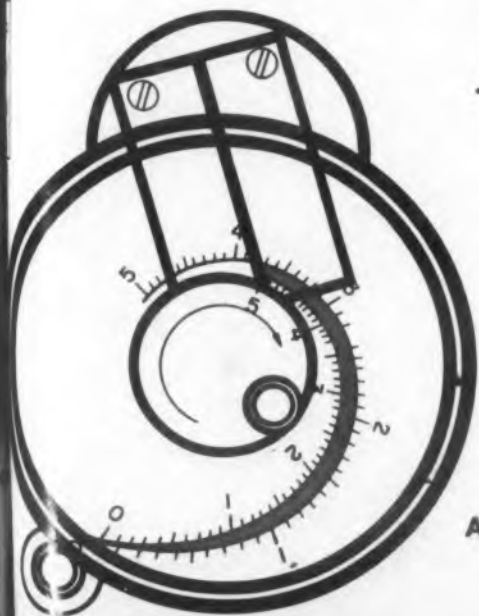
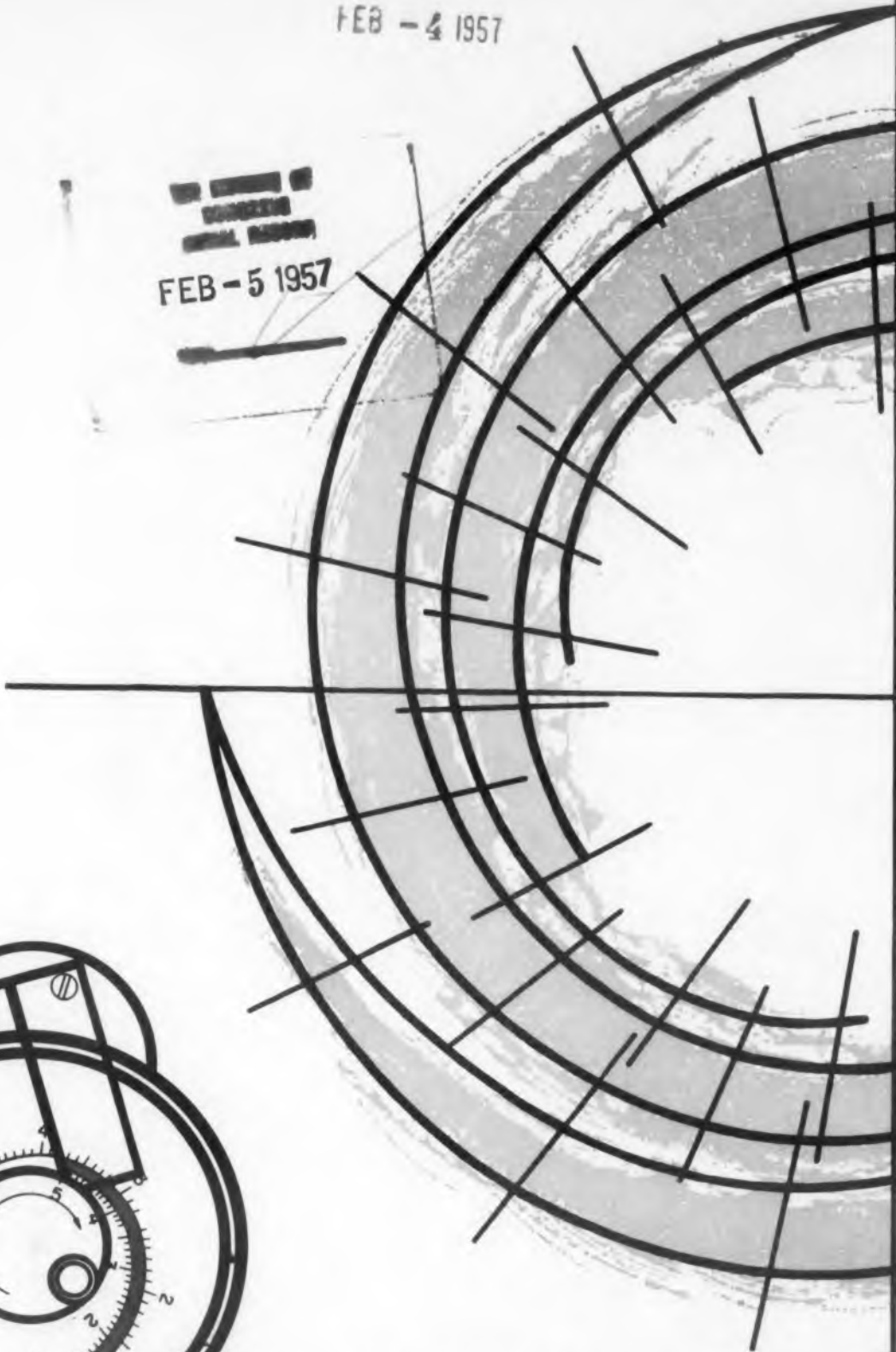


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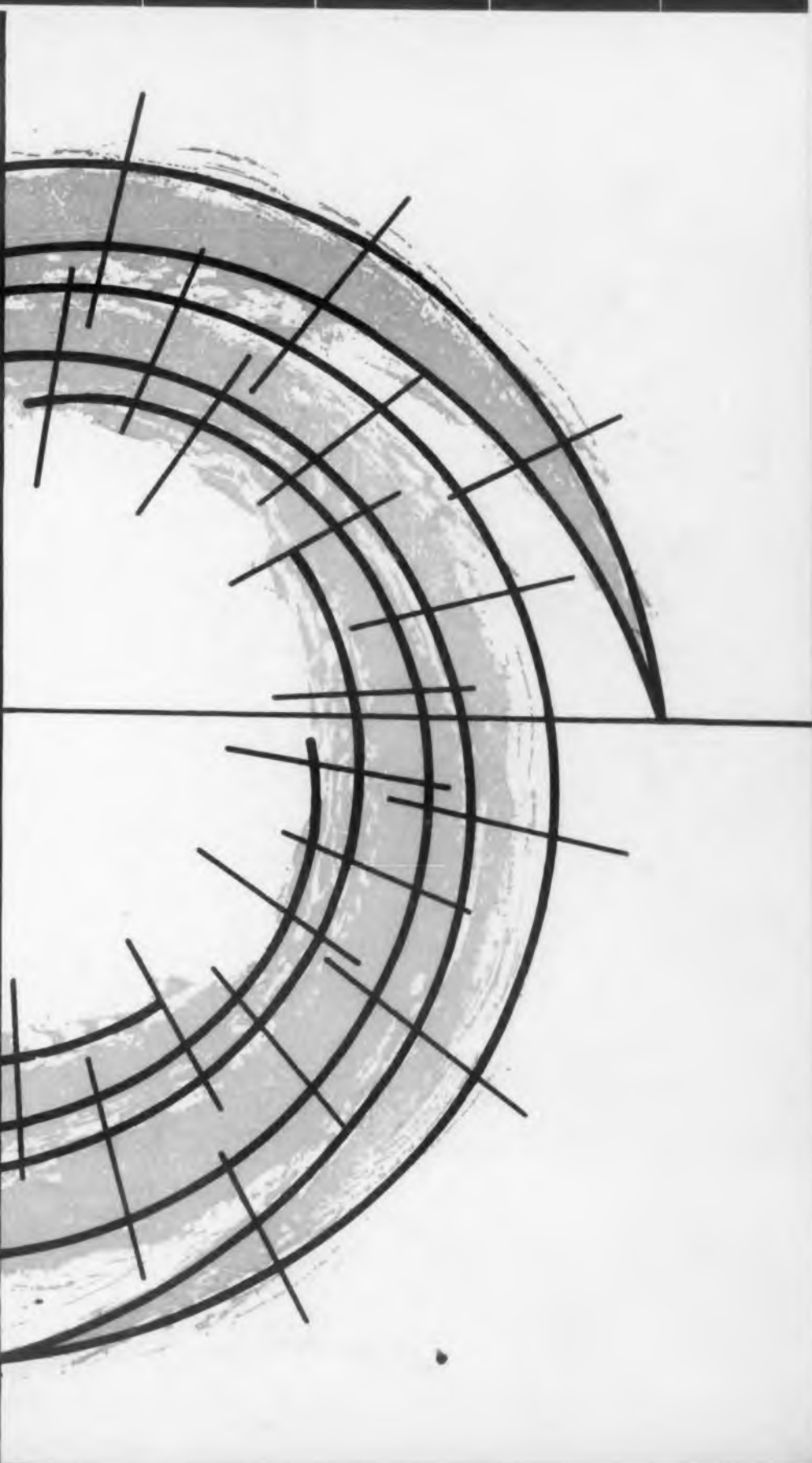
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Automatic Interpolation with Spiral-Scale Dialr . . . p. 38

OWING SIGN



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EPON[®] RESINS

give excellent electrical, thermal and mechanical properties, plus—

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- ✓ high mechanical strength
- ✓ outstanding adhesion to metal, glass, plastics
- ✓ exceptional dielectric properties



Applying Epon resin sealing compound, formulated by Epoxyllite Corporation, El Monte, California, to a 400-kva transformer winding at Larsen-Hogue Electric Co., Los Angeles, Calif.



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Although relatively new, the Epon resins have won an important place in electronic and electrical manufacture. Their applications are manifold . . . in printed circuit laminates, transformer and motor sealing compounds, potting compounds for components and subassemblies, protective enamels, adhesives, tool and die materials.

For potting and encapsulating—the excellent dimensional stability of Epon resins, which can, for example, withstand solder bath temperatures without ill effect, and their outstanding adhesion to metals and glass assures airtight enclosure of delicate components and vacuum tubes

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Write for information on the use of Epon resins in electrical and electronic applications.

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GOOD AS NEW!

after 96 hours at 320 cps, 35G VIBRATION



Conventional rectifiers are destroyed by this same vibration test in less than five hours.

The NEW



CK6763 Cold Cathode Medium Voltage Rectifier

(a ruggedized version of the popular CK5517)

The improved structure of this Raytheon CK6763 makes it almost impervious to fatigue from high level vibration.

What's more it requires *no heater power* • *no warm-up time* • and it permits a wider ambient temperature range.

Some of the characteristics of this and other Raytheon Cold Cathode Rectifiers are shown in the chart.

ENGINEERING • DEVELOPMENT PRODUCTION

When you have an application calling for gas filled tubes, whether it involves modification of an existing type or a completely new design, Raytheon, with over thirty years of experience in this field, can provide the engineering, development and production resources to meet your needs.

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RAYTHEON COLD CATHODE, HALF WAVE, GAS RECTIFIER TUBES

Type	Max. Dimensions Inches		Max. Peak Inverse Voltage	Max. Peak Plate Current Per Plate	Max. DC Output Current
	Height	Diam.			
CK5517	2.25	0.75	2800	100 ma.	12 ma.
CK6174	2.25	0.75	2800	30 ma.	3 ma.
CK6436	1.82	0.40	1500	10 ma.	100 μ a.
CK6659	2.13	0.40	2800	40 ma.	8 ma.
CK6763	2.25	0.75	2800	100 ma.	12 ma.

*MIL Specification



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Editorial

That's A Good Idea

Before we're going to get the utmost reliability, an optimized design, or even a preferred circuit, we have to explore all ideas on these subjects. Passing along ideas which you can use now, practical tested ones, has been ELECTRONIC DESIGN's business since Vol. 1, No. 1 five years ago. We have tried hard not to hide these ideas "under a bushel" of trivia.

Of the wealth of material produced by a prolific industry, we have tried to select that which will do the most good for the most design engineers. Your acceptance and response to our efforts has steadily increased our advertising income. We're plowing back dividends to give you still more ideas—in an efficient, readable way. Last year we expanded our Russian translations, expanded our survey of research and development reports, instituted translations of good design ideas from Germany, and started a department covering production equipment which affects the way a product is designed. These are all departments which give us thorough coverage. Our features naturally expanded to cover more, more often. This year and this issue see three new expanded services to readers. First of these is "Ideas for Design" to appear on a regular basis.

We want your contributions to Ideas for Design. We know you have them. The trouble is, engineers too frequently sit on them, keeping them "under the bushel." What is needed is more interchange of ideas. Since one idea frequently parlays into several others, everyone gains. We're opening ELECTRONIC DESIGN's pages to become an inverted bushel—a basket overflowing with Ideas for Design. And to give you incentive to do it now, not to delay till you've got a little free time, we will pay \$1 for each item we accept for publication. So think about one right now—It can be brief, several hundred words or less. Simply state the problem and then present your solution. You might write about simple circuit tricks, new circuits, clever use of new material or component, good packaging, time-saving and cost-saving short cuts.

Include with your entry, photos, or drawings, preferably inked diagrams made with mechanical aids; name; and company affiliation.

Other innovations beginning in this issue include "Services for Designers," which announces new facilities such as plating, computing, testing, that are available to designers, and Meeting Programs. To help readers evaluate all the meetings that are going on, we plan to publish details on papers that are of special interest to design engineers.—JAL

Engineering Review

For more information on developments described in "Engineering Review," write directly to the address given in the individual item.

Television Cancer Studies

Immediate comparative data of chemical activity within normal and cancer cells is provided by an ultraviolet closed circuit system. Used with a high-power microscope and an electronic oscilloscope the ultraviolet-sensitive system permits direct observations and oscillographic measurements of the metabolism of living cells.

Developed by RCA, Commercial Electronic Products, Camden, N.J., the system is now under test at the National Institute of Health, Bethesda, Md. Dr. George Z. Williams, Chief of the NHI Pathology Department, reports that the ultraviolet TV camera tube sees more than the eye can discern when living cells are illuminated with visible light.

Ultraviolet rays are absorbed in specific and measurable quantities by different chemicals. This characteristic enables the medical researcher to: a) identify the nature and scope of several cellular chemical substances by exposing the cell to ultraviolet light and measuring the absorption ratio; b) introduce foreign chemicals and study their reaction with the cell's normal chemicals and, c) by ultraviolet exposure, to maintain serial studies of disease-suspected cells and tissues and detect and identify chemical changes which may develop.

"Heretofore," Dr. Williams pointed out, "the study and observation of ultraviolet-treated specimens represented a long and laborious process due to the lack of a practical medium for direct observation. The ultraviolet TV camera tube developed by RCA makes practical "seeing" ultraviolet pictures by television."

The ultraviolet absorption image, viewed by the TV camera through a microscope, is converted to an electronic signal by the ultraviolet camera tube. The signal is amplified and then viewed on the screen of the TV monitor, a few feet away. Any one of the 525 horizontal scanning lines can be selected and analyzed by a special oscilloscope, which produces a tracing of the absorption characteristics.

Electric Watch—Miniature Marvel

Wire five times finer than human hair, a power supply the size of a shirt button, permanent magnets smaller in diameter than the metal in an ordinary paper clip, screws barely visible to the human eye—80,000 would weigh one ounce—all combine to make the world's first electric wrist watch a marvel of miniaturization.

No larger than a conventional wrist watch, it offers the highest accuracy and dependability ever achieved (99.995 per cent), according to the Hamilton Watch Company of Lancaster, Pennsylvania. The watch will retail from \$89.50 to \$150.00. A tiny battery used to power the unit was developed by the National Carbon Company. It will power the watch for at least 12 months and replacements cost less than \$2.00.

A sub-miniature d-c motor acts as both a motor and a balance wheel. Thus the balance wheel not only controls the time (the same thing it does in conventional watches) but, in addition, it supplies the power to keep itself in motion and to turn the

hands—basically the only thing a watch need do. Each time the coil on the balance wheel moves in one direction past a pair of magnets fixed in the pillar plate, the balance wheel itself closes a little switch to send a pulse of current through the coil. The magnetic field generated by that current reacts with the magnetic field from the permanent magnets to kick the balance wheel along its way. This gives it the energy necessary to keep running and also the extra energy needed to permit it to serve as a motor running the rest of the mechanism.

The motor has an efficiency of 60 per cent—ten times greater than available motors of similar size. This efficiency is particularly good when you consider that it must run continuously for a minimum of twelve months. The drag of the brushes in the motor must be reduced almost to zero, but never quite reach it.

The Electronic Industry is becoming more and more dependent on the miniaturization of all types of devices. Technical know-how obtained by the Hamilton Company in perfecting this watch should be an aid to the entire industry.



Electric watch (right) has energizer top center which replaces mainspring; manual watch (left).



Held by tweezers is the combination balance wheel and DC motor which powers the watch.



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Six Models Covering 1,000 to 26,000 mc

rugged, portable. For field measurements, leakage measurements and other laboratory uses. Excellent front to back ratio

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... only 3" long and 1" diameter. Useful where miniaturization and high power are essential. Frequency can be varied by simple tool adjustment. Meets stringent military requirements for shock and vibration.

**BROADBAND
MICROWAVE
COMPONENTS**

**Microwave
Attenuator**

In addition to this wide range of Broadband Microwave Components, Polarad manufactures an extensive line of microwave equipment created to accomplish a variety of difficult testing tasks with a minimum of operational procedure.

For information regarding Polarad General Electronics, Microwave and Color TV Equipment consult your Polarad Field Representatives.



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CIRCLE 4 ON READER-SERVICE CARD FOR MORE INFORMATION



Dr. John P. Hagen, Director of Project Vanguard, is shown with a Full-Scale Cutaway Model of the Earth Satellite.

Satellite Computer Center

Dr. Herget, Director of Cincinnati Observatory and Professor of Astronomy at the University of Cincinnati, has been appointed by the Navy Department to head the staff of the VANGUARD Computer Center, Washington, D.C.

The VANGUARD IBM 704 computing facility will be directly connected by Teletype and telephone with the Project VANGUARD Communications Center. Following the launching of the satellite, the Computation Center will go into action on a "round-the-clock" basis. Data from a number of radio tracking stations in various parts of the world will be used to calculate the satellites orbit. Each set of data will consist of two angles defining the direction of the satellite and the times of measurement determined by tracking station observers.

The VANGUARD Communications Center also will process information received from unofficial tracking stations and optical observation points throughout the world and turn this data over to the Computation Center for calculation.

No False Alarms

When fire breaks out in an aircraft engine space, it must be detected and quenched within seconds to avoid serious damage or possible loss of life. Too often in the past, frequent false alarms have undermined the airman's confidence in his fire detector, causing him to hesitate or neglect to take action when an alarm sounded.

To provide design specifications for reliable, fast-acting fire detectors, the National Bureau of Standards, Washington, D.C., has been studying flame characteristics that might be applied to aircraft fire detection systems. Results of this work indicate that reliability could be greatly increased by a system

that would not respond unless several intrinsic properties of a flame were all present at the same time. These properties are (1) characteristic rate of increase of radiant flux, (2) sufficient level of radiant flux in the required spectral region, and (3) characteristic frequency of flicker.

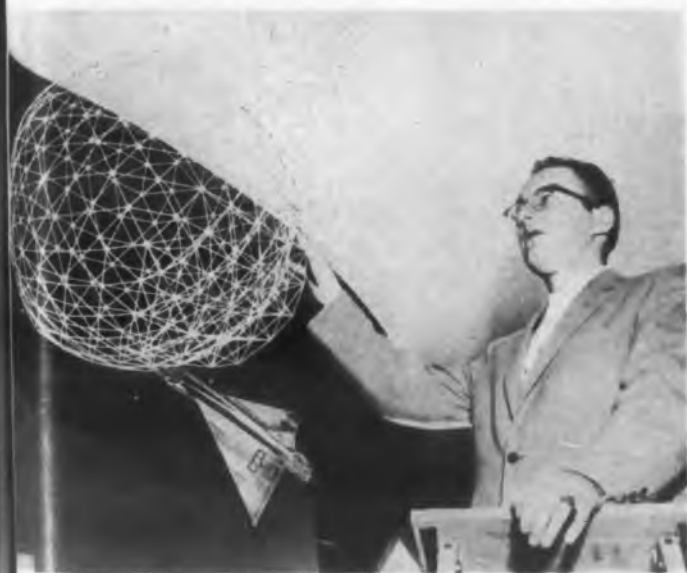
World of Numbers

Two dozen newly created, colorful displays to show the vital significance of mathematics in our modern world were recently put on exhibit by the International Business Machines Corporation at the Museum of Science and Industry, Chicago, Illinois.

By dramatizing the fascinating and active part of numbers in our ordinary daily lives as well as in complex business and scientific operations, the displays encourage the study of mathematics.

One of the most exciting features of the exhibit is the cycloramic staging of PROJECT SAGE, the nation's electronic air defense system. The three dimensional display and film shows how information is relayed from early warning radar stations and ground observer corps to Air Defense Command Centers. At these Centers, the SAGE computer, calculates the speed, course, and altitude of the approaching enemy planes in a millionth of a second. Within minutes, jet interceptors, NIKE missiles, and coastal anti-aircraft batteries go into defensive action with exact knowledge of where the enemy is, where he is headed, and when he will reach the point of interception.

Hanging models of an earth satellite and a geodesic sphere are exhibited as examples of scientific developments involving the use of mathematics. The sphere illustrates the theory of geodesic, or self-bracing, curved construction, by which man may some day be able to build a huge "tent" around portions of the earth's surface and control the atmosphere in which he lives.

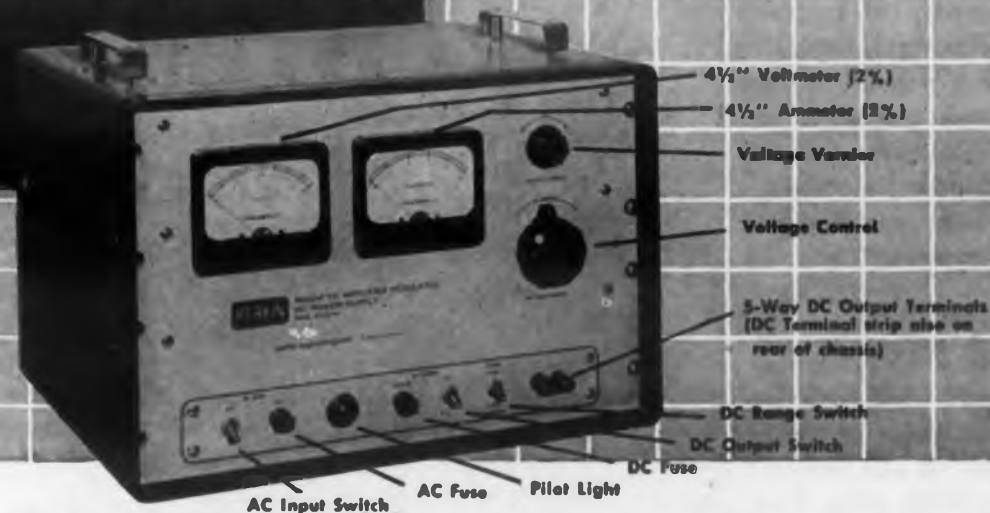


Geodesic dome

**2 TO 36
VOLTS
@ 15 AMPS
DC POWER SUPPLY**

The **NEW PERKIN**
MODEL MR532-15A
with $\pm 1/2\%$ **REGULATION**

**IMMEDIATE
DELIVERY!**



**Now... for Your Laboratory... the most versatile TUBELESS,
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OTHER STANDARD MODELS AVAILABLE:

VOLTS	AMPS	REG.	MODEL
0-32	25	$\pm 1\%$	M60V
24-32	10	$\pm 1/2\%$	28-10WX
24-32	30	$\pm 1/2\%$	28-30WX
5-40	30	$\pm 1\%$	MR 1040A
24-32	100	$\pm 1/2\%$	100 XA

Ripple on all above models: 1% rms
 6, 12 and 115 V models also available. Write for complete specifications on all models listed above.

- REMOTE SENSING • VERNIER VOLTAGE CONTROL
- NO TUBES, MOVING PARTS OR VIBRATING CONTACTS

Specifications

REGULATION: 5-32V Range: $\pm 1/2\%$ for combined line changes of 105-125VAC and load of 0-15A. DC.

2-5V Range: $\pm 2\%$ for combined line changes of 105-125VAC and load changes of 0-15A. DC.

32-36V Range: $\pm 2\%$ for combined line changes of 110-125VAC and load changes of 0-15A. DC.

RIPPLE: 1% rms max. @ 36 volts and full load. Increases to 2% @ 2 volts and full load.

AC INPUT: 105 to 125 volts, 1 phase, 60 cps. (8 amps, Input)

RESPONSE TIME: 0.1 to 0.2 seconds maximum.

DIMENSIONS: 19 1/2" wide x 15 1/2" deep x 13 1/4" high with cabinet. (19" wide x 14 3/4" deep x 12 1/4" high rack panel construction)

FINISH: Gray Hammertone **WEIGHT:** Approx. 135 lbs.

Representatives in principal cities throughout the country.
 Wire collect for complete price information.



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CIRCLE 5 ON READER-SERVICE CARD FOR MORE INFORMATION

Loudspeaker Bomb

A bomb-like loudspeaker system which is dropped from high-flying airplanes and delivers a three to five minute message to anyone within a half-mile area is one of the newer weapons of the Wright Air Development Center at Dayton. Heart of the system is a lightweight magnetic tape unit and a 500-watt battery-powered amplifier.

Descending on a 66-foot chute, the equipment begins broadcasting its recorded message at 4000 feet while dropping at about 14 feet a second over its "captive" audience.

The system of mercury cell batteries giving a total of 2880 volts, explosive squibs for activating parachutes and the compact electronic packages was assembled by Cook Research Laboratories of Skokie, Ill., under the sponsorship of WADC's communication and navigation laboratory.

Meteor and Auroral Studies

Reflection of VHF and UHF radio signals from meteor and auroral ionization is being studied at the Stanford Research Institute, Palo Alto, California. The experimental radar station is equipped with a giant 61-foot diameter antenna and a 100-megacycle transmitter.

An SRI team has been assigned to install and operate a similar radar unit at College, Alaska. The northern station is part of an associated program being carried on in conjunction with the Geophysical Institute, University of Alaska.

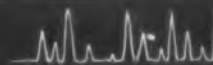
Air to Ground Rocket

The Air Research and Development Command (ARDC) announced that a half-million dollar study contract has been awarded to the Minneapolis-Honeywell Regulator Company, Los Angeles, California. The contract is concerned with the development of a new type of air-to-ground rocket suitable for delivery by fighter aircraft. Additional work on the project will be conducted at ARDC's Air Force Armament Center, Eglin Air Force Base, Florida.

CIRCLE 6 ON READER-SERVICE CARD >



THE G-V LINE—(l. to r.) Thermal Relays, a Thermal Relay Assembly, Sealed Thermostats. The complete G-V line, incorporating over 1,000 variations, covers more than 98% of all application requirements.



No. 1 of a series

Research and Engineering



What Makes G-V Control

G-V TOPS IN THERMAL RELAY FIELD

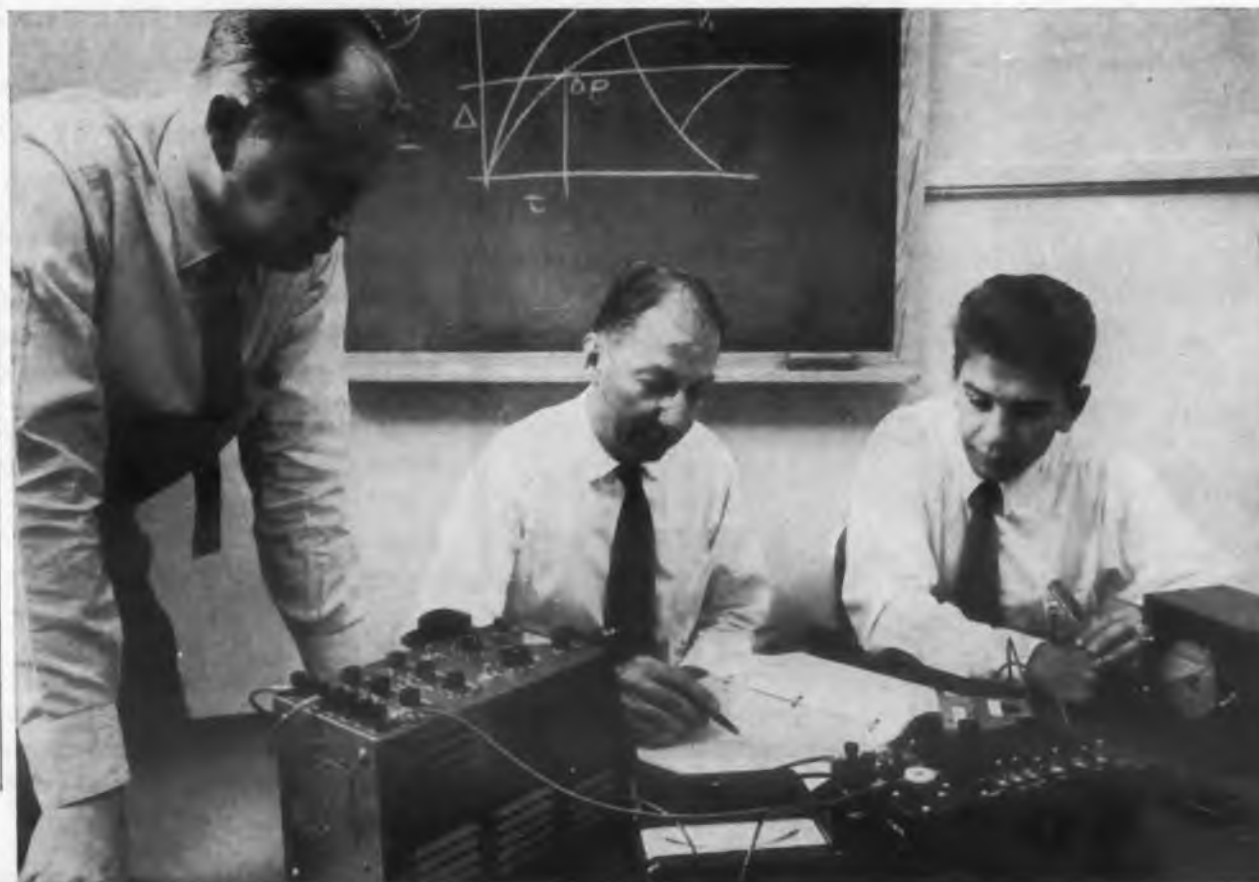
In business as a producer of thermal relays and thermostats for less than 6 years, G-V Controls has already achieved the enviable position of undisputed leader in the design, development and manufacture of thermal relays. In the vast, competitive electronic industry, this can be considered an outstanding accomplishment.

G-V OFFERS UNIQUE FACILITIES

G-V Controls' rapid progress has been due in large measure to the highly competent personnel and modern equipment which it has devoted to the field of thermal relays. Its Engi-

neering Staff has produced most of the recent technical advances in this field. Its Manufacturing Department has built a reputation for high quality and dependable deliveries. Its Field and Sales Engineering Organization is known throughout the country for helpful and intelligent cooperation. All of these facilities are freely available to our present and prospective customers. They can help you to make your products better.

We give you on these pages a view of some of our Research and Engineering activities. Later in this series, we will feature Production and Sales and Field Engineering.



APPLICATION ENGINEERING

Every new relay application is studied by the Application Engineering Group. Complete operating data on over 1000 types and variations of thermal relays permits these men to recommend the best type and to predict its behavior.

Key spots open for engineers interested in going places with a young progressive organization.



RESEARCH and DEVELOPMENT—G-V Controls developed the first 7-pin miniature thermal relay, the first adjustable hermetically sealed thermal relay, the first her-



metically sealed hot-wire relay. The precision and uniform characteristics of G-V's relays have qualified them for many uses new to relays of this type.

The Leader In Thermal Relays ?



Complete catalog data is available.

G-V CONTROLS INC.

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UNUSUAL APPLICATIONS are "bread-boarded" to duplicate conditions in users' equipment.

G-V ENVIRONMENTAL TEST LABORATORY—This modern laboratory, with all the newest testing equipment, assures the user of maximum reliability. Qualification

tests to military requirements, followed by periodic quality control testing, guarantees continued reliability under extreme environmental conditions.



Radioactive Environment

Design engineers working on future weapons systems are faced with the problem of developing electronic components which can survive and operate in nuclear radiation fields. Fortunately, it appears that there is some compatibility in achieving materials that will survive both high temperature and nuclear radiation.

Cold Punching Printed Circuits

A new cold punching copper clad laminated plastic Formica XXXP-36 for printed circuits can be punched without heating in thicknesses up to 1/16 in.

Printed circuit designers have instinctively shied away from long circuits because the expense of rejects mounts in direct proportion to the square feet of area involved.

The Komak Corp. of Philadelphia, Pa. has fabricated two circuits 34 in. long for an Allen electronic organ. Using Formica XXXP-36 provides dimensional stability and resultant circuit accuracy that practically eliminates the reject problem.

\$4 Million Grant for Education

The National Science Foundation has granted \$4,065,000 to 16 colleges and universities for teacher training. Purpose of the grant is to help high-school teachers stay abreast of advances in science, mathematics and engineering.

Interest at this level has been heightened because high-school population is the heaviest it has ever been, and is growing steadily. NSF Director, Alan T. Waterman said that the money is to be used for academic-year institutes.

ASA's Scope of Work

The Standards Council of the American Standards Association, recently adopted the following resolution: "that the ASA should be so organized that it can handle any standard standardization project which deserves national recognition—whether, but not exclusively, in the field of engineering, accounting, business practice or consumer goods."

◀ CIRCLE 6 ON READER-SERVICE CARD

FOR HIGHEST STABILITY...

WESTON precision in a metal film resistor...

PRACTICALLY FULL 1/2 WATT
ZERO T.C. AT 25 C

WESTON
VAMISTOR

Actual Size



Enlarged Cutaway view

The Weston VAMISTOR offers you many advantages over wire wound or conventional film resistors, in critical applications. It is a sealed, metal-film resistor that provides greater stability than all previous types. Following are a few of its outstanding characteristics:

- Stable under temperature, moisture and load life
- Stable under vibration, acceleration
- Non-inductive
- Noise free
- Excellent HF performance

As shown on table at right, VAMISTORS meet or surpass MIL specifications. They are now available in the following types:

	INITIAL TOLERANCE	TEMP. COEFF.
Model 9851 - 1/2 watt at 85C	1% or .5% ± 50 or ± 25 ppm	
Model 9852 - 1/2 watt at 125C	1% or .5% ± 50 or ± 25 ppm	
Model 9853 - 1 watt at 70C	1% or .5% ± 50 or ± 25 ppm	

all models available in resistance values from 1000 to 100,000 ohms

For complete information on VAMISTORS, return the coupon today.

Weston Electrical Instrument Corp.
617 Frelinghuysen Ave., Newark 12, N.J.

Rush me full particulars on WESTON precision metal film resistors.

Name _____

Company _____

Address _____

Characteristic	Vamistor production units	MIL-R-19074A (ships) Style RI-94	Wirewound MIL-R-93A Style RB-52 Char. A	Film MIL-R-10509B Style RN-70 Char. A
Short Time Overload 2.5 Times—10 min	Average + .01% Low .00% High - .06%	.5% max.	.5% max.	.75% max.*
Load Life 1000 hr—85 C	Average + .15% Low + .10% High + .20%	.5% max.	.5% max.	1.0% max.**
Low Temperature -65 C—24 hours	Average .00% Low .00% High + .02%	.5% max.	(no test)	1.0% max.
Moisture Resistance MIL-STD-202, Method 106	Average + .23% Low + .15% High + .36%	.5% max.	1.0% max.	3.0% max.
Salt Water Immersion 0 to 85 C—5 cycles	Average - .04% Low + .02% High - .10%	.5% max.	.5% max.***	(no test)
Temperature Cycle -55 to 85 C—5 cycles	Average + .04% Low + .02% High + .07%	.2% max.	.2% max.	1.0% max.
Insulation Resistance 100 v d-c	Greater than 10,000 megohms	100 megohms min.	50 megohms min.	10,000 megohms min.
Dielectric Strength 900 v rms—1 minute		.05% max.	.05% max.	.5% max.
Terminal Strength	Below measurable value—all samples	.5% max.	(no limit)	.5% max.
Effect of Solder		.5% max.	(no test)	.5% max.

*MIL-R-10509B test 2.5 times—5 seconds

**MIL-R-10509B test at 70 C ambient

***MIL-R-93A test not cycled, 25 C—24 hours

WESTON VAMISTORS

precision metal film resistors

A DAYSTRON UNIT

FCC Policies Airwaves

In Pennsylvania a local official complained to the Commission and to his Congressman about interruption of his TV reception by a community antenna TV system. Inquiry pinned a double guilt—on cable radiation by the community TV system and on the complaining official's own defective TV receiver. Both parties promised corrective action.

The Commission received letters of thanks from a Congressman and from a woman because it induced a Pennsylvania farmer to mend a break in his electric fence, which improved broadcast reception for the lady constituent.

New Highway System

A new rail-type highway system with a rail either overhead or on the highway itself will be introduced for greater safety according to William Schmidt, Vice President and Director of Styling of the Studebaker-Packard Corporation.

Over 75 million American cars will be on the road by 1970 and crowding will be an increasing problem in the distant future he said. Power for the system could be supplied by a source other than that of the car's own power plant which would allow cars traveling off the highway to run on a compact storage battery.

Better Radar Presentation

An automatic device which defines radar targets more clearly has been developed by the Government Division of Allen B. Du Mont Laboratories, Inc.

Designed to complement airborne radar equipment, the device is called the Clutter-Operated Anti-Clutter (COAC) Receiver. It uses the impulses returned from a "cluttered" target to adjust the radar set to each element of the target shown on the screen so that these elements are shown as well-defined individual images.

The COAC receiver in airborne radar equipment will provide clearer landmarks for navigation, give more faithful and complete information for avoidance of air collision with other aircraft, and show storm fronts in the

◀ CIRCLE 7 ON READER-SERVICE CARD

path of the aircraft. Du Mont has designed and flight tested the new receiver in standard airborne radar sets. Provisions are made for manual gain control of the radar equipment when it is desirable to focus on one individual image to the exclusion of definition of others within a target area. The COAC receiver, with minor modifications, could be adapted to radar equipment other than that used in aircraft. It could be useful in meteorological, land, or ship radar sets.

Computer Education For Business

Local business men will be taught what digital computers and similar machines can do for them at the University of Pittsburgh's new Data Processing Center. The new director hired to educate the community, is William B. Kehl, formerly with MIT's Instrumentation Labs. Forty-five business executives, many of them from top Corporation Offices, have enrolled.

High Frequency Lighting

Successful use of high frequency electric current in fluorescent lighting was reported at the Winter General Meeting of the American Institute of Electrical Engineers. Eight hundred and forty cycle frequency was installed in a small industrial office building at lower initial cost, increased efficiency, greater flexibility, and a 20 per cent power consumption reduction over a comparable 60 cps system.

R. D. Burnham, of the Wakefield Company, Vermilion, Ohio, author of the paper said that frequency conversion from 60 to 840 cycles was effected by utilizing a motor generator. A 400 volt, three-phase motor was used to drive an 840 cycle, 400 volt, three-phase generator. Capacitors were used for current limiting. Mr. Burnham further said that "increased frequency for the purpose of operating fluorescent lamps under more advantageous conditions seems to be practical with electrical components available today."

Transitron

MILITARY type silicon diodes



1N457
1N458
1N459
1N251

TRANSITRON'S Military type silicon diodes are designed to meet the requirements of MIL-E-1, and are characterized by reliability under the most severe operating conditions.

Their subminiature size and rigid specifications make them ideal for a wide range of applications. Types 1N457, 1N458, and 1N459 are intended for low and medium frequency uses, requiring voltage ratings up to 175 V. Type 1N251 is a high frequency diode especially designed for detector and high speed pulse units.

In addition to these four military types, silicon diodes meeting many other application requirements are also available. These include high conductance types, as well as fast switching-high voltage diodes.

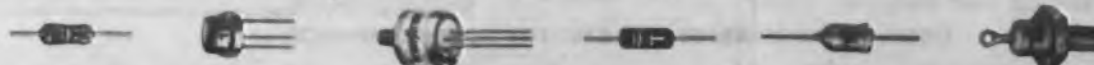
Type	Minimum Forward Current at + 1 v (ma)	Inverse Current at Specified Voltage (μ a)	Maximum Operating Inverse Voltage (volts)	MIL-E-1 TSS #
1N457	20	.025 @ -60 V	60	1026
1N458	7	.025 @ -125 V	125	1027
1N459	3	.025 @ -175 V	175	1028
1N251*	2	.2 @ -10 V	30	1023

*Inverse recovery time under .15 microseconds

SEND FOR
BULLETIN TE 1350

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Germanium Diodes

Transistors

Silicon Diodes

Silicon Rectifiers

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OPPORTUNITY keynotes your career in the IBM Airborne Computer Laboratories

Walk the red carpet to IBM's Airborne Computer Laboratories in Owego, New York, to see for yourself, first-hand, the challenging opportunities available in Military Products engineering. Talk with the men who are now carrying out these advanced projects and let their enthusiasm stir you to join our ranks.



Opportunity in Engineering: High-speed electronic computers, both digital and analog types, are developed within the ACL to fit specific Air Force requirements. As an ACL engineer, you will find ample opportunity to put your talents to work in a variety of assignments.



Opportunity to learn: If you believe knowledge is your greatest security, ACL offers opportunities to obtain advanced degrees, attend seminars, training courses; to consult with renowned experts and to prepare yourself for greater responsibility.



Opportunity for adventure: IBM Flight Test engineers fly with the Air Force in B-47 and B-52 aircraft, checking the dynamic operation of our airborne equipment. Field Engineers work on the flight line, maintaining operating production systems.



Opportunity for better living: Ideally located Owego, close to the Finger Lakes, offers you and your family every opportunity for recreation and pleasant living. The IBM C.C. (725 acres) offers diverse recreational facilities for the family, including swimming pools, two golf courses, rifle range, bowling, etc.

For more information, write, outlining background and experience, to: R. A. Whitehorne, Room 901, International Business Machines Corporation, 590 Madison Avenue, New York 22, New York.

Exceptional career opportunities are now open at the IBM Airborne Computer Laboratories for E.E.'s, M.E.'s, physicists, and mathematicians, in the following fields:

Digital and Analog Systems	Reliability	Power Supplies
Inertial Guidance	Components	Transistors
Servo-Mechanisms	Physics	Heat Transfer
Electronics	Mathematics	Optics
Mechanical Design	Human Factors	Test Equipment
Packaging	Installation	Cost Estimating

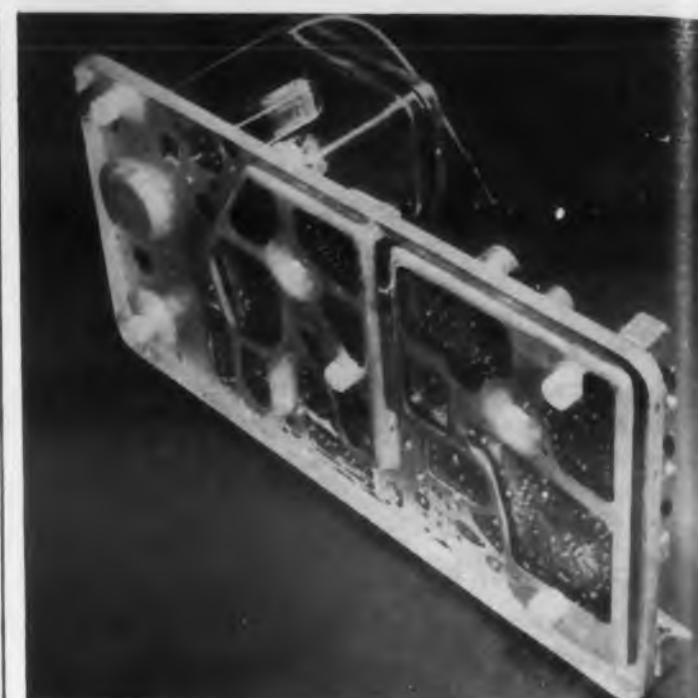
Tremendous job flexibility enables ACL to custom-fit the engineer to the job. ACL offers you small-company advantages with large-corporation security. IBM's salaries are excellent; company benefits tops for industry. The rate of turnover at IBM is less than 1/6 the national average.

MILITARY PRODUCTS
DATA PROCESSING
ELECTRIC TYPEWRITERS
TIME EQUIPMENT

IBM

MILITARY
PRODUCTS

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Packaged Electronic Circuit for TV

A TV receiver is now in production at Motorola that has as its primary design purpose the use of a plated circuit chassis with packaged electronic circuits. The result is a decrease of chassis area by 20 per cent, the combining of 97 separate parts into 17 group units, and the reduction of conventional wiring by 90 per cent.

By incorporating the new Centralab PEC technique to the fullest possible extent, Motorola has reversed the usual circuit-design procedures. This is the first time that a television receiver has been designed specifically to utilize the advantages offered by a new technique in component parts. The usual practice is for component parts to be fabricated for existing circuitry. This new development is the result of cooperative engineering effort between Motorola Inc. and Centralab.

Reliability

At the 38th Annual meeting of the American Ordnance Association, Daniel E. Noble, Vice-President, Motorola, Inc., pointed out four basic requirements that must be met when supplying the Armed Forces with electronic systems.

- The equipment must be designed in modular and sub-modular construction to permit servicing and maintenance by substitution of sub-modules.
- Testing procedures, which must be coordinated with the sub-module construction plan, must be devised to permit determination of modular failure through the following of routine procedures printed in an instruction manual.
- Printed Circuitry, automatic assembly, and sealed modular construction must be used to improve the uniformity and produceability at the manufacturing level and to protect the equipment from the overzealous serviceman in the field.

• Transistors should replace vacuum tubes whenever the substitution is practical. The use of transistors makes possible the first truly acceptable design for sealed modular construction of military equipment.

He further pointed out that we are not ready for technological warfare until we equip our military forces with apparatus which can function without the attention of career maintenance men or corps of equipment nursemaid scientists.

Measuring Interatomic Forces

Highly pure and perfect metal crystals known as "whiskers" are being used to gain new insight into the enormous forces which bind atoms together. Dr. R. L. Eisner, research physicist, Westinghouse Research Laboratories, Pittsburgh, Pa., described a new technique for evaluating these forces at the Seventh New York Meeting of the American Association for the Advancement of Science. By measuring the tensile strength of whiskers of iron, Dr. Eisner found that iron had a strength of more than a half a million pounds per square inch.

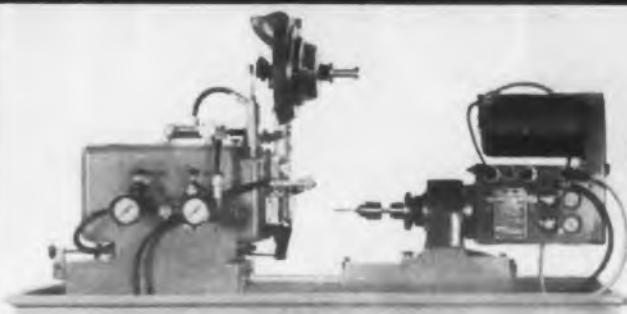
In "whiskers," a metal exists in perfect condition. In contrast, any ordinary piece of metal contains countless millions of structural imperfections. Under stress, it is these imperfections which govern how and when the metal will break. They mask any attempt to measure the much larger forces which hold the metal atoms themselves together.

The strength of the tiny whiskers is measured by reflecting a beam of light from flat optical mirrors attached to the clamps at each end of the whisker, to form an "interference pattern." As the whisker stretches, the mirrors move and cause changes in the pattern similar to the changing "rainbow" colors seen in soap bubbles or thin films of oil. These changes are electronically amplified and analyzed to disclose the amount of stretch. The technique accurately measures changes in whisker length down to less than one millionth of an inch.



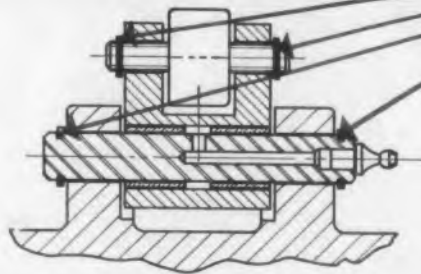
Interatomic forces in an iron crystal "whisker" are measured by stretching the tiny strand of metal.

Waldes Truarc Retaining Rings Eliminate Machining and Parts—Cut Assembly Time on Drill and Tapper



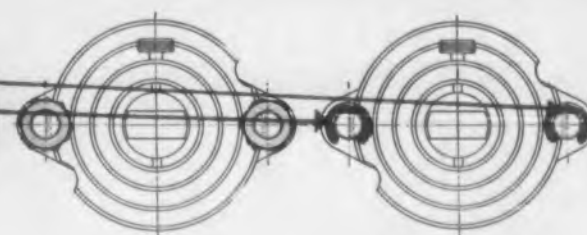
Beco Model 410 Drill and Tapper

The Batchelder Engineering Co., Inc., Springfield, Vermont uses 4 different sizes of 2 different type Waldes Truarc rings in their new BECO Model 410 Automatic Drill and Tapper. Truarc rings speed assembly, reduce machining, improve design.



Bell Crank Pivot Assembly

Truarc Rings (Series 5100) in Bell Crank Pivot assembly permit grease hole not possible with cotter pin fastener. Use of nuts would have increased machining and assembly costs considerably.

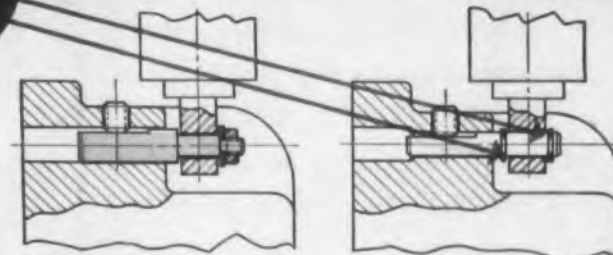


ALTERNATE DESIGN

TRUARC DESIGN

Clamp Cylinder Rod Stop Assembly

Truarc "E" Rings (Series 5133) replace stop nuts in the Clamp Cylinder assembly. They eliminate need for threading 2 rods...the danger of cross-threading nuts...and costly rejects. Truarc Rings cut assembly time and cost.



ALTERNATE DESIGN

TRUARC DESIGN

Hopper Cylinder Anchor Pin Assembly

2 Truarc Rings (Series 5100) secure and position end of vertical air cylinder. Rings eliminate extra cost of machining 3-diameter pin, threading and undercutting...plus nut and washer. Assembly is quick and sure.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product...to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types...as many as 97

different sizes within a type...5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today...let our Truarc engineers help you solve design, assembly and production problems...without obligation.

For precision internal grooving and undercutting...Waldes Truarc Grooving Tool!



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Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
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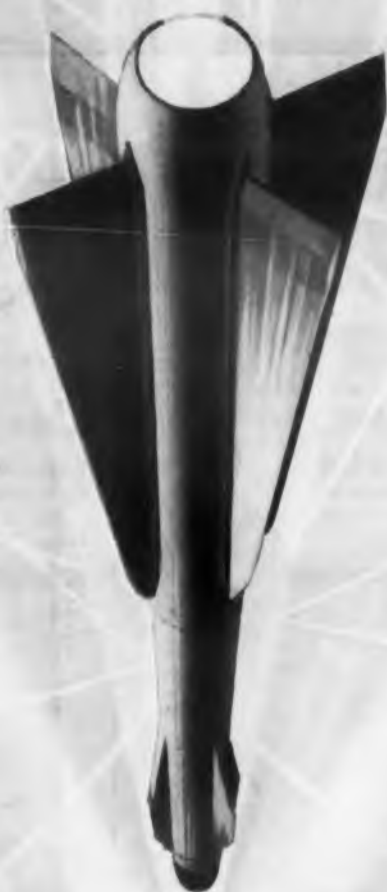
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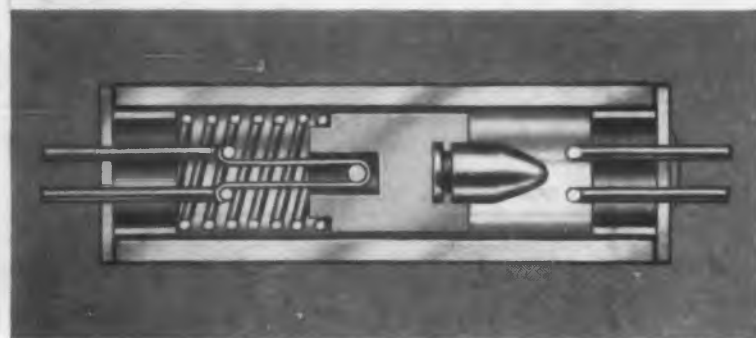
WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

CIRCLE 10 ON READER-SERVICE CARD FOR MORE INFORMATION



EXCLUSIVE

method of Bonding Metal to Glass



EXACT SIZE

MINIATURE THERMAL RELAYS

99.99% plus reliability. Withstand extreme conditions of temperature (-100°F to $+450^{\circ}\text{F}$), shock (200 G's), vibration (20–3000 cps), and precise electrical characteristics with the added feature of visibility.

Another typical example of our exclusive process of bonding metal to glass for better, more efficient hermetically sealed electronic components for guided missiles, rockets and supersonic aircraft.

WHAT ARE YOUR REQUIREMENTS?

Engineering Bulletin containing complete Specifications available upon request.

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ORIGINAL DESIGNS FOR HIGHER RELIABILITY IN GLASS-HOUSED RESISTORS AND MINIATURE RELAYS FOR ALL PURPOSES

CIRCLE 11 ON READER-SERVICE CARD FOR MORE INFORMATION

Washington Report

Herbert H. Rosen

Automation Progress Aired

A distinguished assembly of scientists and engineers appeared recently before a subcommittee of the Joint Economic Committee, headed by Rep. Wright Patman (D-Tex.). They presented their version of the progress automation has made in the past few years. Most of the witnesses before the committee were Instrument Society of America members.

The theme for the hearings was set by R. T. Sheen, President of ISA. He thought that there were certain conditions tending to strangle the growth of automation. To counteract these, he cited certain needs: the current labor force should be further trained; new blood and technical personnel should be brought into the industry; worker efficiency should be increased through current instrumentation services, and worker effectiveness should be enhanced through broader communications systems on techniques and equipment.

Sheen's recommendations to meet these needs are: (1) better trained high school teachers and more basic scientific courses, (2) vocational training for "instrument mechanics" and technicians, (3) engineering extension services, (4) better use of military training periods, (5) creation of instrumentation-automation information centers, (6) better liaison between industry and the military, and (7) augment the work of the National Science Foundation and ISA's Foundation for Instrumentation Education and Research.

Most of the other witnesses echoed Mr. Sheen's statements during the four-day hearing. The Labor Department announced that it had conducted a survey of five companies that had turned to automation. The report showed that only a small percentage of worker dislocation occurred. Where the worker could not grasp the operation of the new machines, he was moved horizontally to another position of less complexity with no loss in pay. But increased demand and enlarged production of the automated products invariably resulted in an increased labor force.

Labor unions were concerned with three major areas: migration of industry, training and adjustments in collective bargaining. The migration aspect concerned itself with the movement of industry to other locales, thereby leaving an unemployed work force behind. These would be, in large measure, older workers who could not or would not move with the industry. The training problem, according to the AFL-CIO will have to be solved jointly by management and the union. Pay differentials will also enter this area. Some of that will come up in the collective bargaining aspect in which the unions show concern.

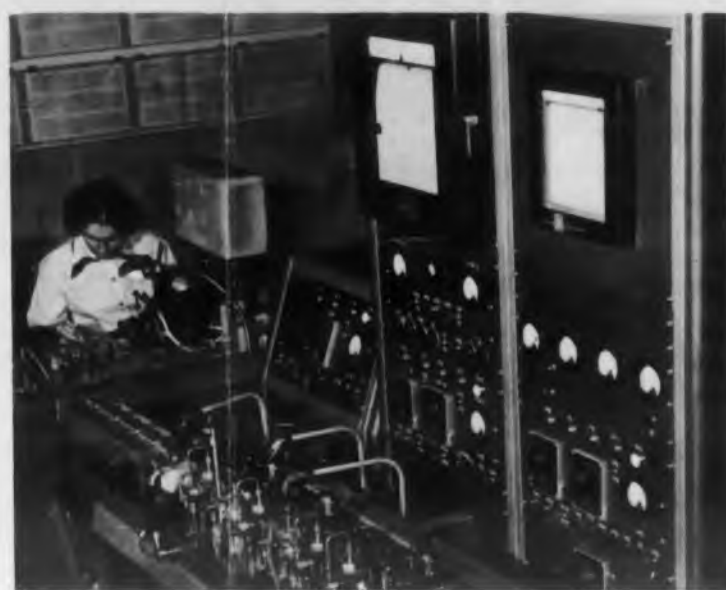
CIRCLE 299 ON READER-SERVICE CARD



An exclusive machine, designed by Philco engineers. It's a Surface Barrier Transistor Lead Attacher which feeds, cuts, plates, precisely positions and automatically solders the whisker wire to the transistor emitter and collector.



New Philco automatic "Carousel" assembles and processes alloy junction type transistors. It prepares stems by localized plating, solders stems to transistors, solders leads to emitters and collectors, and follows with electrolytic clean-up etching, dip rinsing and ultra sonic rinsing to remove contaminants.



This exclusive Philco Automatic Transfer Machine performs nine operations in the manufacture of surface barrier transistors. Following each step is a rinsing operation, and finally—hot nitrogen drying. Critical operations are automatically monitored and recorded for quality control.

WITH THIS GREAT NEW AUTOMATED PLANT **PHILCO**

revolutionizes production methods and sets new quality standards in the transistor field

It's the greatest development in transistor history. A complete plant, housing the most advanced transistor manufacturing equipment and utilizing entirely new production methods, is now in mass production at Spring City, Pa. We call it Philco Transistor Center, U.S.A.—and, that's exactly what it is. From this plant come the world's finest transistors—unmatched in quality and reliability.



100,000 square feet of area devoted exclusively to semi conductor production. This plant is equipped with centralized supplies of de-ionized water, vacuum, disassociated ammonia, hydrogen, nitrogen and high purity compressed air, plus complete air conditioning with dust and humidity control.

Shown below is a portion of the Life Test Section where all types of Philco transistors are tested under a variety of storage and operational conditions. Individual test positions are provided for over 10,000 units.

The new Spring City Transistor Plant is unmatched for advanced testing methods. Below is a Philco designed high speed Automatic Test Facility for testing seven parameters of power transistors.

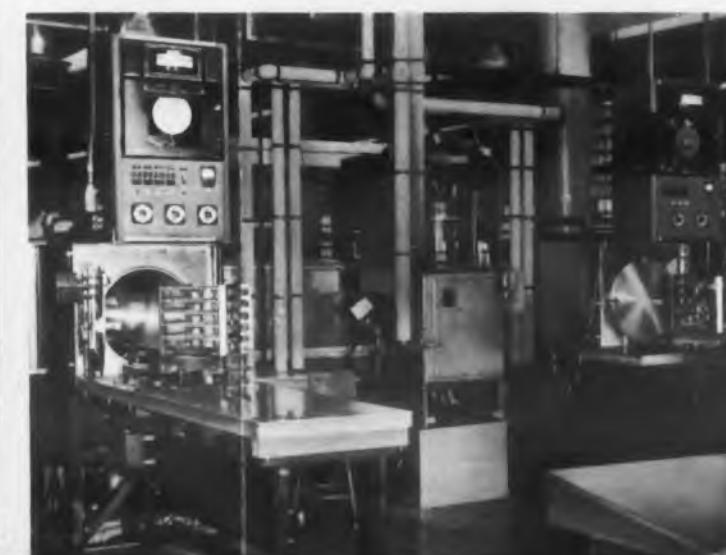
Unsealed power transistors in large batches go into vacuum oven (shown below at left) for baking, while simultaneously caps go into vacuum oven (shown at right). After baking cycle the transistors roll on carriers into dry box for cold weld sealing.

NEW METHODS Extensive research, design and planning by Philco engineers has resulted in completely new and far superior transistor production methods. Mass production is now a reality, and special equipment results in closer device tolerances.

NEW MACHINES Designed specifically for the new mass production methods at Spring City, Pa., machinery completely new in concept is now in operation, with the finest precision control in the industry. These new machines have been designed with the flexibility to accommodate future advances in the transistor field.

NEW AUTOMATION The result of this new production machinery is automation—more automation than ever before in the transistor field. This automatic equipment eliminates human error, increases production capacity and minimizes contamination.

NEW TEST CONTROLS Automatic test equipment, designed by Philco engineers, tests each transistor at every stage of fabrication. Each vital performance parameter is accurately tested. Environmental and life tests assure utmost reliability.



See Back Page FOR DETAILS ON PHILCO TRANSISTORS

NOW IN MASS PRODUCTION AT SPRING CITY, PA

PHILCO

Transistor

Center, U.S.A.



For the first time, the dream of the electronic industry comes true . . . made possible by many years of Philco pioneering, research and production of semi conductors. Philco's great new transistor plant at Spring City, Pa. is designed for and dedicated to the mass production of reliable transistors.

← *Lift the Page and read this important news!*

FOR RELIABLE PERFORMANCE,
STABILITY OF OPERATION AND LONG LIFE
...base your designs on

PHILCO *Transistors*

Proven performance of Philco Hermetically Sealed Transistors has made them the basis for design in commercial and military applications where reliability is the major consideration. Philco transistors range from the world's smallest germanium transistors now in production to silicon transistors with excellent performance at temperatures from -60°C to $+150^{\circ}\text{C}$. The following are some of the available Philco transistor types:

 <p>ACTUAL SIZE</p>	<p>Low Level Transistors 2N207, 2N207A and 2N207B—Germanium PNP Alloy Junction Transistor ... world's smallest transistor in production. Useful in any low level audio application such as hearing aids where size is an important consideration.</p>	 <p>ACTUAL SIZE</p>	<p>Medium Power Transistors 2N223, 2N224, 2N225, 2N226, 2N227—Germanium PNP Alloy Junction Transistor for portable radio output stages, medium power switching, servo-amplifiers and other applications where medium power must be handled at low frequencies.</p>		<p>Power Transistors T1040, T1041—Germanium PNP Alloy Junction Power Transistor with low thermal drop designed for audio output stages, power switching, servo-amplifier output stages and other applications where high power must be handled.</p>
 <p>ACTUAL SIZE</p>	<p>High Frequency Transistors Surface Barrier Types 2N128 and 2N129—Surface Barrier Transistors for critical military applications, produced to meet MIL-T-12679A (SigC) military requirements.</p>	 <p>ACTUAL SIZE</p>	<p>High Speed Switching Transistors 2N240—Germanium Surface Barrier. High Speed switching transistor with response time in the low millimicrosecond range. Made the basis for design of both military and commercial computers where speed and reliability are essential.</p>	 <p>ACTUAL SIZE</p>	<p>Silicon Transistors T1025, T1159—PNP High Speed Silicon Transistors for computers and amplifiers operating at high ambient temperatures. These transistors feature low saturation voltage.</p>

All Philco transistors are hermetically sealed to insure long life. In addition to the above types, Philco produces a wide range of transistors designed for special applications in accordance with customer requirements. The Philco Micro Alloy Transistor is already in pilot production and tentative specifications and design quantities are available. New and exciting transistor types, such as the Philco Micro-Alloy Diffused Base Transistor, are now in development. In keeping with our policy, specifications will be made available as soon as these units reach pilot production and are available in design quantities.

Make Philco your prime source for complete transistor application information ... write to Lansdale Tube Company, Dept. 1-2, Lansdale, Penna.

Regional offices—Merchandise Mart Plaza, Chicago 54, Ill.—10589 Santa Monica Blvd., Los Angeles 25, Calif.

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LANSDALE TUBE COMPANY DIVISION
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Automation hearing on Capitol Hill are beginning to show a periodicity. Last year many days were spent on the subject. No bills concerning automation were presented to Congress last session. The Patman Committee, this time, appeared satisfied that the nation's social and economic structure was not being marred by the little automation now being used. Therefore, it was concluded that no legislation on automation will come out of this session of Congress.

FCC TV Interference Ban

Manufacturers of TV receivers and some fm receivers have an additional six months before they must begin to make provisions for interference limiting. The Federal Communications Commission has announced that Section 16.58 (c) of the rules is amended by this notice. This section of the rules governs "Incidental and Restricted Radiation Devices." It also covers the power line interference limit in frequencies between 3 and 25 mc applicable to TV and fm broadcast receivers.

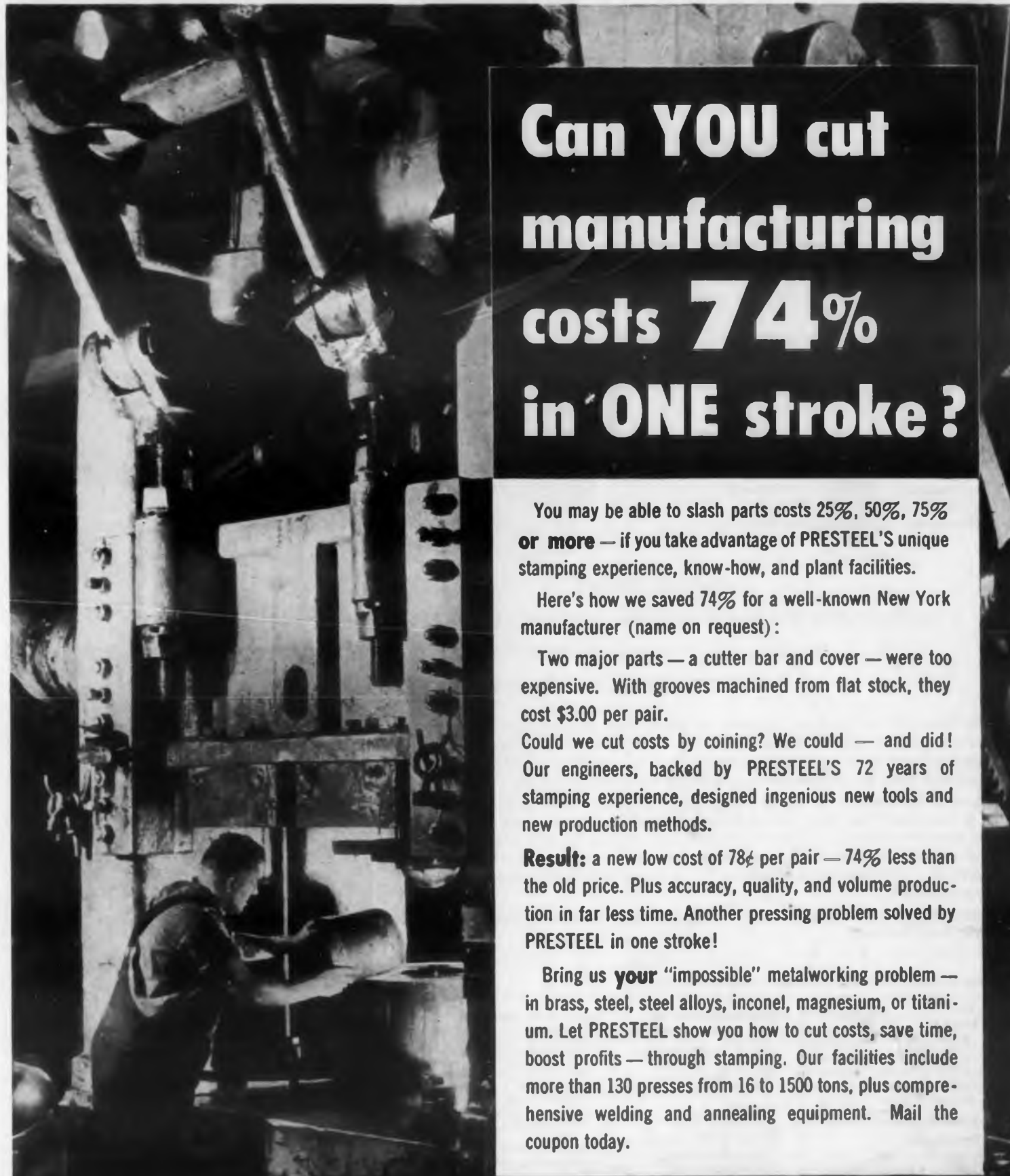
The Notice gives manufacturers of TV receiver chassis until June 30, 1957 to design their circuits for interference-free operation. Manufacturers of television broadcast receivers have until December 31, 1957 to comply.

Delay in the implementation of the rule stems from the fact that the FCC has only partially developed a testing and monitoring technique for interference in this frequency range. Actually, the ruling is part of a larger scheme for interference limiting in the frequency range from 3 to 890 mc. The last act in this area occurred several years ago when a ban was placed on interference from diathermy machines used by doctors and hospitals. As a result of the ruling at that time, new machines had to be purchased that were more carefully radiation shielded, or if the old diathermy machines were used, the rooms had to be shielded.

The manufacturer of TV receivers, like the diathermy machine producers, will have to make certain that oscillations will not interfere, either through the power line or by radiation. Once the compliance has been met, the manufacturer will have to certify in writing or place some kind of seal on the set that it is radiation-free. The FCC will attempt to test pre-production receivers in its own laboratories. If circumstances preclude this prior testing, the reputation of the manufacturer will have to stand by his certification. However, the FCC has some 500 local community TV committees whose job is to listen to complaints. These may be either from people who are getting interference from a TV set or are having their receiver interfered with. This, then becomes a good check on the manufacturer's certification at the all-important customer level.

CIRCLE 299 ON READER-SERVICE CARD

ELECTRONIC DESIGN • February 1, 1957



**Can YOU cut
manufacturing
costs 74%
in ONE stroke?**

You may be able to slash parts costs 25%, 50%, 75% or more — if you take advantage of PRESTEEL'S unique stamping experience, know-how, and plant facilities.

Here's how we saved 74% for a well-known New York manufacturer (name on request):

Two major parts — a cutter bar and cover — were too expensive. With grooves machined from flat stock, they cost \$3.00 per pair.

Could we cut costs by coining? We could — and did! Our engineers, backed by PRESTEEL'S 72 years of stamping experience, designed ingenious new tools and new production methods.

Result: a new low cost of 78¢ per pair — 74% less than the old price. Plus accuracy, quality, and volume production in far less time. Another pressing problem solved by PRESTEEL in one stroke!

Bring us your "impossible" metalworking problem — in brass, steel, steel alloys, inconel, magnesium, or titanium. Let PRESTEEL show you how to cut costs, save time, boost profits — through stamping. Our facilities include more than 130 presses from 16 to 1500 tons, plus comprehensive welding and annealing equipment. Mail the coupon today.

WORCESTER PRESSED STEEL COMPANY



FREE!

from Worcester Pressed Steel, this handsome, practical ashtray — an example of PRESTEEL craftsmanship — is yours for the asking. Attach the coupon to your business letter head.



Get a quote from the leader — PRESTEEL!

100 E Barber Ave., Worcester 6, Mass.

Please send me a PRESTEEL ashtray and brochure illustrating facilities and products.

Name _____

Title _____ Company _____

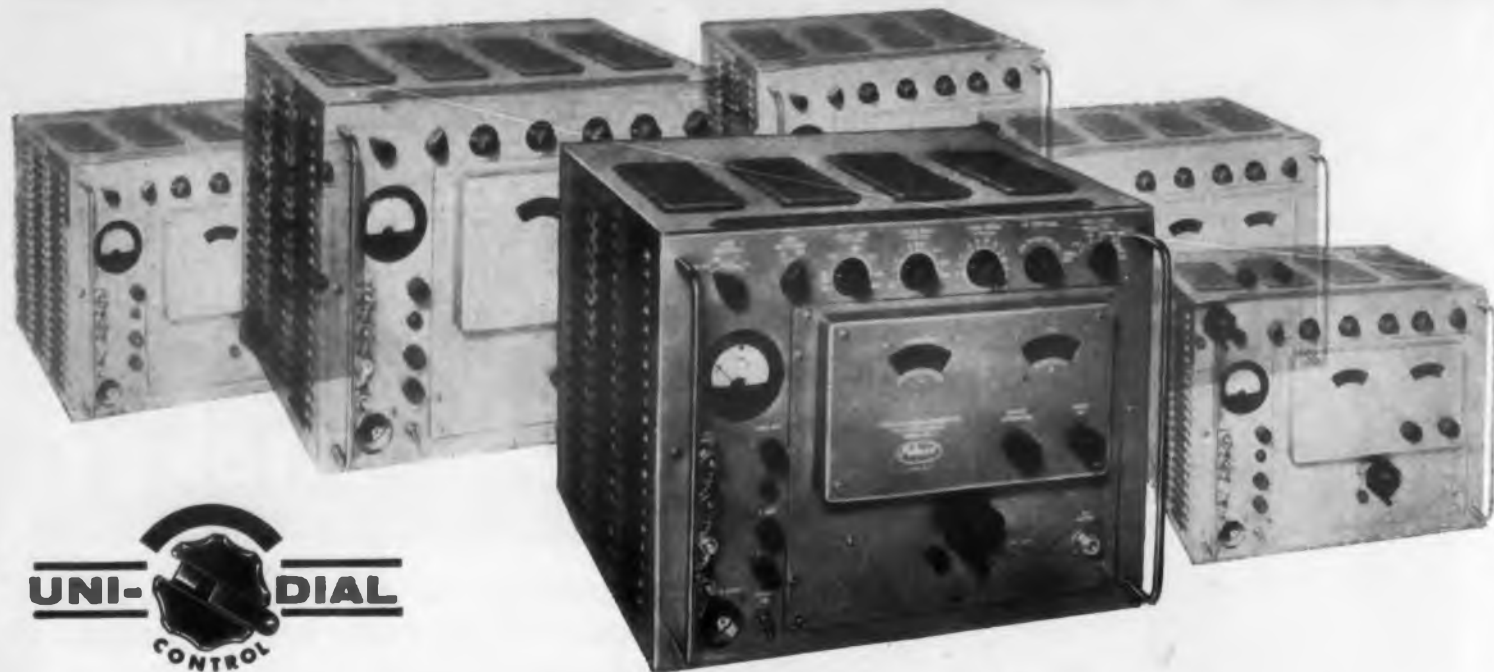
Street _____

City _____ Zone _____ State _____

CIRCLE 12 ON READER-SERVICE CARD FOR MORE INFORMATION

MICROWAVE SIGNAL GENERATORS

950 to 11,500 mc



**JUST ONE POLARAD
MICROWAVE SIGNAL GENERATOR
CAN MAKE ALL
THESE MEASUREMENTS**

Each Polarad Microwave Signal Generator (4 models cover 950-11,500 mc) is equipped with the unusually simple UNI-DIAL control that tracks reflector voltages automatically while tuning continuously. Frequency, accurate to $\pm 1\%$, is read directly on the single frequency dial. There are no mode charts, no slide rule interpolations necessary.

But, most significant are the built-in features that enable use of these rugged instruments for so many applications: internal modulation, pulse and FM; internal square wave modulation; synchronization outputs, delayed and undelayed; provision for multi-pulse modulation input; provision for external modulation and synchronization; variable attenuator calibrated directly in -dbm; engineered ventilation to insure specification performance over long operating periods.

Contact your local Polarad representative or write directly to the factory for the latest detailed specifications.

SPECIFICATIONS (all models unless indicated)

Model #	Frequency Range	Internal pulse modulation:	External pulse modulation:
MSG-1	950 - 2400 mc	Pulse width: 0.5 to 10 microseconds	Polarity: Positive or negative
MSG-2	2150 - 4600 mc	Delay: 3 to 300 microseconds	Rate: 40 to 4000 pps
MSG-3	4450 - 8000 mc	Rate: 40 to 4000 pps	Pulse width: 0.5 to 2500 microseconds
MSG-4	6950 - 10,800 mc	Synchronization: Internal or external, sine wave or pulse	Pulse separation (for multiple pulses): 1 to 2500 microseconds
MSG-4A	6950 - 11,500 mc		
Frequency accuracy: $\pm 1\%$		Internal FM:	Output synchronizing pulses:
Power output:		Type: Linear sawtooth	Polarity: Positive, delayed & undelayed
MSG-1 & 2: 1 mw		Rate: 40 to 4000 cps	Rate: 40 to 4000 pps
MSG-3, 4 & 4A: 0.2 mw		Synchronization: Internal or external, sine wave or pulse	Voltage: Greater than 25 volts
Attenuator range: 120 db		Frequency deviation:	Rise time: Less than 1 microsecond
Attenuator Accuracy: ± 2 db		MSG-1 & 2: ± 2.5 mcs	
Output impedance: 50 ohms nominal		MSG-3, 4 & 4A: ± 6 mcs	
		Internal square wave modulation:	
		40 to 4000 pps	



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Meetings

1957 Transistor and Solid State Circuits Conference

February 14-15, 1957
University of Pennsylvania
Philadelphia, Pennsylvania

Thursday, February 14, AM
Session 1 Switching Circuits

A DECADE RING COUNTER USING AVALANCHE-OPERATED JUNCTION TRANSISTORS. *J. E. Lindsay, Radio Corp. of America*

TRANSISTOR CIRCUITS FOR MAGNETIC DRUM RECORDING. *Gordon Kuster, Ferranti Electric Limited*

LARGE SCALE TESTING OF SWITCHING SPEEDS OF JUNCTION TRANSISTORS. *Irwin Dorros, Bell Telephone Laboratories*

EFFECTS OF LOW TEMPERATURES ON TRANSISTOR CHARACTERISTICS. *A. B. Credle, IBM*

Thursday, February 14, PM
Session II Computer Switching

MILLIMICROSECOND TRANSISTOR CURRENT SWITCHING CIRCUITS. *Hannon S. Yourke, IBM Laboratory*

DCTL COMPLEMENTING FLIP-FLOP CIRCUITS. *E. Gary Clark, Burroughs Research Center*

A NEW BISTABLE TRANSISTOR ELEMENT SUITABLE FOR DIGITAL COMPUTER. *N. F. Moody, Defence Research Board, Ottawa*

AN ANALYSIS OF THE COMPLEMENTARY PAIR TRIGGER CIRCUIT. *C. D. Florida, Defence Research Board, Ottawa*

A COMPLEMENTARY SYMMETRY MOMENTARY MULTIVIBRATOR. *F. F. Chang and A. I. Aronson, Radio Corp. of America*

THE DESIGN OF DUAL-RANGE TRANSISTOR CIRCUITS FOR MINIMUM STANDBY-CURRENT SYSTEMS. *Howard E. Tompkins*

Thursday, February 14, PM
Session III Linear Amplifiers

TRANSISTOR LOW NOISE PREAMPLIFIER WITH HIGH INPUT IMPEDANCE. *Andrew E. Bachmann, General Electric Co.*

WIDE BAND FEEDBACK AMPLIFIERS. *F. D. Wadhauer, Bell Telephone Laboratories*

A TRANSISTORIZED HIGH VOLTAGE PUSH-PULL SWITCHING GENERATOR USING HIGH IMPEDANCE TECHNIQUE. *P. Abzalone, Radio Corp. of America*



ELECTRONICS CORPORATION 43-20 34th STREET, LONG ISLAND CITY, N. Y.

REPRESENTATIVES: Albuquerque, Atlanta, Baltimore, Boston, Buffalo, Chicago, Cleveland, Dayton, Denver, Fort Worth, Kansas City, Los Angeles, New York, Philadelphia, Portland, St. Louis, San Francisco, Schenectady, Syracuse, Washington, D. C., Winston-Salem, Canada; Arnprior, Ontario. Resident Representatives in Principal Foreign Cities

CIRCLE 13 ON READER-SERVICE CARD FOR MORE INFORMATION

RIES TUNED METHODS IN TRANSISTOR RADIO CIR-
CUTRY. *W. F. Chow and Donald A. Paynter, Gen-
eral Electric Co.*

NEW APPROACH TO TRANSISTOR RECEIVER DESIGN.
*Proudfit, K. M. St. John, C. R. Wilhelmsen, and
J. Farber, Hazeltine Research Corp.*

**Friday, February 15, AM
Session IV Power Circuits**

ME SOLUTIONS TO PROBLEMS OF OPERATING GER-
MANIUM TRANSISTOR SERVO AMPLIFIERS AT HIGH
AMBIENT TEMPERATURES. *P. M. Thompson and
Mitchell, Defence Research Board, Ottawa.*

ASE CONTROLLED TRANSISTOR POWER SUPPLY
REGULATION. *D. E. Deutch, Radio Corp. of America*

TRANSISTOR D. C. AMPLIFIER UTILIZING "FIRING-
ANGLE" CONTROL. *H. R. Lowry, General Electric Co.*

IMPROVED SQUARE-WAVE OSCILLATOR CIRCUIT.
Lee Jensen, Minneapolis-Honeywell

THREE-PHASE STATIC INVERTER. *Thomas M. Corry
and Ruby P. Putkovich, Westinghouse Electric*

NEW TRAMAG OSCILLATOR. *Albert J. Meyerhoff
and Robert M. Tillman, Burroughs Research Center*

**Friday, February 15, PM
Session V Special Device Circuits**

TEMPERATURE COMPENSATION OF TRANSLUXORS.
*Gold W. Abbott and J. J. Suran, General Elec-
tric Co.*

OUNTING CIRCUITS USING FERROELECTRIC DEVICES.
M. Wolfe, Bell Telephone Laboratories

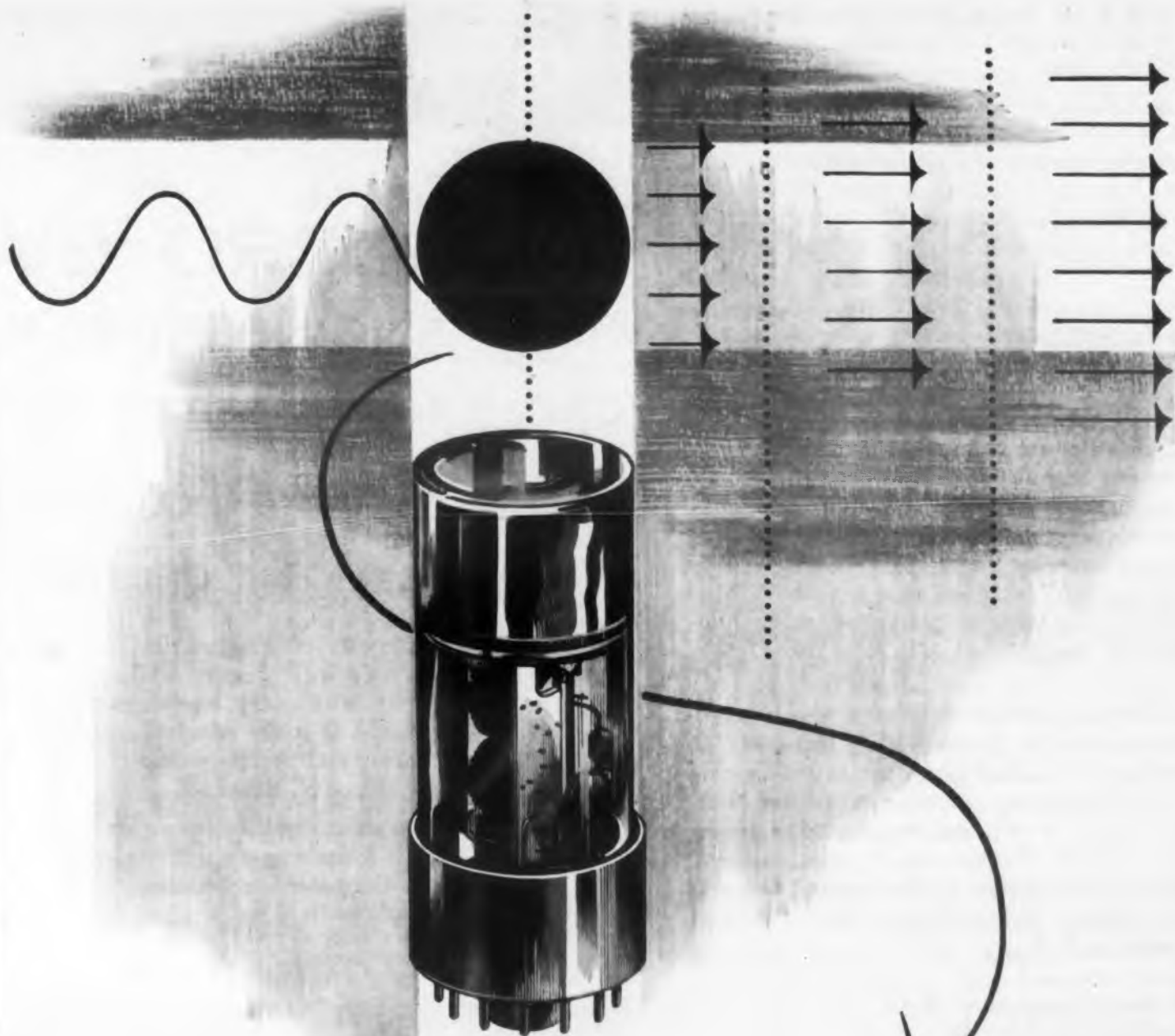
ITCHING CHARACTERISTICS OF MAGNETIC CORES
CIRCUITS ELEMENTS. *R. D. Torrey, A. Krell,
Meyer, Sperry Rand Univac*

ANSIENT AND FREQUENCY RESPONSE CHARACTER-
ISTICS OF FIELD EFFECT UNIUNCTION TRANSISTORS.
J. Suran and B. K. Eriksen, General Electric Co.

Tutorial sessions will be held Thursday morning
and Friday morning. Tutorial sessions are aimed at
conveying recent advances in the subject and will
provide the practicing engineer in solid-state cir-
cuitry a broader picture of the state of the art.

The 1957 Transistor and Solid State Circuits Con-
ference is sponsored jointly by the Philadelphia
Section of the IRE, the Science and Electronics
Technical Division of the AIEE, the IRE Profes-
sional Group on Circuit Theory, and the University
of Pennsylvania. The Conference will be held on
the Campus of the University of Pennsylvania, in
the Irvine Auditorium and the University Museum.

Registration and hotel reservation forms may be
obtained from Mr. F. W. Anderson, General Elec-
tric Company, Missile and Ordnance Systems De-
partment, 3198 Chestnut Street, Philadelphia 4,
Pennsylvania. Advance Registration Fee is \$3. At
the Conference \$4.

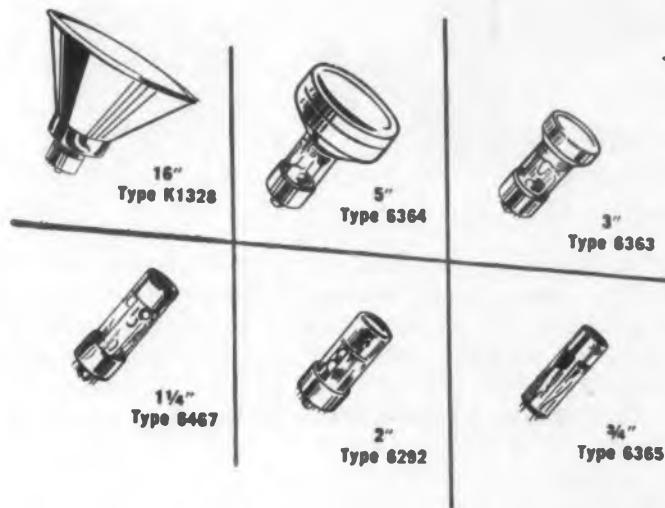


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CIRCLE 14 ON READER-SERVICE CARD FOR MORE INFORMATION

Feb. 4-9: Audio Engineering Society West Coast Convention and High Fidelity Show

Ambassador Hotel, Los Angeles, Calif. Technical sessions will be held Feb. 7-8, Institute of Hi Fi Mfgs. Show afternoon and evenings Feb. 7-9. Various awards and honors will be presented at the Audio Engineering Society banquet Feb. 4. For further information, write Audio Engineering Society, Box 12, Old Chelsea Station, New York 11, N.Y.

Feb. 5-7: Twelfth Reinforced Plastics Division Conference

Edgewater Beach Hotel, Chicago, Ill. Latest developments in both technical and practical aspects of reinforced plastics. Subject matter will range from reports on research and testing, product design, production methods, to marketing techniques. A complete program, listing papers and speakers, registration forms for the three day conference and hotel reservation blanks are now available. Those interested should write to The Society of the Plastics Industry, Inc., 250 Park Ave., New York 17, N.Y.

Feb. 7: Operations Research Symposium

University Museum Lecture Hall, University of Pennsylvania. Sponsored jointly by the Professional Group on Engineering Management of the Philadelphia Section of IRE and the Society of Industrial and Applied Mathematics. Major theme will be Mathematical Models in Management Decision Making. Contact Haydn Ringer, 1303 Highland Ave., Palmyra, N. J.

Feb. 7: Annual Symposium of the New York Section of the ISA

Garden City Hotel, Garden City, N. Y. Short papers on "Practical Accuracy of Measurement" will be presented followed by a discussion. Afternoon session will be on "Data Handling." For further information contact G. Newberg, Publicity Chairman, Fairchild Engine Division, Fairchild Engine & Airplane Corp., Deer Park, L. I., N. Y.

Feb. 7-8: Special Conference on Nucleonics in Industry

Hotel Statler, New York, N. Y. Principal subjects for discussion will be the present and prospective profitability of atomic investment. Sessions will cover industrial applications as the use of nuclear energy for processing purposes, development of auxiliary power, and the uses of isotopes. Conducted by the American Management Association, 1515 Broadway, New York, N. Y.

Feb. 15-16: Cleveland Electronics Conference

Masonic Auditorium, Euclid Ave. and E. 36th St., Cleveland 14, Ohio. For information, write Robert A. Dambach, Cleveland Electronics Conference, 18511 Euclid Ave., Cleveland, Ohio.



MICRO SWITCH Precision S

... FIRST IN PRECISION SWITCHING

HOW MICRO SWITCH ENGINEERING SERVICE

can keep a small switch from becoming

a BIG PROBLEM in your design

MICRO SWITCH Engineering Service is a two-way street. Field engineers and factory engineers work together to make sure you get the right MICRO SWITCH precision switch for your application.

This teamwork between experienced switching specialists assures that the precision switches you incorporate in your equipment are

the right switches for your application and will give reliable, dependable, day-in, day-out service.

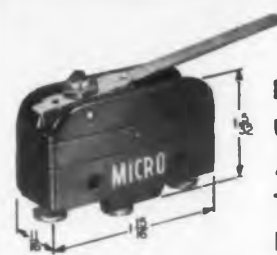
You can take advantage of this teamwork by calling MICRO SWITCH today. Switching specialists—with close contact at the world's largest headquarters for precision switches—are available at branch offices in key cities.

CONTROLS MANY CIRCUITS WITH ONE MANUAL MOTION



This three-position, rotary-type toggle switch offers all the advantages of a toggle switch mechanism with longer operating life and better detent "feel." Shown is a four-pole double-throw switch with 12 terminals. It is maintained in all three actuation positions, on-off-on. This switch can handle a high electrical load and has passed severe tests for impact, shock, acceleration and vibration.

(Send for Data Sheet 112)



PRECISE, UNERRING ACTUATION THROUGH MILLIONS OF OPERATIONS

Adjustable lever actuator permits close adjustment of switch operating point without removal from mounting. It provides unusually reliable service on such equipment as timers, computers or other multiple-mounted devices which require precise, unerring operation through millions of operations. Available with normally open, normally closed double-throw or split-contact circuitry.

(Send for Data Sheet 100)



FOR PRECISE PERFORMANCE UNDER MOST EXTREME CONDITIONS

MICRO SWITCH "EN" switches are capable of reliable, long-life performance under extreme environmental conditions. They are completely sealed, cylindrical and can be mounted wherever a through hole can be provided. Variations of the "EN" are capable of actuation by almost any means. Available in choice of four different contact arrangements. Equal in performance to many switches twice the size.

CIRCLE 15 ON READER-SERVICE CARD FOR MORE INFORMATION

Switches have uses unlimited



Switches put "THINK" into this press transfer feed

Here is a typical example of how a manufacturer improved his product. With MICRO SWITCH Precision Switches designed into the press, blanks are loaded and fed automatically, dangerous manual feeding is eliminated, mistakes are "erased" without interrupting production. This product improvement was due in no small measure to the help of MICRO SWITCH application engineers.



For more information for your design engineers, write for Catalog 83.

When a stack of blanks is nearly depleted, the descending elevator trips this switch which starts a motor and turns the six-station turret to the next full station for blanks.

Plunger which picks up the blanks is controlled by switches shown. Upper switch stops the press if the blanks do not reach level of gripping fingers. Switch at left brings new stack of blanks into position. If stack doesn't come into position, the third switch stops press.

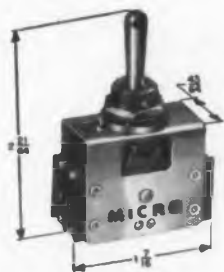


When two blanks stick together and feed into the press they trip this switch which actuates a solenoid and opens a trap door in the press bed. The blanks fall through, the press goes on uninterrupted.



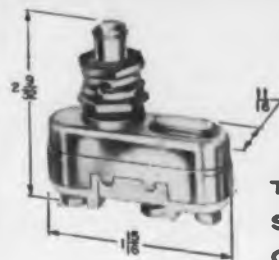
SWITCH "REMEMBERS" CIRCUIT WHICH WAS LAST ACTUATED

This is the first of a new series of "electrical memory" toggle switches. The switch indicates through a pilot light or buzzer which circuit was last actuated. The assembly uses one pole of its four-pole circuitry to indicate which circuit was last operated. Use of this switch simplifies basic circuit designs of radar units, computers, aircraft control panels and other similar devices. Seal prevents entrance of liquids and dust. Basic switches are Underwriters' Listed at 5 amperes 125, 250 volts a-c, d-c rating at 28 volts-3 amperes at sea level, 2.5 amperes at 50,000 feet (inductive); 4 amperes at sea level and 50,000 feet (resistive); maximum inrush, 15 amperes.



MICRO SWITCH, a Division of Honeywell, pioneered the manufacture and development of precision snap-action switches.

CIRCLE 15 ON READER-SERVICE CARD FOR MORE INFORMATION



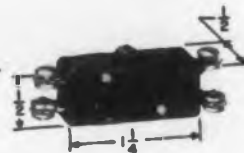
THIS SWITCH OPERATES

RELIABLY AT TEMPERATURES FROM -50° TO $+1000^{\circ}$ F

Use of laboratory-tested, heat-resistant materials makes this switch an extremely dependable component for use in applications where high temperatures are present. It will operate satisfactorily in a temperature range of -50° to 1000° F. Contact arrangements are single-pole double-throw. Switch is available in panel-mount design (shown) or with pin- or roller-plunger actuators.

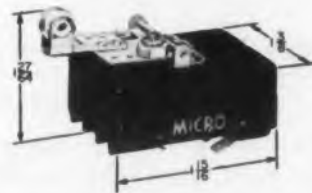
(Send for Catalog 77)

A TWO-CIRCUIT SWITCH WITH ACCURATE REPEATABILITY



This switch uses a snap-action spring to provide quick make and break of both contacts in each double-break circuit. It is Underwriters' Listed for 10 amperes 125 or 250 volts a-c; $\frac{1}{2}$ H.P. 125 volts a-c; 10 amperes 30 volts d-c.

(Send for Catalog 62)



TWO SWITCHES OPERATED BY A SINGLE LEVER ACTUATOR

This is an assembly of two single-pole double-throw switches. It provides for switching of two isolated circuits at the same time. The basic units are listed by Underwriters' Laboratories at 15 amperes 125, 250 or 460 volts a-c; $\frac{1}{2}$ ampere 125 volts d-c; and $\frac{1}{4}$ ampere 250 volts d-c.

(Send for Data Sheet 100)

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

In Canada, Leaside, Toronto 17, Ontario • FREEPORT, ILLINOIS



February 14-15: Transistor and Solid State Circuits Conference

University of Pennsylvania, Philadelphia, Pa. Sponsored by the Institute of Radio Engineers, American Institute of Electrical Engineers, and the University of Pennsylvania. For further information contact G. H. Kunststadt, Radio Corp. of America, Defense Electronic Products, Camden 2, N. J.

Feb. 25-27: Special Conference on Electronics In Action

Statler Hotel, New York, N. Y. Several major companies will show electronic data-processing equipment in action through closed-circuit television. Sponsored by the American Management Association's Finance Division, 1515 Broadway, New York, N. Y.

Feb. 26-27: Third Conference on Radio-Interference Reduction

Chicago, Ill. Sessions include equipment design techniques, instrumentation and measurement techniques, practical interference reduction methods, and special suppression components. For further information contact Armour Research Foundation of Illinois Institute of Technology, Technology Center, 10 West 35th St., Chicago 16, Ill.

Feb. 26-28: Western Joint Computer Conference

Statler Hotel, Los Angeles, Calif. The Conference is under the joint sponsorship of the IRE, AIEE, and ACM. Theme of the meetings will be "Techniques For Reliability." For further information contact S. Dean Wanlass, Aeronutronic Systems, Inc., 13729 Victory Blvd., Van Nuys, Calif.

March 11-15: 1957 Nuclear Congress

Convention Hall, Philadelphia, Pa. Theme of the Congress is "For Mankind's Progress" and peacetime uses of atomic energy will be discussed. Included in the Congress are four major elements, including the Second Nuclear Engineering and Science Congress, coordinated by Engineers Joint Council on behalf of twenty engineering and scientific societies. This will include 130 technical papers during a four-day program. The National Industrial Conference Board will hold its Fifth Conference on Atomic Energy in Industry, featuring twelve round-table discussions. The International Atomic Exposition, sponsored by the American Institute of Chemical Engineers in cooperation with four other engineering societies, will display industry's latest items in the atomic field. The Fifth Hot Laboratories and Equipment Conference, sponsored by the Hot Laboratories Committee of the Oak Ridge National Laboratory, Oak Ridge, Tenn., will take place March 14 and 15. For information, write Engineers Joint Council, 33 W. 39th St., New York, N.Y.

FIRST silicon transistors meeting NAVY SPECS



For reliability under extreme conditions... design with TI's military silicon transistors... built to give you high gain in small signal applications at temperatures up to 150°C. Made to the stringent requirements of MIL-T-19112A (SHIPS), MIL-T-19502 (SHIPS), and MIL-T-19504 (SHIPS) - these welded case, grown junction devices furnish the tremendous savings in weight, space, and power you expect from tran-

sistorization... plus close parameter control that permits you to design your circuits with confidence.

All 20 Texas Instruments silicon transistor types have proved themselves in military use. First and largest producer of silicon transistors, TI is the country's major supplier of high temperature transistors to industry for use in military and commercial equipment.

degradation rate tests for TI's USN-2N117, USN-2N118, and USN-2N119

test	condition	duration	end point at 25°C
lead fatigue	three 90-degree arcs	—	no broken leads $I_{CO} = 2\mu A$ maximum at 5V $h_{OB} = 2\mu mhos$ maximum $h_{FB} = -0.88$ minimum (USN-2N117) $h_{FB} = -0.94$ minimum (USN-2N118) $h_{FB} = -0.97$ minimum (USN-2N119) no mechanical defects interfering with operation
vibration	100 to 1000 cps at 10 G	3 cycles, each x, y, and z plane	
vibration fatigue	60 cps at 10 G	32 hours, each x, y, and z plane	
shock	40 G, 11 milliseconds	3 shocks, each x, y, and z plane	
temperature cycle	-55°C to +150°C	10 cycles	
moisture resistance	MIL-STD-202	240 hours	
life, intermittent operation	$P_c = 150$ mW, $V_c = 30$ V	1000 hours, accumulated operating time	
life, storage	150° C, ambient	1000 hours	
salt spray	MIL-STD-202	50 hours	

LOOK TO TI FOR: SILICON HF, MEDIUM POWER, POWER, AND SMALL SIGNAL TRANSISTORS
SILICON DIODES AND RECTIFIERS • GERMANIUM VHF, POWER, RADIO, AND GENERAL PURPOSE TRANSISTORS

pioneer producer of
silicon transistors



TEXAS INSTRUMENTS
INCORPORATED
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CIRCLE 16 ON READER-SERVICE CARD FOR MORE INFORMATION

March 18-21: The 1957 SPI Annual National Conference and Pacific Coast Plastics Exposition

Hotel Biltmore, Los Angeles, Calif., sponsored by the Society of the Plastics Industry, Inc. Sessions will cover plastics in the fields of electronics, aircraft and defense, building, and processing. Exposition will be held at the Shrine Exposition Hall. Further information may be obtained from the Society of the Plastics Industry, Inc., 250 Park Avenue, New York, N. Y.

March 18-21: IRE National Convention

Waldorf-Astoria Hotel and New York Coliseum, New York, N. Y. Twenty-three technical subjects such as Telemetry, Antennas and Propagation, Circuit Theory, Electron Devices and Receivers, Computers, Information Theory, Automatic Control, Microwave and Instrumentation, Manufacturing Electronics, Audio and Broadcast, Aeronautical Communication and Military Electronics, Ultrasonics, Medical and Nuclear Electronics will be presented at the convention. For further information on exhibits, contact Mr. William C. Copp, IRE Advertising Dept., 1475 Broadway, New York, N. Y. Contact the IRE, 1 East 79th St., New York, N. Y. for other information.

March 25-27: Special Conference on Research and Development

Palmer House, Chicago, Ill. Sponsored by the American Management Association. Subject will be "Product Development in Medium and Small Companies." For information, write American Management Association, 1515 Broadway, New York, N. Y.

April 4-5: Special Conference on Research and Development

Hotel Statler, New York, N. Y. Sponsored by the American Management Association. The conference will be an Engineering Forum. For information, write to American Management Association, 1515 Broadway, New York, N. Y.

April 8-11: Fourth National Electrical Industries Show

71st Regiment Armory, New York, N. Y. Sponsored by the Eastern Electrical Wholesalers Association. For more information, contact William S. Ork, Co-Producer, The American Electrical Industries Expositions, Inc., 19 W. 44th St., New York, N. Y.

April 11-13: Southwestern IRE Conference and Electronics Show

Houston, Texas. Sponsored by the Houston Section of the IRE. This conference will be augmented by the National Simulation Conference which will be sponsored by the IRE Professional Group on Electronic Computers. For information, write to National Southwestern IRE Conference and Electronics Show, P. O. Box 1234, Houston 1, Texas.

April 15-17: Symposium on Systems for Information Retrieval

Western Reserve University, Cleveland, Ohio. Sponsored by the School of Library Science of Western Reserve University in conjunction with its center for Documentation and Communication Research. This will be a comprehensive demonstration of systems presently in use for the organization, storage and retrieval of recorded information, together with a symposium on information-handling problems and techniques. Further information may be obtained from Jesse H. Shera, Dean, School of Library Science, Western Reserve University, Cleveland 6, Ohio.

April 16-18: Symposium on Nondestructive Tests Developed in the Field of Nuclear Energy

Marriott Hotel, Chicago, Ill. Sponsored by American Institute of Chemical Engineers, American Nuclear Society, American Society for Testing Materials, and Society for Nondestructive Testing. Information resulting from 15 years research and development in testing applications in the nuclear field will be presented. Papers will be in three categories: reactor materials, completed fuel assemblies, and miscellaneous. For information, write to American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

April 23-25: International Symposium on the Role of Solid State Phenomena in Electrical Circuits

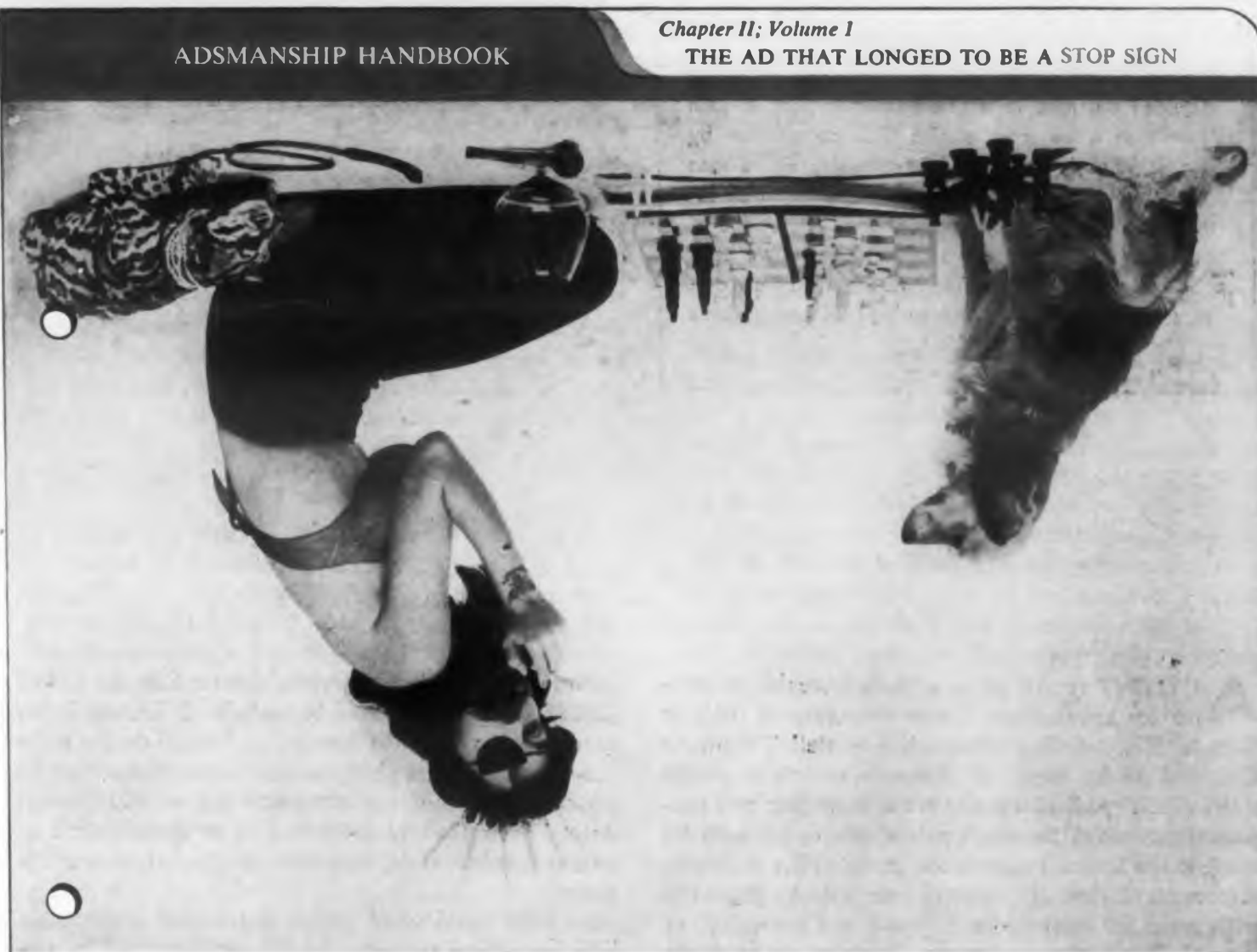
Auditorium of the Engineering Societies Building, New York, N. Y. Symposium will cover recent developments in application to electrical circuits on systems of unusual physical effects in solids. For information write to the Polytechnic Institute of Brooklyn, Microwave Research Institute, 55 Johnson St., Brooklyn 1, N.Y.

April 24-26: Seventh Region IRE Conference

San Diego, Calif. Theme of the meeting is "Electronics in Space." Sessions will be held on electronic aids to air navigation, audio, management, uses of computers, antennas and propagation, nuclear activation and damage of electronic equipment, electronic devices, electron tubes, microwave instrumentation, telemetering, data handling and automation, magnetic components, and radio astronomy. For information, write to IRE Seventh Region Conference, U. S. Grant Hotel, San Diego, Calif.

April 25-26: Annual Technical Meeting of the Institute of Environmental Engineers

Salle Hotel, Chicago, Ill. For information contact the President of EEI, Henry F. Sander, Vapor Engineering Corp., 6420 W. Howard St., Chicago, Ill.



There was once an ambitious ad that was vastly impressed by the stopping power of a few singularly successful advertising campaigns. Consequently, this foolish ad deliberately distilled the charm of each of these campaigns and used them all at once.

The ad came out standing on its head and looking like nothing you've ever seen . . .

that is, unless you've read this, as what red-blooded intellectually curious engineer hasn't?

MORAL: *Well-read stop signs needn't be red to be investigated. (An ocelot helps a lot)*



In the interest of greater adsmanship, this advertising parable is provided as a public service by the Benson-Lehner Corporation. Incidentally, the Benson-Lehner Corporation, leading manufacturer of data processing equipment, has available their new precision film reader, the BOSCAR Model N. For information re: data reduction, write:

benson-lehner corporation

11930 Olympic Boulevard, Los Angeles 64, California

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For a permanent file of this series write to Benson-Lehner, Dept. F9, for your Adsmanship Handbook folder

CIRCLE 17 ON READER-SERVICE CARD FOR MORE INFORMATION

A big problem for designers is that of knowing what has been patented in a given field. Sources of such information often seem elusive. This compilation by John T. Milek is the most comprehensive we've seen and is published for purposes of reference. In an attempt to increase the designers general knowledge of patents and their value, two other articles have been published recently in ELECTRONIC DESIGN. They are: "What Good are Patents"—May 15, 1956 and "Patents are Valuable"—Sept. 15, 1956.

Searching Electronic Patents

John T. Milek

A PATENT search often reveals a wealth of electronics information. Large corporations such as General Electric Co., Westinghouse, Bell Telephone Co., and Radio Corp. of America maintain patent staffs which specialize in the art of searching and preparing patents. A thorough patent search can only be made in the Search Room at the Patent Office in Washington, D. C. Row after row of search desks, provided with racks for convenient "flipping and scanning" of patent subclasses, extend across the room. An excellent description of the United States Patent Office facilities is provided by Fleischer ("Exploring United States Chemical Patent Literature," Searching the Chemical Literature, Washington, D. C., American Chemical Society, 1951, pp 61-69).

Patent Indexes

The Electronics Engineering Master Index, published by the Electronics Research Publishing Co., Inc., covered many electronics patents in their four volumes: 1925-1945, 1946, 1947-1948, 1949. For example: In the 1947-1948 volume, 5500 patents were listed; in 1949, 4000 were covered. In 1946, a companion volume, Electronics Engineering Patent Index, covering approximately 2000 patents, was published by the same company.

The United States Patent Office has prepared a Classification Bulletin of the United States Patent Office, Number 400, Revision I, January 1954. The bulletin is a consolidated index to Classification Bulletins 103-416, containing the defined classes arranged numerically with their titles and for each a list of all classification bulletins containing a reference thereto. This index is available gratis from the Commission of Patents, Washington 25, D. C. Approximately thirty-five classes are listed which pertain or relate to electronics and electrical engineering.

The United States National Bureau of Standards published a "List of the More Important United States Patents Covering the Materials and Methods of Manu-

facture of Insulating Materials," Letter Circular LC-51 (1922), 29 pp. It intended to include all United States patents issued prior to September 1, 1920 on the manufacture and use of electrical insulating materials. The publication includes a numerical list of 450 patents dating from 1888 to 1920 and other details such as patent number, date, inventor, assignee, title and re-issues.

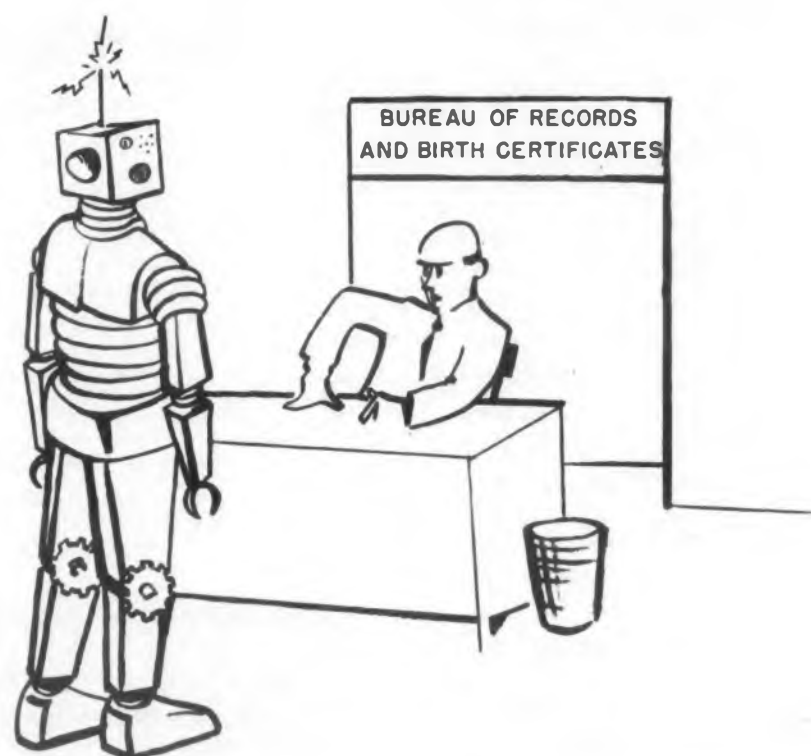
In 1936 the United States Bureau of Mines published an information circular (No. 6883) titled "Patents on Geophysical Prospecting Issued in the United States, England, Canada, Australia, Germany, France, and Russia." It was subsequently continued in the United States Geodetic Survey Bulletin Numbers 887 and 895b. The publication includes many electrical

methods of prospecting as well as electronic devices and apparatus.

The United States Government Patents Board in 1953 began a series of volumes containing Government-owned inventions available for license. The volumes of this series are detailed under 9, 10 and 11 of the bibliography.

Abstracts

The United States Patent Office issues a weekly Official Gazette, recording and abstracting all current issued patents in numerical sequence. Complete or nearly complete sets of the Official Gazette can be found in the libraries of the major cities of the United States. For information on electrical patents prior



"How do I go about looking up my Birth Certificate?"

7, a useful source of information is the United States Patent Office publication titled "Index of Patents Relating to Electricity, embracing patents issued in the United States Patent Office from July 1, 1881-1917." This index will save numerous hours of searching for electrical patents of that period since it is arranged by patent class and numerically within the classes. An alphabetical, numerical and chronological index of all patents is included also. A more recent patent indexing literature tool is the Index of Patents issued from the United States Patent Office, 1920—. It includes an alphabetical list of patentees, and prior to 1924 an alphabetical list of inventions. The publication, Index of Trade-marks Issued from the United States Patent Office, 1928—affords the searcher trade mark information of patented products and processes. Chemical Abstracts includes many patents relating to electronics, such as plastics insulation, ceramic insulation, dielectric materials, and semiconductors. Annual and decennial indexes facilitate finding such patent data.

Another source of electronics patent information is the RETMA Radio-Electronics Patent Service issued weekly by the Radio-Electronics-Television Manufacturers' Association, Suite 800, Wyatt Bldg., 777-14th Street, N.W., Washington 5, D. C. This service (which is free to members) reproduces in brief all patent listings from the United States Official Gazette in the electronic field.

During World War II the Custodian of the United States Office of Alien Property prepared and published a compendium, Abstracts of Mechanical and Electrical Vested Patents, in five volumes. Several thousand electrical patents are listed by classes.

Many periodicals and trade journals include electronics patents as regular features. These usually can be located through the periodical's index, Engineering Index, or Industrial Arts Index. Norman Chalfin has 777 Peading Avenue, Los Angeles 45, Calif.

reviewed electronics patents in a series of articles titled "Pertinent Patents" in 1955 in *Electronics*, McGraw-Hill, New York. A comprehensive bibliography, "Transistor Circuits and Devices" by John T. Milek was published in the January, 1955 issue of *Electronics Digest*. Over 200 patents are included on the subjects of semiconductor devices, germanium and silicon diodes, and germanium and silicon transistors.

A new patent service called "Picturesort" was inaugurated recently offering copies of all United States patents issued. The company (Picturesort Co., New Haven, Conn.) will supply copies of electronics patent abstracts and microfilm on a punched card which can be coded and filed for easy reference.

Patent Suits

In 1926 the Radio Manufacturers' Association, Inc. published a volume titled Information on U.S. Radio Patents and Suits (New York, The Association, 1926, 175 pp.). Supplements numbering 1-21 have been published dating from December 31, 1926 to December 31, 1931. The first half of the original volume is a collection, classification and tabulation of all United States patents relating to radio receiving circuits and systems exclusive of circuits employable peculiarly or only for radio transmitting, and to radio parts or instruments usable in such receiving circuits. The report on each subject is preceded by a discussion of the scope of the report and the methods of treatment and contents, with an analysis of the classification followed. The patents are listed numerically under each subject. Information on each patent includes patent number, date, inventor and title. The second half of the original volume on suits appeared separately (371 pp.). The first half of each supplement continues the patent compilation, the last one going through December 1931. Subject indexes to the original volume and supplements are also included.

Foreign Patents

Information on foreign electronics patents is scarce. Belknap Severance, chief cataloger of the Scientific Library of the United States Patent Office, has prepared a valuable guide to foreign patent source material in his Manual of Foreign Patents, Washington, D. C., Patent Office Society, 1935, 161 pp. In its introduction, it incorporates "Searching Foreign Patents" by Arthur Worischek, Patent Attorney for General Motors. Worischek describes the problems and difficulties besetting a patent searcher in locating patent information in the various countries. The contents include patent source information of fifty-six countries arranged alphabetically by country. Such information is included as name and address of patent office, patent journals and periodicals, with complete detailed information on each; indexes, classifications, abridgments, specifications, patent laws, legislation and statistics.

White and Ravenscroft give details of patent laws of over 200 countries, islands, territories and colonies

in *Patents Throughout The World*, New York, Trade Activities, Inc., 1944, 416 pp plus Supplements.

Langner has prepared a compendium of useful information relating to foreign patents and trade marks with complete tables and charts specially prepared for the use of attorneys: *Langner's Foreign Patent and Trade Mark Digest*, New York, Langner, Card, & Langner, 1928-, loose-leaf.

Obtaining Patents

Electric and electronics patents are discussed by Toulmin (*Handbook of Patents* by H. A. Toulmin, Jr., New York, Van Nostrand, 1949, Chapter VII: Special Types of Patents). He discusses such basic patents as radio, Morse telegraph patent, De Forest radio Tube, Bell telephone patent, incandescent lamp patent, Marconi patents, television, electrical fields, and electrical methods. The reader is referred to this work for a discussion of patent-ability, court decisions, and patent applications of electrical and electronics patents.

A few other books on electrical patents providing sources of information are:

- *Beginnings of Telephony* by F. L. Rhodes. New York, Harper, 1929, 261 pp. Pages 234-238 includes a numerical list of patents from 1875-July 1918, giving date, patentee, feature covered, and page reference to text.
- *Electrical Technology and the Public Interest* by Frank J. Kottke. Washington, D. C., 1944, 199 pp.
- *The Law of Electrical Invention* by Frank G. Kirtz. New York, Boardman, 1954, 742 pp.
- *Radio and Television Rights*. (A standard reference book on the law of copyright, trade-marks, and unfair competition and the broadcasting industry) Albany, New York, Matthew Bender & Co., 1953, one volume.

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4. KIRTZ, FRANK G.
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5. KOTTKE, FRANK J.
Electrical Technology and the Public Interest (A study of our national policy toward the development and application of inventions). Washington, D.C., American Council on Public Affairs, 1944, 199 pp.
6. RADIO-ELECTRONICS-TELEVISION MANUFACTURERS ASSOCIATION Radio-Electronics Patent Service, Washington, D.C., The Association, 1945-, weekly.

7. RADIO MANUFACTURERS' ASSOCIATION, INC.
Information on U.S. Radio Patents and Suits. New York, The Association, 1926, 175 pp. Supplements Nos. 1-21 (December 31, 1926-December, 1931).
8. TOULMIN, HARRY A., JR.
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9. U.S. DEPARTMENT OF COMMERCE, GOVERNMENT PATENTS BOARD
Government Owned Inventions Available for License. Washington, D.C., 1953, 168 pp.
(A list of 3658 patents arranged by industrial use. Supersedes 1951 publication, "Government-owned inventions for free use covering 2339 patents active as of January 1, 1951. Information included in the list comprise U.S. patent number, title of invention, name of inventor, and the abbreviated name of the government agency administering the patent. The following major group: Electrical Machinery, Equipment and Supplies and its sub-groups are included:
- 36-11 Wiring devices and supplies.
 - 36-12 Carbon and graphite products for use in the electrical industry.
 - 36-13 Instruments for indicating, measuring, and recording electrical quantities and characteristics.
 - 36-14 Motors, generators, and motor-generator sets.
 - 36-15 Power and distribution transformers.
 - 36-16 Switchgear, switchboard apparatus, and industrial controls.
 - 36-17 Electrical welding apparatus.
 - 36-19 Electrical equipment for industrial use, not elsewhere classified.
 - 36-21 Electrical appliances.
 - 36-31 Insulated wire and cable.
 - 36-41 Electrical equipment for motor vehicles, aircraft, and railway locomotives and cars.
 - 36-51 Electric lamps.
 - 36-61 Radios, radio and television equipment, and phonographs.
 - 36-62 Radio tubes.
 - 36-64 Telephone and telegraph equipment.
 - 36-69 Communication equipment.
 - 36-91 Storage batteries.
 - 36-92 Primary batteries.
 - 36-93 X-ray and therapeutic apparatus and non-radio electronic tubes.

10. U.S. DEPARTMENT OF COMMERCE. GOVERNMENT PATENTS BOARD
4300 Government-owned Inventions Available for License. Patent Abstract Series No. 1: Instrumentation. Washington 25, D.C., U.S. Dept. of Commerce, Small Business Administration, P.B. 11464. (Lists 775 Government-owned inventions available for license applicable to the instrumentation industry, covered by patents active as of December 31, 1953. Inventions are divided into eight groups:
- 1) Laboratory, scientific, and engineering instrument.
 - 2) Instruments for indicating, measuring, and recording electrical quantities and characteristics.
 - 3) Mechanical measuring and controlling instruments.

HOW TO TEST CORES

With the growing realization that cores are here to stay, more companies every day are expressing an interest in their application. But as Burroughs discovered some six years ago, a core investigation program must be a core testing program as well. And since the special equipment and procedures needed for core testing were not available at the time, Burroughs had to develop them.

These tools and techniques, born of a practical need are available now for your core testing needs. The tool is the Burroughs BCT-301, a complete and flexible system for accurately measuring the operating characteristics of tape wound cores. Allowing precise control over frequency, pattern, amplitude, and rise time of the core driving signal, the BCT-301 gives you extremely accurate measurements of the switching time of the core as well as the amplitude of the output pulse. And since it is constructed of unitized sections, the BCT-301 can be expanded and modified to meet new testing requirements as they arise.

But the BCT-301 is more than just a tool. With it you get the benefit of techniques and procedures which are now in everyday use at Burroughs, and are accepted practice among major core manufacturers. If you're interested in designing tape wound cores into your products, we'll be glad to send you additional detailed information on the BCT-301. Or, if you wish, have a Burroughs Sales Engineer demonstrate how the BCT-301 can get your core testing program off the ground . . . NOW.

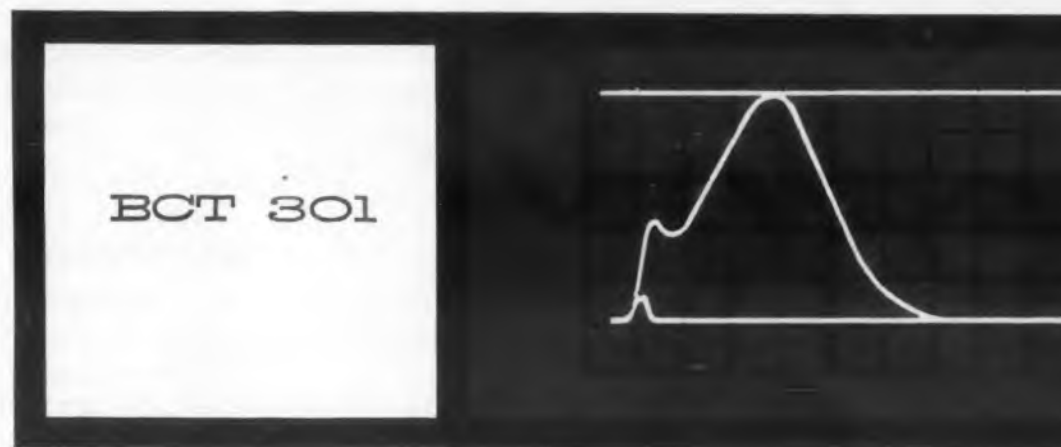


Figure ① shows the peak voltage amplitude of the output pulse being measured with the calibrating voltage. For amplitudes less than one volt, measurements can be made in millivolts.

Figure ② shows the calibrating voltage being used to measure pulse width at 10% of the amplitude.

tools for engineers



Burroughs Corporation • ELECTRONIC INSTRUMENTS DIVISION
DEPARTMENT B • 1209 VINE STREET • PHILADELPHIA 7, PENNSYLVANIA

with the BCT-301

A Complete and Flexible Core Testing System

The BCT-301 has been designed expressly for the individual testing of square loop cores. It provides precise control over the frequency, pattern, amplitude and rise time of the core driving signal, and allows extremely accurate measurements of the switching time of the core, as well as the amplitude of the output pulse. The unit is composed of five basic sections, each of which can be replaced or expanded for other types of core testing.

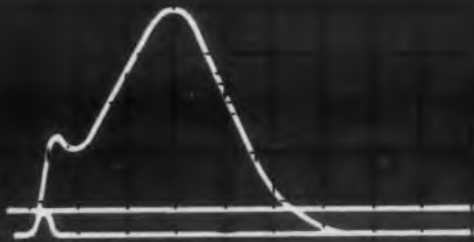
Core Mounting Jig This low-noise test mounting jig applies eight single turn loops around the core for input and output windings. It has been designed to minimize not only pickup by the secondary, but also other disturbances caused by air flux. Adjustable pins accommodate a wide range of bobbin sizes with equal precision.

Pattern Generator The Pattern Generator provides extreme flexibility in generating the pulse patterns which are applied to the core. This section of the system controls the pulse spacing, repetition rate of the cycle, and the number of pulses in the pattern.

Current Drivers Two Current drivers convert the voltages from the pattern generator into the positive and negative constant current pulses used for driving the core.

Front panel controls provide:

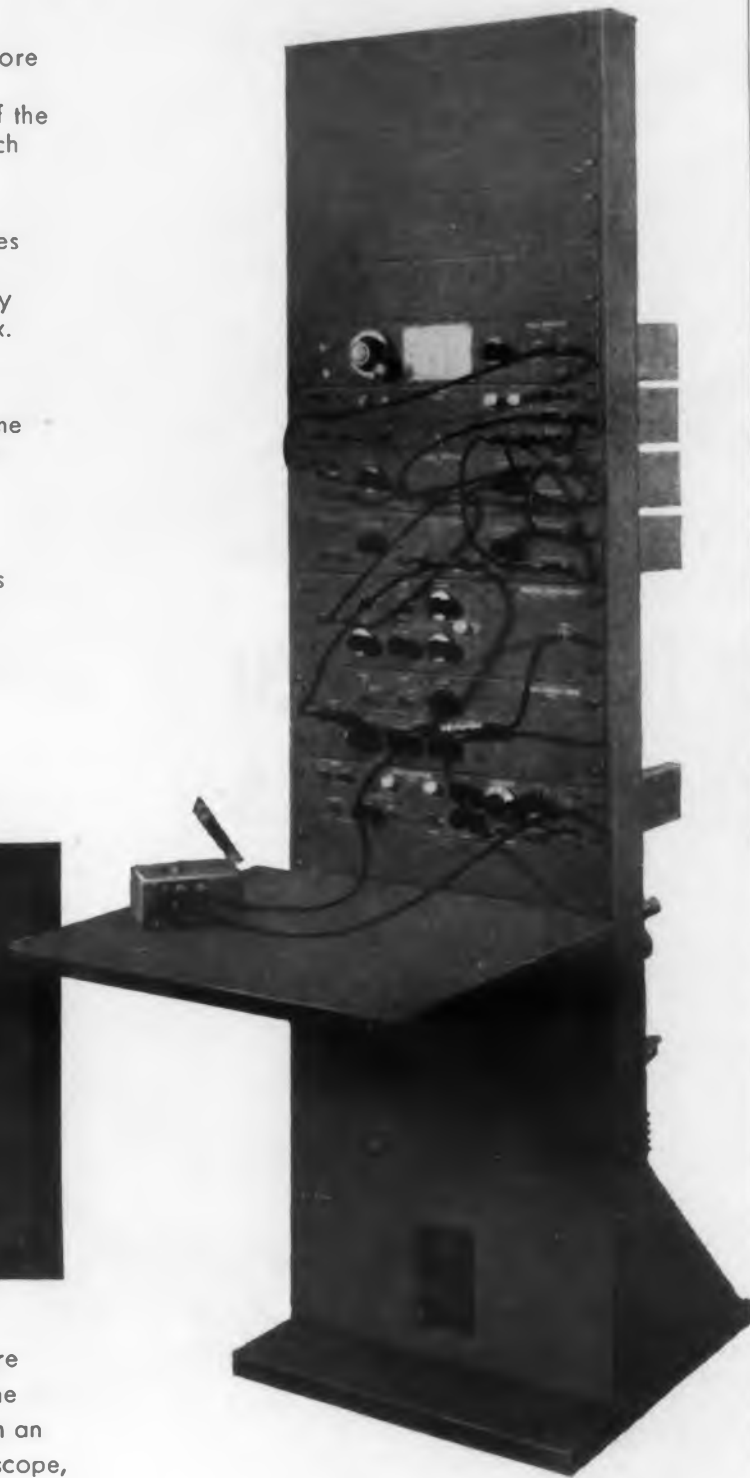
- Variable current amplitude from 0 to 1.0 ampere
- Variable rise time from 0.2 μ sec. to 1.0 μ sec.
- Variable pulse duration from 1.0 μ sec. to 10.0 μ sec.



Calibrator The calibrator is designed to accurately measure currents and voltages. It permits the measurement of both the driving current and the amplitude of the output voltage with an error of less than 1%. When used with a calibrated oscilloscope, it makes possible highly accurate readings of switching time.

Power Supply The power supply provides seven regulated voltages.

CIRCLE 18 ON READER-SERVICE CARD FOR MORE INFORMATION



- 4) Optical instruments and lenses.
- 5) Surgical and medical instruments.
- 6) X-ray and therapeutic apparatus.
- 7) Surgical and orthopedic appliances and supplies.
- 8) Photographic equipment and supplies.

11. U.S. DEPARTMENT OF COMMERCE. GOVERNMENT PATENTS BOARD

4300 Government-owned Inventions Available for License. Patent Abstract Series No. 5; Electrical and Electronic Apparatus. Washington 25, D.C. U.S. Dept. of Commerce, Small Business Administration, P.B. 11468. (Includes 1915 abstracts of govt-owned patented inventions in the electrical and electronic field and a list of govt. agencies which administer the patents. The inventions are classified as to industrial use in the following groups: Wiring devices and supplies; measuring instruments; particle accelerators; motors and generators; controls and switches; heating and welding apparatus; electric lamps; radio and related object locating and navigation apparatus; tubes; computing apparatus; telephone and telegraph equipment; batteries; X-ray apparatus; and miscellaneous electrical equipment.

12. U. S. NATIONAL BUREAU OF STANDARDS

List of the more important U.S. Patents covering the materials and methods of manufacture of insulating materials. Letter circular LC-51, 1922, 29 pp.

13. U. S. OFFICE OF ALIEN PROPERTY CUSTODIAN

Abstracts of mechanical and electrical vested patents. Vols. 1-5. Washington, D. C., Office of Alien Property Custodian, Division of Patent Administration, 1942-.

Vol. 1: Classes 1-75

Vol. 2: Classes 76-150

Vol. 3: Classes 151-225

Vol. 4: Classes 226-315

Vol. 5: Correction Supplement.

(Several thousand electrical patents are listed).

14. U. S. PATENT OFFICE

Index of Patents relating to electricity; granted prior to July 1, 1881, with an appendix . . . 1881-1882. Supplementary appendices Nos. 1 to 16 (1883-1897). Washington, D. C., U. S. GOVERNMENT PRINTING OFFICE. (Includes alphabetical, numerical and chronological indexes).

15. U.S. PATENT OFFICE

Official Gazette of the U.S. Patent Office. Washington, D. C., U.S. Government Printing Office, 1872-, weekly.

16. U.S. PATENT OFFICE

Index of Patents Issued from the U.S. Patent Office. Washington, D. C., U.S. Government Printing Office, 1920-.

(Inventions and patentees are listed alphabetically).

17. U.S. PATENT OFFICE

Index of Trade-marks issued from the U.S. Patent Office. Washington, D.C., U.S. Patent Office, 1928-.

18. WARNER, HARRY PAUL

Radio and Television rights; a standard reference book on the law of copyright, trade-marks, and unfair competition and the broadcasting industry. Albany, New York, Mathew Bender & Co., 1953, 1 volume in loose-leaf.



Exploded view of aircraft spark plug, showing the two concentric insulating sleeves of "Teflon." Two sleeves are used to provide extra protection against dielectric failure.

Insure trouble-free design with R/M Teflon* products

For thousands of electrical applications "Teflon" has proved to be the best material because of its combination of properties—electrical, thermal and mechanical. It permits compactness of design, and because of its resiliency and toughness, components made from it often simplify installation. R/M Tape handles easily, conforms well to corners and unusual shapes, can be readily adapted for automatic wrapping.

Here are some of the electrical properties of R/M "Teflon":

1. **Power factor** — less than 0.0003 over entire spectrum from 60 cycles to 30,000 megacycles.
2. **Volume resistivity** — greater than 10^{15} ohm-cm, even after prolonged soaking in water.

3. **Surface resistivity**— 3.6×10^{13} ohms even at 100% humidity.

4. **Good arc-resistance**— on exposure to an arc, the material vaporizes, leaving no carbonized path.

5. **High short-time dielectric strength**— values range from 1000 to 2000 volts per mil, depending on thickness.

6. **Resists high temperatures** — electrical properties are essentially unchanged up to at least 400°F.

Take advantage of R/M's long experience in developing the potentials of "Teflon" for the electrical industry. We fabricate "Teflon" to your specifications or supply it in rods, sheets, tubes, wire and tape in all standard color codings. Send for our bulletin "R/M Teflon Products."

*A Du Pont trademark



RAYBESTOS-MANHATTAN, INC.

PLASTIC PRODUCTS DIVISION, MANHEIM, PA.

FACTORIES: Bridgeport, Conn.; Manheim, Pa.; No. Charleston, S.C.; Passaic, N.J.; Neenah, Wis.; Crawfordsville, Ind.; Peterborough, Ontario, Canada

RAYBESTOS-MANHATTAN, INC., Engineered Plastics • Asbestos Textiles • Mechanical Packings • Industrial Rubber • Sintered Metal Products • Rubber Covered Equipment
Abrasive and Diamond Wheels • Brake Linings • Brake Blocks • Clutch Facings • Laundry Pads and Covers • Industrial Adhesives • Bowling Balls

CIRCLE 19 ON READER-SERVICE CARD FOR MORE INFORMATION

Germanium

GERMANIUM power rectifiers, at a cost competitive with dry rectifiers commonly used in TV receivers, offer a practical means of improving reliability of TV power supplies. The low cost of these rectifiers also makes them desirable for other power supply circuits.

Specially developed and designed for television receiver use by General Electric, Semiconductor Products, Syracuse, N.Y., the rectifier should outlast the TV set. At the present time, approximately 20 per cent of all television problems result from rectifier failure. Unlike selenium rectifiers, no derating is necessary because of aging effects. Germanium allows full rated performance over the entire life of the rectifier. The very low forward voltage drop provides a higher d-c output than any other type of rectifier. Output from a 1N575 germanium rectifier is compared with that from a typical selenium rectifier in the accompanying graph.

In keeping with automatic assembly trends, the rectifier, with its heat sink, has a mechanical "snap-in" type construction. Maximum ambient temperature is 55 C.

The three rectifiers now available are RETM type designated 1N573, 1N575 and 1N581. The 1N573 is a half wave rectifier capable of 250 ma d-c output. The 1N575 is also a half wave rectifier but is designed for 350 ma d-c output. Type 1N581 consists of two germanium rectifiers connected in voltage doubler configuration and has a d-c output rating of 250 ma.

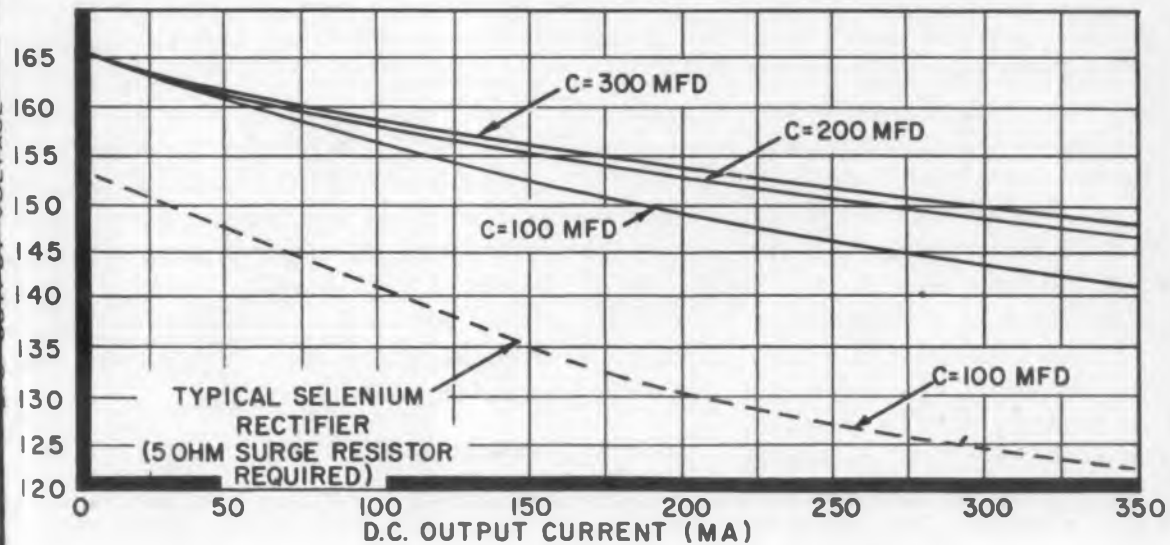
Rectifier for TV



Germanium rectifier mounted on "snap-in" heat sink assembly. Photo is approximately twice actual size.

Full load voltage drop for the 1N575 is 0.15 v maximum; for the 1N575, 0.30 v, and for the 1N581 0.15 v each section. Maximum peak inverse voltage rating for the three rectifier types is 380 v. Recommended load capacitor for all three types is 100 to 300 μ fd.

For further information on this germanium rectifier, fill out the Reader's Service Card and circle 20.



TYPICAL VOLTAGE REGULATION CURVES
IN575 GERMANIUM RECTIFIER
HALF WAVE - CAPACITIVE LOAD

military test equipment



TS-419
SIGNAL
GENERATOR

900 to 2100 mc

AN/USM-26
FREQUENCY
COUNTER

10 cps to 220 mc



FREQUENCY
METER

TS-186D/UP

100 to 10,000 mc

northeastern engineering

Manchester

New Hampshire

CIRCLE 21 ON READER-SERVICE CARD FOR MORE INFORMATION

Vibration Tube Testing

Lewis B. Martin

Project Engineer
Receiving and Cathode Ray Tube Operations
Raytheon Manufacturing Company
Newton, Mass.

THE study and treatment of microphonic noise in subminiature receiving tubes requires quite specialized testing techniques, both in simulating expected mechanical vibration environment and in observing the resulting effects on electronic behavior of the tube. As in all phases of electronic development, the amount of engineering time and cost involved depends very much on the effectiveness of the test methods and equipment. This article describes the methods that were used in a specialized program of microphonics study in which it was particularly necessary to develop vibration test methods which were accurate and fast.

Four Steps in Microphonic Tests

There are generally four basic steps in reducing tube microphonics in vibration testing:

1. Create the mechanical vibration. Apply external vibration forces which represent possible external excitation in the critical audio range from 100 to 10,000 cps.
2. Observe microphonics during vibration. Determine accurately the magnitude of tube noise voltage and the corresponding exciting frequencies for all mechanical resonances occurring in the tube.
3. Locate each source of tube resonance. Filament, anode, grid side rods, and other components may be producing one or more resonant peaks.
4. Reduce the effects of resonance. Mechanical changes in the tube design can either raise the reson-

ant frequency of a component above the audio range or damp the resonant magnitude.

Usual practices for locating and reducing tube resonances in Steps 3 and 4 will be briefly summarized later in the article. The same techniques are used no matter how vibration is created or how the noise is observed in Steps 1 and 2.

Creating the Mechanical Vibration

In the series of tests described herein, mechanical vibrations were created with an electrodynamic vibration exciter, in which the frequency and acceleration of specimen motion were controlled at the power source by varying the input current to an exciter driver coil. Three power sources were used; (1) a manually-controlled single-frequency source; (2) a random-noise source; and (3) an analyzer-controlled swept-frequency source. The test equipment (Fig. 1) includes all the elements required to create vibration and observe tube noise in using each of the three sources.

Tube specimens were mounted in a rapid-loading tube carriage device on the table of the exciter (closeup in Fig. 2). The Model C7 electrodynamic vibration exciter used was made by the MB Manufacturing Company, New Haven, Conn., and developed by MB in cooperation with Raytheon and the Diamond Ordnance Fuze Laboratories, Washington, D. C. The manufacturer rates the exciter for a continuous-duty force output of 1.20 lbs, a total displacement of 0.025 in., and less than 5% distortion of table accelera-

tion waveform in the test frequency range from 100 to 10,000 cps.

In Fig. 3, an operator has placed a tube specimen in the test fixture and is sliding it into position on the exciter in preparation for a vibration test.

With the manually-controlled single-frequency source, the driver coil of the vibration exciter was energized with the sinusoidal output of an audio signal generator (Fig. 1). The random-noise source was a gas-tube generator, with a bandwidth maintained between 100 and 10,000 cps. A high-gain amplifier on the output of the random-noise generator provided sufficient current in the driver coil to develop an average table acceleration of 10 g. With the analyzer-controlled swept-frequency source, an audio spectrum analyzer (left in Fig. 2) provided a sinusoidal swept-frequency output synchronized with the response frequency of the trace on the analyzer's oscillograph. As the analyzer swept the test frequency range from 40 to 10,000 cps, the specimen tube under test was vibrated at any instant by only one frequency of sinusoidal vibration rather than by a random band as with the random-noise source.

Observing the Electrical Noise

The occurrence of microphonics during the test was usually observed on the oscillograph of the audio spectrum analyzer. The vertical position of the trace represented the instantaneous magnitude of plate noise. As shown in Fig. 4, the face of the oscillograph

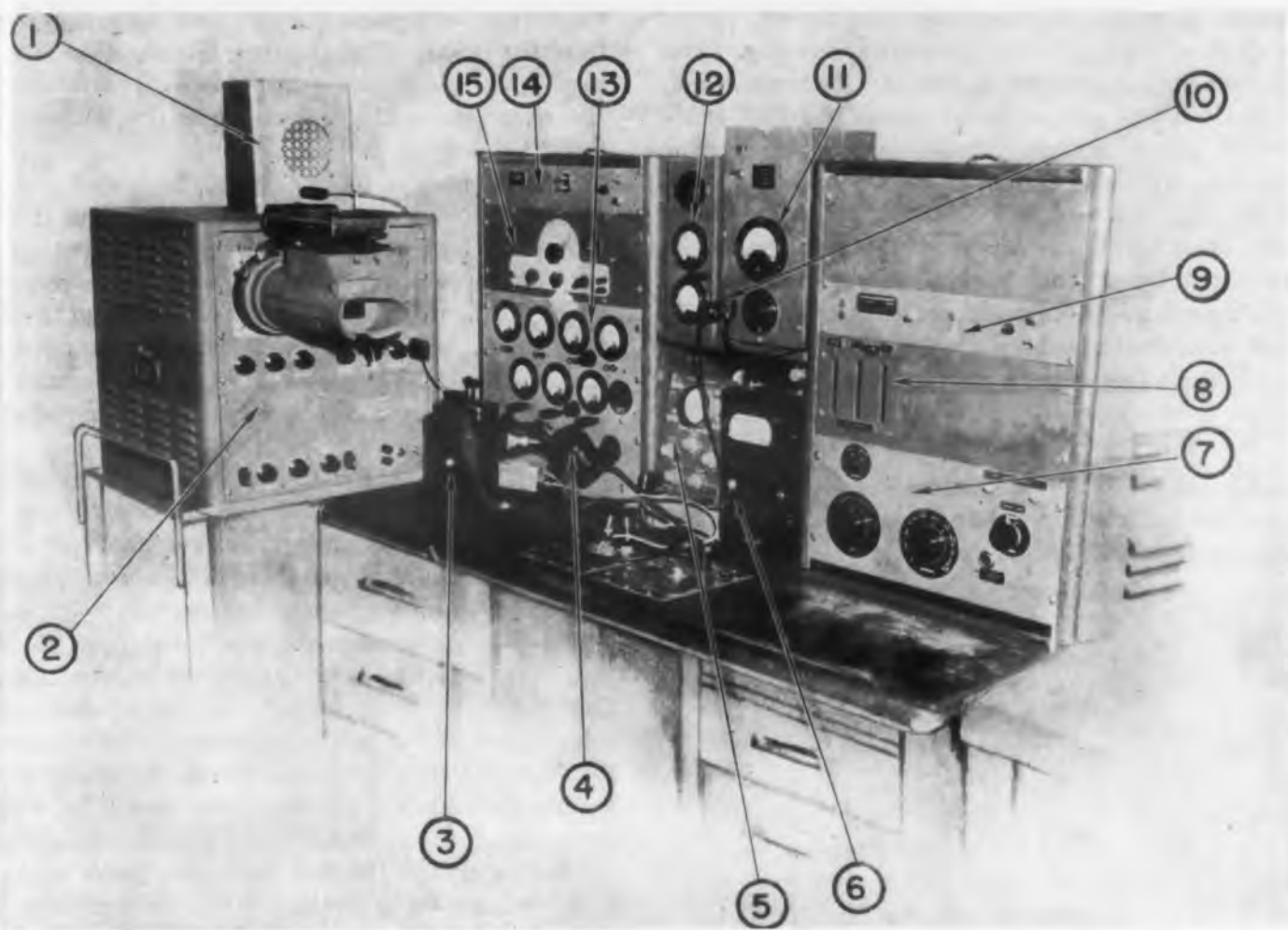


Fig. 1. Tube vibration testing facilities at Raytheon. Keyed items are: (1) speaker for listening to tube noises; (2) audio spectrum analyzer with camera; (3) vibrator; (4) tube under test, circuit, and special noise-free socket; (5) oscilloscope for observing tube instantaneous noise; (6) general-purpose a-c vtvm; (7) control panel, including built-in calibration signals; (8) impulse counters to record occurrence of noise peaks above preset levels; (9) high-gain amplifier for noise signal; (10) vibrator voice-coil current; (11) rms thermal meter for measuring tube noise level; (12) vibrator field supply and control; (13) power supplies for tube under test; (14) random noise source; (15) audio signal generator for driving vibrator with sine wave.



Fig. 2. Closeup of the vibration exciter shows the tube envelope secured in a block on the exciter table.



Fig. 3. An operator is sliding a subminiature tube into the exciter block in preparation for a vibration test. Tube leads are held in a clamping device which connects the tube to its operating circuit during test.

was calibrated linearly on the ordinate in millivolts rms and logarithmically on the abscissa in cycles from 40 to 20,000 cps. The Panoramic spectrum analyzer (Fig. 1) can sweep the frequency range in one second. With a long-persistence oscillograph screen, a plot of tube noise as a function of sweep frequency provided a graphic record of the microphonics behavior of the tube under test.

The test facility shown in Fig. 1 also included other means for finding resonances. A speaker was provided (upper left) to permit the test engineer to listen for tube rattles in the low-frequency range. A standard oscilloscope indicated the instantaneous noise output of the specimen, an rms thermal meter measured tube noise level, and impulse counters were available to record noise peaks above pre-set levels.

Manually-Controlled Single-Frequency Source

The manually-controlled single-frequency source is the slowest and most laborious of the three methods described, but it is most useful in sweeping very narrow frequency ranges and in studying vibration responses very near known resonant peaks. Manual control of the signal generator is common practice in studying microphonics of receiving tubes and any other mechanical and electronic devices in which neither the frequency range nor the number of specimens tested are as large as in the studies performed here.

The plate noise output of a tube specimen is most frequently detected in manual operation as an instantaneous trace on the standard oscilloscope or, if the shape of a resonant peak must be studied, on the calibrated oscillograph of a spectrum analyzer.

Random-Noise Source

While all existing mechanical resonances in a tube are excited simultaneously with a random-noise source, each is easily distinguished on the oscillograph of a spectrum analyzer. A random-noise source permits a much faster test than the manually-controlled single-frequency source and is therefore preferred wherever possible.

It is possible that an oscillograph trace may be too fuzzy for proper interpretation. Because the energy input from the random-noise source is not constant at any given frequency in the sweep range, the traces produced in successive sweeps are not identical. The amplitude of a particular resonant peak will be different on successive sweeps (as the energy input in the vicinity of frequency changes). In such cases, it is necessary to average out the observed peak magnitudes in order to determine noise level. As shown in Fig. 4, the random-noise source used in the tests described here resulted in a good deal of low-magnitude fuzz in the vicinity of resonances and particularly in the "rattle" region below 100 cps. For this reason, manually-controlled single-frequency testing was frequently used for closer investigation of resonances detected in random-noise tests.

Analyzer-Controlled Swept-Frequency Source

Because it retains the advantages and avoids the disadvantages of a random-noise source, the analyzer-controlled swept-frequency source was extensively used in this program. In such a test, tube resonances occur sequentially rather than simultaneously, as both the table motion of the vibration exciter and the analyzer trace sweep in synchronization from 40 to 10,000 cps. Since the pattern of energy input to the tube specimen is identical throughout each one-second sweep of the analyzer, the traces overlap each other with the analyzer-controlled swept-frequency source. A sharp and steady picture is then produced, with each resonance represented by only one trace peak.

There are commercial spectrum analyzers available which are capable of sweep times as high as three

minutes. However, it was found that the one-second sweep time obtained with the analyzer in Fig. 1 was sufficient for the program described. Of course, it may be possible that a one-second sweep duration is too short to permit complete build-up of resonances at lower frequencies in certain cases. A sweep that is too fast may be observed as a cluster of several resonant peaks of reduced amplitude at various frequencies above and below the actual resonant peak. These peaks represent partial build-ups to resonance of different degrees. In such rare cases, the manually-controlled single-frequency source may be used.

Locating the Sources of Tube Microphonics

It is often possible to determine the sources of tube resonances simply by interpreting an oscillograph trace on a spectrum analyzer in terms of relative

magnitude, sharpness (or Q), and frequency of the resonant peaks. When further investigation is necessary, a damping probe may be used with an open specimen to isolate resonating tube elements, as further described below.

In filament-type tubes (Fig. 5) the major and most obvious resonance is usually in the filament. It is distinguished by a comparatively large amplitude and a very sharp resonant peak (high Q). The distinctive high Q of filament resonance may also be detected by tapping the tube lightly with a mallet and listening for a high ring. In a cathode-type subminiature tube (Fig. 6), there is no such outstanding source of resonance as the filament.

Other than in the filament, mechanical resonances are most frequently found in grid side rods and in the anode or anode supports. The resonant frequencies of the grid winding wires are well above the range of interest in microphonics studies.

Non-filament resonances usually can only be definitely pinpointed by removing the tube envelope and applying a damping probe. The open subminiature tube is operated as a condenser microphone in such a test, with a voltage placed between two electrodes at a time through a very high resistance. The voltage across the load resistance is then proportional to the relative motion of the two electrodes under study.

In the Raytheon tests, the damping probe was pressed against a particular tube component and the trace observed to determine whether the resonant peak had been lost, reduced, or shifted to another frequency. If so, it was evident that the component being damped was the cause of, or was contributing to, the resonant condition. In investigating anode resonance, it may become necessary to apply the damping probe at a number of points on the surface in order to detect local modes of vibration.

Resonance occurring in the grid side rods is not usually due to flexing of the rods, but rather motion of the entire rod, in the support holes of the two mica spacers. The nature of this type of resonance is often that of a rattle, having a low Q and low frequency (usually from 100 to 3000 cps).

It is possible to calculate roughly the approximate resonant frequency of some modes of grid side rod vibration, knowing the material and dimensions. However, because of the complex nature of resonance in the plate, it has been found that the damping probe technique is the only practicable approach.

Typical Traces in Vibration Studies

In Fig. 4a and Fig. 4b, two specimens of a filament-type tube each show extreme microphonics at about 5000 cps. These noise peaks were caused by resonance of filament strands. Apart from that one response, it is evident from the graphs that one specimen was much more microphonic than the other.

The traces in Fig. 4c and Fig. 4d represent tests made on two cathode-type triodes. The tube in Fig. 4c was designed with only normal emphasis on low

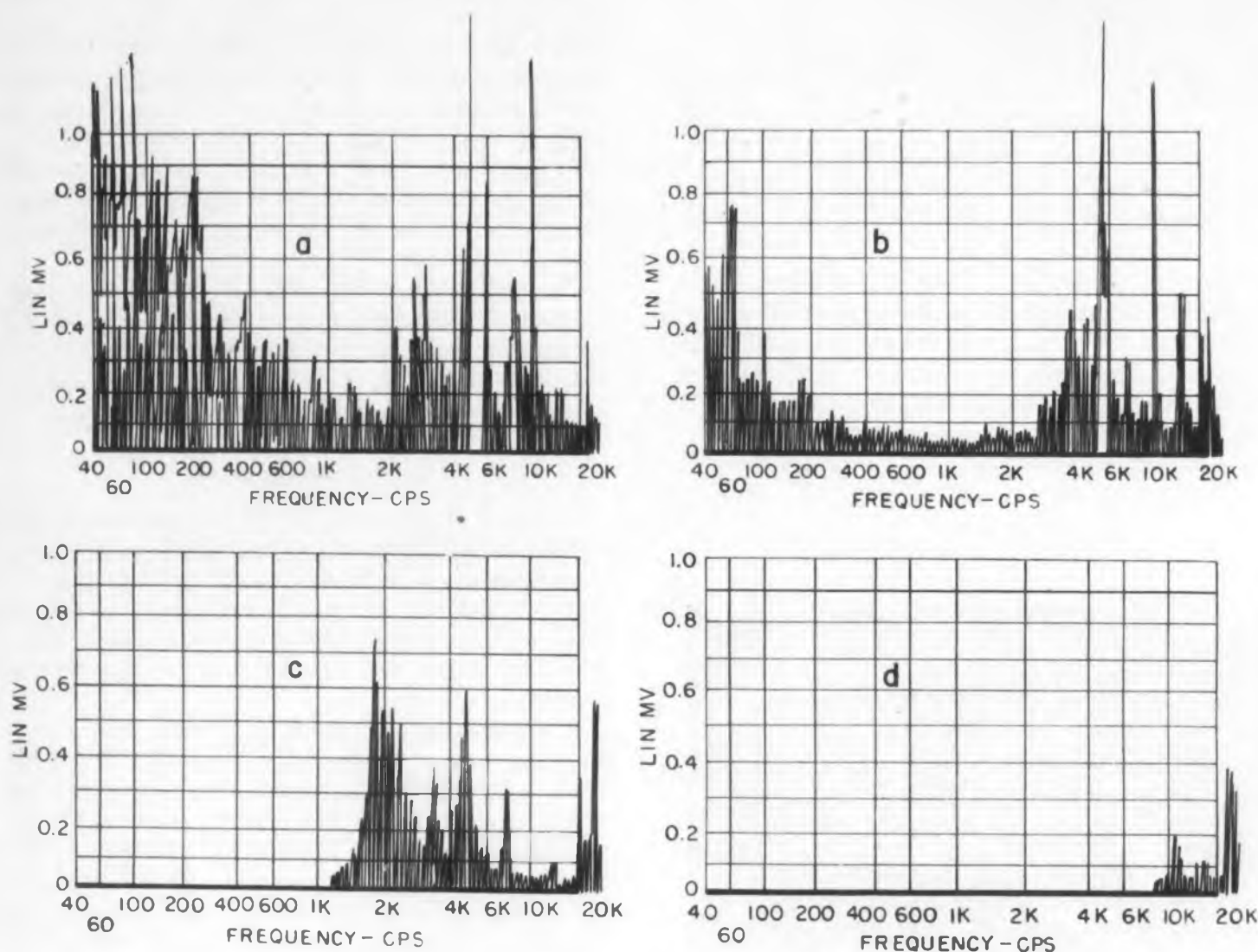


Fig. 4. Tube noise spectrum curves obtained with the test setup in Fig. 1. Tests on two samples of a filament-type tube are shown at (a) and (b). Note the improvement at (c) for a cathode-type tube where normal attention was given to microphonics. The still improved noise factor at (d) is for the specially developed low-microphonic Raytheon

tube, Type CK6533. The ordinate is calibrated linearly at 5 mv full scale in each test. A random-noise source was used to produce a constant acceleration level of 10 g in a frequency band from 100 to 10,000 cps. The resonance peaks which rise above the calibrated area have gone off the oscillograph screen and are actually much higher.

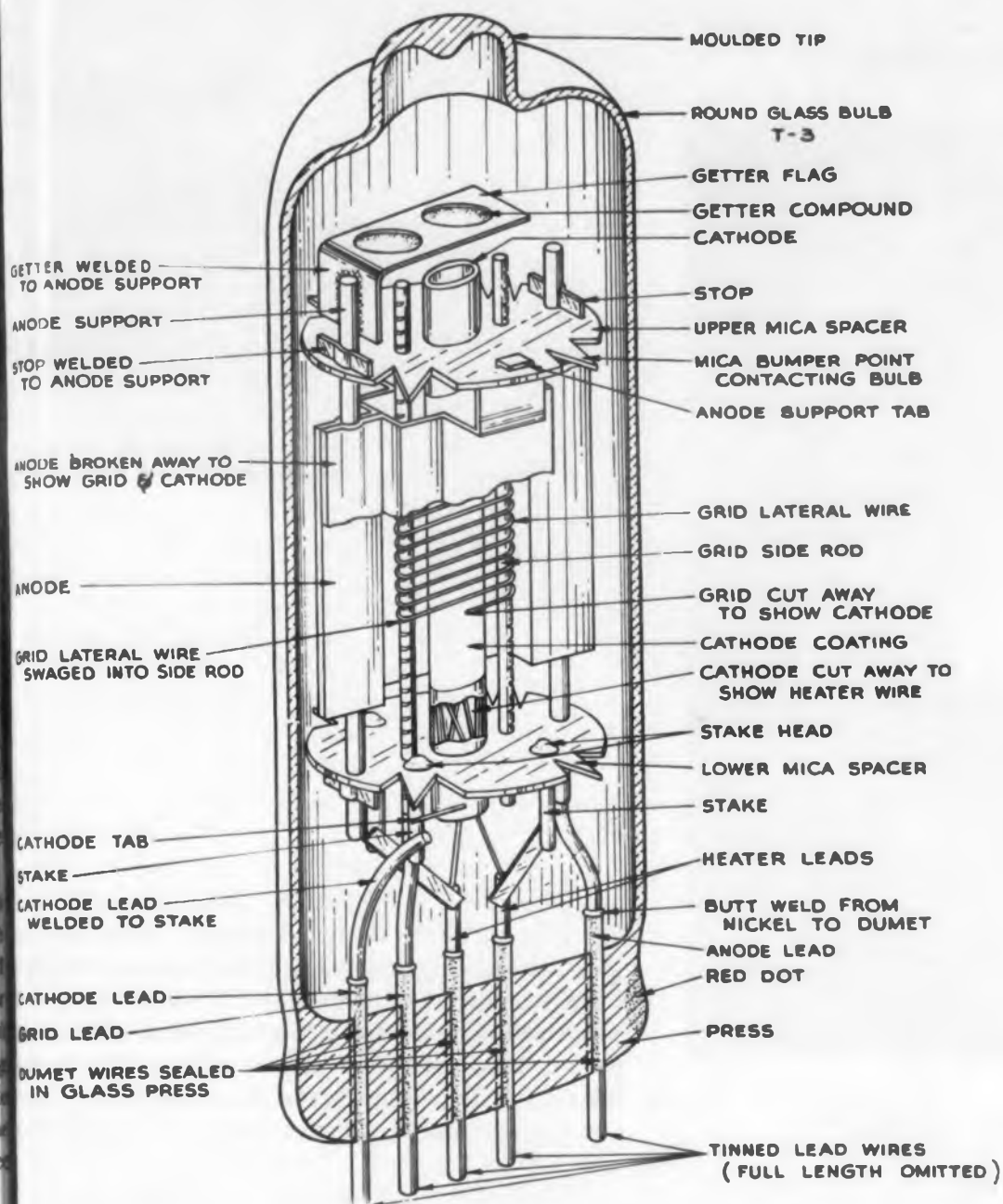


Fig. 5. Cross-section of Raytheon's filament-type CK5672 flat hearing aid tube. The major source of microphonics is resonance of the filament strand between the upper and lower mica spacers. Motion of the grid side rods and resonances in the plate structure may also produce plate noise.

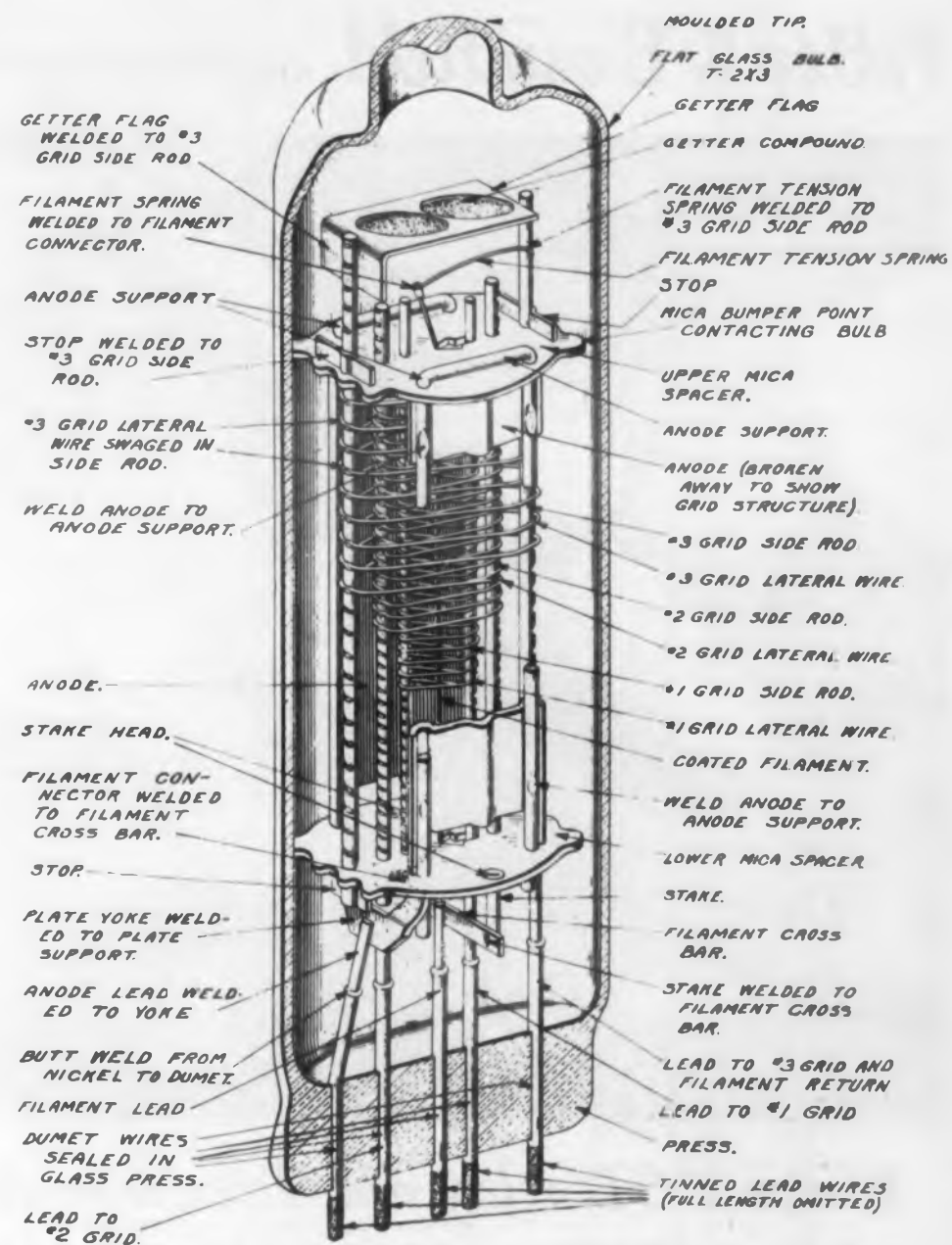


Fig. 6. Cross-section of Raytheon's cathode-type CK5703 subminiature triode. Resonances may occur in the grid side rods or plate structure. Cathode-type tubes inherently exhibit lower microphonics than the filament-type (see Fig. 4) because filament resonance is not present.

microphonics. Note the successive resonant peaks at about 2000, 3000, 5000 and 7500 cps exciting frequencies. The CK6533 tube in Fig. 4d, on the other hand, has been developed by Raytheon for exceptionally low microphonics. With the vertical scale calibrated linearly at 5.0 millivolts full scale throughout the tests recorded in Fig. 4, the relative superiority of the CK6533 is evident.

Eliminating Excessive Tube Resonances

There are two possible approaches for eliminating undesirable resonances. The natural frequency of the tube component may be raised above the audio range or the peak amplitude may be reduced by lowering the Q.

Since it is not practical in most applications to attempt to damp the filament strand in a filament-type receiving tube, the natural frequency of the filament

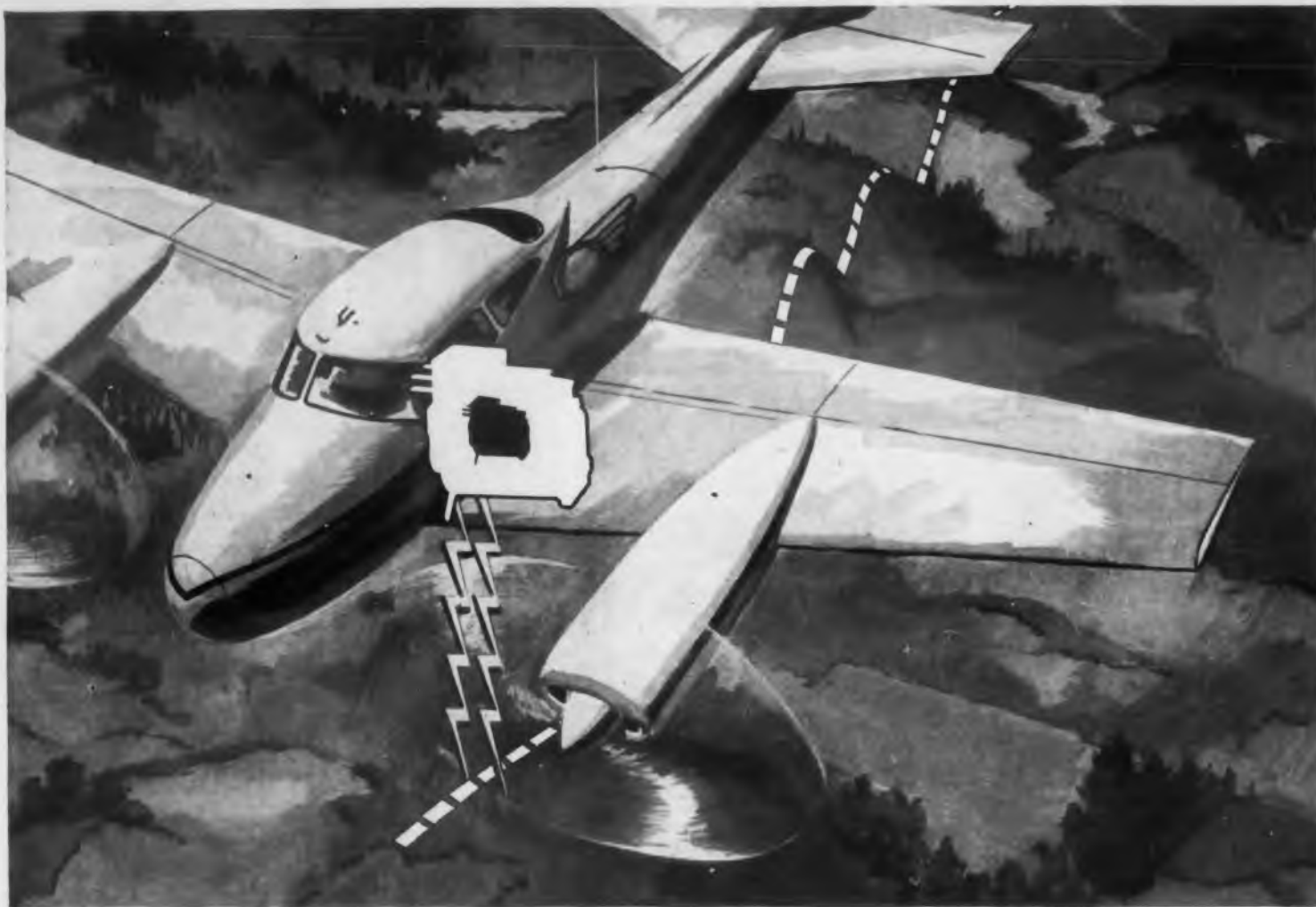
is always designed to be as high as possible, consistent with burnout life. In Fig. 5, the filament is stretched tightly between the filament cross bar under the lower mica spacer and the filament tension spring above the upper mica spacer. The natural frequency of the filament strand between these two points is raised by tightening the strand.

The filament is tightened by using a stronger filament tension spring, which may be a cantilever type (as in Fig. 5) or a helical coil type. In the last 10 years, receiving-tube manufacturers have changed from oxide-coated nickel filaments to oxide-coated tungsten filaments on most tubes because tungsten wire can be stretched more tightly without breaking. Because the filaments may therefore be more taut, tungsten-filament tubes generally have much lower microphonics. However, certain low-cost miniature tubes still include nickel filaments because they are

more efficient emitters, and yet adequate in microphonics.

Grid noise is usually due to vibratory motion of the entire grid side rod rather than resonance; therefore, microphonic output that is traced to the grid side rods may be reduced by anchoring the grid side rod to the upper and lower mica spacers more firmly. This may be accomplished by special straps, welded to the grid and firmly anchored in the spacer by suitable design. In designing anode structure to reduce plate microphonics, the requirement again is to keep the natural frequencies of the anode high enough to avoid the signal frequency range used in the application. To raise its natural frequency, an anode can be made stiffer either by reducing its length or by changing its shape in some manner. The amplitude of resonant peaks in an anode are most effectively damped by proper design of the anode supports and mica spacers.

Potter & Brumfield engineering is in this picture



Which P&B relay did Television Associates specify
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MH Series



MB Series



MC Series

Surveys for pipe lines, electric transmission routes and microwave paths are now made from the air, by radar. Television Associates of Indiana, Inc. developed this speedy new technique—and the equipment—which provides clients with detailed profiles of the terrain to be crossed.

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ENGINEERING DATA

SERIES: MH Miniature Telephone.

CONTACTS: Up to 18 springs, maximum 9 in each stack, forms A, B, C, D, E, X and Y. AC relays are limited to a maximum of 2 poles. Various contact material available.

VOLTAGE RANGE: DC-.05 to 110 V.—AC-6 to 230 V. 60 cycle.

COIL RESISTANCE: 22,000 ohms maximum.

TEMPERATURE RANGE: High temperature range (DC) -55°C . to $+135^{\circ}\text{C}$.
 Standard DC -55°C . to $+85^{\circ}\text{C}$.
 Standard AC -45°C . to $+40^{\circ}\text{C}$.

Other temperature ranges available to specification.

TERMINALS: Standard pierced solder lug holes will take (2) No. 18 hook-up wires. Adaptable for printed circuits.

ENCLOSURES: Dust cover plus wide range of hermetically sealed covers and types of terminations.

DIMENSIONS: 1-9/16" L. x 25/32" W. x 1 3/4" H. (4c Relay).

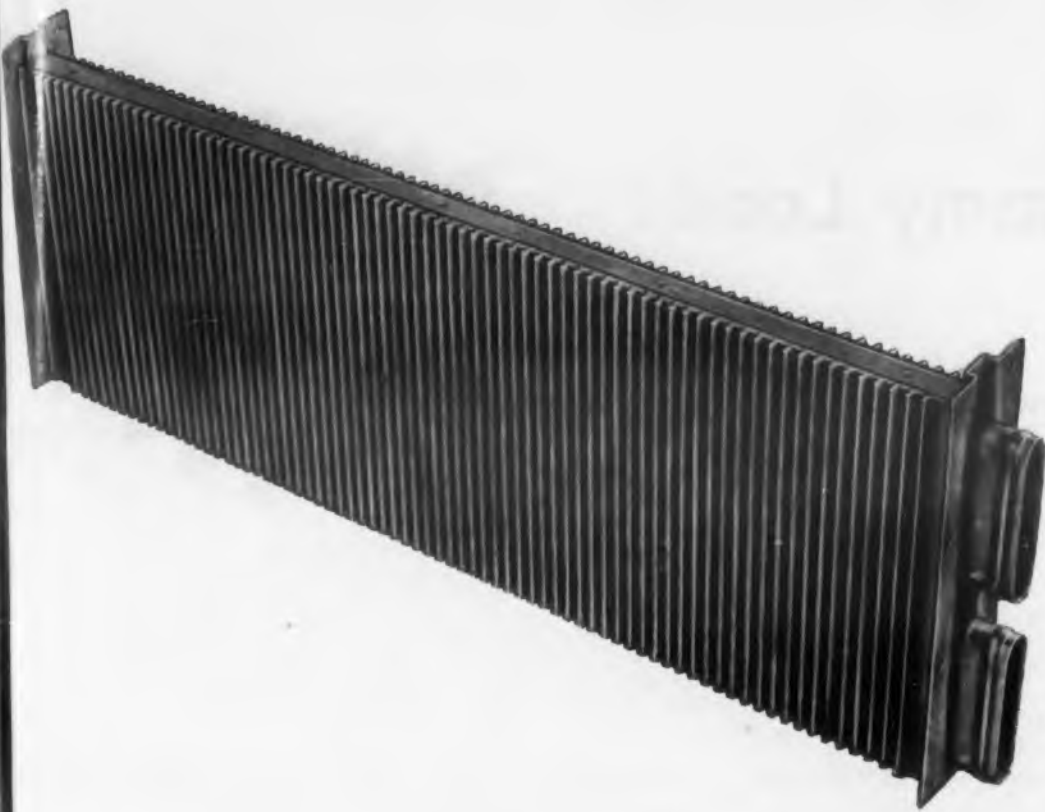
Printed Circuit Heat Exchanger

THIS specially designed air-flow heat transfer unit provides an efficient means for cooling a number of printed wiring boards mounted in close proximity. The heat exchanger, built into the case shown, has accurately machined grooves to correspond with similar grooves in the case. Thus accurate alignment of the printed wiring assemblies is assured.

Although this air-flow heat exchanger was developed specifically for an application at North American Aviation, Inc., it is being made available commercially by United Aircraft Products, Inc., 1116 Bolander Avenue, Dayton 1, Ohio. It can be furnished, not only in the size standardized by NAA but in accordance with a designer's specific requirements.

Termed a "cold-plate heat exchanger," the unit shown has a dry weight of 2-1/2 lbs and is built into a case approx. 18 x 9 x 6 in. It meets requirements of MIL-E-5400 and MIL-E-5272. The grooves, which receive the printed wiring boards, are machined spaced 0.062 in. ± 0.005 -0.000 in. tolerance. Air flow required is 2 lb per min at a pressure of 1 lb per sq ft. Maximum airside mean temperature difference is 7 F; minimum heat removal capacity at 150 w is 8-1/2 btu per min. It will perform at an ambient temperature up to 160 F at altitudes of 50,000 ft and above.

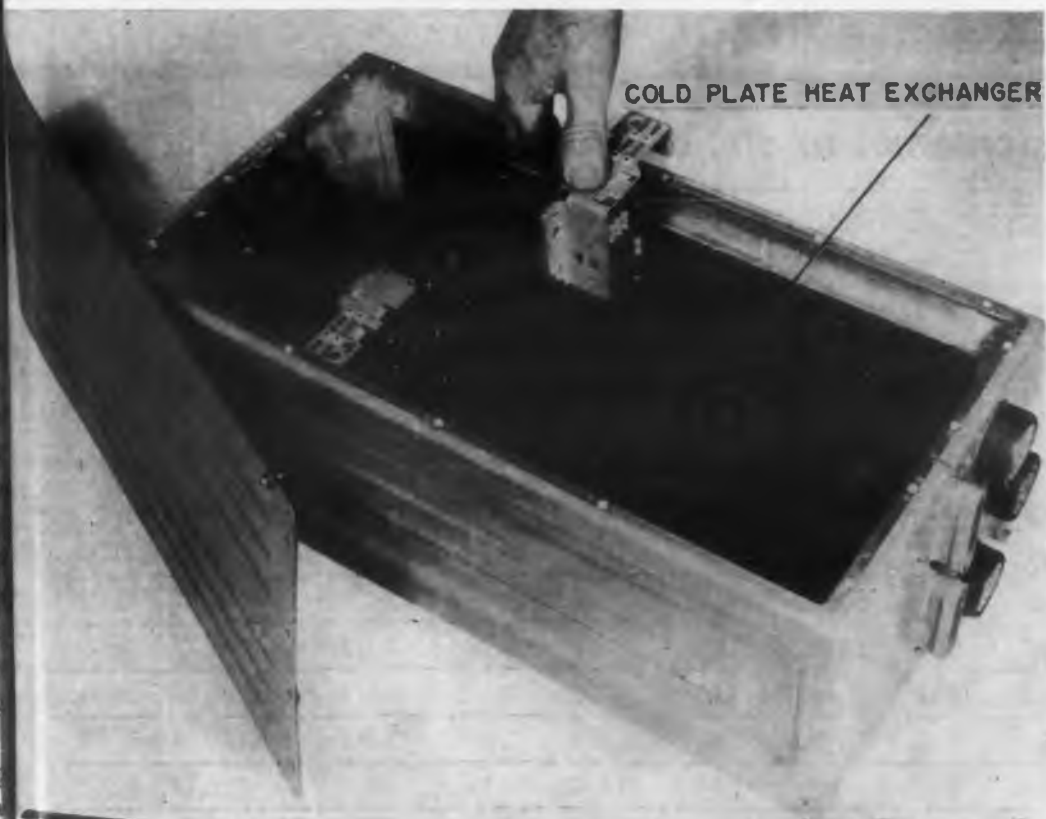
The cold-plate assembly is of aluminum, die cast and brazed; then black anodized after assembly and machining. The printed circuit shells may be installed in solid banks along either or both sides of the cold plate exchanger with minimum clearance.



space between shells, or they may be inserted at random within the case.

In addition to providing a compact printed circuit assembly, efficiently cooled, this arrangement facilitates maintenance of the printed circuit boards. For additional information about this product, fill out the Reader's Service Card and circle No. 23.

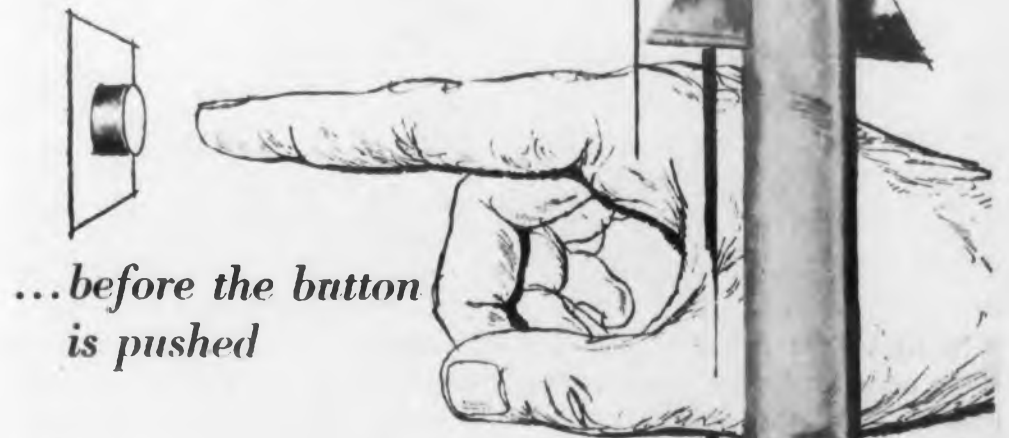
COLD PLATE HEAT EXCHANGER



Printed wiring housing designed for efficient cooling using UAP cold-plate heat exchanger. Design is one developed by Autonetics Div. of North American Aviation, Inc.

Farnsworth

HAS THE ANSWER



...before the button is pushed

Four... three... two... one... Fire! a tense finger pushes a button.

WHOOSH... and a fiery missile unerringly heads for its target. It worked!

Of course, it *had* to work. In atomic warfare there's no second chance. Farnsworth, a division of International Telephone and Telegraph Corporation, developed the uncanny electronic test equipment that knows—before the button is pushed. This not only avoids costly mis-fires or missed targets—it actually safeguards our very lives.

This is another answer supplied by Farnsworth Electronics Company, where scientists and engineers of many related skills are applying the vast experience and facilities of IT&T to solve many complex problems in the fields of electronics and communications for industry and the military.

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CAREER OPPORTUNITIES: There are important new openings on our professional staff for graduate engineers and scientists. Write for complete information. Confidential.

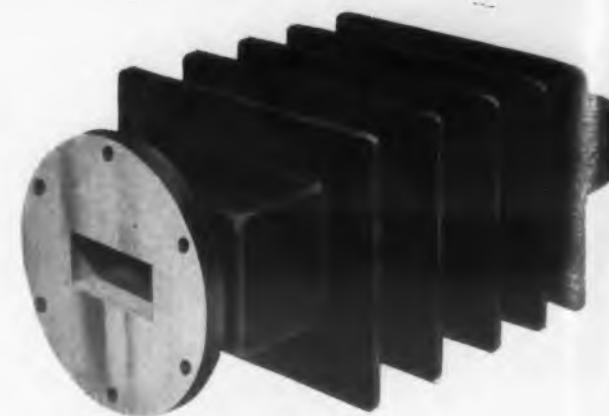


FARNSWORTH ELECTRONICS COMPANY, Fort Wayne 1, Indiana
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CIRCLE 24 ON READER-SERVICE CARD FOR MORE INFORMATION

Military Standardization of Dummy Loads

Leon Field and Arthur C. Metzger

Frankford Arsenal



INCREASING power output of radar systems and the need for lighter, more rugged components for military applications, have obsoleted the old lossy wall-high type dummy loads. Dummy loads made of, for example, Portland cement and graphite as the lossy material have too many thermal, electrical, and mechanical disadvantages. Each load has a limited microwave frequency range over which it provides a satisfactory match to the waveguide. In the past, each time a requirement for dummy loads came up, a special design was worked up. No standardization, coupled with the fact that the loads were not very

suitable, made the need for improvement obvious. This article is a report on the process of establishing a military standard.

Problems

Thermal—The basic thermal problem in dummy load design is to adequately transfer the generated heat in the lossy material to the surrounding air. This heat transfer is principally due to convection and conduction. The heat is carried from the lossy material to the metal housing by conduction and to the surrounding air from the housing by convection at tempera-

tures up to approximately 200 C. At higher temperatures, both convection and radiation effect this transfer. The conversion from electrical energy to heat energy is made entirely in the lossy material; therefore, the most efficient transfer of heat would take place if a large temperature differential and a low thermal impedance existed between the lossy material and the ambient air. The lossy material in the older Portland cement type loads have very poor inherent conductivity; this molded material tends to shrink with age and will pull away from the inner surface of the housing, thus introducing air gaps and

MILITARY CHARACTERISTICS OF STANDARDIZED DUMMY LOADS

ANOMENCLATURE	ORD. DRG. NR.	FREQ. RANGE (KMC/S)	MAX. PEAK POWER (MEGAWATTS)	MINIMUM AV. POWER (WATTS)	MAXIMUM VSWR	LENGTH (IN.)	WIDTH (IN.)	HEIGHT (IN.)	APPROX. WEIGHT (LBS.)	WAVEGUIDE AN TYPE	BAND
DA-147/U	C8212205	1.12- 1.70	17.2	8000	1.10	32-71/8	8-7/8	11-1/2	90	RG-103/U	L
DA-145/U	C8212204	2.60- 3.95	3.2	4500	1.10	14	4-7/8	6-3/8	9-1/2	RG-75/U	S
DA-149/U	C8212208	3.95- 5.85	2.0	2000	1.10	9-3/4	3-5/8	4-1/8	5	RG-95/U	H
DA-144/U	C8212207	5.85- 8.20	0.71	1000	1.10	8	3-1/8	3-7/8	3-1/4	RG-106/U	C
DA-148/U	C8212206	7.05-10	0.46	600	1.10	6-3/8	2-1/2	3-1/8	1-3/4	RG-68/U	B
DA-146/U	C8242917	8.2 -12.4	0.29	500	1.10	5-3/4	2-3/4	2-3/4	1-1/2	RG-67/U	X
DA-159/U	C8227529	12.4 -18.0	0.16	250	1.15	4-1/4	2-1/2	2-1/2	1/2	RG-107/U	K
DA-160/U	C8227532	18.0 -26.5	0.125	150	1.15	4-1/4	2-1/4	2-1/4	3/8	RG-121/U	K
DA-158/U	C8227526	26.5 -40.0	0.075	75	1.15	4-3/16	2-3/16	2-3/16	3/8	RG-96/U	K

As a result of a new standardization and simplification program for high-powered dummy loads, the number of government-approved units has been reduced from 54 to 9. The table in the article shows the nine standardized units. A typical unit is illustrated. Despite the desirability of standardization, problems to overcome are many and often apparently insurmountable. We hope this factual success story will give encouragement to others concerned with establishing standards.

Typical very high power dummy load. The lossy material is a ceramic substance rather than one composed of the more conventional plaster of Paris or graphite in sand. The ceramic approach offers the decided advantages of no moisture absorption and no deleterious effects due to high temperature. There is no binder to disintegrate and temperatures of 3000 F will not destroy the lossy material of the load.

decreasing heat transfer.

Electrical—The older type loads also have a tendency to create voltage breakdown across the waveguide as a result of either chemical changes in the lossy material or by the inherent nature of the material. The compounds themselves will normally have exceedingly high temperature stability; but secondary reactions, such as loss of water of crystallization or loss of absorbed moisture, cause high humidity conditions within the waveguide, influencing voltage breakdown. If extremely high temperatures are placed on certain loading materials, bonding agents will be destroyed and resistive qualities will disappear.

Mechanical—Another problem encountered is the appearance of surface imperfections in the lossy material as a result of forming. These imperfections in the dissipative material may cause field concentrations and eventual breakdown.

Facing the Problem

The military had long been aware of these deficiencies in existing loads. Several programs had been initiated for the development of a high-power dummy load which was compact, lightweight, resistant to moisture absorption, and which would last for the life of the associated transmitting equipment. During the period from January 1954 to January 1955, the Bureau of Ships surveyed the dummy load field and issued a report whose purpose was:

- To consolidate all the information available concerning waveguide and coaxial dummy loads which have been designed for and used by the three Services. This information was to be put into a form which could be made available to all interested personnel for use as a guide in the procurement of dummy loads for new equipment and for replacement purposes.
- To establish a list of dummy loads which, depending upon electrical and mechanical characteristics,

ANNOUNCING THE 104 MEMO-SCOPE



The MEMO-SCOPE Model 104 is a new memory oscilloscope with a selection of 5 plug-in preamplifiers that will satisfy the most critical production, test and laboratory requirements. MEMO-SCOPE incorporates the famous Hughes-developed Memotron direct-display storage tube that captures and retains any number of traces indefinitely at a constant intensity until intentionally erased. Traces are readily visible in a brightly-lighted room, and may be easily photographed for file records.

MEMO-SCOPE 104 SPECIFICATIONS

ERASURE: internal waveform generator triggered by front panel push button or by external switch.

DC BLANKING: CRT grid direct coupled to external or internal blanking gate allows beam to be turned off except during sweep and insures constant sweep-time intensity over any sweep duration.

DEFLECTION PLATES: available at rear terminal strip for direct connection.

MAIN VERTICAL DEFLECTION AMPLIFIER: frequency response of DC to 700 kilocycles within 3db. Rise Time of 1/2 microsecond.

TRIGGERED LINEAR SWEEP: range of 10 μ sec to 10 seconds per division, adjustable continuously or in 18 calibrated steps. Trigger: vertical amplifier signal, AC line or external pulse, either polarity, DC or AC coupled. Minimum external trigger amplitude: 0.1 volt. Neon ready lamp indicates sweep is at left side of screen, ready for trigger.

AMPLITUDE CALIBRATOR: available at front panel terminal—one kilocycle square wave with peak-to-peak amplitude of 0.01, 0.1, 1.0 or 10 volts, within 3%.

BEAM POSITION INDICATORS are four neon lamps showing position of writing beam when not on screen.

ILLUMINATED GRATICULE: scale calibrated in 1/3" squares in 10 X 10 array.

RACK MOUNTING: Model 104 available on standard 14" X 19" relay rack panel.

DIMENSIONS: 13" wide, 14" high, 20" deep. Etched circuit epon-glass electrical chassis. Hinged camera mount optional.

OPTIONAL PLUG-IN PREAMPLIFIERS INCREASE FLEXIBILITY

(All units with frequency response from DC to 250 kilocycles down 3db.)

WB/4. Wide Band, DC.

WB/SE/5. Wide Band, DC plus Speed Enhancement.

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HS/SE/7. High Writing Speed, High Sensitivity.

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For additional information or demonstration of the new Model 104 write to HUGHES PRODUCTS
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Model GLH

A rugged magnetically damped instrument with low natural frequencies for low range. High-quantity production assures good price and delivery schedules. Available in ranges from ± 1 G to ± 30 G.



Model DDL

Magnetically damped low-range instrument available in ranges from ± 1 G to ± 30 G. Ultra-sensitive models supplied as low as ± 0.1 G. Certified to MIL-E-5400 and MIL-E-5272A. Especially good in severe shock and vibration applications. An acceleration-sensitive switch version of the DDL is designated as the Model DDS.



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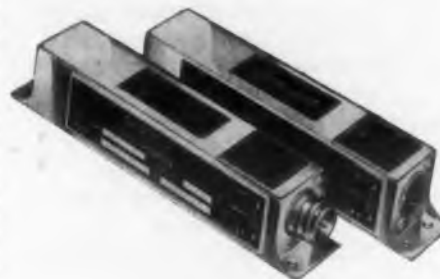
Model GMO

A rugged, miniature, viscous-damped instrument with ranges from ± 2 G to ± 30 G. Unbalanced-range instruments also available. Medium high natural frequencies.



Model GMT

Basically a Model GMO with internal thermostat-operated heater, assuring maximum environmental stability within the instrument. Damping remains constant with change in ambient temperature.



Model GDM

Miniature double-potentiometer instrument capable of sensing lateral acceleration in two mutually perpendicular planes (e.g., pitch and yaw). Ideally suited for missile and high-speed aircraft flight control systems.

NEW! GENISCO ACCELEROMETERS NOW GOLD PLATED FOR GREATER RELIABILITY

CASES GOLD PLATED INSIDE AND OUT—This new trend in instrument plating has two important advantages over tin plating or fusing. Being the least active metal, gold prevents the formation of crystalline "whiskers" inside the case which could reduce performance and even cause malfunction. Gold plating also assures positive protection against corrosion to the exterior of the case and, because of its excellent solderability, makes possible a more reliable hermetic seal. The new gold plating is available on *all* models at *no extra cost*.

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would represent the preferred items. These loads were to be the best available and have general application.

From the approximately one hundred loads tabulated, twenty were selected as preferred types. It was estimated that an equal number of loads had not been tabulated for two reasons. Many loads were designed for a specific purpose or as an integral part of a system and as a result had never been submitted for nomenclature and designation. Also, the nomenclature prefixes for dummy loads had changed over the years and, therefore, prefix letters other than "TS" and "DA" had not been checked in the survey.

This list was presented to the Miscellaneous Test Equipment Working Group of the Joint Test Equipment Subpanel (J/TE) of the Standardization Panel of the Joint Communications Electronics Committee (JCEC) for consideration. In view of the work that was currently being done in this field by the Frankford Arsenal, Ordnance Corps, the J/TE assigned the standardization of dummy loads to this group in January 1956.

History of Frankford's Action

In an attempt to obtain a suitable high-power dummy load during the latter part of 1949 for a particular radar application, Frankford Arsenal was advised by both the Signal Corps and the Air Force that none was available; in fact, one dummy load type tentatively selected as a possible choice was found to be optimistically rated and had to be derated far below the required application. Consequently, Frankford Arsenal contacted various commercial suppliers in order to find a suitable load but met with little success. A development contract (DA-36-038-ORD-15179) was placed with the Bogart Manufacturing Co., Brooklyn, N. Y., for the design of a high power load for a specific fire-control radar application. The specifications for the load included the following:

- 1. Weight**—The load should be lighter than existing loads at specified maximum average power and ambient temperature ratings.
- 2. Size**—The load should be small enough to comfortably fit in a system allowing sufficient room for radiation of heat. (Compactness is necessary for aircraft application or ordnance fire control systems where it is now being considered for use in association with switching devices.)
- 3. Operating temperature**—The load should not exceed 300 C ambient temperature for use with ground systems.
- 4. Power rating**—The maximum average power requirements for classified systems or radar systems presently being conceived are not specifically known. The load should absorb more average power than other loads and still fulfill all other requirements.
- 5. Pressurization**—The load should be capable of being pressurized.
- 6. Voltage Standing Wave Ratio**—The load should maintain a VSWR less than 1.10 over the complete specified frequency range.

7. **Cooling**—The maximum average power ratings are those which produce the specified maximum operating temperature without external cooling (forced air or water).

8. **Flange**—The load shall be terminated in a plain type flange and attached to the system by different adaptors or wave-guide couplers.

This contract was terminated in July 1954 with the satisfactory testing of the sample load at the Bell Telephone Laboratories, Whippany, N.J. The tests proved beyond doubt that this dummy load was capable of absorbing all of the energy that could be emitted from the radar. In fact, the load was successfully tested to a power 30 percent greater than the anticipated output of the system then being produced.

The Bogart Manufacturing Co. developed a new ceramic-type lossy material resulting in a load which is smaller, cheaper and lighter in weight than any heretofore available. Subsequent testing of this dummy load at a Philco Corp. plant and at the Johnsville Naval Air Development Center conclusively proved that the load could easily accommodate the power of existing systems with indication that even higher power systems will be accommodated when they became available.

Frankford Arsenal submitted nine Military Characteristics for a new family of loads based on the Bogart development. This basic group of dummy loads can, with suitable adapters, readily replace many loads, both high and low power, now existing with their unique electrical requirements and mechanical configurations. Under the old concept of dummy load applications, both a high and low power type dummy load were established. It was assumed that weight, size and price differentiation between the two classes of loads would be great. However, the development of this new family of "high power" loads compares favorably in weight, size and cost of the "low power" loads and Frankford Arsenal has recommended that these become Standard for both applications.

Status

Listed are the nine Military Characteristics for the new family of loads submitted to J/TE by Frankford Arsenal. Based on this technical and standardization accomplishment, the Ordnance Corps has requested a subassignment under Federal Supply Classification 6985 for the Dummy Load area. A new specification has been promulgated which incorporates more stringent requirements than presently specified in MIL-D-1954, Dummies, Load, Electrical, Wave-guide. Military standards and associated implementing documents are also being prepared.

The Navy and the Air Force have indicated a keen interest in these basic loads and a program will be instituted to develop adapters to accommodate various flange terminations. It is anticipated that the bulk of the multitudinous load applications presently in use will be obsoleted by this single family of loads effecting a decrease in cost due to central procurement and simplifying the stocking problem.

**for low voltage
power supply...**

SANGAMO Type DCM Electrolytic Capacitors

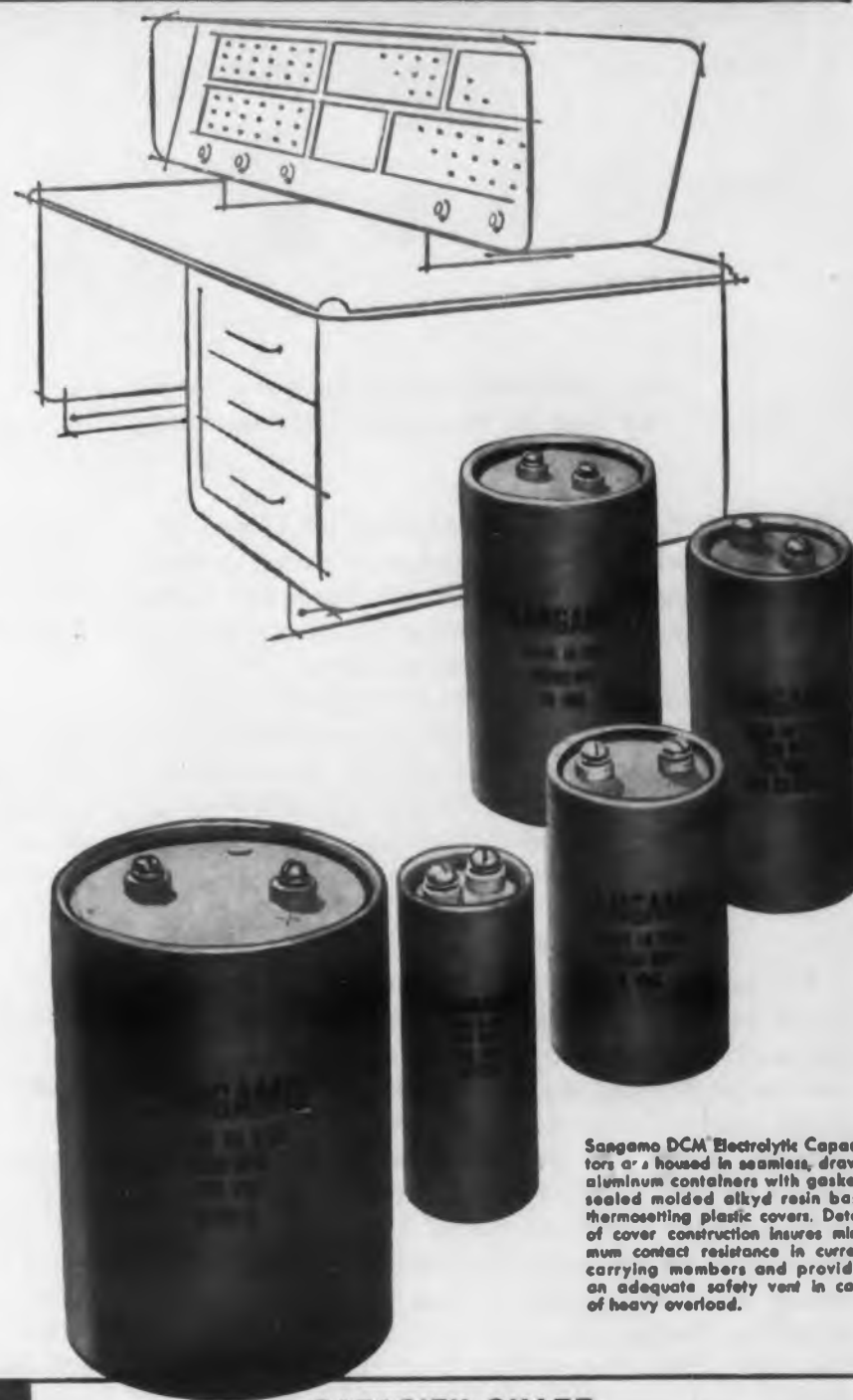
In computers, calculators, electronic controls, and related equipment—wherever *capacity stability with long life* is a must—count on Sangamo Type DCM Electrolytic Capacitors.

They minimize ripple voltage and insure steady, stable DC voltage. They save space by eliminating any need for heavy, bulky choke components with their substantial and often-varying load voltage drops.

Maximum Voltage Rating: 450 VDC

Sangamo DCM Electrolytic Capacitors provide exceptionally low equivalent series resistance . . . assure extremely high capacity for case size in low voltage ranges . . . and are specially designed to permit high ripple current without overheating. They can be supplied in maximum energy content rating of 80-watt seconds in voltage ratings from 15 to 450 VDC. Maximum capacity value of 33,000 mfd. can be supplied at 15 WVDC.

Write to-day for your file copy of Sangamo Engineering Bulletin TS-114.



Sangamo DCM Electrolytic Capacitors are housed in seamless, drawn aluminum containers with gasket-sealed molded alkyl resin base thermosetting plastic covers. Detail of cover construction insures minimum contact resistance in current carrying members and provides an adequate safety vent in case of heavy overload.

CAPACITY CHART

Rated Voltage DC	Surge Voltage	Max. Cap. in 2 1/2 x 4 3/8 Can	Max. Cap. in 2 3/8 x 4 1/2 Can	Max. Cap. in 3 1/8 x 4 1/2 Can
15	20	12,500	20,000	25,000
30	40	9,000	15,000	20,000
50	75	4,800	8,000	10,000
100	125	2,000	3,500	5,000
150	175	1,500	2,500	3,500
200	250	1,000	1,500	2,500
250	300	800	1,250	1,750
300	350	700	1,000	1,500
350	400	600	1,000	1,250
400	475	400	500	1,000
450	525	350	400	800

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SC57-1



Fig. 1. Automatic Interpolation dial in use on PRD Type 504 Heterodyne Frequency Meter.

MEASURING instruments having non-linear characteristics, such as heterodyne frequency meters, have in the past been provided with linear dial scales which require that measurements be determined by making an interpolating computation. The dial described here¹ permits such interpolated measurements to be read directly without computation; the required interpolation being effected automatically by manipulation of the dial. The principle of operation, a discussion of the factors that affect applicability, and design equations are given in this article.

The Problem

The interpolation of readings on non-linear instruments becomes necessary when a single non-linear dial scale which would cover the entire range of the instrument becomes too long to be physically practicable, and a shorter scale must do service for several different portions of the instrument's range. For example, on the TS-186/U Frequency Meter (which is provided with a single turn scale and a turns counter) readings of an unknown frequency are taken by first noting the dial readings at two bracketing crystal-controlled frequencies, *a* and *c*, which are 5 mc apart, then noting the dial reading, *b*, at the unknown frequency and determining the known frequency by making the linear interpolation

$$fx - fa = \frac{fb - fa}{fc - fa} \times 5 \text{ mc},$$

and adding this value to the known frequency measured at *a*. In this way, the same single-turn linear dial scale is made to serve over a hundred different frequency intervals on the instrument, each of which requires a scale of unique length. However, the advantage of being able to use a single short scale in this

manner has the disadvantage of requiring the operator of the instrument to make an interpolation by calculation (or by looking-up recorded results of such interpolation in a book).

Scale Expansion and Compression

It is apparent that this disadvantage can only be overcome if a dial which was effectively extensible or compressible were available, for then the dial could be made to correspond to each different portion of the instrument's range. The dial mechanism incorporated in the PRD Type 504 Heterodyne Frequency Meter (Fig. 1) makes such expansion or contraction of scale length possible. The essential feature of this dial mechanism is a scale of spiral form operating relative to a moveable, rather than fixed index line. When the position of the index line is changed, the dial must be turned by a different amount in order to get the same readings. This, effectively is extension or compression of the dial scale.

In Fig. 2 and 3 is shown how changing the position of the index line effects such a scale expansion. In Fig. 2, the index line is in a radial position; that is, it lies in the same plane as the axis of rotation of the dial, and the dial must be turned through an angle of 260 deg to go from the "0" on the scale (as shown in solid line) to the "5" on the scale (as shown in the dashed line).

In Fig. 3, the index, which is mounted so that it can pivot, has been turned through a small angle, and no longer lies in a radial plane. The result is that the dial must now be turned through an angle of 287 deg to go from "0" to "5". Tilting the index has thus made the dial scale 27 deg or approximately 10 per cent longer. Tilting the index in the opposite direction makes the

Automatic Interpolation with Spiral-Scale Dials

Christian D. Berger*

Polytechnic Research & Development Co., Inc.
Brooklyn, N. Y.

dial scale shorter. The greater the tilt angle of index, the greater the increase or decrease in length.

The reason that tilting the index line, lengthens shortens the dial scale is due to the fact that a point on the scale is at a different distance from center of the dial. If the index is tilted too far, of course, it will no longer intersect the spiral scale. This is the angle of tilt allowable, and consequently, amount of expansion or contraction available is limited.

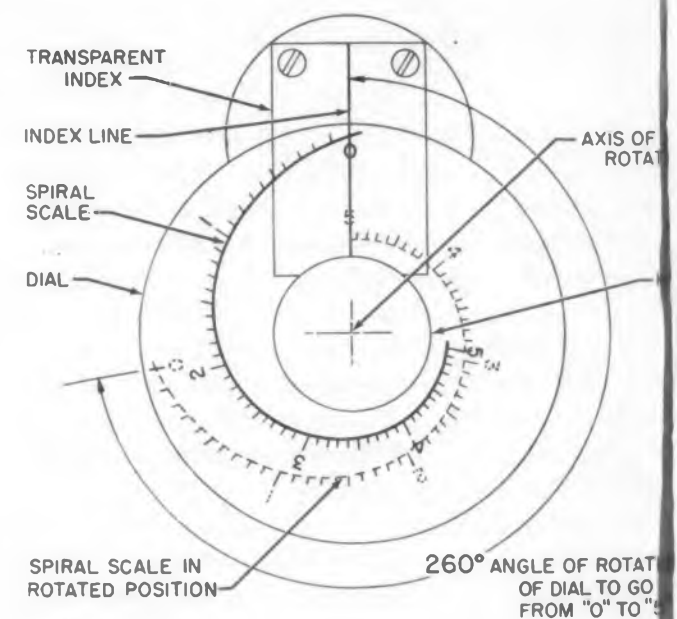


Fig. 2. Angular rotation of dial required to go from 0 to 5, when index line is in radial position.

*Now with The Hoover Company, North Canton, Ohio.
¹Patent pending.

How The Dial Operates

When the non-linearity of an instrument is so great that one spiral scale cannot be expanded or contracted enough to fit all portions of the instrument's range, two or more spirals of different actual length can be used. It is for this reason that the PRD Type 504 Heterodyne Frequency Meter has two spiral scales. The outer spiral is generally used at the low frequencies and the inner spiral at the higher frequencies. The dial mechanism on this meter is operated in the manner shown in Fig. 4 in measuring an unknown frequency. The disk on which the dial scales appear is not fixedly attached to the control shaft but is applied to it by a friction clutch. This permits the dial to be turned around, for zero-setting purposes, while holding the control shaft.

To provide a convenient means for holding the control shaft, a lock is provided which engages the larger knob in back of the dial. The disk is attached fixedly to the shaft, so that by clamping it, the shaft is held. This coarse indication of frequency appears in the rectangular window at the left of the dial. It should be noted that the pivot axis of the index is at the same distance from the dial center of rotation as is the "0" graduation on the spiral scale. This makes it possible to tilt the index to any position without affecting the zero setting of the dial.

Up to this point, the tacit implication has been made that points or graduations on the spiral scale which are equal angular distances apart relative to a dial position of the index will be equal angular distances apart relative to the index in a tilted position. Put it another way, any mark or graduation on the dial, such as the "1" or "2" in Fig. 2, which is $1/5$ or

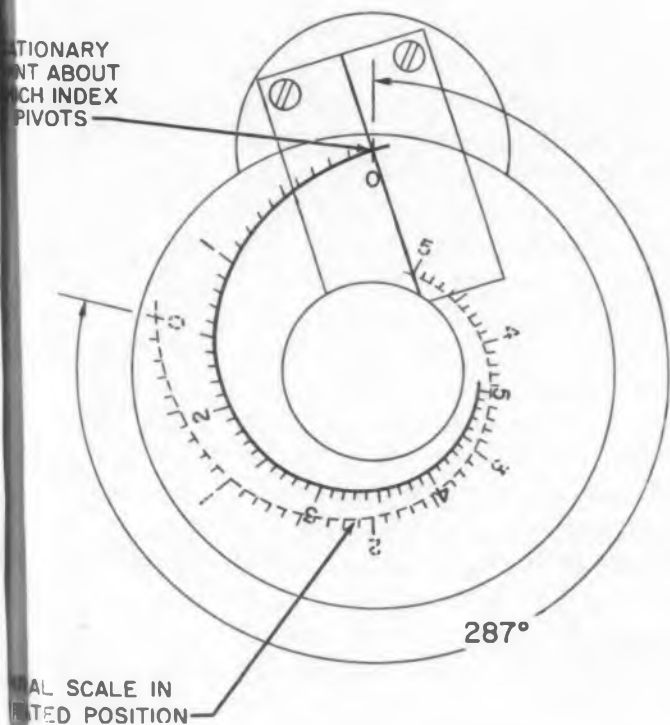


Fig. 3. Angular rotation of dial required to go from 0 to 5, when index line is in a tilted position.

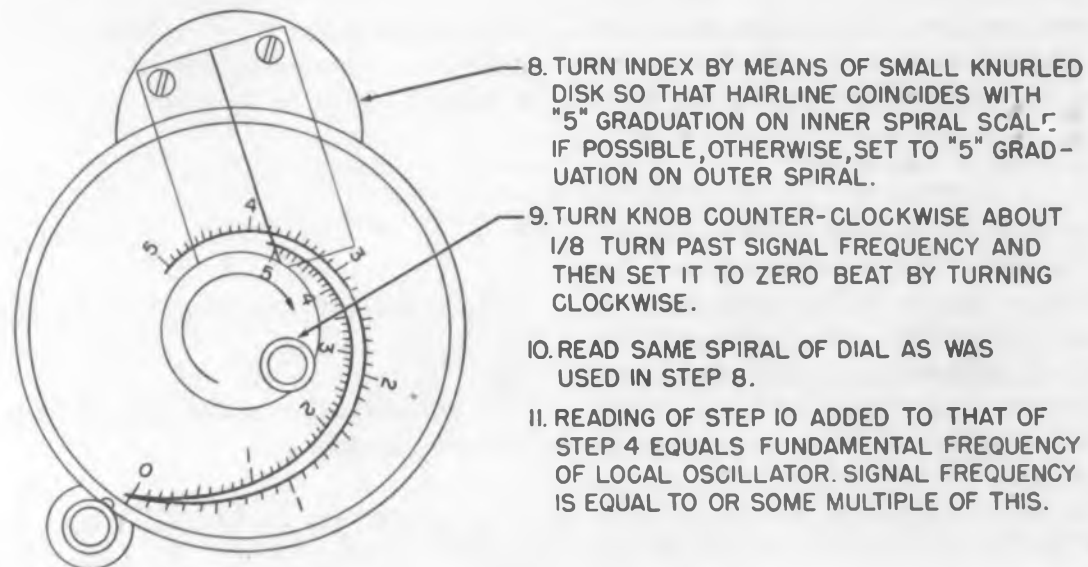
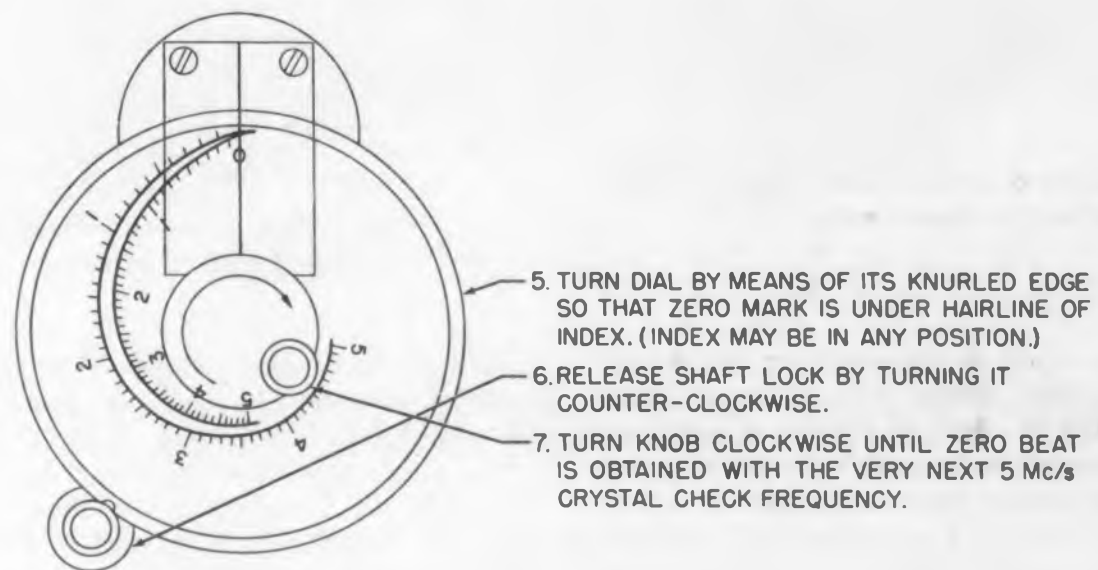
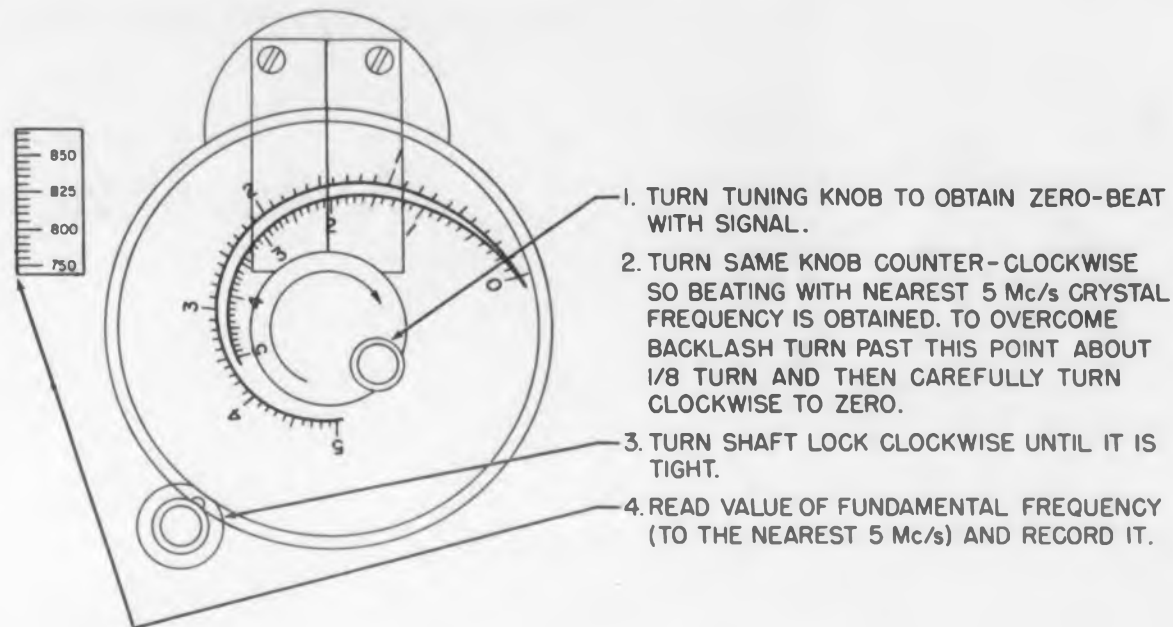


Fig. 4. Instructions for operating spiral-scale interpolating dial on PRD Type 504 frequency meter, to determine frequency of a signal.

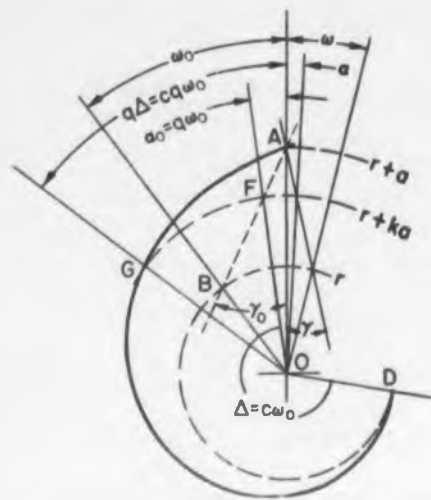


Fig. 5. Spiral of Archimedes dial scale.

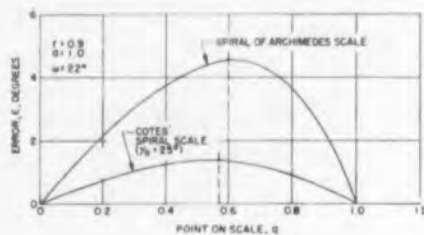


Fig. 6. Error of spiral scales as a function of location of point on scale, q .

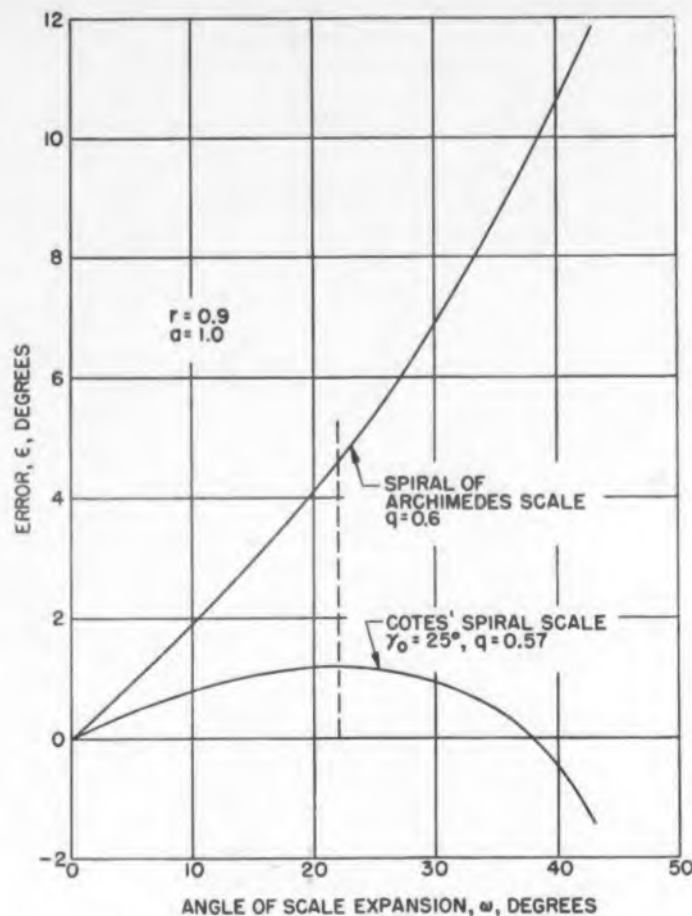


Fig. 7. Error of spiral scales as a function of angle of expansion, w .

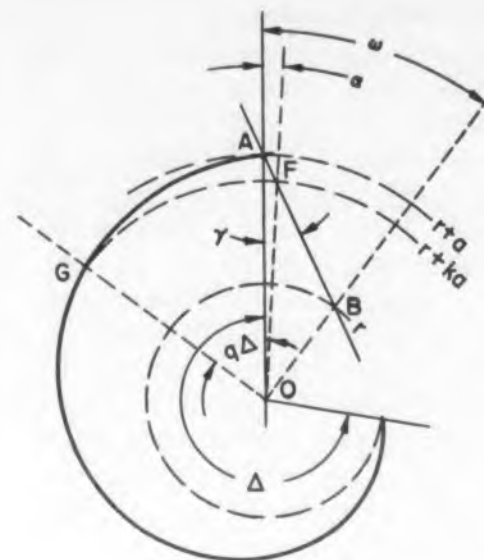
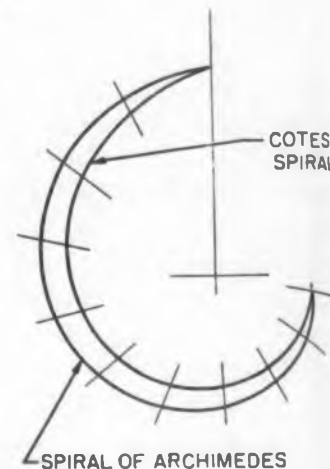


Fig. 8. Cotes' spiral dial scale.

Fig. 9. Comparison of spirals.



2/5 of 260 deg around on the spiral should intersect the index in the tilted position of Fig. 3, when the dial is turned through 1/5 or 2/5 of 287 deg, respectively. Such a condition obviously is necessary in order that the linear interpolation described above is valid.² However, this condition is never precisely satisfied; intermediate points on the scale are always slightly out of place, or in error, when the index is tilted (except for the singular case to be described). The suitability of this dial mechanism for any particular instrument is governed by the magnitude of this structural error. The remainder of this article is therefore devoted to a discussion of the factors that affect its inaccuracy.

Accuracy

The inaccuracy or structural error at any position is best defined as the difference in angle between the position of the dial as shown by the intersection of the scale with the index and the actual position of the dial when the dial is operated in the manner shown in Fig. 4. By definition, the error at both ends of the dial is zero. The magnitude of the structural error for any particular point on the scale depends on the angle of tilt of the index line and on the shape of the

spiral scale. It is entirely independent of the angular length of the scale, even when the spiral has more than one convolution.

The spiral scale shown in Fig. 5 has an arbitrary angular length, Δ , and the radii of the outer and inner ends are, respectively, $r+a$, and r . The index pivots about the fixed point, A , which is also at a distance $r+a$ from O . When the index is in a tilted position, the effective expansion of the entire scale is the angle, ω , and the expansion (or contraction) for an intermediate point, G , at an angle $q\Delta$ from the outer end, is the angle, α . In order for the structural error, as defined above, to be zero:

$$\frac{\alpha}{\omega} = \frac{q\Delta}{\Delta}$$

or

$$\alpha = q\omega$$

The structural error, therefore, may be defined as:

$$\epsilon = q\omega - \alpha$$

By an application of the Law of Sines it can easily be shown that:

$$\omega = \text{Arc Sin} \left[\left(\frac{r+a}{r} \right) \text{Sin } \gamma \right] - \gamma$$

and

$$\alpha = \text{Arc Sin} \left[\left(\frac{r+a}{r+ka} \right) \text{Sin } \gamma \right] - \gamma.$$

To determine the error from these equations, it is necessary to know the relationship between q and k , and this depends on the shape of the spiral. For the simplest spiral—the Spiral of Archimedes— $q = 1-k$, so that ϵ can be easily evaluated. Curves of the error obtained with a Spiral of Archimedes, for which $r = 0.9$ and $a = 1.0$, are shown in Fig. 6 and 7. (This is the spiral actually shown in Fig. 5.)

In Fig. 6, the error is shown as a function of q ; that is, for different positions of the point G on the scale. The curve shown is for the particular angle of index tilt which provides an angle of expansion of 22 deg. This curve indicates that the maximum error at this setting occurs at $q = 0.6$. In Fig. 7, the error is shown as a function of the angle of expansion; that is, for varying angles of tilt of the index. The curve shown is for the particular point, G , for which $q = 0.6$.

These curves plainly show that, for the purpose of an expandable dial scale, the Spiral of Archimedes is unsuitable; except perhaps where a very small range of expansion is required. The underlying reason for this unsuitability of the Archimedes' Spiral is the fact that equal angular segments at different radii sweep through different angles in passing a tilted index line. At larger radii, smaller angles are swept through. It was reasoned, therefore, that to reduce the error, a spiral with a more rapidly increasing radius vector is needed. Furthermore, the author conceived that there was a way of constructing a special spiral curve which would have no error whatever for at least one particu-

²Non-linear or curvilinear interpolation with this dial mechanism is also possible. All that is required to obtain such interpolation is that the spiral scale be graduated, i.e. angularly divided, in a non-linear manner. For example, the scale can be divided logarithmically by making the angle between each succeeding pair of graduations equal to a constant fraction of the angle between the preceding pair.

lar angle of tilt of the index, as well as no error for the radial position of the index.

The spiral, as shown in Fig. 8, is constructed by first drawing the line AB at an arbitrary angle, γ_0 , and then transforming this line into the spiral by distorting the angular coordinate of each point on the line by a constant multiplier, while preserving the radius vector coordinate unchanged. Thus, point D at angle $\Delta = C\omega_0$ and radius r corresponds to point B at angle ω_0 and radius r ; and point G at angle $q\Delta = cq\omega_0$ and radius $r+ka$ corresponds to point F at angle $q\omega_0$ and radius $r+ka$. It can be shown that this special spiral has an equation of the form:

$$\rho \cos\left(\frac{\theta}{c}\right) = \text{constant},$$

which is known as Cotes' Spiral. Both Cotes' Spiral and the Spiral of Archimedes are shown in Fig. 9 for comparison and clearly illustrates how much more rapidly the former increases in radius with increase in angle.

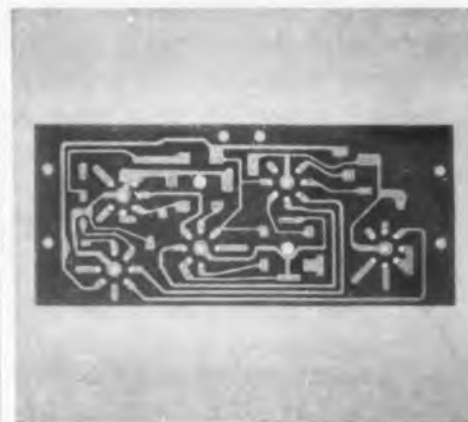
The spiral, shown in Fig. 8 and 9, has $c = 7$; but for our purposes, c can have any value. Its error properties are not a function of c . By virtue of its construction this spiral can have no error when the index is tilted at angle γ_0 . This is because the effective angle of expansion (or contraction) of the whole scale is ω_0 , while that for point G is $\alpha = q\omega_0$. Thus, the ratio of these angles is q , which is the requirement for zero error. However, there is an error at all angles of $\gamma \neq \gamma_0$ and $\gamma \neq 0$. This can readily be determined from the previous equations, after q is evaluated from:

$$q = \frac{\alpha_0}{\omega_0} = \frac{\text{Arc Sin}\left[\left(\frac{r+a}{r+ka}\right) \text{Sin } \gamma_0\right] - \gamma_0}{\text{Arc Sin}\left[\left(\frac{r+a}{r}\right) \text{Sin } \gamma_0\right] - \gamma_0}$$

Curves of the error obtained with a Cotes' Spiral having an angle $\gamma_0 = 25$ deg and the same values of r and a as for the Archimede's Spiral previously discussed, are shown for the same angle of ω in Fig. 6, and for $q = 0.57$ in Fig. 7. They are plotted with reversed sign (which is of no consequence), to aid comparison. Perhaps the most noteworthy observation to be made from these curves is that for the same allowable error of 1.2 deg, Cotes' Spiral permits expanding or contracting the scale by 42.5 deg while the Spiral of Archimedes would only permit 6.5 deg. The spiral scales used on the PRD Type 504 Heterodyne Frequency Meter dial are Cotes' Spirals having these proportions (the outer scale being identical to that in Fig. 8, and the inner scale differing only in that $c = 5$ instead of 7. The maximum percentage error caused by the use of these scales occurs at the lowest fundamental frequency, which is 500 mc, at which point the outer 260 deg scale is stretched to about 300 deg. As this 300 deg of dial rotation represents 5 mc or 1.0 per cent of the frequency, the 1.2 deg error that can occur amounts to only 0.004 per cent of the frequency.



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CIRCLE 29 ON READER-SERVICE CARD FOR MORE INFORMATION

BEST features of both the film and wire-wound resistors are worked into the Vamistor®. High physical strength and toughness, as opposed to the fragility of most deposited metal films is one of the desirable properties of these precision resistors. The film is thin enough to give low skin effect phenomena at high radio frequencies. Additional styles of this metal film, ceramic-type precision resistor have been developed recently which extend its usefulness to many new applications.

In the Vamistor, developed by Weston Electrical Instrument Corp., Newark, N.J., the resistance element is actually a ribbon of metal which is thermally fused to the inside wall of a ceramic tube having silver terminals fired to each end. Plated brass terminal caps with tinned copper wire leads are attached to the silver ends of the tube, and the entire unit is molded in epoxy resin for protection.

The internal surface of the tube is prepared with a high-temperature fired glaze coating, and the resistive material deposited on this surface between the two conducting silver bands. The resistive film is a highly refined and carefully controlled alloy of the nickel chromium family. After it is deposited on the internal surface, a second firing treatment is given to disperse the deposited film evenly throughout the body of the glaze. The desired resistance is obtained by cutting a helical groove of a predetermined pitch in the hardened film. Encapsulation of the resistor in epoxy resin is for insulation primarily, but it also makes the unit impervious to weather, humidity and salt spray. The insulating cover, while thin enough to allow full wattage dissipation without excessive rise in internal temperature, is sufficiently thick to provide satisfactory flow under severe thermal shock conditions.

Specifications and Performance

The Vamistor not only meets all known military and civilian specifications pertaining to film type resistors, but also is the first non wire-wound resistor to meet, or surpass, requirements of MIL-R-93A covering precision wire-wound resistors. Vamistors are smaller and operate at higher ambient temperatures than this specification requires, and also exceed several of the stability requirements. They meet the upgraded MIL-R-19074A (ships) specification, MIL-R-10509B, or the proposed MIL-R-10509C (film) specifications. They will operate wherever wire-wound or film re-

Ceramic Film Resistor

sistors are specified, providing greater stability under most conditions than either type.

Some of the design specifications are: resistance range, 1000 to 100,000 ohms; power rating 1/2 w at 85 C derating to zero watts at 150 C; accuracy 1/2, 1, or 5 per cent; temperature coefficient, +50 ppm/degrees C (± 25 on selected units). Low temperature rating is -65 C. Size is 3/4 in. long, 5/16 in. diameter. For r-f work the over-all capacitance from end to end is only 0.9 μf . The temperature coefficient is a sum of an inherent positive magnitude for

Fig. 1. Per cent change in resistance with temperature for various specifications. Resistors of comparable size were selected. For an 80 C variation, a composition resistor will change 12 per cent compared with 0.25 per cent for a Vamistor.

Fig. 2. Total per cent resistance change due to effect of adding tolerances for major specification requirements. Lowest temperature coefficient and adjustment tolerance for each spec was used.

*Registered trade mark.

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Miniaturization with maximum quality.

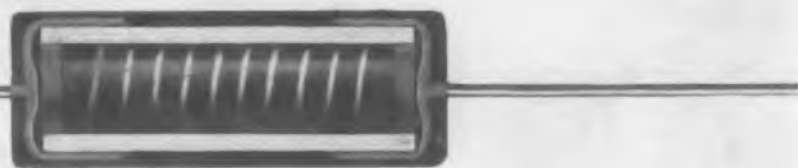
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Enlarged sectional view of the ceramic-film resistor.

perature for various specifications.

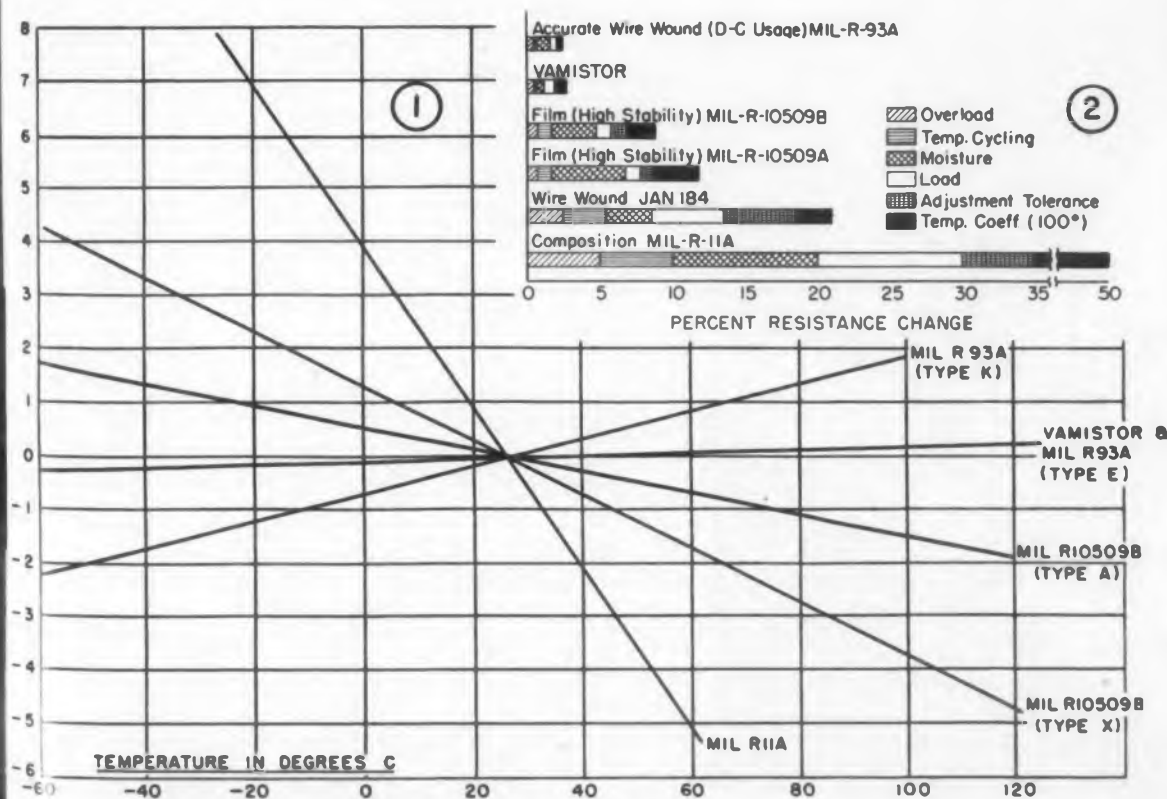
Departures from the rated resistance value can be caused by such things as overload, temperature cycling, moisture, load and adjustment tolerance. It is unlikely that all of these factors would be strictly additive in any one installation, but considerable information can be obtained by adding these changes to show the relative overall merits of the different resistor types, Fig. 2. On this basis, Vamistor specs compare favorably with military requirements.

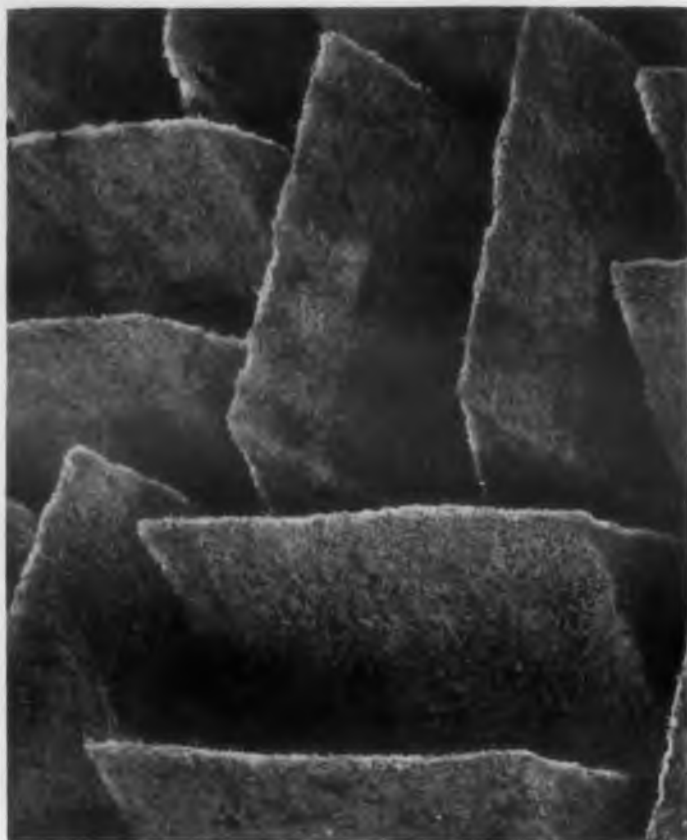
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metal alloy and negative coefficient to stress change.

Although present specifications list the highest ambient temperatures for full load dissipation as 85 C, other ratings are possible. By special treatment, units are now available that dissipate one watt at 70 C or alternatively 1/2 w at 125 C ambient.

In an attempt to compare the Vamistor qualities with military requirements for other type resistors, Figs. 1 and 2 show how resistance changes. Fig. 1, for example, shows what happens to the over-all value of the resistor with changes in ambient tem-





This treated-fiber wedge-shape absorber material (Eccosorb CHW) is useful at VHF, UHF and microwave frequencies. The wedges are mounted on a plywood panel and are used mainly in darkrooms. Because of its wide frequency coverage, it is useful in making simultaneous tests on several antennas. For example, a complete aircraft could be placed in such a darkroom and all electronic equipment tested to simulate in-flight performance.

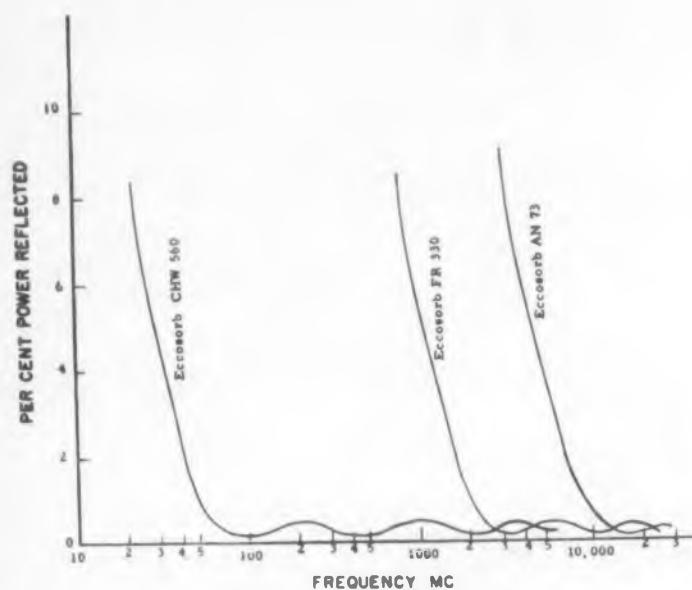


Fig. 1. Reflection from selected absorbers.

ELECTROMAGNETIC energy absorbers to simulate free-space are currently produced to cover the VHF, UHF and microwave frequency ranges. Described here are characteristics of available absorbing materials, methods of selecting, and application.

Where Used

The largest use for free space absorber is in antenna measurement darkrooms, sometimes termed "anechoic chambers" because of the audio analogy. Antenna measurements can be made indoors with the same accuracy of outdoor test range measurements, but with none of the weather uncertainty. The darkroom can be shielded with metal screening on the outside surface or may be unshielded depending upon

whether external electrical disturbances are present. The absorbing material is applied to walls, ceiling, and floor of the room. Attachment is done by impaling the absorber on nails, cementing, or tying with twine.

Free-space absorber is used in enclosures to prevent unwanted reflections. Housings which contain antennas are frequently lined with absorber at certain critical areas. This prevents reflected energy from detuning the transmitter; it also eliminates unwanted echoes on the radar presentation. Many radar antenna nacelles aboard aircraft are so lined. Areas in which magnetrons or other transmitting tubes are located can be lined in order to absorb radiation.

For most free-space applications it is imperative that the absorber be broad-banded. Thus, if the fr

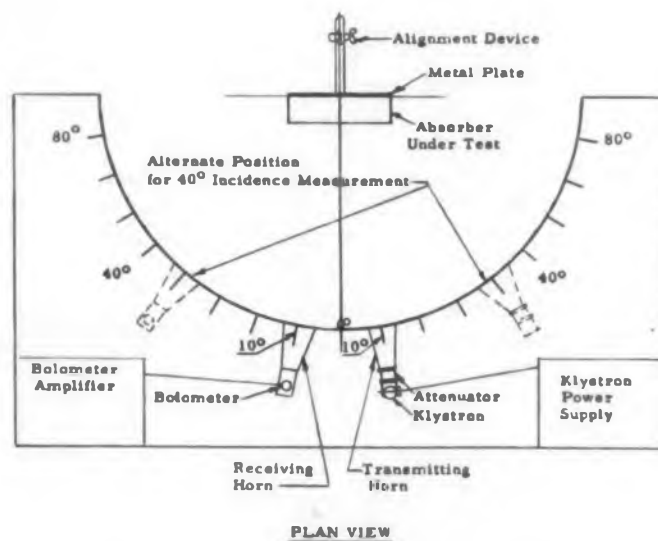


Fig. 2. Absorber test equipment for single-frequency reflection measurements.

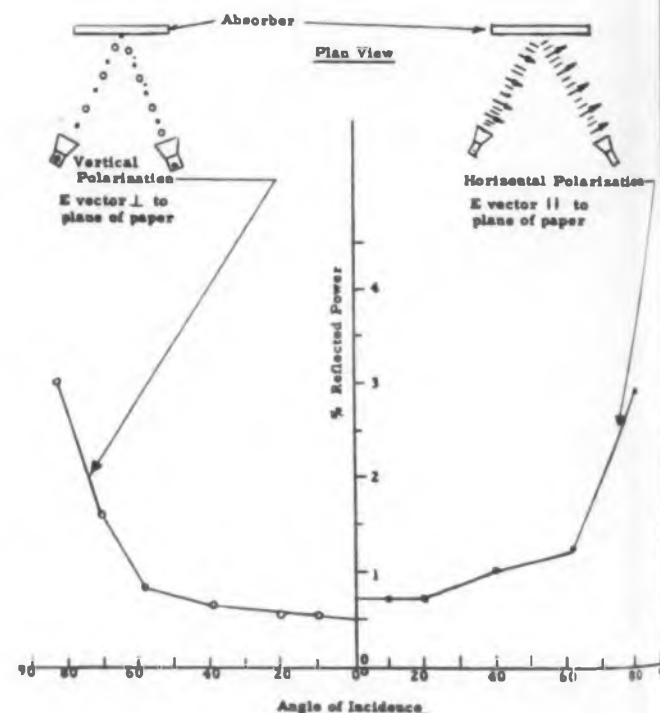


Fig. 3. Typical incident-angle reflection data for Eccosorb FR 330 at 3.2 cm.

Donald J. Newman
Emerson & Cuming, Inc.
Canton, Mass.

frequency of the incident energy changes, the absorber effectiveness is undiminished. At the present stage of development, broad-band absorbers have a thickness which is dependent upon the longest wavelength to be used. An absorber which is effective at S band (10 cm wavelength) can also be used at X band (2.5 cm) and K band (1.0 cm) with at least equal effectiveness.

In addition to the free space absorbers, other materials are produced for use in waveguides and coaxial transmission lines. Supplied in rod or sheet form, these materials are machined for use as terminations, dummy loads, and attenuators. There are two general classes of absorbers for these uses—those which have a high dielectric dissipation factor and those with a high magnetic dissipation factor. The former materials are bulk conductive.

Absorption Theory

A broad-band electromagnetic energy absorber is so constructed that dissipative material is increased with depth. Incident energy is confronted with a material which does not differ greatly from free space; i.e., a good match is made. As the energy proceeds into the absorber, it is confronted with more dissipative material and it eventually becomes greatly attenuated.

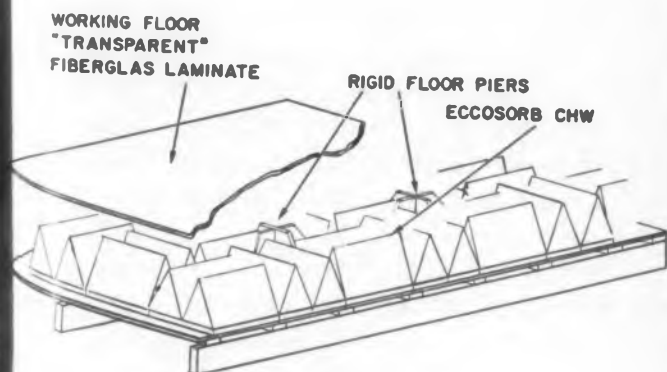


Fig. 4. Floor construction for darkroom using wedge-type absorber. For details, see text.

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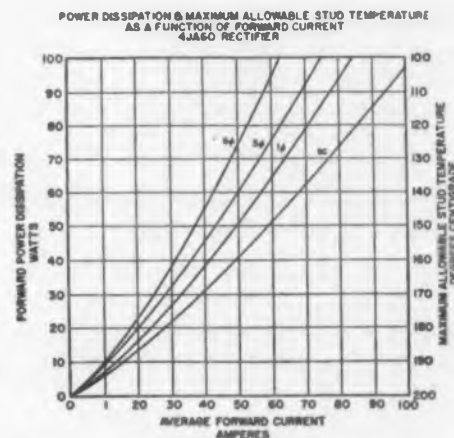
Produced by the alloy technique developed in General Electric laboratories, these high-capacity rectifiers show no deterioration in rectifier characteristics during

extended life tests at full rated condition. The silicon element is hermetically sealed in a steel housing for protection against moisture, fumes, dust, vibration, and corrosion. Effective cooling is assured by the tapered thread "plumbing type" stud that screws tight into heat sink or cooling fin.

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General Electric Silicon Rectifiers are installed in any position or location, and work in any rectifier operation. They are now serving in many applications such as arc furnaces, welding, and protection against cathodic erosion.

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TYPICAL APPLICATION GENERAL ELECTRIC HIGH CURRENT SILICON RECTIFIER

CIRCUIT	Three Phase Bridge Rectifier, Resistive Load.
DC OUTPUT	280 Volts, 215 amperes, 60 kilowatts.
RECTIFIER LOSSES	Approximately one percent (½ kilowatt).
COOLING REQUIRED	One 6½-inch square, ⅛" thick copper fin for each of six rectifying units when used with 2000 fpm 30°C forced air. Free convection cooling may be utilized by increasing the fin area.
VOLUME	Total volume of rectifiers and fins—less than ½ of a cubic foot.



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Standard Manufactured Absorbers

Description	Temperature Range	Wavelength Range	Frequency Range	Bands Covered	Size	Thickness Nominal	Weight Per Sq Ft	Eccosorb Type
Rigid foam block for microwave darkroom	-94 to +180 F	13 cm and all shorter	2300 Mc and up	S,C,A,B, X,G,K	12"x36"	2"	10 oz	FR 330
		32 cm and all shorter	940 Mc and up	L and S,C,A,B, X,G,K	12"x36"	4"	1 lb 4 oz	FR 340
		66 cm and all shorter	455 Mc and up	UHF and L,S,C,A,B, X,G,K	12"x36"	8"	2 lb 8 oz	FR 350
Modification of rigid foam block for flooring applications	Data on the various types of Eccosorb FR applies. Absorber has thin laminate facing to distribute load.							
Flexible foam sheet for antenna enclosures and airborne uses	-94 to +300 F	1.5 cm and all shorter	20 kMc and up	K	24"x24"	1/8"	0.6 oz	AN 72
		4.0 cm and all shorter	7.5 Mc and up	X,G,K	24"x24"	3/8"	2.0 oz	AN 73
		8.6 cm and all shorter	3.5 kMc and up	C,A,B, X,G,K	24"x24"	5/8"	4.0 oz	AN 74
		12.5 cm and all shorter	2.4 kMc and up	S,C,A,B, X,G,K	24"x24"	1"	5.0 oz	AN 75
Rigid foam block for extreme temperature use	-94 to +1200 F	4.0 cm and all shorter	7.5 kMc and up	X,G,K	24"x24"	1/2"	6 oz	HT 620
		12.5 cm and all shorter	2.4 kMc and up	S,C,A,B, X,G,K	12"x12"	1"	12 oz	HT 630
Enmeshed fiber Sheet for darkrooms	-94 to +200 F	13 cm and all shorter	2300 Mc and up	S,C,A,B, X,G,K	24"x24"	2"	1 lb	CH 460
		32 cm and all shorter	940 Mc and up	L and S,C,A,B, X,G,K	24"x24"	4"	1 lb 12 oz	CH 475
		66 cm and all shorter	455 Mc and up	UHF and L,S,C,A,B, X,G,K	24"x24"	8"	2 lb 6 oz	CH 490
Two wedges mounted on plywood panel for extremely wide band darkrooms	-94 to +200 F	600 cm and all shorter	50 Mc and up	VHF, UHF and all Microwave bands	24"x24"	Wedge Height 54"	Unit Weight 27 lb	CHW 560
		300 cm and all shorter	100 Mc and up	"	24"x24"	28"	17 lb	CHW 570
		150 cm and all shorter	200 Mc and up	"	12"x12"	15"	13 lb	CHW 580

The exact nature of the change in electrical properties of the absorber with depth is the key to manufacture of a high efficiency material.

In designating a broad-band absorber, the lower frequency of usefulness is given. The absorber is useful at all higher frequencies. This is illustrated in Fig. 1 for a few selected materials. There are several members of each absorber type; each with a designated lower frequency limit.

Broad-band absorber functions equally well whether backed by a reflective surface or not. Energy is attenuated to such a degree in passing through the absorptive material that an insignificant amount is present at the back surface. A metal or screen room is, therefore, not required so far as the absorber is concerned. The screen room merely prevents external electrical disturbances affecting the test area.

Absorber Rating

Absorbers are usually rated with respect to returned power at normal incidence. Most absorbers are rated at a maximum of 2 per cent reflection of incident energy. This means that reflected power is down 1 db with respect to transmitted power. Certain absorbers will operate over the temperature range from -94 F (-70 C) to +1200 F (+648 C), are unaffected by humidity, are non-flammable and are lightweight.

Reflection Measurements

A typical set-up for reflection measurement is diagrammed in Fig. 2. The transmitting and receiving horns are at essentially the same location with their axes normal to the plane of the sample. Power reflection from the sample when backed with a metal plate is compared with power reflection from the metal plate alone. The metal plate is aligned to return the maximum signal.

Reflectivity is expressed as a per cent or as dB down. For some applications, reflected power at angles other than normal are important. The horns are merely adjusted appropriately in azimuth. The power reflected from the sample is calculated as a per cent of the power reflected from the plate at these new locations.

A typical curve for a good quality absorber at various angles of incidence is shown in Fig. 3. Certain absorbers are sensitive to polarization. It is, therefore, good practice to measure samples at mutually perpendicular polarizations. At high incidence angles reflected power increases significantly. This usually is not disadvantageous, due to the fact that energy at high incidence angles is not reflected back directly to the source but strikes other absorbing material. Multiple reflection, of course, attenuates the energy enormously.

Darkroom Considerations

Construction of a darkroom is relatively simple. Wooden 2 x 4's are usually adequate. Only a frame

properly which the absorber is attached is needed. The cost of absorber for S, X and K band measurements in the room (3 walls, floor and ceiling) would be about \$2000. Attachment of the absorber is done by impaling on nails, cementing or tying with twine. For the walls, it is convenient to drive nails into the wood and impale the absorber on them. Reflection from the nails embedded in the absorber is negligible. Wedge-type absorber (see photo) is available mounted on plywood panels. Screw inserts in the panels permit mounting by bolts through the 2 x 4's.

Ceiling mounting is usually done by the use of a quick setting cement, or by tying. Nails or hooks have also been used. One method consists of attaching the absorber to large plywood panels which they rest on the ground and then inverting and lifting them to the ceiling. Several possibilities exist with respect to the darkroom floor. Loose pieces of absorber can be placed on the floor only where needed and may be shifted as required. The rigid foam sheet absorber is available in a form suitable for flooring. A very thin fiberglass laminate facing is applied to the foam to permit walking on it and for the bearing of moderate loads. Complete absorber room floors can be put down using this material.

When using the wedge type absorber on floors, a working floor can be laid of fiberglass laminate as shown in Fig. 4. Reflections from this "transparent" fiberglass floor are small except in the microwave range. Pieces of rigid foam absorber could, of course, be placed on top of the "transparent" floor when microwave measurements are to be made.

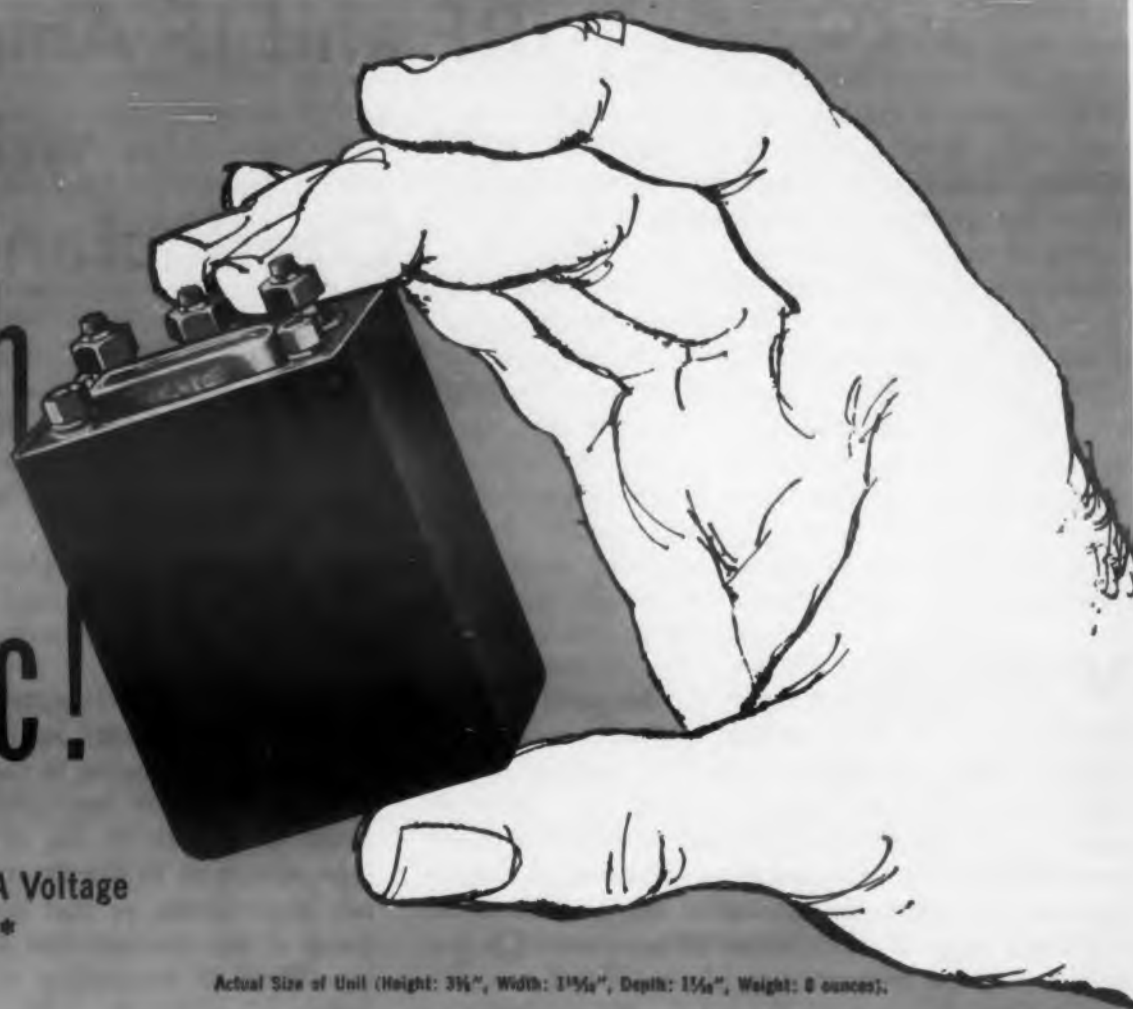
For highly critical applications, baffles made of absorber are used in the microwave darkroom. These consist of movable wooden frames to which absorber is attached. Baffles are so located that undesirable radiation undergoes multiple reflection. Selection of absorbing material and judicious use of baffles can result in rooms which are 50 db down when measured with transmitter and receiver located at essentially the same point.

Most measurement work requires only a rectangular room with absorber attached to all surfaces. It is often convenient to leave one side of the room completely open for easy access of equipment. Such a room, using absorber rated at a maximum of 2% reflection (17 db down) for normal incidence at the operating frequency, would actually measure considerably better—at least 30 db down. This is due to most of the absorber being better than the 2% figure and the possibility of multiple reflections.

Available Absorbers

Absorbers generally have a white surface so that good lighting conditions can be maintained, and they are made from fire retardant materials. Various available standard types of free-space absorber are listed. Contoured pieces and a few special types are made on a custom basis.

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RF and IF Amplifier Design with Conductance Curves

Keats A. Pullen, Jr.

Ballistic Research Laboratories
Aberdeen Proving Ground, Maryland

VACUUM tube conductance curves¹ can be employed directly as a tool in the design of rf and if amplifiers. The rf or if amplifier is slightly more complicated than a rc voltage amplifier because of the regenerative feedback problem and the range of amplification which needs to be available without manual adjustment. Control of amplification is usually obtained by automatic biasing of the amplifiers for amplitude type of modulation, or automatic biasing and limiting for frequency or phase type of modulation. Discussed here, with the aid of tube conductance curves, are recommended tube operating conditions, and their associated circuit parameters. A few helpful suggestions for chassis layout, socket orientation, and electrical grounding are made.

The Basic Tuned Amplifier

In a tuned amplifier having not more than two amplifying stages at a given frequency, the regeneration problem is primarily one of reducing magnetic and capacitive couplings to well below the level which may provide unity voltage feedback. In multi-stage tuned amplifiers, electromagnetic field propagation must be considered in addition to direct magnetic and capacitive coupling.

The distribution of coupling currents and chassis currents needs careful attention in all tuned amplifiers. The selection of an input grounding point and an output grounding point for each amplifying stage is the first step in the actual construction of an rf or an if amplifier stage. The grid pin on the tube socket should be oriented toward the input circuit and the socket hole actually located as close as possible to the input circuit. Then, the output circuit should be located as close as possible to the plate pin of the socket. The output bypass point is located near the plate pin of the tube.

Where a separate suppressor connection is provided for a tube, the screen bypass should be returned to the input ground. The suppressor then is returned to the output ground. The plate decoupling circuit by pass also is returned to the output ground. If a

single tuned circuit is used interstage, the output ground for the first stage and the input ground for the succeeding stage may be a common point. The bypass circuits connected to the various common ground points should be arranged to provide sufficiently small impedance to the rf voltages applied to the tube compared to the input, output, shunt, and cathode impedances, so that good isolation is provided. Some of the interrelations affecting the isolation are considered in connection with the experimental designs.

The design of the tuned amplifier is accomplished in the same manner as for the resistance coupled amplifier. The equation for amplification of the tuned amplifier is

$$VA = -G_m Z_L \quad (1)$$

where Z_L is the resonant impedance of the tuned circuit. A combination of a static and a dynamic load line is required.

The Limitation of Amplification

Tuned amplifiers normally have to be designed to provide amplification of a limited magnitude. If the voltage amplification provided becomes unduly large, the tube plate to grid feedback may become excessive, causing oscillation. To show the feedback effect, assume that an if amplifier for a center frequency of 5 mc is to be built, using 6CB6 tubes. Single tuned circuits are to be used as interstage coupling circuits for this design. The screen characteristics curves of the 6CB6 tube of Fig. 1 show that for small signal levels, operation with a plate current of about 5.2 ma and a transconductance of about 6000 μ mhos may be obtained with a screen voltage of about 60 v and a bias of $-1/2$ v. For a stage amplification of approximately 20, the load impedance Z_L , should have a maximum value of 3300 ohms. The reactance of the grid to plate capacitance should be of the order of 250,000 ohms at 5 mc for a stable amplifier design. This reactance corresponds to a grid to plate capacitance of 0.13 μ f. Since the grid to plate capacitance

of the 6CB6 amplifier, including stray capacitance could probably be held to 0.13 μ f, an amplification of 20 per stage should prove satisfactory at 5 mc.

The choice of the screen series resistor, if used and the cathode series resistor is entirely conventional. Frequently, the screen and plate supply voltages are taken equal, to reduce the number of parts in practical amplifier designs. Since this reduction of number of parts may result in an increase of mutual coupling between the input and the output of the tube, caution should be used in the choice of the simplified circuit for practical problems.

Choice of bypass capacitors, particularly for the screen, may require special consideration. Variation of screen voltage, because of the resultant cross coupling in an rf or an if amplifier, should be kept not more than 1/20 of the incoming grid signal. To lower the magnitude of the signal voltage developed in the screen circuit, the more effective is the isolation, and the more stable the resulting amplifier. A convenient equation for the tolerable amplification in the screen circuit is:

$$G_m X_{C_2} Z_{C_2} < 0.05$$

where Z_{C_2} is the effective impedance from screen to ground, and X_{C_2} the screen factor. Fixed tuned amplifier circuits may profitably use resonant bypass capacitors to reduce the screen signal voltage to the smallest possible value.

Nominal size of the bypass capacitor for either screen or cathode may be a poor measure of its bypassing effectiveness. For effective isolation, the actual screen structure within the tube must be held at ground potential. Either short, stubby, low inductive reactance leads to both sides of the bypass capacitor itself must be provided, or the structure must be resonated. Resonating of the screen circuit to ground may be accomplished by removal of plate and screen voltages from the tube whose screen is being resonated, and adjustment of the screen capacitor lead lengths to provide minimum signal feed-through to the tube.

Cathode degeneration should be used sparingly in amplifiers tuned to frequencies above 10 mc. The reactances of stray capacitances and inductances normally present in tube circuits can introduce serious difficulties, due to sneak regeneration paths when signal frequencies are high.

As the operating frequency of an rf or an if amplifier is increased, the stage amplification which can be obtained without instability becomes less and less. Possibly fortunately, the effect of transit time loading becomes serious as the effect of low grid to plate reactance becomes serious. The combination of both these factors is to reduce the available amplification.

Bandwidth, Q, and Impedance

The relation between tuned circuit Q and bandwidth may become rather involved in the high frequency tuned amplifier. Where natural circuit loading is small, and the required bandwidth is small, the

tuned circuit should, if possible, be designed to provide the required load impedance without swamping resistance. This results, when properly compensated for temperature effects and similar phenomena, in a high C type of circuit having a high inherent stability and good selectivity. For the 5 mc if amplifier mentioned earlier, for example, use of a tuned circuit having a Q of 100 would require coil and capacitor reactance levels of 33 ohms. Approximately 1000 μ f capacitance is required for this circuit. Where additional bandwidth is required to be obtained by resistive swamping, the tuned impedance required should be divided by the required loaded Q to give the design reactance levels. Then, sufficient loading resistance is added to provide the required load impedance.

In amplifiers using double tuned circuits, the same basic principles apply. Limitation of amplification to minimize oscillation requires that the load impedance

be determined by Eq. 1, and also by a feedback calculation to make certain that with the grid circuit impedance selected, the signal voltage fed back is small compared to the input voltage. A designer would at first think that one could limit the amplification in the plate circuit and obtain additional amplification by an impedance transformation between the coupled coils. He finds, however, that the increase in grid circuit impedance which results, reduces the amount of amplification which can be obtained to a point that no advantage is obtained. Since the grid circuit impedance rises as the square of the voltage step-up ratio, the intrastage amplification permitted is an inverse function of the square of the voltage ratio. The overall plate to plate amplification then depends on the inverse one-half power of the grid circuit inductance. The significance of this condition in optimizing the signal-to-noise ratio of input stages appears worthy of study.

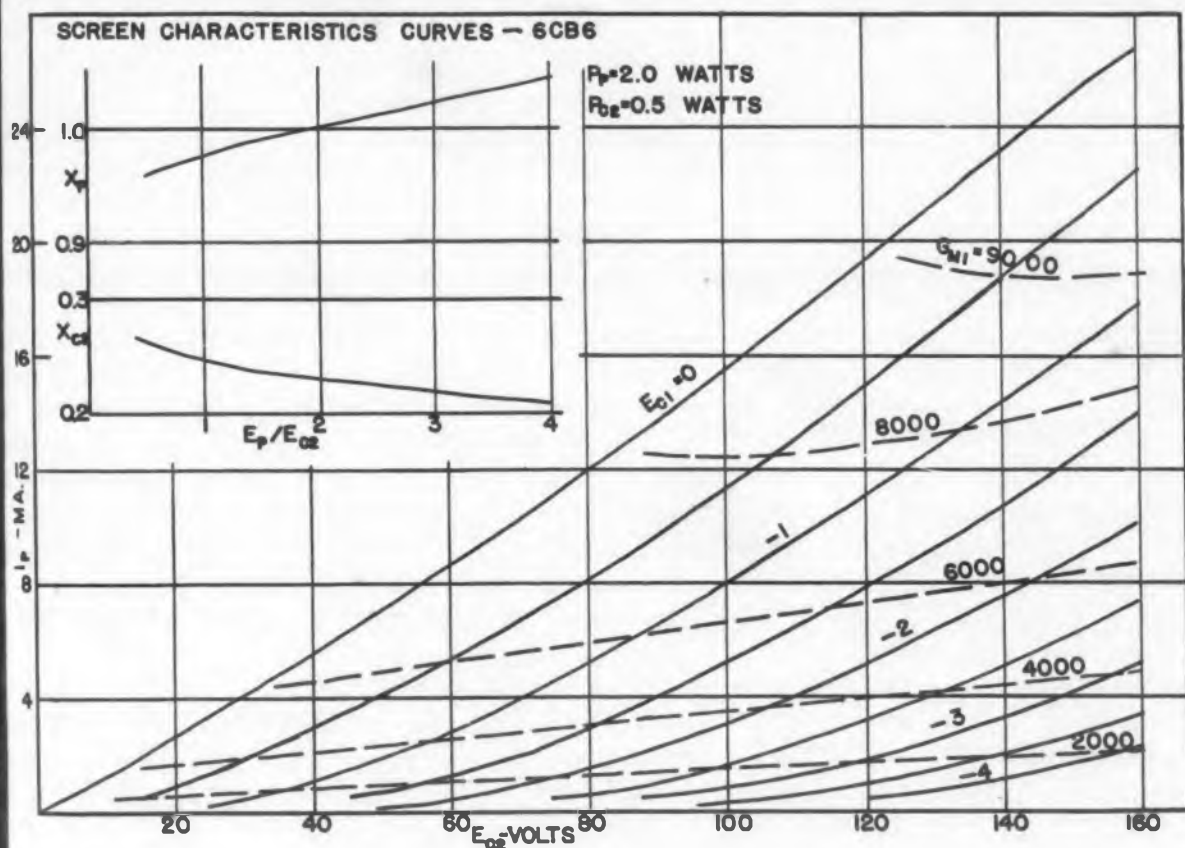


Fig. 1. Characteristics Curves—6CB6

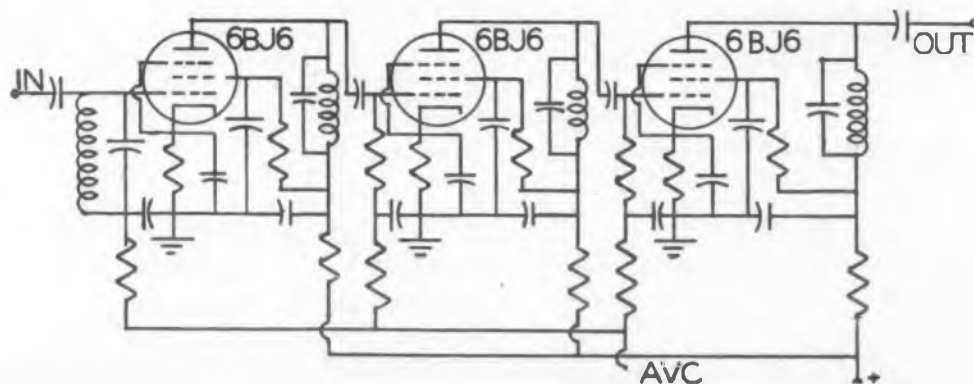


Fig. 2. Three Stage IF Amplifier

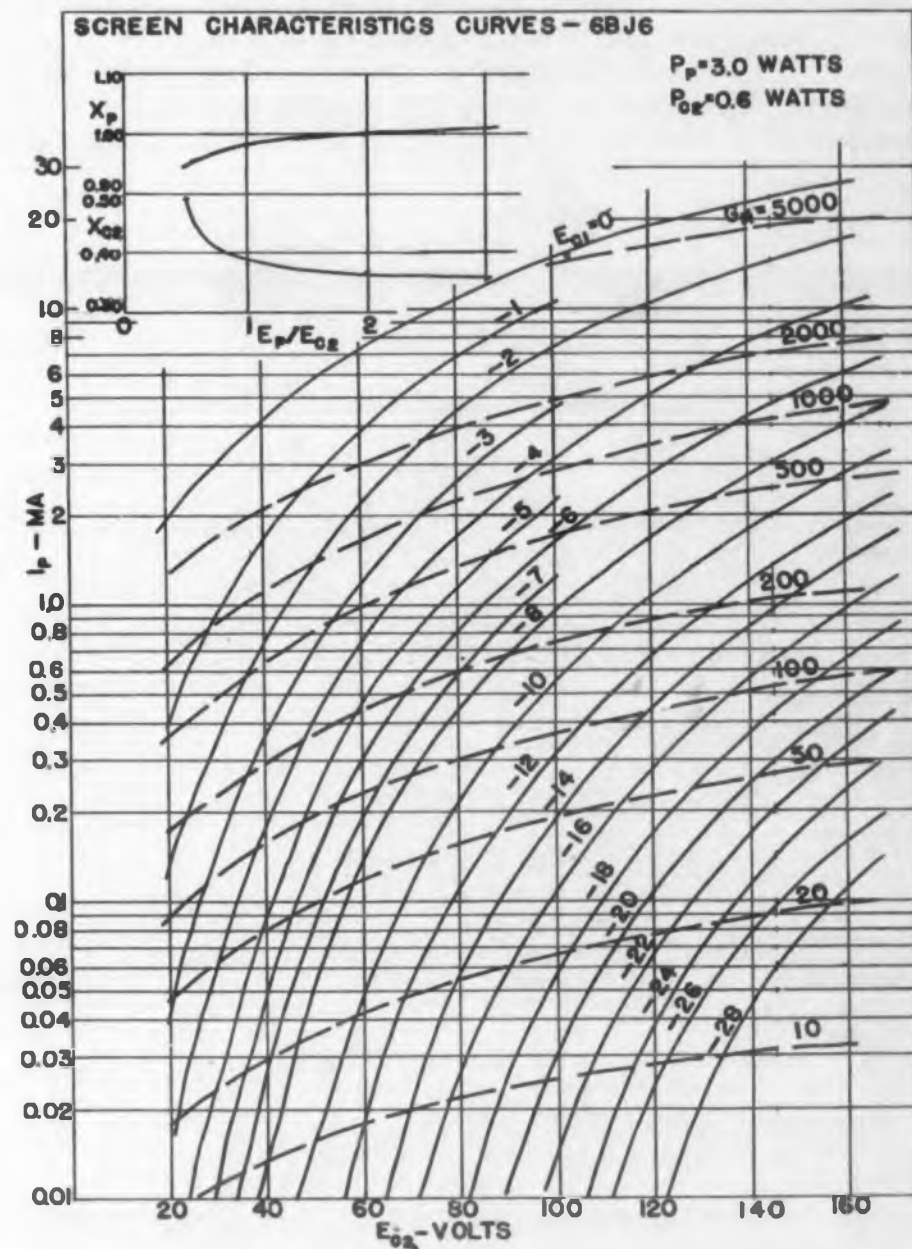


Fig. 3. Logarithmic Characteristics Curves—6BJ6

The bandpass built into any receiver should be kept as small as the physical limitations of the design problem permit. Attenuation of strong interfering signals prior to cross-modulation with the desired signal is the most effective means of controlling interference yet found. The use of broad-band, or over-coupled, input transformers, although satisfactory with small signals, should consequently be avoided wherever possible. Design of stability into an amplifier stage does not necessarily require broad-banding, if adequate attention is given to proper choice of impedance levels and proper components in the interstage circuits. The design of low inductance coils having adequate Q and the selection of the proper size capacitors are the main problems faced in the design of the required low impedance circuits.

The Design of Variable Gain Amplifiers

Variable gain amplifiers are frequently used to compensate for variations of signal strength of one or more received signals. The usual method of varying the gain of an amplifier is the use of some form of bias control of tube transconductance. The form of curves normally provided for pentodes, does not provide the design information needed where variable gain is required. Data on tube transconductance from values as low as 10 to as high as 5000 to 10,000 μmhos may be required to meet the range of amplification needed

in some practical problems.

Assume that a three stage 465 kc if amplifier, shown in Fig. 2, is required, which will develop a bias for any incoming signal having more than 3 v peak amplitude at the detector. The amplifier shall provide a maximum amplification of 15,000, and shall function properly with a 0.1 v peak input. The minimum peak input signal which will activate the AVC bias then is 200 μv .

Establishment of a design to provide proper operation with minimum signal input requires techniques of the sort already discussed in detail. Setting the design to handle adequately the entire range of signals is now examined. The 6BJ6 tube is used in this design and the conductance curves for this tube are shown by Fig. 3. The nominal load impedance of each plate load circuit is set by the required maximum amplification per stage of 25. Assuming a maximum effective transconductance of 3000 for each stage, the load impedance required is about 9000 ohms for unity interstage transformer amplification. The screen supply voltage is arbitrarily chosen as 100 v.

Uniform distribution of the amplification among the three stages would require a minimum stage gain of between 4 and 5. Assuming a stage amplification of 5 for an input of 0.1, gives an output of 12.5 v. The available bias then is 9.5 v. A quick check of the feedback loop shows that the output will not be quite

12.5 v, since 9.5 v AVC bias would limit the stage amplification to 1.53.

An iterative calculation yields the correct bias and stage amplification. With a 100 v screen potential and six v bias, each stage would have an amplification of 4. The overall amplification of 64 would provide a bias of 3.4 v. For a 5.7 v bias, the stage amplification of about 4.4 develops about 5.5 v bias. Consequently, a 0.1 v incoming signal produces an output of about 8.5 v and a bias of about 5.6 v.

Linearity is the next question. The 1.9 v final amplifier stage peak excursion either side of the mean bias point will produce non-linearity and distortion. The distortion is nearly 15 percent. This high a percentage of distortion in general is not tolerable. The designer might either raise the screen voltage or decrease the AVC voltage on the last tube in the amplifier. In either of these ways, or by use of both together, one may reduce the distortion appreciably.

One of the reasons the large distortion is developed with strong signals in this amplifier is the large signal voltage which must be developed to provide the bias for the gain control action. The use of an AVC amplifier, since it could reduce the amount of excess signal voltage required to provide control, would provide both a more constant amplification and a lower amplifier distortion. For example, a triode or a pentode amplifier, which used a negative supply and

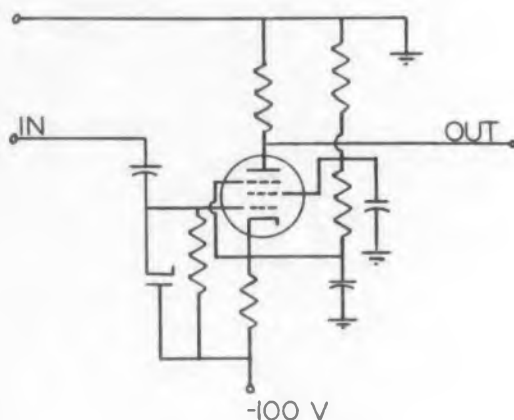


Fig. 4. AVC Amplifier

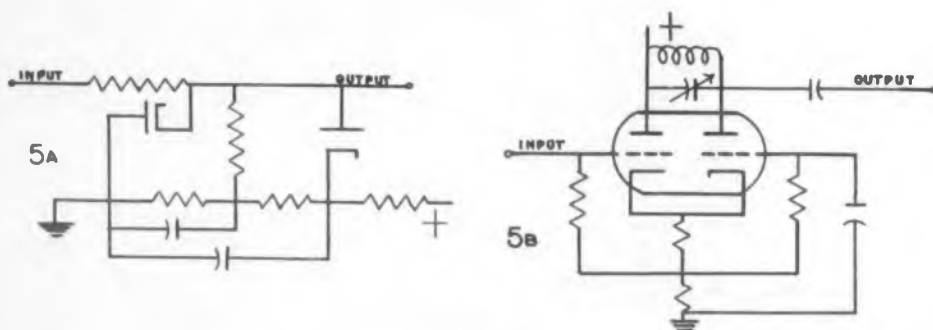


Fig. 5. Balanced Limiter Circuits

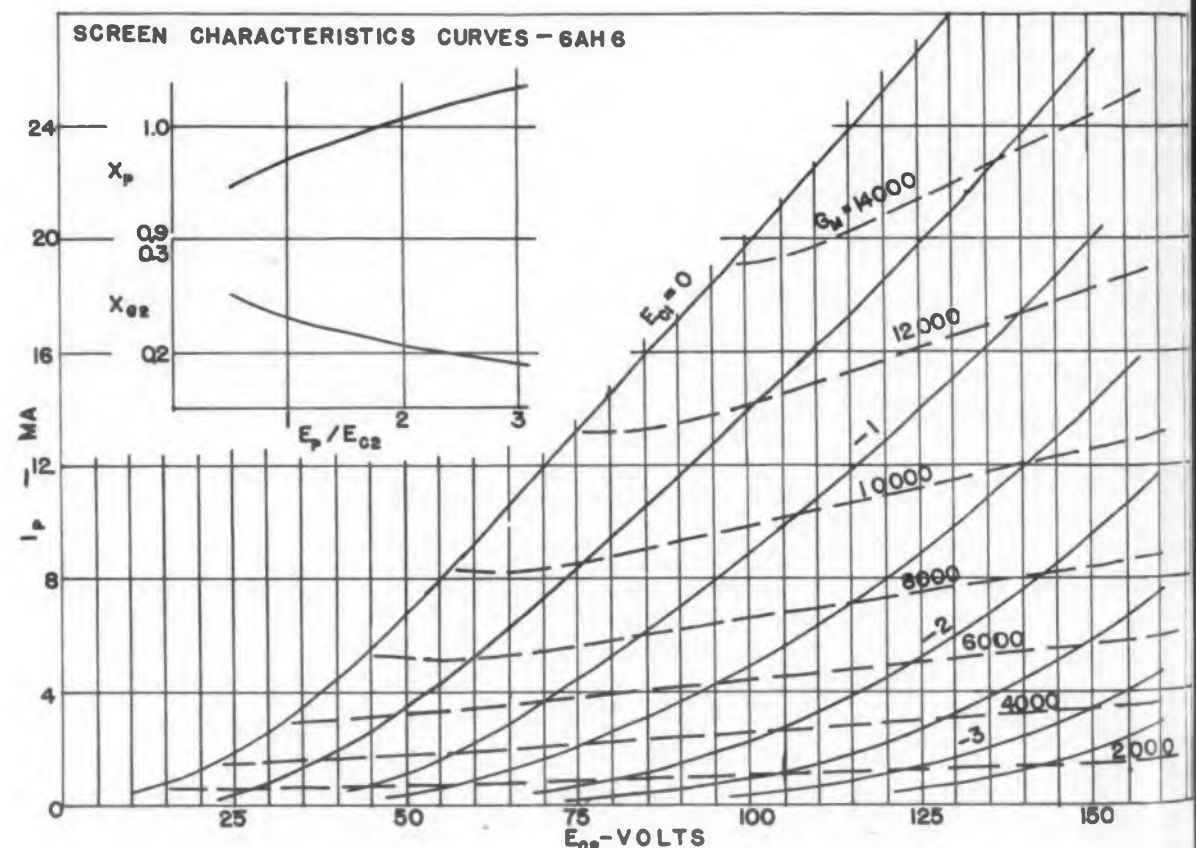


Fig. 6. Characteristics Curves—6AH6

had its control grid biased about 3 v below cutoff, would provide both the delayed action desired and also the required constancy of output level. Maximum efficiency in this amplifier would be obtained by the use of a crystal rectifier and filter rather than using the tube as a bias rectifier. Since only a fraction of a volt over 3 v signal now would produce as much as 8 or 10 v AVC, the amplifier distortion would be markedly reduced. Proper distribution of the volume control action among the various stages of the amplifier and the use of the AVC voltage amplifier in most cases can provide an amplifier having both low distortion and excellent constancy of amplification.

The fixed minimum bias applied under no-signal conditions has been ignored in the above discussion. A zero signal bias of -1.5 v is required to provide the net zero signal gain of the amplifier. Since this bias is normally provided by the flow of the cathode current through a bypassed cathode resistor, the effect of the cathode bias with large amounts of AVC becomes small enough to be neglected.

As an example of the design of an amplifier for amplified AVC operation, assume that a 6BH6 pentode were to be used as a delayed AVC amplifier, shown in Fig. 4. A crystal rectifier is to be used to rectify the rf being applied to the AVC rectifier. The amplifier is biased 3 v below approximate cutoff. Taking the 6HB6 screen to cathode potential to be 75 v, a net bias of approximately -6 v is required. Using a plate load resistance of 20,000 ohms and a plate supply voltage of 100 v, 0.5 ma of plate current in the amplifier will produce an AVC of 10 v. Since a net bias of -2.2 v produces the 0.5 ma plate current change, a peak signal of 3.8 v amplitude can limit the amplification by the application of 10 v AVC. The overall if amplification per amplifier stage will be approximately unity for 10 v bias. Consequently, an input signal range from 200 μ v to about 4 v would be provided with an input change of only one third.

Checking the effect of distortion shows that the amplification of the final amplifier stage of the amplifier cannot be reduced as much as the amplifications of the earlier stages. If the maximum incoming signal in the above amplifier were 0.1 v peak, then, the final amplifier stage should have an amplification of 10 with maximum input signal. With a screen voltage of 100 v on the 6BJ6 tubes, and a final stage amplification of 10, a bias of -8.8 v is required on the first two stages. The peak output of the amplifier then corresponds to about 3.5 v for a 0.1 v input, as against 3 v for 200 μ v input.

Limiter Amplifiers

In fm receivers, removal of incidental amplitude modulation is obtained by the use of limiting amplifiers. Basically, there are two types of limiters, the symmetrical, and the non-symmetrical. The symmetrical limiter usually uses either a pair of biased diodes or a cathode coupled clipper, shown in Fig. 5. The non-symmetrical clipper uses a grid rec-

tification and cut-off to accomplish its action. The non-symmetrical limiter is the more commonly used form.

The symmetrical limiter appears to introduce a smaller magnitude of carrier phase shift as a function of signal amplitude than the non-symmetrical limiter. This is a result of two considerations. The first consideration is that with the symmetrical limiter, the limiting is localized in one or two stages exclusively. The second consideration is that the symmetry causes the tuned circuit in the output of the limiter, which is shock excited by the limiter output current pulses, to be excited in relatively unchanged form regardless of the applied signal voltage. Consequently, where phase stability is important, use of symmetrical limiting is indicated. Conventional if amplifier design techniques apply to the amplifier used with biased diode limiting.

Non-symmetrical limiter stages frequently are used in pairs. In the average limiting amplifier, the number of tubes actively limiting an incoming signal may increase as the input signal voltage is increased. Where carrier phase stability need not be considered, the limiting action obtained is entirely adequate.

Normally, the non-symmetrical limiter circuit uses a rectification biased (zero bias static) pentode having a screen voltage low enough so that limiting is obtained with comparatively small changes in grid voltage. For a 6AH6 tube whose conductance curves are shown in Fig. 6, with a 20 v screen voltage for example, limiting occurs on input signals exceeding 0.5 v peak to peak.² Since the limiter clips the negative peaks only, two limiters in cascade are required to minimize the effects of noise on both negative and positive peaks.

Non-symmetrical limiters should be designed to use sharp cut-off pentodes, operating at a very low fixed value of screen voltage. Only then can the desired limiter characteristics be obtained.

One caution should be mentioned with regard to limiter and discriminator circuits. Arguimbau and Granlund² have shown that wide band tuned circuits are essential in all circuits following a nonlinearity in an fm receiver. If adequately wide band tuned circuits are used, the desired signal does not lose control of the limiters and the discriminator. Consequently, loss of readability of a signal occurs at an appreciably lower signal-to-noise ratio.

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2. Sky-Wave F-M Receiver, L. B. Arguimbau and J. Granlund, *Electronics*, Dec. 1949, p 101.

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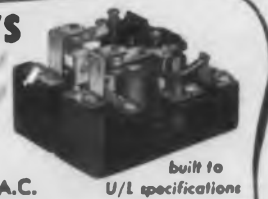
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Improved Selenium Rectifier No Center Mounting Shaft



A new selenium rectifier of standard 65-mil rating but of improved construction that offers major advantages is pictured here. There is no center mounting shaft; the individual cells

are placed flat against each other like pages in a book and there is no air space between cells. This new construction is more rugged, gives greater protection against moisture, and gives each cell a larger effective area. The metal "wrap-around" protects the rectifier against physical damage and provides thermal coupling to the chassis.

Federal Telephone and Radio Co., Dept. ED, Components Div., 100 Kingsland Road, Clifton, N.J.

CIRCLE 37 ON READER-SERVICE CARD FOR MORE INFORMATION

Humidity Sensing Element Uses Semiconductor Principles



A new type of electric humidity sensing element has been designed using thin films which have charge patterns on the molecules.

Energy bands are set up in the films which are controlled by water molecules in the air close to the film.

The elements will operate over a temperature range to 200 F. An all glass unit will operate up to 600 F. The unit has good stability and reproducibility.

Photo-Crystals Inc., Dept. ED, 15 South First St., Geneva, Ill.

CIRCLE 38 ON READER-SERVICE CARD FOR MORE INFORMATION

Transistorized Generator Square Wave Output



This miniaturized, transistorized square wave generator covers the frequency range from 5 cps to 30 kc; and delivers a peak-to-peak voltage output that may be varied from 1 v to 1 mv. Output wave has a rise time of 0.25 usecs and is flat at top and bottom. Operating temperature is 0 F to 140 F.

Required power source consists of nine standard "C" size flashlight cells. In this application the cells have an approximate service life of 1500 hours, continuous operation.

Burr-Brown Research Corp., Dept. ED, Route 4, Box 139, Tucson, Arizona.

CIRCLE 39 ON READER-SERVICE CARD FOR MORE INFORMATION

Tuneable RF Probe 900 to 18,000 Mc



The rf probe Model 229 has a fine wire, which is adjustable in depth over a wide range by means of a fine-pitch threaded knob, and which in effect is an extension of the center conductor of a coaxial line. This line is provided with shunt and series tuning elements for tuning the probe pick-up over the range of 900 to 18,000 mc. The probe has two outputs. Its detector output takes a BNC series connector and has provision for either a Series IN21 or IN23 standard microwave crystal, or for a Narda N-610B bolometer. The rf output is for use with microwave receivers or other internal detectors. In most slotted lines probe insertion loss is 25 db or less.

Narda Corp., Dept. ED, Mineola, L. I., N.Y.

CIRCLE 40 ON READER-SERVICE CARD FOR MORE INFORMATION

Closed Circuit TV Monitor

Coax to Camera Unit

Requiring only one coaxial cable between itself and the camera control unit this 14-in.-screen TV monitor provides remote viewing of

information in industrial or broadcast television cameras, and remote control of camera pan, tilt, iris, focus and 3-lens turret. The remote controls, however, are not part of this unit; the rack mount model is designed to accept any three remote control units. The monitor itself consists of a 14-in. tube suitably mounted, and an installed video amplifier providing a bandwidth of more than 8 mc and a horizontal resolution better than 600 lines, available either in a cabinet or on a 19-in. rack-mounting chassis. Sync is obtained from the blanking pulses in the video waveform, and only one coaxial cable is needed between monitor and camera. Line amplifiers are not needed for distances up to 1000 feet; but operation at greater distances can be obtained by adding line amplifiers.

Kay Lab, Dept. ED, 5725 Kearny Villa Road, San Diego, Calif.

CIRCLE 41 ON READER-SERVICE CARD FOR MORE INFORMATION

Synchro Performance Meter

Accuracy ± 0.2 Per Cent



This meter, designated Model 100, reads the performance of synchros and synchro systems with a high degree of rapidity and accuracy. The reading is given in the form of percentage deviation of the actual synchro transformation ratio from ideal ratio. The instrument consists of

high-accuracy, expanded scale voltmeter, a precision voltage divider, and input switching. Full scale covers ± 3 per cent, smallest division is 0.1 per cent, and accuracy ± 0.2 per cent. Nominal input voltages are 57.3, 78, 90, 105, 115; frequency range 50-1000 cps, and impedance 10,000 ohm/v. Beckman Instruments, Inc., Dept. ED, Shasta Div., P. O. Box 296, Station A, Richmond, Calif.

CIRCLE 42 ON READER-SERVICE CARD FOR MORE INFORMATION



miniaturized CERA-MITE* capacitors for transistor radios

TRIED AND PROVEN in thousands of transistor radios, Sprague's miniaturized line of Cera-Mite* disc capacitors is building an enviable record of trouble-free service in the field.

Mass production of a standardized line of the five popular capacitance values in the new smaller 50 volt d-c sizes assures continued high quality.

Two widely separated plants, one at Nashua, New Hampshire, and another at Grafton, Wisconsin, assure our customers of a dependable source of

* Trademark

supply to meet production schedules.

Complete technical data on Cera-Mite capacitors for transistor applications is given in Engineering Data Sheet 6121. Write (on your business letterhead, please) for your copy to the Technical Literature Section, Sprague Electric Company, 347 Marshall Street, North Adams, Mass.

Sprague on request will provide you with complete application engineering service for optimum results in the use of ceramic capacitors.

the mark of

SPRAGUE[®]

reliability

Export for the Americas: Sprague International Ltd., North Adams, Mass. CABLE: SPREXINT

CIRCLE 43 ON READER-SERVICE CARD FOR MORE INFORMATION

Smooth-Surface Cleanser

Cancel Static Fields

GTC-59 cleaning compound cancels static fields on glass, plastic or ceramic surfaces, cleans and degreases them, and coats them with a tough, dust repellent and water repellent protective coating. It contains no caustics or abrasives, and has been approved by the Air Force for use on such delicate equipment as electron-optical systems. It is available in 16 oz., 32 oz., gallon and drum containers; and is recommended by its maker not only for cleaning glass, plastic or ceramics, but also for stainless steel, porcelain, enamel, chrome and marble.

Beaver Laboratories, Inc., Dept. ED, 86-51 Palo Alto St., Hollis 23, N. Y.

CIRCLE 46 ON READER-SERVICE CARD

Elastomer-to-Metal Adhesives

Bond Many Materials

Natural rubber, Neoprene, GRS, Buna N or butyl may be bonded to carbon steel, alloy steel, stainless steel, aluminum alloys, magnesium alloys, die casting alloys, copper, brass, plated metals and rigid plastics by synthetic polymers and reagents designated Chemlok 201 and 220. When Chemlok 201 is used as a primer for Chemlok 220 the resulting bond resists wide temperature variations, hot and cold water, salt spray, solvents and corrosive atmospheres. In suitable circumstances, Chemlok 220 may be used without a primer. Metal parts may be coated with Chemlok at room temperature by any of a number of methods, such as brushing, spraying, dipping or rolling; the resultant surface is non-tacky and non-smearing. Coated metal parts may be stored for up to four weeks before the rubber, etc., is bonded to them.

Lord Mfg. Co., Dept. ED, 1635 W. 12 St., Erie, Pa.

CIRCLE 47 ON READER-SERVICE CARD

Correction

The precision potentiometer, Helipot Series 5300, announced on page 74 of the November 1 issue was erroneously stated to have a diameter of 1-1/2 in. The correct diameter is 1-1/4 in.

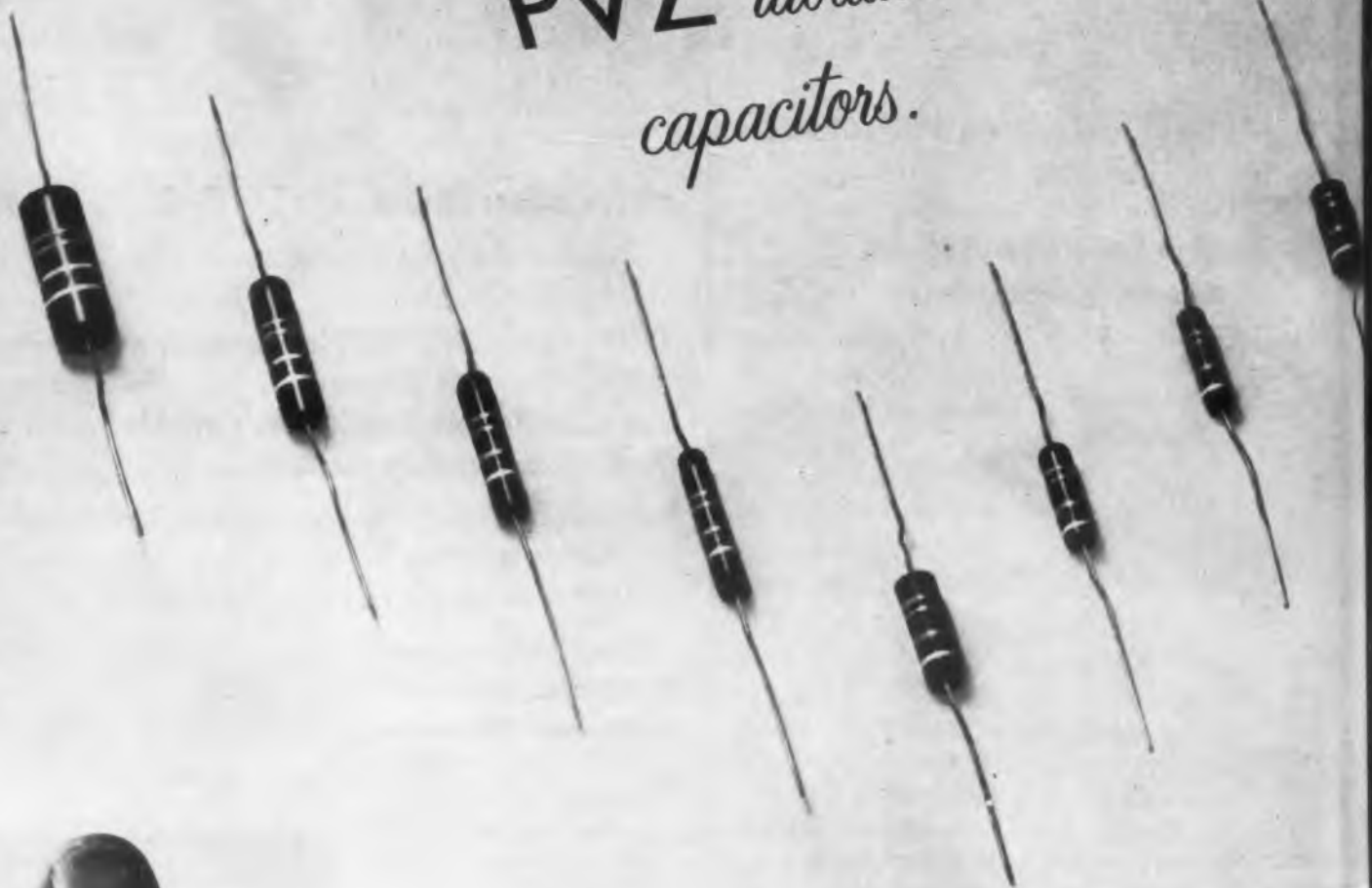
CIRCLE 48 ON READER-SERVICE CARD >



CAPACITORS

Announcing

*A high quality line of paper capacitors.
General Electric's molded
PVZ tubular
capacitors.*



A new line:

General Electric's molded PVZ* tubular capacitors operate from -55 C to $+125\text{ C}$... yet are moderately priced

The new General Electric molded PVZ paper tubular capacitors meet the electronic designer's need for a high-quality line that offers, at a moderate price, characteristics similar to "K" of MIL-C-25A.

- Price of the units is less than one-half that of a comparable metal-clad tubular.
- They are designed for a minimum of one year's life, operating at 125 C , rated voltage.
- Insulated bodies are easy to locate in the chassis, and provide protection from other parts or ground.
- They are small, both physically and electrically, in order to aid equipment miniaturization.
- They are solid—resistant to shock and vibration.

In general, you will find these molded PVZ paper tubular capacitors suitable for use where you might normally expect to find either 85 C or 125 C metal-clad tubular capacitors; in computers, missiles, telephone equipment, and

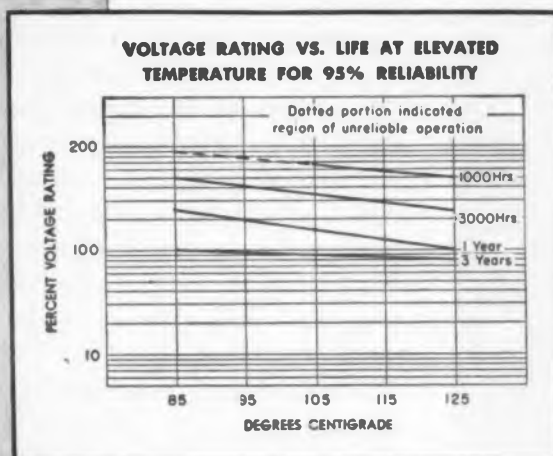
other high-grade military and commercial electronic equipment.

Microfarad ratings extend *down* to .00047 uf—100 to 400 volts; *up* to .15 uf—100 volts, .1 uf—200 volts, .068 uf—300 volts, and .022 uf—400 volts. Capacitance ratings are available with $\pm 20\%$, $\pm 10\%$, $\pm 5\%$ tolerances.

In many instances, the units are physically smaller than equivalent metal-clad tubulars, especially if the metal-clads are insulated. PVZ capacitors range in size from .175" diameter x $\frac{5}{8}$ " long to .375" diameter x $1\frac{1}{16}$ " long. Nine different sizes are offered to accommodate the various ratings.

READY NOW: Stocks of most sizes and ratings of General Electric's new PVZ capacitors are on hand, ready for shipment. If you would like to receive technical data on the new line get in touch with your local G-E Apparatus Sales Office or write to the General Electric Company, Section 442-43, Schenectady 5, N. Y.

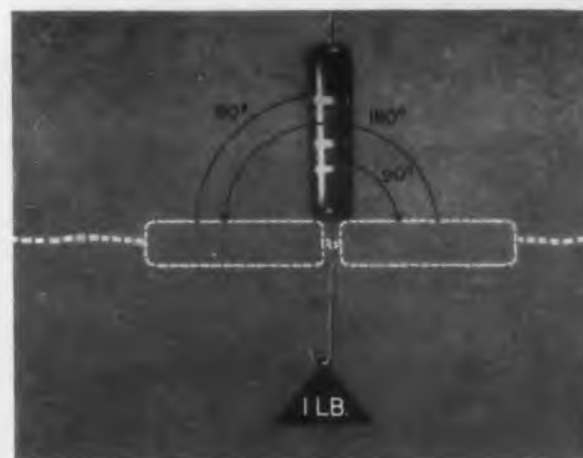
*A General Electric Trade-mark.



OPERATES FOR 1 YEAR AT 125 C Molded PVZ capacitors are designed for a minimum of one year's life at rated voltage and 125 C operation. Curves shown above are typical of performance.



EXCELLENT HUMIDITY CHARACTERISTICS Molded PVZ capacitors withstand stringent humidity tests, thanks to a combination of high-grade case material and carefully-controlled molding techniques.



HIGH LEAD BEND RESISTANCE The new capacitors withstand one-pound-vertical-pull test moving the body of the unit 90° , then 180° in the opposite direction, then back 90° , to the original vertical position.

Progress Is Our Most Important Product

GENERAL  ELECTRIC

Automatic Electric Typewriter

120 Words Per Minute

Designed for use as an input and output device for the data processing field, a new electric typewriter has been developed.

Automatically typing at a rate of 120 words a minute or approximately twice as fast as the average typist, it can be used in conjunction with computers as well as with measuring and recording instruments, scales, and meters in such applications as engine testing, liquid flow through pipelines, production control, wind tunnel research and others, to provide a visual record.

The input-output typewriter is operated by a series of electro-magnets and solenoids mounted beneath the keyboard. The magnets and solenoids act as receivers of signals transmitted from the controlling device, or computer, and automatically actuate keyboard functions of the typewriter, including carriage return, spacing, tabulation, ribbon color control and others.

International Business Machines Corp., Dept. ED, 590 Madison Ave., New York 22, N.Y.

CIRCLE 49 ON READER-SERVICE CARD

Rubber Products That Cling

In Rolls, Shapes and Forms

Available either in continuous length rolls of many sizes, or die cut to specifications, or fabricated in specified shapes and forms, polyurethane foam rubber products are now supplied with "non-stretch" pressure sensitive adhesive coatings. These pressure sensitive coatings attach the product to practically any surface—all that is necessary is to remove the protective paper backing and press the product firmly against the surface. These products, relatively new to the American market, have the ability to resist oils, solvents and aging. They are of high compression strength, provide excellent sound insulation, and are available in a wide range of colors.

Durable Rubber Products, Dept. ED, 609 W. Lake St., Chicago, Ill.

CIRCLE 50 ON READER-SERVICE CARD

◀ CIRCLE 48 ON READER-SERVICE CARD



**ULTIMATE IN
TOROIDS
FILTER NETWORKS
MAGNETIC
AMPLIFIERS**

When you "team up" with C-A-C, you have at your disposal an outstanding engineering staff...backed by facilities of the world's largest exclusive producer of toroidal components.

**COMMUNICATION
ACCESSORIES COMPANY**

Hickman Mills, Missouri • Phone Kansas City, South 1-6111

*A Subsidiary of the
Collins Radio Company*

C-117

Copper Clad Sheets

Photo Sensitive

With these photo-sensitized copper clad sheets any etched circuit panel may be produced in any quantity on the user's premises. Processing chemicals and supplies are also available. The sheets are available in any rectangular size desired up to 18 in. x 21 in.

This method of processing produces circuit boards to satisfy critical applications. Extremely fine circuit detail and exact circuit reproducibility is obtainable.

Requirements on the part of the user necessitates exposing, developing and etching to a finished panel. Large sheet sizes allow the preparation of more than one circuit panel simultaneously.

Sample quantities for experimental and prototype use may be obtained in kit form which supplies the presensitized sheet, all processing chemicals and handling equipment.

Keil Eng. Products, Dept. ED, 4358 Duncan Ave., St. Louis 10, Mo.

CIRCLE 52 ON READER-SERVICE CARD

Feed-Through Terminal

For High Horsepower

A higher horsepower hermetically sealed electrical feed through terminal has a range to 7-1/2 horsepower at 220 v. Specifically designed for high horsepower applications, it is made in both singles and three pin multiples. The new terminals feature special glass extensions on the pins both top and bottom to provide over the surface spacing necessary to meet Underwriter Laboratories specifications. Increasing the current carrying characteristic is the copper core stainless steel pin. This core runs the entire length of each pin.

Connections to the electrical source and the hermetic motor are made through a mechanical spade type connector. Male spade or tab is resistance welded to the terminal electrodes. Female portion of the connector is attached to lead wires.

Fusite Corp., Dept. ED, 6000 Fernview Ave., Cincinnati 13, Ohio.

CIRCLE 53 ON READER-SERVICE CARD

← CIRCLE 54 ON READER-SERVICE CARD

Lettering-Slot-Guide Template

Simple to use

Announced is a new convenient lettering-slot-guide template made of 0.060 in. thick acrylic material which is durable, shatterproof and transparent. The template is cut in five guide slots in the popularly needed sizes of 1/8, 3/16, 1/4, 3/8 and 1/2 in. Five circles in these same sizes have also been incorporated. In addition, the top of the template is a 6 in. ruler in 16ths and the bottom a 6 in. ruler in mm.

Compact and handy (overall size 1-1/8 x 6-3/4 in.), this template is designed to give an unlimited choice of lettering or numbering in slant, broad or narrow characters wherever uniform capitals or lower case letters are required.

Alvin & Co., Dept. ED, Windsor, Conn.

CIRCLE 56 ON READER-SERVICE CARD

Flexibly Sealed Resistors

Precision Wire-Wound

Precision grade wire-wound resistors have been developed that combine the advantages of resin embedment and hermetically sealed metal cans. These units can be supplied oil-filled, wax-filled, etc., where special conditions so require. In any case the seal forms a vulcanized bond, with flexibility sufficient to compensate for differences in expansion coefficients of the components. No void is needed to compensate for pressure increases resulting from expansion of the filler, while the non-metallic nature of the enclosure results in better frequency stability. The resistors are produced in two classes, A and H; A having a temperature range from -30 C to +250 F; while the temperature range of Class H is from -130 C to +250 C. Both classes exceed the requirements of MIL-R-93A with respect to voltage overload, salt water immersion, salt spray, 100 per cent humidity, temperature cycling and stability resistance.

Dmeter Mfg. Co., Dept. ED, 22-24 Larkin Plaza, Yonkers, N. Y.

CIRCLE 57 ON READER-SERVICE CARD

CIRCLE 58 ON READER-SERVICE CARD >

WHERE ELECTRONICS MEETS THE EYE

**marion
MEDALIST
meters**

marion
advancement
in instrument
design

Three things set Medalists apart from other panel instruments: style, color and readability. Their distinctive shape enhances whatever equipment they become a part of; standard or custom-matched case and dial colors further improve equipment appearance. Longer scale length, larger numerals and better over-all dial illumination vastly increase their readability.

Medalists are made in all standard ranges, in 1 1/4", 2 1/4" and 3 1/4" sizes. They provide a functional beauty that is unique among panel instruments today.

marion electrical instrument company
GRENIER FIELD, MANCHESTER, NEW HAMPSHIRE

At the I. R. E. Show, March 18-21:
Booth 2126

Copyright © 1967, Marion

The Greatest Names in British Electronics use

Mullard Tubes

British equipment manufacturers are making a vital contribution to the development of electronics in all fields of application.

Their products are being exported to every corner of the world, earning a universal reputation for advanced techniques and excellent performance.

The majority of these electronic equipment manufacturers consistently use Mullard tubes. This choice is decided upon because they prefer the greater assurance of efficiency and dependability, and because the vast manufacturing resources of the Mullard organisation guarantee ready availability of Mullard tubes wherever they are needed.

Supplies of Mullard tubes for replacement in British equipments are available from the companies mentioned below:—

In the U.S.A.

International Electronics Corporation,
Department ED2,
81, Spring Street, N.Y. 12.
New York, U.S.A.

In Canada

Rogers Majestic Electronics Limited,
Department JB,
11-9 Brentcliffe Road,
Toronto 17, Ontario, Canada

Mullard

Electronic Tubes — used throughout the world

MULLARD OVERSEAS LTD., MULLARD HOUSE, TORRINGTON PLACE, LONDON, ENGLAND

Mullard is the Trade Mark of

Mullard Ltd. and is registered in most of the principal countries of the world



MEV 45

CIRCLE 60 ON READER-SERVICE CARD FOR MORE INFORMATION

Audio Spectrum Analyzer Speeds Design, Production



To speed up laboratory and production processes, simplify testing and trouble-tracing, and improve product performance is the object of the sonic analyzer LP-1a, used for spectrum analysis of sounds, vibrations and waveforms. With this analyzer, any audio-frequency parameter, having first been converted to an electrical waveform by a sensing device such as a microphone, is presented as a visual waveform picture. Relative strength of various components, individual distortion components, changes in energy, and the like can be seen, measured and recorded. Frequency and amplitude data can be compared and analyzed. The LP-1a is versatile, substituting for many different types of machines and testing methods, and eliminating complicated point by point measurements.

The LP-1a sonic analyzer (an improved version of the same manufacturer's earlier model, the LP-1) provides a logarithmic sweep range of 40 to 20,000 cps. It identifies mechanical and electrical defects and variations. It is used to make fine adjustments, to improve the design of such products as jet and reciprocating engines, electric motors, and other types of rotating or oscillating machinery.

A companion, optional feature is a recorder, which may be added to make a permanent record of waveform content over extended periods. Tuning controls allow the selection of narrow bands within the frequency range for recording and subsequent analysis.

Panoramic Radio Products, Inc., Dept. ED, 10 S. Second Ave., Mount Vernon, N. Y.

CIRCLE 61 ON READER-SERVICE CARD FOR MORE INFORMATION

Small 120 Kv Capacitors Have Corona Shields



Among the very smallest high voltage capacitors commercially available, these units function in 10 kv to 120 kv range, and feature corona

shields of spun aluminum to permit closer operation. They are designated as the type OT.

Plastic Capacitors, Inc., Dept. ED, 2620 N. Clybourn Ave., Chicago, Ill.

CIRCLE 62 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • February 1, 1957

High-Mu Triode

Sharp-Cutoff Pentode

The 6AW8-A is a general-purpose high-mu triode, sharp-cutoff pentode of the 9-pin miniature type intended for application in television receivers. The pentode unit is especially useful as a video amplifier tube, video intermediate-frequency amplifier tube, or as an automatic-gain controlled amplifier tube. The triode unit may be used in sync-amplifier, sync-separator, sync-clipper, and phase-inverter circuits.

The 6AW8-A is like the popular 6AW8 but features a pentode unit having a plate-current characteristic with a controlled knee to provide good linearity at relatively low plate voltage and a high value of transconductance (9000 μ mhos). In addition, this tube is designed with a 600-ma heater having a controlled warm-up time to insure dependable performance in television receivers employing series heater-string arrangement. The 6AW8-A has two cathodes with individual base-pin terminals.

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

CIRCLE 64 ON READER-SERVICE CARD

Tape Resistive Strip

Versatile For Wide Applications

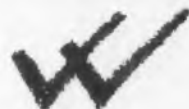
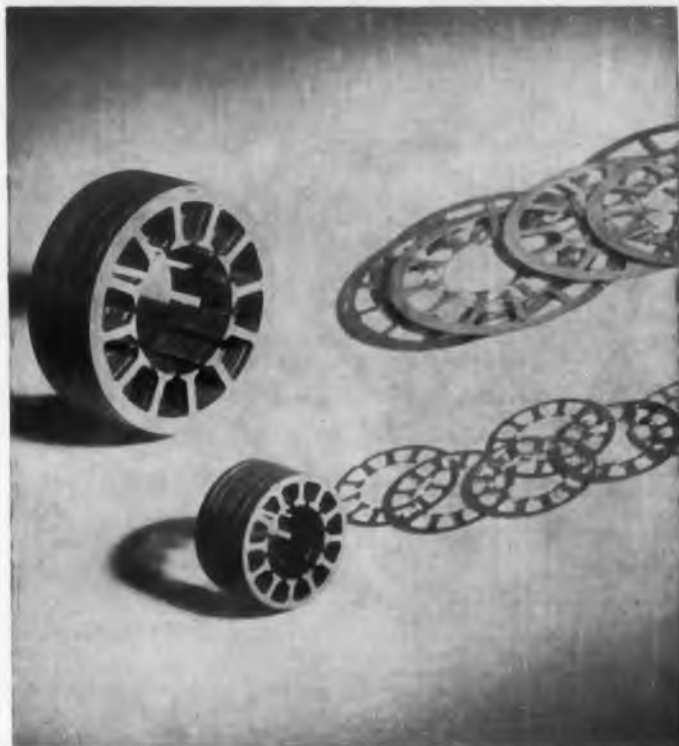
Stripline and waveguide dissipative cards made by the Tape Resistor Process have a thickness of only 0.008 in. This allows operation at much higher frequencies in waveguide. A further advantage with stripline is that cards may be sandwiched between stripline boards with much less interference than with thicker boards which are usually about 1/32 in. thick. Scissors may be used to cut the strip into triangular and other shapes as required to give matching. HF-1 Resistive Strip has standard dimensions of 1 x 3 in. and values of 50, 100, and 200 ohms per square. Other sizes and values are available.

Hansen Electronics Co., Dept. ED, 117 Santa Monica Blvd., Los Angeles 46, Calif.

CIRCLE 65 ON READER-SERVICE CARD

CIRCLE 66 ON READER-SERVICE CARD ►

C I B A



*Ciba Araldite Epoxy Resins come with the assurance that they have met not only our rigid PRODUCTION quality control standards but the specific APPLICATIONAL requirements of the user as well.

Ciba produces basic resins only which are formulated for intermediate and end uses by accredited formulators.

Araldite® First in Epoxies

Wherever great strength with light weight, excellent electrical properties, chemical resistance, and an ability to adhere to almost every kind of surface are needed, Araldite "Double Check"* Epoxy Resins are ready to step in with this unbeatable combination of properties unavailable before in one class of basic resins. Results? Case histories like these to point the way to advance your own engineering planning and stream-line production with overall savings in time and money that will bring the all-important "plus" to your profit picture!

PRECISION... IN MINIATURE!

High bond strength and excellent electrical properties of Araldite Epoxy Resins make possible the design and production of this chatter-less stator.
Formulator: Rubber & Asbestos Corp.
Customer: Kollsman Instrument Company.

WHEN PRECISION COUNTS—

Lower photo shows how the outstanding electrical, adhesive and mechanical properties of resins based on CIBA Araldite Epoxies facilitate the precise machining of slip ring assemblies.
Courtesy: Electro-Tec Corp.

CIBA Formulator: Houghton Laboratories, Inc.

The Technical Services of Ciba's Plastic Division are the finest in their field. For full information on how Ciba Araldite Epoxies lead to product development and production improvements, write...

CIBA COMPANY INC., Plastic Division
Dept. 2, Kimberton, Pennsylvania

ED-2

Please send me full information on CIBA Epoxy Resins for

<input type="checkbox"/> Tooling	<input type="checkbox"/> Structural Laminates	<input type="checkbox"/> General
<input type="checkbox"/> Electrical	<input type="checkbox"/> HI-Strength Adhesives	<input type="checkbox"/> Surface Coatings
		<input type="checkbox"/> Plastic Body Solids

NAME _____

COMPANY _____ TITLE _____

ADDRESS _____

CITY _____ STATE _____

Chromatograph Scanner Charts Radioactivity



Accurate graphical presentation of the activity distribution along a paper chromatogram which has been tagged with low-energy beta-emitting isotopes is provided by this automatic radioactive chromatograph scanner. The scanner has important advantages over a rectilinear chart. Any of ten different scanning speeds can be selected by setting a lever. Chart and chromatogram speeds are always identical, facilitating reading the result by simple alignment. Chromatograms up to 3 in. width and 5 ft length can be accommodated.

The radioactive chromatograph scanner can be operated without a window to increase its sensitivity to C-14, S-35, H-3, etc. If used with a window, contaminated windows can be exchanged in a few seconds for a cost of less than one cent. All parts of the instrument are designed for easy de-contamination; the scanning head has been made readily removable for that purpose.

Scanning is interrupted automatically when the end of the chromatogram is reached, and in addition an audible signal is given to alert the operator. The instrument is portable, weighing only 32 pounds, and is provided with a convenient carrying handle.

Forro Scientific Co., Dept. ED, 833 Lincoln St., Evanston, Ill.

CIRCLE 69 ON READER-SERVICE CARD FOR MORE INFORMATION

100 Kc Quartz Crystals For Secondary Standards






This quartz crystal unit is sealed in glass and intended for use in secondary frequency standards. It is a DT-cut, 100-kc element with a tolerance of ± 5 ppm at 70 C, and a temperature coefficient of less than 0.7 ppm per degree C between ± 65 C and ± 75 C. The unit, designated BG9D-S, measures 3-1/16 in. overall, and is mounted in T-9 bulb with a standard octal base.




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

CIRCLE 70 ON READER-SERVICE CARD FOR MORE INFORMATION

Switching Problems?...

ELECTRO-SNAP ENGINEERING CAN HELP YOU

	MINIATURES			BASICS				MULTI-POLE		
										
DESIGNATION	E4			S1				D8		
CIRCUIT ARRANGEMENTS	SPST NC	SPST NO	SPDT	SPST NC	SPST NO	SPDT	SPDT 2 Ckt.	DPDT NC	DPDT NO	DPDT 4 Ckt.
AMPS-LIFE @ 125/250 V. AC	2.5A-150,000 CYLS.			10A-750,000				15A-500,000		
AMPS-LIFE @ 30 V. DC IND.	2.5A-50,000 CYLS.			10A-200,000				10A-500,000		
TEMPERATURE RANGE	-65° TO +250° F.*			-100° TO +375° F.*				-100° TO +375° F.*		
WEIGHT	.005 lbs.			10 GRAMS				15 GRAMS		
SIZE (INCHES)	27/32 X 23/64 X 0.260			1-1/4 X 1/2 X 1/2				7/8 X 1-1/4 X 1/2		
COMMENTS	Vibration/shock resistant, precise operation.			To 10,000,000 Ops. @ 1 Amp. 125 V. AC.				Simultaneous operation; poles may have different voltages.		

	MINIATURES			BASICS				MULTI-POLE		
										
DESIGNATION	EF			G3				K3		
CIRCUIT ARRANGEMENTS	SPST NC	SPST NO	SPDT	SPST NC	SPST NO	SPDT	TPST 2 Ckt.	TPST NC	TPST NO	TPDT 6 Ckt.
AMPS-LIFE @ 125/250 V. AC	2.5A-150,000			40A-100,000				15A-500,000		
AMPS-LIFE @ 30 V. DC IND.	2.5A-50,000			30A-100,000				10A-500,000		
TEMPERATURE RANGE	-65° TO +180° F.			-65° TO +300° F.*				-100° TO +275° F.*		
WEIGHT	1 OZ. APPROX.			20 GRAMS				30 GRAMS APPROX.		
SIZE (INCHES)	19/32 X 15/16 X 11/32			1-3/4 X 43/64 X 35/64				1-15/16 X 1-1/4 X .491		
COMMENTS	Sealed against dust, dirt, moisture, and corrosion.			Unusual space/capacity achievement; long life; can be ganged.				Reverses 3 ph. motors to 1 HP. Simultaneous make & break. Excellent life.		

* OTHER MODELS AVAILABLE IN TEMP. RANGES FROM -100° TO +400° F.

*Need a
Special
Switch?*

Often, a standard or modified-standard switch will do your job. But Electro-Snap engineers are ready to create truly unique switches in any quantity to your specifications. Send us your problem . . . our answers can save you time and money.



CIRCLE 71 ON READER-SERVICE CARD FOR MORE INFORMATION

Switching problems resulting from new size, weight, rating, environment, circuit simplification, or cost requirements can be time consuming and expensive to solve if tackled alone. But Electro-Snap engineering can save you time, money and performance—and usually with “standard” switches—if you bring your switching problems to us. The switches and actuators on these pages may solve some of your problems immediately, but they are only a fraction of the thousands of

switch configurations available “off-the-shelf” at Electro-Snap. Remember that *all* Electro-Snap switches have self-wiping contacts and quick, positive snap action . . . and are built to the toughest aircraft and industrial specifications. Complete data are available for every switch so you always deal with known quantities—no wasted time in finding out for yourself. Ask for this data. Use the coupon below, write us your problem directly.

HERMETICALLY-SEALED

DIE-CAST



H1-43

ES4-KM

DPDT

SPDT
NO

SPDT
2 Ckt.

10A-200,000

10A-MIN 100,000

10A-200,000

-100° TO +250° F.

-67° TO +160° F.

8 oz.

4-1/2 oz.

1-1/4 X 3-3/4 X 1-7/32

1-3/4 X 2 X 1-1/32

Hermetically sealed case; adjustable actuator arm. New “Landing Gear Switch”.

Impulse one way, opens circuit during over-travel and return.

HERMETICALLY-SEALED

DIE-CAST



H10-7

ES4-D

DPDT
4 Ckt.

DPDT 4 Ckt.

10-50,000

15A-500,000

15-50,000

10A-500,000

-100° TO +250° F.

-67° TO +160° F.

6 oz. APPROX.

7 oz.

1-7/64 X 2-1/8 X 1-7/16

2-1/2 X 2 X 1-3/4

Rotary actuator with seal bonded to shaft AND case; 120° travel.

Environment free; good for machine tool applications; wet areas.

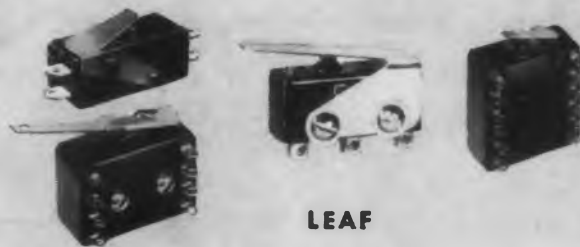
TYPICAL ACTUATORS



TOGGLE



PUSH BUTTON



LEAF



ROLLER



GANG

Colored Toggle Switches

Eye Appeal and Coding



A new toggle switch with toggles of colored plastic in many colors improves the eye appeal of commercial appliances, and facilitates color coding of multi-circuit panel boards. These switches are available in sp, dp and center-off types; with screw, solder, or quick dismount spade terminals, or with wire leads. They

are rated for up to 20 amps, and 1 hp, and carry the Underwriters' label of approval.

Carling Electric, Inc., Dept. ED, West Hartford, Conn.

CIRCLE 72 ON READER-SERVICE CARD FOR MORE INFORMATION

Motor-Gearhead-Clutch

Bu Ord Size 10



Designed to operate directly from either a 115v or 26v 400 cps line, this motor-gearhead - clutch measures only 0.938 in. in diameter and 1.75 in. long. It conforms to the requirements for Bu Ord

size 10 specifications, and to MIL-E-5400.

Input power per phase at stall is 3.0 watts, motor stall torque 0.26 oz.-in. no load speed 7000 rpm, rotor inertia 0.46 gm-cm², backlash at gearhead 30 min max, continuous torque rating of gearhead 25 oz.-in., available slip clutch settings 2 to 25 oz.-in., gearhead efficiency 90 per cent min. and weight 2.1 oz.

Available standard gear ratios are 4.8, 6.4, 8.1, 11, 14, 18, 24, 30, 39, 53, 67, 90, 115, 150 and 200. Gear ratios up to 10,000 are available to order (with increase in the length of the unit). Special voltage and power ratings, and extra high internal damping, also are available on request. The internal slip clutch, which protects both gearing and loads when operating under high stall torque conditions, can be omitted if desired.

The unit is installed and completely encased in an aluminum housing. The pinion shaft is 0.1250 in. in diameter and protrudes 7/16 in.

Servomechanisms, Inc., Mechatrol Div., Dept. ED, 625 Main St., Westbury, N. Y.

CIRCLE 73 ON READER-SERVICE CARD FOR MORE INFORMATION

MAIL COUPON FOR CATALOG DETAILS



ELECTRO-SNAP SWITCH & MFG. CO.

4216-30 W. Lake St., Chicago 24, Illinois

Please send complete information on the Electro-Snap Switches checked below:

- Miniature Switches
 Basic Switches
 Multi-Pole Switches
- Hermetically-Sealed Limit Switches
 Die-Cast Limit Switches

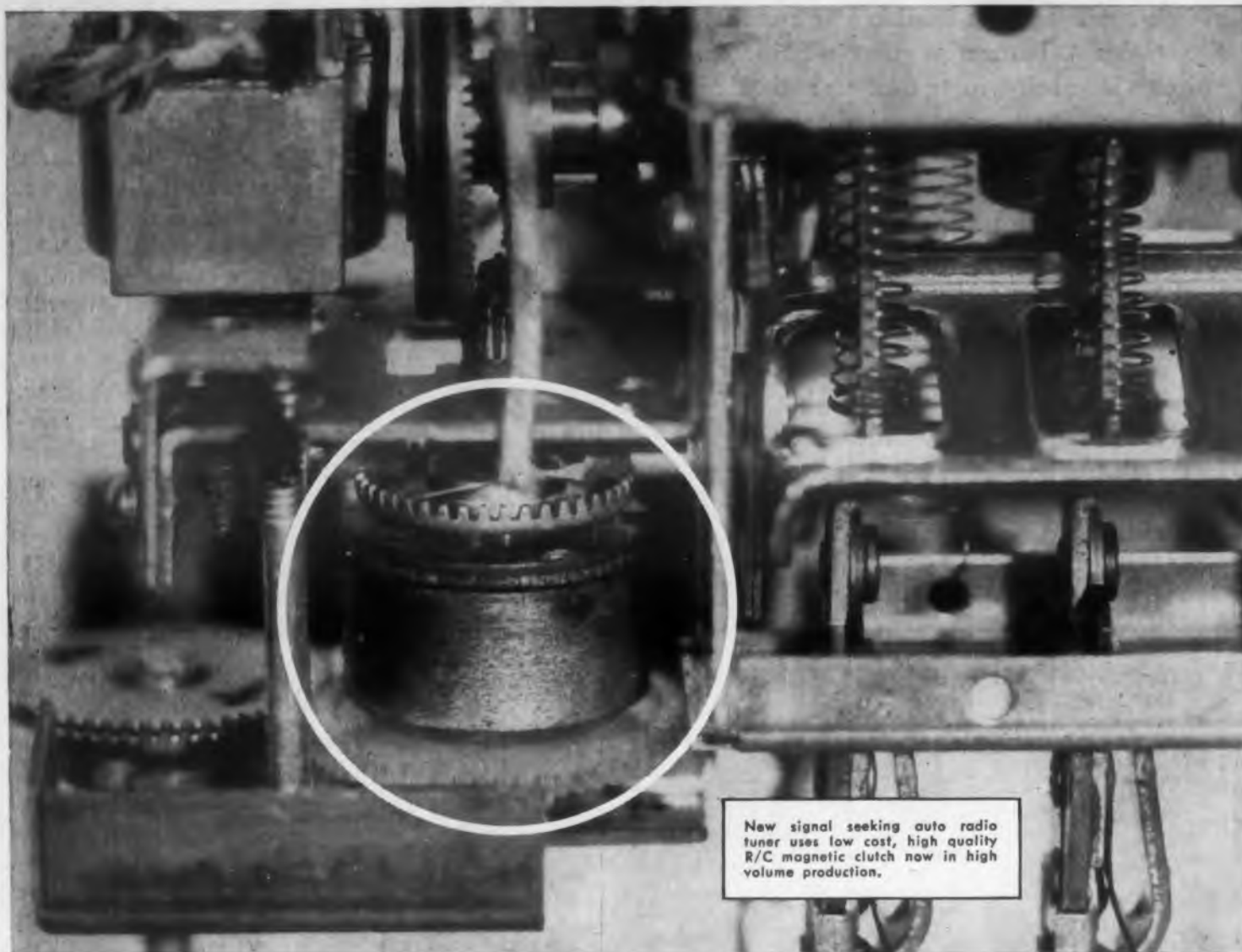
Name _____

Company _____

Street _____

City _____ Zone _____ State _____

CIRCLE 71 ON READER-SERVICE CARD FOR MORE INFORMATION



New low cost magnetic clutches from



Now you can get the same magnetic clutches used in today's finest signal seeking radio tuners. Originally designed by R/C for the rigid price-performance requirements of the automotive industry, they are finding new applications throughout electrical manufacturing. Designers are using them to replace cumbersome, complex assemblies . . . to save space and eliminate costly production steps. They show further promise in accomplishing jobs now being wastefully done with heavy duty and servo types at fifty to one hundred times the cost.

Two types of R/C magnetic clutch are in high volume production now. Designed for operation at from 11 to 16.2VDC, they are also available for 32V operation . . . and can be further modified to meet your special requirements.

We'll be happy to send you complete information on the two types shown, or if you wish, we'll have an R/C engineer at your desk ready to work with you to better fit R/C clutches to your needs.



CIRCLE 75 ON READER-SERVICE CARD FOR MORE INFORMATION

RADIO CONDENSER CO.

Davis & Copewood Streets • Camden 3, New Jersey
 EXPORT: Radio Condenser Co., International Div., 15 Moore St., N.Y. 4. N.Y.
 CABLE: MINTHORNE
 CANADA: Radio Condenser Co. Ltd. 6 Bermondsey Road, Toronto, Ontario

Operating Characteristics Of New R/C Magnetic Clutches	
Voltage	11 to 16.2V 32V also available
Torque	8 in.-oz. minimum
Residual Torque	0.3 in.-oz. maximum
Operating Temperature	130F to -20F
Relative Humidity	tested to 95%
Life	successfully completed 120,000 operations with no sign of failure

Temperature Controllers

Thermistor-Actuated



Two dual-range models thermistor-actuated temperature controllers can be used for sub-zero applications. The operating ranges of Model 56006 are 200 to 600 F and 100 to 300 F, providing a total coverage of 100 to 600 F. Model 56007 will cover -100 to +50 F and 0 to 150 F, providing a total spread of -100 to +150.

The ranges can be switched instantly without recalibration or other adjustment.

These controllers deliver exceptionally accurate control (0.25 per cent over their entire control range). Connecting leads can be up to 200 ft long, using ordinary electrical wiring without diminishing sensitivity and control accuracy. The instrument is ruggedly-built, is not position sensitive, and can be moved without affecting accuracy or calibration. Because of the high stability and excellent aging characteristics of the thermistor sensing element, the controller can be operated for periods of several months or more without recalibration. Recalibration is done simply with screwdriver adjustments without external reference standards.

The controllers contain an integral spdt power relay rated at 10 amps, 115 v ac. Separate circuits for indication and control make these two functions independent.

The thermistor sensing element can be supplied encased in a stainless steel probe 3/16 or 1/8 in. in diameter and 2 to 5 in. long, with a choice of three types of mounting heads.

Fenwal, Inc., Dept. ED, Ashland, Mass.

CIRCLE 76 ON READER-SERVICE CARD FOR MORE INFORMATION

Chopper in All Frequencies

Small-Size Series

Now available in all operating frequencies and models, a new series of choppers features reduced size, better dust seal and improved shielding. Measurements of this smaller unit are 2-5/8 in. high overall, and are 1-1/2 in. in diameter.



James Vibrapowr Co., Dept. ED, 4050 N. Rockwell St., Chicago 18, Ill.

CIRCLE 77 ON READER-SERVICE CARD FOR MORE INFORMATION

Thermal Time Delay Relay

Sub-Miniature Size

With a timing range from 3 to 120 seconds (± 10 per cent) this relay has a non-inductive contact rating of 3 amps either at 115 v ac or 28 v dc. It operates on 2.5 v to 115 v ac or dc; and can be supplied to order for voltages up to 220 ac or dc, as well as for 400 cps 115 v ac. Heater power is 3.75 w.



Overall size of the relay, exclusive of base pins, is 1-13/16 in. long by 0.750 diameter. Port is provided so adjustments can be made without removing the metal dust cover. The unit is supplied with solder lugs, 7-pin miniature, glass to metal pins.

Belltron Mfg. Co., Dept. ED, 463 Hoover Ave., Bloomfield, N. J.

CIRCLE 79 ON READER-SERVICE CARD FOR MORE INFORMATION

Electro-Hydraulic Control And Transistor Amplifier



A transistorized servo amplifier and electro-hydraulic servo valve for electro-hydraulic control of industrial machinery is made in two new "building block" components. They combine features of elec-

tronic signal sensing with hydraulic control of variable delivery pumps, hydraulic motors, cylinders, and similar equipment. The XRJ301A amplifier and the electro-hydraulic servo valve, XVJ300A, make it practical to apply hydraulic power to many applications previously limited to electric drives.

The fully-transistorized amplifier is designed to receive signal inputs from any standard 60-cy a-c signal source. The user can provide manually variable controls, can make the control source a function of position, velocity or other command variable, or can utilize input signals from tracers or computers. The amplifier is designed for parallel summation, ratio comparison, or series summation of input signals. Output is designed to power a balanced single load, or split loads, of as high as 5 w.

The amplifier supplies the driving power for the new electro-hydraulic, 3-way servo valve which, in turn, controls the flow of oil to hydraulic linear or rotary motion drives. The single stage servo valve is driven by a high performance torque motor and is available in ratings up to 10 gpm, and 3000 psi.

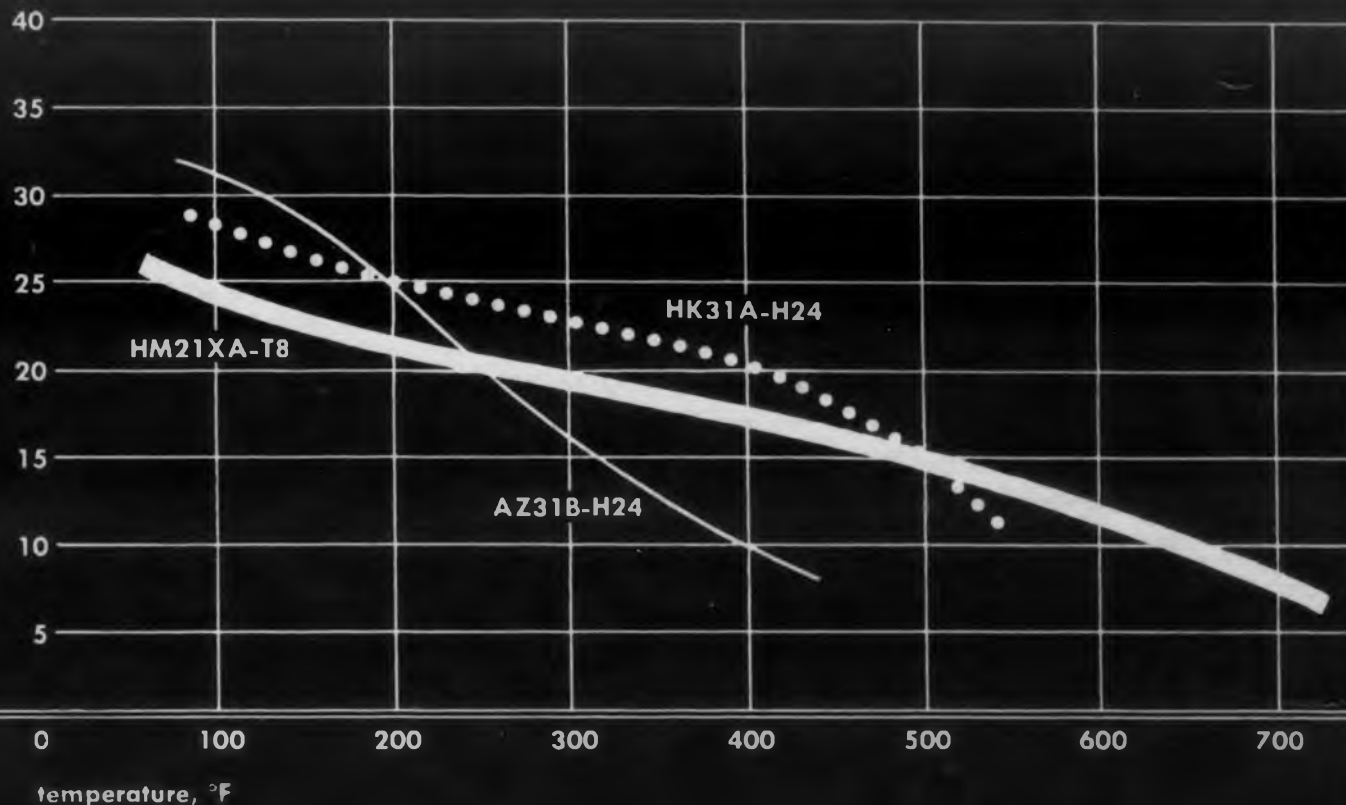
Minneapolis-Honeywell Regulator Co., Dept. ED, 275 1/2 Fourth Ave. S., Minneapolis, Minn.

CIRCLE 80 ON READER-SERVICE CARD FOR MORE INFORMATION

tensile yield strength 1,000 psi

tensile yield strength

of Dow magnesium alloys after 100 hours at temperature



New magnesium alloy holds properties for 100 hours up to 700°F.

Dow Magnesium HM21XA-T8 alloy extends further the range of conditions under which light metals can be used in aircraft design. Second in the series of sheet alloys designed specifically for elevated temperature applications, it supplements the excellent characteristics of HK31A alloy.

HM21XA-T8 retains its properties at temperature during long periods of time. Even one hundred hours at 700°F. results in relatively little change in tensile yield, creep and elastic modulus.

Magnesium lightness is combined with strength at elevated temperature in HM21XA-T8, offering new ways to save weight or gain increased rigidity in the design of missiles and aircraft. This alloy is supplied in the -T8 temper and can be formed in this temper without the need for further heat treatment after fabricating. Samples of HM21XA-T8 along with detailed information are available. Contact your nearest Dow Sales Office or write to THE DOW CHEMICAL COMPANY, Midland, Michigan, Department MA 1400L.

YOU CAN DEPEND ON

DOW

CIRCLE 81 ON READER-SERVICE CARD FOR MORE INFORMATION



**For
High Voltage,
High Current
CAPACITANCE**

**... in small space
... and trouble-free**

For lump capacitance at high voltage and/or high current, Lapp Gas-Filled Condensers offer the advantages of extreme compactness... low loss... high safety factor... elimination of puncture hazard... construction with gaskets which can be externally tightened under full operating

pressure... assurance of *long trouble-free service*. Variable and fixed units are available with capacitances to 30,000mmf; current ratings to 400 amps at 1 mc; operating voltages to 80 Kv peak. Write for Bulletin 302 with complete description and characteristics data. Lapp Insulator Co., Inc., Radio Specialties Division, 943 Sumner St., Le Roy, N. Y.



CIRCLE 83 ON READER-SERVICE CARD FOR MORE INFORMATION

Pressure Transducer

For Fuels or Gases



A new, small, low-cost pressure transducer for both airborne and ground applications is designed for reliable and accurate service with jet and piston engine fuels, lubricating and hydraulic oils, and air, carbon dioxide and oxygen.

Output signals may be either linear or to any desired curve, as required for actuating the appropriate control or measuring system.

The transducer will be available in pressure ranges of from 0 to 2 psi to 0 to 250 psi, although other ranges can be supplied as required. It is offered with potentiometer cards in resistance ranges of from 0 to 2000 ohms to 0 to 20,000 ohms. Current rating of a typical potentiometer is 10 ma at 5200 ohms, although other requirements can be handled. Models with resolution of better than 0.1 per cent are available.

Fitted with standard 3-pin connector plug terminals, and 1/8 in. ANPT or 7/16 in. 20NF3 pressure fittings, the units are hermetically sealed; all materials have been selected for galvanic similarity. Over-all length is 2-7/16 in., diameter is 2-7/8 in., weight is 6 oz.

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

CIRCLE 84 ON READER-SERVICE CARD FOR MORE INFORMATION

Electronic Demodulator Unit

30 Cps To 100 Kc



Suitable for portable and airborne applications because of its high degree of tolerance for severe vibration and shock, the Model ED-551 and ED-551L electronic demodulator compares an ac input with a fixed reference and furnishes a dc output that is a direct measure of the amplitude and phase comparison. Input range is 0-15 v rms, 30 cps to 100 kc, reference input

is 0-25 v rms; output 0-10 v dc. Dimensions are 1-1/2 in. x 3 in. The units are hermetically sealed. Model ED-551 plugs into a standard octal socket; Model ED-551L is mounted on a miniature 7-pin solder lug header.

Atlas Electro-Mechanical Labs., Inc., Dept. ED, 14734 Arminta St., Panorama City, Calif.

CIRCLE 85 ON READER-SERVICE CARD FOR MORE INFORMATION

**"Simplifies
assembly...
Improves
performance"**

SAYS:

**SARKES TARZIAN,
INC.**



**ART WIRE
UPSET
PINS**

Sarkes Tarzian, manufacturers of television and radio equipment, use Art Wire and Stamping Company's special upset pins because their uniformly high quality eliminates manufacturing problems. They say: "Through the use of this part we have simplified assembly and improved performance."

We supply upset pins of any workable metal or alloy in diameters from .010 to .090. Thickness of upset flange on head from .010 on fine wire to .062 on heavy wire. Flanges precision positioned to your specifications.

Precision manufacture on modern high speed machines results in uniformly high quality, lowest production costs.

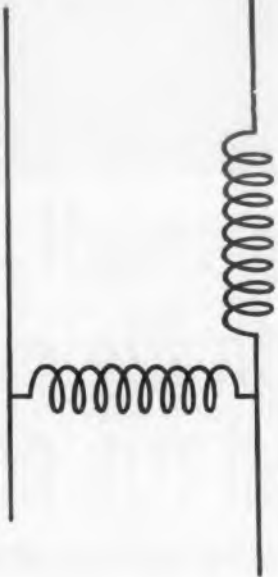
Why not let us quote on your next order? Send a blueprint or sample for a prompt estimate.



**ART WIRE
AND STAMPING CO.**

17 Boyden Place, Newark, New Jersey
CIRCLE 86 ON READER-SERVICE CARD

No Brushes



G-E Inductrol* Voltage Regulators Mean Reliability

Because it is an induction regulator, the Inductrol maintains $\pm 1\%$ a-c output voltage *without using brushes*.

This means radically lower maintenance costs than are possible with old brush-commutator type regulators. There are no brush inspection, cleaning, replacing, or stocking problems. There are no commutators to arc over or wear down. General Electric Inductrols mean precise, highly reliable, economical voltage regulation.

For more information, write Section 125-7, General Electric Co., Schenectady 6, N.Y., or contact your nearest General Electric sales office or agent.

*General Electric Trademark for induction voltage regulators.

Progress Is Our Most Important Product

GENERAL ELECTRIC

CIRCLE 88 ON READER-SERVICE CARD

Aircraft Sensing Relays Built to Requirements



Sensing relays for aircraft and other applications, built to requirements, are announced by Cook Electric Company. They are intended for accurate voltage sensing by means of a controlled differential between operate and release voltages. These relays are used, for example, in a miniaturized inverter failure warning device which meets the requirements of MIL-R-7611, Cook Electric Company part number 645-40. Another typical application is in the same company's 645-14 relay. This unit, working on 400 cps ac, has an operating voltage of 93 to 10 v, release voltage of 82 to 92 volts, and is normally adjusted for a differential of 5 v. The unit can be tailored to sense either ac or dc, and to meet a wide range of temperature, shock and vibration ratings.

Cook Electric Co., Dept. ED, Diaphlex Div., 2700 Southport Ave., Chicago 14, Ill.

CIRCLE 89 ON READER-SERVICE CARD FOR MORE INFORMATION

Rugged Missile Gyros Resist Severe Shock



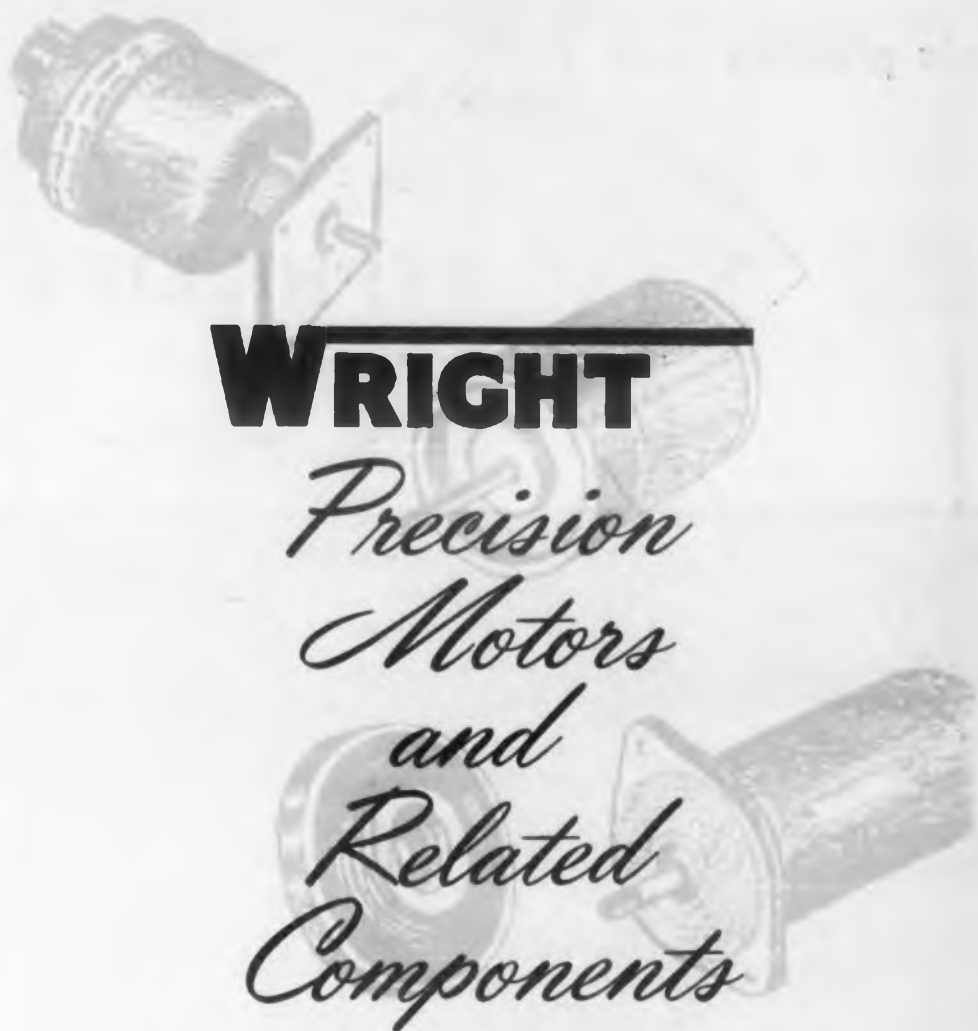
Designated Series RG03-0100, this gyro, designed specifically for missile applications, and built for severe shock and vibration requirements, more than conforms to MIL-E-527A. Advance design features include replacement of pivots and bearings by wheel and gimbal system, use of stand-

ard miniature motors, high natural frequency, potentiometer pickoff, pressure-sealed cases and floating piston dry air dampers. Conventional spin axis orientation permits easy interchangeability with other gyros.

The motor is 115 v, 400 cps, one or three phase. Standard potentiometer pickoff is 5000 ohms, power dissipation 1 watt, maximum. Available ranges are ± 10 deg/sec to ± 800 deg/sec. Resolution is 0.35 per cent, linearity ± 1.0 per cent, hysteresis ± 0.5 per cent, and angular momentum 250,000 cgs units. Weight is 14 oz. The case measures 2.47 in. high and 2.13 in. diam.

Humphrey, Inc., Dept. ED, 2805 Canon St., San Diego 4, Calif.

CIRCLE 90 ON READER-SERVICE CARD FOR MORE INFORMATION



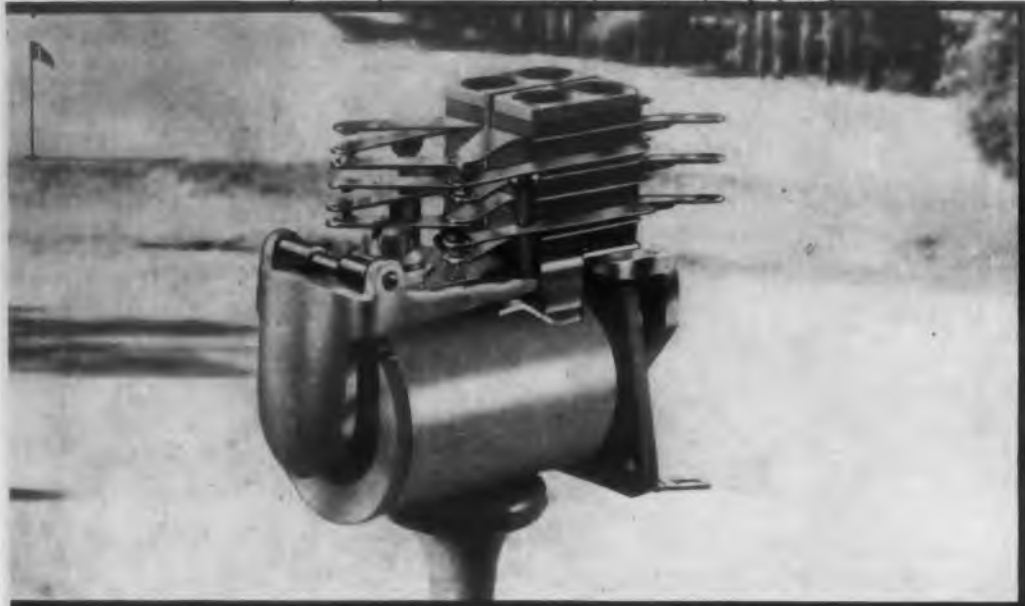
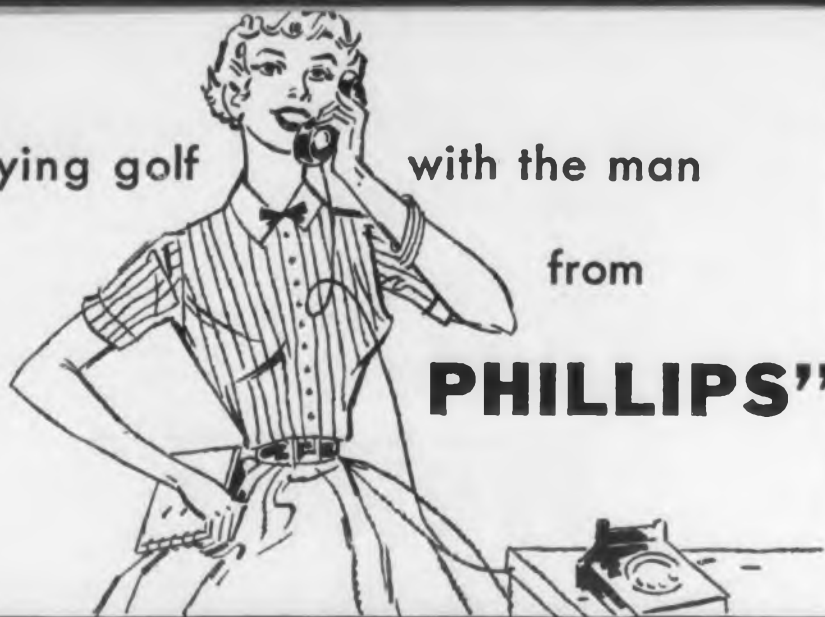
Exceptional design
and manufacturing facilities for
Precision A.C. and D.C. Motors
Servo Tach Units
Synchros in all categories
Gyro Motors
Tachometer Generators
and Related Components
Your inquiry is invited.

MOTOR DIVISION

WRIGHT MACHINERY COMPANY
ESTABLISHED 1883 • DURHAM, NORTH CAROLINA
SUBSIDIARY OF SPERRY RAND CORPORATION

CIRCLE 91 ON READER-SERVICE CARD FOR MORE INFORMATION

He's playing golf with the man from PHILLIPS"



COIL CHARACTERISTICS:

Operating Voltage:
up to 230 volts D.C.
Resistance: up to 14,000 ohms.
Single or double wound.
Operating Current:
0.004 Amps., minimum
Operating Time:
0.003 Secs., minimum

CONTACT ASSEMBLY:

All forms A, B, or C.
Single or double
pile-up. Code #4 Palladium
contacts, standard.
Other contacts available.

MOUNTING:

Two 4-40 tapped
holes on 3/8" centers

what's your handicap

For lightning calculations of high speed computers and data processing equipment — for lightning responses of guided missiles and modern aircraft, the new Type 9 relay meets all the critical requirements. A miniature telephone-type multi-contact relay, the Type 9 combines speed of action, reliability and high resistance to shock and vibration. It is available in a wide choice of contact materials and with a maximum of 18 springs (9 per pile-up). Springs are phosphor bronze for long life. Each unit is individually adjusted to insure conformance with rigid operating specifications. Type 9 is available as a hermetically sealed unit, measuring 1" x 1 5/8" x 2", only slightly larger than the regular relays.

Work with your man from PHILLIPS on any relay problem — multi-contact, power, hermetically sealed, A.C. or D.C.

HERMETIC SEALS, MULTI-CONTACT, POWER, HERMETICALLY SEALED RELAYS, ACTUATORS

PHILLIPS

PHILLIPS CONTROL CORPORATION . . . JOLIET, ILLINOIS

AN ALLIED PAPER CORPORATION SUBSIDIARY

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Aircraft Beacon Antenna For 75 Mc Marker Beacon



Intended to be installed by flush mounting on the bottom of an airplane fuselage, the Model AT-134, 75 mc marker beacon antenna has a shunt-fed, bent-channel receiving element top loaded by a small variable capacitor in parallel with a 25 mmf temperature-compensated fixed capacitor. It measures 11-3/4 in. long by 7-3/4 in. wide and 3-1/4 in. high. Its flanged, deep-drawn aluminum-alloy case forms the antenna cavity. This case is open at the bottom, or airplane, side; the enclosure of the cavity is completed when the case is mounted on the airplane. The slotted shaft of the variable capacitor extends through the closed top of the case to permit screwdriver adjustment and tuning. Lead-in receptacle is provided, and an 18-mm threaded hole which may either be closed with a plug or used for dehydration.

Telectro Industries Corp., Dept. ED, 36-16 37th Street, Long Island City 1, N. Y.

CIRCLE 94 ON READER-SERVICE CARD FOR MORE INFORMATION

Frequency Indicator Counts to 60 Kc



Developed specifically for industrial applications, the Model 7340B frequency indicator and

counter features a 50 mv input sensitivity, counting rate to 60 kc, and the use of printed wiring for compactness and reliability. The instrument provides economical measurement of frequency or speed, counts events per unit item, or operates as a totalizer.

Gate times of 1 or 10 seconds are available, with automatic recycling or single sample operation, and manual gate control is provided for longer sampling times or totalizer operation. Indication to 10,000 events per second, with automatic decimal point location, is easily read directly from glow transfer counting tubes.

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

CIRCLE 95 ON READER-SERVICE CARD FOR MORE INFORMATION

◀ CIRCLE 93 ON READER-SERVICE CARD FOR MORE INFORMATION



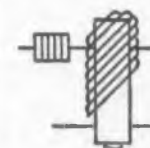
for small coils with big power -call TUR-BO JET

We'll build more ampere-turns into your small-wire magnet coils than you can—and at a lower cost. Tur-bo Jet coils—relay types for example—pull in at lower voltages, and air gap becomes less critical. You can use stronger spring action, and eliminate 50% of need for fine adjustments during assembly.

In boosting your coil power, we find ways to use larger wire and more turns, without increasing resistance or size of coil. Or we'll reduce your coil size without loss of power. Tur-Bo Jet's highly efficient techniques result in prices less than your cost-to-produce.

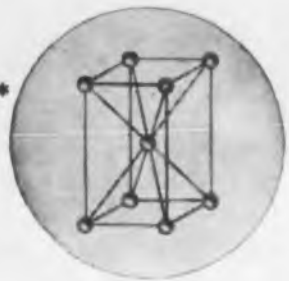
Winders of Mylar[®] bobbin and self-supporting relay coils, solenoid coils and chokes—vacuum impregnated to your specifications, and non-gassing types. Designed to meet class "H" and all A & N specifications. Fast prototype service. Write for literature: "Coil Information".

*DuPont trademark



TUR-BO JET
PRODUCTS CO., INC.
424 S. San Gabriel Blvd.
San Gabriel, Calif.

CIRCLE 96 ON READER-SERVICE CARD



+

Somers
THIN STRIP

*PURE TIN plated on Somers Thin Strip.

Somers engineers have developed a special hot tin plate process which now will provide the smooth surface, solderability, adherence and complete absence of slag so essential to manufacturers of:

**PRINTED CIRCUITS
CAPACITORS
CABLE WRAPPING**

Tin coatings of .00002 to .00008 and .0002 to .0003 are available on brass, copper, bronze and other Thin Strip metals in gauges from .012 down to .002, widths from 1/8" to 6" and wider.

And, of course, Somers exacting standards for tolerance, tensile strength and other physical properties are rigidly maintained.

Whatever your requirements for tin plated thin strip, you can depend on Somers long experience and modern equipment for a quality product.

Write for further information and confidential data blank. Somers will gladly analyze your problem without obligation.

FOR EXACTING STANDARDS ONLY

Somers

Somers Brass Company, Inc.
116 BALDWIN AVE. WATERBURY, CONN.
CIRCLE 98 ON READER-SERVICE CARD

3-Inch Oscillograph Tubes

Varied Phosphor Persistence



A line of three 3-inch cathode ray tubes, with short-, medium- and long-persistence phosphors, has been made available. They are coded 3WP1, 3WP2 and 3WP11. The last has a short-persistence phosphor suited to photographic recording of the indicated phenomena. The 3WP2 utilizes a long-persistence phosphor especially useful in applications where only a temporary record of the phenomena is desired. 3WP1 has a medium-

persistence phosphor for general oscillographic use. Each tube has a flat face, a minimum useful screen diameter of 2-3/4 in. and a maximum overall length of 11-5/8 in.

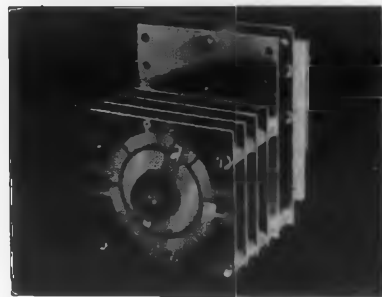
Design features permit the spot to be sharply focussed and to remain in sharp focus both at the edges and at the center, when beam current is varied over a wide range.

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

CIRCLE 99 ON READER-SERVICE CARD FOR MORE INFORMATION

Versatile Sequence Timer

Controls 32 Circuits



A miniaturized, small size, light weight sequence timer, originally developed for balloon instrumentation, has now been made available for general use in any field. Its power requirements are 8 ma at 6 v dc. It can be supplied with from 1 to 4 decks, with from 2 to 8 contacts on each deck, thus controlling a maximum of 32 circuits. Within these limits any timing sequence is supplied to the user's requirements by means of printed circuit manufacturing techniques. Speed regulation of the timer is ± 1 per cent over a wide voltage range; weight is 3-1/2 to 4-1/2 oz. and dimensions (depending on the number of decks) are 1-3/4 in. to 2-5/8 in. deep, 2-1/4 in. high and 2-5/8 in. deep. Designation is Model AGC Sequence Timer.

Brailsford & Co., Inc., Dept. ED, 670 Milton Rd., Rye, N. Y.

CIRCLE 100 ON READER-SERVICE CARD FOR MORE INFORMATION

the wire problem?
try **CONTINENTAL**
insulated electronic wire

No door is closed to the company that specifies Continental insulated wire or cable. That extra tough problem requiring seemingly impossible performance of wire may have you asking "What wire?" Why not let Continental's engineering help? There's a wide range of wires developed for special applications at Continental everyday.

Maybe the answer that you've been after is even now a standard in the Continental line. It's worth a letter or call today.

ELECTRONIC INSTRUMENT INSULATED WIRE

600-3000 volt service. Sizes: 32 AWG to 6 AWG inclusive. CONSTRUCTION: stranded tinned copper, polyvinyl insulation with or without nylon jacket. Maximum operating temperature: 100°C.

CONFORMS TO: MIL-W-16878B

COLOR CODED: 1, 2, or 3 spiral stripes over polyvinyl insulation.



FACT-FILLED CATALOG
NEW, COMPLETE CATALOG OF CONTINENTAL INSULATED WIRE AND CABLE AVAILABLE ON REQUEST. WRITE TODAY.

Continental
WIRE CORPORATION

WALLINGFORD, CONNECTICUT • YORK, PENNSYLVANIA

CIRCLE 101 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN ADDS ANOTHER SERVICE FOR READERS

NEW "HOME REPLY FORM" BECOMES PART OF READER SERVICE CARD

Inquiries relating to employment can now be routed directly to your home. ELECTRONIC DESIGN'S new Reader Service Card carries a special "Home Reply Form" with space for your home or non-business address. If you wish to reply to any of the employment opportunities listed in ELECTRONIC DESIGN'S "CAREERS SECTION", simply circle the appropriate number in the gray area of the card . . . then fill in your home address in the space provided at the bottom of the card. The privacy of your inquiry is protected, while still offering you the speed and efficiency of ELECTRONIC DESIGN'S reader service card system.

ELECTRONIC DESIGN

Name and Title (Print or type all information)

Company

Company Address City Zone State

For Change of Address: Old Company Name

Old Company Address										City										Zone		State	
10	20	30	40	50	60	70	80	90		300	310	320	330	340	350	360	370	380	390				
1	11	21	31	41	51	61	71	81	91	301	311	321	331	341	351	361	371	381	391				
2	12	22	32	42	52	62	72	82	92	302	312	322	332	342	352	362	372	382	392				
3	13	23	33	43	53	63	73	83	93	303	313	323	333	343	353	363	373	383	393				
4	14	24	34	44	54	64	74	84	94	304	314	324	334	344	354	364	374	384	394				
5	15	25	35	45	55	65	75	85	95	305	315	325	335	345	355	365	375	385	395				
6	16	26	36	46	56	66	76	86	96	306	316	326	336	346	356	366	376	386	396				
7	17	27	37	47	57	67	77	87	97	307	317	327	337	347	357	367	377	387	397				
8	18	28	38	48	58	68	78	88	98	308	318	328	338	348	358	368	378	388	398				
9	19	29	39	49	59	69	79	89	99	309	319	329	339	349	359	369	379	389	399				
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101	111	121	131	141	151	161	171	181	191	401	411	421	431	441	451	461	471	481	491				
102	112	122	132	142	152	162	172	182	192	402	412	422	432	442	452	462	472	482	492				
103	113	123	133	143	153	163	173	183	193	403	413	423	433	443	453	463	473	483	493				
104	114	124	134	144	154	164	174	184	194	404	414	424	434	444	454	464	474	484	494				
105	115	125	135	145	155	165	175	185	195	405	415	425	435	445	455	465	475	485	495				
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201	211	221	231	241	251	261	271	281	291	501	511	521	531	541	551	561	571	581	591				
202	212	222	232	242	252	262	272	282	292	502	512	522	532	542	552	562	572	582	592				
203	213	223	233	243	253	263	273	283	293	503	513	523	533	543	553	563	573	583	593				
204	214	224	234	244	254	264	274	284	294	504	514	524	534	544	554	564	574	584	594				
205	215	225	235	245	255	265	275	285	295	505	515	525	535	545	555	565	575	585	595				
206	216	226	236	246	256	266	276	286	296	506	516	526	536	546	556	566	576	586	596				
207	217	227	237	247	257	267	277	287	297	507	517	527	537	547	557	567	577	587	597				
208	218	228	238	248	258	268	278	288	298	508	518	528	538	548	558	568	578	588	598				
209	219	229	239	249	259	269	279	289	299	509	519	529	539	549	559	569	579	589	599				

For Personal Ads Only
(Nos. 550-559)

HOME ADDRESS City Zone State

LOOK FOR THE JOB OPPORTUNITIES LISTED IN ELECTRONIC DESIGN'S "CAREERS SECTION"

Begins on page 115 this issue
Hayden Publishing Company, Inc.



SPAGHETTI TUBING

MADE FROM

TEFLON*



For SLIP-ON INSULATION
BUNDLE SHEATHING
BUSHING INSULATION
BARRIER INSULATORS, PIGTAILS
And Similar Applications Where
Only PF TEFLON* Can Do The Job

ADVANTAGES . . .

- good dielectric strength (500 to 1000 volts/mil)
- lowest dielectric constant (2.0) and dissipation factor (0.0002) of any solid dielectric
- no change of electrical properties with temperature (-25°C to +250°C) or frequency (60 cycles to 100 mc).
- zero moisture absorption
- unaffected by any commercial chemical

PF spaghetti tubing is stress relieved for minimum shrinkage and carefully inspected and controlled dimensionally. A full range of sizes and colors are available to meet your specific needs. Write, wire or call for further information, competent engineering assistance and information on special sizes and walls. PF flexible tubing, heavy-walled tubing and rod stock made from Teflon* is also available.

PENNSYLVANIA FLUOROCARBON CO., INC.
1115 N. 38th Street, Philadelphia 4, Pa.
EVergreen 6-7680

* Teflon—DuPont trade name for Tetrfluoroethylene resin

CIRCLE 103 ON READER-SERVICE CARD

Tube Tester

Gives Triple Test



The Model 107 tube tester is a portable tester which provides three important vacuum tube checks. All tubes may be given the grid-circuit test to reveal in-

termittent leaks or shorts, gas content or reverse grid current, commonly called grid emission. A pre-wired panel permits a dynamic mutual conductance test to be run on all popular high trans-conductance or amplifier type tubes. All tubes may also be tested for cathode emission. Free point selection sets up every tube that fits six popular sockets and will not be obsoleted.

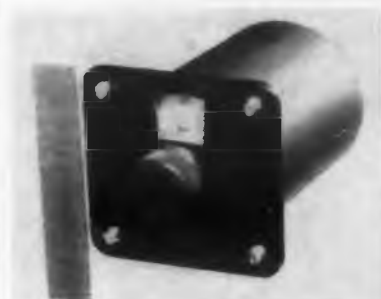
A handy "flip-chart" lists complete tube setup data for all current tubes. Completely self-contained, mounted in a handsome vinyl-plastic covered light green carry case. This tube tester weighs just 11-1/2 lbs.

Seco Mfg. Co., Dept. ED, Minneapolis, Minn.

CIRCLE 104 ON READER-SERVICE CARD FOR MORE INFORMATION

Vernier Pot-Rheostat

Miniaturized



Available with either wire wound, carbon or carbon film resistors, a rheostat - potentiometer just announced has a rated accuracy of 0.1 per cent of full scale, resolution

rated at 0.1 per cent or better, and rated linearity within plus or minus 0.1 per cent. Resistance range is 0 to 10,000 ohms for the wire wound model; other ranges and other accuracies are offered in the carbon element units. Single knob control of two decades is among the features of this unit; two turns of the knob cover the full range and provide resolution equal to that of a conventional ten turn potentiometer. Basic construction of the unit is that of a four terminal voltage divider. Panel space required is only 2 x 2 in., with 2-1/2 in. projecting behind the panel; wattage rating is 4 w when used as a potentiometer, 25 ma when used as a rheostat.

Research Instrument Co., Dept. ED, P.O. Box 9168, Portland 16, Ore.

CIRCLE 105 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 106 ON READER-SERVICE CARD >

TEFLON[†]
INSULATION

BERYLLIUM-COPPER
CONTACT



ACTUAL SIZE

SEAELECTRO'S

"PRESS-FIT"

New SKT-10
FOR "TOPS" IN
TEST POINT JACKS!



Yes, still another Seaelectro development! The exclusive SKT-10 is the only test point jack that meets severest requirements such as spelled out in MIL specs. Combines resilient TEFLON[†] with resilient BERYLLIUM-COPPER, for ideal installation.

Designed for standard .080" test probe, yet takes oversized .083" without deforming, or holds .077" pin with minimum of 2-ounce retention. Regardless of chassis thickness, the insertion and extraction ease remains unimpaired.

It's a genuine "Press-Fit" terminal. Just press-fit, that's it—in either drilled or punched hole, by means of simple insertion tool.

- Beryllium-copper rod machined for one-piece metal insert.
- Four-leaf floating contact. Maximum and lasting spring temper
- Heat-treated after machining—not pre-tempered stock. Gold-over-silver plated.
- Superlative insulating properties of Teflon. Unbreakable. Corrosion- and heat-resistant.
- Marked savings in material and labor by eliminating mounting hardware and fussy seals.
- Mounts in thin aluminum stock. Eliminates thick insulating panels.

Available in eight RETMA code colors.

SAMPLE AND LITERATURE . . .

Write on business stationery for an SKT-10 Test Point Jack and engineering details. Make your own tests!

[†]Trademark

[†]Registered trademark, E. I. Du Pont de Nemours & Co.



Seaelectro

CORPORATION

610 Fayette Avenue • Mamaroneck, N.Y.








Now - threaded ceramics that permanently hold precision tolerances!

Centralab
Engineered
Ceramics...

- can be extruded or molded
- can be worked before firing the same as metal
- ground, drilled, threaded, or tapped
- can be metallized

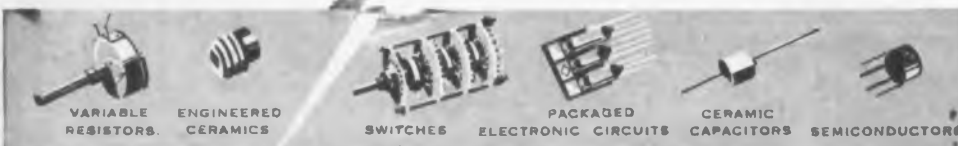
Another reason to insist on Centralab

-  Threads ground into the ceramic itself — after firing. There's no shrinkage to cause variations in width and depth.
-  Other fired-ceramic precision-grinding operations include centerless, cylindrical, disc, surface, and lap grinding — to precision tolerances previously unavailable.
-  Ask Centralab to quote on your requirements.

Write for Centralab's Ceramic Buyer's Guide, Bulletin 42-221. Or refer to it in Sweet's Product Design File.

Centralab

A DIVISION OF GLOBE-UNION INC.
980B East Keefe Avenue • Milwaukee 1, Wisconsin
In Canada: 804 Mt. Pleasant Road, Toronto, Ontario



CIRCLE 108 ON READER-SERVICE CARD FOR MORE INFORMATION

Wide Band Sweep Generator VHF-UHF Range



A wide band sweep generator contains all the essential features of a standard cw and am signal source and covers the range from 15 to 400 mc. The model SG-132 is intended for use with vhf-uhf receivers and with similar equipment. It is helpful in measuring receiver sensitivity, selectivity, image rejection and gain, and for calibration, etc., of if amplifiers, broadband amplifiers, television equipment, and the like. Its output is entirely fundamental, not derived from beat-frequencies. Sweep width is 40 per cent of the center frequency of 15 to 400 mc, dial accuracy 0.01 per cent, output constancy with ± 0.2 db over the entire frequency range, calibration from 0.1 to 150,000 μ v throughout the frequency range. There is an integral de-coupled oscilloscope, and the panel also incorporates modulation, dbm and microvolt meters.

Transitron, Inc., Dept. ED, 186 Granite Street, Manchester, N. H.

CIRCLE 109 ON READER-SERVICE CARD FOR MORE INFORMATION

80 To 10 Meter Tank Assembly Continuous Tuning



Here shown is an improved version of a continuous - tuning amateur band transmitter tank assembly spanning the range from 80 to 10 meters. It is designated MB-40DL and is intended for use in grid circuits with approximately 20 watts input or in final plate circuits with not more than 40 watts input power, loaded. The tuning range is from 3.2 to 9.0 mc and from 12.0 to 34.0 mc and to tune to any of these frequencies it is only necessary to turn the dial to the proper setting. A vernier dial with 180 degrees rotation is recommended.

The Model MB-40DL can be used with push-pull or single-ended circuits. Output power can be coupled to an antenna or to a link; preferably to a 300-ohm load. Tetrodes such as the 6V6 or 6L6, etc., are recommended; but pentodes also can be used.

National Co., Inc., Dept. ED, 61 Sherman St., Malden 48, Mass.

CIRCLE 110 ON READER-SERVICE CARD FOR MORE INFORMATION

STROMBERG-CARLSON

"BB" Series Relays



For your automation
...computing...control
circuit applications...
"Telephone Quality"
at an ordinary price

To meet your needs for precision and durability in automation, computing and control circuitry, this relay provides telephone quality at an ordinary price.

The "BB" Series Relay accommodates up to 100 Form A spring combinations. It incorporates such important advantages as twin contacts, knife-edge pivot and special frame-armature construction. Like all Stromberg-Carlson relays, it is built to operate under extreme ranges of temperature and humidity. Prompt delivery is available on all orders.

This catalogue will give you complete technical details and specifications. We will gladly send you a free copy on request. Please ask for Catalogue T-5000R.



S-C
STROMBERG-CARLSON

STROMBERG-CARLSON

A DIVISION OF GENERAL DYNAMICS CORPORATION
TELECOMMUNICATION INDUSTRIAL SALES
116 CARLSON ROAD, ROCHESTER 3, N. Y.

CIRCLE 111 ON READER-SERVICE CARD

An Engineer
Speaks Out...



...about a Very Unusual AM-FM-c.w. VHF Receiver

It's called the Servoflight* 5200 VHF Communications Receiver. It's unusual because it's the only VHF receiver for both laboratory work and communication field use that includes all of the following features:

- maximum sensitivity — less than 2 micro-volts input will produce a 10-db signal plus noise-to-noise ratio over entire frequency range of 50-200 mc
- high frequency stability — less than 0.08% drift over line voltage range of 105-125 volts . . . over ambients of -10°C to +60°C temperature and 0 to 95% humidity
- less than 50 micro-watts radiated local oscillator power
- continuous tuning over entire frequency range without switching
- automatic noise limiter
- exclusive squelch circuit
- patented, directly-calibrated 72° band-spread dial with a resolution of 0.2%
- excellent spurious and I.F. rejection
- antenna trimmer

All these features are integral parts of the 5200 Receiver. In addition, there are special outputs for the operation of external equipment to facilitate use of the 5200 Receiver as a component in complete communication, monitoring, telemetering, and direction finding systems. Power input required is 125 watts from 115/230V, 50/60 cycle source.

Howard Busman

Senior Development Engineer



Send for the full story on the Servoflight* 5200 VHF Communications Receiver. Just address your request on your company letterhead, to: Dept. HBB. *t.m.

SERVO CORPORATION
OF AMERICA

20-20 Jericho Turnpike
New Hyde Park, L. I., N. Y.

CIRCLE 113 ON READER-SERVICE CARD

Enclosed Limit Switch

For Industrial Control



An enclosed precision limit switch, Type 30, has three choices of actuators and three housings, to form sixteen types of switches. Die-cast aluminum housings provide a rugged enclosure, adequate wiring space and a 1/2-14 internal tap conduit hub. Actuators include a plung-

er, roller arm and roller plunger types.

The roller arm actuator has a micrometer screw adjustment which moves the arm through a wide arc in setting the trip point. When the switch trips, a slight additional turn is given to allow for overtravel, then the locknut is tightened. This way of setting the trip prevents borderline operation and offers an unlimited number of trip positions. The roller plunger type actuator is adjustable through 360 degrees to take actuation from any direction. The plunger actuator type switch has a 0.002 movement differential and a 1/2-in. overtravel.

The Type 30 Sealed Enclosed Limit Switch is oil, dust and water tight, by use of improved methods. Switch actuation is sensitive. The switches give more than 10,000,000 actuations under severe operating conditions. The serpentine switch mechanism largely eliminates the problem of switch fatigue and assures positive equipment actuation.

Licon (R) Switch and Control Div., Dept. ED, Illinois Tool Works, 2501 N. Keeler Ave., Chicago 39, Ill.

CIRCLE 114 ON READER-SERVICE CARD FOR MORE INFORMATION

Fiber Glass Switch Box

Corrosion-Resistant

Produced entirely of fiber glass reinforced polyester to make it strong, flame and corrosion resistant, a new insulated switch box is now on the market. Its corrosion resistance makes it ideal for application in barns and all farm buildings, industrial plants, or in all buildings where contaminated or highly humid air is present. The new switch box in itself is completely insulating and on many circuits eliminates the necessity of grounding. Its strength brought about by the inherent characteristics of fiber glass reinforced plastic is great enough to withstand any abnormally rough treatment in shipment or installation.

Porcelain Products, Inc., Dept. ED, Findlay, Ohio.

CIRCLE 115 ON READER-SERVICE CARD FOR MORE INFORMATION

MARS outstanding design SERIES



birth of a satellite

Most new ideas, like this inhabited satellite, start out as drawings on a sheet of paper. Here artist Russell Lehmann shows the first step in building the space station proposed by Darrell C. Romick, aerophysics engineer at Goodyear Aircraft.

Two ferry ships, one stripped of rocket units, are joined end to end. As others are added, this long tube forms temporary living quarters for crews. Eventually, outer shell will be built around core, making completed station 3,000 feet long, 1,500 feet in diameter.

No one can be sure which of today's bright ideas will become reality tomorrow. But it is certain that in the future, as today, it will be important to use the best of tools when pencil and paper translate a dream into a project. And then, as now, there will be no finer tool than Mars — from sketch to working drawing.

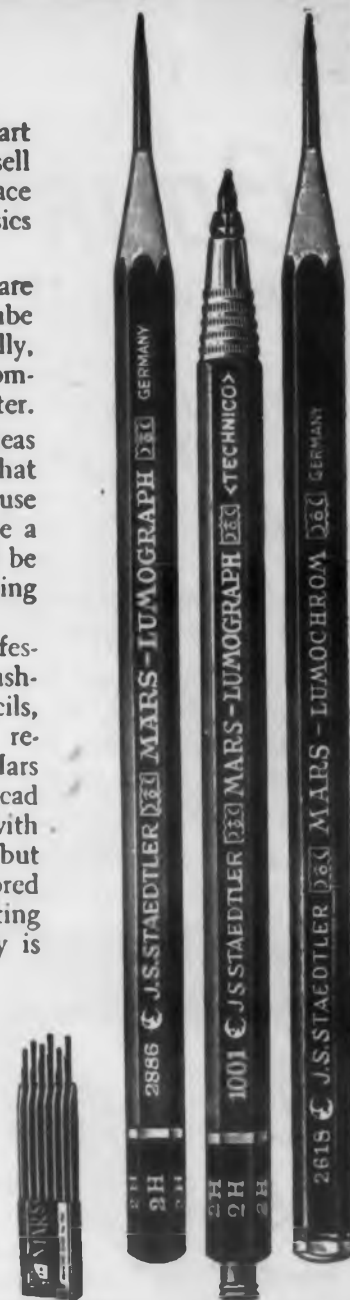
Mars has long been the standard of professionals. To the famous line of Mars-Technico push-button holders and leads, Mars-Lumograph pencils, and Tradition-Aquarell painting pencils, have recently been added these new products: the Mars Pocket-Technico for field use; the efficient Mars lead sharpener and "Draftsman's" Pencil Sharpener with the adjustable point-length feature; and — last but not least — the Mars-Lumochrom, the new colored drafting pencil which offers revolutionary drafting advantages. The fact that it blueprints perfectly is just one of its many important features.

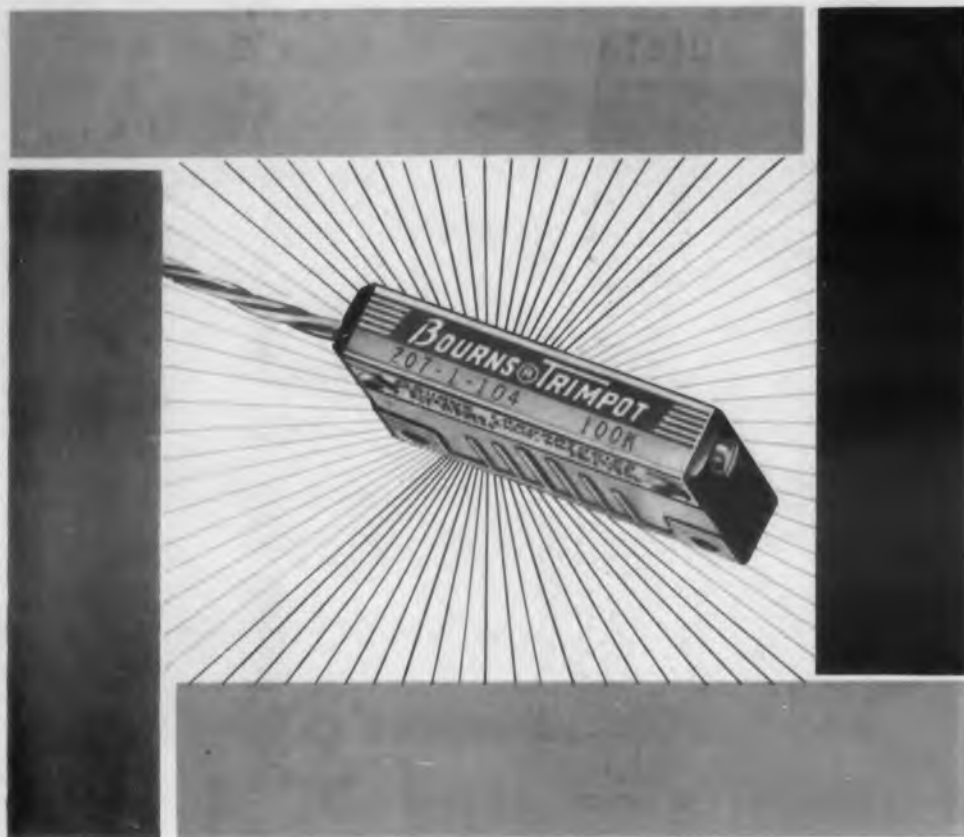
The 2886 Mars-lumograph drawing pencil, 19 degrees, EXEXB to 9H. The 1001 Mars-Technico push-button lead holder. 1904 Mars-lumograph imported leads, 18 degrees, EXB to 9H. Mars-lumochrom colored drafting pencil, 24 colors.

J.S. STAEDTLER, INC.
HACKENSACK, NEW JERSEY

at all good engineering and drawing material suppliers

CIRCLE 116 ON READER-SERVICE CARD FOR MORE INFORMATION





BOURNS TRIMPOT®

MODEL 207 Hi-R*

High Power—2 watts
High Resistance—100,000 ohms
High Temperature—175°C

The latest addition to the expanding line of Bourns TRIMPOTS is the new high power, high temperature, Hi-R.

The Hi-R will dissipate 2.0 watts at 50°C and has a maximum operating temperature of 175°C. Model 207 is available in total resistances of 100 ohms to 100K; Model 208, the variable resistor counterpart, is offered in 100K, 150K and 200K. High resistance values are combined with the excellent temperature coefficient and stability of a wirewound resistance element.

In addition to these many outstanding features, the Hi-R is miniature in size: only $\frac{1}{2} \times \frac{1}{4} \times 1\frac{1}{4}$ —0.28 cubic inches. The 25-turn adjustment shaft is self-locking, thus insuring stable settings under extreme conditions of shock, vibration and acceleration.

Delivery from stock on standard resistances. Send for Bulletin 207.



BOURNS LABORATORIES, INC.

General Offices: 6135 Magnolia Ave., Riverside, Calif.
 Plants: Riverside, California—Ames, Iowa

*Trade Mark

COPR. BL

TRIMPOTS • LINEAR MOTION POTENTIOMETERS • PRESSURE TRANSDUCERS AND ACCELEROMETERS

CIRCLE 118 ON READER-SERVICE CARD FOR MORE INFORMATION

22.5 V DC Power Supply

Is Line Transient-Free



A new line transient-free, short circuit-proof airborne power supply unit provides 22.5 v dc for various telemetering and instrumentation applications.

While the MRP 22.1 may be used for various purposes requiring 22.5 v dc, it was designed specifically to power MRC's new MMO-522 low-level magnetic dc signal amplifiers, which eliminate gain variations by operating directly from a dc source. The power supply itself operates from a standard 400 cy aircraft main, feeding dc input to the MMO-522 signal amplifiers, each of which incorporates a transistor oscillator. Since they are dc-powered, the amplifiers are free from the variations normally encountered when excitation is provided by a 400 cy line supply which is subject to a ± 10 per cent tolerance. The MRP-22.1 power supply drives from 10 to 12 of the MMO-522 amplifiers. The amplifiers themselves are used principally in the amplification of the thermocouple and strain gauge output in industrial, military and medical installations. They serve equally well as very stable dc v amplifiers for radio telemeter systems or as high-gain dc power amplifiers for relay-type temperature and servo control systems.

Magnetic Research Corp., Dept. ED, El Segundo, Calif.

CIRCLE 119 ON READER-SERVICE CARD FOR MORE INFORMATION

Precision Resistor Networks

For Strain Gauge Amplifiers

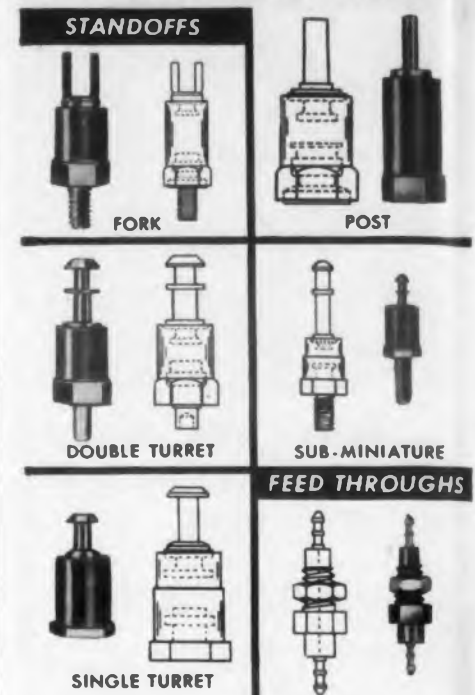


Especially designed to fit the front panel of strain gauge amplifiers, these resistor networks are available on anodized aluminum front panels to facilitate ease in selecting the proper resistor block. Each resistor is wound on glass-reinforced plastic forms with glass-insulated wire, and is capable of dissipating 10 watts overload for short periods of time. Any number of these precision resistors can be supplied in one encapsulated package, and a variety of configurations and schematics can be arranged.

Eastern Precision Resistor Corp., Dept. ED, 675 Barbey St., Brooklyn, N. Y.

CIRCLE 120 ON READER-SERVICE CARD FOR MORE INFORMATION

GET THE EXACT TERMINAL YOU NEED AT NEW LOW PRICES!



FROM THE LARGEST
 STANDARD and CUSTOM
 LINE AVAILABLE...

Over 100 varieties are furnished as standard. This includes a full range of types, sizes, body materials and plating combinations. Specials can be supplied to any specification. The Whitso line is complete to the fullest extent of every industrial, military and commercial requirement.

Standoff terminals include fork, single and double turret, post, standard, miniature and sub-miniature body types—male, female or rivet mountings—molded or metal base. Feed through terminals are furnished standard or to specification.

Whitso terminals are molded from melamine thermosetting materials to provide optimum electrical properties.

Body Materials: Standard as follows—melamine, electrical grade (Mil-P-14, Type MME); melamine impact grade (Mil-P-14, Type MMI); and phenolic, electrical grade (Mil-P-14, Type MFE).

Plating Combinations: Twelve terminal and mounting combinations, depending on electrical conditions, furnished as standard.

Specials: Body materials and plating combinations, also dimensions, can be supplied to any custom specifications.

PROMPT DELIVERY IN ECONOMICAL QUANTITY RUNS

Get facts on the most complete, most dependable source for terminals and custom molded parts. Request catalog.



WHITSO, INC.

9326 Byron Street, Schiller Park, Illinois
 (Chicago Suburb)

CIRCLE 121 ON READER-SERVICE CARD

HOW **2** INEXPENSIVE

MICRO-MICROAMMETERS

1 MODEL 411 for maximum stability

Meets or exceeds the zero stability of the most costly equipment; recommended for long-term control, alarm, and monitoring work, as in thickness gaging and reactor control. No transients created by switching from range to range.

- ★ **RANGES:** two per decade, from 10^{-3} to 10^{-11} ampere full scale.
- ★ **ZERO DRIFT:** less than 2% per week, with source voltages above 10 volts.
- ★ **TIME CONSTANT:** less than 4 seconds on the 10^{-11} range with 5000 mmf across input.



2 MODEL 410 for maximum sensitivity

The general purpose instrument for measurement and control of microcurrents. Typical uses: currents in ion gages, ion chambers, photocells, vacuum tube grids, back currents of silicon transistors.

- ★ **RANGES:** two per decade, from 10^{-3} to 3×10^{-13} ampere full scale.
- ★ **ZERO DRIFT:** less than 2% per day, with source voltages above 300 millivolts.
- ★ **TIME CONSTANT:** less than one second on the 10^{-11} range with 5000 mmf across input.

BOTH MODELS include a 250-volt tap for polarizing ion chambers, an output that drives 50-millivolt and 5-milliampere recorders, input and output connections at both front and back. Suited to both bench and rack mounting, and available with a contact meter in place of standard meter.

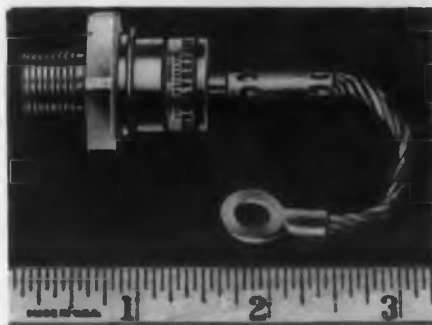
DESCRIPTIVE LITERATURE is now available. A request on your company letterhead will bring your copy promptly.

KEITHLEY
INSTRUMENTS, INC.
12415 Euclid Ave., Cleveland 6, Ohio

CIRCLE 123 ON READER-SERVICE CARD

Silicon Power Diodes

14 to 70 HW Amps



A series of silicon diodes in the 14 to 70 (half wave) amp rating have been made available for such industrial uses as motor loads welders and battery chargers, and for

dc power supplies in aircraft and missiles, and on ships. Six of these diodes assembled on heat sinks and connected in a three-phase bridge can supply 13 kw at 175 v dc with natural cooling or 33 kw at 175 v dc with forced draft cooling. The diodes are available for peak inverse voltages from 50 to 300 v. They are miniaturized, and hermetically sealed.

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

CIRCLE 124 ON READER-SERVICE CARD FOR MORE INFORMATION

Data Recording Cameras

Have Synchronized Control



These all-purpose precision data recording cameras provide **automatic** matched-frame analysis. They have been used for data reduction

by aircraft manufacturers in fire control evaluation, flight testing, missile tracking and bomb spotting.

The cameras can be used for time and motion studies, the analysis of machine operation techniques, testing new products, and expediting the study of various manufacturing processes.

The cameras photograph motions or events taking place simultaneously at separated locations. The shutter and film drives are synchronized to an accuracy of one and one-half milliseconds from camera to camera, providing automatic frame-for-frame comparisons of films taken by any number of cameras in a parallel-operated gang. Three individual coding lights in each camera permit the coding of film sequences and indicate time intervals on film.

Small and lightweight, the cameras are available in 16 mm and 35 mm models. The MOD III 16 mm camera accepts the standard Eastman 50 ft. magazine; the MOD IV-C 35 mm camera has an internal film capacity of 100 ft on daylight loading spools.

Flight Research, Inc., Dept. ED, Richmond, Va.

CIRCLE 125 ON READER-SERVICE CARD FOR MORE INFORMATION

Here's your guide...
to better wiring with
one-third the work



This new bulletin gives you the facts . . . and complete how-to-do-it instructions for wiring your product with **PANEL CHANEL®** raceways. All steps are fully illustrated. **PANEL CHANEL** does the wiring job with one-third the work . . . and even greater reductions in cost. **PANEL CHANEL** is relatively new . . . but it is already the standard wiring method used by hundreds of leading electrical and electronic equipment manufacturers for their products. **You Should Have the Facts.** Send for your copy of Bulletin S-301, today.



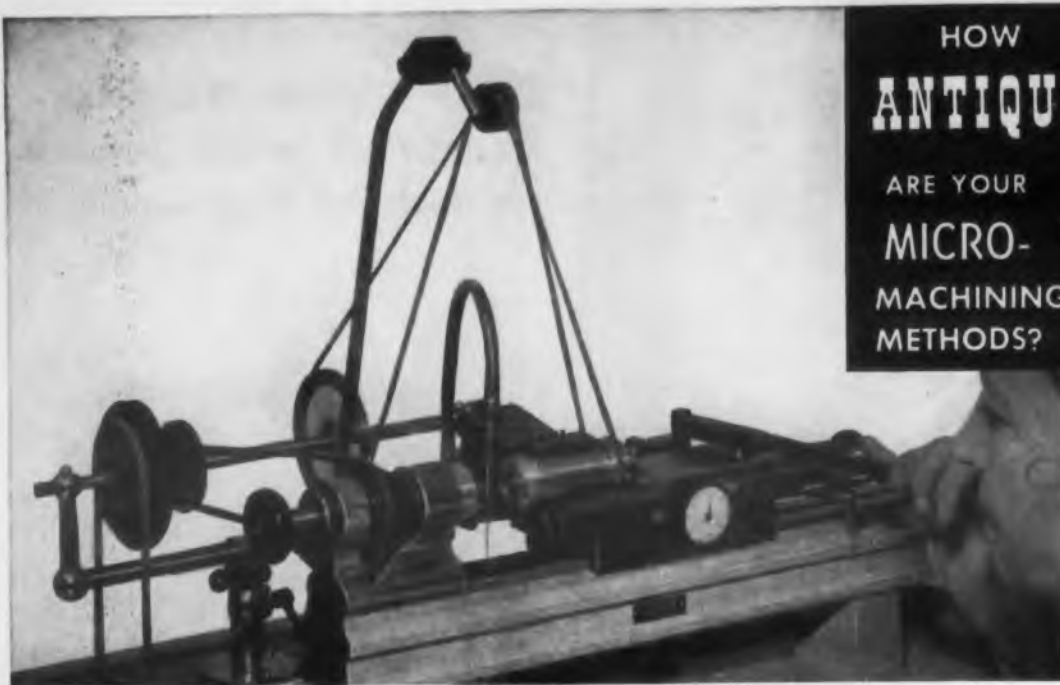
PANEL CHANEL



Panel Chanel®

STAHLIN BROTHERS, INC. • 103 MAPLE STREET
Belding, Michigan

CIRCLE 126 ON READER-SERVICE CARD FOR MORE INFORMATION



HOW
ANTIQUE
ARE YOUR
MICRO-
MACHINING
METHODS?



The Levin micro-drilling equipment shown here can be used with the smallest drills available. It is designed so that the drilling does not depend on the operator's sense of feel. The drill can be retracted for chip removal and returned to the drilling position without striking the bottom of the hole. While commercial drills can be had as small as .0016" this micro-drilling apparatus has successfully produced holes as small as .0006".

Send for Catalog M describing complete line of instrument lathes and accessories.

DRILL MICRO-HOLES

DOWN TO .0016" with SPEED & ACCURACY

ON **LEVIN**® INSTRUMENT LATHES

LOUIS LEVIN & SON, INC.—3610 S. BROADWAY—LOS ANGELES 7, CALIFORNIA

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"INDIUM"

prepared to your
own specifications . . .

Indium or indium alloys in ingots, sheets, wire, powder, ribbon, and pellets (disc or spherical) are supplied by us to leading U.S. manufacturers of electronic equipment. These and other forms prepared to your own requirements are available in two grades:

Tadanac High Purity — approximately 99.999+% In
Tadanac Standard Grade — guaranteed 99.97+% In
As one of the world's leading primary producers of indium, we apply the services of our Research and Development Division to assist our customers in obtaining the full benefits of this most versatile metal.

Our prices include customs' duties, and we handle all customs procedures.

For further information or quotations contact:

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THE CONSOLIDATED MINING & SMELTING COMPANY OF CANADA LIMITED.

Metal Sales Division

215 ST. JAMES STREET WEST MONTREAL, CANADA

TI-11-56

CIRCLE 129 ON READER-SERVICE CARD FOR MORE INFORMATION

Production Products

Designers might find it profitable to redesign their present products, or to conceive of better products, to take advantage of the capabilities of these new production equipments.

Ultrasonic Cleaner

For Small Parts



A new ultrasonic cleaning apparatus has been developed. The AP-10-B is a small, compact instrument, designed specifically for bench-top operation in the washing of delicate, intricate parts that must be "surgically" clean.

The new instrument comprises a 36-40 kc/sec. power generator, and a cylindrical cleaning tank with transducers hermetically sealed into the base. RF power output of the generator is 50 w avg, 200 w peak on pulses. Tanks are of 1 pint, 1 quart, or 1/2 gallon capacity, giving a maximum effective cleaning area of 18 sq. in. Two of the smaller tanks may be operated simultaneously, and two of the larger tanks alternately, depending on tank size specified.

Branson Ultrasonic Corp., Dept. ED, 37 Brown House Rd., Stamford, Conn.

CIRCLE 130 ON READER-SERVICE CARD FOR MORE INFORMATION

Tool Room Miller

Multipurpose Uses



A new Model 422 precision tool room model bench milling machine has been designed. This small precision mill has the machine tool accuracies of mills costing two to three

times its price. This mill can also be quickly converted into a precision surface grinder and for special lathe operations. A new low cost 4 x 8 in. magnetic chuck is offered as one of the many accessories.

Lloyd Tool Corp., Dept. ED, P.O. Box 647, Burbank, Calif.

CIRCLE 131 ON READER-SERVICE CARD FOR MORE INFORMATION

Production Products

Rotary Hearth Oven Permits Production Runs



This oven has been designed and built to permit loading and unloading from the same position by a single operator, and at the same time permits a continuous movement of work in and out of the heating zone.

A large volume of work space is obtained with this rotary design. Standard speed range from 2 to 10 in. per min or approximately one to five revolutions per hour makes this type of oven practicable for processing many types of products. No doors are used. An alloy steel chain curtain is used to conserve heat and provide convenient access to work chamber.

These ovens are built to individual requirements. Oven illustrated has inside working space 14 x 9 x 50 in. long on an OD of 54 in., ID 26 in. Maximum working temperature 1000 F.

Grieve-Hendry Co., Inc., Dept. ED, 1401 W. Carroll Ave., Chicago 7, Ill.

CIRCLE 132 ON READER-SERVICE CARD FOR MORE INFORMATION

Two-Sided Spray Etching Machine For Printed Circuits



Expressly designed for the production of printed circuits, a new and advanced spray etching machine has been built. Among some of the salient features of the new etching machine are simultaneous two-sided etching of a circuit board,

temperature and baume control, rapid etching time as well as certain very interesting automation features.

Robertson Photo-mechanix, Inc., Dept. ED, 7440 Lawrence Ave., Chicago 31, Ill.

CIRCLE 133 ON READER-SERVICE CARD FOR MORE INFORMATION

General NEW HI-SPEED SWITCHING TRANSISTORS Assures Computer Reliability

Computer engineers long seeking PNP transistors in applications requiring high current and fast switching will specify General Transistor's new 2N315, 2N316, and 2N317 for peak reliability.

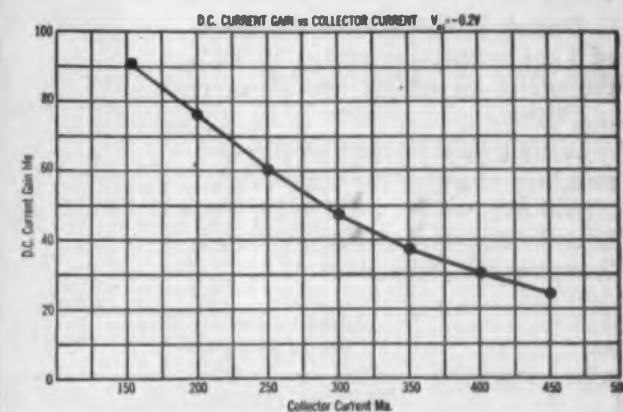
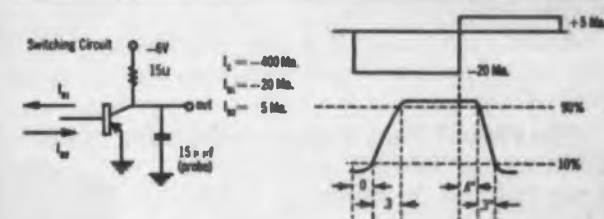
2N317: As developed by General, a typical switching speed of .3 of a microsecond at 400 milliamps of collector current is possible with only 20 ma. of drive current.

The series resistance of these GT transistors, when conducting, is 1/2 ohm; the nonconducting series resistance is as high as 10 megohms with a result that approaches optimum efficiency at high current levels.

Computer manufacturers know they can depend on General's engineering and development as well as their quality and service. That's why GT is the largest supplier of transistors for computers.

CHARACTERISTICS

Parameter	Conditions	Min	Typical	Max
Collector-Base Voltage (Vcbo)	Ic = -25μa Emitter Open	-20V	-30V	
Collector Cut-off Current (Icbo)	Vcb = -5V Ic = -400ma	-1μa	-2μa	
D.C. Current Gain (hfe)	Vce = -2V	20	30	50
Alpha Cut-off Frequency (fafb)	Vcb = -5V Ic = -1ma		20mc	



2N315, PNP
2N316, PNP
2N317, PNP

CIRCLE 134 ON READER-SERVICE CARD FOR MORE INFORMATION



Write for GT's special Computer Transistors Specifications Bulletin.

GENERAL TRANSISTOR CORP.
Richmond Mill 18, N. Y.—Virginia 9-8900
Cable: Transistor New York



Official U. S. Air Force photograph

Throws out electron tubes... keeps chopper

Today's aviation electronic standards are often tough to meet. Demands for extreme miniaturization are coming hard on the heels of new reliability and performance standards.

We've heard of one well-known manufacturer, for example, who has gradually eliminated all electron tubes and most other conventional electronic parts from his jet engine control system.

But it's significant that this manufacturer is still using the Bristol Syncroverter® Switch to convert servo signals from d-c to a-c.

The reason? There's no equivalent that comes up to the Syncroverter Switch's performance. Long life and Immunity to Severe Shock and Vibration are outstanding characteristics of the Syncroverter Chopper.

During vibration over the range of 5 cps to 2000 cps and up to 30G, the effect on output waveform is negligible.

Write today for data on this outstanding chopper for your critical signal conversion problems. The Bristol Company, 151 Bristol Road, Waterbury 20, Connecticut.



Bristol Syncroverter Switch.
Covered by patents.

6.73

TYPICAL OPERATION

Driving frequency range: 0-2000 cps (400 cps used for these characteristics)

Coil voltage:	6.3V sine, square, pulse wave
Coil current:	55 milliamperes
Coil resistance:	85 ohms
*Phase lag:	55° ± 10°
*Dissymmetry:	Less than 4%
*Switching time:	15° ± 5°
Temperature:	-55°C to 100°C
Operating position:	Any
Mounting:	Flange or plug-in—fits 7-pin miniature socket

*These characteristics based on sine-wave excitation.

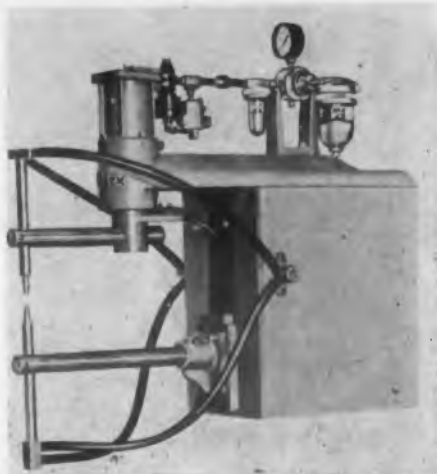
BRISTOL

FINE PRECISION INSTRUMENTS
FOR OVER 67 YEARS

CIRCLE 137 ON READER-SERVICE CARD FOR MORE INFORMATION

Production Products

Bench Type Welders 5 and 10 Kva



Two new bench type air-operated 5 and 10 kva spot or projection welders specially designed for light and nonferrous metals are available. Features include valve and speed controls mounted at the cylinder for easy access

and greater speed, and a ram bearing surface of 15 sq in. at full stroke. When horns are used, the greater bearing surface gives more rigidity and reduces tip skidding. Air controls are mounted above the welder for better cylinder lubrication. Spring follow-up heads are available.

The welders are water-cooled and the transformers have four heats. No. 1 Morse taper electrodes are used and the lower bracket has a 4 in. vertical adjustment. Cylinders are 2-1/2 or 3 in. with a 2 in. stroke. Similar floor type and foot-operated welders are offered for use where air is not available. The company has a complete line from 1 to 50 kva.

Weldex, Inc., Dept. ED, Detroit, Mich.

CIRCLE 138 ON READER-SERVICE CARD FOR MORE INFORMATION

Gearless Bobbin Winder High Speed Direct Drive



Need to make gear changes on this coil winder is eliminated entirely by a unique time-saving pitch selector which cuts job change-over time in

half. The high speed, direct drive, adjustable winding length bobbin winder has an emergency safety stop button which halts the machine instantly.

Winding speed is up to 8000 rpm with a range of 60 to 700 turns per inch. Features include wire sizes from 27 to 46, 2 in. max coil OD, 3-1/2 in. maximum transverse for any single continuous winding, 8-1/2 in. max loading area for multiple winding, and winding traverse infinitely adjustable from 1/8 to 3-1/2 in.

Geo. Stevens Mfg. Co., Dept. ED, Pulaski Rd. at Peterson, Chicago 30, Ill.

CIRCLE 139 ON READER-SERVICE CARD FOR MORE INFORMATION

Measure ANY Impedance



from a SHORT to an OPEN
Real or Imaginary Positive or Negative

with the  Type 1603-A Z-Y Bridge: \$370

- ☆ Covers Entire Audio Range — 20 c to 20 kc
- ☆ Always Gives the Answer No Matter What the Unknown
- ☆ Answer Directly in Ohms or Micromhos
- ☆ Measures Grounded, Direct or Balanced Impedances and Admittances
- Its Countless Uses Include:
 - ☆ Determining leakage reactance, self and mutual inductance and coefficient of coupling of transformers
 - ☆ Reactance-resistance curves on loudspeakers, microphones, magnetic recorder heads
 - ☆ Complex input, output and characteristic impedances of filters and other networks
 - ☆ Transistor input and output impedance

Write for Complete Data

GENERAL RADIO Company



275 Massachusetts Avenue, Cambridge 39, Massachusetts, U.S.A.
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1150 York Road, Abington, Pa. PHILADELPHIA
8055 13th St., Silver Spring, Md. WASHINGTON, D. C. 1000 N. Seward St. LOS ANGELES 30
CIRCLE 140 ON READER-SERVICE CARD FOR MORE INFORMATION

NEW!

Spirap^{*}
drastically reduces time
and work of cable wrapping



- simple and easy to use; up to 2" cables can be wrapped
- inexpensive; one size answers all your needs
- holds wires together tightly but allows flexibility for forming cable
- provides excellent insulation and protection over entire cable length
- easily unwound to allow wire to be added, taken out, or relocated

*patent pending, trademark property of 3C

Free Sample

New SPIRAP is a modern idea that eliminates hours of tedious work. It is ideal for both prototype and production construction. Standard material is white polyethylene. Immediate delivery through your local distributor. Write us for free sample and complete information.

COMPUTER CONTROL COMPANY, inc.

92 Broad Street — Wellesley 57, Massachusetts
CIRCLE 141 ON READER-SERVICE CARD FOR MORE INFORMATION

New

SHAKEPROOF® AUTOMATIC POWER SCREW DRIVER

- New Model "400" can drive up to 60 hopper-fed screws per minute!
- Ideal for automation as well as conventional mass-production assembly lines!

Write for this today!

Model "400"
Catalog Flyer

SHAKEPROOF

"Fastening Headquarters"®

2501 N. Keeler Avenue, Chicago 39, Illinois
Offices in Principal Cities

SHAKEPROOF
FASTEX

Divisions of Illinois Tool Works

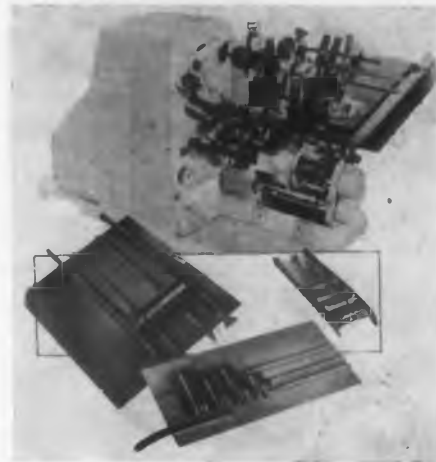
CIRCLE 143 ON READER-SERVICE CARD FOR MORE INFORMATION

Production Products

High Speed Machine Brands

Variety of Vacuum Tubes

Tube manufacturers can now imprint trademark, company name, tube type designation and other detail on vacuum tubes at rates as high as 7000 per hour, with a cylindrical object marking machine.



The Model 20A machine handles tubes ranging from miniature glass types to "bulgy" or pear-shape types, by means of five different interchangeable chutes. Chutes are marked according to the tube types they accept, together with calibrated adjustment scales. Precision molded rubber printing elements, and specially formulated marking compounds for glass, metal, etc., assure clear, attractive imprints. Chute feed and automatic ejection provide production speeds from 3000 to 7000 tubes per hour.

Specifications of the 20A machine include dimensions of 26 x 13 x 18 in.; bench mounting; 1/4 HP motor drive; max imprint size 2-7/8 x 6 in.

Marken Machine Co., Dept. ED, Keene 59, N.H.

CIRCLE 145 ON READER-SERVICE CARD FOR MORE INFORMATION

Subminiature Toroidal Coiler

Electronically Actuated

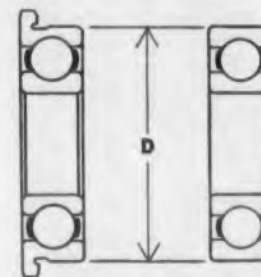
A completely new approach to the problem of high speed production of the diminutive toroidal components used in shift register, computer memory and similar magnetic devices, is used in this miniature machine. Specifications: core size, maximum outside diameter 3/4 in. height to 1/2 in.; residual hole, minimum, using smallest ring, 0.055 in.; wire size, 34 to 45 AWG; winding rings, 3 in. diameter, 1/8 to 3/64 in. cross-section; wire capacity, exceptionally large, typical value for 1/16 in. winding ring is 235 circular mill feet; turns counter, thyatron actuated high speed impulse counter provides positive counting to a maximum of 1200 counts per minute; speed, variable to limits of counter capabilities; footage counter, automatic registration of loading footage; feed, manual, 180 or 360 degree, as desired; power, 115 v, 60 cy for motor and electronic counting equipment.

Donald C. Harder Co., Dept. ED, 3710 Midway Drive, San Diego 10, Calif.

CIRCLE 146 ON READER-SERVICE CARD FOR MORE INFORMATION

A NEW COST-SAVING FEATURE of Fafnir Flanged Instrument Bearings

Simplification of housing designs is made possible by the addition of flanged bearings with *straight outside diameters* in several sizes that match those of Fafnir unflanged or plain radial ball bearings. Now, one-size, straight bored housings may be planned. This new series of flanged bearings is available with or without shields. For additional information, write The Fafnir Bearing Company, New Britain, Connecticut.



FLANGED BEARING NUMBERS	OUTSIDE DIAMETERS	BORE	EXTRA SMALL SERIES RADIAL BEARING NOS.
F33K3	.3750	.1250	33K3
F33K5	.5000	.1875	33K5
F51K7	.6250	.2500	51K7
F53K	.8750	.3750	53K



Atomizer Wash

PATHWAYS TO PRECISION

The atomizer wash given to Fafnir Instrument Ball Bearings illustrated at the left is typical of the extremes to which Fafnir will go to assure the maximum of consistent high quality. The operation takes place in air-conditioned areas where the air is slightly pressurized and thoroughly cleaned.

Write for latest catalog.

FAFNIR BALL BEARINGS

MOST COMPLETE LINE IN AMERICA

CIRCLE 147 ON READER-SERVICE CARD FOR MORE INFORMATION

DC-AC CHOPPERS

For 60 Cycle Use

Built to rigid commercial specifications.

Twenty-two types, both single and double pole.

Long life.

Low noise level.

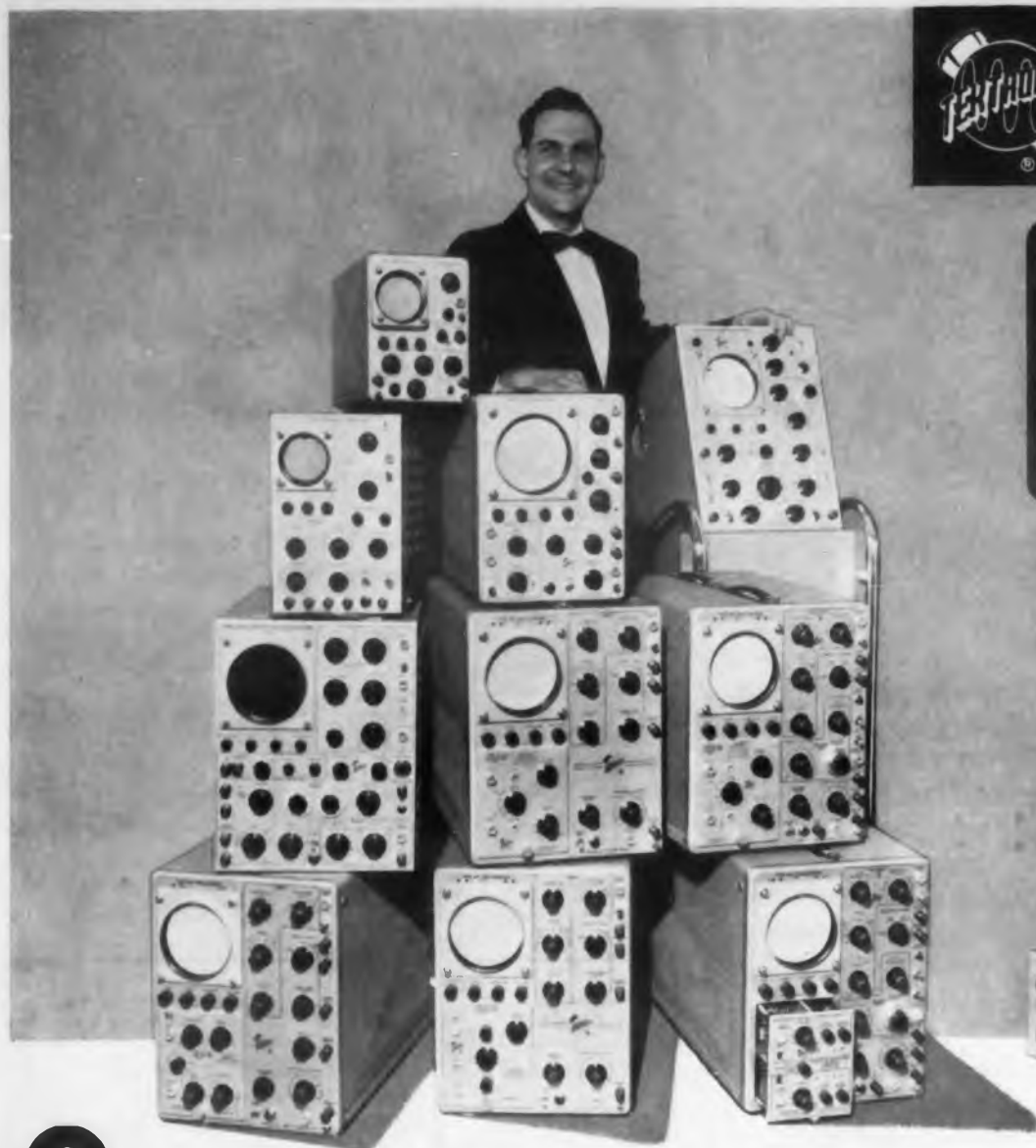
Extreme reliability.

Write for
Catalog 370.

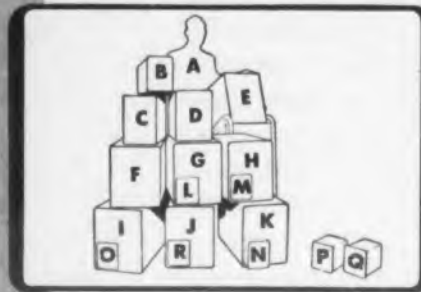
STEVENS
INCORPORATED
ARNOLD

22 ELKINS STREET
SOUTH BOSTON 27, MASS.

CIRCLE 144 ON READER-SERVICE CARD FOR MORE INFORMATION



- A. Tektronix Field Engineer.
 B. Type 310 Oscilloscope. 3" portable, dc to 4 mc, weight only 23½ lbs. Price \$595.
 C. Type 315D Oscilloscope. 3" portable, dc to 5 mc, weight only 36 lbs. Price \$770. Rack-mounting model also available.



- D. Type 515 Oscilloscope. 5" portable, dc to 15 mc. Weight only 40 lbs. Price \$750.
 E. Type 517A High-Speed Pulse Oscilloscope. Seven-millisecond risetime, 24 kv accelerating potential. Price \$3500.
 F. Type 524AD Television Oscilloscope. DC to 10 mc, 0 to 25 millisecond sweep delay. Price \$1180.
 G, H, I, J, K. Oscilloscopes using plug-in preamplifiers. Seven Plug-in Units available. Extra wide sweep range. Extreme versatility.



- G. Type 531 Oscilloscope. DC to 10 mc, 10 kv accelerating potential. Price, without plug-in units, \$995.
 H. Type 535 Oscilloscope. DC to 10 mc, 10 kv accelerating potential, 1 µsec to 0.1 sec sweep delay. Price, without plug-in units, \$1300.
 I. Type 532 Oscilloscope. DC to 5 mc, 4 kv accelerating potential, 8-cm linear vertical deflection. Price, without plug-in units, \$825.
 J. Type 541 Oscilloscope. DC to 30 mc, 10 kv accelerating potential. Price, without plug-in units, \$1145.
 K. Type 545 Oscilloscope. DC to 30 mc, 10 kv accelerating potential, 1 µsec to 0.1 sec sweep delay. Price, without plug-in units, \$1450.

PLUG-IN UNITS

- L. Type 53/54A Wide-Band DC \$85
 M. Type 53/54B Wide-Band High-Gain125
 N. Type 53/54C Dual Trace Fast-Rise DC275
 O. Type 53/54D Differential High-Gain DC145
 P. Type 53/54E Differential Low-Level AC165
 Q. Type 53/54G Differential Wide-Band DC175
 R. Type 53/54K Fast-Rise DC..125
 All prices f.o.b. Portland, Oregon

One of these oscilloscopes may belong in *YOUR* picture

If an oscilloscope with the right characteristics will help speed progress in your work, you'll be interested in the performance range covered by these ten Tektronix Oscilloscopes. Each has been designed for a particular application, from the compact Type 310 Portable Oscilloscope to the Type 517A, specialized for high-speed pulse analysis. Each of the five oscilloscopes designed to work with interchangeable plug-in preamplifiers offers an extremely high degree of versatility in a single instrument.

Your complete oscilloscope requirement may be satisfied by one of the more versatile instruments. Or, you may have an unusual requirement that can be satisfied only by a highly-specialized oscilloscope. In selecting the right oscilloscope for your present and future needs, a consultation with your Tektronix Field Engineer can be very helpful. It's a matter of great importance to him that you make the best possible selection, because his term of responsibility parallels the useful life of your Tektronix instrument... and that's a huge chunk of his future.

ENGINEERS—interested in furthering the advancement of the oscilloscope? We have openings for men with creative design ability. Please write to Richard Ropiequet, Vice President, Engineering.

Tektronix, Inc.

P. O. Box 831 • Portland 7, Oregon

Phone Cypress 2-2611 • TWX-PD 265 • Cable: TEKTRONIX

CIRCLE 149 ON READER-SERVICE CARD FOR MORE INFORMATION

Production Products

Miniature Toroid Winder

1/16 Inch Core Diameter

Employing a new winding technique, a unique toroidal winder has been developed which uses a magnetically controlled needle. The needle, of the ordinary sewing variety, is threaded with a length of wire and, by means of a rotary permanent magnet, is made to pass successively through the toroidal core in a simple sewing action. In this manner, turns of wire are placed on the core. The ID of the toroid is limited essentially by the size of the needle.

Toroids with initial hole diameters of 1/16 in. or smaller are readily accommodated by the machine. This technique is in contrast to the conventional winder which employs a split, circular bobbin. A simple needle passes through a smaller hole than can a more complex bobbin.

In addition to accommodating smaller cores, the new machine has simplified the winding action in that wire is wound directly onto the core. No involved intermediate actions are required, such as the insertion, winding and removal of bobbin.

Hughes Aircraft Co., Dept. ED, WSDL, Culver City, Calif.

CIRCLE 150 ON READER-SERVICE CARD FOR MORE INFORMATION

Commutator Turning Machine

Finishes Up to 700 Per Hour



Model CTM 2000, a fully automatic commutator turning machine has been introduced. By employing diamond cutting tools, the new design of this machine allows a single semi-skilled operator to turn automatically from 500 to 700 finished commutators per hour. Rough and finish turning can be performed simultaneously by simply using two diamond tools.

Completely flexible, the machine can be quickly adjusted to turn commutators of up to 2 in. diameters and 2 in. lengths, with a tolerance of 0.0003 in. or better, and with a 15 micro-inch surface finish if so desired. A complete armature change can be made in approximately fifteen mins.

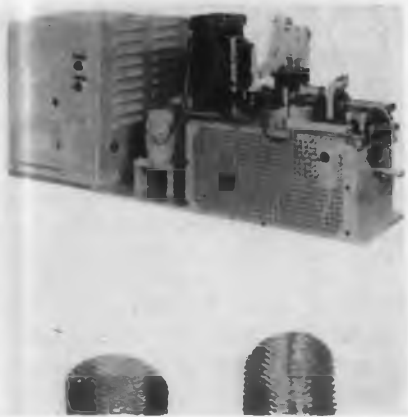
Motor-Mation, Inc., Dept. ED, 116 W. 9th St., No. Canton, Ohio.

CIRCLE 151 ON READER-SERVICE CARD FOR MORE INFORMATION

Production Products

Wire Cloth Welding Machine

Completely Automatic



A new, completely automatic machine for forming and welding cylindrical screens of wire cloth has been introduced. The new welding machine is expected to find wide use in the

electronics industry for forming and welding vacuum tube and microwave parts. The wire cloth is fed to the machine from a reel, cut to exact size, wrapped on an arbor, welded, then ejected. This complete process is automatic, and nominal production rate is 3000 parts per hour.

For fuel filters, the automotive industry is using 120 x 108 mesh of monel metal wire cloth, 0.687 in. wide, formed on a 0.192 in. arbor. However, with appropriate tooling, the machine will form other cylindrical parts in a wide range of diameters and in lengths to 0.750 in. The automatic wire cloth welding machine is supplied complete with all power supply components and controls, ready for installation and operation.

Federal Tool and Engineering Co., Dept. ED,
1384 Pompton Ave., Cedar Grove 1, N.J.

CIRCLE 153 ON READER-SERVICE CARD FOR MORE INFORMATION

Thread Cutting Fastener

For Thin Sheet Metals



Specially designed to hold die-cut or cold-forged name plates, emblems and trim against sheet metal surfaces, this thread cutting

fastener cuts clean, deep threads on unthreaded studs, and can also be used in other applications which require a spring take-up fastener.

When used with its pre-assembled plastic sealer, the new TCF makes a watertight seal. (The sealer precedes the fastener onto the stud so that it is not damaged by the thread cutting process.)

The TCF is low cost, re-usable, self-locking, vibration proof and has a spring take-up which guarantees flush mounting on flat or contoured surfaces.

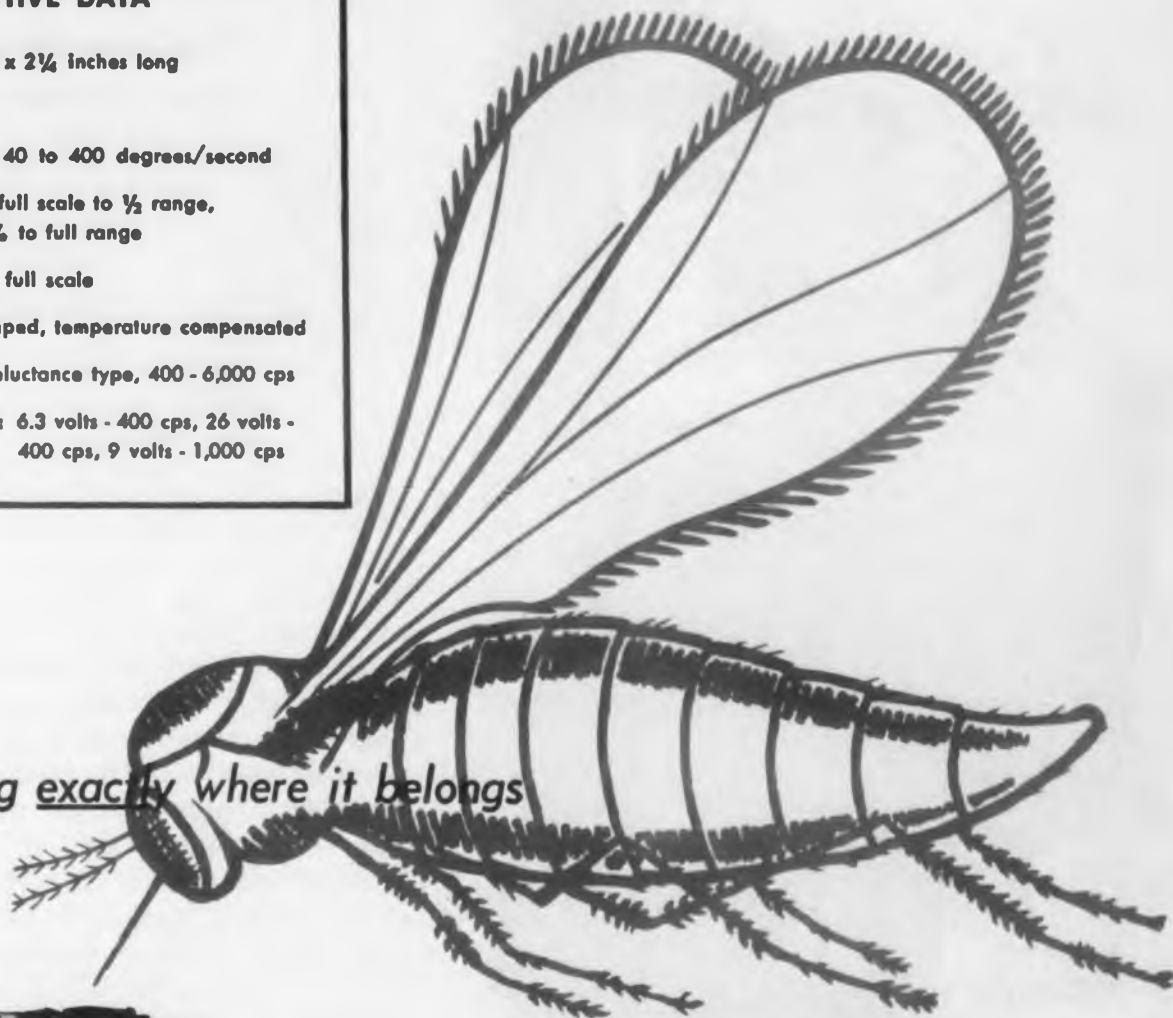
United-Carr Fastener Corp., Monadnock Mills Div., Dept. ED, San Leandro, Calif.

CIRCLE 154 ON READER-SERVICE CARD FOR MORE INFORMATION

DESCRIPTIVE DATA

- **SIZE:** 1 inch diameter x 2¼ inches long
- **WEIGHT:** 3.8 ozs.
- **FULL SCALE RANGE:** 40 to 400 degrees/second
- **LINEARITY:** 0.1% of full scale to ½ range, within 2% to full range
- **RESOLUTION:** 0.01% full scale
- **DAMPING:** Fluid damped, temperature compensated
- **PICKOFF:** Variable Reluctance type, 400 - 6,000 cps
- **MOTOR EXCITATION:** 6.3 volts - 400 cps, 26 volts - 400 cps, 9 volts - 1,000 cps

Putting the sting exactly where it belongs



GOLDEN GNAT

Miniature Rate Gyros for Missiles and Aircraft

Here is a precision, miniature rate gyro. It's tiny . . . measures only 1 inch in diameter and 2¼ inches in length. It's rugged . . . withstands 100G shock and 10G vibration to 2,000 cps. It has a record of proven performance.

Even under the most severe environmental conditions the Golden Gnat will perform as required. To make this possible many unique design details have been incorporated. One such detail is the Gnat's gold plated steel housing for improved corrosion resistance and positive hermetic sealing.

Wherever the need exists for high performance miniature rate gyros such as for autopilot stabilization in missiles and aircraft, antenna stabilization and fire control applications, the Golden Gnat is ideally suited. Write for Bulletin GN . . . Minneapolis-Honeywell, Boston Division, Dept 10, 1400 Soldiers Field Road, Boston 35, Mass.



Gnat Rate Gyro
Shown actual size

MINNEAPOLIS
Honeywell

BOSTON DIVISION

CIRCLE 155 ON READER-SERVICE CARD FOR MORE INFORMATION

10,000
now in use
throughout
the world



MV-17C
DC-VTVM

100 microvolts to 1 KV-DC.

For Sensitivity And
Ultimate Reliability Choose
the Millivac MV-17 C DC-VTVM

Millivac established its leadership in the field of sensitive DC VTVM's in 1948 when we introduced the world's first high impedance millivoltmeter for DC, the MV-17 A, forerunner of the present MV-17 C. It had a lowest range of 0-1 mV, at 6 megohms input impedance. Since then we have steadily improved our DC meters. Our latest model, the MV-27 C, is 4 times more sensitive than the original instrument (0-250 uV, 6 meg).

These instruments are available in portable or rack-mounted form, also with or without circuitry to drive recorders, with or without insulated dummy ground as well as for regular 60 cps line operation or for odd line frequencies (50 cps-500 cps, 117V).

Over 10,000 of these meters are now in general use throughout the world. If you are not yet familiar with the MV-17 C or MV-27 C, write for complete literature.

Tomorrow is our yesterday

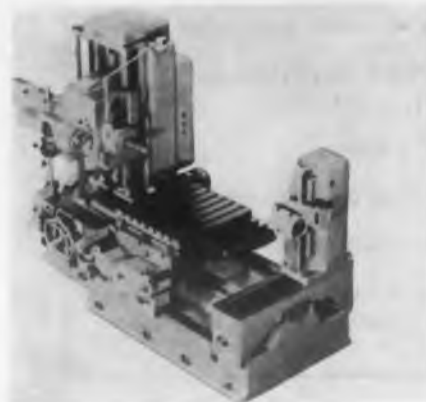
MILLIVAC INSTRUMENT CORP.
BOX 997, SCHENECTADY, N. Y.



CIRCLE 158 ON READER-SERVICE CARD FOR MORE INFORMATION

Production Products

Tool-Room Boring Mill Optical Coordinate Settings



A new system of optical coordinate setting has been incorporated in the "Optimetric" tool-room boring mill.

Projection screens are fitted to the vertical adjustment of the spindle slide

and boring stay, and the transverse movement of the table. This patented system of optical measuring permits utilization of the full degree of accuracy available in a machine of this capacity. Settings within an error of no more than 0.00025 in. are easily obtained. The wide bed support enables the table to be brought out at either extreme end without deflection. Three sizes are available in the series: Model OA, 2-1/2 in., Model OB, 2-3/4 in., and Model OC, 3 in.

British Industries Corp., Dept. ED, 80 Shore Rd., Port Washington, N.Y.

CIRCLE 159 ON READER-SERVICE CARD FOR MORE INFORMATION

Transfer Molding Press Completely Automatic



For thermo-setting plastics, Model 99-A Automatic Transfer Molding Press uses general purpose powder which does not require pre-heating. Stand-

ard mold blocks are held in place by a standard mold retainer set. The unit is particularly well suited for low quantity runs.

Tolerances to ± 0.0005 in. are possible. Flash is minimized and finishing holes are possible, since core pins can be piloted through to the other half of the mold. Maximum parts dimensions (2 cavity mold) are 1-1/8 x 1-1/8 x 7/8 in. Per cycle feeder capacity is 0.9 cu in.

After mold is put into operation, the press is completely automatic, other than the refilling of the hopper and emptying the container of finished parts.

Hull Standard Corp., Dept. ED, Abington, Pa.

CIRCLE 160 ON READER-SERVICE CARD FOR MORE INFORMATION

NEW—self-locking UNBRAKO flat head socket screws



The Nylok* self-locking feature locks these screws securely in place. They won't work loose. Can be reused without loss of locking action. Tough, resilient nylon locking pellets permanently installed. Successfully withstand temperatures ranging from -70 to 250°F. Uniform 82° angle under heads for maximum contact—accurate hex sockets for positive, non-slip internal wrenching. Heat treated alloy steel, continuous grain flow, fully formed Class 3A threads for maximum strength and exact fit. Pellets act as liquid seals. Standard sizes #6 to 3/4 in. Write for Bulletin 2193. Unbrako Socket Screw Division, STANDARD PRESSED STEEL CO., Jenkintown 12, Pa.

*TM Reg. U.S. Pat. Off., The Nylok Corporation

UNBRAKO SOCKET SCREW DIVISION

Unbrako Products are sold
through Industrial Distributors

STANDARD PRESSED STEEL CO.

SPS

JENKINTOWN PENNSYLVANIA

CIRCLE 161 ON READER-SERVICE CARD FOR MORE INFORMATION

See ELECTRONIC DESIGN'S

New "Career Section"

Page 115 in this issue

Offered only in ELECTRONIC DESIGN

Hayden Publishing Company, Inc.

19 East 62nd Street

New York 21, N.Y.

Templeton 8-1940



NEW PACKAGE CRYSTAL and OVEN

**HIGHER STABILITY
BETTER AGEING FACTOR
HERMETICALLY SEALED**

The plug-in BTC-2 incorporates an all-glass vacuum mounted crystal plus integral temperature stabilization for high precision frequency control at 75°C. or 85°C.

For example, this hermetically sealed package will stabilize within .00004% at 5 mc at -55°C. ambient. In this instance, frequency shift due to ageing will not exceed .0002% during first year of service.

Available at specified frequencies from 4 kc to 125 mc. Write for Bulletin #497.

BTC-2 SHOWN
ACTUAL SIZE

**BLILEY
ELECTRIC COMPANY**
UNION STATION BUILDING
ERIE, PENNSYLVANIA

CIRCLE 163 ON READER-SERVICE CARD FOR MORE INFORMATION

SAVE TIME & MONEY ON INSPECTIONS

FINE, AMERICAN-MADE INSTRUMENT
... AT OVER 50% SAVING

**STEREO
MICROSCOPE**
FOR INDUSTRIAL OR HOBBY USE

Up to 3" Working Distance — Erect
Image — Wide 3 Dimensional Field

Now, ready after years in development—this instrument answers the long standing need for a sturdy, efficient STEREO MICROSCOPE at low cost. Used in production—in research—in the lab, shop, factory, or at home; for inspections, examinations, counting, checking, assembling, dissecting—speeding up and improving quality control. 2 sets of objectives on rotating turret. Standard pair of wide field 8X Kellner Eyepieces give you 21 power and 34 power. Additional eyepieces available for greater or lesser magnification. A low reflection coated prism erecting system gives you an erect image—correct as to right and left—clear and sharp. Helical rack and pinion focusing. Interpupillary distance adjustable. WE WILL SHIP ON 10-DAY FREE TRIAL.

Order Stock No. 85,039-DA full price . . . \$99.50 f.o.b.
Shipping weight approximately 11 lbs. Barrington, New Jersey

Send check or M.O.—or order on open account

WE'LL SHIP ON 10-DAY FREE TRIAL SATISFACTION
OR MONEY BACK

FREE! Giant CATALOG of OPTICAL BUYS!

OVER 1,000 OPTICAL ITEMS . . . Many on-the-job helps . . . quality control aids! 64 pages — hundreds of illustrations. Many war surplus bargains! Imported instruments! Lenses, Prisms, Magnifiers, Telescopes, Microscopes, Binoculars, etc. Optics for industry, research labs, experimenters, hobbyists. No obligation. Write for FREE Catalog DA.

MUND SCIENTIFIC CO., BARRINGTON, N. J.

CIRCLE 164 ON READER-SERVICE CARD FOR MORE INFORMATION

Production Products

Strip Cutter

Produces Precision Grids



A series of new grid strip cutter (chopper) machines is now being marketed. Typical of these new strip cutters is

machine No. 2823 which accurately cuts wound strips into individual radio tube grids of all sizes. These sizes are controlled by a unique "stop strip" holder which assures accuracy, and by special steel cutting blades. To facilitate sharpening these cutting blades are easily removed.

Designed for safety, these grid strip cutters have full, protective guards that help prevent possible accidents. An air operated mechanism is used in this equipment to assure positive, dependable operation with minimum maintenance. Standard machines handle a variety of materials and material sizes, "customized" units for every production requirement can be supplied with a selection of features including full automatic programming.

Kahle Engineering Co., Dept. ED, 1400 Seventh St., No. Bergen, N.J.

CIRCLE 165 ON READER-SERVICE CARD FOR MORE INFORMATION

Portable Koil Kradle

Simplifies Materials Handling



For supplying coil stock to presses and other equipment, an improved koil kradle is announced. The new koil kradle is equipped with casters enabling it to be moved

easily from machine to machine, as needed, and also facilitating alignment of Koil Kradle to the machine. It is available in capacities from 1200 to 16,000 lbs, handling 60 in. diam coils up to 48 in. wide.

Front wheels of the portable model swivel for steering. As tongue is lowered, bed is lifted by a cam, clearing the floor 1/4 in. With tongue in vertical position, front of bed is lowered to set solidly on the floor.

Benchmaster Mfg. Co., Dept. ED, 1835 W. Rosecrans, Gardena, Calif.

CIRCLE 166 ON READER-SERVICE CARD FOR MORE INFORMATION

*Somewhere —
New Product Success
Depends on a
Single Wire or Cable*



*The Wire or Cable
PHALO*

Will Custom Make!

On the drawing board and in the blueprints, the product holds a world of promise . . . it appears that a waiting market will accept it with open arms. Yet a single element . . . that very special and vital wire or cable is still missing and until it's found the product is still a dream on paper.

Phalo enters the picture at this stage many times each year. Sometimes the answer is found in days, sometimes it takes longer but most times the right answer is found and the product becomes a reality.

*If your product needs a
wire or cable to get rolling
— you need PHALO.*



PHALO PLASTICS CORPORATION
25-4 Foster Street
WORCESTER, MASSACHUSETTS



CIRCLE 167 ON READER-SERVICE CARD FOR MORE INFORMATION

ridiculous!
you can't mix magic and
Pulse Transformers

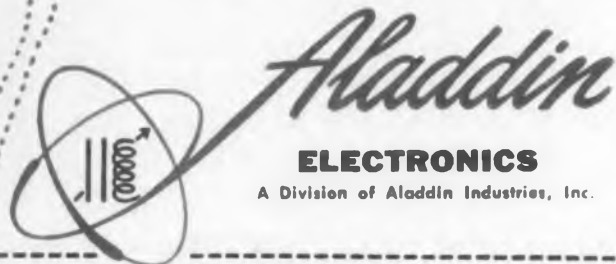


but—sir—you're wrong
and here's why...

Samples appear with almost magic speed when you turn your pulse transformer problems over to Aladdin. We have a long list of stock items, plus the know-how to meet your specific performance requirements—if you'll give us just a hint about the circuit and what it's supposed to do.

Our construction is standard. We're big enough to stock thousands of standard core parts in readiness for your orders. We move with magic speed when we learn of a new requirement. We deliver quality components on schedule.

Send the coupon for our engineering bulletins.



ELECTRONICS

A Division of Aladdin Industries, Inc.

ALADDIN ELECTRONICS
715 Murfreesboro Road, Nashville 2, Tenn.

Send me technical information on Pulse Transformers.

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____



CIRCLE 169 ON READER-SERVICE CARD FOR MORE INFORMATION

Services for Designers

Extra Long Laminates
Cut by Special Saw



A special long-length saw enables the Synthane Corp., of Oaks, Pa. to saw laminated plastic sheets up to 38 in. wide and lengths up to 25 ft, although sheets of almost any length can be sawed by hitching. By the use of hitch-curing or multiple pressing techniques, Grades C and L can be furnished in extra long lengths from the Company's 96 in. x 24 in. press. The maximum length for sheets of 2 in. thickness is 276 in., but lesser thicknesses can be furnished in lengths up to 29 ft.

The new saw may be equipped with diamond or abrasive cut-off wheels, tungsten-carbide tipped wheels, or high carbon steel saws, depending upon the grade of laminated plastic to be cut.

**Display Boards
Of Short Run Stampings**

Display boards showing different types of short run stampings have been developed to provide factual information to companies

using or considering short run stampings in their manufacturing process. It gives tooling costs and running costs in addition to showing actual samples of typical short run applications.

Included on the display are short run samples of stamping, forming, and drawing. Metals included are copper, brass, aluminum and steel. There are also samples of plastic and phenolic stampings.

The Display Boards can be loaned from the Federal Tool and Manufacturing Company, 3640 Alabama Ave., Minneapolis 16, Minn.



FREE SELECTION CHART
for
AGASTAT®
time delay
relays



Now you can select exactly the right Agastat time delay relay for your particular timing need—in a hurry. This free selection chart lists data on every popular model in the Agastat line—the most complete line of pneumatic time delay relays in the industry. They're adjustable for timing from 0.1 second to 10 or more minutes, unaffected by voltage variation, dust-proof, light, and mountable in any position. And there's an Agastat model to precisely fit your requirements, including two-step, electrical interlock and double head units. A glance at the free selection chart tells you which model to order.

Write for your free copy to Dept. A26-224



Elastic Stop Nut Corporation
of America

1027 Newark Avenue, Elizabeth, New Jersey
Pioneers in pneumatic timing.

CIRCLE 170 ON READER-SERVICE CARD FOR MORE INFORMATION

Advertisement

**New Perma-Torq*
keeps coils tuned as set**

It's new! Now CTC offers you Perma-Torq—a constant tensioning device for tuning cores of CTC ceramic coil forms.



It also allows for immediate resetting without removal or loosening of any mounting nut or locking device.

New Perma-Torq units come completely factory assembled to mounting studs, eliminating the bother of assembling and adjusting separate locking springs. CTC coil forms with Perma-Torq are designated PLST, PLS5, PLS6, and PLS7, and are completely interchangeable with CTC's LST, LS5, LS6 and LS7 series.

Send for complete details. Cambridge Thermionic Corporation, 457 Concord Avenue, Cambridge 38, Massachusetts.

* Patent pending

CIRCLE 171 ON READER-SERVICE CARD FOR MORE INFORMATION

you don't need a Blowtorch
to light a Cigarette...



in delay lines, too,
you waste money
when you
"over-specify"

you are sometimes unsure as to how much
attenuation is required for your delay line ap-
plications, do not take chances on expensive
"over-specification"

Avoid the costly pitfalls of "over-specifica-
tion" of custom-designed delay lines by taking
advantage of the engineering service and lab re-
ports offered by ESC. As pioneer manufacturers
and specialists in this field, ESC offers complete
slow-through on the equipment applications of
fixed and variable delay lines. "You tell us the
problem . . . we'll recommend the realistic and
economical specifications for your delay line
requirements." The well-rounded equipment back-
ground of the ESC Engineering Staff makes this
possible.

A lab report, submitted with the ESC pro-
totype, will include your submitted electrical
requirements, photo-oscillograms, which indicate
input and output pulse shape and output rise-
time; the test equipment used, and evaluation
of the electrical characteristics of the prototype.

Write ESC for an informative catalog and
complete information.



ESC

CORPORATION

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CIRCLE 175 ON READER-SERVICE CARD

Services for Designers

Printed Circuit Design
And Packaging Service



A printed circuit and modern packaging service,
complete from design to manufacturer, is now being
offered to the electronic industry for commercial and
governmental use.

The service, available through the Federal Tele-
phone and Radio Co. Printed Circuit Laboratory,
offers the latest techniques for solving complex
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sembly modules, Microstrip, aircraft communication
equipment and electronic calculators.

Among the facilities are equipment for rapid etch-
ing of copper laminates, a variety of plating equip-
ment ranging from solder-coating to gold, equip-
ment for processing printed-circuit resist patterns by
several techniques including photography, special
facilities for automatic potting and encapsulation,
and protection of printed circuits by many types of
protective coatings. Development of special dielec-
trics and laminates for particular requirements is
also a part of the service.

Complete details may be obtained from Elec-
tronic Systems Sales Department, Federal Tele-
phone & Radio Company, 100 Kingsland Road, Clif-
ton, N. J.

Miniature Coil

Production and Design

A nationwide design and production service is
available for users of miniature magnetic coils. Tur-
Bo Jet Products Co., Inc., of San Gabriel, Calif.,
specializes in the engineering and rapid production
of tiny coils, a job which many users find difficult.
The firm has methods of winding miniature coils
with such high-temperature insulations as epoxy,
silicone, Teflon and Ceroc-windings which conform
to NEMA and military specifications. The company
has a national service for manufacturers of relays,
valves, clutches, gyros, synchronous motors and
solenoids.

The company uses controlled-tension winding
machines, and has large stock of small wire, down
to #52 AWG copper in size.

Prototypes are built in a very short time; only a
few days at most. The company maintains two
plants, each equipped for short runs or mass pro-
duction under quality control. Literature will be
sent on request to Tur-Bo Jet Products Co., Inc., 424
So. San Gabriel Blvd., San Gabriel, Calif.

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MicroMatch Directional Couplers* measure RF Power and
VSWR—giving you, the designer, positive confirmation of
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tomer with a monitor that constantly watches his trans-
mission line and antenna.

Built into major military communications and ballistic
missile programs, these compact, rugged—and low cost—
couplers produce an output essentially independent of
frequency over the range of 3 to 4000 megacycles. They
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YOU KNOW WHAT'S GOING OUT

*U. S. Letters Patent No. 2,588,390



M. C. JONES ELECTRONICS CO., Inc.
BRISTOL, CONNECTICUT

CIRCLE 176 ON READER-SERVICE CARD FOR MORE INFORMATION

P PRECISION

The Only COMPLETE COIL FORM SERVICE

Available...

- SQUARE TUBES
- ROUND TUBES
- RESINITE COIL FORMS
- BOBBINS
- MANDRIL SERVICE
- FABRICATING SERVICE

SQUARE AND RECTANGULAR TUBES

Produced in any length, shape or size from $\frac{1}{16}$ " to 8", wall thickness from .010 to .125. Fabricated from dielectric kraft, fish paper, quinterra or combinations, including mylar. Bowed sidewall or Di-Formed construction.

ROUND TUBES

Produced in any decimal size up to 8" I.D. Fabricated from kraft, fish paper, cellulose acetate, mylar, polystyrene, quinterra, fibre glass and other dielectric materials.

RESINITE COIL FORMS

These coil forms have the highest resistivity of any resinated product. Furnished plain, embossed, internally threaded or triangular shape... also flyback transformer forms.

BOBBINS

Supplied round, square or rectangular. Cores fabricated from any of the above materials. Metal, asbestos, plastic or fibre flanges. Constructed to fit smaller spaces and permit multiple winding.

MANDRIL SERVICE

Accurately ground steel and aluminum coil mandrils at cost economy comparable to commonly used undependable wood or undersized steel mandrils.

FABRICATING SERVICE

We have modern high speed equipment to provide you with any special shape or form... rolled, spun, flared, punched or formed to your particular requirement.

Ask about Precision's complete coil form service.
Request informative bulletin.



PRECISION PAPER TUBE COMPANY

2055 West Charleston Street, Chicago 47, Illinois
Plant No. 2: 1 Flower Street, Hartford, Conn.

CIRCLE 180 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Engineer—Author's Guide 181

Title of this guide is "It's Easy to Write Articles for ELECTRONIC DESIGN." What to write about, and how to write the article is covered. Subject ideas covered are circuits, design techniques, design aids, measurement techniques, design data charts, application stories, and design survey stories. The guide is concise and easy to read. ELECTRONIC DESIGN, 19 E. 62nd St., New York 21, N.Y.

Germanium Plating Rectifier 182

Bulletin GED 2934 describes an air-cooled germanium plating rectifier. Among the design features explained are the hermetically sealed cell, the cooling system, the remote control installation, and the automatic voltage control. Illustrations show both individual parts and the entire assembly. The folder also contains a list of available models. General Electric Co., Schenectady 5, N.Y.

Impedance Meters 183

Two models of coaxial impedance meters operating in the frequency range of 1500 to 12,400 mc, and six models of waveguide impedance meters, operating in the frequency range of 2600 to 18,000 mc, are described in data sheet just published.

Photographs, features and specifications are included in the data sheet. The Nard Corp., 160 Herricks Rd., Minneola, L.I.

Electronic Design Article Index 185

A reprint of the Index of Articles appearing in the Dec. 15 issue of ELECTRONIC DESIGN is offered to readers. The index covers the period of July 1 through Dec. 15. A précis of each article is included. Cross-reference aid breaks the coverage into various subjects under the categories of Components, Design articles, Materials, and Test Equipment. ELECTRONIC DESIGN, 19 E. 62nd St., New York 21, N.Y.



CINTEL MUTUAL and SELF INDUCTANCE BRIDGE

Coverage:
0.001 μ H to 30mH in 12 ranges
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Accuracy:
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MARCONI Instruments 44 New Street • New York 4

CIRCLE 267 ON READER-SERVICE CARD FOR MORE INFORMATION

Filtered DC Power Supply 192

Literature explaining the construction and operating principles of the Model NFA, a specially filtered dc power supply, has been announced. With less than a 3/4 per cent ripple at top load the NFA is used for design testing and servicing radios and electronic equipment in aircraft, autos, tanks, and marine craft; transistor circuits; relays and solenoids; telephone circuits; laboratory and research instruments; plating operation; and low voltage devices. The illustrated catalog sheets give specifications and design features. Electro Products Labs., 1500 N. Ravenswood Ave., Chicago 40, Ill.

Batching and Counting 193

Printed in booklet form is a 7-page article entitled "Batching and Counting Using Gas-filled Decade Tubes" by W. Grimmond and W. H. P. Leslie. The article describes a range of units in the form of "building blocks" which can be quickly assembled to form a variety of frequency meters, chromatometers, frequency dividers, batching counters. International Standard Trading Corp., 22 Thames St., New York 6, N.Y.

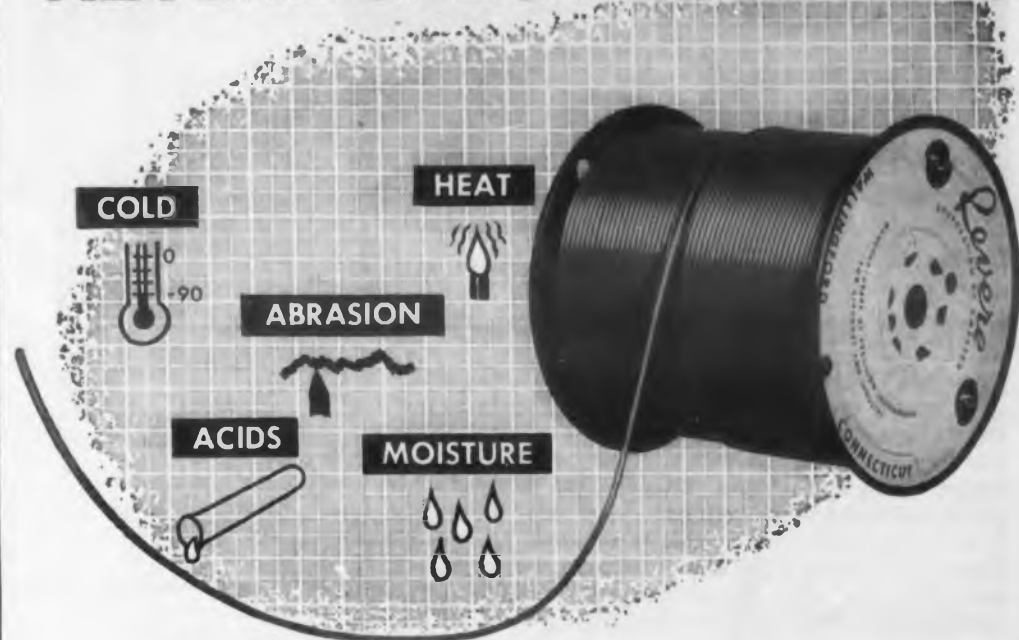
Teflon 196

The first of a series to be devoted to Teflon, Bulletin T-50 considers this plastic resin as a material. In 4-pages it details chemical, mechanical, thermal, electrical and other properties. A number of Teflon products — thin-and-heavy-walled tubing and rod, steel pipe lining, insulated wire, machine parts, and sheet—are illustrated and described. Haveg Industries, Inc., Halocarbon Div., 900 Greenbank Rd., Wilmington 8, Del.

Electrohydraulic Servo Valves 197

Volume 3, No. 1 of the Cook Technical Review, an issue of 28 pages, deals with electrohydraulic servo valves. Part I presents basic information relative to the types and characteristics of high response servo control valves. A second part describes the various types of valves which are commercially available and discusses the selection of electrohydraulic servo valves and their system application. The issue is \$1.00 per copy in the U.S. and Canada and \$1.25 in other countries. Cook Electric Co., 2700 N. Southport Ave., Chicago 14, Ill.

Insure Product Performance... REVERE SPECIALTY WIRES



For those tough design jobs where ordinary hook-up and thermocouple wires die from the heat, get brittle in cold, abrade and corrode . . . Revere SPECIALTY wires stand up. Built to MIL and customer specifications. Range includes:

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REVCOTHENE—(Extruded Monochlorotrifluoroethylene) —40°F to +275°F, AWG 28 to 10, silver-plated copper conductors, inert, excellent dielectric strength, no volatile plasticizers, non-flammable, thin wall, abrasion and moisture resistant.

PERMACODE — Teflon[®] insulated wire with striping down to the conductor for permanent identification, single or multiple stripes, 15 colors, —130°F to +410°F, AWG 28 to 16, silver-plated copper conductors, excellent abrasion and dielectric characteristics.

For Extremely High Temperatures

Fiber glass (to 700°F), asbestos (to 900°F), pure silica glass fiber (to 1500°F) wrapped or carded with outer braid and saturant as required by application.

HOOK-UP WIRES

A variety of telemetering and other multi-conductor cables constructed to customer specifications. Teflon, polyethylene, polyvinyl, nylon, glass, Revcothene, asbestos insulations for singles and jackets. Twisting, braiding, shielding, color coding to suit conditions.

MULTI-CONDUCTOR CABLES

THERMO-COUPLE WIRES

Iron-constantan, copper-constantan, Chromel-Alumel conductors, AWG 36 to 14, various insulation combinations and protective braids, temperature range from —100°F to +1500°F, constructed to rigid tolerances.

*E. I. du Pont trademark

Saturants for flame and abrasion resistance, metallic braids for severe service and electrical shielding. Color coding in 15 solid colors and stripes.

Prompt delivery of standard stock wires. Write for samples and literature on specialty hook-up or thermocouple wire.

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CIRCLE 200 ON READER-SERVICE CARD FOR MORE INFORMATION

Specialists in the Unusual

Precision Produced MATERIALS for TRANSISTORS and DIODES

- **GOLD** doped with N-type or P-type elements—supplied in the form of wire, sheet or ribbon and cut or stamped pieces.
- **INDIUM** electroplated base or precious metal wires.
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Since  1901

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CIRCLE 194 ON READER-SERVICE CARD FOR MORE INFORMATION



MODEL MS-4

MULTISCOPES MEET THE PROBLEM

By use of Tinker & Razor Multiscopes it is now possible to rack mount oscilloscope indicating units more compactly than heretofore. Rack mounting achieves neatness, efficiency and greater convenience with oscilloscope tubes grouped for instant observation of trace variations. You may order Multiscopes indicating units (without sweep forms) in 1, 2 or 4 tube multiples compactly mounted in a standard 19-inch rack panel fully supported from the panel face. If you would like further information on Multiscopes and applications — Write for data sheets to —

Makers of electronic testing apparatus, indicating and signal recording equipment for field and laboratory



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CIRCLE 209 ON READER-SERVICE CARD FOR MORE INFORMATION



CUT FASTENING COSTS with HASSALL THREADED PINS

- Low cost
- To your specifications
- Roll threaded for greater strength
- Large or small quantities
- Close tolerances
- Any finish • All metals

We are saving many of our customers from 20% to 50% on their special small threaded pins. These threaded pins may be made to your specifications in a wide variety of metals and finishes. Large or small runs are economical.

Let HASSALL quote on your small threaded pins... we can show you real savings.

Other HASSALL Specials

- Rivets
- Nails
- Studs
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- Screws
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- Small parts

WRITE FOR CATALOG... with it we will send you our popular decimal equivalent wall chart.

John Hassall, Inc., Box 2202, Westbury, L.I., N.Y.

HASSALL

SINCE
1850

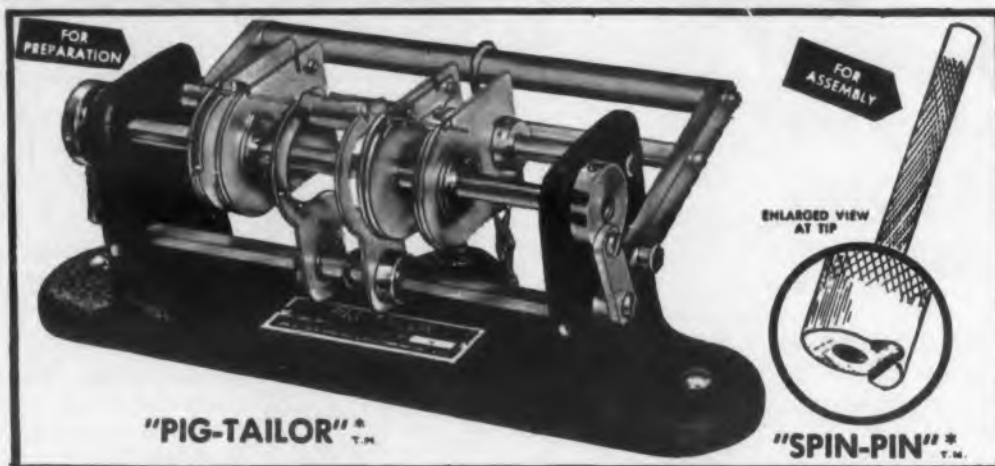


MAILS, RIVETS, SCREWS
AND OTHER COLD-HEADED
FASTENERS AND SPECIALTIES

CIRCLE 210 ON READER-SERVICE CARD FOR MORE INFORMATION

"PIG-TAILORING"

... a revolutionary new mechanical process for higher production at lower costs. Fastest PREPARATION and ASSEMBLY of Resistors, Capacitors, Diodes and all other axial lead components for TERMINAL BOARDS, PRINTED CIRCUITS and MINIATURIZED ASSEMBLIES.



The "PIG-TAILOR" plus "SPIN-PIN" — Accurately Measures, Cuts, Bends, Ejects and Assembles both leads simultaneously to individual lengths and shapes — 3 minute set-up — No accessories — Foot operated — 1 hour training time.

PIG-TAILORING provides:

1. Uniform component position.
2. Uniform marking exposure
3. Miniaturization spacing control.
4. "S" leads for terminals.
5. "U" leads for printed circuits
6. Individual cut and bend lengths.
7. Better time/rate analysis.
8. Closer cost control
9. Invaluable labor saving
10. Immediate cost recovery.

PIG-TAILORING eliminates:

1. Diagonal cutters.
2. Long-nose pliers.
3. Operator judgment.
4. 90% operator training time.
5. Broken components.
6. Broken leads.
7. Short circuits from clippings.
8. 65% chassis handling.
9. Excessive lead tautness.
10. Haphazard assembly methods.

* PATENT PENDING

Write for illustrated, descriptive text on "PIG-TAILORING" to ED-2P

BRUNO-NEW YORK INDUSTRIES CORPORATION

DESIGNERS AND MANUFACTURERS OF ELECTRONIC EQUIPMENT

460 WEST 34TH STREET

NEW YORK 1, N. Y.



CIRCLE 204 ON READER-SERVICE CARD FOR MORE INFORMATION

Cathodes for Electron Tubes

206

Up-to-date information on cathodes and other tubular electronic parts is given in the revised catalog No. 51 just released.

Using a smaller ceramic than standard, the narrow neck disc cathode permits manufacturers to produce cathode ray tubes with glass neck, thereby increasing the deflection angle of the tube to allow a shorter tube design. In order to provide cathode alloys with improved performance characteristics, a new series of alloys has been developed. These are covered.

The dimension and tolerance tables of round and shaped seamless and Lockseam form cathodes has been expanded, and additional information on standard and miniature disc cathodes is included. Chemical analysis, mechanical and physical properties of electronic materials is included for 11 cathode nickel alloys, glass sealing alloys, and alloys for fabricated tubular parts.

Other items described in the catalog are anodes and grid cylinders, tubing and tubular parts for transmitter and special purpose tubes and semi-conductor devices and fabricated tubular parts. Superior Tube Co., 1848 Germantown Ave., Norristown, Pa.

Fluorescent Lamp Ballasts

207

Listings of a complete line of fluorescent lamp ballasts are tabulated in Bulletin GEC-983J. The booklet's 12-pages contain electrical specifications and prices of ballasts for germicide, circline, rapid-start, and slimline and 40 w instant starting lamps, and of weatherproof, trigger-start, and general line fluorescent ballasts. Also covered are ballasts for dimming and flashing. Wiring diagrams and cross section drawings illustrate the booklet, and a cross-referenced table shows ballast lead lengths. Installation and operation instructions are included. General Electric Co., Schenectady 5, N.Y.

Pressure Gages

208

Four-page bulletin No. 403A describing pressure gages with new concept in transmitting linear motion is now available. Deflection of the pressure cell is transmitted to the indicating pointer of the gage without gears.

Among the advantages are elimination of backlash, and positive response to movement of the pressure element; accurate calibration over the full dial arc; and elimination of hairspring.

The bulletin is illustrated and gives the specifications and the standard ranges—from 0-60 psi to 0-20000 psi. Norden-Ketay Corp., Instruments & Systems Div., Commerce Rd., Stamford, Conn.

CIRCLE 300 ON READER-SERVICE CARD

TUBE DESIGN NEWS

GENERAL  ELECTRIC



RECEIVING • POWER • CATHODE RAY

Using Low-Noise GL-6299's, Applied Research Analyzer Monitors Republic Fighter Planes for Radio Interference



ABOVE: narrow white band across bottom of the scope portrays low noise level of the GL-6299 triode (less than 5 db) in 225-to-400-mc service. Actual (or simulated) signal impulses of microvolt and up show as sharp spikes, easy to detect. RIGHT: monitoring the electrical components of a Republic plane for absence of radio interference or interaction.



Applied Research Inc., Flushing, N. Y. employs 11 GL-6299 tubes in the SPA-224 visual noise-interference analyzer, developed jointly by Applied Research and Republic Aviation Corporation to detect any radio interference from airborne electrical equipment.

Super-sensitive, the SPA-224 analyzer continuously presents 225 mc to 400 mc, making possible identification of any spurious signal in this range from one microvolt up.

While an extremely low noise figure and high tube gain were primary reasons for specifying Type GL-6299 in the SPA-224 analyzer, other features were its small size (1 inch long by 1/2 inch diameter), planar design, and metal-ceramic construction. The GL-6299 is suited to many advanced instrument and other applications which call for precise, dependable performance and space-saving compactness.

Wide frequency range—from v-h-f to 3,000 mc—plus tube efficiency throughout this range, make for versatility. Extensive tests show life to 2,500 hours.

GL-6299's are in full-scale production, for immediate delivery. Characteristics, ratings, and price available from any General Electric office on the next page.

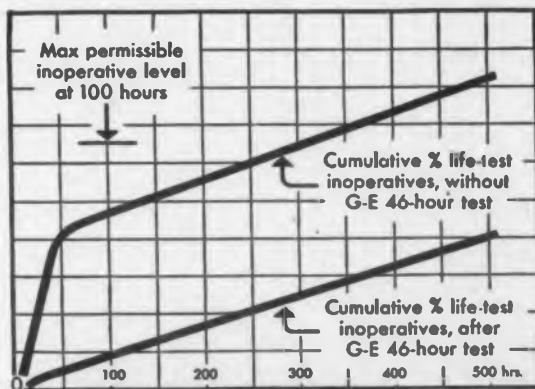
46-Hour Inoperative Control Test of All G-E Five-Star Tubes Cuts Failure Rate Sharply

By operating all 5-Star Tubes for 46 hours as an additional process before life tests begin, General Electric weeds out early-life tube failures.

Consequently, as the chart at right shows, the inoperatives in any 5-Star lot on life test are only half as many, at 500 hours, as they would be without G-E inoperative control. Furthermore, at 500 hours, the percentage of G-E 5-Star inoperatives is still far below the permissible figure established for 100 hours.

Employed only by General Electric, this 100% inoperative control process helps assure that 5-Star Tubes installed in critical military and industrial sockets will perform dependably across the board.

(Continued on Page 2, Column 1)



RIGHT: General Electric 5-Star Tubes on 46-hour inoperative control test. Only G.E. conducts this 100% pre-life test process on high-reliability tubes, to weed out early-life failures. ABOVE, the result: curve of General Electric 5-Star inoperatives is far lower throughout regular life test—1 to 2 at 500 hours' operation.



CLOSE G-E TUBE-MICA SPECIFICATIONS MEAN STEADIER TV. With tapered-pin micro-gages like that shown above, the diameter of grid side-rod apertures in G-E vertical sweep-tube micas is checked to an allowable half-mil tolerance, providing tight grid fit and minimum microphonics. By micro-measuring G-E tube micas and holding the grids to precision tolerances, image "jitter" on TV screens is virtually eliminated.

46-Hour Inoperative Control Test

(Continued from Page 1)

All 5-Star tests, as well as all product inspection—all manufacture of parts and assembly of tubes—are carried out in a special 5-Star factory set apart for the purpose, which is air-conditioned and pressurized to keep out dust and dirt. Lint-free Nylon and Dacron garments are worn throughout.

The industry's most extensive testing, plus manufacture under "Snow White" conditions, continues the quality theme that was established in the 5-Star Tube design stage, where ruggedness, reliability, and long life were the aims. For a convenient listing of these high-reliability types, ask any General Electric tube office for the 5-Star Selection Chart (ETD-1276-A) described on this page.

EASTERN REGION

General Electric Company, Tube Sales
200 Main Avenue, Clifton, N. J.
Phones: (Clifton) GRegory 3-6387
(N.Y.C.) Wlconsin 7-4065, 6, 7, 8

NEW PRODUCT BRIEFS

Receiving Tubes:

5DH8. New G-E triode-pentode for TV, especially suited to 600-ma series-string use.

6BW8. New G-E duplex-diode pentode for TV, useful as a horizontal phase detector and sound i-f amplifier, limiter, and AGC keyer.

6CX8, 8CX8. New G-E triode-pentodes for TV. Identical except for heater ratings. Also, 8CX8 is suited to 600-ma series-string circuits.

6919. New G-E twin diode for computer gating and clamping circuits. Has separate cathodes, low heater power, high perveance.

Cathode-Ray Tubes:

New radar types with high-resolution gun. 5FP7-B, 5FP14-A, 7BP7-B, 10KP7-A, 12DP7-C, 12SP7-D. Fully interchangeable with their prototypes.

ASK FOR COMPLETE INFORMATION!

CENTRAL REGION

General Electric Company, Tube Sales
3800 North Milwaukee Avenue
Chicago 41, Ill.
Phone: SPring 7-1600

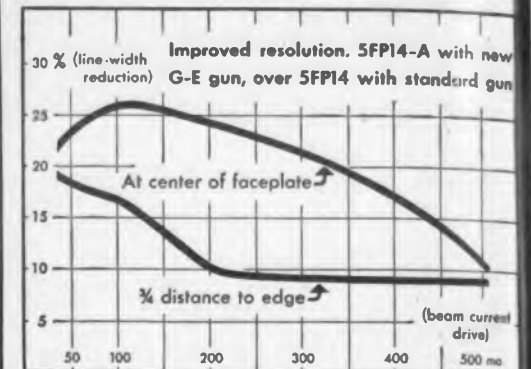
WESTERN REGION

General Electric Company, Tube Sales
11840 West Olympic Boulevard
Los Angeles 64, Cal.
Phones: GRanite 9-7765; BRadshaw 2-8566

Higher Resolution up to 35% from New G-E Precision C-R Gun

A new General Electric gun for military and industrial cathode-ray tubes make possible improved image resolution, which with some types reaches the high figure of 35% at center of face-plate.

Three construction features are re-



Improvement in image resolution in Type 5FP14-A with the new gun is shown by these curves of increased line-width reduction over the 5FP14 at successive beam drives. Better resolution for this tube ranges 8.5 to 26.1%

sponsible for the new gun's efficiency: smaller grid apertures . . . less space between Grids 1 and 2 . . . closer tolerances on parts.

G.E.'s high-resolution gun has wide application—can be used in any magnetic focus and deflection tube, with any phosphor.

Six radar tubes with the new gun already are available, ranging from 5 to 12 inches. Their presentations show details that with former types were cloudy or obscure. These types are listed under **NEW PRODUCT BRIEFS** at left.

REVISED!

General Electric
5-Star Tube
Selection Chart



Up-to-the-minute . . . all types are included, with key ratings. Useful to designers of military and industrial equipment. Ask for ETD-1276-A!

Progress Is Our Most Important Product

GENERAL ELECTRIC

ELECTRONIC COMPONENTS DIVISION, GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

Electronic Computing System Guide 214

Recently published is a 9-page operational guide to the 1103A electronic computing system. The letter-size booklet includes a 3-page section on the terminology of the system, with definitions of word length, instruction word, address allocations, arithmetic registers, control registers, input-output registers, magnetic tape and magnetic drum storage, program sequence control, and automatic program interruption. Also featured is a complete list of the system's instruction repertoire, along with the execution time, in μ secs, for each instruction. A keyed block diagram of the system, and descriptions of the computer's characteristics and mode of operation are also included. Remington Rand Univac Div. of Sperry Rand Corp., 1902 W. Minnehaha Ave., St. Paul, Minn.

Thermopiles 215

A 12-page illustrated brochure features air and vacuum-sealed thermopiles which convert infra-red energy into electrical energy suitable for amplification and measurement. Recently introduced in the United States, the thermopiles are designed for use in infra-red spectrophotometry, astronomical infra-red measurement, emission pyrometry, and as components of temperature control devices. The booklet, CH313, cites principal characteristics, specifications, and available window materials for a variety of models and points out suitable applications for each. An amplifying galvanometer system is also illustrated and described. Jarrell-Ash Co., 26 Farwell St., Newtonville 60, Mass.

Precision Cameras 216

Eight-page illustrated brochure describing the multiple-purpose precision data recording cameras has been released.

It was designed and developed specifically to meet the increasing demand for multi-purpose photographic data recording instruments. Being small and light-weight, the cameras permit automatic, synchronized motion picture or single frame operation.

The brochure shows how the cameras have eliminated hundreds of hours in data reduction time for our armed forces and aircraft manufacturers in such diverse applications as fire control evaluation, flight testing, missile tracking and bomb spotting. Among the features of the cameras are the radar scope recording, neon lights code film for timing and event marking; frame-for-frame synchronization within 1.5 millisecc., and withstanding ambient temperature extremes from -65 to $+135$ degrees F.

Full operating specifications and details of construction are given for both models. Flight Research, Inc., Post Office Box 1-F, Richmond 1, Va.

CIRCLE 300 ON READER-SERVICE CARD

ELECTRONIC DESIGN • February 1, 1957

IMPORTANT NEWS

for design engineers



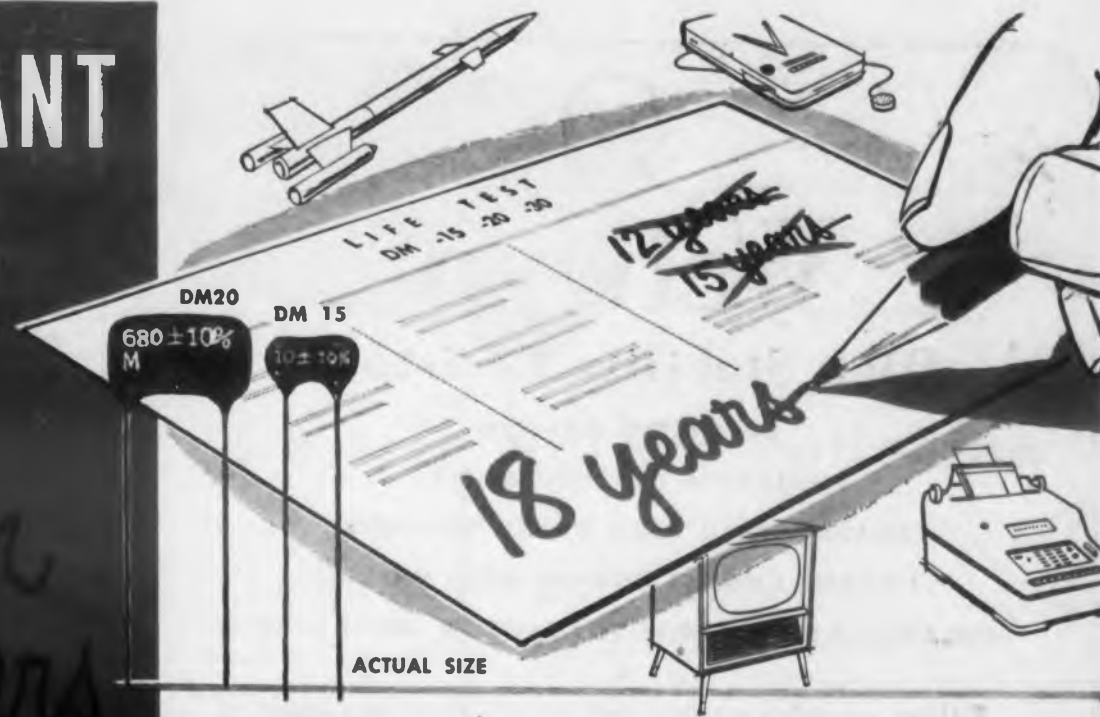
WHAT IS YOUR CAPACITOR APPLICATION PROBLEM?

Make your own test of
El-Menco Dur-Mica Capacitors



Write for FREE samples and catalog on your firm's letterhead.

El-Menco



El-Menco Dur-Micas

now rated for even

LONGER LIFE!

El-Menco Dur-Mica Capacitors Can Now Assure You Of Dependable Performance Up To 18 Years!

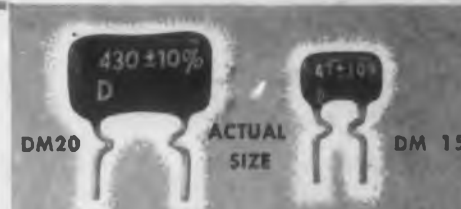
Not An Extravagant Claim, But A Tested Fact. The latest series of rugged trials by El-Menco engineers found El-Menco DM15, DM20 and DM30 Dur-Mica Capacitors outlive and outperform all others. Under accelerated conditions of $1\frac{1}{2}$ times rated voltage at 125°C ambient temperature; El-Menco capacitors continued to perform reliably after 12,000 hours. Translated into normal conditions, this indicates a lifetime of from 15 to 20 years!

MEET ALL ENVIRONMENTAL AND ELECTRICAL REQUIREMENTS OF BOTH CIVILIAN AND MILITARY SPECIFICATIONS.

El-Menco Dur-Mica DM15, DM20 and DM30 Capacitors Mean:

1. LONGER LIFE
2. POTENT POWER
3. SMALLER SIZE
4. EXCELLENT STABILITY — SILVERED MICA
5. PEAK PERFORMANCE

In addition to longer life, El-Menco Dur-Mica Capacitors with tougher phenolic casing assure greater stability over wide temperature range.



WITH NEW CRIMPED LEADS.

Crimped, parallel leads simplify application in television, printed circuits, electronic brains, computers, guided missiles and other civilian and military uses.

THE ELECTRO MOTIVE MFG. CO., INC.

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- molded mica
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Arco Electronics, Inc., 64 White St., New York 13, N. Y.
Exclusive Supplier To Jobbers and Distributors in the U.S. and Canada

CIRCLE 217 ON READER-SERVICE CARD FOR MORE INFORMATION



Welwyn

High Stability Resistors

DEPOSITED CARBON

MINIATURE POTENTIOMETERS

GLASS SEALED HIGH VALUE WELMEGS

VITREOUS ENAMEL COATED WIRE WOUND

ENCAPSULATED DEPOSITED CARBON RESISTORS

Welwyn precision products are manufactured in Canada and England. They are designed and constructed for the most exacting electronic requirements. These standards are uniformly maintained through rigid quality controls.

Please address communications to Dept. NB-5

Welwyn International, Inc.

3355 Edgecliff Terrace, Cleveland 11, Ohio

CIRCLE 224 ON READER-SERVICE CARD FOR MORE INFORMATION

MICRO-MINIATURE

Metallized Paper

CAPACITORS

NEW!

Contain all of the outstanding Hopkins quality characteristics so well recognized throughout the world. Super-small for transistorized circuits and other compact circuitry requirements. Only $\frac{3}{16}$ " max. length in values from .005 to .05. Standard tolerances in voltage ratings from 100 to 400 VDC. Operating temperature range from -55°C to $+100^{\circ}\text{C}$, without voltage derating. Hermetically sealed in metal cans or phenolic encased. Prompt delivery.

Send for catalog!

Phone, write or wire, TODAY!

HOPKINS
Engineering Co.

12900 Foothill Blvd.
San Fernando, Calif. • EMpire 1-8693
Offices in Washington, D.C. and San Francisco

CIRCLE 225 ON READER-SERVICE CARD FOR MORE INFORMATION

High Frequency Resistors 226

Bulletin F-1A describing high frequency and miniature high frequency resistors designed to meet specifications MIL-R-10683A, has been released.

Eight-pages of comprehensive data on construction, characteristics, specifications, applications, types, resistance values, tolerances, terminals and installations are given.

The bulletin is well illustrated and includes detailed charts and graphs. International Resistance Co., 401 No. Broad St., Philadelphia, Pa.

Screw Machine Products 227

A brochure on screw machine products is now available. Printed in three colors, it depicts typical screw machine work in a variety of tough alloys including stainless steels, Inconel, nickel, and titanium. Fabrication operations and techniques required for each of the eight illustrated items are described. Dimensions and tolerances for both cold-headed and screw machine products are included. Allmetal Screw Products Co., Inc., 821 Stewart Ave., Garden City, N.Y.

Cylinders and Hydrometer Jars 228

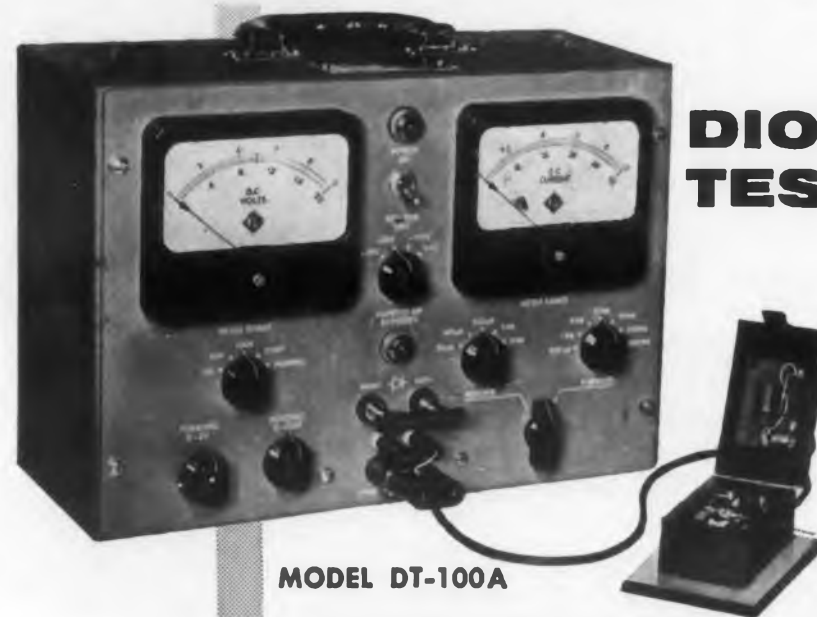
Product data sheet No. 4 on flasks and sheet No. 5 covering cylinders and hydrometer jars which are a part of a continuing series of data sheets are now available.

Sheet No. 4 describes the multi-purpose flasks which are able to withstand temperatures of 20°C and have a capacity of from 10 to 2000 ml.

No. 5 describes cylinders and hydrometer jars with diameter from 25 to 115 mm. Doerr Glass Co., No. East Boulevard, Vineland, N.J.

Phenolic Products 229

Catalog CDC-322 describes a full product line of phenolic molding materials and resins. The 12-page booklet cites special properties and product features of phenolic molding powders, rubber phenolic molding powders, phenolic laminating varnishes and industrial and foundry resins. Detailed technical data are presented in table form and illustrations show many typical applications for the compounds. General Electric Co., Chemical Materials Dept., 1 Plastic Ave., Pittsfield, Mass.



DIODE TESTER

MODEL DT-100A

- PRE-SET REGULATED REVERSE VOLTAGES
- -10, -50, -100, 0-100 VOLTS AT 5 ma.
- FORWARD CURRENT TO 500 ma. AT 1.0 VOLT
- REVERSED OR SHORTED DIODE INDICATION
- INTERNAL METER OVERLOAD PROTECTION
- TEST FIXTURE ALLOWS QUICK CONNECTIONS
- PROVISION FOR ACCESSORY DIODE HEATER



TELETRONICS LABORATORY, INC. 54 KINKEL STREET
WESTBURY, L. I., N. Y.

CIRCLE 230 ON READER-SERVICE CARD FOR MORE INFORMATION

28 Hydraulic Plate Shear 234

Illustrations and a detailed description of hydraulic plate shear are provided in Catalog 305. The 8 pages contain complete data on controls, construction, and dimensions. Pacific Industrial Mfg. Co., 848 49th Ave., Oakland 1, Calif.

Steel Tube Fittings 235

Complete engineering specifications for a wide range of steel tube fittings are listed in a 48-page catalog. Hydraulic and hydraulic flareless types are included. The booklet contains a section on assembly instructions, materials, finishes and operating pressures. The Weatherhead Co., 128 W. Washington Blvd., Fort Wayne, Ind.

Tubular Capacitors 236

An 8-page publication, GET-2671, covers gold-plated tubular capacitors for computers, missiles, telephone equipment, and other high grade military and commercial electronic equipment. The illustrated booklet contains descriptive information and lists ratings and dimensions. General Electric Co., Schenectady 5, N.Y.

Two-Way Radio 237

Bulletin ECR-380-A is devoted to the Progress Line two-way radio. It gives details on printed circuitry, interchangeable components, cabinets and mounting. General Electric Co., Communication Equipment, Electronics Park, Syracuse, N.Y.

Servo Components 238

Bulletin 410 is a single illustrated page which lists a number of high temperature servomechanism components such as servomotors, tachometers, etc., along with the degree of heat under which each can operate. The sheet also lists important features of the units. Norden-Ketay Corp., Commerce Rd., Stamford, Conn.

Solderless Wiring Devices 239

In Bulletin 856 a line of solderless terminals and connectors are catalogued and described. The 8 illustrated pages list ring, spade, and hook tongue devices; snap plugs; flag types; and parallel, butt, and 3- and 4-way connectors in a variety of sizes and wire ranges. Electric Terminals Corp., 2019 Center St., Cleveland 13, Ohio.



to put Silicone Rubber to work for you

PRODUCT DEVELOPMENT

Stability at extreme high or low temperatures, electrical characteristics and other properties of silicone rubber may answer your design problem. Our engineering staff, facilities and experience are at your disposal, to help you find an exact solution. Compound selection and custom molding are among the many additional, special services offered.

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Modern equipment and experienced

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CIRCLE 240 ON READER-SERVICE CARD FOR MORE INFORMATION



*A new sealed,
shaft-driven precision
AC voltage divider
for accurate positioning
and calibration.*

Gertsch Rotary RatioTran*

100-turn or 1000-turn models available, both in anodized aluminum cases, sealed against dirt and moisture. Ratio is controlled by a single ball-bearing mounted shaft. An internal mechanical counter provides easy readout. Printed silver switches assure long life and reliability.

- High accuracy . . . as good as .005% linearity
- High resolution . . . as good as .0005%
- Low phase shift . . . less than 1'
- High input impedance . . . approx. 50 henrys (200 henrys in 1000-turn model)
- Continuous transient-free output

*TRADEMARK

FOR COMPLETE DATA SHEET, CONTACT YOUR NEAREST
GERTSCH ENGINEERING REPRESENTATIVE OR

GERTSCH PRODUCTS, INC.

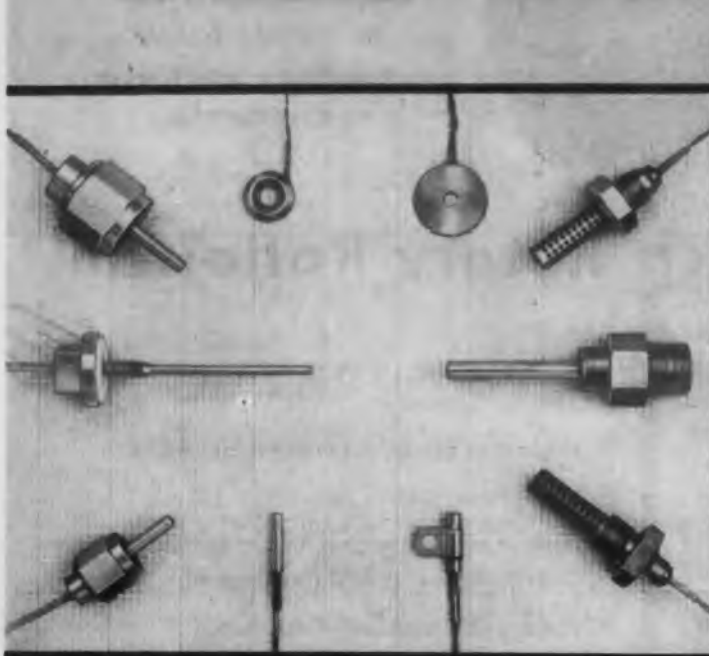
11846 MISSISSIPPI AVENUE
LOS ANGELES 25, CALIFORNIA

CIRCLE 241 ON READER-SERVICE CARD FOR MORE INFORMATION



CIRCLE 242 ON READER-SERVICE CARD FOR MORE INFORMATION

For the highest degree of *Accuracy*
in AIRBORNE TEMPERATURE INSTRUMENTATION



**HIGH OUTPUT • RESISTANCE-TYPE
 TRANSDUCERS**

ArnoUX high resistance temperature probes are designed for telemetering and other applications requiring high signal levels. Models are available in a wide variety of physical configurations for measuring surface, fluid, and air temperatures.

- Output up to 5 volts without amplification.
- -320°F to $+500^{\circ}\text{F}$ range with $\pm 2\%$ linearity. (Special units are available up to 1600°F .)
- Nominal resistance values: 100 to 20,000 ohms.
- May be used in AC or DC Bridge circuits.
- Meets MIL-E-5272A specifications.
- Calibration curve supplied with each probe.

When used with ARNOUX miniaturized companion "TME" system, 20K transducers provide 5 volts output for as little as 150°F change.

Write for Bulletin 300

**MINIATURE MULTI-CHANNEL
 TEMPERATURE MEASUREMENT
 SYSTEM . . . full scale output 5 volts**

ARNOUX "TME" is a completely self-contained system designed for operation with ARNOUX special resistance-type transducers. Models are offered in 7, 14, and 20 channel capacity. The unit contains two precision mag-amp type, regulated D.C. power supplies, series connected with common neutral, for excitation of the transducers in half bridge circuitry.

- Power requirement: 115 volts, 400 cps.
- Power consumption: 20 channel model requires less than 20 watts.
- Balance and attenuation controls for each channel.
- No vacuum tubes or transistors used.
- Output voltage and impedance characteristics — directly compatible with F.M. sub-carrier and P.W.M. coder input requirements.
- System stability: within 1% throughout MIL-E-5272A environmental.
- Dimensions: 20 channel model: 7" x 4 1/4" x 3", wt. 5 1/2 lbs.

Write for Bulletin 500



**ARNOUX . . . foremost in
 TEMPERATURE MEASUREMENT EQUIPMENT . . .
 . . . TRANSDUCERS, ACCESSORIES AND
 CUSTOM ENGINEERED SYSTEMS.**



Designers and Manufacturers of Precision Instrumentation

11924 W. WASHINGTON BOULEVARD • LOS ANGELES 66, CALIFORNIA

CIRCLE 244 ON READER-SERVICE CARD FOR MORE INFORMATION

Ideas for Design

No-Mistake

WHERE fast, accurate readings must be taken, a direct-reading digital dial can eliminate many reading errors. It is generally more esthetically pleasing as well. The dial shown is Beckman/Heli-pot Corp.'s answer to the problem. They have designed a 10-turn, direct reading "Digidial."

This dial has three windows across its face. The left-hand window indicates full turns; the middle tenths; and the right-hand window, hundredths. Reading accuracy is 0.05 per cent. White-filled numerals on a black background allow readings to be taken up to six feet away. The design of the Plexiglas snap-on cover allows the numbers to be seen at wide angles from head-on.

A positive friction brake can be engaged to hold a given setting and prevent the dial from being turned. The use of precision steel pinions and a brass spur drive reduces backlash to one one-thousandth of a turn. There are no mechanical stops. After ten full turns have been completed, the reading returns to zero and counting begins again.

The "Digidial" is 1-15/16 x 2-1/16 x 1-1/8 in. overall. It accommodates standard 1/4 in. shaft and 3/8-32 NEF-2A bushing mountings. It weighs only 2-1/4 oz. and can be installed on panels up to 1/4 in. thick. A snap-on cover allows for easy indexing of the dial to the device being metered. The finish consists of a clear Plexiglas cover, blue-coated on its inside surface, and a buffed aluminum knob fitted with a blue vinyl grip.

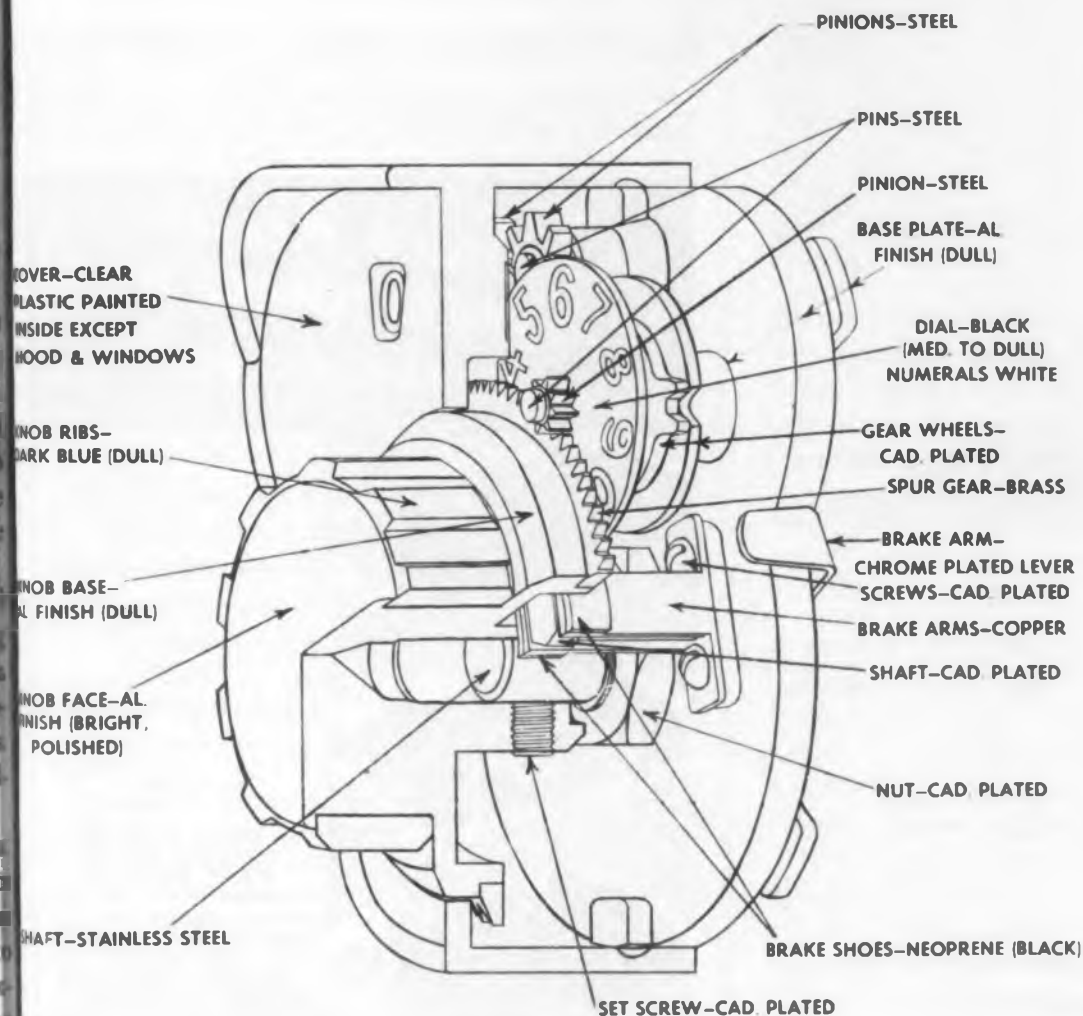
The cutaway view shows in detail how the dial is designed, including materials employed.

A new regular feature covering clever circuit and mechanical design ideas—individual contributors will be paid \$10 for items published.

e Dial



"Digidial" direct-reading digital dial for quarter-inch shafts and standard panel mounting.



Cutaway view of "Digidial" showing details of design and materials.

4 Intercoupled servo loops



weight less than 2 lbs.*



This indicator, part of an Automatic Navigational System, contains 6 synchros, 2 motors and 2 motor generators—all Clifton Size 10 units.

These units (and 2 mechanical differentials) are built into 4 independent, intercoupled servo loops. Weight of these 4 loops plus gears and gear plates is less than 2 lbs.

The main reason for the lightness of Clifton synchros, and hence the lightness of systems built around Clifton components, is that no unnecessarily heavy materials are used in their manufacture.

When it is a question of highest accuracy with the least bulk and weight, look to CPPC rotary components.

* If this system had been built with our latest Size 8 synchros, weight would have been brought to about 1 1/3 lbs.

Look to CPPC for Synchro Progress

cppe
CLIFTON PRECISION PRODUCTS CO., INC. Clifton Heights, Pa.

CIRCLE 245 ON READER-SERVICE CARD FOR MORE INFORMATION

VHS* RELAY

(*Very High Sensitivity)

● The VHS is a balanced armature, Alnico magnet type relay. It is internally shock-mounted and resistant to vibration. The screw-on cover is gasket sealed. It can be opened and resealed.

Connections: 9 pin octal style. Dimensions: 1 1/4 diameter x 2 1/4 long. Weight: 4 ounces.

Sensitivity: Infinite variations from 0.2 Ua. to 10 Amp. or 0.1 Mv. to 500 volts, self contained. Higher volts or amps with external multipliers. A.C. rectifier types. Trip point accuracies to 1%. Differential 1%. The degree of resistance to shock and vibration primarily depends upon sensitivity and type of action wanted. In general, the relays will not be permanently damaged by shocks of 100 G's and vibrations up to 2,000 cps at 3-4 G's. The most sensitive relays may close their contacts under these conditions. Contacts: SPST or SPDT, 5-25 Ma. D.C. Other ratings to 1/2 Amp. A.C. A locking coil gives high pressure and chatter free contact even under shock and vibration. Prices on the order of \$20-\$80. Delivery 4 to 6 weeks. Assembly Products, Inc., Chesterland 17, Ohio (West Coast: P.O. Box XX, Palm Springs 17, Calif.

- | | |
|---------------------------------|-------------------|
| 1. Shock mount | 5. Cast bracket |
| 2. Contact assembly | 6. Alnico magnet |
| 3. Contact detail | 7. Bearing detail |
| 4. Armature with contact detail | 8. Yoke (steel) |
| | 9. Mounting frame |



Model 266

Sample specs. are:
0.2 micro-ampere, (12,000 ohms coil) or,
0.1 millivolt, (5 ohms.)

Booth 3916, I.R.E. Show, March 18-21, Coliseum, N.Y.C.

CIRCLE 246 ON READER-SERVICE CARD FOR MORE INFORMATION



THE \$20,000 DELAY

For want of a simple nameplate, the Automatic Temperature Control Co., Philadelphia, had to hold up shipment of \$20,000 in control equipment.

Now, a portable Engravograph (size of a typewriter) makes individual nameplates on the premises. Cost, per label, less than 50¢—with unskilled labor.



WRITE FOR LITERATURE DEPT. IM-08

new hermes Engraving Machine Corp.

13-19 University Pl., New York 3, N.Y.

CIRCLE 247 ON READER-SERVICE CARD FOR MORE INFORMATION

Ideas for Designers

Transistor Circuits

Recently released by P. R. Mallory & Co. Inc. of Indianapolis, Ind. are two transistor circuits of general interest, primarily conceived for aircraft applications.

In Fig. 1 two transistors and a reversing switch are used to actuate the lamps, as in "wing and tail" flashers. Most important advantage of this circuit is the tremendous reduction in radio interference (28 v at 75 ma motor current and 0.5 v at 100 ma base drive) thereby reducing the filter size from approximately 12 cu in. and 1 pound to 1 cu in. and 1 oz for a 5 amp flasher. Peak interference is in the hundreds of microvolts at low power instead of 0.1 to 0.2 v at 1.5 kw inrush. At the same time, the overall flasher volume is cut in half and the contact life of the switch is extended indefinitely. Relaxation oscillators might also be used.

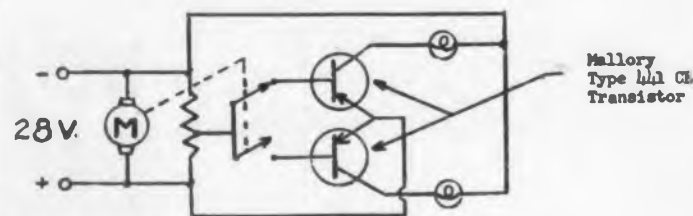


Fig. 1. Low Radio-Interference Flasher Circuit.

In Fig. 2 is a possible use of transistors for relay action, thus eliminating all moving parts and contact points. The motor employed is a blower motor from Globe Industries Inc., and is a 28 v at 6 amp unit. It is possible, at the present time, to control a 5 amp load using approximately 200 ma drive.

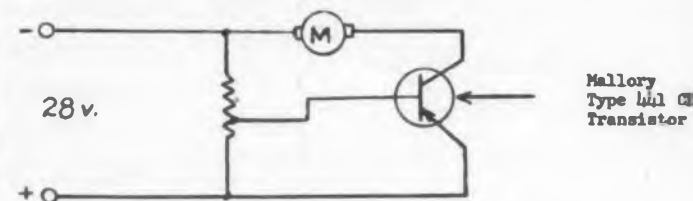


Fig. 2. Relay Action Without Relays.

Simplified Testing of Printed Circuit Laminates

Use of a standard, direct-reading force indicator greatly simplifies bond-strength testing of foil coatings on printed circuit laminates at the Synthane Corporation, Oaks, Pa., manufacturers and fabri-

SAVE TIME
SAVE MONEY
with
NATIONAL COIL
COMPANY'S
MOLDED
COIL
KITS



AVAILABLE FROM STOCK FOR IMMEDIATE SHIPMENT

ADVANTAGES:

- All Chokes Pass Latest MIL Specifications
- Most Used Electrical Values at Your Finger-Tips.
- Cost Less than Requisitioning Samples.
- No Lost Time in Waiting for Samples.
- Speeds Up Development Work.
- All Items Regular RETMA Color Coded.
- Designed for Easy Use in Laboratories.

ORDER INFORMATION:

- KIT "N", 108 coils, (6 of a value) Inductance from .15 uh to 15 mh \$10.00
- KIT "Q", 120 coils, (6 of a value) Inductance from .47 uh to 39 uh \$12.75
- KIT "R", 120 coils, (6 of a value) Inductance from 1.2 uh to 120 uh \$15.50
- KIT "S", 66 coils, (6 of a value) Inductance from 150 uh to 1000 uh \$11.50

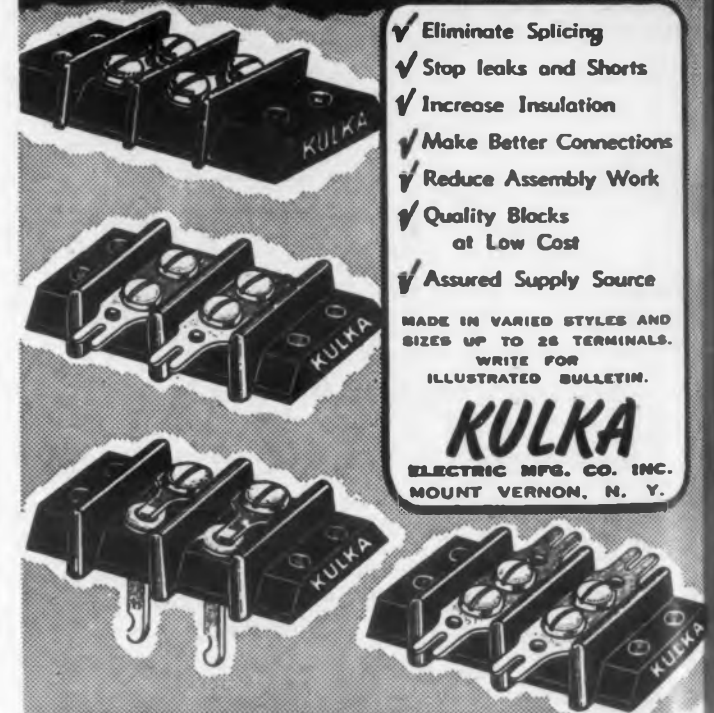
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CIRCLE 248 ON READER-SERVICE CARD FOR MORE INFORMATION

7 Sound Reasons
for using KULKA TERMINAL BLOCKS
on your Electronic Equipment



- ✓ Eliminate Splicing
- ✓ Stop leaks and Shorts
- ✓ Increase Insulation
- ✓ Make Better Connections
- ✓ Reduce Assembly Work
- ✓ Quality Blocks at Low Cost
- ✓ Assured Supply Source

MADE IN VARIOUS STYLES AND SIZES UP TO 28 TERMINALS. WRITE FOR ILLUSTRATED BULLETIN.

KULKA

ELECTRIC MFG. CO. INC.
MOUNT VERNON, N. Y.

SEE OUR EXHIBIT IRE SHOW, 2D. FL. BOOTH 2901

CIRCLE 249 ON READER-SERVICE CARD FOR MORE INFORMATION



for transit case
and chest hardware
to exact
government
specifications

S-1085 Bar
with S-1084
Fastener
for Signal
Corps chests.

see

J. H.
SESSIONS
& SON

Write for catalog of hardware for Air,
Signal and Engineer Corps Transit Cases
and Chests, and other applications where
government specifications must be met.

J. H. SESSIONS & SON
289 RIVERSIDE AVE., BRISTOL, CONN.

CIRCLE 250 ON READER-SERVICE CARD FOR MORE INFORMATION

TELEX TAKES PLEASURE . . .

. . . in presenting L. H. Josefson, new Sales Manager of our Electro-Acoustics Division, a post he assumes after varied experience in other divisions of the Telex organization.

Formerly manager of research for Superior Separator Co., and a member of the product development staff for General Mills' Mechanical Division, Josefson has wide product development and marketing experience. He is a graduate of the University of Minnesota.

Mr. Josefson is thoroughly familiar with our design, production, engineering and marketing facilities. Right at your desk he'll discuss your problems in component and assembly miniaturization, and can suggest some ingenious techniques in shrinking the dimensions of design—as well as wide know-how in encapsulation. "Joe" Josefson will be calling on you soon. If you'd like an early visit, just drop us a line, or wire, and we'll make immediate arrangements.



L. H. JOSEFSON

TELEX

ELECTRO-ACOUSTICS DIVISION



ST. PAUL 1, MINN.

TELEX PARK

CIRCLE 251 ON READER-SERVICE CARD FOR MORE INFORMATION

Ideas for Designers

cators of laminated plastics. The device replaces the more conventional but inconvenient and unwieldy test set-up requiring a dead weight, a cord-and-pulley system, and a framework to support them.

The photograph illustrates the simplified test



Simplified testing procedure

procedure. A special knife, with edges spaced exactly 1 in. apart, cuts a test strip of copper foil. A knurled clamp, with chain attached, is then fastened to a free end of the strip, which has been peeled from the laminated phenolic to receive the clamp.

A model L-20 Force Indicator, manufactured by the Hunter Spring Company, Lansdale, Pa., is then hooked to the chain at a convenient height for the operator to apply tension and read the dial. The operator then lifts the indicator, pulling the chain and attached test strip until the copper test strip peels from the base material as shown. The maximum indicator dial reading gives the bond strength—in pounds and fifths of pounds—between the strip and the laminated phenolic. Once the foil has begun to peel, the dial reading will fall off slightly.

LEDEX

**HERMETICALLY
SEALED**

**ROTARY SELECTOR SWITCHES
AND STEPPING RELAYS**



STANDARD ENCLOSURE AND
STANDARD HEADERS . . .
AVAILABLE ON MANY MODELS

Two standard models
. . . available with a
maximum of 4 wafers and 105 pins in header . . .
capable of many switching combinations.

If standard Leduc models do not meet your requirements, send the design requirements for your hermetically sealed relay application today.

MODEL	MAX. NO. WAFERS	MAX. NO. HEADER PINS	A	B	C	D	E	F	G	H
No. 4	4	45°	2 1/4"	2 3/8"	4 1/2"	2 1/8"	3 1/8"	1/2"	3"	3 1/4"
No. 5	4	105°	3 3/8"	3 3/8"	8 3/8"	4 3/8"	4 3/8"	3 3/8"	4"	3 3/8"

*Circuits should allow for header pins to carry arc suppression items externally.

G. H. Leland INC.

WRITE FOR COMPLETE
INFORMATION TODAY!

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Report Briefs

Automatic Data Reduction

This catalog lists five categories of devices useful in automatic data recording and reduction systems which are available commercially or under development. The scope of the catalog is limited to devices essentially digital in nature. Categories: Analog Voltage to Digital Converters, Shaft Position to Digital Converters, Digital Plotters and Digital to Analog Converters, Miscellaneous Digital Devices, and Special Tape Recorders. An appendix lists the manufacturers. *PB 111928 Automatic Data Reduction, Part II, R. S. Hollitch and A. K. Hawkes, OTS, US Dept. of Commerce, Washington 25, DC, Nov. 1954, 80 pp. \$2.00.*

Fast Video Pulses

Preliminary work is described toward the attainment of pulse repetition rates of 1000 pps and greater, and pulse duration below 0.1 μ sec. Methods were studied for generating fast voltage step functions at the desired rates, and for shaping very narrow pulses. Experimental circuits are described and analyzed. *PB 121404, Generation of Fast Video Pulses, S. Krasnick, Signal Corps, OTS, U.S. Dept. of Commerce, Washington 25, D.C., Dec. 1955, 2 pp. \$.75.*

Reliable HF Communications

Investigations for improving antennas, open-wire transmission lines and associated lumped-constant circuits for reliable high-frequency communications. A major emphasis in the study is to be placed on consideration of high-power levels, from 50 to 500 kw. *PB 120378 Reliable High-Frequency Communications, Second Report, Apr.-July 1955, D. F. Bowman, Order from Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D. C., 47 pp, Microfilm \$3.30, Photocopy \$7.80.*

Radar Simulation Study

During the period of Sept. to Oct. 1955, work continued on the simulation program which includes development of a digital multi-target radar simulator of high realism and precision, and the further improvement and extension of the existing single target radar simulator in connection with its application to beam splitting and automatic track-while-scan problems. *PB 122375 Simulation Study For The Period 1 Sep-31 Oct 1955, Columbia Univer., Order from Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D. C., Nov. 1955, 49 pp, Microfilm \$3.30, Photocopy \$7.80.*



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Radio Astronomy Antennas

This report discusses the progress of antenna designs for measurements of ionospheric absorption and refraction of discrete radio noise sources at low frequencies in the range of 15 to 80 mc. The requirements of the antenna are: *a* Sufficiently broad-band characteristics to permit operation without essential change in pattern (but not necessarily impedance) over the range from 16 to 20 mc, *b* Forward gain 10 db over a dipole, *c* Compactness, so as to allow alt-azimuth mounting. *PB 123219 Antenna Studies For Radio Astronomy, Scientific Report #1, 15 June to 15 Sept. 1955, Contract AF19(604)-1503, J. W. Warwick and P. W. Carlin, Colorado University, Order from Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D.C., Jan. 1956, 18 pp, Microfilm \$2.40, Photocopy, \$3.30.*

Electron Beam Interaction

A field theory of a spaced-harmonic traveling wave tube is developed using a stationary field matching procedure. The circuit is the circularity symmetric disc loaded waveguide. Two cases are studied: a solid low current electron beam which completely fills the openings between sections, and a hollow beam of arbitrary radius. *PB 120413 Interaction of an Electron Beam With a Periodic Circuit, R. W. Gould, California Inst. of Technology, Order from Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D. C., Mar. 1955, 23 pp, Microfilm \$2.70, Photocopy \$4.80.*

Mag-Amp Two-Speed Servo

Described is a half-wave magnetic amplifier which utilizes a full-wave slave output stage to replace a vacuum tube amplifier in a two-speed servo system. Complete system performance is given, and a comparison between vacuum tube and magnetic amplifier systems is made. *PB 120818 Magnetic Amplifier Two-Speed Servo System, J. J. Suozzi, NAVORD 3973, Order from Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D.C., Aug. 1955, 25 pp, Microfilm \$2.70, Photocopy \$4.80.*

Radar Modification To Improve Stability

Investigation of improving the stability and accuracy of the AN/CPN-18 indicator for PPI presentation required in a traffic control system. Stability and accuracy are much improved with the recommended modifications and PPI presentation is considerably enhanced. *PB 120415 Modification of Indicator Group OA-184/CPN-18, J. J. Bogart, US Air R&D Command, Order from Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D. C., Mar. 1955, 23 pp, Microfilm \$2.70, \$4.80.*



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Ionospheric Antennas Survey

The material presented covers first a study and survey of propagational effects associated with ionospheric forward scatter transmission, then an examination of various antenna types having possible use, and finally a comparison of the advantages and disadvantages of the various antennas. PB 122372 *Survey Study On Antennas For Forward Ionospheric Scatter Transmission, Pickard & Burns, Inc., Order from Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D. C., Feb. 1956, 59 pp, Microfilm, \$3.60, Photocopy \$9.30.*

Traffic Control Radar Simulator

The radar simulator described is capable of simulating 30 moving aircraft targets on a PPI indicator. Control of target heading, velocity, position, and turn rate are available at each aircraft target operating station. Additionally available are: simulation of wind drift effect, distinctive coding symbol on each target, automatic variation of aircraft speed as a function of altitude, continuous targets display on CRT. PB 123088 *Radar Simulator For Use In Air Traffic Control Studies, Hixson, Harter and Warren, Ohio State University, Order from Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D.C., Jan. 1954, 28 pp, Microfilm \$2.70, Photocopy \$4.80.*

Cathode Studies Demountable Diode

Described is a demountable planar diode with a movable anode. The tube has been used to confirm an experimental method for determining the motional transconductance of a diode. It has also been used to compare two distinctly different methods for measuring the conductivity of oxide coated cathodes. Modifications are suggested for improving the tube. PB 119937 *Demountable Diode For Cathode Studies, A. Eichenbaum and H. Farber, Brooklyn Polytechnic Inst., Order from Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D. C., Mar. 1955, 23 pp, Microfilm \$2.70, Photocopy \$4.80.*

Spontaneous Magnetization Curves

Curves of spontaneous magnetization vs. temperature have been computed for simple ferromagnetic materials containing only one kind of magnetic ion. The results for various values of the parameters lambda, alpha, beta are tabulated and graphed. PB 122057 *Computed Spontaneous Magnetization Curves For Ferromagnetic Materials, Warfield, Smart and Wangness, NAVORD 3815, Order from Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D.C., Dec. 1954, 50 pp, Microfilm \$3.30, Photocopy \$7.80.*

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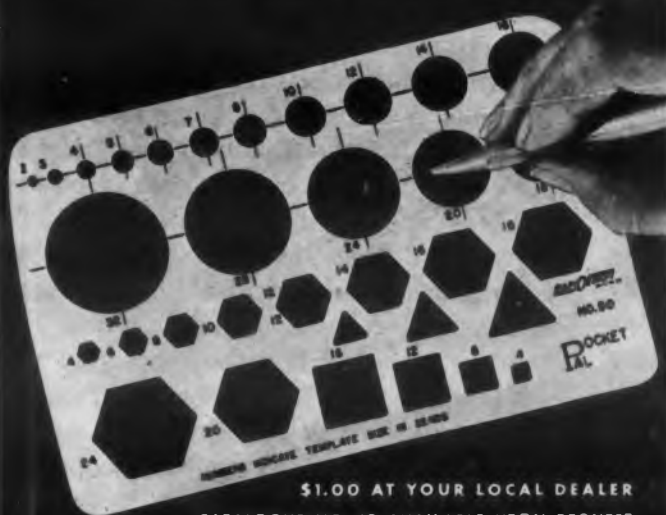
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VLF Recording and Analyzing

An FM system of magnetic tape recording for signals from dc to 15 cps has been developed along with playback apparatus permitting wide band frequency analysis from 0.016 to 4.2 cps. The recorder operates for 24 hours unattended. The recordings can be played back either 30 or 60 times faster than when recorded, producing frequencies great enough to be separated by special octave band pass filters which were developed. PB 120991 *Very Low Frequency Recording and Analyzing Instrument*, W. E. Austin, NAVORD 3615, Order from Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D. C., Jan. 1954, 25 pp, Microfilm \$2.70, Photocopy \$4.80.

Transponder Approval Tests

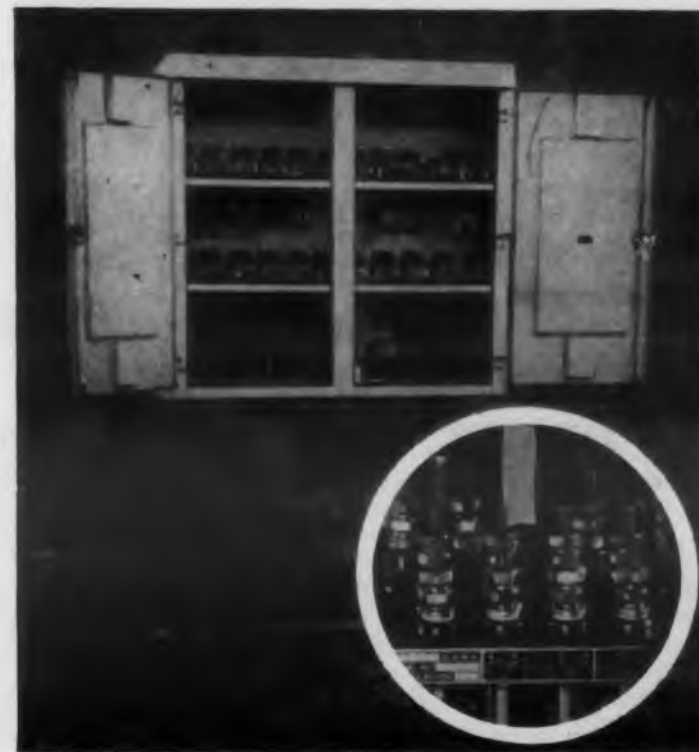
Final report on the type approval tests for TN-103/APX "Black Maria" transponder. Horizontal and vertical directivity patterns were taken of the antenna and horizontal patterns for the S-band portion over the frequency band required. SWVR of the antenna for both S- and G-bands were measured at several points. PB 120718 *Type Approval Tests For TN-103/APX "Black Maria" Transponder (For IFF Mark III)*, D. P. Heritage, NRL Report 2740, Order from Library of Congress, Photoduplication Service, Publications Board Project Washington 25, D.C., Jan. 1946, 21 pp, Microfilm \$2.70, Photocopy \$4.80.

Ordnance Resistance Measurement

The problem of measuring resistance of a sensitive initiator, such as a primer or detonator, has resulted in the development of a number of special meters. Presented is a brief description of several special purpose meters and analysis of some common general purpose meters, with low current characteristics usually. PB 122077 *Discussion of Some Meters and Test Sets For the Resistance Measurement of Electric Primers and Detonators*, A. M. Corbin, NAVORD 2288, Order from Library of Congress, Photoduplication Service, Publications Board Project, Washington 25 D.C., Jan. 1952, 22 pp, Microfilm \$2.70, Photocopy \$4.80.

Data Reduction and Storage

This report is on superimposed coding as recorded in two are more codes in the same field to facilitate information searching on machine-sorted index cards. Multiple and single field types are discussed and tables on dropping fractions for multiple and single field coding used for searching any machine or catalog are included. PB 121345 *Superimposed Coding For Data Storage*, M. Taube, OTS, US Dept. of Commerce, Washington 25, DC, Sept. 1956, 27 pp. \$0.75.



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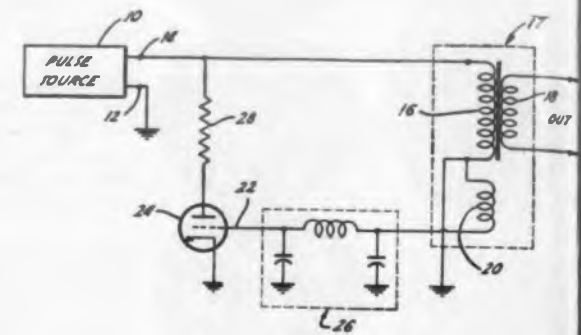
Patents

Post-Pulse Clipping Circuit For Pulse Modulators

Patent No. 2,744,195. P. Winokur, Jr. (Assigned to Philco Corporation.)

In radar systems, a magnetron is usually used in the oscillator and it is triggered by a negative pulse of short duration and relatively high amplitude. This negative pulse is applied to the cathode of the magnetron through a coupling transformer. Because of the inductance and distributed capacitance in the coupling transformer and the non linearity of the magnetron, there is a "backswing" positive voltage generated which can detrimentally affect the magnetron, such as setting up spurious oscillations. Damping of this backswing voltage has been sought by using a diode as a unidirectional switch shunting the primary winding of the transformer. Diodes, however, have limited current capacity with the result that a relatively high resistance must be used in series therewith, with the result that in high power systems the clipping of the backswing voltage is not wholly effective. Backswing voltages can also damage the magnetron.

Thyratrons also have been used in such damping circuits because they have high current capacity and, therefore, require considerably less load resistance. A difficulty is encountered with thyratrons because of the high interelectrode capacitance which acquire a negative charge on the grid cathode capacitance during the negative triggering pulse. As a result, there is a delay in firing the thyratron. This delay causes a sharp spike of backswing potential before the thyratron becomes conducting to damp the backswing voltage. This spike of positive potential sets up oscillations which generate undesired signals in the magnetron. In order to avoid this effect, it has been the practice to generate a thyratron triggering pulse which is applied to the control grid of the thyratron to render the tube conducting without delay. This additional cir-



cuit means makes the circuit more complex.

The circuit illustrated provides effective damping in a very simple manner, using a thyratron tube. The pulse source 10 is coupled to the cathode circuit of the magnetron through a coupling transformer, 16, 18. The backswing potential is dissipated through the resistor 28 and the thyatron 24. In order to avoid the negative charge developed between the cathode and grid of the thyatron by the negative triggering pulse, a winding 20 is coupled to the primary winding 16 of the transformer so that a positive pulse is generated by the negative triggering pulse in the primary winding 16. This positive pulse is applied to the control grid of the thyatron through a delay circuit 26. As a consequence, a positive pulse is applied to the electrodes of the thyratron during the negative pulse which counteracts the negative interelectrode charge and maintains the thyratron in a conductive state when the backswing voltage is generated. The backswing potential is dissipated through the thyatron without any positive spike as heretofore encountered in a circuit using a thyratron in the damping connection.

Transistor Trigger Circuits

Patent No. 2,744,198. G. Raisbeck. (Assigned to Bell Telephone Laboratories, Inc.)

Trigger or multivibrator circuits using two vacuum tubes are well known. With

the tubes alternately becoming conductive, symmetrical wave forms are derived from such circuits because of the phase inversion characteristic of the vacuum tubes. Similar circuits have been attempted using a pair of transistors. Since phase inversion is not a characteristic of a transistor such circuits have not been entirely successful.

If each of a pair of like transistors have their respective collector electrode connected with the emitter electrode of the other, a circuit is derived in which both transistors change from a current conducting state to a non-conducting state at the same time and not alternately as in the usual multivibrator circuit. A multivibrator circuit using a pair of transistors has been devised in which the collector of each transistor is coupled to the base electrode of the other transistor. In such a circuit the transistors become conductive alternately and a symmetrical output wave is secured. The difficulty in this circuit is that no electrode can be connected to ground, and as a consequence stability is lost and it is not suitable for some applications.

The patentee has devised a multivibrator circuit using transistors as shown in Fig. 1.

This is accomplished by using a P-type of transistor as one of the amplifying elements and an N-type transistor for the other. These two transistors have current voltage characteristics of opposite sign which is made use of to generate a symmetrical wave form. In this circuit the emitter of an N-type transistor 1 is coupled to the collector of the other transistor 2 which is a P-type and the collector of the latter is coupled to the emitter of the former. For the N-type transistor operating current is provided for the emitter by the circuit R2, battery 3, and inductance L. The P-type emitter circuit has operating current supplied by battery 4 through resistors R'2 and inductance L'. In this circuit the base electrodes are and can be grounded to provide stability.

The frequency of oscillation of the transistor multivibrator circuit can be adjusted as desired by selection of proper values for the resistors and inductors. The circuit may also be used as a frequency divider. The patent illustrates many variations of the circuit. Fig. 2, included here, is a schematic circuit diagram of a "one-shot" or mono-stable trigger circuit. Fig. 3 is a bistable or so-called "flip-flop" trigger circuit.

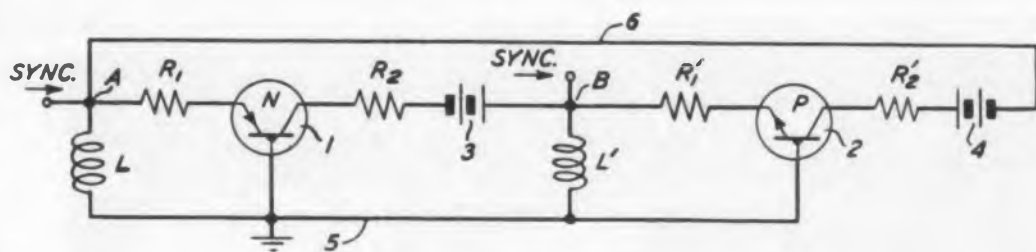


FIG. 1

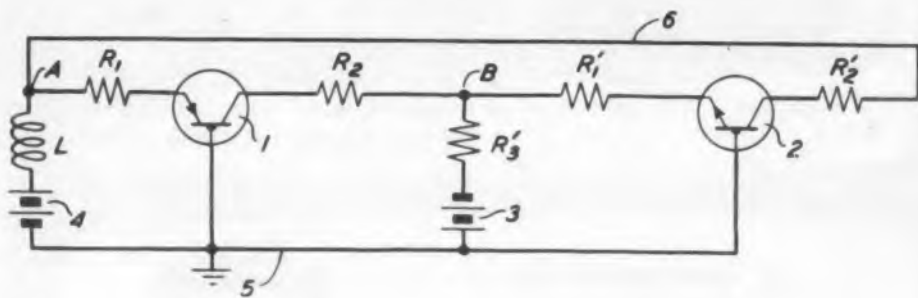


FIG. 2

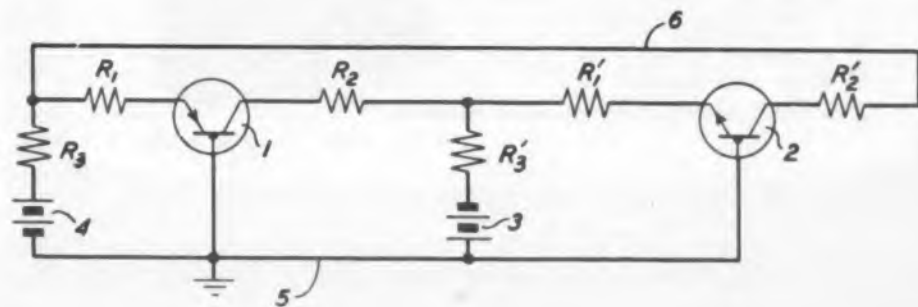


FIG. 3



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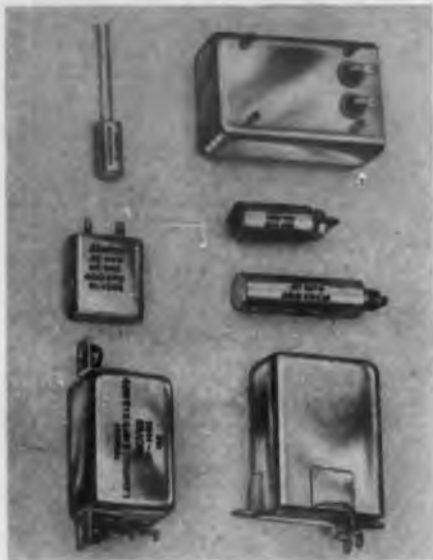
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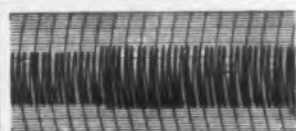
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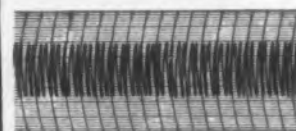


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Mechanical Design for Electronics Production

John M. Carroll, McGraw Hill Book Co., Inc., 330 W. 42nd Street, New York 36, N.Y., 348 pages. Price: \$6.50.

This book is directed primarily at the mechanical engineer who wishes to acquire knowledge of problems peculiar to the design of electronic equipment or for the beginning electronics engineer who needs to know more about the mechanics of packaging circuitry. It contains the following chapters: The Importance of Mechanical Design, Space Planning in Equipment Design, Chassis Design and Layout, Fabricating the Chassis, Manufacturing Small Parts, Shielding Components and Equipment, Potting, Embedding and Encapsulating, Moving Parts, Electric Motors and Rotating

Books

Components, Wiring and Soldering, Assembly Methods, Cabinet Construction, and Environmental Factors in Equipment Design.

Basics of Phototubes and Photocells

David Mark. John F. Rider Publisher, Inc., 480 Canal St., New York 13, N.Y., 136 pages, \$2.90.

Suitable for servicemen or newcomers to the field, this book provides an elementary explanation of the principles and practices surrounding phototubes and photocells. To make the subject more readily understandable, picture presentation is used wherever possible. The book contains a number of typical circuits and a good bibliography which designers may find helpful.



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Selected ASTM Engineering Materials Standards

American Society for Testing Materials, 116 Race St., Philadelphia 3, Pa., 358 pages. \$4.00.

Although prepared for engineering students and teaching staffs, this book is a valuable reference for designers who must specify materials of construction, including metals and nonmetals in common use. An unusually worthwhile chapter is included on "Writing A Technical Paper or Report." It lists standard abbreviations and states the rules governing their use.

Frequency Modulation Engineering, 2nd Revised Edition

Christopher E. Tibbs and G. G. Johnstone. John Wiley & Sons, Inc., 440 4th Ave., New York 16, N.Y. 435 pages. Price: \$8.50.

Intended for both students and engineers, this readily digestible survey of the whole field of frequency modulation engineering. Chapters are devoted to the frequency modulation of a carrier wave, interference and noise structure, interference suppression, frequency modulation propagation,

and aeriels. The remainder of the book describes the technique and circuits employed for frequency modulation and reception. Wherever possible, circuits of actual commercial equipments have been described and component values indicated. The work includes treatment of the theory of discriminator circuits and working designs together with measured response curves. This second edition has been substantially altered and enlarged.

Training Manual On Antennas, Vol. I

Philco Corp., TechRep Div., 22nd St. and Lehigh Ave., Philadelphia 32, Pa., 221 pages, \$1.93.

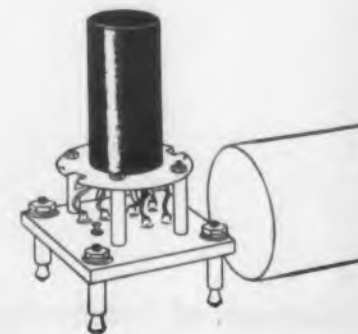
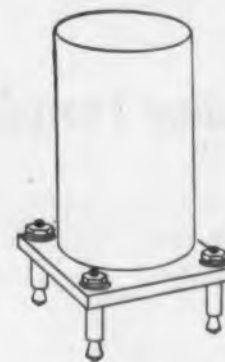
This manual, intended primarily for training technicians, is an excellent elementary text on antennas and propagation. The electronic designer may find the manual useful as a reference, or for familiarization with a specific-type antenna system or construction. The main topics treated are propagation of radio waves, antenna fundamentals, transmission-line theory, methods of feed at the antenna, coupling circuits, and types of antennas. Construction and measurement information and a glossary of antenna terms are provided.



Deliquescent Domains

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COMPARISON—WE 255A AND SIGMA 72AOZ-160TS

	255A	72AOZ-160TS
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URNS PER COIL	3200	2400
INDUCTANCE PER COIL, HENRY	0.9 *	1.0
CONTACT GAP, NORMAL MINIMUM, INCHES	.004	.004
CURRENT SENSITIVITY, ONE COIL, MA.	0.86-1.8	0.6-1.4
NORMAL RANGE OF SIGNAL LEVEL, MA.	10-60	10-60
MAXIMUM INTELLIGIBLE SPEED, PULSES/SEC. (70% CONTACT EFFICIENCY)	—	800
WORDS/MIN. EQUIV.	—	1250
BIAS DISTORTION ALLOWED, 5 MA. SIGNAL 60 CPS	—	3%
PERCENT BREAK, 100 WORDS/MIN., 20 MA. SIGNAL	—	4%
TOTAL COIL DISSIPATION FOR 40° C. RISE, WATTS	2.3 *	1.3

* AS MEASURED IN SIGMA LABORATORY

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What The Russians Are Writing

J. George Adashko

Contents of Avtomatika i Telemekhanika No. 8, 1956

DC Amplifiers with Photo Compensation, B. A. Seliber, S. G. Rabinovich, (18 pp, 13 figs).

When bolometers or similar devices are used to measure photocell currents, low temperatures, radioactivity, etc., it is necessary to employ dc measuring instruments with sensitivities much higher than those of conventional moving-coil or d'Arsonval galvanometer elements. This paper deals with galvanometric instruments with photocell feedback amplifiers, so-called photo-compensation amplifiers. A diagram of such an amplifier (designated F-16) is given in Fig. 1. The authors discuss the principal parameters of some amplifiers, the inherent errors, and actual methods of error compensation. The operation of photocells and photo-resistances is analyzed, and some recommendations are made concerning the best selection of photocells.

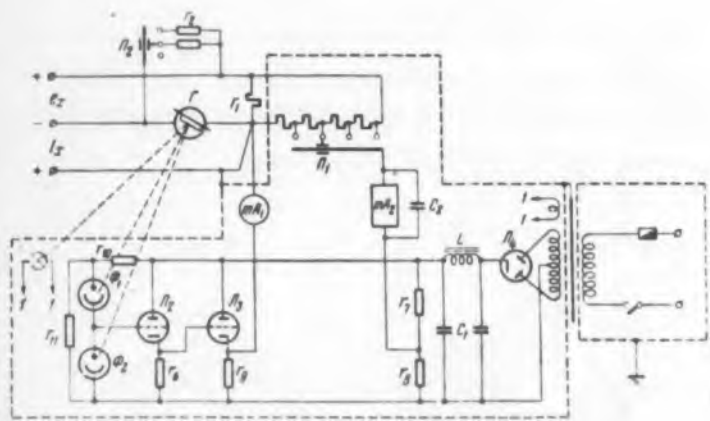


Fig. 1

Narrowing the Signal Spectrum in Telemetry Radio- activity Measurements, V. N. Mikhailovski, A. N. Svenson, (6 pp, 5 figs).

The output signal of radioactivity indicator consists of pulses of various amplitudes, the spectrum of which is sometimes too wide for the transmission channel. It is therefore of interest to find ways of narrowing the spectrum, principally by converting the random distribution of the pulses obtained at the output of the indicator into an equivalent discrete distribution, with the pulses spaced by time intervals that are either

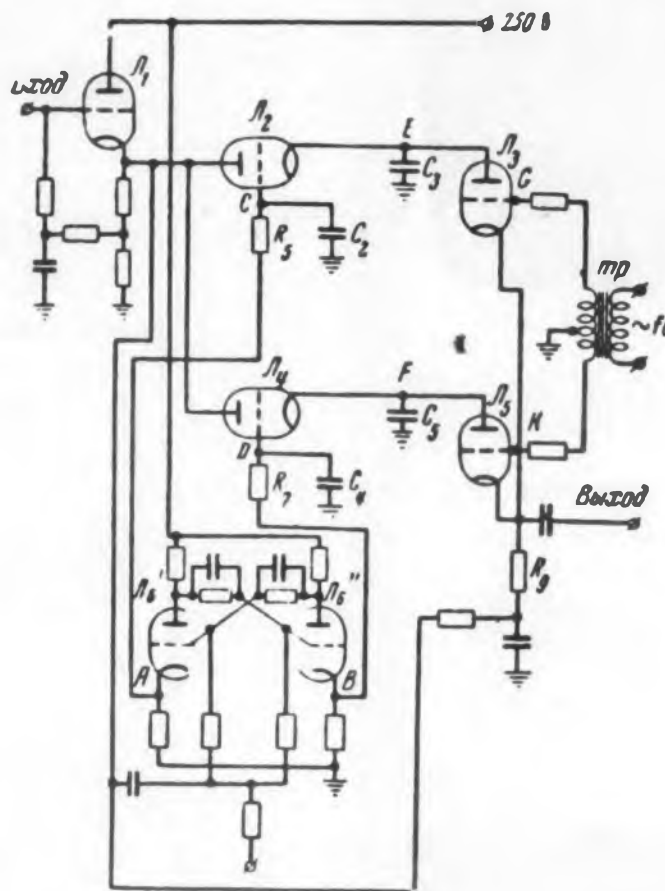


Fig. 2

equal or multiples of a fixed value. Essentially this involves storing the random signals in a memory device and cyclic pickoff at a constant frequency. The memories used may be capacitors, ferromagnetic coils, or cathode-ray storage tubes. A memory device using capacitors is shown in Fig. 2. The various stages of pulse shaping are illustrated in Fig. 3.

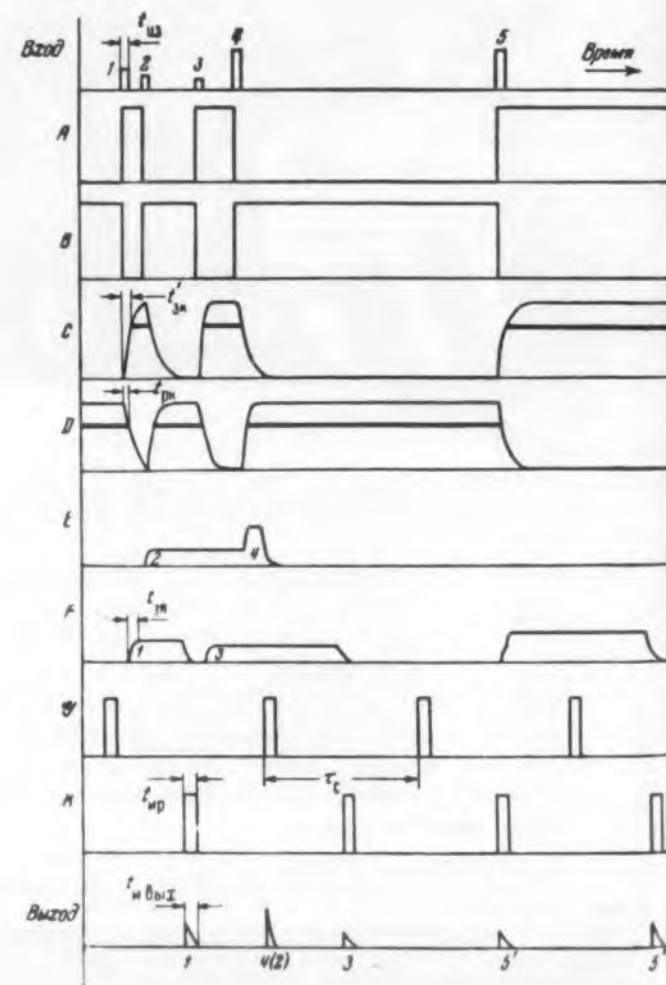


Fig. 3

Magnetic-Amplifier Control of Two-Phase Induction Motor, O. I. Aven, S. M. Domanitski, A. Ia. Lerner, (5 pp, 7 figs).

The use of two ordinary saturated reactors instead of a push-pull magnetic amplifier for reversing control of two-phase induction motors is shown to be more efficient. The control of a servomotor, Fig. 4, is used as an illustrative example. The discussion includes simple mathematical analysis, curves, and experimental test results.

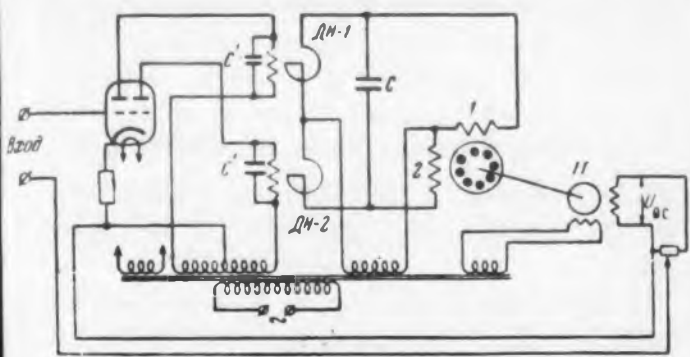


Fig. 4

Automatic Control Systems Containing Digital Computers, Ia. Z. Tsykin, (15 pp, 13 figs).

The digital computer is treated in this article as an element of the control loop, and the usual operational analysis is performed. A classification is given for various automatic control systems containing digital computers. Some of the more advanced control-theory methods, including the theory of intermittent-control systems, are used to determine the dynamic behavior of the system.

Comparison Analysis of some Improved Methods of On-Off Control, A. A. Kampe-Nemm, (19 pp, 22 figs).

On-Off control of temperature or other parameters is still among the most widely used regulation methods. Its main shortcoming is that it is sometimes accompanied by a continuous, frequently considerable fluctuation of the regulated quantity. In many cases this limits the accuracy and applicability of the control. The article discusses several methods of improving the accuracy of On-Off control. Among the methods considered are the addition of first-derivative supplementary pulses, the use of thermocouple correcting devices, and other schemes. Experimental and graphical analysis of the various schemes presented is given.

Approximate Theory of Magnetic-Modulated Transducers, M. D. Ageev, (13 pp, 15 figs).

Theoretical analysis of magnetic-modulated transducers without initial magnetization. Also discussed are the considerations dictating the choice of optimum operating conditions and choice of optimum settings of the transducer. Experimental results are given. The particular transducer discussed in this article comprises an open ferromagnetic core with ac excitation.

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Use of Semiconductor Diodes in Non-Linear Analog Computer Elements, G. M. Petrov, (10 pp, 16 figs).

In several previously abstracted articles it was shown that the non-linear elements most extensively used in Soviet computers for such operations as multiplication of two quantities or for function generation employ essentially piecewise-linear approximation with diode circuits. Some of the characteristics of such diode circuits are discussed in this article, and new diodes for use in non-linear computers are proposed. Included among such diodes are silicon point-contact and junction elements as well as germanium junction diodes.

New Russian Books on Electronics

The publication of the following book is scheduled for the last quarter of 1956 and the first quarter of 1957:

“Pulsed Thyratrons,” by T. A. Vornchev. Devoted to the results of theoretical and experimental investigations of pulsed thyratrons. Discussion of the development and design of the hydrogen-filled thyatron and of the physical processes that take place during its operation. The book also contains an analysis of the operation of a linear modulator, as well as technological and construction information.

“Transistors in Automatic-Control Installation,” by I. I. Konev. Covers application of junction transistors in medium-current amplifiers and in phase-sensitive amplifying circuits. Gives procedure for the design of several circuits.

“Theory of Random Processes and its Application to Radio Engineering,” B. R. Levin. In addition to providing the minimum theory needed by the radio engineer for handling the subject, the book contains copious radio-engineering examples, illustrating the potentialities of probability-theory methods in the solution of many practical problems.

“Elements of the Theory of Bessel Function with Applications to Radio Engineering,” T. A. Rozet.

Other books scheduled for publication are a new edition of Andronov and Khaikin’s “Theory of Oscillation,” a book on Radio Meteorology by D. Nasilov, a book on Thermocouple Cooling by A. Ioffe (Soviet expert on semiconductors) and other two books, one by S. A. Lebedev “Electronic Computers,” and the other by A. I. Kitov, and “Automatic (i. e., Machine) Translation” by D. Iu. Panov.

Announced titles that are somewhat off the beat track are: “Theory of Potential Noise Stability” by V. A. Kotel’nikov, “Mathematical Analysis of Beams” by A. N. Popov, “Non-Linear Ceramic Capacitors” by D. M. Kazarnovski.

It may interest our readers to know that among many American books to be translated soon in Russian are “Television” by Zvorykin and Mortimer, “Magnetic Amplifiers” by Storm, “Ferromagnetism” by Bozorth, “Information Theory” by Goldman, and “Principles of Color Television” by Kyver.

Russian Hams

We notice with interest that Russian amateurs are no different from hams all over the world and like to let their fellow hams in on all sorts of makeshift gear and various hookup hints. Two such tips are given in the December 1955 *Radio*, a popular amateur magazine.

Whether this is indicative of the relative availability of transformers and tubes in Russia your editor does not dare to guess, but the circuit of Fig. 1 will enable a ham to double his rectifier power by using two transformers to feed a single tube. The dotted lines show an optical 220 v circuit (rather than 450).

The circuit of Fig. 2 is somewhat more novel—a rectifier with a continuously varying output, capable of delivering 40-250 v to 1.5 kilohm or 60-380 v to 5 kilohm, with a maximum current output of 180 ma. The value of grid-control potentiometer R_1 is 0.5 megohm.

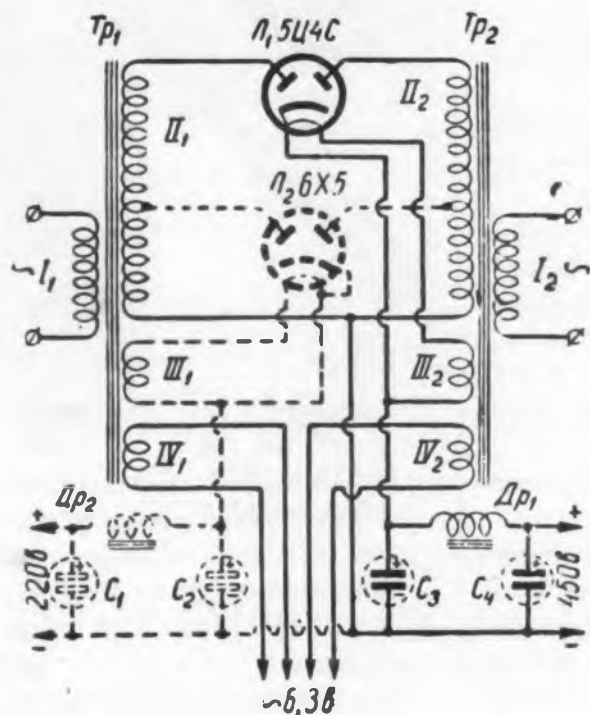


Fig. 1

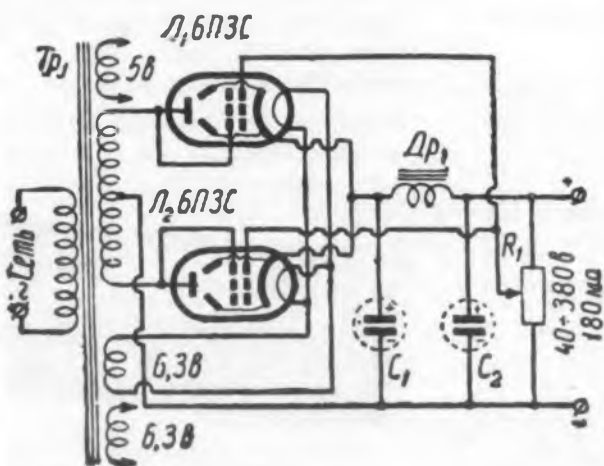


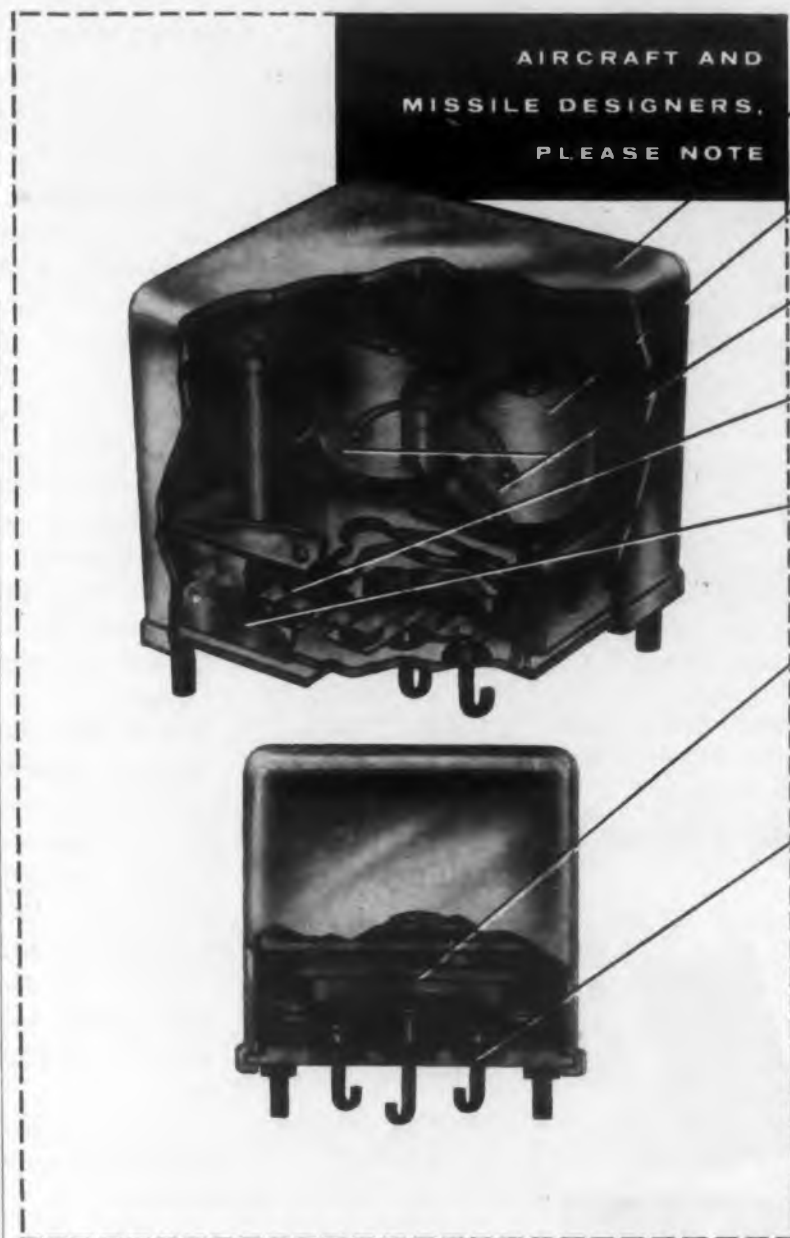
Fig. 2

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Russian Wire and Cable

Those who attempt to read Russian wiring diagrams sooner or later come up against the types and sizes of wire used in radio communication and allied fields. The following rather extensive table is taken from "Spravochnik Radioliubitelia" (Radio-Amateur's Handbook), a 250-page booklet published by Gosenergoizdat (State Power Publishing House) in 1955. Wire sizes are always given in mm (unless otherwise described).

Winding Wire

Russian Letters	Transliteration	Description
ЛЭШО	LEShO	Lietz (h-f) wire with enamelled, single silk cover
ЛЭШД	LEShD	Lietz wire with enamelled strands, double-silk cover
ПБО	PBO	Copper wire, single cotton cover
ПБОО	PBOO	Copper wire, cotton cover and braid
ПБД	PBD	Copper wire, double cotton cover
ПШО	PShO	Copper wire, single silk cover
ПШД	PShD	Copper wire, double silk cover
ПШКО	PShKO	Copper wire, single-layer silk-capron cover
ПЭВ	PEV	Copper wire, coated with "viny-flex" enamel
ПЭЛ	PEL	Copper wire, enamelled lacquer-proof
ПЭЛБО	PELBO	Copper wire, enamelled lacquer-proof in cotton single-layer cover
ПЭЛБД	PELBD	Copper wire, enamelled lacquer-proof in cotton double-layer cover
ПЭЛШО	PELShO	Copper wire, enamelled lacquer-proof in silk single-layer cover
ПЭЛШД	PELShD	Copper wire, enamelled lacquer-proof in silk double-layer cover
ПЭЛШКО	PELShKO	Copper wire, enamelled lacquer-proof in silk-capron single-layer cover
ПЭЛШКД	PELShKD	Copper wire, enamelled lacquer-proof in silk-capron double-layer cover

The marking of constantan or manganin wire is the same as that of copper, except that the letter K or M follows the marking, e.g.: ПШOK PShOK Constantan wire, single-layer silk cover.

Hookup Wire

МГШ	MGS	Hookup wire, flexible, silk braid
МГШД	MGSd	Hookup wire, flexible, silk single-layer cover

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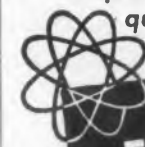
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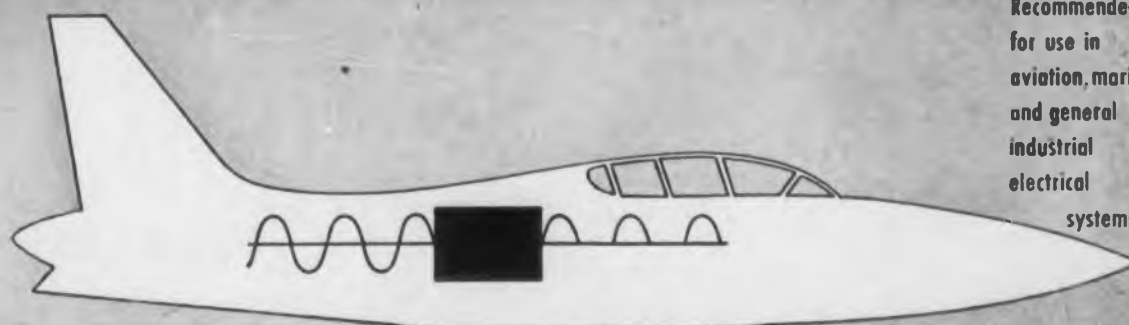
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CIRCLE 280 ON READER-SERVICE CARD

МГБЛ	MGBL	Hookup wire, flexible, cotton lacquered braid
МГБ00	MGB00	Hookup wire, flexible, cotton cover and braid
МГБ00Л	MGB00L	Hookup wire, flexible, cotton cover and lacquered braid
МГВ	MGV	Hookup wire, flexible, vinylite insulation
МГВЛ	MGVL	Hookup wire, flexible, vinylite insulation, lacquered cotton braid
МР	MR	Hookup wire, single-conductor, rubber insulated
МРГ	MRG	Hookup wire, rubber-insulated, flexible
МРГЛ	MRGL	Hookup wire, rubber-insulated, flexible in lacquered cotton braid
ММВ	PMV	Hookup wire, single-conductor, vinylite insulation
ММОВ	PMOV	Hookup wire, single-conductor, vinylite insulation, braided
ММВГ	PMVG	Hookup wire, vinylite insulation, flexible
МВР	PVR	Hookup wire, vinylite insulation, for wired-radio installations
МШ	RMSH	Speaker cord with tinsel-wire conductors in cotton braid
МШ	RPSH	Cord with rubber installation for radio-installation wiring in rubber sheath
МШЭ	RPSHE	Cord with rubber insulation for radio-installation wiring, in rubber sheath, shielded
МШ	RSh	Speaker cord in colored or glazed cotton braid
МЭП	ShEP	Cord for electric record players

The identity of a wire not listed above can be guessed at by noting that the code is based on the following abbreviations (those underlined are the most probable).

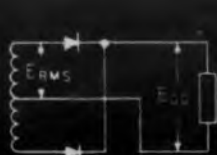
Russian Letter	Transliteration	Designation
Б	B	cotton
В	V	vinyl, vinylite, vinyflex
Г	G	flexible
Д	D	double
К	K	capron, constantan (end of symbol only)
Л	L	Lietz wire, lacquered, lacquerproof
М	M	hookup wire, manganin (end of symbol)
О	O	single, braid, single-layer, cover
П	P	wire, supply, player
Р	R	rubber, radio, speaker
Ш	Sh	silk, cord, sheath
Э	E	enamelled, shielded, electric



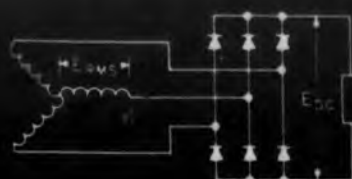
Recommended for use in aviation, marine and general industrial electrical systems.

WN-5051 and WN-5091 with maximum peak inverse voltage ratings of 50-350 v. (up to 200 amperes in bridge assemblies).

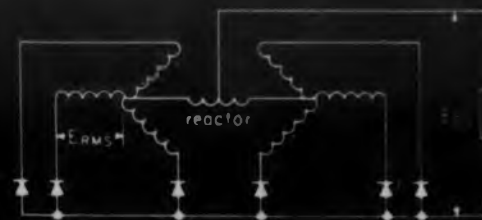
TYPICAL RECTIFIER CIRCUITS



Single phase full wave (center tap)



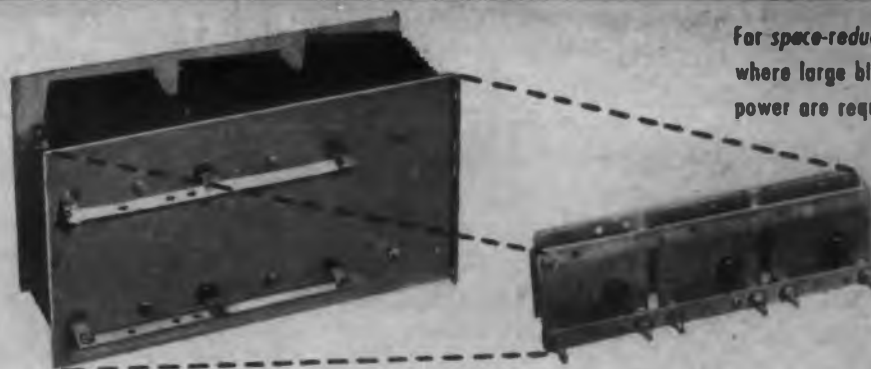
Three phase full wave bridge



Six phase half wave



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- Improves A.C. to D.C. conversion efficiency

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Semi-Conductor Division, Dept. ED
Youngwood, Pa.

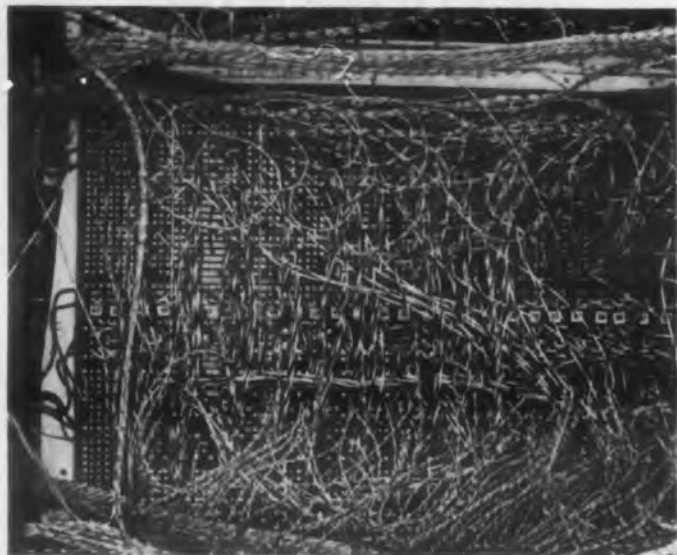
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7ET-4101

CIRCLE 278 ON READER-SERVICE CARD FOR MORE INFORMATION

Abstract

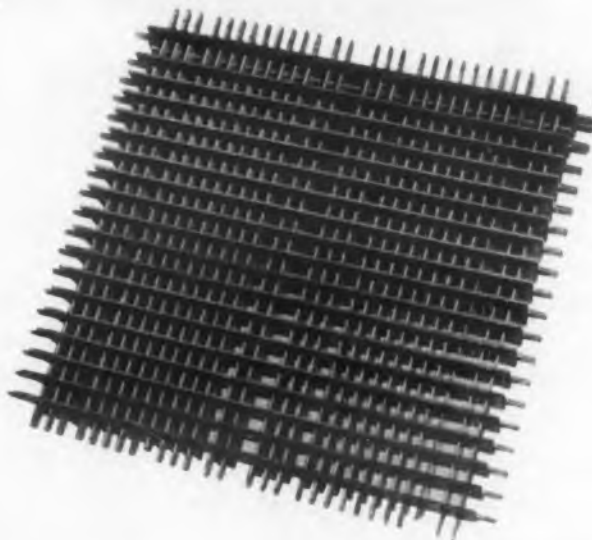
PRINTED wiring techniques have long been applied to computers in the design of individual printed circuit cards, but the interconnection of these cards has remained a wiring and cabling problem. To eliminate the drawbacks of hand wiring in a recent transistorized computer (IBM 608), a three-dimensional printed wiring lattice was developed to replace the usual back panel and its maze of wires and cables. In this new design the printed circuit cards plug directly into the printed lattice. All interconnections have been printed into the lattice in three dimensions. This arrangement is shown to be flexible in design and adaptable to a highly mechanized manufacturing



Problem

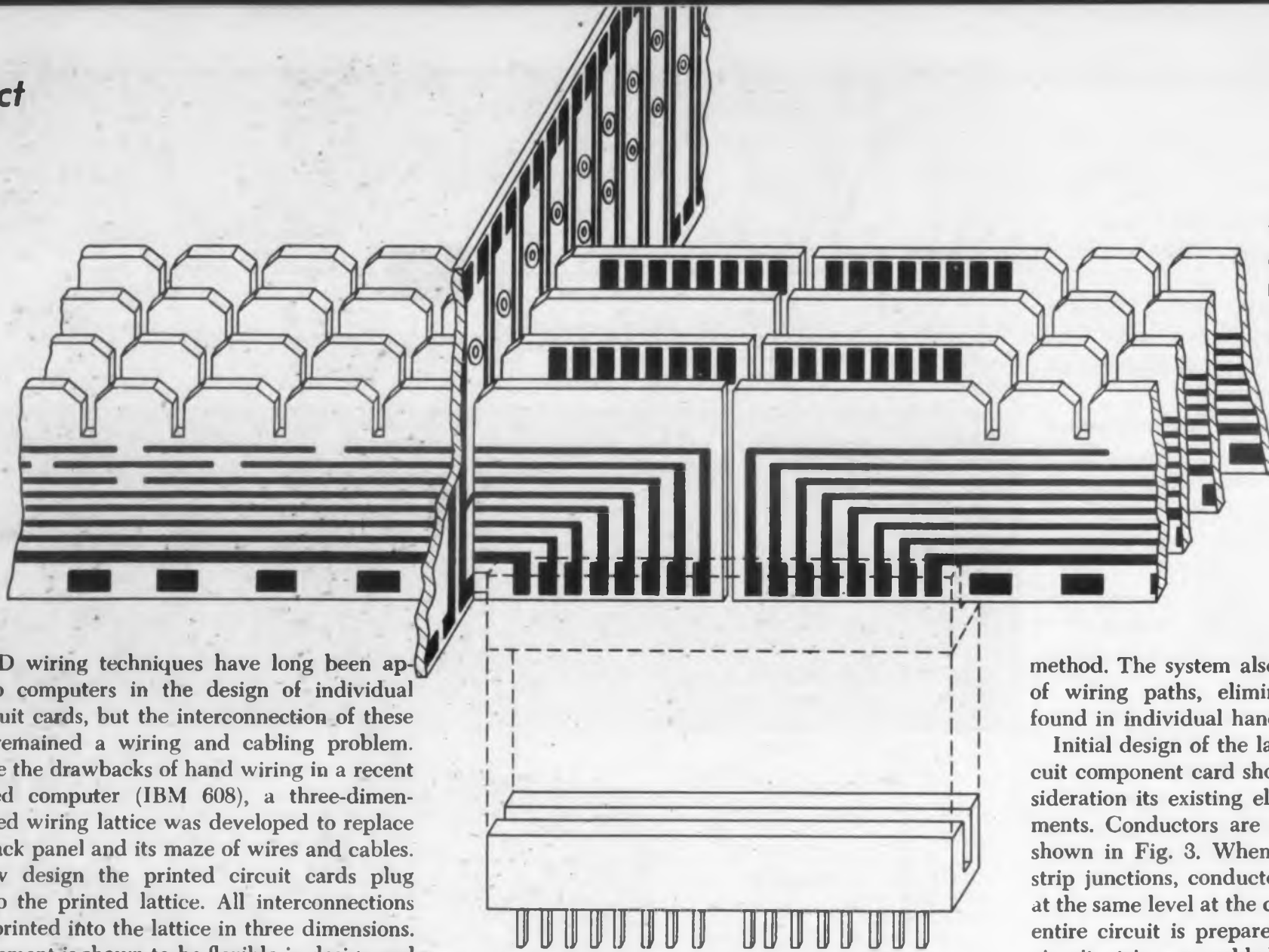
Fig. 1—Back panel of computer storage register. The wires and cables are connections between printed circuit component cards plugged into the panel.

Printed Wiring in Three Dimensions



Solution

Fig. 2—Three dimensional printed circuit lattice is equivalent to all interconnecting cables on back panel of computer.



Three dimensional printed circuit replaces complicated interconnecting cables. Single terminating tab shown.

method. The system also guarantees the repeatability of wiring paths, eliminating stray coupling errors found in individual hand-wired computers.

Initial design of the lattice centered around the circuit component card shown in Fig. 4, taking into consideration its existing electrical and physical requirements. Conductors are arranged in narrow strips as shown in Fig. 3. When conductors must connect at strip junctions, conductor paths are brought together at the same level at the corner, as shown in Fig. 3. The entire circuit is prepared in this manner and all the circuit strips assembled. The assembly is then immersed in a solder bath. The solder wets the con-

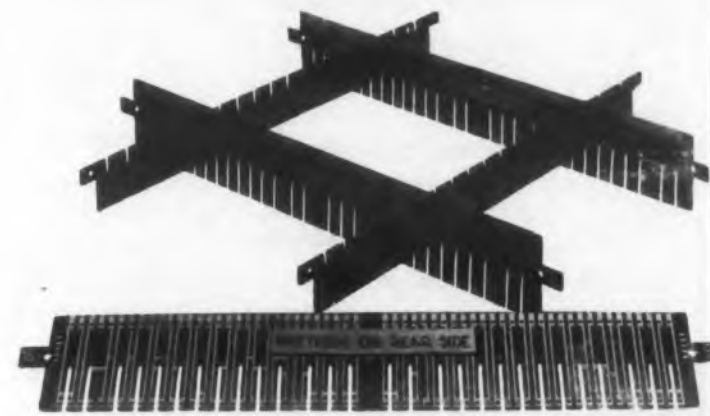


Fig. 3—Modular elements for three dimensional printed wiring.

ductors and fillets in the corner where two conductors meet, completing the electrical circuit.

An assembly of the elemental strips nested together prior to the soldering operation is shown in Fig. 2, and the same assembly after immersion into the solder and affixing of hardware is illustrated in Fig. 4. The spring contacts shown on the top of the assembly are the connecting device between the back panel section and the tabs of the circuit cards. Two of the 36 circuit cards are plugged into the assembly in Fig. 4. A molded connector for cable information for service voltages and communication to and from the rest of the computer is provided. This assembly physically and electrically replaces the sockets and wiring shown in Fig. 1. The array replaces approximately 650 wires and the sockets. It should be noted that the cable entry and exit hubs have been centralized and systematized in one location.

Engineering changes can be handled by several methods. In Fig. 3, in the rear view of the larger element, the contact pads on top all have conductors leading to pads on the bottom of the strip. In the array, the bottom pads are at the back of the panel and are easily accessible. Part of a conductor is easily removed by scratching or cutting with a sharp tool. After all of the undesired circuits have been removed, the customer engineer can either clip or solder conventional insulated wires to the small pads in the rear and thereby create a new wiring hook-up. Preliminary indications are that it might be possible to remove a vertical card from a soldered assembly and install a new vertical card. On an extensive change, the relatively low cost of a back panel module would indicate it might be economical to send a new, completely

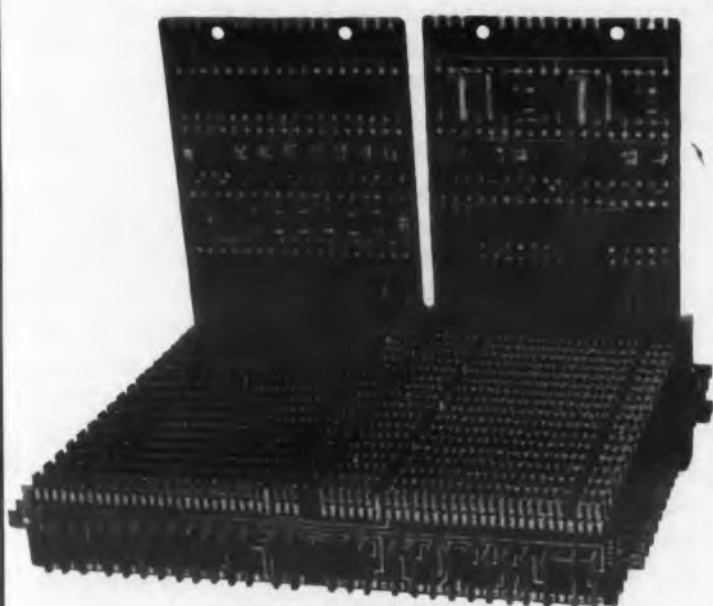


Fig. 4—Modular printed back panel with component cards clipped in.



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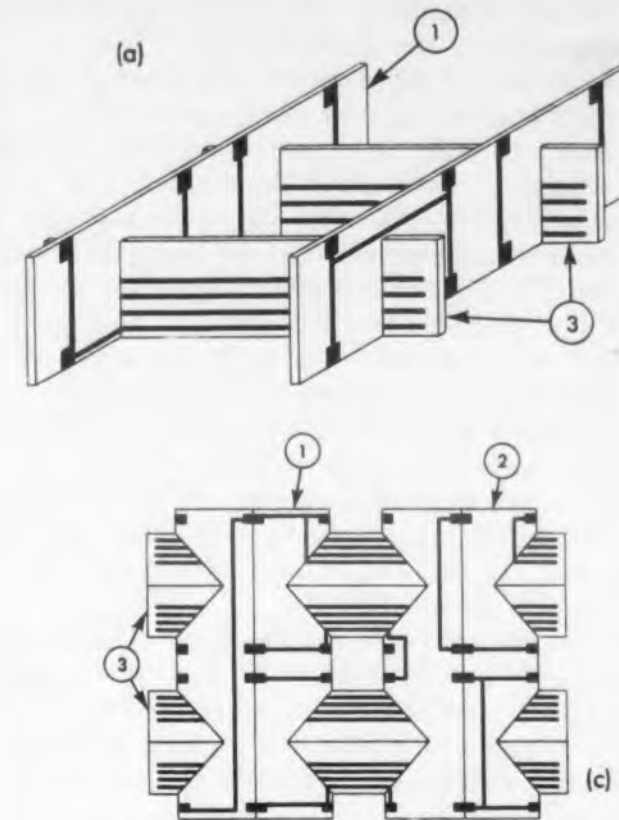


Fig. 5—Three views of an assembly section, showing layout of circuits. Cards have been drawn split at the

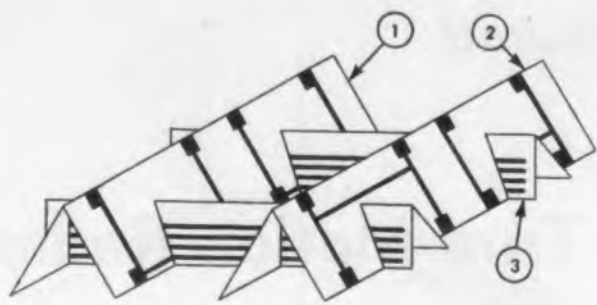
tested assembly to the field to replace an obsolete section. The old section would either be destroyed or returned to the factory for updating.

Changes can be accomplished quite easily at the manufacturing level. Because of the relatively large number of conducting paths available, it is comparatively easy to effect a change in artwork to add new circuits to the required vertical elements.

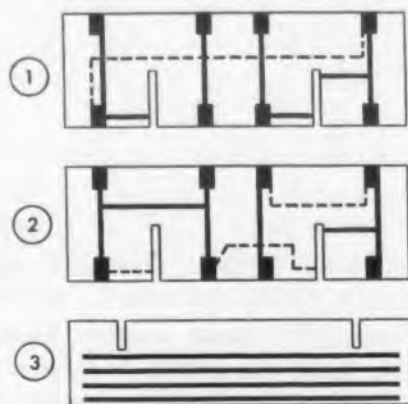
Each point in the circuitry is available for probing by virtue of the pads at the bottom of the strip. In Figure 3 it can be seen that these pads also serve a mechanical purpose. After the circuit strips are soldered, a strong fillet is formed at the intersection of the horizontal and vertical elements, adding much to the inherent strength of the assembly.

The physical spacing is identical to that of the sockets used in the IBM 608, thus allowing the same circuit-to-volume ratio. This system provides a large number of conductor paths. By increasing the width of the strips and thereby allowing more conductors, the designer can allow for his circuit requirements.

Engineering prototypes can be easily and quickly bench-built. Utilizing vertical elements that contain all the unvarying patterns of printed conductors, the technician can construct new circuit elements without conventional wires laid along the eventual path of the printed wires. The conventional wires are soldered to the printed pads. When these elements are joined to the standard horizontal strips and the solder fillet is made, the circuit is complete. Thus, circuits can be evaluated in a matter of a few hours after they have been designed, with electrical characteristics identical



(b)



bottom to show connections on both sides. A work sheet similar to (c) is used in laying out printed wiring paths.

to those of the manufactured product. This aid may prove quite valuable.

The mechanical design of the circuits for vertical cards turns out to be a fast and relatively simple task. The design of the printed wiring for the circuits shown in Fig. 1 has been done by an uninitiated technician in less than three hours. This includes the routing and assignment of the 170 cable conductors associated with this section. A section of an assembly is shown, in perspective, in Fig. 5a, and Fig. 5b shows the same section with the elements split and opened at the bottom. A view looking directly down at the opened-element section is shown in Fig. 5c. A work sheet similar to Fig. 5c is used to draw in the conductors connecting the desired contact points. From this work sheet the artwork for the vertical elements is drawn. The horizontal members are identical, a standardized conductor pattern on each element. The section of back panel wiring shown in Fig. 4 has been in actual use on an IBM 608 Computer for several months. During this period it functioned without any trouble or disturbance. Compared to the conventionally wired circuits, the printed back panel shows approximately 15 per cent more capacitance to ground. The same section shows approximately 33 per cent less interlead capacitance than the conventional wires. This improvement is probably due to the greater uniformity of conductor spacing possible with printed wiring than with flexible wires. On the basis of limited experience, it is reported that the solder fillets performed satisfactorily on the low-power transistor circuits. *Abstracted from an article by E. R. Wyma, IBM Journal, Jan. 1957.*



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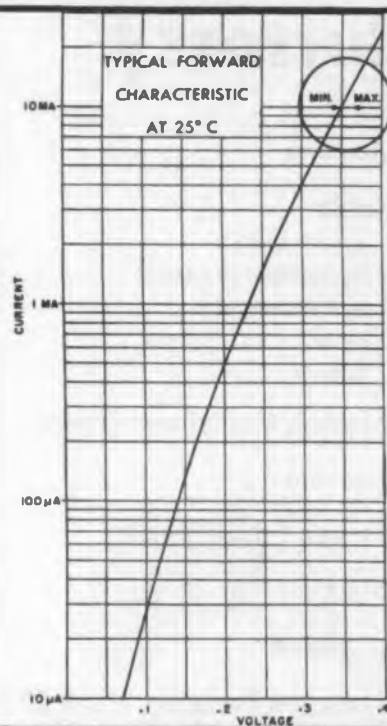
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Maximum Ratings at 25° C

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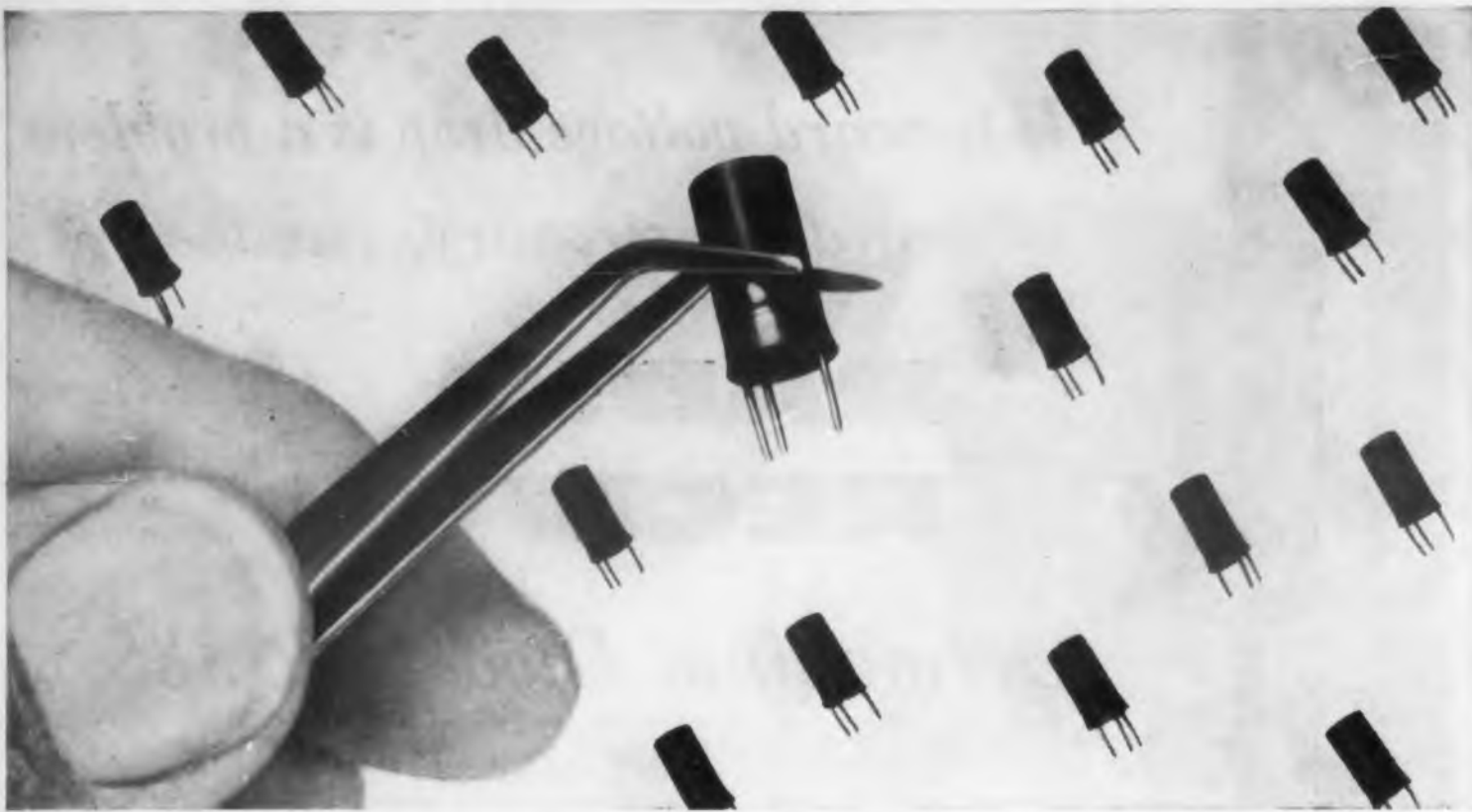
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CIRCLE 282 ON READER-SERVICE CARD FOR MORE INFORMATION

Abstract

True Motion Radar

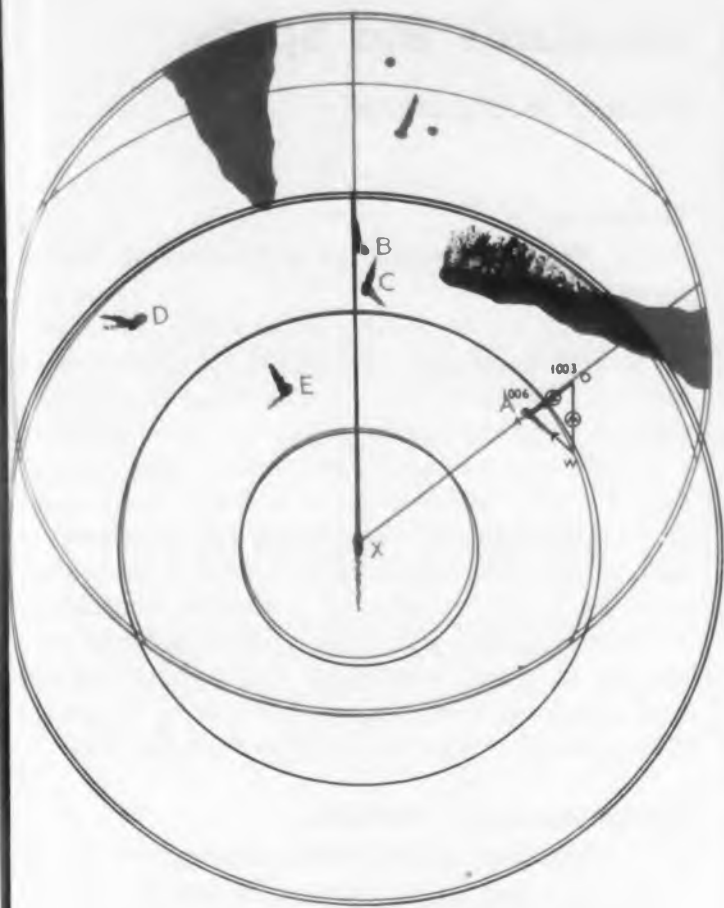
TRUE movement rather than the conventional relative movement can now be shown directly on a ship-borne PPI radar display. Introduced by Decca Radar Ltd., the system indicates the "own" ship's true heading pictorially and offers the viewer a more dynamic presentation of marine traffic within the range of the radar.

A distinct advantage of this Decca True Motion Radar TM46 is illustrated in the comparison between PPI patterns. All objects seem to be in movement in "black" with the apparently "fixed" conventional radar transmitter at location X. With the new system, color clearly explains that ship X is in motion, shows its path of travel (as well as the absolute path of travel of all other moving targets) and, additionally, indicates all stationary targets which could not be so identified earlier.

True motion display is obtained in the new system by feeding compass and speed information into a small resolver. Speed and direction of the "own" ship are converted into E-W and N-S movements which control currents in the offcentering coils of the CRT. This, in turn, affects the center source position about which the PPI trace rotates.

Range rings and a variable range marker appear as concentric circles around "own" ship and an electronic bearing marker enables bearing of other vessels to be measured regardless of "own" ship's position. Since "own" ship moves over the PPI continually in the vector of the ship's course, the range of warning ahead is steadily reduced. Periodically, then, it is necessary to reset the "own" ship position and this can be done anywhere over the CRT face. After resetting, the true, absolute picture is developed almost instantaneously. The PPI tube persistence acts to create the true course directions very rapidly, affording reliable and accurate information for the pilot-navigator.

Abstracted from "True Motion" Radar, British Communications and Electronics, Heywood & Co., Ltd., Drury House, Russell St., Drury Lane, London, W.C.2, Dec. 1956, p. 659.



Conventional relative motion PPI display is shown in black. New true motion PPI display is shown in color. "Own" ship at location X shows clearly its travel vector. Buoy B and other fixed targets are so indicated by no movement on true motion PPI. Land outline is distinct and clear.



Indicator of new true motion radar for ship-board use.

SOLID GLASS HEADERS



Val Cichowski
V. P. Manufacturing



There are several reasons that Fusite customers have for going to a solid glass header. Compact size is one of them. While 1" diameter is about maximum for this type terminal, we can pack 21 electrodes into this space with the same voltage limits that would require either a much larger disc or fewer pins in a multiple bead terminal. Size for size this is a more rugged terminal than one using a light gage stamping. Where the terminal serves as a structural part of an electrical assembly, solid glass is better able to support stress. Before resting the case for solid glass, it is worthy of mention that it costs less per pin. Fusite offers a complete line of solid glass headers.

MULTIPLE BEAD TERMINALS



Andy Wyzenbeek
V. P. Engineering

While our friend Cichowski presents a strong case for the solid glass header, a large percentage of Fusite Terminal business is still done in multiple bead terminals. There are good reasons. Wherever weight is a factor, you'll usually find a multiple bead terminal in a light gage stamping with its remarkably favorable weight to strength ratio.

This type construction is more versatile. When large sizes are needed, where very heavy pressures are involved or extreme conditions of any nature exist, they can best be coped with, by using multiple beads in a heavy gage body.

While speaking of unusual conditions, it gives me an excuse to mention our special engineering section. Our line of standard terminals is very large but we are constantly at work developing special custom designs to solve specific problems. We solicit yours.



Jim Marsh
V. P. Sales



If you found anything helpful in the words of wisdom from Val and Andy, I'm real happy for you. But frankly, I can't get too excited over which kind of terminal you buy. As long as it comes from Fusite, you can be sure it's the best of its type available. We develop our own glass formulas and do our own smelting right here at the plant. It gives us the best control over quality in the industry.

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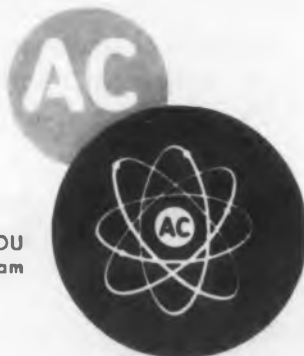
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CIRCLE 565 ON READER-SERVICE CARD FOR MORE INFORMATION

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Standards and Specs

Sherman H. Hubelbank

Grounding

AIEE No. 953, GROUNDING OF INDUSTRIAL POWER SYSTEMS

Although not an AIEE standard, this report presents a well-rounded analysis of the problems of grounds. The discussions are of value to all interested in systems grounds, equipment grounds, static and lightning protection grounding, and connections to earth. Included in the material are the pros and cons of grounded systems, the problems of making equipment grounds, how static is generated, and what should be done to prevent its generation, and the problems of making a low resistance connection to earth. Copies of this publication are available from the American Institute of Electrical Engineers, 33 West 39th St., New York 18, N.Y.

RETMA Standards—Revisions

The following RETMA standards proposals are being circulated for comment. Although the official comment period may have expired, you are encouraged to contact the RETMA Engineering Department, 11 West 42nd St., New York 36, New York. S.P. 517, RIGID COAXIAL TRANSMISSION LINES AND CONNECTORS—50 OHMS

Gas-filled rigid coaxial transmission lines and their connectors containing electrically transparent supporting structure are covered in this proposed standard. This standard does not apply to any semi-flexible transmission lines or connectors. It is the intent of this standard to provide complete mechanical interchangeability for all lines and connectors. It is not the intent of this standard to restrict electrical design parameters.

S.P. 518, TERMINATING AND SIGNALING EQUIPMENT FOR MICROWAVE COMMUNICATIONS SYSTEMS—PART I: TELEPHONE EQUIPMENT

Covered in this proposal are standards for talking circuits and standards for signaling circuits. Included within each section are definitions of terms and methods of measurements. A section of supplementary definitions is also included. A cross listing of ASA definitions of telephone terms is included.

S.P. 519, DIMENSIONAL CHARACTERISTICS—45RPM PHONOGRAPH RECORDS FOR HOME USE

This proposed standard is dimensional in character, and serves to permit interchangeability and facilitate equipment design. It is not intended to indicate or imply quality or performance levels.

SP. 520, DIMENSIONAL CHARACTERISTICS—33-1/3RPM PHONOGRAPH RECORDS FOR HOME USE

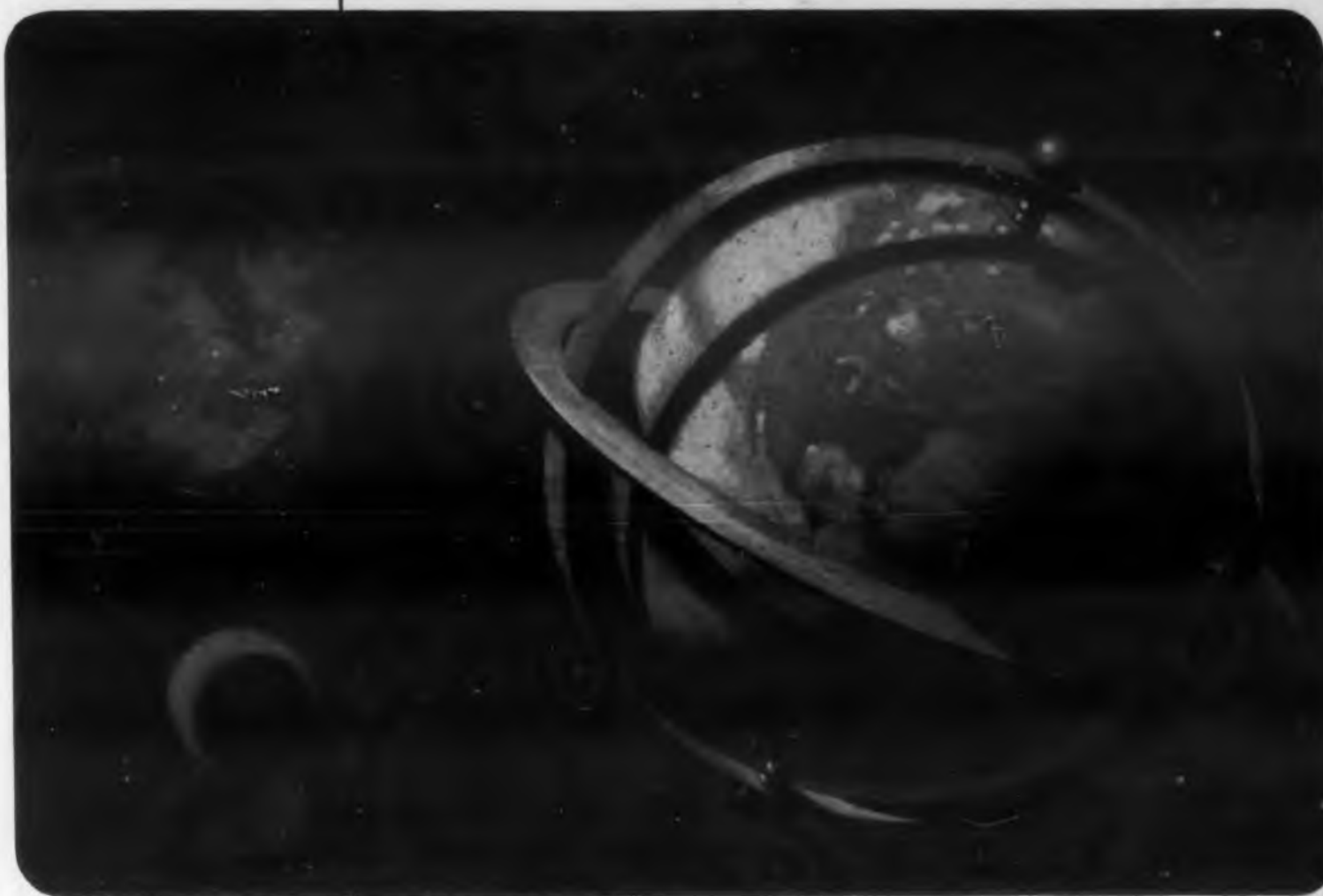
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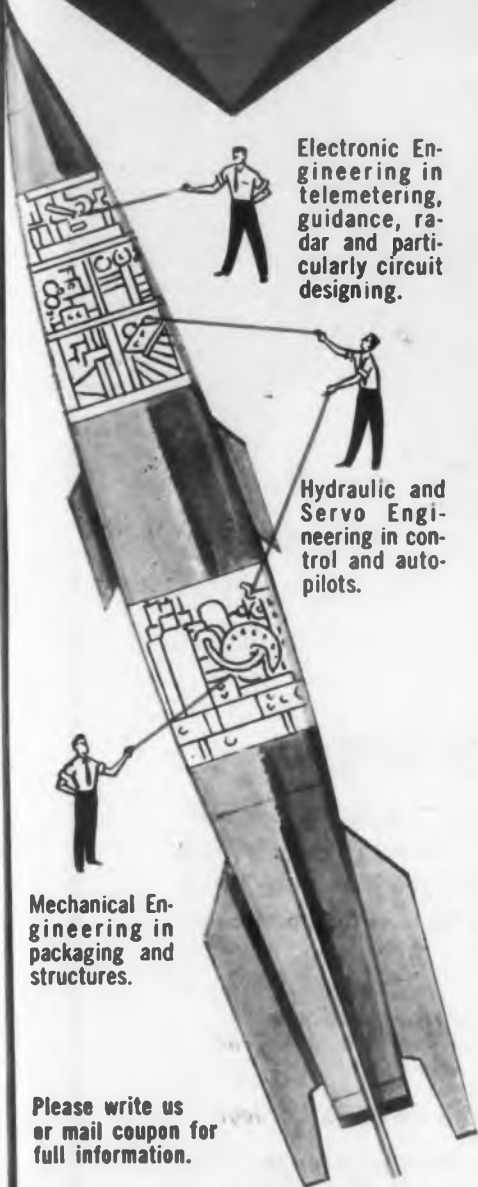
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A. A. Daush (center), head of the Electronic Components Design and Packaging Section, discusses the use of transistors and other new components in packaging techniques involving modular construction and etched boards with N. J. Schuster (left), Electronic Research Design Engineer, and P. A. Alpine, Missile Guidance Group Leader.

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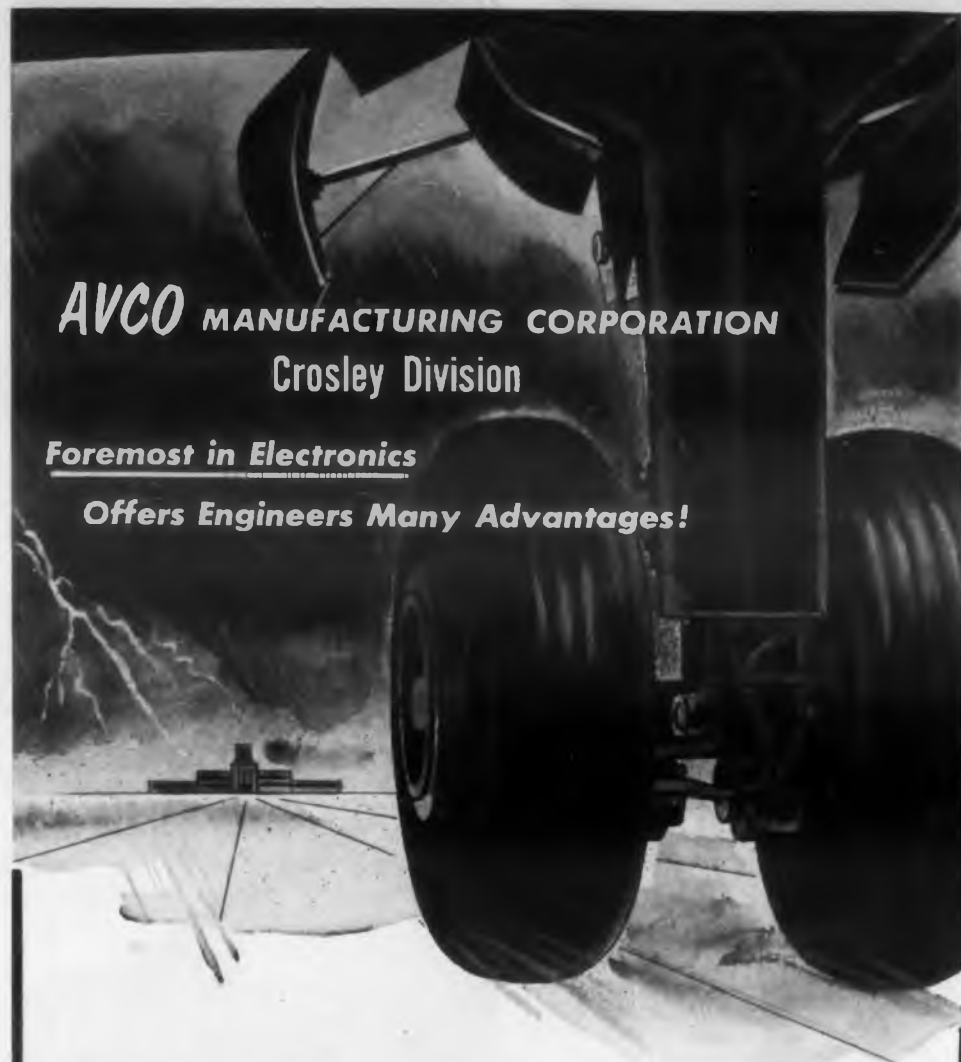
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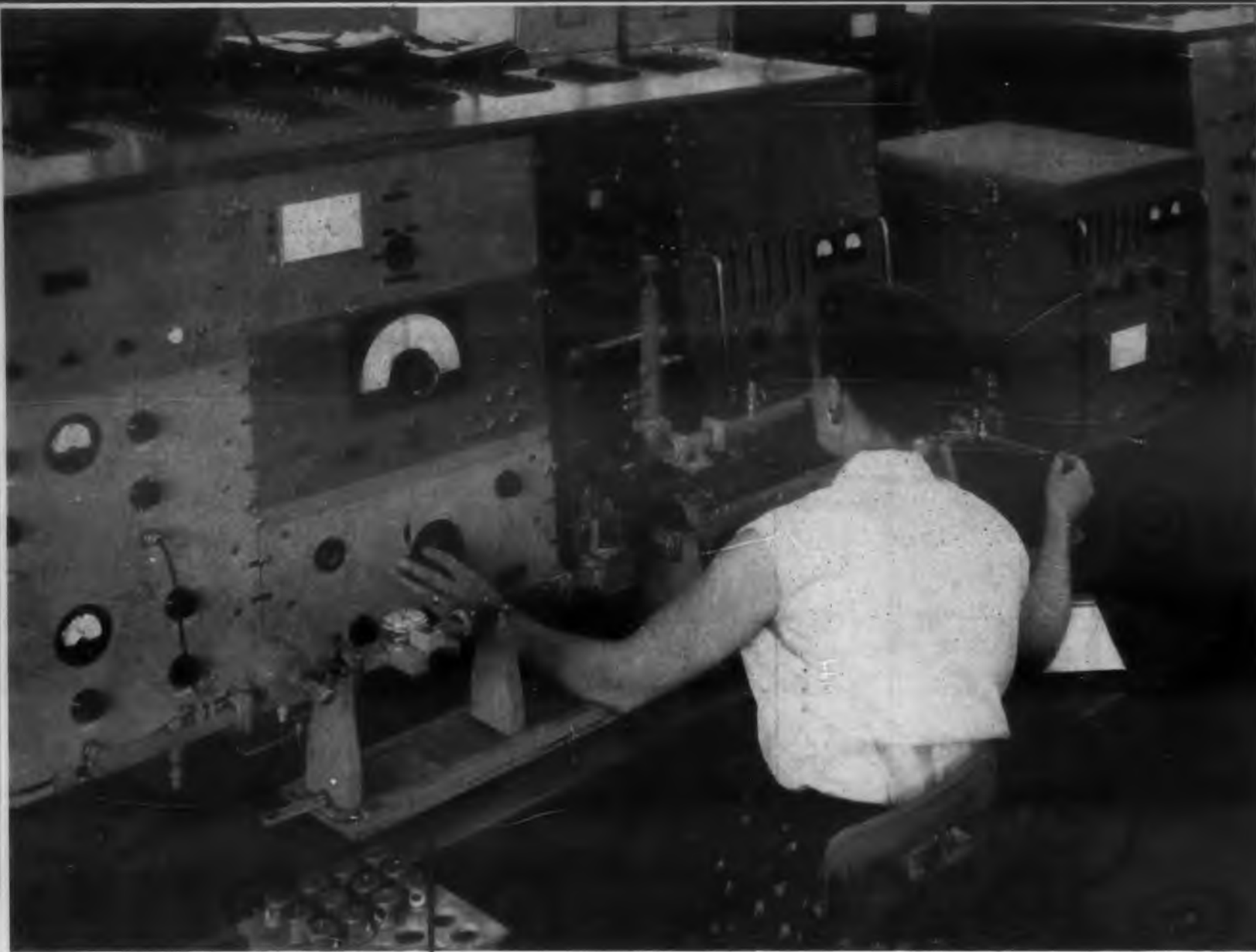
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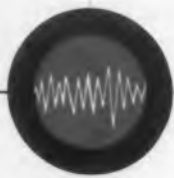
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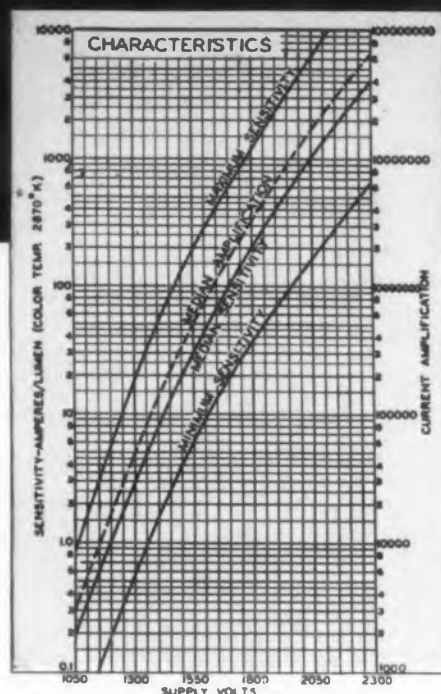
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