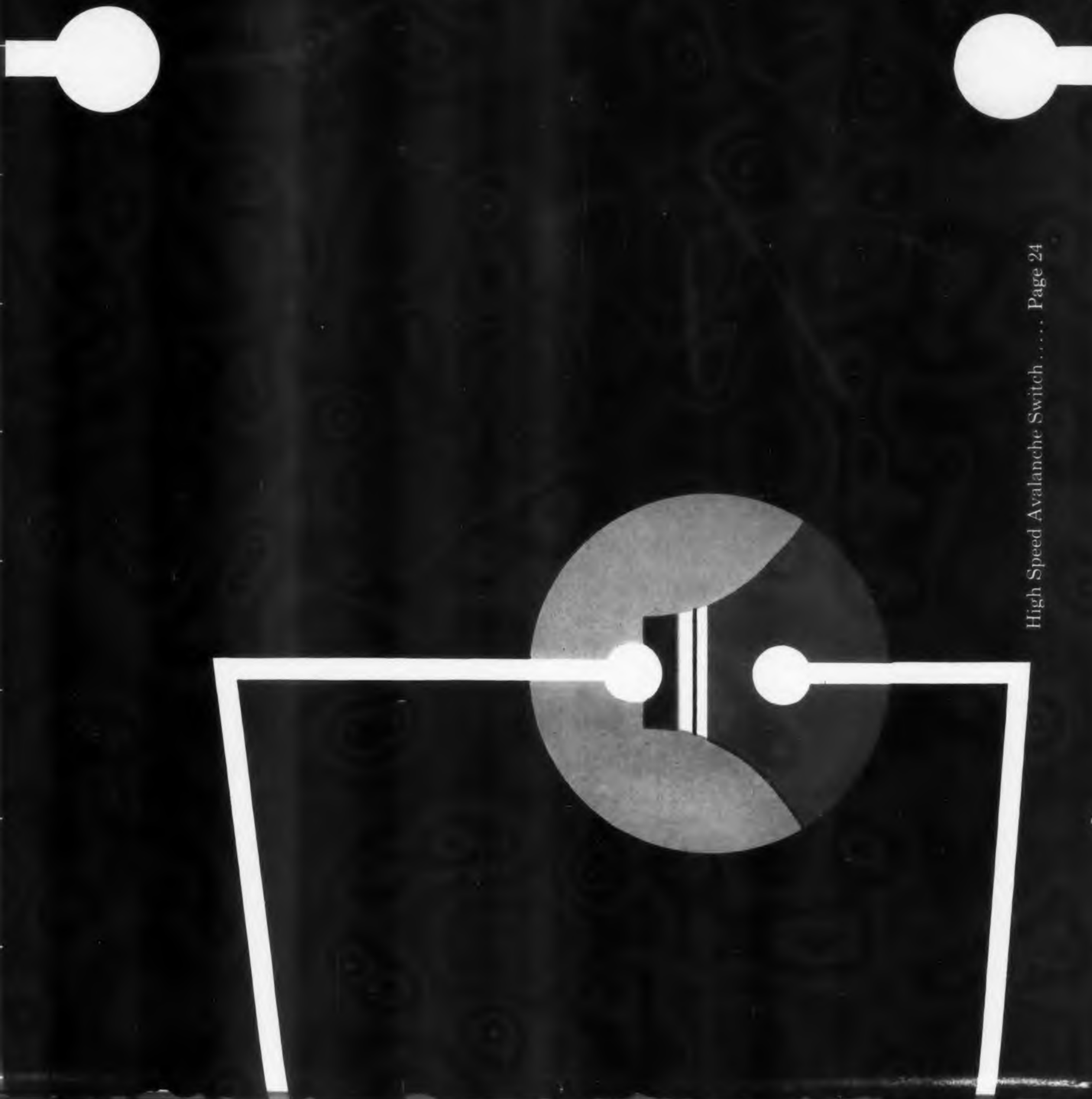
ELECTRONIC DESIGN



High Speed Avalanche Switch . . . . Page 24

January 7, 1959

◄ CIRCLE 1 ON READER-SERVICE CARD

HIGHLIGHTS OF ISSUE

High Speed Avalanche Switch 24

It takes the avalanche switch about 50 trillionths of a second to turn current on. This is a hundred times faster than the best semiconductor switch. And it has good current handling capabilities.

6 Systems for Tracking Down Vibration Resonance 20

W. A. Reinman presents a very down-to-earth discussion of vibration resonance and how to spot it. Six basic signs of resonance that can be observed directly are: failure, modulation of output signals, visible motion of equipment relative to its supporting fixture, high acceleration of one part in relation to another, loud noises, and large changes in power required to provide vibration at the desired level.

Starting This Issue 38

The first two of a series of papers presented at the Symposium on Microminiaturization of Electronic Assemblies sponsored by Diamond Ordnance Fuze Laboratories late last year. Because symposium attendance was limited to government personnel only, ELECTRONIC DESIGN is publishing these papers as a special service to our readers.

January 21, 1959 Vol. 7

NUMBER

2

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DESIGN

BEHIND THE NEWS

BOMARC To Join SAGE As Air Defense System's First Automated Missile

NEWEST WEAPON in America's air defense system is Boeing's BOMARC IM-99 supersonic missile, which will be the first automated surface-to-air missile integrated into the Semi-Automatic Ground Environment (SAGE) warning system.

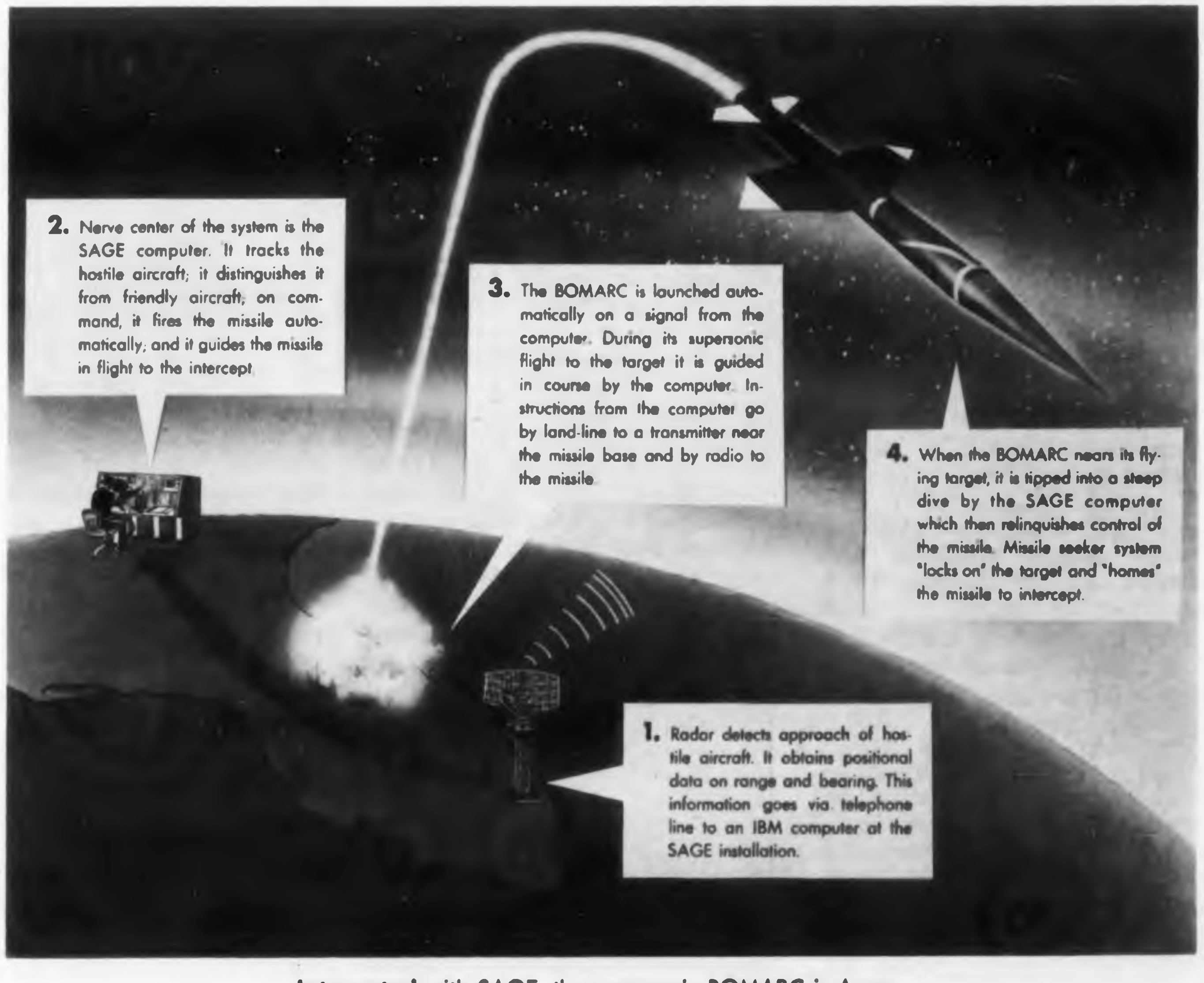
Air Force Secretary James H. Douglas has revealed that the 15,000-lb. BOMARC will become operational this year. The first four of 14 planned BOMARC sites are being readied at McGuire Air Force Base, N.J. (where the first SAGE center has been operating 24 hours a day since July); Suffolk County AF Base, Long Island, N.Y.; Dow AF Base, Me., and Otis AF Base, Mass.

Douglas explained that the Army's 200 Nike batteries, several of them now equipped with the Hercules missile, are effective for point defense, but BOMARC is designed "to go as far out as possible from our borders to meet attacking bombers."

Remote Control Tests Successful

From an experimental IBM-SAGE center at Kingston, N.Y., BOMARC missiles 1500 miles away at Cape Canaveral, Fla., have been launched by remote control and have successfully downed drone targets more than 200 miles at sea. But Douglas reveals that an advance type "will have several times that range." And work is underway on a solid propellent propulsion system.

BOMARC, 47 feet long, 35 inches in diameter, with an 18-foot wing span, now combines the high thrust feature of a booster rocket with the



Integrated with SAGE, the supersonic BOMARC is America's first wholly automated air defense missile. An IBM computer at the SAGE center tracks the target, fires the missile automatically, guides it to the target.

fuel economy of twin ramjet engines to achieve altitudes above 70,000 feet and speeds over Mach 2.5. Carrying either nuclear or conventional warhead, it employs the latest electronic guidance systems, including the terminal guidance system in the missile itself. When integrated with SAGE it is fully automated; the target—subsonic or supersonic—is tracked automatically, the missile is launched and guided automatically.

The SAGE/BOMARC system consists of the missile plus two elements of the air defense ground environment: search and height-finding radar with a built-in data processor, and a giant IBM-SAGE computer which functions as the control center for the system.

Heart of the SAGE system is this IBM AN/FSQ-7 computer, which digests radar returns from all sources, plus ground observer reports, domestic flight plans and weather information. The computer automatically calculates the most effective employment of guided missiles, anti-aircraft batteries and jet interceptors.

A single BOMARC firing sequence, in which the computer must run through many thousands of individual steps in continuous sequence, is organized into four phases: target detection and reporting, target tracking, missile firing preparation, and missile guidance and intercept.

Target Detection and Reporting

The firing sequence begins when an AN/FPS-20 long-range search radar detects what may be a flying object in a sector screened by that radar. The return is passed along an AN/FST-2 coordinate data transmitter, which converts it to polar coordinates—range and azimuth—for transmission in digital form over leased lines to the nearest SAGE AN/FSQ-7.

This information is stored in "long range input" magnetic drums, where it is read by a "program" previously stored in the computer, then converted into "Cartesian coordinates." The "program" consists of detailed instructions fed into the computer by punched cards and by magnetic tapes, while the "Cartesian coordinates" supplant the range and azimuth relayed to the center from the radar site. These coordinates are referenced to the launch pad of the nearest BOMARC. Thus when the missile is launched, track information on the target and guidance information on the BOMARC are referenced to the same fixed point.

At this stage, the radar return is examined by the track correlation program to determine whether it is a new track, part of a previous track (as a regularly scheduled airliner), electronic "noise," or atmospheric interference.

Target Tracking

The computer checks subsequent radar returns at five-second intervals to determine if they correlate with the initial pickup. If this correlation is established, the computer automatically classifies the initial pickup as a "tentative" track and gives it speed and heading. Another return with the same correlation, and the "tentative" track becomes "established."

The program transmits the "Cartesian coordinates" of the target—for which height still must be calculated—to the output buffer drums of the computer, and the request for height data is transmitted by telephone lines to an AN/FPS-6 height finder radar at the radar site. This information returns to the SAGE center by the same AN/FST-2 data transmitter that carried the search radar data; the height information is automatically inserted into the computer along with other track data.

The program compares the new track with filed flight plans to determine if the target is "hostile" or "friendly." The blip on the tracking console appears with a three-letter symbology—a letter identifying the track, a letter indicating the "merit" of the track, and, when determined, a letter indicating whether it is friendly or hostile.

The "merit" of each track is constantly reviewed as all subsequent returns are correlated —"G" for good, "F" for fair, "P" for poor. If the merit rating of a track declines or the track disappears, it could indicate it was caused by interference. But if the track remains and the program determines it is a violator of the air space, the symbol for "enemy" appears on the console and BOMARC is called on to intercept it.

Missile Firing Preparation

The computer requests information from the nearest BOMARC base as to what stage the missile is in—Ready Storage, Warm-up, Standby, Fire-up, Launch, or Malfunction. This information is sent from a "launcher status multiplexer"

BEHIND THE NEWS

close to the launch pad, and goes via telephone lines into a cross tell drum of the IBM computer at the SAGE center, appearing as a digital display at the console. Missiles ready for firing will show up in "Standby" status.

The console operator requests an "engagement prediction point"—the point at which the intercept would be made if the BOMARC were fired at this time. The computer, referring to its program, relates range, speed, heading and altitude of the target to the complex performance characteristics of the BOMARC.

The "engagement prediction point" appears on the scope in the form of a small square. The SAGE operator presses a FIRE button. The signal is relayed by telephone lines to the missile site. The "Standby" stage becomes the "Fire-up" stage, preparatory to launch. The computer continues to follow the target track.

Missile Guidance and Intercept

Pre-launch computations are initiated and transmitted to the guidance unit in the BOMARC. A few seconds after the FIRE button has been pressed, the BOMARC is boosted into a vertical climb by its rocket motor. The missile's ramjets cut in as soon as ignition speed is achieved. Computations, fed to the launch site by land-line from the SAGE center, go by radio to the missile. The square "engagement prediction point" on the SAGE console now is replaced by an "X" to mark the computed intercept point as the missile completes its climb to altitude and levels off for the midcourse phase.

Commands are transmitted to the BOMARC as required to maintain an intercept course. Commands concern missile azimuth, time remaining to dive, dive angle, and the pointing angle of the homing device built into the missile. All computations are programmed in the computer so the same program can be employed in firing other missiles of varying characteristics.

The flight path of the target appears on the SAGE scope as a line of tiny crosses; the path of the BOMARC is a succession of slants or slashes. When the missile is guided to within striking distance of the target, the IBM computer tips it into a steep dive. Soon after the dive begins, the computer cuts out; the missile track is dropped by the computer program and the BOMARC is on its own. The missile's seeker then "locks on" the target. The BOMARC "homes" to the target and makes the intercept. The enemy is destroyed before it gets within sight of land.

Says Secretary Douglas: "SAGE and its proven reliability provide a great step forward in air defense."

New Transducer Seen As Ultrasonic "Breakthrough"

The transducer, heart of any ultrasonic system, yet traditionally its weakest link, may now be at a stage of development justifying forecasts of abundant ultrasonic energy for the future.

Intensive research and development has scored successes possibly opening the door to a wide range of applications for which ultrasonic equipment long has been considered too costly, too inefficient and too low in usable power.

Latest advances in the field were made by Westinghouse. Using a new concept of "spaced laminations," engineers in its new products department have developed a magnetostrictive ultrasonic transducer providing twice the normally usable power for the same electrical output.

Breakthrough in Design

"We consider this new transducer a significant breakthrough in transducer design for applications requiring sizeable amounts of ultrasonic power," said the department's manager, Dr. R. A. Ramey. "A radical new design has resulted in a device that is twice as efficient and considerably more compact than any existing units of comparable power."

Conventional transducers have plates that must be "tuned" by grinding them carefully to an exact thickness. This time-consuming, costly operation is eliminated in making the Westinghouse transducer, for the plate is an uncritical piece of metal requiring no grinding or machin-

New Westinghouse ultrasonic transducer (right) has laminations spaced in a latticework across the plate, compared with stacks scattered across the plate's surface in conventional transducer (left). Instead of wavelike motion requiring expensive "tuning," a pistonlike motion results, permitting use of simple, unmachined plate.

ing. Such a simple plate can be used because the transducer does not vibrate in a wavelike motion, as do conventional transducers. Dr. Ramey described the difference this way:

Stacked vs Spaced Laminations

In conventional magnetostrictive transducers, metal laminations are built into a stack wrapped lengthwise in wire through which flows current driving the entire assembly. Several stacks, placed end to end a few inches apart, are welded to a metal plate; any stack energizes the plate only at the spot to which it is attached. Driven at these scattered points, the plate vibrates in wavelike motion. It therefore must be "tuned" so vibrations reinforce instead of cancel out each other.

In the Westinghouse transducer the whole plate pulses in and out with a single piston-like movement, the most efficient motion for producing ultrasonic vibrations.

To obtain this motion, separate stacks of laminations are discarded. Instead the laminations are spaced in a latticework across the plate. Each lamination, attached individually to the plate, is a driving element working in unison with the others.

This "spaced lamination," in addition to doubling usable power, distributes it over the plate instead of concentrating it in scattered "hot" and "dead" spots.

No More "Weak Link"

"Spaced lamination," said Dr. Ramey, "has proved so successful that we no longer consider the transducer as a 'weak link' in useful ultrasonic systems. Instead we view it as a component whose perfection will make ultrasonic energy abundantly available in the future."

Suggested applications include electroplating aluminum bus bars with silver, cleaning printed circuitry boards for TV and radio receivers, and decontaminating pieces of nuclear apparatus. In one application, manufacturing operations were reduced from 12 steps requiring 30 minutes to three steps taking only two-and-a-half minutes.

Cause of Atomic Clock Differences Discovered

Results of an investigation to discover the reasons for discrepancies between British and American atomic clocks have been announced. (See Electronic Design, July 23, page 9.) The two standards were constructed quite independently and although they both employ the same spectral line of the metal caesium they differ markedly in the methods of operation.

Comparisons made by means of radio transmissions indicate that the British clock was gaining relative to the American clock by seven parts in ten thousand million (less than a ten thousandth part of a second per day).

New Alternator Puts Out Steady Frequency At All Drive Speeds

Development of an electronically-controlled alternator that puts out a constant frequency regardless of the speed of its mechanical drive has put the Hallamore Electronics Division of the Siegler Corp. into the electrical power plant field.

Ultimately, when perfected and marketed, the device may account for $50,000,000 annually in new sales.

A unique feedback mechanism is used in the constant-frequency alternator, developed by Hallamore design engineers headed by Leo Johnson.

Exciter Counter-Rotates

An exciter feeds a rotating field into the alternator. If the alternator slows down, the exciter field counter-rotates in radio. The exciter is controlled by a demodulator or comparator, which receives information from a tuning-fork reference and a tachometer.

All parts are on the same shaft. The only maintenance required is on bearings and brushes.

Advantageous applications are numerous. In jet aircraft, plagued by variations in engine speed, mechanical hydraulic or pneumatic speed compensators could be done away with. Use of the Hallamore system here would save a third of the weight—roughly that of a man—and eliminate the relatively high maintenance of mechanical compensators.

Any Number—in Parallel

Present systems require that independent electrical systems be used in multijet aircraft, each working from a different engine. With the Hallamore variable-speed CFA, any number of alternators can be worked in parallel.

Also eliminated would be special stabilizers now used for aircraft electronic fire control, gyro and auto pilot. And any such reduction in flight equipment means a proportionate reduction in spare parts and maintenance. This means an increase in reliability.

The alternator was designed to hold any constant frequency—400 cycles for aircraft, or any other frequencies used by power utilities or industrial plants. (A complete technical description of the Hallamore CFA will be included in a future issue of ELECTRONIC DESIGN.

BEHIND THE NEWS

New High Accuracy Transistor Tester Built

A new machine is automatically testing transistors, to a degree of accuracy hitherto unknown.

The Stromberg-Carlson equipment processes any type of transistor through seven successive tests, at rates up to 430 transistors per hour. The new machine was designed especially for the Sperry Gyroscope Co. Another similar machine, for the testing of diodes, also is being built for the same firm.

One feature of the original machine is a temperature chamber in which the transistors can be subjected to any one of the tests in the series, while being operated at any preselected temperature up to 200.

Transistors which fail any one of the tests are automatically ejected at the station at which they fail. Thus the machine sorts rejected transistors according to their defects.

The parameters in which the machine will test transistors are: dc beta (pulse test); ac beta (small signal); saturation, and leakage. The additional test positions provide for testing these parameters by more than one method, or for testing additional parameters, if desired.

Since this original machine will be used primarily to test transistors for military applications, the specifications for the various tests have been set to exceptionally close tolerance limits, with accuracy maintained to within ± 2 per cent of the range, company official explained. However, the machine is modular in construction, and the tolerances can be changed easily, simply by the substitution of a few plug-in modules, officials noted.

Operation of the machine is completely automatic, requiring only one operator, for loading. An additional facility, called a "remote test table," provides for even greater output where less extensive tests are needed. With up to six operators, working at this table, as many as 2000 transistors can be tested per hour.

Accurate operation of the testing machine is assured by 60 built-in trouble indicators. These not only flash a light if any part of the equipment fails, but they also serve to indicate the exact location of any such trouble. In most cases trouble can be corrected by the substitution of a plug-in module, requiring only a few minutes. Additional development work is now in progress on different modules which will adapt the machine to testing other components, such as capacitors, resistors, and transformers.

NEWS BRIEFS . . .

. . . **MARCONI OF ENGLAND** is delivering for jet airliner use a completely crystal-controlled automatic direction finder in production quantities. The AD712, abandoning conventional tuning methods, has crystal control permitting simple switch selection of frequencies in the bands 100 to 415 kc/s, and 490 to 1799.5 kc/s in steps of 0.5 kc/s. The control is locked to within plus or minus 50 c/s of the indicated frequency under all normal working conditions, a degree of accuracy never before attained by radio compass designers.

. . . **R. H. MACY,** launching the "biggest automation program in department store history," by 1961 will put in operation a $1,000,000 National Cash Register system to prepare customers' statements at a rate of 50 a minute—25 times faster than present speed. An all-transistor NCR 304 computer and 40 other machines will automatically handle 750,000 customer accounts of Macy's six New York stores. In one hour the system will handle punched-tape data on 300,000 sales checks.

. . . **SUPPLY PROCEDURES** at the Philadelphia Army Quartermaster Depot have been streamlined by installation of the IBM 650 Tape RAMAC (Random Access Method of Accounting and Control). Unveiled at Dec. 3 ceremonies, the system was hailed as "the greatest advance yet made towards office automation by electronics." The computer, storing some 35,000 stock numbers and 120,000 stock records, provides more sensitive inventory control by automatically processing 115,000 requisition line items monthly. The basic IBM 650 magnetic drum processing system features four disk memory units providing storage capacity of 24,000,000 alpha-numeric characters. Darting arms locate dates, names or quantities instantly. Magnetic tape units provide daily input and output at the rate of 15,000 digits per sec.

. . . **EXPERIMENTAL MICROWAVE SYSTEM** will be set up between Dallas and Fort Worth, Tex., by Central Freight Lines if FCC approves application. Central and 12 other trucking firms will use microwave stations on nonprofit, cost-sharing basis, they told Dec. 15 FCC hearing. Voice and teletypewriter communications would speed routing, administration and billing, while TV would help driver safety and salesman training, said spokesman, adding: "We see in microwave, with its admitted lower costs over wire line construction costs, the possible key that may provide the greatest forward step in trucking efficiency in the next 10 or 20 years." Long lines firms opposed the application.

BEHIND THE NEWS:

New Electrostatic Memory

RUGGED, COMPACT, FAST

A NEW electrostatic memory device has been proposed in France by E. Nazare. According to Dr. A. V. J. Martin of the Carnegie Institute of Technology, the new device uses the breakdown property of a thin sheet of dielectric material placed between two sets of electrodes. Claimed advantages are economy, ruggedness, compactness and high speed.

Principle

The sparkover voltage between two electrodes is greatly increased when a dielectric material fills the gap betwen the electrodes. This provides a simple way of determining two voltage levels.

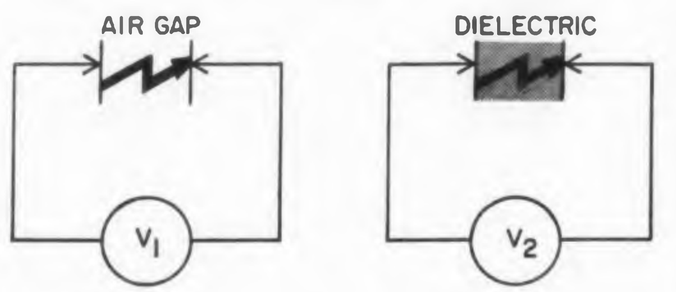


Fig. 1. The two basic states of the new electrostatic memory.

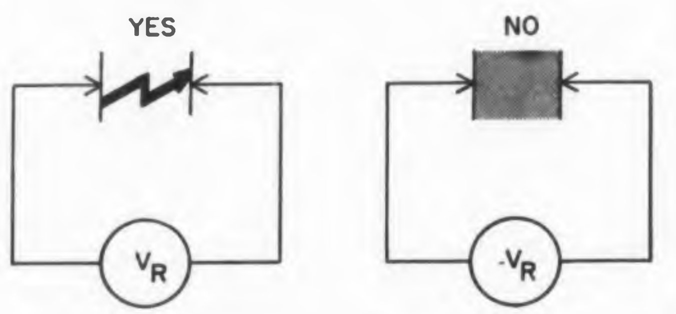


Fig. 2. A voltage V_R, halfway between $V1$ and $V2$, will cause a current to flow if there is no dielectric. No current will flow if there is a dielectric.

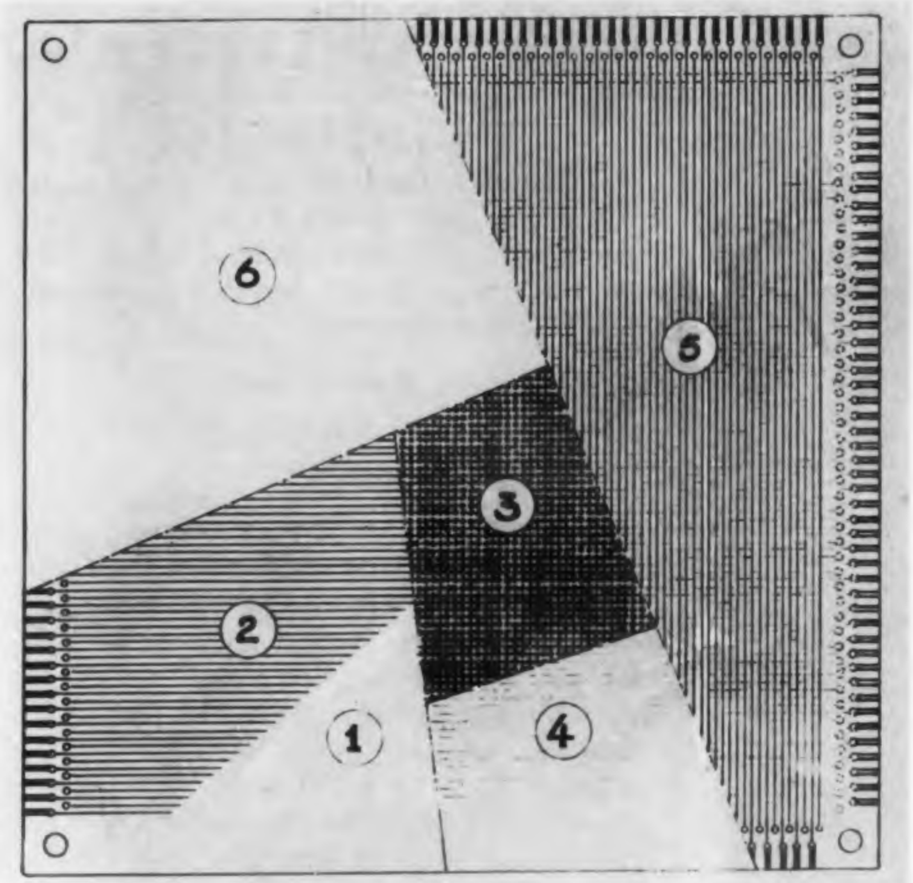


Fig. 3. A memory plane. *1* and *6* are insulating boards, *2* and *5* are orthogonal set of wires, *3* is the perforated matrix sheet, and *4* is the dielectric sheet.

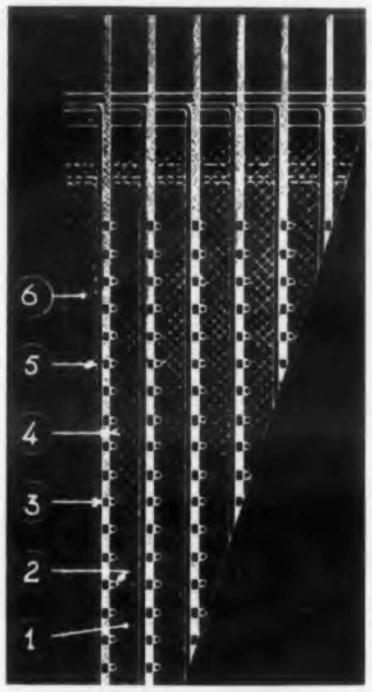


Fig. 4. The memory planes can be stacked to make a memory block.

If there is no dielectric, breakdown will occur for a voltage *V1* dependent on the electrode spacing. If there is a dielectric, breakdown will occur for a voltage *V2* much larger than *V1* (Fig. 1).

Hence, by applying across the electrodes a voltage V_R halfway between *V1* and *V2*, either current will flow (no dielectric) or the circuit will stay open (dielectric). These only two possibilities, current or no-current, correspond to the yes-no or 0-1 positions of the basic binary system (Fig. 2). The readout function is thus easily obtained with a very wide tolerance, since $V2 \gg V1$.

Originally, there is a dielectric between the electrodes. Writing-in, that is in fact suppressing the dielectric in the air gap, is also a simple matter. A voltage V_W higher than *V2* is applied, and the spark jumps across the electrodes and burns a hole through the dielectric. This constitutes of course a permanent recording.

An erasure process might even be envisioned. Coating the erroneous hole with an appropriate varnish would cancel the recording.

There is then the simple and necessary

relationship between the various voltages

$$V1 < V_R < V2 < V_W$$

This multiple inequality is easily satisfied because of the wide gap between $V1$ and $V2$. In other words, neither V_R nor V_W is at all critical. These two voltages are in fact provided by capacitors discharging in the circuit.

Memory Sheet

Each pair of electrodes thus stores a bit of information, and any storage capacity can be obtained by multiplying the electrodes. A convenient arrangement is illustrated Fig. 3. It uses two orthogonal sets of wires *2* and *5*, separated by the dielectric sheet *4* and a perforated matrix sheet *3*. Mechanical protection is provided by the external insulating boards *1* and *6*.

Such an arrangement is called a memory plane. Its dimensions can be quite small. The type represented has a 100 x 100 matrix of 0.4 mm diameter wire and can store 10,000 bits. For a wire spacing of 1 mm, this is obtained by a flat plane 10 x 10 cm.

Larger areas provide proportionately larger memories. Moreover, the small thickness of the planes makes it easy to stack a large number of them, as indicated in Fig. 4. The reference numbers have the same meaning as in Fig. 3.

Such a stack is called a memory block. One type, measuring 50 x 50 x 90 cm, or approximately 20 x 20 x 36 inches, has a capacity of 24 million bits. At 6 signals per letter, this is equivalent to 4 million letters. If numbers only are used, the equivalent capacity is 6 or 8 million numbers, according to whether the binary decade or pure binary system is used.

For comparison, such a memory block is equivalent to 60,000 perforated cards of 100 numerical columns, or 40,000 alpha-numerical cards.

Memory blocks in their turn are combined in memory racks. The small type contains 8 blocks and has a capacity of 192 million bits. The standard type contains 24 blocks and has a capacity of 576 million bits.

Notice that the data is accumulated only in the dielectric sheets. When starting anew, they are the only parts to be removed and replaced by virgin sheets in the memory planes.

The somewhat complex arrangement of Figs. 3 and 4 could be greatly simplified and made more economical by using printed circuit techniques. A saving in space and weight would also result.

It is claimed that, compared with the common perforated card system, the new memory increases the operating speed by a factor between 40 and 200.

WASHINGTON REPORT

H-Hour for Decisions

In the Pentagon, in the councils of America's military, executive and legislative leaders, this again is an hour of decision.

Right now must be made the judgments that will insure or lose the nation's security in the next five years, a half-decade that will see the coming of age of the intercontinental ballistic missile. For the 90,000 members of the Air Force ballistic missile team, this time of decision is a particularly critical one, and may be recorded by historians as the watershed hour when the tenets of America's defense philosophy began to flow through new channels.

If this sounds like an exaggerated view of the situation facing Washington decision-makers, listen to the words of Maj. Gen. Bernard A. Schriever, commander, USAF Ballistic Missile Division, ARDC:

"To get where we are today in our ballistic missiles and other space vehicles, we had to make basic, far-reaching, long-term decisions back in 1954. We had to make decisions on design, on investment in production and test and operational base facilities. Now we face a similar time of decision. We now have to make the same kind of basic, far-reaching, long-term decisions—looking toward 1963 and beyond—as we made in 1954. . . . Otherwise, in this age of space weapons, we shall not be able to convince any potential enemy that he cannot hope to gain victory from any surprise assault."

The 1959 decisions cannot be made within the same frame of references as the 1954 decisions, anymore than World War III could be fought with World War II methods. Says a tough fighting man, Gen. Curtis LeMay, Vice Chief of Staff, USAF:

"Today Air Force readiness and capabilities are tied directly to the accomplishments and advancements of science. In this period of remarkable breakthroughs in all fields of scientific endeavor, we are hard pressed to keep up with these advances. Some of the things that were new to us five years ago are obsolete today. You can imagine the impact this must have not only on our hardware—our bombers, fighters, radars and so forth—but also on our concepts. In the past, opportunities were lost when military leadership compromised the potentials of new weapons by measuring their worth in terms of old, time-worn concepts. We cannot run this risk today when time is so critical and the margin for error so slim."

So the decision-makers have their goals set for them—new hardware, but also new concepts.

The concept of readiness for both "brushfire" wars and nuclear wars seems fairly well accepted in Pentagon halls by now, so Army and Navy potentialities will not be neglected. But perhaps the most crucial decisions facing the military lie in the field of ICBM's, and the decisions to be made run the gamut, including choices between liquid fuel or solid, "soft" or "hard" bases, entrenched or mobile launching pads.

The liquid-fueled Atlas and Titan will remain star performers. Atlas, its propulsion capability so dramatically demonstrated when it became the largest satellite in orbit last December, will be tested at an accelerated pace. And Air Force Secretary James Douglas reveals that the first operational Atlas squadron will be equipped in 1959. Schriever meanwhile has announced that launching sites for later Atlases will be "toughened," that is, revetted with sheaths of steel and concrete, like Titan bases.

Titan, a back-up to Atlas, but more sophisticated—a true two-stage missile designed to be well dug in at "hardened" bases—already is getting final tests at Cape Canaveral. And Schriever adds: "As in the case with Atlas and Thor, every Titan flown—even in the earliest test flights—will be fabricated on a production line. There will be no costly time lag for tooling up and for converting blueprints into the finished product."

These liquid-fueled birds will get high priority. But in Pentagon councils an air of excitement pervades discussions of the new solid-fueled missile, the Minuteman ICBM. Schriever could not suppress that excitement when he said:

"The Minuteman promises to be a major economic breakthrough. The Minuteman will reverse the whole previous trend in modern weapon system development—a trend marked by the fact that the newer and more effective weapon has been invariably more complex and more costly than its ancestors."

Solid-fueled Minuteman can be operated and maintained with fewer personnel than can Atlas or Titan. Says Schriever: "Hundreds of Minuteman missiles can be placed in underground bombproof shelters, left unattended for long periods of time, ready to be fired from remote control centers on a few seconds' notice."

Douglas shares his optimism. "The Minuteman missile," says the Secretary, "may be the most important of our Air Force developments. It will provide intercontinental range, with all the advantages of a solid-propellant system relative to ease of handling, quick reaction, dispersal, and hardening of launching sites."

So the trend would seem to be toward solid fuel and hardened bases. As for entrenchment versus mobility, the white hope for the future, at least in Navy circles, is Polaris. An IRBM in range, it will be an ICBM for tactical purposes, because its launching pad—a submerged submarine—can bring targets near. Even the air Force Secretary, though more restrained than Navy advocates, looks forward to the 1960 operational target date for Polaris, and says:

"We count on the successful development of the Navy Polaris missile, with an atomic submarine as its launching base, to provide a useful addition to our strategic weapons. Its mobility will present new and difficult problems of defense to an enemy."

Some Navy brass see Polaris as more than "a useful addition" to our arsenal. They see it ultimately making the easily-pinpointed pads of land-based ICBM's obsolete.

The first Polaris submarine will be launched this spring; some eight to 12 are currently programmed. One of the major decisions of our policy makers will be whether these eight to 12 should be reinforced fourfold in the next half decade.

For 1959—New Peaks

Importance to the industry of all this military preparedness effort is seen in the fact that electronic equipment and components now account for 28 per cent of all military purchasing for major production and procurement. In 1958, military electronics totaled \$4.1 billion, more than half the record \$7.7 billion total factory sales of electronics manufacturers. EIA anticipates \$8.3 billion total sales for 1959, a year when military sales should top \$4.4 billion.

EIA president David R. Hull points out that electronics emerged from the recession as one of the few industries to establish a new sales record in 1958 (up \$100 million from the previous 1957 high). Although consumer goods declined from \$1.5 to \$1.3 billion, industrial electronic products rose from \$1.3 to \$1.4 billion, passing consumer goods in dollar volume for the first time.

For 1959, Hull predicts consumer sales, boosted by the growing popularity of hi-fi and stereo, will climb back to \$1.5 billion or more. And industrial sales, spurred by computer and data processing advances, should total about the same.

LETTERS

New Year's Greeting

Dear Sir:

Please accept my thanks for publishing my "Idea for Design" in the May 28 issue, and for extending your invitation to submit more ideas for publication. I enclose two ideas that I have developed here in the design of ground electronic checkout equipment, which may prove of general usefulness. Each is on a separate sheet with the pertinent drawings attached.

Congratulations on an excellent year of publishing one of the most helpful of all technical journals, and best wishes for even better years to come.

George S. F. Orsten
Sr. Engineer
The Martin Co.
Denver, Colo.

Seeks Soldering Solution

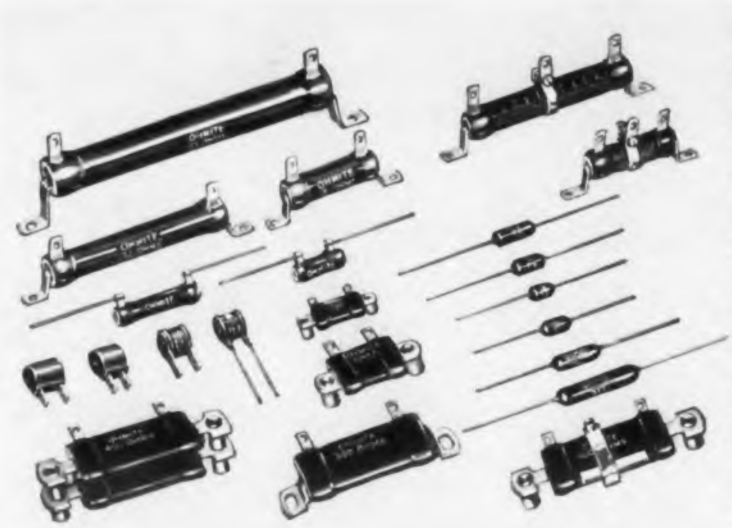
Dear Sir:

I would greatly appreciate it if one of your other readers could enlighten me regarding one aspect of soldering iron design. I think most engineers will agree that, in the ideal case, the only hot portion of a soldering iron would be the extreme end. Having any other portion hot means that:

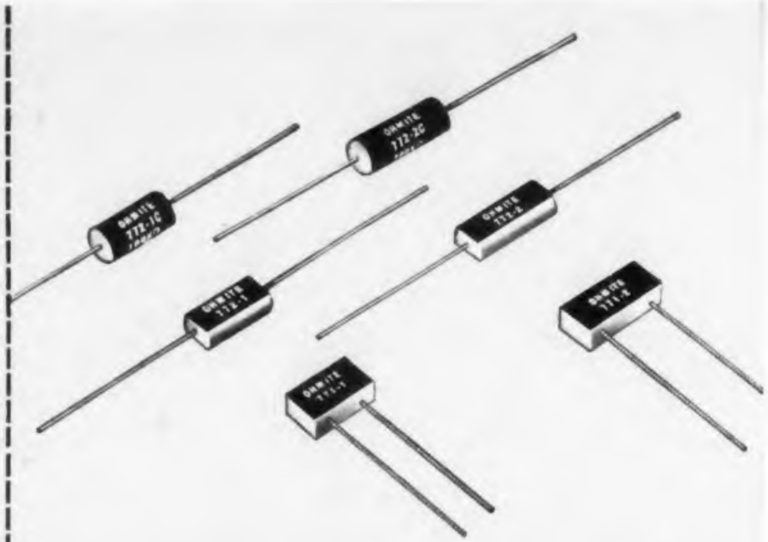
1. Wire insulation may be accidentally damaged by it; 2. Operator's fingers may be accidentally burned by it; and 3. Power paid for will be unnecessarily wasted in it.

It would seem to me that applying some heat insulator to soldering iron tips at the factory would present little problem and add only slightly to their cost. The resultant sales advantage should be considerable. It would seem that either I am overlooking an important consideration in this problem, or that soldering iron manufacturers are overlooking an opportunity for significant product improvement.

A. I. Tersoff
Chief Project Engineer
Intelligent Machines Research Corp.
Alexandria, Va.

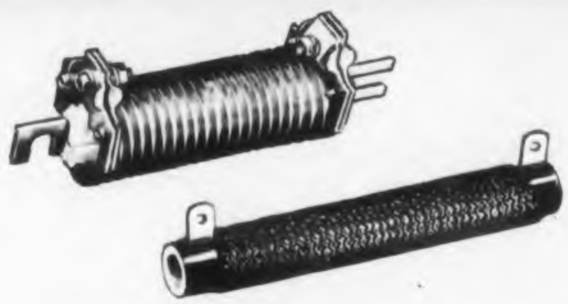


VITREOUS-ENAMELED RESISTORS Tremendous variety of types and sizes. Fixed, adjustable, tapped, noninductive, thin, and precision resistors available in a wide range of wattages and resistances. Also available to meet MIL-R-26C requirements.



METAL FILM RESISTORS Riteohm® metal film precision resistors feature full ¼-watt rating at 150°C ambient; excellent high frequency characteristics; low temperature coefficient of resistance. Long-term load and shelf stability.

OHMITE® INDUSTRY'S MOST COMPLETE LINE OF QUALITY WIRE-WOUND RESISTORS



POWER RESISTORS Power-type resistors for high-current, low-resistance applications. Vitreous-enameled, edge-wound, corrugated ribbon Corrib® units and open-type, edge-wound ribbon or round-wire Powr-Rib® units handle a wide range of power resistor needs. Available in fixed or adjustable "DIVIDOHM®" types.

MOLDED PRECISION WIRE-WOUND POWER RESISTORS Insulated units with Silicone-Type molded covering. Available in 3-, 5-, and 10-watt sizes. Tolerances: 0.1%, 0.25%, 0.5%, 1%, and 3%. Maximum resistance: 3-watt, 10,000 ohms; 5-watt, 25,000 ohms; 10-watt, 50,000 ohms.

OHMITE HAS EXACTLY THE RESISTOR YOU NEED
Ohmite offers the most complete line of high quality resistors on the market . . . fixed, adjustable, tapped, noninductive, and precision resistors in many sizes and types of terminals . . . in a wide range of wattages and resistances. All-welded construction. Ohmite application engineers will be pleased to help you in selecting the resistors for your job.

Write on company letterhead for Catalog 58.

NONINDUCTIVE
Tubular vitreous-enameled resistors with special winding. Dummy antennas consist of assemblies of several resistors. Watts, 5 to 1000; ohms, 1 to 5000.

SPECIAL VARIETIES
Ohmite can provide toroids, flat strips, plaques, special-sized tubes, or tubes with mixed terminals, etc. Watt ratings and resistances available as required.

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R. F. CHOKES VARIABLE TRANSFORMERS DIODES

EDITORIAL

Conferences Are For Communicating

An unusual approach to the exchange of ideas was tried at the recent Third EIA Conference on Reliable Electrical Connections, held in Dallas, Texas, on December 2, 3 and 4, 1958. No technical papers were read. The three days were devoted entirely to discussion between the audience and the various panel members who had written papers. (Last week the Symposium on Reliability and Quality Control followed the same format.)

Technical papers prepared for the conference were published in book form. The books were distributed in advance of the meeting to those who desired them. This allowed the papers to be studied and questions formulated before the conference got under way.

A sampling of those who attended showed that the approach was a success. Minor suggestions were made for improving this type of conference, but the basic format was endorsed.

Actually, this round-table method of discussion, so to speak, is not new. Most companies have a conference room where engineers meet to review their problems. With ties unloosened and sleeves rolled up they try to arrive at some solutions of their problems. Maybe the answers aren't established at the first discussion. What is important, though, is that there has been communication and understanding between the participants.

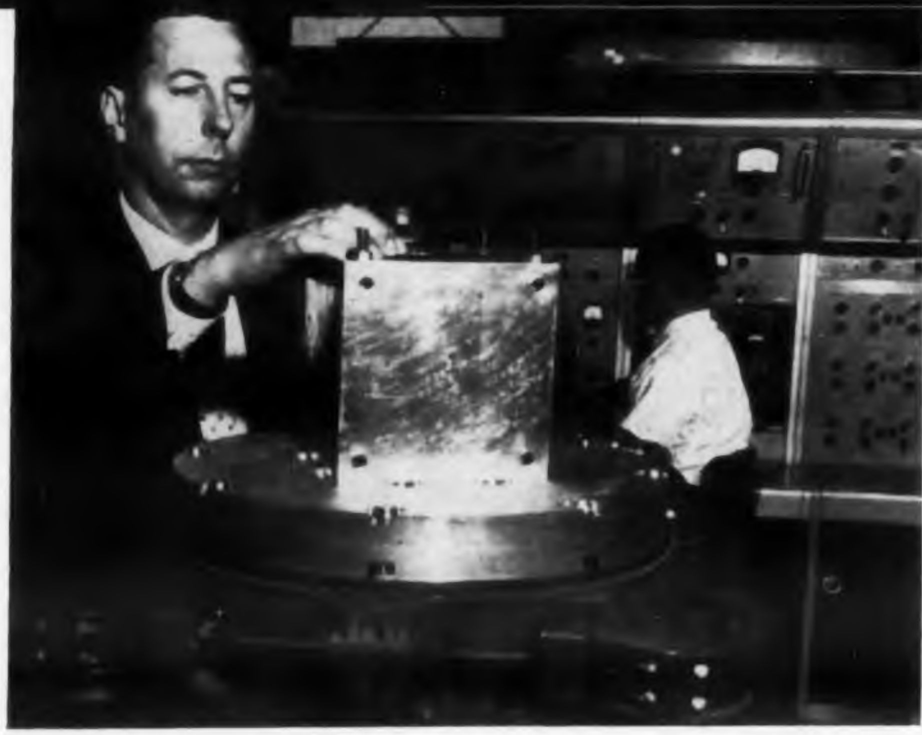
When the engineer leaves his company and attends a conference he goes through some sort of metamorphosis. Instead of communicating with others in the field at a technical session, he retracts into a shell. Fear that he might not be among peers but superiors (or just a downright fear of crowds), keeps him from venturing beyond a prepared script.

When the reading is over there is usually little time for questions and discussion. If the speaker is not button-holed in the corridor then the question the engineer had may go unanswered. And the long trip to the conference was not as fruitful as was originally anticipated.

The round-table type of conference does have weaknesses and can fall to pieces. As was mentioned at the conference, "large groups sometimes get too unruly." Also, "people who take the floor should stick to the point." And, "moderators need to be strong enough to cut off irrelevant discussion."

Nevertheless, with some modifications, this format seems like the right step towards better communication at technical conferences. And that is what conferences are for.

Leon N. Tolopko



William Reinman has a conviction. He feels that electronic equipment designers need some plain-language explanations of what vibration resonance means and doesn't mean. Elegant mathematical analyses are fine—but they're hard to apply while watching the pieces fly during a vibration test.

Despite improvements in low-mass accelerometers and direct-writing recorders, which will make vibration instrumentation easier to use, Mr. Reinman's direct observation techniques will continue to be important test tools.

6 symptoms For Tracking Down Vibration Resonance

W. A. Reinman
Astronautics Div. of Convair
San Diego, Calif.

WHEN AN electronics engineer's design moves into the vibration laboratory for testing, he must be able to understand and interpret the various symptoms of vibration resonance. He must learn not only what they mean but what they *don't* mean.

The most consistent "killer" of electronic airborne equipment, in flight and in the laboratory, is vibration. Circuits open. Unwanted modulations develop. Parts break loose and smash around inside. Electro-mechanical parts slow down, chatter, or stop working. And arc-overs develop into fires.

However, vibration itself is not the true villain. The undesirable vibratory response of the equipment, commonly known as vibration resonance, really causes the damage. If *all* the parts of a device move together as a unit, no damage results from exposure to vibration.

Vibration resonance is usually thought of as local amplification of input vibration. This is the most common form of resonance, and the most dramatic. But in many cases, one part may stand still, while the rest of the assembly moves in response to the vibration input. Or two parts may move at comparable amplitudes but out of phase with one another. The various forms of resonance all have one thing in common—more stress exists in some part of the device than when no resonance occurs. Therefore, a more suitable definition of vibration resonance is "relative motion of parts of an object in response to a vibration stimulus."

There are six basic signs of resonance which can be detected during vibration testing of equipment:

1. ***Failure*** of a device in the equipment.
2. ***Modulation*** of equipment. outputs or internal signals.
3. ***Visible Motion*** of the equipment relative to its supporting fixture, or of one part of the equipment relative to another.
4. ***High Acceleration*** of some part of the equipment relative to another part or to the supporting fixture.
5. ***Loud Noises*** emanating from the equipment, or *changes of sound quality*, especially *harsh* or *shrill* or *random* sounds.
6. ***Large Changes in Power Required*** to provide vibration at the desired g level.

Failure of a part of the equipment needs little explanation or comment. At least it's definite data. Only a foolish engineer would replace the part and not think twice about what might have caused the failure. And only a foolish engineer would fail to repeat the test to evaluate the fix he tried.

Many designers cringe at the very idea of a failure. Yet failure provides what a passed test never can yield—the *limit* of a sample of the design.

Modulation of the equipment outputs or internal signals is often the most important sign of resonance. Modulation itself may be objectionable in the quantity detected. Even when it is not undesirable in itself, it may indicate potential failure. Sometimes designers prefer to have a modulating vibration input continued or increased in amplitude during laboratory testing until the sensitive part fails. This makes pinpointing of failures easier in complex circuits, especially when other methods of identifying the sensitive part can't be used.

A fingertip (or a pencil's eraser tip, if the circuit is "hot") may be used to damp part vibration selectively, and thus to isolate the modulating part. When a sensitive part is found, it is wise to continue to search for excessive vibration in some other part which may be driving the sensitive part to significant amplitudes.

In one case, modulations of signal and open circuits in a receiver were traced to several different parts, all supposedly quite resistant to vibration. The true source of trouble was a small transformer on the other side of the chassis, mounted cantilever fashion on a bracket which was a cantilever beam in itself. When this assembly resonated, it shook the whole chassis, causing malfunctions in parts which were reasonably vibration resistant in themselves.

Modulation may occur at the vibration frequency, at harmonics of this frequency, or as a beat between an operating frequency and the vibration frequency. In some instances an offset may appear in a dc signal or a long-term amplitude change will appear in an ac signal. In a recent test, an experimental amplifier showed all these forms of modulation during one run.

Visible Motion indicates resonance at low frequency, or extremely severe resonance at high frequency. The probability of physical breakage is high with large deflections.

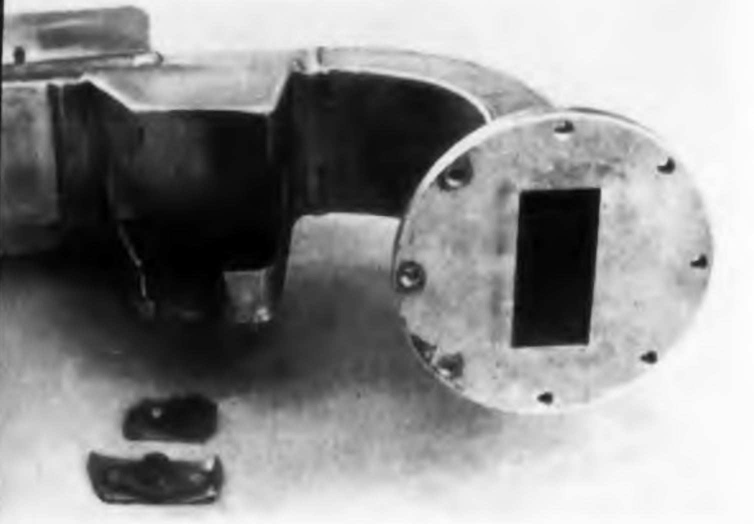
Relative motion of various parts may be seen with the unaided eye if the motion is pronounced enough. Stroboscopic lighting aids in detection of the "sneaker" forms of resonance, such as out-of-phase motion. If a stroboscopic light is not available, a fluorescent lamp or an incandescent lamp shuttered by a fan or slotted rotating disc, may serve as well.

Photographic records of visible resonance can be made with motion picture cameras, with high-speed still cameras, or by deliberate use of the smearing effect of long exposures. The latter method proved most successful in obtaining proof of switch arm resonance, after an attempt to use high-speed motion pictures failed. A 1/25 second exposure with a still camera showed about 25 cycles of switch arm vibration, neatly documenting the maximum travel of the switch arm, the amplification ratio, and the mode of vibration, all in one picture. When the input g level and frequency were lettered on the picture, the story was complete.

High Acceleration, as measured by vibration pickups, is often the only clue to high frequency resonance. High g levels in themselves are not dangerous—they're only danger signs. It must be remembered that high vibratory acceleration at high frequency results in tiny displacements.

(Continued on following page)

Missile parts must take a beating. In this vibration test, the specimen is mounted in the heavy jig. Acceleration and frequency are monitored at the test console.



"All shook up" by exposure to 400 cps vibration at 26 g.

Improved design breaks later in different place (bottom right).

Peak-to-peak displacement for 10 g vibration at 10 cps is two inches; at 100 cps it is 0.02 inch, and at 1000 cps it is only 0.0002 inch. So small a displacement as 200 microinches seldom causes any physical breakage, but it may produce modulation of signals in tubes, klystrons, and capacitors, or it may cause resistance variations in relay contacts or potentiometer wipers.

Often an oscilloscope study of vibration pickup output reveals that the high g levels are not occurring at the input vibration frequency, but at very high frequency or a scramble of frequencies. This display often accompanies loud, discordant noises coming from the equipment. It may indicate harmonics excited by the input vibration, vibratory transients excited by parts slapping together as they vibrate, or transients excited by impacts of a loose part rattling around. It may indicate a loose vibration fixture or some loose part in the vibration exciter, too. The "hash" thus produced can represent very tiny displacements of the portion of equipment upon which the vibration pickup is mounted. It can also represent a very-high-Q resonance of the pickup itself. Some crystal (piezoelectric) accelerometers are notorious for this "ringing." It may be necessary to filter the accelerometer output to distinguish vibration at the frequencies of interest.

High g indications at higher frequencies sometimes are assumed to represent high accelerations of the whole equipment. As the vibration frequency goes up, the equipment behaves less and less as a single mass, and more as a collection of little spring-mass systems. Each has its own vibration spectrum, its own standing or traveling wave patterns, and with its neighbors, creates local reinforcements, beats, and cancellations.

After the first major resonance appears as the vibration frequency is increased, a given vibration pickup is less and less reliable as an indication of the vibration response of the equipment. Thorough quantitative vibration analysis soon becomes impossible, because the pickup's mass and the structural effect of attachment of the pickup distort local vibration characteristics.

Fortunately for the designer, most circuits and circuit elements are relatively insensitive to vibration breakage at frequencies above 500 cps.

Loud Noises or Changes of Sound Quality sometimes indicate vibration resonance in the equipment. Since loudness indicates good coupling of mechanical motion to air, the loudest racket usually occurs when an equipment cover or chassis plate vibrates, either directly or because some other vibrating element is driving it. This sort of resonance is often more annoying than serious, but it shouldn't be overlooked. The vibrating cover may crack, or it may induce crippling vibration in a sensitive part. Many times a simple stiffener will cure a severe cover resonance.

Be sure, when tracing a noisy resonance, that the specimen is guilty. Vibration exciters sometimes howl like banshees when nothing is really wrong.

Raucous changes in tonal quality of noise may indicate loose parts, or slapping together of parts which don't touch each other unless vibration of a certain amplitude is induced. This "velocity impact" often accounts for the sudden appearance of high-intensity, high-frequency "hash" on the pickup output. This "hash" frequency appears when some threshold level of vibration intensity is exceeded.

The hand is a useful damper to snub vibration of first one part and then another when tracking down noise sources. When the noisy part is damped, the sound diminishes.

The fingertips also serve as relative accelerometers. Since they are soft, they are "low-frequency elements" and do not interfere markedly with the motion of even small parts unless considerable pressure is applied. The fingertips can detect very small g levels, even at quite high frequency. Thus they can be used to determine which part of a complex structure is vibrating most, when installation of sufficient or small enough pickups would be impracticable.

Large Changes in Shaker Power required to maintain a given vibration g level are significant only if the equipment being tested is an important part of the whole vibrating system—that is, if resonance in the equipment can affect the power required to drive the shaker. In many cases of supposed resonance, the equipment is just going along for the ride, and the vibration exciter or the fixture is the guilty member of the vibrating system.

The old $F = ma$ equation is a handy one for vibration work. It checks dimensionally with F as pounds of force, m as mass in pounds, and a as peak acceleration in g units. Without resonance—when shaker armature, fixture, and test specimen are moving as a unit—m is the sum of the three masses and a is the measured g level. Under any other condition, $F = ma + m_2a_2 + m_3a_3 + \ldots\ldots$, for as many parts as are moving in their own response to the induced vibration. Phase relationships among the various vibrations complicate matters further, so that the general equation is $F = \Sigma\,(ma < \phi)$.

The series and parallel resonant circuit analog apply, helping to explain why at resonance the shaker power requirement may go up or down. In one case the system is absorbing power; in the other case, phase and amplitude relationships are such that overall power requirements are very low, while one part of the system may be excited to very high g levels.

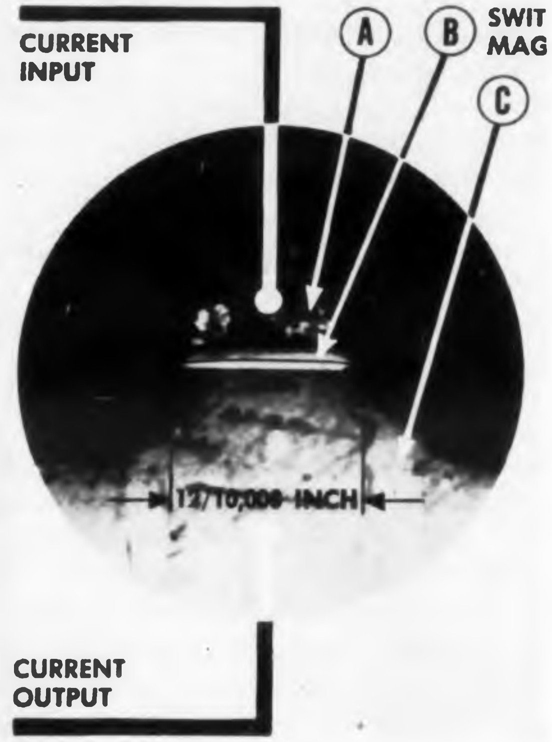
In one classic example, internal resonance of a gyro mechanism created an effect similar to what would be expected if the weight of the gyro suddenly multiplied by about ten times. By the basic $F = ma$ formula, the shaker should have been capable of producing an acceleration of 20 g, but the accelerometer on the fixture showed only 3 g at full applied power. When the gyro case was cut open for high-speed movies, it was seen that at this resonant frequency the internal mechanism was moving at very high amplitudes relative to the case. At a slightly different frequency, the opposite phenomenon occurred. It was difficult to hold shaker input power low enough to stay at the desired 10 g level on the fixture. The gyro mechanism then appeared to be standing still while everything else moved.

Often the two resonant conditions follow each other so closely during a frequency sweep that the shaker operator is unable to compensate in time for either condition. Manufacturers and users of vibration equipment have been working on this control problem for years, with only qualified success.

The caution must be repeated that this power-level symptom of resonance may, and often does, indicate a problem that hasn't anything to do with the resonant characteristics of the equipment under test. The g levels induced in the equipment may cause malfunction or failure; therefore, control of resonances outside the equipment is important. But there may be no *design* problem in the equipment.

To Summarize: Of the six symptoms of vibration resonance, failure is the most positive evidence of vibration trouble in electronic equipment. Modulation is a common symptom, and often serious. Visible motion is significant because large relative motions mean high stresses and the possibility of physical breakage. High accelerations, loud noises, and unusual shaker power requirements frequently are misleading, since they may have little or no bearing on the behavior of the device under test. Systematic investigation of each symptom of resonance will allow the test engineer and the designer to locate the resonant condition and evaluate it. This is the first step in correcting vibration troubles. ■ ■

This tiny avalanche switch operates in the trillionth second range. In "off" condition, the current entering section ***A*** is prevented from flowing to section **C** by an atomic mechanism contained within the joining layer, represented by fine line ***B***, about four millionths of an inch thick. When voltage at input section ***A*** is raised slightly, the mechanism turns current "on" in less than 100 trillionths of a second.



Too Fast to Measure

High Speed Avalanche

THIS NEW semiconductor device switches current on and off in less time than it takes light to travel one inch. The switch is 100 times faster than any previously available device—so fast its action cannot be timed with any accuracy. Use of the switch will increase the speed of computers measurably. With it, special purpose navigational and guidance computers for missiles and spacecraft can be built not only to operate faster, but to supply improved accuracy over long ranges.

Avalanche Effect Employed

Developed by the Semiconductor Division, Sperry Rand Corp., S. Norwalk, Conn., the tiny device has for its working element an alloy junction formed by fusing a speck of aluminum to a small piece of silicon. It operates by making use of a controlled avalanche effect.

Although this effect is an annoyance in other semiconductor devices, contributing to sudden breakdowns in transistors and rectifiers, it is put to good use in the Sperry device.

A slight increase in voltage accelerates one or more electrons to speeds sufficient to knock new electrons out of their atomic shells; these accelerate and free more electrons in a mounting avalanche. Each electron creates a microplasma which almost instantly spreads throughout the layer formed at the semiconductor alloy junction—a layer with a diameter of two-thousandths of an inch and a thickness of four-millionths of an inch.

Conversely, a slight decrease in voltage reduces electrons' speeds so they no longer release other electrons, and the current-carrying microplasma is swept out of the layer. The action is almost instantaneous, for no measurable delays or recovery time constants have been found to accompany the slight voltage changes.

Switch Characteristics

Switching voltage of the devices produced to date ranges from 6 to 7.5 v.

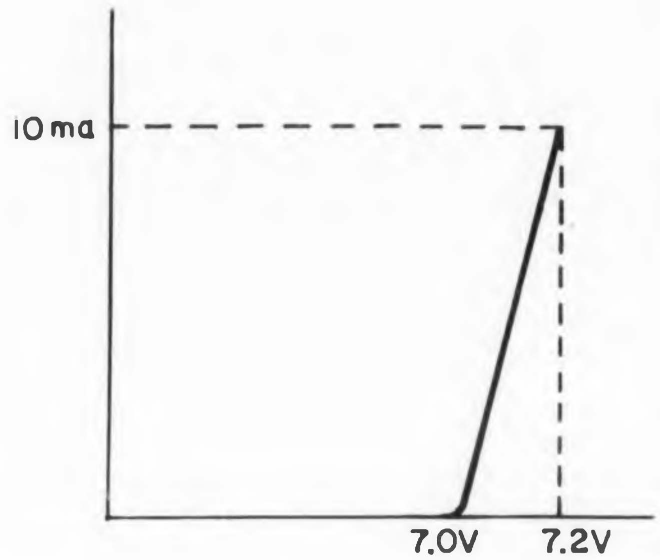


Fig. 1. Characteristic curve of the switch. The avalanche effect occurs at 7 v. 10 milliamps of current is almost instantaneously turned on as the voltage at the input section is raised slightly.

Switch

Other characteristics:

- Current ratings: 20 to 50 milliamp.
- Dynamic resistance: 8 to 20 ohms at 10 milliamp.
- Junction capacitance: 1.8 μμf typical.
- Power dissipation: 250 milliwatts.
- Maximum operating temperature: 150 C.

Its typical characteristic curve is illustrated in the accompanying figure.

The switches have been employed in new computer logic circuits operating at 100 mc clock speeds—and the switches proved very much faster than any of the computer's other components.

Working elements presently are sealed within relatively large glass capsules, 45 of which can be placed in a thimble. Production is being limited to the output of a pilot manufacturing line, but sample quantities will be made available for developmental models of advanced equipment.

For more information on this high speed semiconductor avalanche switch, turn to Reader-Service card, circle 103.

THE FLOW GRAPH

A Shortcut to Network Simulation

George V. Woodley
Raytheon Manufacturing Co.
Wayland, Mass.

George Woodley spends almost all his time at Raytheon's Surface Radar Dept. in circuit design. Looking for a simple way to analyze network behavior, he remembered the flow techniques taught at MIT by Professor Sam Mason. Applying these techniques, he developed this interesting way of setting up an analog computer with a flow graph.

SIMULATING networks with analog computers can be simplified by flow graph analysis. The beauty of this method lies in the fact that a block diagram of the computer setup can be drawn directly from the flow graph, providing a very simple configuration.

The rules for flow graphs are simple: Labeled circles represent currents and voltages. Impedances or coefficients are placed above arrow heads pointing to the solution. These arrows replace "equal" signs.

The method is best illustrated by the network of Fig. 1, which is to be set up on an analog computer. The loop equations are:

$$e_2 = e_i - e_3 \tag{1}$$

$$i_1 = \frac{e_2}{Z_g} \tag{2}$$

$$e_3 = \frac{i_1 - i_2}{s\,C_1} \tag{3}$$

$$e_4 = e_3 - e_o \tag{4}$$

$$i_2 = \frac{e_4}{s\,L_2} \tag{5}$$

$$e_o = i_2 Z_L \tag{6}$$

where:

$$Z_g = L_1\left(s + \frac{R_g}{L_1}\right) \tag{7a}$$

$$Z_L = \frac{1/C_2}{s + 1/R_L C_2} \tag{7b}$$

If the differential equations are written this way, the complex frequency s appears only in the denominator. This allows the use of integrators throughout.

Equations appear also for the impedances Z_g and Z_L. These two equations can be rewritten, breaking up the components in the impedances.

Eq (1) through (6) are readily transformed to the flow graph in Fig. 2. Since the branches are unilateral, this flow graph represents a block diagram of an analog computer setup of the network in Fig. 1.

Branches with s in the denominator can be replaced directly by an integrator. Branches with Z can be replaced by the configuration in Fig. 3. Caution must be used with signs, however, since active computer elements have an inherent inversion. Correctness of signs can be checked from the fact that any closed loop must have an odd number of amplifiers. Fig. 2. is then redrawn on the basis of the system block diagram as in Fig. 4. Note that only one element is redundant. The two potentiometers marked $1/c$ can be combined following their associated integrator.

A note on the scaling of network coefficients: There are two variables which can be scaled at will in any linear network—the time base and the impedance level. To scale resistors, capacitors, and inductors:

Let:

$$R' = \frac{R}{n} \tag{8a}$$

and

$$s' = \frac{s}{m} \tag{8b}$$

where R' and s' are the scaled impedance level and complex frequency, respectively.

then:

$$\frac{1}{C'} = \frac{1}{nmC} \tag{9a}$$

$$\frac{1}{L'} = \frac{n}{mL} \tag{9b}$$

$$\frac{R'}{L'} = \frac{R}{mL} \tag{9c}$$

$$\frac{1}{R'C'} = \frac{1}{mRC} \tag{9d}$$

Eq (8a) lowers the impedance level of the circuit by a desired amount and eq (8b) slows the time base by a factor m. These two factors can be balanced to give "reasonable" computer coefficients. The latter should be held between 0.1 and 10. Large coefficients should be avoided as much as possible so as not to overload the amplifiers. The time base should be slowed down sufficiently to fall within the capabilities of the computer. ■ ■

References

Feedback Theory—Some properties of Signal Flow Graphs, S. J. Mason, *Proceedings of the IRE*, Sept. 1953. Only a few beginning paragraphs need be read to be able to draw Fig 2 from eq (1)–(6).

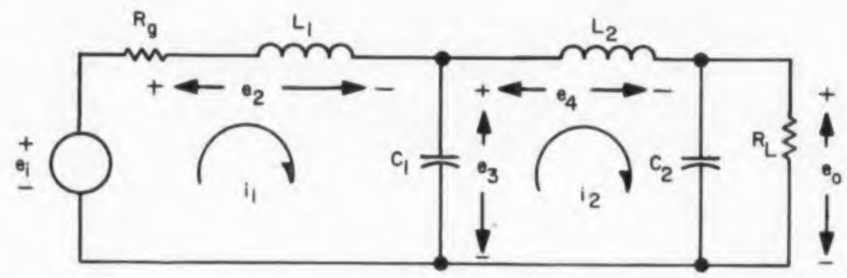


Fig. 1. This is the basic network which, for illustration, is to be set up on an analog computer.

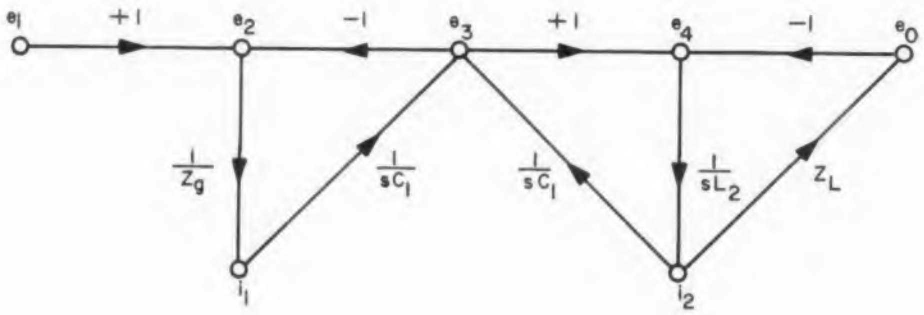


Fig. 2. This flow graph for the network of Fig. 1 is the basis of the computer setup.

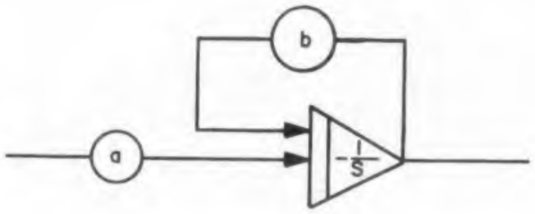


Fig. 3. The computer replacement for impedance branches in the flow graph.

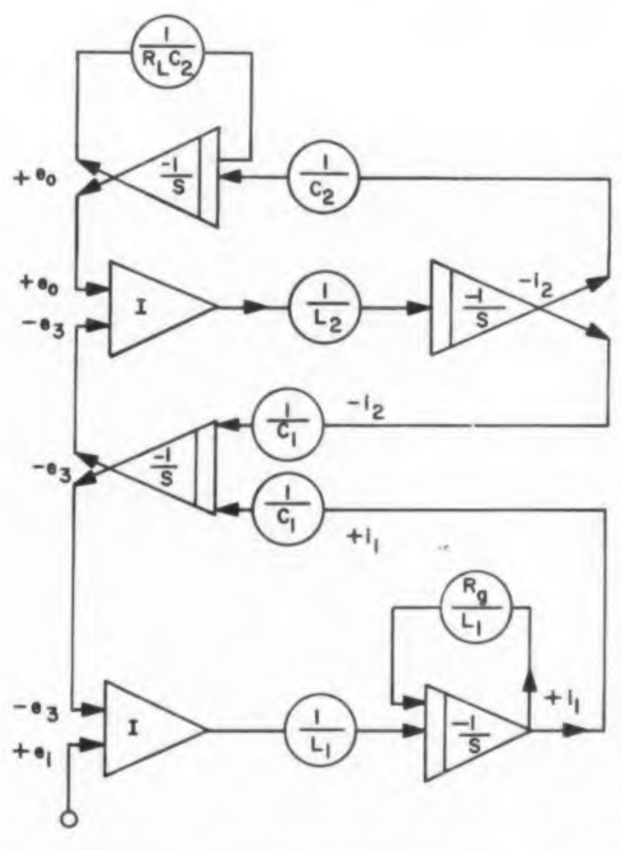


Fig. 4. The system block diagram drawn from the flow graph in Fig. 2.

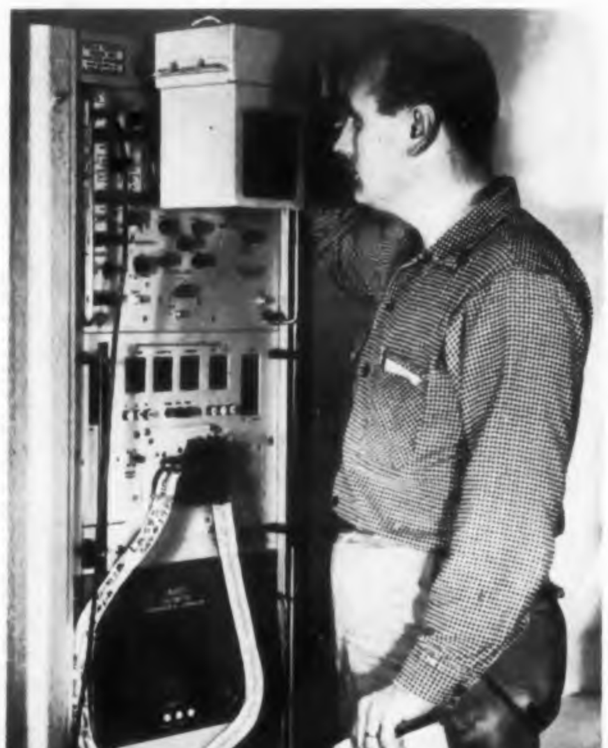
TEST COMPLEX SYSTEMS RAPIDLY WITH S.P.A.M.

AN OPERATOR presses a button and S.P.A.M. starts measuring voltages—in almost any system. In less than five seconds, lights tell the operator if the reading is within prescribed tolerance, if it is too high, or too low. If the voltage is correct, S. P. A. M. (Selective Programmed Automatic Maintenance) starts measuring another voltage.

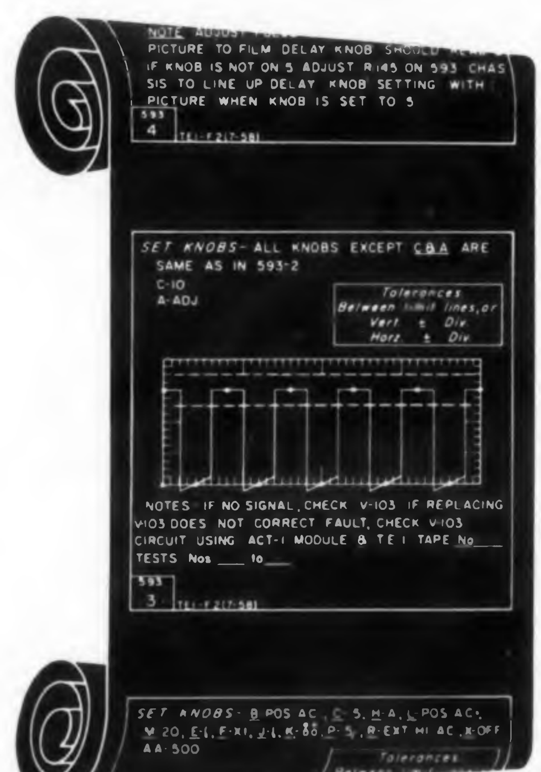
Developed as a universal tester by the Engineering Division of Taylor Engineering, Inc., 2100 St. Paul St., Baltimore, Md., S.P.A.M. can be used by unskilled personnel to check any system properly instrumented with test points.

The basic system includes a very high impedance voltmeter, a highly stable modified oscilloscope, and an automatic circuit tester or modified Lavoie Laboratories "Robotester."

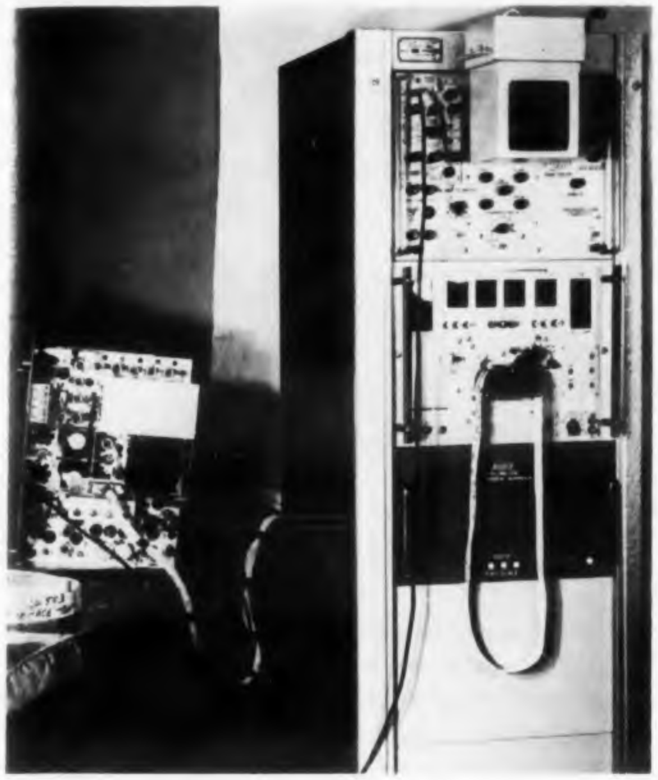
Since the voltmeter reads voltages in operating circuits, such as phantastrons, pulse modulators, and oscillators, with no disturbance to the circuit, it is called "Nodis."



Critical waveshapes on film can be compared directly with scope patterns.



Sample of data on 120 mm film.



S.P.A.M. provides rapid "go—no go" check on voltage or resistance.

The oscilloscope displays video and rectified rf signals. Equipped with a "Film Data Comparator," it becomes a "Video-Scope." The "Film Data Comparator," mounted in front of the crt, has filmed information telling the operator exactly how to set up the equipment under test and how to set up the scope to view critical waveshapes. An optical arrangement superimposes the filmed waveshapes on the scope pattern, allowing the operator to make a direct, exact comparison. One to two wave shape tests can be made per minute.

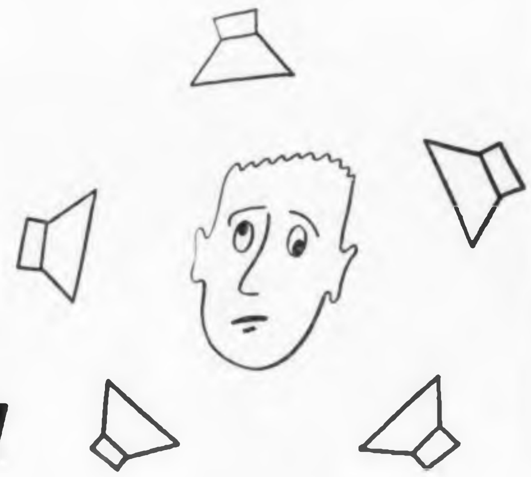
"The Automatic Circuit Tester" uses punched tape to program resistance or continuity tests at 60 to 120 per minute, or voltage tests at 20 to 40 per minute. The punched tape provides complete instructions. It tells the instrument

- between which two points to measure,
- what the voltage should be,
- if the voltage can be less than, higher than, or on either side of the prescribed voltage,
- if the tolerance can be 5, 10, or 20 per cent of the required value.
- if the measurement should be on a 5, 50, or 500 volt scale.

Illuminated digits show where S.P.A.M. is measuring at any time, what the voltage should be, and what type of check is being made. Illuminated buttons show if the actual voltage is all right, too high, or too low.

For further information on this almost universal tester, turn to the Reader-Service Card and circle **105**.

Design Ideas At The Hi Fi Show



George Rostky
Associate Editor

WITH MORE than a hundred manufacturers showing their wares at New York's High Fidelity Music Show, one might well expect to find at least a few clever design ideas. Your editors combed the show for ideas electronic design engineers could use. They found a few—very few.

Show Theme—Stereo

Any visitor could see immediately that stereo is here. Manufacturers had stereo cartridges with two signal outputs; two loudspeaker systems for each program source; two amplifiers in one box—or, at least, two amplifiers side by side. Only turntables (and pickup arms) did not leave one with the impression of seeing double.

New Design Concepts—A Few

Stripped of all fanfare and tinsel, the show was very sparing in design ideas. Cartridges and records, of course, were different. Amplifiers and other equipment were different only in styling and front panel design.

Loudspeakers were the same—with very few exceptions. Outstanding perhaps, was the new Acoustic Research high frequency speaker (Fig. 1). It looks like no tweeter we've ever seen, using no spider, no horn, no cone, no dispersion device, no voice coil former, and no skiver. Yet this tweeter combines unusually wide dispersion with a very flat frequency response.

Stereo System Doesn't Demand Much

The almost universal adoption of the Westrex system of stereo disc recording and playback is most fortunate. Beyond the record playing equipment no basic changes are needed, except of course, that all components must appear in pairs.

The major change that stereo calls for is in the phonograph cartridge. It must have equal compliance in all directions so as to transfer the information recorded in each channel. Monaural cartridges need have no response to vertical stylus movement.

Fig. 1. Synthetic rubber in the gap of Acoustic Research's tweeter holds the self-supporting voice coil in the magnetic gap. The entire moving system (diaphragm, voice-coil, and rubber suspension) weighs slightly more than a gram.

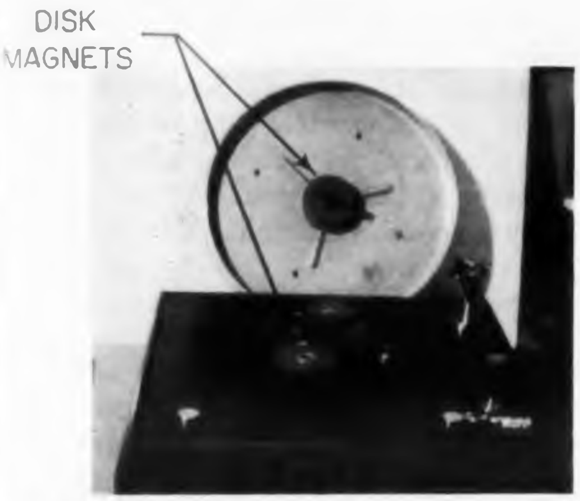


Fig. 2. The platter rides on air in Pickering's turntable.

Here Comes Rumble

Rumble, the low frequency noise that results from mechanical vibration being coupled to the turntable platter or pickup arm, plagues every turntable and record changer to some extent. In monaural systems, where the phono cartridge has little or no vertical response (records are cut laterally), the effects of rumble are often negligible. But in binaural (or stereophonic) systems, rumble can be very annoying indeed.

Sensitive to this problem, many manufacturers have redesigned their turntables to reduce rumble to almost unmeasurable levels. Others have modified their tables slightly, and a few, feeling they had the problem licked long ago, made no changes.

It's hard to tell from manufacturers' claims, just how successful they've been. Though the National Association of Radio and Television Broadcasters has very clearly spelled out standards for measuring rumble, only one major manufacturer (Fairchild), publicly claims to measure according to NARTB specs.

This is not to say that other manufacturers don't measure rumble. They all do. But it's not always clear how they measure. So, matching rumble figures of different manufacturers may not be too meaningful. Only by one criterion are all published figures the same: every one is "conservative."

Design Ideas In Turntables

Some of the concepts used in turntables may well serve electronics engineers in entirely unrelated fields. Particularly in vibration isolation, one or more of these ideas may avoid lots of trouble.

Pickering. Perhaps the most novel and simplest approach appears in Pickering's "Gyropoise 800." To minimize coupling of motor noise through the

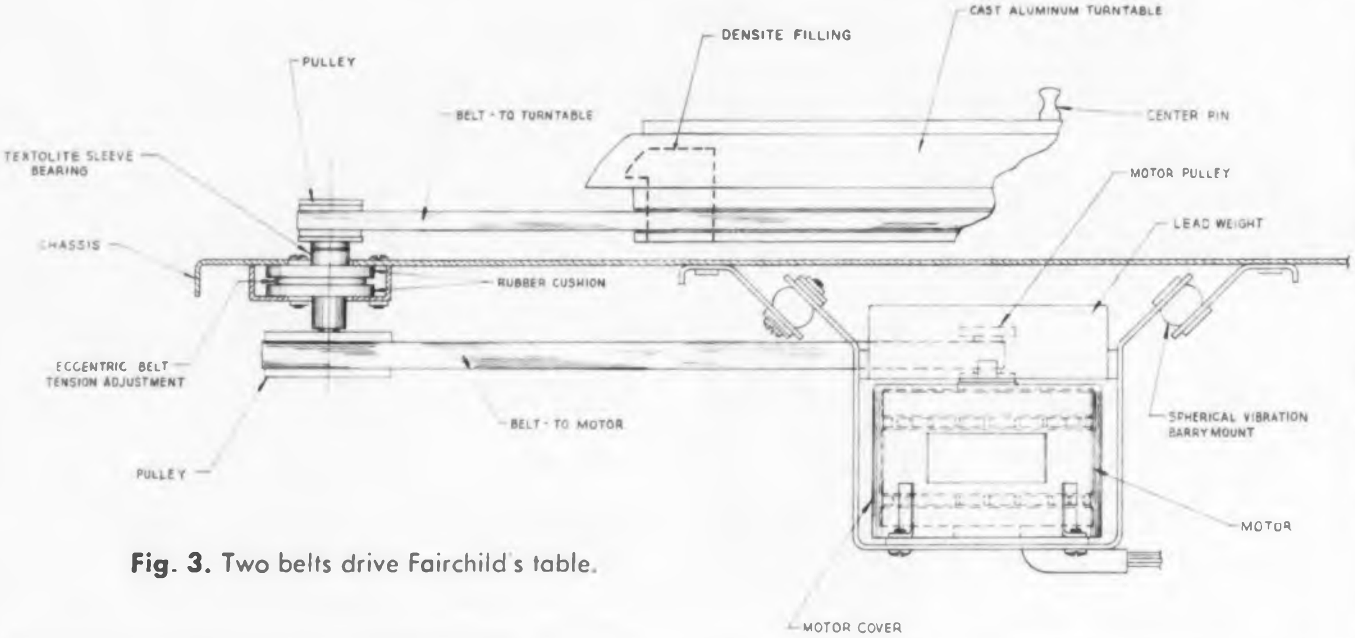


Fig. 3. Two belts drive Fairchild's table.

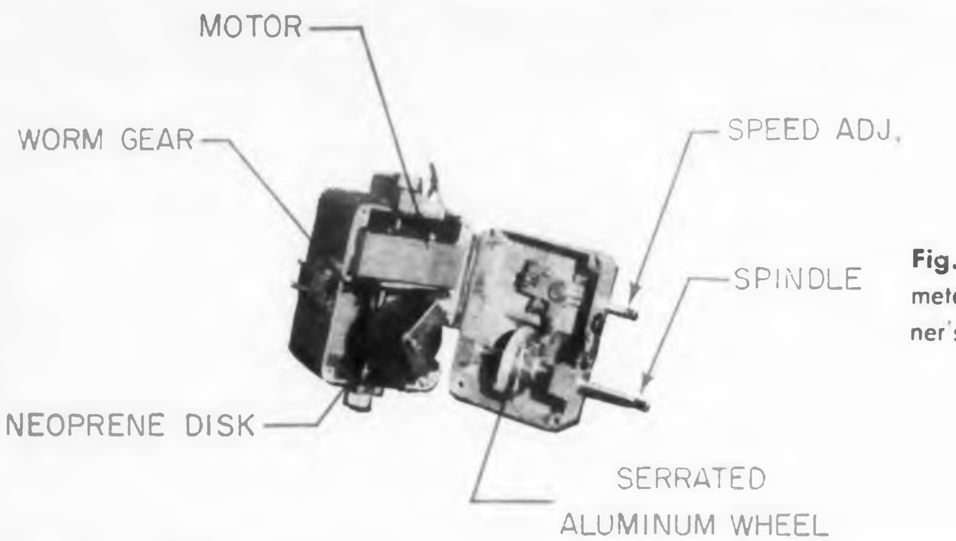


Fig. 4. No metal-to-metal contact in Metzner's "Starlight."

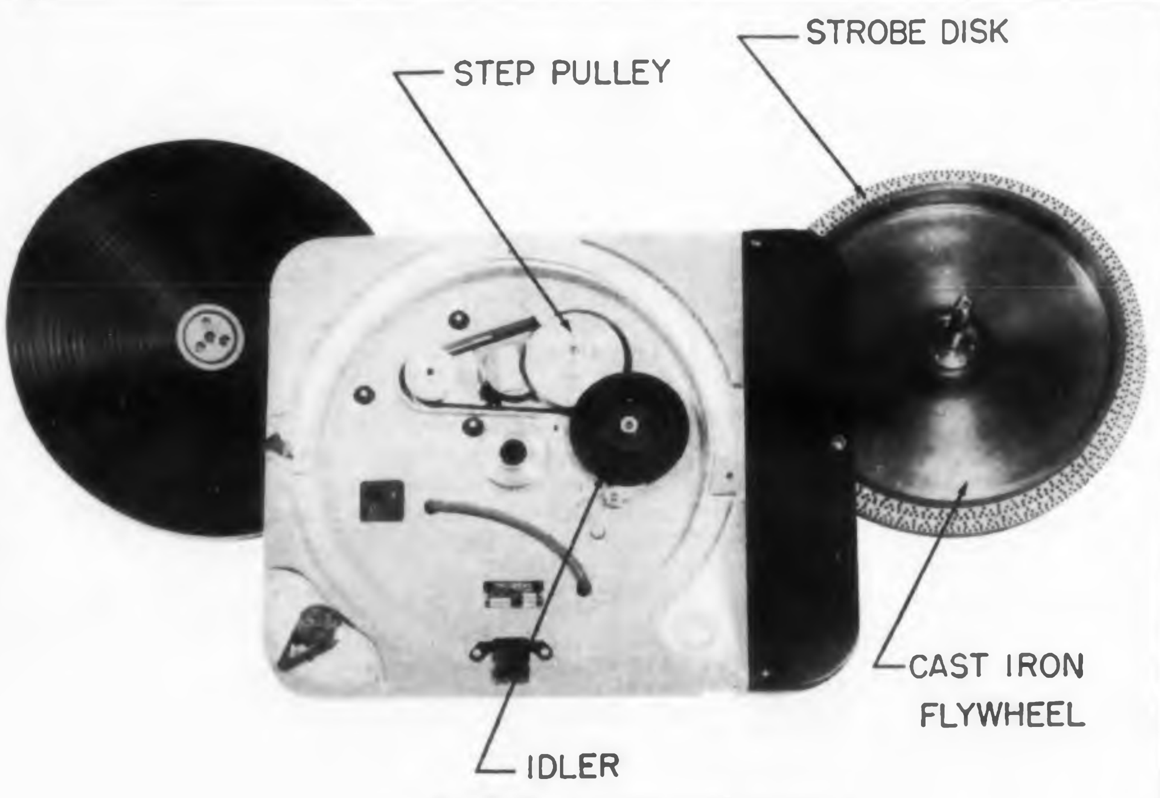


Fig. 5. Thorens uses a belt to drive a step-pulley.

table to the pickup arm, the table spindle sits on air (Fig. 2).

A disk magnet under the table repels another one on top of the motor board to support the table vertically, yet keeps the spindle at least 1/8 in. clear of the bottom of the bearing well.

Fairchild. Many factors contribute to the rumble-free operation of the "412 Series" turntables (Fig. 3). There are as few moving parts as possible. In the four-speed model, a four-frequency Wien bridge oscillator drives a single-speed hysteresis synchronous motor. This removes the need for additional mechanical parts for speed changing.

Most unusual in the "412" is the two-belt drive. One belt delivers rotation from the motor to a shock-mounted intermediate pulley. This pulley drives a second belt which drives the outer rim of the turntable. This two-stage speed reduction allows for a larger motor capstan whose diameter can be held to tighter tolerances. It also minimizes belt slippage.

The cast aluminum turntable is machined on its own shaft. Before machining, Densite is cast into the rim to eliminate table ringing and to provide a flywheel effect. The motor cradle rests on flexible Barry mounts whose axes are 45 degrees from the vertical.

For further noise reduction, the bottom of the babbit-lined bearing well is screwed to the bottom of the chassis.

Weathers. Like the Fairchild machine, the Weathers turntable uses electronic speed changing. Beyond that there is little similarity. This machine uses a small 12 pole synchronous motor, about the size you'd use to drive a clock. The light, stamped aluminum table is driven by a gum-rubber drive wheel.

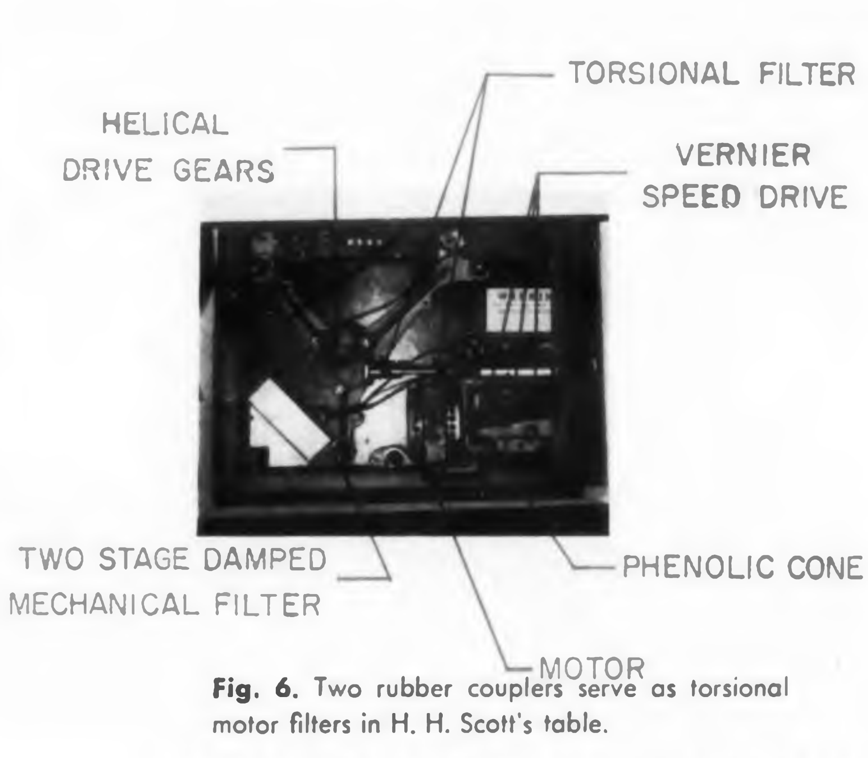


Fig. 6. Two rubber couplers serve as torsional motor filters in H. H. Scott's table.

A very unusual feature is the free-floating spindle which rides on Teflon bearings above and below. With a diameter of about 1/8 in., the spindle is at least four or five times smaller than most.

To eliminate acoustic feedback, the motor board sits on four conical springs tuned to resonate at 3 cps.

In spite of the use of direct rim drive from the motor, Weathers claims an unbelievably low rumble figure of −70 db.

Metzner. In the "Starlight" turntable (Fig. 4), the motor drive system uses no metal-to-metal contact. In this center-drive system, the motor drives a worm gear with a highly compressed felt center. Two pieces of aluminum are staked to the felt before the gear is hobbed.

This worm gear drives a neoprene disk whose surface drives a serrated aluminum wheel. This wheel, which drives the table spindle, can be moved across the radius of the neoprene disk to provide continuous speed variation from 16 to 84 rpm.

Thorens. The "TD 124" (Fig. 5), has a belt from the motor driving a step-pulley which, in turn, drives the rim through a soft rubber idler.

One of the tricks in this machine is the use of a "two-in-one" table. A light aluminum turntable proper is coupled to a heavy 10 lb rim-concentrated, cast iron flywheel, which is driven by the idler.

H. H. Scott. The motor drives a phenolic cone which drives a separate rubber-tired wheel for each speed in the "Stroboscopic Turntable 710 A" (Fig. 6). Moving any of the wheels along the cone provides a five per cent speed adjustment.

The engaged rubber wheel drives a dynamically-balanced metal drum. This drum drives a train of hardened steel and nylon helical gears through a shaft with two rubber isolation couplers. The gears which drive the spindle are housed in an oil bath.

To reduce noise even more, the motor and speed control drum are suspended on springs independent of the turntable and pickup board.

Rek-O-Kut. Rek-O-Kut's single speed machines use a crowned pulley integral with the motor shaft to drive the belt which drives the rim of the table. The pulley is ground on the motor shaft. Rek-O-Kut attributes very low noise levels to extreme care in machining. They keep the surface of a 12 in. table flat to 0.003 in. and the concentricity to within 0.002 in.

Other manufacturers didn't seem to use any "new" ideas. This does not mean other turntables are inferior—but rather that "new" ideas are not essential ingredients of quality. No turntable, no machine, no system can provide top quality performance without top quality workmanship, materials, and care. ■ ■

Heart of the chopper is the tiny reed with the multi-fingered moving contact. It is shown between the armature and the stationary contact assembly.

Rugged Microminiature Chopper

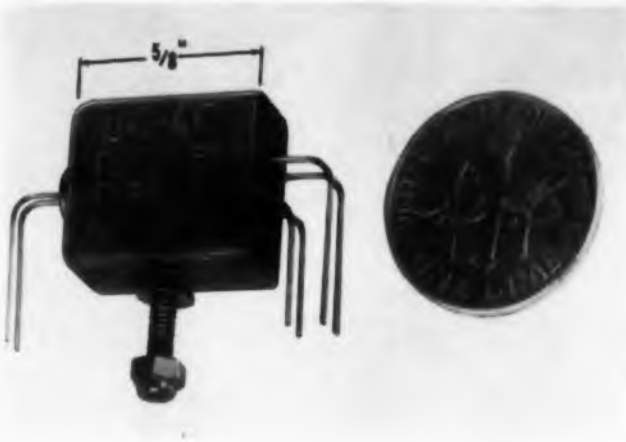
A DIME can almost conceal this rugged chopper. The edge of a dime conceals the reed and shorting contact assembly. The entire chopper, potted and encased in steel, weighs less than 1/4 oz.

Yet it withstands 50 g shock in any direction. Contacts, in operation, are deranged no more than 10 electrical degrees when subjected to 15 g vibration at any frequency from 10 to 2500 cps. Life at rated load is guaranteed to exceed 2000 hrs.

It takes unusual construction to build that kind of ruggedness into a tiny chopper. And this unit, by Rawco Instruments Inc., 3527 W. Rosedale, Fort Worth, Tex., certainly has unusual construction.

Construction

Most unusual is the moving contact assembly. The reed, made of fatigue-resistant elgiloy, supports a multi-fingered shorting contact. These fingers, arranged in a square cluster, alternately short pairs



of fixed contacts. This configuration allows for a wide choice of contact materials for optimum life and performance.

The balanced armature, with a very low mass, travels only 0.025 in. Its slotted configuration shock mounts the vee jewel pivots. The armature springs open to compensate for pivot wear, and opens and closes to take up dimentional changes due to temperature variations. (The unit operates from −65 to 125 C.)

Solder grouting the sapphire vee jewels provides maximum support area for the pivots and eliminates the stresses usually incurred in conventional mountings. It also facilitates production, as no sizing of vee jewels is required to obtain a perfect fit. The pivot can take 500 times the armature weight.

The armature and contacts are fully isolated from the shielded and potted coil, and are hermetically sealed in one atmosphere of dry nitrogen. This eliminates oxidation and organic contamination of the contacts.

Performance

Despite its size, this chopper outperforms many larger units. It can supply resistive loads up to 10 v at 1 ma. In the 400 cycle unit, the coil requires only 25 ma at 6.3 v. Insulation resistance is at least 100 megs between all terminals and ground.

The noise level is normally less than 10 μv rms across 1 meg, and is never greater than 100 μv. The moving contact dwells on a pair of fixed contacts for at least 150 electrical degrees of the switching period, with a contact bounce never exceeding 4 degrees per period.

For more information, turn to the Reader-Service Card and circle 101.

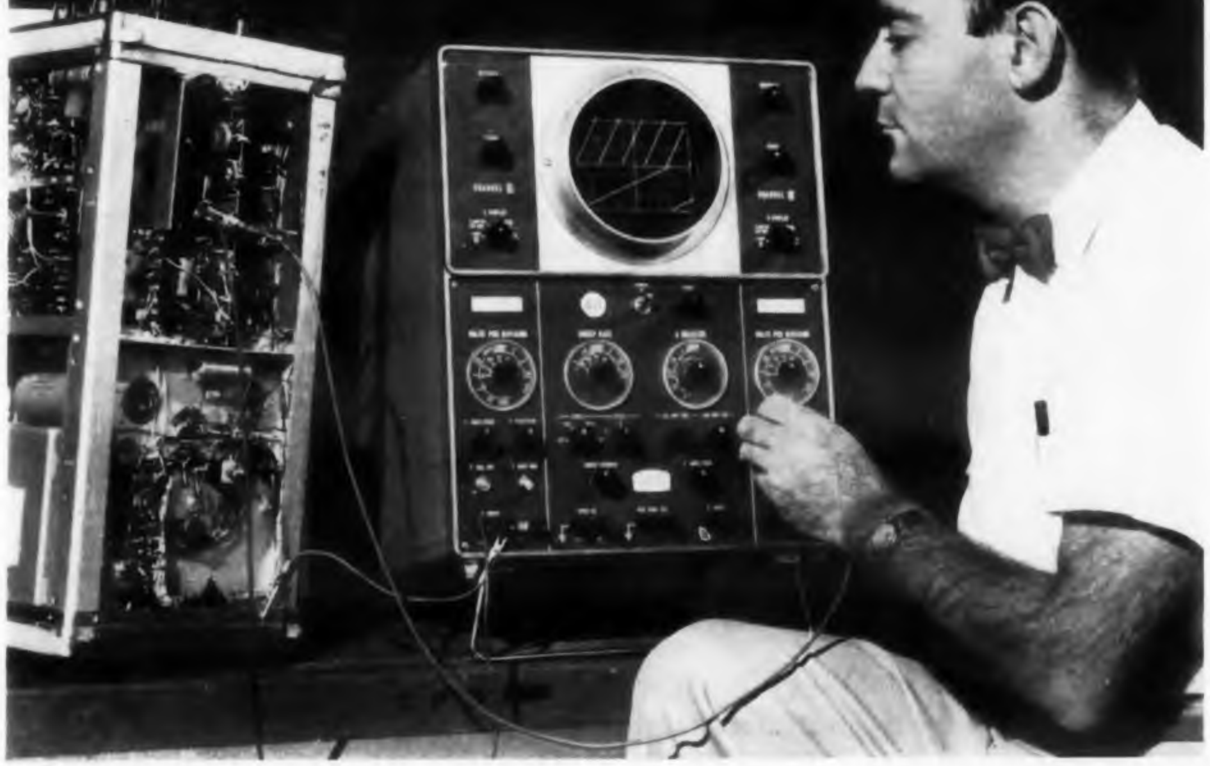
CIRCLE 35 ON READER-SERVICE CARD

Engineer checks sawtooth with two-gun, dual-beam oscilloscope. Channel A is used here to show the sawtooth on the calibrated time base. Channel B shows an expanded part of the sawtooth.

Flexibility Two Scopes

WITH a one-millivolt full-scale sensitivity for each amplifier this dual-beam two-gun scope has many unusual features. It can display *X-Y* plots and, simultaneously, either the *X* or *Y* signal against time. It has nine major modes of display. With Z axis modulation, 27 additional modes are possible. By plotting the

No beam splitting or electronic switching can provide the kind of trace shown on the screen of this cro.



Plus—with In One

Y signal against X, or Y against the variable time base in one channel while performing analogous feats in the other, a host of display combinations are possible.

Another innovation lies in the sweep circuitry. Both expanded and calibrated sweeps can be positioned independently while being displayed. Since the calibrated sweep is generated at a high level, it can be fed directly to the H deflection plates. Hence one gun of the crt can be used as a single beam oscilloscope with identical amplifiers, while either the X or Y input can be displayed against time on the other channel.

Developed by Allen B. Du Mont Laboratories, Inc., 750 Bloomfield Ave., Clifton, N.J., the Type 411 provides completely independent control of each electron beam. Each channel has its own focus and intensity controls, and either beam can be switched off. "Pin-ball" indicator lights clearly show when a channel is in operation.

With a flat frequency response from dc to beyond 100 kc, the instrument provides a vertical resolution of 20 μv. Front panel controls offer 19 calibrated sweeps from 1 μsec/cm to 1 sec/cm, and 17 vertical full-scale measurements from 1 mv to 500 v.

The "Unusual" Is Built In

Both driven and recurrent sweeps are available with automatic beam brightening during trace time. On driven sweep, the beam is brightened only when the sweep is triggered, so the shutter of a recording camera can be left open without fogging the film while waiting for the sweep.

For capturing transients, an unusual "electronic shutter" can be triggered to turn on the display for a predetermined time. All unwanted parts of the trace are invisible.

For more information on this dual-beam scope turn to the Reader-Service Card and circle 104.

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

Using Thin Films in Microminiaturization

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Royal Radar Establishment
Malvern, England

In any typical tubular component, most of the available volume is occupied by material which plays no part in the electrical performance. An increase in power with small size could be made by opening the cylinder and its leads into flat strips. This article discloses new methods and materials for making these components flat initially.

SEVERAL new thin film techniques for making miniature components offer interesting approaches to miniature component production.

Thin film components have the advantage of high surface area to volume ratio. This leads to a substantial reduction in size for a given wattage rating. Three types of thin films are: (a) resistive, (b) capacitive and (c) inductive.

For resistive films of 200-500 ohms per square, thickness should be a few hundred Angstroms.

For high capacitive films greater than 0.1 μf, thickness required is about 0.0001 in.

For inductive films, thickness should not exceed 200-300 Angstroms, otherwise eddy current losses become appreciable.

Three classes of base material used are:

- Inorganic materials (ceramic, glass)
- Plastics (Teflon, etc.)
- Semiconductor materials (silicon, germanium)

Ceramics are probably the simplest to use. It is possible to deposit silver or other compositions by chemical means or by evaporation upon them. With material of suitable permittivity, high value capacitors may be obtained by metallizing both sides of the base.

Plastics do not make good bases. Although they have excellent electrical properties, their low resistance to heat precludes their use in "fired-on" processes, while their high vapor pressure and occluded gases make them difficult to use in vacuum systems.

The use of semiconducting material, such as silicon, as a base is very attractive. By suitable alloying and doping, the active elements can be produced directly on to the substrate instead of being added separately as is required when using other materials.

Preparation of Resistive Films

Resistors of platinum/gold alloy deposited on glass have been developed[1] at the Royal Radar Establishment and are now in production.[2] They have excellent temperature coefficient and are very stable. An alloy of 80 per cent gold and 20 per cent platinum gives a resistivity of 60 microhms per cm in a thickness of 1000 Angstroms with a temperature coefficient of 0.025 per cent. An alloy of 60/40 gold-platinum has a resistivity of 75 microhms per cm in the same thickness and its temperature coefficient is then 0.06 per cent.

Various stages in the process of manufacture are shown in Fig. 1. The final value of resistance is adjusted by cutting through the requisite number of trimming bars. By suitable design of the master an accuracy of 0.1 per cent is obtainable.

So far this process has only been applied to making actual resistors, but by scaling it down it can be adapted to making the complete circuit. The resolution that can be obtained by the photo-mechanical process has been demonstrated[3] when it is applied to the making of transistors on a dice only 0.05 in. sq.

High resistivity is obtained from films of nickel chromium. Recent advances[4] in the evaporation of this alloy make it attractive. Typical properties as used in resistors are shown in Table 1.

Because of its excellent temperature/resistance properties, nickel chromium is being carefully studied[4] as, even in the microminiaturized subunits, a high order of stability will be required once the initial novelty of being able to make them at all has passed. However, the resistivity as given is not entirely satisfactory, because to make very small units would entail a line width of not more than 0.010 in. which, although practicable, in thin film form requires scrupulous care in processing with a probable high reject rate in production.

An alloy of chromium 20 per cent, iron 3 per cent, aluminum 3 per cent and nickel 74 per cent (Karma Alloy) looks interesting. Early experiments in evaporation of this alloy gave a resistiv-

Table 1—Typical Properties of Nickel-Chromium Films

Thickness (Angstroms)	Resistance (Ohms/sq.)	Temp. Coefficient (ppm/C)
50	300	+24
80	210	—38
90	180	—27

ity of 400 ohms per square, and evaporation at 1650 C on a cold, glass substrate. The film showed good adhesion and apparently good stability. Work on this material continues, but at the same time alloys with much higher resistivities are being sought.

Practical resistors have been made and values up to 1 megohm have been obtained by photomechanical processing. A circuit using Ni/Cr resistors and nickel electrodes is shown in Fig. 2.

Preparation of Capacitative Films

Dielectrics for capacitors can be made in the form of strips or films as thin as 0.00025 in. (glass) or 0.005 to 0.010 in. (ceramics). But it is probably more convenient to evaporate them on a metallic substrate which forms one electrode, with a further metal evaporated layer to provide the other. Repetition of this process can build up a stacked film capacitor of high value of the type required in low impedance circuits.

Single thickness films of high permittivity are attractive and, if only a few molecules in thickness, high value capacitors can be realized. A useful formula for capacitance is: 1000 μμf per cm sq per micron in thickness (assuming K in air $= 1.0$). This formula results in a value which is about 10 per cent too high, and should be reduced accordingly.

In a proposed standard module[5] of 0.31 in. sq, about 1 cm sq could be considered as the working area, of which 5 mm sq could be allowed as a maximum for one component.

If a high permittivity material such as barium titanate is used, a K of 1000 can be expected, and it would be possible to make a capacitor of 0.25 μμf within the alotted area. Care would be necessary to insure that its ferroelectric properties and its low Curie point do not interfere with its operation as a capacitor. But for use with transistors with their inherent low operating temperature this is quite possible.

Experimental capacitors have been made by producing an oxide film on tantalum[6] in a mix-

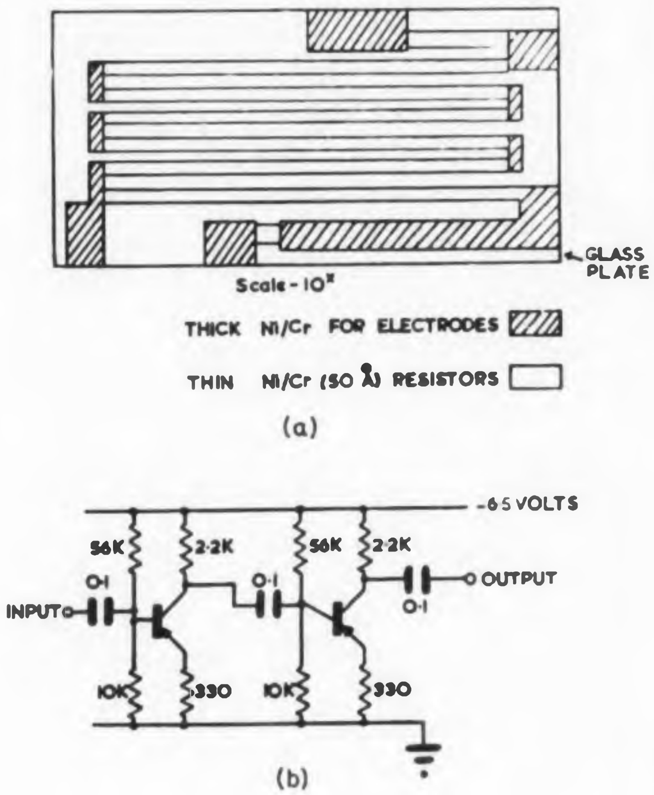

Fig. 2. Resistor and conductor pattern printed on glass (a), and its circuit diagram (b).

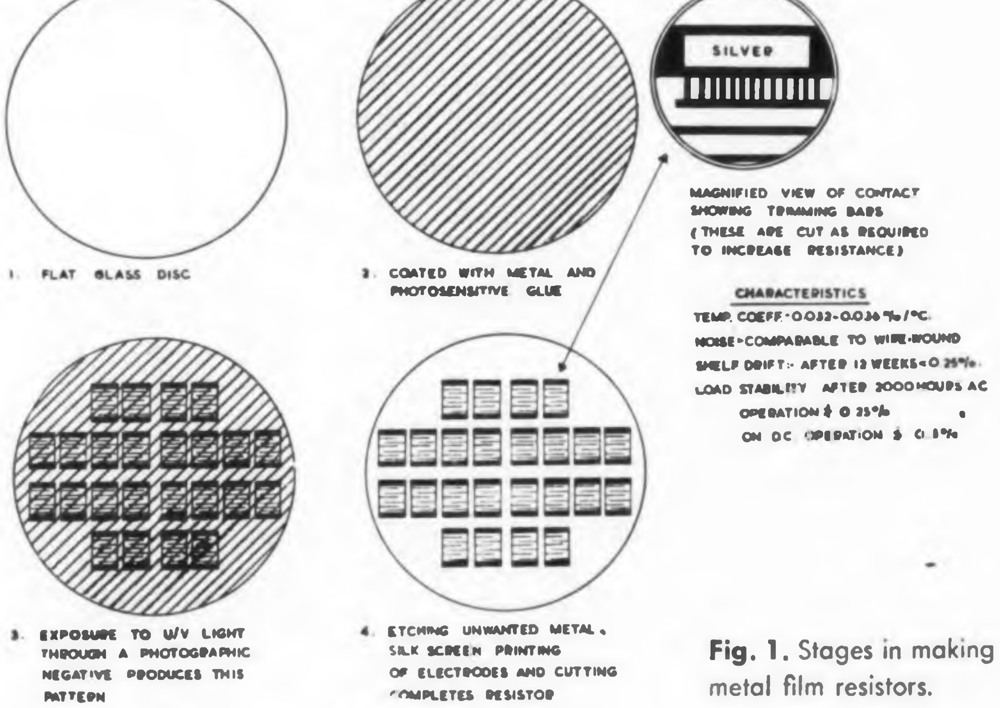

Fig. 1. Stages in making metal film resistors.

ture of phosphoric acid and amyl alcohol. The dielectric thickness was about 1200 Angstroms. After drying, a layer of zinc oxide was evaporated on to its surface and a counter electrode of silver followed. Manganese dioxide is more usual than zinc oxide, but the latter is easier to evaporate. These oxide coatings increase the breakdown voltage.

A sample capacitor made by this method had a capacitance of 0.1 μf for 0.6 sq cm, with a power factor better than 1 per cent which is good enough to warrant investigating the effects of different thicknesses of zinc oxide layers on breakdown. A multilayer capacitor can be made by utilizing both sides of the tantalum and in this way a capacitance of several microfarads is obtainable in a very small space.

Silicon monoxide has also been examined. Good, uncracked films were obtained up to thicknesses as great as 0.02 in. However, the power factor of these films was very high. At best it is 40 to 50 per cent which makes such material of little interest for this work.

In some circuits, a rapid discharge time of less than a microsecond is required. This is not possible with electrolytic capacitors and must be considered as a limiting factor.

There are many more materials which can be evaporated for use as capacitor dielectrics:

Magnesium fluoride
Calcium fluoride
Calcium silicate
Zinc sulphide
Lead sulphide
Cadmium sulphide

Some of these are well known as lens blooming agents, and zinc sulphide has been used extensively in infra-red detectors. With a permittivity reported[7] as 8.2 at 1000 kmc and measured locally as about 9 at 10 mc, it is considered to be worth examining.

To obtain high stability and low coefficient of temperature will be just as big a problem as with resistors. Very thin films will not be practicable if they are unstable. This means that as no compromise is possible between high capacitance and stability the latter must be made the dominant factor. In consequence, it is important to develop a multilayer film capacitor as it is essential to achieve values in excess of 0.1 μf and preferably of at least 1.0 μf.

Plastic Films

Although inorganic materials can be evaporated more readily, plastics have already been made in very thin films. Their progress has been sufficiently fast to justify the belief that they may be used in microminiaturization techniques, although they will probably be used as components to be added separately.

Table 2—Characteristics of Ferrite and Metal Magnetic Films

	Metal	Ferrite
Operating Speed	30 mμsec	1 μsec
Drive Power	400 ma into 5 ohms (transistor)	800 ma into 50 ohms (tube)
Repetition Rate	5 mc	500 kc

Following the work by Bell Telephone Laboratories[8] on cellulose-acetate-butyrate, thin films have been made from high molecular weight polystyrene and copolymers of this with poly-alpha-methylstyrene. These films are cast on to a carrier of polyethylene-terephthalate (Mylar or Melinex) from a solvent solution. The carrier is subsequently stripped after the film has been metallized, is then demetallized and slit for the making of metallized capacitors. So far very thin films have not been made—about 0.0002 in. or 5 microns being used to gain experience.

It is the necessity of handling on a substrate that makes it essential to use cast films; extruded films of this thickness would be far too thin and fragile to handle. A cast film limits the material to one which can be dissolved fairly readily. This is the reason that an otherwise ideal material—polyethylene-terephthalate—is unsuitable and polystyrene is preferred.

Capacitors have been made from these films but early models have been made from multilayer wound foils. As the final units will almost certainly be required in the form of single sheet "castellated" metallized capacitors, work has now been directed into making this type only.

The gain in capacitance-volume ratio is calculated as 5:1 over conventional metallized paper capacitors. It is unfortunate that polystyrene has a permittivity of only 2.5 but this is the price paid for an almost perfect dielectric material. Experiments have been made with high permittivity fillers and it has been found possible to achieve a permittivity of 5 with films less than 0.001 in. thick.

A novel method of making large value capacitors is by using differential solvents. On to a substrate of polyester film a layer of polystyrene is cast and dried as usual. It is metallized and another insulating layer of cellulose nitrate is cast on top. As the metallized layer is not a barrier for the styrene solvent, a material dissolving in a different solvent is needed. So far, cellulose nitrate has been used experimentally. Although this is by no means a good dielectric, it can be cast from solvents which do not attack the polystyrene. By building up multilayers, say ten, it is possible to strip off the substrate as the dielectrics are strong enough in the form of laminae to support themselves. By this technique it is hoped to produce capacitors of very high capacitance per unit volume.

On the whole, plastics do not seem to hold much promise for these techniques except as an interim measure for use in separate components until such time as all the components are made on the substrate which itself forms an integral part of the sub-unit.

Preparation of Magnetic Films

The choice between magnetic films of metal or of ferrite is in favor of the former because they have superior physical properties (Table 2). Also, they are easier to evaporate as an alloy.

Both have rectangular hysteresis loops and are suitable for use as memory devices. Eddy current losses are high for a thickness exceeding a micron or so, and interference between opposite domain walls can occur if the thickness falls as low as about 20 Angstroms. The usual thickness is between 300 and 1000 Angstroms.

Attempts are being made to deposit a conducting layer on top of the magnetic film with an intervening layer of an insulant, but so far great difficulty has been experienced with pinholes.

To be able to make a complete memory device by deposition would be a tremendous advance over the painstaking method of ferrite-core threading practiced at present. There is the additional advantage that the speed of operation can be improved by keeping down the conductor lengths.

Detailed information on the production procedures mentioned in this article will be found in the complete paper to be published in our proceedings of the Symposium on Microminiaturization of Electronic Assemblies. For further information on the proceedings, turn to the Reader Service Card and circle **100**.

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Another article of the exclusive series on microminiaturization. See note accompanying article p. 38 in this issue regarding the entire series.

Miniaturizing Shipboard Simulators

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Port Washington, N.Y.

EXTENSIVE and complex simulator systems have been developed for training of Armed Forces personnel at shorebased schools in the fields of Fleet Air Defense Weapon Systems and CIC training. With the advent of shipboard guided missile weapon systems, a new concept of installing simulator systems aboard Naval vessels has been implemented. This concept calls for miniaturization of equipment.

Due to the critical need for minimum weight, size and power requirements for shipboard installations, extensive redesign and new techniques have been investigated in the areas of transistorization and microminiaturization.

In the shipboard type trainer, the

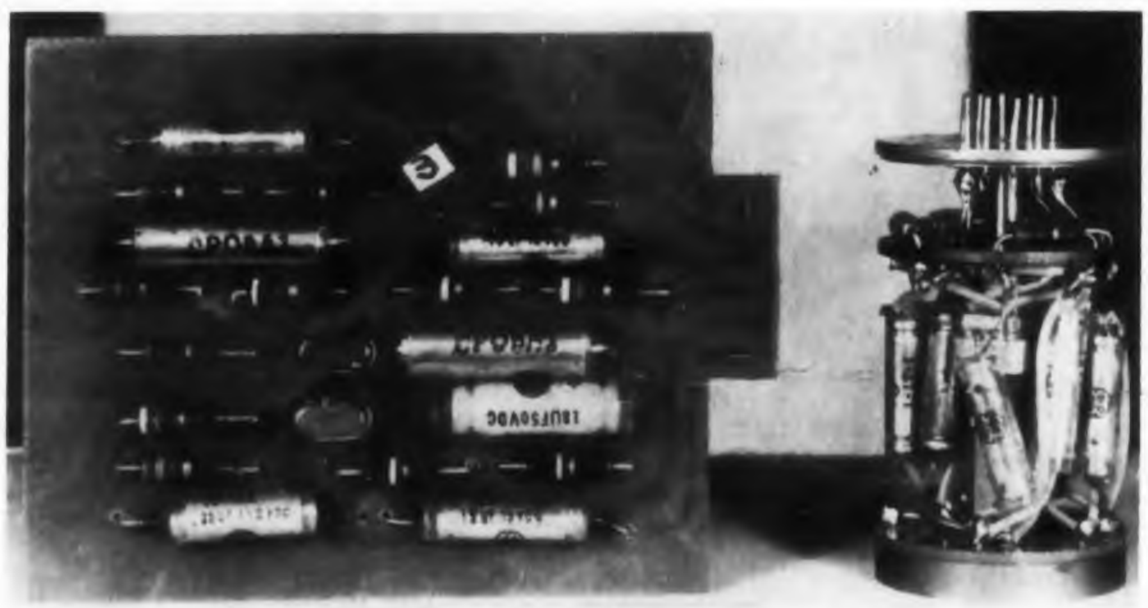


Fig. 1. Typical transistorized assemblies used to reduce size.

Fig. 2. Large 60 cps motor (left) replaced with smaller motor when 400 cps power supply was adopted.

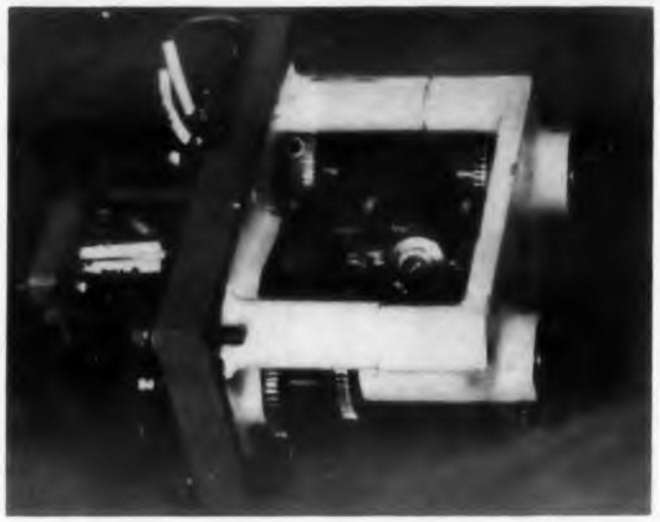


Fig. 3. Mechanical bearing gate comparator mechanism that was discarded.

tubular type transistorized assemblies (Fig. 1.) are used extensively as compared to the molded card type. The advantages lie in greater maintainability and replacement. The disadvantages are larger size and weight. Since the units have to be capable of replacement, it was agreed that the use of the tubular transistorized type is preferred.

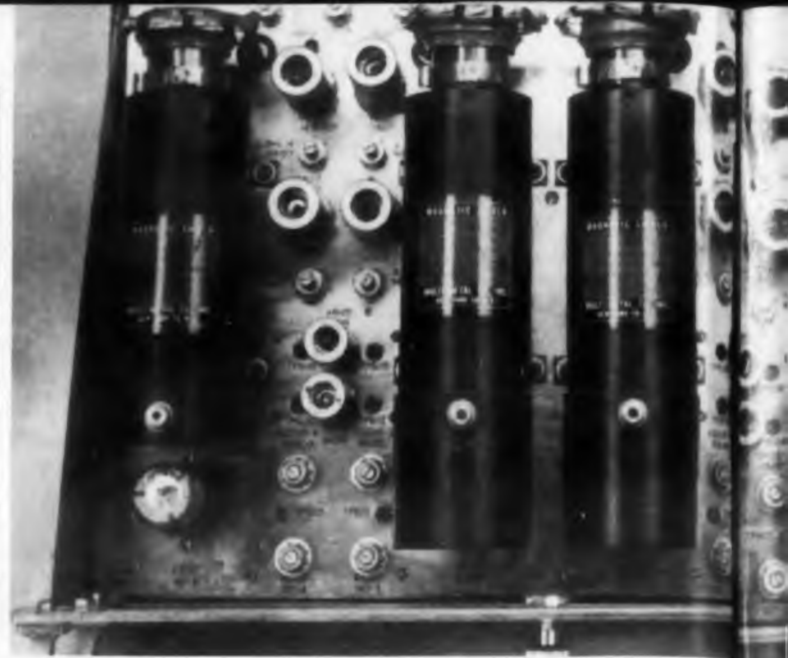
Fig. 4. Electronic bearing gate comparator mechanism replaced large mechanical unit.

Change to 400 cps

When one considers that approximately 50 to 60 of these circuits are used, the size is quite appreciable. In addition, the console and chassis assembly are decreased in size. An obvious shrinkage was obtained in converting the system from a 60 cps power system to a 400 cps system (Fig. 2). The major weight saving was in transformers, filters and motor assemblies. Weight and size shrinkage ratio was approximately 4 to 1. Another area of miniaturization was the careful investigation of design techniques utilized and possible use of other techniques. Fig. 3 shows the electro-mechanical assembly which is utilized as a bearing gate simulator.

Replace Mechanical Assembly

After careful study, a design technique utilizing target input to the rotor of a control transformer and antenna position data fed to the stator leads was developed. The error signal was fed to a dc level comparator circuit (Fig. 4). Bearing width is readily adjustable by



changing the dc level. The weight and shrinkage ratio gained was approximately 10 to 1.

Another typical example of circuit redesign was the replacement of crt tubes and associated circuits utilized for simulation of complex conical and spiral scan simulation of fire control simulators with ring modulators. Fig. 5 shows a four target conical spiral simulator chassis utilizing crt as compared to Fig. 6 which is a six target chassis utilizing ring modulators. Size and shrinkage accomplished was approximately 3 to 1.

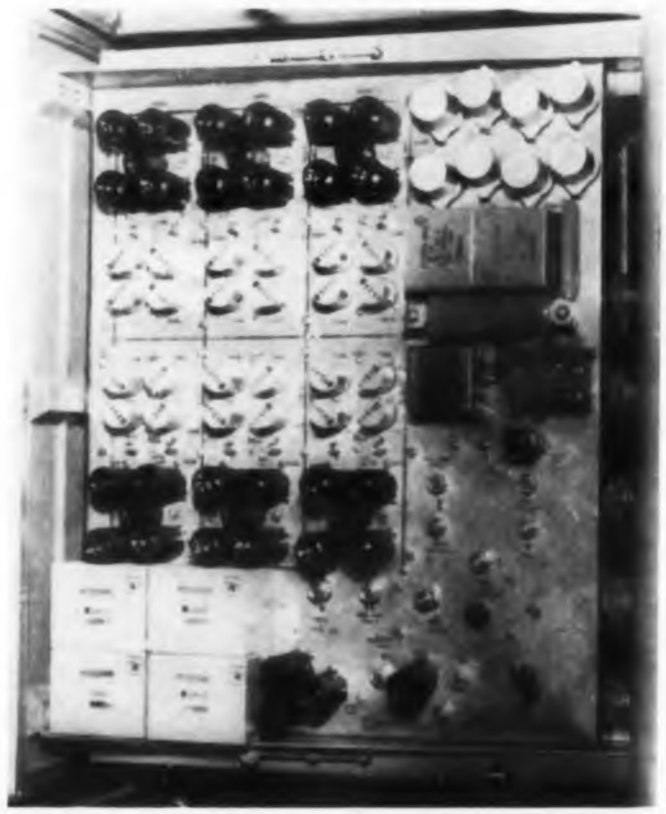


Fig. 6. Large ring modulator type conical-spiral simulator that was replaced by smaller unit.

Fig. 5. Miniature cathode ray tube conical-spiral simulator.

Smaller Power Supplies

Another extensive saving in weight and size is realized in power supply units utilized with transistors. Regulated power supply units as shown were decreased in voltage and current requirements. Power supply shrinkage ratio varied from 5 to 1 to as high as 10 to 1. A complete analysis showed that 80 to 85 per cent of the circuits in this design are capable of transistorization.

Shrinkage, then, of 50 per cent was accomplished by:

- Complete analysis of circuit design. Transistorize only when warranted and conforms with good design practices. In some specific cases it was found that conventional miniature tubes were better suited and more efficient.
- Using 400 cycle supply in lieu of 60 cycle whenever possible.
- Investigating alternate design techniques when possible and warranted.

It must be realized that transistorization and miniaturization are not the panacea for all design problems. Its application is usually expensive and time consuming. However when the ultimate requirement is a maximum shrinkage of size and weight, these factors can be realized using the above analytical approach without the sacrificing of good design practices and reliability.

More detailed information on the equipment described in this article will be found in the complete paper to be published in our Proceedings of the Symposium on Microminiaturization of Electronic Assemblies. For further information on the Proceedings, turn to 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.

SYSTEM ERROR BRIDGE

With this bridge the angular position of any synchro or resolver can be measured directly without any mechanical coupling. The only connection is through electrical leads. Three dials display angular position digitally to three decimal places over a 360 degree range. Readability is 3.6 sec; accuracy within 10 sec. The unit's measurements are 19 x 10.5 x 8 in.

Theta Instrument Corp., Dept. ED, 48 Pine St., East Paterson, N.J.

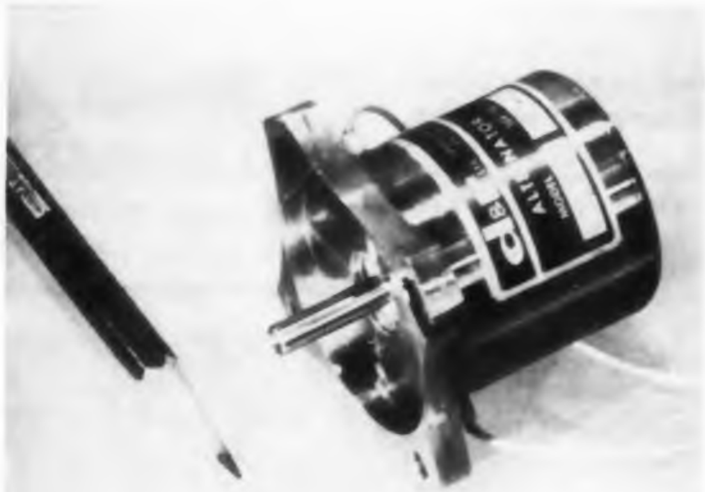
CIRCLE 56 ON READER-SERVICE CARD

SILICON RECTIFIERS

Rated from 100 through 400 piv, the 1N1563A through 1N1566A silicon rectifiers were designed for military and industrial applications. Forward rectified currents are 1.5 amp and 250 ma at 25 C and 150 C ambient temperature. One cycle average reverse current is limited to 150 μa max when rectified output is 250 ma and ambient temperature is 150 C. These diffused-junction units can be used with both printed circuit and chassis construction.

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

CIRCLE 57 ON READER-SERVICE CARD



HIGH FREQUENCY GENERATOR

Suitable for a missile power supply, the Model D-1309 generator develops 100 w at 6000 cps with shaft speeds up to 60,000 rpm. It can be driven by a hot gas turbine or other suitable means. Featured in the design is low inertia and short circuit protection. The unit weighs 6.5 oz, and its measurements are 1.5 in. in diameter and 1.67 in. long.

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

CIRCLE 58 ON READER-SERVICE CARD

METAL FILM RESISTORS

Standard tolerance of these metal film resistors is ±1 per cent. Their temperature coefficient is ±50 ppm per degree C over a temperature range of from −65 to +165 C, independent of resistance value. Type WHM, equivalent Mil style RN-75, measures 1.125 x 0.406 in. It has a maximum voltage rating of 500 v. Type WFH measures 0.781 x 0.25 in.

Resistance Products Co., Dept. ED, 914 S. 13th St., Harrisburg, Pa.

CIRCLE 59 ON READER-SERVICE CARD

COMMUTATOR

This commutator is spring-driven. Due to this drive mechanism the commutator has no rf noise generation, no gyroscopic effect, no heat generation and extremely low average power consumption. The unit is hand-wound and can be used for missile and space telemetering systems. Up to 100 or more sampling revolutions can be made before rewinding. Typical sampling speeds are 1/2 or 1/50 of a sec per revolution.

Applied Science Corp., of Princeton, Dept. ED, P.O. Box 44, Princeton, N.J.

CIRCLE 60 ON READER-SERVICE CARD

MAGNETIC AMPLIFIERS

Each of the four magnetic amplifiers in the Preac 60-cps line can be used by itself or as a preamplifier for such devices as thermocouples, strain gages and bolometers. The four units provide a power gain greater than 50 db and a full linear output of 2 v into a 5000 ohm load with null drifts as low as 0.03 μamp, 2.25×10^{-12} w, referred to the input. They are rated for operation from 60 ± 6 cps power lines at 115 v ± 11 rms v.

Airpax Products Co., Seminole Div., Dept. ED: Fort Lauderdale, Fla.

CIRCLE 61 ON READER-SERVICE CARD

CIRCLE 62 ON READER-SERVICE CARD

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

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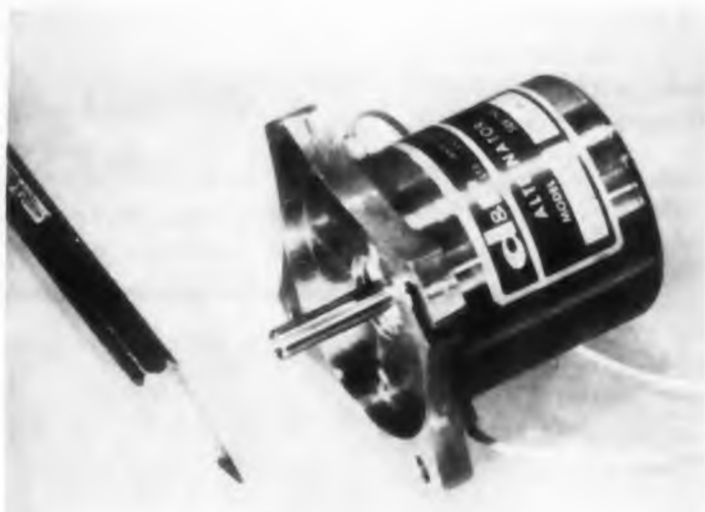
Motorola, Inc., Semiconductor Products Div., Dept. ED, 5005 East McDowell Road, Phoenix, Ariz.

CIRCLE 57 ON READER-SERVICE CARD



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Airpax Products Co., Seminole Div., Dept. ED, Fort Lauderdale, Fla.

CIRCLE 61 ON READER-SERVICE CARD

Tube, Transistor, and Diode Tester

Portable

Model 10-60 Electronamic tester affords comprehensive tube, transistor, crystal diode, and TV picture tube testing for industrial and communications applications. In tube tests, the unit covers a complete path of operation and checks all elements. It has built-in pin straighteners for 7 and 9 pin tubes. On voltage regulator tubes, it performs picture tube beam current tests, ultrasensitive gas tests, and functional tests. For transistor and crystal diode testing it has I_{cbo} ranges to cover low, medium, and high power types. The I_{cbo} readings are directly related to true collector current. Collector potential range is from 0.5 to 160 v dc in 22 steps. The direct-reading Beta ranges employ separate injection currents for low and high power types. The tester comes in a carrying case 20 x 15 x 7 in.

Precision Apparatus Co., Inc., Dept. ED, 70-31 84th St., Glendale, N.Y.

CIRCLE 64 ON READER-SERVICE CARD

Microwave Frequency Calibrator

Generates harmonics up to 25 kmc

Harmonics up to 25 kmc can be generated with the 101 microwave frequency calibrator. The 450 mc crystal controlled signal is designed to feed directly into a waveguide or coaxial crystal holder. A 5 mc fundamental crystal provides a means of calibrating the instrument against WWV. Lower intensity markers at 150 and 50 mc are present for wavemeter or receiver calibration.

Micro-Now Instrument Co., Dept. ED, 6340 N. Tripp Ave., Chicago 46, Ill.

CIRCLE 65 ON READER-SERVICE CARD

◄ CIRCLE 63 ON READER-SERVICE CARD

Binary Scaler

Has automatic reset

Binary scaler model GS-7 is designed for use with Geiger, scintillation, or proportional detectors. It has an automatic electric reset button which resets the register, timer, and binary scale indicators all at once. The unit contains a 5 digit Sodeco register and a 300 to 3000 v dc detector supply. For predetermined counts, there is a selector switch which automatically stops the scaling action after 1, 10, or 100 register counts.

Technical Associates, Dept. ED, 140 W. Providencia Ave., Burbank, Calif.

CIRCLE 66 ON READER-SERVICE CARD

Tantalum Capacitors

Offer high capacitance at low voltage

Providing large capacitance for low voltage circuits, type 200D tantalum electrolytic capacitors operate from −55 to +125 C under severe vibration and shock. In rectangular cases and five sizes, they have maximum capacitances of 2400 μf, 15 v at 85 C or 10 v at 125 C; 1300 μf, 30 v at 85 C or 20 v at 125 C; 1100 μf, 45 v at 85 C or 30 v at 125 C; 1000 μf, 50 v at 85 C or 35 v at 125 C; 660 μf, 75 v at 85 C or 50 v at 125 C; and 360 μf, 110 v at 85 C or 75 v at 125 C. All units have glass-to-metal solder seal terminals and porous anode type internal construction.

Sprague Electric Co., Dept. ED, North Adams, Mass.

CIRCLE 67 ON READER-SERVICE CARD

NEW PRODUCTS

Chart Recorder

For temperature and humidity

For indoor or outdoor use, model HGS-HYT-1SA temperature and humidity recorder consists of a sensing section and a signal cabinet which may be remotely located. From 32 to 130 F, it records relative humidity between 15 and 95% with ±3% accuracy. Temperature recordings are within ±1 deg F from 0 to 100 F. The unit incorporates a variable range limit alarm and has 6 in. daily or weekly recording charts. The sensing section is 12 x 15 x 6 in., and the signal cabinet is 8 cu in. Combined they weigh 20.75 lb.

Serdex, Inc., Dept. ED, 12 Bowdoin Sq., Boston 14, Mass.

CIRCLE 70 ON READER-SERVICE CARD

Encapsulated Silicon Rectifiers

Have piv values from 350 to 3200

This line of encapsulated silicon rectifiers includes units with piv values from 350 to 3200 and current ratings from 150 ma to 1 amp. Ambient temperature ratings are up to 140 C. Stock items include direct replacement types for 6X4, 5Y3, and other vacuum tubes. Also available are printed circuit and under-chassis types in full wave, full wave bridge, and half wave versions.

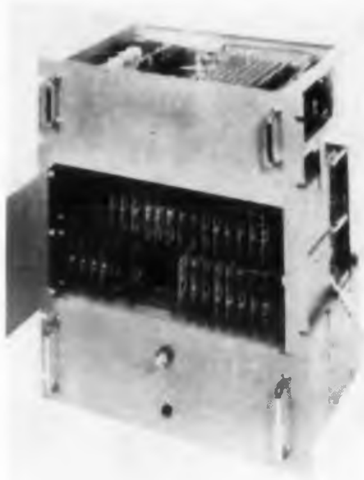
Control Circuits, Inc., Dept. ED, 5 Barton Hill, East Hampton, Conn.

CIRCLE 71 ON READER-SERVICE CARD

◄ CIRCLE 69 ON READER-SERVICE CARD

Core Storage Buffer

Handles 100,000 characters per sec



Adaptable to printers and to paper tape, magnetic tape, and punched card units, model 720-BA7 core storage buffer handles 100,000 characters per sec. It accepts any size block of data up to 720 characters of 6, 7, or 8 binary bits each. Marker pulses indicate the loading of a block, permitting more than one to be loaded at a time. The buffer provides parallel loading and unloading of all bits of each character, sequential loading and unloading of characters, and remote manual or electronic clearing. For mounting in a standard relay rack, it has all solid state elements and a self-contained power supply.

Telemeter Magnetics, Inc., Dept. ED, 2245 Pontius Ave., Los Angeles 64, Calif.

CIRCLE 72 ON READER-SERVICE CARD

Mylar Capacitors

No derating to 125 C

Epoxy encapsulated, type MD Mylar dielectric capacitors operate from −60 to +125 C without derating. For use in filters and couplings, they come in capacitances of 0.001 to 1 μf, for voltages from 100 to 800 v. They have a nonconductive case with a hard, thin outer shell that eliminates tube enclosure, end seals, tube fillers, and ground insulation.

Electronic Fabricators, Inc., Dept. ED, 682 Broadway, New York 12, N.Y.

CIRCLE 73 ON READER-SERVICE CARD

CIRCLE 74 ON READER-SERVICE CARD ➤

Terminal Block

Has gold plated lugs

Terminal lugs on the T-1000 block are gold plated to meet environmental conditions of salt spray and humidity. Designed for use with ground support equipment, this terminal block is constructed of a molded phenolic base with reinforced barriers between terminal cavities. One cavity will accommodate four terminals. Up to 40 connections can be made with one block. The block measures 5 x 1-1/16 x 3/4 in.

Twin Lock Inc., Dept. ED, 1024 W. Hillcrest Blvd., Inglewood, Calif.

CIRCLE 76 ON READER-SERVICE CARD

Regulated DC Power Supply

0.04% ripple

Tubeless model KM-254 power supply delivers in two ranges: 30 to 60 v dc, 0 to 4 amp; and 60 to 90 v dc, 0 to 2.8 amp. Regulation for line or load is less than ±1% and ripple is less than 0.04%. The unit has a control for optimizing regulation at any given output voltage, short circuit and overload protection, and good line transient response and resolution. It is 19 in. wide, 5-1/4 in. high, and 13 in. deep.

Kepco Labs, Inc., Dept. ED, 131-38 Sanford Ave., Flushing 55, N.Y.

CIRCLE 77 ON READER-SERVICE CARD

Decimal Selector

For transistorized binary counter

A decimal to four line binary code converting switch, model 319C can be used to preset the complement nine binary code directly into the company's model 190A or 312 transistorized binary decimal counters. The selector panel measures 2-7/8 x 3-1/4 in. and is mounted directly on a miniature 10 position switch which can in turn be mounted directly to a control panel in a 1/4 in. mounting hole. The selected decimal number is converted into four line binary code and is controlled by four diode gates at the output points. With complement nine presetting, the carry pulse from the last decade can be used as a stop pulse in a counting operation, and no resetting is needed.

Navigation Computer Corp., Dept. ED, 1621 Snyder Ave., Philadelphia 45, Pa.

CIRCLE 78 ON READER-SERVICE CARD

Silicon Power Diode

70 to 250 amp

These silicon power diodes provide up to 250 amp forward current and are rated from 50 to 500 piv. They are designed for high temperature use and can operate at a junction temperature of 190 C. Units are hermetically sealed and no soft solders or fluxes are used in sealing.

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

CIRCLE 79 ON READER-SERVICE CARD

NEW PRODUCTS

Transistor Tester

Has five I_{cbo} ranges

Portable model 960 transistor and crystal diode tester checks I_{cbo}, gain, leakage, and shorts on low, medium, and high power transistors. It handles tetrode, pnp, and npn types. In five I_{cbo} ranges, it provides direct readings in terms of true collector current on a wide angle 5-1/2 in., 100 μa meter. The unit also offers collector potentials from 0.5 to 100 v dc in 17 selected steps, and direct reading gain ranges with five separate injection currents for low, medium, and high power types. Leakage tests check emitter to collector current at fixed collector bias. All transistor test settings are on a high speed roller chart. The unit has a patchcord element selector system. A self-contained, ac operated unit, it comes in an 18 x 10-1/2 x 6-1/4 in. case.

Precision Apparatus Co., Inc., Dept. ED, Glendale, N.Y.

CIRCLE 81 ON READER-SERVICE CARD

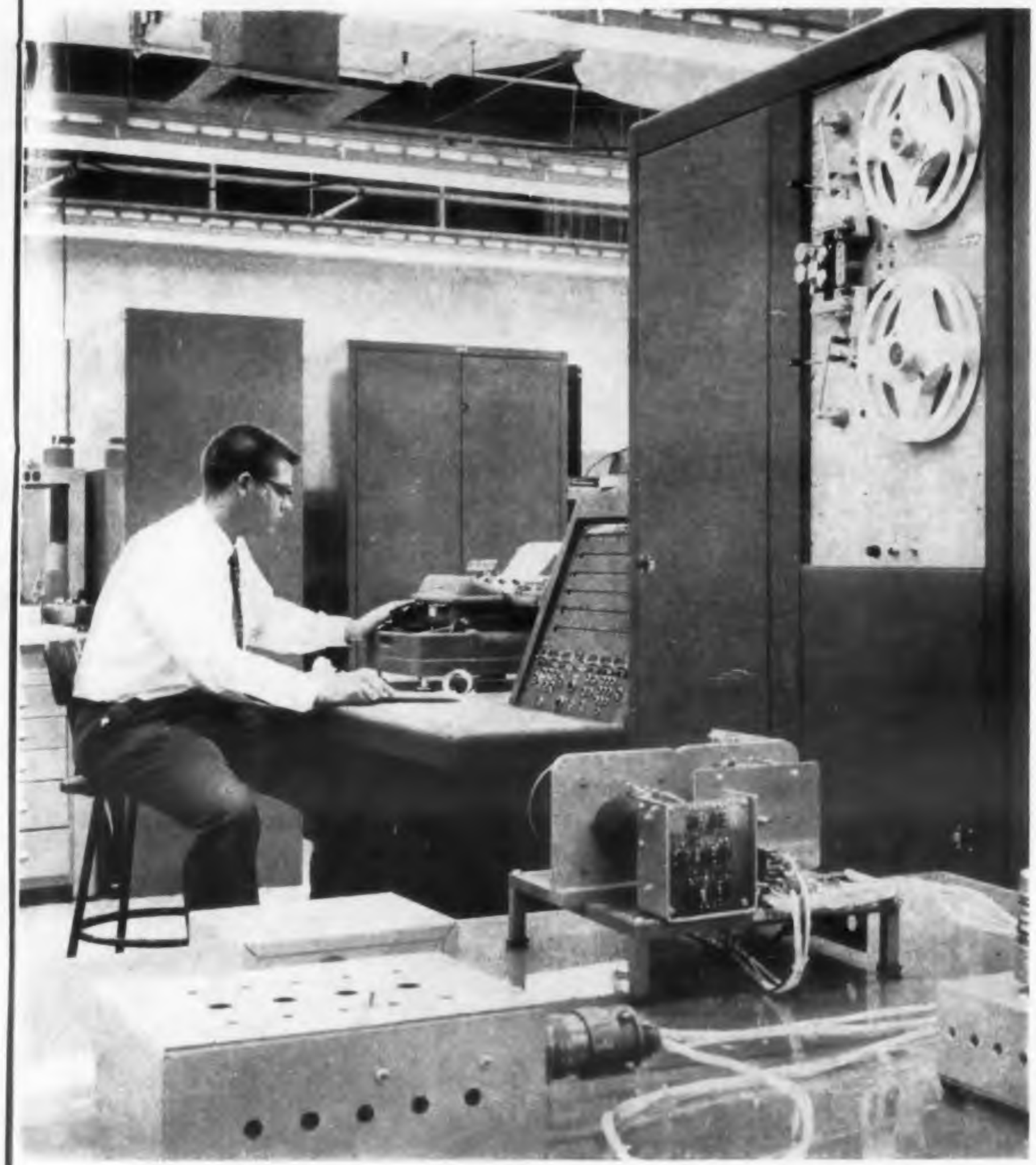
Tachometer Generator

Brush lasts over 10 years

The brush in this dc tachometer generator is guaranteed to last through 100,000 hours of continuous operation at 3600 rpm. From 0 to 12,000 rpm, the generator provides a linearity of better than 0.1% of the voltage output at 3600 rpm. The commutator is fabricated from an alloy containing more than 85% pure silver.

Servo-Tek Products Co., Dept. ED, 1086 Goffle Rd., Hawthorne, N.J.

CIRCLE 82 ON READER-SERVICE CARD



Microwave Attenuator

Electronically variable

Called V Pad, this broadband coaxial attenuator is electronically variable from 10 to 25 db. Variation is continuous, being a function of solenoid current. Maximum attenuation requires 30 ma at S-Band and 70 ma at X-Band. Other models available with attenuation as low as 3 db over the 2 to 10 kmc range.

Microwave Control Corp., Dept. ED, 250 W. 57th St., New York 19, N.Y.

CIRCLE 83 ON READER-SERVICE CARD

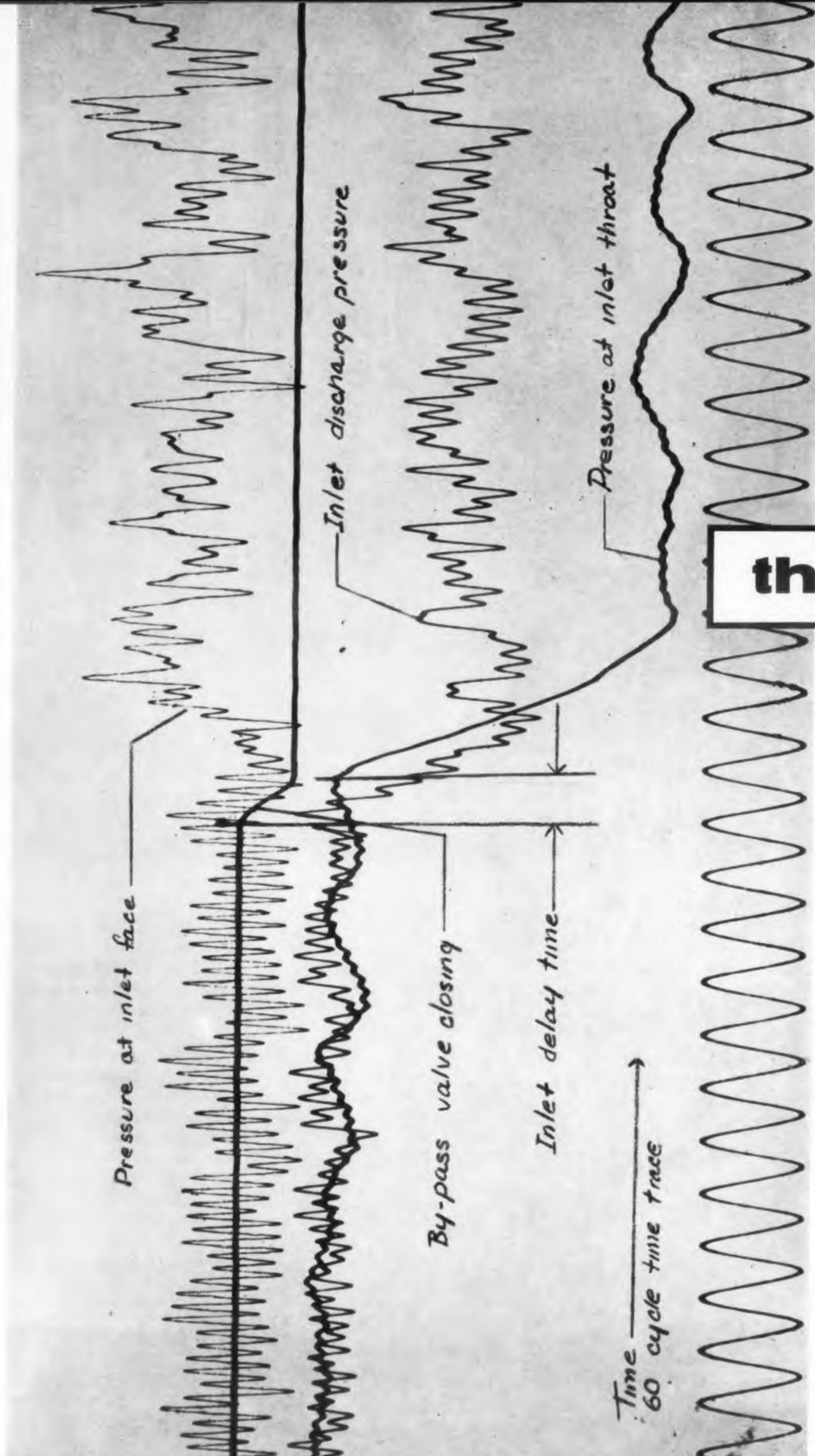
SSB Transmission Tester

150 cps to 30 kc preset sweep widths

Made up of a spectrum analyzer, a tuning head, and a two-tone generator, the SSB-3 tester incorporates equipment needed to set up, adjust, monitor, and trouble-shoot ssb and a-m transmissions. It has preset sweep widths of 150, 500, 2000, 10,000, and 30,000 cps; a continuously variable sweep width to 100 kc; a dynamic range of 60 db; and hum sidebands of 60 cps measurable down to —60 db. The unit has linear and logarithmic amplitude scales, a standard 5 in. crt, and two auxiliary outputs for chart recorder or large screen crt. The tuning head spans the 2 to 39 mc spectrum with direct reading dial.

Panoramic Radio Products, Inc., Dept. ED, 514 S. Fulton Ave., Mt. Vernon, N.Y.

CIRCLE 84 ON READER-SERVICE CARD



this

Limiting Amplifier

Has fast attack time

Designed to overcome problems encountered in automatically controlling program level, the model 660 limiting amplifier has a fast attack time to catch short transients without audible or observable thumps. Release time is adjustable from 0.5 to 40 sec in six steps. Three of these positions made the release time the automatic function of the nature of program material, thus providing fast recovery for short duration peaks and automatic reduction of overall level should the program level remain high. Audible thumps are eliminated by the use of a single push-pull stage of audio amplification and high control voltage. The unit has low distortion and noise and may be placed into any normal line level circuit. It is mounted on a 10.5 in. chassis.

Fairchild Recording Equipment Corp., Dept. ED, 10-40 45th Ave., Long Island City 1, N.Y.

CIRCLE 86 ON READER-SERVICE CARD

Precision Resistors

High temperature

Sealed by metal to glass fusion, these resistors are free of contamination. The PT501, 17/32 in. long, is rated at 0.5 w, 350 v; the PT1001, 1-1/32 in. long, is rated at 1 w, 500 v. Derating is linear from full power at 70 C, with usable properties to 400 C. Storage at high temperatures shows negligible changes. The units exceed MIL-R-10509B requirements.

Pyrofilm Resistor Co., Dept. ED, U.S. Highway 46, Parsippany, N.J.

CIRCLE 87 ON READER-SERVICE CARD

Microwave Oscillators

3950 to 11,000 mc range

Test oscillators C772A and X772A are self-contained power sources for the 3950 to 11,000 mc range. Their output is 10 to 100 mw. They have an integral regulated power supply and modulator, single knob direct reading frequency control, automatic reflector voltage tracking, and an rf attenuator.

F-R Machine Works, Inc., Dept. ED, 26-12 Borough Place, Woodside 77, N.Y.

CIRCLE 89 ON READER-SERVICE CARD

Servo Amplifier

Voltage gain of 2500 at 10 v output

Hermetically sealed model 1800-3300 is a plug-in, transistorized servo amplifier primarily intended to receive signals from a synchro control transformer and to operate a size 11, 400 cps, 3.5 w servo motor. The unit has a nominal voltage gain of 2500 at 10 v output and an input impedance of 5000 ohms. Input power is 28 v dc at 100 ma, and output is 20 v. Phase shift is essentially 90 deg, and carrier frequency is 380 to 420 cps. Designed to exceed MIL-E-5400A environmental requirements, the amplifier operates continuously between −55 and +100 C, and intermittently to 125 C. A 7-pin unit, it is 1-3/16 x 1-11/16 x 2-37/64 in. and weighs 4-1/2 oz.

M. Ten Bosch, Inc., Dept. ED, 80 Wheeler Ave., Pleasantville, N.Y.

CIRCLE 90 ON READER-SERVICE CARD

FLIGHT DATA and CONTROL ENGINEERS

Cross new frontiers in system electronics at The Garrett Corporation.

High-level assignments in the design and development of system electronics are available for engineers in the following specialties:

1. ELECTRONIC AND FLIGHT DATA SYSTEMS AND CONTROLS A wide choice of opportunities exists for creative R & D engineers having specialized experience with control devices such as: transducers, flight data computers, Mach sensors, servo-mechanisms, circuit and analog computer designs utilizing transistors, magamps and vacuum tubes.

2. SERVO-MECHANISMS AND ELECTRO-MAGNETICS Requires engineers with experience or academic training in the advanced design, development and application of magamp inductors and transformers.

3. FLIGHT INSTRUMENTS AND TRANSDUCERS

1) DESIGN ANALYSIS Requires engineers capable of performance analysis throughout preliminary design with ability to prepare and coordinate related proposals.

2) DEVELOPMENT Requires engineers skilled with the analysis and synthesis of dynamic systems including design of miniature mechanisms in which low friction freedom from vibration effects and compensation of thermo expansion are important.

4. PROPOSAL AND QUALTEST ENGINEER For specification review, proposal and qualtest analysis and report writing assignments. Three years electronic, electrical or mechanical experience required.

Forward resume to:
Mr. G. D. Bradley

THE GARRETT CORPORATION
9851 S. Sepulveda Blvd.
Los Angeles 45, Calif.

DIVISIONS:
AiResearch Manufacturing—Los Angeles
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Air Cruisers • Airsupply
Aero Engineering
AiResearch Aviation Service

CIRCLE 725 ON READER-SERVICE CARD

THE NAVY'S FIRST WEAPON SYSTEM...

The A3J "Vigilante," equipped with vital AiResearch subsystems

Centralized Air Data Computing System

Refrigeration Package

Ram Air Turbine

North American Aviation's twin-jet A3J "Vigilante" is the Navy's newest attack weapon system . . . an all-weather, carrier-based, 30,000 lb. thrust aircraft which delivers both conventional and nuclear weapons from high or low altitudes at supersonic speeds.

Contributing to the success of the first aircraft produced under the Navy's weapon system management concept is the following AiResearch equipment:

AiResearch Centralized Air Data Computing System provides information for the major flight data subsystems dealing with bombing, navigation, engine inlet control, radar, automatic flight control and includes cockpit indicators showing true air speed, altitude and engine inlet air temperature.

AiResearch Environmental System Components for personnel and compartment air conditioning and pressurization include: cabin pressure regulators, safety valves, cabin refrigeration package, equipment compartment refrigeration package, primary heat exchangers, pressure suit heat exchangers and water-alcohol tanks for evaporative cooling.

AiResearch Ram Air Turbines provide power for operation of surface controls, instrumentation and landing gear in case of emergencies. Also included are miscellaneous valves and electro-mechanical equipment.

Systems engineering, support services and systems management have enabled AiResearch to integrate these vital subsystems into North American's A3J.

ENGINEERING REPRESENTATIVES: AIRSUPPLY AND AERO ENGINEERING, OFFICES IN MAJOR CITIES

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

CIRCLE 91 ON READER-SERVICE CARD

Tubular Capacitors

For high voltage use

In hermetically sealed steatite housing, these tubular capacitors are constructed of polyester film impregnated with a stable purified silicone fluid. They are designed to operate at full voltage from —60 to +125 C with no derating. Capacitances range up to 0.5 μf, and dc working voltages range from 2 to 15 kv for continuous operation at 125 C. The units are available with plain end caps for clip mountings; with axial threaded studs no. 8-32 x 3/8 in. long; or with axial tinned no. 20 copper wire leads 1-3/8 in. long at the ends.

Axel Bros., Inc., Axel Electronics Div., Dept. ED, 134-20 Jamaica Ave., Jamaica 18, N.Y.

CIRCLE 92 ON READER-SERVICE CARD

Time Delay Relays

Provide instantaneous reset

Available with multiple poles and various current ratings, type MTRH-6 time delay relays provide immediate reset at the completion of a delay cycle. In standard mounting arrangements, the units occupy 2.25 cu in. and weigh 3 oz.

Branson Corp., Dept. ED, 41 S. Jefferson Rd., Whippany, N.J.

CIRCLE 93 ON READER-SERVICE CARD

TECHNICIANS, shown here working side by side with engineers at Sylvania's Williamsport, Pa., plant, are applying new testing techniques to mass production.

PRODUCTION engineers and specialists are developing new control techniques for better mass production of microwave components.

LETTERS

different types of Klystrons. A full commercial line of ferrite devices ranges from wave guide and coaxial isolators to variable attenuators and other ferrite devices.

MICROWAVE DIODES

Long an acknowledged leader in microwave crystal diodes, Sylvania is continuing to add new and improved versions to its extensive line. New mixer diodes are available that can extend radar coverage by as much as 18 per cent. New dual duty S and X band types that can be used in either forward or reverse applications are also available.

OTHER S.T.O. PRODUCTS

In addition to a full range of microwave components Sylvania's Special Tube Operations also produces a complete line of counter tubes, planar triodes and trigger thyratrons.

S.T.O. stands ready to meet the industry's microwave components needs—for present production items in volume—for custom modifications—or for pure research and development in microwave electronics.

A. Microwave Crystal Diode, **B.** Ferrite Isolator, **C.** Coaxial TR Tube, **D.** Traveling-Wave Tube, **E.** Ka Band Magnetron.

SYLVANIA

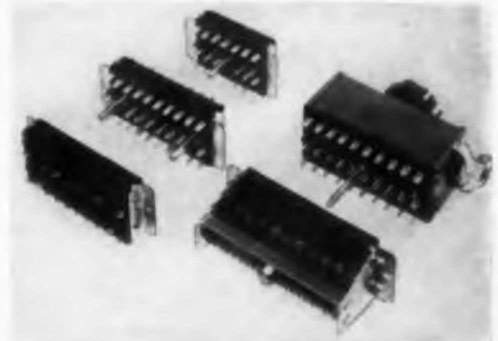
SYLVANIA ELECTRIC PRODUCTS INC.
Special Tube Operations
500 Evelyn Ave., Mountain View, Calif.

LIGHTING • TELEVISION • RADIO • ELECTRONICS • PHOTOGRAPHY • ATOMIC ENERGY • CHEMISTRY-METALLURGY

CIRCLE 93 ON READER-SERVICE CARD

Connectors

Parallel insertion insured



The contacts cannot be overstressed when these Varicon connectors are put together because there is a guide pin or screw to insure parallel insertion. The pin type connectors are double tier with 10 to 42 contacts and one or two guide pins. The pins, which may be mounted either on the male or female member of the connector, are 0.19 in. in diameter and extend 13/16 in. ahead of the insulator. They are made of cadmium plated steel. The screw type Varicons have a spindle which is operated by a knob on top of the connector and screws into a nut located in a bridge behind the mating member. Besides affording parallel insertion, this screw device acts as a vibration proof lock for mated connectors. These screw connectors are double tier with 20 to 44 contacts.

Elco Corp., Dept. ED, "M" Street below Erie Ave., Philadelphia 24, Pa.

CIRCLE 95 ON READER-SERVICE CARD

Transistorized Power Supply

0.1% regulation and stability

Transistorized power supply model SC-18-2 delivers 0 to 18 v, 0 to 2 amp. Regulation for line or load is under 0.1% or 0.003 v, whichever is greater. Ripple is 1 mv rms; recovery time is 50 μsec; and stability for 8 hours is 0.1% or 0.003 v, whichever is greater. The unit operates at a maximum of 50 C ambient and has a temperature coefficient of 0.05% per deg C and an output impedance of 0.01 ohm. It offers overtemperature protection and a continuously variable output voltage without switching. It is designed to operate continuously into a short circuit and is suitable for square wave pulsed loading. There are terminations on the front and rear of the unit, and either positive or negative can be grounded. Power requirements are 105 to 125 v, 50 to 65 cps. Dimensions are 8-1/4 x 4-5/32 x 13-5/8 in. The units can be series connected.

Kepco Labs, Inc., Dept. ED, 131-38 Sanford Ave., Flushing 55, N.Y.

CIRCLE 96 ON READER-SERVICE CARD

NEW PRODUCTS

Rotary Mechanical Stops

Size 10

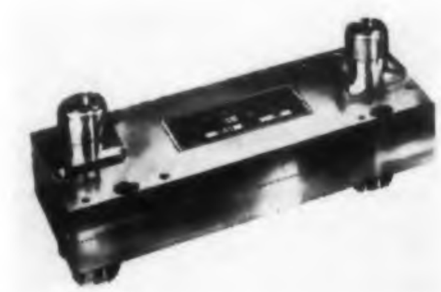
Regardless of turn setting, these rotary mechanical stops are all size 10. Standard units are set for 15 or 30 turns; others can be set for partial turns or any number of full turns from 1 through 30. Suited for use in instruments and gear trains, the stops have a total turn accuracy of ±5 deg. Starting torque is 0.04 in.-oz maximum; static torque, 200 in.-oz minimum; and rotor inertia, 0.68 gm cm^2. The units operate from —54 to +71 C.

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

CIRCLE 98 ON READER-SERVICE CARD

Coaxial Hybrid Junctions

Cover 460 to 4000 mc



For use in duplexers, mixers, and other circuits, these three coaxial hybrid junction models cover frequencies of 460 to 950, 950 to 2000, and 2000 to 4000 mc. They provide 3 db coupling, ±0.25 over the entire band and have a vswr of 1.2 with 20 db isolation. A signal into any terminal of the hybrid appears at the two opposite terminals. The two output signals are equal in amplitude, but one is 90 deg out of phase with the other. Each unit consists of two coupled coaxial transmission lines with rectangular center conductors. Type N female terminals are standard, but types C, TNC, BNC, or SC may be ordered.

Narda Microwave Corp., Dept. ED, 118-160 Herricks Rd., Mineola, N.Y.

CIRCLE 99 ON READER-SERVICE CARD

Teflon Terminals

For high voltage requirements

Teflon insulated, these Press-Fit terminals are available in nominal voltage ratings of 5500 or 13,000 flashover at sea level. The Teflon offers high surface resistivity and does not carbonize or form decomposition products during flashover or arcing. Thus there is no insulation loss with successive arcing.

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

CIRCLE 106 ON READER-SERVICE CARD

Synchros

Indicate shaft rotation

These synchro transmitters indicate shaft rotation about a reference position in the form of a polarized voltage. Phase relationships indicate the direction of turn. Induction type, the potentiometers need no sliders to make electrical contacts, and thus eliminate circuit interruptions and the wear found in other potentiometer types. Outputs of shaft rotation are linear over a range of ± 60 deg from electrical zero. Linearity of the unit is 0.28 to 1%; nominal output, 20.4 or 60 v; sensitivity, 0.34 to 1 v per deg. Input to output phase shift is 9 deg. The unit has a 2 gm cm^2 rotor moment of inertia and operates from -55 to $+100$ C. It weighs 4 oz.

Kearfott Co., Inc., Dept. ED, 1378 Main Ave., Clifton, N.J.

CIRCLE 107 ON READER-SERVICE CARD

NEW PRODUCTS

Low Frequency Analyzer

2 to 22 cps resolution

Model SS-5 low frequency analyzer will give a fourier analysis of all signals in the 1 cps to 5.3 kc range, and simultaneously measure frequency and amplitude. The unit provides continuously variable tracked sweep width, sweep rate, and gain compensation. It has neon tube failure indicators, front end overload protection, a spurious rejection input filter, and a built in power supply. Center frequency is 0 to 5 kc; sweep width, 20 to 600 cps; sweep rate, 1 to 30 sec; resolution 2 to 22 cps; and full scale sensitivity, 5 mv to 500 v. Voltage scales are linear and 2 decade log. The SS-5 is suited for the design and harmonic analysis of servo and telemetering systems; for tape recorder wow and hum analysis; and for vibration and noise analysis of motors, generators, and electron tubes.

Probescope Co., Inc., Dept. ED, 8 Sagamore Hill Dr., Manorhaven, N.Y.

CIRCLE 110 ON READER-SERVICE CARD

Voltage-Current Calibrator

0.3% accuracy

Designed to serve as either a comparator type calibrator or a secondary voltage standard, model 1080 voltage-current calibrator has better than 0.3% accuracy. As a voltage reference, it delivers calibrated positive or negative voltages continuously variable through four ranges between 1 mv and 100 v. The standard voltage is available either as a direct voltage or as a 5 msec level repeated at rates of 5 to 50 times per sec. In comparator type operation, the unit calibrates positive or negative voltages from 1 mv to 1000 v or currents from 1 ma to 10 amp, continuously variable through five and four ranges, respectively.

Rese Engineering, Inc., Dept. ED, 731 Arch St., Philadelphia 6, Pa.

CIRCLE 111 ON READER-SERVICE CARD

Antenna Multicoupler

45 db minimum isolation

This antenna multicoupler will pass the frequency range between 200 and 400 mc from a single wideband antenna to four separate-channel receivers. By cascading multicouplers, the same antenna will feed additional receivers. Used as a wideband amplifier, the unit will feed the signals of one generator to four independent rf amplifiers or receivers. Isolation between outputs is 45 db minimum; gain is 10 db for each channel; and uniformity of response is ± 2 db. The unit has an integral power supply and is packaged for standard rack mounting.

Resdel Engineering Corp., Dept. ED, 330 S. Fair Oaks Ave., Pasadena, Calif.

CIRCLE 112 ON READER-SERVICE CARD

Digital Shaft Position Encoder

Has magnetic readout

With passive circuitry and no mechanical or optical contact, model EPD-3 shaft position encoder provides long life and resistance to heat, cold, humidity, and dirt. Its readout is magnetic. The unit has a disc with magnetized code spots arranged in concentric tracks around the wheel. The spots are invisible and never wear out. Above the path of each track, a toroid is mounted close to the disc. As the disc turns and a magnetic spot passes beneath a toroid, the toroid is saturated and its impedance drops to zero. Readout is accomplished by interrogating the toroids with a constant current pulse. With a voltage pulse across the unsaturated toroids, and none across the saturated, a binary 1 or 0 is generated on demand. The angular position of the disc, whether it is still or turning at 10,000 rpm, is determined within 0.5 deg resolution by the output pulse code. The interrogation rate can be up to 5 million pulses per sec.

Applied Science Corporation of Princeton, Dept. ED, P.O. Box 44, Princeton, N.J.

CIRCLE 113 ON READER-SERVICE CARD

Miniature Pulse Amplifier

Supplies 2 amp peak in 10 μsec pulses

Miniature twin-triode type 6955 is a 9-pin, medium-mu amplifier suited for blocking oscillators, square wave modulators, and multivibrators. It can supply 2 amp of peak current in 10 μsec pulses and warms up to 80% of steady state plate current within 10 sec. It has high resistance to the formation of cathode interface resistance and operates from −62 to +100 C. It is also vibration resistant. The unit has twin 175 ma heaters that can be connected in series or parallel for operation at 6.3 or 12.6 v.

CBS-Hytron, Dept. ED, Danvers, Mass.

CIRCLE 116 ON READER-SERVICE CARD

Precision Potentiometers

Linear and nonlinear

Single turn precision units, type 757 potentiometers are 1-3/4 in. in diameter and come in four basic design variations. Type 757C potentiometers, for linear or nonlinear applications, use a card winding. They operate from −55 to +85 C and have a resistance range from 1 to 300 K. Standard linearity is ±0.5%, but values to ±0.25% are obtainable. Resolution varies between 0.035 and 0.15% depending on resistance.

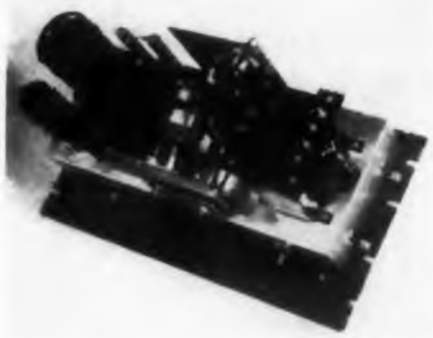
Type 757M units use a mandrel winding for linear applications, and can be ganged with up to eight cups on a single shaft. The external clamp band does not increase the diameter of the units. Temperature range is −55 to +85 C for standard units and up to +150 C for high temperature versions. Resistance range is 1 to 250 K; resolution is 0.025 to 0.12% according to resistance; and linearity is ±0.25% in standard models, ±0.15% in special models.

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

CIRCLE 117 ON READER-SERVICE CARD

Silicon Power Rectifiers

1% ripple



Operating without electronic tubes, series GX silicon power rectifiers have an output voltage of 30 v dc and output currents of 0 to 10, 0 to 15, and 0 to 20 amp. They consist of a double wound varnish impregnated step-down transformer, a full wave silicon rectifier, a varnish impregnated reactor, and a filtering network. Models 15GX and 20GX have a protection circuit with a front panel warning light which flashes when continuous ratings are exceeded. All models have several transformer taps so that the voltage output may be adjusted to 30 v dc for various values of line and load. The units operate from 110 to 125 v ac and have under 1% ripple. Their overload capacity is 400% for 1/2 minute; 200% for 2 minutes. Model 10GX is 19 x 8-3/4 x 10 in.; models 15GX and 20GX are 19 x 10-1/2 x 11 in. All are for rack mounting.

Gates Electronic Co., Dept. ED, 2090 Barnes Ave., Bronx 62, N.Y.

CIRCLE 118 ON READER-SERVICE CARD

Voltage-Controlled Oscillators

For airborne telemetry

Available in standard and miniature sizes, these voltage-controlled oscillators are designed for airborne telemetry. The standard unit has ±1% temperature stability from 20 to 100 C and withstands 100 g shock and 20 g vibration at 2000 cps. B supply variations of 10% produce less than 1% bandwidth frequency shift. The unit will drive most transmitters without a mixer amplifier. The miniaturized unit uses a single 18 v dc supply and has ±3% temperature stability from 20 to 100 C. It withstands the same shock and vibration as the standard unit. Bandwidth frequency shift is under 2% for 10% B supply variation, and distortion is less than 1%. Both standard and miniature units are also available with germanium transistors and temperature ranges to 70 C.

Data-Control Systems, Inc., Dept. ED, Danbury, Conn.

CIRCLE 119 ON READER-SERVICE CARD

Tantalum Capacitors

Shock and vibration resistant

Improved type PP miniature tantalum capacitors have an anode base support for resistance to shock and vibration. Suited for airborne equipment, they operate at high altitudes and remain electrically stable from —55 to +85 C.

Fansteel Metallurgical Corp., Dept. ED, North Chicago, Ill.

CIRCLE 122 ON READER-SERVICE CARD

Volt-Ohmmeter

For TV and industrial testing

Supplied in kit form or factory-wired, the WV-77E VoltOhmyst can be used for television and industrial test applications. It measures ac rms sine wave voltages from 0.1 to 1500 v; dc voltages from 0.02 to 1500 v; peak to peak ac voltages from 0.2 to 4000 v; and resistance values from 0.2 ohm to 1000 meg. The ac voltmeter portion features an electron tube as the full wave signal rectifier. The unit has provision for zero center indication; separate scales for low ac voltage measurements; and protection against meter burnout. The resistors in the ohms divider network are protected by a separate fuse. Input impedance is high on all dc and ac voltage ranges.

Radio Corporation of America, Electron Tube Div., Dept. ED, Harrison, N.J.

CIRCLE 470 ON READER-SERVICE CARD

Electronic Tachometers

Accurary of 1%

With transistorized circuitry and no moving parts except for a meter movement, series ET tachometers maintain 1% accuracy through variations from —30 to +160 F, 95 to 135 v ac, and 55 to 65 cps. They have a built in frequency test reference for calibration, and can be used to measure rotary or linear speeds of such devices as conveyors, motors, pumps, machine tools, and jet and reciprocating engines. Models are available with a variety of ranges from 0.1 to over 1 million rpm full scale. The units have deep-drawn aluminum cases and a can front that is extended and profiled to protect the panel meter and control knob.

Southwestern Industrial Electronics Co., Dept ED, 2831 Post Oak Rd., Houston 19, Tex.

CIRCLE 123 ON READER-SERVICE CARD

Capacitors

Highly stable

For laboratory standards, compensating networks, rf filters, and general coupling use, these high stability polystyrene dielectric capacitors offer 0.03 to 0.01% retrace. Temperature coefficient is —100 ppm per degree C, ± 20 ppm; insulation resistance is 1 million meg per μf at 25 C; dielectric absorption is 0.01 to 0.02%; and operating temperature range is 0 to +70 C. Dissipation factor at 1000 cps is 0.05%. Various capacitance and voltage ratings are available with tolerances of ± 5, ± 2, ± 1, and ± 0.5%.

Electronic Fabricators, Inc., Dept. ED. 682 Broadway, New York 12, N.Y.

CIRCLE 124 ON READER-SERVICE CARD

Linear Potentiometer

Mounts inside hydraulic actuators

This linear potentiometer mounts to the piston inside a hydraulic cylinder. Built to withstand virtually all specified MIL and JAN environments, it operates effectively at high altitudes, under high humidity conditions, and at constant temperatures to 400 F. Linearities are 0.1% or more, depending on the stroke, and resistances start at 1 K with either center or functional taps on standard models. The potentiometer elements, made from precious metal alloys, are produced with OD's down to 0.5 in., and strokes from 0.1 to 8 in.

Edcliff Instruments Inc., Dept. ED, 1711 S. Mountain Ave., Monrovia, Calif.

CIRCLE 125 ON READER-SERVICE CARD

NEW PRODUCTS

Instrument Load

Suitable as a secondary standard

A stable instrument load, type 1108B provides a nearly reflectionless termination on a 50 ohm coaxial transmission line. For the 0 to 1100 mc frequency range, the unit is suitable for use as a secondary standard. It has a rated vswr below 1.02 and a maximum input power of 0.5 w. It is designed for use with type N connectors.

Alford Mfg. Co., Dept. ED, 299 Atlantic Ave., Boston 10, Mass.

CIRCLE 128 ON READER-SERVICE CARD

Printed Circuit Sockets

Precision molded

Available in eight types, these precision molded printed circuit sockets come with 7 to 9 pins. All have center shields.

Waldom Electronics, Inc., Dept. ED, 4625 W. 53rd St., Chicago 32, Ill.

CIRCLE 129 ON READER-SERVICE CARD

VHF Silicon Power Transistors

Triple-diffused npn junction type

These six silicon power transistors are triple-diffused npn junction units with mesa configuration. Three are 70 mc oscillator transistors and three are 70 mc amplifier transistors. In each group, power capabilities at 70 mc are 1/4, 1/2, or 3/4 w. Collector power dissipation rating at 50 C case temperature is 2-1/4 w. All units operate at collector voltages up to 100 v dc. The three amplifier transistors have a typical gain of 10 db at 70 mc.

Pacific Semiconductors, Inc., Dept. ED, 10451 W. Jefferson Blvd., Culver City, Calif.

CIRCLE 130 ON READER-SERVICE CARD

Servo Analyzer

Covers 0.1 to 2 and 1 to 20 cps

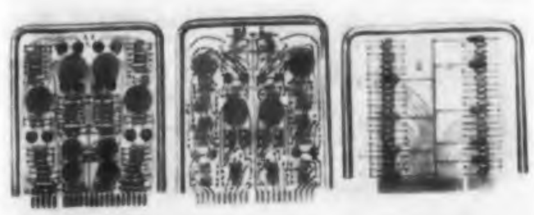
Measuring phase, transient response, and gain, model H servo system analyzer facilitates the plotting of Nyquist, Bode, or Nichols diagrams. Covering the 0.1 to 2 and 1 to 20 cps ranges, it provides direct reading of amplitude, frequency, and phase lag. Phase measurements are accurate within ±1 deg, and frequency accuracy is ±5% of setting. The unit generates sine wave and modulated carrier waveforms. For standard 19 in. rack or bench use, it measures 19 x 8.75 x 12 in.

Servo Corporation of America, Dept. ED, 20-20 Jericho Turnpike, New Hyde Park, N.Y.

CIRCLE 131 ON READER-SERVICE CARD

Digital Components

Plug-in



This set of transistorized digital computer circuit packages includes flip-flops, diode logic boards, read amplifiers, write amplifiers, and blocking oscillators. Each component contains two identical circuits except the logic board. This contains 2-1, 2-2, 2-3, 1-4, and 2-5 function AND gates, and nine OR gates. Dc pulse gating techniques permit operation of 75 pulse gates from each output of the flip-flop and read amplifier at frequencies up to 500 kc. The boards are supplied individually or with mounting racks, power supplies, magnetic drums, and other circuitry to serve as memory units, shift registers, buffer registers, counters, and logical control units.

Aeronutronic Systems, Inc., Computer Div., Dept. ED, P.O. Box 486, Newport Beach, Calif.

CIRCLE 132 ON READER-SERVICE CARD

NEW PRODUCTS

Coupling Type Clutch

Size 2.5

The SM clutch is a size 2.5, stationary field, coupling type furnished with a mounting flange 2-1/8 in. square. It is 1-9/16 in. long with armature and driven hub, 1 in. long without. The unit has a static torque rating of 30-in. lb and can be offered with a coil suitable for operation on any dc source with voltages up to 90 v dc.

Stearns Electric Corp., Dept. ED, 120 N. Broadway, Milwaukee 2, Wis.

CIRCLE 135 ON READER-SERVICE CARD

Delay Lines

Continuously variable

Model IR continuously variable delay lines are available with delay ranges from 0.18 to 0.22 μsec, 0.23 to 0.27 μsec, 0.28 to 0.32 μsec, 0.33 to 0.37 μsec, 0.48 to 0.52 μsec, and 0.58 to 0.62 μsec. Characteristic impedance is 250 ohms, with higher impedances available. Rise time is 0.06 μsec and maximum attenuation is 1 db. In the lower delay ranges, case size is 1 x 1.25 x 7.75 in.; in the upper ranges, it is 1 x 1.25 x 10 in. Sturdily built, the lines are hermetically sealed and feature infinite resolution.

Digitronics Corp., Dept. ED, Albertson Ave., Albertson, N.Y.

CIRCLE 136 ON READER-SERVICE CARD

Servo Multiplier

0.25% static error

Miniaturized servo multiplier type SL-1024 consists of a servo loop that positions a shaft to follow a ±dc signal and a multisection potentiometer for computation. It uses a transistor-magnetic amplifier with all circuits sealed and operates directly from a 117 v, 400 cps line. Typical input signals are within ±100 v dc, with static error under 0.25% and full scale travel within 0.5 sec. The output position is indicated on a calibrated dial. Four of the units fit into a 19 in. rack panel type 764-A. The computing potentiometer sections are customer specified. Other data elements, such as autosyns or resolvers can be coupled to the potentiometer.

Industrial Control Co., Dept. ED, 805 Albin Ave., Lindenhurst, N.Y.

CIRCLE 137 ON READER-SERVICE CARD

Transistorized Digital Totalizer

Accuracy of ±1 indicated count

Designed to perform independently or with the company's turbine-type flowmeters, model 521 digital totalizer is a fully transistorized modular plug-in subassembly. Its print wired circuitry is stabilized for operation up to 160 F. The counter will totalize any events, such as flow or revolutions, which can be converted to electrical impulses. Switch selected digital circuitry can extend its range by 10 or 100 times. Frequency range is 0 to 4000 cps for pulse input and 10 to 4000 cps for sinusoidal signal; sensitivity is 10 mv, rms 10 to 400 cps, 20 mv at 1 kc, and 50 mv at 4 kc. Count capacity is 999,999 and accuracy is ±1 indicated count, including the effects of line voltage from 105 to 130 v and of temperature to 160 F. Standard styles include portable, half-rack, explosion proof, and industrial panel mounted versions.

Potter Aeronautical Corp., Dept. ED, Route 22, Union, N.J.

CIRCLE 138 ON READER-SERVICE CARD

NEW PRODUCTS

Secondary Voltage Standards

Absloute accuracy of ±20 ppm for 8 hr

These two secondary standard reference power supplies have an absolute accuracy of ±20 ppm for 8 hr, and ±50 ppm for long terms over their entire load and line voltage ranges of 0 to 100 ma and 105 to 125 v. Model PVS-105A has a dual output of ±50 v, or 100 v if used end to end. Model PVS-105B provides ±36 v, or 72 v end to end. In dual channel application, the voltages track each other to within 20 ppm. Total adjustment range is ±120 mv around the nominal voltage rating, and thermal stability is better than 2 ppm per deg C in the region of 25 C. The units incorporate a cycled zener reference diode and a stable transistorized preamplifier, both mounted in an isothermal oven. Meters and controls are provided to permit calibrating the output against an internal reference cell, to ±20 ppm.

Julie Research Labs, Inc., Dept. ED, 556 W. 168th St., New York 32, N.Y.

CIRCLE 141 ON READER-SERVICE CARD

Crystal Can Relays

Sensitivities of 25 and 40 mw

Type RS800 spdt and R800 dpdt crystal can relays provide sensitivities of 25 and 40 mw, respectively, without the use of permanent magnets or polarized exciting power. The units measure 1.281 x 0.915 x 0.462 in. and withstand 20 g vibration to 2000 cps and 100 g shock. They have a minimum life of 100,000 operations at 125 C while carrying contact loads of 2 amp at 115 v rms and 28 v dc. Header terminals are arranged on a 0.2 in. modular basis for plug-in circuit applications. Solder hook terminals are also available.

Iron Fireman Mfg. Co., Electronics Div., Dept. ED, 2838 S.E. Ninth Ave., Portland 2, Ore.

CIRCLE 142 ON READER-SERVICE CARD

Multiconductor Cable Tester

Checks 150 circuits per minute

Fully automatic, model 50-A is a go no-go cable test set that checks continuity, insulation resistance, and high potential of cables or junction boxes with up to 109 conductors. Each circuit under continuity test is isolated from all others; and each terminal in the leakage resistance and high potential test series is checked against all other terminals simultaneously tied to ground. Any no-go decision halts the testing, and the exact fault is located by the indicators. Parts of a test or one or more of the three functions can be by-passed. For continuity, test rate is 150 circuits per minute; for insulation resistance, 150 terminals per minute. High potential test duration is selectable from 2 to 120 sec per terminal.

Optimized Devices, Inc., Dept. ED, P.O. Box 38, Gedney Sta., White Plains, N.Y.

CIRCLE 143 ON READER-SERVICE CARD

Resistance-Capacity-Ratio Bridge

Portable

Resistance-capacity-ratio bridge model RC-1 is a portable tester with four resistance ranges from 0.5 ohms to 200 meg, four capacity ranges from 10 μμf to 2000 μf, and ratio test ranges from 0.05 to 20. The unit incorporates a 3 v amplifier for checking electrolytics used in miniaturized equipment such as transistor radios. It provides a 0 to 60% power factor test on capacitors from 0.1 to 2000 μf and a sensitive leakage test for all types of capacitors at rated voltages between 0 and 500 v dc. It also provides a quick reactance ratio between any two capacitors, inductors, or resistors within the ratio test range, and can be used to determine the turns ratio of transformer windings. Power requirements are 117 v ac, 60 cps, 25 w; dimensions, 7 x 11-1/2 x 5 in.

Pyramid Electric Co., Dept. ED, 1445 Hudson Blvd., North Bergen, N.J.

CIRCLE 144 ON READER-SERVICE CARD

Environment Cabinets

Temperature-humidity

"Weatherlab" temperature-humidity environmental cabinets can sustain temperatures from −120 to +350 F and humidities from 20 to 98%. Models range in size from 5 cu ft to large walk-in types. They are equipped with high pressure, large volume air blowers to assure uniform temperature throughout the chamber. Humidity is supplied and controlled through a water float, feed valve, and electrically heated steaming chamber or a separate, electrically heated steam generator that is mounted externally. All electrical or electronic controls are interlocked, and recorder-controller programmers are available for cycling operations according to military specifications. Of double wall construction, the units have Monel metal interiors for corrosion resistance and Fibreglas insulation a minimum of 6 in. thick. Thermopane windows in doors and penetrations in the walls can be supplied as required.

Hudson Bay Co., Dept. ED, 3070-82 W. Grand Ave., Chicago 22, Ill.

CIRCLE 147 ON READER-SERVICE CARD

Directional Couplers

Have high directivity

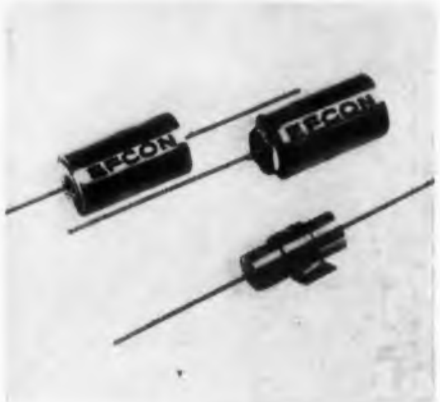
Designed for reflectometer measurements in waveguide systems, these dual directional couplers have flat coupling response, ±0.4, and high directivity, 40 db minimum. Coupling structures are placed on opposite broad walls of the primary line, and the output arm of each secondary line is an H-plane bend, brought out on a common side. Detector mounts can be readily attached to these arms for power monitoring or for measurement of reflection coefficients within systems. All models except the M band are constructed from precision waveguides; milled blocks of tellurium copper are used in the unit covering 50 to 75 kmc. Coupling holes are placed on thin metallic foils which form the common broad walls between the primary and secondary lines. Input and output arms of all models are terminated with standard cover flanges. Coupling value of all units is 20 db; primary line vswr is 1.1 maximum for the M band unit, 1.05 for all others; secondary line vswr is 1.15 maximum.

Narda Microwave Corp., Dept. ED, 118-160 Herricks Rd., Mineola, N.Y.

CIRCLE 148 ON READER-SERVICE CARD

Polystyrene Capacitors

Tolerances of ±5 and ±2%



Reduced in length, these hermetically sealed polystyrene capacitors meet all existing military specifications in the 0.001 to 100 μf capacitance range for voltage ratings to 1200 wvdc. They operate from −65 to +85 C without derating. Standard tolerances are ±5 and ±2%, but tolerances closer than ±1% may be specified.

Electronic Fabricators, Inc., Dept. ED, 682 Broadway, New York 12, N.Y.

CIRCLE 150 ON READER-SERVICE CARD

Current Pulse Generator

Produces mμsec pulses

Current pulse generator model 1051 produces jitter-free positive or negative pulses with durations of approximately 10, 20, 50, and 100 mμsec. Pulse amplitudes are continuously variable from 0 to over 2 amp, and pulse repetition frequency is continuously variable from 100 pps to 10,000 pps. Rise time for 10 mμsec pulse widths is approximately 5 mμsec. The unit can be used for thin magnetic film studies, diode and transistor switching and recovery studies, and basic magnetics switching research. In addition to periodic operation from internal clock timing, the 1051 may be triggered from an external source or manually operated from a front panel push button. Supplied in a cabinet 16-1/2 x 8-1/4 x 8 in., it consumes 75 w from a 115 v, 50 to 60 cps line.

Rese Engineering, Inc., Dept. ED, 731 Arch St, Philadelphia 6, Pa.

CIRCLE 151 ON READER-SERVICE CARD

NEW PRODUCTS

High Voltage Power Supplies

0.1% line or load regulation

High voltage, high current Magnitran power supplies combine the properties of a magnetic regulator with the fast transient characteristics of a transistor regulator. Two models are available: the TR160-1M which provides an adjustable output of 10 to 160 v dc at 0 to 1 amp, and the TR300-1M with an adjustable output of 150 to 300 v dc at 0 to 1 amp. The units operate from an input of 100 to 130 v ac, 60 cps with line or load regulation of 0.1% and ripple of 0.01% or 50 mv, maximum. Completely protected against short circuits, they feature instant warmup and minimum heat dissipation on all transistors, independent of line voltage variations. They incorporate differential dc amplifiers, compensated Zener references, and silicon rectifiers. Intended for bench or relay rack mounting, they occupy a minimum of space.

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

CIRCLE 154 ON READER-SERVICE CARD

Lumped Constant Delay Lines

Custom built

Custom built to meet military specifications, these lumped constant delay lines have delay time tolerances to 0.1%. The illustrated unit has a delay time of 40 ±0.04 μsec at 25 C. Temperature coefficient of delay is 20 ppm per deg C; attenuation is 4 db; and rise time is 0.4 μsec. The unit occupies 50 cu in.

PCA Electronics, Inc., Dept. ED, 16799 Schoenborn St., Sepulveda, Calif.

CIRCLE 155 ON READER-SERVICE CARD

Printed Circuit Reliability through Custom Production

Have you ever had to discard freshly delivered printed circuits that didn't meet your specifications? Whether the holes you need are plated or eyeletted, whether the base material is fiber or plastic, *demand precision first!*

The Bureau is striving for perfection in each circuit *before* it reaches your plant. We have developed production flexibility to custom-tailor our manufacture to your circuit. That is why our engineers and personnel are successfully building boards in the varified atmosphere of missile-tolerances at a rate that exceeds normal probability. Consider the Industrial Division of the Bureau of Engraving, Inc. for your important circuits . . . why settle for less?

We have a limited surplus of our U.S. Air Force approved QUALITY CONTROL MANUAL FOR PRINTED CIRCUIT BOARDS AND BOARD ASSEMBLIES. Copies will be sent to qualified persons on request . . . write today on your company letterhead.

Member of the Institute of Printed Circuits

BUREAU OF ENGRAVING, Inc.

Industrial Division

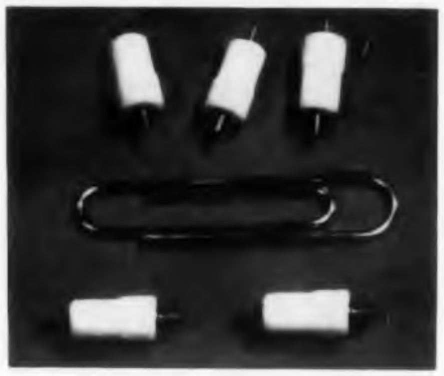
500 S. 4th St., Minneapolis 15, Minn.

Telephone FEderal 9-8721

CIRCLE 157 ON READER-SERVICE CARD

Teflon Terminal

Has two standoffs



The DST-900 double-standoff Teflon terminal provides separate connection points on both sides of a chassis. It consists of two straight shank lugs mounted in a single body, but electrically and physically separated.

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

CIRCLE 158 ON READER-SERVICE CARD

Digital Voltmeter

Accuracy of 0.01% ±1 digit

In four automatic ranges from 0.0001 to 1000 v dc, model 501 digital voltmeter maintains 0.01% ±1 digit accuracy. In range cross-over areas, it keeps this accuracy by adding a first-place 1 at the top of the range. Thus, the 0 to 9.999 range becomes 0 to 19.999, with millivolt accuracy retained well into the 0 to 99.99 v range. The unit has five windows for digit display and a sixth to show polarity. Range selection automatically places the decimal. The built-in printer drive can handle 10-line parallel input printers without accessories, and a print control allows either automatic drive when the unit comes to balance or remote operation by an external switch. Average balance time is 1 sec with transistor switches feeding voltages at about 20 steps per sec. Input impedance at null is 10 meg on all ranges. A switch selects 0.1, 1, or 10 mv sensitivities to facilitate the reading of noisy signals.

Kin Tel, Div., of Cohu Electronics, Inc., Dept. ED, 5725 Kearny Villa Rd., San Diego 12, Calif.

CIRCLE 159 ON READER-SERVICE CARD

*as encountered in air-ground systems per MIL E 7894A

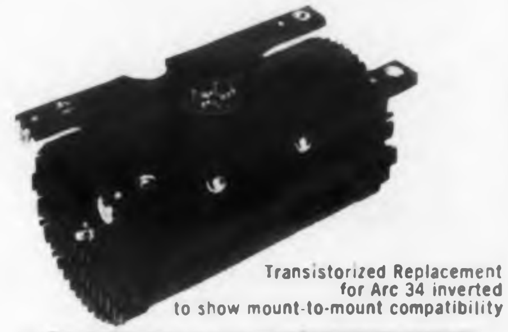
The pioneer in transistorized circuitry for power supply applications now puts you a tremendous step ahead in the design of truly reliable missile and aircraft systems. Universal's intensive research toward total protection against the hazards encountered in these systems results in a notable achievement!

Advanced circuitry now provides built-in protection against spikes and transients which disturb the system voltage. Coupled with the well-known reliability of the Universal static supplies now powering much of today's operational mobile electronic equipment, these units set a new standard for the field. They retain Universal's superior protection against input polarity reversal and against short circuits while providing you with unmatched overvoltage control, as well. Clearly, Universal has the experience to supply the reliable power needed for your most critical applications.

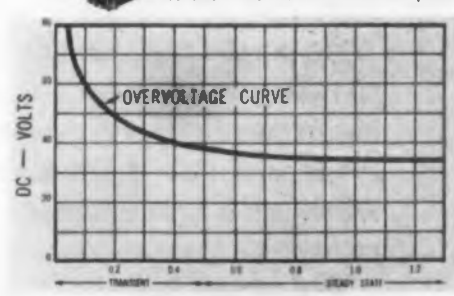
For many other types of power supplies, too, Universal provides the most complete source for designers who want the highest in performance and the most modern in design. Special circuitry, conservatively rated, results in their specifications being met—and surpassed! You can look with confidence, to Universal for:

- **DC to DC**
- **AC to DC**
- **DC to AC**
- **High Voltage**
- **Low Voltage**
- **High Power**
- **Low Power**

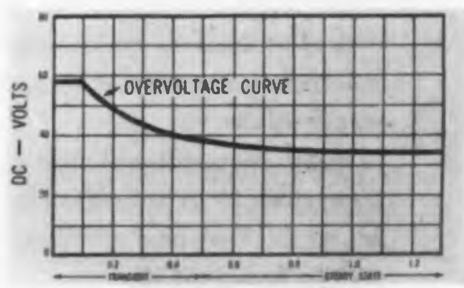
Or custom units to meet wide temperature range and rugged shock specifications.



Transistorized Replacement for Arc 34 inverted to show mount-to-mount compatibility



NORMAL OVERVOLTAGE CURVE —28v DC System



OVERVOLTAGE with UNIVERSAL POWER SUPPLY in same system

Universal Atomics A DIVISION OF **UNIVERSAL TRANSISTOR PRODUCTS CORP**

Dept. ED-1 • 17 Brooklyn Ave., Westbury, L. I., N. Y. • EDgewood 3-3304 • Cable: Univatoms

IN CANADA—Conway Electronic Enterprises Regd., 1514 Eglington Ave., Toronto 10, Ont., Canada

CIRCLE 160 ON READER-SERVICE CARD

NEW PRODUCTS

Audio Response Plotter

Covers 20 cps to 20 kc range

With permanent, pen-written frequency response curves, audio response plotter ARP-2 gives immediate visual proof of the smoothness of performance and sound production of any audio system or component. The unit has a 20 cps to 20 kc audio oscillator which supplies an input to the system to be tested. As the oscillator sweeps its range, driven either manually or by a self-contained motor, output signals from the system or component under test are either fed directly to the plotter or detected by an accessory condenser microphone. Records are plotted automatically on a 40 db range logarithmic chart by a servo-controlled pen. An input attenuator network enables the instrument to accept voltages up to 10 v. The oscillator is directly connected to the recording drum to permit retracing or multiple recording of any portion of a curve. A single sweep of the drum covers 20 cps to 20 kc.

Southwestern Industrial Electronics Co., Dept. ED, 2831 S. Post Oak Rd., Houston, Tex.

CIRCLE 162 ON READER-SERVICE CARD

Electronic Chopper

Modulates 0.1 mv to 1 v signal amplitudes

Using matched transistors as switches, model M-1 electronic chopper modulates differential or ground referenced voltages into square waves at carrier frequencies from 60 to 2000 cps. It will modulate signal amplitudes from 0.1 mv to 1 v. When operating from low signal source impedances, it achieves a null accuracy of 0.1 mv. The switching action is always in-phase and synchronous with the 6 ma excitation current. Epoxy encapsulated, the unit has no moving parts and is insensitive to vibration. The 0.5 cu in. package is suited for chassis or printed circuit mounting.

Servo Devices Co., Dept. ED, Box 244, Huntington Station, N.Y.

CIRCLE 163 ON READER-SERVICE CARD

Centrifugal Blowers

For high altitudes

Light and compact, these custom centrifugal blowers automatically vary their speeds inversely with density, thereby approaching constant cooling with a minimum of power drain and noise. The illustrated unit increases in speed three times from sea level to 50,000 ft. The blowers are available with a variety of operational frequencies, cfm outputs, blower housings, and mounting bases. Constant speed and other modified types may be provided.

Ashland Electric Products, Inc., Dept. ED, 32-02 Queens Blvd., Long Island City 1, N.Y.

CIRCLE 166 ON READER-SERVICE CARD

Aluminum Electrolytic Capacitors

Have long shelf life

Aluminum electrolytic capacitors in the PET series have a low-resistance electrolyte which affords a long shelf life at temperatures to 85 C. They have a temperature range of —30 to +85 C, and a capacitance stability of —15 to +10% within this range. Leakage current, power factor, and impedance are low. The units are encased in plastic with an epoxy end seal and vary in size from 3/8 x 5/8 in. to 5/8 x 1-7/8 in. At 25 C they have a capacitance tolerance of —10 to +250%. Their ratings cover voltages from 3 to 50 wvdc and capacities of 1500 to 1 μf total per unit. Maximum capacity in the 5/8 x 1 in. size ranges from 550 μf at 3 v to 86 μf at 50 v.

P. R. Mallory & Co., Inc., Dept. ED, Indianapolis 6, Ind.

CIRCLE 167 ON READER-SERVICE CARD

NEW PRODUCTS

Static Inverters

±0.02% frequency regulation

For use in driving rate gyros, inertial guidance equipment, and other missile and aircraft devices, these transistorized static inverters are available with single phase or three phase outputs. Operating from an input of 28 v dc, they provide 115 v, 400 and 2000 cps single phase and 115 v, 400 cps, three phase. Voltage regulation is ±1%; frequency regulation, ±0.02%; and distortion, 5 to 10%. The units weigh 5 to 15 lb, depending upon power requirements, and are designed to meet MIL-E-5272A specifications.

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

CIRCLE 170 ON READER-SERVICE CARD

Toroidal Inductors

Temperature stabilized

Type S toroidal inductors are small, temperature stabilized units with a range of —55 to +71 C. Inductance change can be as low as ±0.25% in this range. Fully encapsulated and built with a stabilized and meet the specifications of MIL-E-5272A and MIL-T-27A. Units are available with inductance values from 0.1 mh to 17 h and useful core, they withstand extreme shock frequency ranges from 60 cps to 500 kc. They are designed for printed circuit boards, or stacking on a single screw for chassis mounting.

Arnold Magnetics Corp., Dept. ED, 4613 W. Jefferson Blvd., Los Angeles 16, Calif.

CIRCLE 172 ON READER-SERVICE CARD

RF Head

Direct reading

For use with the company's model SA30 microwave spectrum analyzer, the 30X5 rf head covers the 8500 to 9700 mc range. Accurate to 0.05%, it has a direct reading frequency dial. The unit features automatically tracked reflector voltage for constant display centering and a precision 80 db rf input attenuator.

Itek Corp., Dept. ED, 1583 Trapelo Rd., Waltham 54, Mass.

CIRCLE 173 ON READER-SERVICE CARD

Mesa Germanium Transistors

Have millimicrosecond switching speeds

A diffused base mesa germanium transistor, the 2N559 meets and exceeds all reliability specifications outlined in MIL-T-19500A. It has switching speeds into the millimicrosecond range and a typical alpha cutoff frequency of 250 mc. It dissipates over 150 mw in free air and operates at temperatures to 100 C. The unit is provided in a miniature round-welded case that is less than half the size of the standard JETEC TO-5 unit. The case is compatible with the 100 mil grid mounting system. The 2N559 was originally developed and produced by Bell Telephone Labs for military missile and airborne electronic circuits.

Texas Instruments Incorporated, Semiconductor-Components Div., Dept. ED, P.O. Box 312, Dallas 9, Tex.

CIRCLE 174 ON READER-SERVICE CARD

NEW PRODUCTS

Mercury-Wetted Contact Relay

Has 5 mw sensitivity

Type HBS mercury-wetted contact relay is biased with permanent magnets which are adjustable for single-side stable or bistable operation. Sensitivity may be ±2.5 mw for a bistable adjustment or 5 mw for a single-side stable adjustment. Operating speeds are up to 200 cps, and contact rating is 2 amp, 500 v, with a limit of 100 va. The units have no contact bounce and provide billions of trouble-free operations.

C. P. Clare & Co., Dept. ED, 3101 Pratt Blvd., Chicago 45, Ill.

CIRCLE 178 ON READER-SERVICE CARD

Transistor-Diode Tester

Needs no external power supply

For testing the dc characteristics of semiconductors, model TDT-200 transistor-diode tester contains no batteries and needs no auxiliary motor, pulse generator, oscilloscope, or external power supply. With a wide selection of voltage, current, and metering ranges, the unit checks current gain, voltage, and reverse and forward current.

Transistor Electronics Corp., Dept. ED, 3357 Republic Ave., Minneapolis 26, Minn.

CIRCLE 179 ON READER-SERVICE CARD

Trimmer Potentiometer

Operates up to 150 C

Trimmer potentiometer model H-0505-T operates at temperatures up to 150 C; and in ambients of 125 C, it can carry 4 ma of current through its brush contact on the winding. Available in resistances up to 100 K, it is designed to withstand 30 g vibration from 50 to 2000 cps and 150 g shocks for 11 msec. It also passes the humidity requirements of MIL-STD 202, Method 106. The unit is 1/2 in. in diameter and has silver plated gold-flashed terminals which afford maximum corrosion resistance and installation and connection simplicity.

Tucson Instrument Corp., Dept. ED, 1050 E. Valencia Rd., Tucson 2, Ariz.

CIRCLE 181 ON READER-SERVICE CARD

Digitizer

For punched tape or telemetering

Designed for use with any of the company's Autronic transmitters or converters, model A9M indicating digitizer translates analog signals into a digital code for punched tape or telemetering. Operating on a 0 to 0.5 v ac signal, it can also be used in parallel with the company's controllers or recorders. The unit is housed in a standard case which fits into a panel cutout five inches square.

Swartwout Co., Dept. ED, 18511 Euclid Ave., Cleveland 12, Ohio.

CIRCLE 182 ON READER-SERVICE CARD

NEW PRODUCTS

DC Microvoltmeter

100 meg input impedance on all ranges

Transistorized model 1362 dc microvoltmeter has over 100 meg input impedance on all ranges from ±0.001 to ±1000 v. It will operate for 12 consecutive hours from an integral storage battery which automatically recharges when the instrument is plugged into a power line. Intended for low level measurements in transistor circuits, the unit is chopper-stabilized to avoid drift problems. It provides total isolation from power lines.

Dynamics Instrumentation Co., Dept. ED, 1118 Mission St., South Pasadena, Calif.

CIRCLE 186 ON READER-SERVICE CARD

Flow Control Servo Valve

For missiles and aircraft

Series FC-30 flow control servo valves weigh 14.5 oz and measure 1.75 x 2 x 2.8 in. They cover the entire flow range from 0.15 to 13 gal per min and have a supply pressure range of 500 to 4000 psi. Internal leakage for a 4 gal per min valve at neutral position, using MIL-O-5606 hydraulic fluid at 90 F and 3000 psi supply pressure, is 0.09 gal per min maximum.

Cadillac Gage Co., West Coast Div., Dept. ED, Costa Mesa, Calif.

CIRCLE 187 ON READER-SERVICE CARD

Silicon Rectifiers

Diffused junction type

With piv ratings ranging from 50 to 600 v, type 1N1612 through 1N1616 diffused junction silicon rectifiers can deliver 5 amp of rectified current. They have an operating temperature range from —65 to +175 C, a low forward drop, and a low reverse leakage current. Furnished in packages that conform to proposed JETEC Group 20 standards, they can be used in magnetic amplifier and dc blocking circuits as well as for power rectification.

Bendix Aviation Corp., Semiconductor Products, Red Bank Div., Dept. ED, 201 Westwood Ave., Long Branch, N.J.

CIRCLE 189 ON READER-SERVICE CARD

Tube Tester

Rejects burned out tubes instantly

On model 3414 tube tester, all switch settings can be made before the tube warms up, and burned out tubes are rejected instantly without waiting for the filaments to heat. It will test receiving tubes, gaseous rectifiers, series filament tubes, ballast tubes, and others. The continuity test circuit may be used to check electrical appliances for shorts or open circuits. The unit also provides a neon indicator short test.

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

CIRCLE 190 ON READER-SERVICE CARD

Strain Gage Recording System

Expandable

This expandable strain gage recording system has a wide choice of configurations for operating adding machines, printers, or Flexowriter typewriter and tape punch units. Standard rack mounted units can be assembled into a ten channel system which selects, measures, and records each channel in sequence and automatically records the strain gage data in microinches per inch units. Additional modules in groups of ten channels, each with its own span and gage factor controls and a bank omit switch, may expand the system to accommodate 100 or more channels without rewiring or modification of the basic ten channel system. The record produced by the printer or typewriter-tape punch unit includes a 2 digit channel number, a 1 digit span number, a plus or minus sign, and 3 digits of strain gage data followed by a tens multiplier. The unit records at rates of 1 to 4 sec per channel with overall accuracy of 0.25% excluding the transducer. Linearities for any range are 0.1%.

Datran Electronics, Dept. ED, 1836 Rosecrans Ave., Manhattan Beach, Calif.

CIRCLE 194 ON READER-SERVICE CARD

Coil Bobbin

For high temperature solenoids

For class H application, this double drawn glass silicone coil bobbin incorporates a lead wire extrusion in its flange. Designed for high temperature solenoids, the units are deep drawn from one piece. They have close tolerance ID and OD dimensions to fit precision made cases.

Stevens Products, Dept. ED, 86-88 Main St., East Orange, N.J.

CIRCLE 195 ON READER-SERVICE CARD

Strip Resistors

Match copper conductors

Fitting directly into Stripline circuits, these two dimensional strip resistors are as thin as the copper-clad conductor and exactly match the shape and configuration of the circuit. The resistors consist of a base of natural mica and a pure metal alloy resistance film about 50 μin. thick sealed with a coating of quartz. Fired silver terminations can be supplied for dc connection of the resistor to the copper center conductor of the Microstrip or Stripline circuit. Resistances are about 1 to 500 ohms depending upon shape, and standard tolerances are ±5 or ±10%. Closer tolerances can be provided. The units can be supplied as matched loads, fixed pads, variable attenuator elements, and terminations. They are available as straight rectangular or square sections, tapered rectangular sections, or curved sections. Several resistances with appropriate contact points can be supplied as one unit. Shapes not requiring silver terminations can be hand cut from sheets which are available in various thicknesses.

Filmohm Corp., Dept. ED, 48 W. 25th St., New York 10, N.Y.

CIRCLE 197 ON READER-SERVICE CARD

Plastic Ties

Made of nylon base

Made of nylon base Moldarta material, this wire tie looks and works like a miniature belt. It can be adjusted to a wide range of wire bundle diameters and held securely in place by ratchets on the leader and the buckle. Its under side has a V ridge to prevent side slip. It can be quickly tied by hand or with a special plier designed for the purpose.

Westinghouse Electric Corp., Component Products Dept., Dept. ED, East Pittsburgh, Pa.

CIRCLE 198 ON READER-SERVICE CARD

NEW PRODUCTS

VIBRATING CAPACITORS.—Less expensive than its predecessor, model VC-713/500, the VC-1006/500 capacitor is insulated with ceramic instead of fused quartz. Minimum insulation resistance is 10^{12} ohms; contact potential, 30 mv maximum; drift, ± 2 mv per day.

Stevens-Arnold, Inc., Dept. ED, 22 Elkins St., South Boston, Mass.

CIRCLE 202 ON READER-SERVICE CARD

WIRE ALLOY.—Conductor base metal for insulated wire applications. Called Alloy 63, the material is designed to replace copper in the finer gages where high temperatures must be endured. Wires are available silver-coated, nickel-coated, or uncoated.

Surprenant Mfg. Co., Dept. ED, 172 Sterling St., Clinton, Mass.

CIRCLE 203 ON READER-SERVICE CARD

110 DEGREE PICTURE TUBES.—Front-to-Back lengths of 17 in. model 17DKP4 and 21 in. model 21EQP4 are 10-11/16 and 12-9/16 in., respectively. Both aluminized, the units have nonion trap construction and use magnetic deflection.

Sylvania Electric Products Inc., Dept. ED, Seneca Falls, N.Y.

CIRCLE 204 ON READER-SERVICE CARD

FLAME-RETARDANT LAMINATE.—A Grade XXXP paper-base laminate made with phenolic resin, Fireban 321 extinguishes itself when set afire. In some instances it can substitute for melamine and silicone grades. In sheets 49 x 49 in. from 0.02 to 0.25 in. thick.

Taylor Fibre Co., Dept. ED, Norristown, Pa.

CIRCLE 205 ON READER-SERVICE CARD

ELECTRONIC MICROMETER.—Type B-721 distances between 0 and 45,000 μin. with 1% accuracy and without physical contact. It is suited for making measurements on rotating objects and for monitoring distance with reference to a predetermined value. It can be used to determine temperature coefficient, elasticity, and other characteristics of fragile samples.

Wayne Kerr Corp., Dept. ED, P.O. Box 801, Philadelphia 5, Pa.

CIRCLE 206 ON READER-SERVICE CARD

SHORT LINE TELEPRINTER.—For wire communications and data processing systems, this unit offers two color printing; automatic answering and querying; automatic start and stop; end of line lock; reperforating; and a variety of keyboards, including standard typewriter. The size of an electric typewriter, it punches or reads five channel perforated tape.

TelAutograph Corp., Dept. ED, 8700 Bellanca Ave., Los Angeles 45, Calif.

CIRCLE 207 ON READER-SERVICE CARD

FIBER GLASS PUTTY.—Good insulating material, this semifluid resin can be used as an encapsulating agent or as a cement. Hardening speed can be controlled by the amount of setting agent added. Available in bulk, it is also supplied in a kit with a setting agent, glass cloth for reinforcing, and mixing and measuring tools. Sticks to metal, plastic and wood.

Fibre-Glass Evercoat Co., Inc., Dept. ED, Blue Ash and Kugler Mill Rds., Cincinnati 36, Ohio.

CIRCLE 215 ON READER-SERVICE CARD

TAPE TRANSPORTS.—Series 460 transports maintain exact synchronization between a recorded and a fixed reference frequency over wide speed and line variations. Portable model 460A has 2 ms start-stop time and handles 1/4 to 1 in. tape. Fixed model 461 has 30 ms start-stop time and accommodates tapes up to 2 in.

D. G. C. Hare Co., Dept. ED, New Canaan, Conn.

CIRCLE 216 ON READER-SERVICE CARD

POWER RELAY.—Heavy duty 25 amp model 2210-U is a 2pst normally open unit that meets UL specifications. Coil assembly can be removed and replaced in a few minutes. Contact assemblies can also be replaced.

Guardian Electric Mfg. Co., Dept. ED, 1621 W. Walnut St., Chicago 12, Ill.

CIRCLE 217 ON READER-SERVICE CARD

MINIATURE TEST CLIPS.—Designed to allow rapid connections without manual opening and closing of jaws. Units may be used for breadboarding, and for testing resistors, transistors, capacitors, and other pigtail components. Model 2-20 has threaded stud; model 2-24 has molded phenolic insulating washers. Clips have adjustable tension, extend 3/4 in. above the mounting surface.

Grayhill, Inc., Dept. ED, 561 Hillgrove Ave., La Grange, Ill.

CIRCLE 218 ON READER-SERVICE CARD

NYLON STRAIN RELIEF BUSHING.—Model 6S-1 protects wire from heat, vibration, pull, and torque. Hinged with a flexible nylon web, it snaps and locks in the chassis hole. A spring prevents sharp bending or excessive wire flexing and chafing at the chassis entrance.

Heyman Mfg. Co., Dept. ED, 100 Michigan Ave., Kenilworth, N.J.

CIRCLE 219 ON READER-SERVICE CARD

PORTABLE TACAN TESTER.—Model HLI-119 tests performance of TACAN and DMET air navigation equipment by simulating the operation of the TACAN ground beacon. Checks range and bearing operation, coding and decoding, and operating frequency. Permits measurement of peak power-and receiver sensitivity.

Hoffman Electronics Corp., Hoffman Labs Div., Dept. ED, 3740 S. Grand Ave., Los Angeles 7, Calif.

CIRCLE 220 ON READER-SERVICE CARD

NEW PRODUCTS

CONDUCTIVE COATING.—Based on epoxy resins, Hysol 6251 can rebuild areas worn away by sliding contacts or provide a conductive base for plating plastics. It cures in 48 hr at room temperature, in 7 min at 300 F. Volume resistivity at 25 C is 0.0008 ohm-cm.

Houghton Labs, Inc., Dept. ED, Olean, N.Y.

CIRCLE 224 ON READER-SERVICE CARD

EPOXIDE RESINS.—Based on novolac-epichlorhydrin reactions, Epiphen resins are resistant to chemicals, salt spray, water, and heat distortion. They cure rapidly.

Hastings Plastics, Inc., Dept. ED, 1551 12th St., Santa Monica, Calif.

CIRCLE 225 ON READER-SERVICE CARD

THREE IN ONE NUT DRIVER.—The Atom pocket wrench consists of three nut drivers arranged as spokes and welded together at a central hub. While one size is being used, the other two provide leverage. The wrench handles no. 8, 10, and 12 nuts.

Hunter Tool, Dept. ED, P.O. Box 564, Whittier, Calif.

CIRCLE 226 ON READER-SERVICE CARD

HARD-TUBE PULSE MODULATOR.—For klystron and twt testing, model 70M has a 30 cps to 12 kc range with pulse lengths continuously variable from 0.5 to 30 μsec. As a cathode pulser, it operates from 0 to 35 kv at up to 10 amp; as a modulating anode pulser, from 0 to 35 kv into a 25 μμf load.

Levinthal Electronic Products, Inc., Dept. ED, Stanford Industrial Park, Palo Alto, Calif.

CIRCLE 227 ON READER-SERVICE CARD

SPEED CHANGER KIT.—Contains parts to make one of the company's Bantam speed changers in any one of 29 ratios between 1 to 1 and 44 to 1. Units are rated at 130 oz.-in. torque at low speed shaft; 10,000 rpm at high speed shaft; and 0.1 hp at low speed shaft. Case hardened steel gears are 48 pitch, 20 deg pressure angle spur type.

Metron Instrument Co., Dept. ED, 432 Lincoln St., Denver 3, Colo.

CIRCLE 228 ON READER-SERVICE CARD

TEMPERATURE INDICATORS.—For measuring and recording, direct reading Metta-Therms can be applied like decals or tied to cables. Numbers are distinct, and no color charts are needed.

Meta Engineering and Sales Co., Dept. ED, 252-262 E. 16th St., Paterson 4, N.J.

CIRCLE 229 ON READER-SERVICE CARD

DIRECT READING RATIO SET.—With a precision of 1 ppm, this 4 dial set provides a quick method of comparing high precision resistors against known standards.

Physics Research Labs, Inc., Dept. ED, P.O. Box 555, Hempstead, N.Y.

CIRCLE 230 ON READER-SERVICE CARD

ROTARY TEST HEAD.—For quick, accurate indexing of shaft position on rotary components, model THM 101 permits phasing to within 1/2 min. Repeatability of settings can be within 1 part in 200,000.

Millitest Corp., Dept. ED, 88 Madison Ave., Hempstead, N.Y.

CIRCLE 233 ON READER-SERVICE CARD

MINIATURE COAXIAL CONNECTOR.—This connector is 1/25 the size and 1/30 the weight of a standard BNC connector.

Microdot, Inc., Dept. ED, 220 Pasadena Ave., South Pasadena, Calif.

CIRCLE 234 ON READER-SERVICE CARD

PACKAGING FILM.—Poly-On-Mylar has a high moisture and grease barrier, does not become brittle with age. By a 10 sec process, it can be put around electronic parts like a tight fitting skin.

Print-A-Tube Co., Dept. ED, 114 Essex St., Rochelle Park, N.J.

CIRCLE 235 ON READER-SERVICE CARD

MULTIPLIER PHOTOTUBE.—Model 7326 is a 10-stage, head-on type with an improved photocathode that provides high sensitivity, low thermionic dark current, and high conductivity at low temperatures. Spectral response is 3000 to 7500 angstroms. Minimum photocathode diameter is 1.68 in.; maximum length is 6.78 in.

Radio Corporation of America, Electron Tube Div., Dept. ED, Harrison, N.J.

CIRCLE 471 ON READER-SERVICE CARD

FLOW TRANSDUCER.—Sensing fluid flows down to 0.002 gal per min, the Mark X translates them into linear electrical signals. Maximum working pressure, 3500 psi; maximum fluid temperature, 250 F.

Ramapo Instrument Co., Inc., Dept. ED, Bloomingdale, N.J.

CIRCLE 236 ON READER-SERVICE CARD

CYCLING THERMOSTATS.—Shallow models C21 and C22 have side access to terminals and optional rotary circuit selector switches. Designed to operate air conditioners, compressors, strip heaters, and reverse cycle heat pumps under cross ambient conditions.

Ranco Inc., Dept. ED, Columbus 1, Ohio.

CIRCLE 237 ON READER-SERVICE CARD

TRANSISTORIZED TRANSCEIVER.—For serial binary data transmission, the Sebit-25 transmits digital data over voice communication circuits at speeds up to 2500 baud. Power consumption is less than 50 w.

Rixon Electronics, Inc., Dept. ED, 2414 Reedie Drive, Silver Spring, Md.

CIRCLE 238 ON READER-SERVICE CARD

NEW PRODUCTS

BUTTON GUARD.—For protection against accidental operation, these guards come in a choice of thread sizes to fit standard pushbutton switches.

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

CIRCLE 242 ON READER-SERVICE CARD

TAPE RECORDER SWITCH.—Rated at 3 amp, 250 v ac, this switch automatically shuts off a tape recorder when the tape breaks. Body length is 1.5 in., movement differential is 0.233 in. maximum, and operating force is as low as 6 g.

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

CIRCLE 243 ON READER-SERVICE CARD

INTEGRATOR.—The portable Planimeter integrates regular size strip chart records and the 3 or 4 in. charts used with pneumatic control systems. On square root charts, accuracy is 0.5% at the upper half of the scale and 1% at the lower. Linear accuracy is 0.5%.

Royson Engineering Co., Dept. ED, Hatboro, Pa.

CIRCLE 244 ON READER-SERVICE CARD

FUNGICIDAL INSULATING VARNISH.—Type 642-AF is designed to protect the surfaces of transformers, printed circuits, ceramic resistors, insulators, and other electronic equipment from fungus attack in hot, humid climates.

Schenectady Varnish Co., Inc., Dept. ED, Schenectady, N.Y.

CIRCLE 245 ON READER-SERVICE CARD

ADJUSTABLE-SPEED DRIVES.—In 17 models from 1/20 to 3/4 hp, Motorformers provide smooth control from zero to maximum rated speed. The controlled rectifier is contained in a compact enclosure that is designed for either bench use or wall mounting.

Servo-Tek Products Co., Dept. ED, 1086 Goffle Road, Hawthorne, N.J.

CIRCLE 246 ON READER-SERVICE CARD

WIRE STRIPPING TOOL.—Strips nylon sheathing from plated copper braid wire without scoring the braid.

Stavid Engineering, Inc., Dept. ED, Plainfield, N.J.

CIRCLE 247 ON READER-SERVICE CARD

MULTIRANGE FREQUENCY GENERATOR.—Model T868 supplies accurate frequency reference voltage to the company's T806 turntable rate motor drive amplifier, as well as other gyro test tables. A self-contained module, it incorporates tuning fork resonators and frequency dividing networks.

Sterling Precision Corp., Instrument Div., Dept. ED, 17 Matinecock Ave., Port Washington, N.Y.

CIRCLE 248 ON READER-SERVICE CARD

New Products Index

New Products, new materials, and production products announced during the last half of last year are listed here by category. Following each category are issue and page numbers. The date corresponding to the issue number is given below.

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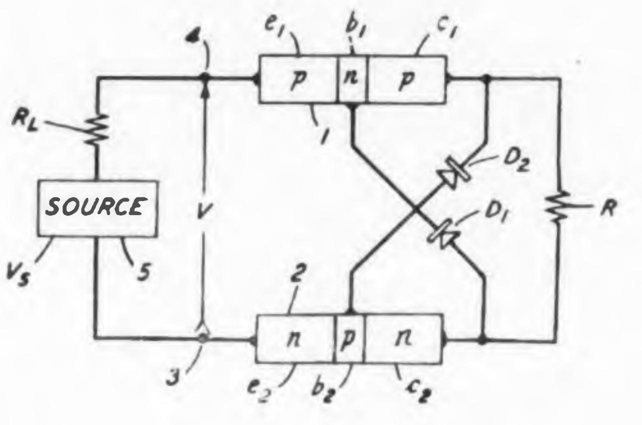
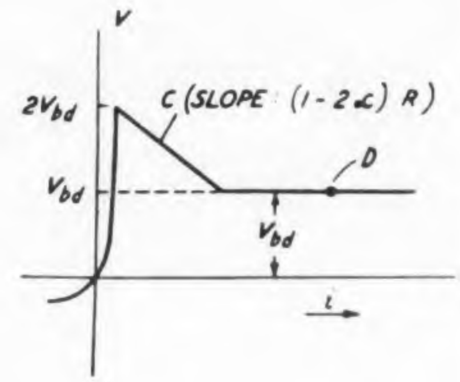


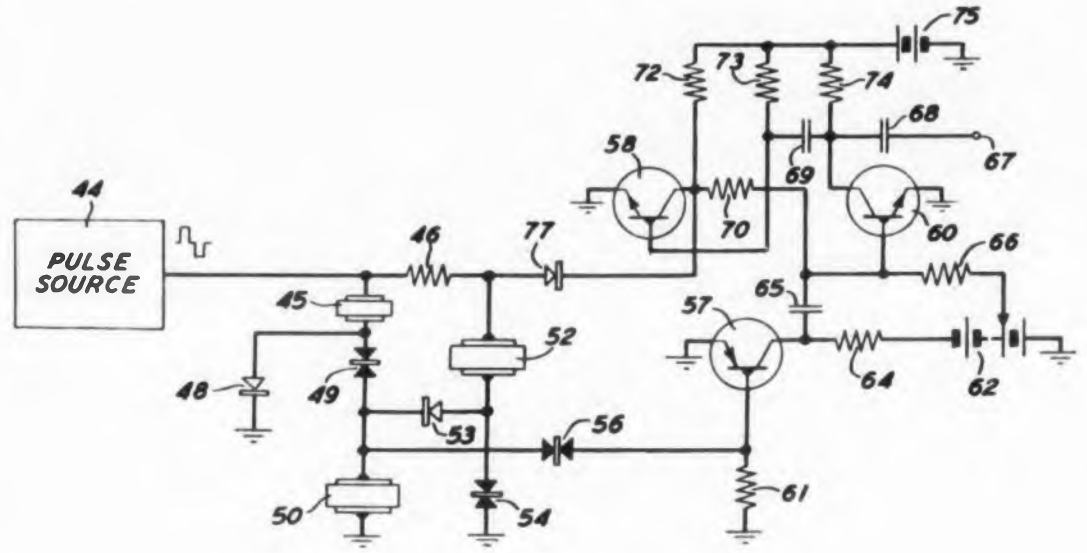


Signal-Operated Switch

Patent No. 2,853,631. Robert L. Wallace Jr. (Assigned to Bell Telephone Laboratories, Inc.)

Signal power from the transistor switch is used to establish a low-impedance path for signal between its source and load.

Complimentary transistors *1* and *2* are cross coupled by diodes D_1 and D_2 which are poled to impede the flow of base current. However, when the signal voltage exceeds the sum of the breakdown voltages of the diodes, the transistors saturate and the source to load circuit is closed. Distortion due to the switch is negligible since the variational resistance is small.



Counting Circuits Employing Ferroelectric Capacitors

Patent No. 2,854,590. Robert M. Wolfe. (Assigned to Bell Telephone Laboratories, Inc.)

Storage characteristics of ferroelectric capacitors are used to provide a counter which is immune to random or noise pulses. The counted pulses may be either closely spaced or separated by intervals measured in hours.

Briefly, ferroelectric capacitors have dielectrics in which electrical dipoles align themselves parallel to each other by mutual interaction such that the polarization versus applied field curves show hysteresis loops similar to the *B-H* curves for ferromagnetic materials. An applied voltage which shifts the polarization from one stable point to another produces a fixed charge depending upon the area of the electrodes.

The typical counter circuit shows ferroelectric capacitors *45*, *50*, and *52* connected to the monostable multivibrator comprising transistors *58* and *60*. Capacitor *50* integrates the applied pulses while capacitor *52* performs resetting after a predetermined count. The relative area of the capacitor plates is as shown.

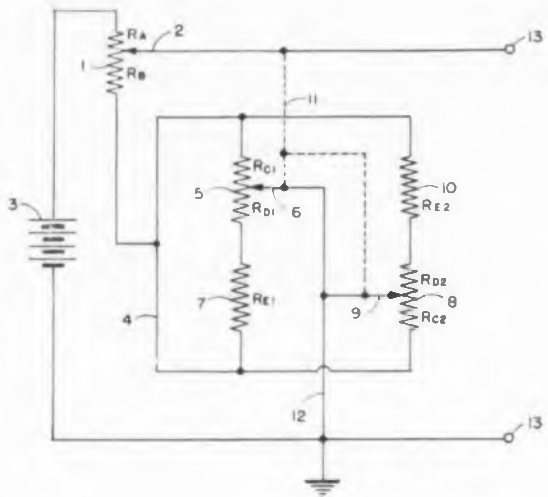
Assume, initially, that the remanent polarization of the capacitors is downward such that a negative pulse will reverse each capacitor and also that transistor *58* is conducting. The first negative pulse applied to capacitors *45* and *50*, in series, produces a charge which is metered by capacitor *45* such that only a portion of the remanent polarization of capacitor *50* is reversed. A negative pulse does not affect capacitor *52* since diode *54* will not pass negative pulses to ground. Subsequent positive pulses reverse the remanent polarization of capacitor *45* through diode *48*. Thus, negative pulses reverse the polarization of capacitor *45* to deliver consecutive discrete charges to capacitor *50* until the remanent polarization of capacitor *50* is reversed completely. This last pulse is transmitted through diode *56* to flip the multivibrator causing transistor *58* to cut off and to provide a positive bias on diode *77*. Hence the next positive pulse switches the polarization of capacitor *52* through diode *53* and resets integrating capacitor *50*. When the multivibrator flops back, transistor *58* is again conducting and the counter is restored to its initial condition.

Circuits for Producing Nonlinear Voltages

Patent No. 2,854,622. Homer G. Boyle. (Assigned to Avco Manufacturing Corp.)

In many applications, it is necessary to convert the linear rotation of a shaft into a nonlinear or complex electrical function. Rather than wind impedance elements on an odd-shaped form or convert the linear shaft rotation to a nonlinear motion by means of cams, linear

PATENTS



potentiometers are used to generate complex functions.

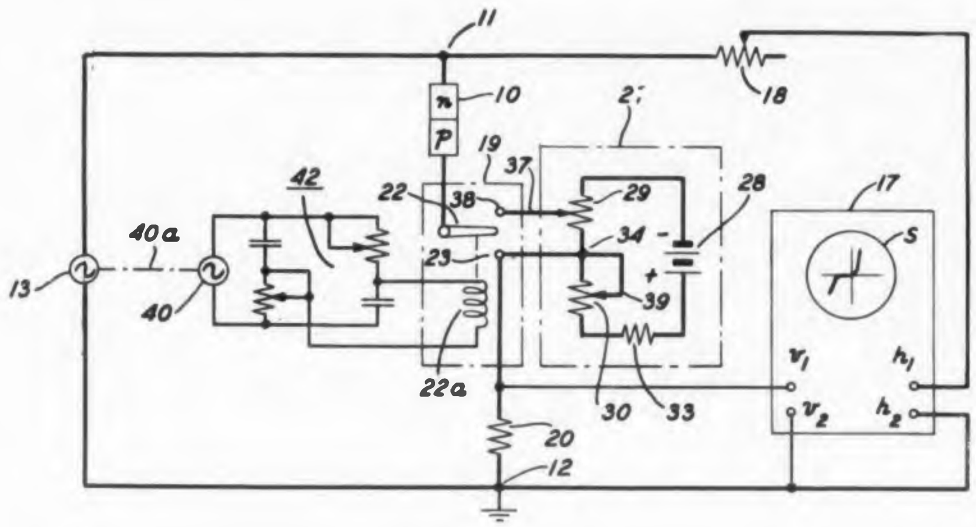
The basic network consists of linear potentiometer *1* connected to dual potentiometers *5* and *8*; the dual pot forms a first and second parallel branch both short-circuited by line *4*. Depending on the complexity of the curve to be duplicated, any number of branches may be selected. With the second branch disconnected, parabolic or lambda functions can be obtained by selection of proper values for the network elements. Use of all branches with proper component values will produce logarithmic or asymptotic functions. Finally, with all branches connected, and potentiometer taps *2*, *6*, and *9* arranged to move in unison or opposition, higher order effects can be realized.

An equation is derived for determining the total network impedance for μ branches. A practical solution to match almost any curve can be accomplished quickly and accurately, using standard, commercial gaged potentiometers.

Diode Test Set

Patent No. 2,847,646. Frank C. Marino. (Assigned to Bell Telephone Laboratories.)

Forward and reverse voltage-current conduction characteristics of a semiconductor are simultaneously displayed on the screen of a cathode ray tube oscilloscope. The apparatus likewise displays the diode reverse dynamic resistance to determine suitability of the diode in switching circuits.



A semiconductor diode characteristic has forward and reverse regions of low impedance and an intermediate region of high impedance. The revise bias for conduction is much greater than the forward bias to be applied for conduction. The reverse breakdown point is important in switching circuit design.

The characteristic shown on the screen is generated as follows: The output of ac generator *13* is applied to the horizontal amplifier and the voltage across diode current sensing resistor *20* is connected to the vertical amplifier. For the forward half cycle the generator is across diode *10* and resistor *20* in series. During the reverse half cycle, mercury-wetted switch *22* places a preselected portion of battery *28* voltage in series aiding with ac generator *12*. Diode *10* conducts the instant the combined voltage exceeds breakdown. The horizontal and vertical amplifier sensitivities are constant for the entire conduction characteristic in order that the actual slope at breakdown be displayed.

BOOKS

Sampled-Data Control Systems
John R. Ragazzini, Gene F. Franklin, McGraw-Hill Book Co., 327 West 41st St., New York 36, N.Y. 331pp, $9.50.

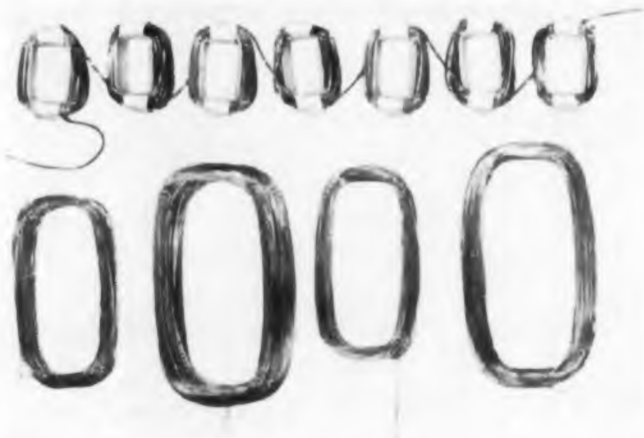
This book discusses analysis and design of sampled-data feedback and control systems. It presents a unified treatment of the material found in original papers, reports and recent research made by the authors and their colleagues, plus new material previously unpublished in any book.

While specifically directed to control systems, there is much material which has general application. This includes the transformation, data-reconstruction theory, applications of transform methods to numerical processes, and the theory of sampled random function.

The book is largely theoretical as applied mainly to the design of sampled-data control systems where such specifications as stability, response, and output ripple are of importance. Sampled-data theory serves as a common base for the analysis and synthesis of linear digital systems, pulsed continuous systems, and their combinations often found in practice. In addition, the subject is broadly treated to include applications in the fields of communications, data processing, and filtering.

Escapement Mechanism

For fast coil production



This escapement mechanism permits the winding of any number of connected series coils, depending upon wire size, coil size, winding speed, and mandrel weight. It will handle rotor, field, bobbin, repeater, solenoid, and single layer coils. Production is increased because pauses are eliminated, and no operator is needed to move wire from one series coil to another. Instead, the operator can prepare the next mandrel. Maintaining an exact turn count per coil, the unit handles wire sizes from 17 to 46 at winding speeds up to 1200 rpm. Winding pitch is determined by gear train and cam by coil length.

Geo. Stevens Mfg. Co., Inc., Dept. ED, Pulaski Rd. at Peterson, Chicago 46, Ill.

CIRCLE 274 ON READER-SERVICE CARD

Tension Analyzer

Helps make uniform wire coils

By recording both static tension level and dynamic tension variations, tension analyzer model BL-825 helps produce uniform wire coils at high winding speeds. Affording proper winding speed control, it reduces the overstretching of wire, thus eliminating overheating of the coil, variations in resistance, and breakdown of insulation. It can also control the electrical characteristics of a coil and the number of turns it has. Static and dynamic peaks in wire or fiber stress can be located on an oscillographic chart record.

Brush Instruments, Div. of Clevite Corp., Dept. ED, 37th and Perkins Ave., Cleveland 14, Ohio.

CIRCLE 275 ON READER-SERVICE CARD

CIRCLE 276 ON READER-SERVICE CARD

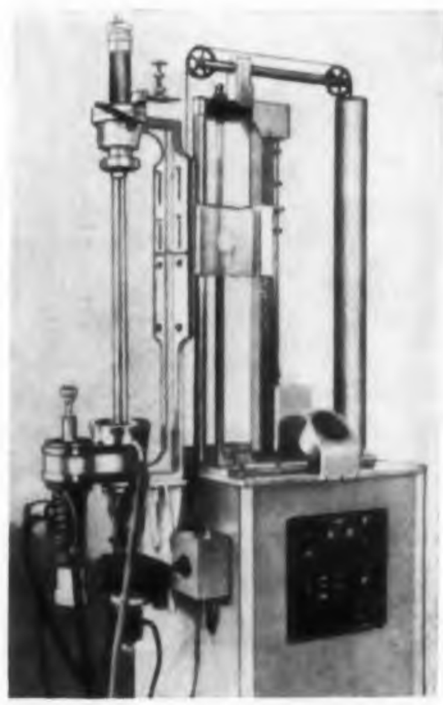
Toroidal Winding Machine

Handles 20 to 40 AWG wire

From size 20 to 40 AWG wires, model L-7 toroidal winding machine produces coils that have a minimum ID of 9/16 in., a maximum height of 3 in., and an OD between 1 and 9-1/2 in. Wired for 110 v, 60 cps, ac operation, the unit incorporates a Variac speed control, a self-releasing shuttle to the magazine loading lock, a wire guiding device for uniform wire distribution in the magazine, and a high speed geared predetermining counter. One standard magazine is available in sizes of 1/8, 3/16, or 1/4 in. The machine measures 20 x 18-1/2 x 17 in.

Universal Mfg. Co., Inc., Dept. ED, 1168 Grove St., Irvington, N.J.

CIRCLE 279 ON READER-SERVICE CARD



Floating Zone Fixture

For Crystal growing

This floating zone fixture produces high purity metals and semiconductor materials. Purification or crystal growing is achieved by traversing a narrow molten zone along the length of the process bar while it is being supported vertically in vacuum or inert gas. The unit has a mechanical drive system with continuously variable up, down, and rotational speeds, all independently controlled. The process bar can be quickly centered within a straight walled quartz tube that is supported between gas tight, water cooled end plates. Placement of the quartz tube is simple, and adapters can be used to accommodate larger diameter tubes for larger process bars. The outside of the quartz tube is continuously water cooled during operation.

Lepel High Frequency Labs, Inc., Dept. ED, 54-18 37th Ave., Woodside 77, N.Y.

CIRCLE 282 ON READER-SERVICE CARD

Hot Stamping Machine

Marks two colors at once

With dual hot stamping heads, model 2AH marking machine can stamp two separate colors at the same time. Each head has individual dwell and pressure controls. The machine is hand fed, but it may be automatically fed if the parts or products being marked lend themselves to automatic positioning. The dial feed has 20 stations, and up to 4500 parts can be handled in an hour. Each hot stamping head has its own temperature control and transfer foil automatic advance for marking in any color desired.

The Acromark Co., Dept. ED, 411 Morrell St., Elizabeth, N.J.

CIRCLE 283 ON READER-SERVICE CARD

NEW LITERATURE

Miniaturized VTVM's 286

Miniaturized electronic voltmeters in four basic styles are described in 4-page, short form catalog, No. 10-A. Data includes performance specifications, dimensions, and prices. Catalog covers panel-mounted models and half-relay rack styles. Metronox, Inc., Chesterland, Ohio.

Electroplating 287

Series of newly available information bulletins on barrel and rack chromium plating of small parts includes an illustrated bulletin on firm's services and facilities and technical progress reports. Each issue planned to indicate progress and improvements in electroplating. Descriptions of services for burnishing, testing, laboratory work and research are included. Whico Chromium Co., Inc., U.S. Route 8, Thomaston, Conn.

Teflon Tapes 288

Leaflet describes in detail Temp-R-Tape pressure-sensitive Teflon tapes and thermal curing pressure-sensitive Teflon tapes for —100F to 500F electrical and mechanical applications. The Connecticut Hard Rubber Co., 407 East St., New Haven 9, Conn.

Insulation 289

Three illustrated booklets on electrical insulation products: No. 26 Standards is 16-page catalog providing a listing of pertinent insulation standards publications; No. 27 IMC Products List of Electrical Insulation is an 8-page booklet issued as an alphabetic guide to electrical insulating materials; and No. 28 INMANCO Electrical Insulation describes shaped wood and plastic wedges in 32-page bulletin. Insulation Manufacturers Corp., 565 West Washington Blvd., Chicago 6, Ill.

Electronic Equipment 290

Short form catalog 1-58, 4 pages and in color, lists telemetering equipment, recording systems, test equipment and data processing equipment. Units covered include: fm transmitter, multicoupler for telemetry receivers, fixed styli recorder and super-regulated current and voltage standard. Radiation, Inc., P.O. Box 37, Melbourne, Fla.

Insulating Tapes 293

A 6-page, colored catalog folder showing the entire line of electrical insulating tapes with complete specification data charts for all friction tapes, splicing compounds, and plastic tapes prepared by Plymouth Rubber Co., Inc., Tape Div., Canton, Mass.

Overheat Protectors 294

New product catalog, "Klixon Inherent Overheat Protectors for High Performance Motors" details construction, operation, electrical ratings, capacities, and weights of both open and hermetically sealed types. Complete dimensional drawings are included. Metals & Controls Corp., Spencer Div., Attleboro, Mass.

Environmental Chambers 295

Latest 6-page brochure showing environmental chambers for temperature, altitude, and humidity also describes complete missile test facilities and components testing units. Conrad, Inc., Conrad Square, Holland, Mich.

Deflection Potentiometers 296

Data Sheet E-51(8) describing the Brooks Deflection Potentiometers lists complete specifications of both models 7 and 8 and their accessories and contains a schematic diagram of model 7. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.

Thermoplastic Knobs 297

Standard thermoplastic knobs—available in polystyrene and acetate—are described with photographs, diagrams, and dimensions. Knobs range in size from 5/16 in. to 2-7/8 in. diam and have a wide variety of applications. Waterbury Companies, Inc., 528 Washington St., Waterbury 20, Conn.

Digital Indicator and Printer 298

Features, applications and specifications of Digital Indicator and Printer Model 176 are described in two-page bulletin. The Model 176 is designed for high accuracy and resolution indication and permanent recording of weight, strain, temperature, pressure, and other variables which can be measured by sensitive bridge-type transducers. Gilmore Industries, Inc., 13015 Woodland Ave., Cleveland 20, Ohio.

Get $10.00 plus a by-line for the time it takes you to jot down your clever design idea. Payment is made when the idea is accepted for publication.

Tips For Machining Glass Base Laminates

Sawing a full sheet of glass base laminate.

Punching the laminate.

GLASS BASE laminates, with their high flame and heat resistance, mechanical strength, and moisture resistance, are extremely useful to printed circuit designers, but they often pose manufacturing problems.

Here are some basic recommendations for machining these laminates. It is important to remember that when machining parallel to the laminations, there is the danger of splitting. But if the piece is clamped firmly and machined carefully, the danger is very small.

Sawing

With a good exhaust system, good cutting will result at speeds of 3000 to 3600 rpm with a diamond impregnated wheel with copper body 1/16 in. thick by 12 in. in diameter. The material can be fed by hand without forcing. The work and wheel can be flooded with water to prevent overheating. Abrasive wheel cutting should be done under water to minimize the heat which is generated by friction.

Band sawing, one of the most difficult and expensive operations, should be performed with steel blades with hardened teeth and a soft back. The work should be fed lightly and the blade kept sharp. Diamond coated band saw blades are better than steel. A good exhaust system allows for dry sawing.

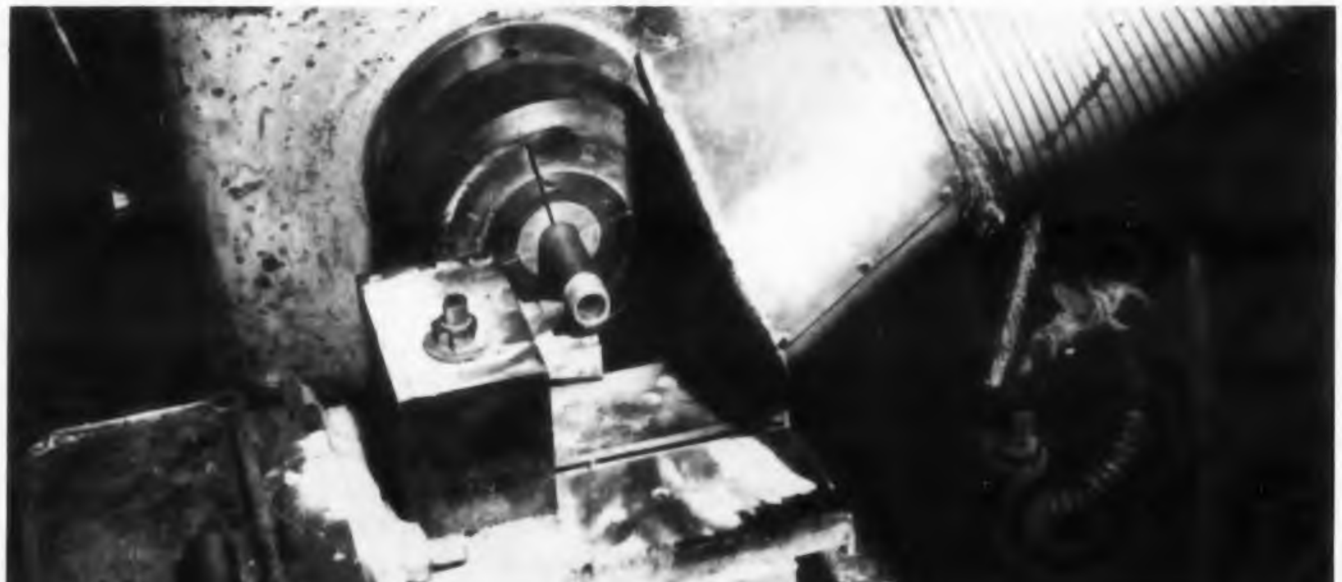
Punching

Punching glass base materials follows standard practices with other materials, though die life is shorter. But carboloy and special die steels help increase die life. Good punchings will result on sheets as thick as 3/32 in.

Drilling

A carbide drill should be used. The material can be drilled dry with a good exhaust system,

Turning glass base tubing on a lathe.



Threading on a lathe.

Tapping the glass.

but water on the work and drill can be used to prevent overheating and dulling of drills. High speed drills, nitrate treated, must be sharpened more often. When sharpening, it is necessary to cut the drill back to the original body diameter. For quarter inch drills, the speed can be 4800 rpm.

Tapping

Tapping is the same as with paper base laminates. The abrasiveness may cause taps to cut very close to size, and there may be a tendency to bind when backing out.

Standard high speed steel taps are all right for short runs, but carbide taps should be used for long runs. The taps should be purchased oversize. Coolant can be used, but is not needed if a good exhaust system is used.

Threading

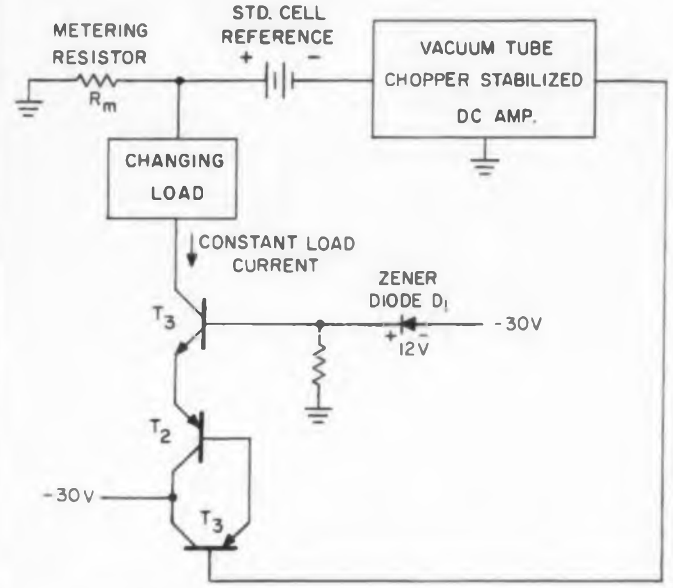
External and internal threads can be cut dry on a lathe with a carbide-tipped tool. Fine cuts give best results. A coolant can be used, but isn't essential.

Machining

Conventional turning, boring, facing, and milling can be performed on automatic screw machines, standard and production lathes, hand turret lathes, and standard millers. Carbide tipped tools and cutters should be used with slower surface speeds than those required for paper base laminates.

Tools should be ground with a zero rake, and a coolant can be used but isn't essential if the dust is exhausted.

More information is available from the National Vulcanized Fibre Co., 1058 Beech St., Wilmington, Del.



This constant current driver uses directly connected transistors to provide high input and output impedances.

Direct Connection of PNP and NPN For High Input, Output Impedance

A precisely controlled constant current drive was needed for a time-varying load impedance. Large load currents made transistors the obvious choice as regulator elements.

The regulator was to have a high output impedance to regulate against high frequency load changes; and a high input impedance, since a vacuum tube, chopper-stabilized, dc amplifier was to provide high loop gain.

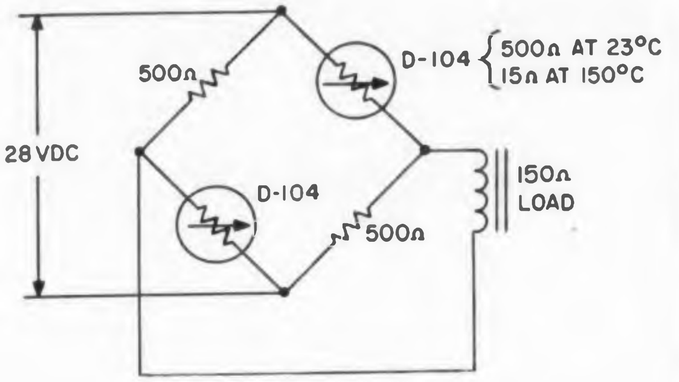
The circuit shown here met the requirements simply. Here's how it works.

A voltage proportional to the load current develops across metering resistor R_m. The difference between the metering voltage and a standard cell voltage is amplified to drive the regulator consisting of T_1, T_2, and T_3. This keeps the load current constant.

Npn transistor T_3, with a grounded base, provides the dynamically high output impedance. It is directly connected to pnp T_2, which has a grounded collector configuration. The compound connected pnp transistor T_1 further increases the regulator's input impedance so as not to load down the vacuum tube amplifier.

The zener diode D_1 provides a voltage to keep T_1 and T_2 in their active regions and to keep the base circuit of T_3 low.

Robert B. Craven, Research Engineer, MIT Instrumentation Lab., Cambridge, Mass.



Thermistors in bridge supply power to low impedance load gradually.

Slow Starts for Low Impedance Loads

A mechanical drive system was designed using a 28 v dc electromagnetic clutch which had a dc resistance of about 150 ohms. It was desired to energize the clutch gradually, starting at 0 v and reaching full voltage in about 3 to 5 seconds. *RC* timing circuits were impractical because of the low impedance of the load. Placing a thermistor in series with the clutch was not satisfactory since the "cold" resistance of suitable thermistors is not high enough to limit the initial clutch voltage to less than about 8 v.

A bridge circuit using thermistors in opposite arms solved the problem. The General Electric D-104 thermistors have a "cold" resistance (25 C) of 500 ohms, so the bridge is balanced initially, giving zero output. As the thermistors heat up due to bridge current, the bridge is unbalanced by the simultaneous decrease in resistance of the two thermistors. Since the resistance of the thermistors at 150 C is only 15 ohms, the output voltage levels off at about 80 per cent of the input. The time constant is about 5 seconds.

Thomas N. Tyler, Development Eng., Heiland Div., Minneapolis-Honeywell Regulator Co., Denver, Colo.

Solder Blotter

To get excess solder out of those inaccessible corners in a chassis, dip a short strip of shielding braid (about 6 in. long) in solder paste flux; then hold it against the device containing the excess solder. Place a soldering iron in contact with the braid and the excess solder will be drawn into the braid by capillary action.

Phil Moser and Connie Yabes, Hughes Aircraft Co., Culver City, Calif.

Nonlinear and Radio

Part 10

Nonlinear Circuits

13. Practical Modulation Circuits

Let us consider the simplest and the most frequently used modulator circuits.

A. Amplitude Modulation

For ordinary amplitude modulation the two schemes principally used are grid modulation and plate modulation. The grid modulation circuit is shown in Fig. 42. The carrier-frequency voltage U_1 and the modulating voltage U_2 are applied to the grid of a triode. A blocking capacitor C_1 bypasses the high frequency past the winding of the low frequency transformer.

The modulation is due to the nonlinearity of the triode characteristic, $I_a = f(U_o)$. The resultant plate current contains extraneous components which are filtered out by an LC circuit, tuned to the carrier frequency. The bandwidth of the circuit is made somewhat greater than the width of the modulation spectrum, i.e., more than double the width of the signal spectrum. Under this condition, the network will filter both the low frequency and dc components, and the high fre-

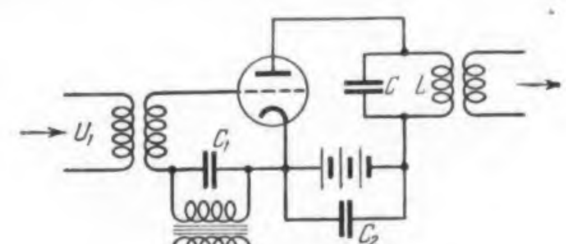


Fig. 42. The grid modulation circuit.

Parametric Phenomena in Engineering

A. A. Kharkevich
(Translated by J. George Adashko)

Chapter 1

and Fundamental Nonlinear Processes

quency components that contaminate the modulation spectrum.

The plate modulation circuit is shown in Fig. 43. It differs from grid-modulation in that the carrier voltage U_1 is applied directly to the grid, and the modulating voltage U_2 is applied to the plate of tube T_1. Since the effect of the voltage in the plate circuit is roughly speaking, μ times weaker than the effect of the same voltage in the grid circuit, the modulating voltage is amplified by T_2.

From the point of view of operating principle, Fig. 42 and 43 are equivalent. However, the plate modulation circuit of Fig. 43 has several purely technical advantages which can usually be found in texts on transmitters.

B. Frequency Modulation

For frequency modulation it is necessary to change the frequency of the master oscillator. This is most simply done by varying the tuning of the tank circuit of the master oscillator. In the simplest modulation circuit this is accomplished by connecting a capacitor microphone directly in the master oscillator tank circuit. In modern equipment this is accomplished with a circuit based on the use of the so-called reactance tube. The input impedance of this tube, practically a pure reactance, changes magnitude in accordance with the changes in the applied modulating voltage. The theory of the reactance tube is really very simple and reduces to the following. Let us examine the circuit of Fig. 44 and write an expression for the current I.

$$I = \frac{U}{R + j\omega L}$$

If we choose the parameters R and L such that

$$R \gg \omega L,$$

then

$$I \cong \frac{U}{R}$$

The grid voltage is

$$U_g = j\omega LI \cong j\omega \frac{L}{R} U$$

(Continued on following page)

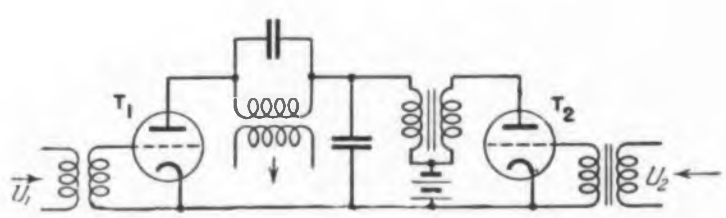


Fig. 43. The plate modulation circuit.

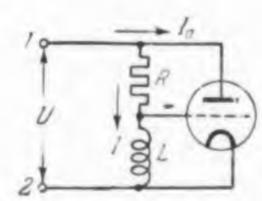


Fig. 44. The basic reactance tube.

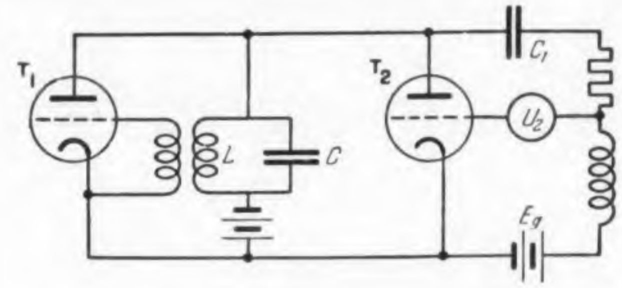


Fig. 45. A basic fm modulator using T_2 as the reactance tube.

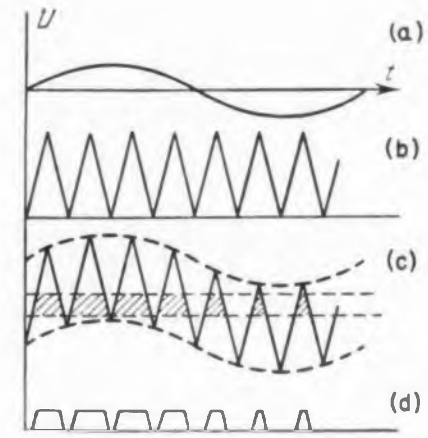


Fig. 46. The basis of pulse duration modulation. The trapezoidal pulses in (*d*) result from limiting the waveform in (*c*) which is derived from the triangular wave (*b*) generated by the modulating voltage (*a*).

The anode current (neglecting the reactance of the plate) is

$$I_a = SU_g = j\omega \frac{LS}{R} U$$

where S is the tube's transconductance.

Let us now assume that the parameters are so chosen that

$$I \ll I_a$$

i.e., that the input current depends only on the anode current I_a (the component I is neglected). We can then find the admittance of the circuit between points 1 and 2 by dividing the input current by the applied voltage.

$$Y = \frac{I_a}{U} \cong j\omega \frac{LS}{R} = j\omega C_{eq}$$

where the equivalent capacitance is

$$C_{eq} = \frac{LS}{R}.$$

It turns out therefore that under the assumptions made the input admittance of the circuit is purely capacitive, or, in brief, that the circuit behaves like a capacitor.*

*By changing the phase-shifting *RL* network, it is possible to obtain inductive or any complex input admittance.

It now remains to make this capacitance adjustable. This can be done readily, since the capacitance depends on the transconductance. Choosing the operating point on the quadratic portion of the triode characteristic, we obtain a variation in the transconductance, and consequently in the equivalent capacitance, proportional to the change in the voltage on the grid.

In fact if

$$I_a = a_o + a_1 U + a_2 U^2$$

then

$$S = \frac{dI_a}{dU} = a_1 + 2\,a_2\,U$$

The basic circuit of a-m f-m modulator with a reactance tube is shown in Fig. 45. In this circuit T_1 is the oscillator tube, LC the master tank circuit, T_2 the reactance tube parallel to the tank circuit, U_2 the modulating voltage applied to the grid of the reactance tube, C_1 the capacitance that blocks the plate voltage from the grid of the reactance tube, and E_g is the bias voltage to set the operating point.

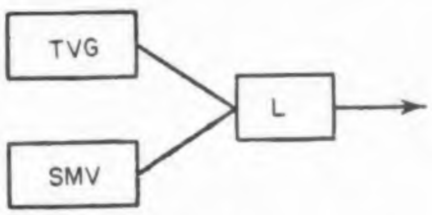


Fig. 47. Block diagram of PDM consists of a Triangular Voltage Generator, a source of Modulating Voltage, and a Limiter.

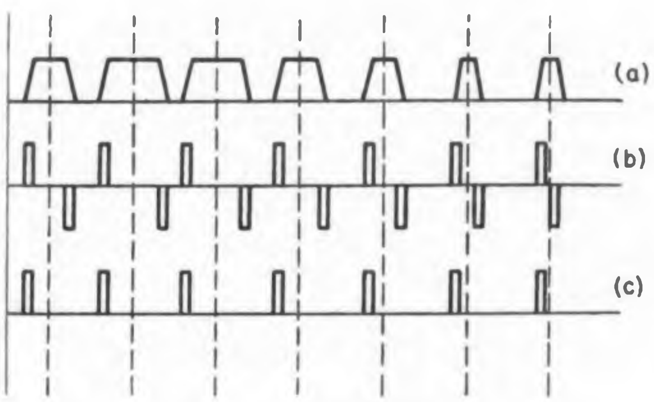


Fig. 48. Pulse phase modulation can be derived from PDM (a), by differentiating (b), then cutting off the negative pulses. The pulses in (c) are of different phase with respect to the vertical reference markers.

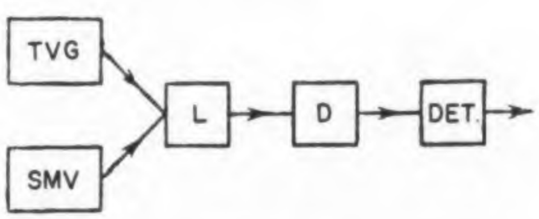


Fig. 49. Block diagram of PPM includes the block diagram of PDM plus a Differentiator and Detector.

C. Pulse Modulation

We shall not dwell on Pulse Amplitude Modulation since, first, the same methods are used for this type of modulation as for ordinary a-m, and second, because PAM is not used extensively at present because of its low interference immunity.

Most widely used are PDM and PPM, the mechanisms of which we shall now consider. A sequence of pulses, modulated in phase or in duration, is obtained most simply and most universally by superimposing a modulating voltage on a triangular periodic voltage whose fundamental frequency equals the repetition rate of the unmodulated pulse sequence. The resultant sum of voltages if then subjected to subsequent treatment such as limiting, differentiation, etc.

We shall start with pulse duration modulation. Fig. 46a shows the modulating voltage, Fig. 46b the triangular voltage, and Fig. 46c the superposition of the two. If we now limit the resultant voltage from above and from below, as shown by the dashed lines of Fig. 46c, we obtain trapezoidal pulses, modulated in duration. The slope of the wave fronts can be readily controlled by changing the relationship between the spread of the triangular voltage and the limiting band.

The block diagram of a PDM circuit consists of a triangular voltage generator (*TVG* on Fig. 47), a source of modulating voltage (*SMV*) and a limiter (*L*). The circuits of these elements contain no essential distinguishing features, so we shall restrict ourselves to the block diagram.

To obtain PPM it is possible to employ PDM first. Let us take a sequence of pulses, modulated in duration, as obtained by the method just described. Let us differentiate this sequence (Fig. 48b). We obtain rectangular pulses of opposite polarity; the positive pulses correspond to the leading edge of the differentiated trapezoidal pulses, and the negative ones to the trailing edge. If we now pass the resultant sequence through a detector which cuts off the negative pulses, we obtain (Fig. 48c) a sequence of rectangular** pulses, modulated in phase, i.e., shifted with respect to the reference points, shown in Fig. 48 as vertical dashed lines.

Thus, the PPM block diagram differs from PDM in that the former contains a differentiating element (*D*) and a detector (*Det*, Fig. 49). The different versions and details of pulse-modulation circuits are considered in special texts.

(*To be continued*)

**In practice, the pulses cannot be rectangular. Their shape is also approximately trapezoidal, i.e., the edges of the pulses have finite slopes, determined by the width of the passband of the entire modulator circuit.

What the Russians Are Writing

J. George Adashko

Measurement of Weak Signals Having Continuous Spectra by V. S. Voyutskiy and A. I. Slutskovskiy, RE 9/58, p 25-29, 3 figs.

The sensitivity and accuracy of measurements of weak signals having continuous spectra is limited essentially by the random noise in the measuring apparatus. Two basic methods are presently used to cope with this limitation. In one, the noise is measured separately and subtracted from the overall reading of the apparatus. In this method the null setting of the output instrument becomes dependent on the gain of the system and on the noise level of the output. Its effectiveness is therefore dependent on the degree with which the noise remains constant during the measurement time.

Another method (cf Dicke, *Rev. Sci. Instr.*, 17, 268, 1946 or M. Ryle, *Proc. Roy. Soc.*, Nov 4, 1948) involves low-frequency amplitude modulation of the measured weak signal prior to amplification. The weak sinusoidal variation of the modulation frequency, obtained at the detector output, is separated with a narrow-band filter. The amplitude of this sinusoidal variation is proportional to the signal intensity. Although this modulation method eliminates the null drift due to variation in noise level, fluctuations in the gain coefficient of the apparatus, which affect the calibration, are not eliminated.

Fig. 1 shows a measurement circuit free of the above shortcomings. A standard signal generator is used. A simple network produces the sum and the difference of the standard voltage v and the signal voltage u. Since the order of the noise components in the product is lower than that of the signal components, the output is essentially proportional to $u^2 - v^2$ and vanishes identically when the two are equal.

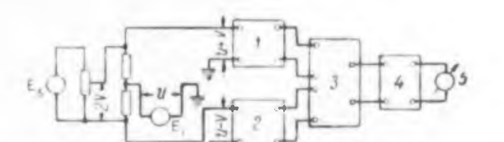


Fig. 1. The input signal E_i is compared with a standard signal generator output E_s. The sum and difference of the two voltages are amplified (amplifiers 1 and 2) and multiplied (block 3). Block 4 is a square-law detector and filter combination. If $u = v$, meter 5 reads zero.

Fig. 2 shows a modification of the same circuit in which the noise component of the signal is also eliminated. It involves the use of two identical antennas such that their signals are fully coherent. The apparatus was tested at signal voltages of 0.25 to 0.5 microvolts with high-gain amplifiers (1.5 to 2 x 10^6 voltage gain) and found to be superior to previously employed schemes.

Calculation of Internal Noise of Transistor Receivers by V. V. Pavlov, RE 19/58, p 30-37, 5 figs, 1 table.

After deriving expressions for the noise

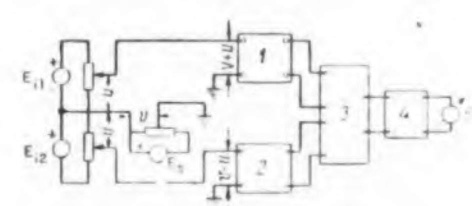


Fig. 2. It is possible to eliminate the noise content of the signal itself by using two antennas (E_{i_1} and E_{i_2}) so arranged that their outputs are coherent.

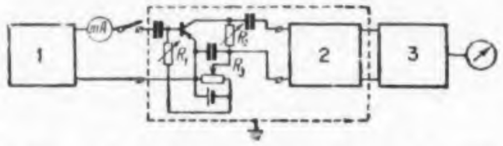


Fig. 3. Test of single transistor stage. *1*—noise generator (saturated diode), 2—vacuum tube amplifier with low internal noise, 3—bandpass filter. The setup is shielded against external noise.

factors of grounded-collector, grounded-emitter, and grounded-base circuits, the author reports test results obtained with various types of Russian and foreign transistors. (See Fig. 3).

All-Union Scientific Session devoted to the "Day of Radio." RE 9/58, p 71-80.

The "Day of Radio" session is probably the counterpart of our IRE convention (although we have not been able to discover the ratio of personnel recruiters to participants or obtain statistical data on the flow of vodka in hotel suites). The variety and scope of the session is similar to that of last year.

Transients and Steady State in an Automatic Range Scope by F. M. Kilin, AT 10/58, pp 901-916, 6 figs.

The analysis used in this paper takes account of certain discontinuous processes that take place in some parts of the range scope, and variation of circuit parameters with the received pulses.

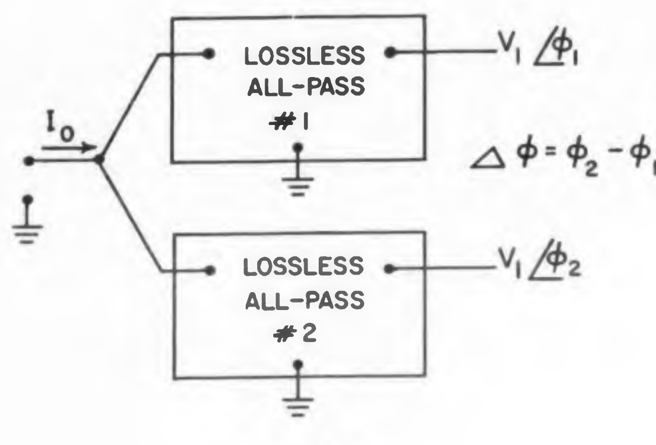
Servo Systems Containing Two Pulse Elements with Unequal Repetition Rates by Fan Chun-Wui, AT 10/58, p 917-930, 8 figs.

Servo systems with several pulse elements having equal repetition rates were investigated by Ragazzini and Zadeh (*Trans.* AIEE, Vol 71, pt. II, 1952), Glawyn and Truxal (*ibid.* vol 73, 1954), and by several Russian authors. Systems in which the repetition rates are common multiples have been investigated by Kranc (*Application and Industry,* July 1957), and others. This is the first thorough theoretical analysis of the case of unequal repetition periods.

It is concluded that, other conditions being equal, the stability margin of the system can be improved substantially by varying the ratio of T_1 to T_2, and that $T_1 = T_2$ does not necessarily produce optimum operating conditions.

Practical Two-Phase

E. Brenner



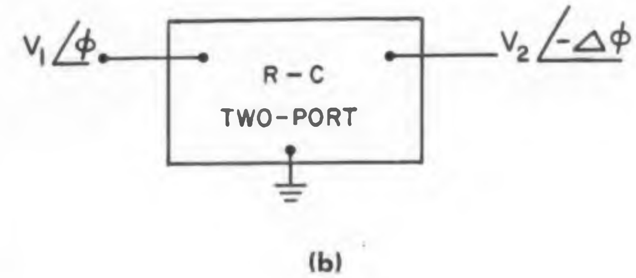


Fig. 1. (a) The lossless "two channel" system results in equal amplitude outputs which have the required phase difference. This type of arrangement is referred to as Class "A" in the abstract. (b) An R-C two port. To obtain the required phase characteristics frequency dependent attenuation is allowed. This type of network is referred to as Class "B".

TWO SINUSOIDAL outputs, different in phase by a prescribed angle, may be obtained from a sinusoidal input by means of a linear passive structure termed a "two-phase" network. While the special case of 90 deg phase shift has been solved rigorously (see e.g. German Abstracts, *ED*, Aug. 20, 1958, Vol. 6, No. 17), the solution does not lead to elementary functions. It is possible to design two-phase networks with tolerances which are adequate for many applications using elementary functions if the number of elements which are required in the realization is restricted.

Two classes of two-phase networks are defined. Class "A" is represented by the familiar scheme shown in Fig. 1a. In this network, two "all-pass" (lossless) two-ports are used so that two voltages of equal amplitude, which differ in phase by $\Delta\phi$ over the required band, are produced. In Fig. 1b

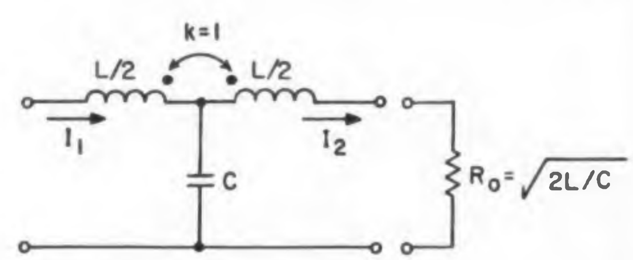


Fig. 2. "Prototype" all-pass phase shifter. When terminated in R_0 the driving point impedance is R_0. Each all pass of Fig. 1a consists of a cascade of prototypes, the last one terminated in R_0. It is assumed that the cascades are fed from a high impedance ("current") source.

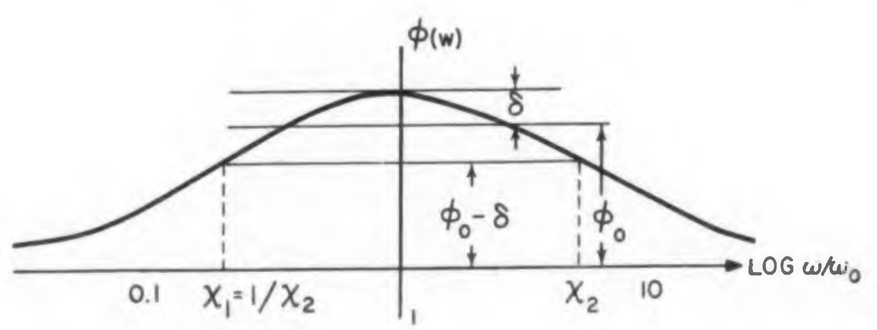


Fig. 3. Phase characteristics for $n = 2$. The curve is symmetrical when the log of the normalized frequency is the abscissa.

Networks

class "B" is indicated. An R-C two-port is used to produce the phase shift between V_2 and V_1. In this case V_2/V_1 is a function of frequency so that this scheme is generally used only when small phase differences are required.

To realize a network of Class A, it is assumed that the input is fed from a current source I_o (high impedance source) and that the all-pass phase shifters have the form of the prototype shown in Fig. 2. For this network, the driving point impedance at all frequencies is R_o if the termination is R_o, hence they can be cascaded. It can also be shown that for the prototype with termination R_o

$$\frac{I_2}{I_1} = \frac{\alpha - j\omega}{\alpha + j\omega} = 1\underline{/-2\tan^{-1}\omega/\alpha} \quad (1)$$

where $\alpha^2 = 2/LC$, $R_o = 2L/C$.

By the use of trigonometric identities, three practical designs can be prescribed using two, three or four prototype sections. As the number of sections increases, the tolerance on phase shift within a prescribed band decreases. If the two-phase network, realized as in Fig. 1a, is to furnish a phase shift of $2(\phi_o \pm \delta)$ within the band of radian frequencies ω_1 to ω_2, then the band-ratio, $B = \omega_2/\omega_1$, depends on the half tolerance δ.

1. *Design parameters* (a) Define $\omega_o^2 = \omega_1 \omega_2$ and normalized $x = \omega/\omega_o$, ($x_2 = \omega_2/\omega_o$; $x_1 = \omega_1/\omega_o$ etc.);

$$B = \omega_2/\omega_1 = \omega_2^2/\omega_{o2} = x_2^2$$

(b) Frequency parameter $y = x + 1/x$, ($y_k = x_k + 1/x_k$)

(c) Maximum and minimum phase shift in band: define H and T

$$H = \tan(\phi_o + \delta),\ T = \tan(\phi_o - \delta)$$

(d) Prototype parameters

Let $\varepsilon = \alpha/\omega_o$ then $(L/2) = R_o/(2\omega_o\varepsilon)$;

$$C = 2/(\omega_o \varepsilon R_o).$$

2. *Case* $n = 2$. Each all pass of Fig. 1a consists of a single prototype. A typical curve of phase

GERMAN ABSTRACTS

shift as a function of log x is shown in Fig. 3. The band ratio B is related to δ through $y_1 = 2H/T = x_1 + 1/x_1$ or $x_1^2 = B = [H/T + (H^2/T^2 - 1)^{1/2}]^2$

The prototypes forming all pass No. 1 and No. 2 respectively are determined from ε_1 and ε_2 where

$$\epsilon_1 = (1 - \sin(\phi_o + \delta)/\cos(\phi_o + \delta);$$

$$\epsilon_2 = 1/\epsilon_1 \text{ or } \quad \epsilon_2 - \epsilon_1 = 2\,H$$

The two phase network has a phase shift of $2\varphi_o$ with tolerance $\pm 2\,\delta$ in the normalized band x_1 to x_2 (ω_1 to ω_2). The factor of 2 appears for all Class "A" networks.

3. *Case n* = 3. This case (as for all odd values of n) does not yield to analytical treatment except for special values of φ_o. A graphical procedure can be used in general. Assign two two-ports determined through ε_1 and ε_3 to all pass No. 1 and let all pass No. 2 be the two port determined through ε_2. Let $\varepsilon_1\,\varepsilon_2 = 1$. The phase-normalized frequency dependence is then

$$\phi(x) = \tan^{-1} x/\epsilon_3 + \tan^{-1}(2Kx/(1 + x^2) \quad (2)$$

The curve $\tan^{-1} 2Kx/(1 + x^2)$ is the phase characteristic for $n = 2$ and is shown in Fig. 4 for several values of K. Now one graphs the three curves $\varphi_o \pm \delta - \tan^{-1} x/\varepsilon_3$; ($\varphi_o - \tan^{-1} x/\varepsilon_3$) as a function of log x as in Fig. 5a. By trial and error a curve from Fig. 4 is superposed on Fig. 5b so that the equation $\varphi(x) = \varphi_o \pm \delta$ in the interval x_1 to x_2 is satisfied; result as shown in Fig. 5b. From Fig. 5a, ε_3 is determined. The chosen value of K (determined by the curve of Fig. 4 used) and the relationship $\varepsilon_1\,\varepsilon_2 = 1$ determines ε_1 and ε_2: $K = (\varepsilon_2 - \varepsilon_1)/2$.

If $\varphi_o = 45$ deg is required ($2\varphi_o = 90$ deg) the special symmetry results in analytical expressions. The bandwidth tolerance relation is shown in Fig. 6. The maximum error δ occurs at $x = x_m$, $x_1^2T^2 = x_m^2 = T^2B$. Corresponding to x_m, $y_m = x_m + 1/x_m$ ($y_m = 2$ gives monotonic phase response). Determine u from $y_m^2 = 2 + u - 3/u$; then $u = \varepsilon_1 + 1/\varepsilon_1 - 1$. Choose $\varepsilon_1\,\varepsilon_3 = 1, \varepsilon_2 = 1$. As before ε_1 and ε_3 determine cascade of the two protoypes in all-pass No. 1. For all pass No. 2, $\varepsilon = \varepsilon_2 = 1$.

4. *Case n* = 4. This case has symmetrical phase

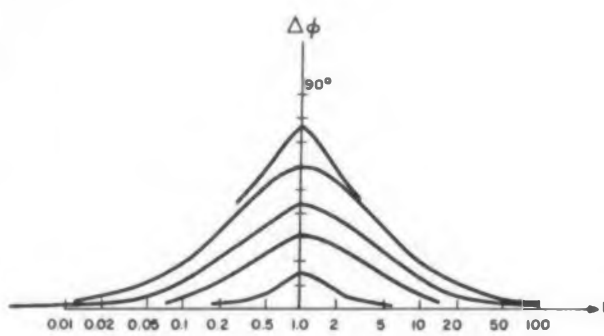


Fig. 4. Curves of the function $\varphi = tan^{-1}(2Kx/(1 + x^2))$ for various values of K. This function describes the two phase network $n = 2$ and is used in the graphical procedure for $n = 3$.

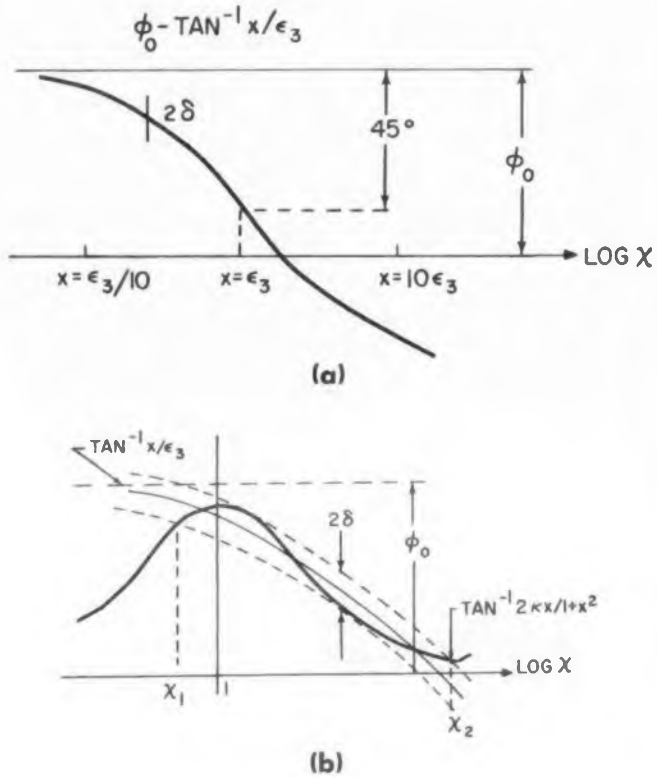


Fig. 5. (a) The function $\varphi_o - tan^{-1}x/\varepsilon_3$ vs log x. (b) Graphical solution of the equation $\varphi_o \pm \delta - tan^{-1}x/\varepsilon_3 = tan^{-1}(2Kx/(1 + x^2))$.

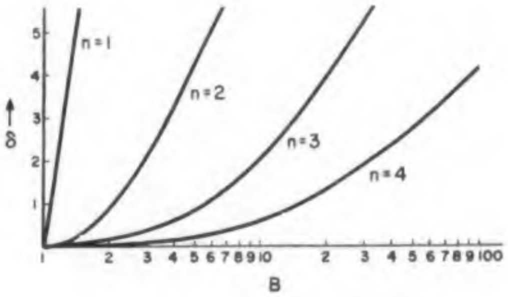


Fig. 6. Tolerance δ as a function of B and ratio $B = x_2/x_1$ for $\varphi_o = 45$ deg with n as a parameter. In networks of the type shown in Fig. 1a, the tolerance is $2\,\delta$ and $2\,\varphi_o = \varphi_2 - \varphi_1 = 90$ deg. The case $n = 1$ is trivial.

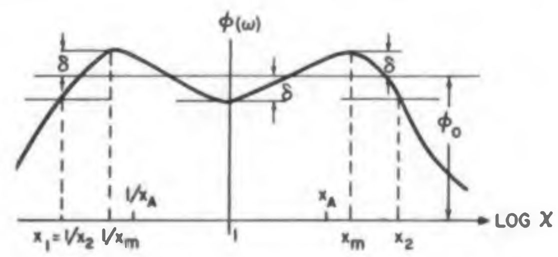


Fig. 7. Phase as a function of log x for the case $n = 4$.

characteristics (see Fig. 7). For $\Phi_0 = 45$ deg the $B - \delta$ curve is shown in Fig. 6. The bandwidth-tolerance and the circuit elements are determined from the following general formulas.

Let $$D = (\sqrt{1 + T^2} - 1)/T$$

calculate

$$y_A = \frac{2H^2}{D^2}\left[(1 - D^2) + \sqrt{(1 - D^2)^2 - \frac{4D^2}{H^2}}\right] = x_A + 1/x_A$$

and $$K = y_A\, D/2$$

then

$$y_1 = \frac{K}{T}\, y_A + \left[\left(\frac{K}{T}\, y_A\right)^2 + 4\,(1 + K^2) - y_A{}^2\right]^{\frac{1}{2}}$$

and

$$x_1{}^2 = B = \left[\frac{1}{2}\, y_1 + \sqrt{\left(\frac{y_1}{2}\right)^2 - 1}\right]^{\frac{1}{2}}$$

The all pass No. 1 is the cascade connection of the two prototype sections determined by ε_1 and ε_3 through x_A and θ. Let $\theta = \tan^{-1} K$ then

$$\epsilon_3 = \frac{x_A\,(1 - \sin\theta)}{\cos\theta}$$

$$\epsilon_1 = \frac{\cos\theta}{x_A\,(1 + \sin\theta)}$$

For the two protoype sections in all pass No. 2, $\varepsilon_2 = 1/\varepsilon_3$ and $\varepsilon_4 = 1/\varepsilon_1$.

While this general procedure can be extended to $n = 5$, 6, etc., the above cases are sufficient. From a practical viewpoint, networks more elaborate than $n = 4$ are unsatisfactory because the element values in a cascade of prototypes are of different orders of magnitude. This results in unreasonable tolerance requirements on the L and C values.

In the original paper, the R-C networks, Fig. 1b, for $n = 1$, 2, 3 and 4 are also examined. In this case, n refers to the number of zeroes and poles which the network function has on the negative real axis. The phase characteristics can be immediately deduced by using the result of the Class "A" networks: For the same pole-zero pattern but with zeroes restricted to the left half p-plane, the phase shift is half of that obtained for the corresponding L-C prototype case. Consequently, R-C networks are used over smaller frequency ranges and for smaller phase shifts that all-pass networks. The attenuation change over the effective frequency band is also given for the RC networks $n = 1 - 4$, in the original paper.

Abstracted from an article by G. Fritzsche, Nachrichtentechnik, *Vol. 8, No. 8, August 1958, pp 365-370.*

STANDARDS AND SPECS

Sherman H. Hubelbank

Reliability

MIL-STD-441, RELIABILITY OF MILITARY ELECTRONIC EQUIPMENT, 20 JUNE 1958

Effective 20 September 1958, this standard is mandatory for use by the Department of Defense for the Army, Air Force, and the Navy. The purpose of this standard is to establish a procedure for the development and design of electronic equipment to insure required inherent reliability. This procedure is to be applied specifically to the development and design of all electronic equipment, whether for use in aircraft, shipboard, ground, or other categories of special use and expendability. Probability of mission accomplishment is the most important consideration for airborne electronic equipment. A low failure rate over a long period of time is the prime consideration in ground and shipboard equipment. Highly complex (from the standpoint of numbers of parts) equipment, such as computers and large complex systems, require ultraconservative circuit design in terms of parts application and may require controlled environments in order to meet a high operational reliability for continuous operation over extended periods. Some operational requirements can only be met by equipment which is extremely small, light weight and which, as a result may have a reduced inherent reliability. Included in the standard is a complete bibliography of design guidance for use in connection with this standard.

Resistors

MIL-R-10509C, RESISTORS, FIXED, FILM (HIGH STABILITY), 29 SEPTEMBER 1958

Characteristics A and X have been deleted. Characteristic C has been added. This new characteristic provides a maximum ambient operating temperature of 125°C at rated wattage and tightened test requirements as compared to characteristic B. Resistance tolerance of 5% has been deleted. Requirements and test procedures have been added for acceleration, shock, and high-frequency vibration tests. The low-temperature exposure test has been deleted. Group B inspection tests have been modified.

MIL-R-11804C, Resistors, Fixed, Film (Power Type), 12 September 1958

Tests and requirements have been added for acceleration, shock, and high-frequency vibration applicable to the axial-wire-lead-terminal styles only. Group C inspection test has been modified. Detail specs have been issued for five tab-style resistors, and three axial-wire-lead terminal resistors.

Test Points

MIL-STD-415A, Test Points and Test Facilities, Design Standard for, 31 March 1958

A system for providing test points and test facilities to be utilized in the testing of ground, shipboard, and airborne electronic equipment has been established by this standard. This standard is intended for use in the design of new equipment and may also be used with existing equipments. Test facilities are those built-in devices which are used to facilitate installation, maintenance, operation, and calibration of electronic equipment. A test point is a convenient, safe access to a circuit, which is to be used so that a significant quantity can be measured (or introduced) to facilitate maintenance, repair, calibration, alignment, or monitoring. In designing test points, techniques shall be included for assessment of overall performance of the entire equipment. The built-in test facilities shall utilize go-no-go devices to enable rapid performance evaluation by nontechnical operating personnel. The degree of complexity of the built-in test features shall be held to a minimum. If possible, techniques incorporating anticipated failures by testing shall be used.

Transistors

MIL-STD-701(NAVY), Transistors, 15 August 1958

Included in this standard are transistor types approved by the Department of the Navy for use in the design and manufacture of electronic equipments under Navy jurisdiction. Also included are requirements for the application and utilization of transistors in Military equipment; requirements for the reporting of transistor complement information; and requirements for the reporting of the need for new transistor development. This standard as three primary purposes: (1) to provide the equipment designer with a list of transistor types considered by the Navy to be the best available for most military applications; (2) to restrict and minimize the variety of transistor types used; and (3) to outline criteria for the choice, use, and application of transistors.

Electron Tubes

MIL-STD-200D, Electron Tubes and Semiconductor Devices, Diode, 15 September 1958

This supplement covers a listing of electron tubes and semiconductor devices, diodes, which have been selected by the Department of the Navy for use, in conjunction with MIL-STD-200D, by contractors of Navy designed equipment. The basic standard includes requirements for the application and utilization of electron tubes in military equipment; requirements for the reporting of tube complement information; and requirements for reporting the need for new electron tube developments.

Enclosures

MIL-STD-108D, Definitions of and Basic Requirements for Enclosures for Electric and Electronic Equipment, 27 June 1958

An enclosure is defined as a mechanical item which wholly or partly surrounds some electrical or electronic item or group of items and is an integral part of them. Included in this standard are tests and definitions of failure to meet requirements, and an alphabetical listing of current standard and discontinued enclosures. Water tests other than submergence, gunblast tests, and submergence tests are included in tabular form.

Test Methods

MIL-STD-202A, Test Methods for Electrical and Electrical Component Parts, 28 August 1958

This change notice adds a new medium impact shock test method 205. The purpose of this method is to insure that all users of the shock-testing apparatus will use the same procedure in performing medium-impact shock tests. Instructions are also given concerning additional weights that are to be added to the elevator table when required.

Guided Missiles

MIL-E-8189B(ASG), General Specification for Guided Missiles Electronic Equipment, 15 July 1958

The philosophy of design and the general requirements for the design and manufacture of electronic systems and equipments for guided missiles are covered in this spec. All classes and types of missile-borne electronic equipment are covered by this spec. Also covered are all applicable phases of design, including research, service test, preproduction, and production.

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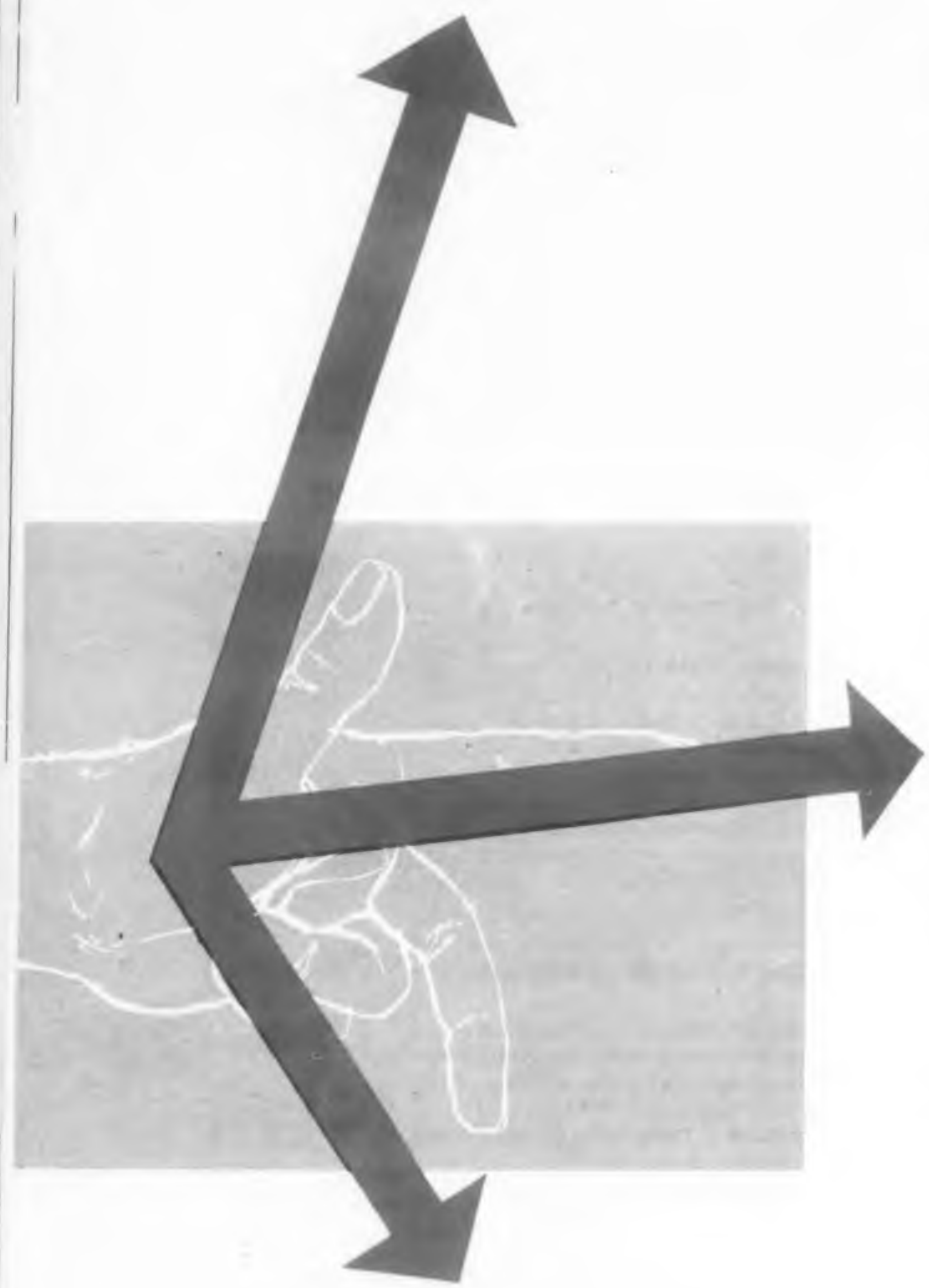

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