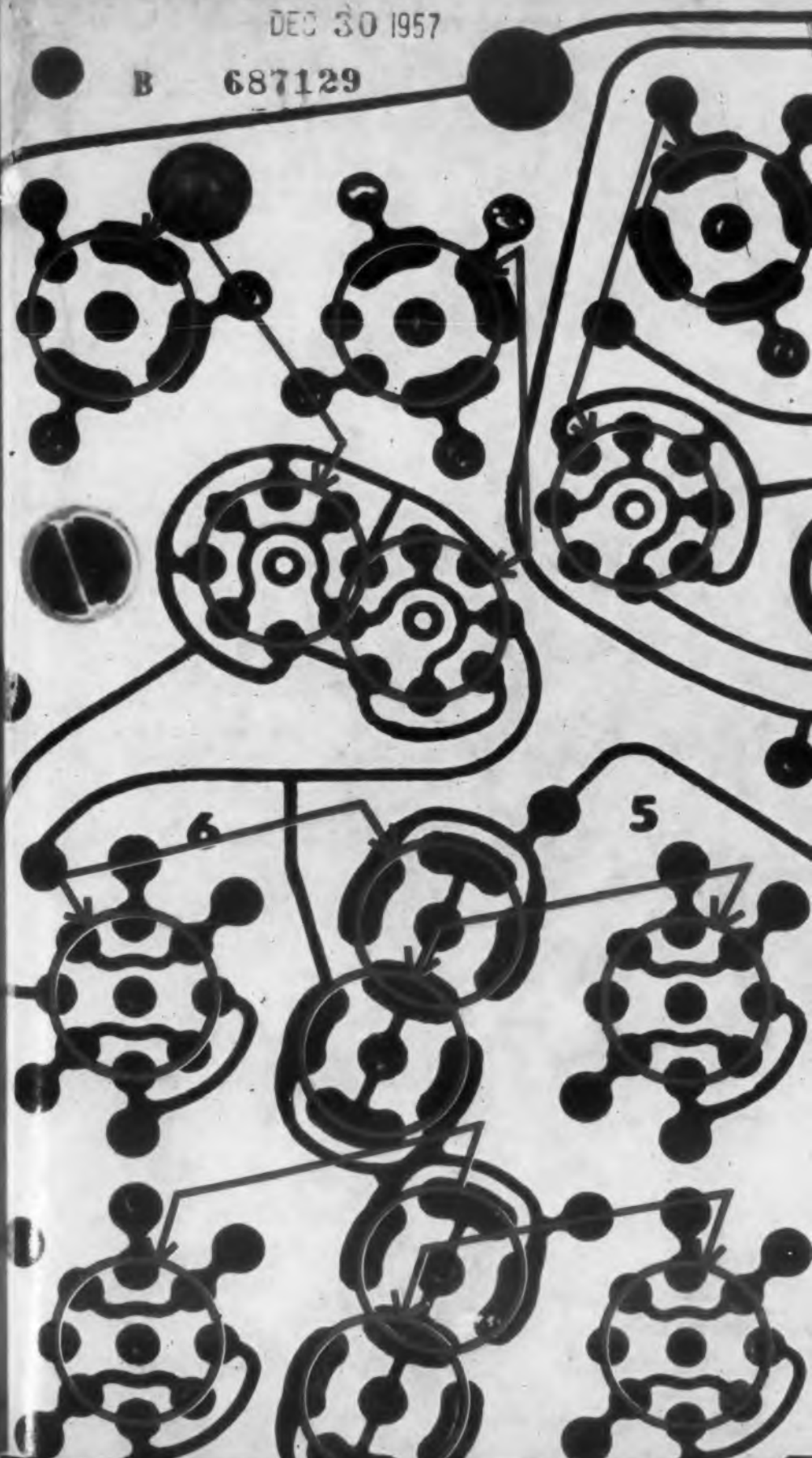

RONIC ESIGN

Printed Circuit Switch . . . page 44

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ELECTRONIC DESIGN

Contents

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ABPA

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NBP

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peripheral equipment for digital computers

FEATURES

- Completely transistorized
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- As many as 4 speeds forward and reverse
- Rewind or search at 400 ips
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- 3 millisecond starts
- 1.5 millisecond stops
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Potter

POTTER INSTRUMENT COMPANY, INC.

CIRCLE 2 ON READER-SERVICE CARD

Editorial

Engineer Joe Smith vs Ivan Kasovich

In this column last issue we urged that the individual as well as the government do something about keeping the United States abreast of Russian technology.

The Russians can be ahead of us because they can start where we leave off. They read our journals and books to know what we know. We must do the same. There is no justification to rediscovering common knowledge when such time spent is at the expense of time doing original, creative thinking. The case documented by the National Science Foundation of American industry spending time and $200,000 developing electrical circuits that could be copied from Russian journals dramatically illustrates the point.

For the Russians to start from where we leave off is easier than vice versa. Not only does the Soviet government translate our material, but many of their engineers and scientists read English. Over 60 per cent, we are told, compared to our Russian readers of roughly one per cent. Common sense says we should learn Russian.

It is time we considered competing with the Russian engineer with all the vigor of our American ideal of competition. This calls for individual action. The Defense Department may represent our "team" in the military might race, but it's up to each member to run his lap of the race well. Let's not pass the buck, but pass instead the baton.

Let's try for top honors intellectually. It will be rough. A graduate of a Soviet physics course has 4290 hours of education compared to an MIT man's 2415. We'll have to commit ourselves to work for more than financial remuneration. We can check our progress simply by buying and reading Russian articles, or counting the Sputniks and Vanguards.

Where do we get Russian translations? If the government is lax, our individual responsibility should tell us to get our professional groups to do it. For that matter, a cooperative buying effort of only a few could do the trick. If a translation costs $150, 15 customers could bring the cost down to $10 apiece.

Scan our Russian abstracts in this issue. If you see a title which you are knowledgeable on, send ELECTRONIC DESIGN a post card saying you'll put up $10 if enough others will. We'll then get you a translation at cost—it may be less than $10.—JAL

[We will be happy to follow up by publishing your critique of the Russian article.]

Engineering Review

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

Experimental high power long range radar installation. Developed by MIT Lincoln Laboratory at Millstone Laboratory in Westford, Mass. Staff member, (right), measures and records observations of the Sputniks.

Millstone Radar

A research tool, designed for studying the problems in ballistic missile defense has been announced by Lincoln Labs, Lexington 73, Mass. The Millstone radar is expected to provide valuable information on the applications and operation of high power, long range radar. It will also provide valuable information on the radio effects of meteors and the aurora.

The development of the Millstone radar required new tools and techniques in the design of both the radar and its associated equipment. Advances were made in transmitter power, in large antenna and mount mechanics, and in other types of equipment.

A special transistorized digital computer was designed and constructed. This computer processes the radar return signals on a real time basis at very high speeds. A tape printer records these radar returns at a rate of thousands of characters per second.

High power signals are applied to the transmitting antenna through specially designed klystron tubes. These tubes stand over eleven feet high.

The antenna system consists of a parabolic reflector 84 ft in diameter mounted on a concrete and steel tower 90 ft high. With a horizontal rotating capability of 360 deg, and a vertical elevating capability of 90 deg, the antenna can sweep the sky.

The high degree of precision required by the Millstone radar made it necessary to position the antenna with such accuracy that the minute bending of the antenna tower caused by the sun could not be tolerated. This bending was minimized by painting the surface of the tower white to secure maximum reflectivity of the sun's rays.

The Millstone Hill facility will support cooperation between the U. S. Air Force and the Defense Research Board of Canada in research concerning the ballistic missile defense of North America.

The high powered system has been detecting the Russian Satellites, Sputnik I and 11 at remote distances. These detections have confirmed the accuracy of predicted positions calculated by radio observations made by Lincoln scientists and engineers.

The observations made with the radar system have allowed the scientists to measure range, elevation, bearing, and doppler frequency of the Sputniks. It is expected that Lincoln Labs will cooperate with the U. S. Naval Research Laboratory in tracking the satellites in the Project Vanguard, IGY program.

Engineering Review

An experimental magnetic memory array which was used to evaluate the "Twistor" concept. In this experimental set-up, the longitudinal magnetic field for the magnetic wires is provided by small solenoids wound around glass tubes.

The Magnetic Twistor
A New Memory Concept

A new concept in memory devices has emerged from exploratory work at Bell Telephone Laboratories, New York 14, N. Y. This concept, which has been named the "Twistor," is expected to make possible memory systems which are simpler to fabricate and more economical to manufacture than existing systems. Such devices may have extensive applications in computers and electronic switching systems where rapid-access high capacity memories are necessary.

The "Twistor" concept opens the way for the construction of magnetic memory arrays by merely interweaving horizontal copper wires and vertical magnetic wires, much as window screen is woven. Such a device would be similar in appearance to a ferrite core array, but without the cores, and would operate in much the same manner as a core array.

This new concept gets its name from a characteristic of wire made of magnetic material. Torsion applied to such a wire shifts the pre-

ferred direction of magnetization from a longitudinal to a helical path. The coincidence of a circular and a longitudinal magnetic field can then be used to insert information into this wire in the form of a polarized helical magnetization, and the magnetic wire itself can be used as a sensing means.

In practice, the circular magnetic field is provided by a current pulse through the magnetic wire, and the longitudinal field by a current pulse through the copper wire which is perpendicular to the magnetic wire. Thus, storing a bit requires two coincident current pulses. Readout is accomplished by overdriving the longitudinal field in the reverse direction. The readout signal is sensed across the magnetic wire. Because the lines of magnetic flux along the helical path wrap the magnetic conductor many times, a favorable increase in the output signal is obtained.

Silicon Power Transistor Dissipates 85 Watts

Production prototype silicon power transistors have been made at General Electric Company, Syracuse, N. Y., using large area diffused base structures.

Small amounts of phosphorous and gallium are introduced into silicon wafers by solid state diffusion to form the electrically active regions of the npn transistor. Uniform n type emitter and p type base regions .0002 in. thick can be formed over an area of about 1/20 sq in. required for a power transistor.

The contacts to the emitter base and collector regions of the diffused structure are alloyed to the silicon wafer in a single process to form a complete transistor sub-assembly. The transistor has excellent heat transfer from the junctions in the silicon to the mounting base. Allowable power dissipation is 85 w at a mounting base temperature of 25 C and 35 w at 85 C.

The maximum rated collector current is 5 amp. Power outputs of 25 w in Class A sine wave operation and 80 w in Class B push pull operation have been obtained with low signal distortion. Since the grounded emitter cut off frequency for these units is about 400 kc they are useful well above the audio frequency spectrum.

The maximum storage temperature and maximum junction operating temperature is 150 C. For this reason these transistors are expected to have applications in a wide variety of military and industrial amplifying and switching circuits.

Engineering Review

Apparatus for controlling the electron beam must b shielded from external electrical signals. Compensatio for Earth's magnetic field must also be made.

Low Energy Electron Accelerator Produces Adjustable Beams

In studies of matter, particles with energies o millions or even billions of electron volts hav commanded most attention. Particles of low energy, however, have an important role to pla in basic investigations of atomic structure.

To facilitate such studies—under the sponsor ship of U.S. Army Engineer Research and De velopment Laboratory, Fort Belvoir, Virginia Stanford Research Institute, Menlo Park, Calif has developed a low-energy electron accelerato capable of producing a defined electron bean adjustable to energies from a fraction of an elec tron volt to several hundred electron volts. Th difficulty of controlling such low-energy beam makes it necessary to compensate for the earth' magnetic field and to screen the apparatus fron external electrical signals.

In a current study, a small crystal of alph lead-azide is placed in the vacuum of the acceler ator and bombarded by the electron beam. In teractions between the electron beam and the sur face of the crystal are recorded as an electrica current. When sufficient data have been collected they will be compared with similar data for the interactions of photons, or light, through the crystal. The comparison will indicate whether the slow electrons "see" the crystal structure or the individual molecules of the crystal.

With modifications, this apparatus could be used to study problems of immediate practical

importance such as surface effects believed to shorten vacuum-tube life, and aging characteristics of semi-conductor surfaces. Atomic and molecular collisions and electronics, important in gas discharges, atmospheric physics, and radio wave propagation, could be studied.

Euphorian Seating: This unusual chair is expected to reduce human fatigue and also weight specifications in aircraft. Designed by a team of medical scientists, the new development is known as Euphorian Seating and is manufactured by the Future Products Engineering Corp., 5450 W. 83rd St., Los Angeles, Calif.

The medical skeleton was used by a team of medical scientists, applying principles of human engineering, to the solution of a fatigue problem.

It is anticipated that the new type of seat will be used in such applications as transportation and military and industrial seating where operation of machine controls over an extended period of time is required. Future uses include seating for space travel where it is necessary to equalize body weight for high accelerations

Engineering Review

AEC Process Waste for Industrial Firms

The Atomic Energy Commission, Washington 25, D. C. will process in existing Commission radiochemical facilities, for an interim period, the irradiated fuel elements discharged from research and power reactors. This decision is the result of a Commission survey of the chemical industry that revealed that industry is not ready to undertake radiochemical processing of private fuels under the current Commission program for industrial participation in chemical processing.

The survey showed that industry believes that the prospective income from the business available from the commission and private reactors is not sufficient to warrant the risks involved in a very substantial investment in new facilities, in the face of uncertainties as to the future rate of growth of the industry, the composition of the fuel elements that will be used in the private reactors, and the problems associated with waste storage and disposal.

Closed-Circuit Television Aids Radiation Treatment

Closed-circuit television is being used in a London Hospital to assist in the deep therapy radiation treatment of patients. Equipment supplied by Marconi Wireless Telegraph Co. Ltd., Chelmsford, Essex, England, is used at the Royal Marsden Hospital to permit the treatment to be carried out by remote observation. In this way doctors and radiographers are safe-guarded against excess radiation which can produce harmful effects.

Observation of the patient is necessary during this type of treatment since a beam of gamma rays is accurately directed into the affected region. It is therefore important that this region be kept in a fixed position relative to the beam, since a centimeter's movement in any direction would render the treatment useless.

By keeping the patient under constant supervision during the irradiation treatment any movement is immediately observed. The treatment is then discontinued while the patient is repositioned. In this way the specialist knows that the equipment is being used at maximum efficiency and in the most economical manner.

The television component has been designed so no operating skill is required. It is brought into use by the operation of a master switch and normally no further adjustment is necessary.

Letters to the Editor

Readers to the Rescue

Dear Sir:

For a new garage door actuator design we are working on, we need a part that cannot at the moment be found on the market.

What is needed is a current sensitive switch that will be connected in series with a 1/8 hp 117 v high-speed motor. The starting surge (up to 3a) must not operate the device. However, a rise of current above a predetermined level (anywhere between 1 and s.5 a) must cause the switch to operate a relay and reverse the motor. This is to cause the motion of the door to reverse as soon as possible if it hits any object during its travels.

An added advantage would be obtained if the bi-metal strip could have an overtravel so that the current rises and stays at a high level, it would trip a manually reset control and break the supply to the motor. Both operations should be as quick as possible providing that the starting surge does not trigger either operation.

This is for a commercial unit with an initial production of approximately 1000 every six to eight weeks, and must be relatively inexpensive.

We would be grateful if your readers could help us in this matter.

Brian E. Hooper
Senior Engineer
Packard-Bell Electronics
12333 W. Olympic Blvd.
Los Angeles 64, Calif.

▶ If you can help Mr. Hooper, please address your communications to him direct. A carbon copy to ELECTRONIC DESIGN would be appreciated.

Stable Comb Filters Available

Dear Sir:

"Principles of Filtering" in the October 15th issue of ELECTRONIC DESIGN has been read with considerable interest. The author's presentation of various techniques, designed to improve the signal-to-noise ratio is enlightening. However, his dismissal of comb filters because of "the technical difficulties involved in achieving the necessary frequency stability" may have been premature.

The recent development by Hycon Eastern of the high frequency crystal filter has removed the road block of frequency drift presented by conventional LC filtering methods. We have sup-

Letters to the Editor

plied comb filter sets for various radar applic tions. These sets have been delivered at cent frequencies of 200 kilocycles and 1.5, 10 and megacycles. It is felt that the satisfactory pe formance of these comb sets of crystal filte proves this approach practical.

Austen Madeson, Manage
Crystal Filter Sales
Hycon Eastern, Inc.

More on the Filter Design Slide Rule

Dear Sir:

I have constructed the slide rule (Do-it-your self Slide Rule for Filter Design, ED, Oct. 1 and received satisfactory results.

Howard K. Cooper
Gov't. Lab. Div.
Admiral Corporatio

Dear Sir:

. . . I built the slide rule, and I wish to com mend your publication for another worthwhil and practical aid in engineering work.

Allen E. Herbeck
Apparatus Development
Stromberg-Carlson Compan

Dear Sir:

I have just finished reading Mr. Davidson's article on Slide Rule Filter Design in the October 1 issue of ELECTRONIC DESIGN. Since I am engaged in this type of work from time to time, I feel that a slide rule of this type would be very helpful. Therefore, would it be possible for you to have one sent to me?

Edward C. Bigelow
Commercial Electronic Products
Radio Corporation of America

▶ ELECTRONIC DESIGN will forward a reprint of the slide rule to Mr. Bigelow and anyone else requesting it.

Dear Sir:

Re: Page 42, October 1 issue ELECTRONIC DESIGN—it *does* make a difference how the slide is inserted! !

L. C. Cole
Instrument Engineer
General Electric Company

▶ That's why the slide is identified "High" and "Low" on opposite sides.

Dear Sir:

This letter is in reference to the article in your Oct. 1, 1957 issue entitled "Slide Rule for Filter Design," by R. Davidson. This is to assure all of the design hobbyists who have built the slide rule and cannot duplicate the sample calculation in the article that the slide rule is fine and that an error must have been made for the sample calculation. . . .

Robert H. Brook
Design Engineer
Filtron Co., Inc.

Dear Sir:

I made the slide rule and will find it very handy, but the example was in error. The capacitance of 10.8 μμf should be 42.5 μμf, and the inductance of 0.00265 μh should be 0.106 μh. The high-pass and low-pass formulae near the top of the article should read Ro in place of Rc in both formulae. . . .

L. N. Merson
Surface Communications
Radio Corporation of America

▶ We thank Messrs. Brook and Merson for calling our attention to the error in the example problem. A correction was published on p. 7 in the December 1 issue of ELECTRONIC DESIGN.

More on the Solid Electrolyte Battery

Dear Sir:

In reference to the article, "A Solid Electrolyte Battery" which appeared in your 1 October issue, the Glass Products Division of Fischer & Porter Company supplied the glass case to the General Electric Company for these batteries . . . you may be interested in the exceptional close dimensional tolerances which we hold while fabricating this glass case.

The following is a rundown of the tolerances held on the various dimensions of this case: id plus or minus 0.0005 in.; od plus or minus 0.005 in.; length plus or minus 1/64 in.; and concentricity within 0.005 in.

These are rather typical specifications that we receive from the electronic industry; in some instances, they are considerable closer.

Thomas J. McCabe
Ass't Sales Manager
Glass Products Division
Fischer & Porter Company
Hatboro, Pennsylvania

▶ We thank Mr. McCabe for this interesting addition to the ELECTRONIC DESIGN story on this recent battery development.

Meetings

Dec. 18-19: EIA Conference on Maintainabil of Electronic Equipment

University of Southern California, Los Angel Calif. Sessions will cover military concepts a requirements for maintainability, ground en ronment equipment, missile maintainability, a borne equipment maintainability, and ro blocks to maintainability. For additional inform tion contact Engineering Office, Electron Industries Association (formerly RETMA), R 650, 11 W. 42nd St., New York 36, N.Y.

Jan. 6-8: Fourth National Symposium on R liability and Quality Control

Hotel Statler, Washington, D.C. Sponsored b the IRE, ASQC and AIEE. Covering fields reliability in the electronic industries, the symp sium will encompass the following topics: r liability organization and management; theo and mathematical techniques; application these techniques; design information; and educ tion and training for reliability.

Jan. 22-24: EIA 1958 Conference on Automati

Arizona State College Auditorium, Tempe, Ari Sessions will consider the place of automation the electronic industries, the application of co puters to control of machinery outside the ele tronic industries, and the economic, educationa and social aspects of automation. Write to t Engineering Office, Electronic Industries Ass ciation (formerly RETMA), Rm. 650, 11 W. 42 St., New York 36, N.Y. for full details.

Jan. 27-28: Sixth Scintillation Counter Symposium

Hotel Shoreham, Washington, D.C. Sponsored b the IRE, AIEE, AEC, and NBS. There will four half-day sessions covering Phosphor a Cerenkov Scintillators; Photomultipliers; Ener and Time Resolution; and Scintillation Count Applications. Papers on components, equipmen and applications will be read. Write IRE, 1 79th St., New York 21, N.Y., for information.

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"OPERATE" this new -hp- oscilloscope—**Fast, Easy!**

see yourself the unique features that make this oscilloscope

world's easiest to use • quickly learned by anyone • instant, direct reading

most widely versatile • world's best scope value

Instantly adjust
horizontal sensitivity between steps on external input attenuator.

Eliminate errors
Light indicates when fastest calibrated internal sweep is exceeded.

Easy to examine
leading edge, any part of signal with x 5 to x 100 magnifier.

Twist of wrist
for perfect focus; no bloom, no ghosts, high writing rate without CRT post-accelerator.

Instantly position
any part of normal or **30-foot long expanded** trace center screen for clear, detailed study.

Select calibrated
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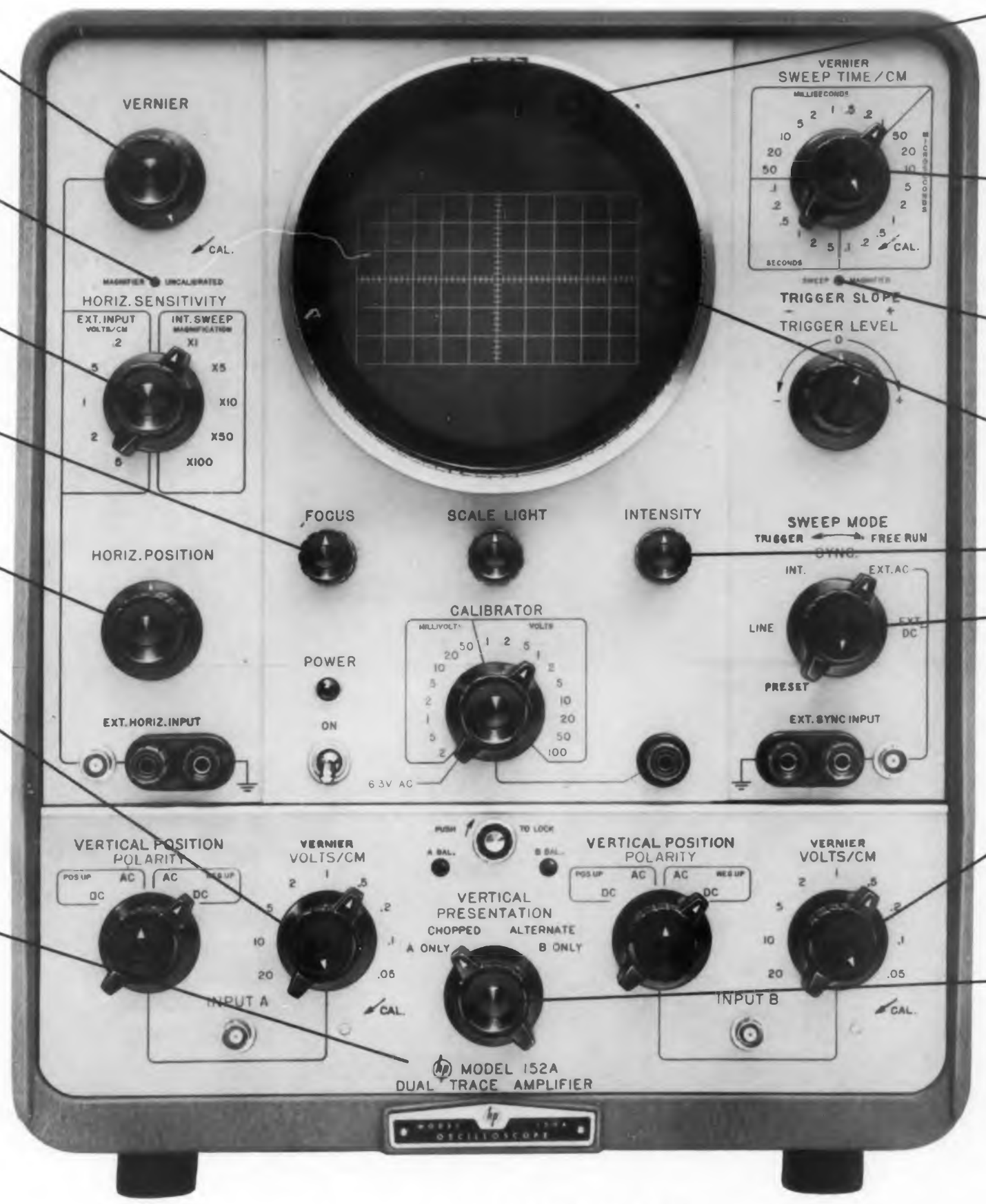
Widely versatile
plug-in amplifiers. -hp- 151A for highest sensitivity, maximum dc gain of 5 mv/cm, dc to 10 MC. -hp- 152A for perfect dual trace presentation without complexity and expense of dual beam scope.



Quick change
Exclusive -hp- twist-lock bezel means instant access to filters, front change of CRT tubes; convenient, fast camera mounting.

Save time
Direct reading sweeps; no calculation or multiplying factors; instantly select exact sweep desired.

Eliminate error
lamp warns when sweep is magnified on CRT.

Amplifiers
have Gaussian frequency response; no overshoot or ringing.

Bright, clear trace
mono-accelerator CRT.

No sync adjusting
Universal automatic PRESET condition provides optimum triggering for almost all inputs. Just select type of synchronization wanted; scope does the rest.

Easy to learn
concentric, color-coded controls, human-engineered for fast learning, easiest use without training!

Instantly examine
"A" or "B" inputs singly, alternately or "CHOPPED." Complete blanking of switching transients on "CHOPPED" presentation. Independent trace positioning.

SPECIFICATIONS

-hp- 150A Oscilloscope

SWEEP

Range: 0.02 μsec/cm to 15 sec/cm.

Calibrated: 24 calibrated sweeps in 1, 2, 5 and 10 sequence, 0.1 μsec/cm to 5 sec/cm. Accuracy within 3%.

Vernier: Permits continuous adjustment of sweep time.

Triggering: Internally, line voltage; externally with 0.5 v or more.

Trigger Point: Any positive or negative level on positive or negative slope of signal triggering sweep +30 v to —30 v range for external trigger.

Preset Triggering: Switch position on sweep mode control automatically selects optimum setting for stable triggering for majority of conditions.

Single Sweep: Sweep circuits may be set for triggered single sweep operation. After being triggered, sweep remains locked out until reset. Indicator light glows when sweep is armed.

HORIZONTAL AMPLIFIER

Sweep Magnification: Sweep may be expanded 5, 10, 50 or 100 times. Multiturn horizontal positioning control provides a fine degree of adjustment, permits viewing any 10 cm portion of expanded sweep.

Indicators: "Reminder" lights glow when sweep magnifier is used, or when expanded sweep time exceeds fastest calibrated sweep time.

External Input: Pass band dc to over 500 KC. Sensitivity range 200 mv/cm to 15 v/cm. Five calibrated ranges plus vernier.

VERTICAL AMPLIFIER

Main Vertical Amplifier: Pass band dc to more than 10 MC. Optimum transient response and rise time less than 0.035 μsec.

Signal Delay: 0.25 μsec. delay permits viewing leading edge of signal triggering sweep.

Input: Through plug-in preamplifier.

GENERAL

Amplitude Calibrator: 18 Calibrating voltages in 2, 5, 10 sequence, 0.2 mv to 100 v peak-to-peak, are available at a binding post to provide maximum flexibility. Accuracy within 3%. Approximately 1 KC square wave with rise and decay times less than 1 μsec.

Sawtooth Output: +20 to —20 v sawtooth waveform of sweep.

Gate Output: +20 v signal for duration of sweep.

CRT Bezel: CRT Bezel readily removable by a 15° twist, providing rapid means of changing filters and replacing CRT if different phosphors are required. Bezel locks to provide firm mount for standard oscilloscope camera equipment.

CRT Plates: Direct connection to deflecting plates via terminals in access compartment.

Intensity Modulation: Terminals provided; 20 v positive signal blanks CRT at normal intensity.

Price: $1100.00.

-hp- 151A High Gain Amplifier

Sensitivity Range: 5 mv/cm to 50 v/cm.

Input Attenuator: 12 calibrated ranges, in 0.5, 1, 2 and 5 sequence, from 5 mv/cm to 20 v/cm. Vernier permits continuous adjustment between ranges.

Input Impedance: 1 megohm shunted with 27 μμf.

Pass Band: dc to 10 MC, 0.035 μsec rise time.

Coupling: ac or dc.

Dual Inputs: Two signal inputs with Type BNC. Selection of either input by panel switch.

Price: $200.00.

-hp- 152A Dual Channel Amplifier

Sensitivity Range: 0.05 v/cm to 50 v/cm.

Input Attenuator: 9 calibrated ranges, in 1, 2, 5 and 10 sequence, from 0.05 v/cm to 20 v/cm. Vernier permits continuous adjustment between ranges.

Input Impedance: 1 megohm shunted with 27 μμf.

Pass Band: dc to 10 MC, 0.035 μsec rise time.

Coupling: ac or dc.

Electronic Switching: By alternate sweeps or chopped at approximately 100 KC.

Vertical Positioning: Individually adjustable.

Polarity of Presentation: Input signal as applied or inverted.

Input Connectors: Type BNC both channels.

Price: $250.00.

Data subject to change without notice.

PRESENTING one completely new instrument that

can be worth more to you than any similar equipment

you have ever owned because it does more things better

and faster, eliminates errors, ends tedious computation

—saves hour upon hour of precious engineering time.

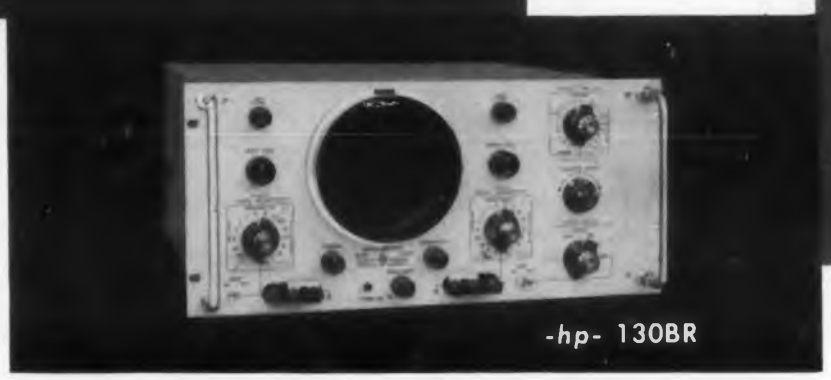
THE WORLD'S PREMIER

HIGH FREQUENCY OSCILLOSCOPE

simplest to use
direct reading
most widely useful
fastest operating

offers still more simple, fast, time saving oscilloscopes

Low Frequency Cabinet Oscilloscope, Model 130A. Covers dc to 300 KC. Similar horizontal and vertical amplifiers. Input circuits balanced on 5 most sensitive ranges. Single ended input may be dc or ac coupled. Direct reading, linear sweep times. With most transducers, needs no preamplification to produce brilliant, high resolution trace. Universal automatic triggering; one preset condition provides optimum triggering for almost all inputs. $650.00.



Low Frequency Rack Mount Oscilloscope, Model 130BR. Similar to *-hp-* 130A except for rack mount and includes x5 magnifier usable on all ranges and expanding fastest sweep to 0.2 μsec/cm. Parallel input terminals front and rear. $650.00.

High Frequency Rack Mount Oscilloscope, Model 150AR. Same as *-hp-* 150A except for mounting in standard relay rack. Fitted with "pull-out" slides for maximum servicing accessibility. $1,200.00.

ON YOUR OWN BENCH, ON YOUR OWN PROBLEMS, SEE, FEEL, OPERATE THESE NEW -hp- OSCILLOSCOPES

Call your *-hp-* representative.
Ask him to bring an *-hp-* oscilloscope to your lab or shop. Try it, side by side with old-style scopes you may have been using.

Let the instrument itself show you how much time, work, mathematics and do-over it can save.

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Jan. 27-Mar. 10: Monday Evening Lecture Series on Modern Circuit Theory from an Elementary Point of View

Western Union Bldg., 160 W. Broadway, New York City. Jointly sponsored by the IRE Professional Group on Circuit Theory and the AIEE Basic Science Division. Starting with Jan. 27 and ending with Mar. 10 there will be a lecture every Monday evening at 7:00 p.m. Registration must be made in advance. Tickets will not be sold at the door. Write IRE, 1 E. 79th St., N.Y.C.

Feb. 3-4: Flight Control—Panel Integration Symposium

Biltmore Hotel, Dayton, Ohio. Sponsored by the USAF, Flight Control Lab., WADC. Philosophy of flight instrumentation, system integration, and many other topics will be covered. For reservations and program information write to John H. Kearns, Box 942, Dayton, Ohio.

Feb. 3-7: AIEE Winter General Meeting

Statler and Sheraton-McAlpin Hotels, New York City. The 96 sessions will encompass power generation and computing devices; data communications and telegraph systems; radio communication; television and aural broadcasting; telegraph systems and wire communications; industrial power rectifiers and systems; industrial control; feedback control; electric heating; nucleonics; basic sciences; dielectrics; electrical techniques in medicine and biology; magnetic amplifiers; metallic rectifiers; solid state devices; high frequency instruments; recording and controlling instruments; and a variety of other subjects. For additional information write the AIEE, 33 W. 39th St., New York, N.Y.

Paper Deadlines

Jan. 15: Deadline for papers to be presented at the **1958 National Symposium of the Professional Group on Microwave Theory and Techniques.** The symposium will be held May 5-7 at Stanford University, Stanford, Calif. Prospective authors should submit a 100-word abstract and a 500-word summary. Both must be in triplicate with the title of the paper and the name and address of the author. Papers on microwave physics and applications, microwave components, and microwave techniques are appropriate. Submit abstracts and papers to Dr. Kiyo Tomiyasu, Chairman, Technical Program Committee, 601 California Ave., Palo Alto, Calif.

CIRCLE 15 ON READER-SERVICE CARD

Effects of Nuclear Radiation on Transistors

A. J. Schwartz

Defense Electronic Products
Radio Corp. of America
Camden, N. J.

HOW DOES nuclear radiation effect the application of transistors in military equipment? In an attempt to answer this question, RCA has subjected transistors to nuclear environments in the Brookhaven National Laboratories. The results of such tests and the interpretation of such results are described here.

Preliminary Considerations

It was determined that it was necessary to make measurements of the transistors under actual operating conditions while being subjected to radiation. It was felt that measurements taken before and after tests would not give a good enough insight into what was actually happening. It was therefore decided that the most meaningful and generalized results could be obtained by measuring the output characteristics of each of the transistors before, during, and after radiation.

Suitable switching equipment was designed to allow for the monitoring of ten transistors at one time. Special cables and boards were made to provide for the irradiation of ten transistors simultaneously. The boards were made of a glass epoxy material which is known to stand up extremely well under radiation. Two types of cable were used. One type cable was made up of copper wire with a polyethylene dielectric; the other type was made up of aluminum wire with Formex insulation. Both types of dielectrics are good for radiation resistance; but the aluminum wire was the only type which could be used at high radiation levels because of its extremely short half life.

Test Data

A complete listing of the transistors which were tested and the radiation levels to which they were subjected is given in Fig. 1. There was no special selection of transistors. In general, the units were obtained at random from stock. Since the most drastic changes occurred in I_{co} and gain, these were the quantities which were plotted.

Fig. 1 Table of Tested Transistors
Number Subjected to Radiation

Transistor Type	Gamma	Neutron
H2		1
2N35	1	18
*2N35U	1	1
*2N35D	1	1
2N37	2	3
2N43	1	5
2N43A	1	5
2N64R	1	3
2N64T	1	2
*2N77U	1	1
*2N77D	1	1
2N79	1	2
SB-100	3	15
2N109		8
2N112	3	2
2N140	3	3
TI-202	1	15
HD-454		2
CK-790	2	2
TI-904	2	2
TI-951	1	2
TAE-1579	1	4

*Specially made transistors, undipped and dipped respectively in SR-98 Silicon Resin

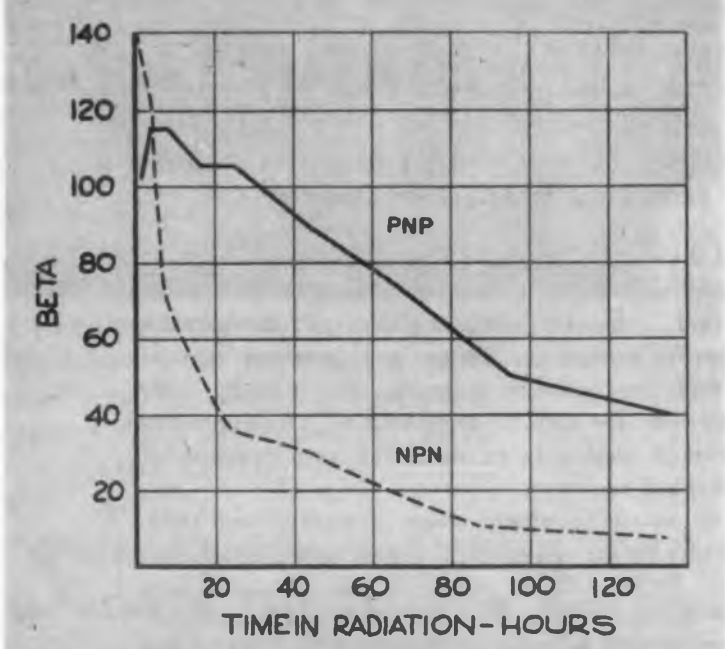


Fig. 2. Effect on beta vs irradiation time for p-n-p and n-p-n germanium transistors. The p-n-p unit showed a temporary improvement in gain prior to its expected hyperbolic deterioration. The n-p-n transistor deteriorated along the predicted hyperbolic curve.

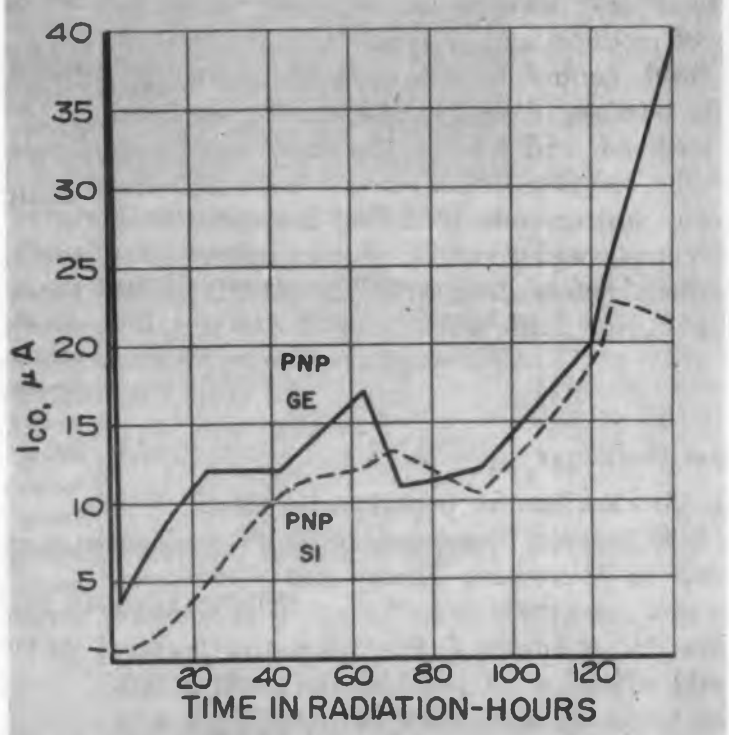
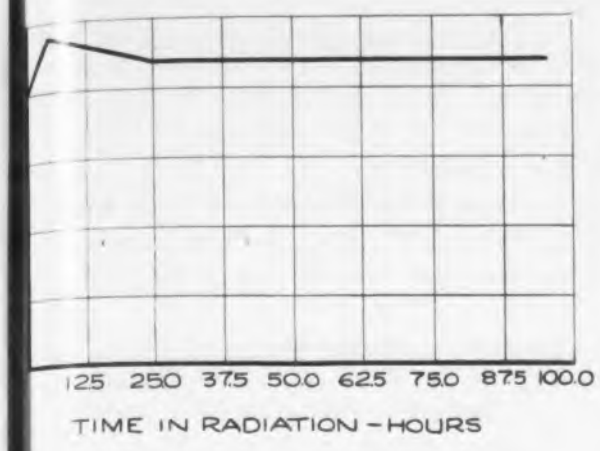
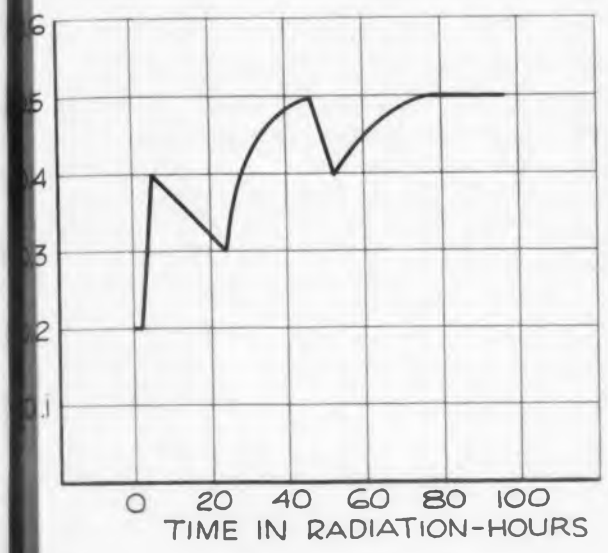


Fig. 3. I_{co} vs irradiation time for p-n-p germanium and silicon transistors. The germanium curve shows improvement in I_{co} for an initially poor transistor. For the silicon transistor there was a gradual increase in I_{co} up to slightly over 20 μamp after 130 hours radiation.



g. 4. Typical high-frequency p-n-p germanium
t which shows negligible change in gain
radiation times in the order of 100 hours.



g. 5. I_{co} vs irradiation time for high-frequency
-p transistor. This transistor showed only a
y slight increase in I_{co} during radiation.

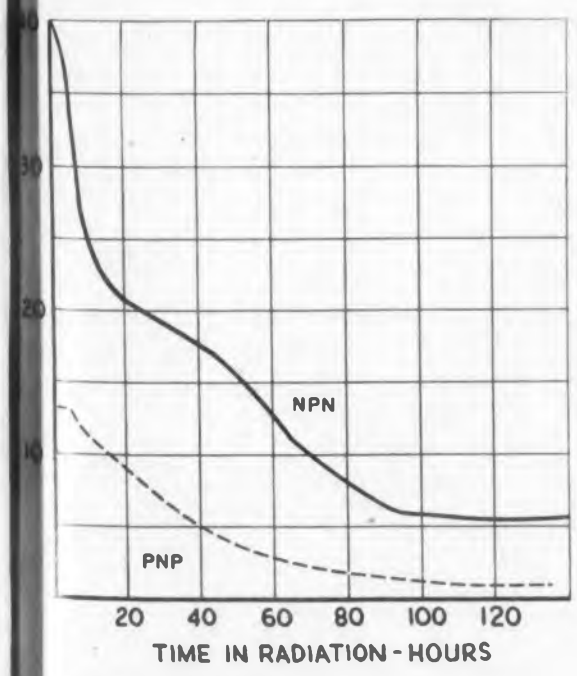


Fig. 6. Typical n-p-n and p-n-p silicon units showing the expected hyperbolic deterioration in gain.

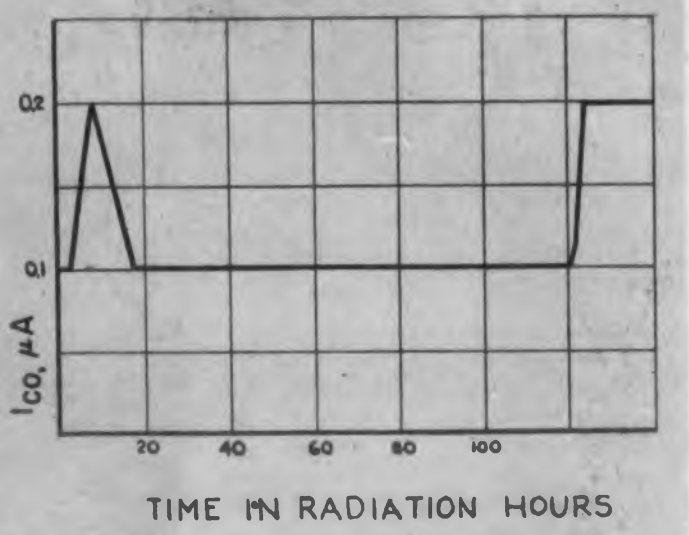


Fig. 7. N-p-n silicon transistors have very good resistance to radiation in-so-far as leakage current is concerned, as shown here.

Typical curves for transistors subjected to reactor pile radiation in the tunnel are shown in Figs. 2 to 7 inclusive.

Typical curves for transistors subjected to pure gamma radiation are shown in Figs. 8 to 13.

Conclusions

Under Neutron Radiation

- It appears that high frequency transistors are best for use under nuclear radiation environments. Samples of this type were found to last at integrated flux levels greater than 10^{13} NVT (fast neutrons).
- The next best type for use under radiation was found to be n-p-n silicon category which generally was found to survive only about 1/10 as long as the high frequency type.
- N-P-N and p-n-p germanium as well as p-n-p silicon units were found to deteriorate at a somewhat faster rate by an additional factor of two.
- Silicon transistors showed particularly good resistance to radiation damage as far as leakage current is concerned; there being little increase to 10^{13} NVT. However, they did suffer severely from decreased gain as indicated.
- In apears that cadmium shielding has little effect in protecting transistors from nuclear radiation. This indicates that slow neutrons are not as damaging.
- Over the range of fluxes investigated, (10^8 to 4×10^{10}) fast neutrons, no dose rate effects could be observed.

Under Pure Gamma Radiation

- N-P-N germanium appear to be about the best, being capable of withstanding in the order of 17 x 10^6 roentgens.
- N-P-N silicon units are next best and can withstand about 14 x 10^6 roentgens.
- Germanium and silicon p-n-p units are about the same—failing after approximately 8 x 10^6 roentgens.
- High-frequency units showed no particular advantage over their low-frequency counterparts.

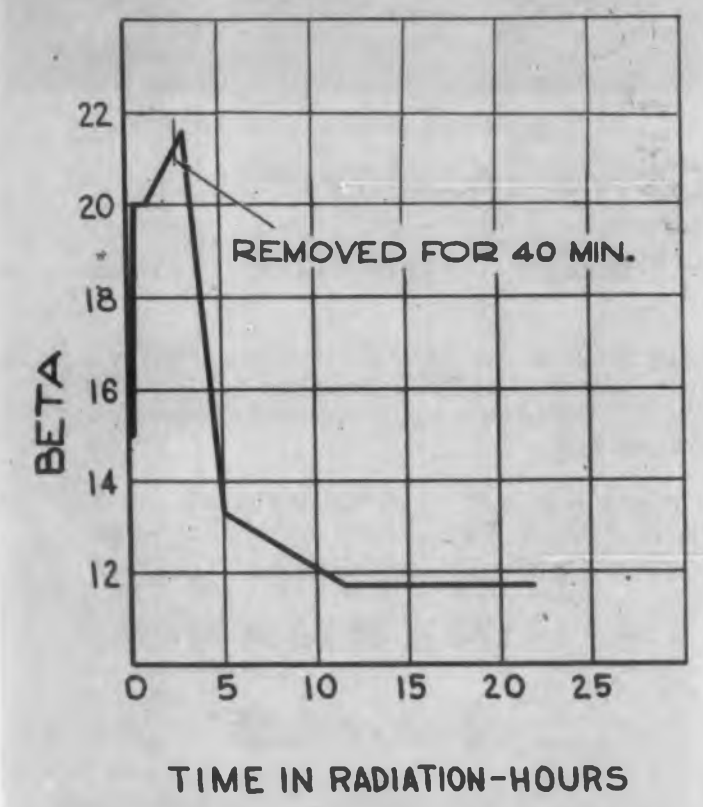


Fig. 8. A high-frequency p-n-p germanium transistor which was erratic in behavior under radiation. Particular interest is the initial improvement of beta after a short term of irradiation.

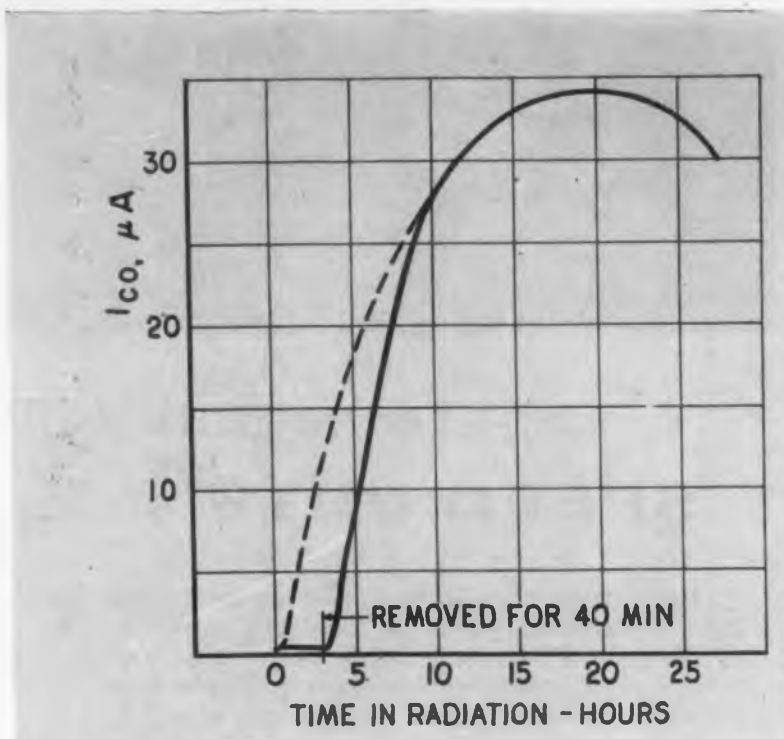


Fig. 9. Typical p-n-p germanium transistor which showed increased I_{co} up to a high value within a short duration of radiation, but then started to improve after additional radiation.

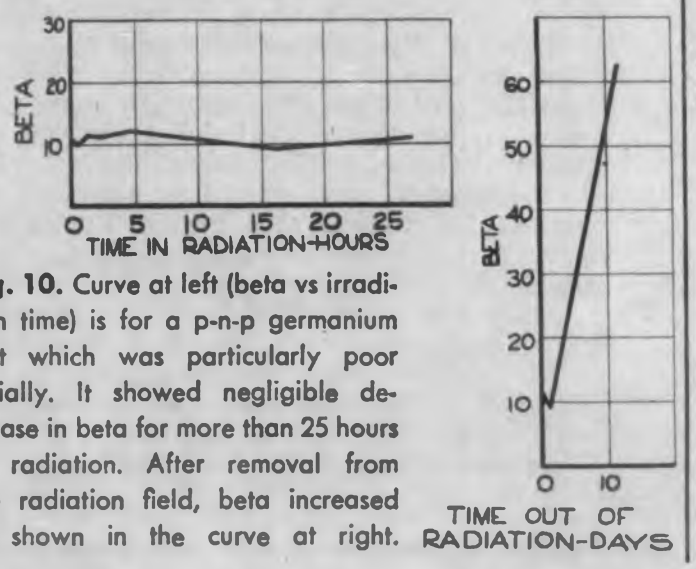


Fig. 10. Curve at left (beta vs irradition time) is for a p-n-p germanium unit which was particularly poor initially. It showed negligible decrease in beta for more than 25 hours of radiation. After removal from the radiation field, beta increased as shown in the curve at right.

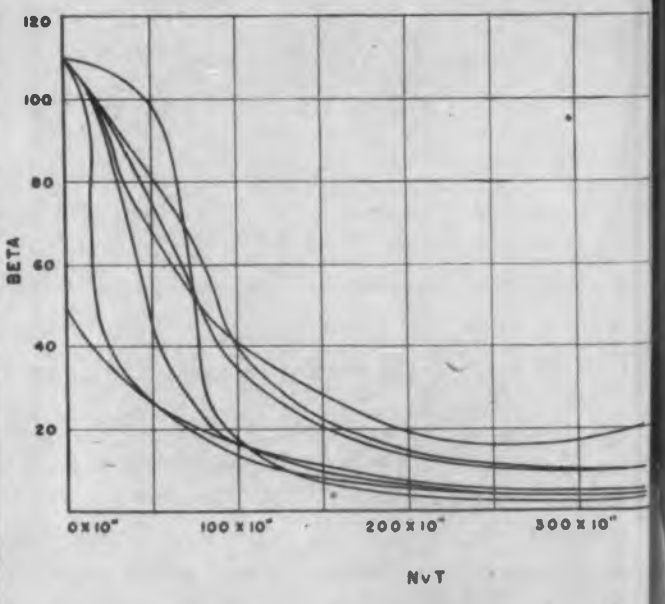


Fig. 11. Summary of beta variation as a function of total dosage (NVT) for 7 units of one type of p-n-p germanium transistor. Note the consistency of results.

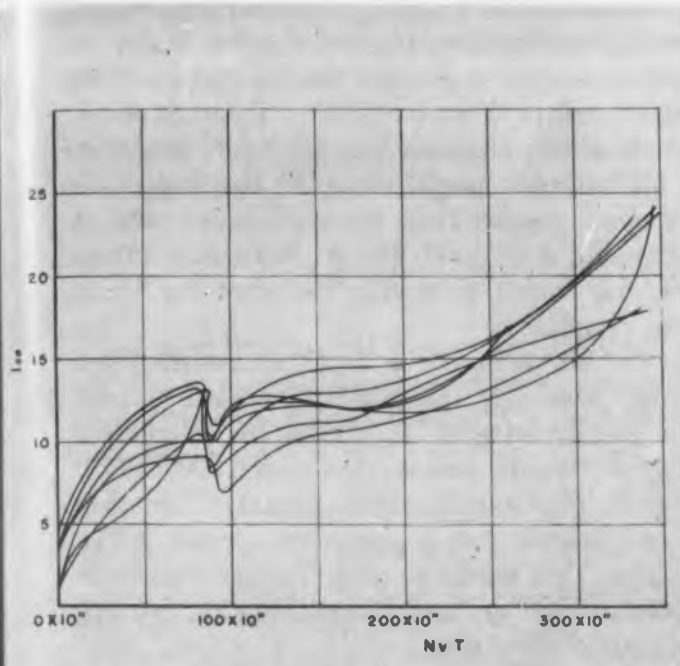


Fig. 12. A similar summary to that of Fig. 11 for I_{co} variation as a function of total dosage for the same transistor type. Again, note the consistency.

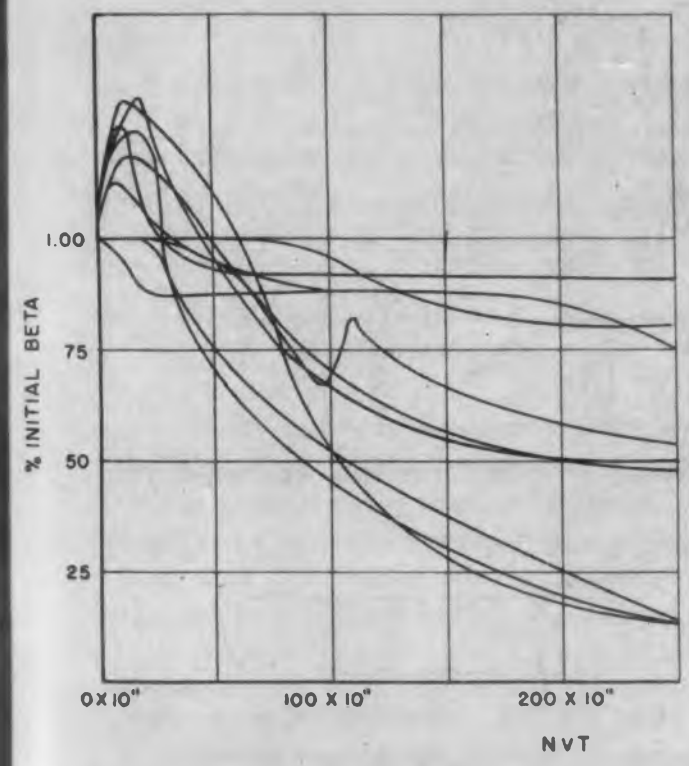


Fig. 13. Some types of transistors showed considerable variation from unit to unit. Here is shown the beta variation as a function of total dosage for one of these. Note the large inconsistencies which stand out even when beta is normalized.

The capacity-coupled, single-tuned rf amplifier is economical and simple. It is found quite commonly in receiver and transmitter design.

In portable, compact equipment, coupling efficiency is of particular importance. Eeach milliwatt of wasted power may mean several watts of needless prime power supplied by bulky batteries. Because of a 3 db loss of drive power, a typical transmitter might require huskier tubes to achieve required output. This could necessitate doubling the prime power.

Design of Capacitive Divider Coupling Circuits

Irving Dlugatch,
Supervisor,
UHF and Microwave Group
Hoffman Laboratories, Inc.
Los Angeles, California

HERE IS A streamlined technique for designing capacity-coupled rf stages. It provides a happy course between the Scylla and Charybdis of the empirical approach and the involved classical method.

In this scheme, restricted to fixed frequency operation, impedance matching is obtained by selecting precise values of C_1, C_2, and C_3 in Fig. 1 to form a capacitive divider. However, the capacitor combination must be able to tune L to the correct frequency required by the equipment. Meeting both conditions imposes a complex design problem.

In the circuit of Fig. 1, commonly found in receiver and transmitter design, R_i represents the driver impedance and R_g represents the input impedance of the following stage. It is important to match them to optimize efficiency. In the circuit, R_i, R_g, C_{gk}, C_{pk}, and ω are known. C_1, C_2, C_3 are unknown and depend on the desired impedance transformation and the capacity required to tune L. Experience will dictate a value of Q_L which may be assumed, knowing the frequency of operation, and thus the range of inductance likely to be used. Lacking this experience it is necessary to start the design with a stock coil, or to assume one of the two special cases to be discussed. It is then necessary to recheck after computation to see whether the coil will fit the assumed case.

Circuit Simplification

Fig. 1 may be simplified to Fig. 2 by using the following definitions.

$$C_{gk} + C_1 = C$$
$$C_{pk} + C_2 = aC$$
$$C_3 = bC$$

$$\omega^2 = \frac{1}{LC\left(1 + \frac{ab}{a+b}\right)} \qquad (1)$$

$$\omega_1^2 = 1/LC$$

Here ω relates to the frequency to which the circuit is tuned by all the capacitances in the system and ω_1 relates to the frequency to which the coil is tuned by C_{gk} and C_1 alone. Throughout, R_i is assumed much greater than R_g. Should the opposite be true, it is necessary to substitute one for the other wherever they appear in an equation. In that case, C_{pk} and C_{gk} would also be transposed since these are the tube and wiring capacitances.

Further simplification is achieved by eliminating all but two special cases. In the first, R_g is very much smaller than the tank impedance; in the second, it is much larger. With rare exceptions, the circuit is readily designed for either of the two cases.

In the first case, the coil's Q_L is assumed sufficiently high that the parallel resonant impedance greatly exceeds R_g for ω (to which the circuit is tuned), and ω_1 (to which the coil is tuned by C_{gk} and C_1 alone. L and C are then ignored and the simple equivalent circuit of Fig. 3 results. This is the familiar L network which responds to any of the fundamental filter analysis methods. We find then,

$$X_{bC} = j\sqrt{R_g\,(R_i - R_g)}$$

$$X_{aC} = jR_i\sqrt{\frac{R_g}{R_i - R_g}}$$

$$\frac{X_{bC}}{X_{aC}} = \frac{R_i - R_g}{R_i}$$

but $X_{bC} = 1/\omega bC$ and $X_{aC} = 1/\omega aC$

Hence $$\frac{a}{b} = \frac{R_i - R_g}{R_i} \qquad (2)$$

For the second special case, R_g is so large that the tank is considered unloaded. Then R_g is ig-

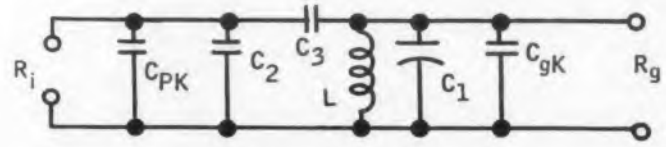


Fig. 1. A typical coupling circuit commonly found in receiver and transmitter design.

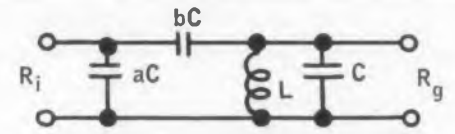


Fig. 2. A simplified version of Fig. 1, achieved by lumping capacities.

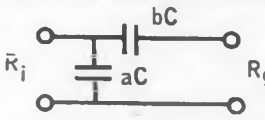


Fig. 3. A further equivalent circuit simplification for the special case where the tank impedance greatly exceeds the input impedance of the following stage.

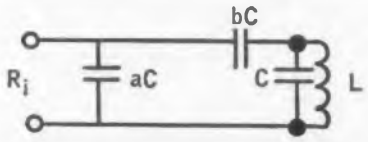


Fig. 4. A simplified equivalent circuit for the case where the tank may be considered unloaded.

nored. This results in the equivalent circuit of Fig. 4, wherein the tank impedance replaces R_g. The tank impedance can then be taken, with negligible error as QX, where Q is for the coil of Fig. 4, and X is the reactance of the coil or tank capacitor. Then,

$$\frac{a}{b} = \frac{R_i \omega C - Q}{\omega C R_i} \qquad (3)$$

The constants a and b are now determined, with the limits that their values must satisfy Eq. (1) and aC must equal or exceed C_{pk}, and C must exceed C_{gk}.

Design Procedure

- Determine R_i, R_g, ω, C_{pk}, C_{gk}.
- Select C_1 arbitrarily, on the basis of mechanical fit in the equipment.
- Find C from $C = C_{gk} + C_1$
- Determine approximate minimum value of a from $aC = C_{pk} + C_s$.*
- Solve for b using Eq. (2) or Eq. (3)
- Set $C_s = bc$
- Solve for L using eq (1)
- If L and C_s have impractical values, a may be increased. If it is necessary to decrease a, then no solution is possible since a is already minimized.

* C_s has not been determined, but it is known that it must have a practical minimum value, say 5 μμf. It is also known that aC must exceed C_{pk} and be less than C. A curve may be plotted showing the relationship between a and C_s, from which one may select a suitable value for C_s based on a minimum value of a.

Sample Problem

Given: $R_i = 5000$ ohm, $R_g = 400$ ohm, $C_{pk} = 5$ μμf, $C_{gk} = 4$ μμf, $Q_L = 100$ and $\omega = 600$ (10^6)

Here, Q is high enough to make the problem fit the first special case. Let $C_1 = 10$ μμf.

Then $C = C_{gk} + C_1 = 14$ μμf, and aC must be more than C_{pk} and, preferably, less than C. This is based on trying to use a reasonable value for C_s, say 5 μμf. For a first trial, set $a = 0.7$.

Then $b = 0.76$, $L = 0.14$ μh, $C_3 = 10.6$ μμf, and $C_s = 4.8$ μμf.

All the values are realizable in commercial components. The designer must decide when it is economical to continue computations to arrive at solutions closer to stock values. It is normally better to accept the inevitable loss of efficiency due to component tolerances than to use special items or continue calculation in pursuit of perfection. In any case, the actual loss is usually under 1 db.

The method has been found very useful, particularly in the vhf range.

For a reprint of this article

CIRCLE 379 ON READER-SERVICE CARD

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From Globe you can get fast delivery of complete miniature power systems designed around new FC motors—115 or 200 V.A.C., 60 or 400 cycles—induction, hysteresis, or dual speed rotors, wound 3 phase, 2 pole or 4 pole; 2 phase, 2 pole or 6 pole; single phase with a matched capacitor. Units are designed to meet MIL specs; operating characteristics and configuration can be modified.

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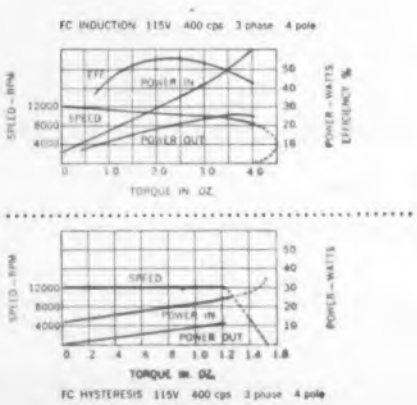


CIRCLE 20 ON READER-SERVICE CARD

Automatic Battery Activator

PRIMARY batteries can now be activated and operated in any position, thanks to a new high speed method of automatic activation. This new method outmodes the slower mechanical activation process which depends upon gravity and demands that liquid primary cells always stand in the upright position.

Life is made a lot easier for the missile designer when he doesn't have to worry about keeping his battery upright. The new development by Yardney Electric Corp., 40 Leonard St., N. Y. C., will eliminate some headaches also, for designers of torpedoes, servos, emergency radio transmitters and receivers, gyroscopes and ejection seats.

In seconds, this device activates primary silver-zinc batteries and readies them to provide 100 per cent power.

The patented system has been so standardized that it can be applied to all battery sizes. The mechanism has three parts which may be placed in any position.

- A gas pressure tank holds an inert gas under fixed pressure. A sealed-in pressure switch checks the reserve pressure from remote points and indicates when the battery is ready for activation. A pressure gage may be used if the battery can be seen and reached.
- A formed stainless steel cylinder holds the potassium hydroxide electrolyte. Upon activation, gas from the pressure tank expands a bladder at one end of the

This silver-zinc primary battery features a new type of automatic activation. The lightweight battery requires no maintenance and has a long shelf life.

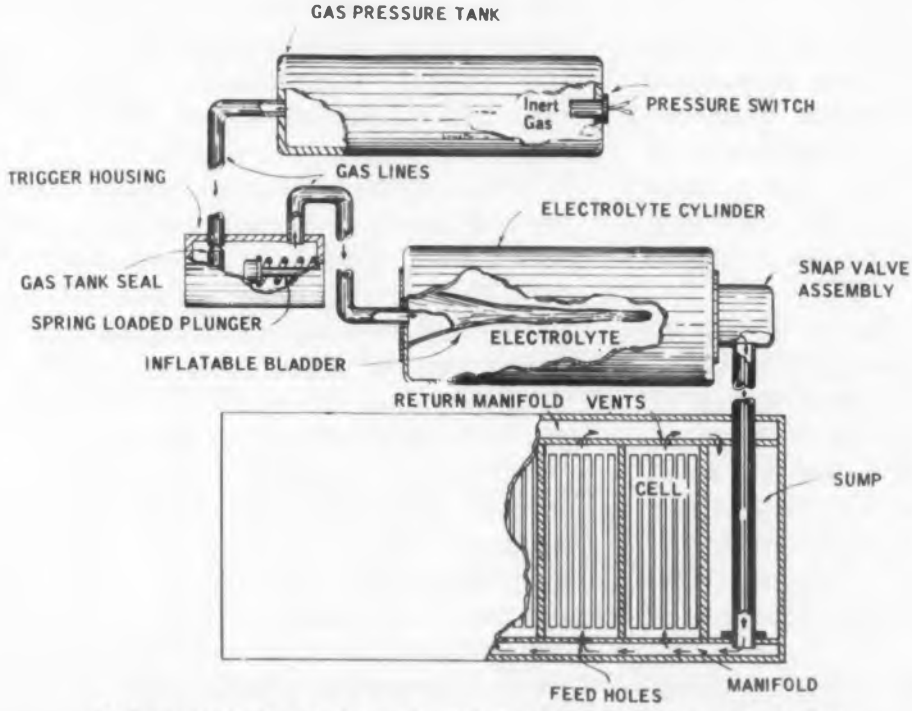
cylinder. A quick-acting snap valve at the other end releases electrolyte to the battery.

■ A spring-loaded plunger in a molded housing triggers the gas from the gas tank to the electrolyte cylinder. This trigger can be tripped electrically or mechanically.

When the plunger is triggered it breaks the gas tank seal. Gas inflates the bladder of the hermetically sealed electrolyte cylinder. Then the electrolyte forces open a snap valve at the other end and flows through the feed tube to the manifold. Here it is evenly distributed through feed holes into the individual cells.

Special vents allow surplus electrolyte, gas and vapors to escape through a return manifold into a sump. Since the electrolyte does not contact the electrodes till the battery is activated, the battery may be dry stored indefinitely.

For further information about this automatic battery activator, circle **21** on the Reader's Service Card.



Cutaway view of the principal parts of the battery activator

New G-E Indicator Lamp "lives" 10,000 hours ... resists shock and vibration ... needs no transformer

The light output of the new General Electric Glow Lamp, NE-79 is easily sufficient to illuminate the legend in a cover glass or lenses in a diversified array of indicators. Made for use on 105-125 volt circuits, in series with a 1 watt 7500 ohm resistor, no transformer is needed. Since the bulb is only $\frac{7}{8}$" in diameter it fits pilot assemblies which go into a 1" mounting hole.

The NE-79 has inherent resistance to both shock and vibration and, since it is equipped with a double contact bayonet base, it cannot shake loose in the socket. For further information on the NE-79 glow lamp write to General Electric Company, Miniature Lamp Department ED-127, Nela Park, Cleveland 12, Ohio.

Other General Electric Glow Lamps have electrical characteristics that let them serve as relaxation oscillator, leakage indicators, switches, voltage regulators, or voltage indicators.

Progress Is Our Most Important Product

GENERAL ELECTRIC

CIRCLE 22 ON READER-SERVICE CARD

Metal Ceramic Tubes to Withstand 500 C and High Vibration

John H. Wyman and R. H. Kuhnapfel
Bendix Aviation Corp.
Red Bank Div.
Eatontown, N. J.

Fig. 1. Temperature distribution about external anode tubes made of .020 in. thick monel. (Temperatures in deg C.) $E_f = 6.3$ vac, $E_b = E_{c1} = 250$ vdc, $I_b = 65$ madc.

FLIGHT at sonic speeds and guidance of missiles beyond the convecting gasses of the earth's atmosphere has not only increased the complexity of electronic control gear, it has also presented new problems in heat dissipation and high-vibration environments. Control of the environment requires weighty equipment where an almost insurmountable problem already exists in merely carrying the jet or rocket engine, the fuel and basic pay load to its objective. The development of components capable of operation in the environments encountered without the aid of pressurizing and cooling is obviously desirable and almost mandatory.

Current estimates of environmental requirements include swept-frequency or random frequency vibration with frequency components up to 2000 cps at levels of 20g and ambient temperatures of 500 C.

The operation of tubes in the environments described, gives rise to a number of problems:

- If ambient temperatures of 500 C are encountered, envelope temperatures must exceed the ambient by some gradient temperature between the internal element temperature and the ambient. Conservatively, in a conventional glass tube, the differential temperature would be 100 C for a bulb temperature of 600 C. Operation of glass envelopes at 600 C is impractical for a host of reasons, including electrolysis, deterioration of seals, diffusion, mechanical limitation, etc.
- The vibrational requirements preclude the use of large structural masses and a situation results where large dissipating surfaces are desirable for heat dissipation but are undesirable for vibration reasons.
- A high vacuum tube must be processed at temperatures considerably in excess of any operational temperatures or outgassing of internal parts and surfaces will occur resulting in deterioration in cathode activity among other effects. The processing temperatures required eliminates the use of any glass currently available that is otherwise adaptable to tube manufacture.
- At temperatures above 250 C the use of conventional barium getters becomes marginal, at 500 C it becomes impossible. If some internal surface of the tube could be maintained at 700 C or higher, zirconium getters conventionally used in small power tubes might be used; but operation at various temperatures below 700 C would most certainly happen in most applications. There is also a problem of transient outgassing of hydrogen at 400 C with zirconium.
- With a wide range of envelope temperatures, a variation in cathode temperature may be expected and the need for automatic compensation in heater input for changes in ambient temperature is probable.

The approach to the problems outlined above and described herein consist of replacing the glass envelope in a conventional tube with a metal-ceramic envelope, using the envelope as the anode and providing a suitable getter to replace the barium flash getter. The reasons for this approach and its advantages follow:

- The use of a metal envelope provides better heat radiation than can be gained with a refractory. Further by using the envelope as the anode the greatest possible radiation area is achieved. Inasmuch as the anode usually has the greatest mass of any element, it is desirable not to require its support with the structure by ceramics or micas which may fracture or wear under vibration. A number of metals were investigated for use in envelopes and the choice of monel was made mostly on the basis of its oxidation resistance.

To complete the envelope, a stem of alumina ceramic closely resembling the glass button of a conventional tube is used. The ceramic is coated using a moly-manganese technique. The stem shown in Fig. 2 has two piece leads, the inner portion of moly provides a vacuum tight seal which remains in compression. The outer section of monel completes the circuit through the brazing material and provides an oxidation resistant base pin.

A flare is sealed to the outer periphery for subsequent heli-arc welding to the metal envelope. (See Fig. 2)

- The use of the stem enables the assembly to proceed by making cages, and mounts in the conventional manner, replacing the header sealing machine with a heli-arc sealer and evacuating in a conventional exhaust machine. Processing temperatures in the neighborhood of 1000 C can be used. Fig. 2 shows a typical mount.
- Various getter techniques have been tried including parts made of titanium and zirconium or parts coated with titanium, zirconium or Ceralloy powders. The results of many of these tests were inconclusive and the constant suspicion of getter materials or coating processes led to the development of a technique for quantitatively measuring the gettering ability of various coated parts. A closed glass system was provided which could be baked-out and subsequently filled with CO_2. The system contained approximately 2 liters of volume and comparison measurements were made by admitting a pressure of 50 microns of CO_2, heating the getter and plotting rate of pressure decrease for various getter temperatures. (See Fig. 3)

Results of tests in this system confirmed much

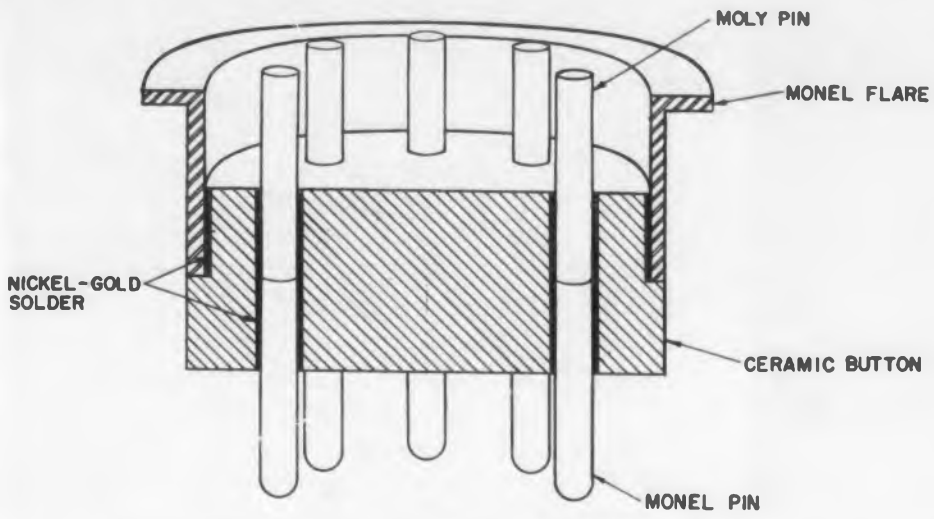
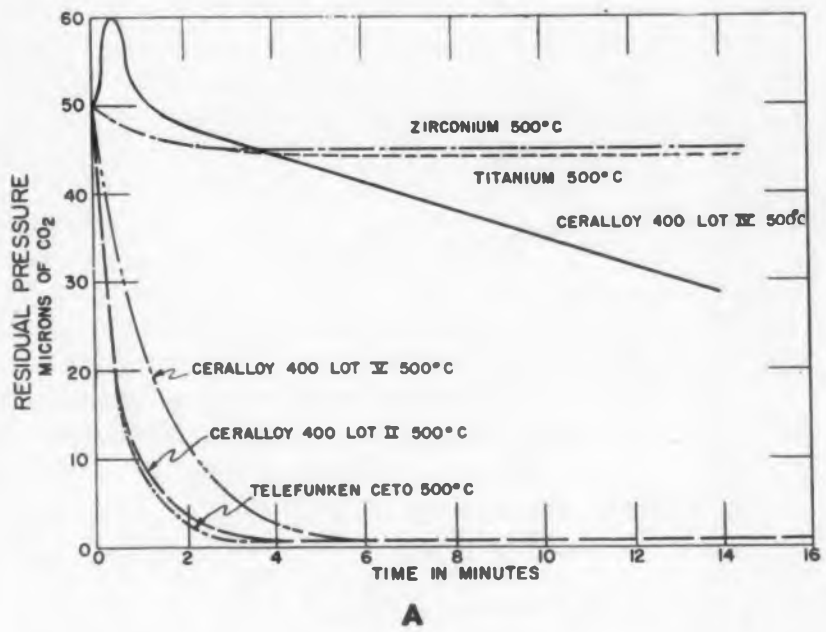


Fig. 2. Alumina ceramic stem of the metal ceramic tube. The moly portion of the pin provides a vacuum tight seal which remains in compression.



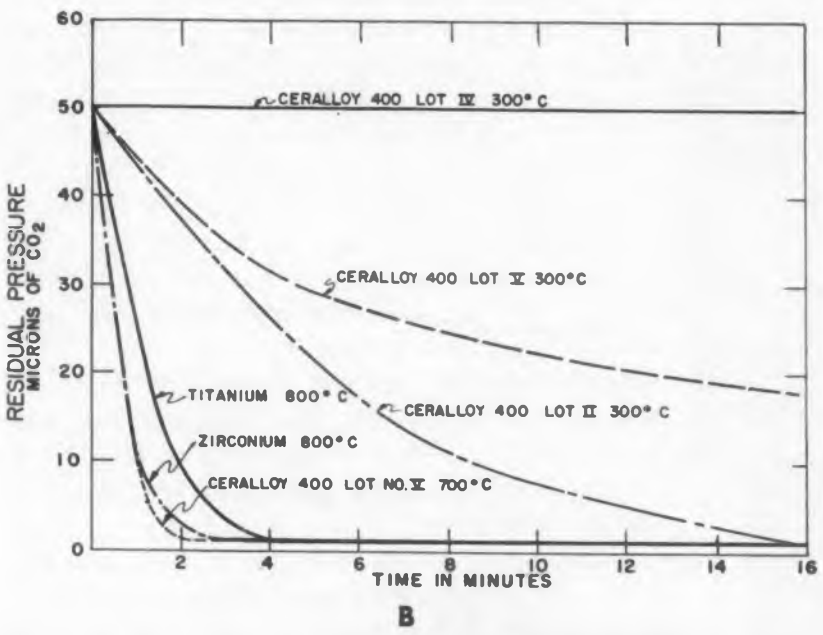
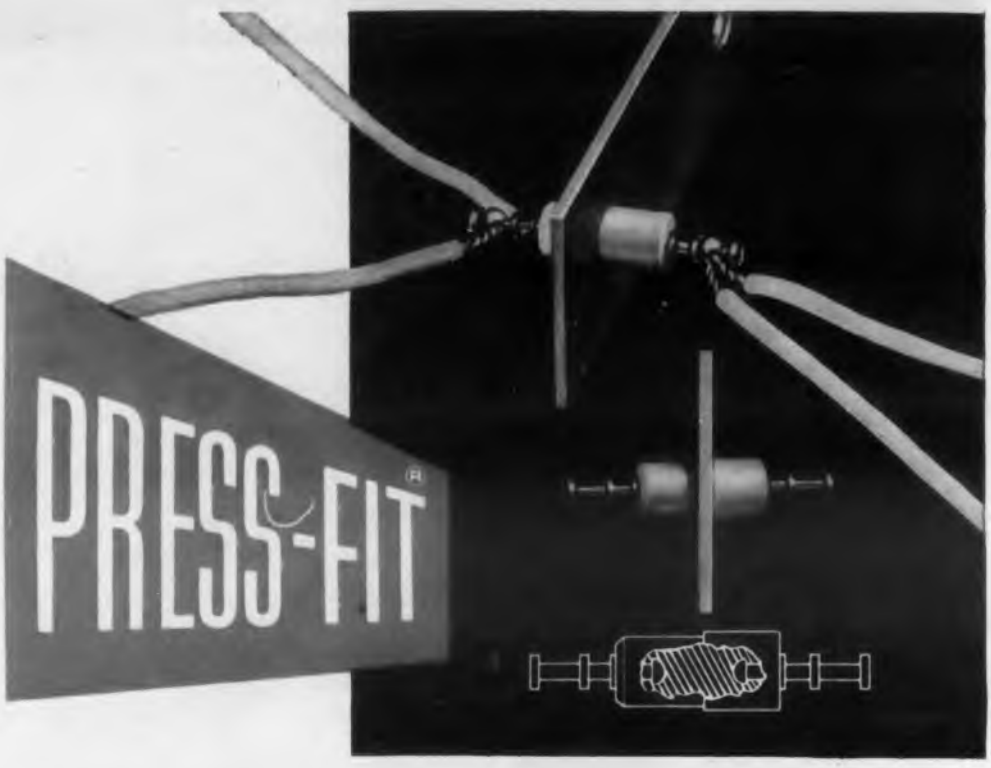


Fig. 3. (a and b) Residual Pressure Vs. Time—These graphs show the rate of pressure decrease as a function of getter temperature for different getter materials.
a) Effect of low and high getter temperatures (300 C Lot IV was bad.)
b) Getter temperature = 500 C.



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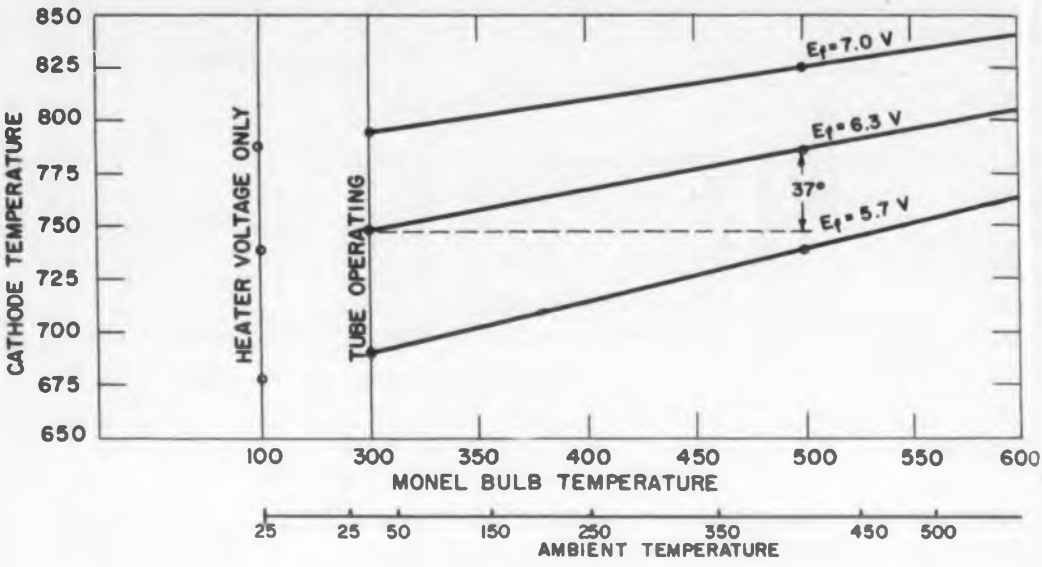

Fig. 4. Cathode temperature variation as a function of ambient and bulb temperatures (deg C). $I_f = 800$ ma at 6.3 vac, $I_b = 65$ madc.

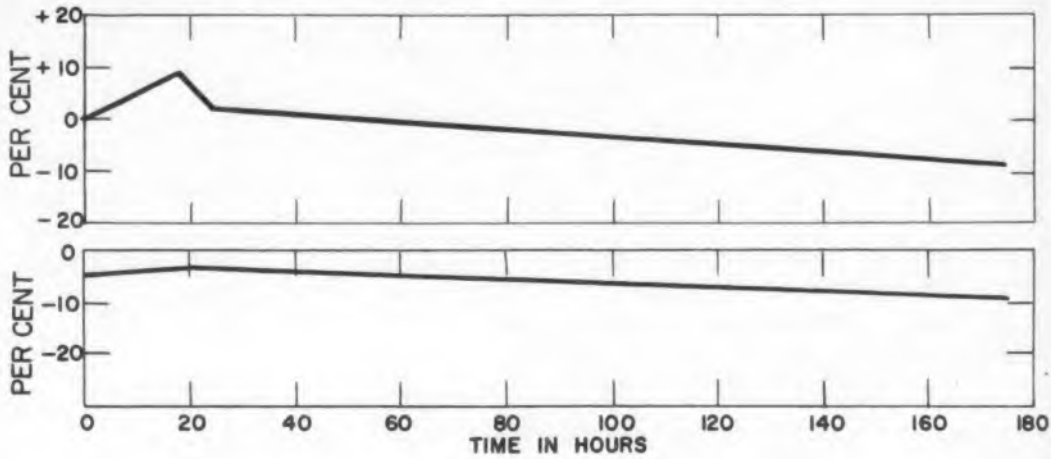

Fig. 5. Transconductance vs. time in a 500 C ambient a) Per cent change from initial value with $E_f = 6.3$ vac b) Per cent change from value at normal filament voltage with $E_f = 5.7$ vac.

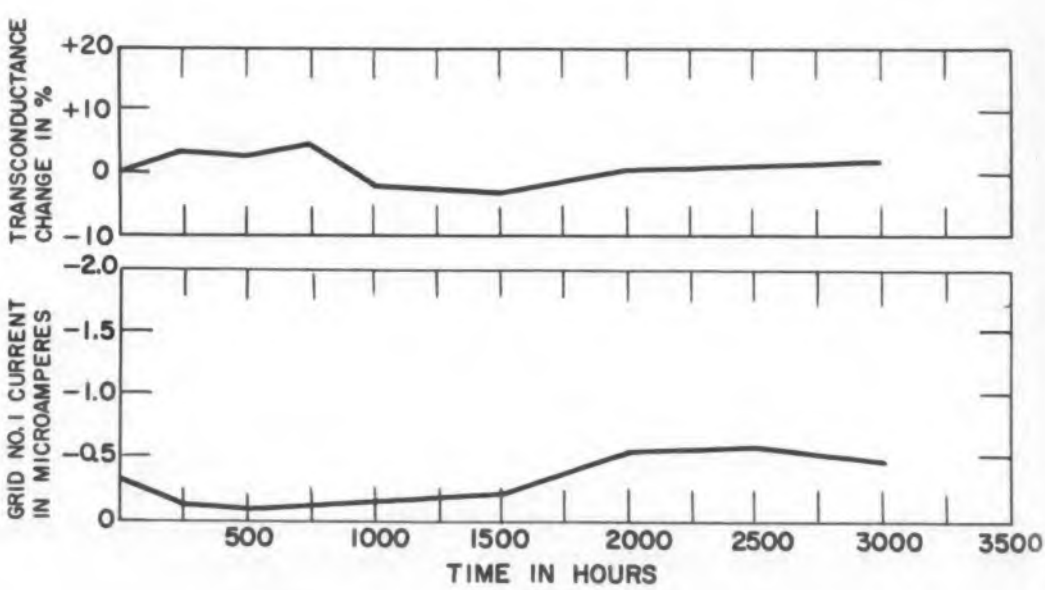

Fig. 6. Room temperature life tests.

of the information gleaned from literature indicating Ceralloy (or Ceto) as the best getter for this application. The Ceralloy getter, when properly manufactured and processed shows great promise. Tests of a good lot of this getter showed that 1500 liter microns could be gettered in a matter of minutes in the temperature range from 300 C to 700 C. Some gettering, at the slower rate, was observed at temperatures down to 100 C.

The Ceralloy getter is either sprayed on various element surfaces or sprayed onto a metal flag which is welded in a strategic place in the tube. The minimum 100 C for gettering has been found to exist in tubes due to radiation from the cathode alone.

Due to the opaque nature of the subject tubes, exact variations of cathode temperature due to changes in ambient temperature have been difficult to measure. Fig. 4 shows within reasonable experimental error the variation of cathode temperature with both ambient and bulb temperatures. In the case of the ambient temperature, measurements were made midway in the 1/8 in. clearance between the tube envelope and an enclosing oven, opposite a point roughly midway between the bulb hot spot and the dome of the envelope.

The variation in cathode temperature is lower than was expected. However, at the 400 C ambient, the external anode is not appreciably hotter than the vacuum and glass insulated internal anode of a conventional glass tube when operated at full dissipation in a room temperature ambient. This fact permits high ambient rating without heater power derating.

Tubes of the type described herein have been operated for several thousand hours at room temperature ambient and up to 200 hours at ambients in excess of 400 C. Several tubes have been operated at —60 C for 100 hours. Curves of various characteristics for the high temperature and room temperature life tests are shown in Fig. 5.

The room temperature data is averaged for 14 tubes in the group which were tested to 3000 hours. Much larger groups were tested to the 1000 hour point and removed to provide space for succeeding groups. This additional data in the majority of cases merely confirms the 1000 hour data shown (Fig. 6).

The high temperature data is provided for 172 hours. The equipment required for this test is fairly involved and at the time of writing is limited to engineering test quantities. Gas current readings throughout the test remained below 0.2 microamperes which was characteristic of high temperature life tests run for short periods.

From a paper presented at the 1957 National Conference on Aeronautical Electronics, Dayton, Ohio.

Design Forum

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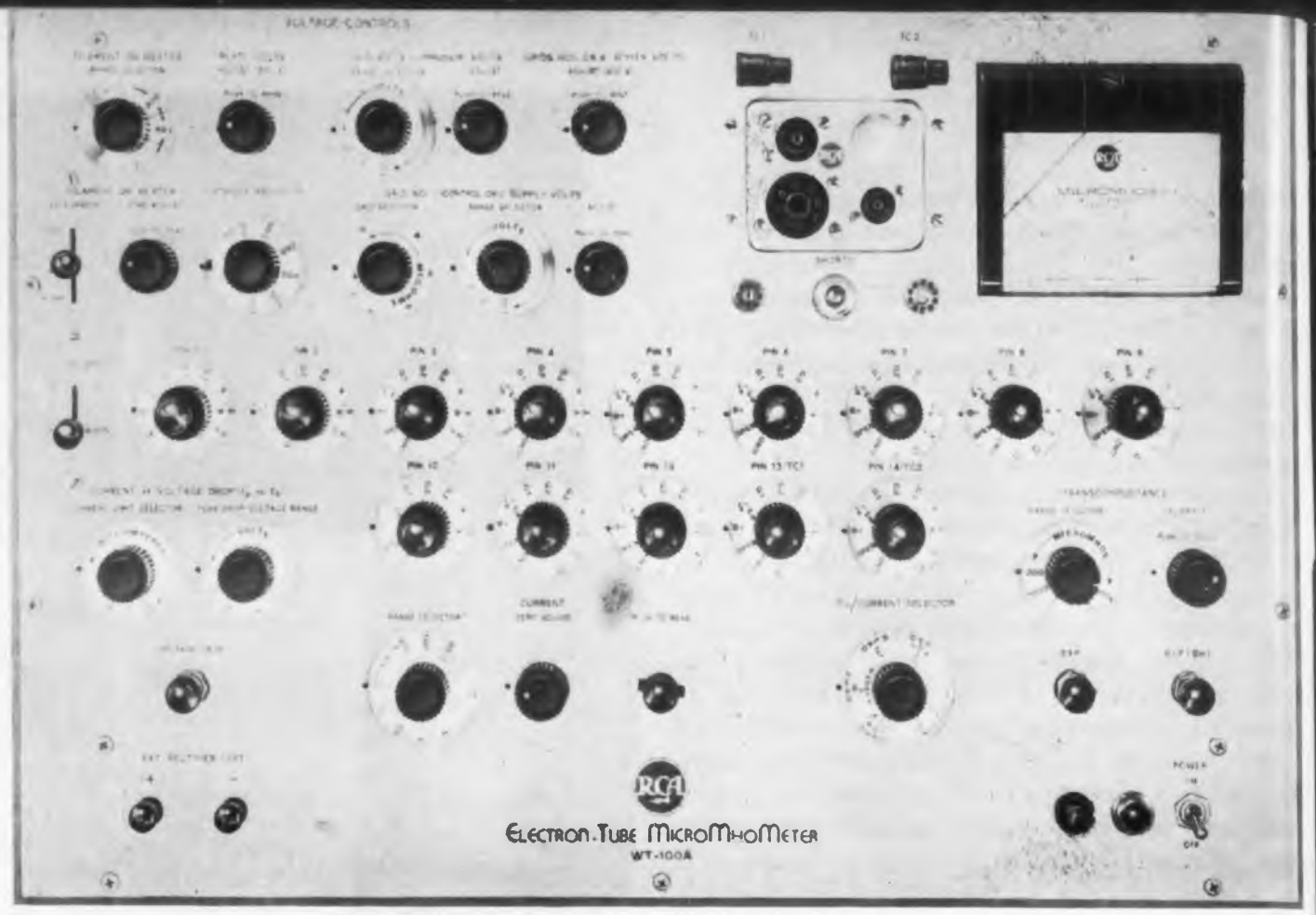


This tube tester offers many possibilities to the circuit designer because it doubles as a circuit simulator.

Realistic Tube Testing

J. M. Lowery
Components Div.
Radio Corporation of America
Camden, N. J.

A VACUUM tube is an adaptable component. It is not restricted to one particular plate voltage or only one value of grid bias. It can be used at many different operating points by correctly varying the voltage and impedance applied to the tube electrodes. Theoretically the number of useable operating points that are possible for a particular tube approaches infinity.

A measure of the worth of a tube tester is the extent to which it will duplicate intended tube application and the accuracy with which it measures tube variables in this application. For the technician, a test instrument which rates a tube as either good or bad might be acceptable; for the design engineer, a tube tester should indicate *how* good or *how* bad the tube performs when it is subjected to the conditions of his circuit. The RCA WT-100A was designed to permit this kind of testing.

As often happens when designing new equipment, features result beyond those originally desired which add greatly to the value of the equipment. An interesting advantage which resulted from the design used in the WT-100A is its ability to be used as an experimental test circuit. Rather than laboriously calculating the effect on tube characteristics caused by changing the impedance at one of the electrodes, the engineer can insert the tube in the tester, duplicate the desired conditions, and read changes in voltage, current, and transconductance directly from a meter. Results are easily obtained and in many cases more accurate than data obtained from a graphical solution of tube characteristic curves.

Measurements Needed

Tube characteristics which should be measured include not only "true" grid-plate transconductance, but also peak-emission capabilities of the cathode, grid voltage required for cutoff, and in many cases, grid-current characteristics. With a multigrid tube, it is often necessary to determine the transconductance between plate and suppressor grid and plate and control grid. To determine the quality of a rectifier tube it is necessary to measure the internal voltage drop at an anode current proportional to the anticipated peak current through the tube. A tester which shows the emission current at some arbitrary anode voltage does not give a true picture of the tube's quality.

Transconductance Tests

Perhaps the most important single test for a large percentage of tube types is a transconductance measurement. To measure "true" transconductance, a small ac signal is applied to the control electrode of the tube and appropriate dc voltages to the other electrodes. The resulting ac current in the plate circuit is a measure of tube transconductance. All dc supply voltages are well regulated and require no readjustment to compensate for the effects of tube loading. Metering facilities are provided to permit the test circuit to be set up at precisely the desired operating point.

For maximum accuracy on transconductance measurements, internal impedance of test instrument power supplies should be small compared

with the plate resistance of the tube under test. Some present tube types have plate resistances as low as 125 ohms. To handle these tubes, power supplies in the WT-100A were designed with extremely low internal impedance.

A block diagram of the transconductance-measuring circuit is shown in Fig. 1. A relatively high signal frequency (45 kc) is used to eliminate errors due to power-supply ripple and hum. The oscillator output is applied to a voltage divider R_1R_2 and to the grid of the tube under test. R_1, R_2, and R_L are precision resistors. For each measurement range, R_L is equal to R_2, and R_1 is chosen so that a full-scale meter reading will equal the conductance, $1/(R_1 + R_2)$. When oscillator output is adjusted to produce full-scale deflection of the meter with switch S in the CALIBRATE position, the measurement circuit is calibrated in terms of an accurately known current-voltage ratio I_{R2}/E_{R2}.

The meter is preceded by a low-noise, high-gain preamplifier designed to produce full-scale deflection with an input of 0.025 v. During the measurement operation, the preamplifier is connected across R_L and the oscillator signal voltage applied to the grid of the tube under test. If the ac signal current produces a voltage of 0.025 v across R_L, the tube under test has a transconductance equal to the full-scale value for that particular range of the meter. If less than 0.025 v appears across R_L, the measured value of transconductance will be proportionately less than the full-scale value. Six separate transconductance ranges are provided to permit accurate, easy meter reading. Since the meter is calibrated with the same oscillator output applied to the grid of the tube under test, accuracy of meter readings is independent of the oscillator, the preamplifier, and except for extreme cases, the tube under test.

Circuit design and the components employed in the oscillator and transconductance preamplifier allow for large variations in the characteristics of tubes tested with the WT-100A. The transconductance preamplifier has a substantially flat response from 15 kc to well beyond 100 kc and provides more than a 50 db attenuation for frequencies below 10 kc. Consequently, the oscillator output frequency is not critical. Important considerations in the design of the oscillator were a substantially pure sine-wave output and a low output impedance. These requirements are achieved with a high-Q tank circuit.

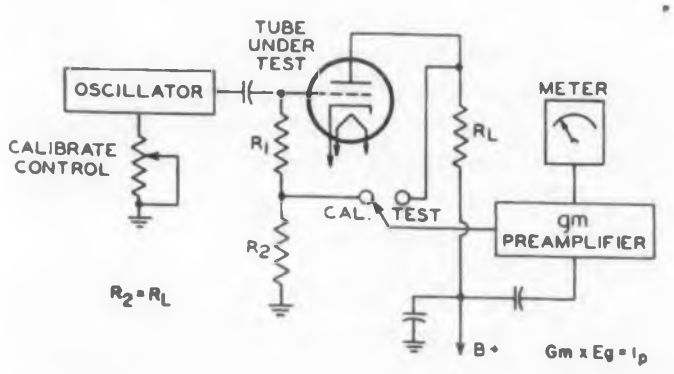


Fig. 1. Transconductance measuring circuit. Variations in oscillator or preamplifier components do not affect tube test accuracy.

In the case of tube types having more than one signal grid, it is often necessary to measure the transconductance between each signal grid and the plate. The WT-100A has facilities for supplying the appropriate dc voltage to each grid and switching the ac signal from one signal grid to the other for the different measurements. This feature also permits rapid measurements on multiunit tubes.

Electrode Currents

Another test which is an important consideration in the evaluation of tube performance is current measurement. Facilities are provided to measure plate, screen, suppressor, and control grid currents from 3 μa to 300 ma full scale. Minute gas currents, interelectrode leakage, and reverse grid current can be accurately measured on the lower ranges. High peak currents of rectifiers and tubes used in deflection amplifiers can be accurately measured on the higher scales.

The ability of a multigrid power tube to carry high peak plate current at low plate voltage is an important factor in determining its usefulness for deflection-amplifier service. The optimum place for making this measurement is usually the point at which the chosen grid-No. 1-voltage curve levels off for a given grid-No. 2 voltage, (Fig. 2). This point at which the grid-No. 1 curve terminates its rise from the zero-plate-current point is called the "knee," and is rather sharply defined. Because measurements at the "knee" usually involve very high currents, they should be made on a short-duty-cycle basis to avoid tube damage.

The circuit used for dc electrode-current measurements is shown in Fig. 3. For current measurements, the meter is driven by a push-pull cathode-coupled differential amplifier which produces full-scale deflection with an input of 0.5 v. The 3-megohm series resistor in the grid circuit serves a double purpose: it protects the amplifier tube from damage if excessive voltage is accidentally applied to the input circuit, and it prevents the tube from being driven into the positive-grid region, thus limiting the maximum plate current to a value well within the capacity of the meter. A large amount of negative feedback is employed in the amplifier to assure good linearity. The balanced bridge circuit helps to minimize the effects of line-voltage fluctuations on the accuracy of current measurements.

Voltage Drop

Vacuum tube power rectifiers are evaluated by measuring the voltage drop across the tube at chosen values of plate current. Because the tube is

switched abruptly from cutoff to full conduction in such measurements, sufficient resistance must be used in series with the plate to assure that the resulting current surge will not damage the tube or test circuit. The value of this current-limiting resistance should be based on the maximum current that would flow if the device under test were suddenly short-circuited. Voltage-drop curves are usually furnished in the technical data for vacuum-tube rectifiers. The range of resistances available in the tester is adequate to handle currents ranging from a few milliamperes to several hundred milliamperes.

Shorts or Leakage Tests

Interelectrode leakage and shorts are among the most troublesome failures in tube testing. Under JAN-1A and MIL-E-1B specifications, leakage currents as low as 1 μa or less are considered significant.

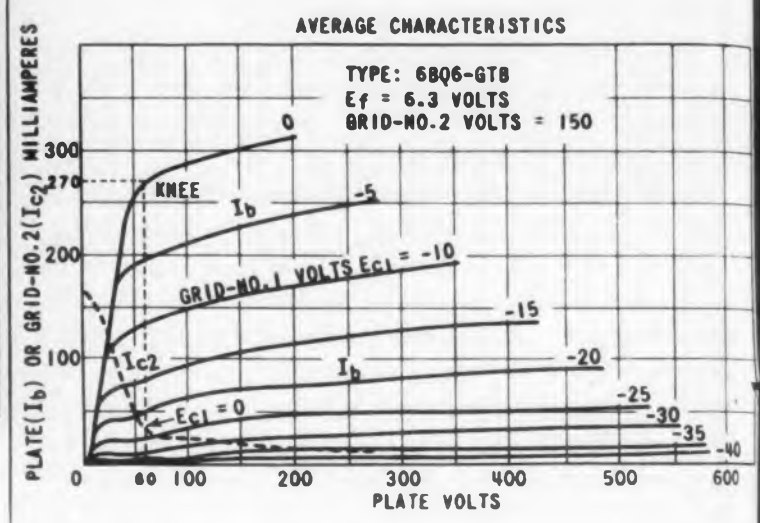


Fig. 3. (right) Push-pull amplifier used for current measurements. The 3.3 megohm grid resistor prevents both the test meter and the 12AU7 from being overdriven.

Interelectrode shorts, filament continuity, and the continuity of internal jumpers are determined by means of neon-lamp tests. Sufficient series resistance is provided in the neon-lamp leakage-test circuits to protect delicate grid structures from damage by the surge currents which flow when a neon lamp fires. In addition, the actual leakage current value between any two elements or combination of elements can be measured. These tests will also indicate leakage resistances up to several megohms.

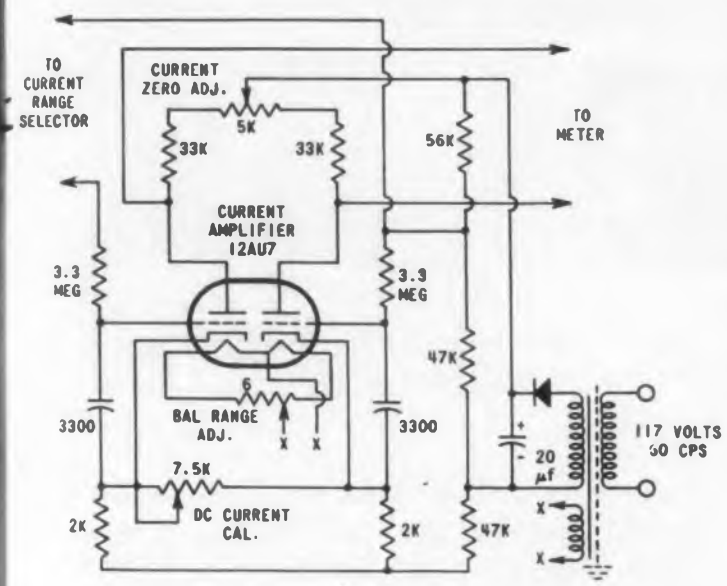
Gas Tubes

Performance of glow-discharge (cold-cathode) tubes used in voltage-regulator service may be predicted with considerable accuracy from measurements made with the WT-100A. These measurements include breakdown or ionization voltage,

voltage drop at the regulating point, and the effect of variations in the regulating current over the permissible range of operation. In evaluating tubes from such measurements, consideration should be given to the operating conditions at which the tube was used prior to testing, ambient temperature of the tube application, and the test conditions. All of these factors have a direct bearing on the final regulation point. For best results, the proposed circuit conditions should be simulated as closely as possible, using the current of the intended tube circuit to determine the regulation point.

Thyratrons can be tested in a manner similar to that used for voltage-regulator tubes. The critical grid-No. 1 voltage of a thyratron at a given anode voltage can be determined by operating the tube first with a high negative grid voltage, and then reducing this voltage until the tube fires. Because a

Fig. 2. (left) Ability of a power tube to carry high peak plate current is measured at the "knee" of the curve.



thyratron normally draws a small amount of grid current, the firing point is dependent on the grid-circuit resistance as well as the grid voltage. Both anode voltage and grid-circuit resistance of the proposed circuit should, therefore, be considered in these tests. Anode breakdown voltage is another significant factor in evaluation of thyratrons. It is measured with the control grid tied to the cathode.

Test Meter

A single high-quality meter with two linear scales (0 to 3 and 0 to 10) and three unit markings—micromhos, volts, and amperes—provides all 72 different measurements which can be made with the tester. The two linear scales are uncluttered and permit easy reading and determination of all values. The 100-μa movement of the meter has a fundamental accuracy of 1 per cent and a tracking error of not more than 1 per cent. Until the button for the desired function is depressed, the meter is completely disconnected from all circuits.

Supply Voltages

All ac and dc power supplies are continuously adjustable over their full operating ranges. The dc plate, grid-No. 2 (screen-grid), grid-No. 3 (suppressor-grid), and grid-No. 1 (control-grid) supplies are adequately regulated to minimize the effect of changes in line voltage and load conditions. Maximum current limits of 300 ma for the plate supply and 30 ma for the grid-No. 2 supply will satisfy all conventional test requirements.

Controls

Specially designed dual controls consisting of concentrically mounted switches and potentiometers permit simultaneous adjustment and measurement of all electrode voltages. Rotation of a control while it is pressed down adjusts the corresponding electrode voltage to the value indicated on the meter. This design permits a clear indication of the particular voltage or current on the meter. However, except for filament voltage, no voltage is actually applied to the tube under test until the GM, GM-CALIBRATE, CURRENT, or VOLTAGE-DROP buttons are pressed.

A single, clearly labeled function-selector switch automatically sets up the proper internal circuits for both transconductance and dc electrode-current measurements. When set for plate or grid-current measurement, the switch automatically removes the transconductance test signal from the tube. The range-selector switches for transconductance and current measurements are designed so that all multiplier or shunt resistors not actually in use are removed from the circuit.

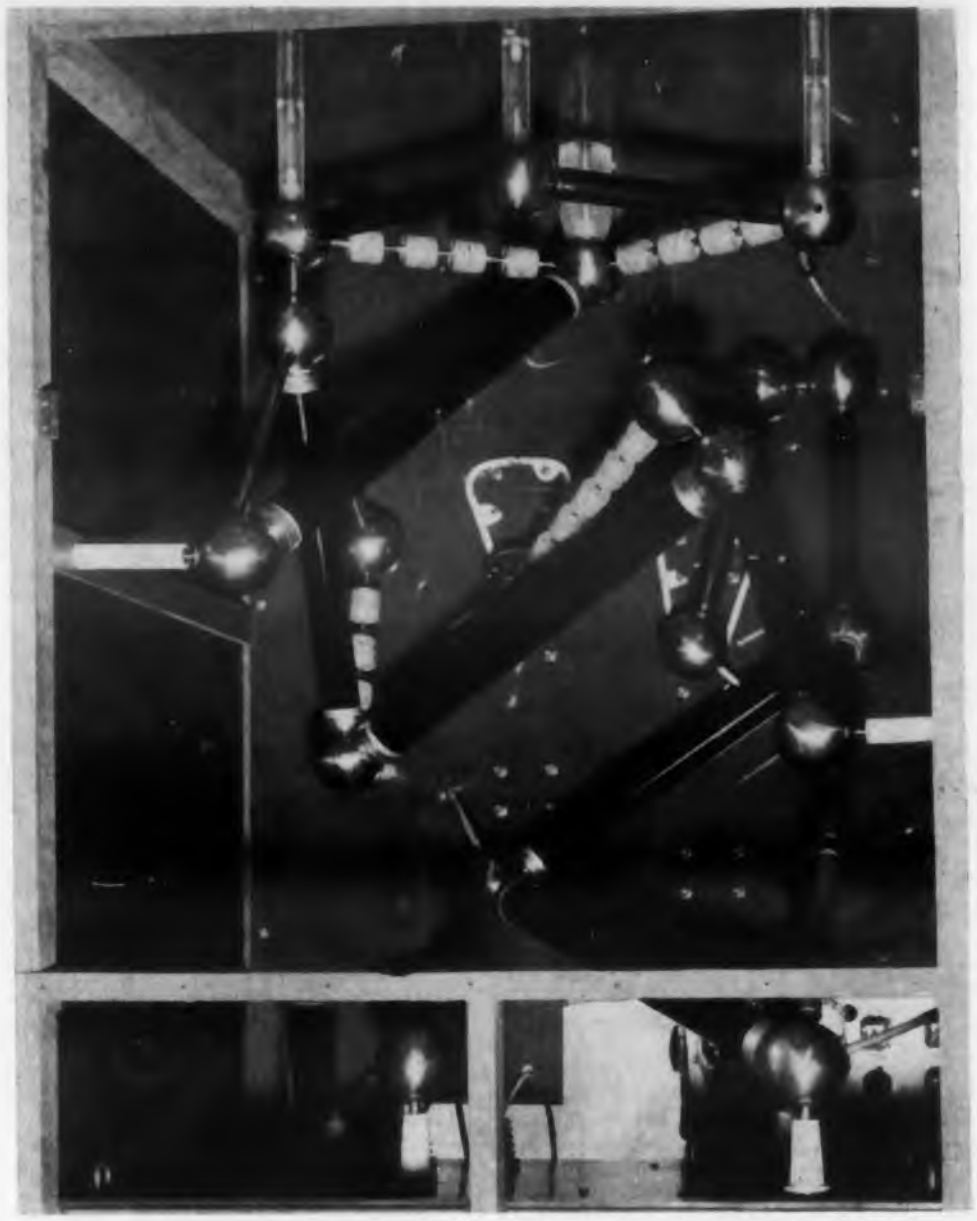
Connections and Switches

The pin-switching system is designed to accommodate up to 14 base-pin connections, and is flexible enough to meet a wide variety of test conditions. Multiple-socket adapter units are provided which can accommodate up to 14 base-pin connections. Each tube element can be connected to any of the available voltage sources, open-circuited, grounded, or paralleled with any other element. In addition, any two separate elements can be brought out to external connections. A tube which uses an irregular input signal can be more realistically tested by using one of these external connections to supply the ac test signal. Any element can be polarized negatively or positively and checked for leakage to other elements or ground. All measurement circuits are mechanically or electrically interlocked through the switching system so that meter burnout is virtually impossible.

Designing a Wide Range Spark Gap Switch

T. R. Nisbet
Alto Scientific Co., Inc.
Palo Alto, Calif.

The ability of a spark gap to act as a high voltage, high current switch makes it a useful overload protection device. Its fast action—typically 0.1 μsec and its lack of moving parts are among its attractive properties; but ranking high among the demerits of the spark gap is its limited voltage range. Here are design procedures to ensure that a gap hold off the highest operating voltage in a circuit without spontaneously firing, and at the same time will not fail to fire at the lowest operating voltage.



Spark gap circuitry uses 30 in. ribbon-type resistors and anti corona spheres that are 5 in. diam. Three dimensional configuration enables critical spacings to be maintained in a minimum cabinet volume.

IN THE more sophisticated spark gap, high voltages to ground may exist simultaneously with a lower limit voltage between adjacent electrodes. If three electrodes are supplied with voltage and arranged as in fig. 1, a theoretical maximum voltage range of 3 to 1 is possible. With a two to one voltage division between the two gaps, the application of a trigger pulse will cause first the lower, and immediately after it the upper, gap to break down, creating a low resistance path through the gaps to discharge the hv supply. At any voltage higher than 9 kv, the gaps of fig. 1 would break down spontaneously; at any voltage lower than 3 kv, neither gap would break down when triggered. In this example, no safety factors have been included.

One artifice which can sometimes be used to advantage is the inclusion of a small starter gap within an electrode, as shown in fig. 2. The small gap breaks down first, and the presence of ions and/or ultraviolet light facilitates the breakdown of the main gap. Unfortunately this phenomenon does not lend itself to easy prediction, and though the gap breakdown voltage is probably decreased by it, the size of the decrease may only be a few per cent. Since it is always important to have g_1 (the gap between *0* and *1*) fire before g_2, it is helpful, though not essential unless operation is to be in total darkness, to insert a starter gap in the trigger electrode, facing g_1.

Wide Range Spark Gaps

To achieve a range of operation substantially beyond 3 to 1, a multi-electrode arrangement with a bias voltage applied to one of the electrodes must be used. The electrodes are arranged as in fig. 3, and the bias voltage is selected so that the voltage of the hv supply may be varied either below or above the bias voltage, without causing the chain of gaps to fire spontaneously.

The application of a trigger pulse causes g_1 to break down, resulting in an increased stress across g_2, which breaks down and allows the bias supply to discharge through the two gaps. A resistance in series with the bias electrode spreads the duration of this discharge over a discrete period, during which the path through g_2 and g_1 remains conducting, while electrode *3* is almost at the same potential as electrode *0*.

For operation at the high limit of voltage, a similar series of steps takes place as g_4, g_5, etc., fire in rapid succession, until, with the last breakdown, the hv supply is discharged through the conducting path of the series of gaps.

When the supply voltage is at the low limit of operation, the gradient in the upper gaps is of the opposite polarity; measured with reference to electrode *0* before firing the dc voltage at *3* is less than that at 2. When g_1 and g_2 fire, however, the instantaneous voltage at *2* becomes almost zero, while *3* is held at its dc value by the use of capacitors (not shown in fig. 3).

In this way the dc potential which formerly

existed between 3 and 0 is applied across g_3, causing it to break down. Similarly, the subsequent gaps are fired in succession until the entire series of gaps is ignited. The whole operation occurs within a fraction of a microsecond.

Capacitive Attenuation

Since gap capacitances affect operation at the low voltage limit these should not be overlooked for a successful design. Consider the case where the gap capacitance of g_3 is 10 μμf, and electrode 3 is held to the hv line by an external 100 μμf capacitor. At the low limit of operation, 2 is at 70 kv, while 3 is at 40 kv. When g_1 and g_2 have fired, 2 is at zero, resulting—it would seem—in 40 kv being applied across g_3. However, the change in voltage, 70 kv, is in effect applied across a capacitive divider of 10 μμf in series with 100 μμf, so that only 33.6 kv is available instead of 40 kv to break down g_3.

Reduction of stray capacitances is therefore of importance. Inevitably, some capacitance remains. This can be allowed for in the final design by reducing the breakdown voltage of each of the upper gaps by the amount of the capacitive loss (6.4 kv in the example). This means a departure from the general principle that each gap is stressed to the same percentage of its breakdown voltage at the limits of operation.

Design Principles

In the design of a complex spark gap, the first step is the selection of the two safety factors, k_1 and k_2, which can be regarded as the undervoltage factor and the overvoltage factor respectively. The former is always less than unity, the

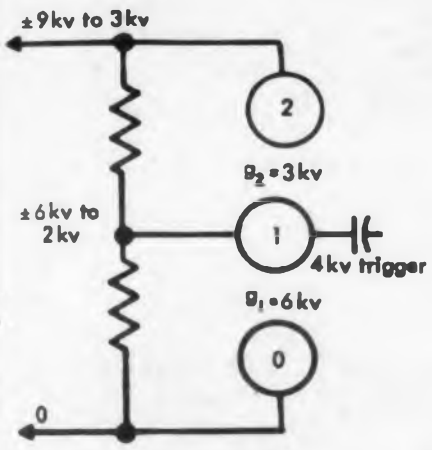


Fig. 1. Spark gap configuration with three electrodes. Breakdown voltage of gap between 0 and 1 must be 6 kv minimum. Three kv is necessary between 1 and 2.

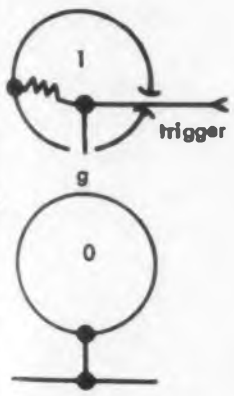


Fig. 2. Starter gap installed in the trigger electrode increases likelihood of g_1 firing before other gaps. Facilitation of gap breakdown is attributed to presence of ions and/or μv light.

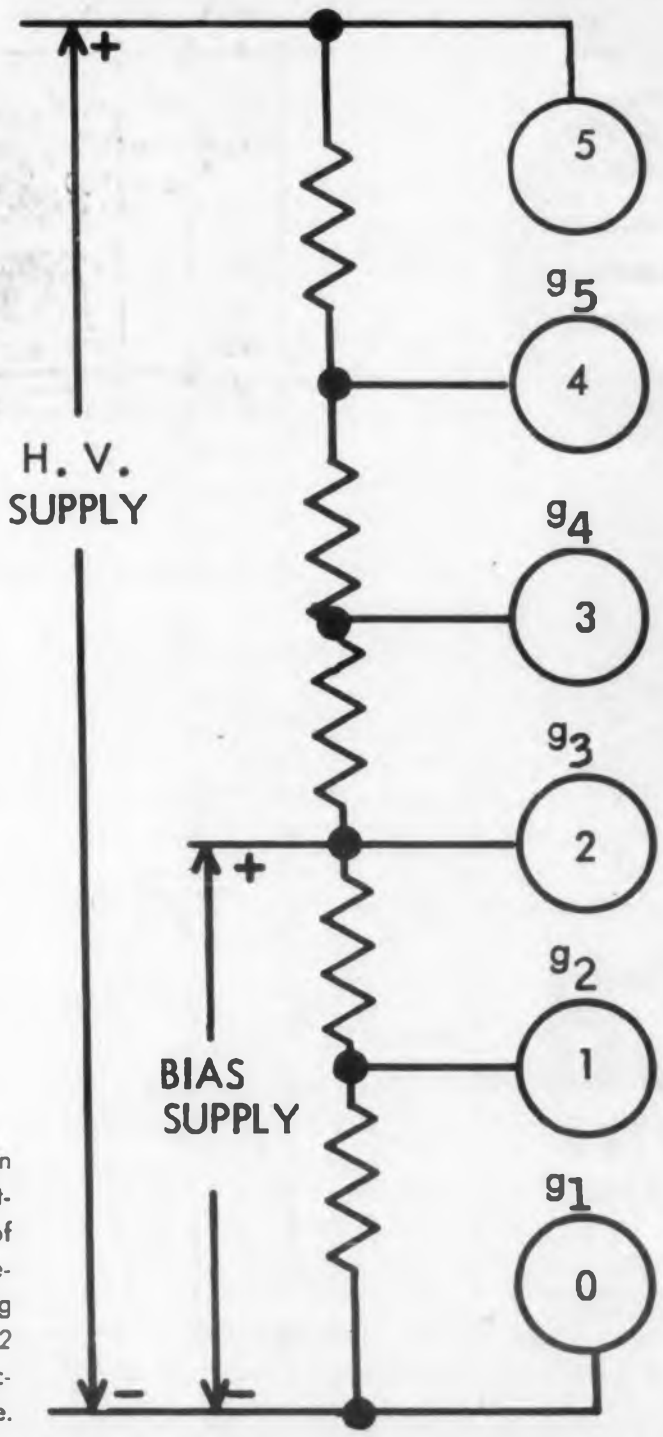


Fig. 3. Bias voltage in this configuration is selected to permit variation of the hv supply above or below the bias without firing through gaps. Electrode 2 is biased in the same direction as the supply voltage.

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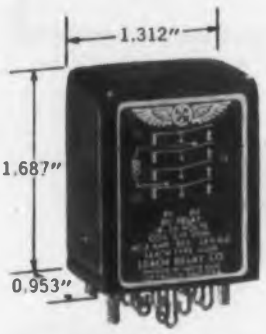

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latter always more than unity, being defined as follows:

- k_1 = *voltage to be held off without firing any gap/breakdown voltage of the gap,*
- k_2 = *voltage applied to any gap to insure firing/breakdown voltage of the gap.*

The nature of the application—whether and to what extent it is equally undesirable that the chain of gaps should fail without being triggered—influences the choice of safety factors. Typical values are 0.8 and 1.2.

The bias voltage is basically the arithmetic mean of the high and low voltage limits of operation, but both technical and economic considerations may dictate a departure from this level. When the hv supply is at a lower voltage than the bias, there is some current drain from the bias supply through the resistive chain to the hv supply. This should be allowed for in designing

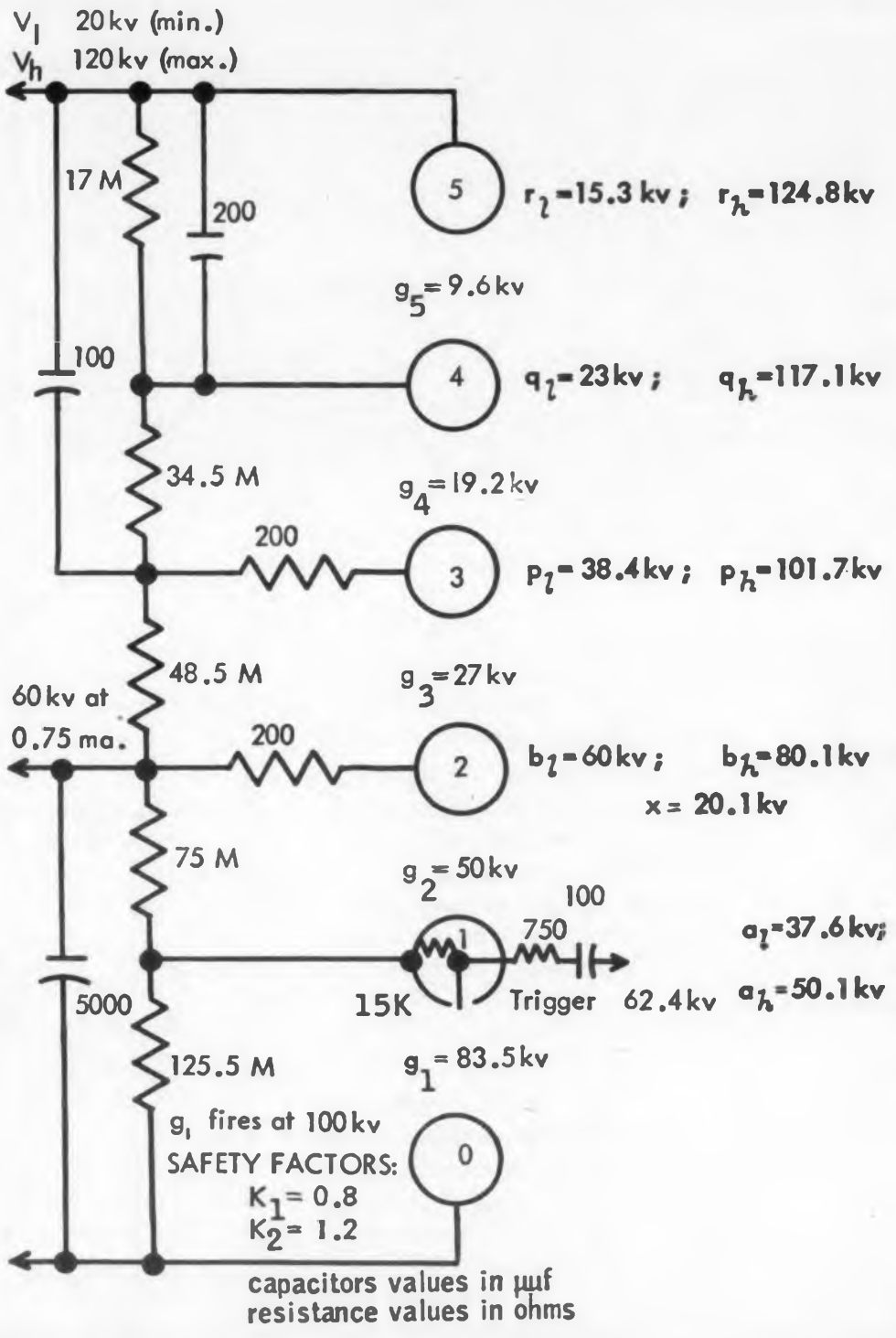


Fig. 4. Gap circuitry, showing high and low voltages at each electrode, and resistive chain values. Capacitive attenuation amounting to 6 kv has been allowed for at g_5. The rise in effective bias level, 20.1 kv, is considerably below the maximum, which would have meant a bias level rising from 50 kv to 90 kv.

the bias power supply. When the hv supply is at a much higher voltage than the bias, the bias supply may well be delivering no current at all, and the voltage at all the electrodes will then be determined entirely by the values of the various resistance chains used.

The optimum design from a gap voltage standpoint, however, may imply some objectionally high voltage stresses in the bias supply components, and in such cases theory should be tempered with economics. Increasing the bias supply voltage permits the use of a smaller maximum rise in bias level, and the cost of the former may be quite trivial by comparison with the cost, for example, of insulating the bias rectifier filament transformer to withstand the higher voltage.

An interesting similarity exists between the increase in bias level in a complex gap and the increase in supply voltage in a simple gap. With safety factors excluded, the theoretical maximum voltage range occurs when the change from low to high limit of supply voltage causes the effective bias level to rise in the ratio 1 to 3—which is the same as the maximum voltage range of the arrangement of fig. 1.

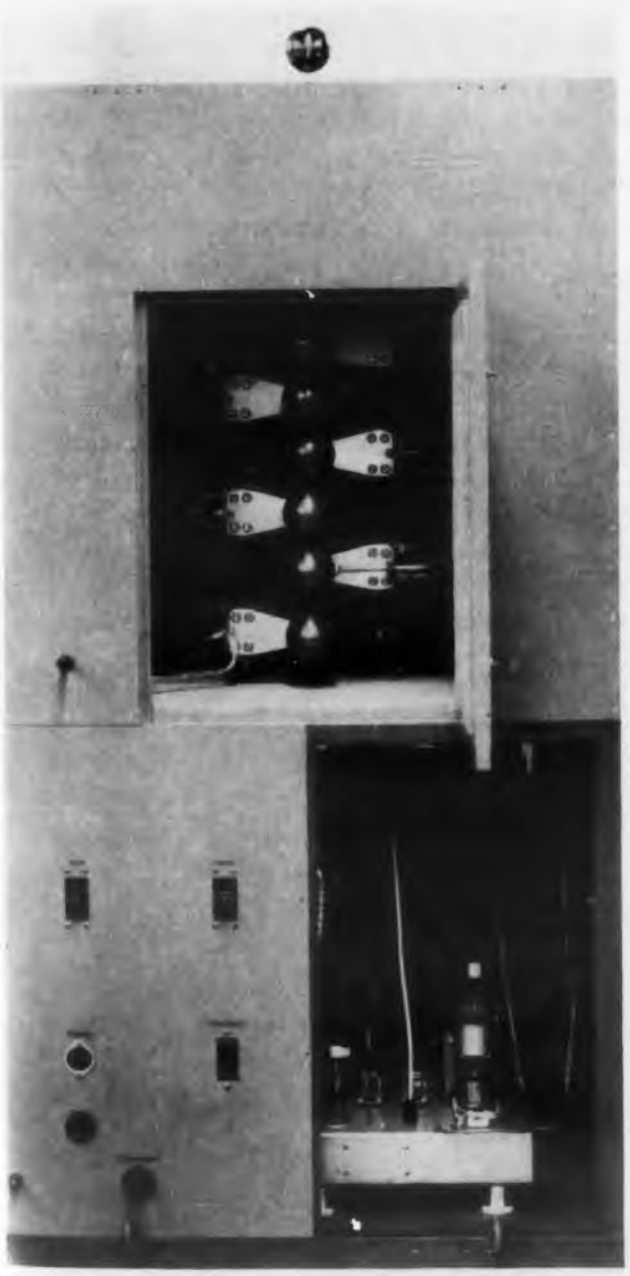


Fig. 5. Spark gap and trigger generator. Enclosure is dust free and sound proofed. The noise of a 7 μf capacitor discharging through the gap is about as loud as a revolver shot.

Design Procedure

(See Fig. 4)

- Select values for k_1 and k_2 (e.g. 0.8 and 1.2).
- $b_l = (V_h + V_l)/2 + [(k_1 + k_2)/k_2^2]\,[k_1 - k_2 + 2k_1k_2/(k_1 + k_2)]$

where b_l is the lower limit supply voltage at electrode 2, referred to electrode 0, and V_h and V_l are the high and low limits of the supply voltage.

- $x = b_l\,[(k_1 + k_2)/k_2^2]\,[k_1 - k_2 + 2k_1k_2/(k_1 + k_2)]$

where x is the rise in bias volts due to the change from V_l to V_h. The above value need not be used for x so long as b_l is increased by n volts while x is reduced by $2n$ volts. [In Fig. 4, b_l is increased approximately 10 v.]

- $g_1 = b_l\,[(k_1 + k_2)/k_2^2]$
- $g_2 = b_l/k_2$
- $a_l = b_l\,[g_1/(g_2 + g_1)]$; $a_h = (b_l + r)\,[g_1/(g_2 + g_1)]$

where a_l and a_h are the low and high supply voltage conditions, respectively, obtaining at electrode 1, with reference to 0.

- $g_3 = (b_l - A_{cg3})/(k_1 + k_2)$,

where A_{cg3} is the attenuation or loss of voltage due to capacitive effect of g_3. Similarly for A_{cg4}, etc.

- $p_l = b_l - k_1g_3$, p_l being the lower limit voltage at electrode 3.
- $g_4 = (p_l - A_{cg4})/(k_1 + k_2)$,
- $q_l = p_l - k_1g_4$, where q_l is the voltage at 4.
- For the lower limit voltage at 5 and g_5, etc. follow as for q_l, g_4.
- When one of the voltages, q_l, r_l, etc. reaches V_l, this determines the number of electrodes required. Estimate the reduction in volts due to the capacitance effect and repeat from the second step, using these values for A_{cg3}, A_{cg4}, etc. If, for example, r_l is the lowest voltage required, then $V_l = r_l$ and $V_h = 2b_l + x - V_l = r_h$.
- $ph = 2b_l + x - b_l$
  $q_h = 2b_l + x - q_l$
  $r_h = 2b_l + x - r_l$.
- Voltage at 2 at which g_1 fires $= k_2g_1$. The trigger amplitude required is $k_2g_1 - a_l$ plus the allowance for capacitive losses.
- From b_l and x, determine values of the resistive chains.

For a tabulation of spark gap breakdown voltages for different radius spheres at varying temperatures and pressures, consult *Reference Data for Radio Engineers*, 4th Edition, International Telephone and Telegraph Corp.

Design Ideas Wanted

More than 300 technical puzzles as yet unsolved by military research teams are presented to professional and amateur inventors for analysis and solution. Answers to these problems can be of vital significance to the defense of the United States.

In the following paragraphs some inventions or ideas that are needed by the Armed Forces in the electronics field are listed.

1. Problems submitted should be on separate documents, typewritten, if possible. Submitters should retain copies of each item presented, since Government regulations do not permit the return of material once it has been received and reviewed.
2. Descriptions should be as complete as possible and should include principles underlying the invention, the discussion of any experimental work or tests conducted, the points of novelty or superiority of the invention, as well as supplementary sketches or drawings.
3. Address correspondence to: The National Inventors Council, U.S. Department of Commerce, Washington 25, D.C.

Notes—This problem list is not issued in an attempt to locate firms or organizations interested in obtaining development contracts, as the Council's work does not include assistance of this type.

Emergency power system. Instantly available power and/or stabilization system to maintain minimum flight control and to affect the safe landing of single engine ducted fan aircraft.

Miniature chemical batteries. Batteries should be as small and light as possible, require little or no effort to put them in operation, keep indefinitely in storage whether at low temperatures or high temperatures, and provide relatively even service life over range of temperatures from —100 F to 160 F.

Microwave filters. Extremely sharp cutoff selective filters for the microwave region in the L-Band or X-Band. Their purpose would be to increase the accuracy or reflection of Doppler systems by increasing signals and noise ratio.

Transistors. Transistors which operate satisfactorily in the high frequency vhf or uhf regions at temperatures well in excess of 70 C. There is also a demand for transistors which will function at the various microwave frequencies.

Heat dissipation in electronic assemblies. The high incident temperatures in small electronic devices require a new means of cooling such devices other than the conventional means which require electrical energy and comparatively large cooling devices, such as blowers, fans, etc. A static device of material is needed to serve as a heat rectifier to provide unidirectional transfer of heat or unidirectional heat exchanger.

Broadband amplifier. An amplifier with high gain and bandwidth for frequencies up to and including uhf of light-weight, rugged and reliable design having relatively simple low-gain power supply requirements.

Frequency magnetic materials. Frequency sensitive magnetic material which would increase with frequency for use in chokes and transformers for electronic equipment.

Instrument rectifier. A low current instrument rectifier of 200 ma dc which will function properly from —60 to +160 F.

An all-weather fuse. A fuse that neither receives nor radiates electromagnetic or acoustical energy capable of initiating a projectile at a distance of from 3 to 30 feet from the ground. Performance should be independent of the condition or composition of the ground. It should be unimpaired by rain, snow, or other adverse weather conditions, and work equally well day or night.

Radio-proof blasting cap. An inexpensive and efficient electrical blasting cap which cannot be initiated by electromagnetic, radio or radar waves.

Infra-red sensors. Regular type infra-red sensors and heads which are unusually sensitive to several selected bands and frequencies rather than the entire infra-red spectrum.

Infra-red image device. A device capable of converting an infra-red image into a visible counterpart. It should have high sensitivity, fast response, and should be capable of operating at wave lengths as high as 14 microns.

Thermo generator. Improved techniques by which chemical, thermal, and nuclear energy may be converted to electrical energy with considerably greater efficiency than that of present thermal electric generators. This desired procedure should be suitable for incorporation into a simple device which could be made sufficiently rugged for field use. Electrical output should be obtainable at 6, 12, and 24 v with a capacity of 100 w. It should have a constant current output and good voltage regulation, it should be rugged and unaffected by atmospheric conditions, should be capable of operating from —65 to +185 F. The device should be light, compact and simple to operate.

Counter-counter measures. Several methods of jamming a radar set are successful in varying degrees. These include such methods as noise jamming, cw jamming, pulse jamming, chaff, spoofing, and artificial glint. Methods for combating these various jamming methods are needed.

Radar displays. Improvements in displaying radar data so that more accuracy and resolution are obtainable. Variable persistence cathode ray tubes would also be desirable if they can be affected simply.

Wind measuring equipment. An instrument for the measurement of surface wind speed and direction. This instrument is intended primarily for arctic and sub-arctic operation where icing and high winds preclude normal operation of standard anemometers of wind vanes. The equipment is to have no external moving parts and the external head must have small mast to minimize

ice and frost formation, and to permit purging by hot air electrical elements. Considerations may include investigation of multi open pitot static systems.

Absolute altitude device. Development of an accurate means of determining absolute altitude above terrain which would not require prior knowledge of the terrain altitude. This device is to be used in aircraft to maintain a constant absolute altitude.

Anoxia warning device. Indicating device that will warn imminent loss of consciousness of personnel in flight due to anoxia.

Underwater target detection. A means, other than sonic, is needed to determine direction and range to an underwater target.

Artillery orientation system. A system of orientation of artillery to a reference independent of line of sight, earth's magnetic field or earth's rotation with azimuth accuracy of 1/4 mil.

Destructive ray. Scope: equipment of usable size capable of producing destructive or death rays effective at 500 yards without excessive power input. Military Application: to augment conventional weapons.

Solid electrolyte battery. A solid ion conducting material which will function as the electrolyte of an electrochemical cell and which can be used in conjunction with an electrode couple having an EMF in excess of one volt. Such a cell should deliver a practical current density of 100 microamps per square centimeter or less between −40 and 165 F and have a long shelf life.

Method of heating dry batteries. Small lightweight equipment suitable for heating dry batteries so that full output can be obtained in regions where temperatures drop to −65 F. Military Application: for general use with battery operated communications equipment at low temperatures. Status: investigations and experiments have been conducted using heat tablets, sterno-type heaters, oxidation of thermophoric materials, activated charcoal blocks, and chemical heaters. None of these, to date, has resulted in a practical battery heating device suitable for military use in arctic regions.

Self-luminous material. Scope: luminous sheet material which will glow in the dark without external excitation for marking roadways, buildings, obstructions, personnel, etc. If radioactive,

Drawing by Chas. Addams, 1953 The New Yorker Magazine, Inc.

"Death ray, fiddlesticks! Why, it doesn't even slow them up."

Design Ideas Wanted (cont.)

the emitted radiation must be below tolerance level. It is essential that the sheet be fabricated from nontoxic materials. Brightness should be minimum of one "effective microlambert."

Trajectory data system. A ground-based trajectory measuring system for missiles which will provide accurate data in three dimensions almost simultaneously with the flight, with a time lag of no more than a small fraction of a second.

Microwave source. A microwave source in millimeter range which is capable of delivering watts of coherent radiation.

New energy source for firing rockets. A firing device with the following characteristics: four amperes; 15 ohm; 10 milliseconds; 20 pounds; must be used once per hour; must operate in temperatures from –65 to 180 F.

New tracking methods. A tracking method to determine the position of a test vehicle in space with extreme accuracy, in respect to a known reference coordinate system. The system should not be limited by weather and visibility. Available systems are of optical and electronic characteristics. The first is limited by requirement of illumination and slowness in obtaining data in usable form. The second is limited in accuracy of data.

Supersonic radome. Develop a supersonic radome with minimum aberration and reflection, immune to dust, rain, and ice erosion.

Wireless power transmission. The development of a technique whereby an appreciable amount of power (1000 watts) may be transmitted without the use of cables up to a distance of fifty miles. Techniques for accepting this power at the receiving end in a usable form are also required, of course.

Radiation indicating and measuring equipment. A convenient pocket size instrument should give continuous indication of radiation intensity and cumulative dosage using techniques not presently employed in commercial instruments. Military Application: general use by individuals potentially subject to radiation exposure.

Thermionic or cold emitter. Devise a thermionic emitter or cold emitter capable of greatly increased efficiency and suitable for use as a cathode in the usual thermionic electron tube.

Non-magnetic compass. A simple directional device capable of being carried by a foot-soldier which would determine true north within an accuracy of 5 mils, independent of the earth's magnetic field.

New type of communication. Scope: a revolutionary new method of transmitting intelligence. Military Application: to augment or replace present systems. Status: present systems in general

depend on electrical impulses, electromagnetic waves, sound waves, etc. A system utilizing completely new concepts is desired.

Visibility meter. Develop a meter for measuring visibility at any angle without requiring specific known sighting target (s). Any physical phenomena may be employed providing the resulting data can be equated to visibility indices.

New methods of converting light energy into electrical energy. New, efficient ways to convert light energy into electrical energy are needed. A number of approaches to this problem have been tried so far, and the most promising at the moment from the military standpoint is the Silicon Solar Converter. All present devices are costly and are limited to low power ranges of less than ten watts. So far, no efficient, cheap, compact converter of light to electrical energy has been developed in the 100 watt plus range. If such a converter could be invented, it would be of great value in military equipment using power. The converter should have a constant current output and good voltage regulation; it should be rugged and impervious to atmospheric conditions; it should operate satisfactorily in temperatures ranging from –65 to 185 F; and should be lightweight, small and simple to operate.

Resistors. Resistors in the range of one to 100 megohms must have positive temperature coefficients up to 100 parts per million per degree C for temperature compensation of specialized electronic circuits.

Winds in the stratosphere. A new technique should measure the wind speed and direction in the region 100,000 to 400,000 feet. Equipment is to be carried aloft in a small sounding rocket. Determination of the wind speed and direction is to be made during either the ascent or the descent of the rocket.

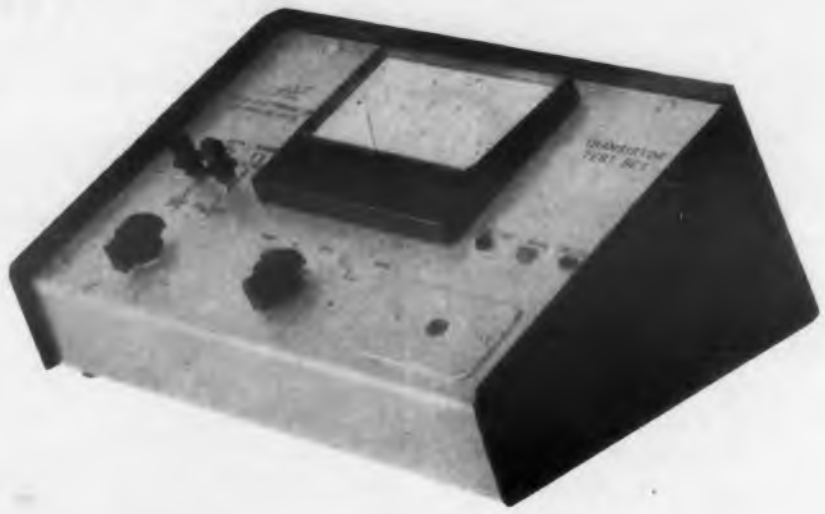
Electromagnetic radiation receiver. A device for receiving electromagnetic radiation in the 9-12 micron region which will have a response time of microseconds, and will operate within normal temperature ratings.

Multi-tube manometer. A compact multi-tube manometer readout system converting manometer fluid height into binary digital form capable of traversing a 120 in. range of readings in less than 5 seconds. The manometer is vertical (120 in. is the height of the tube), with 40 to 50 tubes in a bank. All tubes in a bank must be read with a resolution of 0.01 in. in less than 5 seconds.

Spark inclosed electric fork lift. A spark inclosed electric fork lift truck for handling ammunition. At present, when spark inclosed trucks are operated at low speeds, the resistance heats up excessively, presenting a safety hazard. Since the operation of trucks in ammunition handling calls for prolonged operation at low speeds, a different type of truck is needed.

Transistor Test Set

for Quick Quality Control



Calibrated to read I_{cbo}, I_{co}, and β, this transistor test set is designed to provide measurement of parameters which give a good picture of transistor performance. Characteristics can be measured at any level for circuit design purposes; testing procedure is simple for production line operation.

ONE figure of merit for a transistor, I_{cbo}, is tested with unusual ease and low cost with this compact transistor tester. Designed for rapid quality control testing, the device will measure I_{cbo}, β, and I_{co} of pnp and npn transistors to an accuracy of 3 per cent.

This transistor figure of merit, the static parameter, I_{cbo}, says Armour Electronics, 10800 Ventura Blvd., Los Angeles, Calif., manufacturers of the instrument, is a particularly desirable value to be measured, and though it is not presently a popular parameter, should soon see a revival of interest. Being a static value, and involving collector current leakage, emitter current resistance, transistor gain, base and emitter resistances, I_{cbo} is a reliable, *reproducible* value for matching transistors. Identified as the base current required to reduce the collector current to zero, I_{cbo} is measured in this instrument by applying voltages to base and collector emitters.

Base emitter voltage is applied in a negative sense and is increased until the collector current is driven to zero. The current change is established using the circuit shown in Fig. 1. The magnitude of I_{cbo} defines the point of Class B operation and the limit of Class C operation for the transistor, and provides the designer with a direct measure of circuit stability variations from transistor to transistor.

As an aid to transistor matching and evaluation, β and I_{co} are also measured. For β measurements the base emitter voltage is increased until the collector current reaches a set value. The meter shown in Fig. 2 is then switched to measure the base current. The meter is scaled to read β directly, and is used while operating in the linear region of the transistor's characteristic.

To determine I_{co}, 4.5 v battery voltage is applied between the collector and base with an open emitter circuit. The current flow through this circuit is the leakage collector current which would appear at the base emitter junction under normal operation of the test transistor.

The control panel, as shown in the photograph, is simple enough to make the test set useful in production testing. The instrument weighs 4.25 lb and measures 5 x 11 x 9 in. All power is derived from four mercury cells. I_{cbo} range is from 0 to 50 μa, β range is from 10 to 1000 in two steps and I_{co} ranges are from 0 to 50 and 0 to 500 μa. Instrument accuracy is 3 per cent; transistors can be matched to an accuracy of 2 per cent.

For further information on this transistor tester turn to the Reader Service Card and circle 38.

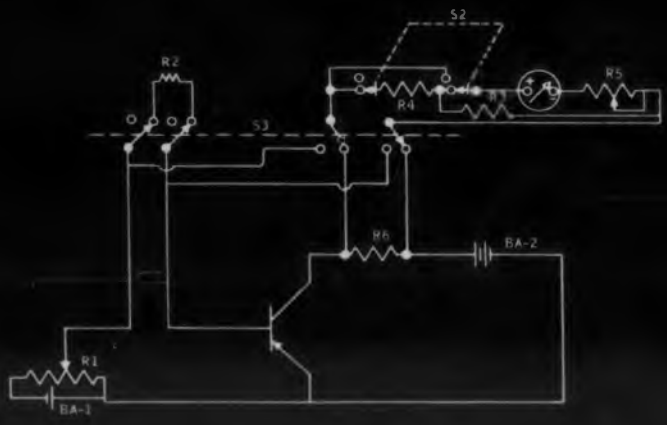
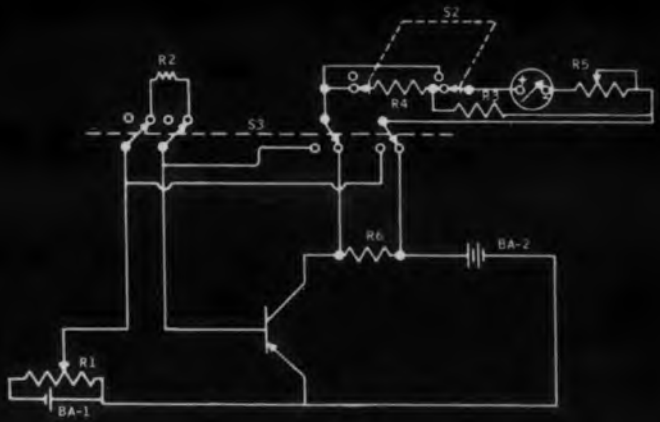
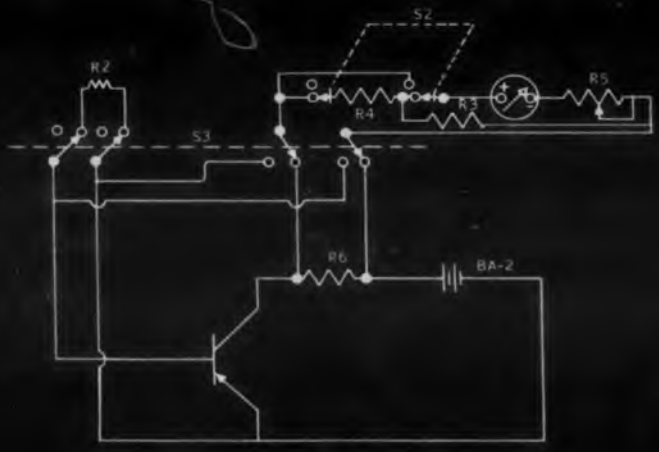


Fig. 1. Circuit for measurement of I_{cbo}. Backbiasing is increased until the collector current is zero. The current change measured by the meter is one figure of merit for the transistor.



(a)



(b)

Fig. 2(a) Circuit for β measurement, (b) Circuit for I_{cbo} measurement. The meter is scaled to read both values directly and for each operation is switched to maintain total circuit impedance. The circuit can be switched to measure npn transistors.

ENGINEERS!

THE JOY AIRCRAFT

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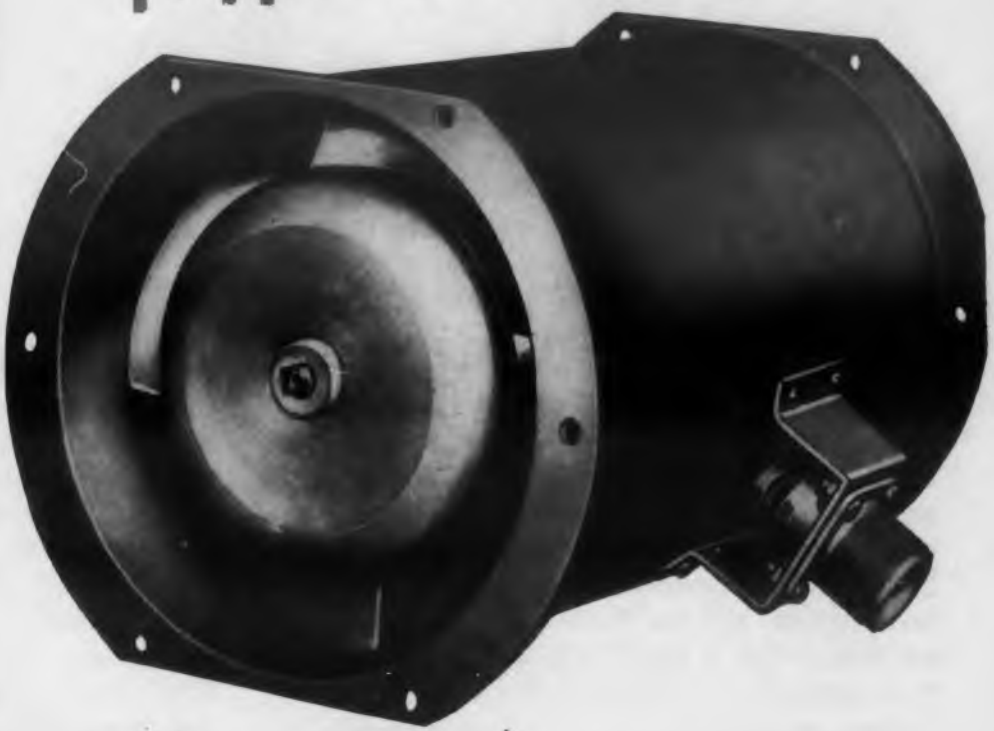

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CIRCLE 39 ON READER-SERVICE CARD

Meeting Report

Advances in Aeronautical Communications

"Technical team" approach discussed by Hoffman's prexy McLean (facing page) gets rapt attention

ALTHOUGH discussion of Sputnik and "Mutnik" took precedence over most everything else at the Third Aero-Com Symposium Nov. 6 and 7, much serious consideration was given to advancement of the communications art by the approximately 900 delegates. Sponsored by the IRE Professional Group on Communications Systems and the Rome-Utica IRE Section, this symposium is one of the largest and fastest growing meetings under Professional Group sponsorship.

Key Concern on Spectrum Utilization

The biggest communications problem discussed was that of squeezing more communication channels into the available frequency bands allocated to aeronautical communications. Various methods for accomplishing this purpose were proposed. Most are in the laboratory stage at present.

Westinghouse engineers, M. I. Jacob and John Mattern have worked on a time compressed single sideband system. This system makes use of time-sharing techniques which avoids many problems of a frequency multiplexed system. By digitizing essential speech or data information and employing compressor and expander units, more messages can be transmitted in a given time in the same spectrum. At Melpar, Inc. a speech bandwidth compression system has been developed which requires only 150 cps bandwidth to transmit. The system contains a speech analyzer which extracts from the acoustical speech signal six vocal analog control signals which are transmitted and reconstructed at the receiving end. This equipment (recordings of which were demonstrated) can synthesize speech surprisingly well. Further improvements are anticipated.

Dr. William L. Firestone, Chief Engineer of Motorola's Applied Research Department, talking on synchronous single sideband as a desirable approach to spectrum conservation, stated that the recent pressure on efficient spectrum utilization has brought single sideband to a high level of development. He stated his belief that single sideband will eventually win out for aeronautical communication. Basic requirements for successful systems, he said, include use of VHF and UHF bands presently assigned plus new higher frequency allocations; elimination of doppler effects (which is accomplished with synchronous SSB); provision of data call and tone signalling; and small size and light weight. Although a-m signals are subject more to ignition-type noise than f-m signals, Motorola's newly-developed noise blanker allows weak SSB a-m signals to be read when present-day f-m would be inaudible, according to Firestone.

H. E. Haynes and D. T. Hoger of RCA have described a system for spectrum conservation called "stop-go scanning." By this system effective utilization of the spectrum in the transmission of black-white images has been increased by factors of five or more, depending on subject matter. Speed of scanning depends upon the number of digits of information in the scanning line. The fewer the digits, the faster the scanning. This conserves the spectrum needed for transmitting a given message.

George J. Kelley of General Electric noted that no single method of modulation is best in every case. The decision on the system—a-m, double sideband suppressed carrier, SSB, or f-m—depends on whether voice or pulsed data is to be transmitted and the relative importance of such factors as compatibility, effective range, bandwidth, signal-to-noise performance, interference rejection capabilities, distortion characteristics, required stability, required transmitter power, and resulting circuit complexity.

Biological Studies of Radiation Effects on "Crash" Program

Colonel G. M. Knauf, Commander of Griffiss Air Force Base Hospital debunked repeated reports of deaths and injuries resulting from exposure to high power microwaves. Col. Knauf is responsible for accelerted research and investigation of rumors on biological effects of radiation at all frequencies.

Col. Knauf stated: "I know of no serious injury or death that has resulted from exposure to radar energy." He also pointed out that although dangerous radars and other high-powered communications equipment may be built in the future, no such equipment now exists.

Three years ago, investigations were started at Rome Air Force Base on the biological effects from electronic equipment. It was expected that x-rays might be produced, but little information or data could be obtained from manufacturers. Most concern was with the new series of high-powered klystrons where it was felt that the collector was a likely source of such radiation. X-ray film showed that at 2-foot distance the intensity of the rays was 200 Rankin per hour which is half the considered safe lifetime radiation for human beings. As a result, exposure limits for personnel have been established, and shielding has been required in equipment using these tubes.

Unfortunately, methods of measurement of microwave r-f energy had not been well established, and safe doses are not known. Expediting data on this is difficult. Reflection, absorption and radiation of such energy compounds the problem, Col. Knauf said. Frequency apparently has an effect, and the coefficient of absorption varies from tis-

sue to tissue, making conclusions difficult.

Tests of microwave radiation effects have so far been made at one middle-range frequency (2450 mc), but it will be necessary to explore extreme limits of the spectrum before complete conclusions can be reached, and data must provide reliable information covering all of the physiology of man.

Recommended maximum exposure at present is 0.01 watt per square centimeter and is considered *absolutely* safe. Experiments on animals indicate that danger is compounded by exposure to successive doses over 0.01 watt per square centimeter. Thus, accumulation of successive doses is apparently as much a factor as quantity of the individual dose.

Hoffman Laboratories has teamed up with other companies to form a team of technical experts on various phases of an electronic system to bid for a prime government contract. This team approach was described at the Aer-Com luncheon by Hoffman's president James D. McLean. The team approach to getting electronic business is based on the idea that no single small or medium-sized company has enough know-how on all elements of a complicated military electronics system to handle a prime development contract alone; and that the serious shortage of "top-drawer" management people makes it desirable to employ them efficiently. One good manager can head up the technical team of experts from several companies.

CIRCLE 40 ON READER-SERVICE CARD ➤

To Replace Wafer Types:

Printed Circuit Switch

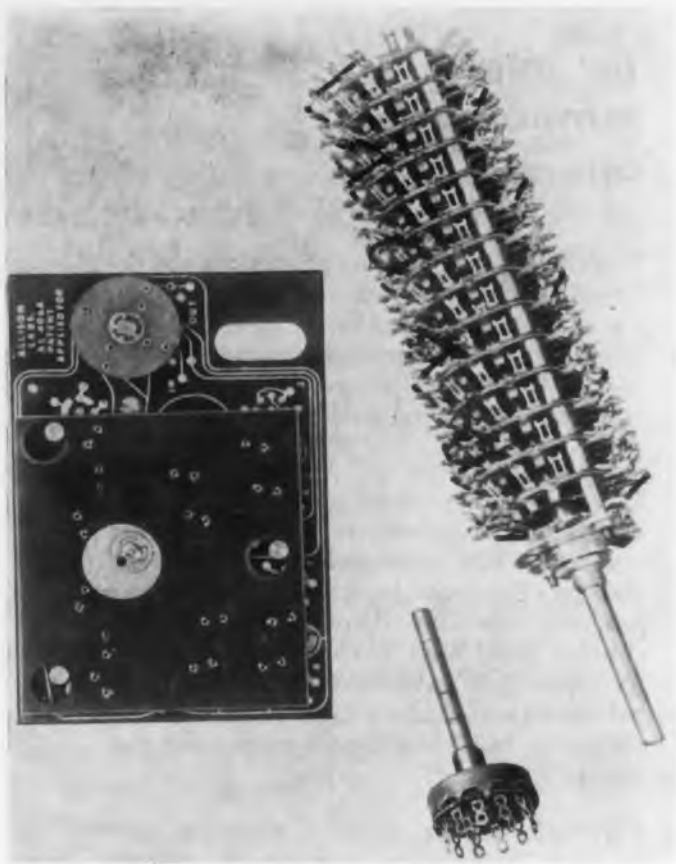


Fig. 1. Size comparison of 28 circuit *HEP* switch and wafer switches it replaces. Above the contact board, which rotates in a cycloid motion, is a second, 4 circuit 3 position switch. This combination of switches showed no appreciable wear after 50,000 revolutions.

RELIABILITY, volume reduction and easy turning by hand or servo are the principal advantages of this new etched plate switch. Designed to replace multiwafer switches, it has a light, very positive detent, eliminates complex strapping and wafer indexing problems due to torque deflection of multiwafer shafts. The switch consists of a printed circuit board faced by a contact board. As the contact board is rotated in a cycloidal motion, numerous spring contacts describe a circular path around each circuit.

An eccentric cam is used to rotate the contact plate. Stationary guide pins are set in circles whose radii duplicate the radius of eccentricity of the cam. Every point on the contact plate describes a circle of the same radius.

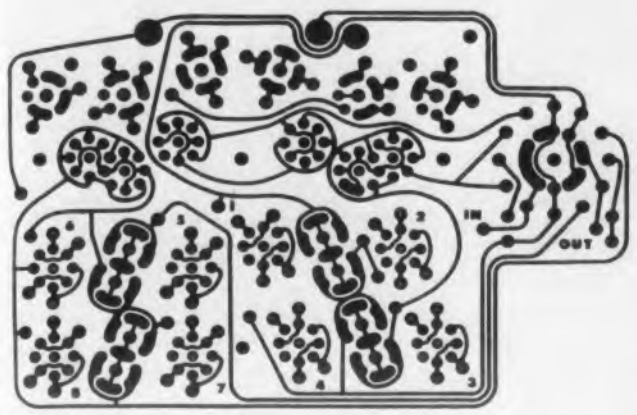
Developed and produced by Allison Laboratories, Inc., 14185 Skyline Drive, La Puente, Cal., the *HEP*–Hartsock Etched Plate–switch aids substantially in the simplification of circuitry, since all the strapping is printed and many of the components may be mounted on the board. This is clearly a long step in the direction of

Reliability. A prototype switch, using silver contacts on rhodium plate, was cycled 110,000 times without appreciable wear. This compares with the 25,000 cycle life of a typical multiwafer switch. The switch assembly shown in Fig. 1–rhodium contacts to gold plate–was designed for installation in an octave band filter with eight pass bands, and replaces the two switches shown at the right. The larger segment is a 28 circuit 8 position switch, the smaller, circular unit a 4 circuit 3 position switch. It was cycled 50,000 times without significant wear. The complex, time consuming strapping shown on the 14 wafer switch is all printed on the *HEP* switch.

When the two types of switches are installed the difference becomes even more pronounced: 233 soldered connections are needed to wire the complete octave band filter to the 14 wafer switch–63 soldered connections complete the filter when the *HEP* switch is used. Other aids to reliability include the possibility of printing a symbol next to every contact point on the back of the switch for wiring instructions to the production worker. Finding and correcting wiring and wafer trouble is of course eliminated.

In addition to determining the decrease in

Fig. 2. Demonstration model of a *HEP* switch used in an octave band filter assembly. Contact board is rotated in a cycloidal motion so that each of the spring loaded contacts describes a perfect circle around its associated circuit. All circuitry is printed on board, capacitors and inductors mounted behind. Contact plate is plexiglas. Note variety of switch shapes on board.



number of soldered connections necessary for the *HEP* switch is was found that considerable

Volume reduction was possible. In the prototype switch shown in Fig. 1, 42 capacitor values with a total capacitance of 16 μf were obtained from 23 values with a total connected capacitance of 9.6 μf. This was accomplished by means of switching that might easily have proven uneconomical using the multiwafer switch. Reduction in volume due simply to the size of the switches was from 22 in.^{3} to 9 in.^{3}.

In another unit a *HEP* switch, shown in Fig. 2 as a demonstration model with a plexiglas contact plate, accomplished—by means of some purely internal strapping—an effective total connected capacitance of 253 μf with a true total capacitance of 133 μf. Ninety soldered connections were used instead of 611.

As shown in the photograph the capacitors were mounted directly behind the board, instead of being mounted on a separate parts board.

Dimensions of the switch may be altered in any way to conform with odd shaped spaces available in a piece of equipment.

Ease of turning. Note that the only unit to be turned in the *HEP* switch is the contact plate. This means that a low power servo motor can be used for automatic switching. It also means a positive detent, for hand turning. It is clear that the difference between the extra effort involved in overcoming the detent resistance and the effort necessary simply to turn the switch must be pronounced. With the *HEP* switch, only a light detent is necessary for positioning.

Since much of the circuitry of a piece of equipment can be printed on the plate along with the *HEP* switch, the most efficient way to take advantage of the new switch is to design a switch for each specific installation.

For further information on this printed circuit switch circle 56 on the Readers Service Card.

New Products

Kerr Cell Camera

0.1 μSec Shutter Speed

Shutter speeds as fast as 0.1 μsec are obtained by this model D20 Kerr cell camera. The unit uses a large aperture, hermetically sealed Kerr cell shutter which can be synchronized to within 2 mμsec. The aperture measures 1.25 x 2 in. and the Kerr cell is designed to mount on a Crown Graphic 45 camera. The unit is particularly adaptable to use for photographing transient or impulsive phenomena such as occur in shock tube studies, and electrical discharge processes.

Electro-Optical Instruments, Inc., Dept. ED, P.O. Box 4234, Pasadena, Calif.

CIRCLE 59 ON READER-SERVICE CARD

Trimming Potentiometer

Direct Mounting

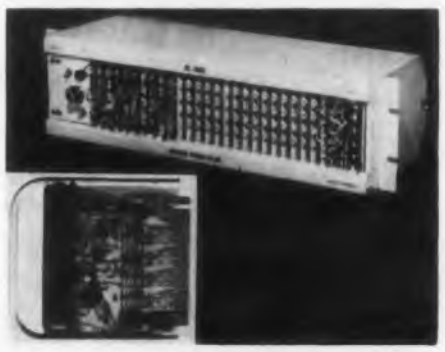
A 0.6 w, wire-wound potentiometer, model DM requires no mounting hardware and mounts directly to chassis or printed circuit either manually or by machine. Available in stock values from 10 ohms to 50 K with a resolution of 0.2 per cent. The trimmer measures 1/2 in. diam, and has no electrical noise when shock tested for 25 g, 3 planes.

B-H Electronics, Dept. ED, P. O. Box 25124, Los Angeles 25, Calif.

CIRCLE 60 ON READER-SERVICE CARD

Digital Computer Modules

Versatile Logic Elements



The T-PAC series of printed circuit transistorized digital modules operate at a 1 mc repetition rate and perform a comprehensive variety of operations and computations. The circuits have been designed around a basic logical element package, model LE-10. A single logical element can serve as an amplifier, inverter, driver, buffer, flip-flop, counter stage, multiple-coincidence gate, frequency divider, half adder and shift register stage. The T-PACs may be plugged into a chassis called a T-BLOC. By making the proper jumper connections on the plugboard format of the front panel of the T-BLOC, logical statements and system configurations can be quickly implemented. T-PACs can be used in conjunction with other input-output and storage devices to build any size installation.

Computer Control Co., Inc., Dept. ED, 92 Broad St., Wellesley, Mass.

CIRCLE 61 ON READER-SERVICE CARD

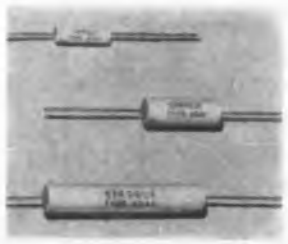
TV Camera

High Resolution

Resolution of 600 lines is achieved in this TV camera. The camera is designed to operate under shock of 20 g, temperature of ±60 C, and altitudes of 60,000 ft. Overall size is 7.5 x 2.6 in. and the unit is ruggedized to operate in high noise and vibration areas. Any focal length lens may be used including zoom type.

Photo Research Corp., Dept. ED, 837 N. Cahuenga Blvd., Hollywood 38, Calif.

CIRCLE 62 ON READER-SERVICE CARD



Carbon Film Resistors

Ceramic Jacketed

Type 402E, 403E, and 404E Filmistors are furnished in hermetically-sealed dense ceramic cases using ceramic-to-metal solder seals, providing a minimum possibility of field failure through electrolytic action and penetration of water vapor through the outer resistor shell. The units are rated at 1/2, 1, and 2 w respectively, and are designed to meet the requirements of MIL-R-10509B.

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

CIRCLE 63 ON READER-SERVICE CARD

Connectors

Miniature Design

Series 8000 miniature Varicon connectors is presently available in 16, 40 and 48 contact units. Series has screwdriver actuated locking devices, guide pins, floating mounting holes, and co-axial contact arrangements as optional accessories.

Featuring the maximum number of contacts in a minimum space, the connectors withstand 2000 v rms at sea level and 900 v rms at 3.4 in. Hg vacuum. Current rating is 5 amp. Illustrated is a 48 contact double tier connector, showing wire connections to contacts and honeycomb insulator.

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

CIRCLE 64 ON READER-SERVICE CARD

Combined RPM-Voltmeter

Provides Quick Measure of Speed

Designed primarily to give a quick and accurate measure of speed, the Speedvolter employs a highly linear tachometer generator to convert the motion of rotating parts or moving surfaces into a proportional dc voltage. The test unit serves as a volt-ohmmeter with good sensitivity, accuracy on all ranges.

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

CIRCLE 65 ON READER-SERVICE CARD

New Products

AC Motor
60 In.-Oz at 1 RPM

Type 117 Form H ac motor is a permanent magnet synchronous type rated at 60 in.-oz at 1 rpm. Designed for application in high speed controllers, counters and metering devices, the motor is offered in speeds from 72 rpm to 2 rpm. Features are an input of 2.5 w, size of 1-5/16 in. depth, and a maximum temperature rise of 35 C.

Cramer Controls Corp., Dept. ED, Centerbrook, Conn.

CIRCLE 67 ON READER-SERVICE CARD

Non-Reset Counters
Nylon Cushioned

A series of non-reset counters has been announced having a range of 3 to 6 figures. The 1/8 in. driveshaft projects from either side of the case, or from both ends where further connection is necessary. Revolutions may be counted at a maximum of 1000 per minute, and actuation is cushioned by a shock absorbing device of nylon.

Technicraft Co., Dept. ED, 6221 Ridge Avenue, Philadelphia, Pa.

CIRCLE 68 ON READER-SERVICE CARD

Cooling Unit
Compact Size

This cooling unit is composed of an efficient circulating fan joined with a heat exchanger, fea-

vibration test systems

MB MODEL C10VB EXCITER rated for frequencies up to 6000 cps. Works in environmental test chambers, combining vibration with altitude and temperature testing.

VIBRATION testing grows more discriminating. First, sinusoidal testing; and now random and complex motions. Whatever *your* program, look to MB to keep you ahead. As the world's largest producer in its field, MB provides complete systems for advanced techniques.

Basically, *what you're really buying is the motion at the shaker table.* And nobody knows the requirements of the shaker better than its maker. MB builds equipment around the operational needs, thereby assuring optimum performance from system as whole, and from shaker specifically.

MANY AMPLIFIERS IN SERVICE

MB has built over 850 electronic amplifiers for vibration test systems since 1945. More than 275 are 3 KW and larger. In advancing the science of complex motion testing, MB builds the required electronic gear with similar advanced thinking . . . to make it easier to use, and fit for future needs.

SOME FEATURES

MB amplifiers feature automatic operation. Push a button to start. No need to fuss with filament and plate voltages. Amplifier can be remotely located to cut down noise and heat and save floor space at test location. Control console facilitates automatic or manual sine wave testing. The compensation console equips system for rapid setup and high fidelity complex motion work.

The largest field service organization of vibration specialists are on call nationwide to users of MB test systems. They provide technically qualified service on the *whole system.*

MODEL TEMC CONTROL CONSOLE offers optimum control reliability. It is the only true servomechanism in the vibration testing field that integrates the error and reduces it essentially to zero.

MODEL T88 COMPLEX MOTION CONSOLE equips system for duplicating "noise" or random motion. Uniquely, it contains peak notch equalizer . . . which is an analog computer for giving exact inverse of the resonant response from specimen on the exciter.

TYPICAL PERFORMANCE OF SYSTEMS			
Amplifier Model	Exciter Model	Sine Force pounds	Random Force pounds
T444	C10VB	1750 peak	850 rms
T666	C25H	3500 peak	2500 rms
T888	C25HB	5000 peak	3500 rms

SEND FOR COMPLETE DATA

MB manufacturing company

A DIVISION OF TEXTRON INC.

1058 STATE STREET
NEW HAVEN 11, CONN.

CIRCLE 69 ON READER-SERVICE CARD

turing high heat transfering capacity per exchanger volume. The fan circulates air through the heat exchanger, and then forces it over components within hermetically sealed compartments. One version weighs only 2.5 lb and measures 7 x 6 x 3 in.

Garrett Corp., Dept. ED, 9851 Sepulveda Blvd., Los Angeles 45, Calif.

CIRCLE 70 ON READER-SERVICE CARD

Automatic Environmental Testing

Eliminates Manual Tests

Complete testing of components and systems is done automatically with this equipment. Control and cycling, periodic sequential sampling and measurement, and a permanent printed record giving all relevant data regarding test and operating conditions are provided.

Canadian Marconi Co., Dept. ED, 970 McEachran Ave., Outremont, Quebec.

CIRCLE 71 ON READER-SERVICE CARD

Pressure Transducer

Linearity of ±0.2 Per Cent

Series 6000 pressure transducers uses a precision carbon film resistance element and thus has virtually infinite resolution. Instruments are available with a high-level output signal which varies linearly or non-linearly over ranges of from 0-5 to 0-5000 psi. Non-linearities of the Bourdon tube are negated by appropriate trimming of the resistance element after final assembly. Linearity is rated at 0.2 per cent.

Computer Instruments Corp., Dept. ED, 92 Madison Ave., Hempstead, L.I., N.Y.

CIRCLE 72 ON READER-SERVICE CARD

New Products

Molded Connector Plugs
Fit Standard Sockets

These seven and nine prong molded plugs fit standard tube sockets and provide means for easily engaged multi-lead connections. Offering space savings over the earlier octal and wafer type construction, plugs and mating sockets are available in both commercial materials and to the applicable requirements of JANS-28A.

Methode Manufacturing Corp., Dept. ED, 7447 W. Wilson Ave., Chicago 31, Ill.

CIRCLE 74 ON READER-SERVICE CARD

Miniature Switch
Ten Position

This switch, a 10-position unit mechanically operative through the range of 50 to 150 C, is rated at 3 amp at 115 v, and withstands vibrations of 5 to 2000 cps. The switch has hermetically sealed terminals and base and is immersion tested and salt resistant. The unit has an insulation resistance of 100,000 meg. Designated MPM-10 and MFM-10, it is available in panel and flange mounted versions.

IT&T Components Div., Dept. ED, 100 Kingsland Rd., Clifton, N.J.

CIRCLE 75 ON READER-SERVICE CARD

Transistor Power Supply

Low Ripple of 0.05 Per Cent

The DV60-2 transistor power supply features a ripple attenuation down to a maximum of 0.05 per cent at full rated output. Designed for developmental and experimental transistor work, the unit delivers 0-60 v dc at currents up to 1000 ma. Line operated, the power supply employs a continuously variable autotransformer, a full-wave bridge selenium rectifier and a two-section choke input filter.

Model Rectifier Corp., Dept. ED, 1068 Utica Ave., Brooklyn 3, N.Y.

CIRCLE 76 ON READER-SERVICE CARD

Plug-In Transformer

Input Matching

The P-16 plug-in input transformer is primarily suited for matching amplifiers to microphone and line sources. It has a center tapped primary suited to 150, 200, 250, 500, or 600 ohm sources, and provides a step-up to grid impedance ratio of 200:1. Frequency response is within approximately 1 db from 30 to 20,000 cps.

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

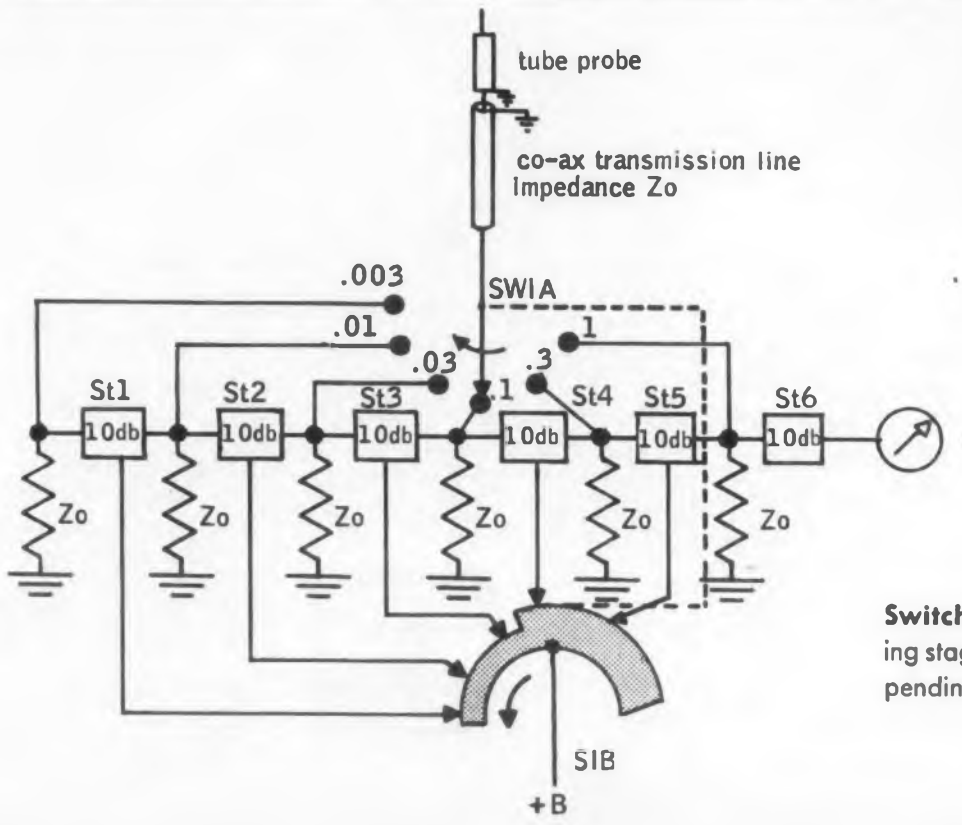
CIRCLE 77 ON READER-SERVICE CARD

CIRCLE 78 ON READER-SERVICE CARD ➤

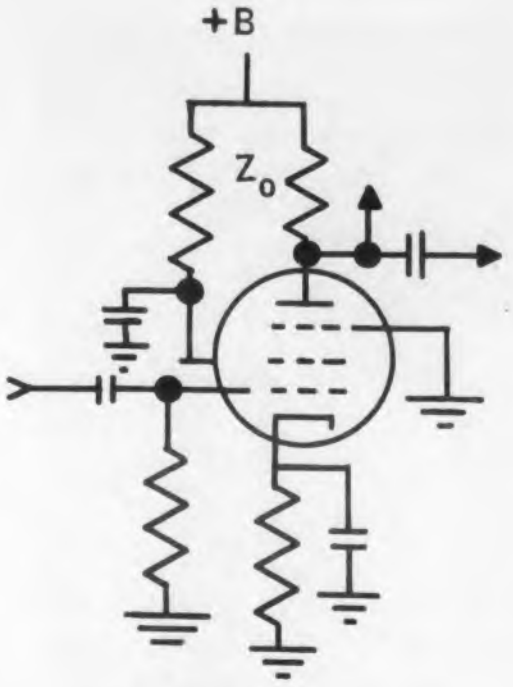
Stabilized High-Frequency Vacuum Tube Voltmeter

HIGH IMPEDANCE input at 50 mc is achieved in a new high-sensitivity vacuum-tube voltmeter, called the Microlter. Where other instruments achieved operation to 50 mc by converting to dc using diodes with low-impedance input, this instrument maintains an input impedance of 30,000 ohms at 50 mc by employing video amplifiers with individual stage stabilization. Sensitivity of the instrument permits measurement of low-level rf signals down to 250 microvolts. It also doubles as a wide-band video amplifier with a maximum output of 0.25 v at 75 ohms and gains up to 40 db. The Microlter, manufactured by Kay Electric Company of Pine Brook, New Jersey, is an amplifier which may be used as a voltmeter, consisting of a number of stages of gain of 10 db, together with a switching arrangement which permits the probe to be fed into any of the stages.

The type of amplifier used is shown schematically. The plate load is made equivalent to Z_o. This means that when the tube is turned off, the



Switches show how succeeding stages are connected in, depending upon range selected.



Basic circuit of each video stage employed in the Microlter.

impedance looking into it from the probe is Z_o. The reason for the Z_o is that the transmission line from the pick-up or tube probe must match at the other end its characteristic impedance, or Z_o.

The block diagram shows the combination of elements. Switch 1A is shown as switching the probe and its transmission line to the various positions of the amplifier. Switch 1B is the power switch which simultaneously turns off the stages prior to the unwanted point. For example, suppose 4 stages are needed or 40 db amplification; the switch would be set to the position 0.03. This means that stage 3 would be active but stage 2 would be inactive. At stage 2 the Z_o would be the probe termination only. However, should a further stage back be needed, this same Z_o would then become the plate load, or stage 2.

A 7-position switch provides full-scale steps of 1, 0.3, 0.1, 0.03, 0.01, 0.003, and 0.001 v when the Microlter is used as a vtvm. The frequency range is 100 cycles to 50 mc, ±1 db, direct reading in voltage or decibels. Accuracy is 10 per cent of full scale. Input resistance varies from 1 megohm at 1 mc to 30,000 ohms at 50 mc. Input capacitance is 5 μμf. Dimensions of the instrument are 10 x 8 x 7 in. Weight is 17 lb.

The Microlter is particularly applicable to the checking of transistors and has been incorporated in a Kay Electric Tranquilizer for determining alpha cut-off. It has numerous applications in video work.

For additional information on this instrument, please turn to the Reader Service Card enclosed and circle 80.

Fig. 1. Providing a 50 μamp sensitivity for 180 deg deflection, the assembled meter measures no more than one inch in diameter.

Sensitive Meter with 180 Degree Movement

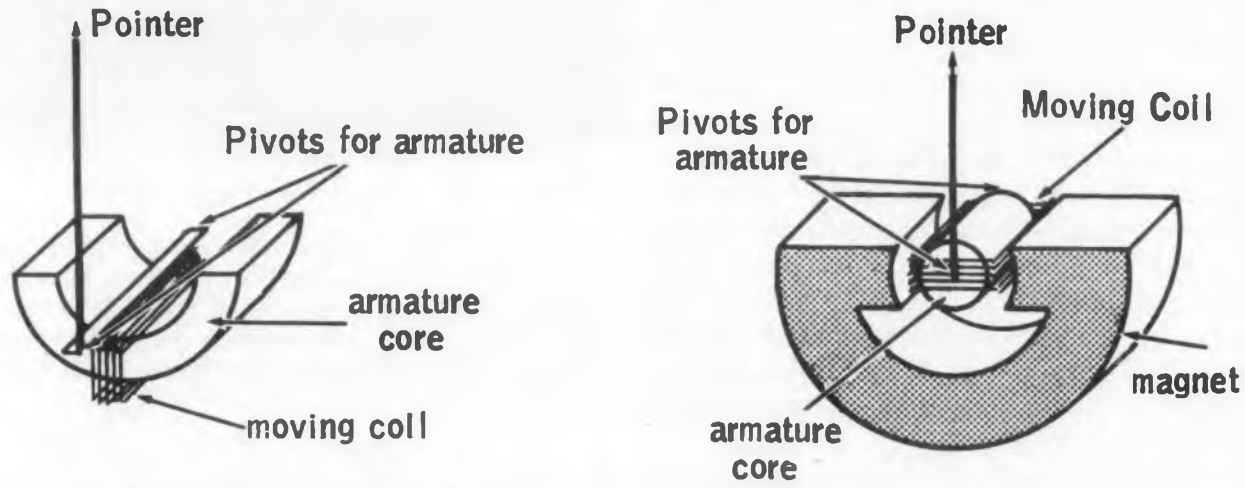


Fig. 2. The basic meter movement (left), as compared to a conventional movement (right), shows how the 180 deg deflection is obtained. The complete magnetic circuit consists of an Alnico V magnet attached to the top of the crescent-shaped armature core. A cylindrical outer pole piece, to which the top of the magnet is anchored, surrounds the entire unit and provides complete shielding. The coil, therefore, has a full 180 deg movement through the space between the lower surface of the armature core and the lower half of the outer pole piece. The field strength in this airgap is approximately 1500 gauss.

BY VIRTUE of a unique design approach, the meter movement shown in Fig. 1 makes possible 50 μamp sensitivity for 180 deg. deflection in a 1-in. unit. The meter is completely self-shielding, has good damping characteristics, and withstands high impact and vibration without impairing the accuracy or functioning of the movement.

The meter movement was the result of a series of design attempts by Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland 8, Ohio, to provide the Signal Corps with a 180 deg sensitive meter. Three previous designs were involved, each attempting to provide the highest flux density possible in a limited space. Despite the trial of new materials, such as an iron-iobalt alloy called Vanadium Permendur, it was an entirely fresh approach using standard material which resulted in the final design. As shown in the comparison of the new movement with a conventional unit, Fig. 2, the moving element is capable of a full 180 deg deflection. The entire magnetic circuit consists of an Alnico V magnet, under which the crescent-shaped armature core is mounted. The magnet is in turn securely mounted within a cylindrical outer pole piece which surrounds the entire unit. The moving element is suspended from two bridge supports mounted to the outer pole piece. Two hair springs, at either end of the element, energize the armature.

By charging the magnet radially, magnetic poles are set up across the small spacing between the armature core and the lower half of the outer pole piece. It is through this small gap that the lower half of the armature moves. The natural features of this design are, the allowance of 180 deg armature rotation, a completely self-shielding magnet circuit, and the functioning of the permanent magnet at an exceptionally high efficiency point. The 1500 gauss field in the airgap provides both the 50 μamp sensitivity and the good damping characteristics of the meter.

In order to meet the specifications of the original Signal Corps contract, the meter movement had to be made extremely rugged. The armature core was secured to the magnet by means of an interlocking device which prevented shifting of the core under shock. The suspension of the armature was given considerable attention. The final design consisted of an osmium-tipped pivot and a reinforced cushion back jewel. The supporting bridges resist bending on impact tests, and were made of beryllium copper rather than bronze for added strength. Equal attention given to the case resulted in a highly sensitive meter well protected from shock or vibration.

For further information turn to the Reader's Service Card and circle 83.

New Products

Telemetering Tachometers

Provide 5-V DC Output

These tachometers have a built in frequency converter that provides in one miniature unit the necessary 0-5 v dc output for telemetering. The output of all models is adjustable and the 5-v level can be set for any speed between 3500 and 18,000 rpm. All models are designed to operate under MIL-E-5272A environmental conditions.

Cardinal Instrumentation Corp., Dept. ED, 4201 Redwood Ave., Los Angeles 66, Calif.

CIRCLE 85 ON READER-SERVICE CARD

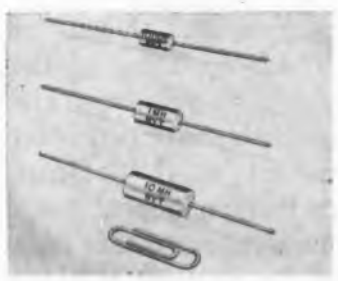
Pressure Pickup

Lightweight, 100 PSI Range

Type 4-380 pressure pickup is designed for absolute and differential pressure measurements of non-corrosive fluids in ranges up to 100 psi. A high level dc output eliminates the need for signal amplifying equipment. Weighing 8 oz, the unit is vibration resistant and operates to 200 F.

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

CIRCLE 86 ON READER-SERVICE CARD



RF Chokes

Rated at 125 C

A line of 125 C epoxy encapsulated rf chokes, meeting performance requirements of MIL-C-15305A, grade 1, class B, is available from stock. Series S, M, and L, have inductance values

ranging from 0.1 μh to 10 mh. Maximum current ratings at 125 C are 1/3 w for the S and M series and 1/2 w dissipation for the L series.

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

CIRCLE 87 ON READER-SERVICE CARD

Photoelectric Scanners

Actuated by Small Objects

These photoelectric units provide whole-light-beam interruption by 1/32 in. diam objects. The pair of heads can be installed in a small space and the photocell will respond to reflected as well as direct light. Two types of miniature photocells are available for moderate and high speed operation. Several types of response are possible by choice of relays.

Farmer Electric Products Co., Inc., Dept. ED, 2300 Washington St., Newton Lower Falls, Mass.

CIRCLE 88 ON READER-SERVICE CARD

Plug-In Series

Covers Variety of Circuits

Designed to meet a wide variety of applications, these units are being made in four standard series: an NBS series, for use in Navy electronic equipment; an instrument series, which includes gate circuits, multivibrators, and dc amplifiers; a transistor series; and a general purpose series which includes a variety of voltage and power amplifiers, control, regulating, and computing circuits. Each unit has a permanent schematic on the outside of the case.

Dayton Electronic Products Co., Dept. ED, 320 Vermont Ave., Dayton 4, Ohio.

CIRCLE 89 ON READER-SERVICE CARD

SYNCHRO NEWS

CLIFTON HEIGHTS, PA. DECEMBER 1957 Vol. 1 No. 1

CLIFTON PRECISION ANNOUNCES NEW WESTERN DIVISION

New Clifton Precision plant at Colorado Springs, Colorado

ONLY OUTSTANDING PERFORMANCE MAKES GROWTH LIKE THIS POSSIBLE

Today shipments of CPPC rotary components are running 4 times the rate of two and a half years ago (see chart).

The new facility will permit a further 100% increase in rate of shipments.

Only outstanding performance makes growth like this possible. CPPC synchros have provided highest accuracy and reliability in the least bulk and weight.

Colorado Springs Area Named

Production Capacity Doubled

Clifton Heights, Pa., November 4, 1957—Clifton Precision Products Co., Inc. today announced completion of arrangements for the purchase of a 33,000 sq. ft. plant at Colorado Springs, Colorado. The plant will approximately double the Company's capacity to produce synchros and electro-mechanical components for aircraft and missile instrumentation, guidance and control.

The new plant, which is situated on 13 acres of land at the foot of the Rocky Mountains, is presently being equipped and will be in production shortly.

Clifton Precision is a leading independent manufacturer of synchros, servo motors and all types of rotary components for airborne electronic equipment. The Company has specialized in sub miniature, high accuracy units.

CIRCLE 90 ON READER-SERVICE CARD

New Products

5-Mc Precision Crystal

Long Term Stability

Frequency tolerance of these 5-mc crystals is held at ±0.0001 per cent. Aging does not exceed one part per hundred million parts per week. The crystals are available in hermetically sealed glass T5 1/2 enclosures with pigtail leads or 9-pin Bakelite base.

Dynamics Corp. of America, Reeves-Hoffman Div., Dept. ED, Carlisle, Pa.

CIRCLE 92 ON READER-SERVICE CARD

Mechanical Oscillator

150 CPS Square Pulse

Output of the X-00006 mechanical oscillator is a 150 cps square pulse. Weighing 13 oz, the oscillator is essentially a sampling switch with a commutator-segment-type construction and two adjustable graphite brushes.

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

CIRCLE 93 ON READER-SERVICE CARD

Plug-In Limit Switch

for Quick Replacement

Type 201LS1 plug-in limit switch answers the need of automatic production lines for a precision unit which allows immediate replacement. The unit consists of a terminal block enclosure, containing wiring connections, and a switch en-

closure, including all moving parts. To make a complete replacement of the switching unit, it is only necessary to loosen two screws, pull off the switch, plug in the replacement unit and tighten the screws.

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

CIRCLE 94 ON READER-SERVICE CARD

Thread-Cutting Screw

High Stripping Torque

Recommended for applications that have little screw-thread engagement, Nibscrews have protrusions under the head to act as the brake, so that the head rather than the threads takes up the tightening torque. This permits a broader range of driver settings reducing rework, rejections.

Illinois Tool Works, Shakeproof Div., Dept. ED, St. Charles Rd., Elgin, Ill.

CIRCLE 95 ON READER-SERVICE CARD

Ionization Tube

Reads 10^{-12} MM HG Region

Model GIC-001, a Bayard-Alpert type of vacuum ionization tube, indicates pressures in the 10^{-12} mm Hg region and at the same time has a sensitivity of 100 μamp per micron. Output of the tube is linear throughout a range from $5x10^{-4}$ to 10^{-12} Hg. A double filament is used for longer tube life, and the grid can be outgassed easily by electron bombardment. Recommended collector voltage is —25 v, while the grid can be operated from +150 to +240 v.

Consolidated Electrodynamics Corp., Rochester Div., Dept. ED, 1775 Mt. Read Blvd., Rochester 3, N.Y.

CIRCLE 96 ON READER-SERVICE CARD

New Products

Radar CRT Series

Short to Long Persistance

Three 5-in. cathode ray tubes for radar indicator application have been announced. The tubes employ electrostatic focus and magnetic deflection, are designated types 5AHP4A, 5AHP7 and 5AHP7A, and have a clear faceplate, a deflection angle of 53 deg and a heater voltage of 6.3 v. The 5AHP4A has aluminized P4 phosphor with white fluorescence and short to medium persistence. Type 5AHP7 makes use of a non-aluminized P7 phosphor which has blue-white fluorescence, yellow phosphorescence and long persistence. The 5AHP7 is the aluminized version of the 5AHP7.

Sylvania Electric Products Inc., Dept. ED, 1740 Broadway, New York 19, N.Y.

CIRCLE 99 ON READER-SERVICE CARD

Low Level Multicoder

For Airborne Telemetering

Sensitivity of the D Series Low Level Multicoders permits use for missile telemetering and aircraft flight instrumentation in the low 0-15 mv and 0-30 mv ranges. The multicolor makes possible the multiplexing and coding of up to 86 low level sources. and is capable of discerning signal magnitudes as low as 75 μv. Direct operation is possible from a variety of low level pressure pick ups and other low level transducers. Models are available for composite pulse rates of 900 pps.

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

CIRCLE 100 ON READER-SERVICE CARD

◀ CIRCLE 98 ON READER-SERVICE CARD

Miniature Coaxial Cables

High Temperature

This line of miniature coaxial cables is insulated with Teflon and has a 0.154-in. od. Extra flexible standard constructions are available in 50, 70, 75, 93, and 95 ohm ratings. In addition to the all-Teflon and Kel-F constructions, nylon, vinyl, Teflon, and silicone lacquered glass braided jackets are available at choice.

Tensolite Insulated Wire Co., Inc., Dept. ED, Box #66, Tarrytown, N.Y.

CIRCLE 101 ON READER-SERVICE CARD

Transductors

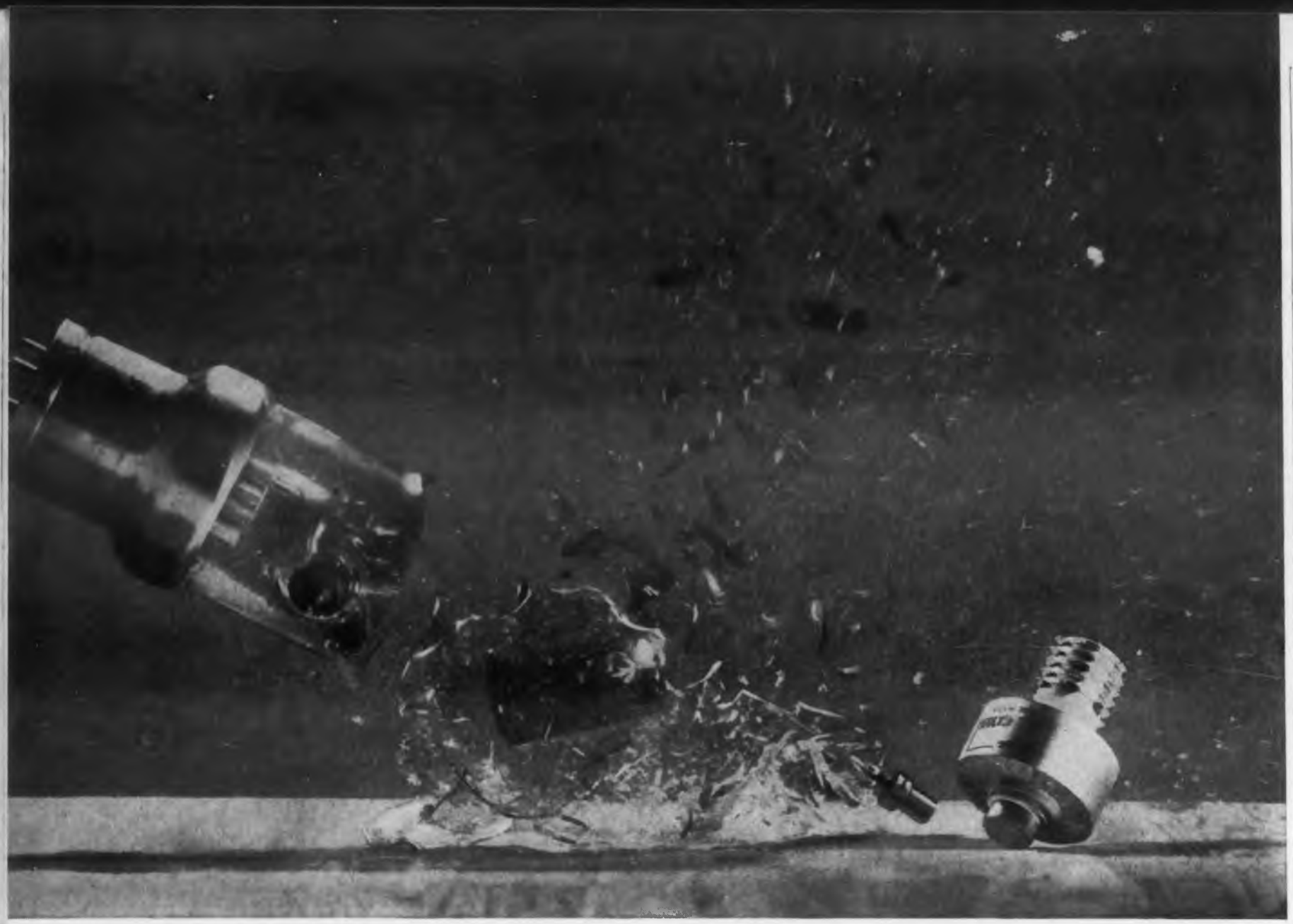
Measure Currents to 10,000 Amp

Designed to measure large amounts of direct current without electrical connection, this line of transductors consists of nine units, six for 120 v and three for 240 v, ranging in capacity from 200 to 10,000 amp. Accuracy of current measurement is to within 1 per cent, with up to ±10 per cent voltage variation. In addition to measurement of line current, transductors can be used for overload relaying, recording, and providing a feedback signal to a magnetic amplifier, or they can be used in a summation system.

Control, Div. of Magnetics, Inc., Dept. ED, Butler, Pa.

CIRCLE 102 ON READER-SERVICE CARD

CIRCLE 103 ON READER-SERVICE CARD ➤



Surviving Impact is an Eimac Ceramic Tube Extra

Aeronautical electronics demands extras from vacuum tubes. Among them is the ability to withstand heavy impact without impairing electrical characteristics. The photograph dramatically shows what happens to a 250 watt glass envelope tube and an Eimac 300 watt ceramic tube when both are dropped from a height of seven feet. The ceramic tube "took it."

Other advantages of Eimac ceramic tubes are: resistance to damage by vibration and temperature; smaller size without sacrificing power; ability to undergo optimum processing techniques that lead to tube reliability and longevity.

The small Eimac ceramic 4CX300A, shown above, will withstand 50G shocks of 11 millisecond duration. It will operate in airborne or ground station service at full ratings up to 500mc.

In its new line of ceramic tubes, Eimac has the answer for the aeronautical engineer who needs a tube that will deliver full output under extreme environment.

For further information, consult our Application Engineering Department.

EITEL-McCULLOUGH, INC.
SAN BRUNO · CALIFORNIA

Eimac First **with Ceramic Tubes that can take it**

Eimac

4CX300A MAXIMUM RATINGS TO 500MC

	FM	AM	SSB		FM	AM	SSB
D-C Plate Voltage	2000	1500	2000	Plate Dissipation, watts	300	200	300
D-C Screen Voltage	300	300	400	Screen Dissipation, watts	12	12	12
D-C Grid Voltage	—250	—250	—	Grid Dissipation, watts	2	2	2
D-C Plate Amperes	.250	.200	.250				

New Products

Test-Point Jack
Shortened Length

For assemblies where depth is a vital factor, two shortened versions of the SKT-10 test-point jack have been made available. Types SKT-2BC and SKT-5BC have identical dimensions but take 0.08 and 0.09 in. diam pins or plugs, respectively. The bushing diam is 0.185 and 0.218 in. for the front face, while overall length including lug is 7/16 in. Machined contact members of beryllium-copper gold flash over silver provide a firm grip. Insulation is Teflon.

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

CIRCLE 105 ON READER-SERVICE CARD

Transistorized Amplifier
Wide Band, Low Noise

Model 6000 Dec-Amp is a transistorized amplifier powered by a mercury battery with available gain of either 10 or 100 from 10 cps to 1 mc, ± 0.2 db. Input impedance is 50,000 ohms shunted by 8 μμ, and output impedance is 150 ohms. Maximum noise referred to the input for 1 mc bandwidth is 50 μv. Maximum output, at less than 0.5 per cent total harmonic distortion, is 1 v rms.

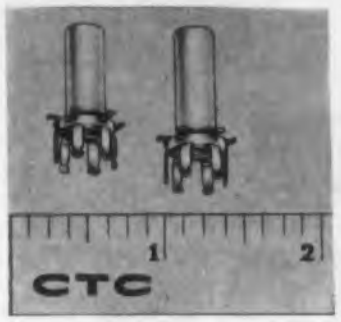
Electro-Voice, Inc., Dept. ED, Buchanan, Mich.

CIRCLE 106 ON READER-SERVICE CARD

< CIRCLE 104 ON READER-SERVICE CARD

Terminal Collars

for Coil Forms



These terminal collars extend the use of regular coil forms for more complicated circuitry. The five and six terminal collars have been designed for vertical mount ceramic printed circuit coil forms SPC 11 and SPC 12. Of silicone fibre glass with silver plated brass terminals.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge, Mass.

CIRCLE 107 ON READER-SERVICE CARD

75 Ohm Video Terminator

for Coaxial Lines

A video termination for 75 ohm coaxial transmission lines, type RF-300 has the following characteristics: a turret type lug at the rear of the termination providing connection point for an oscilloscope; negligible reactance of less than two degree phase shift up to 250 mc; deposited carbon resistor rated at 1/2 w; accuracy of 1 per cent; nominal resistance of 75 ohms with other values available on order; and rf resistance at 100 mc within —1 per cent of the dc value. The terminations are housed in standard uhf connectors.

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

CIRCLE 108 ON READER-SERVICE CARD

CIRCLE 109 ON READER-SERVICE CARD ➤

Get Your Own *B-NOBATRON!*

Multi-purpose B-Power Source Available in Five Models, Ranging from 300 to 1000 VDC Tops; Low Ripple, Accurate Regulation; Provide Filament and Bias Current in Addition to High Voltage Output.

Here's the economical and lasting answer to B-Power supply needs for nearly every laboratory, and many industrial operations. Nobatrons are built to last, and serve without maintenance. Damage to the Nobatron and its load is prevented by input and output fuses. Five models offer ranges of: 0-300 VDC, 0-325 VDC, 0-500 VDC, 0-600 VDC, and 200-1000 VDC. All but the largest model deliver 6.3 volts for filament supply and all but the 300-B and 1000-BB offer 0-150 volt regulated bias.

Regulation accuracy is within a maximum tolerance of 0.5%*, and ripple is held to five millivolts RMS or below (except for 20 mv. maximum on the 200-1000 VDC model). Input range is 105 to 125 VAC, with frequency of 50, 60, or 400 cycles. B-Nobatrons may be used in either cabinet or rack mountings, and are a handsome contribution to their quarters. Your local Sorensen representative will be glad to tell you all about these B-Nobatrons. Write directly for technical data, to

SORENSEN & COMPANY, INC. Richards Avenue, South Norwalk, Connecticut

**Only 0.15% maximum variation on the 0-300; and 0.25% on the 0-600 models.*

SPECIFICATIONS

Model	300B*	325BB	500BB	600B	1000B
Output Voltage VDC	0-300	0-325	0-500	0-600	200-100
Output Current Ma	0-150	0-125	0-300	0-500	0-500
Regulation Accuracy	±0.15%**	±0.5%	±0.5%	±0.25%	±0.5%
Ripple (MV-RMS)	5 max.	5 max.	5 max.	3 max.	20 max.
Bias Supply (VDC)	—	0-150	0-150	0-150	—
Max. Bias Circ. Imp. (Ohms)	—	25000	25000	50000	—
Max. Int. Imp. (Ohms)	2.0	2.0	2.0	2.0	2.0
AC Voltage (CT Unreg.)	—	6.3/10 amps	6.3/10 amps	6.3/15 amps	—
Filament Voltages (Unreg.)	6.3 at 5 amps, series or parallel (two outputs)	—	—	—	—

*may be connected positive or negative, in series or para
**or ±0.3 volts, whichever is greater

Sorensen

CONTROLLED POWER FOR RESEARCH AND INDUSTRY

New Products

Kilovoltmeter Multiplier

For 100 μA Movements

This voltmeter multiplier for dc voltages up to 30 kv consists of a stabilized resistor immersed in high grade insulating oil. Designed for 100 μa meter movements, the accuracy is within ±2 per cent.

Del Electronics Corp., Dept. ED, 521 Homestead Ave., Mount Vernon, N.Y.

CIRCLE 110 ON READER-SERVICE CARD

Magnetic Tapes

Longer Life

Latest addition to the Scotch instrumentation tape line, nos. 148 and 149 magnetic tapes outwear previous tapes by an average of 6 to 1, and increase short wave length response by 3.5 db. Expected use is throughout the instrumentation recording field where higher tape speeds, head pressures and temperatures to 200 F are encountered. The tape incorporates a durable binder construction which minimizes problems of oxide rub-off and deposit on the machine heads.

Minnesota Mining and Mfg. Co., Dept. ED, 900 Bush Street, St. Paul 6, Minn.

CIRCLE 111 ON READER-SERVICE CARD

Blind Fastener

Full Expansion of 3/8 In.

Designed to cut costs and assembly time, these miniature threaded blind fasteners grip all materials of any thickness to 3/8 in. They will grip evenly on rough and curved as well as smooth and level surfaces. Called Jack Nuts, they can be used as rivets and/or blind fasteners in expansion space as small as 3/8 in. Anchorage is permanent permitting screws to be removed and replaced. Hole size is not critical.

Molly Corp., Dept. ED, Reading, Pa.

CIRCLE 112 ON READER-SERVICE CARD

UHF Transmitting Triode

Compact Design

Type 7004 coaxial transmitting triode was developed for uhf oscillator, amplifier and frequency multiplier service, especially where space is at a premium. It has an external anode and is forced-air-cooled via an integral radiator. Maximum plate dissipation is 300 w. Both a glass and a ceramic version are available. Maximum ratings apply up to 900 mc.

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

CIRCLE 113 ON READER-SERVICE CARD

New Products

Circuit Breadboard

For Semiconductor Circuitry

Called Mini-Lab, this unit provides means for the rapid development, assembly, study and testing of circuits and components. Designed specifically for sub-miniature, miniature, and semiconductor circuitry, the instrument includes a built-in multimeter and regulated power supplies.

Stanley Aviation Corp., Dept. ED, 2501 Dallas St., Denver 8, Colo.

CIRCLE 115 ON READER-SERVICE CARD

Production Test Scope

Handles 86 Variables

Up to 86 test point variables can be inspected with the C-Series Monitorscope equipment. The equipment is designed for flight instrumentation, production line testing, and for industrial process monitoring. Test data is observed as a varying lines display on an oscilloscope screen. Individual data samples are presented in bargraph form with the amplitude component of specific markers equivalent to the information content at the data source.

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

CIRCLE 116 ON READER-SERVICE CARD

◀ CIRCLE 114 ON READER-SERVICE CARD

CRT Recorder

Covers 12 Channels

Model 204-A12 temperature and strain recorder is designed especially for high-speed recording of short-term dynamic phenomena. The system features 12 channels of simultaneous data with a calibrated linear time base and zero time on a 10-in. wide by 31-1/2-in. long record. The canted position of the drum camera and crt tubes gives 8 more channels of information than previous models, with less than 10 per cent increase in effective volume. The recorder inclues amplifiers, timing circuits, automatic sequencing and control circuits, and a drum camera with driving mechanism for 3600 rpm operation.

Allegany Instrument Co., Inc., Dept. ED, 1091 Wills Mountain, Cumberland, Md.

CIRCLE 117 ON READER-SERVICE CARD

Portable Test Oscillator

Battery Power Supply

Featuring transistor circuitry, printed wiring, and a self-contained power supply, the model 20A test oscillator is continuously variable over a frequency range of 15 cps to 150 kc at a source impedance of less than 0.5 ohm. The oscillator will maintain its output level within ± 2 per cent, and has an output impedance of less than one ohm. The instrument's power supply consists of seven mercury cell.

Consolidated Electrodynamics Corp., Alectra Div., Dept. ED, 325 N. Altadena Dr., Pasadena, Calif.

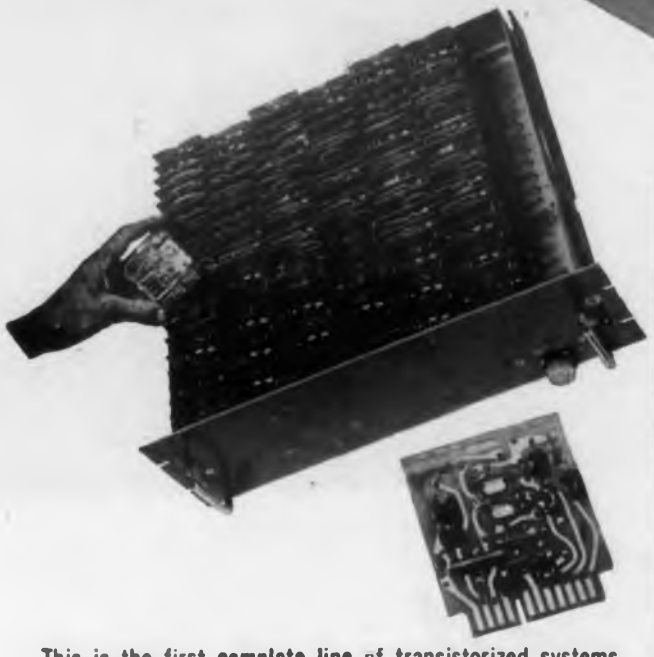
CIRCLE 118 ON READER-SERVICE CARD

CIRCLE 119 ON READER-SERVICE CARD ➤

NEW EECO Silicon TRANSISTOR PLUG-INS

–40° C to +100° C

for extremely reliable ground and airborne equipment



This is the first **complete line** of transistorized systems components offering hermetically sealed **silicon** semiconductors and components.

Check these features:

- Operate reliably in ambient temperature range of −40°C to +100°C.
- Smaller, more compact (mounted on 2-7/8" x 2-9/16" x 1/16"-thick epoxyglass); still incorporating more components.
- Power supply requirements ±20 Volts.
- Plug into any standard 12-contact etched-circuit connector.
- All plug-in contacts rhodium-plated for long life and trouble-free service.
- Complete supply of compatible systems hardware.

CIRCUITS: The complete line of EECO Silicon Transistor Plug-in circuits includes:

FLIP-FLOPS	**EMITTER FOLLOWERS**
ONE SHOTS	**SQUARING CIRCUITS**
NEON DRIVERS	**LINEAR AMPLIFIERS**
RESET GENERATORS	**BLOCKING OSCILLATORS**
DIODE LOGICS	**and many others.**

NEW EECO RUGGEDIZED STANDARD-SERIES PLUG-INS

The full line of tested and proven circuits available in EECO's Standard-Series Plug-ins has been ruggedized for even greater reliability and more efficient performance.

Each unit now incorporates the IERC Shield to:

- Protect tube from vibration and shock.
- Dissipate heat more effectively.
- Ensure longer tube life with cooler, more efficient operation.
- Provide even greater electrical shielding.

New mechanical construction and design assures full protection to critical components against stress or tension.

All ruggedized units are compatible with EECO Standard-Series hardware and EECO Systems Development Racks.

NEW CIRCUITS include High-Speed Flip-Flops, Oscillators, etc., in both Computer-Series and Standard-Series Plug-ins . . . plus other systems building blocks: D-C Chopper Stabilized Amplifiers, Power Supplies and Compatible Accessories, Systems Development Racks, Systems Components. Detailed information available in Catalog No. 856-A.

AVAILABLE SOON: New EECO Germanium Transistor Plug-ins. These EECO units will comprise a complete line of transistorized systems components, including a full complement of circuits (One Shots, Flip-Flops, Linear Amplifiers, Pulse Amplifiers, "And" Gates, "Or" Gates, and many others) as well as compatible systems hardware.

ENGINEERED ELECTRONICS Company

ENGINEERED ELECTRONICS COMPANY

a subsidiary of

Electronic Engineering Company of California

506 EAST FIRST STREET · SANTA ANA, CALIFORNIA

CIRCLE 120 ON READER-SERVICE CARD

New Products

Varnish-Enamel Insulation

Withstands 180 C

Isonel no. 175 wire enamel and Isonel no. 31 high bonding insulating varnish will withstand hot spot temperatures of 180 C when used together. The insulating system can be applied and cured at conventional temperatures of 290 to 325 F. Particular use is in high-speed motors and in generators.

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

CIRCLE 121 ON READER-SERVICE CARD

Data Logger

Handles 2000 Variables

Featuring modular construction and pinboard programming, series 1200 can handle from 200 to 2000 input variables, make conversions to dc voltages, perform zero offset, scaling, characterization of non-linear inputs, and record all readings on an automatic typewriter. Readings can also be recorded simultaneously on a punched tape which can then be used with an analog computer for closed-system control of the process variables.

Fischer & Porter Co., Dept. ED, 464 Jacksonville Rd., Hatboro, Pa.

CIRCLE 122 ON READER-SERVICE CARD

Diode Clip

Press Fit Mounted

Fastened to a teflon insulator for press fit mounting, type 2323 clip is designed to securely support ferrule contact diodes. The clip can be used in chassis and panels up to 1/8-in. thick.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

CIRCLE 123 ON READER-SERVICE CARD

Rectifier
20-Amp Silicon
Rated 200 C

This series of stud-mounted 200 C silicon rectifiers have been given a current rating of 20 a. The four types which comprise the series are designated 1N1301, 1N1302, 1N1304, and 1N1306. Respectively, they have peak inverse voltage ratings of 50, 100, 200, and 300 v. The units have a peak one-cycle surge current rating of 300 a with operating currents up to 20 a. Maximum leakage current rating on the rectifiers is 5 ma. The maximum full cycle average voltage drop at 10 and 200 C junction temperature is 1/2 v.

General Electric Co., Dept. ED, Electronics Park, Syracuse, N.Y.

CIRCLE 125 ON READER-SERVICE CARD

Power Supply
5 Kv Unit

Designated Model PS5-S, this unit delivers 5 kv dc at 5 ma from a 117 v ac, 60 cps source. The output voltage may be varied from 0-5000 V at rated load by varying the input voltage. Ripple is 1.5 per cent rms maximum at rated load, less for smaller values of load. The unit can also be used for 400 cps operation if desired, with no change in output specifications except reduced ripple. The unit measures 3-3/4 in. x 4-9/16 in. and overall height including the solder sealed terminals is 7-1/8 in.

Film Capacitors, Inc., Dept. ED, 3400 Park Ave., New York 56, N.Y.

CIRCLE 126 ON READER-SERVICE CARD

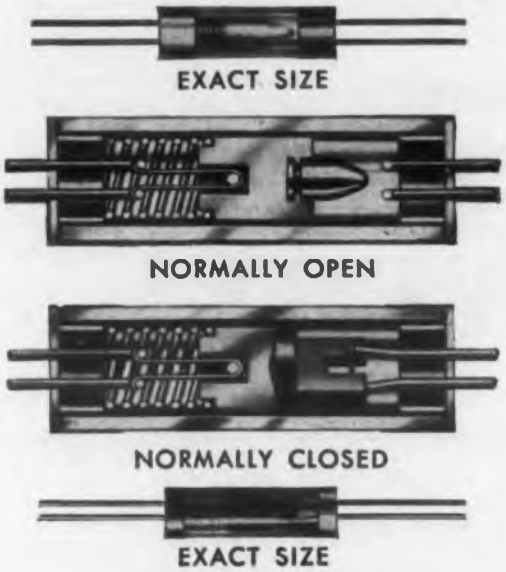
CIRCLE 127 ON READER-SERVICE CARD ➤

ORIGINAL DESIGNS

MINIATURE THERMAL RELAYS

with

99.99% PLUS RELIABILITY



Our complete environmental testing laboratory samples and certifies daily production.

New NORMALLY CLOSED RELAYS NOW AVAILABLE. Hermetically sealed by an exclusive process of bonding metal headers to high thermal, shock resistant glass housings. Designs are based on the "fuse burnout" principle and will open or close a circuit *positively* in 0.1 second or other delay times. They can also be safely used as a "squib" or timing mechanism.

Relays have been qualification tested for high performance and are being used extensively on current production missiles and complex electronic equipment.

Withstand extreme conditions of temperature (−100°F to +450°F), shock (250 G's), vibration (20-3000 cps at 40 G's), and precise electrical characteristics with the added feature of visibility.

WHAT ARE YOUR REQUIREMENTS?

Write TODAY for new Brochure containing detailed characteristics and specifications.

NETWORKS ELECTRONIC CORPORATION

14806 OXNARD STREET, VAN NUYS, CALIFORNIA

Original designs for highest reliability in glass housed miniature Relays and Resistors for all purposes.

CIRCLE 128 ON READER-SERVICE CARD

New Products

Tantalum Capacitors

Temperature Range
—80 to +85 C

The electrolyte in Tan-Sol type TAS tantalum capacitors is a solid semi-conducting material that is not subject to corrosion, thus permitting use in severe operating conditions. Capacity and dissipation factor are stable over the range from —80 to +85 C.

P. R. Mallory & Co. Inc., Dept. ED, 3029 E. Washington St., Indianapolis 6, Ind.

CIRCLE 129 ON READER-SERVICE CARD

Transistorized Power Supply

280 V, 1.5 Amp

Completely transistorized, model PS-4000 occupies 5-1/4 in. height in a standard rack. It provides 280 v at 1.5 amp with less than 0.2 v variation from minimum to full load or over a 10-v line variation. Over-all efficiency is 70 per cent. Output ripple and noise combined are 10 mv peak-to-peak maximum. The output impedance is less than 0.2 ohms.

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

CIRCLE 130 ON READER-SERVICE CARD

Solar Cells

1-In. Diam

These p-n junction silicon solar cells, when grouped in a series parallel configuration, provide a practical source of energy to portable devices. Cells measuring approximately 1 in. in diam are available in mounted and unmounted types.

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

CIRCLE 131 ON READER-SERVICE CARD

AC Voltmeter

30 Cps to 300 Kc

This portable, multi-range, ac voltmeter is designed to bridge balanced circuits such as encountered in multi-channel carrier-frequency equipment. Designated model 15A, it is capable of measuring ac voltages from 1 mv to 300 v full-scale within the frequency range of 30 cps to 300 kc. Measuring 6 x 8 x 6 in. and weighing 6 lb, the instrument has a self-contained battery power-supply of four 4-volt mercury cells. Transistor circuitry permits quick operation and stable readings.

Consolidated Electrodynamics Corp., Alectra Division, Dept. ED, 325 N. Altadena Dr., Pasadena, Calif.

CIRCLE 133 ON READER-SERVICE CARD

Rotary Switch

90 Circuits per Pole

This rotary switch sequentially switches up to 90 circuits per pole break-before-make at any constant speed up to 1800 times per min. Each circuit can be switched with noise levels less than 20 μv, contact resistance variations smaller than 0.05 ohms. Numerous switching combinations can be included in a single unit, such as 45 contacts at 1200 times per min, plus 90 at 600, plus 30 at 1800.

Instrument Development Laboratories, Inc., Dept. ED, 67 Mechanic St., Attleboro, Mass.

CIRCLE 134 ON READER-SERVICE CARD

CIRCLE 135 ON READER-SERVICE CARD ➤

Custom cabling as you want it ...when you want it

Imagine a vast storehouse containing every electronic cable which you may ever require—every combination of conductors, fillers, wrappings, jackets, and connectors—all combined into tough, reliable cable assemblies—all tested and proven to be electrically, mechanically and environmentally suited to whatever applications you may ever have.

The facilities of Pacific Automation Products, Inc., *are* such a storehouse. Here you can obtain custom cable—tailored to your most exacting requirements—and available at off-the-shelf speed.

Place this Infinite Inventory at your disposal today. Phone, write or wire:

PACIFIC AUTOMATION PRODUCTS, INC.

1000 AIRWAY, GLENDALE 1, CALIFORNIA *Phone: CHapman 5-6871 or CItrus 4-8677*

137 WALNUT HILL VILLAGE DALLAS 20, TEXAS FLEETWOOD 2-5806
1809 VIRGINIA AVE. REDWOOD CITY, CALIF. EMERSON 9-1962
420 LEXINGTON AVE. NEW YORK 17, N. Y. LEXINGTON 2-5193

Engineers: This Company has imagination, youth, spirit, and goals that are well defined. Why not send your resume today?

17 light-years late for dinner . . .

As everybody knows, space ships travel by cutting magnetic lines of force . . . and a supply of good permanent magnets is a "must" if you're going to make with the $E=mc^2$ in outer space. (Technical details on this are not quite ready for release.)

This wandering spaceman from Planet Plexippedes was making a routine flight over California and forgot to watch his flux density indicator. Suddenly—no power . . . and he had to limp home on his auxiliaries, to face an irate wife.

Too bad nobody told him about Thomas & Skinner's complete line of magnetic materials—permanent magnets, wound cores, laminations and SiFeMag tapes. T & S magnetic materials have proved ideal in literally thousands of industrial applications. No reason why they wouldn't be ideal for space ship installations, too.

SPECIALISTS IN MAGNETIC MATERIALS

Permanent Magnets · Magnetic Tapes · Laminations · and Wound Cores

Thomas & Skinner, Inc.

1157 E. 23rd St. **Indianapolis, Indiana**

CIRCLE 136 ON READER-SERVICE CARD

New Products

Ferrite Isolater

Rated at 350 Kw

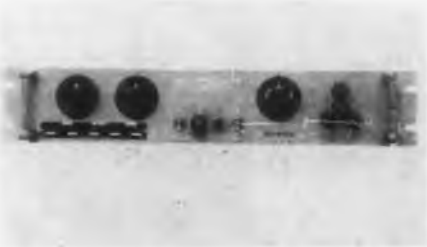
This C band 350 kw unit is the latest addition to the company's line of ferrite isolators. This model has a maximum insertion loss of 0.5 db. A maximum vswr of 1.15 with matched load, and a minimum isolation of 15 db is provided in the 5400 to 5650 mc range, whereas the 5400 to 5900 mc range provides a maximum vswr of 1.10 with matched load and a minimum isolation of 10 db. These ferrite isolators will withstand repeated temperature cyclings from —55 to 100 C.

Airtron, Inc., Dept. ED, 1101 W. Elizabeth Ave., Linden, N.J.

CIRCLE 137 ON READER-SERVICE CARD

Power Oscillators

Stable 6-W Source



Suitable for powering computers, ac transducers, or for production testing, these oscillators provide 6 w of stable, harmonic-free ac power. Single or multiple channel units range in frequency from 200 to 15,000 cps and from 10 to 150 v rms output into a 6 w load. Output frequency, voltage stability and distortion are better than 0.08 per cent of rated output from no load to full load. Frequency is adjustable by means of trimmers, and the output voltage can be varied from 0 to rated value with an attenuator. A four terminal output provides flexibility for operation with balanced or unbalanced load, either floating or grounded.

Cardinal Instrumentation Corp., Dept. ED, 4201 Redwood Ave., Los Angeles 66, Calif.

CIRCLE 138 ON READER-SERVICE CARD

Inductors and Transformers

High Q Miniatures

These r-f and i-f inductors and transformers are available in various core formulas to give an inductance free from non-linear effects with a high Q. Coils and transformers are available for −50 to +100 C operation with negative temperature coefficients of inductance of approximately 50 ppm per deg C. Size of the double-tuned transformer is a 1-1/8 in. cube while the inductor has a 3/4-in. diam and is 1-1/8 in. long. Tuning range is more than 2 to 1 in inductance.

Moore Associates, Dept. ED, 2628 Spring St., Redwood City, Calif.

CIRCLE 140 ON READER-SERVICE CARD

Pressure Switch

Remotely Adjustable

Called the Electroset pressure switch, this device can be automatically calibrated and set from a remote position. In operation, one contact is positioned when the desired set pressure is applied. The other contact is unlocked by energizing a solenoid and is locked by de-energizing the solenoid. In this set position, the switch contacts will open at pressures below the calibrating pressure and close at pressures equal to or above the calibrating pressure.

Specifications are: range—adjustable from 0 to 15 psia; repeatability of ±1 mm Hg; accuracy of ±2 mm Hg; acceleration of 50 g in any direction; vibration of 25 g to 2000 cps; weight of 14 oz.; temperature range −65 to +160 F; switching current of 1 amp resistive load.

Trans-Sonics, Inc., Dept. ED, Burlington, Mass.

CIRCLE 141 ON READER-SERVICE CARD

CIRCLE 142 ON READER-SERVICE CARD ➤

New Products

Digital Frequency Meter

Accuracy of ±3 Mc

The model 114 wavemeter assembly provides digital readout in gray binary code of unknown frequencies in the range from 3600 to 5600 mc. The unit consists of a high-Q coaxial resonant cavity, automatically tuned through the complete frequency range and back in one second. In operation, the wavemeter works in conjunction with an airborne superheterodyne and searches out the local oscillator frequency of the receiver. When the wavemeter tunes through this frequency, it resonates and transmits a pulse of energy which keys the coded output to indicate the frequency to an accuracy of ±3 mc.

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

CIRCLE 144 ON READER-SERVICE CARD

Power Supply

For Travelling Wave Tubes

The Model 500 is a general purpose traveling wave tube power supply which will operate most low-level and intermediate-level traveling wave tubes. Regulation is within 0.1 per cent on the anode, helix, and bias, within 1 per cent on the solenoid and collector, within 1 per cent line on the heater, and within 10 per cent on the input.

Wave Particle Corp., Dept. ED, P.O. Box 252, Menlo Park, Calif.

CIRCLE 145 ON READER-SERVICE CARD

Silicon Power Diodes

Forward Currents to 1.6 Amp

Types 305, 320 and 321 hermetically sealed silicon rectifying cells provide dc forward currents up to 1.6 amp with a maximum peak inverse voltage up to 800 v. Maximum forward voltage drop at 1 amp and 125 C case temperature is 1.3 v. The peak leakage current at the same case temperature will not exceed 1.5 ma. Maximum operating frequency is 50 kc. Type 305 has a stud base for through mounting; type 320 has a pigtail base and type 321 has a plain base without the pigtail.

Westinghouse Electric Corp., Dept. ED, Box 2278, Pittsburgh, Pa.

CIRCLE 146 ON READER-SERVICE CARD

Audio Sweep Generator

Precision Pattern Output

The complex output signal of this audio sweep frequency generator is produced by scanning photo-electrically a synchronously rotating disc. The modulation on the disc is the photographic reproduction of a precision pattern, the accuracy of which assures a positive signal which eliminates anomalous distortion, frequency and other discriminations which could be introduced by non-stable reactive components of more complex circuits. The signal, as it comes from the generator, scans from 80 to 20,000 cps. The sweep frequency is covered by 20 signal pulses per second. The signal is flat over the range within 1 db. Frequency markers occur at 2, 5, 10, 14, 18 and 20 kc. A base line is provided for determining relative amplitudes. The reduction of any point to half its amplitude is an attenuation of 6 db. The output is 4 v, open circuit; internal impedance is 290 ohms.

Pacific Transducer Corp., Dept. ED, 11836 W. Pico Blvd., Los Angeles 64, Calif.

CIRCLE 147 ON READER-SERVICE CARD

New Products

Speed Control Relay

Self-Powered

Model 3420 relay operates as an over or under speed control and requires no external source of power other than that generated by a power type magnetic pickup. The pickup consists of a magnet with a coil of wire surrounding it, and acts as a miniature generator when placed near the teeth of a gear. At a set peripheral speed of a given gear, the speed control relay will close due to the power generated in the relay. Critical speed is set by adjusting spacing between the magnetic pickup and actuating metal.

Electro Products Labs., Inc., Dept. ED, 4500 N. Ravenswood Ave., Chicago 40, Ill.

CIRCLE 150 ON READER-SERVICE CARD

Silicon Transistors

Medium Power

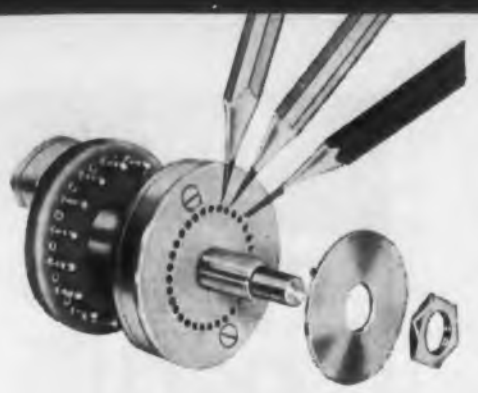
Designed for medium power applications, these two diffused-base transistors have dissipation ratings of 4 w at 25 C case temperature and 1 w at 150 C case temperature. Both npn types feature a typical saturation resistance of 20 ohms at 25 C plus an operating range of −65 to +200 C.

The 2N497 is a 60-v transistor, for use with 28-v power supplies. The 2N498 is a 100-v unit for use in equipment such as servo amplifiers and regulated power supplies. Other characteristics include an 800-mw free air temperature rating, an 8-v minimum emitter-to-base rating and a typical static forward current transfer ratio of 20.

Texas Instruments, Inc., Dept. ED, P. O. Box 312, Dallas, Texas.

CIRCLE 151 ON READER-SERVICE CARD

CIRCLE 152 ON READER-SERVICE CARD ▶



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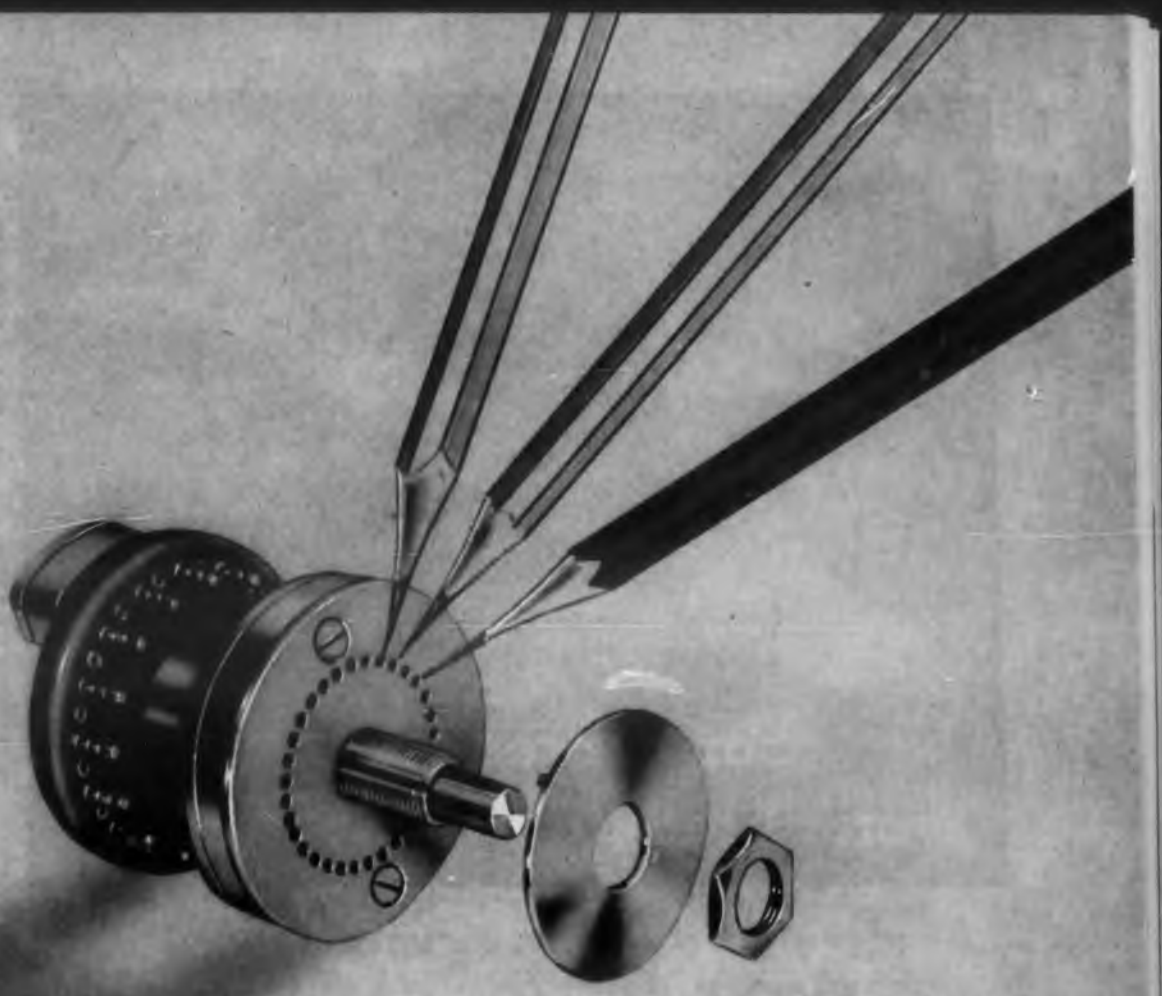


Stop it ... where you want it!

Daven's New Rotary Switch with Adjustable Stop

For flexibility in all types of circuit experimentation, laboratory work, breadboard setups, and in circuitry where the exact number of switch positions might be changed at a later date, the new DAVEN Rotary Switch with an Adjustable Stop is ideal. This unit, as a single pole switch, can have a maximum of either 24 shorting positions with 15° spacing or 32 shorting positions with 11¼° spacing. One, two, three, and four pole units are available in this design.

In common with all other DAVEN Rotary Switches, the Adjustable Stop Switch features sturdy, dependable construction; silver alloy contacts and slip rings; tamper-proof, KNEE ACTION* silver alloy rotor blades; high grade, accurately machined dielectric; and gold flashed turret-type terminals for ease of soldering.

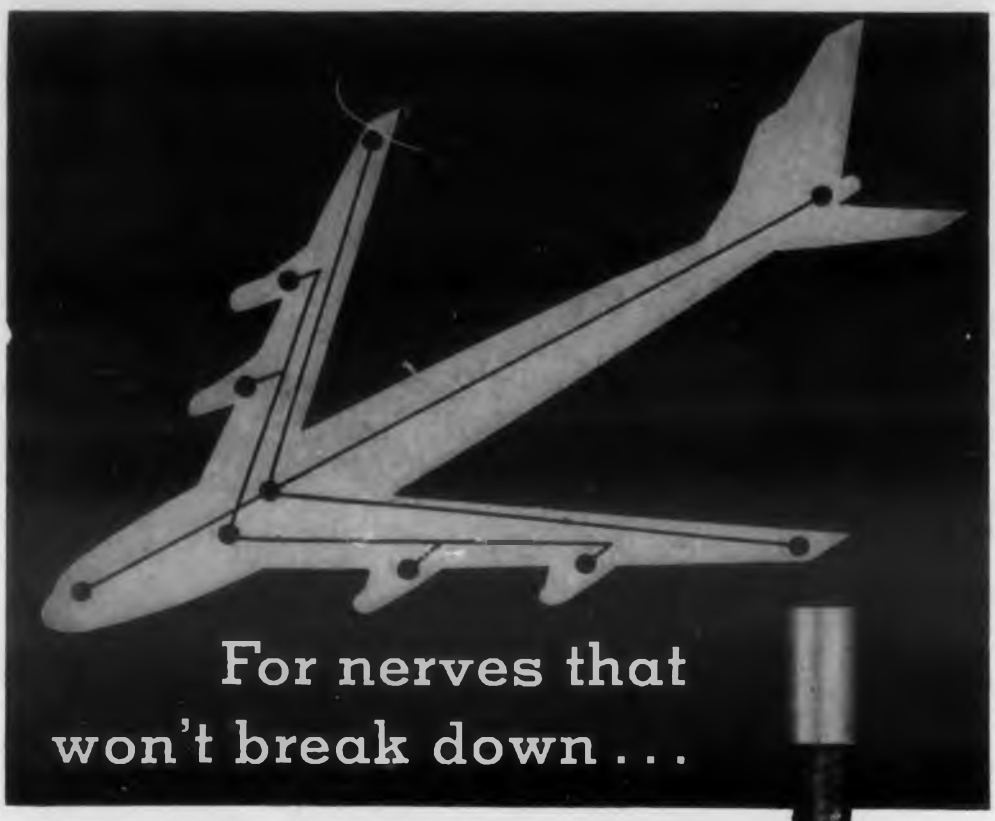
*Patented

Write for complete information.

THE DAVEN CO.

LIVINGSTON, NEW JERSEY

TODAY, MORE THAN EVER, THE DAVEN ... STANDS FOR DEPENDABILITY!



For nerves that won't break down . . .

. . . specify
REVERE TEFLON* CABLE

Electronic cables, the "nerves" of monitoring and testing systems in missiles, rockets and aircraft, are constantly being stressed by the searing heat around jet engines . . . the sub-zero cold of the stratosphere . . . immersion in fuels, chemicals or solvents. Revere Teflon Cable meets these high service requirements . . . and those of computer and radar applications, too.

Revere Teflon Cables are available with 1, 2, 3 or 4 teflon-insulated, silver plated, stranded copper conductors, rated for continuous operation from —90°C. to +210°C. Cables are shielded with silver plated copper to give 90% coverage. Jackets to suit application — silicone treated glass braid, teflon, Kel-F**, vinyl, nylon, etc.

Conductor size: 24 to 18 gage in .008" (300 volt), .010" (600 volt) and .015" (1000 volt) wall thicknesses. Ten and fifteen mil wall conductors meet applicable requirements of MIL-W-16878, Type E and EE.

*E.I. du Pont trademark
**M.W. Kellogg trademark
† Wire passes 500 hr., 250°C heat-aging test . . . also cold bend test

TYPICAL SPECIFICATIONS — Single Conductor Teflon Insulation

Spark Test Voltage	3000 volts
Insulation Resistance	Greater than 10^4 megohm/1000 ft.
Continuous Operating Range	—90°C. to +210°C. (†)
Dielectric Constant @ 1 MC/Sec	2.5 maximum
Power Factor @ 1 MC/Sec	Less than 0.0003
Flammability	Does not support combustion
Shrinkage	Less than ⅛" in 18" @ 250°C for 96 hrs.
Abrasion (per MIL-T-5438)	Passes 38" of 400 grit, aluminum oxide, ½ lb. weight
Moisture Absorption	0.0%
Specific Gravity	2.2 average
Chemical and Solvent Resistance	Excellent

Write today for Engineering Bulletin 1905 describing Revere TEFLON CABLE.

REVERE CORPORATION OF AMERICA
Wallingford, Connecticut
A SUBSIDIARY OF NEPTUNE METER COMPANY

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CIRCLE 153 ON READER-SERVICE CARD

New Products

Valve Operator

Controlled by Small Signal

The SM-11-X explosion proof valve operator mounts directly on the stem of rotary valves. Called the Valvetrol, it provides remote control from a pushbutton station, or it may provide proportional control in automatic systems with the control signal originating from a dc, 0 to 5 ma source, or from an ac control signal. Accuracies are provided of ± 0.2 per cent full scale for standard models or ± 0.04 per cent in special types. Conversion from manual to remote or automatic operation is obtained for most valves by removing the hand wheel and installing the Valvetrol in its place. The unit provides proportional control for valves requiring from 1/6 to 40 turns and stem torques up to 800 in.-lb. Operating times from full open to full close may vary from 2 to 60 sec.

The Jordan Co., Inc., Dept. ED, 3235 W. Hampton Ave., Milwaukee 9, Wis.

CIRCLE 154 ON READER-SERVICE CARD

Miniature Motors

Adjustable Brush

Measuring slightly over one inch in diameter, these permanent magnet motors feature a rotatable brush holder which is adjustable for best commutation and power output. All armatures are wound with heavy Formvar wiring utilizing Mylar insulation. Motors designed for operation from 6, 12, and 27.5 v are carried in stock, with other windings or mechanical modifications available on special order.

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

CIRCLE 155 ON READER-SERVICE CARD

Beam Power Pentodes

TV Vertical Deflection

Designated types 6DW5 and 12DW5, these 9-pin miniature beam power pentodes are designed for vertical deflection amplifier application in TV receivers with 110-deg deflection systems. Capable of operation at relatively low B supply voltages, adequate vertical deflection is insured by an 11-w max plate dissipation and a 2.5-w max screen dissipation. Both types feature a maximum peak positive-pulse plate voltage of 2200 v, and maximum peak cathode current of 225 ma.

Sylvania Electric Products, Inc., Dept. ED, 1740 Broadway, New York, N.Y.

CIRCLE 157 ON READER-SERVICE CARD

Microvoltmeter

High Selectivity

Type USVH microvoltmeter has a frequency range of 20 kc to 30 mc and a sensitivity of 1 μv to 1 v, full scale. Voltage level range is from −120 to 0 db in sub ranges of 10 db. The frequency range is available in six sub ranges, and the meter has two bandwidths, 500 cps and 5 kc, the latter useable between 0.1 and 30 mc. Other specifications include an accuracy of voltage indication at 1 mc and 1 v of ±2 per cent; frequency response referred to 1 mc of ±5 per cent; suppression of image frequency better than 60 db; and a noise level of about 0.4 μv for 5 kc bandwidth and 0.1 μv for 500 cps bandwidth. Input impedance is greater than 500 K with 200 μμf in parallel.

International Telephone and Telegraph Corp., Dept. ED, 100 Kingsland Rd., Clifton, N.J.

CIRCLE 158 ON READER-SERVICE CARD

CIRCLE 159 ON READER-SERVICE CARD

New Products

Silicon Rectifiers

100 to 600 PIV

Type M14 diffused silicon rectifiers are available in peak inverse ratings of 100 through 600 v with average forward currents of 500 ma. Case is common to either cathode or anode. A single-ended package allows automatic assembly techniques in installation.

Motorola Inc., Dept. ED, 4545 W. Augusta Blvd., Chicago 51, Ill.

CIRCLE 160 ON READER-SERVICE CARD

Spinner Knobs

Rapid Rotation

Models HRT-C and HRT-MC spinner knobs are offered with spinner shafts of a cadmium finished steel and sleeves in black or gray anodized aluminum. Overall diameters are 2-1/8 and 1-1/2 in. respectively. Both fit 1/4 in. shafts.

National Company, Inc., Dept. ED, 61 Sherman St., Malden 48, Mass.

CIRCLE 161 ON READER-SERVICE CARD

High Voltage Capacitors

2 to 5 Kv

High voltage and deflection yoke capacitors have been added to the company's line of ceramic disc capacitors. The capacitors are available in a range from 2 kv through 5 kv, with capacitance values extending from 4.7 to 250 μμf.

Electra Manufacturing, Dept. ED, 4051 Broadway, Kansas City, Mo.

CIRCLE 162 ON READER-SERVICE CARD

Data Processor

Analog to Digital

Series 160 analog to digital data processor is designed to be a mobile data handling unit for in-plant use. Analog information is made available either visually as an in-line 3 digit indication or as a number printed sequentially on paper tape or in punched tape form. Typical specifications would provide a range of ±5 mv full scale, a sampling interval of 0.001 sec at repetition rates of up to 400 samples per second or as otherwise limited by output device, and an accuracy of ±0.1 per cent of full scale.

Systron Corp., Dept. ED, 2055 Concord Blvd., Concord, Calif.

CIRCLE 164 ON READER-SERVICE CARD

Vibration Mounting

Integral Part of System

Model 1514 opposed cushion center-of-gravity mounting system is designed as an integral part of equipment. An shown here, the mount has the dual function of chassis and all-altitude mounting system for an aircraft servo amplifier. Load rating for model 1514 is between 19 and 25 lb. Mounting system weight is approximately 3-1/2 lb. Natural frequency is between 15 and 21 cps. The percentage of vibration isolation at 55 cps is as high as 90 per cent and improves at higher frequencies. These results are obtained after 15 g drop tests on all six sides.

Robinson Aviation, Inc., Dept. ED, Teterboro Air Terminal, Teterboro, N.J.

CIRCLE 165 ON READER-SERVICE CARD

...a complete data file for electronic designers concerned with—

RF SUPPRESSION!

Here's a new METEX data file that's just bulging with important information for designers. This folder contains individual data sheets plus a big, illustrated, 16-page, two-color bulletin on the suppression of radio interference.

Get your free copy of this valuable, informative, fact-filled folder today. Just fill in and mail the coupon below for complete data.

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Gentlemen:
Please send me your fact-filled METEX data file today.

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CIRCLE 166 ON READER-SERVICE CARD

New Products

Single-Turn Potentiometer

125 K Range, 0.2 Per Cent Linearity

Model 700 potentiometer is now available with resistance values to 125 K and ±0.2 per cent linearity. This 7/8-in. diam. unit incorporates all aluminum construction, up to 6 sections ganged on a single shaft, first pot section 0.687-in. long and each additional cup 0.5 in. in length.

Spectrol Electronics Div., of Carrier Corp., Dept. ED, 1704 South Del Mar Ave., San Gabriel, Calif.

CIRCLE 167 ON READER-SERVICE CARD

Voltage Monitor

for Accurate Telemetering

Capable of achieving accuracies of 0.04 per cent or less in telemetering and recording systems, this voltage monitor measures 6-in. long. Output is provided by potentiometers, synchros, or coded discs. These are shaft driven through a precision gear train at a ratio of 100:10:1 with respect to one another. Thus, one output will be a function of a 100 per cent change in the analog input signal, the second output a function of a 10 per cent change, and the other a function of a 1 per cent change. The unit has input impedances of 100 or 200 K.

G. M. Giannini & Co., Inc., Dept. ED, 918 E. Green St., Pasadena 1, Calif.

CIRCLE 168 ON READER-SERVICE CARD

Centrifugal Blower

5-1/4 In. High, 100 CFM

Model 1H300 cooling unit consists of a rack mounted centrifugal blower package, measuring 5-1/4 in. high with 9-1/2 in. panel width allowing 2 to a regular 19 in. rack if required. The blower delivers 100 cfm and is equipped with a large permanent type filter and a stainless steel grille. A matching filter grille assembly is available to prevent the back-flushing of dust when blower is not in operation. The filter acts as an r-f shield.

McLean Engineering Labs., Dept. ED, P.O. Box 228, Princeton, N.J.

CIRCLE 170 ON READER-SERVICE CARD

Punched Tape Reader

Fast Start-Stop

Capable of handling paper tape strips or reels with equal facility, this perforated tape reader can operate at speeds of up to 750 characters per sec, with less than 5 msec start or stop time. At 300 characters per sec it stops in the space following the stop character. All standard 5, 6, 7 or 8 level tapes are handled and 11/16, 7/8, or 1-in. wide tape can be used interchangeably. The unit includes highly stable reading heads using silicon photodiodes; transistorized output drivers for low impedance output, and magnetic amplifier reel servos.

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

CIRCLE 171 ON READER-SERVICE CARD

Readouts

Both Digital and Message

An assortment of readouts includes digital information with polarity signs or other special symbols, and message readouts with color-coded printed information. Design allows side by side mounting of the units for inline presentation of information.

Milman Engineering Co., Dept. ED, 1831 Pontius Ave., Los Angeles 25, Calif.

CIRCLE 172 ON READER-SERVICE CARD

True RMS Voltmeter

Measures Random Signals

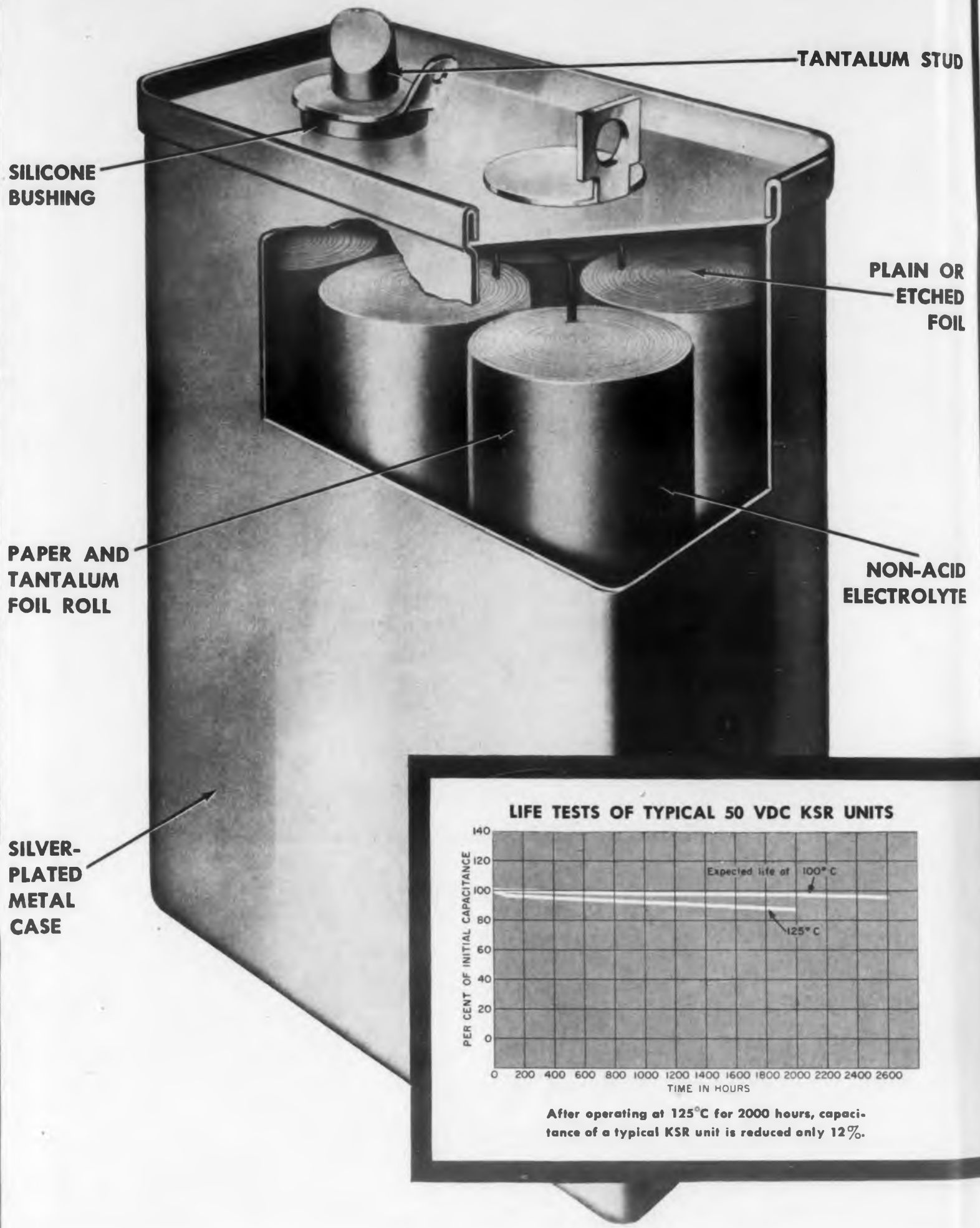
Model TMB random signal true rms voltmeter provides accurate, long-time-average measurements in the presence of low frequency signal components. The voltmeter has a panel switch selection of "fast," about 0.1 sec, for quick estimates of rms level and "slow," about 10 sec, for exact measurements. The slow reading provides true rms voltage measurements through a thermal squaring-averaging device. Readings are accurate to 2 per cent full scale on all ranges.

Bandwidth is 2 cps to 250,000 cps flat ± 0.2 db. Eighteen voltage ranges are provided, 500 μv to 250 v rms full scale. Peak factor is 10. Calibration and overload protection are built in. Input impedance is 1 meg, shunted by about 20 μμf to 250 mv, and by about 5 μμf above 250 mv. The instrument measures 8 x 7 x 12 in.

Flow Corp., Dept. ED, 85 Mystic St., Arlington 74, Mass.

CIRCLE 173 ON READER-SERVICE CARD

General Electric announces . . . .



CIRCLE 174 ON READER-SERVICE CARD

new KSR† Tantalytic* Capacitors

KING SIZE RECTANGULAR units offer thousands of microfarads in lighter, smaller cases

Now General Electric offers a completely new Tantalytic capacitor for use in computers, missiles, radar, and airborne electronic equipment—the King Size Rectangular Capacitor. This unit offers more joules per size, weight, and cost than any other tantalum capacitor available.

On a volt-microfarad basis, the new KSR's are 40% lighter, 30% smaller, and 40% less expensive than other 125°C rectangular capacitors. Compared with 125°C cylindrical designs, KSR's may be as much as 50% lighter, 30% smaller, and 15% lower in cost.

Like other General Electric Tantalytic capacitors, the KSR units offer "bulk capacitance," i.e., high volt-microfarads in an extremely small case. Now, one King Size Rectangular capacitor can often be used where several lower rated units were needed before. As a result of this bulk capacitance, costly connections are reduced and extra mounting brackets are eliminated.

† Trade-mark of General Electric Co.

In addition to the great size and weight advantages, the KSR capacitors offer these outstanding features:

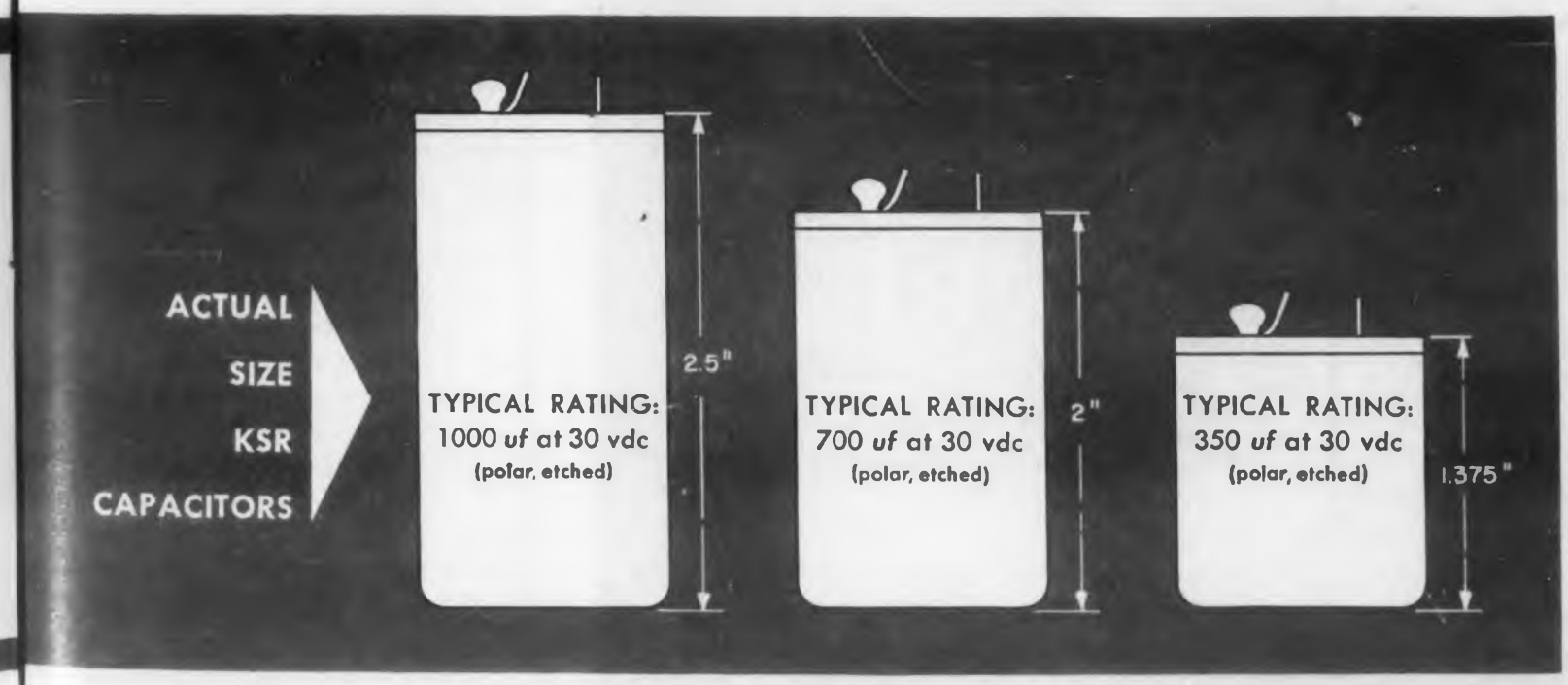
- **High reliability from −55°C to +125°C.**
- **Polar or non-polar construction; plain or etched foil.**
- **Long operating life at 125°C; extra long life at 85°C.**
- **Excellent shock and vibration characteristics.**
- **Non-acid electrolyte for long shelf life.**
- **Dual temperature and voltage ratings.**

KSR Tantalytic capacitors are now available in three case sizes: 1.375 inches, 2 inches, and 2.5 inches in height. All three have the same base size: 1.316 inches by .75 inch. For more information on these new capacitors or for assistance with your capacitor applications, contact your General Electric Apparatus Sales Office. Or write to General Electric Co., Section 449-1, Schenectady, N.Y.

* Registered trade-mark of General Electric Co.

Progress Is Our Most Important Product

GENERAL ELECTRIC



CIRCLE 174 ON READER-SERVICE CARD

Wire Tantalum Capacitors

Miniatures for Low-V Use

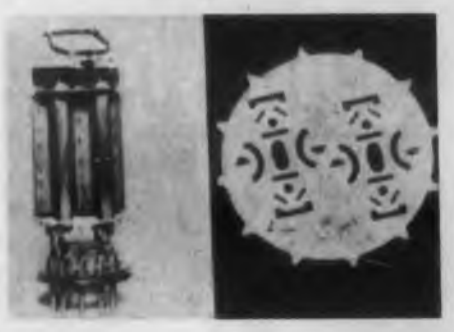
Designed for low voltage dc applications such as in transistorized audio amplifiers, type WT wire tantalum capacitors feature extremely small size and operating temperature range of −20 to +50 C. Of polar construction, the capacitor case and the attached lead form the cathode terminal and are available in insulated and non-insulated construction. The anode tantalum wire extends through a Teflon bushing to which a solderable lead is attached.

Aerovox Corp., Dept. ED, New Bedford, Mass.

CIRCLE 175 ON READER-SERVICE CARD

Twin Triode

for Computer Use



Designated type 7044, this computer tube features high zero bias plate current, separate cathode connections, and freedom from cathode interface and interelement leakage. The tube is particularly useful in inverter, frequency divider, cathode follower and multi-vibrator circuits.

Structurally, the tube makes use of a protective shield of mica to prevent deposition of getter material on micas and electrodes, thus minimizing interelectrode leakage. Leakage slots in the mica are designed to eliminate direct leakage paths between tube elements and to maintain high insulation resistance. The tube has a plate dissipation of 4.5 w per plate with a total of 8 w for the two sections.

Sylvania Electric Products, Inc., Dept. ED, 1740 Broadway, New York 19, N.Y.

CIRCLE 176 ON READER-SERVICE CARD

New Products

Transistors and Magnetic Cores

Encapsulated Plug-In Modules

A series of eight epoxy-encapsulated units is available for equipment requiring computer-type circuitry. Currently available units consist of: three magnetic register modules, two flip-flop modules, one pnp transistor module, one npn transistor module, and one diode module. Components mounted on printed circuit boards.

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

CIRCLE 178 ON READER-SERVICE CARD

100W Power Amplifier

for Laboratory Use

Model 6006 power amplifier has application as an audio and ultrasonic source of power in the laboratory or for production testing. The amplifier consists of two 7-in. standard rack units, the power supply and the amplifier, and all interconnecting cables. Rated output is 100 w, sine wave, continuous; frequency response 20 cps to 50,000 cps ± 0.5 db. Total harmonic distortion is less than 0.3 per cent at rated output; intermodulation distortion is less than 0.5 per cent. Hum and noise are 85 db below rated output. Terminating impedance taps provided 4, 8, 16 ohm unbalanced, 70 v unbalanced, 600 ohms balanced. Damping factor is 10; input impedance is 250 K and sensitivity is 1.25 v rms.

Electro-Voice Inc., Dept. ED, Buchanan, Mich.

CIRCLE 179 ON READER-SERVICE CARD

◀ CIRCLE 177 ON READER-SERVICE CARD

Pulse Generator

10 Mc Repetition Rate

Designed particularly for use in the development of high speed pulse handling equipment, model B-5 pulse generator has an upper repetition rate, from internal oscillator, of 1 cps to 10 mc. Pulse widths are 0.02 to 12.5 μsec, rise time is 8 mμsec, and amplitude is 40 v. Internal impedance is 185 ohms.

Rutherford Electronics Co., Dept. ED, 8944 Lindblade St., Culver City, Calif.

CIRCLE 181 ON READER-SERVICE CARD

High Torque Actuator Motor

Split Second Start-Stop

This actuator motor features a high starting equal to the running torque. Basically it is a compact, ac rotary solenoid with a vibrating rate of 120 cps when operated on 60 cps. This vibratory motion is translated into rotary stepping motion through a fast acting one-way clutch. It can be used as a rotary selector for wafer, coaxial or other types of switches; for remote control switching and homing devices; for valve operation, or for power stepping switching and indexing devices of all types.

The device stops within 10 msecs at 60 cps operation and 5 msec at 400 cps. Operating temperature is −65 to +500 F. Models are available for delivering up to 10 in.-lb at 15 rmp.

Viking Tool and Machine Corp., Dept. ED, 20 Main St., Belleville 9, N.J.

CIRCLE 182 ON READER-SERVICE CARD

Centralab can put your variable resistance problems on

This quality construction—I.C.E.—is now featured in these Centralab Radiohms®

MODEL 3 RADIOHM®
Standard or locking bushing; ¼ watt; 1000 ohms to 2.5 megohms. Meets MIL-R-94 specifications.

MODEL 6 RADIOHM®
Plain or switch type; 1/10 watt; 500 ohms to 10 megohms. Dia., .502". Wide range of values and tapers.

MODEL 1 RADIOHM®
Switch or plain type; 1/10 watt; 500 ohms to 10 megohms. Dia., .625". Seven standard tapers.

Centralab's exclusive

Interfused Composition Element

offers these advantages:

- Exceptional wattage dissipation
- Low moisture absorption
- Voltage and temperature stability
- Smooth electrical curve
- Noise-free performance
- Proven load-life reliability

Write for free technical bulletins.

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CIRCLE 184 ON READER-SERVICE CARD

New Products

Transistorized Null Detector

High Sensitivity

The model 2050 transistorized null detector is a battery operated instrument suitable for all types of ac bridge measurements. Specifications include a sensitivity, with 400 or 1000 cps filter, of 200 μv for full-scale in the linear position, and 2000 μv for full-scale in the null position. Input impedance is approximately 1 meg at 1000 cps. Frequency range is 40 cps to 20 kc, ±1 db. In the direct position, it is 20 cps to 50 kc ±5 db. Rejection of 2nd harmonics is greater than 22 db.

Freed Transformer Co., Inc., Dept. ED, 1727 Weirfield St., Brooklyn 27, N.Y.

CIRCLE 185 ON READER-SERVICE CARD

Phase Shifter

Direct Reading

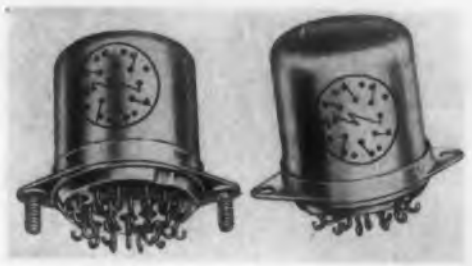
Type 208 phase shifter consists of resistant-capacitance phase shifter networks, a phase inverter, and an output cathode follower. The phase angle lag can be read directly in degrees at 400 cps. In conjunction with a phase detector, the instrument is suited for precision measurement of phase angle between the output and input of any four-terminal network. Phase range is 0 to 360 deg. The maximum error is less than 0.1 deg at 400 cps. Maximum input signal is 25 v rms. The output impedance is 300 ohms nominal shunting resistance, and 2 μf series capacitor for dc blocking. The input impedance is about 100 K in series with 2000 μμf to ground.

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

CIRCLE 186 ON READER-SERVICE CARD

Relays

Withstand Shock and Vibration



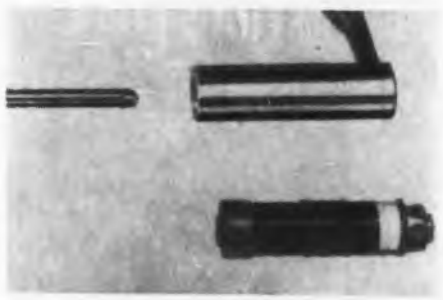
A re-designed version of the FC-6 hermetically sealed, shock and vibration-resistant relay is offered in 4- and 6-pole types. Featuring contact reliability, the new FC-6 relays have ambient temperatures ratings of 85 to 125 C. Operating characteristics include the ability to withstand 30 G vibration at 2000 cps, 50 G shock minimum without contact opening and 2000 ft-lb shock without contact transfer. High contact pressures are maintained. Contact bounce is less than 250 μsec. Substantial contact over-travel is allowed. The relays operate on a nominal voltage of 26.5 v dc. They are adjusted to pick up under 18 v dc at any ambient with the coil hot.

Struthers-Dunn, Inc., Dept. ED, Pitman, N.J.

CIRCLE 187 ON READER-SERVICE CARD

Differential Transformer

3 V Output, ±0.175 In. Range



A 3-v output over a range of ±0.175 in. with a 6-v input at 400 cps, is featured in this differential transformer. Null voltage is 10 mv rms max and linearity is better than 1 per cent. The unit has 2.9 mv per 0.001 in. displacement per volt input at 400 cps. From null to maximum displacement, the phase angle shift is 10 deg maximum over an ambient temperature range from −67 to +185 F. The transducer is designed to withstand a 15-day humidity test, a 90-min vibration test of total excursion of 0.06 in. at 10 and 55 cps and a salt spray test for 50 hours. It is for use in altitudes up to 50,000 ft.

Automatic Timing & Controls, Inc., Dept. ED, King of Prussia, Pa.

CIRCLE 188 ON READER-SERVICE CARD

New Products

Transistor Tester

Measures Basic Characteristics

The TT-2 transistor tester measures the basic characteristics of npn, pnp transistors and crystal diodes. The transistor is first measured for short, open and leakage. A precisely known signal is then automatically applied to the input terminals of the transistor and the current gain read on the beta-300 scale. If beta is less than 100, a second precise signal is applied and the gain read on beta-100 scale. The alpha range of interest, 0.9 to 0.990, is displayed over most of the meter scale using a logarithmic calibration.

Kit-tronics, Dept. ED, 2315 Hendola Dr. N.E., Albuquerque, N.M.

CIRCLE 191 ON READER-SERVICE CARD

AC Transducer Amplifier

100 Meg Input Impedance

Model 1060 ac amplifier system is a seven-channel preamplifier for piezoelectric transducers. Some of its features are: 100 meg input impedance, 0.4 cps to 200 kc bandwidth, 1 and 10 voltage gains (remotely controlled), and full output into 6000 μμf of cable capacitance up to 70 kc. Tubes are used to obtain high input impedance, and silicon transistors are used to provide high output current capability. The system is designed to minimize ground loop problems since each amplifier has its own isolated power supply with doubly-shielded transformer. All amplifiers are insulated from the cabinet.

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

CIRCLE 192 ON READER-SERVICE CARD

High Power Amplifiers
for Vibration Testing

A series of three high power amplifiers have been designed to extend the frequency and force ranges of vibration test systems for sinusoidal and random motion vibration testing. Models T444, T666 and T888 are rated at 7.5, 15 and 22.5 kva, and have plate dissipations of 18 kw, 32 kw, and 54 kw, respectively. Rated power output is maintained over wide frequency range into any power factor load from 0.2 lead to 0.2 lag. The amplifiers can therefore be used for wide-sweep sinusoidal testing and random-motion studies which must be done without power factor correction or intermittent impedance matching. Frequency response is 5 to 5000 cps, ±0.5 db.

Textron Inc., Dept. ED, New Haven, Conn.

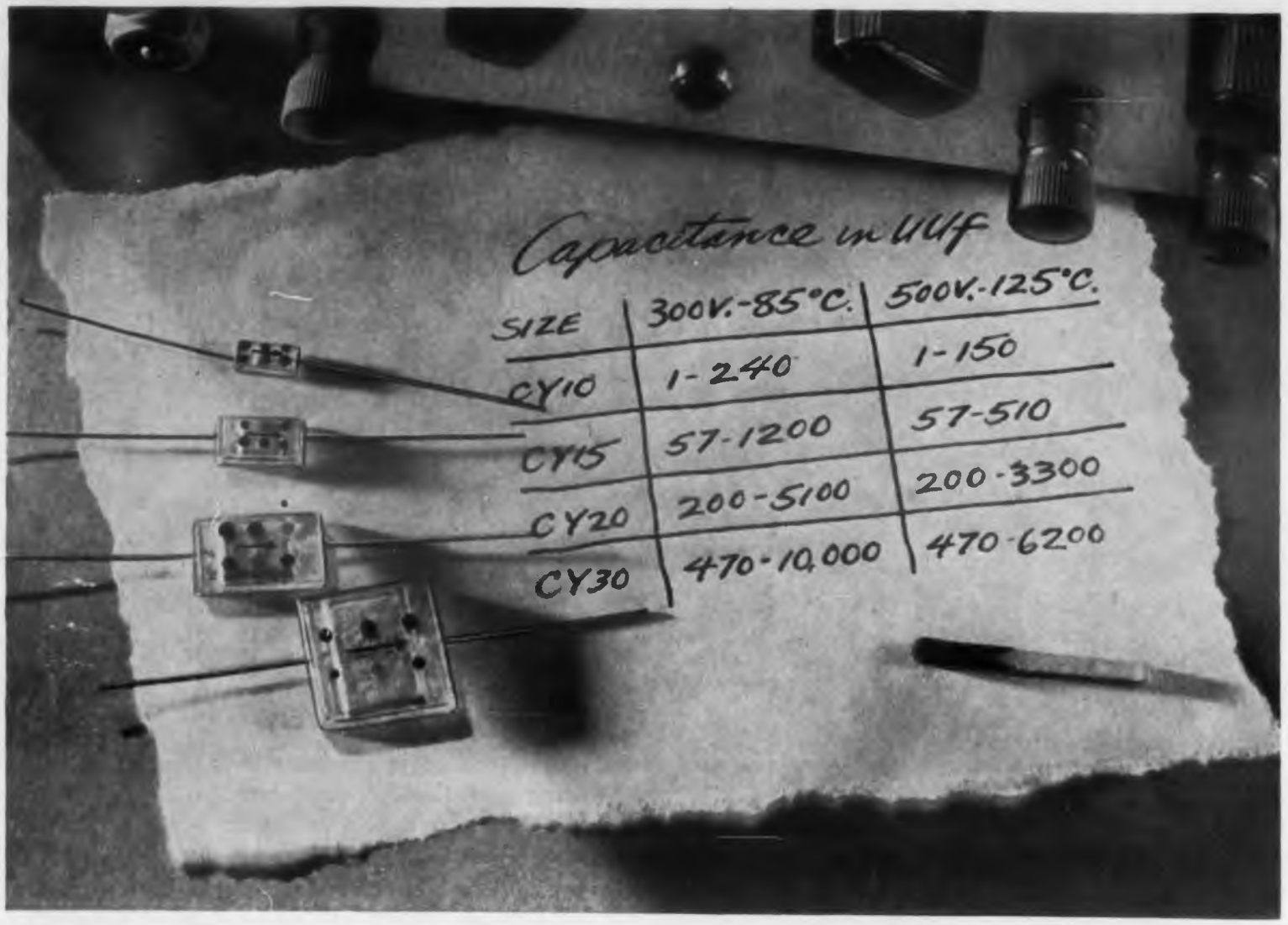
CIRCLE 193 ON READER-SERVICE CARD

Temperature Meter
with Interchangeable Scales

Called Thermotest-1, this potentiometer is primarily used for measuring temperature. Four interchangeable disc scales are provided; three are for temperature and one for millivolts. Compensation is built in for any one of three common types of thermocouples—copper-constantan, iron-constantan, or chromel-constantan. The battery-operated instrument makes accurate temperature measurements from −200 to +600 F, or voltage from zero to 21 mv. Scales which are calibrated in C units are also available.

Technique Associates, Inc., Dept. ED, P.O. Box 91, Indianapolis, Ind.

CIRCLE 194 ON READER-SERVICE CARD



uuf for *uuf*, the smallest, most stable, fixed capacitors you can buy—Here's why...

These are *glass* capacitors—probably as much as one-third smaller than those you're used to; certainly much lighter.

Though made with glass, they are *not* fragile. In fact, the layers of glass dielectric, the metal foil plates and the leads are fused into a surprisingly rugged, inseparable unit.

This unusual construction, developed at Corning offers you these advantages:

Small size, light weight. If you're at work on guided missiles, fire controls, computors, and similar devices, you can cut valuable ounces and inches from your assemblies with these capacitors. See table above for some indications.

Exceptional stability. After a load life test at 50% more than rated voltage at 85° C., the average change in capacitance of these units is less than 0.4% after 1,000 hours, less than 0.6% after 10,000 hours.

Very low drift. This drift is so slight that it's generally within the normal error of measurement. Taking MIL-C-11272A as a standard, capacitance drift is less than 0.1% or 0.1 *uuf* (whichever is greater).

Predictable, retraceable TC. The difference in TC between any units at any given temperature is less than 15 ppm/° C. It is well within the limits of 140 ± 25 ppm/° C. from −55° C. to +85° C. and referred to 25° C.

Low loss. Even at elevated temperatures, the dielectric loss is relatively low. Dissipation factor at 1 kc. and 25° C. is about 0.055% and independent of capacitance.

Bulletin shows performance charts. Bulletin CD-1.00 contains charts and other data on these capacitors. Circle this magazine's service card for a copy or write us direct at Corning.

Capacitance in uuf

Size	300 V. —85° C.	500 V. —125° C.
CY10	1-240	1-150
CY15	57-1200	57-510
CY20	200-5100	200-3300
CY30	470-10,000	470-6200

Ask for information on these other Corning Capacitors:

Medium Power Transmitting—CY60 and CY70. Ideal for mobile RF transmitters.

Canned High Capacitance—Provide the advantages of rugged glass design to your specifications.

Subminiature Tab-Lead—Up to 90% less volume compared to pigtail types. To your specifications.

Special Combinations—The performance and benefits of glass in infinite shapes, sizes and leads. To custom order.

Other electronic products by Corning Components Department: Glass Film Type Resistors*. LP, LPI, H, R, N, S, HP and Water Cooled Styles. Direct Traverse and Midget Rotary Trimmer Capacitors*. Metallized Glass Inductances, Delayline Coil Forms, Bushings, Enclosure Tubes, Rectifier Tubes and Attenuator Plates. **Distributed by Erie Resistor Corporation*

Corning means research in Glass

CORNING GLASS WORKS, 97-12 Crystal Street, Corning, N.Y.

Electronic Components Department

CIRCLE 196 ON READER-SERVICE CARD

New Products

Axial Flow Fans

Direct Mounting

This series of 4-, 8- and 10-in. axial flow fans come complete with venturi rings facilitating direct mounting against enclosures. Available for 50, 60 or 400 cps operation, or for variable power supply frequencies, the fans meet various conditions of altitude or ambient temperatures. Fans and motors are matched for static pressure conditions as required. The 8-in. fan illustrated delivers 750 cfm, with a total temperature rise of 35 C.

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

CIRCLE 197 ON READER-SERVICE CARD

Ultrasonic Probe

Increased Sensitivity

Type 2 ultrasonic testing transducer has an increased sensitivity permitting thickness gaging and flaw detection in materials such as lead, laminated plastics, castings, and other normally poor transmitters of ultrasonic energy. The transducer will also detect flaws which are very close to the surface of the material under test. The probes sensitivity is much greater than that of quartz, noticeably more than conventional barium titanate, and equal to that of lithium sulfate. They are completely waterproof and designed for continuous operation at up to 250 F.

Branson Instruments, Inc., Dept. ED, 40 Brown House Rd., Stamford, Conn.

CIRCLE 198 ON READER-SERVICE CARD

Solenoid

Lifts 9 Lb

A more powerful version of the standard no. 4 solenoid is being offered for ac or dc intermittent or continuous duty. The unit lifts up to 9 lb, and plunger stroke is adjustable from 1/32 to 3/4 in. They are available for any specific voltage from 6 to 230 v.

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

CIRCLE 199 ON READER-SERVICE CARD

Patch Cords

Compact Design

These model P patch cords provide a greater number of patch cords per given area by stacking connections on top. Heat treated spring contacts are beryllium copper for long life and low contact resistance.

Pomona Electronics Co., Inc., Dept. ED, 1126 W. Fifth Ave., Pomona, Calif.

CIRCLE 200 ON READER-SERVICE CARD

Selenium-Rectified Power Supply

250 Kv at 2 Ma

Model 4250-2 is an air-insulated selenium-rectified 250 kv, 2 ma power supply. Input power is approximately 1 kva, and output is continuously variable with approximately 2.5 per cent ripple at maximum rated output.

Sorensen & Co., Inc., Beta Electric Div., Dept. ED, 333 E. 103 St., New York 29, N.Y.

CIRCLE 201 ON READER-SERVICE CARD

New Products

Pulse Transformer Series
Airborne Radar Application

This series of high power pulse transformer assemblies is designed to match the impedance of a given pulse forming network to a magnetron in a line type modulator. The units feature compactness and high resistance to temperature variations, mechanical shock and vibration. A self-contained filament transformer, radio noise filter and bypass capacitors are provided. Models available for use with a 50 ohm pulse forming network and 2J51A, 4J52 or 6543 magnetron.

Specialties, Inc., Dept. ED, Skunks Misery Rd., Syosset, L.I., N.Y.

CIRCLE 204 ON READER-SERVICE CARD

Synchro Test Set
Gives Graphical Plots

Model 25 transducer test set graphically plots the performance of electromechanical transducers such as syncros, differential transformers, and resolvers. Either direct comparison of outputs, or the difference between a standard unit and a test transducer may be plotted.

Either ac or dc transducers may be tested and functions of either X vs Y or X-Y vs X are automatically plotted. The ac input impedance is 80 K and the dc input impedance is 200 K, min. The maximum dc input voltage is 500 v and the maximum ac input is 150 v rms. Both X and Y ac coordinate inputs are independently variable over 8 ranges from 1 to 150 v and the frequency response is linear from 60 to 5000 cps.

Dorsett Laboratories, Inc., Dept. ED, 401 E. Boyd St., Norman, Okla.

CIRCLE 205 ON READER-SERVICE CARD

Temperature Scanner

Takes 56 Thermocouples

This multipoint temperature scanner provides over-under temperature protection for complete systems. The number of thermocouples used may range from 4 to 56. The scanning rate can be as rapid as 1/2 sec per point.

Tipptronic, Inc., Dept. ED, Chagrin Falls, Ohio.

CIRCLE 206 ON READER-SERVICE CARD

Precision Couplings

Steel and Nylon

These couplings are made of stainless steel with a nylon center block and are also available with an oil-less center block. Pin and clamp type hubs come in bore sizes of 1/8 to 1/4 in. diam.

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

CIRCLE 207 ON READER-SERVICE CARD

Digital Clock

Reads Out to Printer

This digital clock covers a full 24-hours and has digital outputs in mechanical contacts down to minutes. It is available with numerals, or the contact can be used to readout directly to a printer or other output.

Wang Laboratories, Inc., Dept. ED, 37 Hurley St., Cambridge 41, Mass.

CIRCLE 208 ON READER-SERVICE CARD

DELCO'S FAMILY OF HIGH POWER TRANSISTORS

Typical Characteristics at 25°C

	DT100	** 2N174A	2N174	2N173	2N443	2N278	2N442	2N277	2N441
Maximum Collector Current	13	13	13	13	13	13	13	13	13 amps
Maximum Collector Voltage (Emitter Open)	100	80	80	60	60	50	50	40	40 volts
Saturation Voltage (13 amp.)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7 volts
Max. Square Wave Power Output at 400 ~ P-P*	400	310	310	225	225	180	180	135	135 watts
Max. Sine Wave Power Output at 400 ~ P-P*	180	140	140	100	100	80	80	60	60 watts
Power Dissipation (Stud Temperature 25°C)	70	70	70	70	55	55	55	55	55 watts
Thermal Gradient from Junction to Mounting Base	1.0°	1.0°	1.0°	1.0°	1.2°	1.2°	1.2°	1.2°	1.2° °C/watt
Nominal Base Current I_B (V_{EC} = —2 volts, I_C = —1.2 amp.)	-19	-19	-19	-13	-24	-13	-24	-13	-27 ma

*Adequate Heat Sink

**Designed to meet MIL-T-19500 13 (USAF) 18 JUNE 1957

Offer a wide range of performance characteristics to meet your switching, regulation or power supply requirements

These nine Delco Radio alloy junction germanium PNP power transistors are now in volume production. They are characterized by high output power, high gain, and low distortion. And all are normalized to retain superior performance characteristics regardless of age.

Check the data chart above—see how they fit your particular requirements in current switching, regulation or power supply. Write for detailed information and engineering data. Delco Radio maintains offices in Newark, N. J. and Santa Monica, Calif. for your convenience.

DELCO RADIO
Division of General Motors
Kokomo, Indiana

CIRCLE 210 ON READER-SERVICE CARD

New Products

Single Decade Counter
Counts 25 Events per Sec

Normal counting or backward counting at speeds up to 25 events per sec, transmission of a remote numerical indication to a central location, and remote presetting for predetermining control are featured in the type ITD electric impulse counter. The counters have a single figure drum, measure 7/8 x 1-3/4 x 4-3/8 in., and are suitable for flush mounting. The single decade counters can be used independently as decades or interdependently as a multi-digit counter.

Landis & Gyr, Inc., Dept. ED, 45 West 45th St., New York 36, N.Y.

CIRCLE 211 ON READER-SERVICE CARD

Transistorized Voltmeter
1 Mv AC-DC Full Scale

Measuring 3-1/2 in. high, Model D-31 transistorized voltmeter measures either ac or dc with full scale sensitivity of 1 mv. Powered by either 60 cps line or a built-in rechargeable battery, the voltmeter operates on balanced or unbalanced circuits with accuracy of ±3 to ±5 per cent on ac and ±3 per cent on dc. Frequency response on unbalanced circuits is flat through the range 10 cps to 1 mc; on balanced circuits response is flat from 10 cps to 100 kc. The battery can be automatically recharged while the instrument is operating from a 60 cps ac power source.

Alto Scientific Co., Dept. ED, 855 Commercial St., Palo Alto, Calif.

CIRCLE 212 ON READER-SERVICE CARD

Differential

High Torque Capacity

Due to double pinion construction, these differentials can operate at speeds of 2500 rpm with up to 32 oz-in. of torque inputs. Rapid installation in confined spaces is made possible by a hollow shaft design which accommodates 1/8 and 3/16 in. shafting.

Reeves Instrument Corp., Dept. ED, 207 E. 91st St., New York 28, N.Y.

CIRCLE 213 ON READER-SERVICE CARD

Low-Mu Triode

Color TV Deflection Tube

Designated Type 6CK4, this high permeance, low-mu triode is designed for use as a vertical deflection amplifier tube, and features a maximum plate dissipation of 12 w and an average cathode current of 100 ma. With a maximum peak positive-pulse plate voltage of 2000 v (absolute) and a maximum peak cathode current of 350 ma, the 6CK4 is practical for both black-and-white and color TV.

Sylvania Electric Products, Inc., Dept. ED, 1740 Broadway, New York 19, N. Y.

CIRCLE 214 ON READER-SERVICE CARD

High Voltage Transistor

On-Off Control Applications

The 2N398 is a junction transistor of the germanium pnp alloy type. It is specifically designed for high-voltage on-off control applications, such as in neon indicator circuits, relay puller circuits, incandescent lamp driver circuits, and direct indicating counter circuits of electronic computers. The 2N398 features a maximum voltage rating of —105 v for collector-to-base breakdown and for collector-to-emitter punch through. Because the 2N398 has a minimum dc current transfer ratio of 20, neon indicating circuits can perform the functions of a logic circuit without a separate logic stage.

Radio Corporation of America, Semiconductor Div., Dept. ED, Somerville, N.J.

CIRCLE 215 ON READER-SERVICE CARD

875 T

POTENTIOMETER

2 watts at 150°c

+ 200°c rating

+ giannini engineering skill!

=

SHOWN ACTUAL SIZE

Now—the little pot with a big power rating

...is available for high temperature applications. Rated to operate in ambient temperatures as high as 200°C, this ⅞" diameter precision wirewound potentiometer will dissipate 2 watts at 150°C—and even more at room temperature!

Providing linearity and resolution usually found only in much larger units, the 875T represents the finest achievement in subminiature design as well as high temperature operation. It is truly representative of the engineering skill and creative ability of Giannini engineers...craftsmen in the art of precision instrument manufacture.

SPECIFICATIONS:

Resistance: 500Ω to 100,000Ω per section
Power: 2 watts per section at 150°C
Temperature Rating: −55°C to 200°C
Linearity: ±0.5% or better
Resolution: 0.25% to 0.06%
Torque: 0.1 oz-in per section
Multiple Ganging: up to 4 units—one shaft
Dimensions: 0.875" diameter by 0.75" long

Giannini NEW JERSEY DIVISION
"Where reliability counts"

G. M. GIANNINI & CO., INC. • 918 E. GREEN ST., PASADENA, CALIF.

CIRCLE 226 ON READER-SERVICE CARD

New Products

Solid Electrolytic Capacitors

Expanded Ratings of 0.22-4.7 μF

Available ratings of type 150 D solid electrolyte Tantalex capacitors now include ratings from 0.22 to 4.7 μf at 35 v dc. The higher ratings are particularly designed for 28-v systems. These designs are of the sintered-anode type and complement the lower capacitance wire-anode types previously announced.

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

CIRCLE 218 ON READER-SERVICE CARD

Limit Switches

Roller and Plunger Types

These two-circuit limit switches include a roller-plunger switch, designated 5LSI, which can be rotated 90 deg from the switch cover plate, and a plunger actuated switch, designated 2LSI, which offers a 1/4-in. of overtravel. The electrical rating for the series is 10 amp, 120, 240 or 480 v ac; 1/2 hp, 120 v ac; 1 hp, 240 v ac; 0.8 amp, 115 v dc; 0.4 amp, 230 v dc; 0.1 amp, 550 v dc. Pilot duty rating is 600 v ac max.

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

CIRCLE 219 ON READER-SERVICE CARD

Indicating Relays

Neon Lamp Spots Malfunction

This line of relays is equipped with a built-in indicator neon lamp to spot circuit malfunctions. It is available in translucent shades for color coding. Overall dimensions are 1-3/8 x 1-3/8 x 2-1/8 in. high; rated at 5 or 10 amp with up to 3 pdt dependent upon placement of neon lamp. Available in standard ac or dc voltages.

Line Electric Co., Dept. ED, 271 S. 6th St., Newark 3, N. J.

CIRCLE 220 ON READER-SERVICE CARD

Instrument Knobs
12 Color Codes

These aluminum instrument knobs come in 12 different colors for color coding. They are available for 1/8 and 1/4-in. shaft sizes with a variety of sizes skirted or unskirted. Special markings are available.

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

CIRCLE 223 ON READER-SERVICE CARD

Electromechanical Counters
Counting Rates of 40 per Sec

Featured in this line of electromechanical counters and counter-transmitters are counting rates to 40 per sec and a life span exceeding 10,000,000 counts. The line includes both uni-directional and bi-directional units, the latter accepting both add and subtract impulses, thus functioning as efficient summation counters. The basic element of each unit is a dynamically balanced incremental actuator.

Digitac, Inc., Dept. ED, 420 S. Beverly Drive, Beverly Hills, Calif.

CIRCLE 224 ON READER-SERVICE CARD

Compression-Type Fastener
Latches and Screws Tight

These compression-type fasteners, designated No. 25, can be used for any air-tight, light-proof or vibration-resistant application. The low-cost fastening unit is cadmium plated and consists of a sliding, pivoted latch which is tightened down under the compression action of a thumb screw.

Torit Manufacturing Co., Dept. ED, Walnut & Exchange Sts., St. Paul, Minn.

CIRCLE 225 ON READER-SERVICE CARD

New Flexibility in Servo Potentiometers from

CIRCUIT
INSTRUMENTS INC.

Innovation, improvement, and ingenuity are characteristics you find in all CIRCUIT INSTRUMENTS servo and other type potentiometers. They mean greater flexibility in use . . . greater flexibility in specifying. And when you consider that CIRCUIT INSTRUMENTS production facilities feature the same flexibility, you can see why CIRCUIT INSTRUMENTS delivers the goods faster.

MODEL B POTENTIOMETER WITH SERVO TYPE MOUNTING

GANG UP TO 8 SECTIONS
on a common shaft with CIRCUIT INSTRUMENTS servo type potentiometers. Sections can be phased in the field simply by releasing one-piece clamp rings.

CHOOSE MANY RESISTANCES
all the way from 500 up to 600,000 ohms. As a special feature, these servo type potentiometers also can be welded or solder tapped.

MEET TORQUE REQUIREMENTS
with a ball-bearing mounted shaft that assures smooth, low torque operation. Sleeve bearings also available.

MEET OTHER REQUIREMENTS
with linear or non-linear windings, designs for average or high ambient temperatures up to 150° C., and six case diameters from ⅞" to 3"

CIRCUIT
INSTRUMENTS INC.

Subsidiary of
IRC
INTERNATIONAL RESISTANCE CO.

CIRCUIT INSTRUMENTS INC.
P.O. Box 1438, Dept. D, St. Petersburg, Florida

Send data sheets on ☐ Servo Type ☐ Hermetically Sealed ☐ Sub-Miniature ☐ Helical ☐ High Temperature ☐ High Precision Potentiometers.

NAME .....
COMPANY .....
ADDRESS .....
CITY ..... STATE .....

CIRCLE 217 ON READER-SERVICE CARD

New Products

Recording Spectrum Analyzer

Range of 75 to 125 Mc

Model L-1 spectrum analyzer permits rapid and accurate recording of power spectra over a bandwidth continuously adjustable from 0 to 50 mc. The basic frequency coverage of 75 to 125 mc can be extended to any part of the uhf or microwave range the use of auxiliary convertors. Sensitivity is —60 dbm for full-scale output; response is flat within ±1 db over entire swept band. Internally-generated crystal-controlled frequency markers actuate a margin marking pen on the recorder at 2-mc intervals. An input attenuator providing up to 132 db attenuation in 1 db steps permits measurements over a wide range of power levels. Input impedance is 50 ohms.

Granger Associates, Dept. ED, 966 Commercial St., Palo Alto, Calif.

CIRCLE 228 ON READER-SERVICE CARD

Versatile Chopper

Center-Tapped Coil

A version of the Syncroverter chopper with a center-tapped coil has been announced for a variety of driving circuit applications, such as flip-flop, push-pull, or pulsed type. As a result of the center-tapped coil construction, the unit can also be used as a polar relay, when a biasing voltage is applied, or as a true differential relay, which operates at a given predetermined differential, rather than on a specific amperage value for either coil. Coil requirements vary according to application; typical applications require approximately 90 peak amp-turns. Ambient temperature limits for the chopper are —65 to 125 C. It is available in either an external-coil, low-noise version, or in the standard version. Flange mounting is available, or the unit can be furnished for standard 7-pin plug-in mounting.

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

CIRCLE 229 ON READER-SERVICE CARD

◀ CIRCLE 227 ON READER-SERVICE CARD

Oscillograph Recorder

19 Channels

Up to 19 recording channels are available in the Type 503 Dynograph, using either ink or electric curvilinear recording. Pen spacing of 2 in. is normally provided with assemblies of 12 channels or less, and pen spacing of 1-1/4 in. with assemblies of 13 through 19 channels. Other pen spacing can be supplied if desired. The paper is driven at eight speeds from 1 to 250 per sec, accurate to 1 per cent. The recorder features fast response, high sensitivity, and drift-free recording.

Electronics Inc., Dept. ED, 5320 North Kedzie Ave., Chicago 25, Ill.

CIRCLE 232 ON READER-SERVICE CARD

Miniature Screws

Size 000-120

Size 000-120 brass screws, nuts and washers have been made available from stock. Matching taps and dies in both carbon and high speed steel are also available. Experimental or production quantities of the miniature size can be obtained without delay.

J. I. Morris Co., Dept. ED, 394 Elm St., Southbridge, Mass.

CIRCLE 233 ON READER-SERVICE CARD

VSWR Indicator

Handles up to 1000 W

Model T-32 standing wave ratio indicator is used to measure vswr in 50 ohm RG 8/U transmission lines. Power between 10 and 1000 w can be handled over the frequency range of operation of 250 to 550 kc. The unit withstands voltages developed with vswr up to 20:1. Accuracy for vswr between 1:1 and 10:1 is ± 10 per cent.

Alto Scientific Co., Dept. ED, 855 Commercial St., Palo Alto, Calif.

CIRCLE 234 ON READER-SERVICE CARD

8 laboratories at FTL

offer unlimited opportunities to top engineers and scientists

1. Radio Navigation **2.** Missile Guidance
3. Electronic Countermeasures **4.** Electronic Systems
5. Radio Communication **6.** Physical-Chemical
7. Electron Tubes **8.** Wire Communication

In suburban New Jersey—only a few minutes away from New York City—at least *one* of these 8 research and development "centers" comprising Federal Telecommunication Laboratories offers a solid future to you!

Whether your field is computers, data processing, radio communication, air navigation, missile guidance, electronic countermeasures, antennas, transistors, traveling wave tubes or telephone switching, you can be sure your assignment will be interesting, challenging and rewarding.

Opportunities at FTL are unlimited. Our program is long-range . . . commercial and military. We have the finest facilities . . . our future is expanding on both coasts. Ability reaches the spotlight quickly under our "small-company" project system.

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FTL
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Federal Telecommunication Laboratories
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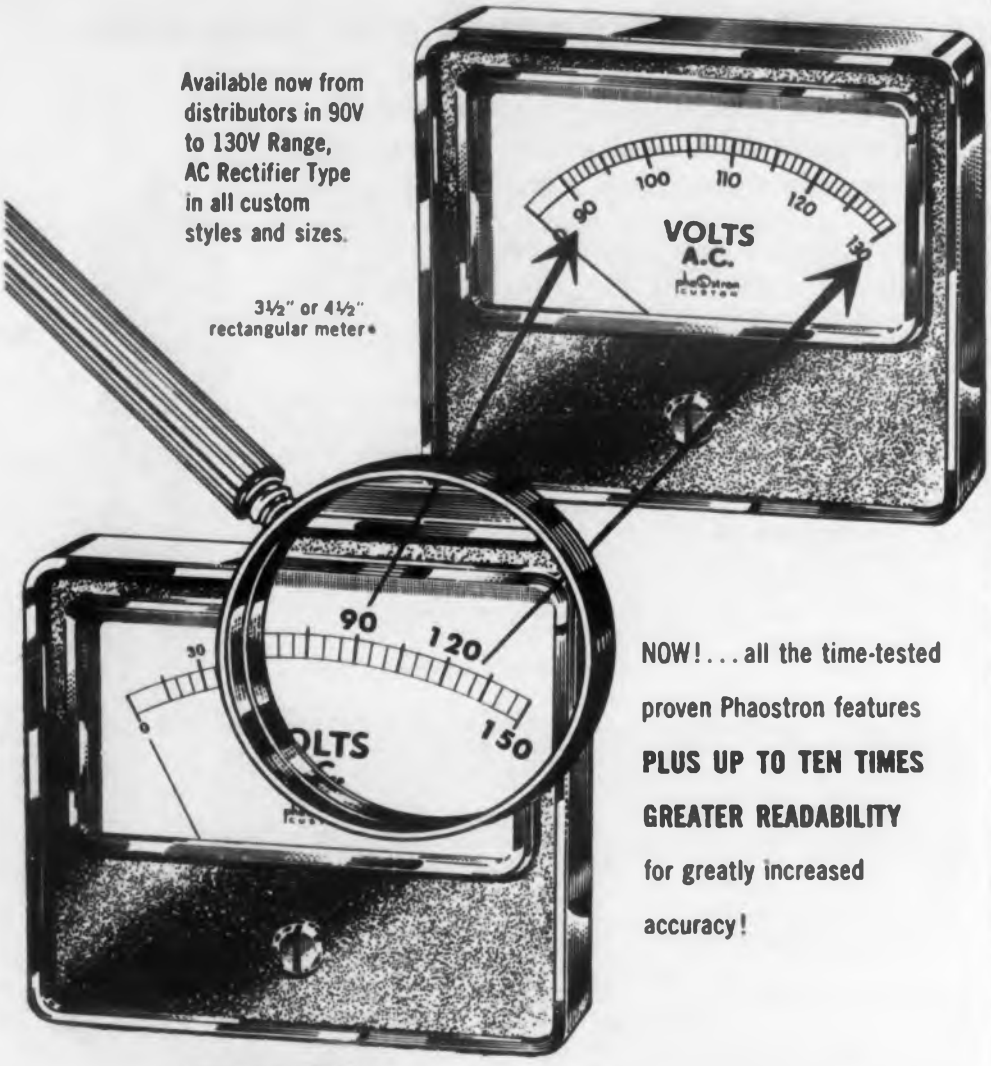
CIRCLE 555 ON READER-SERVICE CARD

NEW PHAOSTRON
EXPANDED SCALE
AC Voltmeter

Available now from distributors in 90V to 130V Range, AC Rectifier Type in all custom styles and sizes.

3½" or 4½" rectangular meter



NOW!... all the time-tested proven Phaostron features **PLUS UP TO TEN TIMES GREATER READABILITY** for greatly increased accuracy!

2½" or 3½" square meter

6" rectangular meter

2½" or 3½" round meter

All meters available with illuminated dial on special order

Phaostron has squeezed down that under 90V portion of the scale, where you don't need it, and expanded the section where you need it most—between 90 and 130V. Precisely calibrated 1 volt scale increments provide greater reading accuracy. Wide frequency range—linearity—true rms reading and Phaostron craftsman construction.

Phaostron Custom Panel Meters, with expanded scale, 90V to 130V AC rms. are available in nine types at your Parts Distributor. For special requirements for AC or DC expanded scale meters, write to Product Development Dept. for practical recommendations.

PHAOSTRON

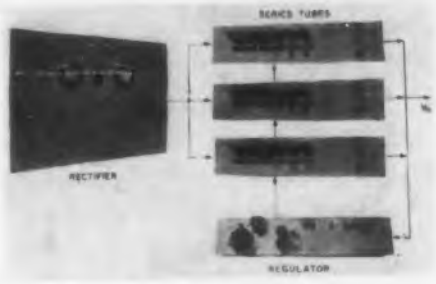
PHAOSTRON INSTRUMENT & ELECTRONIC CO., 151 PASADENA AVE., SOUTH PASADENA, CALIF.

CIRCLE 235 ON READER-SERVICE CARD

New Products

DC Power Supply

Modular Construction



These regulated dc power supplies are sectionalized into three basic panels for rack mounting: rectifier, regulator and series-tube. A single regulator controls any number of series-tube sections operating in parallel. The series-tube panels are conservatively rated at 1 amp. Output voltages range from 0 to 150, 150 to 300, and 300 to 500; current ratings are 1, 3, 6, and 10 amp. Expansion can be provided by paralleling series-tube sections and installing a larger rectifier or a parallel rectifier. Output voltage performance is better than 0.1 per cent for load and line changes, including transients.

Dynamic Controls Co., Dept. ED, 1955 Massachusetts Ave., Cambridge, Mass.

CIRCLE 236 ON READER-SERVICE CARD

Square Wave Generator

Center Frequency of 1 KC

A variable amplitude direct coupled square wave generator, Model #205 finds use as a modulator of signal generators and traveling wave tube amplifiers. The unit delivers 60 v max peak to peak, positive ground, 0.4 μsec rise, 5 per cent overshoot, and has zero to 5 k internal impedance.

Brocker Labs., Dept. ED, P.O. Box 976, Sunnyvale, Calif.

CIRCLE 237 ON READER-SERVICE CARD

Short Wave Antenna

High Power, Compact Design

Measuring 27-in. high by 22-in. wide, this short wave antenna, termed the Little Giant, resonates at a half wave over the full range of the design spectrum and all intermediate frequencies. Model F100 has a range of 7-14 mc and F108 is designed for coverage of the 75/80/CAP bands. The antenna easily accepts rf over a band 50 kc wide each side of the resonant frequency. With several db forward gain over a reference dipole, the antenna has a figure 8 single unit pattern with front to back ratio exceeding 10 db. One feature of the unit is its lack of corona. Particular models are designed to handle substantially over 1 kw of power.

The Freeman Co., Dept. ED, Yankton, S.D.

CIRCLE 240 ON READER-SERVICE CARD

Transistorized Filter

For 28 V DC Systems

This transistorized filter is designed primarily for aircraft, mobile, and portable installations to reduce generator ripple 100 to 1 at worst point, and thereby eliminate the need for heavy chokes. The unit output, 20 v adjustable, is regulated to a tolerance of 0 to 0.5 amp. Intended for use with 24 to 28 v dc systems, the 40 cu. in. filter offers an efficiency of 85 per cent and weighs 2 lb.

Transistor Devices, Inc., Dept. ED, 730 Boulevard, Kenilworth, N.J.

CIRCLE 241 ON READER-SERVICE CARD

✳ a-c stands for analog computer

The Donner a-c, a complete linear computer. Digital voltmeters, scopes, and non-linear equipment may be mounted above the console and/or at one side in modular racks.*

$16,650

buys the new DONNER a-c* console

WITH

- *30 Chopper Stabilized Amplifiers*
- *40 Coefficient Potentiometers*
- *0.1% Temperature Controlled Computing Components*
- *Latching Overload Lights*

✳ Designed as a standard production item, the Donner a-c* combines quality and flexibility with modest cost. For instance, characteristics of the Donner 3101 chopper stabilized operational amplifier, heart of any analog computer, are: dc gain 5×10^7; unity integrator drift 100 millivolts in 15 minutes; phase shift 0.2° at 1000 cps. The reference supply carries a stability of ±0.1% over a 60 day interval.

Formed from molded diallyl phthalate, the removable AMP problem board serves 30 amplifiers, 40 potentiometers, complementary nonlinear equipment, and 70 trunk lines.

Starting with as few as 10 amplifiers and 20 potentiometers, the user can build up a full console as his needs and pocketbook dictate. For further expansion, consoles may be slaved together and operated from one master computer.

Data file 310 detailing the Donner a-c* is yours for the asking. Please address Dept. 1912

DONNER SCIENTIFIC COMPANY

Phone MUlberry 2-6161 · Cable "Donner"
CONCORD, CALIFORNIA

CIRCLE 242 ON READER-SERVICE CARD

ELIN POWER OSCILLATORS...

to "System-mate" Your Equipment Requirements!

CABINET MODEL
DK-102 (2 watts)
DK-106 (6 watts)

RACK MODEL
DK-102R (2 watts)
DK-106R (6 watts)

Pat. Pending.

In applications concerning strain gauges, bridge-type transducers, time correlation, precision 400 cycle gyro testing, process control and preflight missile checkout, ELIN Precision Power Oscillators prove compatible and, in combination with other equipments, readily yield superior systems!

The desirable features of ultra-precise frequency and amplitude stability, low distortion and high output power capacities, make ELIN Precision Power Oscillators the ideal "System-mate" in these applications, and are derived from an exclusive High-Q LC tuned circuit and a special voltage-sensitive bridge combined in a circuit employing a large amount of negative feedback.

FREQUENCY (FIXED)—250 cps. to 15,000 cps. **VOLTAGE (OUTPUT)**—10, 30 & 100 volts RMS, all with floating center-tapped output. **DISTORTION**—0.1% maximum harmonic content, 0.05% maximum AC hum, 0.01% maximum noise. **CALIBRATION ACCURACY**—±0.02% under usual lab ambient conditions*, checked against station WWV as a primary standard. **FREQUENCY STABILITY**—±0.5% maximum, under usual lab ambient conditions*, ±0.02% maximum per ±10 volts variation in line voltage, ±0.05% maximum, zero to full load. **AMPLITUDE STABILITY**—±0.1% maximum under usual lab ambient conditions*, ±0.02% maximum, per ±10 volts variation in line voltage, ±0.2% maximum, zero to full load.

Special models operating from other prime power sources, with higher power capacities and at other frequencies supplied to your specs in cabinet or rack styles. Write today!

*Lab ambient, 10°C to 40°C.

Reg. U. S. Pat. Off.

elin® / Precision Power Oscillators

ELECTRONICS INTERNATIONAL CO.

145 West Magnolia Boulevard, Burbank, California

Special Products Division of International Electronic Research Corporation, Burbank, California

CIRCLE 246 ON READER-SERVICE CARD

New Literature

Standard Frequency Comparator 247

A frequency comparator which eliminates searching for the strongest frequency standard is described in Bulletin 457. The 2-page illustrated sheet gives specifications on the model SR-7 standard frequency receiver and describes applications, using signal soources from stations WWV and WWVH. A diagram on a-f frequency standards illustrates time intervals and program schedules of the two stations. A special antenna kit, designed for optimum response on 2.5, 5, 10, 15, and 20 mc, is briefly described. Specific Products, 21051 Costanso, Woodland Hills, Calif.

Miniature Bearings 248

In a 24-page catalog types and functions of miniature precision ball bearings are outlined. The catalog treats in detail, standard radial miniature bearings which range in size from 1/10 to 3/8 in. OD. There are descriptions and bore dimension charts for all the radial types—radial retainer, flanged radial retainer, single and double shield radial retainer, single and double shield flanged radial retainer, radial, flanged radial, high speed, and flanged high speed. Other bearings covered include grooved raceway and spherical seat pivot, angular contact, grooved raceway thrust, and special types. A numbering system for classifying listed bearings by material, size, type, mounting, torque and lubrication is provided. There are also dimensional code charts, torque conversion charts, and charts on inspection correlation, clearances, tolerances, and preselection. Miniature Precision Bearings, Inc., Keene, N.H.

New Type Magnetic Tape Unit 249

A 6-page brochure has been issued to introduce a new type of magnetic tape handling unit with built-in controls. Designed especially for the Univac File-Computer System, this automatic tape unit can make its own comparisons and its own logical decisions because of its self-controlling features. Complete tape sorts and tape collations can be made independently of the central computer program. Remington Rand Univac Division of Sperry Rand Corp., 315 Fourth Ave., New York 10, N.Y.

Traveling Wave Tubes 252

Technical Bulletin 1 is a 5-page dissertation on traveling wave tubes. Starting with a definition and an explanation of basic principles, the text continues with a discussion of wave structures, facusing, attenuation, microwave coupling, metal tubes, and system applications. A list of TWT types and specifications are presented in table form. The folder, punched to fit notebooks, is illustrated with labeled drawings. Sperry Gyroscope Co., Electronic Tube Div., Great Neck, N.Y.

High Temp Power Resistors 253

Two catalog data bulletins have been published to present information on several high temperature resistors. Bulletin P12c is concerned with 5, 7, and 10 watt resistors with axial leads, while Bulletin P-4 covers a 20 watt model with lug terminals and radial leads. Both leaflets are two pages long and illustrated with charts, graphs, and drawings. Both offer comprehensive data on design, construction, applications, ranges, ratings, tolerance, and identification. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

Facilities Brochure 254

Operations, facilities, and capabilities in the avionics and missile fields are outlined in a brochure of 20 pages. Replete with photographs, the booklet also covers associated technology in electronics, optics, and electro-mechanics. Land-Air, Inc., Subsidiary of California Eastern Aviation, Inc., 7444 W. Wilson Ave., Chicago 31, Ill.

Pulse Xfrs, Resistors, Strobe 255

Data on five pulse transformers, an inexpensive 60 cps stroboscope, and a resistor kit with 153 different 1/2 w 5 per cent units are given in a condensed catalog sheet, G-110. The 2-page sheet also describes labmarkers which generate time markers for cathode ray oscillography, and labcases which make convenient plug-in type housings for 3 and 4 terminal networks. Berkshire Labs., 579 Bank Village, Greenville, N.H.

NEW Development!

HICKOK

250° Arc

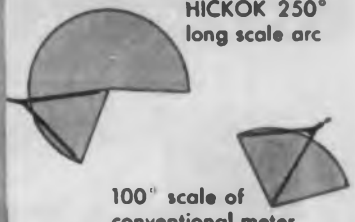
LONG SCALE METERS

Save Valuable Panel Space

The scale in these new instruments is 2½ times as long as conventional meters. A 3½" HICKOK 250° meter has a scale length equal to a conventional 6" instrument.

These exclusive panel style 250° meters fit a smaller space though still provide easier, more accurate readings.

Available in all popular AC or DC ranges. Square, semi-flush or round flush cases. 2½" thru 5½" sizes.



HICKOK 250° long scale arc

100° scale of conventional meter

UNIFORM SCALE
Evenly Spaced Scale Divisions

RUGGEDIZED and SEALED

AC rectifier or DC types

The highly efficient HICKOK shock mount construction permits pointer and scale divisons to be easily read when meter is under vibration. The DC movement is a precise and rugged internal pivot type. The AC movement is of the iron vane principle with unusually efficient magnetic damping for ruggedized purposes. Case is permanently sealed at the factory, however, may be opened and resealed.

These instruments meet military specifications and are in volume production. Your inquiry is invited. Kindly list details of your requirements or request Catalog No. 33.

THE HICKOK ELECTRICAL INSTRUMENT CO.

10525 DuPont Avenue • Cleveland 8, Ohio

CIRCLE 256 ON READER-SERVICE CARD

IMPEDANCE COMPARATORS

PRECISE, RELIABLE AND RAPID COMPARISON OF COMPONENTS

- Tests Resistors, Condensers, Inductors
- Percentage Deviation From Standard Read On Large Meter
- Rapid Response — No Buttons To Push
- High Accuracy And Stability
- Self Calibrating — Requires No Recalibration When Changing Ranges

SPECIFICATIONS

	MODEL 60	MODEL 1010
BRIDGE SUPPLY	6 Volts	2 Volts
FREQUENCY	60 CPS	Either 1 KC or 10 KC
FULL SCALE RANGES	±1%, ±5%, ±10, ±20%	±5%, ±10%, ±20%
IMPEDANCE LIMITS:		
Resistance	5 ohms to 5 megohms	5 ohms to 5 megohms
Capacitance	500 mmfd. to 500 mfd.	50 mmfd. to 10 mfd.
Inductance	15 millihy. to 10,000 hy.	100 microhy. to 100 hy.
PRICE	$179.00	$299.00

OTHER MODELS AVAILABLE

MODEL	BRIDGE VOLTS	FULL SCALE RANGES
1000	8V-1000 CPS	±1, 5, 10%
1025	2V-1 KC, 25 KC	±5, 10, 20%
400	8V-400 CPS	±1, 10, 20%
60-S	2V-60 CPS	±1, 2, 10, 20%

Representatives in Principal Cities

INDUSTRIAL TEST EQUIPMENT CO.
55 EAST 11th STREET • NEW YORK 3, N. Y.

CIRCLE 319 ON READER-SERVICE CARD

SNAP ACTION

IN EVERY CONTROL PHASE

with the Curtiss-Wright "SNAPPER" Thermal Time Delay Relay

Computers, broadcast equipment, motors, lighting systems, missiles, industrial controls — for electrical circuit applications involving time delay that demand unfailing action in every control phase, more and more design engineers specify "SNAPPER" Relays by Curtiss-Wright. These reliable relays eliminate chatter with *positive* snap action, have single-pole double throw contacts and a wide temperature range (—65° +100°C). Preset time delays from 3 seconds to 3 minutes are now available in metal envelope and from 5 to 60 seconds in glass envelope. Write for our new detailed data sheet with complete application information.

Component Sales Department

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

"SNAPPER" GLASS RELAYS
—for commercial applications, single-pole double throw snap action.

MAGNETIC AMPLIFIERS
—custom-designed to fit complex requirements for control systems.

"MEMORY" RELAYS
—thermally operated bi-stable time delay relays with two separate heater circuits.

CIRCLE 320 ON READER-SERVICE CARD

New Literature

Code Color for Thermocouples 257

Handy and durable, a recent chart contains color codes and calibration symbols for thermocouples and thermocouple extension wires and also pyrometer wire resistance figures. The chart, 8-1/2 x 11 in. and punched for three-ring binder use, is concentrated on one easy-to-read sheet, a ready store of useful pyrometric information. Charted on one side of the card are all thermocouple and thermocouple extension wire calibrations with corresponding I.S.A. calibration symbols, company calibration symbols, and I.S.A. color codes. The chart also contains the color codes of all types of MIL-Spec wire.

On the reverse side of the card are resistance tables for standard pyrometer wires in ohms per 100 ft at 68 F. Listed are the resistance figures for solid conductors (individual and loop) from 1 to 40 gage and for stranded conductors (individual and loop) from 14 to 28 gage. Thermo Electric Co., Inc., Saddle Brook, N.J.

Transistorized Converter 258

Catalog 58P describes 20 standard dc to dc, dc to ac, and dc to multiple ac and dc output transistorized power supplies. The 8-page illustrated booklet has a special section devoted to regulation techniques which allow outputs to be furnished up to 500 va with 1 per cent over-all regulation from —55 to +85 C. Both saturable reactors and series and parallel transistor-Zener diode combination regulators are described. Also discussed are methods for providing sinusoidal ac outputs with distortions of less than 5 per cent and better than ±3 per cent frequency regulation over wide temperature ranges. Power Sources, Inc., Burlington, Mass.

Miniature Slip Rings 259

"An Editorial Review" is an 8-page pamphlet concerned with the uses of miniaturized slip ring and brush assemblies. The test explains gyroscope usage, lowering torque, and long life of components. Fully discussed are the features which suit slip rings, brushes, and their accessories to application in such devices as the gimbal axes of gyroscopes, radar antennas, and rotating turrets. The illutrated booklet provides technical details such as mechanical and dielectric strength. Poly-Scientific Corp., Blacksburg, Va.

Electronics Catalog 262

Listings of electronic and high-fidelity equipment fill 180 pages in the 1958 Catalog 305. In addition to high-fidelity items from major manufacturers, the book has a comprehensive array of stereophonic equipment. This includes recording and playback mechanisms, amplifiers, complete stereo systems, and adapters for the conversion of conventional systems. Transistor kits and components occupy a large section of the catalog, as do a wide assortment of electronic, radio, and TV parts, public address components and systems, miniaturized components, ham equipment, tools, books, and drafting equipment. Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N.Y.

Pulse Height Analyzer 263

Form 3005-7 describes a single-channel differential pulse height analyzer which separates groups of pulses of varying amplitudes. The 2-page illustrated bulletin suggests uses for the instrument and gives complete data on performance, dimensions, weights, and specifications. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

Metal Film Resistors 264

A series of metal film precision resistors are fully discussed in the four pages of Bulletin 155. The units are considered with attention to construction, principle of operation, watt rating, resistance range, accuracy, temperature coefficient of resistance, stability, frequency characteristics, noise level, voltage coefficient, and sizes, styles, and coding. A comparison of the resistors and military specification requirements is presented in table form. Graphs, dimensional diagrams, and photographs provide illustration. Ohmite Mfg. Co., 3661 Howard St., Skokie, Ill.

Radar, Communications Equipment 265

A recent folder lists an extensive line of transmitters, modulators, power supplies, and accessories for applications in radar, communications, and tube development. In its four pages 20-odd products are illustrated, while a data tabulation covers these and more to make a total of 37 types. Levinthal Electronic Products, Inc., Stanford Industrial Park, Palo Alto, Calif.

BIG-POT PERFORMANCE in Miniature-pot size

Waters PRECISION MINIATURE POTENTIOMETERS

are built, tested, and certified* to such rigid specifications as AIA, RETMA, JAN-R-19, MIL-E-5272A, and other applicable military specifications. *This new line* of single-turn pots packs Waters traditional performance into tight spots.

NOW! A complete single-turn pot line from Waters

*Complete data on request.

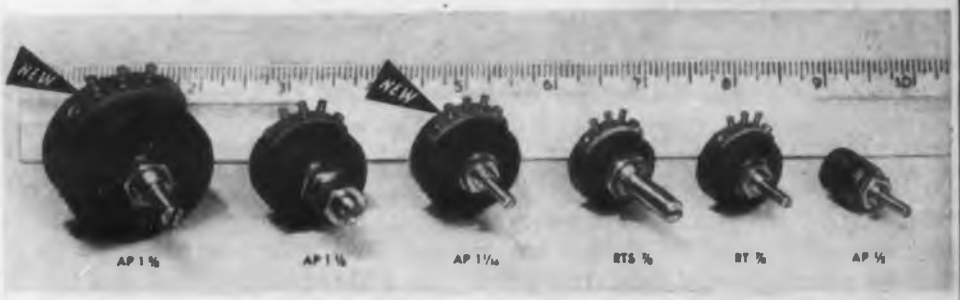
BIG-POT PERFORMANCE in Miniature-pot size

Waters ROTARY TRIMMER POTENTIOMETERS

are built, tested, and certified* to rigid military environmental specifications and are available in many variations: ganged, tapped, with various electrical and mechanical angles, locking shafts, anti-rotation pins, "O" rings, etc.

*Complete data on request

NOW! A complete single-turn pot line from Waters



Write for catalog of the Waters complete single-turn pot line — precision, trimmer, low-torque, miniature.

Waters MANUFACTURING, inc.

APPLICATION ENGINEERING OFFICES IN PRINCIPAL CITIES

Wayland, Massachusetts

CIRCLE 266 ON READER-SERVICE CARD

New Literature

Insulation Reference Chart 269

Electrical insulation materials in the A, B, and H temperature classes are tabulated in the "Electrical Insulation Selector Chart." Over 30 different types of insulation materials are fully described as to base materials used, suggested applications, temperature class and available finishes. In each case, the gage, type of backing, and average tensile and dielectric strength are indicated along with standard specifications for comparative purposes. The 8-page, French-fold chart is handy to file or place above work benches. Sun Chemical Corp., Electro-Technical Products Div., 113 E. Centre St., Nutley 10, N.J.

Blind Bolts 270

Two brochures on bolts have recently been issued. The first, a 10-page booklet entitled "Blind Bolts," describes and illustrates a variety of blind nuts and bolts, their design, characteristics, use, and installation. It also presents illustrated descriptions of driving tools and equipment. The second brochure, "Hi-Torque Bolts," is a 4-page illustrated discussion of the configuration, advantages, applications, materials, and strength characteristics of super alloy and titanium bolts for high temperature use. Hi-Shear Rivet Tool Co., 2600 W. 247th St., Torrance, Calif.

Closed Circuit TV 271

Wired, closed circuit industrial television system, consisting of camera, camera control, and monitor is described in catalog now released. It contains data on remotely controlled pan-tilt, iris-focus, and other camera accessories; special ruggedized equipment for operation under adverse environmental conditions of noise, heat, shock, and extremes of temperature or humidity; and lists and describes a number of potential and actual installations where industrial TV is saving time, money, and providing more efficient use of equipment and personnel in plants throughout the world. KIN TEL, a division of Cohu Electronics, Inc., 5725 Kearny Villa Rd., San Diego 11, Calif.

Microwave Equipment 274

Five-in-one combination test sets, a multipulse generator, a direct-reading peak power meter, broadband barretter mounts, broadband directional couplers, several laboratory instruments, ferrite components, waveguide switches, field test sets, and specialized instrumentation and systems are treated in an 8-page condensed catalog. Each unit is accorded a description, an illustration, and a list of specifications. The catalog also lists, with brief specifications, other laboratory instruments. Sperry Gyroscope Co., Microwave Electronics Div., Great Neck, N.Y.

Magnetostriction Filters 275

A 3-page specifications and price list has been issued to cover a series of magnetostriction filters which may be used as narrow band circuit filters, as the frequency-determining element for oscillators, as comb-filter arrays in classified equipment, and on spectrum analyzers. The literature contains a table which lists available filter types according to half-power bandwidth and range of resonant frequencies. Another table gives three classes of tolerances for frequency, bandwidth, and insertion loss. There is also a brief discussion of general characteristics. Raytheon Mfg. Co., Missile Systems Div., Bedford, Mass.

Flexible Tubing Standards 276

Standards for braided flexible electrical tubing and saturated sleeving for insulating wires and leads in transformers, coils, motors, appliances, and all kinds of electrical and electronic apparatus has been released. Five types of insulation, including silicone rubber and vinyl, covering AIEE temperature classes A, B and H are specified. Grades A, B, C-1, C-2, and C-3 are identified in a table according to their performance under dielectric stress, potting temperatures and burning rate. National Electrical Mfg. Assoc., 155 E.

Power Transmission Data 277

This 1957 handbook on power transmission data has been compiled and revised to meet today's modern engineering standards and tabulations, and calculated to plan the proper transmission for any drive.

The catalog contains engineering charts tables and formulas to help the designer select the right gears and speed reducers for the job.

The new handbook also contains information to which the engineer will constantly refer for valuable transmission ideas. Ohio Gear Co., 1333 East 179 St., Cleveland, Ohio.

Portable
WITH LABORATORY ACCURACY

MODEL 250-DA
universal IMPEDANCE BRIDGE

Specifications...

Resistance: 0 to 12 megohms in 8 ranges. Accuracy: ±(0.10% plus 1 dial division.)

Capacitance: 0 to 1,200 microfarads in 7 ranges. Accuracy: ±(0.25% plus 1 dial division.)

Inductance: 0 to 1,200 henrys in 7 ranges. Accuracy: ±(0.9% plus 1 dial division.)

Price: $495.00

The ESI Model 250 DA is a universal, general purpose impedance bridge with built-in amplifier-oscillator. Rugged and compact for portability, it provides high accuracy in measurements of resistance, capacitance and inductance as well as the dissipation factor (D) and storage factor (Q) for capacitors and inductors at audio frequencies.

For complete information, contact your nearest ESI engineering representative or...

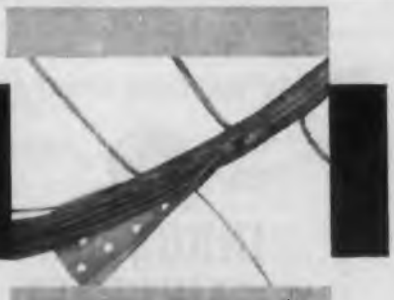
ELECTRO-MEASUREMENTS, INC.
7524 S. W. MACADAM AVENUE
PORTLAND 1, OREGON

esi

CIRCLE 272 ON READER-SERVICE CARD

Invaluable as an easy method of branch-outs in wire harness assemblies

NEW! PERFORATED AUTHENTIC Zippertubing



Features:

- Provides wire branch-outs at convenient locations
- Offers ease of encasing application
- Eliminates moisture condensation
- Simplifies wire handling
- Wall thicknesses of 20-40-60 AWG material
- Sizes of ⅜" I.D. and larger
- Military specification materials available

This new perforated type Zippertubing, allowing immediate branch-outs, makes it the ideal solution for the Aircraft, Electronic, Electrical and Communications industries. The perforation eliminates moisture condensation.

Zippertubing is now available in a perforated type to allow branch-outs along the wire harness bundle, and to simplify wire handling.

SPECIFICATIONS:

Wall Thickness:
.020, .040, .060 AWG

Material:
Fabricated from polyvinylchloride plastic tubing, perforated to meet your requirements. Available in General purpose type, manufactured to commercial quality or Military types, #63 & #74, the material which meets MIL-I-631C and MIL-I-7444 A (1) (Air Force approved, overlap construction).

Put-Up:
Available in 25 to 300 foot rolls. Longer lengths available upon specification.

Sizes:
⅜" I.D. up, in increments of ⅛", ± ¼".

Colors:
General purpose type; black and clear; Military type; amber or black. Other colors available on request.

Zippertubing MANUFACTURED BY
THE ZIPPERTUBING CO.
752 So. San Pedro Street, Los Angeles 14, Calif. (Michigan 0831)

CIRCLE 278 ON READER-SERVICE CARD

New Literature

Saturable Reactors 281

The first standard lines of saturable reactors for industrial and other control, are described in a 32-page catalog now available. These high gain units are manufactured in complete lines for both 240 v and 120 v operation, and contain 88 curves, showing the transfer characteristics of these units under typical operating conditions.

A cutaway view shows the construction of standard reactors as a preliminary to a discussion of electrical characteristics. Electrical characteristics described in detail include rated load, volt-ampere amplification, time of response, and figure of merit. Control, Box 391, Butler, Pa.

Synchro Definition Chart 282

A small chart, defining the important synchro parameters, of interest to engineers engaged in the manufacture or application of synchro components, is now available. It aids in the correlation of the data sheets of various manufacturers as well as emphasizing the dependent variables normally overlooked in defining these quantities. Theta Instrument Corp., 48 Pine St., Paterson, N.J.

Bolts and Rivets 283

A one page technical data sheet covering uses of bolts and rivets of super alloys for high temperature applications is now available. High temperature applications outlined are for jet engines, airframes, and guided missiles. This technical data sheet gives performance characteristics of the various super alloys along with the new A.M.S. specifications covering them.

The new overhauled centerless ground wire and its use for cold headed aircraft fastenings are described. Overhauled centerless ground wire is now available in Monel, K-Monel, Inconel X, and Nickel. Also mentioned is the use of high temperature super alloy bolts and rivets in the new NCAA four-stage guided missile which travels at speeds over 7000 miles per hour. Techalloy Co. Inc., Rahns, Pa.

FREE
new catalog
describes
MPB

Minted Miniature Bearings

MPB has developed "coinage" techniques enabling miniature bearings to increase precision in product performance. Find out which MPB bearings will bring *you* the most advantages. Made in O.D.'s of 1/10" to ⅜" they're available in a wide range of types, all described in this new catalog. For design engineer's free copy of Engineering News and MPB Catalog, write to R. I. Kern, Miniature Precision Bearings, Inc., Keene, N. H.

MPB
MINIATURE PRECISION BEARINGS

CIRCLE 285 ON READER-SERVICE CARD

New

MINIATURE ELECTRICAL WAVE FILTERS

Volume as small as .5 Cubic inch!

- **Miniature Low Pass Telemetering Filters** Standard RDB channels.
- **Miniature and Subminiature Filters of All Types** Low Pass, High Pass, Band Pass, and Band Rejection.
- **High Attenuation Low and High Pass Chebishev Filters**

Polyphase Miniature Electrical Wave Filters conform to Mil Specs, feature excellent temperature stability, good attenuation characteristics, low insertion loss. Units can be hermetically sealed, potted, or encapsulated.

PROMPT ENGINEERING DESIGN SERVICE ON SPECIAL FILTERS

PIC **Polyphase Instrument Company Bridgeport, Penna.**

CIRCLE 378 ON READER-SERVICE CARD

Time Delay Relays 286

Recently released, "Engineering Data Sheet No. 5" describes a line of Mil Spec time delay relays and sequence program switches. It shows how one particular type of timer can replace twenty-five different types of ordinary timers. This booklet describes the two basic types of timers, the repeat cycle type and the reset cycle type. It includes applications, operation, and specifications with illustrations. Also included are diagrams of a typical repeat cycle with up to five load circuits. Automatic Timing & Controls, Inc., King of Prussia, Pa.

Low Cost Nylon Parts 287

Through the use of special techniques and unique equipment Process "N" is described in a brochure now available. Through Process "N," tooling is designed to give precisely the quantity of part required within specified delivery times, and of guaranteed quality. Three to five hundred dollars is usually sufficient to cover such tooling on straight draw parts. This inexpensive tooling can be more readily absorbed within the quantities of parts required. The low cost also allows complete flexibility in changes of part design. Nylon Molded Products Corp., Dept. N-44, Garrettsville, Ohio.

"New World of Electronics" 288

Designed to examine the various factors which affect electronic development, the colorful booklet "The New World of Electronics" is now available. It covers the importance of research, engineering, facilities, quality control, and reliability in electronic components and in any electronics product. Amphenol Electronics Corp., 1830 South 54th Ave., Chicago 50, Ill.

Teflon Products 289

Bulletin A-3C describes a full line of extruded rod and tubing now available. The rod is available in 21 stock sizes up to 2 in. diameter and larger diameter rod is available on special order. The bulletin shows that tolerances are —0 to +063 in. on rod up to 1-1/4 in. diameter and—0 to +.125 in. on rod over 1-1/4 in. diameter. Standard rod length is 6 ft. Chicago Gasket Co., 1271 W. North Ave., Chicago 22, Ill.

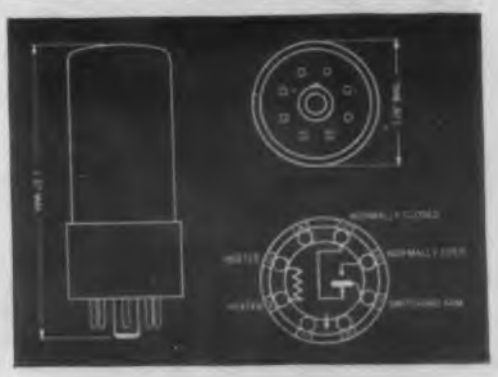
"Just Doing a Little Exploring!"

If you're the man whose product needs this Tung-Sol Relay – then it's you I'm exploring for

Tung-Sol produces a line of thermal relays in the general operating range characterized by the Type 609. Snap action contacts and extremely sensitive actuating heater elements provide uniform cycling. Operating principle permits manufacture of time delay relays and relays which function on small differential of voltage and current. Compact and lightweight, Tung-Sol relays are ideal for instruments and electrical equipment application.

NOMINAL DESIGN CONSIDERATIONS

Contact capacity.....1 amp 30 volt resistive
Contact arrangement.....SPST (NC) or SPDT
Operating power.....As low as ½ watt
Time delays.....Up to 5 seconds
Operate on current differential as small as .05 amps
Operate on voltage differential as small as .3 volts



NOMINAL CHARACTERISTICS OF 609

Operating voltage.....6.4 volts
Operating time.....1. plus or minus .5 seconds
Release time.....1. plus or minus .5 seconds
Contact capacity.....1 amp at 30 volts
Contact arrangement.....SPDT

For additional data write:
Electroswitch Division, Tung-Sol Electric Inc., Newark 4, N. J.

Sales Offices: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Tex.; Denver, Colo.; Detroit, Mich.; Irvington, N. J., Melrose Park, Ill.; Newark, N. J.; Philadelphia, Pa.; Seattle, Wash. Canada: Montreal, P. Q.

TUNG-SOL® THERMAL RELAYS

CIRCLE 290 ON READER-SERVICE CARD

New Literature

Switching Transistor Supply 292

A 60 w unit regulated against both line and load variations simultaneously is described in 4-page folder No. 501-A now released. Small size and outstanding reliability of unit are detailed. Used in aircraft, missile, and commercial fields as a lightweight replacement for rotating equipment having 150 and 300 v dc outputs. Arnold Magnetics Corp., 4613 W. Jefferson Blvd., Los Angeles, Calif.

Metal Alloys Prices, Specs 293

A 35-page price schedule No. 12 has been released for use by purchasing agents. For design engineers it is a technical handbook of wire, rod, and strip. Price Schedule No. 12 offers complete data on chemical, physical and mechanical properties of such alloys as Monel, nickel, and heat-resistance steels. Also included are the Federal, Military ASME and ASTM specifications. Tech-alloy Co., Inc., Rahns, Pa.

Fluoroply-F Laminate 294

Bulletin LT-2 is available with information on fluoroply-f laminate for printed circuit applications. Its 4 pages contain comprehensive data on size and thickness, properties, current-carrying capacities, foil, copper finish, post-etching suggestions, and handling recommendations. Also included is an illustrated listing of fixed and variable resistors. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

Transistor Equipment 295

A 10 page multicolor folder-type catalog covering a complete line of products is now available. The catalog includes listings of transistorized inverters and converters, transistorized high current power supplies, transistorized transpac and price list. Technical descriptions, specifications, application notes, model numbers and prices are shown. Electronic Research Assoc. Inc., 67 E. Centre St., Nutley 10, N.J.

Stainless Fasteners 297

Comprehensive treatment is accorded stainless fasteners in a 52-page stock list and data book. Listed with illustrations and thread and design specifications are forty basic fastening devices in a variety of corrosion-resistant metals. Separate sections are devoted to cap, machine, and self-tap screws; to set, wood, and miscellaneous screws, to bolts and nuts, to washers, rivets, pins, and studs; and to AN specification fasteners and pipe fittings. A final section consists of ten engineering data tables relating to the composition, properties, applications, and weights of stainless steels, and to comparisons and equivalents of interest to those concerned with fasteners. Allmetal Screw Products Co., Inc., 821 Stewart Ave., Garden City, N.Y.

Teflon Molded Parts 298

In four pages an illustrated brochure outlines a patented process for custom molding Teflon parts into thin shapes and sections. The folder cites the properties and characteristics of Teflon and suggests end uses. It illustrates many parts—cup, ball and shaft seals, washers, gaskets, diaphragms, and others—that have been designed through the topic process. Sparta Mfg. Co., Dover, Ohio.

Instrument Components 299

Facilities for protoype and production work on instrument components and assemblies are described in a 4-page, illustrated bulletin recently released. Typical procedures in the design, tooling and assembly of instrument and business-machine components are pictured, along with production operations. Arrow Tool Co., Inc., 36 Mill St., Wethersfield 9, Conn.

Carbon, Wirewound Controls

Hundreds of listings on the latest and most up-to-date replacement control information is now available in Pocket Control Guide No. 6. The special feature of this guide is the complete line of carbon and wirewound controls that are listed by ratings and part numbers, together with handy taper curves and other information.
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Patents

Diode Frenquency Converter with Local Oscillator

Patent No. 2,789,215. Wen Yuan Pan. (Assigned to Radio Corporation of America)

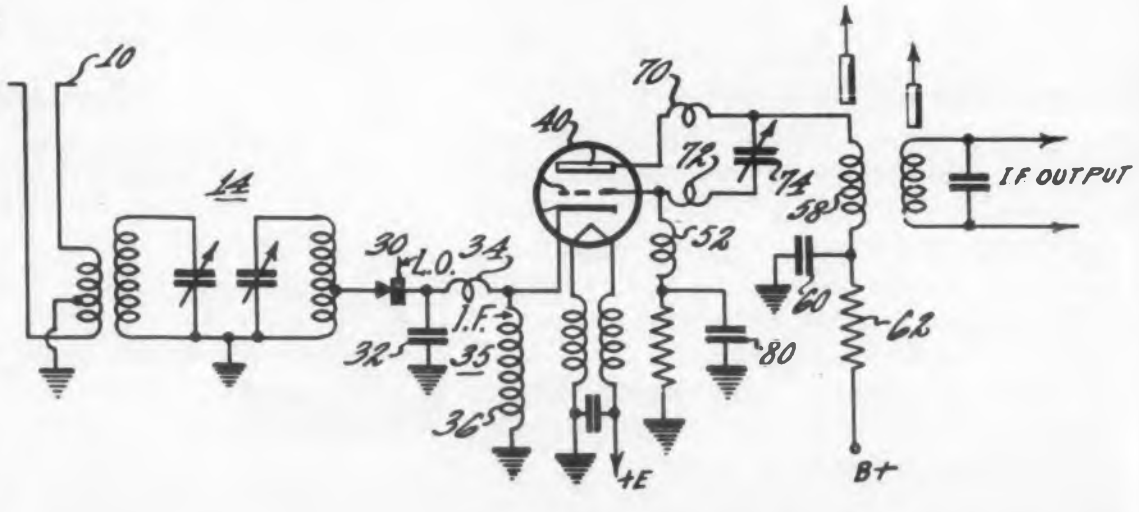
The converter illustrated in the figure provides a simplified circuit for television receivers designed to receive vhf signals so that they may receive the programs of new stations operating in the uhf range. The circuit in using fewer components provides a converter which is economical to manufacture and operates without detriment to a satisfactory noise level. Simplification of the circuit has been secured by combining both the local oscillator and the i-f amplifier in a single tube.

The uhf signal is received at the antenna 10, passes through the selection circuit 14, and is applied to a crystal diode mixer 30. The diode is coupled through a network 35 to the cathode of the tube 40 which serves both as the local oscillator and an amplifier for the i-f signal. The coupling network includes inductors 34 and 36 and capacitor 32 in conjunction with the inherent input capacity of the tube. The inductor 34 and the capacitor provide a low pass filter having a cut off frequency which is always higher than the intermediate frequency. The impedance of the capacitor 32 is low for signal frequencies so that the maximum signal appears across the crystal diode. The coupling network also improves selectivity.

The oscillator includes the tube and a network between the plate and the grid of the tube consisting of series connected inductors 70, capacitor 74, and inductor 72. Adjustment of the capacitor tunes the oscillator through the desired uhf band. The inductors have low impedance at the intermediate frequency so that their effect on i-f amplification is practically nil. The plate supply is provided through a resistor 62 and inductor 58 which inductor presents a high impedance to the oscillator frequency so that it is not impressed on the potential source. The grid of the tube is coupled to ground through an inductor 52 and capacitor 80 which has a low impedance at the intermediate frequency thereby grounding the grid at this frequency for i-f amplification. The low potential signal side of the winding 58 is grounded through a bypass condenser 60 for both i-f and the oscillator frequencies.

The grounded grid amplifier has an input impedance of about 150 ohms and the output impedance of the crystal mixer 30 is approximately 600 ohms. This provides a mismatch of about 4 to 1 which is advantageous with respect to the noise factor. The dc path for the tube is provided by the inductor 36 between the cathode of the tube and ground. This inductor provides a high impedance to either the oscillator frequency or the intermediate frequency. The coupling circuit 35 impresses the hetereodyning signal generated by the oscillator on the mixer diode 30.

Because of the wide differences in frequency there is little interaction between the oscillator and amplifier functions of the tube. The patent also discloses a second circuit which functions essentially the same as the circuit illustrated in the figure.



Semiconductor Devices

Patent No. 2,801,348 Jacques I. Pankove. (Assigned to Radio Corporation of America)

The semiconductor has the usual input and output electrodes. In contact with the body of the semiconductor is a means which provides an electric field oriented between the electrodes for controlling the current flow within the semiconductor between the input and output electrodes. The rectifying electrode controls the electric field and the current flow and is positioned remotely from the input and output and away from the collecting range of the current flow.

Self-Calibrating Limit Indicator

Patent No. 2,801,333 Archie Dean Jordan. (Assigned to Sylvania Electric Products Inc.)

This indicator uses a gas filled tube having a cathode circuit of a resistor, a condenser, and an impedance in series relation. Intermittent electrical energy is applied to the anode. A calibrating voltage is supplied by a suitable direct current source. A device, the voltage of which is to be tested, is connected to input terminals. The source of the calibrating voltage and the terminals are successively connected to the grid circuit of the tube so that the positive value of the calibrating voltage is applied to the control grid of the tube.

Detector

Patent No. 2,796,518. K. Schlesinger. (Assigned to Motorola, Inc.)

The detector is used in a television receiving circuit which has an intermediate frequency amplifying stage, a video detector stage and a video amplifier stage. The video amplifier stage includes a first tube having a first, a second and a third or plate electrode. An energizing circuit is provided for the first and third electrodes through which passes all of the current for both electrodes. The energizing circuit is resistive coupled between the first electrode of the first tube and a reference potential point. The video detector stage includes a second tube having a first, a second and a third or plate electrode. An input circuit is coupled from the intermediate frequency amplifying stage to the first and second electrodes of the second tube. An output circuit is provided for the second tube including a load impedance which is dc coupled between the third electrode of the second tube and a point of the resistor means which is intermediate the first electrode of the first tube and the reference potential point. This output circuit further includes a dc connection to the second electrode of the first tube to apply detected signals thereto. With this circuit arrangement energizing potential for the video detector stage is derived from the energizing circuit of the video signal amplifier stage and an increase of signal level at the video detector stage increases current flow in the energizing circuit to reduce the response of the video detector stage.

Symmetrical Direct Current Stabilization In Semiconductor Amplifiers

Patent No. 2,802,067 Jakob Jawels. (Assigned to Radio Corporation of America)

The amplifier circuit is designed to use a first and a second semiconductor device of opposite conductivity types. The input is coupled between the base electrodes and the emitter electrodes for simultaneously applying input energy of the same polarity between their respective base electrode and emitter electrode. The collector electrodes are connected to a common output load. In the simpler form of the circuit, a first dc conductive stabilizing resistor is provided between the emitter electrode of the first semi-conductor device and the base electrode of the second semi-conductor device and a second dc conductive stabilizing resistor is provided between the emitter electrode of the second semi-conductor device and the base electrode of the first semiconductor device. With this amplifier circuit, the dc operating point is stabilized against varying characteristics of the semiconductor devices.

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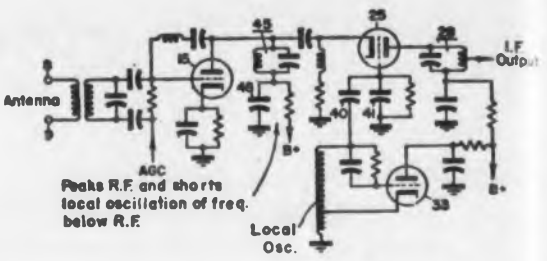
Patents



Cascode Amplifier-Mixer with Trap To Prevent Local Oscillator in Driven Stage from Affecting Driving Stage

Patent No. 2,789,213. Meyer Marks and Robert Adler. (Assigned to Zenith Radio Corporation)

Radar receivers as originally designed used amplifiers having noise levels too high for entirely satisfactory reception. In order to improve the noise level and provide satisfactory gain, cascode amplifier circuits were devised using two triodes. These cascode amplifiers have the noise level of a triode, however, the gain is that of a pentode and in addition provides a separation between the input and output circuits. In these amplifiers most of the amplification is secured in the second triode. As a consequence of the advantages, the cascode amplifier circuits are widely used.

When it is desired to heterodyne the input signal with a frequency generated by a local oscillator and inserting the signal at the grid of the second tube, difficulties resulted which were serious enough to make the circuit unsuitable. One difficulty arises from the fact that the application of large heterodyning currents in the second tube results in large heterodyning currents in the first tube and this destroys separation of input and output which is one desirable feature of a cascode amplifier. There is an increase of the signal to noise ratio. In addition the heterodyne frequency is back-coupled through the first tube and is radiated from the receiver antenna. The circuit illustrated overcomes the objectionable features which arise from the combination of a cascode amplifier circuit with a heterodyning local oscillator.

The rf signal is applied to the terminals *8*, *9* and is amplified in the tube *15* which tube has its plate coupled to the cathode of a second tube *25*. The local oscillator including tube *33* is coupled through the capacitance *40* to the control grid of the second tube. The capacitor *41* is larger than *40* and has a low impedance to rf signals. The parallel-resonance circuit *28* is tuned to the intermediate frequency. The illustrated circuit adds to the usual cascode amplifier, the parallel network *45* in the plate circuit of the first tube which has a high impedance to the rf input so that essentially all of the amplified signal from the first tube is applied to the cathode of the second tube. At the intermediate frequency, the network *45* presents an inductive characteristic so that by using a capacitor *48* in series with this inductive value to secure series resonance at the i-f frequency, the impedance to ground is practically zero. This restores the separability between the two tubes and avoids radiating the intermediate frequency. The circuit also secures an increase in the gain of the overall circuit of two to three times.

The patent describes and illustrates in another figure a circuit similar to that above in which the second tube not only serves as an amplifying tube but also serves as the tube of the oscillator circuit. The circuit otherwise is essentially the same.

Photoelectric Circuit

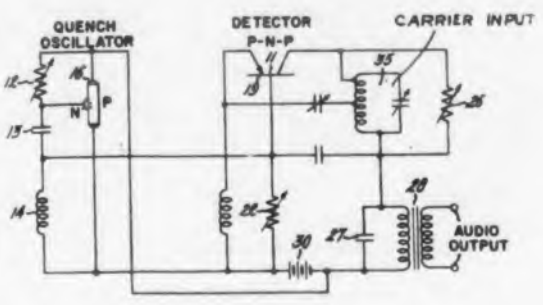
Patent No. 2,803,751 Valentine Hechler IV.

The photoelectric circuit in its less complex form consists of a three element cold-cathode tube and a pair of photocells connected in series with the two photocells in parallel with the cold-cathode tube forming a parallel circuit. A dc source applies the proper potential across this parallel circuit. The anode of the first photocell and the cathode of the second photocell are connected to the grid of the cold-cathode tube. A timing condenser is provided between the cathode and grid of the cold-cathode tube so that a voltage is built up on the condenser in response to an increase in the current flow through the second photocell as compared with the current flowing through the first photocell. The cold-cathode tube is fired, therefore, when the voltage on the timing condenser reaches a predetermined value. The firing of the cold-cathode tube may energize a utilization element such as a relay.

Semiconductor Superregenerative Detector

Patent No. 2,792,494. Jerome J. Suran and Woo Foung Chow. (Assigned to General Electric Company)

A superregenerative detector has found considerable favor for radio receivers because it simplifies circuitry. Such simplification oft-times arises from the ability to eliminate amplifier stages for radio frequency and intermediate frequencies. The detector in addition is efficient and occupies small space. The detector circuit of the patent is one which makes use of transistors.



A superregenerative detector is primarily a radio frequency oscillator which becomes periodically non-oscillating under the influence of a quench frequency oscillator. The latter oscillator operates at a so-called quench frequency which is higher than any of the modulation frequencies received. The detector illustrated uses a PNP transistor 11 having a resonant circuit 35 connected as shown in the figure. A variable load resistor 26 parallels the oscillatory circuit so that some control of the Q of the resonance circuit is secured and in this manner reduces the critical nature of the tuning of the radio frequency oscillator. The output of the oscillator may be through a transformer 28, the primary winding of which is by-passed for quench frequencies through a condenser 27. Control of the quench frequency cycle as applied to the oscillator is secured through a variable resistor 22. Suitable potentials are applied to the various electrodes of the detector transistor from a source 30.

The quench oscillator is also a transistor and preferably an NP crystal which functions as a relaxation oscillator. A double base electrode form of diode has been found to be particularly suitable as the quench frequency oscillator. A variable resistor 12 is provided between the ohmic contact 16 and the base electrode for controlling the quench frequency. The condenser 13 will build up a voltage to a point where the N region of the transistor becomes negative to the P region at which time the condenser discharges through the base electrode and inductance 14. By using an inductance the wave form approximates a sine-wave. The quench oscillator frequency is applied to the base electrode of the transistor 19 through resistor 22 and controls the periods of oscillation and non-oscillation of the detector oscillator 11.

Unblanking Circuit for Cathode Ray Tubes

Patent No. 2,804,571. John R. Kobbe. (Assigned to Tektronics Inc.)

The oscilloscope circuit described uses a grid bias voltage supply for the control grid of the cathode ray tube. A pulse generator supplies voltage pulses to the cathode of the tube through a circuit connected to one side of the pulse generator. The grid bias voltage supply is in series between the other side of the pulse generator and the control grid of the cathode ray tube but is otherwise electrically isolated from the electrodes of the cathode ray tube. As a consequence the voltage of the grid accurately follows the wave form of the pulse despite duration or duty cycle of pulses.

Load Sharing Circuit

Patent No. 2,806,198. Arden H. Frederick. (Assigned to General Precision Laboratory Inc.)

The circuit consists of a pair of discharge tubes each having their anodes connected to an input terminal. The cathode of each tube has an individual resistor between the cathode and a terminal of a utilization circuit. A control potential is applied to the control grid of one of the tubes. A circuit, which may be a third tube, is operated by the potential difference between the cathodes of the tubes, and applies a potential to the control grid of the other of the pair of tubes in a sense such as to mitigate the potential difference between the cathodes and causes the anode-cathode currents flowing through the pair of tubes to be equalized.

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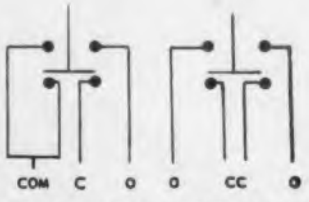

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Books

Transistor Electronics

D. DeWitt and A. L. Rossoff, McGraw-Hill Book Co., Inc., 347 W 41 Street, N.Y. 36, N.Y. 392 Pages, $8.00.

This book is planned to provide a thorough familiarity with the properties of the transistor and its underlying physical mechanisms. It gives the practicing engineer a working knowledge of quantative transistor circuit design, based on a clear cut understanding of the internal workings of the transistor device. It assures useful design accuracy without a prior knowledge of quantum mechanics.

Early chapters deal with semiconductors physics. They touch upon quantum mechanics, energy band theory, and Fermi statistics, and provide a clear picture of important semiconductor processes.

Later chapters provide a practical explanation of the transistor device, incorporting all reasonable approximations and relating device properties to physical theory.

In showing the reader how to employ these methods in practice, the book stresses specific prototype circuit uses, rather than general handbook coverage. It explains basic quantitive concepts and how to apply them to transistors.

Progress in Semiconductors, Vol. II

Alan F. Gibson, General Editor, John Wiley & Sons, 440 Fourth Ave., N.Y. 16, N.Y. 280 Pages, $10.50.

The second of an annual series (see ED Jan. 1, 1957), extends the coverage

in the field of semiconductors, by presenting eight additional papers.

The best treatment of a particular semiconductor aspect varies with the subject matter. The presentations in this volume illustrate the variety possible.

One paper, describes a general model from which the carrier lifetime in a wide range of lifetimes can be deduced. The familiar equation of Shockley and Read appears in a special case appropriate to a material like germanium.

Other papers cover properties of the III-V Compound Semiconductors, Radiation Effects in Semiconductors, Production of High Quality Germanium Single Crystals, Impurities in Germanium High Electric Field Effects in Semiconductors, and Theories of Electroluminescence.

Each article carries a list of references to original sources, and a comprehensive index is included.

Mathematics for Science and Engineering

Philip L. Alger, McGraw-Hill Book Co., Inc., 330 W 42 St., N.Y. 36, N.Y. 360 Pages, $6.95.

This revision presents methods and procedures for finding, understanding, and applying the mathematical procedures best adapted to solve a particular problem. It aims to help students, teachers and practicing engineers to use mathematics effectively by first showing the unity and simplicity of the basic mathematical ideas and then making numerical calculations easy. Beginning with a quick review of arithmetic, it goes on through algebra, trigonometry, calculus, probability, and linear differential equations. Special emphasis is given to complex numbers, infinite series and methods of approximation. A problem section follows each chapter.

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New Positional-Control System Is Frequency Sensitive

DESCRIBED is a system for using a differential motor for accurate remote positional control which will avoid residual error. Differential motors sense a difference in frequency of the error signal rather than amplitude, and since starting friction and slot effect are not present in differential motors, no residual error exists.

Heretofore, remote control positional servomechanisms have often utilized 2-phase ac motors in the feed-forward path to correct the positional error. Because of starting friction and slot effect of the servo motor, an inherent dead zone exists which prevents correction of a positioning error below a lower limit. Control systems, which measure and respond to the amplitude of an error signal, can therefore be expected to have a residual error, particularly in the presence of a load torque.

Motor Description

A differential motor is made up of two synchronous motors (Fig. 1). Stator winding S_1 is energized from a power source having a frequency f_1. The shaft of its rotating member R_1 is connected to the housing which holds the stator S_2 of the second synchronous motor. Power from a source having frequency f_2 is supplied to the stator S_2 through slip rings on the shaft. The rotar R_2 rotates at a synchronous speed with respect to the winding S_2. Connections to S_1 and S_2 are made in such a way that the direction of rotation of R_2 is opposite to R_1.

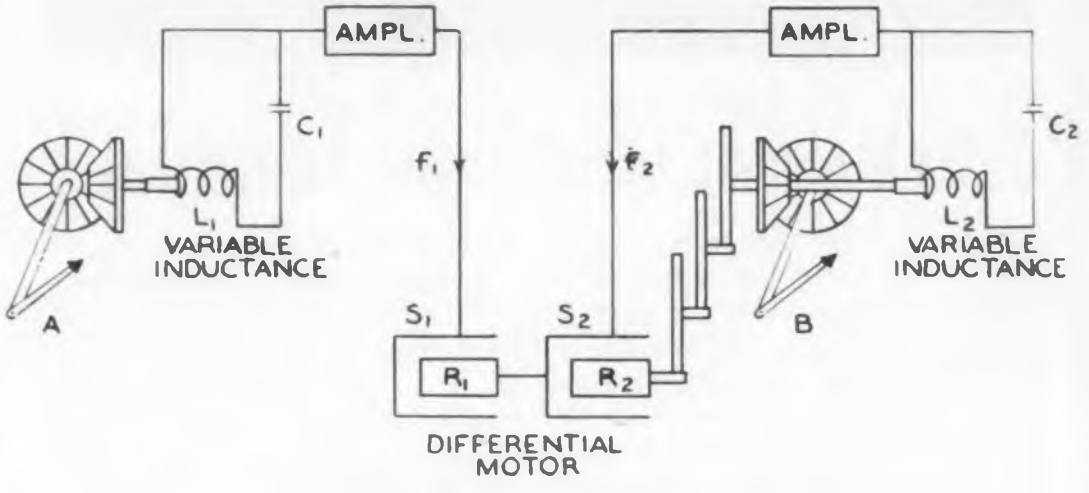
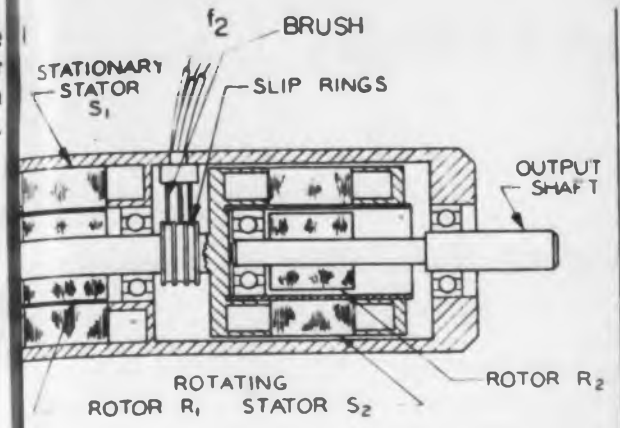


Fig. 2. Frequency sensitive positional control system accuracy is limited only by the precision of the LC circuits.



1. Differential motor removes the dead-zone error ositional control systems.

Therefore, if the frequencies of both power supplies are equal, the output shaft of the rotar R_2 will remain stationary. When the frequencies of the power supplies are not equal, the output shaft will rotate with a speed proportional to the difference in frequency. The differential motor has already found limited use in speed control systems, and also, for the replacement of mechanical differentials. Apparently no attempt has been made so far to apply this motor to positional control problems.

Description of Positional Control System

Position of shaft *A* in Fig. 2 is to be transmitted remotely and displayed at *B*. Shaft *A* is mechanically connected to the core of a variable inductance L_1 of an *LC* circuit, which supplies power to the stationary motor S_1 of the differential motor. The output shaft of the differential motor is connected through a gear train to the shaft *B*. The output shaft also moves the core of the variable inductance L_2. Position of the core determines the frequency f_2 which is fed back to the winding S_2. As long as the frequency f_2 of the output *LC* circuit differs from the input frequency f_1, corrective action is taken by the differential motor. When the core L_2 is positioned so that the feedback frequency f_2 is equal to f_1, the output shaft of R_2 will not rotate. The system will accurately position *B* for any change in *A*, and has no dead zone. Extremely accurate remote control positioning can be obtained since the limiting factor is the precision of the *LC* circuits at the transmitting and receiving ends.

K. Burian, Chief Engineer, G-M Laboratories Inc., 4300 North Knox Avenue, Chicago 41, Illinois.

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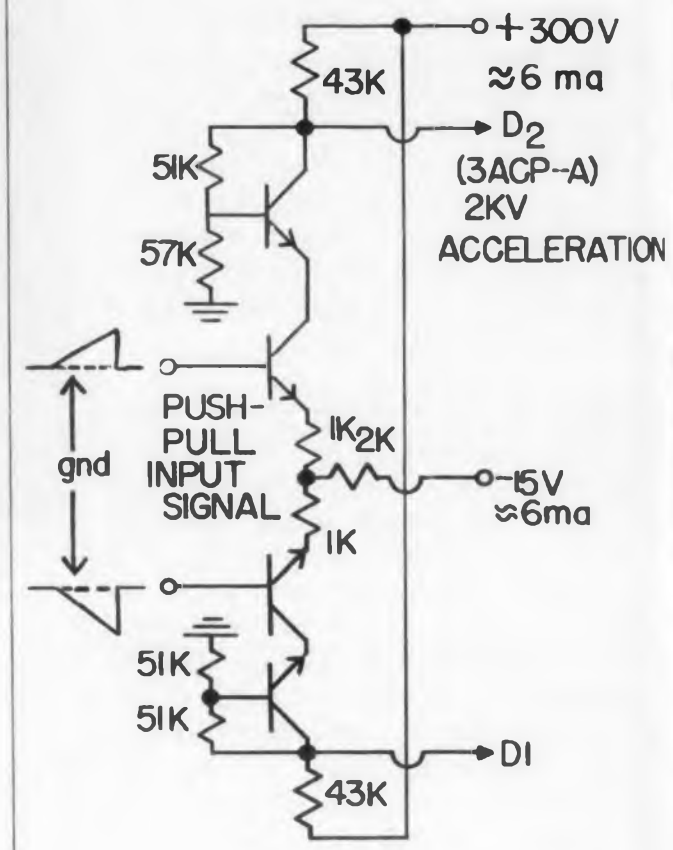
Ideas for Design

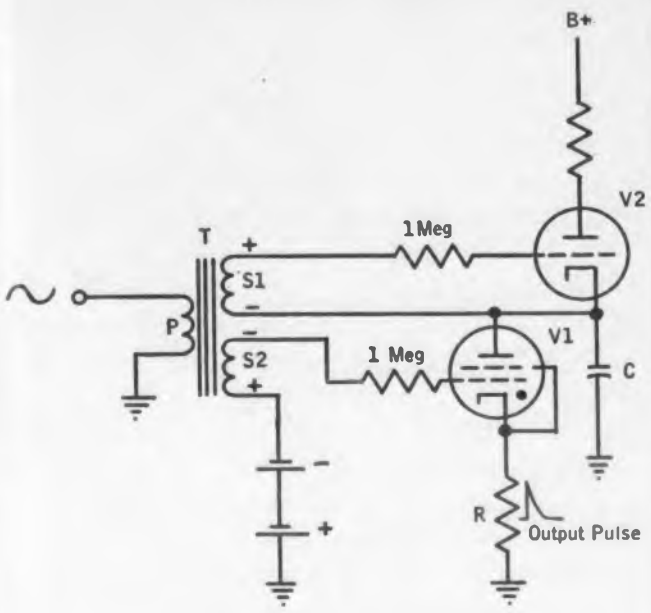
Transistorized Deflection Amplifier for Oscilloscope

The problem was to design direct coupled transistor deflection amplifiers for a 3 in. cathode-ray oscilloscope. Minimum peak to peak voltage requirement was 160 v. Bandwidth required was from dc to approximately 150 kc at 3 db down.



The circuit illustrated was designed using transistors in series to develop the required signal voltage without exceeding the transistor V_{cb} ratings. Texas Instruments 953 Grown Junction Silicon transistors were used, although lower voltage transistors would be satisfactory provided enough were added in series to stay within V_{cb} ratings on each transistor.

Dan R. Bromaghim, Engineer, Massachusetts Institute of Technology, Lincoln Labs., Lexington 73, Mass.



Thyratron Pulse Circuit

This thyratron discharge circuit may be controlled by a sine wave signal to produce uniform pulses at the same rate as the signal frequency. At low frequencies sufficiently strong pulses may be produced to operate a relay, counter, or other device. The upper frequency is limited only by the deionization time required by the thyratron and circuit components.

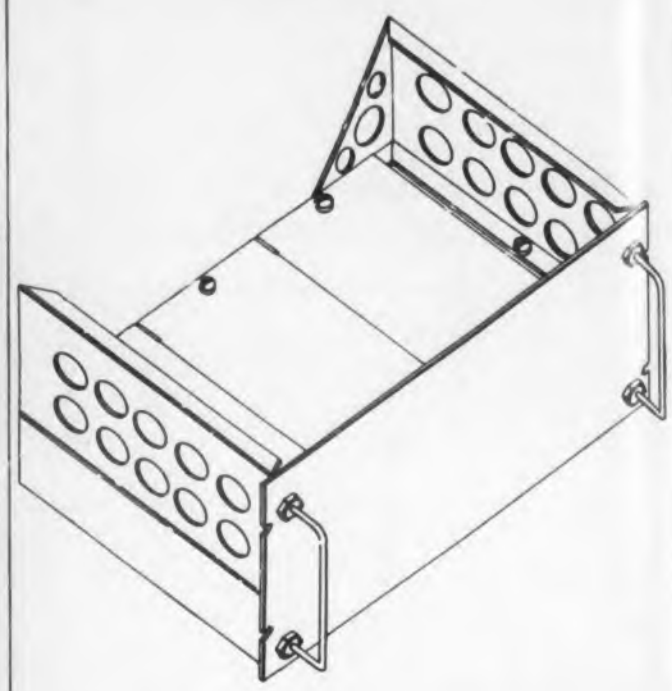
Operation

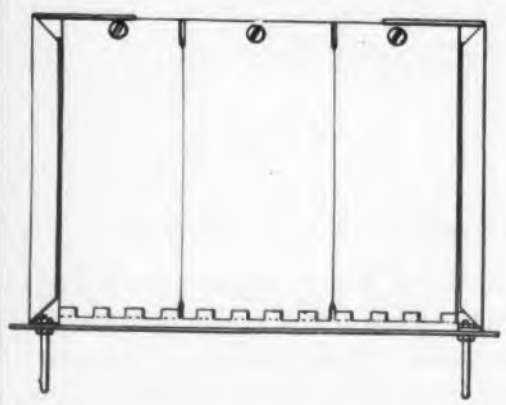
Assume the two secondary windings S1 and S2 on transformer T are equal. Thyratron V1 is biased slightly higher than the cutoff bias required for tube V2. The secondary windings S1 and S2 are connected to the grids of V1 and V2 respectively so that the signal voltages are 180 degrees out of phase. During the first half cycle, when the signal voltage on the grid of V2 is positive, capacitor C will charge up to approximately B plus voltage, and the fixed bias applied to the grid of V1 will prevent this tube from conducting. In the next half cycle, as the negative signal voltage on the grid of V2 increases, this tube will be cut off. As the positive signal voltage applied to the grid of V1 approaches the value of fixed bias, V1 will fire, and capacitor C will be discharged through V1 and load resistor R. The time constant of the charge and discharge circuit must be adjusted to suit the highest operating frequency.

Curtis M. Chappell, 246 Regent Street, Hampton, Va.

Another Application for FERRITES

Ideas for Design





Construction details of standard relay-rack chassis.

Low-Cost Experimental Chassis

This low-cost chassis for rack assembly has features that make it especially time saving for laboratory experimental equipment.

All chassis for rack assembly should have pull-out handles for ease of handling and removal from the rack. Whereas handles on most such units are optional, handles on the chassis shown are structurally essential and poly-functional. They serve the obvious purpose of handles, yet they have been designed of sufficient size and strength to serve as supports for the assembly when turned face down during checking and testing of the wiring and components. They also serve for securing the panel to the frame.

The frame consists of three parts (see figure), a sub chassis and two braces. The frame may be assembled quickly by means of only six screws. The braces are of sufficient weight and so designed to permit stacking a large number of units while in storage. The frame is sufficiently rigid to maintain alignment of components.

The sub chassis is designed to accept circuit elements mounted on strips which are secured by built-in clips at one end and metal screws at the other. This arrangement greatly facilitates the removal of sub-units such as power supplies, scaler strips, etc., in cases of replacements or change of circuit design. The sub chassis has a cut-out on the side facing the panel in order to ease the task of mounting components.

At termination of an experiment, removal of the front panel and strips frees the frame for use again in the next series of experiments.

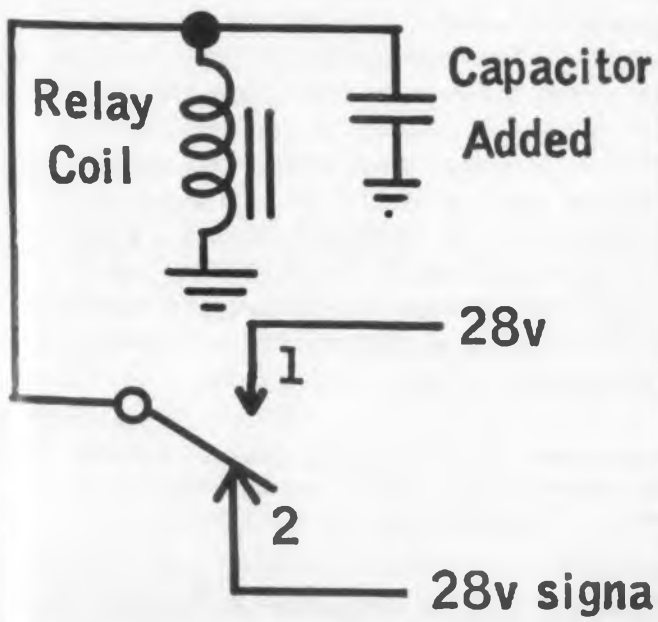
This type of chassis design has a high degree of flexibility and is suitable for experimental development or production. The ease of assembly and installation of unitized circuit elements combined with re-use potential should materially decrease the cost of electronic equipment in present day large scale operations such as computers, nuclear research, etc.

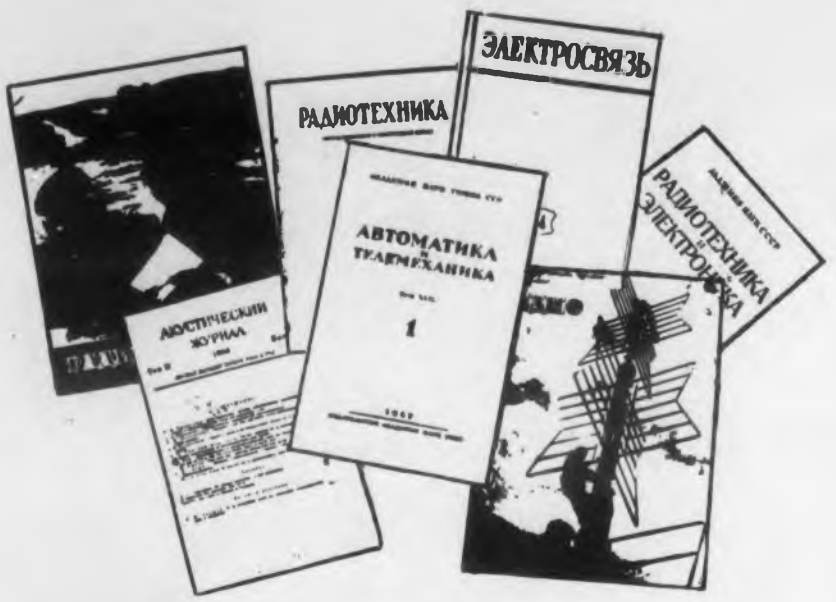
A. R. Ronzio, Research Director, Radiological Research Institute, Inc., 663 Lipian St., Denver 4, Colo.

Improved Sub-miniature Relay Operation

In order to secure make-before-break action from a standard sub-miniature aircraft-type sealed relay (m.b.b. relays are not normally available in this relay type), a small capacitor was added in parallel with the coil as shown. The relay will pull in and hold (without capacitor, it will chatter).

Herman P. Knocklein, Associate Engineer, Sperry Gyroscope Co., Carle Place, N. Y.





What the Russians are Writing

J. George Adashko

RADIO ENGINEERING AND ELECTRONICS

(Contents of Radiotekhnika i Elektronika No. 5, 1957)

TIME BASES

Method for Fixation of Processes in Time, V. I. Nikolenko (13 pp, 10 figs).

Assume that a relay is to operate when, in Fig. 1, the control voltage level reaches U_o. A change in the scale of the control voltage would introduce an error in the operating time. On the other hand, if operation is to take place at a specified fraction of the maximum voltage (relative level), the error in timing can be reduced or eliminated (Fig. 2). The article is devoted to a discussion of self-oscillating circuits of high timing accuracy in the sense illustrated above.

NOISE

Width of Spectral Lines of Pulsed Self-Oscillating Systems, Ia. I. Khurgin (8 pp, 1 fig).

It is shown that the presence of fluctuations in the tubes and in the circuit elements causes a sequence of pulses generated by a self-oscillating system to have a continuous spectrum in the form of splashes in the vicinity of the average frequency of pulse repetition and its harmonics. The connection between the statistical characteristics of a pulse train and the width of the spectral lines is clarified.

General Method for the Investigation of Transients in Pulse Detection, E. L. Gerenrot (4 pp).

An article on pulse detectors with LC filters, by the same author, appeared in the October 1956 issue of *Radiotekhnika* (*ED* July 1, 1957). This article employs the method of slowly-varying amplitudes to analyze the transients occurring in a detector of strong pulses of arbitrary wave-form. The presence of inductance in the detector load is considered, as is the presence of transients in the supply circuit.

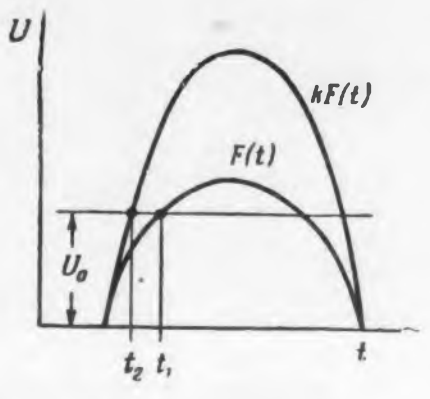


Fig. 1. If a relay is to operate at a time, t_1 corresponding to a given voltage level, and the voltage scale should change, the relay would operate at the wrong time, t_2.

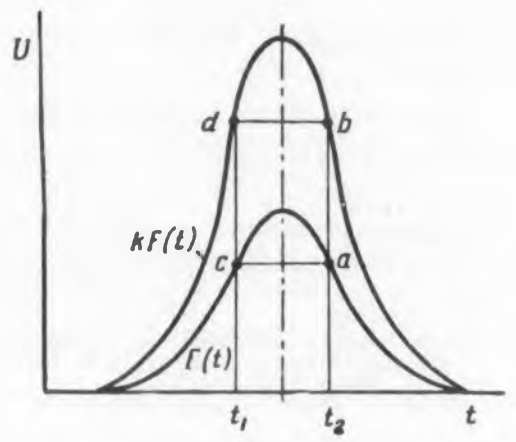


Fig. 2. If relay operation is to take place at a time, t_1 or t_2, corresponding to a fraction of the peak voltage level, the error due to voltage changes is minimized or eliminated. (It may be necessary to discriminate between rising voltages at t_1 and falling voltages at t_2).

Effect of Signal and Noise on Nonlinear Elements (Direct Method), V. I. Tikhonov, I. N. Amiantov (12 pp, 4 figs, 3 tables).

A direct method is used to analyze the effect of a harmonic signal and normal fluctuation on nonlinear elements with piecewise-linear characteristics (modulator, frequency multiplier, limiter, etc.). Quantitative results are obtained.

WAVEGUIDES

Long Symmetrical Waveguide Junction for H_{01} Waves, B. Z. Katsenelenbaum (16 pp, 2 figs).

An allied topic was treated by the author in the March 1956 issue of *Radiotekhnika i Elektronika* (*ED* December 15, 1956). Two waveguides of round cross section with a common axis are joined by a transition piece which is itself a surface of revolution, whose generatrix is inclined to the axis of the waveguides at an angle that is always a small parameter of constant order of magnitude. An H_{01} wave strikes the irregular waveguide, and the amplitudes of the reflected wave and of the H_{01} parasitic waves are determined. The equations are applicable, in particular, where the wave number of one of the waves (as referred to the regular waveguide) vanishes in some sections of the transition piece.

Characteristics of the Faraday Effect in a Cylindrical Waveguide with a Ferrite Rod, Ia. A. Monosov (12 pp, 12 figs).

The author continues his investigation of the theory of a cylindrical waveguide with a ferrite

rod (*See Radiotekhnika i Elektronika*, Feb. 1957, *ED* October 1, 1957) and shows that by proper choice of the geometry and parameters of the ferrite it is possible to vary the parameters of the magnetic rotation of the plane of polarization of the wave in the ferrite. The angle of rotation can be kept constant over a wide frequency range, and can be increased or reduced.

UHF PROPAGATION

Effect of the Inhomogeneous Structure of the Ionosphere on the Absorption of Radio Waves, O. M. Ataev, (8 pp, 4 figs).

Expressions are derived for the amplitudes of a signal multiple-reflected from the ionosphere; these expressions take into account the inhomogeneous structure of the latter. Inhomogeneities that are both much greater and much smaller than the wavelength are considered. It is shown that an increased degree of inhomogeneity can cause the intensity of a multiple-reflected signal to be higher than that reflected from a homogeneous layer. Experimental verification of the analysis is cited.

RADAR

On the Accuracy of the Range Coordinate in Radar Systems Employing Non-Coherent Storage, S. E. Fal'kovich (8 pp).

A sequel to the author's general statistical treatment of range accuracy, published in the April 1957 issue of *Radiotekhnika i Elektronika* (*ED* December 1, 1957).

ANTENNAS

Optimum Linear Antennas Radiating at a Specified Angle with the Axis, V. L. Pokrovski, (7 pp, 5 figs).

Optimum distributions for simpler broadside and endfire cases were treated by the author in many articles, the latest of which was reviewed in *ED* December 1, 1957 (*Radiotekhnika i Elektronika* April 1957). The results are now extended to include other angles as well.

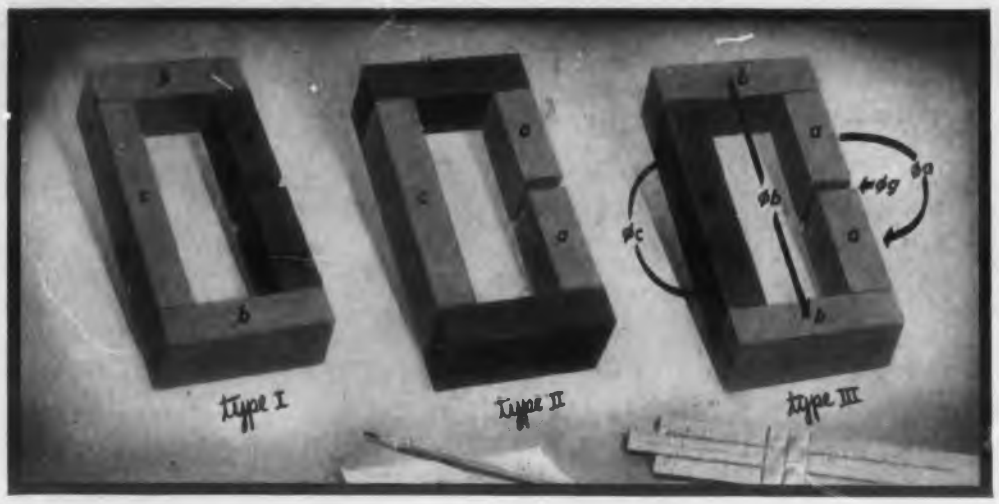
MICROWAVE COMPONENTS

Wide-Band Reflex Klystrons for Millimeter Waves, E. D. Naumenko (4 pp, 6 figs).

Description of an experimental model covering a range from 7 to 19 mm with an output power on the order of 5 milliwatts. Sections of coaxial line placed in the vacuum system are used as resonators.

TRAVELLING WAVE TUBES

Design of a Retarding System with Double "Tandem" Rods, Iu. G. Al'tshuler, A. S. Tatarenko,



How You Can Save Time Estimating Leakage Factors for Magnetic Circuits

Computing even approximate values for leakage flux in magnetic circuits is a time consuming job. The research department of Indiana Steel recently undertook a series of studies, supported by the U.S. Air Force, to simplify these computations. Dr. R. K. Tenzer reported the results of this work, which reduce the time in computing leakage flux up to 90% by diminishing the number of mathematical operations necessary.

The investigations were done on circuits with permanent magnets; the results were also found applicable to unsaturated electromagnetic circuits when the coil-covered parts were treated as permanent magnet parts.

After checking values obtained by this method with actual measured values for many Type I, II, and III magnetic circuits, deviations were found to be less than ± 10%.

Leakage Flux, Leakage Factor

Because of magnetic leakage, only a part of the total flux through the neutral zone of the permanent magnet is found in the air gap. The difference between these two values is known as leakage flux. Mathematically this is:

$$\phi_L = \phi_i - \phi_g. \tag{1}$$

In practical design, leakage is best considered as a factor stated thus:

$$\sigma = \frac{\phi_i}{\phi_g} = 1 + \frac{\phi_L}{\phi_g}. \tag{2}$$

For simplification, the flux can be assumed to follow three basic, probable paths: ϕ_a between parts a, ϕ_b between parts b, and ϕ_c along part c. The equation above then becomes:

$$\sigma = 1 + \frac{\phi_a + \phi_b + \phi_c}{\phi_g}. \tag{3}$$

With $\phi = mmf \times P$, this formula can be written:

$$\sigma = 1 + \frac{1}{P_g}\left(\frac{mmf_a}{mmf_g}P_a + \frac{mmf_b}{mmf_g}P_b + \frac{mmf_c}{mmf_g}P_c\right). \tag{4}$$

Letting the *mmf* ratios be denoted by K,

$$\sigma = 1 + \frac{1}{P_g}\left(K_a P_a + K_b P_b + K_c P_c\right). \tag{5}$$

This becomes the basic equation for numerical calculations of leakage factors after introducing simple expressions for leakage permeances and mmf ratios.

Simplified Leakage Permeances

The following formulas have been found satisfactory for leakage permeances between soft steel parts:

$$P_a = 1.7 \times U_a \times \frac{a}{a + L_g} \text{ where } U \text{ is} \tag{6}$$

cross-section perimeter;

$$P_b = 1.4 \times b \times \sqrt{\frac{U_b}{c} + .25} \tag{7}$$

where U_b/c is greater than .25 and less than 4. The total length of part b is used.

Since permanent magnets have a neutral zone which does not contribute to leakage, the value of 2/3 of the magnet's total length is used when computing leakage permeances—this is the effective length a' and b' to compute P'; thus the two equations above become:

$$P'_a = 1.7\, U_a \frac{.67a}{.67a + L_g} \tag{6a}$$

and

$$P'_b = 1.4 \times .67b\sqrt{\frac{U_b}{c} + .25} = .67\, P_b. \tag{7a}$$

When part c consists of a permanent magnet (Type III) its permeance can be calculated as:

$$P_c = .5\, U_c. \tag{8}$$

The permeance of the air gap itself is

$$P_g = A_g/L_g. \tag{9}$$

Simplified MMF Ratios

Simplifying the *mmf* ratios is done by neglecting the reluctance in *soft steel parts;* so

$$mmf_a = mmf_b = mmf_g \text{ or } K_a = K_b = 1 \quad (mmf_c = 0 \text{ so } K_c = 0). \tag{10}$$

Since the *mmf along permanent magnet parts* is not constant, integral values ($\overline{mmf}$) are used. Experiments showed that 2/3 of the mmf_g was the effective *mmf* for leakage flux between permanent magnet parts; thus

$$\overline{mmf_a} = \overline{mmf_b} = \overline{mmf_c} = 2/3\ mmf_g$$

or

$$K_a = K_b = K_c = 2/3. \tag{11}$$

Basic Formulas

By inserting the permeances for soft steel into equation (5), the general formula becomes:

$$\sigma = 1 + \frac{L_g}{A_g}\left(K_a \times 1.7\, U_a \frac{a}{a + L_g} + K_b \times 1.4\, b\sqrt{\frac{U_b}{c} + .25} + K_c \times .5\, U_c\right). \tag{12}$$

This formula contains only constants and dimensions; and by the two following rules this can be modified into the three basic equations for the Type I, Type II, and Type III circuits.

Rules: (1) For leakage flux paths between soft steel parts, use total lengths and constant K of 1. (2) For leakage flux paths between permanent magnet parts, use 2/3 of lengths and K of .67.

The following provide the leakage factors for the three types of circuits:

Type I:

$$\sigma = 1 + \frac{L_g}{A_g} \times .67 \times 1.7\, U_a \frac{.67a}{.67a + L_g}$$

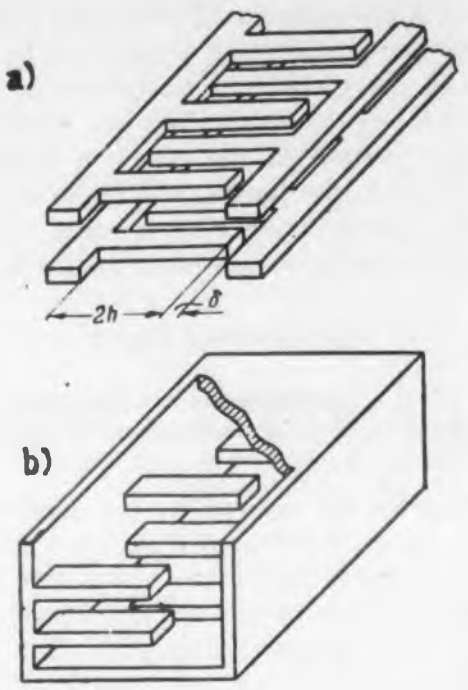
Type II:

$$\sigma = 1 + \frac{L_g}{A_g}\left(1.7\, U_a \frac{a}{a + L_g} + .67 \times .67 \times 1.4b\sqrt{\frac{U_b}{c} + .25}\right)$$

Type III:

$$\sigma = 1 + \frac{L_g}{A_g}\left(1.7\, U_a \frac{a}{a + L_g} + 1.4b\sqrt{\frac{U_b}{c} + .25} + .67 \times .5\, U_c\right)$$

For variations on these basic formulas, write today for the April-June issue of *Applied Magnetics* which also shows examples of the formulas in use.



S. V. Gerchikov (9 pp, 4 figs).

R. C. Fletcher (*Proc. IRE, Vol. 40 (1952),* pp 951-8) showed that systems of this type (Fig. 3) have a zero backward spatial harmonic and are thus of great importance in the design of travelling-wave and backward-wave tubes. The author derives expressions for the potential and current, for the field component, and for the wave impedance of the system, and discusses the dispersion equation and other special topics.

Concerning the Calculation of the Power Flow and Coupling Impedance in a Strip Helix, N. M. Sovetov, V. A. Sukhov (9 pp, 3 figs).

The Umov-Poynting equations are integrated to determine the total power flow as the sum of the flow due to the individual spatial harmonics. It is shown that near cutoff most of the power is in the backward component, and that the power flow is opposed to the direction of the phase velocity of the retarding wave; this explains the energy reflection upon cutoff. Refers to various American articles on the subject.

STABILITY

Concerning the Estimate of the Frequency Stability of an Oscillator, B. G. Gorban', L. P. Terekhina (6 pp, 2 figs).

A brief statistical analysis of oscillator criteria, in which the connection between the approximate frequency and phase characteristics of oscillator stability is established.

ELECTRON PHYSICS

Connection between the Thermoemission Constants of Transistion Metals (and of their Compounds with Certain Metalloids) and the Electron Structure, G. V. Samsonov, V. S. Neshpor, G. A. Kudintseva (6 pp, 4 figs, 1 table).

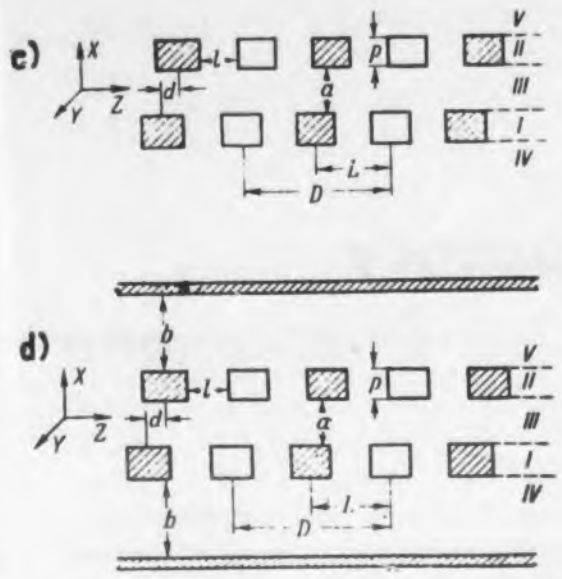


Fig. 3. Retarding System: *a*— overall view of system, *b*— retarding system in waveguide, *c*, and *d*— sections.

Plotting Spatial Trajectories of Charged Particles in Electrostatic Fields by the Radius of Curvature Method, N. I. Shtepa (5 pp, 1 fig, 1 table).

Operation of Cathode-Ray Tubes with Charge Storage, D. A. Novik (11 pp, 10 figs).
(Deals with the electron-phyics aspect of the subject.)

Concerning the Adjustment of Electrostatic Microscopes D. V. Fetisov, V. I. Miliutin (6 pp, 8 figs).
The microscope itself was described in *Radiotekhnika i Elektronika*, Feb. 1957 (*ED* October 1, 1957).

Other Articles In This Issue

Derivation of an Expression for the Scattering Cross Section in the Theory of Diffuse Propagation of UHF in the Troposphere D. M. Vysokovski (5 pp, 1 fig).

Squaring a Voltage with the Aid of a Semiconductor Device, O. V. Sorokin (2 pp, 2 figs).

A PRECEDENT?

For the first time since ELECTRONIC DESIGN began translations of Russian technical journals, (August 1955), an American article has appeared in Russian print. The article, "Signal Stabilization of a Control System" by Professor Rufus Oldenburger of Purdue University's Mechanical Engineering Department appeared on pages 392-396 of the May 1957 issue of *Automation and Telemechanics (Avtomatika i Telemekhanika)*.

According to Professor Oldenburger, the article was originally published by the American Society of Mechanical Engineers, 33 W. 39th St., N. Y. C., in ASME-56-A92. The Russians apparently liked it, requested and obtained permission to translate and reprint.

For those trying to dope out original Russian literature, it may be interesting to obtain both the American and Russian versions to compare the terminology.

German Abstract

Telemetering of Low Frequency Phenomena

IN MANY applications measuring equipment cannot be transported to the point where measurements must be made either with safety or convenience. In such instances telemetering is indicated. This abstract is concerned with the telemetering problems which are encountered in low frequency work, particularly in the field of medical electronics.

The low frequency range of signals (from dc to about 1000 cps), if directly transmitted, is subject to many disruptive and disturbing effects. Hence some modulation method is employed. In order to avoid elaborate rf equipment it is often convenient to choose a carrier below 20 kc, preferably below 5 kc. The ordinary (public) telephone system can then be used for transmission. Both electrocardiograms and electroencephalograms have been successfully transmitted without noticeable distortion with a 5 kc carrier and 300 cps bandwidth.

In choosing the method of modulation, frequency modulation has been found superior to amplitude modulations on theoretical grounds and predictions confirmed by experience.

Amplitude modulation has the advantage of extreme simplicity but the disadvantages include sensitivity to nonlinear distortion, cross-modulation, amplitude dependence on transmitted distance, and limited modulation index because of limitations on carrier amplitude with telephone systems.

Frequency modulation had the well-known advantages of being less susceptible to stray currents and crossmodulation. It has better noise characteristics; non-linear distortion in tubes affects only the amplitude. In addition, the frequency of the effective source remains constant, modulation can be carried out at a lower power level and the limiting action in the receiver eliminates interfering amplitude modulation.

Although the disadvantages of fm include the requirement of more elaborate circuitry, and sensitivity to nonlinear phase characteristics of the transmission system, the fm method is preferred.

Abstracted from "Procedures for Telemetering of Low Frequency Oscillations." W. Nicolai, Electronische Rundschau, *Vol. 11, No. 1, Jan. 1957, pp 8-12.*

Step-Function Response

WHEN THE response of a system whose transmission factor has the form

$$H(s) = \frac{s}{A + Bs + Cs^2 + c_3s^3 + c_4s^4 + \ldots c_ns^n} \quad (1)$$

to a step function source is desired then a good deal about the response can be deduced from the values of the coefficients, *A*, *B* and *C* so that it may become unnecessary to evaluate the inverse Laplace transform or solve the differential equation of the system. (The parameter *s* in Eq. 1 is the generalized frequency parameter and when imaginary ($s = j\omega$) the transfer function becomes the complex input-output relationship used in sinusoidal steady state analysis.)

The general problem is indicated in the Figure. A step of value K_o is applied to the (linear) sys-

tem and the response $X(t)$ which has finite area g, and "dies out" when increasing time is obtained. By application of certain theorems of the Laplace transformation it can be shown that

1. The area, g, under the response curve is related to the coefficient A by $g = K_o/A$.

2. Once the area, g, is determined, then the center of gravity of the area is determined only through the coefficient of B: Location of center of gravity on the t axis is at B/A. Thus, steep and narrow responses are obtained with small values of B, while large values of B give low, broad response curves.

With A and B given the value of C can be chosen so that the height and width of the response curve can be adjusted for fixed area and center of gravity. The moment

$$M_x = \int_o^\infty t^2 X(t)\, dt \qquad (2)$$

of the area of the response curve is related to the coefficients through the relationship

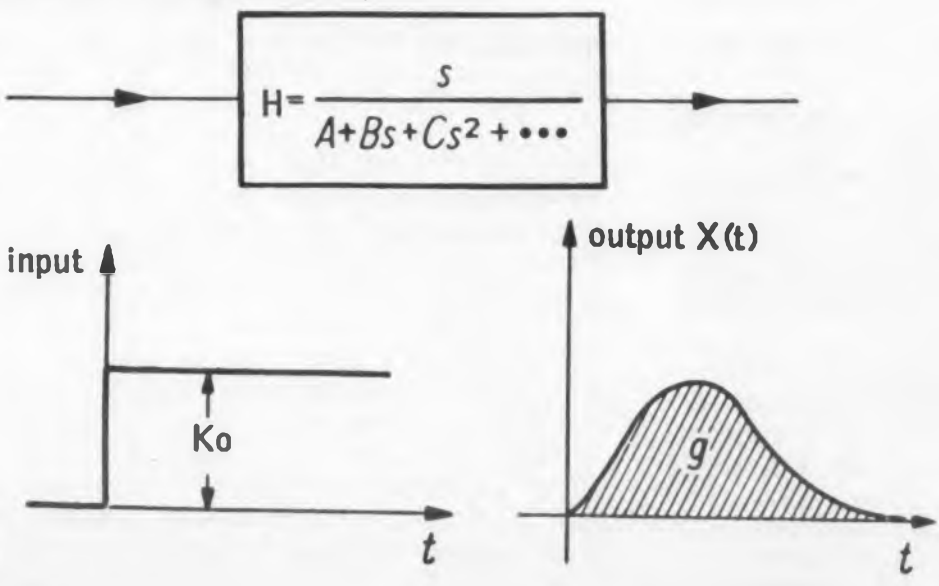
$$M_x = M + g M_1^2;\ M_1 = B/A$$

and

$$M = g \frac{(B^2 - 2CA)}{A^2} \qquad (3)$$

The results obtained in this paper are akin to the popular initial and final values theorems, althought the results of this paper are of course restricted to transfer functions of the type given in Eq. 1.

Abstracted from an article by R. Hofmann and W. Walcher Archiv der Elektrischen Uebertragung, *Vol. 11, No. 8, August 1957, pp 321-324.*



Schematic representation for deducing the response of a system to a step-function.

A Radical New Approach!

TO DIFFICULT SWITCHING REQUIREMENTS

CERAMIC VACUUM RELAYS

by Jennings

Vacuum Enclosure

Insures Clean Contacts that stay clean at dry circuit levels.

Reduces Contact Arcing and Pitting at high currents.

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Provides Small, Compact Body style that Insures reliable performance under extremes of vibration, temperature, and shock.

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Increase Reliability because three relays in parallel are more reliable than one.

Decrease Bounce Time to less than 100 μsec.

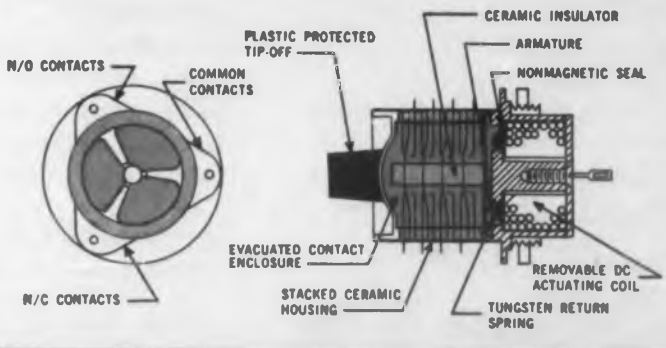
Increase Make Current to 100 amperes inrush because contacts are not bouncing and arcing.

Increase Contact Life when interrupting currents up to 10 amperes at 28 vdc or 2 amp at 300 vdc.

(Heavy Duty contacts will interrupt up to 50 amps at 28 vdc)

This revolutionary new vacuum relay has been fully tested and is available in production quantities.

Send for catalog literature on SPDT and 4PDT Type RA relays.



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July 1

Component Development for Micro-miniaturization, by Henry A. Stone, Jr. (p 17) A discussion of the recent evolution of components towards smaller size and what may be expected in the future.

Micro-Miniaturization Requires New Thinking, by Dr. Cledo Brunetti et al. (p. 24) Suggests eliminating unessentials, considering new materials and new fabrication techniques.

Micro-miniaturization—A Paradox? (p 28) How miniaturization can be applied to large as well as small equipment. Includes graph showing how small reduction in dimensions gives drastic reduction in volume.

Micro-Miniature Techniques, by W. W. Hamilton (p 32) Will watch-making techniques aid micro-miniaturization? A typical design example is described.

Things Are Getting Smaller (p 36) A picture-caption spread showing recent micro-miniaturization designs.

Micro-Miniaturization in Missiles, by John R. Moore (p 38) How micro-miniaturization has improved reliability; dangers in micro-miniaturization and how to avoid over-miniaturization.

Watchmaking Techniques—Key to Micro-Miniaturization, by W. A. Sterling (p 40) A discussion of partial and complete micro-miniaturization together with case histories showing examples of each.

Miniaturization in Component Design (p 44) Miniaturization examples for precision switches, inductors, connectors, transmission lines, and relay contacts.

Tiny Transistor-Amplifier (p 47) An ultra-miniature high gain audio amplifier stage—about the size of the eraser on the end of a lead pencil. (Centralab)

The Vanishing Hearing Aid (p 48) How one company got three transistors and associated circuitry into a package the size of a nickel. (Sonotone Corp.)

Production Techniques (p 50) Picture spread of micro-miniature production techniques, together with descriptions to indicate what can be done by the various methods.

Design of Oscillators—I, by K. A. Pullen, Jr. (p 52) When conductance values are used to analyze an oscillator, the loading effect of resistors, capacitors and inductors in the circuit can be easily determined.

Ultrasonically Regulated Power Supply (p 56) A low voltage dc power supply using an ultrasonic carrier system to achieve optimum performance. (Optimized Devices, Inc.)

High-Power Silicon Rectifier (p 58) Describes the ability of a rectifier to operate at high ambients, which makes it useful in supplying filament power for industrial and transmitting tubes. (General Elec. Co.)

Ideas for Design (p 98) Fast Response Thermocouple, Transistor "Thyratron" Circuit, Fin-Cooled Power Transformer.

What The Russians Are Writing (p 108) Annotated tables of contents of Radio Engineering, October and November 1956 and Automation and Telemechanics, November 1956. (Russian Translation)

July 15

What is the Status of Transistors by B. Reich (p 24) The current status of power, high frequency and switching transistor development is discussed.

New Frontiers in Solid-State Physics by Dr. Malcolm H. Hebb (p 25) Discusses some of the new and future applications of solid state devices.

Analysis of Nuclear Radiation Effects on Transistors by D. B. Kret (p 28) Describes results of tests at RCA on nuclear radiation effects on germanium and silicon semiconductors. Includes curves of diode and transistor characteristics before and after radiation.

Airborne Electronic Telemetering Commutator (p 32) A commutator developed for use in aircraft and missiles designed to operate at fixed speeds and handle twenty-eight input signals. (Arnoux Corp.)

Frequency Division with Semiconductor Devices, by A. William Carlson (p 34) Discussion of numerous methods of frequency division with transistors and other semiconductor devices.

Tiny Transistor Assemblies (p 38) Stable multi-vibrators, audio amplifiers, sawtooth generators and other circuit configurations available in one fifth of a cubic inch. (M. F. Electronics Co.)

Design of Oscillators—II, by K. A. Pullen, Jr. (p 40) Conductance values are used to analyze Transistor Oscillators.

High Speed Converter (p 44) Multiplication and division can be performed during conversion of information from analog-to-digital and digital-to-analog form by the Multiverter. (Packard-Bell Computer Corp.)

Using a Curve Tracer for Transistor Circuit Design by Norman B. Saunders (p 46) The use of a circuit analyzer to measure transistor coefficients and circuit parameters.

Class A Transistor Power Amplifier Design by Robert Minton (p 50) The first of two articles dealing with circuit design considerations for audio-output stages using power transistors.

Extension and Adapter Sleeves (p 54) Sleeves which provide more enclosed space in back-shell area of connectors, and increase the reliability of electrical circuits where they are attached. (Pacific Automation Products, Inc.)

Resettable Grasshopper Fuse (p 54) A device combining a standard grasshopper fuse with a heat coil with separate contacts for operating an alarm circuit when the fuse opens. (Cook Electric Co.)

A Voltage Gain Nomogram for Transistor Circuit Design, by Rudolph Wellsand (p 56) Two nomograms to simplify transistor circuit designs. They can be used to determine gain variations when changes are made in various circuit values.

A Survey of Transistor Characteristics by R. L. Riddle (insert) The present status of transistor characteristics, including gain, frequency response, power, noise, reliability, temperature and irradiation.

Transistor Data Chart (insert) Tables of transistor characteristics for high-frequency, low-frequency, power, and switching applications.

Transistor Parameter Conversion Tables by E. K. Novak (insert) Conversion tables between different notations and for various circuit configurations, including equivalent circuits.

Transistor Test Equipment Survey by Soren C. Ibsen (insert) Tables listing major characteristics of available curve tracers, portable test sets, parameter analyzers, and miscellaneous test equipment.

Microforms for Semiconductors by Herbert Dropkin (p 110) A discussion of microforms of germanium and silicon, their high frequency and temperature properties.

Ideas for Design (p 132) Transistor Beta Tester, Encapsulated Blocking Oscillator, Quick-Release Fastener, Shock Mount Provides Mobility, Regulated Radio-Interference Free Generator, Shock Mounting, Tube Protection Scheme.

Russian Transistors (p 150) Construction features with tabulated electrical parameters of Russian semiconductor devices. (Russian Translation)

What the Russians Are Writing (p 152) Annotated tables of contents of Radio Engineering and Electronics, and Electrical Communications, Nov. 1956, and Automation and Telemechanics, Dec. 1956. (Russian Translation)

Feedback Transistor Circuits, (p. 158) A systematic analysis of four basic resistance-feedback arrangements yielding general results for designers. (German Abstract)

August 1

Encapsulation of Electronic Circuits, by Richard Calicchia (p 22) Evaluation of casting resins for use up to 240 mc.

Decade Counter (p 26) Sharp, bright, easily read numbers are displayed in a horizontal row by the decade counter. (Burroughs Corporation)

August 15, 1957

August 1 (Cont.)

RC-Transistor Network Design—I by Isaac M. Horowitz (p 28) First of two part series which presents theory, background and the Negative Impedance Converter method of design.

Common Component Receiver (p 32) Shows how a conventional Jan-tube ac-dc receiver was modified and reduced from 19 to six parts by using three values each of resistance and capacitance and one tube type. (Packard-Bell)

Direct Coupled Transistor Logic, Complementing Flip-Flop Circuits—II by E. G. Clark (p 34) An investigation into the family of transistor building-block circuits using direct-coupled transistor logic.

4 Millimeter Klystron (p 38) Describes a Klystron that can produce electromagnetic energy 4 mm in wavelength. (Amperex Electronic Corp.)

Voltage Stress Effects on Capacitors by Charles H. Bridenbaker (p 40) Discusses the factors which affect insulation resistance, particularly in paper dielectric capacitors, the most common type.

Nuclear Powered Timer (p 42) A timing unit consisting of a nuclear battery and two cold-cathode gas-diode and resistor circuits. (Universal Winding Co.)

Reliability (p 44) A meeting report of the 2nd RETMA Symposium on Applied Reliability, Syracuse, New York, June 10-11.

Ideas for Design (p 106) Wrong Pulse Polarity Acceptance Circuit, Variometer Pi-Network, Capacitor Testing in the Circuit, Economizing the Hybrid.

What the Russians Are Writing (p 118) Annotated tables of contents of the final 1956 issues of Electrical Communications, Radio Engineering and Electronics, Radio Engineering, and Acoustic Journal. (Russian Translation)

Temperature Compensation of Oscillators (p 122) The use of a reactance tube circuit and a temperature sensitive resistive element for temperature compensation. (German Abstract)

Thermistor Termination (p 124) A termination consisting of a single thermistor and an adjustable transformer used for power measurements. (German Abstract)

Artificial Dielectrics at 3 cm. (p 125) The embedding of powdered iron and graphite in paraffin resulting in an artificial dielectric. (German Abstract)

Cylindrical Reflex Klystron (p 126) The development of a cylindrical reflex klystron with a tubular Lecher system and external frequency control. (German Abstract)

Frequency Control of Synchronous Converters (p 127) Circuit for stabilizing the frequency of rotary converters or small shunt motors. (German Abstract)

September 1, 1957

Standardization of Mu-Min Relays (p 128) The problems encountered because of the non-standardization of mu-min relays and the attempt now being made to standardize these relays. (Abstract)

Test System for Memory Stores (p 132) Discusses an apparatus designed to produce pulses having variable amplitude, duration and repetition-rate. (Abstract)

August 15

VTVM Survey—I by Sol Prensky (p 22) Meters intended for laboratory use are analyzed in Part-I.

Time Rate of Change Meter (p. 26) An electromechanical computer designed to measure samples of voltages, compare and show differences between them.

RC-Transistor Network Design—II by I Horowitz (p 28) Second of two parts which describes the method of RL-RC synthesis using negative feedback.

Servo Amplifiers at High Ambient Temperatures by P. M. Thompson and J. Mitchell (p 32) A three-stage push-pull germanium transistor amplifier which delivers 3 w to a 400 cps servo motor.

Pulse Timer (p 36) Time delays as long as 10,000 μsec are measured with an accuracy of ±.01 percent. (Teletronics Lab Inc.)

Basic Standards for Science and Industry—II, by R. D. Huntoon (p 38) Derived standards, precise physical constants, and fundamental physical constants plus a bibliography for study and reference on fundamental standards.

Wedge Contact Relay (p 42) A new type relay featuring lower contact resistance to small currents, automatic contact planing, and high shock and vibration resistance. (Electro-Tech Corp.)

DC Overpotential Testing by V. Wouk (p 44) Advantages of dc insulation testing which are a direct indication of leakage resistance. This test equipment is much smaller than ac in higher voltages.

Cable in Tape Form (p 48) Describes a flat cable designed for stripping conductors simultaneously and automatic soldering. (Tape Cable Corp.)

Flux Density Nomograph—V, by Martin Berger (p 50) Last of a five-part series on transformer design, this nomograph relates flux density, frequency, voltage, number of turns, and core sizers.

Ideas for Design (p 106) Volumetric Efficiency, Mold-in-place Gaskets, Servo Demodulator, Inexpensive Temperature Indicator, Nylon Screws Eliminate Lock Washers, Phase Determination, Fast-operate, Slow-release Relay.

Russian Thermistors (p 120) Characteristics, construction, and a tabulation of basic parameters of the most widely used Russian thermistors. (Russian Translation)

What the Russians are Writing (p 122) Annotated tables of contents of the January 1957 issues of Electrical Communications, Automation and Telemechanics, and Radio Engineering. (Russian Translation)

Conserving the Mobile Communications Spectrum (p 126) Factors in spectrum conservation are discussed, including channel efficiency, operational efficiency, use of directional antennas, geographic frequency sharing, use of SSB, etc. (Abstract)

Maid Service for Computerman (p 130) A system designed to provide continual automatic detection of errors in complex electronic equipment and to warn the operator of impending circuit malfunctions. (Abstract)

Thermal Relay Applications (p 132) A device that qualifies for functions involving precision and design flexibility—thermal relays can be designed to provide delays from 0.1 sec to 5 min. (Abstract)

A VHF Vacuum Tube Voltmeter (p 134) Design data for a vhf comparative voltage indicator with very wide range. (German abstract)

September 1

Reliability-Design Technique for Complex Systems by H. Elmore Blanton (p 20) Technique for predicting the reliability of a system while in the design stages.

High Accuracy Servo Element (p 24) A position indicating device providing accuracy to one second of arc. (Farrand Controls, Inc.)

Variable Coefficient Trimmer (p 26) An air dielectric capacitor with variable temperature coefficient for controlled compensation. (British Radio Electronics Ltd.)

VTVM Survey—II, Sol Prensky (p 28) Vacuum-tube voltmeters intended for general-purpose maintenance measurements are analyzed in Part II of the Survey. August 15, 1957

250 Mc Coaxial Switch (p 32) Controlled by a blocking oscillator synchronized to some sub-multiple of the 60 cps line, this switch can handle rf signals up to 250 mc making use of one detector for both reference circuit and unit being tested. (Jerrold Electronic Corp.)

Telemeter Decommutation System (p 32) The system consists of a gating unit, pulse selector and regulated power supply, and has been developed for use in airborne or trailer-installed telemeter receiving stations. (Arnoux Corp.)

Ferrite Transducers for Electromechanical Filters by G. S. Hipskind (p 34) Discusses an interesting application for the magnetostrictive property of ferrites which is as electromechanical filters. This filter can be an extremely selective band-pass device where ferrite rods or cores are used as input and output transducers.

Sub-Miniature Metallized Paper Capacitors by P. P. Grad (p 86) A major modification of the metallized paper capacitor has resulted in a 50 per cent volume reduction of smallest available units of this type. This small size and high precision component is suitable for transistor circuitry.

Ideas for Design (p 88) Measuring AC Currents in Transistor Circuits, Antenna Impedance Measurements, Low-Cost Speaker Horn, Improved Harness Layout.

Frequency Compression of Radar Images (p 100) Compressing the bandwidth of radar images for magnetic tape transmission or recording. (German Abstract)

Improved Transistor Biasing (p 102) An amended transistor bias arrangement offers advantages over conventional circuitry in normal as well as critical applications.

What the Russian Are Writing (p 104) Annotated table of contents of Radio Engineering and Electronics, January 1957. (Russian Translation)

September 15, 1957

September 15

Class B Transistor Power Amp Design by R. Minton (p 24) Second of a series of two articles on circuit design considerations. Class B push-pull designs using pnp alloy-junction transistors are discussed including the effect of source and load impedances on distortion.

A Versatile Phasemeter by J. A. B. Davidson (p 28) Principles of measurement, construction details, performance characteristics and applications of a versatile phasemeter.

Capacitor Insulation Resistance Measurement by F. W. Grahame and D. F. Schmidt (p 32) Technique evolved to measure the insulation resistance of capacitors.

New Circuit Board (p 36) Circuit board using no mechanical clips or solder relies on conductive cells for securing components. (Van-Dee Products)

In-Circuit Impedance Measurements, by J. Garthwaite (p 38) Without unsoldering the component; without cutting the leads; in some cases without even removing the power; resistors, capacitors and inductors are measured to an accuracy of better than 0.25 per cent.

Digital Readout Printer (p 42) Using replaceable plug-in matrix modules, this printer has no relays of moving contacts. (Computer Measurements Corp.)

High Frequency Diffused-Meltback Transistors by A. B. Philips and A. M. Intrator (p 44) A description of how diffused meltback transistors help circuit design engineers evaluate their capabilities.

VTVM Survey—III by Sol Prensky (p 48) Vacuum tube voltmeters designed for extremely accurate voltage and current measurements in the micro-range are analyzed in tabular form.

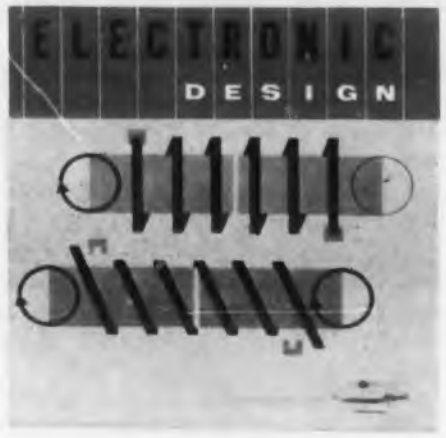
Reliability Achieved (p 50) How a line of capacitors by a major capacitor manufacturer was made reliable to a degree hitherto unreported. Combines careful selection of material and process control.

Accurate Reflectometer (p 52) This instrument provides lab accuracy in measuring load-line mismatch and can be used for production testing. (Industrial Prod. Div. of Fed. Tel. & Radio Co.)

Time Delay Network Design by L. Weinberg (p 54) Presents tables of element values making networks available with little or no computation.

Maintainable Computer (p 58) A unit that provides completely automatic control for process plants with 500-hour mean time between failures. (Ramo-Wooldridge Corp.)

High Frequency Ferrite Phase Modulator, by H. W. Katz (p 60) How a ferrite delay line can delay high frequencies to avoid frequency doubling and tripling to achieve phase deviation for phase modulation. Includes curves and construction details.



October 1, 1957

September 15 (Cont.)

Low Noise Preamplifier, by M. S. Redden, Jr. (p 64) Mounting a receiving system preamplifier at the top of the tower next to the antenna greatly increases receiver sensitivity.

24 Hour Recorder (p 68) Design of a 24 hour tape recorder with a linear tape speed of 2-1/2 in. per min. (SoundScriber Corp.)

British Component Show (p 70) The more outstanding developments exhibited at the British Radio and Electronics Component Show are listed in New Product form.

Ideas for Design (p 154) New Printed Circuit Board, Simplified Transistorized Audio Circuit, Transistorized Deflection Amplifier.

Non-Linear Function Generators Using Piecewise Linear Approximation (p 166) Analysis of function generators employing diode elements. (Russian Translation)

What the Russians are Writing (p 170) Annotated tables of contents of the February 1957 issues of Radio Engineering and Automation and Telemechanics. (Russian Translation)

A Network Theorem (p 174) A formula for current in any branch of a linear network if driving point impedance and input current are known. (German Abstract)

Survey of Microwave Tubes (p 175) A survey of tubes for which the transit time of the electrons has appreciable effect on the operation of the tube. (German Abstract)

3-D Printed Circuit Module (p 176) Discusses modular construction to solve the problem of adapting hand wired turrent shaped modules to printed circuits. (Abstract)

October 1

Principles of Filtering—I by L. S. Schwartz (p 20) The first part of two presents the criterion and inverse probability method of receiver design and discusses the value of envelope detection.

Transistor Switching Circuits, by Mark Smith (p 24) Two properties exhibited by transistors and not found in vacuum tubes, make them ideal active elements for low power switching circuits.

Frequency Spectra for Pulse Type Waveforms, by E. Brenner (p 28) Applying Fourier methods of analysis to aperiodic pulses.

Solderable Magnet Wire by R. Hall (p 32) The wire described is coated with an isocyanate resin that will decompose and flow at 650 to 750 F to provide a flux during soldering. At lower temperatures the coating is a stable insulator.

October 1 (cont.)

High Speed Indexing Clutch (p 34) Small triggering forces can engage this indexing clutch in 1 millisecond to transmit 10 in. lb (min) of torque. (Digitronics Corp.)

Variable Mercury Delay Line Simulates TV Flutter by C. F. Brockelsby (p 36) Applications and construction of a mercury delay line to simulate TV flutter caused by passing aircraft.

Power Tetrode Transistor (p 40) This device has low distortion, high power output and a reduction in complementary circuitry has wide application in the audio amplifier field.

Slide Rule for Filter Design by R. Davidson (p 42) This rule provides a fast and accurate method for calculating reactive elements of low-pass constant K type filter.

A Solid Electrolyte Battery, by Burton F. Wagner (p 44) A new type battery operating by diffusion of positive silver ions through a solid electrolyte. Essentially a high voltage, low-current battery, its main feature is extremely long storage life. Specifications and curves are shown.

Measurement of Capacitor Insulation Resistance, by Thomas F. Richardson, Jr. (p 48) A discussion of the factors which determine the insulation resistance of capacitors and how such measurements can be made without introducing errors. Includes a bibliography.

Ideas for Design (p 88) Automatic Digit Pulser. Design for checking centralized automatic message accounting circuits of telephone plant installations, the timing and control circuits employed are adaptable to other uses.

High Frequency Transistor Oscillator (p 98) Operating features of transistor oscillators at higher than critical frequencies. (Russian Translation)

What the Russians Are Writing (p 102) Annotated table of contents of Radio Engineering and Electronics, February 1957 and selections from Radio, June 1956, and the UNESCO Bulletin for Libraries, Aug-Sept 1957. (Russian Translation)

Quartz Crystal Parameters (p 106) Methods and circuits for analysis of quartz crystal parameters. (German Abstract)

Machine Solution of Higher Order Polynomials (p 108) Solution of higher order algebraic expressions using analog computing devices. (German Abstract)

Noise in Magnetic Tape (p 109) Sources of noise in magnetic tape and their mathematical expression. (German Abstract)

Low-Noise Klystron (p 110) Through an experiment it was possible to construct a non-tunable low-noise tube with precision which could be made for any specific frequency, and be switched over or interchanged with series of such tubes for altering a transmitter frequency. (Abstract)

Mm Wave Source (p 114) Discussed here is a mm wave generator that lessens many of the difficulties inherent in producing mm–waves, the 0 type carcinotron, or backward wave oscillator. (Abstract)

October 15

Thermal Design—I by Harry M. Passman (p 26) Test techniques for thermal evaluation of commercial airborne electronic equipment.

Portable Plenum Test Chamber, by George H. Siegel (p 30) Design and fabrication of a portable plenum test chamber to measure air flow accurately are described.

Flying Spot Programmer (p 34) Designed to convert curves drawn on graph paper into a voltage to be used for control or programming, this scanner uses a "flying spot" crt in combination with a photomultiplier to extract information from a curve.

October 15, 1957

***Principles of Filtering—II* by L. S. Schwartz (p 36)** Second of two parts describes other techniques to improve the signal to noise ratio and relationship they bear to each other. Applications for linear filtering techniques.

Microvolt Instrument Transformer (p 40) Standard transformer theory engineered for peak performance resulted in this moderately priced instrument transformer with a high energy stored to energy dissipated ratio.

A New Evaporative Cooling Technique by Robert Berner (p 42) A method of removing heat from electronic equipment employing the latent heat of vaporization of water.

New Vibration System (p 46) Electronically controlled hydraulic power increases the force capacity of this system while reducing the weight. (Wyle Manufacturing Corp.)

Why Thermal Design? (insert) Background on need for thermal design and brief discussion of various approaches to cooling of electronic equipment. (Staff Report)

Designing Cooling Systems for Airborne Electronic Equipment, by Charles A. Hathaway (insert) Specific design steps for cooling of airborne electronic equipment based on special environmental factors encountered in flight. Includes discussion of free convection, semi-free convection, and forced convection systems. Nomograms included plus sample problems.

Weight Flow Nomograms for High Altitude Air Cooling by J. Constant Van Rijn (insert) A series of nomograms and graphs to take the drudgery out of cooling design.

Motor Design for Fans and Blowers by O. W. Giesecke (insert) Frequency, altitude and reliability considerations in the design of motors for cooling equipment.

Manufacturers of Cooling Equipment for the Electronic Industries (insert) A tabulation of cooling equipment manufacturers, their applicable products and their addresses.

Ideas for Design (p 146) Antenna Ice Alarm, Results from Ultra-Sonic Soldering, Self-Biased Blocking Oscillator, Low-Cost Constant-Voltage Source, Hum Reduction, Zipper Tubing Saves Time.

What the Russians Are Writing (p 162) Annotated tables of contents of Electrical Communications, February 1957, and Radio Engineering and Electronics, March 1957. (Russian Translation)

Electronic Differentiation and Integration (p 166) A feedback amplifier network capable of differentiating or integrating a signal.

Heat-Storage Cooling (p 168) A study on whether cooling components using heat storage materials as heat sinks is practicable, particularly for electronic equipment in high speed aircraft and missiles. (Abstract)

RF Voltmeter Calibration (p 170) Accurate calculations can be performed quickly for any practical voltage level starting with 0.2 v at frequencies of 30, 100, 300, 400, 500, and 700 mc. (Abstract)

November 1, 1957

November 1

Low Plate Voltage Tube Circuit Design by D. Fidelman (p 24) A recent development introduces a series of tubes operating with a 12 v plate potential in vacuum tube design.

Rugged Friction-Free Meter Movement (p 28) A new meter movement eliminates conventional pivots, V-jewels, and hairsprings. (Marion Electrical Instrument Co.)

Fusion-Temperature Controlled Gyro (p 30) The heat-of-fusion principle is used to control the temperature of an integrating rate gyro. (General Electric Co.)

The Selection and Application of Travelling Wave Tubes—I by N. Hansen and A. Nielsen (p 32) Procedures in selecting the proper operating performance and circuit design for particular applications.

Miniature Microsyn (p 36) Accurate translation of angular displacement into an ac voltage is provided by the microsyn. (Lear, Inc.)

Thermal Design—II by Harry M. Passman (p 38) Improvements are presented for the thermal design of electronic equipment.

Self-Powered Square Wave Attachment (p 42) Uses sine-wave input for power. (Mandrel Industries, Inc.)

Replace—Mechanical Tuners with a Voltage Variable Capacitor (p 44) A device that can be obtained in capacitances ranging from 20 to 56 μμf with standard four volts applied. (Pacific Semiconductors, Inc.)

Cooling of Power Transistors by Melvin Mark (p 46) The "cold plate" technique for cooling power transistors is described.

Ideas for Design (p 108) Cementable Teflon Insulation for Rotating Electronic Components; Capacitor Protection; Tamper-Proof Trim Pots; Simplified Electronic Switch; Identifying Polaroid Records; Driftless Emitter-Follower.

What the Russian Are Writing (p 120) Annotated tables of contents of the March 1957 issues of Automation and Telemechanics, Electrical Communications, and Radio Engineering. (Russian Translation)

Design of Two-Phase Networks (p 126) Equations are presented for the design of two-phase networks. (German Abstract)

Hall-Effect Oscillator (p 127) A feedback circuit employing a ferrite core material and a semiconductor pellet may be used as a dc power amplifier or as an oscillator. (German Abstract)

November 15, 1957

November 15

Design For Low-Cost Production (p 30) Staff report covering the following topics: Planning for Low-Cost Production; Prototype Design Compatible with Production; Save Costs In Drafting; Standardization; Selecting Materials and Components for Low-Cost Production; Labor Savings with Printed Wiring; Sheet Metal Design; Cost Savings With Plastics; Packaging for Economy; Process Evaluation and Value Analysis: Hand Assembly vs Automatic Production; and Designs for Low-Cost Production. Specific cost-saving design suggestions are given, and examples of low-cost designs are illustrated. A number of items of special production equipment are illustrated with captions explaining how to design for its use.

The Electronic Designer's Responsibility For Low-Cost Production by F. F. Richards (p 70) Explains the importance of giving consideration to production methods during initial design stages.

Automatic Terminal Capping Machine (p 74) An automatic capping machine for resistors and capacitors. (Halm Instrument Co.)

Human Factors In Low-Cost Production by A. Siegel (p 76) Points up considerations on component spacing, methods of wiring, etc. from the standpoint of assembly-operator fatigue and reliability.

Standardization and Cost (p 76) Relates standardization to interchangeability and lists benefits to engineering, production, procurement, and management.

Decreasing The Cost of Instruction Manuals by P. Billick (p 77) By proper consideration of a number of factors, instruction-book costs can be held to a minimum without destroying the function intended.

Sheet Metal Design by S. A. DeCosmo (p 78) Specific design steps for sheet-metal fabrication. Includes data tables for aluminum and steel.

Blow-Loader—Key to Small Parts Handling (p 84) This machine speeds production for the small parts user. (Whitso, Inc.)

Vacuum Metallizing Unit (p 86) A moderately priced, medium capacity vacuum coater.

Reliable Vibrator Replacement (p 88) A transistorized inverter for replacing mechanical vibrators in mobile equipment. (Transval Engineering Corp.)

Standard "Cans" Cut Enclosure Costs (Staff) (p 90) How tooling costs are eliminated by specifying standard sized enclosures for which tools exist in a vendor's plant. Unique appearance can still be obtained by methods discussed.

Amplifier in a Thermos Bottle (p 92) Transistors, mounted on an aluminum heat sink, are sealed in a thermos bottle for insulation from outside environments. (Video Instrument Co.)

December 1, 1957

Ultrasonic Machining of Ferrite (p 94) A process for machining hard and brittle materials, like ferrites, economically. (Sheffield Corp.)

Prototype Design Compatible With Production by R. E. Gildroy (p 96) Points up how valuable time is saved by coordination of engineering and production during prototype development.

Versatile Low-Cost Production Tester (p 110) A commercially available "breadboard" is described for facilitating production testing of short-run electronic equipment. (Pomona Electronics Co.)

Silicon Unijunction Transistor (p 112) A silicon transistor which performs the same function as the grid-controlled thyratron. (General Electric Co.)

Ideas For Design (p 164) High Vacuum Impregnation Reduces Expensive Rejects; Save Money On Cold Headed Parts; Felt Seals; Plastic-to-Metal Laminate; Aluminum Soldering; Fan Assembly Redesign Cuts Costs; Protection for Printed Circuits; Electronic Timer; Plastic Tooling; Wire Inserts for Wood Cabinets; Liquid "Lock-Washer".

What the Russians Are Writing (p 190) Annotated tables of contents of the April 1957 issues of Radio Engineering, Automation and Telemechanics, and Electrical Communications. (Russian Translation)

Video Coupling Network Nomogram (p 196) A nomogram for the determination of the important parameters in video coupling networks. (Russian Translation)

Band Pass Surface Waveguide (p 198) A surface waveguide constructed of alternating metallic and dielectric discs. (German Abstract)

Pulse Type Cathode Ray Tubes (p 199) A spiral resistive coating introduced as the post accelerating anode results in a linear field increase, eliminating raster distortion due to high ratios of post to second anode voltage. (German Abstract)

December 1

Proving Reliability by L. D. Smith (p 20) Discusses an approach to proving that a given equipment has the necessary reliability to do the job.

December 1 (Cont.)

Wave Analyzer Tracks Automatically (p 24) Permits inspection of vibration power and amplitude spectrum of rotating machinery. (Technical Products Co.)

High Intensity Sound . . . Precision Microphone (p 26) Free field sound pressure intensities over a 10 cps to 50 kc frequency range are accurately transformed in equivalent electrical voltages. (Electro-Voice)

Dynamic Balanced Potentiometer (p 28) Dynamically balancing the wiper arm and its contact gives accurate positioning and constant contact pressure regardless of system vibration or operational speed. (Chicago Aerial Industries)

Shielded Cable Grounding Techniques by M. D. Lazar (p 30) To protect and isolate a signal, and maintain correct impedance, the braided shield must be properly grounded.

Dual Function npn-pnp Flip-Flop (p 32) An npn-pnp flip-flop used to provide a sawtooth signal and in a binary counter as a bi-stable multivibrator. (Cubic Corp.)

Highest Frequency Transistor Covers Entire VHF Spectrum (p 34) Micro-alloy diffused base "field accelerated" transistors with maximum frequency from 250 mc to 1000 mc.

Selection and Application of Travelling Wave Tubes—II by N. Hansen and A. Nielsen (p 36) Solenoid, focusing and power supply design for twt's.

Designing FM Systems with an Analog Computer by H. A. Musk (p 40) How a specially-constructed analog computer was used to analyze synchronously tuned antenna networks for transmitter frequency modulation.

Compact Digital Voltmeter (p 44) A compact two-piece digital voltmeter unusual in its compactness and high accuracy.

Constant Temperature Crystal Oven (p 52) Latent-heat of fusion and proportional heating provide precise control. (Robertshaw-Fulton Co.)

Ideas for Design (p 90) Make Prototypes Compatible with Production . . .

What the Russians Are Writing (p 102) Annotated tables of contents of the April 1957 issue of Radio Engineering and Electronics, and the May issues of Radio Engineering, and Automation and Telemechanics. (Russian Translation)

Phase Shift Network and Phase Shift Oscillator Nomogram (p 110) Two useful nomograms for determination of the important phase shift network and oscillator parameters. (Russian Translation)

Equivalent Circuits for Transistors (p 112) An equivalent circuit which takes into account the effect of load impedance on input impedance. (Abstract)

A Non-Reciprocal Attenuator of 4 Kmcps (p 114) An attenuator with a reverse attenuation of 13 db constructed on the principle of resonant absorption in ferrites. (Abstract)

A Waveguide Slide Rule (p 115) A rapid way of calculating the wavelength within the guide for various modes. (Abstract)

ISSUES IN 1958

LOOK FOR YOUR COPY EVERY OTHER WEDNESDAY

Beginning January 8th, *Electronic Design* will reach your desk 26 times a year. This increase in publishing frequency from 24 to 26 issues may not seem important at first glance, but here are some of the advantages to the reader:

- More timely presentation of new products, materials, and processes.
- Better coverage of important electronic events, conventions, meetings, etc.
- More balanced editorial—some departments will be expanded.
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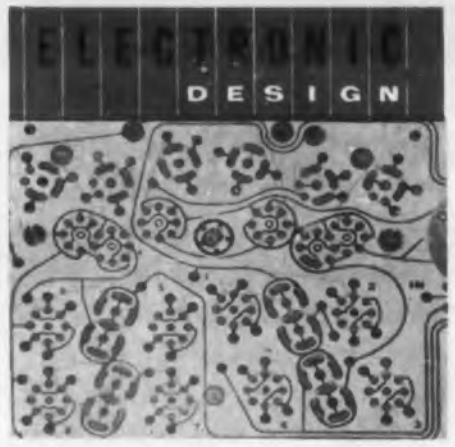

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Designs Wanted by the Army (p 36) Survey of problems listed by the National Inventors Council.

Realistic Tube Testing by J. M. Lowery (p 28) A tube-tester which duplicates the exact circuit conditions when testing a tube.

Designing a Wide Range Spark Gap Switch by T. R. Nisbet (p 32) Procedures to ensure highest operating voltage in circuit without spontaneous firing and that it will not fail to fire at lowest operating voltage.

Metal Ceramic Tubes to Withstand 500 C and High Vibration by John H. Wyman and R. H. Kuhnapfel (p 24) A different approach to the design of highly reliable vacuum tubes.

Design of Capacitive Divider Coupling Circuits by Irving Dlugatch (p 20) A streamlined technique for the design of capacity-coupled rf stages.

Effects of Nuclear Radiation on Transistors by A. J. Schwartz (p 16) Results of nuclear environmental tests on transistors at Brookhaven National Labs., plus interpretation of results.

Transistor Test Set for Quick Quality Control (p 40) A compact low-cost transistor testing unit designed for rapid quality control testing. (Armour Electronics Co.)

Automatic Battery Activator (p 22) An automatic activation mechanism for rechargeable silver-zinc batteries. (Yardney Electric Corp.)

Ideas for Design (p 120) New Positional-Control System Is Frequency Sensitive. G. M. Labs.

What the Russians Are Writing (p 126) Annotated table of contents of the May 1957 issue of Radio Engineering and Electronics. (Russian Translation)

Step-Function Response (p 130) A rapid evaluation of the response of certain systems to a step-function. (German Abstract)

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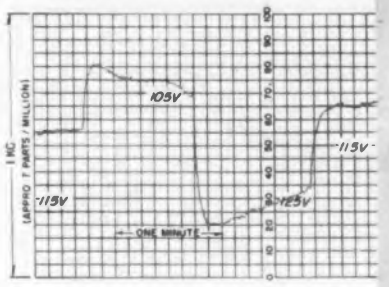
new -*hp*- 560A
DIGITAL RECORDER

Continuous digital record for your frequency counter!

- **Prints 11-digit information at 5 lines per second**
- **Controlled by electronic or mechanical devices**
- **Direct print-out from all -*hp*- counters**
- **Analog output for strip-chart recorder**
- **Expanded scale; full scale can represent 1/10⁷**

Frequency stability vs. line voltage; 150 MC oscillator



SPECIFICATIONS

Accuracy: Identical to that of basic counter used.
Printing Rate: Controlled by counter, 5 lines/sec. max.
Digit Capacity: 11 digits per line.
Driving Source: Parallel entry staircase voltages derived from standard digital frequency counters such as Hewlett-Packard types. Staircase descends from +135 v to +55 v as the count progresses from 0 to 9. Internal impedance of staircase source should be approximately 700,000 ohms.
Print Command Signal: 1 μsec or greater, positive or negative pulse, 15 volts p-p or greater.
Paper Required: Standard 3" roll or folded paper.
Line Spacing: Single or double, adjustable.
Analog Signal: Any three consecutive digits may be selected by selector switch. Output is function of selected digits. For example, if consecutive digits were 3, 8, and 6, output voltage would be 38.6 millivolts or 0.386 ma.
Output Available: 1 milliamp for galvanometer strip-chart recorders. 100 millivolts for potentiometer strip-chart recorders.
Power: 105/125 volts, 60 cycles, 250 watts.
Dimensions: Cabinet Mount: 20½" wide, 12½" high, 18½" deep. (Rack Mount available).
Weight: Net 60 lbs. Shipping 100 lbs.
Accessories Available: 1052-24, 3" folded paper, 48/carton.
Price: Price on request.

Data subject to change without notice

Model 560A is a new kind of continuous duty instrument designed from the chassis up for digital recording of frequency counter output and similar information. It is specifically useful in recording time functions, telemetered data, information to be monitored, tabulated and plotted and system drift phenomena. It is also a convenient digital/analog converter for strip-chart production.

Frequency counter accuracy

Since -*hp*- 560A is a slave to its information source, accuracy is that of the counter or other source. The instrument's motor-driven print mechanism comprises 11 number wheels and associated mixing-comparator circuits. The print mechanism is controlled by a staircase voltage and external print command pulse. The availability of 11-digit lines means secondary or coding data may be printed on the same line as primary data.

Complete details from your -*hp*- representative, or write direct.

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dramatic
new approach
to wide-band
microwave systems

RCA

TRAVELING-WAVE TUBES

• POWER TYPES...lightweight, compact, need no solenoid power

• LOW-NOISE TYPES...increase receiver sensitivity, eliminate crystal "burnout"

POWER TYPES...Featuring *integral periodic-permanent-magnet* focusing systems, RCA's new power traveling-wave tubes eliminate the need for external solenoid power—make possible dramatic advances in physical compactness and weight reduction. Described here are three typical RCA power traveling-wave types designed as a tube complement for light-weight compact airborne systems. *RCA Dev. No. A-1101*...only 2½ inches in diameter and short enough to mount in a standard aircraft ATR-box, this remarkable tube weighs only 12 pounds including the permanent-magnet focusing system! Designed to operate at altitudes up to 70,000 feet, the A-1101 delivers about 100 watts at 10% duty factor over the range from 2000 to 4000 Mc. *RCA Dev. No. A-1063*...complete with permanent-magnet focusing system, the A-1063 weighs only 3½ pounds...is less than 1½ inches in diameter! "Plug-in" construction simplifies field maintenance. Power output is 10 watts from 2000 to 4000 Mc. *RCA Dev. No. A-1113*...weighing less than 1½ pounds, the A-1113 complete with permanent-magnet focusing system measures less than 14 inches long! Suitable as a low-level driver, the A-1113 delivers 100 milliwatts of cw output from 2000 to 4000 Mc.

LOW-NOISE TYPES...RCA low-noise traveling-wave tubes enable the practical design of rf-amplifier and if-amplifier stages for microwave receivers featuring high signal-to-noise ratio and increased sensitivity. Crystal "burnouts" caused by TR-tube leakage are eliminated by the isolation afforded by the rf stage. These tubes find ready applications in radar receivers, countermeasure systems, and wide-band microwave relay equipments. Here are some typical types:

	Frequency Range—Mc	Noise Figure—db	Gain—db
RCA Dev. No. A-1056	1100 to 1400	7.0	25
RCA Dev. No. A-1105	2000 to 2500	7.0	25
RCA-6861	2700 to 3500	6.5	25
RCA Dev. No. A-1079	2500 to 4000	7.0	20
RCA Dev. No. A-1088	3500 to 4000	6.5	20
RCA Dev. No. A-1106	5900 to 7400	7.0	25

MICROWAVE DESIGNERS REFERENCE BOOKLET

"RCA Magnetrons and Traveling-Wave Tubes," MT-301... Contains information on operational theory of magnetrons and traveling-wave tubes, general operating considerations and applications, and techniques for measurement of electrical parameters. For your free copy, send request on *your company letterhead* to: RCA, Commercial Engineering, Section L-18-Q-2, Harrison, N. J.

For details on RCA Traveling-Wave Tubes call your RCA Field Representative.

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