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DATA REQUEST PROCESS CARD
Use Before Aug. 6th, 1958

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Name: JUN 20 1958

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Reliable FRAME GRID* MINIATURE TUBES
for military and industrial microwave relay I. F. service

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*Grounded Grid Service
Tubes shown actual size

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ELECTRONIC DESIGN • June 25, 1958
Relay Conference Stresses Reliability

Ben Patrusky
Assistant Editor

Reliability continues to be the chief concern of relay manufacturers and users. There is little reason to expect improvement. The rapidly increasing stringent demands being made upon the manufacturer will outpace ameliorating effects in advances in the state-of-the-art.

At the Sixth Electromagnetic Relay Conference held at Oklahoma State University recently, one representative summed up the present situation this way:

"We are often being called upon to build relays which we are in no position to make. We build it anyway." He cited instances in which relays built for missile ground support equipment are being used in the missiles themselves.

Paul Gottfried of Inland Testing Laboratories, in a paper delivered at the Conference, explained: "Industry represented at the Conference is making the best relays it can make with present know-how . . . the best isn't enough . . .

while we're capable of determining how good a relay is when it is shipped, we cannot say how long it will stay that way."

The answer is to design reliability into the relay; it is not quality control.

Amplification of the reliability problem was offered by L. E. Massie, design specialist at Convair.

"It is safe to say that statistical evaluation (of reliability) restricts the selection of relays to high production items having an appreciable background of development and use. Many relays now being produced cannot maintain an acceptable degree of reliability. Random samplings disclose a wide variance in quality control and workmanship. This is understandable."

He explained that manufacturers rely on relay assemblers' judgments for such operations as alignment of contacts, contact pressure, and overtravel. Now with the emphasis on minia-

turized and sealed models with greater environmental performance "it is unreasonable to expect a high degree of efficiency from a group of assemblers putting in eight tedious hours a day."

Economic factors, of course, place high in manufacturers' considerations, and the frantic efforts expended to maintain similar tooling at the expense of improved but costly relays plays a highly important role.

"Reliability is basically an engineering responsibility," Mr. Massie stated, but too often the engineers' designs are "apt to be fettered and frustrated by this economic syndrome."

But relay manufacturers are not being caught with their flaps down entirely, as evidenced by several new developments unfolded at the Conference.

T. Ross Welch, manager of TC Components, described a new technique which permits reliability to be designed into the relay. Known as
### NOW — 2 New Raytheon Backward Wave Oscillators

**DOUBLE FREQUENCY COVERAGE**

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Wide, rapid electronic tuning — 1,000 Mc. to 37,500 Mc. — is one outstanding performance advantage in Raytheon's extending line of Backward Wave Oscillators. Others are: permanent magnet focusing; high signal-to-noise ratio; operation under conditions of amplitude or pulse modulation.

Raytheon Backward Wave Oscillators are gaining wide acceptance in microwave equipment applications as local oscillators for radar receivers and as signal generators.

Our development laboratories can tailor tubes for specific requirements including narrower band, lower voltage, or higher power for primary transmitter use. Any question you may have will be answered promptly, without cost or obligation.

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**MEETING REPORT**

The force-function technique, it helps the designer predict the force developed in the moving armature as a function of ampere-turns applied to the relay coil. Comparison of the two is obtained by direct readout on an x-y plotter. The technique reverses the often used method of reliability-through-statistics. Mr. Welch explained that the force-function curves measure hitherto unobtainable forces and make it possible for the designer to specify all the important parameters such as ampere-turns, amount of armature travel, contact overtravel and force, return spring action, pull-in, etc.

Mr. Gottfried and J. W. Grear of Sandia Corp. outlined step-by-step programs for producing reliable relays and eliminating inconsistencies within lots and from lot to lot.

Nor did the Conference experience a dearth in state-of-the-art progress announcements. Two new developments unveiled at the Conference—a 200 C relay and a new mounting arrangement for relays—were of significant interest.

High temperature operation of the 200 C relay is permitted since no organic materials are present on the contact space. The coil is hermetically sealed from the remainder of the relay. High immunity to vibration and shock result from the small mass and relatively high force on contacts when made. Rough calculations were reported to indicate that the relay can with-
Block diagram of force function machine for plotting force function curves. With suitable application machine permits design of reliability into relay during the early design stages.

stand some 100 g's of inertia forces to open the contact. Test results on development models indicated that the relay could perform satisfactorily at 250 C and higher. Some samples showed no deterioration at temperatures of 350 C. The relay is said to substantially meet the USAF specification (MIL-R-25018). P. N. Bossart of Union Switch and Signal Co. who described the new relay stated that there is "no reason to expect different results in production" from those obtained with development models. Production samples are expected in the third quarter this year.

Using a radically new mounting arrangement, Electronic Specialty Co. has developed a relay which is expected to optimize the performance of conventionally mounted subminiature airborne relays. As described by H. S. Woodward, the relay is mounted right in the cable runs. Leads, which are brought out of each end, serve as supports. Known as the "in-line mounted relay," it provides a very low resonant frequency for the system and increases the damping factor to a very large value. Shocks of short duration are transmitted by such a system to the central mass but reduced in magnitude by a factor of 90 per cent or more when the resonant frequency is low.

At the Conference steps were also taken by the National Association of Relay Manufacturers, who cosponsor the Conference with Oklahoma State University, to thwart the rampant confusion now surrounding the "non-standardized" industry.

The NARM established a technical committee with the aim of preparing a test code to cover all test requirements encountered by manufacturers of relays to meet the specifications required by the military and other customers."

Six subcommittees were designated to explore specific areas of testing and draw up codes in the following:

- Dry circuits
MEETING REPORT

- Measurement of electrical characteristics
- Contact life testing
- Environmental testing
- Vibration testing
- Shock, acceleration, tumbling

First reports will be made to the technical committee by June. The final report will be coordinated in time for the Electromagnetic Relay Conference to be held next year.

According to NARM President James Roughan, standardization "will do much to eliminate one of our biggest problems—lack of communication between manufacturers and users."

Roughan estimated that there are now 125 to 150 relay manufacturers who in 1957 made combined sales totaling 125 to 150 million.

Another Conference delegate, who chose to go unnamed, suggested: "It will aid us to offset the military nonsense we are subjected to by giving us definitions of our own. The military are constantly changing personnel who frequently don't know what relays are all about. These fellows write specifications. Sometimes it gets to be pretty ridiculous."

But announcement of the standardization program stirred up quite a verbal storm between manufacturers and consumers concerning the value of such a program.

One delegate from an Army installation contended: "Application is the variable causing all the confusion. To imagine that the manufacturers are going to establish general test procedures for the man who needs the relay is highly absurd. We're the guys who specify the relays and they're going to tell us how to test them."

Representing a West Coast aircraft firm, another delegate stated: "Agreed that lack of communication is a paramount problem, but standardization of test procedures by the industry itself is by no means the answer. What we need is communication on a common plane to reduce the gap in understanding between the manufacturers and users."

< CIRCLE 6 ON READER-SERVICE CARD
The relay industry must supply primarily tailor-made devices, and estimates are that there are presently 15,000 to 20,000 types in existence. And with new modifications and some radical changes due, new and different types of relays will be required demanding new and individual test procedures.

Prof. Charles Cameron of the Oklahoma School of Engineering, who is conference coordinator, asserted:

“If we knew what we wanted in a relay, at least as far as aircraft and missile needs are concerned—since this is an area quite restrained by limitations in the state of the art—about 90 per cent of the manufacturers’ problems would be whipped. We need to know how relays will perform under particular situations in particular circuits.”

(Prof. Cameron has harbored for a long time the conviction that manufacturers are not paying enough attention to transient effects on relays. He feels that test procedures are not the complete answer by any means, since relay characteristics may change from application to application. He also feels that transient analysis will play a considerable role in achieving reliable relays. He has delivered at this and previous conferences several papers concerning transient analysis of relays and their implications.)

A representative from another aircraft corporation revealed that 50 per cent of the relays they purchase must be rejected.

Generally, the industry is aware of its limitations and is striving very diligently to alleviate them. But the very nature of this electromechanical device suggests that the rewards will come only after much painstaking effort.
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- highest performance, easiest to use
- no "pre-amp" needed with many transducers
- immediate delivery; see your rep

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**dc to 200 KC—$435**

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**MEETING REPORT**

**West Coast Conference, Los Angeles**

Notable during the rash of conferences filling California’s calendar in April-May was a genuine “basic research” attitude. Reaction has set in. The consensus, all across the board, was that reliability and better components would be developed through basic research, not so much refinement and testing. Hope was high that somewhere in the new DOD reorganization there would be room for “generalized component research funds,” as Russell Varian put it at a recent AWA meeting.

Electronic Components Conference, Los Angeles

Corridor-talk between sessions was less about the theme of the conference—reliability—than technique for investigating and using component materials structure to obtain higher performance and long life.

Two gentlemen from RCA, Dale and Cunningham, evoked a great deal of interest in their exposition of “A Revolutionary Electronic Equipment Design Concept.” Briefly, Messrs. Dale and Cunningham described a microminiaturization process that carries existing compo-
Typical wafer components of the minification concept developed by RCA. Wafers are 0.3 in. square and most are 0.01 in. thick. Wafers are assembled into one unit and potted.

RCA’s approach to the microminiaturization concept exploits presently known properties of basic solid state materials. A module is constructed of small (0.3 x 0.3 x 0.01 in.) standard wafers of capacitive, resistive, insulating and semiconducting materials stacked one on top of the other, and then sealed together as one module. It is not a kind of tinkertoy, Dale and Cunningham insist.

A personal radio consisting of five modules acting as a converter, two stages

What would you expect to pay for this DU MONT scope?
MEETING REPORT

This conference was a disappointment to many of the design engineers present. As a regional affair, attendance, exhibits and quantity of technical information presented fell short of what might have been expected.

Of general interest to the design engineer: Telemeter Magnetic's Byrd and Naber's outline of the problems associated with transistorizing core memories, particularly core switch drivers and read amplifiers; and "Technique for Stabilizing an All Transistor DC Amplifier," by Cohu Electronics Research Division's Martin Klein. Dr. Klein described the use of a non-symmetric silicon transistor to raise the input impedance and stability of a dc amplifier, and matched synchronous transistor choppers driving a differential amplifier to compensate for temperature drift.

Western Joint Computer Conference, Los Angeles

Notable was a panel discussion on logical computer design methods, where the East Coast-West Coast design con-
traversy was thoroughly hashed out. As is usual in such discussions no particular resolution was made one way or the other, though again as usual, most bystanders went away with the feeling that in the future more work would be done using logical equations—the West Coast method.

Bensky of Reese Engineering and B. K. Richards, a New York consultant, speaking pro-block diagrams pointed out that the use of Boolean algebra tended to obscure physical facts and that certain components, like the flipflop and counters, do not lend themselves to algebraic expression.

Engel of Ramo-Wooldridge and Litton Industry's Hess described the use of computers for component design analysis, an important facet of modern computer design, and the avoidance of logical design errors and imprudent logical design—such as over-loading—guaranteed through proper use of Boolean equations.

Points of interest to the designer at the conference were some new ideas in circuit design:
- The combination of a vacuum tube and a transistor into a bistable device. Rudich of Amperex Electronics chose a low power indicator tube (the 6977 subminiature) to serve as an active element as well as an indicator. He achieved a power output of 200 mw in a circuit with a trigger requirement of 30 µv.
- A novel gating scheme using one diode to connect two circuits. W. J. Popelbaum of the University of Illinois calls the technique "flow gating." It halves the hardware requirements of a flipflop complex. In this technique the gating is done by changing the supply that operates the bistable device—the average potential of the two circuits is adjusted so that information flows through the diode.
- New ways to use some of the shortcomings of diodes to advantage. Litton's Retzinger uses the carrier storage of a cross-coupling junction diode to speed up a flipflop.

Of interest to the chess enthusiast was the description of a chess playing program for the IBM704. Bernstein, Arbuckle and Belsky, all of IBM, showed a program which recognizes and can make all legal moves—with no restrictions on castling, promotions or en passant captures!
Army '59 Electronics Disappointing

Recently released hearings reports on the FY '59 appropriations for the U.S. Army show it running a poor third to its sister services, especially in electronics. It is estimated that the Army will spend about $665 million on electronic equipment, services, and rentals. That’s less than 7 per cent of the total $9 billion appropriation. Meanwhile, the Navy is asking for about $1 billion (10 per cent) and the Air Force, more than $3 billion (10 per cent), to buy electronics.

The Army’s $665 million is deceiving. The sum reflects overall costs—personnel, facilities, lease rents, etc.—and not hardware and equipment purchases alone. A rough breakdown of the areas in which procurements are to be made shows:

- major procurements, missiles and equipment, $285 million;
- operation and maintenance (O&M), $200 million;
- R & D, $80 million;
- security equipment, $20 million;
- aircraft electronics, $12 million;
- training devices, $5 million;
- Army-wide communications services, $60 million.

The major procuring agency for electronics, as would be expected, is the Army Signal Corps. The $565 million it hopes to receive will be divided among studies, tests, personnel charges, and many other non-hardware costs, as well as the electronic and photographic equipment.

One challenging area in which the Army plans to devote effort is electronic warfare. Involved here is equipment to jam enemy projectile, and missile fuses. Also countermeasures to divert and confuse receivers in enemy drone systems, navigational aid equipment, and surveillance radar.

No matter what accounting system is used, it looks like the problem the Army had last year in finding money to equip its Pentomic troops and modernizing its overseas forces will remain with it this year. The small funds allotted to the procurement of simple hardware is deplorable. But of significant importance is the fact that inadequate R & D apportionment will prevent any positive advancements in the basic sciences vital to the existence of the U.S. Army.
Value Engineering—A Boon

Under the leadership of the Navy Bureau of Ships, many more military departments are becoming aware of "value engineering." A similar awakening is occurring in industry. General Electric stimulated the idea in the Navy, and it has since been picked up by a growing number of companies. Presently the topic is even being included on the agenda of meetings and symposia. And the Industrial Education Institute is planning a series of one-day meetings across the nation. The mission: to acquaint industry with the merits of value engineering.

Actually, value engineering is merely the studious application of common sense to the design of a piece of equipment before it is built. Or even common sense applied to existing equipment. The goals are simply to cut cost and complexity while achieving the desired performance. By total cost, the Navy means the combined cost of buying, installation, operation, and maintenance. Recognition is given to the fact that specification writers too often overwrite requirements in terms of practical need. However, the company designer, charged with making hardware out of the words, is in a better position to see where the spec writer went overboard.

The Navy is going all out for VE. MIL-V-19553 (SHIPS) is designed to make value engineering a requirement for all BuShips contracts. The Navy pays for the cost of value engineering a product. Moreover, the contractor will be able to share in the savings accrued to the Navy.

In terms of money, the Navy estimates that "actual savings . . . documented (were) $3.30 for each dollar spent on Value Engineering in fiscal year 1957."

Electronics R & D Widespread

By some standards, the value of R & D in this country amounts to more than $12 billion. This includes government, industrial, and university sponsored programs. The National Science Foundation sets that value closer to $5 billion.

To help anyone interested in obtaining R & D assistance, the Foundation recently published the Directory of Independent Commercial Laboratories Performing Research and Development. The document lists 565 independent commercial laboratories that are engaged, at least in part, in R & D activities. It is considerably more restricted, NSF says, than the National Academy of Sciences-National Research Council's Industrial Research Laboratories of the United States.

Copies of the Directory may be purchased for $0.40 from the Superintendent of Documents, Government Printing Office, Washington 25, D.C.

Rome Cable reports . . .

DuPont Mylar® helps eliminate reject problem in manufacture of cable for "Titan" ICBM

PROBLEM: In designing its instrumentation cable for the "Titan" ICBM project, Rome Cable Corporation wanted a thin, abrasion-resistant tape to protect the insulated conductors from possible puncture by loose strands of the tin-copper braid (See C in illustration). They were also searching for a thin, heat-resistant binder tape to prevent possible puncture from the outer braid (See A) during extrusion of the cable jacket.

SOLUTION: A tape of Du Pont "Mylar" polyester film for both applications (See B&D). Reason: "Mylar" has the desired balance of mechanical and electrical properties . . . it's tough, abrasion- and puncture-resistant, even in thin gauges. "Mylar" has a high melting point . . . runs well on existing machinery.

RESULTS: The two tapes of "Mylar" eliminated shorted cables due to puncture from loose strands of metal. Solving this problem has helped Rome Cable stabilize production, save money on time and materials and produce a cable that assures better performance and greater reliability in the ICBM.

How can "Mylar" help you? Whether you manufacture heavy-duty cable or tiny capacitors, it will pay you to evaluate the combination of properties found only in "Mylar". And when figured on an area basis, this tough, thin polyester film will often cost less than your present insulating material. For more detailed information, send in coupon.

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Please send the new booklet listing properties, applications and types of "Mylar" polyester film available (MB-11).

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HIGH DIELECTRIC STRENGTH. Average of 4,000 volts per mil . . . average power factor of 0.003 to 0.05 cycles . . . dielectric constant above 3.0 at 72°F, 1,000 cycles.
**MEETINGS**

**July 24-25:** 5th Annual Symposium on Computers and Data Processing

Albany Hotel, Denver, Colo. Sponsored by the Denver Research Institute, Electronics Div., University of Denver. Symposium will consist of technical papers on basic problems in the field of data processing, particularly in the areas of formalized analysis techniques, logical design techniques, automatic programming, systems organization, digital communications, and components and devices. Queries concerning the symposium may be addressed to C. A. Hedberg, Head, Electronics Div., Denver Research Institute, University of Denver, Denver 10, Colo.

**Aug. 6-8:** Special Technical Conference on Non-Linear Magnetics and Magnetic Amplifiers

Hotel Statler, Los Angeles, Calif. Sponsored by AIEE. The four technical sessions will include: technological and theoretical aspects of non-linear magnetics and magnetic amplifiers; computer applications; special purpose devices and applications; and "new frontiers" in the field. Exhibits will be displayed by 40 manufacturers selected for their contributions to the industry. For more information about the conference, write AIEE, 33 West 39th St., New York 18, N.Y.

**Aug. 13-15:** 7th Annual Conference on Industrial Applications of X-Ray Analysis

Albany Hotel, Denver, Colo. Sponsored by University of Denver, Denver Research Institute, Metallurgy Div. For additional information write William M. Mueller, Metallurgy Div., Denver Research Institute, University of Denver, Denver 10, Colo.

**Courses—Seminars**

**July 7-11:** Institute in Technical and Industrial Communications. Colorado State University, Ft. Collins, Colo. Further details may be obtained by writing Herman M. Weisman, Associate Professor, Department of English and Modern Languages, Colorado State University, Ft. Collins, Colo.

**July 8-12 and July 14-18:** Two Special Summer Programs on Strain Gage Techniques. Massachusetts Institute of Technology, Cambridge 39, Mass. Additional information may be obtained from Dr. William M. Murray, Professor of Mechanical Engineering, M.I.T.

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CIRCLE 14 ON READER-SERVICE CARD
EDITORIAL

Must We Start From Scratch Each Time?

The benefit of standardization is a popular theme of the Defense Department. The case for using standardized parts is pretty clear. Standardizing equipment is usually out of the question if the state of the art is advancing rapidly. An in-between approach to standardization is to standardize the design approach. This editorial and several to follow will examine this concept.

Standardization of design steps has been suggested as feasible even for such a volatile field as digital computers for weapons systems. J. M. Bridges of ASOD has asked the computer industry to get away from designing from the ground up every time there is a new project thrown at them. A step in the right direction would be settling on standardized construction techniques and standard circuits. Designs adopted should permit change. They should be flexible to take advantage of technological advances as they happen. Possibly it's not too much of an oversimplification to believe that design techniques could change in a step pattern—where engineering would use a certain set of circuit designs for a time, then, after a significant contribution of the art comes along, change to the next better step.

The standardization advocated by Bridges is a living thing. It does not stifle, nor does it allow each engineer to go off in his own direction each time he sits down with a slide rule. Bridges asked industry to take the lead in establishing standards.

Electronic Design polled computer manufacturers some months back to get their reaction to this concept. We asked (1) what areas of computer design were susceptible to circuit standardization, (2) if physical modularization on a standardized basis could be accomplished, (3) for specific recommended standards. We also asked how to accomplish all this, or if it is too premature to think of standardizing.

The consensus of opinion was:

- It is too premature to standardize on any specific aspect;
- Some philosophy of flexible standardization is desirable and should be undertaken;
- If anything is to be done, the Defense Department must show the way.

The range of answers went from "impossible" to "we are doing it now." In future editorials we will examine replies in detail which point to better design. The problem is well stated by J. H. Bigelow of the Institute for Advanced Study in Princeton. To paraphrase Mr. Bigelow: Standardization will never be achieved as a goal—we can only provide incentive for its inclusion in planning, research, development, and production. Heretofore the first three stages have been all but ignored.

[Signature]
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Output Voltage ........... 0.3 volt.
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Tracking Pressure ........ 5.7 grams.
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Electronic Applications Division, Dept. CCG-48
ELMSFORD, NEW YORK
CIRCLE 15 ON READER-SERVICE CARD
Minimize Local Oscillator Drift*

W. Y. Pan and D. J. Carlson
R.C.A. Victor Television Division
Cherry Hill, N.J.

Part 1

Conventional methods of frequency compensation and frequency drift measurement are inadequate in the face of the stability and reliability needs of modern complex receivers. Analytical approaches provide better ways to measure and minimize local oscillator drift.

VIRTUALLY every parameter of a local oscillator system has some effect on the operating frequency. Five significant factors affect the parameters, and hence the oscillator frequency.

1. Harmonics—Harmonics generated in a local oscillator cross modulate each other and the fundamental to produce currents at the fundamental frequency that are not necessarily in phase with the fundamental frequency currents from the normal mode of operation. The phase of the resultant fundamental frequency current changes the frequency of operation. This becomes sensitive to the amount and distribution of harmonics in the circuit. A tuned circuit with a high Q can minimize the effect of harmonic voltages on frequency stability.

2. Input-Power Fluctuations—Fluctuations in line voltage, change the amount of power being supplied to the oscillator tube. This affects the temperature rise of the tube electrodes as well as the tuned-circuit elements. In addition, any input-power fluctuation alters the phase relationship between electrodes thus producing an instantaneous shift of the oscillator frequency.

3. Secular Effect—In most tuned circuits, the operating frequency changes with the passage of time, even if the temperature and other conditions are maintained constant. This secular effect is often referred to as "aging." It is present to a greater or lesser extent in all known tuned circuits and tubes but may be held to a minimum by a choice of materials which are inherently stable.

4. Humidity—The conductivity, dielectric constant, and dielectric strength of air are affected by its pressure and humidity. Therefore, the frequency of a tuned circuit with air dielectric components is a function of these variables. Moreover, the mechanical dimensions of coil forms and supports often change with humidity. Precise control of frequency is, accordingly, possible only if suitable precautions are taken in the construction of the circuit elements.

5. Ambient Temperature Rise—The frequency deviation of an oscillator resulting from ambient temperature rise is commonly known as "warm-up drift." It is the principal and unavoidable cause of frequency instability in practically all receivers.

How to Record Frequency Deviations

Heretofore, measuring oscillator warm-up drift was done by tracking the oscillator signal manually. An operator was required during the entire drift run. Sudden changes in oscillator frequency were often missed.

The operating principles of the automatic and continuous recording equipment are shown by the block diagram in Fig. 1. By using broadband networks in the rf unit, dependence of the recording equipment on the tuner local oscillator is eliminated and only the detected sine-wave difference-signal is used in the video unit. The sine wave is shaped into a square wave and later rectified. The dc output is directly proportional to the frequency deviation of the local oscillator under test.

Fig. 1. Automatic frequency deviation recording apparatus.

*By courtesy of Product Engineering, Radio Corporation of America.

Fig. 2. A sample recording of local oscillator drift.
The equipment sample temperature-sensitive. Therefore, the oscillator frequency drift is caused only by the variations of tube capacitances.

Analysis of Local Oscillator Drift

Oscillator-Tube Drift—The heat flow in an oscillator tube depends on the instantaneous temperature of the hot bodies, the geometry of the tube elements, and other factors. The instantaneous cathode-to-grid radiation, for instance, is

\[ Q = \alpha (1 - e^{-\beta t}) \]  

where
- \( t \) = time
- \( \alpha \) = total radiated power
- \( \beta \) = a time constant, determining the rate of heat flow from the cathode to the grid.

The cathode-to-grid radiation raises the grid temperature which transforms the grid configuration and geometry.

The resultant physical changes taking place in the grid structure cause deviations in interelectrode capacitances and hence the oscillator frequency. For small frequency deviation (\( \Delta f \)), the expression for \( \Delta f \) takes the same form as Eq. (1), except that \( \alpha \) = the maximum oscillator-frequency deviation and \( \beta \) = the rate of change of oscillator frequency.

The frequency characteristics of the 525 mc sample oscillator recorded in Fig. 2 can be represented analytically

\[ \Delta f = -0.750 (1 - e^{-0.4t}) \]  

where
- \( \alpha = -0.750 \text{ mc} \)
- \( \beta = 0.4 \)

and the time,

\[ t = 0 \] when the local oscillator has been energized exactly one-half minute to enable the receiver to attain operable conditions.

To determine the value for \( \beta \), a point corresponding to 0.632a is located on the curve in Fig. 2. The time required at that point is the reciprocal of \( \beta \). The dots drawn along the recorded curve are calculated from Eq. (2), and the accuracy of the analytical representation is believed to be good enough for all practical purposes.

Circuit-Element Drift—The general analytical expression of Eq. (1) applies also to any circuit element that is temperature-sensitive when it is subject to the flow of heat. When several such elements form parts of a local oscillator circuit, the frequency drift caused by each element must be expressed by an exponential equation; thus the overall frequency deviation \( \Delta f \) becomes

\[ \Delta f = a_1 (1 - e^{-\beta_1 t}) + a_2 (1 - e^{-\beta_2 t}) + \ldots \]  

However, when the relative magnitudes of \( a_1, a_2 \ldots \) vary substantially, or the values of \( \beta_1, \beta_2 \ldots \) do not differ too much, the overall frequency deviations for all the circuit elements can be approximately given by

\[ \Delta f = a (1 - e^{-\beta_t}) \]  

Part 2 of this article will show a practical stabilization procedure.
WHEN YOU BUILD MicroMatch Directional Couplers into your transmitters, you add an invaluable feature at extremely low cost—positive confirmation of transmitter performance. Your customers stay sold by the coupler's continuous RF Power indication.

Its VSWR monitor, in addition, stands watch over your customer's transmission line and antenna.

Now incorporated in most modern Government and commercial transmitters, MicroMatch Directional Couplers produce an output essentially independent of frequency. Units are available for use within the range of 20 to 4000 megacycles. Couplers are adjusted to produce full scale meter deflection at power levels of 1.2 watts to 120 KW. Accuracy of power measurements is plus or minus 5% of full scale.

For complete details on the MicroMatch line of monitoring equipment, write for our 68-page catalog.
COMPACT, 3-OUNCE TIME DELAY Relay
with silicone-controlled delay from 1/4 to 120 seconds

Worth a closer look... the Heinemann Type A Silic-O-Netic Relay. Despite its small overall size, the relay offers many big performance features.

For example, double-pole, double-throw switching... at fast snap-action contact speed.

The relay is a load carrier in itself: it may be energized continuously... does not require auxiliary lock-in circuits.

And it has a hermetically sealed time element that is forever free from the effects of aging or fatigue. The Type A Relay has proven itself in countless applications; it will give you reliable service over a long, long operational life.

**BRIEF SPECS**

Time Delays: from 1/4 to 120 seconds

Overall Dimensions: 2-1/16" x 2" x 1-9/16"

Contact Capacity: 3 amps at 120V AC, 1.5 amps at 240V AC (non-inductive load), 1 amp at 50V DC, 0.5 amp at 125V DC.

For full details, refer to Bulletin T-5002. A copy will be sent on request.
Magnetic Toggle Relay

Holds Without Holding Power

WITHOUT mechanical latching, or electrical holding power, this relay is always in a fully energized position. Designed by American Monarch Corp., 81 Lowry Ave. N.E., of Minneapolis, Minn., it represents a radical departure from conventional relay designs—the first in many, many years.

With the same coil, the new relay operates from ac or dc voltages, and from 1 to 115 v. Unlike former relays, this one is pulse operated, and has two very stable positions. When the coil is pulsed with a voltage of the right polarity, the relay switches, and stays in the new position. Another similar pulse has no effect. A pulse of the opposite polarity is needed to switch the relay.

Two permanent magnets hold the Magnetic Toggle Relay (MTR) in either of its two normal positions. The coil armature acts as the magnet keeper. The ends of the armature are magnetically polarized when current is applied to the coil.

If a pulse creates an armature field to oppose the permanent magnet's field, the armature is repelled from one pair of poles and attracted to the other. That's what makes the relay toggle.

While the MTR can operate with a continuous current, it is basically a pulse operated device. A typical unit with a 100 ohm coil will toggle in 4 msec with 20 v applied. The operating pulse, in this case, provides 16 mw-sec. If 100 v...
Magnetically held relay in cutaway view.

were applied, the relay would pull in faster.

Since the MTR is a completely new approach to relay design, there are places where it will not fit in existing circuitry. But its advantages are many.

In a conventional relay, coil power must be enough to pull in the spring-loaded contact assembly, and overcome contact pressure and external forces acting on the contact assembly, like shock, acceleration, and vibration. The MTR is free of these requirements.

- It doesn't have the unreliable dropout point of conventional relays.
- It requires no holding power.
- It operates over a wide voltage range—and fast.

Its rotating action can drive normal contact assemblies, sliding contacts, rotary switch type contacts, leaf types, and others.

It can even be toggled manually, to generate a high energy pulse.

For more information on the MTR, turn to the Reader-Service card and circle 18.
'DAG' COLLOIDAL GRAPHITE...
FOR BETTER PRODUCT DESIGN

High-purity, electric furnace graphite, colloidally dispersed in a variety of liquid carriers — this is the product gaining increasing use in the electronics and electrical manufacturing industries. Design Engineers acquainted with the unusual properties of 'dag' colloidal graphite are adapting this versatile material to solve design problems that heretofore were difficult to overcome in any other way.

Films formed with dispersions of colloidal graphite are chemically inert, non-fusible, electrically and thermally conductive, and resistant to electron bombardment. In addition, it is one of few conductive materials having excellent lubricity.

Conductive coating for grids and plates in vacuum tubes

The excellent thermal-radiation properties of graphite help keep grids cool enough to prevent undesired primary emission. The low photo electric properties of graphite render properly coated parts practically free from the effects of such electromagnetic radiations as light, X-rays, etc. Applied to grids (and frequently to plates) of thermionic tubes, a graphite coating offers protection from the impact of primary particles since it is resistant to electron bombardment. This greatly reduces or entirely eliminates emission of so-called "secondary" electrons.

Colloidal graphite can be applied directly to parts which need not have undergone such preliminary treatments as acid etching, sand blasting, or oxidation. Where radiation effects are desired, it should be remembered that surfaces which are rough, as well as black, radiate more effectively. Graphite coatings can be applied by such convenient methods as dipping, spraying and brushing. Continuous strip stock for plates, for example, may be coated by guiding the strip into a dip tank, then withdrawing past wiper blades and through a drying tower. Graphite coatings on grids or plates are used in various types of power-amplifier tubes to increase radiation or reduce secondary emission.

before they build up to the danger point. Dust-collector bags used on pulverizing, abrading and grinding equipment also are coated with colloidal graphite in alcohol to eliminate this same fire hazard. Graphite dispersions applied to the pulley side of high speed drive belts also hold static electric charges in check. There are many more uses for 'dag' colloidal dispersions in electronic and electrical applications. Write for Bulletin No. 433 or call in your Acheson Service Engineer for his recommendations. They can prove profitable. Address Dept. ED-48.
It may seem silly to spend time “designing” a parts board. If you have such an idea, this article should dispel it. There are real design considerations involved—particularly if good equipment reliability is important. Every designer should find useful suggestions in Mr. Smith’s presentation.

The board on which electronic parts are mounted (other than a printed-wiring board) usually consists of a rigid insulation material in sheet form containing solder-type terminals to support and connect small pigtail-mounted electronic parts to the equipment’s internal wiring. This board sometimes referred to as a mounting strip or terminal strip, is often used for locating parts to make them more accessible for test and replacement, relieving crowded distribution of parts at tube sockets and other areas of complex wiring. When small parts must connect to other small parts and leads, the use of parts boards with the desired arrangement of terminals simplifies wiring. Also, the use of a parts board with flexible wires to tube sockets assures that the relative motions at tube-socket pins will not be transmitted to the pigtail leads.

Only parts which are connected by pigtail leads would logically be used on parts boards. These pigtail-type parts include fixed resistors of all types with two-watt ratings or less, fixed capacitors of paper, mica, glass, ceramic and tantalum, semiconductor diodes, and pigtail-type r-f chokes.

Since one of the main reasons for using parts boards is to effect increased accessibility, parts and wiring should not be placed on both sides unless there is adequate accessibility on both sides. Parts and wiring must be accessible for both visual inspection and for replacement of parts. Accessibility is most important to both fault location and maintenance.

Choosing the Material

The choice of material for parts boards mainly involves considerations for environmental effects. These environmental considerations include dielectric loss of the board material, insulation resistance, mechanical strength or its ability to flex and withstand impact, effect of moisture on electrical properties, fungus resistance, and dimension stability. Other considerations which tend to compromise the choice of materials are ease of fabrication and relative cost.

Some military specifications require the use of laminated sheet, silicone resin, glass cloth (Type CSG, spec. MIL-P-997) in critical circuits where high impedances (above 1 megohm) must be maintained and where the board temperatures exceed 110 C. Laminated sheet, melamine resin, glass cloth (Type GMG, spec. MIL-P-15037) is the second choice. However, both of these materials are difficult to machine. Drills and cutting tools wear out quickly on these materials.

Laminated sheet epoxy resin, glass cloth (Type GEE, spec. MIL-P-18177) is a good compromise in the choice of board material in most applications. Its electrical properties are good and it is easier to machine. Phenolic resin laminates largely have been disqualified because of poorer electrical properties, although they are less expensive and are quite easy to fabricate. How-
ever, some progress is being made in the improvement of their electrical properties and may eventually result in their acceptance as a reasonable compromise for use in less critical applications.

Military specifications preclude the use of paper, cotton, or linen base laminates as electrical insulation because of moisture absorption and fungus nutrient capabilities. The accompanying table gives a ready comparison of the materials mentioned.

Size Limitations

There are almost no size limitations for parts boards. They should be large enough to hold the necessary parts and small enough to fit within the space available. The board materials should be of sufficient thickness to minimize flexibility and to keep the board’s mechanical resonance from becoming so low as to fall within the range of environmental vibration. The thickness should be greater on boards with larger slenderness ratios (board length $\div$ width). The usual thickness of a typical board (2-1/2 x 5 in.) is 3/32 in.

Supporting the Board

The method chosen for the mechanical support of a parts board should be such as to adequately hold it in place and minimize relative motion to the chassis under intended environmental motion. Both rigid support at the bottom and lateral support at the top of the board is best in order to raise the natural resonance of the assembled board structure as high in frequency as possible and to limit motion similar to that of a vibrating reed. Cantilever brackets should be avoided unless the base of the brackets at the chassis is broad in dimension, perpendicular to the board length, or an additional bracket is placed at top to achieve lateral rigidity.

Selecting Terminals

The choice of terminals involves considerations on terminal size, capability of being rigidly anchored to the board, terminal material, plating, solder adherence, and the method of parts interconnection. Single-ended terminals are used when parts are mounted on only one side of the board and double-ended terminals for mounting parts on both sides. Acceptable terminals are made of brass suitably plated to increase ease of soldering. Since silver plating tarnishes easily, gold plating is frequently preferred. Terminals made of steel or ferrous metals are not suitable. Unsatisfactory terminals for parts boards include those punched from sheet stock or leaf terminals and those stud terminals intended to be mounted by a press fit in a hole. Such terminals are unsatisfactory because they are insufficiently anchored to the parts board.

Globe Industries announces a new precision miniature d.c. motor, the smallest we have made. Like all Globe motors, it can be modified easily and quickly to meet your electrical and mechanical requirements. It is called the VS, and takes its place with the SS, MM and LL in Globe’s family of superb quality motors.

The VS weighs 1½ ozs., is ¾ in. thick. A breakthrough in miniaturization, it can deliver .2 oz. in. of torque at 10,000 rpm and is the first precision motor of its size available. Multiple units can be gang-mounted in modules.

The fastest way to get full technical data on the VS motor is to phone or write direct: Globe Industries, Inc., 1784 Stanley Avenue, Dayton 4, Ohio. Telephone Baldwin 2-3741.
Some of the more preferred types of terminals are shown in Fig. 1. The type A terminal is the universal type preferred for the majority of applications where parts are mounted on only one side of the board. It is a combination slotted, ferrule, and sleeve terminal. Connecting wires may be placed through the sleeve, in the slot, or around the terminal between the ferrules. Jumpers and connecting wires can be connected through the sleeve, leaving the slot and grooves for pigtail leads. The terminal is mechanically strong and when properly installed is largely immune to rotation and twist. It is stronger than other split types and is less bulky than stud-type terminals. It is probable that the military will modify specifications to permit soldered connections to be made without mechanical joints\(^1\)\(^2\) for which this terminal is ideally suited since parts leads merely would be placed in the slot and soldered.

Types B and C are stud or turret terminals. Their use is limited to wrap-around wire connections, but they have the advantage of not requiring rotational alignment during assembly. The double type C terminal is necessary where parts are required to be mounted on both sides of the board. Type D is a miniature terminal, similar to type A, intended to be used where space is limited and where parts are small.

**Locating the Terminals**

The parts should be logically arranged for minimum wiring, simplified interconnections, and the reduction of undesired coupling between parts. The terminals should then be located to accommodate the parts and to give them the best mechanical support possible. Standard parts boards with their uniform spacing of terminals have their place in breadboard and experimental models of electronic equipment; but, on prototype and final models, the parts board and placement of terminals should be tailored to fit the parts.

Terminals, widely spaced, requiring long leads on short parts, allow motion under shock and vibration like that of a plucked violin string. With the terminals moved in closer to the part, the mounting is stiffer, restricting the amplitude of resonant-string type motion. In general, the clearance between the soldered connection at the terminal and the body of the part should not be less than 1/4 in., and the combined length of both leads should not exceed 1 in. in total length.

The spacing of adjacent terminals, separating mounted parts, should be such as to accommodate the diameter or width of the parts. There should be sufficient clearance between parts to allow each one to rest against the board. Some military specifications also limit the closeness of adjacent terminals to not less than 1/4 in. for reasons of minimum leakage resistance.

**Mounting the Parts**

Parts should be placed between the terminals in such a manner that the limitations of lead length are not exceeded. In mounting parts, the leads should be reasonably straight but not stretched. A false impression has long existed that pigtail leads should contain a thermal expansion joint similar to that used in long steam pipes. This is wrong. The expansion of the part and lead with temperature seldom exceeds 0.003 in. and is not enough to be a problem. Furthermore, the expansion joint is detrimental in that the tools used to form the loop make nicks in the wire causing stress points which precede and accelerate lead breakage. Also, the unnecessary lead length allows more lateral motion of the part under shock and vibration which expedites breakage of the leads.

The leads should not be stretched while wiring to the terminals. Many part failures can be traced to stretched leads (like a man’s arms pulled out of their sockets) which disturbs the internal lead-to-part junctions and paves the way for a future part failure. It is also unnecessary to wrap the pigtail tightly around the terminal with a turn and a half or so. Actually, by bending the lead slightly more than a quarter turn (not to exceed a half turn) adequate mechanical support results and, when soldered, the mounting and continuity will withstand any military environment. (It is expected that military specifications will soon adapt this arrangement.)

**Anchoring Large Parts**

When mounting large parts by their pigtails, their size and weight allows great lateral displacement, enabling the part to vibrate through wide resonance excursions due to vibration. The mechanical resonance is usually so low as to be within the frequency band or environmental motions. The movement of the parts fatigues the leads which eventually break. Such parts should be clamped to the board by means of cable clamps of nylon or metal. As a general rule-of-thumb, parts larger than 3/8 in. diam and 1 in. in length should be clamped to the parts board. Some military specifications require that parts larger than 1/2 oz be clamped to the board.

The preferred clamps, as specified in MIL-STD-242A (SHIPS), section 501.1, are made of nylon or rubber covered metal. The commercial cadmium plated steel cable straps (Cinch No. 85 or equal) are also quite effective and have the advantage that the parts are clamped against the parts board itself. This closeness prevents relative motion between the parts, the board, and the terminals.
Metal mounting clips, similar to fuse clips, have been used to anchor parts on boards, but have the disadvantage that they space the part away from the board. Usually, it becomes necessary for the pigtail leads to be bent down to connect to the terminal. With parts of large diameter this is quite serious. When using such clips, there is still the possibility that under environmental motion, tension and bending motions will be applied to the leads.

Avoiding Heat

Heat emitted by mounted parts is usually low. Since resistors are usually derated up to fifty percent for reliability considerations, it is not likely that they will produce much heat. The main sources of heat are the operating environment, equipment ambient temperature rise, and heat radiated by adjacent parts such as tubes, power resistors, and transformers. Heat caused by thermal radiation from nearby parts may be reduced by use of metal baffles between the source and the parts board.

Marking The Part

All parts on the board must be identified by markings of reference designations (i.e., R203, C201) to facilitate fault location and parts replacement. Each marking should be located adjacent to the part but not obscured thereby. The location should cause no confusion as to which part is identified. Generally, preference is for the reference designation to be placed just below the right hand pigtail lead and parallel to the axis of the part when the board is viewed from one end. Specifications require that these markings be permanent and legible. Suitable marking processes include silk screening, stencilling with smudgeproof ink covered with a coat of clear lacquer, stamping, and engraving. If cross or interconnections on the parts boards are made by etched or printed wiring, the parts marking likewise might be made by the etched or printed wiring process.

A reference designation for a parts board itself is the letter "A" (i.e., A108), as it is the reference designation letter for structural parts or mounting devices. Since the parts board is intended to mount a group of parts, it fits the specification definition as being a mounting structure. This designation should be located on the board and also on the equipment chassis or supporting structure near the parts board.

Hughes medium power, silicon rectifiers

The exceptionally high efficiency of these rectifiers, obtained by advanced development and construction techniques, makes possible power supply design which was previously impossible. Efficiency like this means less power loss in the rectifier and, for a given size of rectifier, more power to the load. Cooler operation also results, thereby contributing increased life since there is less heat to dissipate.

In most instances, the voltage drop across the rectifier is so small—and it is constant throughout the life of the rectifier—that it may be neglected in power supply design. The low drop improves regulation of the power supply too.

So specify the types listed at right and capitalize fully upon the advantage of high rectifier efficiency. In addition to the types shown, Hughes has two groups of IN-numbered units, one with a lead-mount configuration and the other in the standard JEC 1/16" hex package.

References


Hughes Electronics, Inc.

Creating a new world with ELECTRONICS
SNAPS BACK
Reclaiming spring forces grip down. Holds it firmly in place against surface.

NO PINCING
Handle back plate design permits grip to lift to 90° position. Keeps fingers free.

EXTRA STURDY
Easily attached, each handle is strong enough to lift 200 lbs. with ample safety factor.

BEST HANDLE YET FOR INDUSTRIAL CONTAINERS, CARRYING CASES OR ELECTRONIC EQUIPMENT!

Meets Military Specifications C-4150A and T-945A
There's nothing fragile about this handle! It's strong, rugged, rattle proof, rust and corrosion resistant. Made of tough stainless steel and heavy-gauge anodized aluminum, it will lift 200 lbs. with a big safety factor in reserve.

This Bendix handle has proven its superiority on military and industrial carrying cases, shipping containers and on electronic equipment. The special grip sleeve will not crack, chip, become sticky or tacky in temperatures from \(-65^\circ\) to \(+160^\circ\)F. Our patented design eliminates pinching, holds grip firmly against surface when not in use. Attaches easily with nuts and bolts, welding, etc.

Write today for complete specifications and quantity discounts. Bendix-Friez, 1404 Taylor Ave., Baltimore 4, Maryland.

Friez Instrument Division

CIRCLE 23 ON READER-SERVICE CARD
Save design time with a Miniature Servo Breadboard

AFTER you've tested the servo sub-assemblies, you can just slide them together to check the system performance. That is—if you use the new "Micromation" servo breadboard, this board is easy to assemble, and enables you to observe the dynamic performance of miniaturized servo systems.

Previous breadboards required time consuming parts placement before a system could be checked. Often, special parts and fixtures had to be made up. If a servo motor, synchro, or potentiometer required isolation from the system for separate checking, a troublesome parts-jockeying procedure was called for.

With the system just developed by Waldorf Instrument Co., Huntington Station, N.Y., individual servo subsystems can be integrated into a complete system by mounting frames in tandem, in over-under fashion, or both. Components can be isolated or slipped into position easily and quickly by loosening a pair of screws.
The breadboard system has a 6 or 8 in. long frame, to which all components are secured; a stand to support one or two frames vertically; a rotary component mount for size 5, 8, 10, or 11 servo motors, synchros, or pots; and a bearing mount assembly which includes a bearing block and flanged stainless steel ball bearings with a pinion or plain shaft.

The system also includes a transfer gear assembly to mesh two gear trains mounted in frames where one frame is mounted over the other; an electronic component mounting assembly to hold a specially designed servo amplifier, power supply, and transformer, and a pair of standard terminal boards. Also included are an assortment of spur gears, pinion shafts, or plain shafts.

The breadboard makes it possible to complete closed loop, final test data prior to production engineering, with the same rotary components, gears, shafts, and spacings as are used in the final assembly.

For more information, turn to the Reader-Servic card and circle 24.

Rotary component mount. Hole diameter is varied to accept size 5, 8, 10, or 11 components.

Bearing mount assembly with pinion shaft.

Transfer gear assembly is used when frames are mounted in over-under fashion.

**maintain and control reliability**

**with new**

**PRE-PROGRAMMED INSTRUMENTATION**

**NEW ROBOTESTER — IMMEDIATE AID TO IMPROVE MAINTAINABILITY OF EQUIPMENT RELIABILITY**

A bold imaginative concept has evolved from Lavio Labs in the form of a Programmed Instrumentation Approach with Failure Prediction. Designed for the active control of maintainability and reliability of electronic equipment in aircraft, missile and weapon systems.

The universal-tape programmed performance checking Roboter is versatile and flexible and is the basis of this forward-thinking Lavio program.

The Roboter itself expands checkout capabilities and slashes 80% of final test time. Operational testing and production line check out is accomplished through continuous, high-speed sampling and comparison...split-second recognition, isolation and identification of abnormal functions.

Nominal circuit values and specified tolerances are tape-punched in minutes to accommodate voltages (AC and DC) from 0.5 to 500 volts; Hi Pot to 500 volts; resistances from 1 ohm to 9.99 megohms; and tolerances of 1%, 5%, 10% and 20% of nominal. A total in excess of 60,000 tests possible...the Roboter will check any two circuit points at rates up to 100 tests per minute.

Write today for complete technical information and specifications on the New Roboter.

Write on company letterhead for “Lavio Programmed Instrumentation” ... please specify application.

**Lavoie Laboratories, Inc.**

MORGANVILLE, NEW JERSEY

DESIGNERS AND MANUFACTURERS OF ELECTRONIC EQUIPMENT

CIRCLE 25 ON READER-SERVICE CARD
New Sub-Miniature Size

Now Even Smaller

STA Capacitors
SOLID TANTALUM

APPLICATIONS WITH SELECTIVE REFERENCE

CIRCUIT COMPONENTS

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FANSTEEL METALLURGICAL CORPORATION
North Chicago, Illinois, U.S.A.

RELIABLE TANTALUM CAPACITORS SINCE 1930

CIRCLE 26 ON READER-SERVICE CARD
Traveling-Wave Tube List

The TENDENCY, and often the necessity, of building traveling-wave tubes to suit relatively specialized functions has resulted in a large number of different types. Here is a list of 242 tubes from 17 manufacturers which have been arranged according to major characteristics to simplify the problem of selection.

The list is extracted from the March microwave tube list published by Derivation and Tabulation Associates, Inc., West Orange, N.J. The listing is divided principally into two groups: that of traveling-wave tubes and that of backward-wave tubes. The first category includes forward wave amplifiers, whereas the latter includes both backward-wave oscillators and backward-wave amplifiers. The few backward-wave amplifiers present are identifiable by the notation of gain directly following the type number.

The tubes are arranged in order of center frequency, power output, and type number. In the case of frequency multipliers (see legend), the input center frequency decides the order. Several types are noted as not being immediately available. In most cases, this means that the particular tube is a fairly specialized unit and as such is not carried in stock. Information on all the tubes listed, however, is available.

The characteristics of traveling-wave tubes are flexible to a certain degree. In the majority of types listed, one parameter can be improved at the expense of others. The characteristics given represent the operational limits under which the tube will most likely be used.

For more information on obtaining similar microwave tube lists, write to Derivation and Tabulation Associates, Inc., Dept. ED, 67 Lawrence Ave., West Orange, N.J., or turn to Reader-Service Card and circle 27.

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<th>Frequency Range or Band (Mc)</th>
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ELECTRONIC DESIGN • June 25, 1958
# TRAVELING-WAVE TUBES

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Legend: gr-gridded, pm-permanent magnet focused, di-dispersive amplifier, low noise amplifier, fg5-frequency multiplier, five times, number-duty cycle if not continuous wave, *-not immediately available.

258 ELECTRONIC DESIGN • June 25, 1958
FOR EASIER MOUNTING

NEW

FANSTEEL

SILICON RECTIFIER STACKS

SINGLE-PHASE
FULL WAVE BRIDGE CIRCUIT
1 amp. (resistive or inductive load)
d-c output: up to 249 volts maximum

SINGLE-PHASE
UPPER ARM CIRCUIT
(for magneto amplifiers)
1 amp. (resistive or inductive load)
d-c output: up to 249 volts maximum

SINGLE-PHASE
FULL WAVE CENTER TAP CIRCUIT
1 amp. (resistive or inductive load)
d-c output: up to 125 volts maximum

THREE-PHASE
FULL WAVE BRIDGE CIRCUIT
1.5 amp. (resistive or inductive load)
d-c output: up to 372 volts maximum

DEPENDABLE RECTIFIERS SINCE 1924

CAPACITORS FANSTEEL

FANSTEEL METALLURGICAL CORPORATION
North Chicago, Illinois, U.S.A.

CIRCLE 28 ON READER-SERVICE CARD
TYPICAL APPLICATIONS:

- Low current power supply filters
- Oscilloscope, Geiger counter, electro-meter circuits
- Electronic computers
- Audio coupling and bypass
- High temperature AC and DC circuits, etc.

CAPACITANCE: Standard ±10%, available at ±5%. Other tolerances available on request.

POWER FACTOR: At 60 cycles is approximately 0.25% at 20°C, approximately 0.3% at 85°C.

INSULATION RESISTANCE: 20,000 megohms per mfd. or 20,000 megohms whichever is lesser, measured at 20°C with 500 VDC applied.

TEST VOLTAGE: 1 minute at 1½ times rated voltage at 25°C.

TEMPERATURE RANGE: Standard -60°C to +125°C.

IMPREGNATION: GSA capacitors are IQ160 impregnated and filled.

CASE: Metal ferrules are soldered to silver bands fused to each end of heavy walled glass tubes. The vacuum tight assembly is fungus proof.

Metal caps are embossed to insure a flush contact.
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<th>Power Output (watts)</th>
<th>Frequency Range or Band (Mc)</th>
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Legend: gr-gridded, pm-permanent magnet focused, di-dispersive amplifier, in-low noise amplifier, f0s-frequency multiplier, five times, number-duty cycle if not continuous wave, *—not immediately available.

ELECTRONIC DESIGN • June 25, 1958
Available From Stock!
Additional New Features!
Moderately Priced!

ERA's TRANSISTORIZED

HIGH CURRENT

REGULATED POWER SUPPLIES

IDEAL FOR:
- Battery Substitution
- Computers
- Transistor Bias
- Motor and Relay Control
- Television
- All High Current Laboratory and Industrial Applications

REGULATED POWER SUPPLIES
Ratings up to 12 Amps!

SPECIFICATIONS
Models listed are designed for 105-125 VAC input, 60-400 cps. Continuously adjustable output. Line regulation is within ±0.5%. Load regulation is within ±0.5%. Frequency response of regulator extends into high audio frequencies. Ripple less than 0.05% or 5 mv. Current limiter control on front panel for full overload and circuit protection. Units are for bench or standard 19" rack mounting.

FEATURES
- Continuously Variable Output
- Vernier Voltage Control
- Fast Transient Response
- Low Output Ripple
- Positive, Negative, Zero % Regulation Control
- Line Frequency Insensitive
- Remote Sensing
- Constant Current Overload Limit Control
- Positive or Negative Outputs Ungrounded
- Terminals On Front and Rear
- Hinged Panel For Full Accessibility
- High Efficiency
- Low Heat Dissipation
- Compact, Light Weight
- Instant Warm-up Time
- Moderately Priced

TYPICAL STOCK MODELS

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Additional stock models also available. Special designs also made to customers specifications. Write for quotation.

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

CIRCLE 30 ON READER-SERVICE CARD
Speed Production... Lower Assembly Costs with this New Symmetrical Feed-Thru Capacitor

*patents pending

Centralab's New DA-741 Hi-Kap, the feed-thru you can't put in wrong

...can be inserted from either end... a natural for machine insertion or other types of automation

...embodies a new metalizing technique that completely eliminates capacitance drop-off, silver migration, and silver burn-off during soldering operations

...will withstand soldering temperatures of 450°F for two minutes

...has a solder fillet around center ring eliminating need for solder preforms

...rugged 16 gauge tinned wire lead assures positive connections

SPECIFICATIONS:

Capacitance: Available in values up to 1,000 mmf. GMV
Power Factor: 3% maximum, measured at 1KC
Voltage: 500 VDCW, 1300 VDCT; special units can be supplied for 900 V. RMS test
Humidity: Meets EIA STD RS198, Class 2

DA-740, with same electrical characteristics but without solder fillet or leads, can also be supplied.

For details write for Centralab Engineering Bulletin No. EP-556. For the most complete line of ceramic capacitors in the industry see your Centralab distributor.
### BACKWARD-WAVE TUBES

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<th>POWER Output (watts)</th>
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### CROSS INDEX

- **BEN**: Bendix Red Bank Div.
- **BOM**: Bomac Laboratories, Inc.
- **CSF**: Compagnie Generale De T.S.F.
- **EIM**: Etel-McCullough, Inc.
- **FTL**: Federal Telecommunication Labs.
- **FTR**: Federal Telephone & Radio Co.
- **GEI**: Geisler Labs.
- **GEN**: General Electric Co., Power Tube Dept.
- **HGL**: Huggins Labs.
- **HUG**: Hughes Products
- **HUL**: Hulsta Corporation
- **RAY**: Raytheon Manufacturing Co.
- **SEC**: Stewart Engineering Co.
- **SPY**: Sperry Electronic Tube Div.
- **SYL**: Sylvania Microwave Tube Lab.
- **VAR**: Varian Associates, Inc.
- **WHI**: Roger White Electron Devices, Inc.

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</tbody>
</table>
Tung-Sol's latest 12v auto-radio tube developments—12EZ6 and 12FA6—provide a gain figure substantially above that of any other similar types. With these new tubes, the car-radio designer can simplify circuitry, thereby cutting out possible trouble spots. Bandwidth and frequency-drift problems are minimized...overall radio reliability rises.

Compare for yourself the advanced Tung-Sol types with the tubes they replace! Electrical data below!

---

### Quadratic Equation Nomogram

**Paul Gheorghiu**
Manson Laboratories, Inc.
Stamford, Conn.

**HERE IS a nomogram offering a brief solution for quadratic equations having the form**

\[ X^2 + PX + Q = 0 \]

**for values of P and Q between and including the values ±25. To determine the roots construct a straight line between the values of P and Q with the appropriate signs. Intersection of this line with curves X₁ and X₂ give the value of the roots.**

If there is no intersection with curves X₁ and X₂ for an equation within the designated range of the nomogram, the roots are imaginary.

To extend the reading for decimal coefficients this guide may be used:

**When \( Q \)**

- **multiplied by:**
  - **.0001**
  - **.01**
  - **100**
  - **10,000**

**P and \( X^{1.2} \)**

- **are multiplied by:**
  - **.01**
  - **10**
  - **100**

**Example:** Consider the equation

\[ X^2 + 8X - 20 = 0 \]

The roots are \( X₁ = 2 \) and \( X₂ = 10 \). If now the equation read \( X^2 + 0.8 - 0.02 = 0 \), the roots would be \( X₁ = 0.02, X₂ = -1 \). Similarly for \( X₂ = 8 - 20 = 0, X₁ = 2 \),

\( X₂ = -1 \)

\( X₁ = 20X^2 + 80X - 2000 = 0, X₁ = 20X₂ = -10X^2 + 800X - 20000 = 0, X₁ = 200X₂ = -1000 \)

For a reprint of this nomogram circle 100 on the Reader-Service card.

---

### NEW! two Tung-Sol Tubes for 12-volt auto radios!

Improved Tung-Sol types increase gain...widen design flexibility.

---

**NEW!**

**12EZ6**

Up to 50% more gain than old Types 12AF6 and 12BL6...it replaces!

**Improved Tung-Sol types increase gain...widen design flexibility**

---

**Tung-Sol helped pioneer the 12v hybrid auto radio...makes a high-performance tube for virtually every other entertainment circuit need—radio, TV, hi-fi! For full data on the new 12EZ6 and 12FA6...to fill any socket you have with a quality tube, write or phone us today!**

Commercial Engineering Dept., Tung-Sol Electric Inc., Newark 4, N. J.

**CIRCLE 32 ON READER-SERVICE CARD**

---

**TUNG-SOL®**
Quadratic Equation Nomogram

Nomogram for solving quadratic equations for values of \( P \) and \( Q \) between and including \( \pm 25 \).
From One Dependable Source

Send for this brochure today!

Whatever your deflection component requirements, whether special or standard, whether for military or commercial use, you'll find RCA a convenient and dependable source. The brochure illustrated above provides helpful information on RCA's equipment designed for all makes of Image Orthicons, Vidicons, TV Monitors, Resolvers and PPI Scanning Yokes. Use the coupon to send for your free copy.

RCA's leadership and broad experience in television and radar are reflected in the high quality of these components. All are expertly engineered and manufactured under rigid standards of quality control to assure maximum reliability and performance.

Inquiries for the development of deflection systems and components for special applications are invited.

Radio Corporation of America
Industrial Electronic Products
Dept. GD-292, Building 15-1, Camden, N.J.

Please send me free copy of your brochure "Precision Deflection Systems and Components."

NAME

COMPANY

ADDRESS

CITY

ZONE

STATE

☐ Have RCA representative call

CIRCLE 33 ON READER-SERVICE CARD
To provide a complete coverage of ALL new products generally specified when designing electronic original equipment, the New Product section has been extended. To include the largest number of items, products which are best suited to a brief description have been noted at the end of the section.

TANTALUM CAPACITORS
For use at up to 125 C, these solid tantalum capacitors withstand significantly warmer ambi­ents than most tantalum types. The Kemet line of capacitors are available in ratings from 5 to 120 μF at working voltages from 6 to 30 v at 85 C. They can take vibration of up to 40 g at frequencies of 2000 cps.

Kemet Co., Div. of Union Carbide & Carbon Corp., Dept. ED, Box 6067, Cleveland 1, Ohio.

SAMPLING SWITCH
Measuring 1-1/4 in. in diameter, the Miniplexer sampling switch has sixty contact pins for thirty channels of break-before-make operation. The miniature size of the switch is principally due to the development of contact pins of very high durability and low friction coefficient. The small diameter of the assembly results in lower peripheral wiper speeds and therefore provides longer life. The switch permits service free operation of 500 hrs at 30 rps and operates under ambient of -55 to 125 C and under vibration conditions of up to 2000 cps at 25 g.

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

Using gamma radiation, this indicating system provides an accurate method of scoring the miss distance of ground to air missiles against drone targets. The system consists of a radioactive source and a scintillation type radiation detector (shown). The radioactive source, weighing less than an ounce, is placed in the missile. As the missile nears its target drone, the distance from the drone is measured by the counting rate of the detector placed in the drone.

Topp Industries, Inc., Dept. ED, Beverly Hills, Calif.

CIRCLE 36 ON READER-SERVICE CARD

FILM CAPACITORS

Practically zero temperature coefficient over the temperature span of -10 to +80 C is featured in the Isofarad series of film capacitors. They are useful in such applications as synchroguide circuits in color TV receivers, test equipment, and high stability amplifiers. Capacitor sections are of the extended-foil type. The units are housed in pre-molded phenolic shells with plastic-resin end seals for protection against moisture. The units are presently available only in 500 V ratings. Insulation and dielectric absorption are between that of polyester and polystyrene types.


CIRCLE 37 ON READER-SERVICE CARD

**VOLTAGE REGULATED POWER SUPPLIES**

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<th>OUTPUT AMPERES DC</th>
<th>OUTPUT IMPEDANCE DC</th>
<th>VALUE</th>
<th>SIZE</th>
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<td>0-18</td>
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<td>0-0.5</td>
<td>1.0</td>
<td>1.5</td>
<td>19¥/3</td>
<td>3¥/3</td>
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A 0.01% SERIES IS AVAILABLE IN 13 NEW MODELS
KEPCO OFFERS MORE THAN 120 STANDARD VOLTAGE REGULATED POWER SUPPLIES COVERING A WIDE RANGE OF MAGNETIC, TUBE AND TRANSISTOR TYPES. MOST MODELS AVAILABLE FROM STOCK.
SEND FOR BROCHURE B-585

KEPCO LABORATORIES, INC.
131-38 SANFORD AVENUE • FLUSHING, N.Y.
INDEPENDENCE N.Y. 1-7000

CIRCLE 38 ON READER-SERVICE CARD

REGULATION (for line or load) 0.1% or 0.003 Volts (whichever is greater)

RIPPLE: 1 mv. rms.

RECOVERY TIME 50 microseconds

STABILITY (for 8 hours) 0.1% or 0.003 Volts (whichever is greater)

TEMPERATURE COEFFICIENT 0.05% per °C. Ambient operating temperature 50°C maximum. Over-temperature protection included. Unit turns off when over-temperature occurs.

SHORT CIRCUIT PROTECTION NO FUSES CIRCUIT BREAKERS OR RELAYS! Designed to operate continuously into a short circuit. Returns instantly to operating voltage when overload is removed. Ideal for lighting lamps and charging capacitive loads.

OVER CURRENT CONTROL can be set from 0 to 120% of full load.

REMOTE PROGRAMMING at 1000 ohms per volt.

REMOTE ERROR SIGNAL SENSING to maintain stated regulation directly at load.

Suitable for square wave pulsed loading.

Continuously variable output voltage without switching.

Either positive or negative can be grounded.

Units can be series connected.

Power requirements: 105-125 volts, 50-65 cycles. 400 cycle units available.

Terminations on front and rear of unit.

High efficiency. Low heat dissipation.

Compact, light weight for bench or rack use.

Color: grey hambertone.

ORDERING INFORMATION:
Units without meters use model numbers indicated in table. To include meters add M to the Model No. (e.g. SC-18-1-M) and add $30.00 to price.

* Rack adapter for mounting any two 8¥/8 x 4¥/8 units is available. Model No. RA2 is 5¥/4" x 19¥/w. is $15.00
new...Improved
IN-LINE
DIGITAL DISPLAY
with One-Plane Presentation

FEATURES
- Recently developed high-contrast viewing screen for utmost visual sharpness!
- Digit style of your choice!
- Colored digits of your choice! Suitable to environmental ambient room light.
- Digital presentation complementing manufacturer's original equipment!

Here's a new type of In-Line Digital Display. All numbers and/or characters appear on the front surface of the unit, and are of uniform size and intensity. In addition to being faster and easier to read, the numbers may be quickly seen from any angle of viewing.

The In-Line Display is available as a single unit, or in assembled groups of two, three, four, etc., ready for panel mounting. The viewing screen extends the full width of the individual unit so that final assembly presents a continuous surface for fast, easy reading.

HOW THE IN-LINE DIGITAL DISPLAY OPERATES
The In-Line Display works on a rear-projection principle. When the lamp (A) at rear of the unit is lighted, it projects the corresponding character on the condensing lens (B) through a projection lens (C) onto the viewing screen (D) at the front of the unit.

WRITE TODAY FOR COMPLETE DETAILED SPECIFICATIONS
Representatives in principal cities

PRICE PER UNIT
$15.50

For higher power radar
Megawatt TWT

WITH a peak output of two megawatts over a half-power bandwidth of more than 10 per cent centered at 2800 mc, this new twt gives the radar designer a simple, versatile, power amplifier. No continuous pumping is needed, and the ruggedness of the tube compares with high power klystrons.

Use of the tube will result in increased flexibility and versatility in high power radars with no sacrifice in definition or range for wide bandwidth. Heavy radars will be able to change...
operating frequency over the S band rapidly: jamming is made more difficult and more costly. Mutual interference between friendly radars can be eliminated by the same programming that is used to avoid countermeasures.

Manufactured by Varian Associates, 611 Hansen Way, Palo Alto, Calif., the new traveling wave tube uses many klystron parts to make its production compatible with Varian's line of klystrons. The VA-125 is designed to fit interchangeably into the focusing magnet now used by Varian's mw radar klystron amplifier. X-ray shielding is included in the package.

Clearly to make the broadband device interchangeable with former units a certain sacrifice in performance was required. The twt is somewhat shorter than optimum length; operating gain as a result is on the order of only 30 db—compared to the higher gain but narrower bandwidth of the klystron. Efficiency is 30 per cent. If a given application requires better gain than is available from the VA-125, a third segment can be added without changing the basic performance of the tube. The designer pays in terms of magnet size and weight.

Field use will offer no new problems: operation is like that of any high power klystron. Maintenance personnel and installers will use the same techniques as with the klystron.

Equipment designers should find that cost, reliability and operating life fall into the present klystron pattern. To compensate for the lower gain, of course, an additional driver tube will be needed. In this way, any existing klystron focusing magnet may be used. A number of such drivers are obtainable; their reliability and operating simplicity have been proven out in a number of applications.

**Operation**

The cross-sectional view shows tube structure. Propagation of energy inside the VA-125 follows the pattern of any twt. Because the resonant elements are strongly coupled together the passband of the wave tube structure can be many times greater than that of the individual resonant cavities of a klystron. Gain remains reasonably high because of the continuous interaction between the e-m wave and the electron beam.

The new twt consists of two segments. Each is made up of the resonant elements—and are separated by a short gap region containing microwave attenuator materials. This is to prevent positive feedback, which would result in oscillation—the feedback would arise from reflections at the output end, returning unattenuated to the input to cause regeneration.

For further information on this high-power wide-bandwidth twt, turn to the Readers Service card and circle 40.

---

**SPACE PROBLEM SOLVED**

with **ALLEN-BRADLEY**

**Hot Molded Resistors**

Your space problem may seem impossible, but—try Allen-Bradley Type TR resistors. You'll be able to trim space requirements way down... with no sacrifice in quality or reliability. These unbelievably small composition resistors are made by the same basic hot molding process as is used for the larger Allen-Bradley resistors... assuring complete freedom from catastrophic failures. The Type TR resistors have an insulating coating that will withstand a continuous maximum voltage of 200 volts d.c.

Where higher ratings are needed... and quality is important... it's still Allen-Bradley! These larger sizes have an insulating jacket that eliminates the need for impregnation... yet provides reliable protection against long periods of high humidity.

Allen-Bradley makes other space-saving components, too... including hermetically sealed resistors, variable resistors, capacitors, and filter elements... all built to Allen-Bradley's quality standards. For detailed specifications and application data send for Publication 6024.

Allen-Bradley Co., 1344 S. Second St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

---

**Actual Sizes**

1/10-Watt resistor
1/8-Watt resistor hermetically sealed
1/4-Watt resistor
1/4-Watt resistor hermetically sealed
Bare disc ceramic capacitors
SMC feed-thru filter
Type F—1/4-watt variable resistor
Type G—1/2-watt variable resistor

**ALLEN-BRADLEY**

**QUALITY**

**ELECTRONIC COMPONENTS**

**CIRCLE 41 ON READER-SERVICE CARD**
new eye for infrared...

Sylvania develops cast germanium and silicon discs
for more efficient infrared detection systems

Germanium and silicon lenses, ground from optical blanks cast by Sylvania, are finding wider application in the infrared detection systems in today's missiles and aircraft. These semiconductor materials are transparent to wavelengths above 7 microns where other materials, such as quartz, are opaque.

Sylvania's Chemical & Metallurgical Division now offers cast discs of polycrystalline germanium in sizes as large as 8 1/2 inches in diameter and 6 inches thick. Even larger sizes are being developed to meet the needs of detection system manufacturers. Cast silicon discs, too, are available for infrared use. Silicon, which weighs less than germanium, is finding growing acceptance in airborne systems. Other factors, such as the maintenance of infrared transmission characteristics at higher temperatures are of particular interest.

Through constant research and close cooperation with industry, Sylvania is continually improving its products to meet the needs of all areas of electronics. This is a basic reason why Sylvania has become a leading source for both silicon and germanium for all applications.

TUNGSTEN • MOLYBDENUM • CHEMICALS • PHOSPHORS • SEMICONDUCTORS

SYLVANIA

Sylvania Electric Products Inc.
Chemical & Metallurgical Div.
Towanda, Penna.

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

NEW PRODUCTS

Transistors
For medium and high speed switching applications

Five germanium alloyed junction transistors have been designed for medium and high speed switching applications. Two pnp types 2N592 and 2N593, and three npn types 2N594, 2N595 and 2N596 are available in JETEC 30 package. These units offer a collector to base voltage range of 20 to 40 v, and an alpha cut-off frequency range of 1.5 to 5.0 mc.

General Transistor Corp., Dept. ED, 91-27 138th Pl., Jamaica 35, N.Y.

CIRCLE 43 ON READER-SERVICE CARD

Standard Potentiometer
Accuracy of 0.0015 per cent

Incorporating a standard cell reference, a voltage divider, and resistance standards, this instrument achieves an accuracy of 0.0015 per cent in voltage measurement and 0.003 per cent in current measurement. The standard cell reference, accurate to 0.001 per cent, and the voltage divider, accurate to 0.0001 per cent may be separately used.

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

CIRCLE 44 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 25, 1953
SILICON RECTIFIERS

designed and manufactured to meet

THE NEW JAN SPECIFICATIONS

For AXIAL LEAD TYPES

now from

Automatic

Maximum Values for AUTOMATIC Military Type Silicon Rectifiers designed to meet the new JAN MIL-E-1 Specification

<table>
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<th>DC Output Current @ 150°C Ambient (MA)</th>
<th>Maximum Reverse Current* (MA)</th>
<th>Mounting</th>
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<tr>
<td>JAN 1N547</td>
<td>600</td>
<td>750</td>
<td>250</td>
<td>0.350</td>
<td>Axial lead</td>
<td>1083A</td>
</tr>
</tbody>
</table>

*Average over 1 cycle for inductive or resistive load with rectifier operating at full rated current at 150°C ambient.

PRODUCTION QUANTITIES OF ALL TYPES AVAILABLE FOR FAST DELIVERY

Naturally, you can get these new axial lead JAN types direct from AUTOMATIC, and from authorized distributors throughout the country - and at prices that reflect General Instrument's years of volume production experience.

Together with the earlier JAN type stud mount group, AUTOMATIC now covers the entire medium power silicon rectifier field for the requirements of every military application.

More information? A complete set of data sheets is yours for the asking. Please write us today.

Automatic Manufacturing

General Instrument Corporation

Public Service Company

Radio Receptor Co. Inc.

Micromold Electronics Manufacturing Corporation Subsidiaries
The smallest rotary switch ever made!

Daven's New Series G Sub-Miniature Switch...1/2" Diameter!

A new sub-miniature rotary selector switch, developed by DAVEN, is specifically suited for application in missiles, aircraft, handy talkies, field pack sets, frog-man communication equipment, and all types of mobile apparatus. This explosion-proof, waterproof switch has the same reliability as its bigger brothers...but in a fraction of the space. It meets applicable military specifications on temperature, humidity, corrosion, vibration, acceleration, shock and immersion.

This unit is available as a single pole, 10 position switch and can be obtained with up to four poles on a single deck.

Contact Resistance: Less than .008 ohm.
Contact Rating: 1 ampere, 250V D.C. into resistive load
350 MA, 100V D.C. into inductive load.
Insulation Resistance: 200,000 megohms between any two terminals or between any terminal and shell.
Measured at 25° C., 50% RH, at sea level.
Life Expectancy: 50,000 cycles minimum
Shaft and case: Stainless steel
Panel and hub: Glass filled epoxy
Contacts and terminals: Silver alloy
Rotors: Rhodium plated beryllium copper

Write today for comprehensive technical report on the new Series G Sub-Miniature Rotary Switch.

NEW PRODUCTS

Waveform Analyzer
Frequency range of 50-20,000 cps

Waveform analyzer type A-321 is a superheterodyne type and measures directly the relative levels of the components of a complex waveform to a value —75 db below the fundamental over a frequency range of 50-20,000 cps. The input level of the fundamental can be any value between —20 db and +20 db relative to 1.0 mw into 600 ohm.
Wayne Kerr Instruments, Dept. ED, P.O. Box 801, Philadelphia 4, Pa.
CIRCLE 49 ON READER-SERVICE CARD

Power Supply
Handles 100 transducers

Type 2-200 will provide 100 transducers with up to 5 amp of current at any regulated voltage between 0 to 15 v. Operating over a temperature range of 30 to 120 F, the supply is designed for applications where a large number of bridge-type transducers must be powered from one stable source.
Neff Instrument Corp., Dept. ED, 2211 E. Foothill Blvd., Pasadena, Calif.
CIRCLE 50 ON READER-SERVICE CARD
CIRCLE 48 ON READER-SERVICE CARD
This programming stepper is available for projects such as automated production systems, machine tools, and industrial products. Open or sealed, it operates under high temperatures and altitudes and severe vibration or shock. The unit carries 9-12-18 or 24 points sealed or unsealed, and up to 16 wafers and unlimited switching arrangements.

Guardian Electric Mfg., Programation Div., Dept. ED, 1621 West Walnut St., Chicago 12, Ill.
CIRCLE 51 ON READER-SERVICE CARD

DC Amplifier
Has power gain of 120,000

Model 100C3 low level dc amplifier features power gain greater than 120,000. Input power of only 0.5 µw will drive output to full linear scale. The device is supplied in voltage gains of 250, 500 and 1000. Gain stability of ±1/4 per cent or better is achieved with variations in line voltage of ±10 per cent and frequency of ±5 per cent.

CIRCLE 52 ON READER-SERVICE CARD
CIRCLE 53 ON READER-SERVICE CARD

This General Electric designed and developed amplifier operates without the use of refrigerants at ambient temperatures from -67°F to 750°F.

High-temperature, Radiation Tolerant Electronic Equipment—Without Refrigerants

Here's important news for you if your systems project dictates the need for temperature and radiation tolerant electronic equipment. The General Electric Company stands ready to undertake the design, development, manufacture and evaluation of your equipment where your specifications call for successful operation up to 750°F, without refrigerants. And General Electric's ability to meet your high-temperature requirements is backed by notable successes.

FOR EXAMPLE General Electric has already developed airborne amplifiers which have been successfully operated over an ambient temperature range from -67°F to 750°F. Special circuit designs and packaging techniques permitted this without the use of heavy, complex refrigerating equipment.

FOR INFORMATION on how General Electric can help you solve your high-temperature electronic equipment problems, contact your G-E Missile and Ordnance Systems Department Field Sales Office or mail the coupon below.

FOR MORE INFORMATION ON HOW TO MEET YOUR HIGH-TEMPERATURE REQUIREMENTS

GENERAL ELECTRIC COMPANY
Section D222-6
Lakeside Avenue
Burlington, Vt.

[] Please send me bulletin MPB-32, "High-Temperature Electronic Equipment."
[] I would appreciate a discussion of my equipment requirements with General Electric High-Temperature Engineering Specialists.

NAME

TITLE

COMPANY

ADDRESS

CITY

STATE
IS CONSTANT VOLTAGE POSSIBLE IN THESE CHANGING TIMES?

...Basically, the problem is a classical one of semantics. Higher minds than ours have pondered this question for centuries.

As a practical exercise, let us examine the case of voltage regulation reference source in the power supply circuit shown above. This passive network corrects input voltage changes of more than ±15% of rated outputs and controls them to within ±½%...a feature that is highly important in keeping storage batteries alive longer.

The point is that constancy is a relative term understood only against a background of change. The answer then to the initial question is "yes"...constant voltage is possible.

You can get the complete story about voltage regulators from the higher minds at Raytheon by writing to:

VOLTAGE REGULATOR MAN
Raytheon Manufacturing Company
Magnetic Components Department
Section 6120
Waltham 54, Massachusetts
NEW PRODUCTS

Diode and Transistor Bases
Two, three, and four lead types

This standard line of diode and transistor bases and cases includes strain-free solderable types, compression weldable types, and compression solderable types. Two, three, and four lead types are available. Diode closures are supplied in a wide range of shapes and sizes.

Electrical Industries, Dept. ED, 691 Central Ave., Murray Hill, N.J.
CIRCLE 55 ON README-SERVICE CARD

Switches
Rated at 5 amp at 6 v dc

Series 100 phenolic switches are rated at 5 a at 6 v dc, 100 ma at 110 v ac, make and break, resistive load. Current carrying capacity is 5 a.

Globe Union, Inc., Centralab Div., Dept. ED, 900 E. Keefe Ave., Milwaukee 1, Wis.
CIRCLE 56 ON README-SERVICE CARD

Calorimeter Bridge
Measures 10 kw full scale

This direct reading calorimeter bridge can be used with any water load. It measures 10 kw full scale. Water flow is 4 gallons per min. Accuracy of ac wattmeter is 1 per cent.

Electro Impulse Laboratory, Dept. ED, 208 River St., Red Bank, N.J.
CIRCLE 57 ON README-SERVICE CARD

MINIATURE THERMAL RELAYS
with 99.99% Plus Reliability
SERVICE-FITTED SERVICE-TESTED SERVICE-APPROVED

Our complete environmental testing laboratory samples and certifies daily production.

New NORMALLY CLOSED RELAYS NOW AVAILABLE. They both meet or exceed requirements for guided missiles and complex electronic gear. They are hermetically sealed by bonding metal headers to high thermal, shock resistant glass housings. They open or close a circuit positively in 0.1 second or other delay times. They can also be safely used as a "squib" or timing mechanism.

Typical Characteristics
Temperature: -100°F. to +450°F.
Vibration: 20-3000 CPS at 40 0’s
Shock: 250 0’s

Brochure containing complete characteristics and specifications available upon request.

NETWORKS ELECTRONIC CORPORATION
14806 OXNARD ST., VAN NUYS, CALIF.
Original designs for highest reliability in glass housed miniature Relays and Resistors for all purposes
CIRCLE 58 ON README-SERVICE CARD

ELECTRONIC DESIGN • June 25, 1958
Reliability

IS THE COMMON DENOMINATOR OF ALL NETWORKS MAGNETIC COMPONENTS

Function as DC current transducers for metering large DC currents without conventional shunts and to isolate DC bus from metering circuit. Units rated for bus currents from 100 to 2000 amps with 2500 to 1 current ratio. Accuracy from ± 1/2% to 2% depending on current rating.

COMBINATION MAGNETIC AMPLIFIER AND TRANSISTOR SWITCHING DEVICE WITH EXTREME SENSITIVITY AND RELIABILITY, 3 TO 3 MILLIOMH INSERTION RESISTANCE. SWITCH IS NEC (CONDUCTING) AND OPEN TO INCREMENTAL CURRENT CHANGE OF 40 MA OR MORE FROM PRESET VALUE. CURRENT RANGES 100 MA TO 10 AMPS AVAILABLE. TEMPERATURE RANGE -55°C TO +85°C.

Both current and voltage sensitive versions available. Sensitivities of control circuit as low as 750 microamps. Control resistance from 3 milliohms to 2500 ohms. No moving parts. Switch circuit handles up to 40 V DC at 2 amps. Temperature range -35°C to +85°C. Meet or exceed all applicable military specifications.

COMPLETE SPECIFICATIONS AVAILABLE UPON REQUEST

Concepts of proven reliability—yesterday... today... tomorrow. Standard or custom designs for airborne and ground applications. Engineers, Designers and Manufacturers of All-Magnetic Components.
Cooling Unit
Weighs 11.5 lb

A liquid cooling unit has been developed that measures 11.8 in. long by 5.35 in. high and weighs 11.5 lb. It has a heat rejection capacity of 1.5 kw with 2 gal per min flow, fluid inlet temperature of 150° F, and air inlet temperature of 125° F, under ambient sea level pressure. A variety of fluids, including electronic cooling fluids, can be accommodated.


CIRCLE 60 ON READER-SERVICE CARD
advanced system of COOLING ELECTRONICS extends missile performance

EASTERN AVIONIC COOLING SYSTEM IS LIGHTER . . . SMALLER . . . MORE RELIABLE

Electronic equipment is vulnerable to the fantastic heat encountered by missiles. Eastern liquid cooling and refrigeration systems maintain safe avionic operating temperature limits even in the 800°F environment present at five times the speed of sound.

MINIATURIZING ALL COMPONENTS

In addition to efficient, reliable operation, Eastern cooling systems are miniaturized to meet the most rugged missile requirements for space and weight. By using Monsanto Coolanol 45 fluid, a 24000RPM hydraulic pump no bigger than a fist can be used. Coolanol 45 keeps the high-speed pump lubricated, as well as providing a coolant with outstanding qualities. The high boiling point of Coolanol 45 permits a smaller system since temperature maintained can be higher. Coolanol 45 is an excellent heat-transfer medium with good dielectric properties. Adequate viscosity assures long life of precision hydraulic pumps. Systems are easily sealed to prevent contaminating air leakage, and the low foam tendency of Coolanol 45 minimizes circulation troubles.

DESIGNS TO MATCH MISSILE PERFORMANCE

Using a basic liquid cooling system, or by adding refrigeration cycle, cold plates, or evaporative cooling as needed, Eastern can protect electronic equipment under the severest temperature conditions. Come to the leader in the field for complete and creative help.

Vibration Pickups

Ranges from 15 to 2000 cps

Operable from -65 to +500 F, these small, reliable pickups known as types 4-121, 4-122, and 4-123, will monitor vibrations up to 2000 cps. Type 4-123, with its 45 to 2000 cps operating range, is ideal for jet engine monitoring where the lowest frequency encountered is about 50 cps.

Consolidated Electrodynamics Corp., Dept. ED, 300 N. Sierra Madre Villa, Pasadena, Calif.

CIRCLE 62 ON READER-SERVICE CARD

Test Set

Tests solid state rectifiers

Model 2-38A rectifier test set has been designed to evaluate the dynamic characteristics of germanium and silicon rectifiers. The unit employs a special circuit which permits selecting any forward current or reverse voltage independently of each other. The unit tests average forward current ratings between 0.25 and 50A half-wave, and reverse voltage ratings to 2 kV peak.

Wallson Assoc., Ltd., Dept. ED, 35 E. Runyon St., Newark 12, N.J.

CIRCLE 63 ON READER-SERVICE CARD

Eastern subsystems and systems for missiles and aircraft

AVIONIC COOLING • REFRIGERATION • HYDRAULIC POWER PACKS • PRESSURIZATION-DEHYDRATION

For bulletin 0-123 on Coolanol 45, write

MONSANTO CHEMICAL COMPANY
Aviation Fluids Dept. AV-2
Lindbergh and Olive Street Road,
St. Louis 24, Mo.

*Coolanol 45: Monsanto trademark (formerly OS-45)

For aviation bulletin 350, write

EASTERN INDUSTRIES, INC.
100 Skiff Street
Hamden 14, Conn.

≤ CIRCLE 61 ON READER-SERVICE CARD
How the man from Tensolite cuts assembly costs

FLEXOLON wire's greater flexibility speeds up wiring of Westinghouse control unit

Greater flexibility of new FLEXOLON high temperature hook-up wire makes an easier job of wiring intricate harnesses for Westinghouse Air Arm's armament control systems. Meeting the flexibility requirements of Westinghouse engineers, Tensolite's new wire helps reduce production time and assembly costs.

FLEXOLON wire's greater flexibility was proven in a recent series of tests on the new hook-up wire and wires of other construction. In test after test FLEXOLON wire, insulated with DuPont "Teflon," proved consistently more flexible than all other high temperature hook-up wires tested.

Exceeding the requirements of MIL-W-16878B... and providing greater dielectric strength and higher average concentricity... new FLEXOLON hook-up wire is another example of Tensolite's continuous leadership in miniature wire development.

Tensolite INSULATED WIRE CO., INC.
West Main Street, Tarrytown, N.Y. • Pacific Division: 1516 N. Gardner St., Los Angeles, Calif.

FLEXOLON is a trademark of Tensolite Insulated Wire Co., Inc.

NEW PRODUCTS

Record Amplifiers
For airborne use

For in-flight use with tape instrumentation, these amplifiers and power supply will operate at temperatures up to 100 C. Four interchangeable modules are designed to provide analog, analog with voice, pulse duration modulation or frequency modulation recording on tape. Two record amplifier cases (14 channels) may be stacked with the type 3-135 power supply which will operate all 14 amplifiers. Shockmounts are not required for the units.

Consolidated Electrodynamics Corp., Dept. ED, 300 N. Sierra Madre Villa, Pasadena, Calif.
CIRCLE 65 ON READER-SERVICE CARD

Blowers
For use in military transmitters

A typical centrifugal unit in this line is this 2 hp unit capable of delivering 5000 cfm at 0.4 in. static pressure. The V-belt driven blower measures approximately 40 x 15 in. and weighs 90 lb.

CIRCLE 66 ON READER-SERVICE CARD

< CIRCLE 64 ON READER-SERVICE CARD
Mercury Switch
Resistant to oil and water

This nylon-enclosed mercury switch is made of materials which are resistant to the effects of water, oil, alkalis, and acids. A synthetic rubber embedment material protects the switching unit from shock and seals the lead entrance.

CIRCLE 68 ON READER-SERVICE CARD

Frequency Meter
Range from 10 kc to 3000 mc

This vhf frequency meter is accurate to one part per million over a range of 20 to 3000 mc. The instrument which will measure frequencies as low as 10 kc is capable of generating frequencies over the entire 10 kc-3000 mc range.

Lavoie Laboratories, Inc., ED, Matawan-Freehold Rd., Morganville, N.J.
CIRCLE 67 ON READER-SERVICE CARD

Relay Sockets
Design assures ease of installation

This micro-miniature 8 and 10 contact relay socket is available in four styles of mountings to assure ease of installation in any design. Also available are 8 and 10 contact sockets.

CIRCLE 69 ON READER-SERVICE CARD

Application-tested E-I hermetic terminals feature ruggedized compression construction for complete reliability in severe environments in military and commercial service. The economical E-I standard line offers designers every type terminal from single leads to sub-miniature closures. If your problem involves the use of special seals, E-I will produce custom designs to specifications; or seal components of your own manufacture. Ask E-I engineers for a recommendation on your specific seal application, today!
if a priceless audience switches channels

This situation has happened all too often in the past. But now it seldom occurs, because most of the vast transmission and control networks are designed on a modular basis.

Circuitry is arranged so that essential elements or sub-assemblies can be disconnected quickly...and spare parts inserted...while parts in trouble are checked when convenient.

How about your system or product? Do your customers encounter loss of time, loss of equipment use, loss of production because of hard-to-follow wiring or transference of control elements? Perhaps the reliability of your products could be improved through the use of Cannon Plugs modular units. Cannon makes over 27,000 different plugs—can engineer them to meet your requirements in modular "black-box" unit assemblies to minimize interruptions and make it possible to correct them, if they should occur, in a matter of seconds. Cannon will design and make the plugs and assemblies you need.

Write today for brochure "The Modular Concept" which explains how modular designs can save dollars. Please refer to Dept. 143.

Cannon Electric Company, 3208 Humboldt Street, Los Angeles 31, California.
NEW PRODUCTS

Clutches
Improved torque and response time

Model FCX-59 clutch and FBX-59 brake is the first unit available in a series of clutches. The comparative specifications of this unit against the company’s standard FC-59 and FB-59 models, are as follows: torque has been increased from 4 oz-in. to 8 oz-in. minimum; control wattage has been decreased from as high as 2-1/2 w to 1.1 w maximum; response time has been decreased from 8 msec to approximately 0.9 msec to the first time constant of maximum torque. Other characteristics have been retained: stationary coil, with no slip rings or brushes; class 5 instrument bearings throughout, and rotor construction featuring clean actuation.

Magtrol, Inc., Dept. ED, 240 Seneca St., Buffalo 4, N.Y.

CIRCLE 71 ON READER-SERVICE CARD

Temperature Controller
Range from −6 to +124 C

Model 71 YSI Thermistemp temperature controller can be set from −6 to +124 C within an accuracy

CIRCLE 70 ON READER-SERVICE CARD
T/I diffused junction silicon rectifiers give you full 3-ampere output at 50°C with PIV ratings to 600 volts.

The T/I diffusion process assures you of complete uniformity of characteristics and provides either anode-to-stud or cathode-to-stud polarity. Quick easy wiring into production assemblies is additionally facilitated by the eyelet on the top lead. All welded, rugged construction with glass-to-metal seal provides high resistance to shock and vibration.

Check the characteristics below and specify economically priced T/I rectifiers for all your medium power applications.

Anode-to-stud units denoted by "R" suffix to type number.

<table>
<thead>
<tr>
<th>T/I Type</th>
<th>Peak Inverse Voltage</th>
<th>Peak Rectified</th>
<th>Average Rectified</th>
<th>Recurrent Peak Current</th>
<th>Recurrent Peak Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>1N1124</td>
<td>±50°C to ±150°C</td>
<td>200</td>
<td>3</td>
<td>300</td>
<td>150</td>
</tr>
<tr>
<td>1N1125</td>
<td>±50°C to ±150°C</td>
<td>300</td>
<td>3</td>
<td>400</td>
<td>300</td>
</tr>
<tr>
<td>1N1126</td>
<td>±50°C to ±150°C</td>
<td>500</td>
<td>3</td>
<td>600</td>
<td>500</td>
</tr>
<tr>
<td>1N1127</td>
<td>±50°C to ±150°C</td>
<td>600</td>
<td>3</td>
<td>700</td>
<td>600</td>
</tr>
<tr>
<td>1N1128</td>
<td>±50°C to ±150°C</td>
<td>900</td>
<td>3</td>
<td>900</td>
<td>900</td>
</tr>
<tr>
<td>1N1129</td>
<td>±50°C to ±150°C</td>
<td>1200</td>
<td>3</td>
<td>1200</td>
<td>1200</td>
</tr>
</tbody>
</table>

Maximum ratings:

- Peak Rectified Current: 300 mA
- Average Rectified Current: 300 mA
- Recurrent Peak Current: 150 mA

Also immediately available in production quantities:

TI 1500 VOLT RECTIFIERS

Single junction reliability assures the high reliability your circuits require.

Contact your nearest TI sales office or distributor for detailed silicon diode and rectifier data sheets.
NEW PRODUCTS

Airborne Pumps
Solve shaft leakage problem

Shaft leakage within these airborne pumps is prevented because the pump and pump motor are sealed within the same case. Cooling and lubrication are accomplished by channeling the fluid, being pumped through and around the metal stator case to immerse the rotor and stator.

Pacific Scientific Co., Dept. ED, 6280 Chalet Dr., Bell Gardens, Calif.
CIRCLE 76 ON READER-SERVICE CARD

Pulse Height Analyzer
0.5 per cent linearity

Model PHA/20 pulse height analyzer consists of a 100-channel analog-to-digital converter plus twenty channels of glow transfer tube storage capacity. The linearity of the unit is 0.5 per cent; the deadtime is 500 μsec.

Tullamore Electronics Lab., Dept. ED, 6055 S. Ashland Ave., Chicago 36, Ill.
CIRCLE 77 ON READER-SERVICE CARD

Analog Computer
Comprises 48 amplifiers

The MC-5800 analog computer comprises 48 operational amplifiers; eight relay amplifiers with relays; 24 free diodes; 72 scale factor po-

To help you design more reliable technical applications with

HAND OPERATED SWITCHES AND ASSEMBLIES

ELECTRO SNAP has formed HOP...

• “HOP” carefully considers all applications from a “human engineering” standpoint, beforehand, in order to reduce human failure to a minimum. Some typical examples of “HOP” products are ...  

Toggle Actuated Switches
Maintained or Momentary with variations for Single-Pole to Triple-Pole.

| Single-Pole | A3-20 | A3-14 |
| Double-Pole | A3-8  | A3-15 |
| Triple-Pole | A3-27 | ...... |

Bushing size, above models: 1/4 x 40. (Also available in 5/8 x 32 bushing.)

Push-Button Actuated Switches

| Single-Pole | A4-18 |
| Double-Pole | A4-7  |
| Triple-Pole | A4-14 |

Bushing size, above models: 5/8 x 32. (Also available in 1/4 x 40 bushing.)

Wide Range of Pushbutton Actuators for All Applications.

Lighted Push-Button Switches

C-6 Series — Combines two-piece, color coded push-button, pilot-light and switching unit in one space-saving component, panel mounted. Use singly or stacked.

C-8 Series—Combines 3-color monitoring and switching in one compact, modular unit, panel mounted. Ten-second replacement of lamp modules from front of panel. Variety of colors available.
Hand Operated Products Group

"HOP" is a group of skilled Electro-Snap specialists who know hand-operated switches and assemblies, their limitations, advantages and specifications to fit any application. Their service is available to you for...

- Problem analysis, design development and modifications, testing and practical application of hand operated devices for specified conditions.

"HOP" personnel have broad practical ability, basic experience and modern application knowledge which is particularly valuable in helping to solve your problems at lower overall cost to you.

Whether your problem concerns technical application details on standard products or custom "specials" engineered to your specifications, this new service can give you dependable answers quickly. Just ask for "HOP" by telephone, wire or letter.

Hand Operated Assemblies to Meet Any Specifications

C3-4 — Fire Control Switch assures proper sequence during emergency fire conditions. Eliminates pilot error by controlling all functions when single handle is pulled.

C3-11 — Mechanical override assembly. Will convert from automatic function to manual operation of control surfaces.

C3-8 — Vibration-free, positive detent-action, cut-off switch with potted wire leads in D.P.D.T. with simultaneous action.

C3-13 — High current, manually-operated cut-off switch. Will simultaneously interrupt 4 circuits of 40 amps, 30 V DC—or much higher voltages with lower amperages. Has 8 separate circuits available in one control device.

Digital Converter

Provides unambiguous conversions

Model 1520 digiverter is a photoelectronic system which translates a vertical decimal display directly to an in-line display. The unit is easily attached to the front of a decade counter unit and then secured by two metal bands. It is powered from a 115-120 v, 50-60 cps power line and draws approximately 0.6 w per decade.

Radio Frequency Laboratories, Inc., Dept. ED, Powerville Rd., Boonton, N.J.

CIRCLE 80 ON READER-SERVICE CARD

VTVM

Range from 100 µV to 1 kv dc

MV-57A dc vtvm measures voltages from 100 µV to 1 kv dc. Its input impedance is 6 meg on low ranges, 60 meg from 1 v up. Precision measurements are made through automatic comparison of accurate calibration signals, taken from a standard cell-controlled 1 kv dc supply, with the unknown voltage.

Cohu Electronics, Inc., Millivac Instruments Div., Dept. ED, P.O. Box 997, Schenectady, N.Y.

CIRCLE 198 ON READER-SERVICE CARD
are you a victim of

**ENGINEERING HYSTERISTOR?**

*EPIDEMIC SYMPTOMS:*
**HYSTERICAL**
**TOTAL USE OF TRANSISTORS**

**ANALYSIS:** Transistors like ordinary tubes in many cases are essentially superfluous.

**REALITY:** Use a decimal component like Beam Switching Tube to perform a desired function.

**LIVING PEDIGREE:**
Burroughs Decode Counter Type WC-135 With Tabbed Decimal decimal encoders at 1 ENC. Both 16 outputs for remote control or digital readout not more than 1 megawatt and士兵 $169

**THAT SIMPLIFIES DECODING THREE BECAUSE:**
A single output controls an electron beam to any one of 10 sequential output sectors which has individual bleachable Beam Switching and High Transmission switching.

You will find Beam Switching Tube being used regularly to supplement other components whenever there is distributing, switching, multiplexing, opening, sampling, coding, timing, storing, monitoring, memory, decoding, decoding, converting, or presenting.

**Zener References**
For miniaturized printed circuit systems

This line of silicon junction Zener reference elements have been designed specifically for miniaturized printed circuit systems where low voltage must be held constant under extreme environmental conditions. Operating voltage of the 1N1530 and 1N1530A is about 8.4 v.


CIRCLE 82 ON READER-SERVICE CARD

**S-Band Beacons**
Frequency of 2700-2900 mc

These high sensitivity S-band beacons have been designed for guided missile and drone-control applications. Performance data of the receiver-transmitter includes: over-all triggering sensitivity of 65 dbm; receiver frequency of 2700-2900 mc; and receiver frequency stability of 2 mc.

Telerad Manufacturing Corp., Dept. ED, 1440 Broadway, New York, N.Y.

CIRCLE 83 ON READER-SERVICE CARD

Burroughs Corporation

ELECTRONIC TUBE DIVISION
Plainfield, New Jersey
**BOBBINLESS RESISTORS**

New Subminiature Precision Wirewound Bobbinless Resistors feature exceptional stability, reliability and performance.

General Transistor has developed a new concept for precision bobbinless resistors incorporating these exclusive features... the bobbinless construction eliminates wire stress and strain... a special viscous medium is used providing extreme shock and vibration resistance... welded case for positive hermetic sealing... the temperature coefficient of resistance of the finished resistor is the same as the wire and is not affected by the container. This insures repeatability and minimum hysteresis of resistance characteristics with temperature cycling.

These positive hermetically sealed units are designed for printed circuit boards and subminiature assemblies for airborne and missile applications.

The quality of materials and production superiority of these resistors is the same that has made General Transistor the Fastest Growing Name in Transistors.

Write today for complete technical information.

* PAT. PENDING

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Style</th>
<th>R-2</th>
<th>R-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance Range</td>
<td>0.1Ω to 750kΩ</td>
<td>0.1Ω to 750kΩ</td>
</tr>
<tr>
<td>Resistance Tolerance</td>
<td>±0.05% min. at 25°C</td>
<td>±0.05% min. at 25°C</td>
</tr>
<tr>
<td>Power Rating</td>
<td>1/4 watt continuous in free air (increased dissipation possible with heat sink)</td>
<td>1/4 watt continuous in free air (increased dissipation possible with heat sink)</td>
</tr>
<tr>
<td>Temperature Range</td>
<td>-60°C to -125°C</td>
<td>-65°C to -125°C</td>
</tr>
<tr>
<td>Maximum Operating Voltage</td>
<td>250V, DC</td>
<td>500V, DC</td>
</tr>
<tr>
<td>Temperature Coefficient of Resistance</td>
<td>±20 parts per million°C</td>
<td>±20 parts per million°C</td>
</tr>
<tr>
<td>Dielectric Strength</td>
<td>5000 volts, winding in case</td>
<td>10000 volts, winding in case</td>
</tr>
</tbody>
</table>

Construction - Terminations - Welded

---

**MULTIPLEXER**

Sample-hold type

The sample-and-hold feature of model EM-51S makes possible the simultaneous sampling within 0.2 usec of any number of channels of highly dynamic data. The unit time multiplexes five separate voltage inputs to a single voltage output. Several of these 5-channel modules can be inter-connected to produce a single voltage output. The maximum multiplexing rate from channel to channel is 25 kc.

# Bendix Montrose Division

## Synchros

**MIL-S-16892 • SIZE 11 • 26 VOLT 115 VOLT**

### Actual Size

**Stock Delivery**

<table>
<thead>
<tr>
<th>Primary Voltage (Nominal)</th>
<th>26V 11T84a</th>
<th>26V 11TX4a</th>
<th>26V 11CDX4a</th>
</tr>
</thead>
<tbody>
<tr>
<td>26V 11T84a</td>
<td>26 volts</td>
<td>26 volts</td>
<td>10.2 volts</td>
</tr>
<tr>
<td>26V 11TX4a</td>
<td>26 volts</td>
<td>26 volts</td>
<td>15.2 volts</td>
</tr>
<tr>
<td>26V 11CDX4a</td>
<td>115 volts</td>
<td>115 volts</td>
<td>35 volts</td>
</tr>
</tbody>
</table>

### Other Synchro Types Available

**Size 11**

- CT4b, CX4b, TR4a
- TX4a, 26V-CT4b
- 26V CT4a

**Size 15**

- CX6-XN
- CDX6-XN

**Size 23**

- CDX6a, CT4a, CT4, TX4a, TX6a, TX6a, TR4, TR6, TX4a, TX6a, TR6, TR6a, TX6a, TX6a, CX6a, TX6a, TX6a

**Size 30**

- TX6E-XN, TR6E-XN, TX8-XN, TR84-XN

**Size 31**

- TX4a, TX4
- TX4-XN, TX4-XN, TX6-XN, TX6-XN, TX8-XN, TX8-XN, TX8-XN

**Size 37**

- TX4-XN, TX6-XN, TX6-XN, TX6-XN, TX8-XN

<table>
<thead>
<tr>
<th>Type</th>
<th>HCT, HDG, F, HG</th>
</tr>
</thead>
</table>

**Type 3**

- HG, HDG, HCT, F

**Type 5**

- HG, HDG, HCT, F

**Type 6**

- HG, HDG

**Coast Sales and Service Office, 117 East Providencia Avenue, Burbank, California**

**Export Sales and Service—Bendix International Division, 205 East 42nd Street, New York 17, New York**

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**Outline Drawing**

- AY-1104-0
- AY-1107-0
- AY-1137-0

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**Montrose Division**

**SOUTH MONTROSE, PA.**

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**CIRCLE 87 ON READER-SERVICE CARD**
NEW PRODUCTS

Relay
Sensitivity of 40 mw

Designated as model R-9800, this double-pole double-throw model weighs 2 oz, is hermetically sealed and has an operating temperature range of -65 to +125 C. The relay has a coil sensitivity of 40 mw, a switching capability of 5 a resistive, and 3 a inductive load.

Hi-Spec Electronics Corp., Dept. ED, 7328 Ethel Ave., North Hollywood, Calif.

CIRCLE 88 ON READER-SERVICE CARD

Cores
Have 1 µsec switching time

These ferrite switching cores have a switching time of approximately 1 µsec, at a rise time of approximately 0.3 µsec, and a squareness ratio of 0.85. Maximum remanent flux density is 2200 gauss with maximum permeability of 1150.


CIRCLE 89 ON READER-SERVICE CARD

Impedance Meter
Serves several functions

Model D-22 regmeter will measure internal impedance of any voltage power supply or source.

CIRCLE 90 ON READER-SERVICE CARD

SPECIFICATIONS:

Filament Output: 6.3 volts CT AC @ 3 amperes (unregulated).
Current Range: 0-100 miliamperes, continuous duty; floating output.
Ripple and Noise: 3 millivolts peak-to-peak maximum.
*O.C. Voltage Range: 0-110 volts, continuously adjustable.
Transient Response: Less than 50 milliseconds no load to full load.
Input Voltage: 105-125 volts, 55-400 cps, AC.
Internal Impedance: Less than 1 ohm.
Load Regulation: 0.1%
Line Regulation: 0.1%
Dimensions: 7½" x 5½" x 5½" height overall
Note: We welcome opportunities to discuss your special power supply requirements.

Trans Electronics, Inc.
7349 Canoga Avenue
Canoga Park, California
These 5 forms of EPOXY will solve any component encapsulation problem!

Shells, sheeting, powder, pellets, liquid—EPOXY PRODUCTS can provide the right form of epoxy to solve your component encapsulation problem. Using these 5 basic forms (the widest line available today) we custom-build an epoxy unit that is just the right size, shape and quality for your component. Once the right encapsulating unit is developed, it can be produced in quantity immediately and placed on your production line. In short, no matter what type of component you are encapsulating, no matter what your facilities are now, there is an epoxy form and method just for you—from EPOXY PRODUCTS! Write today for complete technical data and literature.

Test epoxy encapsulation in your own lab!

A special kit containing generous samples of all 5 forms of epoxy resin, plus instructions, is available. Use it to test epoxy encapsulation on your own products—right in your own lab! Only $9.93 from your distributor.

EPOXY PRODUCTS, INC.
A Division of Joseph Waldman & Sons
137 Coit Street, Irvington 11, New Jersey
NOW! SOLVE ANY DC MEASUREMENT PROBLEM—WITH A PROVEN KIN TEL INSTRUMENT

MEASURE MICROVOLTS TO KILOVOLTS, MICRO-MICROAMPS TO AMPS WITH STABILITY, ACCURACY, SIMPLICITY!

From research and development to production line testing...one of these versatile dc measuring instruments can meet your most exacting requirements.

All units incorporate KIN TEL's proven chopper-stabilized circuitry for rock-solid measurement of microvolt level dc signals. All have zero center meters for instant polarity indication.

KIN TEL's microvoltmeters feature high input impedance and can be used as stable dc amplifiers. The model 301 both measures and supplies dc from 1 to 501 volts with 0.02% accuracy - provides 20 ma output as a supply.

One of these instruments can solve your dc measurement problem. And remember - reliable, accurate performance is assured by KIN TEL's experience in manufacturing more than 10,000 instruments.

The 201 utilizes a null voltmeter to indicate difference between voltage being measured and output of its variable dc supply. Its null meter has 4 full scale ranges from ±0.05 to ±50 V.

Write for detailed literature - 5725 Kearny Villa Rd., San Diego 11, Calif. Representatives in all major cities.

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Model 203</th>
<th>Model 202B</th>
<th>Model 204A</th>
<th>Model 301</th>
<th>Model 203AR</th>
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</thead>
<tbody>
<tr>
<td>DC Voltage Ranges (Full Scale)</td>
<td>±100μV to ±1000V</td>
<td>±300μV to ±1000V</td>
<td>±10μV to ±10V</td>
<td>1 to 501 volts</td>
<td>±100μV to ±1000V</td>
</tr>
<tr>
<td>DC Current Ranges (Full Scale)</td>
<td>±100μA to ±100mA</td>
<td>None</td>
<td>±0.001μA to ±1mA</td>
<td>Not Applicable</td>
<td>±0.001μA to 1 amp</td>
</tr>
<tr>
<td>Input Impedance</td>
<td>10 megs to 30 megs</td>
<td>10 megs to 15 megs</td>
<td>10 megs to 10 megs</td>
<td>10 megs to 10 megs</td>
<td>10 megs to 10 megs</td>
</tr>
<tr>
<td>Measurement Accuracy</td>
<td>3%</td>
<td>3%</td>
<td>3% on 2 lower ranges, 4% above</td>
<td>0.02%</td>
<td>3%</td>
</tr>
<tr>
<td>Max. Output as Amplifier</td>
<td>1 volt across 1000 ohms</td>
<td>1 volt across 2000 ohms</td>
<td>1 volt across 1000 ohms</td>
<td>Not Applicable</td>
<td>1 volt across 500 ohms</td>
</tr>
<tr>
<td>Equiv. Input Drift (Max. Long Time)</td>
<td>10μV</td>
<td>15μV</td>
<td>&lt;2μV</td>
<td>0.01% stability</td>
<td>10μV</td>
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<tr>
<td>Price</td>
<td>$550</td>
<td>$350</td>
<td>$325</td>
<td>$625</td>
<td>$550</td>
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</tbody>
</table>

*This 301 utilizes a null voltmeter to indicate difference between voltage being measured and output of its variable dc supply. Its null meter has 4 full scale ranges from ±0.05 to ±50 V.

CIRCLE 201 ON READER-SERVICE CARD

DC AMPLIFIER

Features floating input

This low-level dc amplifier, named the Fitgo (floating input to grounded output), has a floating input, which isolates the input from the rest of the amplifier and allows only the desired signal to go through. The Fitgo amplifier is used to amplify signals from thermocouples, strain gages, pressure transducers and other sensing elements of this type.


CIRCLE 95 ON READER-SERVICE CARD

NEW PRODUCTS

POWER SUPPLIES

Output voltages between 1 and 25 v dc

TPC-8 power supplies are available with any specified outputs between 1 and 25 v dc. Output current is rated at 350 ma with 1 percent regulation over the entire load and input voltage range.

Southwestern Industrial Electronics Co., Dept. ED, 2831 Post Oak Rd., P. O. Box 13058, Houston 19, Tex.

CIRCLE 94 ON READER-SERVICE CARD

DC AMPLIFIER

Features floating input

This low-level dc amplifier, named the Fitgo (floating input to grounded output), has a floating input, which isolates the input from the rest of the amplifier and allows only the desired signal to go through. The Fitgo amplifier is used to amplify signals from thermocouples, strain gages, pressure transducers and other sensing elements of this type.


CIRCLE 95 ON READER-SERVICE CARD
Silicon Rectifier
20 amp, 400 piv

This small unit is rated for continuous service at 20 amp dc at 400 v piv. High temperature range is 150 C.
Fansteel Metallurgical Corp., Dept. ED, 2200 Sheridan Rd., N. Chicago, Ill.
CIRCLE 96 ON READER-SERVICE CARD

Pressure Switch
- Weighs 3-1/2 oz

This low-cost general purpose pressure switch weighs 3-1/2 oz and encompasses pressure ranges from 2 to 3000 lb per sq in. Suitable for use with air, gas, oil, or fuel. Design permits minor changes in setting to be made in the field.
Consolidated Controls Corp., Dept. ED, Bethel, Conn.
CIRCLE 97 ON READER-SERVICE CARD

Strain Gage Supply
Has adjustable 10 v output

This 72 channel strain gage power supply has a resistance to ground of more than 10,000 meg, and internal noise level with respect to ground is less than 5 μv peak to peak. The nominal output of 10 v is adjustable by means of a 10 turn potentiometer. Used with a regulated power source, the output voltage varies less than 0.1 per cent.
Western Gear Corp., Dept. ED, P.O. Box 182, Lynwood, Calif.
CIRCLE 98 ON READER-SERVICE CARD
CIRCLE 99 ON READER-SERVICE CARD

Eimac Announces...
Five New Ceramic Reflex Klystrons

Two important frequency ranges in the C, X and K bands are now covered by Eimac reflex klystrons. Eimac's advanced stacked ceramic design gives these tubes exceptional ruggedness and frequency stability.
The four new tubes of the 1K20 series cover 8500 to 11,700 Mc, at power levels up to 50 milliwatts. They are specifically designed for use in the severe environment of air-borne and missile radar systems. They will withstand vibration levels of 15G in any reference plane, with less than 100 kilocycle frequency deviation. Low beam voltage requirement and simple radiation cooling minimize the weight and complexity of associated equipment.

Eimac First with ceramic tubes that can take it

Additional Frequency Coverage to be announced soon

1K20 Series X and K Band Klystron (left)
1K125CA C Band Klystron (right)

A new C-band tube, the 1K125CA covers 3700 to 4400 Mc. Power levels up to 2 watts make this tube ideal for reliable broadband point-to-point communication. Tuning by dielectric slug rather than variable RF gap avoids sensitivity to shock and vibration. Integral-finned cooler and higher operating temperature ratings minimize cooling requirements.
Eimac know-how in the field of ceramic-metal tube design now brings compactness, ruggedness, high performance and reliability to these important microwave frequencies.

More information on Eimac reflex klystrons is available from our Application Engineering Department

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

Eimac First with ceramic tubes that can take it

GENERAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>Type</th>
<th>Freq. Range Mc.</th>
<th>Beam Voltage</th>
<th>Power Output Range</th>
<th>Reflector Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1K125CA</td>
<td>3700-4400</td>
<td>1000 Vdc</td>
<td>1.5 to 2.0 W</td>
<td>0 to —1000 Vdc</td>
</tr>
<tr>
<td>1K20XS</td>
<td>8500-9300</td>
<td>300 Vdc</td>
<td>25 to 50 mW</td>
<td>0 to —250 Vdc</td>
</tr>
<tr>
<td>1K20KD</td>
<td>9200-10,000</td>
<td>300 Vdc</td>
<td>25 to 50 mW</td>
<td>0 to —250 Vdc</td>
</tr>
<tr>
<td>1K20XO</td>
<td>10,000-10,800</td>
<td>300 Vdc</td>
<td>25 to 50 mW</td>
<td>0 to —250 Vdc</td>
</tr>
<tr>
<td>1K20KA</td>
<td>10,700-11,700</td>
<td>300 Vdc</td>
<td>25 to 50 mW</td>
<td>0 to —250 Vdc</td>
</tr>
</tbody>
</table>

Additional Frequency Coverage to be announced soon
NEW PRODUCTS

CONNECTOR.—A quick disconnect type is available with six coax contacts and fifteen no. 20 contacts. Deutsch Co., Dept. ED, 7000 Avalon Blvd., Los Angeles 3, Calif.

LEAD BENDER.—Model 700 component leads bending block is an improved version available for bending component lead wires so they will accurately register with the holes in printed circuit boards. It can be adjusted to component body lengths up to 1½ in. long.

By-Buk Co., Dept. ED, 4314 W. Pico Blvd., Los Angeles 19, Calif.

CIRCLE 102 ON READER-SERVICE CARD

POTENTIOMETERS.—Two units, called Trim-Tite and the Trim-Tite Jr., measuring ⅝ and ⅝ in. diam respectively, have been added to the potentiometer line. Resistance ranges are 50 K and 25 K.

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

CIRCLE 104 ON READER-SERVICE CARD

PANEL AND SLIDE.—Includes panel, handles, and Chassis-Trak completely assembled ready for rack mounting.

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

CIRCLE 105 ON READER-SERVICE CARD

POTENTIOMETER.—50 ohm, 15 K, 50 K, and 100 K resistance values have been added to the Aceset wirewound potentiometer line.


CIRCLE 106 ON READER-SERVICE CARD

CRYSTALS.—Units which will take vibration up to 2000 cps are now available in ranges from 4 kc to 125 mc.

Biley Electric Co., Dept. ED, Union Station Building, Erie, Pa.

CIRCLE 107 ON READER-SERVICE CARD

CALVANOMETERS.—Types 7-350, 7-352, 7-354, 7-355, 7-381, and 7-382 are for use with the type 5-122 recording oscillograph. They withstand temperatures to 175 F.

Consolidated Electrodynamics Corp., Dept. ED, 300 N. Sierra Madre Villa, Pasadena, Calif.

CIRCLE 108 ON READER-SERVICE CARD

SWITCHES.—A special rotor which will break up to 5 amp ac resistive load at 115 v is now available on all the company’s standard single pole switches.

Daven Co., Dept. ED, Livingston, N.J.

CIRCLE 109 ON READER-SERVICE CARD

SWITCHES.—Series 810 have ratings of 10 a, 125 v ac and 5 a 250 v ac.

Alcor Manufacturing Co., Dept. ED, 4444 W. Roosevelt Rd., Chicago 24, Ill.

CIRCLE 110 ON READER-SERVICE CARD

The Fish and Wildlife Service of the U.S. Department of the Interior has reported that “packaging frozen fish in tin results in superior storage life.” Oxidation of the fish prevents the deteriorating action of seeping oxygen on frozen fish in cold storage over a period of months.

Considerable laboratory progress has been made in the electroplating of tin as a bright coating through the addition of certain wood tars to the electrolyte. Some observers feel there is a distinct possibility that this bright tin plating may take the place of metal polishing in many applications throughout the metal industry.

A new machine has been designed in England to help speed up mass production soldering. It consists of an electrically heated solder bath with motor-driven pump to provide a stationary wave of fresh solder, which is exposed to moving printed circuit boards.

An invention was recently patented which is expected to lengthen the life of heavily stressed bearings from a few weeks to several years. A mesh of tinned wire is embedded just below the surface of babbitted bearings before pouring . . . to prevent movement in the bearing surface leading to fatigue, cracking and spalling.

The Malayan Tin Bureau
Dept. 123, 1029 Connecticut Ave., Washington 6, D.C.

CIRCLE 111 ON READER-SERVICE CARD
VARIABLE TRANSFORMER.—Delivers voltages at 120, 240 or 480 v, single and three phase, with ratings from 2.6 to 8.5 constant-current load up to 12.5 constant-impedance load.
Superior Electric Co., Dept. ED, Bristol, Conn.
CIRCLE 113 ON READER-SERVICE CARD

POWER PENTODES.—For use as vertical deflection output amplifiers, models 6DT5 and 12DT5 have high zero bias plate current.
Sylvania Electric Products Inc., Dept. ED, 1740 Broadway, New York 19, N.Y.
CIRCLE 114 ON READER-SERVICE CARD

STOP NUTS.—Self-tapping nylon stop nuts lock, seal and insulate. Available in standard sizes nos. 4, 6, 8, 10, 1/4, 5/16, 3/8 and 1/2 in.
Byrd Plastics, Inc., Dept. ED, 2953 W. 12th St., Erie, Pa.
CIRCLE 115 ON READER-SERVICE CARD

KNOBS.—Series 50 is available either unskirted, plain skirted, or dial skirted round and is designed for 3/8-in. shafts.
CIRCLE 116 ON READER-SERVICE CARD

TRANSISTOR TESTER.—Accurate to within 3 per cent and direct reading, this tester is applicable to any program requiring quick evaluation of npn or pnp transistors.
Western Instruments, Dept. ED, P.O. Box 621, Ridgecrest, Calif.
CIRCLE 117 ON READER-SERVICE CARD

TRANSFORMERS.—This series is designed to meet the requirements of MIL-T-27A class R and S grade 2 or 4. Reliable life is 10,000 hr min.
Microtran Co., Inc., Dept. ED, 145 E. Mineola Ave., Valley Stream, N.Y.
CIRCLE 118 ON READER-SERVICE CARD

FIXED NETWORKS.—Tapped fixed networks, series 1030, 1031, and 1032, have been redesigned to provide tamper-proof methods of adjusting or setting the gain by means of soldered connections.
Daven Co., Dept. ED, Livingston, N.J.
CIRCLE 119 ON READER-SERVICE CARD

FLOW TRANSDUCER.—Features housings with welded steel flanges in all nominal pipe sizes, and extends the application of the Mark V transducer series to cover many industrial flow requirements.
Ramo Instrument Co., Inc., Dept. ED, 8 1st St., Bloomingdale, N.J.
CIRCLE 120 ON READER-SERVICE CARD

TERMINAL.—For use with no. 26 to no. 22 wire. Grips firmly and evenly when crimped on a conductor.
Thomas & Betts Co., Dept. ED, 36 Butler St., Elizabeth, N.J.
CIRCLE 121 ON READER-SERVICE CARD
Dramatic Reduction in Gyro Drift...

**Condensed Performance Data**

- **Trimmed drift rate:** 0.1/hr. rms
- **Mass unbalance:** 0.3/hr. max.
- **Anisoelastic constant:** 0.025/hr./g^2 rms
- **Maximum command turning rate:** over 20°/sec.
- **Dimensions:** 2" dia., 4" long

**IN NEWEST DESIGN 20 IG INTEGRATING GyROS**

Representing a major breakthrough by Reeves' gyro research laboratories, these advanced instruments show a small fraction of the drift rate hitherto considered low for high-performance units in this class.

Other characteristics are also outstanding, including extremely low anisoelastic constant and high command turning rate.

Of equal importance is the fact that these instruments measure up in every way to well-known Reeves standards of precision, ruggedness and reliability in regular production models. They are now available, and we invite your inquiries for detailed information.

Other Reeves Gyros and Accelerometers meeting equally exacting standards for performance and reliability include a comprehensive series of 10 IG, 20 IG and HIG 5 Integrating Gyros; 20 PIG Pendulous Integrating Gyros and 10A and 20A Linear Accelerometers. Technical information on request.

**Reeves Instrument Corporation**
A Subsidiary of Dynamics Corporation of America
Roosevelt Field, Garden City, New York

---

**NEW MATERIALS**

**Magnet Wire**
Flexible ceramic-coated type

Called Ceramatemp, this flexible ceramic coated magnet wire has a duty rating of 1000 F for continuous operation. The insulation exhibits high abrasion and cut-through resistance. Its flexibility is such that it will not crack when wrapped around a mandrel just three times its own diameter. Nickel clad copper conductors are being coated in single and heavy thicknesses, in sizes 20 to 30 awg. The coating is an inorganic insulating material called Ceramcide, developed by Consolidated Electrodynamics Corp., Pasadena, Calif.

Hitemp Wires, Inc., Dept. ED, 1200 Shames Dr., Westbury, N.Y.
CIRCLE 124 ON READER-SERVICE CARD

**Epoxy Glass Base Laminate**
High strength at 150 C

Grade G-11-861 epoxy bonded fiber glass laminate retains 70 to 80 per cent of its original flexural strength when tested at 150 C after conditioning for one hour at that temperature. The laminate is also made as copper clad phenolic grade G-11-861-1, for printed circuit applications. Bond strength is 10-15 lb; dip solder resistance greater than 30 sec at 500 F, and surface resistivity and arc resistance are excellent.

National Vulcanized Fibre Co., Dept. ED, Maryland Ave., & Beech St., Wilmington 99, Del.
CIRCLE 125 ON READER-SERVICE CARD

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**ELECTRONIC DESIGN • June 25, 1958**
Wire and Cable
Teflon insulated

A line of Teflon insulated wire and cable, Teflon, is available. The wire is being manufactured to Mil Spec W-16878B in type E, with a wall thickness of 0.015 rated at 600 v, and type EE, with a wall thickness of 0.015 rated at 800 v. Stock sizes will cover the AWG range from 16 to 30 gauge.

Stretch-Wire Corp., Dept. ED, P.O. Box 893, New Rochelle, N.Y.

CIRCLE 126 ON READER-SERVICE CARD

Insulating Compound
Withstands high temperature

Two materials withstand continuous exposure up to 500 F. Designated DIALL FS-4, the first is a long fiber, glass-filled molding compound which at 500 F shows a flexural strength of 8700 psi, a compressive strength of 6500 psi, and a tensile strength of 4270 psi. The second, DIALL FS-5, is a short fiber glass-filled compound which at 500 F has a flexural strength of 2000 psi, a compressive strength of 6000 psi, and a tensile strength of 4500 psi. Both materials are considerably stronger at 300 F, and up to 3 times stronger at 80 F. Electrical and chemical properties are reportedly excellent.

Mesa Plastics Co., Dept. ED, 11751 Mississippi Ave., Los Angeles 25, Calif.

CIRCLE 127 ON READER-SERVICE CARD

Cable End Seals
Vacuum tight

A line of vacuum tight ceramic-to-metal cable end seals capable of standing temperatures of 1400 F and pressures of 2000 psi are available. The increased temperature and pressure ratings are due to a pre-brazing coating of molymanganese which becomes an integrally fused part of the metal.

Advanced Vacuum Products, Inc. Div., Central Ceramics Corp., Dept. ED, Keasby, N.J.

CIRCLE 128 ON READER-SERVICE CARD

Transformer
FOR ELECTRONICALLY REGULATED POWER SUPPLIES

* ONE UNIT PROVIDES PLATE AND FILAMENT POWER FOR ENTIRE SUPPLY.
* RATINGS BASED ON D.C. OUTPUT OF SUPPLY.
* APPLICATION BULLETIN WITH EACH UNIT.

2K SERIES

<table>
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<tr>
<td>2X4</td>
<td>300-750 VDC</td>
<td>500-800 V</td>
<td>237</td>
<td>4</td>
<td>3</td>
<td>1.2</td>
<td>3.8</td>
<td>6</td>
<td>45</td>
<td>50</td>
<td>1/2</td>
<td>4.5</td>
</tr>
<tr>
<td>2X8</td>
<td>300-750 VDC</td>
<td>600-1000 V</td>
<td>237</td>
<td>4</td>
<td>3</td>
<td>1.2</td>
<td>3.8</td>
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<td>45</td>
<td>50</td>
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<tr>
<td>2X10</td>
<td>300-750 VDC</td>
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<td>4</td>
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<td>1.2</td>
<td>3.8</td>
<td>6</td>
<td>45</td>
<td>50</td>
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<td>1000-2000 V</td>
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<td>3</td>
<td>1.2</td>
<td>3.8</td>
<td>6</td>
<td>45</td>
<td>50</td>
<td>1/2</td>
<td>4.5</td>
</tr>
</tbody>
</table>

NOTES
1. All Primaries 115 VAC, 50 or 60 Cps.
2. Ratings Based On Capacitor Input Filters
3. Dielectric Test Voltages: Primaries 1500 V RMS
   All Secondaries 2500 V RMS.

CIRCLE 129 ON READER-SERVICE CARD

10 power FLAWE FINDER
Quick-focusing illuminated magnifier—removable handle is a pocket flashlight, $8.95—with leather case, $12.45

40-50-60 power "PEN" MICROSCOPE
Pen size precision instrument with magnification equal to large lab models. With leather case, $17.50

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Since 1927—manufactured in the U.S.A. by—

E. W. PIKE & CO., INC.
577 Penna. Ave., Elizabeth, N.J.
Elsie 2-0630

CIRCLE 130 ON READER-SERVICE CARD
NEW LITERATURE

Instrument Components

A new catalog, No. BED-A90 featuring spec in data and engineering information for electronic design engineers has been announced. Linear definitions, resolution curves, power ratings, curves, applications, operation, and other valuable data about components are included. Also included is a complete list of "Tech Reps" and jobbers for easy location in any area. Borg Equipment Div. of The Geo. W. Borg Corp., 120 S. Main St., Janesville, Wis.

End Seals and Mounts

The availability of Catalog No. 657D describing its complete line of end seals, crystal holders and mounts, and transistors and diode closures has just been announced. This 16-page folder contains complete physical dimensions and line drawings of over 1000 different styles and sizes of Military and RETMA type hermetic seals and their appropriate part numbers. It also offers specific illustrations and information about custom design engineering service on all types of glass-to-metal seals. Hermetic Seal Corp., 29 S. Sixth St., Newark 7, N.J.

Rotary Switches

A four-page data sheet, with information on sealed subminiature assemblies and a "V3" version, is available. These rotary selectors are available with as many as 20 basic switching units. Photographs, dimension drawings, electrical ratings, characteristics, and price information are included. Micro Switch, Div. of Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Panel Fasteners

Two technical bulletins containing complete engineering specifications and qualification test data for a quick-action stressed panel fastener have been issued.

A three-page illustrated brochure contains a complete description of the fastener, instructions for operation and complete dimensional specifications. Typical installations, with illustrations of both flush-type and protruding-head type fasteners, information about sheet preparation, available materials and finishes, and instructions for parts specification are also featured.

A nine-page illustrated bulletin is devoted to the results of a series of qualification tests conducted. Waldes Kohinoor, Inc., 47-16 Austel Place, Long Island City 1, N.Y.
Pressure Transducers

A bulletin describing the complete line of Model H series high pressure transducers has been issued. The transducers are designed to provide very accurate measurement of pressures in corrosive fluids while exposed to extreme environmental conditions. Servonic Instruments, Inc., 640 Terminal Way, Costa Mesa, Calif.

Magnetic Components

A company has assembled data on many standard models of magnetic components. A reference order form is included in this 22-page illustrated brochure. Varo Manufacturing Co., Inc., 2201 Walnut St., Garland, Tex.

Selenium Rectifiers

Bulletin EPD 3116-1 catalogs a line of rectifiers made from grain-oriented selenium. In this material the crystals are oriented for the most effective rectification. Illustrated with photographs, charts, drawings, and performance curves, the 48-page booklet gives details on performance, construction, and dimensions. It also suggests applications and gives installation instructions. Vickers Incorporated, Electric Products Div., 1815 Locust St., St. Louis 3, Mo.

New Miniature AGASTAT®

Time Delay Relay

For missile, aircraft and electronic applications

INSTANTANEOUS RECYCLING ... reset time—less than .020 seconds
UNAFFECTED BY VOLTAGE VARIATIONS ... time delay remains constant from 18 to 30 volts DC
ADJUSTABLE ... time delays from .030 to 120 seconds
CHOICE OF OPERATION ... for either energizing or de-energizing
SMALL ... height—4½"; width—1½"; depth—1½"
LIGHT ... maximum weight—15 ounces
MEETS ENVIRONMENTAL REQUIREMENTS OF MIL-E-5272A

This new AGASTAT time delay relay is an externally adjustable, double-pole, double-throw unit. It incorporates the basic AGASTAT timing principle, proved by a half-century of reliable operation on automatic aids to navigation, in a space-saving miniature unit built to withstand the rugged environmental conditions of missile and aircraft applications.

For specific information on the new AGASTAT relay for your application, write to Dept. A-30-624.

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For specific information on the new AGASTAT relay for your application, write to Dept. A-30-624.
Where can you use this new idea in

Dipping Resins?

A new product for quick, reliable, and economical encapsulation of electrical components by dipping: "SCOTCHCAST" Resin No. 253...

Now you can get all the time-tested sure-protection benefits of epoxy resin encapsulation, combined with all the time-saving cost-cutting benefits of dip coating! "SCOTCHCAST" Resin No. 253 lets you use conventional dipping and heat-curing methods—either automatic-conveyor or hand—to get a uniformly thick, mechanically tough, thermostetting encapsulation. This resin, though new, has already enabled one major manufacturer to meet the exacting MIL-T-27A transformer specification.

FACTS ABOUT "SCOTCHCAST" NO. 253

This new dipping epoxy offers several important production advantages:

1. Long pot life—2-4 days at room temperature.
2. 100% solids resin; thermosetting with a normal bake cycle.
3. A "thixotropic" material... no run-off or drip during curing.

Transforming Meeting MIL-T-27A Specifications is shown above. This was impregnated using "SCOTCHCAST" Resin #241 and then dip-coated using new "SCOTCHCAST" Resin No. 253. There is no limit to the sizes or shapes of components that can be dip encapsulated with this heat-curing resin material.

USES FOR NO. 253

Among the encapsulating uses for which new "SCOTCHCAST" Resin No. 253 has been used are:

- Transformers
- Solenoid Coils
- Motor field coils
- Printed circuits
- Capacitors
- Electronic components

#253 can be used for specialized applications of brush, spray or extruded coatings.

WHAT IS YOUR ENCAPSULATING PROBLEM?

There may be a real opportunity for you to solve it with new "SCOTCHCAST" Resin No. 253. We'll be glad to send complete technical data upon request. Or, we can provide one of our trained field engineers to work with you in testing the resin. No cost or obligation involved; just write on your letterhead to: 3M Co., 900 Bush Ave., St. Paul 6, Minn., Dept. ON-68.

NEW LITERATURE

Russian-English Glossary

A modern Russian-English Solid State Glossary, 90 pages long, with over 4000 terms for the most recent issues of Soviet physics journals has been published. It is priced at $10.00. Included are terms in solid-state theory, crystallography, physics of metals, metallurgy, ferromagnetism, semiconductors, and general quantum theory. The Solid State Glossary is part of a series of 8 interim glossaries on specialized fields of physics.

The Glossary text is clearly reproduced by the multilith process from varityped copy, and stapled bound in durable paper covers; the Dictionary will be case-bound and indexed. Consult Bureau, Inc., Dept. ED, 227 W. 17th St., New York 11, N.Y.

Glass Fabricating

This 8-page illustrated catalog, 80-23, discusses the fabrication, materials, tolerances, and many applications of precision glass products. Fisher & Porter Co., 691 Jacksonville Rd., Hatboro, Pa.

Electrical Connectors

Several lines of electrical connectors are catalogued in the 62 pages of Bulletin 1252-1. Coverage includes specifications, pictures, selection data, and other details are environment resistant, circuit breaking, and delayed action connectors. The catalog also offers assembly and installation instructions. Pyle-National Co., 1334 N. Kostner Ave., Chicago 51, Ill.

High Alumina Ceramics

A file folder on high alumina ceramic standards and special products may be had on request. It contains individual catalog sheets and gives information on the physical properties and characteristics of the material. Diamonite Products Mfg. Co., 1232 Cleveland Ave. N.W., Canton 3, Ohio.

Use of Delay Lines

Bulletin No. 18, a 12-page booklet with detailed compilation of data for the proper use and installation of different delay line types, is now available. Divided into four major sections, mechanical and electrical terminations, mounting and test procedures are discussed in this well-illustrated booklet. Columbia Technical Corp., 61-02 31st Ave., Woodside 77, N.Y.
Rotary Switch


Solenoid Valves

No. 505 stock list contains prices, valve drawings, flow diagrams, illustrations and engineering data for a line of solenoid valves. Ordering information for these zero, three and four way solenoid valves also included in the 8-page stock list. Automatic Switch Co., Hanover Rd., Norham Park, N.J.

High Temperature Equipment

"High Temperature Electronic Equipment" describes the successful operation of electronic equipment at ambient temperatures of -67 to 750 F, without the use of refrigerants. This bulletin summarizes the programs that resulted in this achievement. The bulletin, MPB-32, contains 4 illustrated pages. General Electronic Co., Lakeside Ave., Burlington, Vt.

Ultrasonic Delay Lines

Facilities for designing and making specialized ultrasonic solid delay lines are outlined in a 4-page brochure. The bulletin lists major equipment and covers the range of work in which the company has had experience. The main types of delays manufactured are illustrated and described. Andersen Labs., Inc., 501 New Park Ave., W. Hartford, Conn.

Variable Resistors

Two stock sheets list variable resistors for immediate delivery. In Stock Sheet 163 there are 108 military wire-wound types certified to the latest MIL-R-19A specs. Stock Sheet 164 lists 158 military composition types certified to MIL-R-941. Both lists are single-page and illustrated. Chicago Telephone Supply Corp., Elkhart, Ind.

For permanence of high absorption

...Raytheon specifies McMillan microwave absorbers

Peak quality products are prime requisites at Raytheon Manufacturing Company. As one of the outstanding contractors in aircraft weapons systems, guided missile systems, major defense radars and fire control systems, their superior quality work requires the finest radar testing facilities. They must have both high initial performance and stable, guaranteed performance. To satisfy these conditions they specify McMillan Microwave Absorber Products.

In their 17 large test stations at Maynard, Bedford, Lowell, and Andover, Raytheon has installed McMillan products - either block absorber material or modular prefabricated "free space" rooms. For all types of antenna and radome testing McMillan Absorber Products are specified because their high attenuation characteristics are long lasting.

In the main illustration above, a permanent test area has been "walled" with McMillan "BL" Plastic Foam Block. Inset shows a McMillan Prefabricated "free space" Room. McMillan Microwave Absorbers are available in hair material, plastic foam block and thin flexible material, for ground, shipboard and airborne use, for frequency ranges from 40 mc to 35,000 mc.

With their long experience in the field, backed by complete design, testing and manufacturing facilities, McMillan engineers are ready to assist you in any antenna and/or radome testing problem.

Send for latest catalog.
Here is metal strip—available in virtually any alloy—produced in thicknesses ranging from .010" to .0001". (The glue on a stamp measures .0007") Many of the miniaturization problems facing designers are being solved today by this ultra-thin strip and foil from the Precision Metals Division of the Hamilton Watch Company.

When product emphasis is on compactness and lightness, Precision Metals Division strip and foil will meet your exact mechanical, magnetic and physical specifications. For production orders or the development of new designs, this ultra-thin strip is available in any quantity. Special alloys to your own specification can also be made and furnished in the form you require.

A new 8-page facilities booklet illustrates and describes the operation of the Precision Metals Division, and shows how your precision metals problems can be solved practically and economically. Write on your letterhead today to Dept. ED-6

**Hamilton Watch Company**

**Precision Metals Division / Lancaster, Pennsylvania**

Creator of the world's first electric watch

CIRCLE 160 ON READER-SERVICE CARD

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**NEW LITERATURE**

**Pulse Height Analyzer**

A four-page bulletin describing the model PA-400 multi-channel pulse height analyzer has been released. The bulletin notes the features and applications of the fifty-channel analyzer. It also gives specifications and physical and electrical descriptions of the component parts of the various modules that go into the complete unit. Eldorado Electronics, 1401 Middle Harbor Rd., Oakland, Calif.

**Motorized Devices**

Miniature motorized devices are described in this 10-page illustrated catalog. The devices meet various MIL specifications, and also have application in industrial control equipment. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

**Low Voltage Transformers**

A company has a 3-page bulletin on transformers for transistor applications which gives engineering data on basic audio and rectifier types. Operating characteristics, dimensions, ratings, line drawings, and photographs of cased and uncased units are shown. Ferrotran Electronics Co., 693 Broadway, New York 12, N.Y.

**Mylar Capacitor**

This literature is a 4-page engineering bulletin for Mylar capacitors; types 101, 103, 106, and 107. The bulletin contains engineering data and electrical characteristics for a type of non-hygrosopic polyester film capacitor. Pyramid Electric Co., 1445 Hudson Blvd., N. Bergen, N.J.

**Servo Gain Variations**

A graphical representation of the effects of gain changes at various points in an output rate stabilized servomechanism is provided in Paper CP-58-13. This paper was presented at the Winter Meeting of the AIEE by Mr. E. G. Trunk. Servo Corporation of America, 2020 Jericho Turnpike, New Hyde Park, N.Y.

**Infrared Materials**

This 4-page brochure provides revised comparative information on 15 different infrared transmitting materials suitable for use as optical elements. Transmission curves are included for the 11 most important materials. Servo Corporation of America, 2020 Jericho Turnpike, New Hyde Park, N.Y.

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**SOLUTION TO A PRINTED CIRCUIT DESIGN PROBLEM**

Microdot printed circuit board connectors are available to mate any of the standard Microdot micro-miniature coaxial fittings. Designed with "long" or "short" mounting pins to fit standard .100" grid pattern on panels 1/16" to 3/16" thick. Available in 50, 70 and 99 ohm for quick, easy connect and disconnect—screw or slide-on style, in straight or right angle types. Proven in commercial and military applications. Immediate delivery.

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**Microdot, Inc.**

220 Pasadena Avenue
So. Pasadena, California

CIRCLE 167 ON READER-SERVICE CARD
Here's how General Electric solves typical DC power-supply problems

for computers and special applications

**PROBLEM**

"We need to devote our engineering time to designing our electronic circuitry... not the power components."

**SOLUTION**

This is a frequent problem facing computer manufacturers. General Electric's Rectifier Department has complete engineering and manufacturing capability not only to design and apply all types of power supplies, but also to incorporate power supplies into completely integrated systems.

These systems could include load distribution, supply sequencing, protection for power supply and load, and complete power distribution. Let General Electric tackle your DC power problems such as those associated with load IR drop, "cross talk," and other nuisance-type problems plaguing your engineers.

**PROBLEM**

"It's always a problem making sure transistORIZED equipment is safe from its power supply."

**SOLUTION**

To alleviate this problem, General Electric has developed several methods of making transistORIZED equipment safer in this respect. With G-E protective circuits, shorting a plus high-voltage bus to a plus or minus low-voltage bus would not cause the low-voltage bus to exceed a small percentage of nominal rated value.

General Electric power supplies protect completely transistORIZED pieces of equipment from large losses due to over-voltage failures.

**PROBLEM**

"My power supply requirements fluctuate so much... big jobs, little jobs, all in between."

**SOLUTION**

G.E. has built individual power supplies and complete systems ranging from less than one watt up to 35,000 kilowatts. These power supplies span the complete range of DC power—regulated and unregulated—applying all types of components. G-E experience includes completely transistORIZED supplies, and supplies with the new controlled rectifier, magnetic amplifiers, voltage stabilizing transformers, and motor-alternator "brute force" systems.

**PROBLEM**

"We have a real low-voltage power distribution problem with our computer."

**SOLUTION**

Low-voltage distribution problems can be handled easily through load compensation. Curve "A" is not desired no-load to full-load regulation at load point. "B" is regulation at load without remote sensing or load compensation. "C" represents IR compensation in power supply itself. "D" is amount of IR or load compensation.

If you have a computer or special power-supply problem, free your engineers of this problem and turn it over to General Electric for solution. It's more economical! G-E engineers can call on over 40 years of experience in the metallic rectifier field and put this experience to work in solving your particular problem—large or small. Contact your nearest General Electric Apparatus Sales Office or write Section A465-6, Rectifier Department, General Electric Company, Lynchburg, Virginia.

**Progress Is Our Most Important Product**

**GENERAL ELECTRIC**

CIRCLE 171 ON READER-SERVICE CARD
A Simple Count-down Device

A COLD cathode glow-transfer tube (Dekatron) makes a simple reliable circuit for count-down by various division rates. The circuit shown simultaneously counts down a 10 pps pulse train by division rates of 1, 2, 5, and 10 and would produce outputs of 1, 2, 5, and 10 pps. By monitoring appropriate cathodes, outputs are produced as desired. For division by 10, one cathode (no. 10) is monitored; for division by 5, cathodes 5 and 10 are monitored through a diode isolating network. Division by 2 is obtained by monitoring all even cathodes through a similar isolating network. Dekatron stages can be cascaded for higher division rates. A two stage scaler can count down by any number evenly divisible into 100, i.e.; 1, 2, 4, 5, 10, 20, 25, 50, and 100. Two Dekatron stages will replace 12 tubes of a conventional feedback binary counter system.

A 12 cathode Dekatron can be used if division by 3, 6, and 12 is desired.

Jack Star, Associate Engineer, Johns Hopkins University, Silver Spring, Md.

This circuit can divide by different numbers simultaneously.
Tape Recorder Motor Does Almost Everything

A low-cost German tape recorder has four separate functions. Without gears, clutches, pulleys, belts, or any other mechanisms which tend to cause mechanical failure, the motor is mounted to provide:
- forward wind;
- reverse wind;
- stopping with instantaneous braking;
- slack take-up.

A mechanical lever on the face of the machine tilts the motor to drive either tape reel. When this lever is thrown to neutral, a spring pulls the motor over momentarily to brake the feed reel to prevent tape spillage.

Filnor Products, Inc., 101 West 31 St., N.Y.C.

Simple, Transistorized, 1 Per Cent Voltage Regulator

This voltage regulator supplies 22 v ±1 per cent from a 28 v ±14 per cent line. It can supply loads from zero to 3 amps, and has been built in short circuit protection.

The key to improved performance is the transistor power transistor. Its second base controls the total system leakage. Thus the output terminals can be opened without latching control. If the output current exceeds a predetermined value, the system shuts itself off, and only leakage current will flow.

Minneapolis-Honeywell Regulator Co., Minneapolis 8, Minn.

Millivolt Recorder with self-balancing DC amplifier, 2.5-10-20-50-100-200 mv ranges, 1.5% accuracy except 2 mv range (2%).

Double size recorder models, take up to six multiple, independent movements. Wall and projection mount available.

Miniature Slim Recorder model saves half the width of standard recorders. Only 3 3/8" x 7 3/8" x 8 3/8".

Strip Chart Recorder, standard model 81 (portable) and 82 (flush) are also available for wall and projection mounting. Weighs only 19 lbs. and measures 8 3/8" x 9 3/8" x 8 3/8".

$445.00

Universal AC-DC Recorder with total of 23 ranges. Complete in solid oak case, 13% x 11% x 11" ... weighs 36 lbs.

Miniature Square Model Recorder, in flush mount, 5 1/4" square x 13" deep.

Announcing Curtiss-Wright RECTILINEAR STRIP CHART RECORDERS

Backed by a leading West German maker's 50 YEARS of precision instrument manufacturing

A rare combination of precision and ruggedness ... straightforward in design and simple to operate ... these new Curtiss-Wright precision instruments are made through a licensing agreement with Metrawatt AG, one of the most experienced of West German precision instrument makers.

Important features include: Rectilinear Recording · Inkless and Ink Recording in One Unit · Three-Speed Transmission plus 60:1 Speed Change · 1% Accuracy · Shock, splash and dustproof. The complete line includes double size and miniature sizes; AC, DC, power and combination movements; wide choice of ranges and chart drives. Write for full information.

Curtiss-Wright recorder, DC preamplifiers, and controllers, can be combined into systems to meet varied demands.

ELECTRONICS DIVISION CURTISS-WRIGHT CORPORATION · CARLSTADT, N.J.

CIRCLE 204 ON READER-SERVICE CARD
REPORT BRIEFS

Laminar Flow Electron Beams

It would be desirable in designing an electron stream to be able to determine analytically the electrode shapes necessary to produce a given beam. A procedure for accomplishing this is developed on the basis of the assumption of laminar flow. An equation is derived from Maxwell's Equations, the equation of continuity, and the force equation which relates the shape function and the potential on the axis of the stream. Exact solutions are obtained for the special cases of (1) parallel flow; (2) constant axial potential (the beam spread case); (3) beam diameter decreasing exponentially with distance; (4) beam diameter decreasing algebraically with distance. In addition, approximate solutions for two types of periodic beams are discussed, the first having a boundary with a sinusoidal variation and the second an axial potential which varies sinusoidally. An experimental tube was designed to produce one of the periodic beams studied. Pervenance of the gun was approximately 20 per cent below the design value, but transmission was nearly 100 per cent with very small collection by the various electrodes and little secondary emission.


Theory of Switching Report No. 9

Back Transients in Semiconductor Diodes

This report is designed to clarify the effect of back transients in the operation of semiconductor diodes. Back transients are discussed in relation to circuit parameters and system bandwidth. The transient effect may be predicted if quantitative tests are made on the diodes to be used. Based on these predictions, the effect may be minimized when the test data is intelligently applied to circuit design. *Back Transients in Semiconductor Diodes*, C.G. Dorn, U.S. Naval Ordnance Lab., Corona, Calif. Apr., 1956, 17 pp, microfilm $2.40, photocopy $3.30. Order PB 126193 from Library of Congress, Washington 25, D.C.

Open Rectangular Waveguide

In this report a theoretical study is carried out to determine the phase velocity of a wave being propagated in an open rectangular waveguide of infinite height whose bottom portion has been filled with dielectric material either of the discretely variable type or the continuously variable type. Study of an Open Rectangular Waveguide Partly Filled with a Stratified Dielectric, R. I. Barnett, Jr., and C. T. Tai, Ohio State Research Foundation, Columbus, Ohio. Sept. 1956, 12 pp, diagrams, graphs, microfilm $2.40, photocopy $3.30. Order PB 124718 from Library of Congress, Washington 25, D.C.

Electron Mirror Microscopy

The purpose of the research reported here was to find out if it is possible to utilize electron mirror microscopy for pictorial representation of magnetic patterns in general and of magnetic domains in particular. After establishing the basic facts of image contrast formation with types of artificial specimens, experimentation proceeded to specimens actually containing magnetic domains. The magnetic materials used for the purpose were barium ferrite and nickel ferrite. Samples of electron mirror micrographs of domain patterns of these materials are shown in this report and are compared with domain patterns of the same specimen areas obtained by the conventional powder technique. The identical nature of the configurations on both types of micrograph provided final proof of the feasibility of electron mirror microscopy in depicting magnetic patterns. An elementary theory of image contrast formation is included in this report. Research to Investigate The Feasibility of Electron Mirror Microscopy in the Study of Magnetic Domains, by Ludwig J. Mayer, General Mills, Inc., Mechanical Division, Minneapolis, Minn. Sept. 1957, 32 pp, photos, drawings, $1.00. Order PB 131624 from OTS, U.S. Dept. of Commerce, Washington 25, D.C.
Temperature-Compensated Transistor Oscillator Circuit


The transistor oscillator is of the feedback type where feedback is automatically varied during temperature changes up to 75°C to compensate for inherent instability of the transistor circuit.

An npn transistor is illustrated having fixed bias between emitter 13 and base 12 due to dc voltage-dividing series resistors 45 and 41. Collector 14 is connected to base 12 through high-Q primary 23 of the output transformer. Oscillations are permitted by connecting crystal 33 between the collector and the emitter through dc blocking condenser 35. In addition, temperature compensating condenser 17 between the emitter and the base determines, by voltage division, the magnitude of signal feedback.

For the grounded base configuration:
As the temperature increases, the collector resistance decreases and the emitter resistance increases. Output amplitude would normally decrease with increase in temperature. However, the capacitive reactance of condenser 17 increases as the temperature increases resulting in more feedback to the emitter. This compensates for the changes in emitter and collector resistances so that the output is substantially independent of the temperature change.

High Voltage Power Supplies

Patent No. 2,806,988. T. J. Sulphizio and John E. McWade. (Assigned to the United States of America)

An efficient power supply which can be accurately regulated and which occupies a minimum of space has been devised. This circuit feeds a low dc potential to a charging circuit consisting of inductor 12 and condenser 14. The condenser is discharged through transformer primary 22 and gas discharge tube 24. The pulse generated is the equivalent of a vhf pulse so that step-up in the inductor or primary winding 22 is very large. Therefore, a transformer with a high turn ratio is not necessary. Initially there is also a regenerative action which increases the discharge potential until a point of stability is reached. This action stems from the current-voltage phase relation between the condenser and inductor. When the condenser potential is zero the inductor current is at a maximum. The discharge tube continues conducting until the current is zero at which point the condenser potential becomes negative. The new charge builds up on this negative potential for several initial charging pulses. The secondary circuit of the transformer includes rectifier 36 and filter 38 which provide a high dc voltage at the output terminals 41.

By controlling the time of discharge of condenser 14 through gas tube 24, the potential at the output may be regulated. To accomplish this a resistor 42 is provided across the output terminals and serves as a voltage divider. The potential appearing across the resistor is compared with reference voltage 44 and any difference in potential is amplified by amplifier 46. This amplified voltage controls the grid bias level of free-running multivibrator 48. Any change in the grid bias of the tubes of the multivibrator results in a proportional change in the frequency generated. This change in frequency of the multivibrator changes the time of the discharge of the condenser through the tube and changes the amplitude of the potential appearing across the transformer primary winding 22. By proper adjustment and compensation, the difference potential goes to zero.

However, this increases the amplifier noise and a high supply voltage is required to compensate for the large voltage drop in the emitter resistor.

Compensation for low impedance is accomplished by connecting resistor 22 of relatively low resistance (about 1000 ohms) in series with the emitter electrode 18 of a common emitter transistor amplifier circuit.

In addition condenser 24 (about 0.05 µF) is placed in parallel with the input circuit of the amplifier when the crystal pickup has an internal capacitance of the order of 1,000 µF. The complete circuit includes provision for operating bias for the base and emitter electrodes as well as capacitance bypass of resistor 22 to enable less degeneration at high audio frequencies. It is shown that there is proper impedance termination of the transducer 10 since the time constant is the same with input capacitor 24 connected or disconnected. In general, the increase in the equivalent capacitance reduces the size of the resistance required in the emitter circuit. Thus, for the same operating current the voltage drop across the emitter is less than if a larger resistance were inserted in the emitter circuit.
Electromagnetic Deflection System

Patent No. 2,820,175. Eugene G. Fubini. (Assigned by mesne assignments to the United States of America as represented by the Secretary of the Navy)

Since distributed line amplifiers have excellent h-f response, a distributed line amplifier is designed to drive the electromagnetic deflection yoke for oscilloscope display of narrow pulses. The deflection yoke consists of individual series-connected coils which are coupled as the output transmission line for the distributed line amplifier.

The first two stages and the last stage of distributed amplifier 12 are shown in detail. In practice, four to eight stages are sufficient to obtain the characteristics of an actual distributed line. Series-connected coils, 20a, 20b...20x and 20y and condensers 26a, 26b...26y comprise a tapped delay line which couples the deflection signal to amplifier tubes 22a, 22b and 22y. The output of each amplifier is connected to a point on the output transmission line corresponding to a point on the input delay line such that the delay due to each of the series-connected coils of the deflection yoke is equal to that of the corresponding section of the input delay line. Therefore, the contribution of currents from all of the pentode amplifiers are in phase. Reflections may be reduced by terminating the output transmission line by a resistance equal to the characteristic impedance of the line.
YOUR HEART IS HIS BUSINESS. He's a research scientist—one of thousands supported by the Heart Fund. His life is dedicated to finding the unknown causes of the heart diseases, and new methods of treating and preventing them. He and your Heart Association have made your heart their business.

YOUR HEART IS YOUR BUSINESS. Whatever your way of life, your future depends on your heart. Heart disease causes personal suffering and undermines the happiness and economic welfare of the family. No one—no child or adult—is immune.

THE HEART FUND IS EVERYBODY'S BUSINESS. When you support the Heart Fund, you help all hearts. You support heart research—and you make it possible for your Heart Association to bring the latest advances in heart research to you and your family through your doctor.

Give Generously for Every Heart You Love
Applied Statistics for Engineers

Emphasizing engineering applications rather than theory, and providing a number of illustrative examples, the book deals with the treatment of engineering data for correlation, precision, and analysis of experimental factors. A review of probability theory and frequency distribution is included.

One feature is the statistical handling of correlation data. Not only does it describe the method of drawing the “best” line through the data but also the method of determining how well the line fits the data, how much variation in the data is eliminated by the line and by the correlation, and how much variation still remains. There are also detailed discussions of curvilinear correlation, analysis of the variance, and interpretation of the analysis of variance. Besides offering a view of the whole field of statistics in engineering, the book is arranged so that each chapter is complete in itself, providing a quick idea of how a particular type of problem has been handled.

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Television in Science and Industry

Analyzing both equipment and applications, the authors discuss closed-circuit color television and the improvements achieved by transistorization. Also described are stereo television, specialized television methods in research, television microscopy, etc. The principal fields of applications of television in industry, research, medicine, education, commerce, military affairs, and home are outlined.
What The Russians Are Writing

J. George Adashko

AUTOMATIC CONTROL

This extensive survey article describes fundamental methods and trends in the use of nuclear radiation in automatic control. The article discusses the fundamental characteristics of alpha, beta and gamma rays, and describes various radiation detectors, and radioactive isotopes. It then proceeds to describe the automatic control of productive processes with radiation, such as the automatic control of thickness and weight of material, media density, liquid level, flow regulation, gas and liquid flow regulators.

Fig. 1. Relay circuit used for voltage regulation. A source of radiation is placed on an indicating instrument’s pointer. Whenever the pointer moves outside the range of a screen, whose width is determined by the voltage accuracy required, nuclear particles strike one of the counters and connect the proper relays into the voltage regulation circuit.
CIRCUITS


A method for designing ac magnetic amplifiers with iron-nickel cores is suggested, based on the theory of the “ideal” magnetic amplifier. The performance of an ac magnetic amplifier with an inductive-resistive load is analyzed and the performance of a push-pull magnetic amplifier with inductive load is discussed.

Single Tube Circuit for Division and Multiplication of a Crystal Frequency by G. M. Utkin. RE 9/57, pp 47-54, 7 figs.

The author previously reported extensive investigation of two-loop self-excited oscillators with multiple frequencies. (Radiotekhника, October 1956, ED 7/1/57; Radiotekhника i Elektronika, January 1957, ED 9/1/57; Radiotekhnika, April 1957, ED 11/15/57. He now

Fig. 2. Transistorized gamma ray relay developed by the All-Union Coal Institute.

Fig. 3. A relay with a scintillation counter.

ACEPOT

PRECISION, WIRE-WOUND

NONLINEAR POTENTIOMETERS

0.25% terminal conformity without padding resistors

A potentiometer without padding resistors produces a smooth output function curve as opposed to a stepped function curve when padding resistors are used. With the addition of padding resistors there is also a corresponding decrease in reliability and accuracy since each padding adds a pair of critical tap-offs to the delicate wire windings.

ACEPOT nonlinear potentiometers have terminal conformity to 0.25% without padding resistors. Desired output function is achieved by use of unique winding equipment of microscopic accuracy plus newly developed manufacturing techniques for precision, miniaturized parts. Dependability is guaranteed with ACE quality control. A tabulation of check points showing voltage ratio versus rotation is supplied for each unit.

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uses his test results to develop circuits for practical use of such systems for division and multiplication of the frequency of a quartz oscillator. The equations derived for the self-excited oscillators are similar to those for the quartz oscillators. These circuits can be used to multiply and divide by a factor reaching 15.

Report of an experimental verification of some of the circuits is also made.


Expressions are derived for the temperature coefficients of the frequency of circuits that incorporate thermal compensation such that the temperature errors are reduced to a minimum. Results of calculations of a specific circuit are given; it is shown that simple compensation circuits can in many cases be just as effective as complex ones.


A comparison is made of three basic electronic integrators relative to the minimum integration frequency of a sinusoidal signal and relative to the maximum integration time of a step signal.

An increase in the maximum integration time of a stabilized operational amplifier requires an increase in the dynamic voltage range. This can be done by reducing the error of the operational amplifier or by expanding the linear range of variation of the output voltage. A clever device for doing this is shown in Fig. 4, which represents a step integrator. Here, the operational amplifier integrates only during a given time. After the output voltage reaches a value of ±100 volts, as established by the comparison device EC, the slide of the step switch moves one step and the voltage ±ΔU is memorized. Capacitor C is discharged by relay P-1 or P-2, and the integration starts again. The output voltage $V_{out}$ is taken from the auxiliary adder 2, where the voltage from the stepped selector and from the output of the integrator are added. This results in a piecewise linear curve instead of a stepped curve. Thus, after $n$ steps a voltage $nU$ will be at the output of the divider, corresponding to an $n$-fold increase in the paper limit of linearity and gain of the whole circuit.

Concerning Reduction of Nonlinear Distortion by...
Nonlinear distortion at higher frequencies in feedback amplifiers should be determined only from the difference-tone coefficient; equations are given for this coefficient. Methods for increasing the effectiveness of the feedback at higher frequencies are proposed. The concept of a system with "frequency-dependent nonlinearity" is introduced and various distortion figures for such systems are given.

**COMPONENTS**

Inductive Transducer of Higher Sensitivity for Recording Linear and Angular Displacements by A. S. Sadovskiy. AT 9/57, pp 802-813, 15 figs.

A toothed through-type inductive transducer, having a sensitivity greater than a transducer with a solid armature is described. The transducer enables measurement of displacement and recording of equal and unequal lengths within the range of the entire length of the armature. These can be made as large as desired. The armature may also be made in the form of a cylinder and the teeth in the form of rings or a screw thread. In the latter case the transducer can be used also to measure angular displacements.

Such a measuring device can be used in precision machine building and has replaced optical systems of measuring coordinates and displacement; it also lends itself to automatic positioning of the breadth of a machine tool at a preselected coordinate, something that cannot be done with an optical system.

Investigation of Transients in Germanium Point Contact Transistors by A. I. Skopenko. REE 9/57, pp 1210-1220, 8 figs, 4 tables.

It is shown that the time required to change

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"Paraballool" antenna folds up, flies to the right. It's magnesium light.

Take a high-powered radar installation, and design it with magnesium so it can be assembled and disassembled easily, and toed around from place to place.

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Wondering why the "Paraballool" antenna can do such a big job, yet weigh so little? The unit is constructed almost entirely of lightweight, rugged magnesium alloy. The reflector platform is magnesium sheet and extruded channels. The turning tube is a magnesium sand casting and the tripod is welded magnesium tubing. The radar reflector is a fully deflatable fiber glass balloon.

The "Paraballool" antenna is one of the many examples of how the high strength-to-weight ratio of magnesium pays off in terms of saved weight in electronic equipment. For more information on magnesium in electronics contact the nearest Dow Sales Office or write to THE DOW CHEMICAL COMPANY, Midland, Michigan, Department MA-1416M-1.
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point-contact transistors from the "off" to "on" state depends on factors that influence the transit time of the minority carriers from the emitter to the collector. The time to change from the "on" to "off" depends fundamentally on the effective lifetime of the minority carriers in the germanium crystals of the transistor. Refers to a large number of American articles, the latest of which is by L. B. Valdes (Proceedings IRE, 1956, Pages 178–184).


A magnetic amplifier with ferrite cores is used as a relay, in which the load current changes by a factor of 100–200. A method is given for designing such a magnetic relay.


Good agreement is shown between the diffusion theory of p-n junctions and experimental results for germanium diode frequency characteristics, with allowance for the charge capacity of the blocking layer. For specific resistivities of germanium, ranging from 0.01 to 10 ohm-cm, and for frequencies up to 1 mc the dependence of diode impedance on frequency and on positive bias current is always in line with the values called for by diffusion theory. One can determine the series impedance of a thickness of germanium crystal and the effective lifetime in a diode from the dependence of the real and

KEY

The sources of the Russian articles and their dates of issue follow the authors' names. Here is the key to the names of the journals in which the articles originally appeared.

AT Automation and Telemechanics (Avtomatika i Telemekhanika)
CJ Communications Journal (Vestnik Svyazi)
EC Electrical Communications (Elektrosvyaz)
IET Instruments and Experimental Techniques (Pribori i Tekhniku Eksperimonta)
R Radio
RE Radio Engineering (Radiotehnika)
REE Radio Engineering and Electronics (Radio-tekhnika i Elektronika)
imaginary components of the total impedance of
the p-n junction or from the capacity and resistance
of the blocking layer on the positive bias current
for a constant frequency, if diffusion capacitance is much greater than the blocking-layer capacitance. It is possible also to deter-
mine the charge capacitance of the diode from
the frequency dependence of the resistance and
capacitance of the p-n junction at a con-
stant bias current. Reference is made to work
by Lederhandler and Giaucho, Proceedings

Frequency Characteristics of Junction Transistors
by Ya. A. Fedotov. REE 9/57, pp 1189-1199, 9
figs.

The author shows that the best criterion for
estimating the frequency characteristic of a jun-
tion transistor (i.e., the current gain vs. fre-
quency) is the maximum oscillation frequency,
which is the frequency at which the intrinsic
gain of the transistor becomes greater
than unity. Reference is made to work by
Frolieht (IRE Transactions, 1955, CT-2, 2, Page
178), Mason (IRE Transactions, 1954, CT-1, 2,
Page 20), Pritchard (IRE Transactions, 1955,
CT-2, 2, Page 183) and Early Bell System Tech-

INFORMATION THEORY

Methods of Investigating Transients in Phase-
Correcting Systems Employed in the Reception
of Code Combinations of Telegraph Pulses by

Methods for investigating transients are given
for open and closed pulse networks with variable
pulse repetition frequencies which are multiples
of the elementary telegraph pulse. The regulation
process in the phase correction system of the
hunting fork of multiplex telegraph apparatus in
the reception of code combinations of telegraph
pulses is investigated.

TRANSLATIONS AVAILABLE

Electronic Design is gratified to learn of
the growing availability of full translations of
important Russian electronics journals.

Consultants Bureau, Inc. of 227 W. 17th
St., New York, N.Y. translates Automation
and Telemechanics regularly.

Pergamon Press of 155 E. 55th St., New
York 22, N.Y. is preparing translations of
Radio Engineering, Radio Engineering and Elec-
tronics, and Electrical Communications.

Readers interested in specific Russian jour-
nals can obtain more information by writing
directly to one of these publishers.
NEW! From the Laboratories of General Ceramics

50 MIL O.D. Memory Cores
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These new 50 mil O.D. cores are now available in General Ceramics S-4, the material that has proven so successful in such vital systems as the SAGE computer. Switching time is less than one microsecond with 550 ma full drive. At recommended operating conditions, the “ONE” output voltage is greater than 60 millivolts; the “ZERO” output voltage is less than 6 millivolts. Cores are provided in two quality levels, to .015 AQL and to 6.5 AQL. Dimensions are .050” O.D., .030” I.D. and .015” in height, all with tolerances of ±.002”. General Ceramics has designed and built special equipment for core testing to insure that each unit meets established electrical properties. 50 mil O.D. cores are supplied in production quantities in two quality levels. Parts are shipped according to MIL Specification 105A to 0.015 AQL or 6.50 AQL. For complete information on this core write General Ceramics Corporation, Keasbey, New Jersey, for Bulletin 326; address Dept. ED.

GERMAN ABSTRACTS
E. Brenner

Direct Reading Frequency Meter

The DIRECT reading, wide band, frequency meter can be used in the frequency range 50-300 kc in electronic measurement and control applications.

Operation of the instrument is based on the proportionality existing between current and frequency when a capacitance is periodically charged and discharged at a constant amplitude.

AC Operation of Magnetron Supplies

Both ac and dc sources can be used for magnetron supplies. In low power applications, such as in diathermy machines, ac operation of the magnetron tube may be economically advantageous because of the comparative simplicity of the supply. The magnetron, with an ac supply as indicated in Fig. 1, will only conduct during the positive half cycle of the ac wave.

Using the magnetron characteristics shown in Fig. 2, the voltage or current waveform can be calculated. Portions of sinusoidal pulses result exactly as they do in gas diodes. It can be shown that for a conduction angle between 60 and 120 deg, the peak anode current goes to eight times the value of a dc supply if it were used. For the small angles (less than 90 deg) the life of the tube, due to electron bombardment of the cathode, can be seriously reduced. Large angles require very high supply voltages. It appears advantageous to use the smallest conduction
**LORD designs and manufactures complete, assembled mounting systems in a wide range of standard and special designs. These provide excellent vibration and shock protection for airborne electronic equipment.**

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All materials and designs are selected to satisfy both performance and economical considerations. To initiate your mounting system project or obtain more information, contact your nearest LORD Field Engineer or the Home Office, Erie, Pa.

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**Figure 2. Schematic diagram of the indicating circuit.**

For the voltage applied to the indicating circuit to be independent of the signal amplitude a preamplifier, power amplifier, and limiter are cascaded as in Fig. 1. Therefore, square waves, the amplitudes of which are independent of signal amplitude, are applied to the indicating circuit shown in Fig. 2. It can be shown that the frequency is proportional to the meter reading, within 2 per cent, below 250 kc and within 5 per cent up to 300 kc if the maximum frequency is less than 0.1/RC. Accuracy in the hf range can be improved by calibration curves.

The differentiator section shown in Fig. 1 is used to obtain a voltage which is proportional to the time rate of change of frequency. Such signals can be used for regulation or control purposes.


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**Figure 1. Equivalent circuit of magnetron with ac supply.**

The diagram in Fig. 1 shows one magnetron which is driven by an additional magnetron. The circuit can be expanded as shown in Fig. 2 to include 120 times the number of transistors shown in Fig. 1. The output of the 120 identical stages is a line of angles which appears the same as the output of one stage.
IDEAS FOR DESIGN—ENTRY BLANK

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Here is my design idea for possible publications in your Ideas For Design department. I can expect $10 for this idea if accepted for publication.

(Ideas suitable include: 1. new circuits or circuit modifications, 2. new design techniques, 3. designs for new production methods, 4. clever use of new materials or new components in design, 5. design or drafting aids, 6. new methods of packaging, 7. design short cuts, or 8. cost saving tips)

STATEMENT OF THE PROBLEM—

MY SOLUTION, AND WHY—(Please be explicit. Include sketches or photos that will help the idea across)

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NEMA Standards Guide

The latest edition of "Your Guide to NEMA Standards Publications" is now available without charge from the National Electrical Manufacturers Association, 155 East 44th Street, New York 17, N.Y. The new guide contains information about nine new and thirteen revised standards.

ASTM F-1, Electron Tube Materials

This is the first edition of the Compilation of ASTM Standards for Electron Tube Materials. It is published in recognition of the growing importance of this field. There are 41 standards relating to cathode materials, insulators, strip materials, wire, metallic and non-metallic seals, and miscellaneous materials. Copies of this 242-page publication may be obtained from ASTM Headquarters, 1916 Race Street, Philadelphia 3, Pa., for $3.50 per copy.

Control Panels

MIL-C-18012A(ASG), CONTROL CONFIGURATION AND MARKING (FOR PLASTIC LIGHTING PLATES, CONTROL PANELS, AND PLACARDS), AMENDMENT 1, 24 DECEMBER 1957

Wherever practicable, the criteria of the Society of Automotive Engineers' recommended practice ARP-498 entitled "Panels, Plastic Lighting, Design Criteria and Recommendations for Dimensions and Tolerances," should now be employed.

ASTM B-1, Metallic Conductors, 1958

This is a compilation of all ASTM standards in the field of electrical conductors. It supersedes the December 1955 edition. Contained in this book are 55 standards of which three are completely new and thirteen are revised or have had their status recently changed. Copies of this 334-page publication may be obtained directly from the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa. for $3.75 per copy.

AIEE Standards

The American Institute of Electrical Engineers has published a listing of standards publications. This six-page pamphlet covers AIEE standards, test codes, recommended practices, specifications, guides, and certain reports. In addition, certain ASA standards are included. Copies of this April 1958 revision are available without charge from the American Institute of Electrical Engineers, 33 West 39th Street, New York 18, N.Y.
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ELECTRONIC DESIGN • June 25, 1958
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Diode Manufacturer uses
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