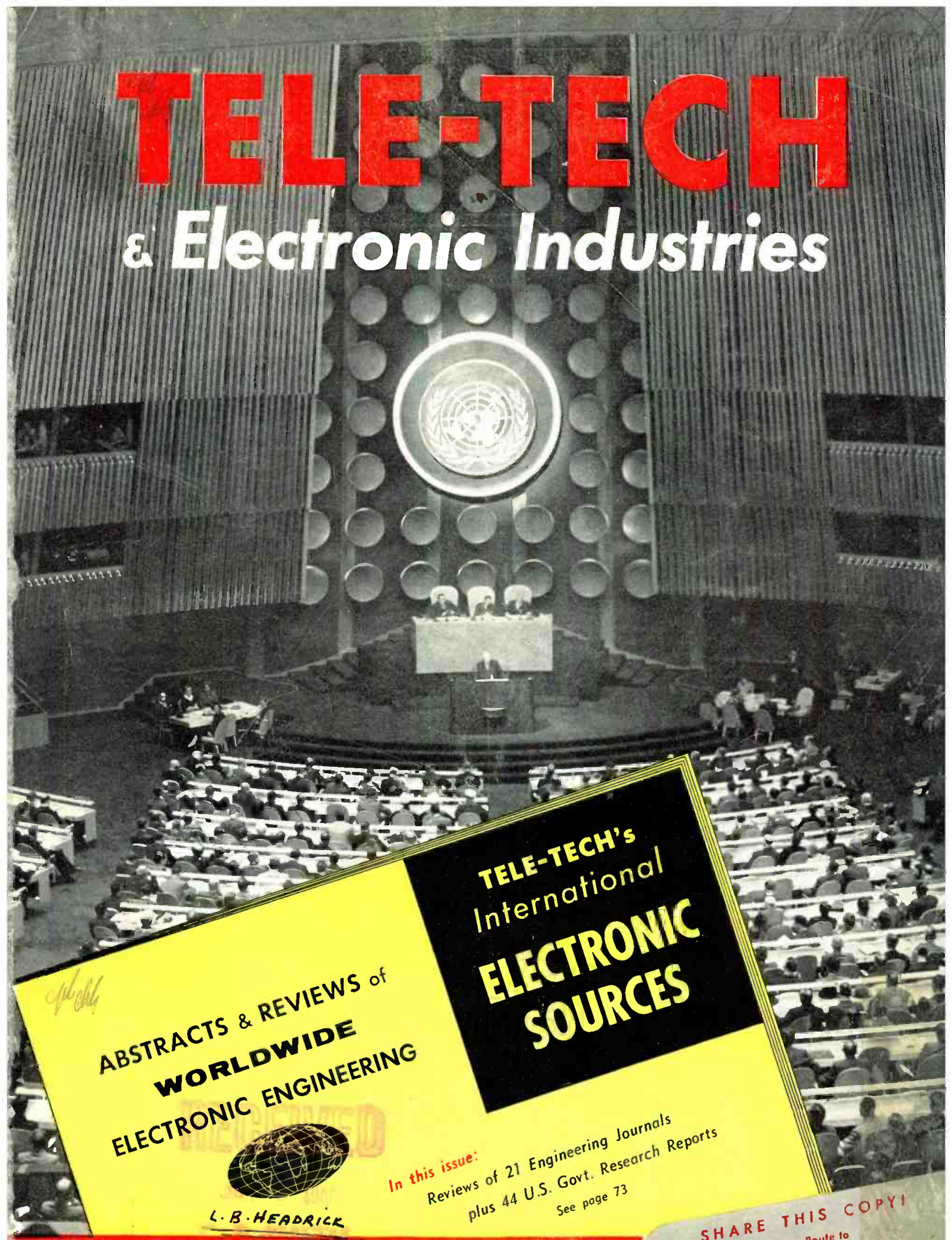
TELE-TECH
& Electronic Industries



TELE-TECH's International ELECTRONIC SOURCES

ABSTRACTS & REVIEWS of WORLDWIDE ELECTRONIC ENGINEERING

L. B. HEADRICK

In this issue:
Reviews of 21 Engineering Journals
plus 44 U.S. Govt. Research Reports
See page 73

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1955-56 Electronic Industries Statistics

January • 1956

Using Ceramic Capacitors?
Specify RMC DISCAPS

Temperature Compensating

These DISCAPS meet all electrical specifications of the RTMA standard REC-107-A. Small size, lower self inductance and greater dielectric strength adapt them for VHF and UHF applications. Type C DISCAPS are rated at 1000 working volts providing a high safety factor. Available in six sizes in all required capacities and temperature coefficients.

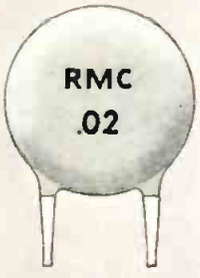
Heavy-Duty

RMC Type B "Heavy-Duty" DISCAPS are designed for all by-pass or filtering applications and meet or exceed the RTMA REC-107-A specifications for type Z5Z ceramic capacitors. Rated at 1000 V.D.C.W., Type B DISCAPS cost no more than lighter constructed units. Available in standard capacities between 470 MMF and 40,000 MMF.

Type JL

Type JL DISCAPS afford exceptional stability over an extended temperature range. They are especially engineered for applications requiring a minimum capacity change as temperature varies between −60°C and +110°C. The maximum capacity change between these extremes is only ±7.5% of capacity at 25°C.

Wedg-Loc



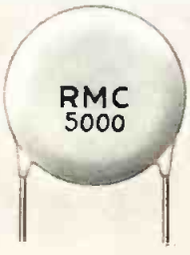
The exclusive wedge design of the leads on these DISCAPS lock them in place on printed circuit assemblies prior to the soldering operation. "Wedg-Loc" DISCAPS are available in capacities between 2 MMF and 20,000 MMF in TC, by-pass and stable capacity types. Suggested hole size is an .062 square.

High Voltage

Special high voltage DISCAPS are available in a wide range of capacities for color television and other electronic applications. RMC DISCAPS for deflection yokes insure the voltage safety factor required in this application. They are available in all capacities between 5 MMF and 330 MMF.

Plug-in

RMC Plug-in DISCAPS will speed up production time in printed circuit operations. Leads are constructed of No. 20 tinned copper (.032 diameter) and are available up to 1½" in length. Manufactured in TC, by-pass and stable capacity types, Plug-in DISCAPS have all the electrical and mechanical features of standard DISCAPS.



Write today on your company letterhead for expert engineering help on any capacitor problem.

DISCAP CERAMIC CAPACITORS

RMC

RADIO MATERIALS CORPORATION

GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.

FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Two RMC Plants Devoted Exclusively to Ceramic Capacitors

TELE-TECH & Electronic Industries

JANUARY, 1956

FRONT COVER: INTRODUCING TELE-TECH'S INTERNATIONAL ELECTRONIC SOURCES, a new reader service. The leading page of this new section which starts in this issue and appears monthly hereafter, is highlighted against a United Nations background as being symbolic of international cooperation. In ELECTRONIC SOURCES the reader will find catalogued abstracts of the most important electronic engineering data published throughout the world. Airmail service from each of the publishers assures that only the very latest issues of foreign engineering journals are abstracted each month. The section starts on page 73.

MONTHLY NEWS ROUND-UP

DEPARTMENTS

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"HI-WATTER"

GATES HI-WATTER SERIES
MORE WATTS PER DOLLAR INVESTMENT

TIP-OFF!

Rugged construction, direct speed shift, precision machining and complete elimination of spring tension and gravity controlled devices is why the new Gates transcription turntable is going into broadcasting stations at a current rate of over 100 per month.

Another Gates "Hi-Watter" Exclusive!

Packaged broadcast equipment is one of the reasons Gates leads all others in the sale of radio broadcast equipment. Here is the newest— packaged *complete* transcription equipment. Starting with the new, direct shift, 3-speed mechanism, Gates engineers added a new 3-stage preamplifier with self-contained power supply, variable equalizer, transcription arm, dual pickup cartridge and dual styli. All of this is inbuilt right on the chassis—ready to do a top quality professional job in America's radio and television broadcasting stations. — Another Gates exclusive.

Model CB-210 complete chassis including pickup, dual cartridge with sapphire styli*, preamplifier, power supply and variable equalizer **$275.00**

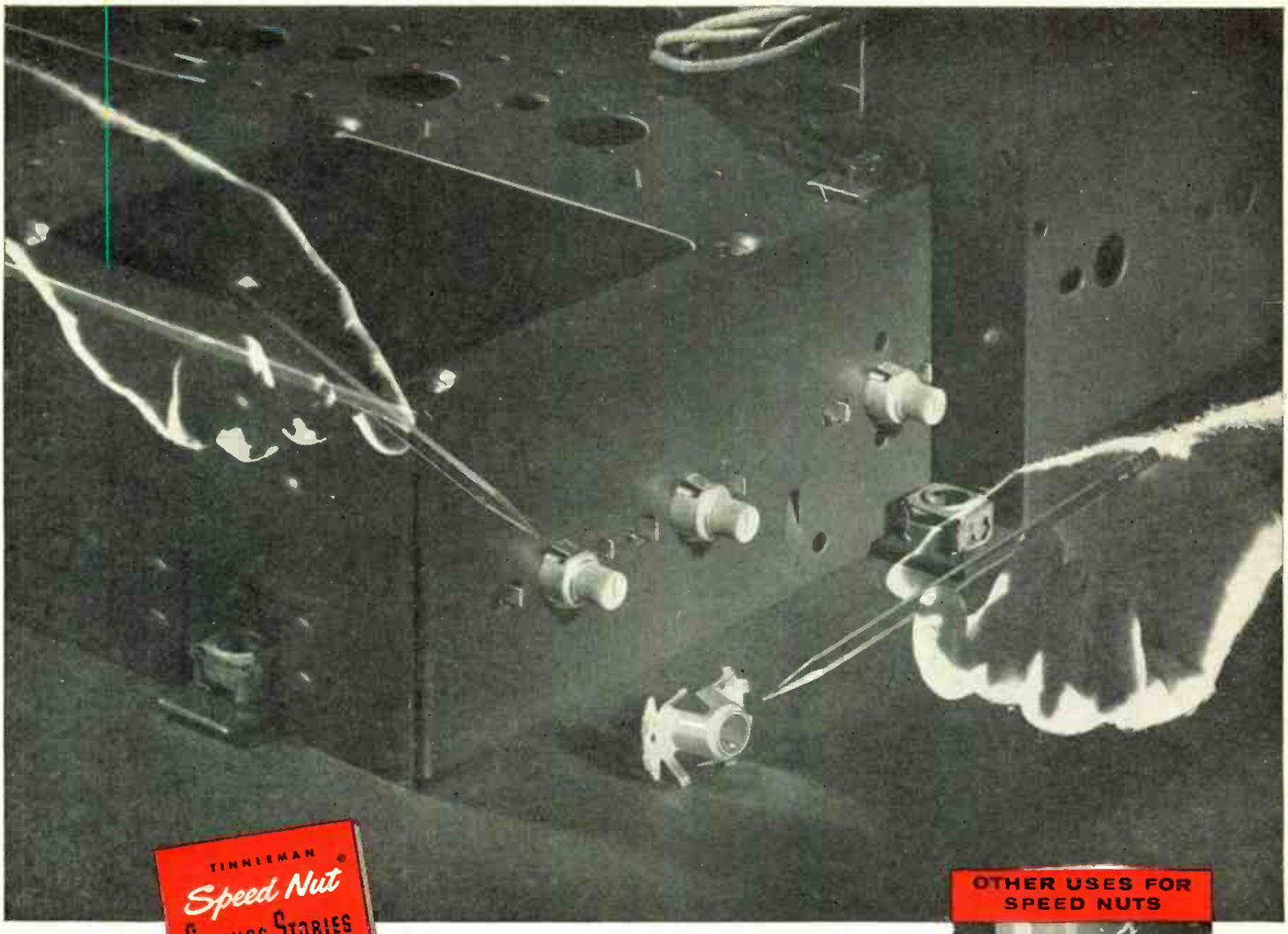
*Add $26.37 where dual diamond styli desired.

Model CAB6 floor cabinet (not illustrated) **$90.00**

GATES

GATES RADIO COMPANY QUINCY, ILL., U. S. A.
Manufacturing Engineers Since 1922

Houston, 2700 Polk Avenue
New York, 51 East 42nd Street
Washington, D. C., Warner Bldg.
Los Angeles, 7501 Sunset Blvd.
New York, International Div., 13 East 40th St
Atlanta, 13th & Spring Sts
Montreal, Canadian Marconi Co.



TINNERMAN Speed Nut® SAVINGS STORIES

Cost-Cutting Chain Reaction Triggered by SPEED CLIP®!

Savings for the parts supplier, the television manufacturer and the ultimate user! That's the triple play that begins every time Centralab, division of Globe Union, Inc., Milwaukee, Wis., assembles a "Snap-Tite" television control. Here's why: There's a job-engineered Tinnerman SPEED CLIP in every control assembly.

A simple two-at-a-time hand operation speeds assembly of controls to chassis for an amazing 73 per cent savings in time. No special skills or tools are required. Spring steel fingers of the SPEED CLIP snap past the panel as inserted . . . hold the controls firmly in place and automatically spaced away from the chassis. Removal for service is simply a matter of pinching the spring fingers inward and slipping the control free.

Another example of Tinnerman fastening know-how, this part is just one of more than 8,000 SPEED NUT brand fasteners designed to make standard or complex attachments. SPEED NUTS can bring savings to you, too. See your Tinnerman representative soon and write for your copy of "SPEED NUT Savings Stories".

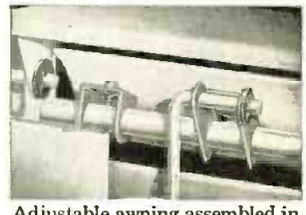
TINNERMAN PRODUCTS, INC. • BOX 6688, DEPT. 12, CLEVELAND 1, OHIO

Canada: Dominion Fasteners, Limited, Hamilton, Ontario. *Great Britain:* Simmonds Aerocessories, Limited, Treforest, Wales. *France:* Aerocessoires Simmonds, S. A., 7 rue Henri Barbusse, Levallois (Seine). *Germany:* Hans Sickinger GmbH "MECANO", Lemgo-i-Lippe.

TINNERMAN Speed Nuts® FASTEST THING IN FASTENINGS®

OTHER USES FOR SPEED NUTS

SPEED CLIP gives desks extra model flexibility and saves money.

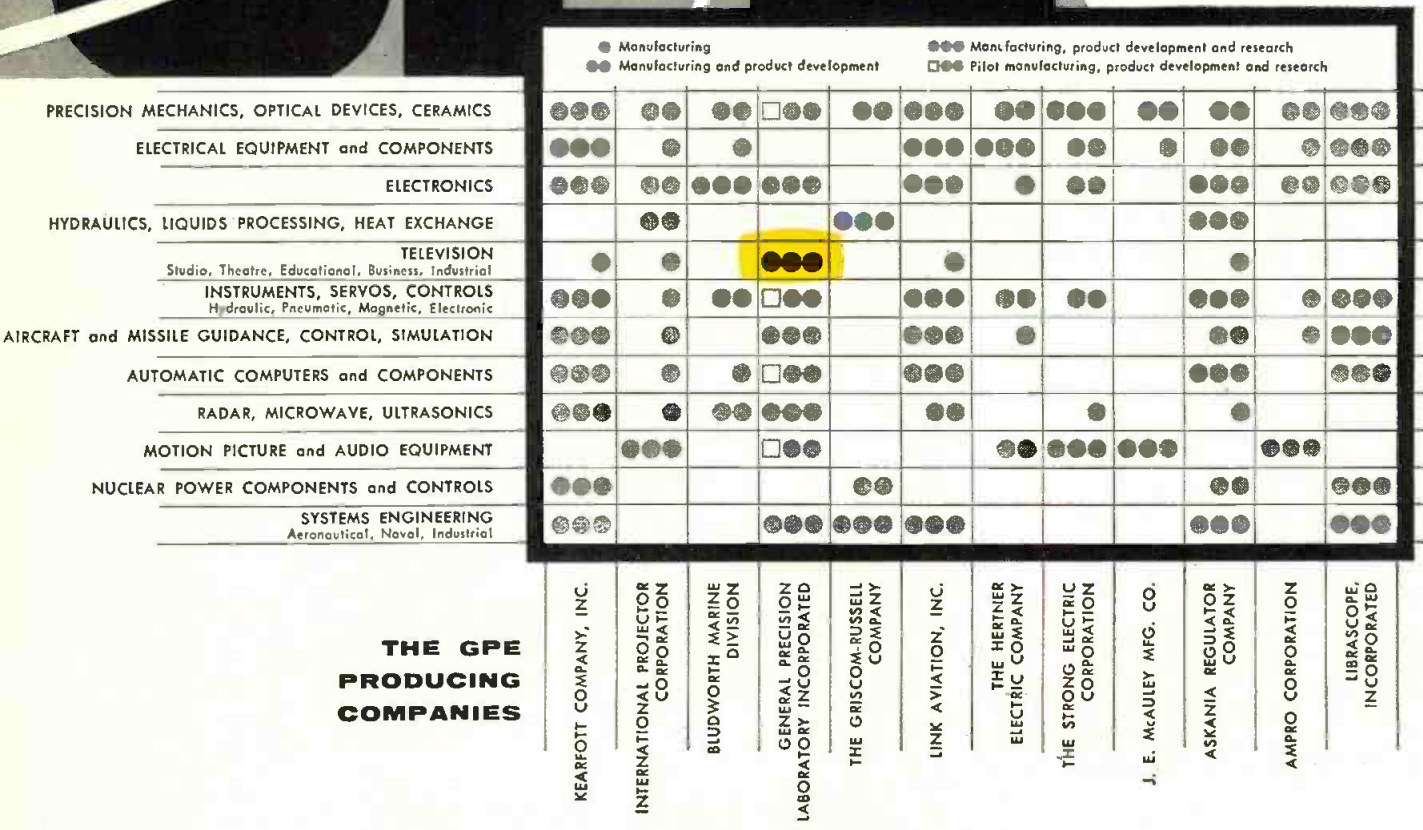


Adjustable awning assembled in 63% less time with special SPEED NUTS.

SPEED NUTS lower assembly costs 40% on casement-window air conditioner.

GPE BUILDING BLOCKS

serving industry through coordinated precision technology



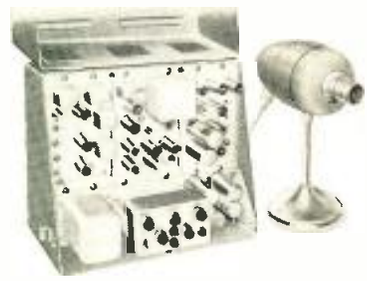
THE GPE PRODUCING COMPANIES

One of a series telling
how the producing companies of
General Precision Equipment Corporation
are contributing to America's progress.

advanced techniques & resources

The producing companies of General Precision Equipment Corporation are engaged in the development, production and sale of advanced technological products. Each of these companies specializes in particular areas of advanced competence and possesses highly developed techniques and resources in its particular field or fields. These are the building blocks of GPE Coordinated Precision Technology, through which GPE serves more than a dozen important industries.

The chart at the left shows the areas in which each GPE Producing Company works. But it cannot show the high degree of specialization and the important position each GPE Company occupies in its field or fields.



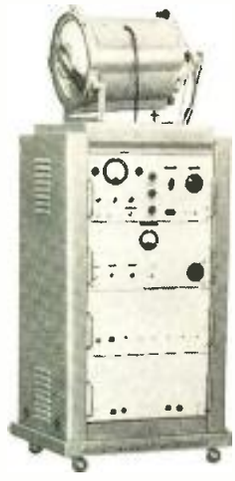
The *ii-TV* Camera; for *industrial* and *institutional* use. Produces useful pictures under conditions of poor light; feeds any TV receiver or monitor; unique packaging permits placement in ordinarily inaccessible areas; unitized construction with plug-in component chassis minimizes maintenance requirements.

Take **TELEVISION,** for instance, and the work of General Precision Laboratory Incorporated, the GPE leader in the field. GPL's research, development and manufacturing activities in TV are concerned with quality equipment for theatre, studio, business, industrial, institutional and military TV and do not relate to the home TV field.

¶ GPL equipment was used for all video recording of the Coronation, both U. S. and Canadian. It is used by 90% of the studios equipped for video recording.

¶ The first appearance of a President on closed-circuit TV—President Eisenhower speaking from the White House to distinguished guests at the dedication of the Ford Research Center in Dearborn—was projected on GPL theatre equipment, producing fine quality pictures up to 65 feet wide.

¶ The same large-screen GPL equipment, and high quality, portable, intermediate size projection equipment newly developed by GPL, enabled guests assembled in several separate ballrooms of the Waldorf-Astoria to see and hear the Queen Mother at two New York dinners last Fall; made possible the historic 53-city TV hook-up which was a feature of GM's fifty-millionth car celebration. Both these types of GPL projection equipment also played key roles in the nationwide "heart-video-clinic"—the largest meeting of its kind ever held—attended by over 20,000 specialists in 35 cities. This GPL equipment is rapidly making closed-circuit TV a practical, everyday business and institutional meeting medium.



GPL TV Projector, with alternate optical systems; for audiences ranging from several hundred to thousands. Does not require skilled operator. Easily transported; set up in matter of minutes. Completely self-contained.

¶ New uses are developing steadily for ii-TV, GPL's highly efficient industrial and institutional closed-circuit TV system: to speed service, eliminate congestion, supervise and instruct; to control and speed train make-up and freight car loadings; to monitor and improve manufacturing processes; to view hazardous operations; for surveillance and security.

¶ Many broadcast studios, including New York network stations, are exclusively equipped with GPL cameras and control equipment.

GPL is a leader in military TV with its special and exacting requirements for airborne, shipboard and under-water uses and is also at work on color TV. A color film camera chain of high quality, for studio use, and additional color equipment are in production.

A broad description of the work of GPL and the other GPE Companies is contained in the GPE brochure, "Serving Industry Through Coordinated Precision Technology." For a copy, or other information, address:

Remote Control TV Camera; for broadcast and industrial use. Pre-set control permits memory of 6 different shots. Mounted on servo-operated pedestal, provides complete remote control of lens selection, iris, pan and tilt. Highly useful for observing dangerous phenomena; permits broadcasting without use of camera man.

General Precision Equipment Corporation

92 GOLD STREET, NEW YORK 38, NEW YORK

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MANUFACTURING													
Automation Equip.	•	•	•	•	•	•	•	•		•	•		
Audio & Video	•	•	•	•	•	•	•	•		•	•	•	•
Avionics	•	•	•	•	•	•	•	•	•	•	•	•	•
Color Television	•	•	•	•	•	•	•	•	•	•	•	•	
Components	•	•	•	•	•	•	•	•		•	•	•	
Computers	•	•	•	•	•	•	•	•		•	•	•	•
Control Consoles	•	•	•	•	•	•	•	•	•	•	•		
Government	•	•	•	•	•	•	•	•	•	•	•	•	•
Guided Missiles	•	•	•	•	•	•	•	•	•	•	•	•	•
Industrial Elec's	•	•	•	•	•	•	•	•	•	•	•	•	
Military Elec's	•	•	•	•	•	•	•	•		•	•	•	•
Mobile	•	•	•	•	•	•	•	•	•	•	•	•	•
Printed Circuits	•	•	•	•	•	•	•	•	•	•	•	•	•
Res. & Dev. Labs	•	•	•	•	•	•	•	•		•	•		
Studio Equipment	•	•	•	•	•	•	•	•		•	•		
Telemetering	•	•	•	•	•	•	•	•	•	•	•	•	•
Test Equipment	•	•	•	•	•	•	•	•	•	•	•	•	•
Transistors	•	•	•	•	•	•	•	•	•	•	•	•	•
TV-Radio-Radar	•	•	•	•	•	•	•	•	•	•	•	•	•
Vacuum Tubes	•	•	•	•	•	•	•	•	•	•	•	•	•
Xmission Lines	•	•	•	•	•	•	•	•	•	•	•	•	•
OPERATION													
Broadcasting	•	•				•	•	•		•	•		
Communications	•	•				•	•	•		•	•		
Consulting Engrs.				•	•			•			•		
Microwave	•	•				•	•	•		•	•	•	
Recording	•	•				•	•	•	•		•		

Chart shows how TELE-TECH's 27,000 circulation is concentrated among top-level engineers in the electronic industry's principal buying power groups.

THE ELECTRONIC INDUSTRIES DIRECTORY

Published annually as an integral section of TELE-TECH in June

Making Electrical Connections Under Pressure

by Andy Wyzenbeek, Chief Engineer

Fusite Hermetic Terminals with new V-24 glass use the principles of both fusion and compression between the metal and glass to assure a rugged air tight electrical connection.

Where great pressures are involved either internally or externally the limiting factor is often solder or other method of sealing rather than the junction of materials on the terminal itself.

The same is true of Fusite Terminals in applications subject to extreme vibrations, or mechanical or thermal shock.

Where one or more of these conditions exist, Fusite threaded bushing terminals have proved themselves capable of withstanding great punishment. The threaded mechanical seal together with soft solder, suitable gasket or epoxy resin extends the capacity of the connection and brings it more nearly to the high limits engineered into the Fusite Terminal itself.

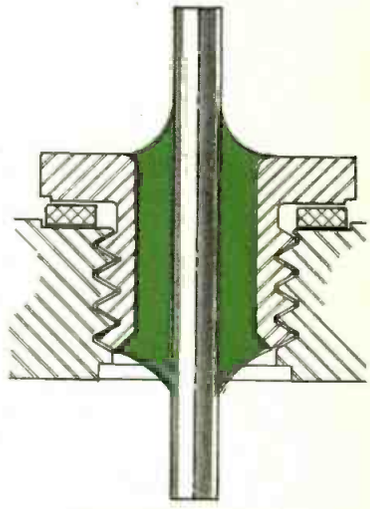
Each of the three illustrated terminals are available in five different electrode treatments and come with standard threads as shown. In addition, for extreme pressure conditions, these terminals are made with tapered pipe plug threads.

We were gratified and a little bit alarmed by a letter of inquiry received recently from a new user of a Fusite pipe plug terminal.

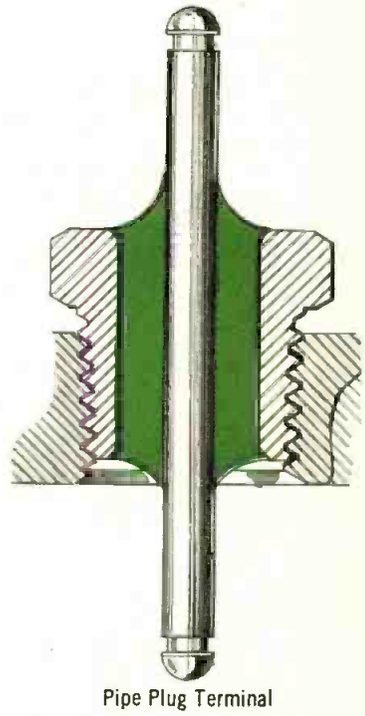
"Thank you for the samples of your terminal and drawings of 1/8 pipe plug. We tested several of these units to 29,500 PSI at 212° and they did not fail. We are curious as to how much higher pressure they will stand."

We had to plead ignorance as to maximum pressure possibilities, but if you would like to test them in your own application, samples are yours for the asking.

Write FUSITE, Dept. U-1, 6026 Fernview Avenue, Cincinnati 13, Ohio

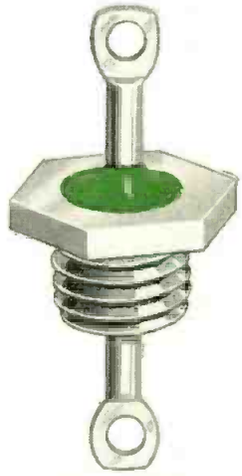


Threaded Bushing Terminal with Gasket



Pipe Plug Terminal

104 TB Series
8-32 Thread 3/16" Hex Head



105 TB Series
1/4-28 Thread 3/8" Hex Head

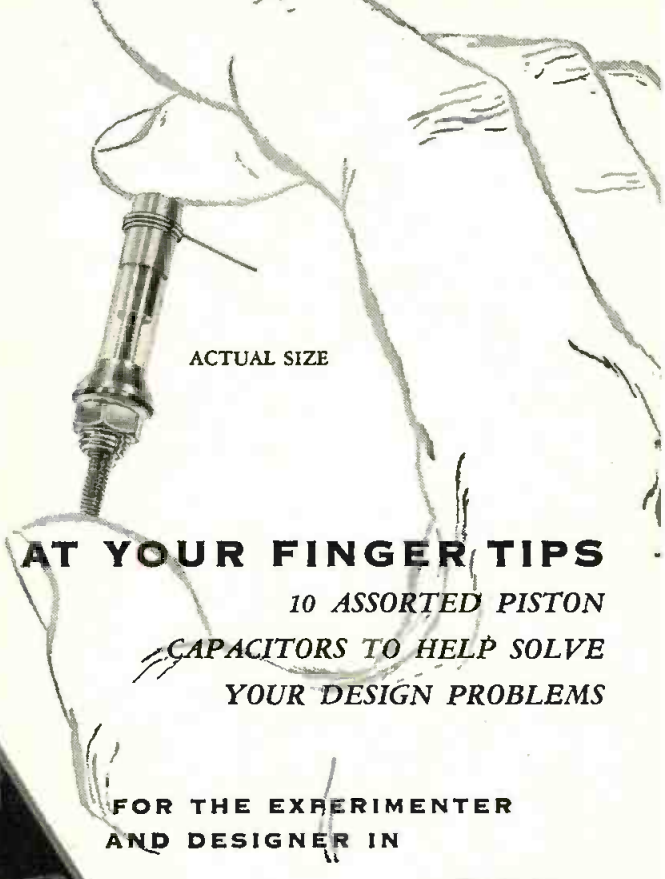
109 TB Series
3/8-24 Thread 1/2" Hex Head

INSULATE ELECTRICALLY GLASS TO METAL FUSITE TERMINALS PROTECT PRODUCT PERFORMANCE SEAL HERMETICALLY

THE FUSITE CORPORATION

6026 FERNVIEW AVE., CINCINNATI 13, OHIO

JFD Electronics — ENGINEER'S EXPERIMENTAL KIT!



AT YOUR FINGER TIPS

10 ASSORTED PISTON CAPACITORS TO HELP SOLVE YOUR DESIGN PROBLEMS

FOR THE EXPERIMENTER AND DESIGNER IN

RADAR
RADIO
TELEVISION
COMMUNICATIONS
MICROWAVE TRANSMISSION
AUTOMATION
GUIDED MISSILES
NUCLEAR PHYSICS

ORDER NO. PK10

THIS KIT CONTAINS THE FOLLOWING 10 JFD PISTON CAPACITORS WITH THE CHARACTERISTICS INDICATED BELOW.

ODEL	CAPACITY RANGE MMF	OPERATING TEMPERATURE RANGE °C	TEMPERATURE COEFFICIENT 1KC P.P.M./°C	Q at 1MC	DIEL.	MOUNTING THREAD SIZE
C5	.5 to 5	—55° to +200°	Approx. 0	1800	Fused Quartz	¼ — 28
C11	1 to 10	—55° to +200°	Approx. 0	1800	Fused Quartz	¼ — 28
C12	10 to 20	—55° to +200°	Approx. 0	1200	Fused Quartz	¼ — 28
C1G	.5 to 8	—55° to +125°	+50 ±50	600	GLASS	¼ — 28
C3G	.7 to 8	—55° to +125°	+500 ±100	600	GLASS	¼ — 28
C4G	1 to 18	—55° to +125°	+500 ±100	700	GLASS	¼ — 32
C8G	1 to 8*	—55° to +125°	+50 ±50	700	GLASS	¼ — 28
C11G	.7 to 12	—55° to +125°	+50 ±50	700	GLASS	¼ — 28
C13G	1 to 10	—55° to +125°	+400 ±100	625	GLASS	¼ — 28
C30G	1 to 30	—55° to +125°	+100 ±50	600	GLASS	¼ — 28

complete physical and electrical data see Engineering Bulletins.

IT'S THE ELECTRONIC ENGINEER'S BEST FRIEND!

Here are *10* different, precision quartz and glass dielectric JFD Variable Trimmer Piston Capacitors to speed your research and experimentation—complete with electrical characteristics charted in easy-to-follow tables—characteristics which offer you:

Matched temperature coefficients to meet a wide number of requirements . . . incremental adjustment of capacity for highly critical tuning . . . plus a new differential type ideal for oscillator and discriminator network applications. All housed in a handsome, felt-lined, dust-proof styrene container. Better order yours today.

JFD Electronics Since 1929

ELECTRONICS CORP.
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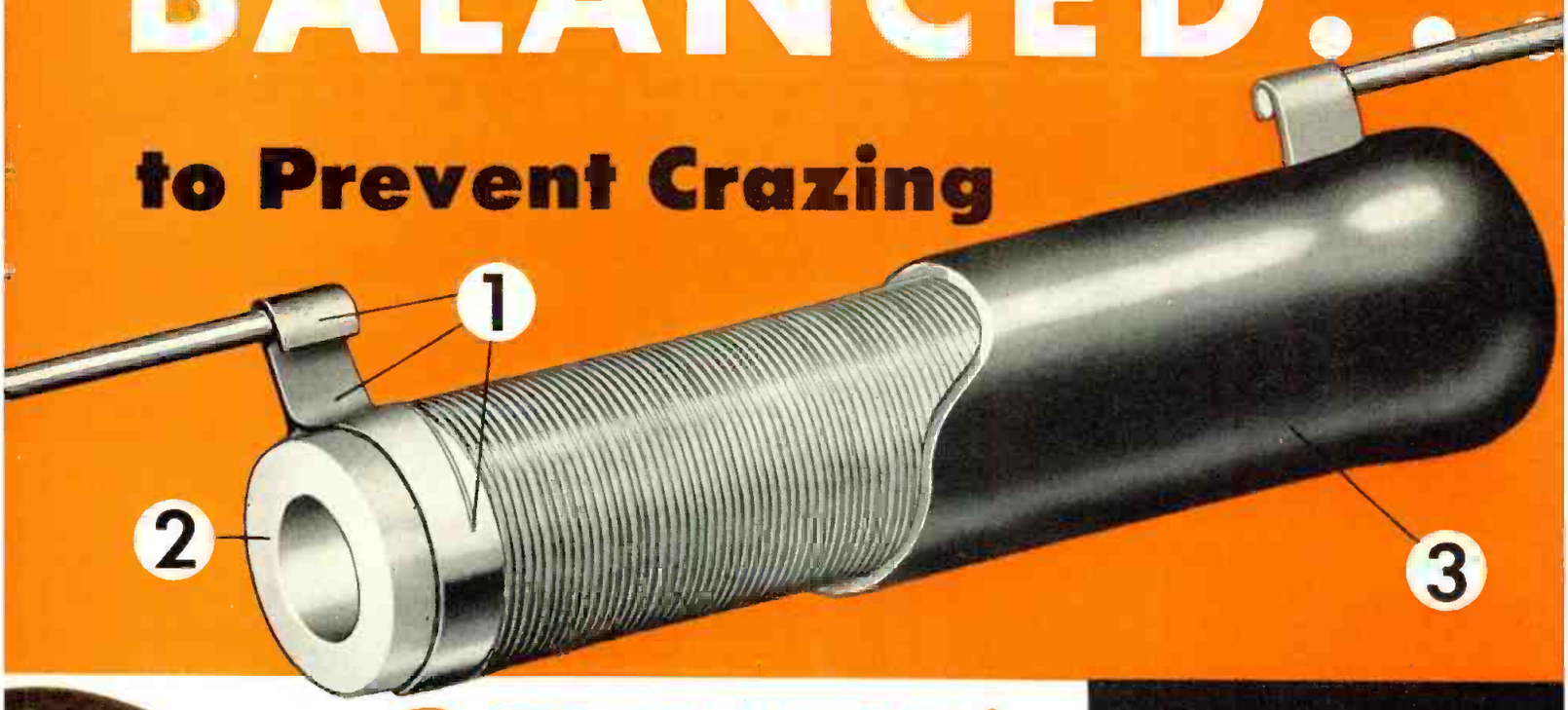
BROOKLYN, N. Y.

"Go Forward with JFD Engineering"

THERMALLY BALANCED...

to Prevent Crazing



OHMITE®

"Brown Devil"® RESISTORS

Ohmite "Brown Devil" Resistors have been carefully designed to provide *balanced thermal expansion*. All parts—core, resistance wire, vitreous enamel coating, and terminal band—have a thermal expansion that has been carefully matched. Consequently, Ohmite "Brown Devil" Resistors expand and contract as a unit. This eliminates cracking of the enamel, keeps terminals firmly anchored, and prevents the entrance of moisture.

THE RESULT: You are assured high-quality resistors that provide the utmost in dependability under the toughest service. Specify Ohmite "Brown Devils" on your next job.

They Last Longer!

1 PATENTED WELDED TERMINALS
Ohmite welded terminals provide a perfect and permanently stable electrical connection that is unaffected by vibration or high temperature.

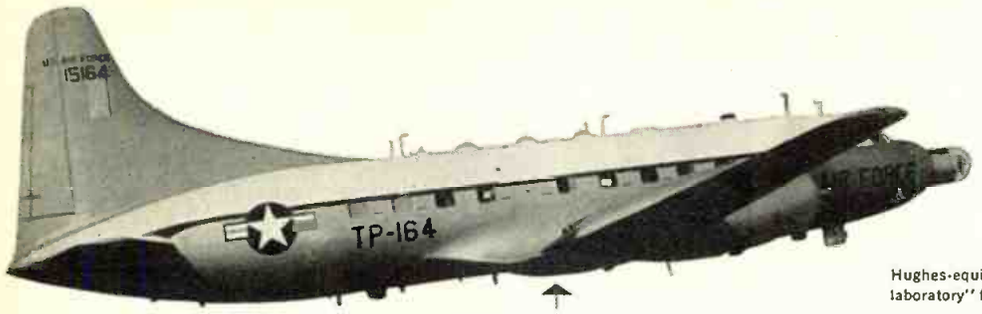
2 HIGH TEMPERATURE STEATITE CORE
This strong, rugged, steatite core has excellent electrical characteristics, and a coefficient of thermal expansion that matches the other resistor materials.

3 EXCLUSIVE HIGH TEMPERATURE VITREOUS ENAMEL
This special-farmula enamel was develaped by Ohmite after extensive research. Its thermal expansian is properly related to that of the steatite core, terminal, and resistance wire.

Be Right with OHMITE®

OHMITE MANUFACTURING COMPANY, 3662 Howard Street, Skokie, Illinois (Suburb of Chicago)

RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES



Hughes-equipped T-29 "flying laboratory" for systems evaluation.

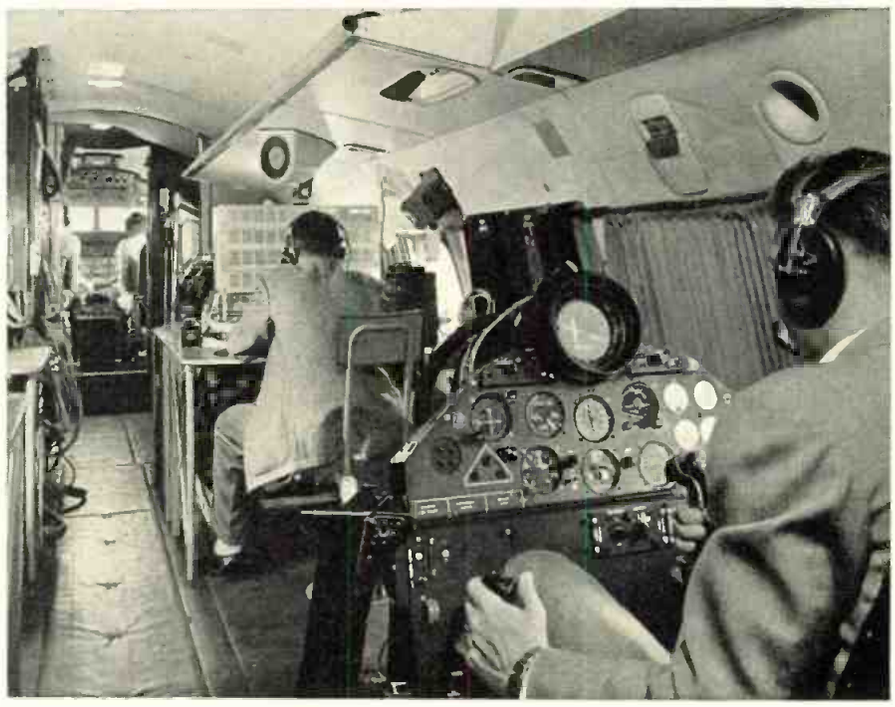
Flight evaluation of advanced interceptor electronic system uses unique approach.

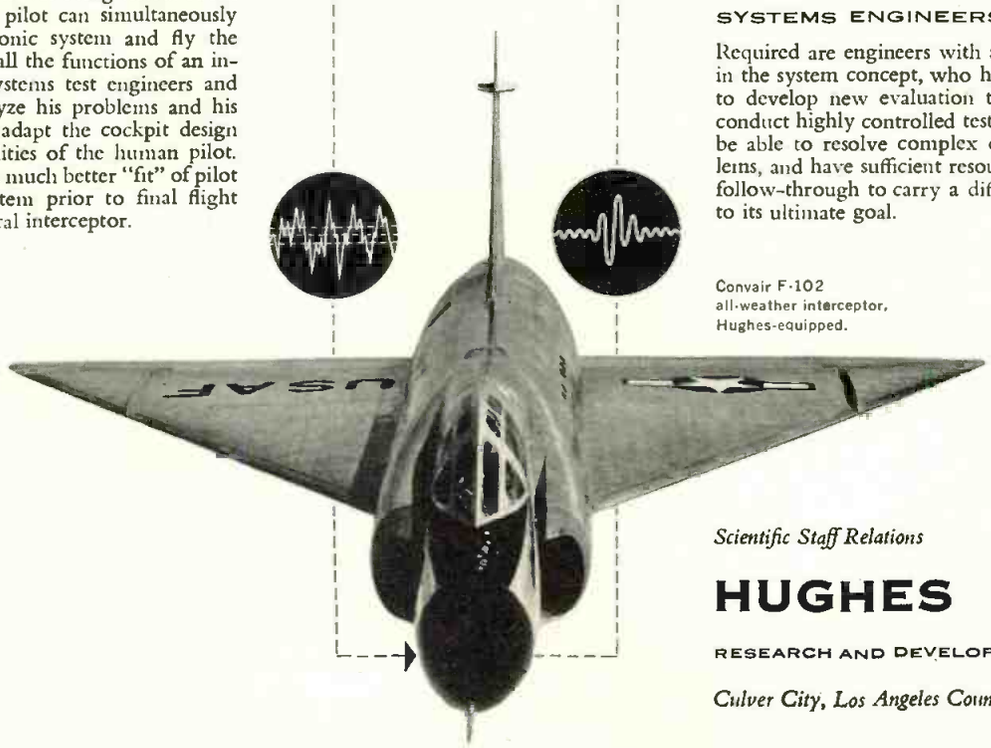
T-29 "INTERCEPTOR"

THE DEVELOPMENT OF AIRBORNE ELECTRONIC SYSTEMS REQUIRES THOROUGH FLIGHT EVALUATION OF BREADBOARD AND PROTOTYPE EQUIPMENT PRIOR TO FINAL DESIGN. AT HUGHES, SYSTEMS FOR INTERCEPTORS ARE FIRST TESTED IN "FLYING LABORATORIES" IN WHICH THE EQUIPMENT IS READILY ACCESSIBLE TO SYSTEMS TEST ENGINEERS.

One interesting problem recently confronting Hughes engineers was that of evaluating the requirements imposed upon the pilot of a high-speed one-man interceptor. This arose in the development of a new integrated electronic system to control several phases of an all-weather interceptor's flight. Because of the great importance of providing the pilot with the optimum design and arrangement of displays and controls, it became necessary to determine accurately the pilot's work load during flight, and the human factors that affect his ability to carry out his task.

The solution was to install a complete mock-up of the actual interceptor cockpit in a large T-29 aircraft in which a breadboard model of the system was being tested. From this cockpit a test pilot can simultaneously operate the electronic system and fly the T-29, performing all the functions of an interceptor pilot. Systems test engineers and psychologists analyze his problems and his performance, and adapt the cockpit design to the natural abilities of the human pilot. The result will be a much better "fit" of pilot and electronic system prior to final flight testing in the tactical interceptor.





Convair F-102 all-weather interceptor, Hughes-equipped.

SYSTEMS ENGINEERS

Required are engineers with a basic interest in the system concept, who have the ability to develop new evaluation techniques and conduct highly controlled tests. They should be able to resolve complex circuitry problems, and have sufficient resourcefulness and follow-through to carry a difficult program to its ultimate goal.

Scientific Staff Relations

HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

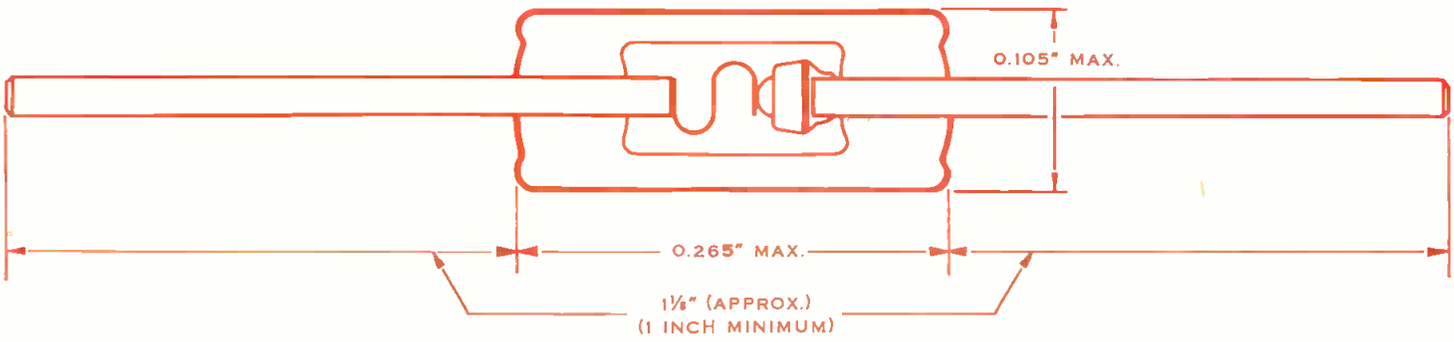
Culver City, Los Angeles County, California

HUGHES

SILICON JUNCTION

DIODES

Dimensions are maximum for standard Hughes Silicon Junction Diodes.



*High Temperature Operation**

Extremely High Back Resistance

Exceptionally Stable Characteristics

FEATURES—High temperature operation...*extremely* high back resistance . . . very sharp back voltage breakdown . . . one-piece, fusion-sealed glass body . . . axial leads for easy mounting . . . subminiature size . . . exceptionally stable characteristics.

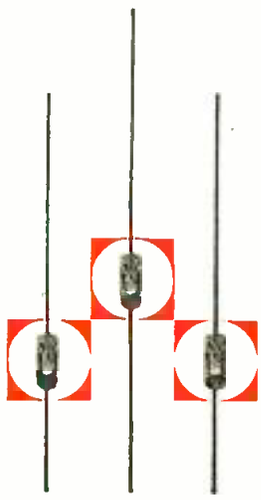
TESTED—All Hughes Silicon Junction Diodes are subjected to rigorous testing procedures. Specific electrical characteristics are measured and, when specified, special tests are also performed.

CONSTRUCTION—Hughes Silicon Junction Diodes are packaged in the famous fusion-sealed glass body, developed at Hughes. This construction is impervious to moisture penetration—*ensures* electrical and mechanical stability, and freedom from contamination.

When high temperatures or high back resistance requirements call for silicon, be sure to specify *Hughes* Silicon Junction Diodes. They are first of all—for RELIABILITY!

Diode glass body is coated with opaque black enamel, color-coded on cathode end. Available now in nine types: HD6001, HD6002, HD6003, HD6005, HD6006, HD6007, HD6008, HD6009, HD6011. Ask for descriptive Bulletin SP-4.

**Characteristics rated at 25°C and at 150°C. Ambient operating range, −80°C to +200°C.*



Actual Size

HUGHES PRODUCTS DIVISION

Aircraft Company, Los Angeles 45, Calif.

New York Chicago Los Angeles

A COMPLETE LINE OF DEPENDABLE ENCAPSULATED RESISTORS

PERMASEAL®

PRECISION WIREWOUND RESISTORS FOR 85C AND 125C AMBIENTS

When you have applications requiring accurate resistance values at 85C and 125C operating temperatures, in units of truly small physical size—you'll find the resistor you want is one of the 46 standard Permaseal designs in tab and axial lead styles.

They meet or exceed requirements for all types of military and industrial electronic apparatus and instruments. They are "extra-protected" by a special Sprague-developed plastic embedding material that performs beyond the severe humidity resistance specifications of MIL-R-93A and Proposed MIL-R-9444 (USAF).

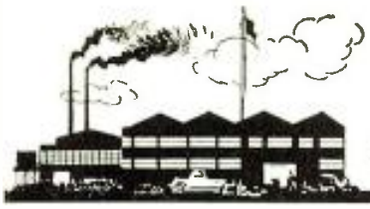
Permaseal winding forms, resistance wire and embedding material are matched and integrated to assure long term stability at rated wattage over the operating temperature range.

These high-accuracy units are available in close resistance tolerances down to ±0.1%. They are carefully and properly aged for high stability by a special Sprague process.

SPRAGUE

FOR COMPLETE DATA WRITE FOR COPY OF SPRAGUE ENGINEERING BULLETIN NO. 122A

SPRAGUE ELECTRIC COMPANY • 233 MARSHALL ST. • NORTH ADAMS, MASS.



As We Go To Press...

David T. Schultz Elected President of Du Mont Labs

David T. Schultz, currently senior vice-president and treasurer of Raytheon Mfg. Co., will succeed Dr. Allen B. Du Mont on Jan. 3, 1956 as president of Allen B. Du Mont Labs, Inc.

The election of Mr. Schultz is a step taken as part of a plan, voted by stockholders in Oct., to separate broadcasting from manufacturing operations, to change the corporate and capital structure, and to revitalize management.

David T. Schultz

Mr. Schultz comes to Du Mont after more than 25 years with Raytheon, as a vice-pres., treasurer and director.

Westinghouse Atomic Plant Scheduled For Belgium

An 11,500 kw atomic power plant, to provide electrical energy during the Brussels World's Fair in 1958, will be the first completely privately financed atomic electric power plant in the world. The installation is a joint venture of Westinghouse Electric Corp. and the Syndicat d'Etude de l'Energie Nucleaire, an organization of Belgian utilities and manufacturers formed to develop industrial uses of atomic energy in that country. Work on the project is already underway in both Belgium and the U. S.

Fuel elements for the unit will be fabricated by Westinghouse from special material furnished by the U. S. Atomic Energy Commission under a separate agreement reached between the AEC and Belgium. In addition to the atomic power plant itself, Westinghouse will furnish the services of its own engineers and scientists to insure that the plant is placed in proper operation.

Table Top Computer Announced by Litton

Production of the first of a series of electronic digital computers of typewriter size, capable of doing in one hr. the mathematical computations of 50 men working for 1 yr. with modern desk calculators, has been announced by Litton Industries of Beverly Hills, Calif.

Designated the Litton 20 the new unit is a digital differential analyzer, priced in the $10,000 range, for solving the complex differential equations found in the great majority of scientific and engineering problems.

Plug-in components are used throughout, and all flip-flops and diodes can be tested in a few minutes. No transistors are used. A small magnetic memory drum is part of the equipment. Operating controls are located on the front panel, together with input keys and CRT output display. Graph plotters, curve followers, and automatic type fill are available as optional accessories. Power requirements are 300 w. at 110 v.

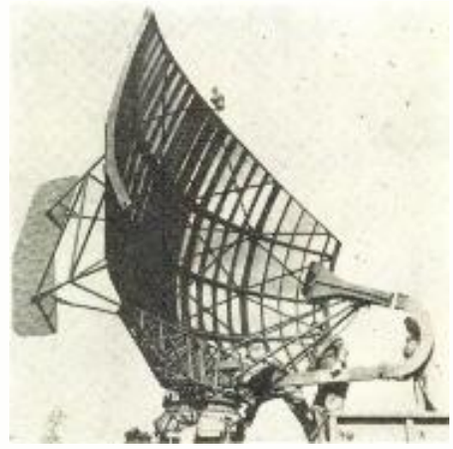
Computer occupies 1 cu. ft. space

The machine was invented by Floyd G. Steele, and engineered in Litton labs under Project Head John Connolly.

New Mobile Radar Developed By G-E

A high powered radar set, which can be erected in less than 3 hrs. by a crew of 30 men, has been built for the Air Force by the General Electric Co. under contract with ARDC's Rome Air Development Center at Griffiss AFB. It has a capability of "seeing" aircraft at high altitudes, and may be used for interception purposes when coupled with a height-finding radar of comparable range capability.

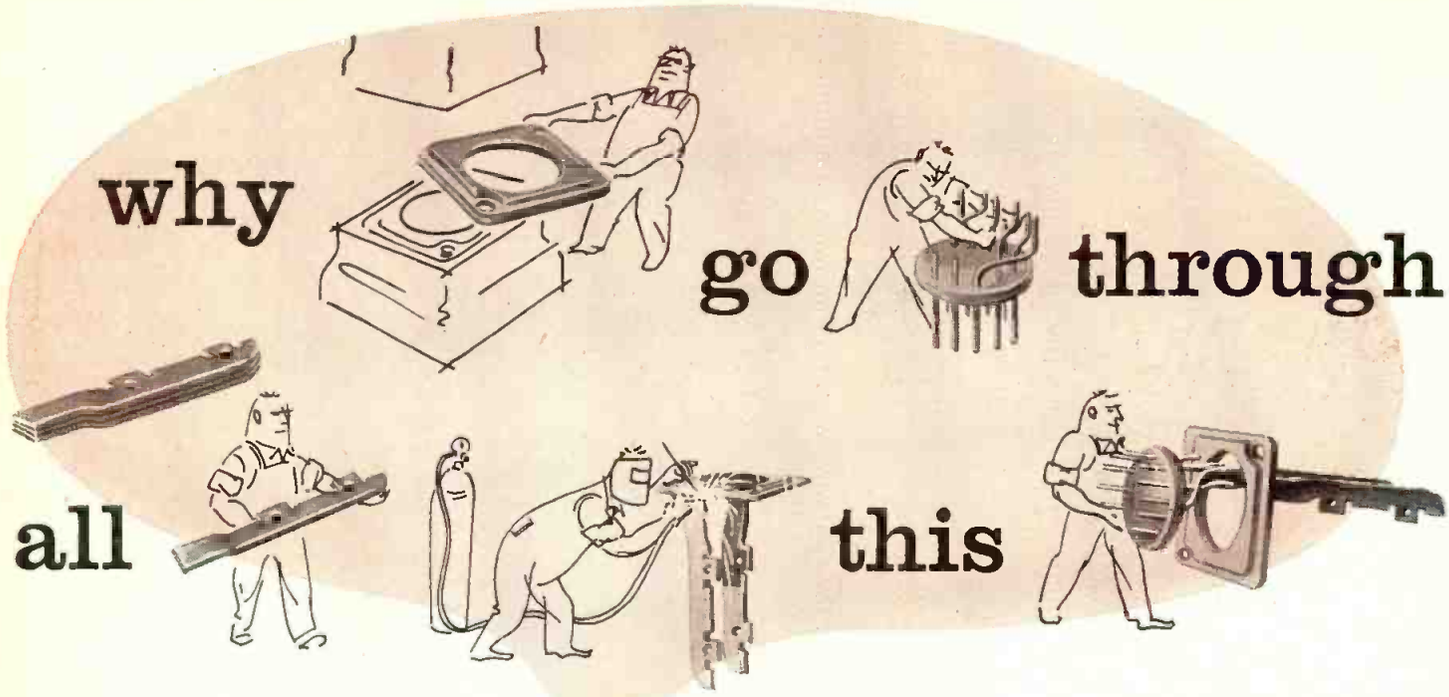
The new set, the AN/MPS-11, combines the highly desirable electrical characteristics of a fixed set with the advantages of extreme mobility. It may be transported to the field in nine trucks and two trailers which comprise a self-supporting radar system for tactical use. Included are shelters for the housing of operational components as well as operating personnel.



Assembly time is less than 3 hrs.

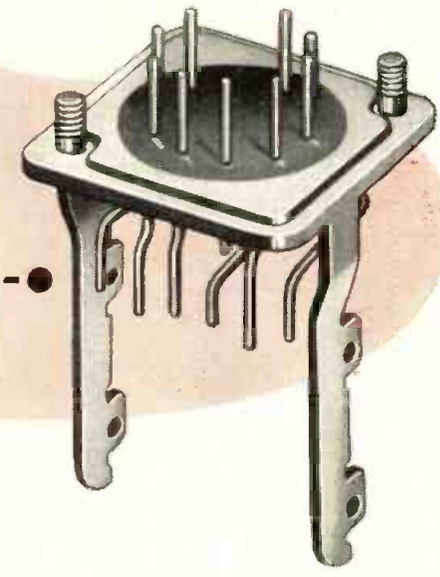
One of the features of the new radar complex is the light-weight reinforced plastic shelter 32-feet long which houses the radar operation equipment. The shelter consists of arch-shaped interchangeable sections, each identical in design, and may be erected by men equipped with only ladders and wrenches. A similar plastic shelter, only 18-feet long, is used for radar maintenance work.

MORE NEWS on page 16



When you can buy

this



Relay Headers Ready for Assembly

This newly developed Relay Header Assembly introduces a new high in simplified production techniques by eliminating these costly steps: buying or producing square cover plates with studs attached; stamping the hole in the cover plate for the hermetically sealed header; attaching and shaping pigtails; soldering or brazing the mounting bracket to the cover plate; mounting the seal in the cover plate.

To the manufacturer, this means a profit increase . . . *to the engineer,* a new horizon in design simplification . . . *to the purchasing agent,* a reduction of orders placed and attendant paper work . . . *to production control,* a reduction of parts inventoried and stocked.

Whatever the problem in mechanical assemblies, whether it be complex Relay Headers, Multi-Headers specially shaped to fit enclosures or cans, or Color-Coded Terminal Plates with studs attached—you'll find the most economical solution to your assembly problem at HERMETIC.

Write for engineering assistance, data, prices and your FREE copy of "Encyclopedia Hermetica"—a handy, desk-top reference guide.

Hermetic Seal Products Company

33 South 6th Street, Newark 7, New Jersey

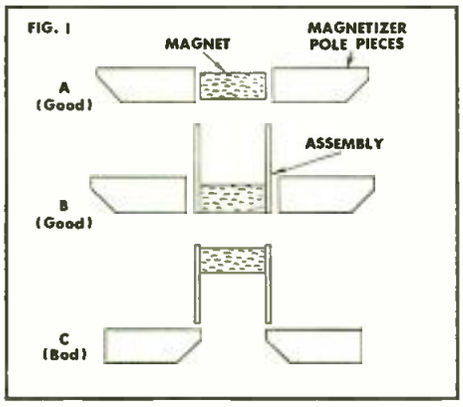
California Associate: Glass-Solder Engineering, Pasadena

FIRST AND FOREMOST IN MINIATURIZATION

INDIANA PERMANENT MAGNET DESIGN INFORMATION

published for industrial and consumer product engineers and designers

HOW TO MAGNETIZE PERMANENT MAGNETS



Magnetizing permanent magnets after assembly into the product offers several advantages. Higher field strengths are obtainable. The magnetic field produced in a loudspeaker, for example, using an Alnico V permanent magnet that has been magnetized after assembly, is about three times as great as the field obtained when the same magnet is magnetized before assembly.

The unmagnetized magnets are easier to handle and to assemble with other parts of the assembly. There is less contamination due to pick-up of magnetic particles.

Magnetizing after assembly is also advantageous in such applications as watt hour meters, polarized relays, and permanent magnet motors.

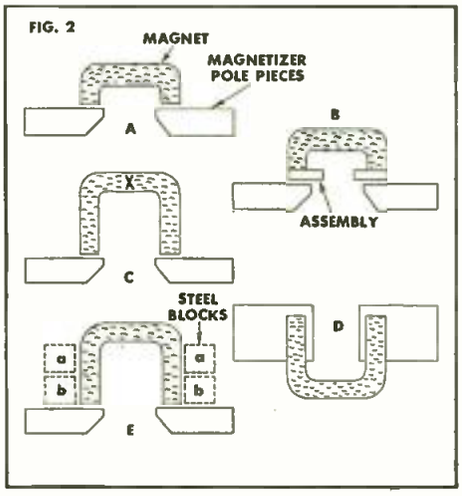
Using the Magnetizer

Most commonly used magnets are of simple bar or "U" shapes, which may be magnetized with an electromagnetic magnetizer in the user's plant.

Fig. 1-A shows how a bar magnet should be positioned between the magnetizer's pole pieces. The square ends of the pole pieces are used toward the gap. The space between the pole pieces is adjusted so the magnet can be easily inserted and removed. Normally, only one to two seconds are required to fully magnetize the magnet.

An assembly consisting of a bar-type magnet and soft-steel pole pieces should be placed with the magnet between the magnetizer pole pieces as shown in Fig. 1-B. Positioning the assembly as shown in Fig. 1-C will not fully saturate the magnet.

"U" shaped magnets and assemblies should be positioned as shown in Fig. 2, with the tapered ends of the magnetizer pole pieces used toward the gap. A meter or separator assembly would be placed on the magnetizer as shown in Fig. 2-B.



When a "U" shaped magnet is tall or larger than the generally accepted setting of the magnetizer, the field produced at point "X" (see Fig. 2-C) may not be sufficient to saturate the magnet. In this case there are two acceptable methods of magnetization. One is to place the magnet with its side on the pole pieces as shown in Fig. 2-D. This allows the yoke of the magnet to become magnetized. The magnet is then raised to the position in Fig. 2-C and again magnetized.

The other procedure is to stand the magnet on the magnetizer pole pieces with one or two steel blocks against each of its legs as shown in Fig. 2-E. The magnet (or assembly) is then magnetized three times: first, with both pairs of blocks in place; second, with blocks (a) removed; and third, with blocks (b) also removed.

For a complete discussion of how to magnetize permanent magnets by the electro-magnetic method, write for a copy of *Applied Magnetics*, Vol. 2, No. 3.

Chesterfield?

Cigarette manufacturers invest a great deal of time and money to bring you the best smoke possible.

Chesterfield is no exception . . and strangely enough, behind some of their recent efforts is an Indiana Permanent Magnet. You've probably read dozens of ads which say, "Chesterfield . . made the modern way . . with AccuRay."

AccuRay is a machine, made by Industrial Nucleonics Corp., that checks and controls the making of Chesterfields. One of the basic parts of this machine is a contact meter-relay, manufacturcd by Assembly Products, Inc. And the heart of this relay is an Indiana Hyflux Alnico V magnet!

Report on Indox I Ceramic Permanent Magnets

This recently published four-page technical bulletin, "Indox I Ceramic Permanent Magnets," suggests factors to be considered during design calculations, and discusses possibilities for new applications or improvements of existing ones.

Also discussed are some 30 representative sizes and shapes available in sample quantities for immediate shipment. Ask for price list and Catalog 15-N-1.

THE INDIANA STEEL PRODUCTS COMPANY
Valparaiso, Indiana

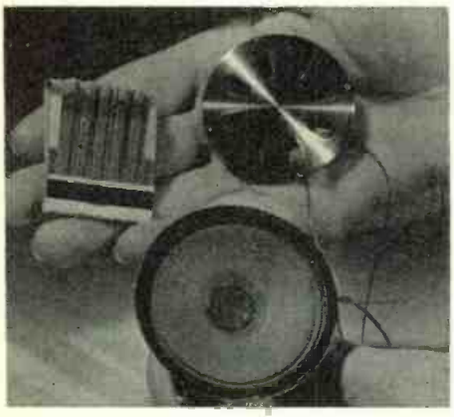
WORLD'S LARGEST MANUFACTURER OF PERMANENT MAGNETS

INDIANA PERMANENT MAGNETS

As We Go To Press . . . (Continued)

Smallest Loudspeaker Designed by RCA Labs

The smallest loudspeaker ever built for commercial radio receivers has been designed by scientists of the Radio Corp. of America for use in transistorized pocket-size radios. The miniature unit is only 2⅛ in.



Pint-size speaker for pocket-size radio

in diameter and little over ½ in. thick.

Extreme savings in size and weight have been achieved by placing the magnetic structure within the shell which surrounds the speaker's vibrating cone.

New Industrial TV Uses Phone Lines

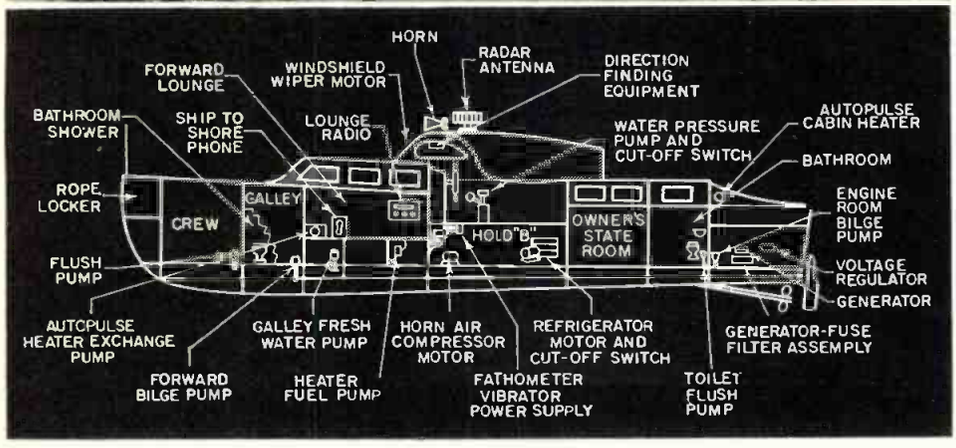
A new slow-scan industrial TV system that uses ordinary telephone lines rather than coaxial cable, was displayed recently in Phila. by the Bell Telephone Co. of Pennsylvania. Developed by Dage TV Div. of Thompson Products Inc., the new system, called "Data-Vision," will be offered, complete with transmission lines, as a service in metropolitan areas, on circuits up to 25 mi.

New Production Process For Low Noise Records

A new process developed by Custom Records, Inc., N. Y., N. Y. for commercial production of high quality records enables the mass-production on a commercial scale of records with playback quality that closely resembles the hi-fi performance of the original master record. Record noises, heretofore lacking in original masters, but present in all commercial discs, may soon become a thing of the past. Consequently, the public can look forward to hi-fi record quality on a mass-production basis.

MARINE MARKET

With interest in private boating reaching an all-time high Cornell-Dubilier is making available a full line of vibrator converters and filters to handle all shipboard needs. C-D pres. Octave Blake's "Gypsy III" was outfitted with a full complement to demonstrate their efficiency. Diagram below itemizes electric equipment that is filtered or vibrator converter powered.



Zworykin Color TV Award Received by Frank Bingley

Frank J. Bingley, Executive Engineer of Philco Research Laboratories, has been awarded the 1956 Vladimir K. Zworykin TV Prize for outstanding contributions to the development of color television, according to word received from the IRE.

Philco's Frank J. Bingley

Mr. Bingley received the award for his study of the relationship between the science of colorimetry and the compatible color television signal developed by the National TV System Committee and approved by the FCC.

New "Pile" Type Battery Gives More Output Per Lb.

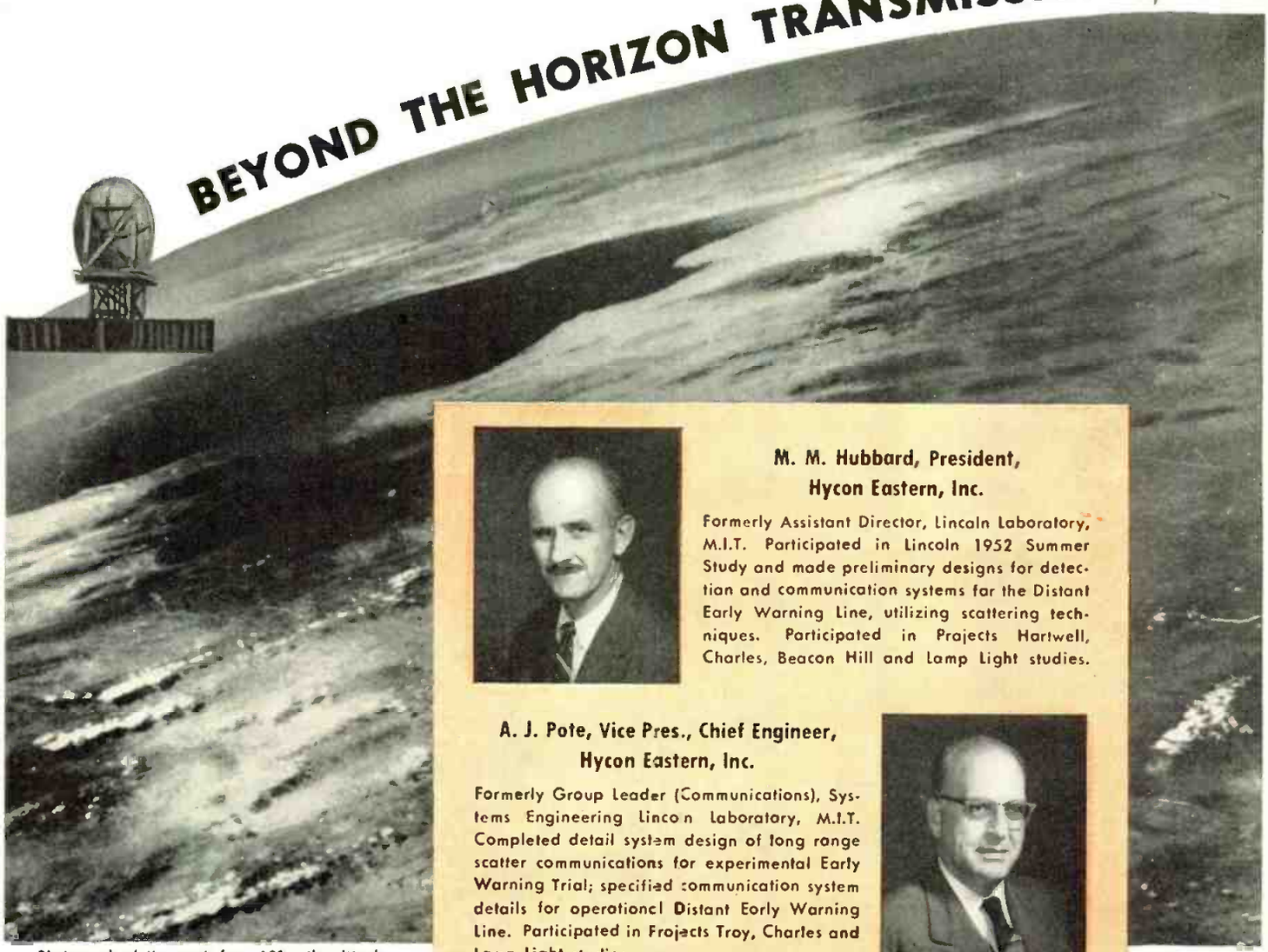
Announced recently by Air Research and Development Command HQ is a new silver oxide-zinc battery which employs a "pile" type construction, instead of the conventional plate type construction. Each cell is an individual battery which prevents inter-cell action due to contact between cells through the electrolyte. In a dry charged condition, the batteries are capable of shelf storage for months.

Designs have been constructed in sizes of 0.1, 3.0, and 12.0 ampere hrs. The latter size shows a yield of over 70 ampere hrs./lb. and 5 watt-hrs./cu. in.

Designed by the Raleigh (N.C.) Engineering Labs of American Machine & Foundry Co. under contract with the Air Research and Development Command, the units will be used for powering special electronic equipment.

MORE NEWS ON PAGE 23

BEYOND THE HORIZON TRANSMISSION



Photograph of the earth from 100 mile altitude — Courtesy U. S. Air Force

M. M. Hubbard, President, Hycon Eastern, Inc.

Formerly Assistant Director, Lincoln Laboratory, M.I.T. Participated in Lincoln 1952 Summer Study and made preliminary designs for detection and communication systems for the Distant Early Warning Line, utilizing scattering techniques. Participated in Projects Hartwell, Charles, Beacon Hill and Lamp Light studies.

A. J. Pote, Vice Pres., Chief Engineer, Hycon Eastern, Inc.

Formerly Group Leader (Communications), Systems Engineering Lincoln Laboratory, M.I.T. Completed detail system design of long range scatter communications for experimental Early Warning Trial; specified communication system details for operational Distant Early Warning Line. Participated in Projects Troy, Charles and Lamp Light studies.

A TECHNOLOGICAL BREAKTHROUGH

Not since the end of the 19th century when Marconi signalled a few miles over a radio circuit has any development in the field of communications had the far-reaching significance of ionospheric and tropospheric "Scatter" transmission . . . "Beyond the Horizon" circuits. Signals as far as several hundred miles beyond the horizon exhibit properties which make possible in long distance radio circuits, for the first time, degrees of reliability equal to or better than wire circuits afford.

EXPERIENCE IN A NEW FIELD

To successfully exploit this new technique in practical applications, fundamental knowledge and experience is imperative. The Communications Engineering Team at Hycon Eastern, Inc. has had precisely this experience working with experimental and operational circuits and in the planning of complete communications systems.

HYCON EASTERN OFFERS AN INTEGRATED SERVICE

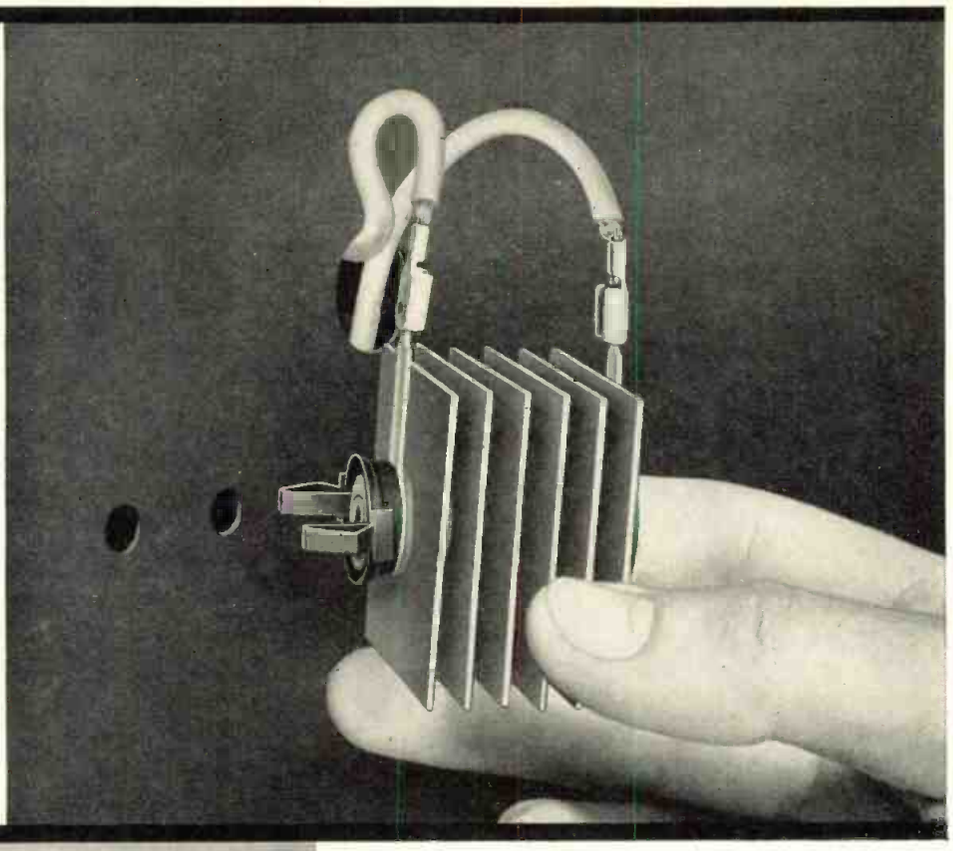
Within the areas of Hycon Eastern, Inc. and its associates, Hycon Manufacturing Company and Hycon Aerial Surveys, Inc. can be found complete facilities not only to design, engineer and specify equipment for Beyond the Horizon Transmission Systems, but to design Central Offices, Connecting Wire Networks, perform Communication Traffic Density Surveys, Aerial Surveys and Mapping to determine the most efficient routes for land lines and for various radio links such as UHF/SHF line of sight. After the necessary facts have been gathered there further exists the experience to evaluate them and to specify practical equipment with complete independence of judgment necessary to create a complete communications system capable of fulfilling present and projected needs.

A COMPLETE FACILITY FOR DESIGN OF INTEGRATED COMMUNICATIONS SYSTEMS

HYCON EASTERN, INC.

75 CAMBRIDGE PARKWAY • DEPT. E, CAMBRIDGE 42 • MASSACHUSETTS

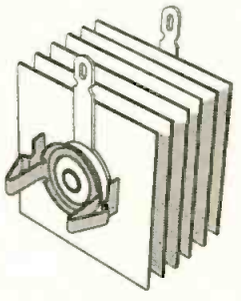
Radio Receptor's NEW money saving rectifier mounting!



"QUI-KLIP" *snap-in type* SELENIUM RECTIFIERS

QUICK MOUNTING! QUICK REMOVAL!

Spring steel clips with safe edges snap into two round, large tolerance holes in chassis (approx 3/16" dia., 3/4" c. to c.). Solderless connectors as shown, when used, simplify servicing



Radio Receptor's unique QUI-KLIP rectifiers will soon make their debut in TV sets produced by one of the country's leading manufacturers, saving them countless dollars in production costs.

QUI-KLIP requires no tools or sockets for mounting. There are no studs to break or threads to strip and the locating tab is now unnecessary. QUI-KLIP provides a positive seat for the rectifier – no rocking. Yet any serviceman can remove the stack quickly by squeezing the QUI-KLIP prongs with his fingers and removing the solderless connectors.

Let us show you how to put the cost saving QUI-KLIP selenium rectifiers to work in *your* production . . . Available in most popular sizes with cells from 1" square to 2" square, for radio, TV and other electronic circuits. For detailed information, write Dept. T-9.

- Speeds assembly time.
- Slashes production costs.
- Simplifies assembly.
- Eliminates stud rejects (No studs or nuts needed.)
- Permits easier replacement in the field.

Really RR Reliable

Semiconductor Division

RADIO RECEPTOR COMPANY, INC.

In Radio and Electronics Since 1922

SALES OFFICES: 251 WEST 19TH ST., NEW YORK 11, N. Y., WAtkins 4-3633 • Factories in Brooklyn, N. Y.

SELENIUM RECTIFIERS, THERMATRON DIELECTRIC HEATING GENERATORS AND PRESSES, COMMUNICATION, RADAR AND NAVIGATION EQUIPMENT

El-Menco Capacitors

If it depends on El-Menco Dur-Mica capacitors, it can run from 12 to 15 years with average use!

Not 1,000—but 6,000 or more hours of accelerated testing.

In rigid life tests in which the applied voltage was 1½ times rated voltage and the ambient temperature was 125° centigrade, El-Menco DM-15, DM-20 and DM-30 capacitors out-distanced all normal ratings with each lasting over *6,000 hours* at 125° centigrade. Because of the acceleration of these tests the life of these capacitors may be equivalent to 12 to 15 years or more under normal operating conditions.

For television, guided missiles, hearing aids, computors, miniaturized printed circuitry, electronic brains, and other civilian or military applications . . . test the life-long potentialities of long-life El-Menco capacitors.

El-Menco Dur-Mica DM-15, DM-20 and DM-30 Dipped Mica Capacitors offer:

1. LONGER LIFE
2. EXCELLENT STABILITY—SILVERED MICA
3. POTENT POWER
4. SMALLER SIZE
5. PEAK PERFORMANCE

Made To Meet Government and Civilian Requirements

For your special requirements — we are pleased to offer information and assistance. Write for free samples and catalog on your firm's letterhead.

El-Menco Capacitors

THE ELECTRO-MOTIVE MFG. CO., INC.

WILLIMANTIC, CONNECTICUT

• molded mica • mica trimmer
• tubular paper • ceramic

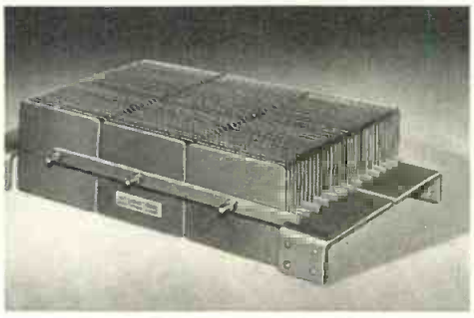
Arco Electronics, Inc., 103 Lafayette St., New York, N. Y.
Exclusive Supplier To Jobbers and Dealers in the U.S. and Canada

International Rectifier

Selenium and Germanium Rectifiers

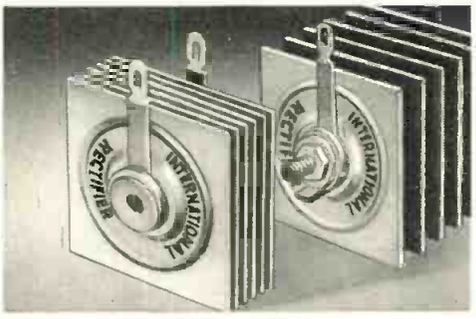
International Selenium Products

Pressed powder or vacuum process used as determined by our Applications Engineering Dept. The most widely used Industrial Power Rectifiers in Industry today!



INDUSTRIAL POWER RECTIFIERS

For all DC power needs from microwatts to kilowatts. Features: long life; compact, light weight and low initial cost. Ratings: to 250 KW, 50 ma to 2,300 amperes and up. 6 volts to 30,000 volts and up. Efficiency to 87%. Power factor to 95%. **Bulletin C-349**

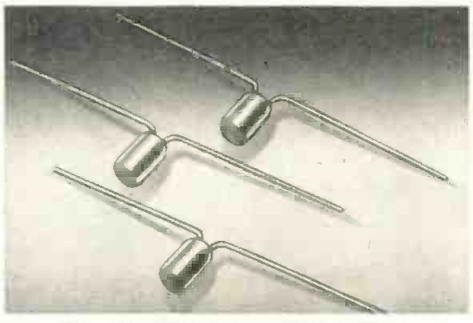


TV AND RADIO RECTIFIERS

The widest range in the industry! Designed for Radio, Television, TV booster, UHF converter and experimental applications. Input ratings from 25 to 195 volts AC and up. DC output current 10 to 1,200 MA. Write for application information. **Bulletin ER-178-A**

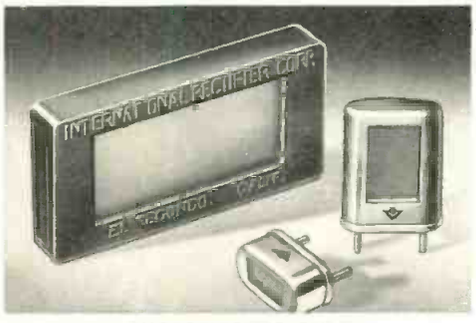
HIGH VOLTAGE CARTRIDGE RECTIFIERS

Designed for long life and reliability in Half-Wave, Voltage Doubler, Bridge, Center-Tap Circuits, and 3-Phase Circuit Types. Phenolic Cartridge and Hermetically Sealed types available. Operating temperature range: −65°C to +100°C. Specify **Bulletin H-2**



SUB-MINIATURE SELENIUM DIODES

Developed for use in limited space at ambient temperatures ranging from −50°C to +100°C. Encapsulated to resist adverse environmental conditions. Output voltages from 20 to 160 volts; output currents of 100 microamperes to 11 MA. **Bulletin SD-1B**



PHOTOELECTRIC CELLS

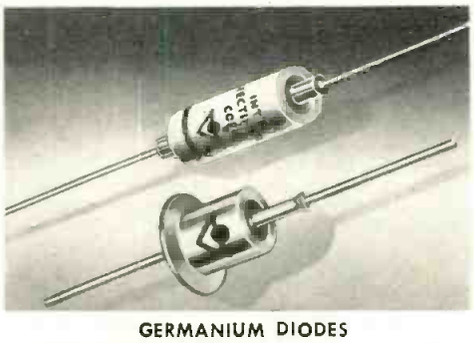
Self-generating photocells available in standard or custom sizes, mounted or unmounted. Optimum load resistance range: 10 to 10,000 ohms. Output from .2 MA to 60 MA in ave. sunlight. Ambient temperature range: −65°C to +100°C. **Bulletin PC 649**

International Germanium Products

High quality units of improved design are the results of years of experience in the production of exceptionally fine germanium crystals plus extensive research, development and field performance testing!

GERMANIUM POWER RECTIFIERS

This new line features: High efficiency—up to 97%, Lowest forward drop, High reverse to forward current ratio, unlimited life expectancy. No reforming required after storage. Ratings: 26 to 66 AC input v. per junction: 150 to 100,000 amps DC output. Operating temperature range: −55°C to +75°C. In three styles. **Bulletin GPR-1**



GERMANIUM DIODES

POINT CONTACT. High quality crystals—long reliable life—superior resistance to humidity, shock, temp.-cycling. **Bulletin GD-2**
JUNCTION POWER. Hermetically sealed—welded construction. Available in Standard JETEC 1N91, 1N92, 1N93 types. For diodes to meet your specific requirements, consult our Semiconductor Division.

a world of difference through research!

For bulletins on products described WRITE ON YOUR LETTERHEAD *to our* PRODUCT INFORMATION DEPARTMENT

International Rectifier

CORPORATION

EXECUTIVE OFFICES: 1521 E. GRAND AVE., EL SEGUNDO, CALIFORNIA • PHONE OREGON 8-6281

WORLD'S LARGEST SUPPLIER OF INDUSTRIAL METALLIC RECTIFIERS

Power Meter Model P-12
DC to 11,000 mc

MICRO POWER METER DC to 11,000 mc

- simplified operation
- linear and dbm scale
- only one probe
- self-calibrating

Over the entire frequency range DC to 11,000 MC, Polarad's new Micro Power Meter utilizes only one power probe, supplied as an integral part of the instrument. This unique power probe will sustain severe overloads without burnout since it does not contain hot wire barreters or other delicate components.

This new rugged and stable instrument reduces microwave power readings to the simplicity of everyday low frequency measurements. It is a true rms milliwatt indicating meter accurately measuring CW and pulse power, in milliwatts and dbm. Insensitive to line voltage changes.

Because of its wide band coverage, the Polarad Model P-2 is outstanding as a general lab and field instrument, available for power measurements at all commonly used frequencies. The P-2 can be completely calibrated from its own self-contained DC source. Price: $360

Features and Specifications:

- Single power probe for all frequencies.
- 150% overload without burnout.
- Direct reading.
- Broadband Coverage ..... DC to 11,000 mc continuous in single mount.
- Multi-Power Range ..... 0-1 mw, 0-10 mw, 0-100 mw. 0 dbm, + 10 dbm, + 20 dbm.
- Impedance ..... 50 ohms coaxial.
- VSWR ..... Less than 1.4:1 from 0 to 5000 mc. Less than 2:1 from 5000 to 11,000 mc.
- Accuracy ..... ± 1.0 db.
- Connector ..... Type N plug.
- Input Power Required ..... 115v ±10%, 60 cps.
- Dimensions ..... 10" x 8" x 8".
- Weight ..... 14 lbs.

KLYSTRON TUBE TESTER

tests all klystron tubes

Model K-100
Klystron Tube Tester

Now, for the first time, you can test all commercially available klystron tubes, built-in cavity types as well as those requiring external cavities, just as easily as you make tests on vacuum tubes.

Polarad's new Model K-100 Klystron Tube Tester provides complete metering facilities and control adjustments with a tube data chart to determine settings. Safety features protect personnel at all times when testing tubes requiring high voltages.

AVAILABLE ON EQUIPMENT LEASE PLAN

FIELD MAINTENANCE SERVICE AVAILABLE THROUGHOUT THE COUNTRY

Features:

Performs the following basic tests:

a. Filament continuity.
b. Short circuit tests between all elements.
c. Static d-c tests—measurement of rated d-c currents and voltages.
d. Life test—relation of cathode current versus reduced filament voltages.
e. Dynamic test—provision is made for external modulation so that klystron tubes may be dynamically tested with external r-f measuring equipment.

- Special adapter mount for all commercial types of klystrons.
- Safety features protect personnel during tests.
- Protective devices prevent misadjustment and save tubes from accidental burnout.
- Built-in heavy duty blower provides forced air cooling of the klystron tubes.
- Tester designed to be adapted for future tubes.
- Built-in Universal Power Supply may be used for klystron testing purposes outside the instrument.

POLARAD
PROVEN RELIABILITY

ELECTRONICS CORPORATION
43-20 34th STREET
LONG ISLAND CITY 1, N. Y. • EXeter 2-4500

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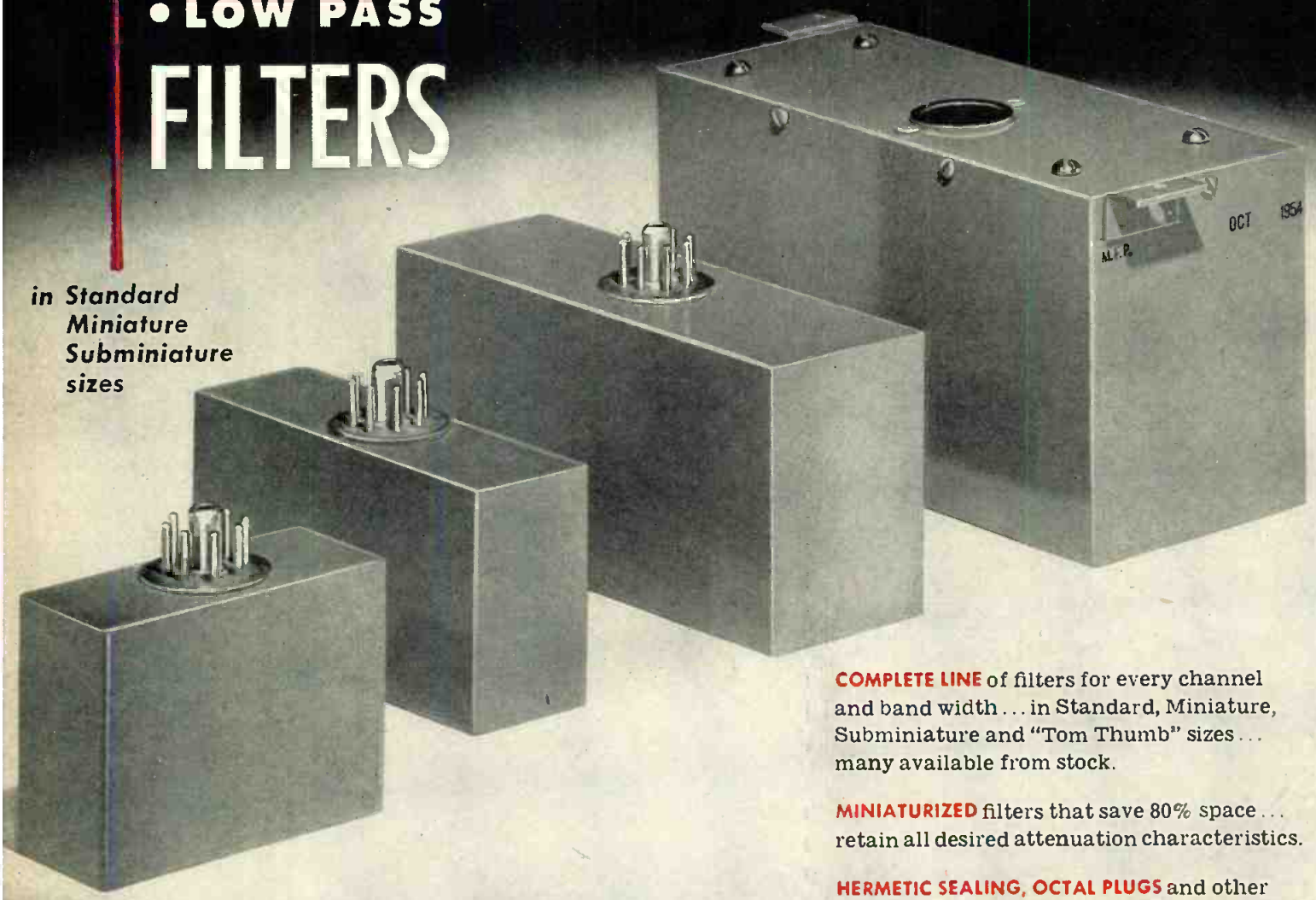
TELEMETERING

- **BAND PASS**
- **LOW PASS**

FILTERS

in Standard Miniature Subminiature sizes



COMPLETE LINE of filters for every channel and band width . . . in Standard, Miniature, Subminiature and "Tom Thumb" sizes . . . many available from stock.

MINIATURIZED filters that save 80% space . . . retain all desired attenuation characteristics.

HERMETIC SEALING, OCTAL PLUGS and other new features.

only Burnell offers you . . .

SPECIAL PHASE LINEARITY characteristics to conform to new concepts of high accuracy telemetering practice.

SPECIFICALLY DESIGNED for telemetering, these filters have found great utility in a wide variety of communications and control applications.

APPLICATION ENGINEERING service plus complete technical literature. Write Dept. G-1 for Catalog 103

PARTIAL LISTING OF MINIATURE TELEMETERING BAND PASS FILTERS

Channel Freq.	15% Band Width	30% Band Width	Case Size	Approx. Weight	Attenuation	
	Type No.	Type No.	W- L- H-		15% B. W.	30% B. W.
400 CPS. 560 " 730 " 960 "	S-15456 S-15457 S-15458 S-15459	S-15477 S-15478	2 x 6 x 2¾	3 lbs.	4DB — 15% 20DB — 23% 40DB — 27%	4DB — 30% 20DB — 46% 40DB — 54%
1300 " 1700 " 2300 "	S-15460 S-15461 S-15462		1⅜ x 4½ x 2¼	1 lb. 7 oz	3.5DB — 15% 20DB — 23% 40DB — 27%	3.5DB — 30% 20DB — 46% 40DB — 54%
2570 " 3000 " 3900 " 4500 " 5400 " 7350 " 10500 " 12300 " 14500 " 22000 " 27000 " 30000 " 40000 " 52500 " 70000 "	S-15463 S-15464 S-15465 S-15466 S-15467 S-15468 S-15469 S-15470 S-15471 S-15472 S-15473 S-15474 S-15475 S-15476	S-15479 S-15480 S-15481 S-15482 S- S-15483 S-15484 S-15485 S-15486 S-15487 S-15488	1⅜ x 3 x 2¼	9¾ oz.	3DB — 15% 20DB — 23% 40DB — 26%	3DB — 30% 20DB — 46% 40DB — 52%

OPTIMUM OPERATING IMPEDANCES — SOCKET TERMINAL CONNECTIONS

INPUT		OUTPUT	
Terminals 1 & 2	500 ohms	Terminals 1 & 6	500 ohms
Terminals 1 & 3	10000 ohms	Terminals 1 & 7	50000 ohms

Teletype: Yonkers, N. Y. 3633

BURNELL & CO., INC.
YONKERS 2, NEW YORK

Pacific Division: 720 Mission St., S. Pasadena, Calif.

FIRST IN TOROIDS, FILTERS AND RELATED NETWORKS

RECTIFIER AWARD

Harry J. Kayner, (second from left) receives award from Dr. Lee De Forest for his winning suggestion in International Rectifier Corp's "Selenium Diode Contest." Looking on are judges F. W. Parrish and J. T. Cataldo.

RTCA Elects Emerson Labs, Bell Aircraft as Members

Bell Aircraft Corp. and Emerson Labs, div. of Emerson Radio and Phonograph Corp., have been elected to membership in the Radio Technical Commission for Aeronautics. J. D. Shantz, Chief Electronics Engineer, will be Bell's delegate, and J. E. Harris will represent Emerson.

Conelrad Stations Receive Civil Defense Awards

The Federal Civil Defense administration has announced that 1,300 of the Nation's radio stations will receive special joint awards from FCDA, the Air Force, and the FCC "in recognition of public service to the people of the U.S. through participation in the Conelrad system of emergency broadcasting."

In announcing the awards, the FCDA also noted that the participating stations have voluntarily invested more than $2 million and an untold number of engineering man-hrs. to make and keep the system operative.

DO-IT-YOURSELF COMPUTER

New electronic analogue computer, by Heath Co., Div. of Daystrom Inc., demonstrated here by Miss G. Meiiott, sells for less than $750.

MORE NEWS on page 128

Coming Events

A listing of meetings, conferences, shows, etc., occurring during the period January through April 19, 1956 that are of special interest to electronic engineers

Jan. 9-10: 2nd National Symposium on Reliability and Quality Control in Electronics, sponsored by the Prof. Gp. on Reliability and Quality Control of IRE, co-sponsored by the American Society for Quality Control and RETMA.

Jan. 16-18: Conference on the Practical Utilization of Recorded Knowledge, at Western Reserve University, Cleveland, Ohio.

Jan. 18-20: Twelfth Annual National Technical Conference, SPE, at the Hotel Statler, Cleveland, Ohio.

Jan. 19-21: National Simulation Conference, sponsored by the Dallas Fort Worth Chapter of the IRE Prof. Gp. on Electronic Computers (PGEC), Dallas, Tex.

Jan. 23-26: Plant Maintenance and Engineering Conference, to be held concurrently with the Plant Maintenance and Engineering Show, at Convention Hall, Phila., Pa.

Jan. 30-Feb. 3: AIEE Winter General Meeting, Statler Hotel, New York, N.Y.

Feb. 2-3: Symposium on Microwave Theory and Techniques, Univ. of Pennsylvania, Phila., Pa.

Feb. 6-12: National Electrical Week, sponsored by NEMA.

Feb. 7-9: Eleventh Ann. SPI Reinforced Plastics Div. Conference, Hotel Chalfonte-Haddon Hall, Atlantic City, N.J.

Feb. 15-17: Conference on High-Speed Computers, at Louisiana State Univ., Baton Rouge, La.

Feb. 16-17: Conf. on Transistor Circuits, sponsored by the Prof. Gp. on Circuit Theory of IRE, and the Science and Electronics Div. of AIEE, at the Univ. of Pennsylvania, Phila., Pa.

Feb. 22-25: RETMA's 1956 Industrial Relations Round Table, Gen. Oglethorpe Hotel, Savannah, Ga.

Feb. 27-March 2: National Meeting of the ASTM, Committee Week at the Hotel Statler, Buffalo, New York.

Mar. 8-9: Fourteenth Ann. SPI Canadian Conference, Sheraton-Brock Hotel, Niagara Falls, Ontario, Canada.

Mar. 12-16: Corrosion Show, held in conjunction with the Twelfth Ann. Conference of the NACE, Hotel Statler, New York City.

Mar. 19-22: IRE National Convention and Radio Engineering Show, Waldorf-Astoria and Kingsbridge Armory, New York City.

April 5-6: Special Technical Conference on Magnetic Amplifiers, co-sponsored by: AIEE Committee on Magnetic Amplifiers, IRE PRO. Group on Industrial Electronics, ISA Central N.Y. Sec. Hotel Syracuse, Syracuse, N.Y.

April 10-12: Twelfth Annual Meeting and 1956 Metal Powder Show of the MPA, at the Hotel Cleveland, Cleveland, Ohio.

April 11-12: IRE 7th Region Technical Conference, Salt Lake City, Utah.

April 13-14: Tenth Annual Spring Television Conference, sponsored by Cincinnati Sec., IRE, 1349 E. McMillan St., Cincinnati, Ohio.

April 15-19; 34th annual convention of NARTB, Conrad Hilton Hotel, Chicago, Ill.

April 17-19: Fourth National Conference on Electromagnetic Relays, Oklahoma Inst. of Tech. Stillwater, Okla.

Abbreviations:

AIEE: American Institute of Electrical Engineers

ASTM: American Society for Testing Materials

IRE: Institute of Radio Engineers

ISA: Instrument Society of America

MPA: Metal Powder Association

NARTB: Nat'l. Assoc. of Radio and TV Broadcasters

NACE: National Assoc. Corrosion Engineers

NEMA: National Electrical Manufacturers Assoc.

RETMA: Radio-Electronics-TV Manufacturers Assoc.

SPI: Society of the Plastics Industry, Inc.

SPE: Society of Plastics Engineers

Electronic Industries News Briefs

Capsule summaries of important happenings in affairs of equipment and component manufacturers

AMERICAN ELECTRONICS, INC. has announced the formation of its Marketing Division to handle Sales, Sales Promotion and Publicity for all five divisions.

BART LABORATORIES CO., INC., Belleville, N.J., announced completion of a new plant to house precision precious metals plating facilities.

BERKELEY DIVISION of **BECKMAN INSTRUMENTS, INC.** has begun construction of its new $250,000 plant in Richmond, Calif.

BROWN CORP. announced an expansion program geared to a new branch plant to be opened this month in Sterling, Kan.

CAMERA EQUIPMENT COMPANY is consolidating all of its component branches under one roof at 315 West 43rd St., New York, N.Y.

CARBOLOY DEPT., GENERAL ELECTRIC COMPANY, Detroit, Mich., is now handling the manufacture and distribution of Thyrite Varistors, non-linear materials, for applications other than lightning protection.

CELAB ELECTRONIC PRODUCTS, Sacramento, Calif., has acquired manufacturing and sales rights relative to Celab Pressure Resistors, as component units, and Celab Pressure Resistance Materials from the Clark Electronic Laboratories.

CLEVITE AERO PRODUCTS, INC. is the new name for the Wallace Aviation Corp., Wallingford, Conn., recently acquired by Clevite Corporation.

COMPONENT CORPORATION, Denville, N.J., has been licensed by the Magnetic Shield Div. of Perfection Mica Co. for the production of magnetically shielded containers for tape recorders.

THE DAVEN COMPANY has opened their new plant at 530 Mt. Pleasant Ave., Livingston, N. J.

DESIGNERS FOR INDUSTRY, INC. is celebrating its 20th ann. by moving to enlarged, modern headquarters at 4510 Memphis Ave., Cleveland, Ohio.

DYNAMIC ELECTRONICS-NEW YORK INC., Forest Hills, L.I., N.Y., has been awarded two government contracts totaling $622,561.

ELECTRICAL TESTING LABORATORIES, INC. has announced the expansion of its electronic testing facilities and services. Of particular significance is its ability to conduct tests and engineering investigations well into the microwave regions.

ELECTRO-ACOUSTIC DIV. of TELEX, INC., St. Paul, Minn., has completed expansion of production facilities and reorganization of its sales dept.

EMERSON RADIO AND PHONOGRAPH CORPORATION, N.Y.C., has introduced its first tape recorder at a list price of $192.

ENTRON INCORPORATED, Bladensburg, Md., has appointed Electroline TV Equipment, Inc., of Montreal, as Entron distributor for Eastern Canada.

EPM CORP., with gen. offices at 675 Barbey St., Bkly'n. N.Y., is a newly-formed org. manufacturing thermosetting plastic bobbins, coil forms, rod and other custom fabricated insulating parts.

THE FORMICA COMPANY, Cincinnati, Ohio, announces that its Management Club has received the National Assoc. of Foremen's first annual "Management Team of the Year" award.

GENERAL ELECTRIC COMPANY has been awarded the largest single order ever placed for commercial two-way radio communication equipment by the U. S. Navy. The approx. $750,000. worth of standard two-way radios will be used at Naval Air Stations in the continental U. S.

THE HOOVER COMPANY, North Canton, Ohio, has purchased controlling interest in Phebco, Inc., Baltimore, Md., electronics firm.

HUGHES AIRCRAFT COMPANY has announced the establishment of the Hughes Products Division at 5330 West Century Blvd., Los Angeles, Calif.

INSTITUTE of HIGH FIDELITY MANUFACTURERS, INC. has announced the confirmation of two new members: Webster-Chicago Corp. and Gray Research & Development Co., Inc.

KLM and **ALITALIA** airlines have purchased airborne radar units for their fleets, from the Bendix Aviation Corporation.

KOLLSMAN INSTRUMENT CORP. announces that construction has begun on its new manufacturing plant in Syosset, L.I., N.Y.

LABORATORY FOR ELECTRONICS, INC., Boston, Mass., has delivered two SPAR precision approach radar systems to the U.S. Navy for use in "Operation Deepfreeze."

ARTHUR D. LITTLE, INC., consulting research firm of Cambridge, Mass., has opened a branch office at 1625 Eye St., N.W., Washington, D. C.

LITTON INDUSTRIES' POWER TUBE DIV., San Carlos, Calif., is planning construction of a 40,000 sq. ft. bld'g. early this year.

P. R. MALLORY & CO., INC. and **SCHWARZKOPF DEVELOPMENT CORP.** announce the formation of Mallory-Schwarzkopf Metals, Inc. A new plant is planned for Huntsville, Ala. with initial operations scheduled for late 1956.

NORTH AMERICAN PHILIPS CO., INC., Research & Control Instruments Div., has opened a West Coast office at 1485 Bayshore Blvd., San Francisco, Calif.

NRD INSTRUMENT COMPANY has greatly expanded offices and plant facilities at 6425 Etzel Ave., St. Louis, Mo.

RADIO CORPORATION of AMERICA is constructing a $2.7 million addition to the company's plant at Cambridge, Ohio.

RADIOMARINE CORPORATION of AMERICA recently moved its marine coastal radio station WSC, Tuckerton, N. J. into a new building, without any interruption of service.

THE RAMO-WOOLDRIDGE CORPORATION has acquired an additional 41 acres of land in the International Airport District of Los Angeles, Calif. The property will provide a land reserve for anticipated company growth.

RAYTHEON MANUFACTURING COMPANY has leased 65,000 sq. ft. of space in the former Assabet Mills of Maynard, Mass.

RC CONTROLS CORP., N. Hollywood, Calif., has acquired the Computer-Measurements Div. of Detectron Corp.

RDM, INC. will begin operation of its West Coast Div. plant this month.

SIGNAL CORPS. SUPPLY AGENCY, Philadelphia, Pa., announced that a study of the electronic component capabilities of West Coast electronics manufacturers and their importance in industrial preparedness is now being undertaken by Gershon Miller at the L.A. area office of the agency.

SPENCER - KENNEDY LABORATORIES, INC. has completed its move to 1320 Soldiers Field Rd., Boston, Mass.

STROMBERG-CARLSON DIV. OF GENERAL DYNAMICS CORP. has broken ground for a new Administration and Research Bldg. at Rochester, N.Y.

SYLVANIA ELECTRIC PRODUCTS INC. has announced plans for a new 76,000 sq. ft. warehouse and sales office in Atlanta, Ga.

TEXAS INSTRUMENTS INC. has opened an Eastern District Sales Office at 500 Fifth Ave., New York, N.Y.

USAF AIR WEATHER SERVICE, Washington, D. C., is planning to move its Severe Weather Warning center from Oklahoma City, Okla. to Kansas City, Mo.

VARIAN ASSOCIATES, Palo Alto, Calif., has gone international, with the formal dedication of a new manufacturing and research plant in Georgetown, Ontario, Canada.

WESTINGHOUSE ELECTRIC CORPORATION has announced the formation of a new department in Baltimore, Md., for the manufacture of a line of industrial electronics products.

STROBOTAC® and Variac® MOTOR SPEED CONTROL

Team up at BULOVA Research Laboratories

The wearing qualities of journal bearings with nylon sleeves are being tested by an engineer of the Bulova Research Laboratories. These measurements are performed under different load conditions and with various shaft materials to determine bearing heating, wear and failure. Since speed is an important factor on which these characteristics are dependent, it is essential that speed be controlled accurately. The motor actuator must be capable of providing the widest range of speeds and, once set, the speed must not vary. There must be no torque pulsations to affect measurements adversely.

Photo Courtesy of Bulova Research Labora

In the G-R Variac Motor Speed Control, the Bulova engineer has a motor drive which easily meets these specifications and provides much more in addition. This device plugs into ordinary 115-v or 230-v lines, converts this power to dc, and makes available all the advantages of d-c motor operation.

Infinite Speed Control, inherent in the design, permits setting at *any* speed from a few rpm to rated speed. *Dynamic Braking* enables *instant* stopping and reversing, permitting the engineer to study the effects of sudden speed changes on bearing life. *Overload Protection* prevents motor burnout when the bearings "seize". *Selenium Rectifiers* for a-c rectification (there are no electron tubes) require no warm-up time and make the Variac Motor Speed Control rugged and dependable in operation. Finally, regulation is good and speed control is smooth; there is no "chattering" even at the very low speeds.

Variac Motor Speed Controls are time-tested, highly recommended motor drives available in six ratings from 1/15 to 1½ hp. Prices from $75 to $380 (motors at extra cost). All models come complete and ready for installation by any electrician. The basic elements can be provided in stripped-down form at even lower cost for the manufacturer who wishes to build this versatile Control into his own product or equipment.

The G-R Strobotac is used in these journal-bearing measurements as a stroboscopic tachometer for the accurate measurement of speed. Speed must be known in order to correlate bearing wear with shaft travel. The advantages of stroboscopic light for measuring speeds of rotating, reciprocating, vibrating, and other cyclic movements are well established. There is maximum ease and rapidity of measurement. Since there is no physical connection between Strobotac and the moving object under test, no drag is imposed on the subject. Portability, a built-in calibration system, and operation from ordinary 115-v, 60-cycle power have all contributed to make this device an invaluable industrial tool.

In addition to its ability to measure cyclic speeds from 60 to 100,000 rpm, the Strobotac makes possible the visual observation of rapidly moving parts and mechanisms as if they were operating in s-l-o-w motion. Misalignments, worn or broken parts, slipping gears and other mechanical defects which are impossible to see with the unaided eye while they are in motion, are readily observed under stroboscopic light.

Where there are moving mechanisms or repetitive operations of any kind, there's a need for the Strobotac. Price is only $150.

WE SELL DIRECT, Prices are Net, FOB Cambridge or West Concord, Massachusetts

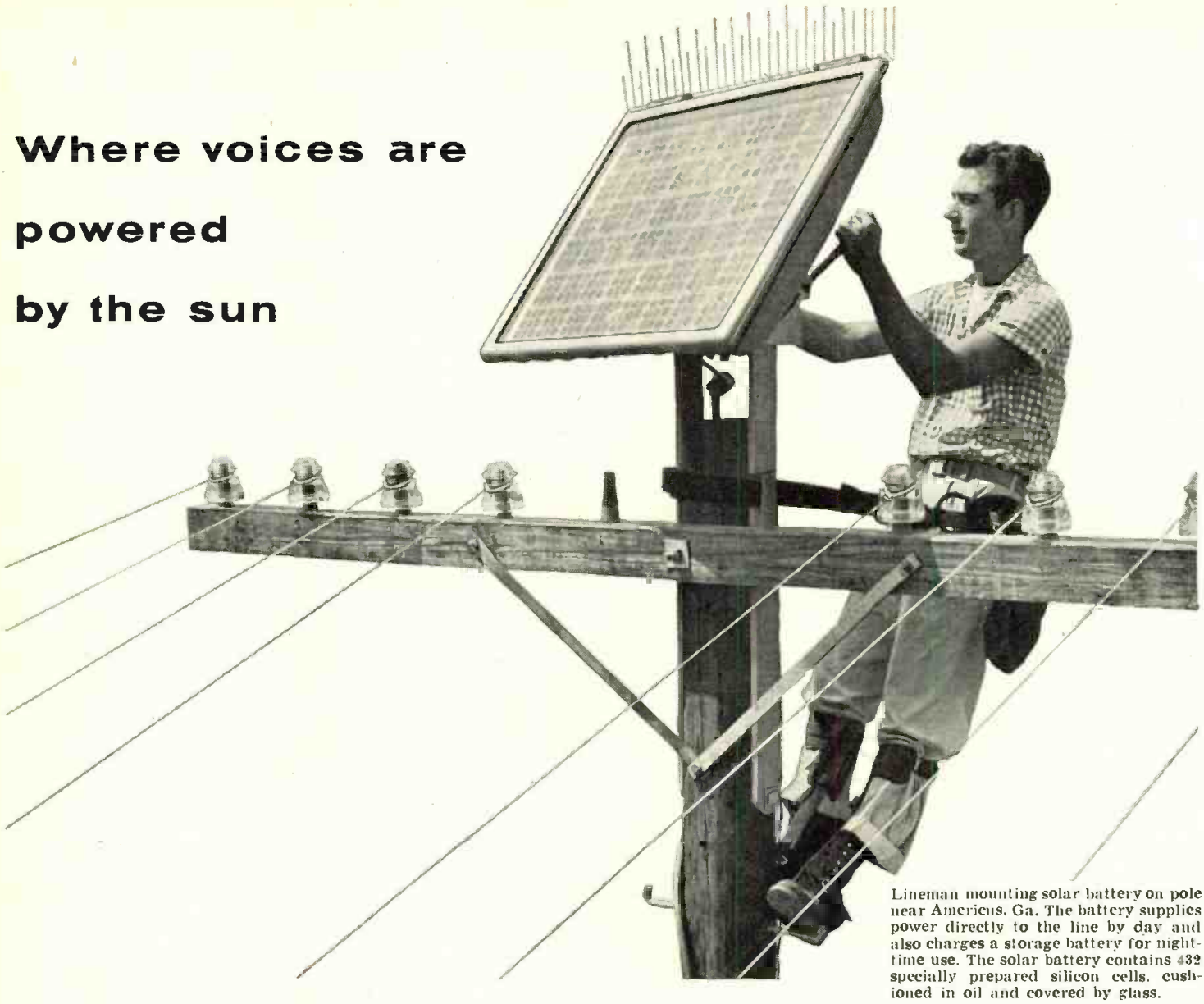
GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Massachusetts, U.S.A.

90 West Street **NEW YORK 6** • 8055 13th St., Silver Spring, Md. **WASHINGTON, D. C.**
1150 York Road, Abington, Pa. **PHILADELPHIA**
920 S. Michigan Ave. **CHICAGO 5** • 1000 N. Seward St. **LOS ANGELES 38**

STROBOTAC and Variac Speed Control
Bulletins Sent On Request . . . For Complete Descriptions, Specifications and Prices

Where voices are powered by the sun

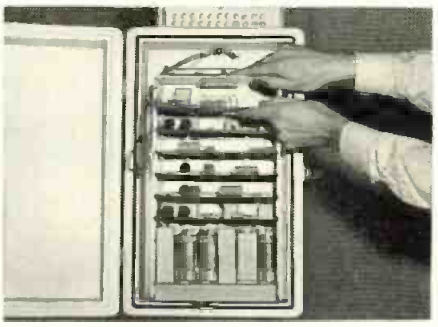


Lineman mounting solar battery on pole near Americus, Ga. The battery supplies power directly to the line by day and also charges a storage battery for night-time use. The solar battery contains 432 specially prepared silicon cells, cushioned in oil and covered by glass.

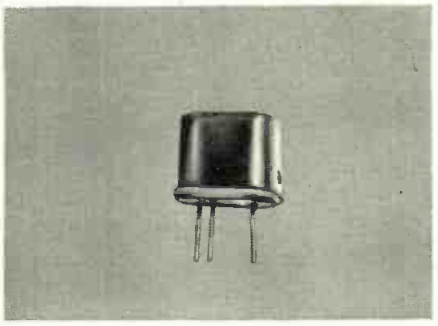
A new kind of telephone system developed by Bell Telephone Laboratories for rural areas is being operated experimentally by electric current derived from sunlight. Electric current is generated as sunlight falls on the Bell Solar Battery, which a lineman is seen adjusting in position.

The exciting achievement is made possible by two Laboratories inventions—the solar battery and the transistor. The new system uses transistors to the complete exclusion of electron tubes. Transistors require little power and this power can be easily supplied by the solar battery.

Compact and economical, the transistorized system can carry several voices simultaneously without interference. It has proved its ruggedness by standing up to heat, cold, rain and lightning. It promises more and improved telephone service for rural areas and it typifies the Laboratories' continuing efforts to make American telephony still better each year.



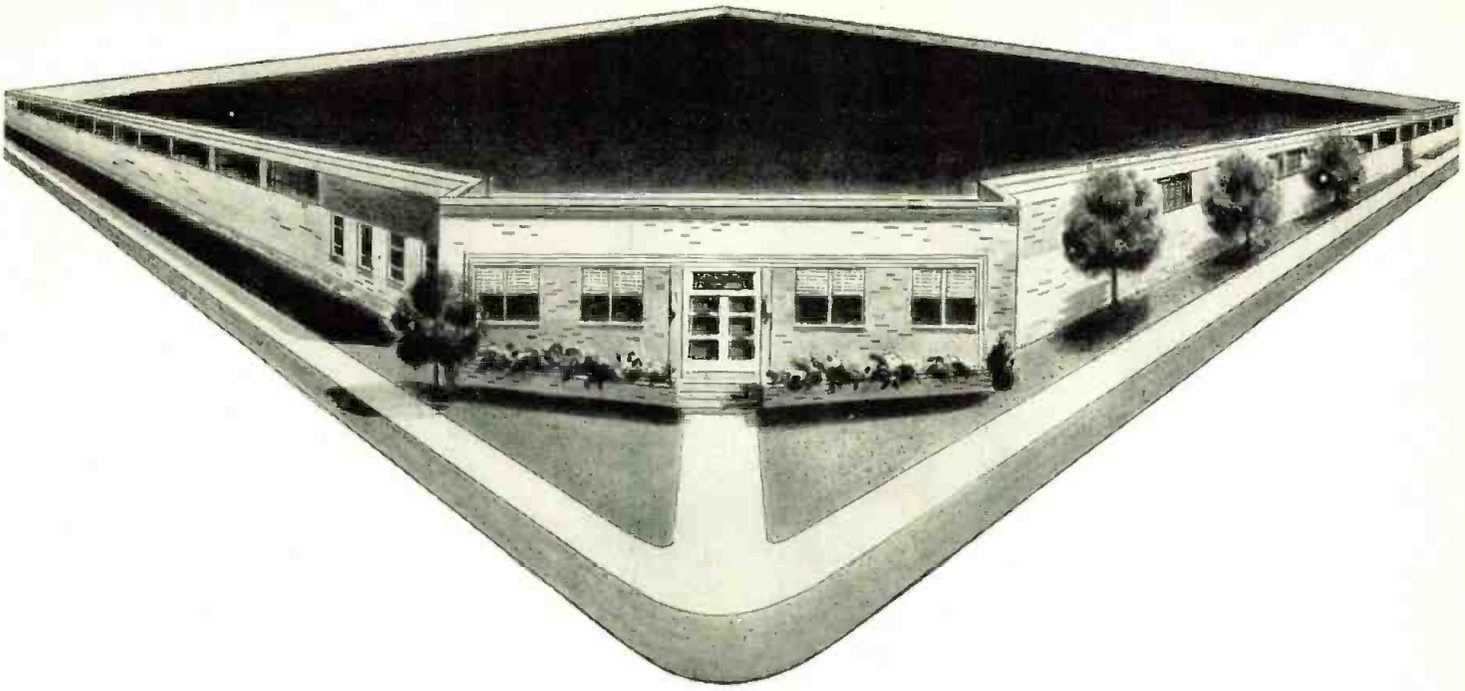
In sending and receiving terminals, transistors are used as oscillators, amplifiers and regulators, and for signaling.



One of the transistors (actual size) used in the new system. New ideas, new tools, new equipment and new methods had to be developed for this project.

BELL TELEPHONE LABORATORIES

IMPROVING AMERICA'S TELEPHONE SERVICE PROVIDES CAREERS
FOR CREATIVE MEN IN SCIENTIFIC AND TECHNICAL FIELDS



here's what's behind the  crystal that's so far ahead

The Midland Factory shown above is the world's largest plant devoted exclusively to producing crystals for frequency control. It is equipped with the finest and most complete production and testing machinery ever developed for this purpose. Here Midland pioneered development of crystals for color television, and is now ready for full-scale production.

All this is important to you for just one good reason: Every Midland crystal you use has been produced by such advanced techniques and under such rigid quality controls that you can be sure it will prove its completely reliable quality under every operating stress.

Midland Critical Quality Control extends through every step of crystal production, and includes precise angular control by X-ray. Uniform accuracy is maintained to the millionth part of an inch.

Whatever your Crystal need, conventional or highly specialized,
When it has to be exactly right, contact

Midland MANUFACTURING COMPANY, INC.

3155 Fiberglas Road, Kansas City, Kansas

WORLD'S LARGEST PRODUCER OF QUARTZ CRYSTALS

Leaders in Electronics rely on Good-All Capacitors

. . . whether for a critical fraction of a second or for a long life of trouble-free performance. Our technical and production people gain real satisfaction from working out capacitor problems with design and component engineers. The confidence of these engineers in Good-All "know-how" has contributed greatly to our rapid growth in the industry

Our engineers are ready to work with you on special applications. Write, wire or phone for specifications and quotations.

MIL TYPES

Good-All produces a broad line of hermetically sealed tubular and bathtub capacitors to specifications MIL-C-25A. Custom designs of various metal enclosed styles can also be provided to your individual specifications.

MYLAR TYPES

The space-saving size and extremely high IR of Good-All Mylar* types are ideal for many special purpose applications. These are available in several metal enclosed designs as well as in ceramic or plastic impregnated tubes.

*DuPont's trademark for polyester film.

GOOD-ALL ELECTRIC MFG. CO. Goodall Bldg. • OGALLALA, NEBRASKA

TELE-TIPS

ABLE BAKER CHARLIE is on the way out. When many of the words were found hard to handle for other languages, the International Civil Aviation Organization turned the problem over to speech specialists. After nearly 7 yrs. of study and experimentation they have finalized on this new alphabet: Alfa, Bravo, Charlie, Delta, Echo, Foxtrot, Golf, Hotel, India, Juliett, Kilo, Lima, Mike, November, Oscar, Papa, Quebec, Romeo, Sierra, Tango, Uniform, Victor, Whiskey, X-Ray, Yankee, Zulu.

THE 21-IN. SCREEN SIZE has taken over the market, reports the American Research Bureau. Latest figures show that 47.6% of the nation's sets boast the big screens. Runner-up is the 16-18 in. size at 34.8%.

FIRST GUIDED MISSILE CRUISER, the USS Boston, whose main armament will be four launching racks for "Terrier" anti-aircraft missiles, will also have an amplified master TV antenna system capable of picking up all VHF as well as several UHF stations. Jerrold Electronics is doing the job.

FCC FIELD ENGINEERS run into some strange happenings in the course of patrolling the radio spectrum. A few of the more interesting experiences are described in the following case histories from the commission's files.

The scene was **Arizona**, and the culprit an unlicensed TV transmitter. A "fix" on the transmitter's location placed it atop a neighboring 9,000 ft. peak. Then the fun started. Laden with their mobile gear, the field engineers started up the mountain. At the 6,500 ft. level they had to transfer to a four-wheel-drive jeep. Conditions worsened, and 3½ miles from the peak, the jeep finally bogged down in the heavy snow. The investigators continued on foot. Two and-a-half weary hours later, they finally reached the peak. There they found their quarry—an unattended transmitter, which was being operated by remote control from an appliance store in the valley.

(*Continued on page* 34)

Pat. Pending

International's new TR*

electron tube shields make JAN shields obsolete!

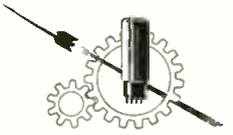
IERC's *Temperature Rated shields provide complete electrostatic shielding and effective cooling of electron tubes to within the manufacturer's recommended operational temperature ratings for longest tube life and dependability. TR heat-dissipating shields are available for direct replacement of JAN shields and fit standard JAN sockets.

Lower tube operating temperatures—to 50% less than that of a JAN-shielded tube—are obtained with TR shields. Complete electrostatic shielding and vibration dampening features combine with effective cooling to make TRs the answer to a major airline's problem with premature tube failures caused by excessive bulb temperatures! TRs, available now, are the first heat-dissipating tube shields ideally suited for retrofitting existing military, aviation, communication, computer and commercial electronic equipment from JAN types to the modern TR shield—or for new equipment applications.

CHANGE FOR THE BETTER—from JAN types to TRs is a simple step! TRs fit standard JAN 7 and 9 pin miniature sockets like the TS102P01, TS103P01, etc. Patented liner provides practical vibration control and more shield-to-tube contact for efficient heat dissipation.

For complete information write for "TR" technical bulletin.

International

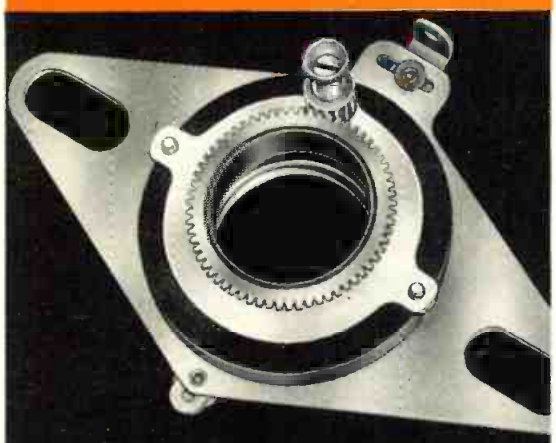


electronic research corporation

177 WEST MAGNOLIA BOULEVARD • BURBANK, CALIFORNIA

There is an IERC heat-dissipating tube shield for every type of miniature, subminiature, octal and power tube.

speaking of TV Quality...
HERE'S HOW TO GET MORE
at LESS COST!



A Stackpole Ceramagnet ring 3⅛" in diameter by ½" thick forms the "heart" of this efficient, magnetic focusing unit produced by Glaser-Steers Corporation, Belleville, N. J. The entire unit weighs less than 13 ounces. Quick, accurate focusing is obtained with simplified gear arrangement.

FROM A COST STANDPOINT, magnetic focusing of television picture tubes paves the way to important cost savings by comparison with electrostatic tube focusing methods. In actual instances, material savings alone have run from 50c to $1.

FROM A DESIGN STANDPOINT, magnetic focusing lends itself well to the trend toward increased second anode voltages.

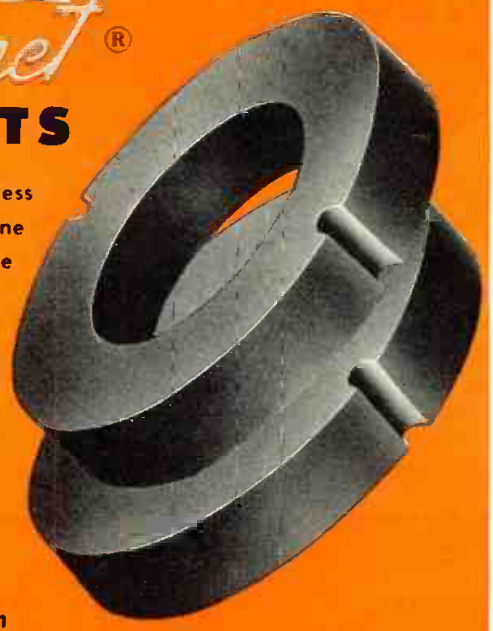
FROM A PRODUCTION STANDPOINT, the predictable higher quality of magnetic tubes reduces incoming inspection costs. Factory focusing of sets is done in less time with less skilled labor.

FROM A PERFORMANCE STANDPOINT, magnetic focusing quality is generally superior, more stable, and more effective over the entire face of large tubes. Focusing is less affected by voltage changes. When tube replacement becomes necessary, servicing adjustment is a relatively simple matter.

STACKPOLE Ceramagnet®
CERAMIC MAGNETS

Magnetic picture tube focusing is but one of countless jobs, both electrical and mechanical, that can be done better and at less cost with this unique new Stackpole ceramic magnetic material.

Ceramagnet is highly uniform, powerful and permanent. Available in almost any shape or size, it opens important new engineering horizons wherever dependable, low cost magnetic attraction, repelling or even "cushioning" may be utilized.

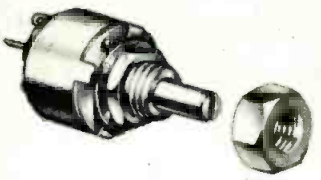


Send details of your application for recommendations and Ceramagnet samples.

Electronic Components Division

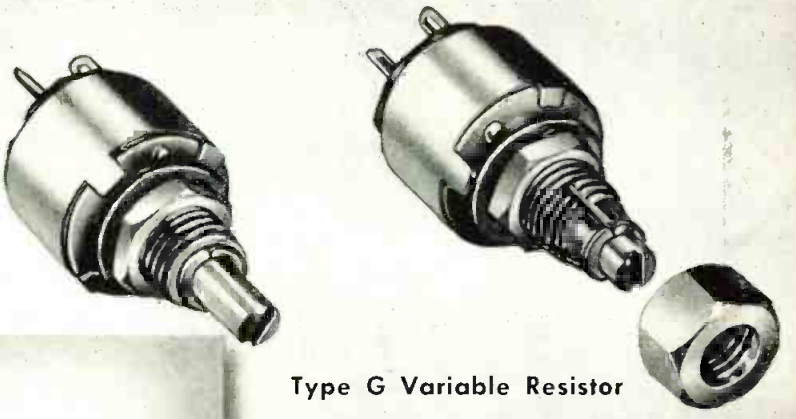
STACKPOLE CARBON COMPANY, *St. Marys, Pa.*

ACTUAL SIZE

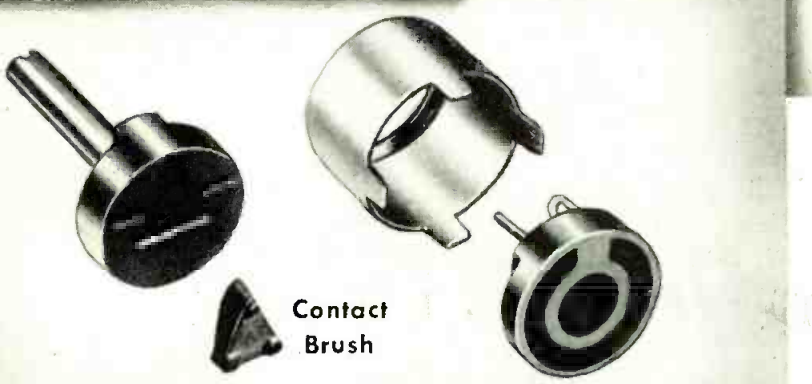


Type G Variable Resistor

ENLARGED VIEW



Type G Variable Resistor



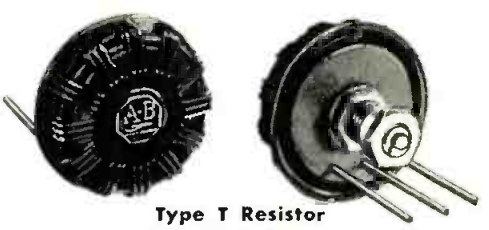
Contact Brush

Molded Resistor Ring

HIGH QUALITY

TYPE G

Continuously Variable 1/2 Watt Resistors

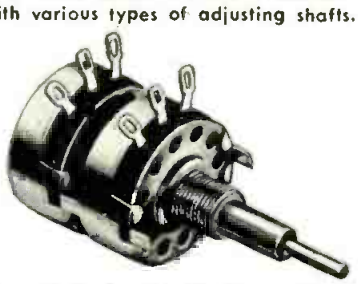


Type T Resistor

A ½ watt variable resistor has 2 styles of operating covers—for hand or screwdriver adjustment.

Type J Resistor

A 2 watt solid molded variable resistor available with various types of adjusting shafts.



Dual Type J Resistor with Concentric Shafts

Two units with separate, concentric adjusting shafts for individual circuit control.

Solid Molded Resistor Assures Long Life, Low Noise, and Permanent Characteristics

The tiny Allen-Bradley Type G, ½ watt variable resistor is a miniature version of the well-known Type J 2 watt variable resistor. It has a solid-molded resistor element progressively tapered in resistance to produce any resistance-rotation curve.

The graduated resistor element is NOT a painted or sprayed unit. The Type G element—being solid molded—does not deteriorate with age or use. It is not affected by heat or moisture. It is conservatively rated at ½ watt at 70 C ambient . . . not at the usual 40 C. The carbon contact brush improves with use. The Type G unit is a QUALITY product, through and through . . . made for electronic applications where performance is the dominant requirement.

Let us send you full technical data on Allen-Bradley variable resistors. Write today.

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In Canada—
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ALLEN-BRADLEY

RADIO, ELECTRONIC AND TELEVISION COMPONENTS

TELE-TIPS

(*Continued from page 30*)

This complaint was handled by phone: It was from a Maryland resident and she complained of severe interference on both radio and TV from 9:15 p.m. to 6 a.m. It had been going on for three months, she said, and the power company could do nothing for her. First check your electrical appliances, suggested the FCC. Two days later she happily reported that she had found the trouble—an old electric blanket!

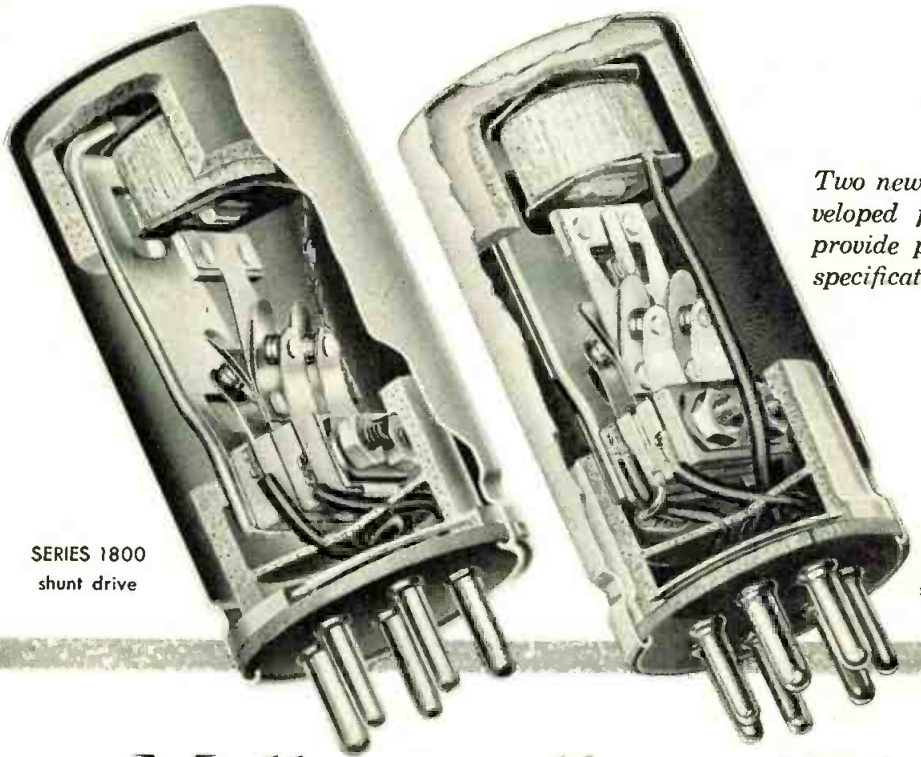
The tip came from a magazine article which described "souped up jalopies with walkie-talkies" being employed to hunt coyotes. The Kansas City investigators tracked it down, and sure enough, the local ranchers had purchased the surplus military units and were using them for just that purpose. They hadn't realized that a license was required for "such short-range transmitters."

The complaint was interference to code reception, and the complainant was a persnickety old codger who was frankly suspicious of the FCC investigator. "If you're a code man, read this," he ordered, and rapped out a message in Morse landline code on the table top. The engineer promptly did. Then followed a message in international code, which the engineer translated also. With his qualifications thus "proved," he was permitted to go to work.

During the recent Connecticut floods, the FCC's Boston office received a complaint on interference to the state forestry radio system. Investigators traced the trouble to one of the forestry service's own transmitters. It was in continuous operation. Flood waters had actuated the relay, and it had remained closed after the waters receded.

Another queer case was reported by an aeronautical service at Honolulu, Hawaii. Their air-ground radio, they complained, was suffering from strong interference. The FCC direction-finder net was alerted and quickly found the trouble. It was a defective ground transmitter of another airline—5,000 mi. away on the east coast of the U.S.!!

MALLORY



SERIES 1800
shunt drive

SERIES 1850
separate drive

Two new Mallory vibrator models, developed for general commercial use, provide performance to meet military specifications . . . without extra cost!

New Mallory self-rectifying vibrators lead in long life, and dependable service

New construction. A new kind of leaf spring construction puts extra life and performance into the self-rectifying vibrators now available from Mallory. The contact arms attached to the vibrating reed are dual springs. This design effectively prevents "bounce" of the contacts to give clean make-and-break action, and provides dynamically balanced self alignment.

Count on them for longer life. Stopping of contact chatter eliminates a major source of contact wear . . . assures far longer service in every vibrator, minimizing danger of occasional early failure.

Engineered to fill the need for a premium-performance vibrator of this type for commercial power supplies, these new Mallory models are capable of meeting stringent military requirements. They can be relied upon to deliver the extra service you need . . . without premium price. For technical data, and for a consultation on your power supply requirements, write or call Mallory today.

New Heavy Duty Mallory Vibrator

The new 1700 series Mallory split-reed "communication type" vibrator* uses special alloy leaves which serve both as contacts and as springs . . . eliminating usual button contacts. Life is up to 100% longer, constancy of output improved, and driving power reduced. The new design is available both as a split-reed model for 6/12 volt service, and in a Duplex heavy-duty model without split-reed construction. For information, write or call Mallory.

*Patent applied for

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
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Parts distributors in all major cities stock Mallory standard components for your convenience.

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MALLORY

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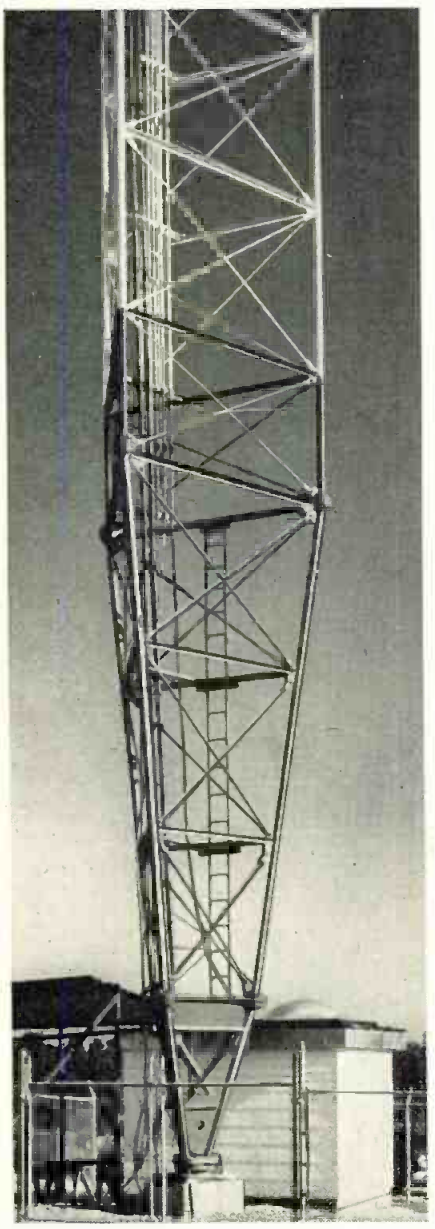
KTBS-TV PUTS NEW TRUSCON 1052-FOOT GUYED TOWER IN OPERATION



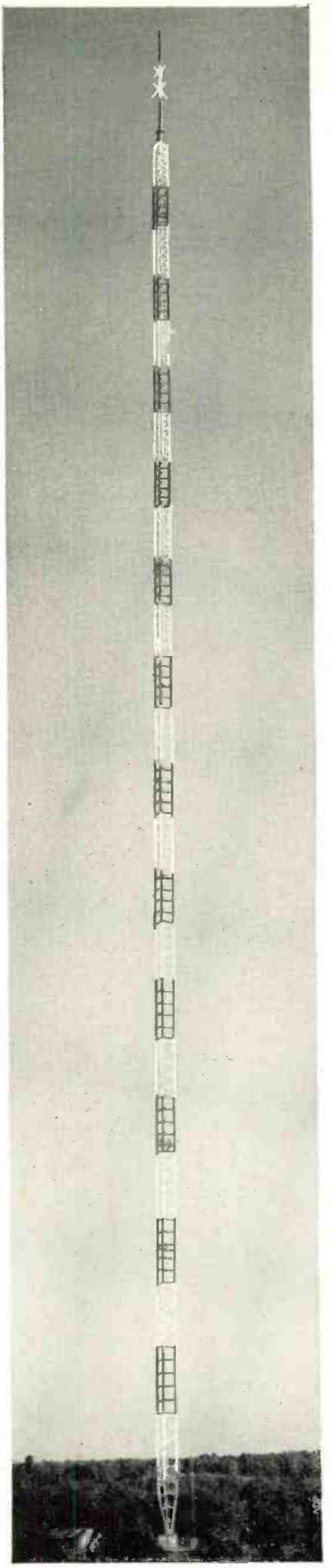
KTBS-TV's 101-foot television antenna is riding high these days. It's anchored securely at the peak of their new Truscon Guyed Steel Tower—1052 feet above the ground near Shreveport, Louisiana.

This giant steel spire is typical of many hundreds of Truscon Towers now standing tall and strong all over the world . . . on all types of topography . . . and in locations where the wind and weather are extremely severe.

On the East Coast, during the recent hurricanes, for example, *every Truscon Tower in the area remained proudly erect with no damage reported* . . . a dramatic tribute to the unmatched technical experience and craftsmanship of Truscon's team of skilled engineers.

And no matter what your requirement, Truscon's modern and efficient manufacturing facilities are geared to produce exactly the tower you need . . . whether it be guyed or self-supporting . . . tall or small . . . tapered or uniform in cross-section . . . for AM, FM, TV or Microwave Transmission.

Get your tower program started by calling or writing your nearest Truscon District Sales Office or "tower headquarters" in Youngstown—today. Our experts will be glad to discuss your problems or help in any way they can.



KTBS-TV—Truscon Guyed Tower 1052 Feet Tall

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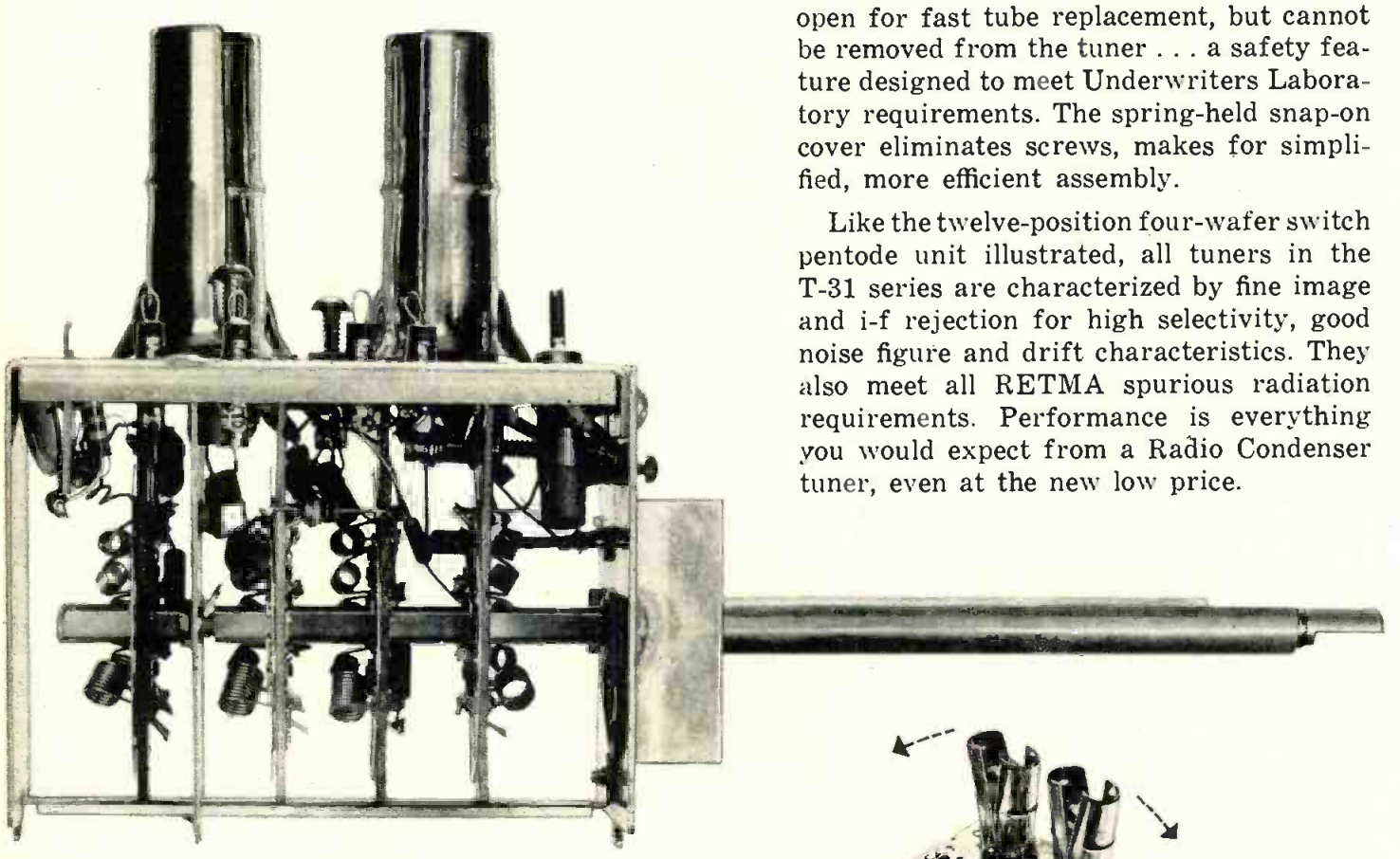
THE NEW LOOK

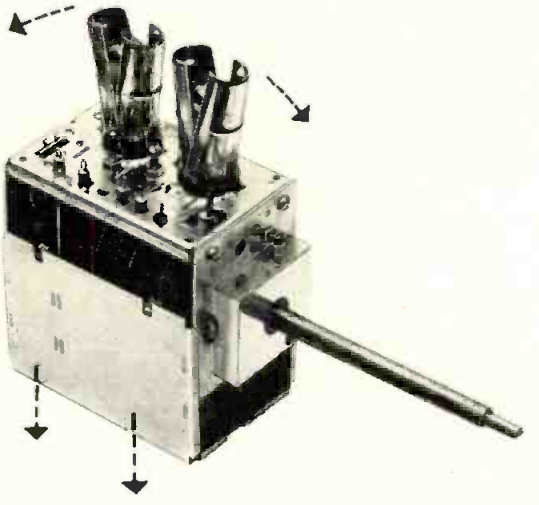
...in vhf-TV tuners

NOW . . . all the desirable performance characteristics of Radio Condenser's well known T-31 series vhf-TV tuners in a completely new package. Designed for greater safety and easier installation, the new T-31 carries an even *lower price*, because of mechanized production methods now in effect.

Here are just a few of the design improvements that make the new T-31 far superior to the original. As you can see in the illustrations, tubes are mounted at the extreme right, for easier installation beside large cathode ray tubes. Captive tube shields snap open for fast tube replacement, but cannot be removed from the tuner . . . a safety feature designed to meet Underwriters Laboratory requirements. The spring-held snap-on cover eliminates screws, makes for simplified, more efficient assembly.

Like the twelve-position four-wafer switch pentode unit illustrated, all tuners in the T-31 series are characterized by fine image and i-f rejection for high selectivity, good noise figure and drift characteristics. They also meet all RETMA spurious radiation requirements. Performance is everything you would expect from a Radio Condenser tuner, even at the new low price.





Get Complete Engineering and Performance Data

Write Radio Condenser for your free copy of Bulletin T-31.

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STRONGER!
Alumina ceramics with higher tensile and impact strengths. Permanent bonding. New glaze with superior surface resistivity. Rugged. Greater resistance to wear, chipping and breakage. Exceed MIL-T-27A torque requirements.

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New, superior metalizing techniques. Pace-setting AlSiMag Alumina ceramics. Greatly extended operating temperature range. Readily attached with hard solder. Permit designing to higher temperatures.

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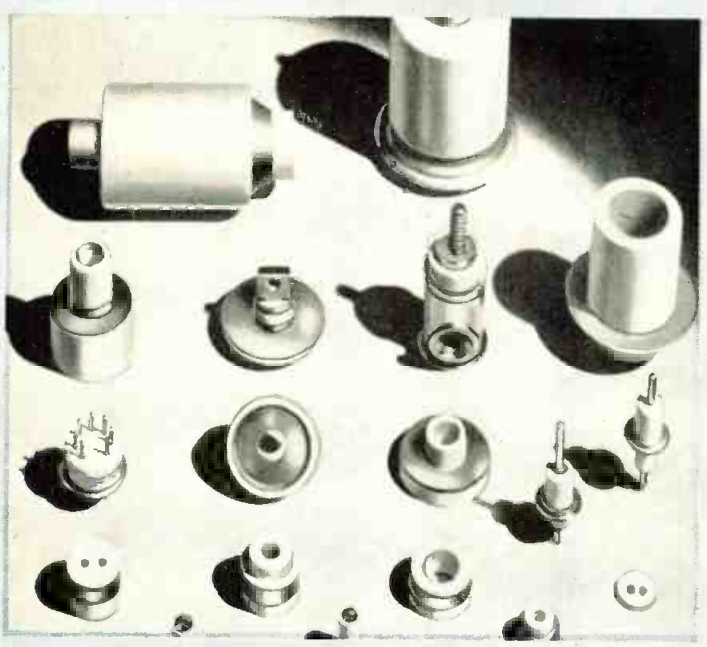
Retain their excellent electrical and mechanical characteristics and deliver outstanding performance throughout their wider operating temperature range.



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in High Temperature Alumina Ceramics with High Temperature Metalizing also available, produced by the same highly skilled techniques. For special applications, a wide choice is offered in metals and ceramics in appropriate design configurations. Metalized parts for low temperature applications can also be supplied. Send blueprint or sketch for complete details.

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3 Functional operating range from —55°C to +125°C.

4 Operates normally under severe humidity conditions.

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6 Capacitance range: .001 mfd. to 1.0 mfd.; voltage range: 100 to 600 V.D.C. operating; can be provided to standard tolerance of ±20% or to closer tolerances, if desired.

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2. Power factor less than 1%.
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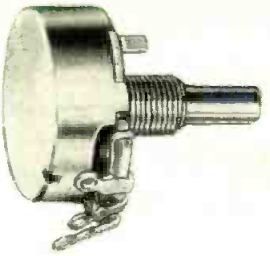

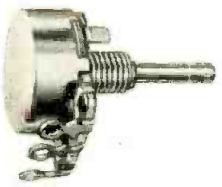

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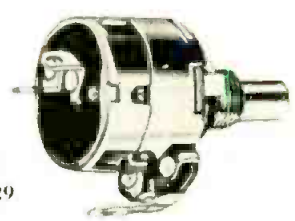

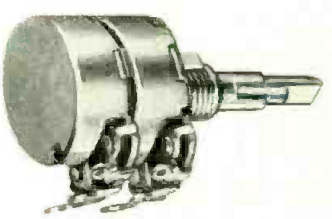

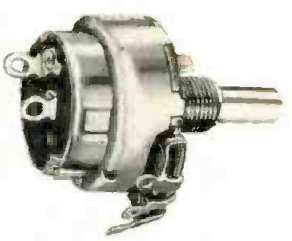

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EIMAC klystrons bring high power to another frequency range...

225-400mc

20kw CW Power Output

TYPICAL CW OPERATION

Eimac X590D Amplifier Klystron
225-400mc

D-C Beam Voltage	20kv
D-C Beam Current	2.32 amps
Power Input	46.4kw
Power Output	20kw
Driving Power	11w
Efficiency	43%
Power Gain	32.6db

Another frequency range, 225-400mc, has been spanned with a commercially available Eimac high power amplifier klystron. The Eimac X590D, the first klystron developed for operation at the VHF-UHF junction, delivers 20kw/CW power output with only 11 watts drive. Its high power gain of 1800 times and efficiency of 43% typifies the incomparable performance of Eimac klystrons.

Incorporation of Eimac's unique modulating anode gives X590D outstanding versatility. It can be 100% modulated to peaks of 40kw in AM operation or easily pulse modulated with low pulsing power.

A new, indirectly heated oxide cathode greatly simplifies cathode power and cooling requirements.

With the X590D, Eimac now covers the 225-1000mc range at high power with only four klystron types. Wide range tuning and an easy, economical approach to high power UHF transmitters is made possible by the Eimac feature of completing RF circuitry outside the vacuum system with permanent circuit components.

Microwave high power is easily obtained by driving an Eimac klystron amplifier with existing low power equipment.

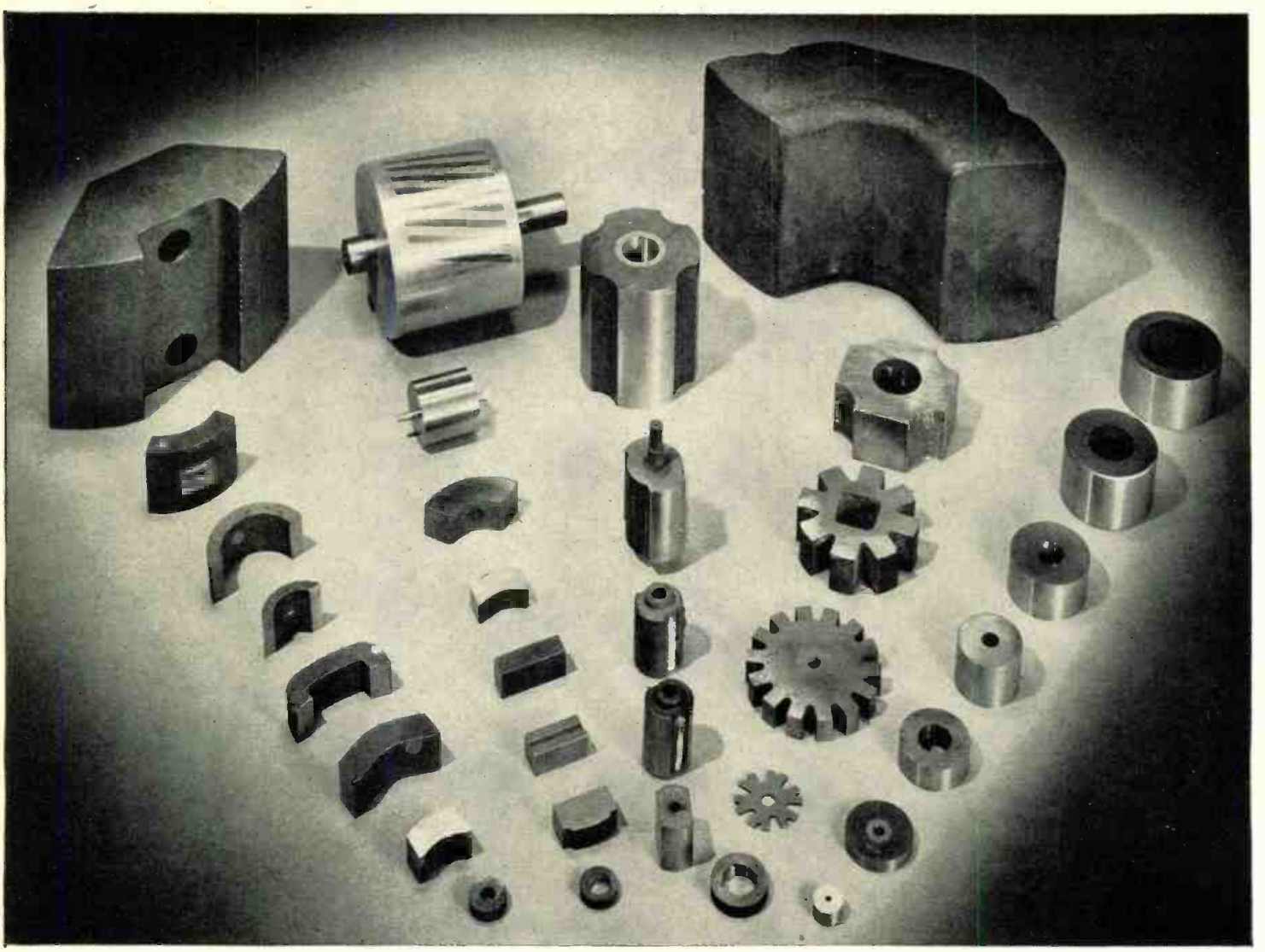
Transmitters employing Eimac klystrons give incomparable performance and reliability plus unmatched economy, since costly RF circuitry is not repurchased with each tube replacement.

Eimac X590D amplifier klystron with circuit components permit ease of transmitter design by equipment manufacturers

● *Eimac offers the most extensive selection of high power amplifier klystrons for pulse, CW and AM applications. For information contact our Technical Services Dept.*

Eimac

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA
The World's Largest Manufacturer of Transmitting Tubes



Magnets for rotors or stators ...any design or size you may require

"MAGNETIC MATERIALS CATALOG"

Write for your copy

Contains handy data on various types of Alnico Magnets, partial lists of stock items, and information on other permanent magnet materials. Also includes valuable technical data on Arnold tape-wound cores, powder cores, and types "C" and "E" split cores in various tape gauges and core sizes.

ADDRESS DEPT. T-61

The use of Alnico permanent magnets in rotor and stator assemblies of motors, generators, magnetoes and tachometers has revolutionized the designs of these devices. Whatever your need may be —from a tiny rotor for a timing device to a large slab for power generators—Arnold can take care of your requirements, either for experimental samples or production quantities.

● *Let us work with you.* You will have the advantage of working with a leading producer of rotor magnets, whose manufacturing and testing facilities—the most modern in the business—give you the best assurance of high quality standards and uniform performance.

W&D5184

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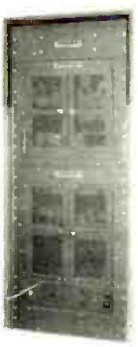

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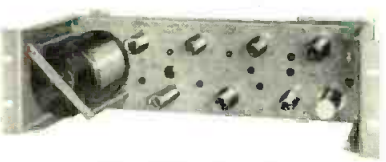

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BOOKS

Electronic Transformers and Circuits

By Reuben Lee, Fellow, IRE. Second edition, published 1955, by John Wiley & Sons, Inc., 440 Fourth Ave., N.Y., N.Y. 360 pages, price $7.50.

Besides providing practical data on the design of transformers used on electronic apparatus, this book furnishes electronic engineers with a clear understanding of the effects of transformer characteristics upon electronic circuits. The aim has been to provide a reference of maximum usefulness with a minimum of unnecessary material. Physical concepts are emphasized, with mathematical treatments simplified wherever possible. This second edition has been expanded to include new sections on magnetic amplifiers, pulse circuits, reactor surges, toroid coils, r-f power supplies, wideband transformers, and charging chokes.

Fundamentals of TV Engineering

By Glenn M. Glasford, M.S. Published 1955 by McGraw-Hill Book Co., Inc., 330 West 42nd St., N.Y., N.Y. 642 pages, price $12.75.

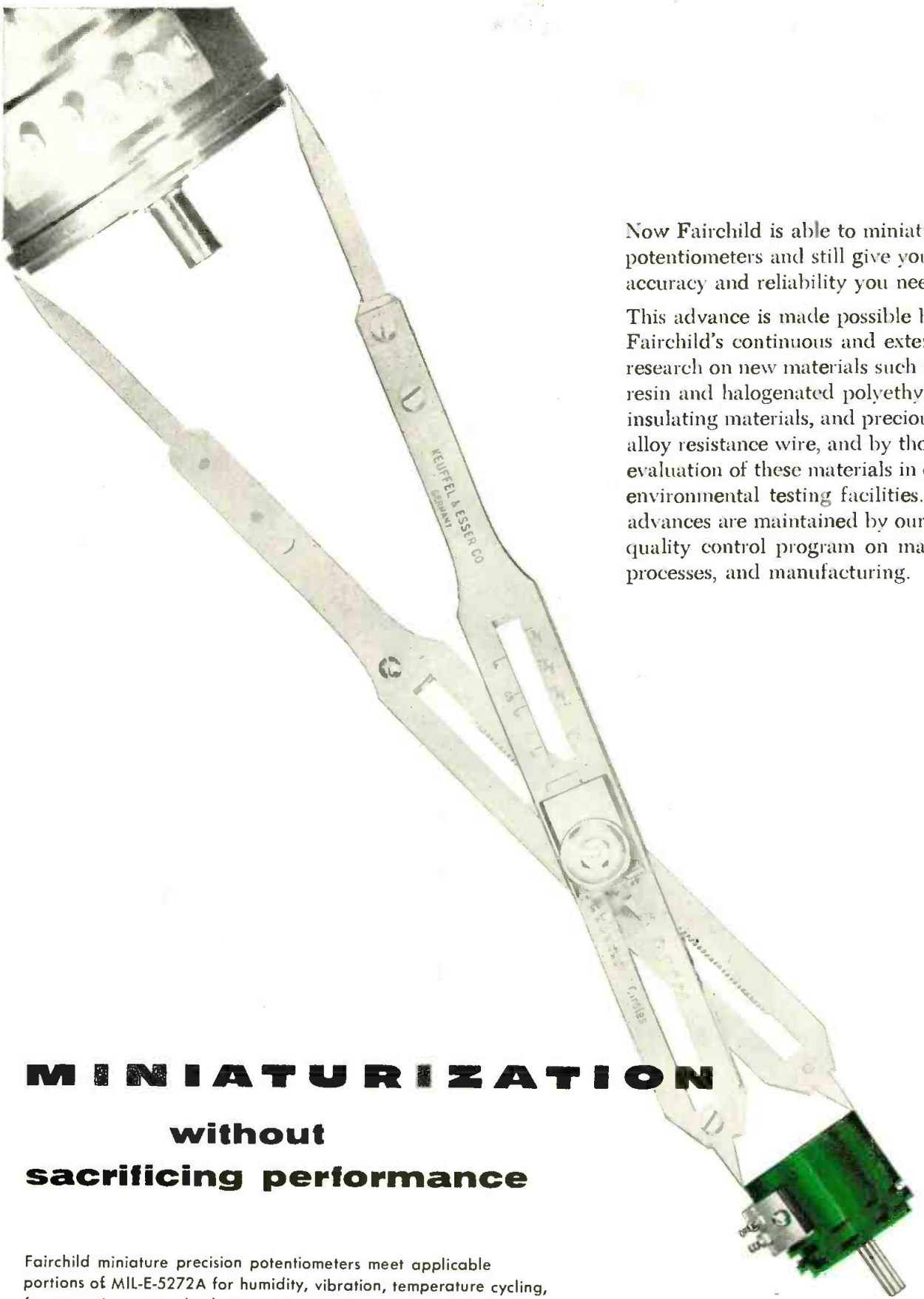
This volume is intended as a reference on the engineering problems of practical TV systems. Beginning with the fundamental principles involved in the transmission and reproduction of visual information, it continues with a study of pick-up and receiving tubes, followed by an analysis of circuits and devices which could be applied in the system. Wherever possible, alternate ways of performing a particular operation are given, along with an evaluation of the relative merits of the possible methods. Recent advances in uhf and color are discussed, with monochrome and color systems treated concurrently, rather than in separate and unrelated chapters. Providing complete information for the design of TV systems and their component parts, this work should aid the engineer in extending his knowledge of this timely subject.

Electronic Data Processing In Industry

A case book of management experience published by the American Management Association, 330 W. 42nd St., New York 36, N.Y. 256 pp. Price $7.75 (AMA members, $5.75)

This new American Management Association, Special Report No. 3, is a comprehensive report on the latest developments in "the office revolution." The volume describes graphically how automatic data-processing offers unparalleled speed, accuracy, controls, and savings for industry. It gives specific practical information on: how to determine whether a company should adopt electronic data-processing; how to plan the installation of such a system; what equipment is available; and

(*Continued on page* 50)



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PRECISION POTENTIOMETERS

BOOKS

(Continued from page 48)

how progressive companies are now using these systems. Also included are reports of company experience with small, medium, and large computers, a forecast of future developments in electronics, and a valuable glossary of programming terms.

Books Received

1955 Book of ASTM Standards: Part I—Ferrous Metals

Published 1955 by ASTM, 1916 Race St., Philadelphia 3, Pa., 1834 pages, 315 standards. Contains standard and tentative specifications, methods of test, and definitions for steel piping materials, springs, corrosion resisting steel, iron, magnetic materials, metal powders, etc. Price $13.50.

TV Repair Questions & Answers (Sync and Sweep Circuits)

By Sidney Platt. Published 1955 by John F. Rider Publisher, Inc., 480 Canal St., N.Y., N.Y. Paper bound, 122 pages, price $2.10. Covers the servicing aspects of all vertical and horizontal sweep and sync circuits, including AFC circuits.

Aeronautical Electronics Digest

1955, a compendium of technical papers exemplifying progress in the field of Aeronautical Electronics. Presented at the National Conference on Aeronautical Electronics, May 9, 10, and 11, 1955, Dayton, Ohio. Price $4.00, copies may be obtained from Publications Committee, National Conference of Aeronautical Electronics, P.O. Box 621, Far Hills Branch, Dayton 9, Ohio.

Government Publications

Some Characteristics of Image Orthicon Camera Tubes

Naval Research Laboratory, Mar. 1955. 44 pages, illustrated. (Order PB 111658 from OTS, U.S. Dept. of Commerce, Wash. 25, D.C., price $1.25.)

Reduction of Power Line Radio Interference

Naval Civil Engineering Research and Evaluation Laboratory, Feb. 1955. 32 pages, illustrated. (Order PB 111666 from OTS, U.S. Dept. of Commerce, Wash. 25, D.C., price $1.00.)

A Reflectometer for H-F Band

Naval Research Laboratory, Sept. 1949. 9 pages. (Order PB 111682 from OTS, U.S. Dept. of Commerce, Wash. 25, D.C., price 50¢.)

Investigations of Permanent Magnet Alloys. Final Report

Arnold Engineering Co., for U.S. Army Signal Corps, May 1948. 51 pages, tables. (Order PB 111664 from OTS, U.S. Dept. of Commerce, Wash. 25, D.C., price $1.50.)

High Voltage Extraction of Electrons From a Plasma

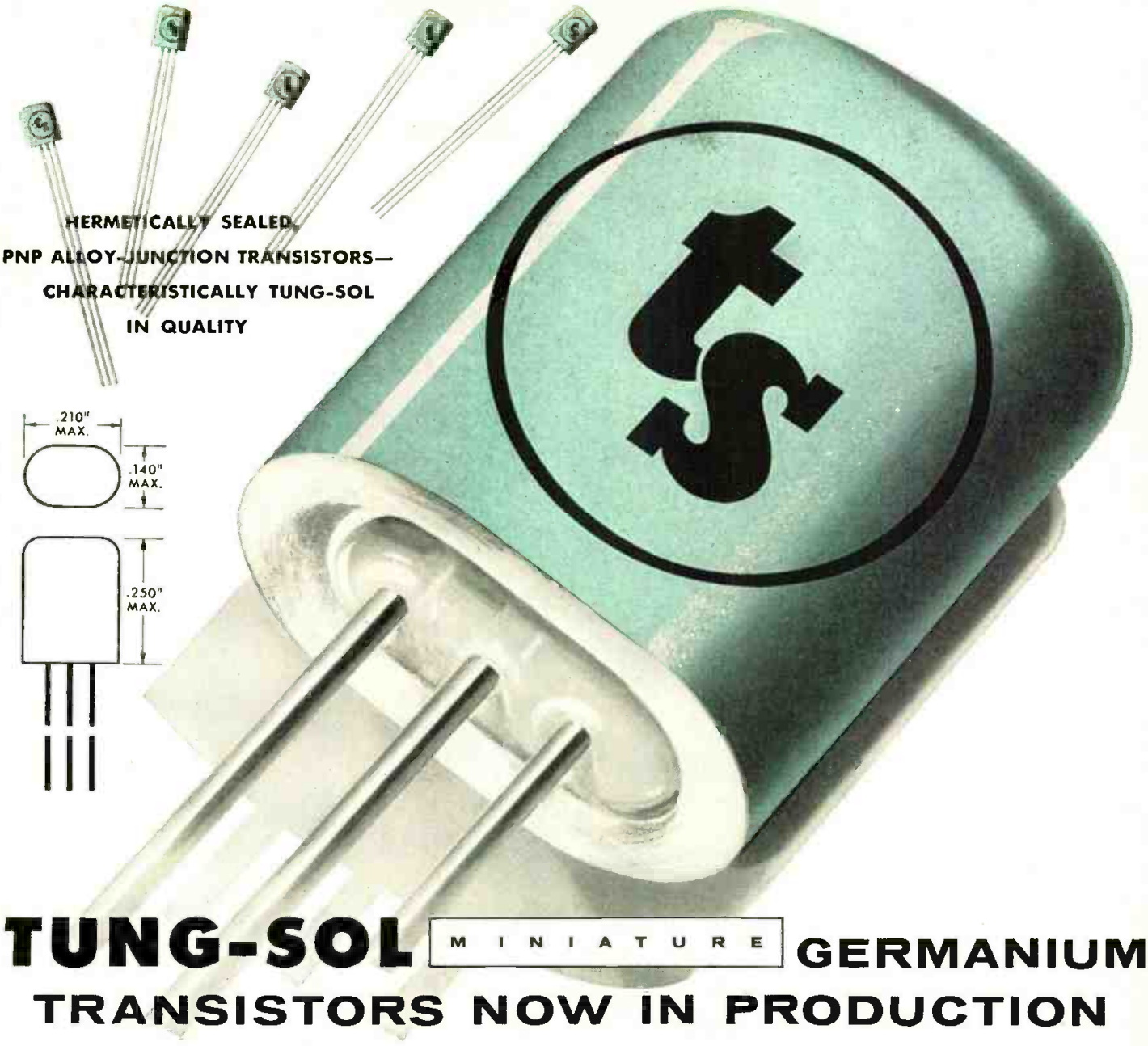
Univ. of Calif. Electronics Laboratory, for USAF, Feb. 1955, 42 pages. (Order PB 111698 from OTS, U.S. Dept. of Commerce, Wash. 25, D.C., price $1.25.)

Evaluation of Dynamotors

Cook Electric Co., for Wright Air Development Center, USAF, Jan. 1955, 90 pages. (Order PB 111733 from OTS, U.S. Dept. of Commerce, Wash. 25, D.C., price $2.25.)

Boundary Layer Radioactive Tracer Technique, Part I, Instrumentation

North Carolina State College, for Wright Air Development Center, USAF, Aug. 1954. 107 pages. (Order PB 111677 from OTS, U.S. Dept. of Commerce, Wash. 25, D.C., price $2.75.)



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Dissipation at 25°C (MW)	50	50	50	50	50
Junction Temp. (°C)	85	85	85	85	85
AVERAGE CHARACTERISTICS (Common Base, I_e = 1.0MA, E_c = −6v)					
Cutoff μA (Max.)	15@-10v	25@-25v	25@-25v	25@-25v	15@-10v
Current Gain	.93	.96	.98	.99	.97
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Frequency Cutoff (MC)	0.5	0.7	0.9	1.1	—
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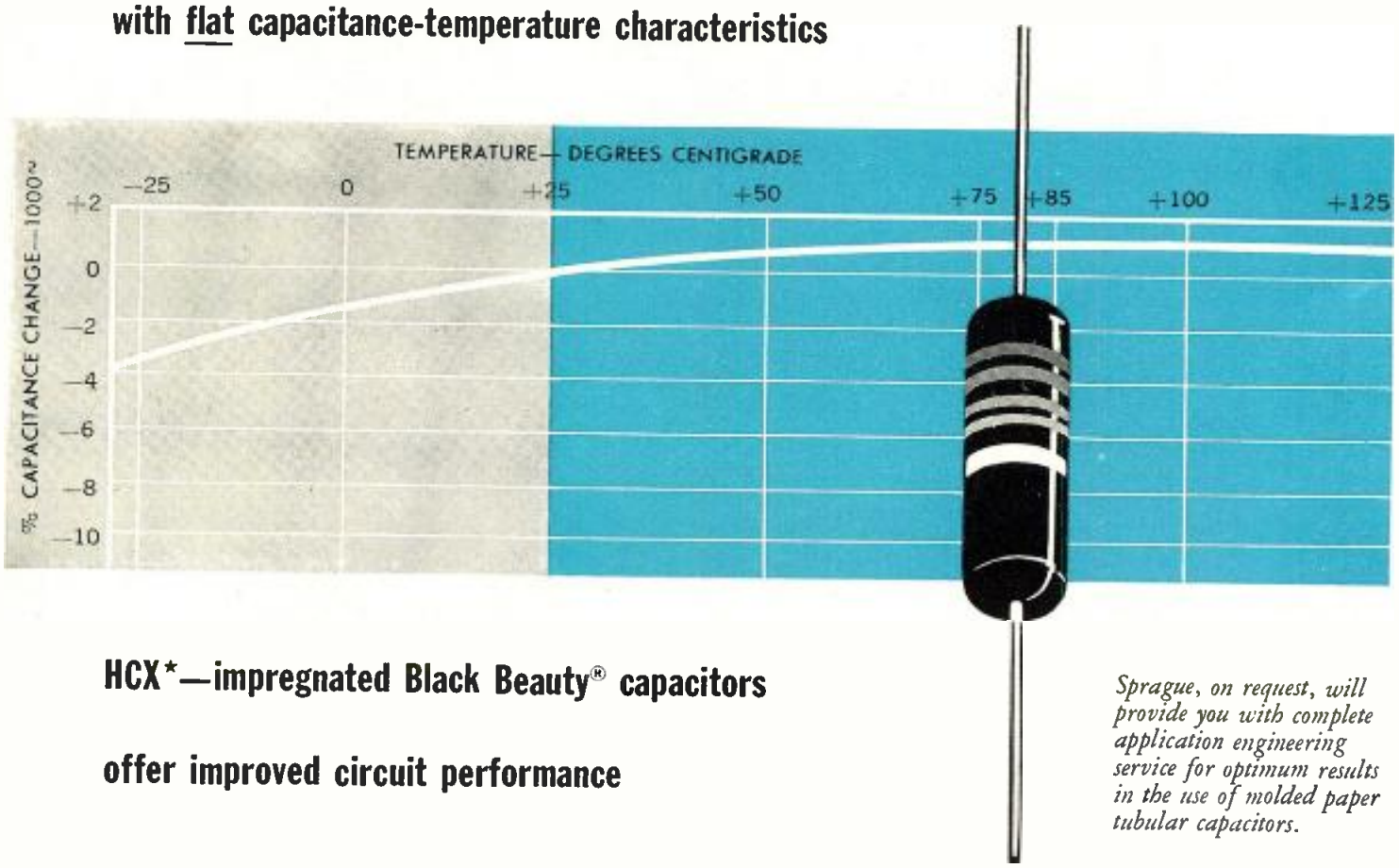

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Complete performance data covering the wide range of sizes and ratings are in Engineering Bulletin 223, available on letterhead request to the Technical Literature Section, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

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WHAT'S AHEAD FOR '56!

ELECTRONIC BUSINESS

ANOTHER GOOD YEAR is predicted. Radio-TV should climb to a new peak, especially if color-TV moves off dead center. The volume in broadcast equipment will be lower unless a new FCC ruling opens the gates for further station construction. Mobile and microwave communications as well as audio are expected to continue at present high levels and electronic equipment in industrial applications will rise.

GOVERNMENT ELECTRONIC ACTIVITY should again account for approximately $3 billion in 1956. Awards for equipment production will be low, the bulk of the funds being used for R&D. Air Force again will provide lion's share of funds with Navy and Signal Corps following. Principal expenditures will be for guided missiles, radar detection and countermeasures.

TELEVISION

BLACK & WHITE TV sales are expected to be at least as high in 1956 as they were in 1955—if not greater. The era of the second and third set is upon us and emphasis will be on selling smaller screen receivers of light weight for portable applications where built-in antennas are effective. The 17-in. screen will probably be the most popular. There is nothing practical foreseen for next year in the way of picture-on-the-wall receivers, light amplifiers or other revolutionary devices.

COLOR-TV is still on dead center so far as sales are concerned. Estimates of 300,000 receivers are forecast for 1956. There is some thinking that more interest in color by the public will be shown by late spring. Cost, programming and receiver reliability are main trouble-spots. When WNBQ in Chicago actually takes to the air with 10 hours daily of color shows, receivers in public places could start the ball rolling. But even if the interest rises in Chicago there will still be a time lag before the East and West follow suit.

SEMI-CONDUCTORS

TRANSISTORS will be found coming into use more and more. They are of course ideally suited for the miniaturized personal type receivers but they are not being used as extensively as they might be because of the high unit cost of transistors compared to tubes. More and more equipment manufacturers however announce transistor production facilities with most of them concentrating on the production of units for their own consumption. By integrating transistor production with end equipment production and making only the end item available some interesting marketing changes can result. Semi-conductor materials are also under constant scrutiny. A germanium-silicon transistor is expected soon and a new composite metal tin-on-nickel has interest for transistor makers.

MATERIALS

A CONTINUED HIGH radio and black and white TV market will bring the electronic industry trials and tribulations from a materials standpoint, particularly if color TV sales take hold in the spring. Copper and brass are still in short supply, and there is no reason to believe that additional copper will be released from Government stockpile in the near future. Nickel is also in acute short supply. With increased receiver production there will be increased raw material requirements for vacuum tubes production. Also, in connection with tube demand, there is a scarcity of first grade mica, which will undoubtedly force manufacturers into using synthetic or substitute materials. Some work is at present being done to try to develop a synthetic first grade mica, but this is progressing at a slow pace.

GE's introduction of an all ceramic planar triode for UHF applications this fall is undoubtedly the forerunner of a number of all ceramic tube types to be manufactured. Unusual strength, insulation characteristics, and temperature characteristics of the alumina ceramics, coupled with the miniaturization possibilities offered through planar construction, indicate good possibilities for this type of tube in 1956. Increased use of these ceramics in other applications, such as sockets, feed-through insulators, spacers, etc., can be expected.

Much larger volume in copper clad laminates is in the offing, as more and more manufacturers convert to printed circuits and automation in their production.

MANPOWER

ELECTRONIC ENGINEERS will continue to be in short supply throughout the coming year. In fact, if the present business boom continues or reaches higher levels, the situation is bound to become more acute. Engineer-want-ads in newspapers, because of their volume, were a contributing factor in the recent price hikes of newsprint. The year 1956 should also see the start of some dynamic educational support programs on the part of government, industry, and trade associations to promote scientific and engineering careers. Obviously none of the programs started in 1956 can contribute effectively toward alleviation of the manpower shortage until after 1960! Why not a GI bill in support of scientific and engineering education?

RADARSCOPE

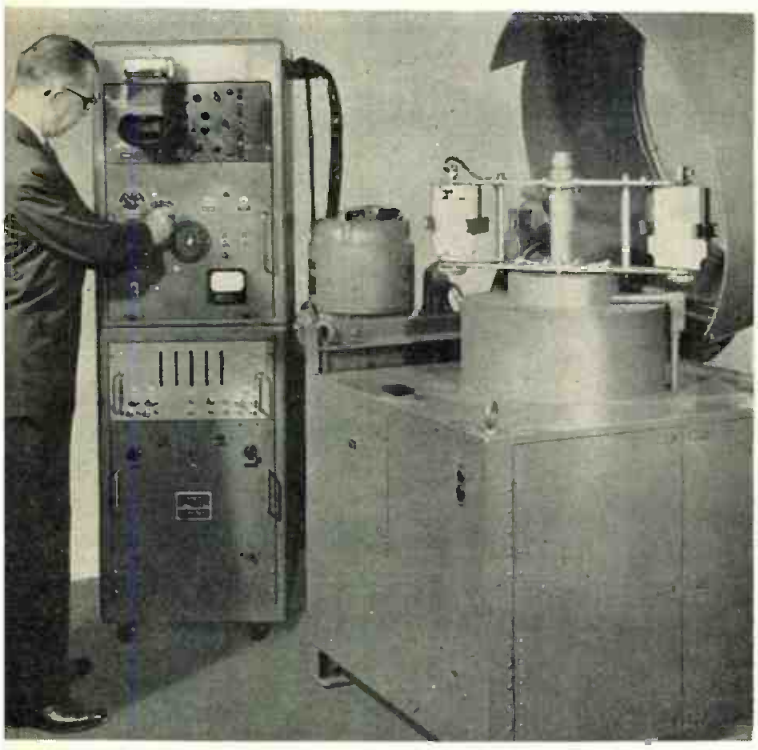
Revealing important developments and trends throughout the spectrum for radio, TV and electronic research, manufacturing and operation

THE NEXT TRANSISTOR development is slated to be combination germanium-silicon transistors, according to reliable industry sources. Combining the two reportedly brings out the most desirable characteristics of each, with few of the disadvantages.

RADIO-CONTROLLED TRAFFIC LIGHTS may revolutionize traffic engineering science. Introduced last month in Chicago, the new system uses coded radio tone signals to remote control electronically equipped stop-and-go signals. Radio coordination from a Central Station provides the traffic signal timing changes necessary to meet the varying traffic conditions. The installation was designed by General Electric.

VACUUM TUBE PROCUREMENT, by the Army and Air Force, will total approx. 4,000,000 units in Fiscal Year 1956. Over 280 different types of tubes will be included.

ROCKET FLIGHT SIMULATOR



Unique new "Vari-G" Centrifuge, designed and built for the Navy by Hycon Mfg. Co. of Pasadena, Calif., will test two 1-lb. specimens simultaneously up to 300 G's, and two 10-lb. units up to 100 G's. The unit reaches peak velocity in less than 1/7th of a second, and virtually any acceleration can be simulated. Designed specifically for testing rocket fuses, the machine has reduced costs from $120 to 20¢ per test.

INDUSTRY HEADS FEAR that the FCC will attempt an unrealistic solution to the UHF-VHF TV problem. Vacuum created by lack of a constructive industry-sponsored program, it is felt, may precipitate the decision. RETMA's Frequency Allocation Study Committee is requesting more time for study, and citing past services to the public of presently existing allocations.

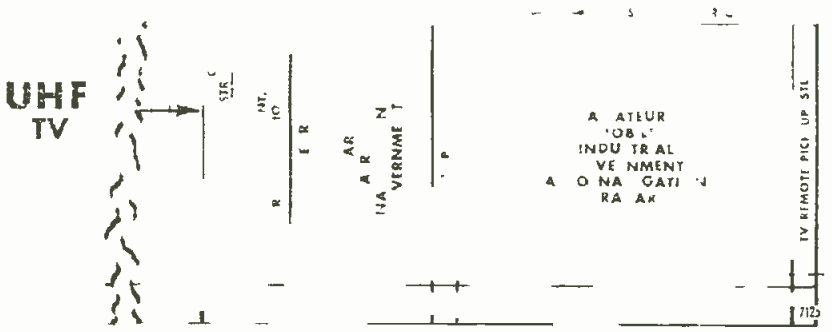
ANOTHER PARTIAL SOLUTION TO THE COPPER PROBLEM is seen in the use of copper clad steel. New technique offers copper saving of 80 to 90%, and much greater yield strength—approximately 4 times that of copper alone. Uses to which copper clad steel is being put include rectangular waveguides, high powered vacuum tubes and high amperage switches.

HINT OF A BOYCOTT against U.S. broadcast equipment manufacturers was voiced to members of RETMA International by spokesmen for the Association Interamerican de Radiodifusion (AIR), 3,000-member association of radio broadcasters covering the Western Hemisphere. The group is reportedly nursing resentment against the American equipment manufacturers because of latter's lack of financial support of the organization.

MORE EFFICIENT USE OF ENGINEERING KNOWLEDGE is the aim of the new science designated "Commercial Engineering." Dr. Henry Ludmer, assoc. professor at Ill. Inst. of Technology, and pres. of the new National Inst. of Commercial Engineering, explains their goal as ". . . to develop and use all relevant scientific methods and principles to maximize efficiency in commerce and to promote mass distribution badly needed for our mass production."

LOOK FOR increasing application of electronic devices in hotels. Time-honored methods of registering guests, assigning rooms and routing messages are considered antiquated by forward-looking hotel executives. Among items envisioned for the hotel of the future are closed-circuit TV to greet guests at the door, computer to pick out and assign room, pneumatic tube system for room service, and automatic conveyor system to handle baggage.

NEW COLOR TV DEVELOPMENT, known as "color video inset," will enable small studios to produce color "spectaculars." Developed by NBC, the device permits the image from one camera to be set into the image from another to form a single picture.



AIRBORNE RADIO UNITS may soon be used to observe and report automobile traffic conditions. The FCC, under pressure from motorists associations, has taken the matter under consideration and is soliciting views from interested parties. Police agencies, in particular, are being sounded out on the possibility of close cooperation between police and the automobile associations.

SUBSCRIPTION TELEVISION

THE TOLL TV QUESTION comes up before the Rules Committee of the New York City Council the second week of this month. As one of the first public hearings to be held on the subject, it will be watched closely by top industry officials. The hearing has been called to consider a resolution which would advise the FCC to withhold approval of toll TV. The resolution describes pay-TV as a "denial of the spirit and intent of Section 303 (G) of the Communications Act of 1934 which directed the FCC to encourage the larger and more effective use of broadcasting in the public interest." The resolution also warns that toll TV would create hardship for many low and middle income families.

TV PICTURE TUBES

RETMA WILL FIGHT the two new Trade Practice Rules which are now being put into effect by the Federal Trade Commission. In connection with Rule 9, "Deception as to Size of Picture," the RETMA petition objects that the rule promulgated by the FTC offers "perhaps 20 different methods of measurement" as opposed to the one standard system of screen size designation now used by the industry. RETMA points out that "through experience the public has learned the size, and how it compares to other sizes. The phrase '21-in.' has a definite secondary meaning when used with TV set. It is a size number, like a size 12 dress . . ."

Also under fire is Rule 12, which requires that any cathode-ray-tube which employs a used envelope must be labelled "used." The rule applies even though the "used" tube is subjected to exactly the same manufacturing process and tests as a tube using new glass. RETMA contends that there is no difference in the quality of picture tubes with re-used containers, from those with unused containers, if both have all new functional parts and undergo the same manufacturing processes. They warned that if the tubes using repossessed glass must be so labelled, customer preference will force the repossessed glass bulbs off the market, and lead ultimately to an increase in cost of tubes and set to the consumer.

MILITARY CONTRACTS

NEW CONCEPT IN CONTRACT AGREEMENTS, initiated and tested by G. M. Giannini & Co., could bring great changes in the manner of handling defense contracts. A one-year test of the contract, between Giannini and the Redstone Arsenal, Huntsville, Ala., has shown savings to the customer of 16½%, and has reduced the delivery time by more than 60%. As described by the firm, the new contract calls for a given number of instrument parts to be manufactured and kept available in a given year. When the customer determines a specific need, the parts are assembled to meet the need. From the manufacturer's viewpoint, this has the advantage of making possible large-scale production of parts on an orderly basis, with only minor peaks of activity when assembly must be performed.

Watch For These Special Issues!

March—IRE Show	April—NARTB
May—Avionic	June—Annual Electronic Industries Directory

PINT-SIZED "REPEATER"

Signal Corps technician splices the new transistorized repeater into field telephone line. New unit, thanks to transistor, and use of printed circuit construction, is only 1/5th the size and weight of the wartime version. Batteries last 90 days, and cost $6.00 yearly. Batteries for similar WW II model cost $105 yearly. Predicted field life of the new repeater is 10 to 15 yrs.—without adjustment.

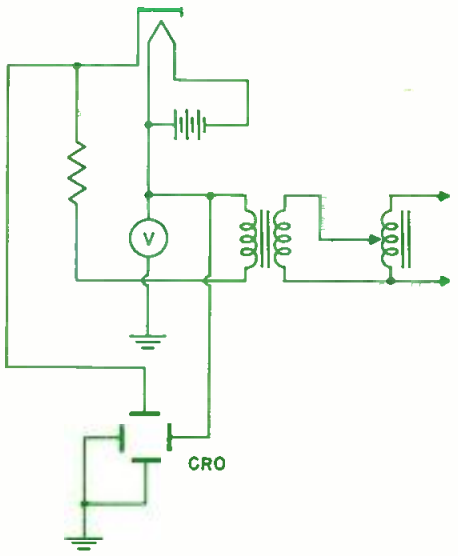


Fig. 1: Method of observing heater-cathode leakage, using an oscilloscope

By THE ADVISORY GROUP ON ELECTRON TUBES

Current flow between heater and cathode of vacuum tubes is often responsible for the malfunctioning of electronic equipment. Examples of the different types of heater-cathode leakage and the steps to be taken to minimize them in electronic circuits are described

Heater-Cathode Leakage

THE oxide coated cathode in an indirectly heated type receiving tube operates in the approximate temp. range of 750 to 875°C and receives its heat from a heater, operating at about 1150 to 1350°C, by both radiation and conduction. The heater is electrically separated from the cathode by a sleeve of insulation material, usually a specially prepared form of aluminum oxide applied to the heater as a coating. The same insulation also separates adjacent heater folds or turns. Any current flow between the heater and the cathode is known as heater-cathode leakage, and should always be considered a detriment, because it may result in the malfunctioning of electronic equipments.

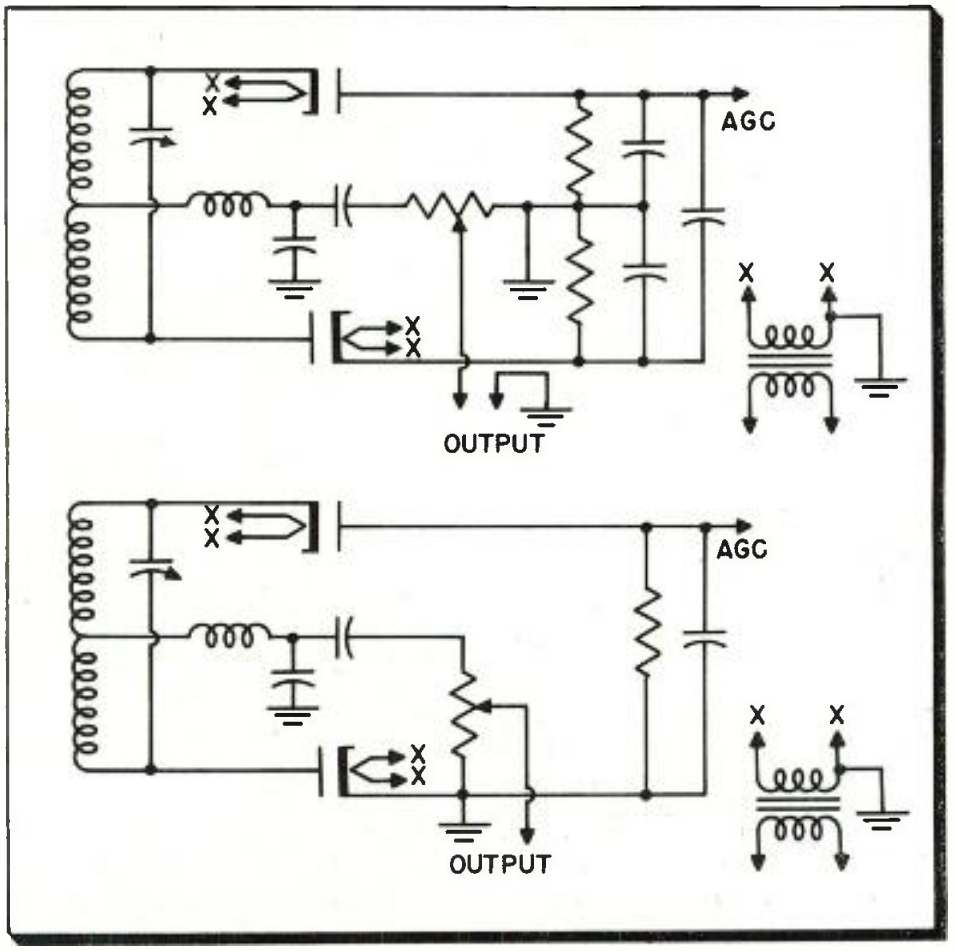
Before specific circuit design problems arising from heater-cathode leakage are discussed it would be well to review some of the physical factors involved in insulating the heater from the cathode of the tube. As previously stated, the insulating material must operate at high temperature and still adhere extremely well to the heater. The coated heater, inserted into the cathode sleeve during the assembly of the tube, and the cathode make physical contact at various places along the outer surface of the insulation and the inner surface of the cathode sleeve. With 100 volts applied between heater and cathode, the voltage gradient in the insulating material can be as high as 50,000 v./in. The coating thickness cannot be materially increased since the thermal expansion of the aluminum oxide is not identical to that of the heater material, and the insulating material or the heater would be subjected to breaking with repeated heater cycling. Increased coating thickness would also greatly prolong the warm-up characteristics of the tube since more mass would have to be heated.

Electrical Behavior

Although the aluminum oxide which is used for the heater-to-

THE ADVISORY GROUP ON ELECTRON TUBES, 346 Broadway, New York 13, N. Y.

Fig. 2: Balanced (top), and unbalanced ratio detectors used for FM demodulation



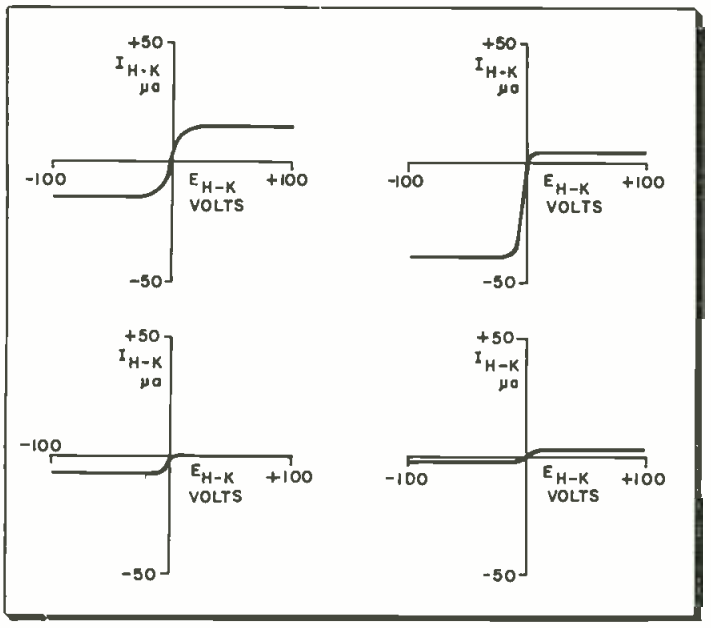


Fig. 3: Leakage with 10-15 v between h & k

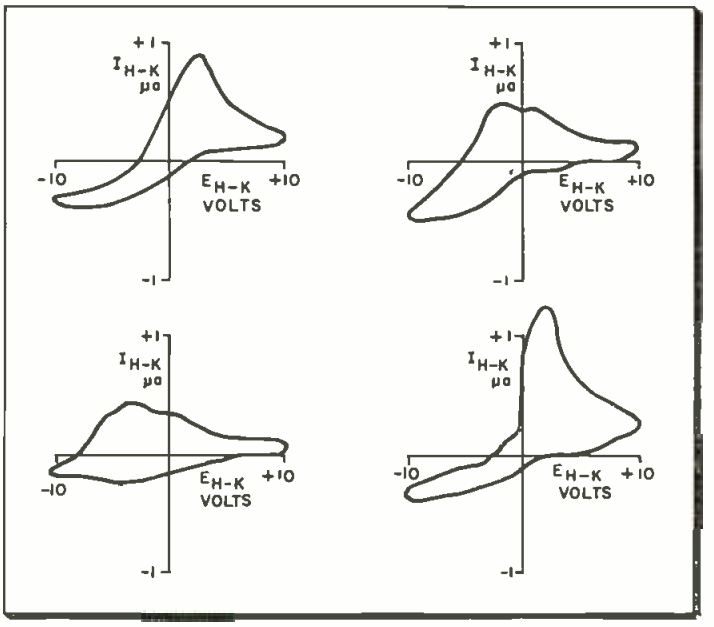


Fig. 4: Leakage with below 10 v between h & k

cathode insulation is an extremely high resistance material, the leakage observed in tubes is not a simple case of a resistance between the heater and the cathode. Electrons find their way, in both directions, between the heater and the cathode by at least three different methods:

(1) The first type of leakage consists of a straight resistive component of current flow through paths that have a lower resistance than the aluminum oxide. Impurities in very small amounts can cause this type of leakage to occur.

(2) Cracks or fissures in the aluminum oxide can expose bare heater wire having sufficient electron emission at the operating temperature to account for the flow of electrons from the heater to the cathode, if the heater is negative in respect to the cathode. In the same manner, electron emission can take place from the cathode to the heater, when the heater is positive with respect to the cathode, if any emitting material is present on the inner surface of the cathode sleeves.

(3) Although there is controversy as to the exact cause, with arguments ranging from positive ion migration to semi-conductor theories, a third type of heater-cathode leakage may be due to some form of ion migration between the heater and cathode.

Methods of Measurement

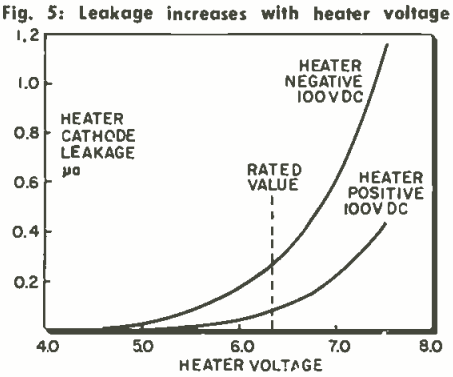
Heater-cathode leakage can be readily observed on an oscilloscope by the method shown in Fig. 1. The use of a dc supply rather than an ac supply for the heaters circumvents the problem of having one half of the heater out of phase with the other half.

Heater-cathode leakage phenomena can be divided into two categories. The first of these shows saturation with about 10 to 15 v. between heater and cathode and may or may not be symmetrical with respect to voltage polarity, as shown in the waveforms in Fig. 3. The second category of leakage takes place with less than 10 v. between heater and cathode. Leakage of this variety is usually below 1 μa. and is characterized by extremely distorted waveforms as illustrated in Fig. 4.

The above two categories may occur separately or together, and when both exist at the same time, one may mask the other.

The test for heater-to-cathode leakage as specified in MIL-E-1[1] is made by applying rated ac voltage to heaters tested at 35 v. and over and either ac or dc voltage to heaters rated below 35 v., and then reading the current flow between heater and cathode when a direct voltage of 100 vdc is applied between the electrodes. The test is made with two polarities, that is, with the heater both positive and negative with respect to the cathode. One μa. leakage under this test implies a resistance value of 100 megohms, but this resistance value may be deceiving because the current may reach saturation below 15 v. Thus at 10 v. the equivalent resistance may be only 10 megohms. A result of this phenomenon is a relatively poor correlation between the leakage measured at 100 vdc and hum developed across the cathode resistor in actual applications.

Fig. 5: Leakage increases with heater voltage



Effects on Performance

Heater-cathode leakage increases rapidly with heater voltage as shown in Fig. 5, and it may improve or deteriorate with life. Because it is also subject to changing levels during shock and vibration, the MIL-E-1 specifications for "reliable" tubes now call for heater-cathode leakage tests to be made before and after shock and vibration tests.

For purposes of illustrating the effects of heater-cathode leakage upon performance in specific equipments, consider:

(1) A low level Class A amplifier
(2) A multivibrator
(3) An FM demodulator

In the case of the low-level Class A amplifier, the cathode bias resistor is usually unbypassed for purposes of degeneration. In conventional circuitry one side of the heater (6.3-v. type) is at ground potential and the cathode is usually about 2 v. positive above ground potential (See Fig. 6.) The underground side of the heater then swings from −10.9 to +6.9 v. with respect to the cathode. During these excursions, current may flow from the heater to the cathode and

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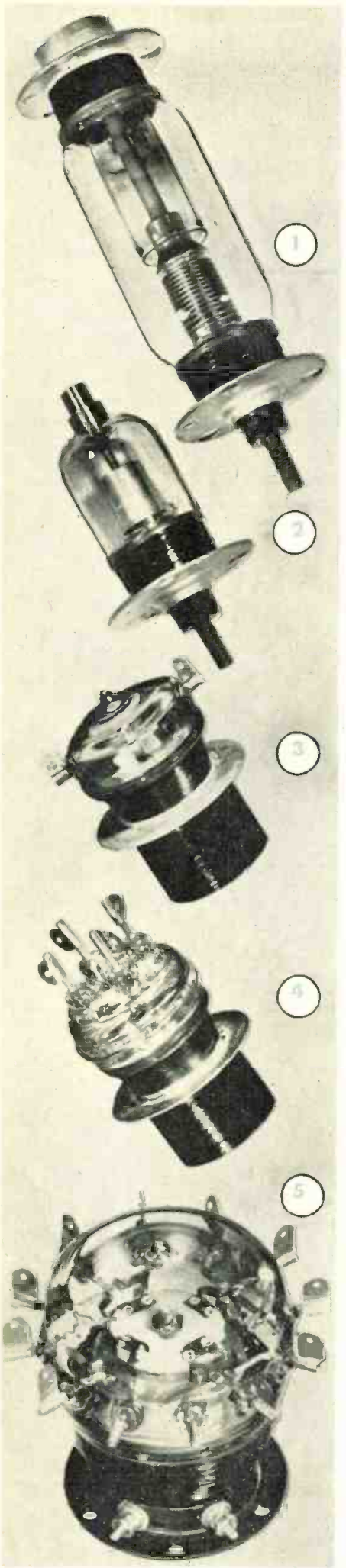


Fig. 1: (top) Metallic bellows type sealing

Fig. 2: SPST relay. Tests to 30 kv, 50 a. RMS

Fig. 3: Relay employing clapper type armature

Fig. 4: SPDT., Handles 10 kv, 10 a. @ 20 MC

Fig. 5: Modified solenoid type vacuum relay 4-pole double throw, has wide contact opening

Dielectric strengths of more than 5,000 kv/in., improved contact life and contact resistance, and faster current interruption are the notable advances. Applications to high and low voltage relaying are described.

By HUGH C. ROSS

New Developments

THEORY says that dielectric strength as high as 15,000,000 v/in. should be possible in proper vacuum. This has offered a challenge to designers of equipment where high voltage gradients exist, and now more than 5,000,000 v/in. can be attained as a result of their many experiments. In applying this vacuum theory to relay contacts many other remarkable benefits were discovered besides high dielectric strength. Some of these benefits are better contact life, less contact resistance, and faster current interruption. They would also seem to indicate advantageous use of vacuum even for many very low voltage relaying applications.

In earlier developments of the vacuum relay, some of which are recorded as far back as 1896, there have been many major difficulties preventing commercial production. One difficulty is the attaining and maintaining of the proper vacuum and maximum dielectric strength throughout the life of the switch. This is a problem of choosing the proper materials to be used inside the vacuum enclosure and the proper method of processing. Another difficulty is proper mechanical operation. This is a problem either of using a flexible vacuum tight seal to allow mechanical movement of contacts from outside the vacuum enclosure or of using a magnetic circuit of some type which, when energized, will pass through the vacuum enclosure and move an armature to which the contacts are attached.

Many experimental models and several successful commercial developments for electronics use have been made over the years. The first actual commercial vacuum relay of which we are familiar (although there were others) was Federal Telegraph Company's single pole double throw "Polarised Vacuum Relay." This was manufactured before 1930 to key 4 kv at ½ a dc in their 2 kw radio transmitters. We have three of these vacuum relays in our historical collection and they still have almost the same dielectric strength as they did over 25 years ago. This type depended on transmission of a magnetic circuit thru the glass envelope to actuate the armature of the center contact in either direction. This of course was a relatively inefficient magnetic circuit due to a large gap between poles and therefore necessitated a good-sized soil. Several small commercial relays of this general principle are on the market today.

HUGH C. ROSS, Engineer, Jennings Radio Mfg. Corp., P. O. Box 1278, San Jose, Calif.

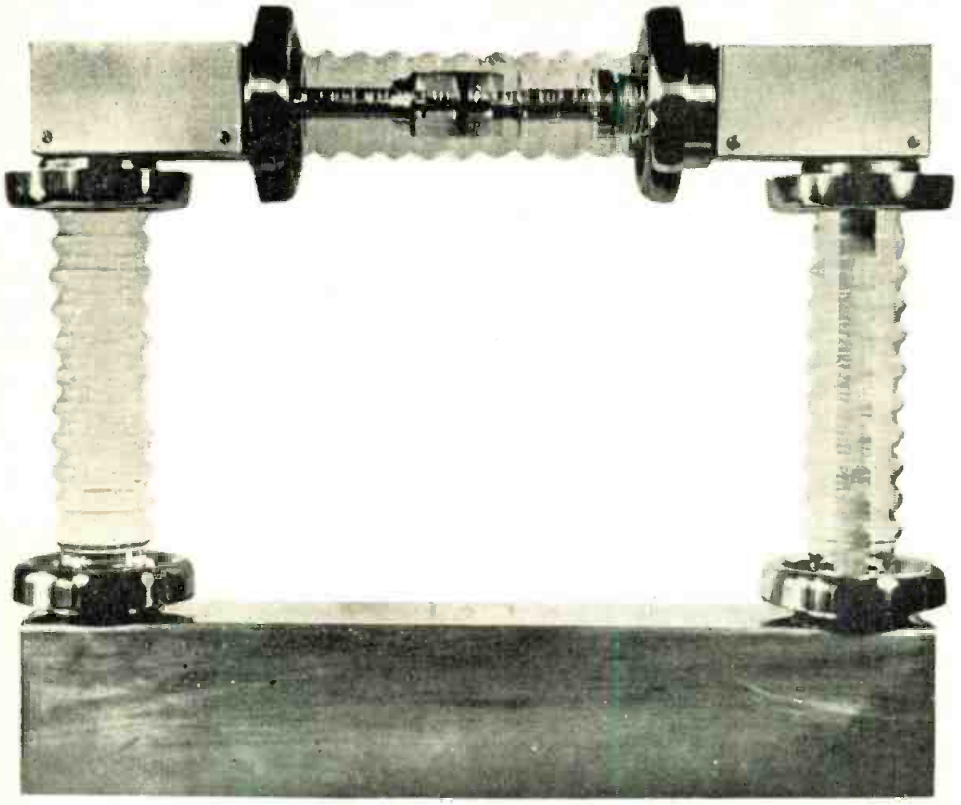


Fig. 7: Coaxial unit, with an enclosed relay

Fig. 6: (1) All glass insulated relay. For precipitator ckts, and explosive atmospheres

in Vacuum Relays

The other basic type of actuation is through a flexible seal such as a diaphragm or metallic bellows which makes contact movement possible from an external mechanical source. There also are several kinds of small commercial switches of the diaphragm type used today.

High Voltage

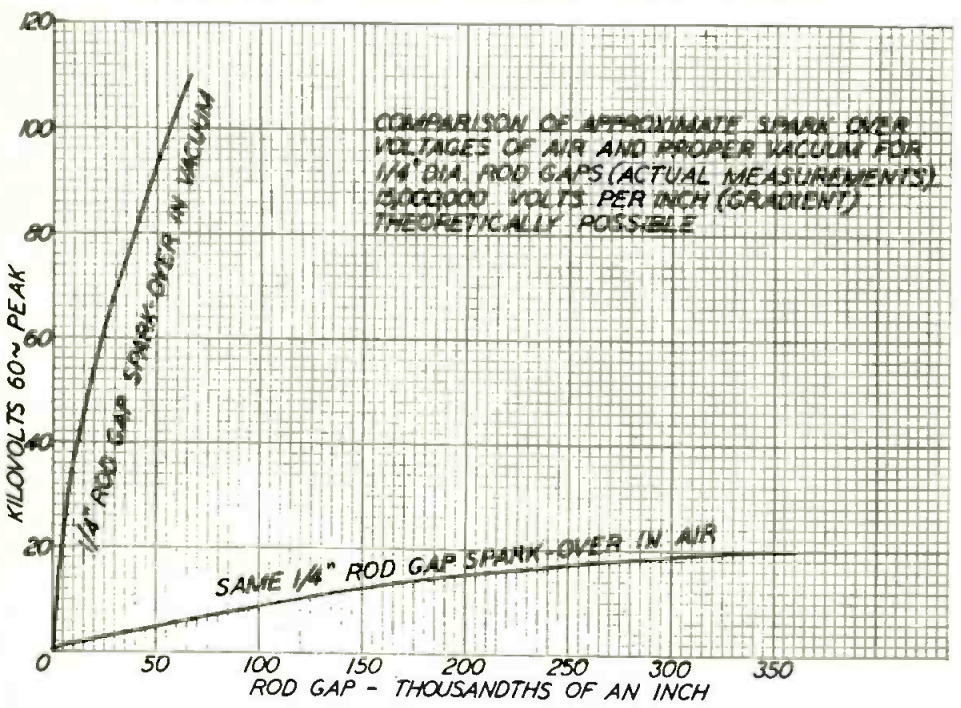
The new developments in vacuum relays which have been made at Jennings were greatly aided by the company's development and production of high voltage vacuum capacitors. Voltages up to 100 kv were obtained for very closely spaced plates in high capacitance units after many experiments in evacuation processes for large masses of material were made. The results of these experiments were then applied in improving vacuum relays.

At the same time there was developed a precision vacuum variable capacitor using a metallic bellows to allow movement of the variable plates from outside the enclosure. The exceptional life these bellows provided even for the long excursions required for their wide capacity change ratio indicated they should be good for millions of operations when used in vacuum relays. This was found to be true and many vacuum relays of this type have mechanical lives of a million operations or more.

Along with many mechanical and processing improvements in thousands of laboratory and production units of both high voltage vacuum capacitors and vacuum switches, it has been necessary to develop completely new high voltage equipment to aid in testing. A good example of this is a 60 kv vacuum capacitor voltage divider. This is used in observing transients generated across vacuum switch contacts when opening, and also used to measure high voltage r-f applied to test r-f switches.

Development work has centered around 3 mechanical types. The first type is the metallic bellows vacuum seal. This seems to be the most useful unit for the large mechanical movements and higher contact pressures required in high power applications (see Figs. 1 and 2). It also can be used with mechanical or electro-mechanical types of actuating mechanisms. The second and third

Fig. 8: Comparison of breakdown voltages for air and vacuum dielectrics



Vacuum Relays (Continued)

types have a magnetic circuit built inside the vacuum, utilizing magnetic conductors as part of the vacuum seal. This arrangement allows the use of a comparatively small, low wattage coil which is easily removable. For simple contact arrangements the clapper type of armature (Figs. 3 and 4) is used. For more complicated contact arrangements a modified solenoid type (Fig. 5) is necessary to provide wider contact opening for more overtravel and greater total contact pressures.

Metal Contacts

Previously, high temperature metals such as tungsten and molybdenum have not been too satisfactory for use as contacts in air due to rapid oxidation and contamination. With new permanent vacuum processing, tungsten and "moly" contact surfaces stay so free from surface contaminants that two closed contacts create practically a solid conductor electrically. These seem to be two of the best metals for good contacts in vacuum.

An interesting result of removing surface contaminating films is found when using some of the more cohesive metals such as copper. When two copper surfaces are gently pressed together after undergoing this vacuum process, molecular cohesion is so strong without the usual intervening oxide layer that they may require forces many times more than the initial pressure to pull them apart again. For a $\frac{1}{16}$ in. diameter butt contact this force was as much as 20 lbs. compared to an initial pressure of 3 lbs. This occurred without any current flow to aid in this cohesion.

There are many satisfactory materials for vacuum seals and structures that can be used to obtain and maintain permanent vacuum in a sealed envelope. The most popular of the metals are copper, stainless steel, nickel, monel, Kovar steel alloy, tantalum and others of high melting point and low vapor pressure. Some of the successful nonmetallic materials have been electrical grade high strength pyrex glass, and fused alumina ceramic. The proper processing must be used with each material to insure permanent elimination of adsorbed or occluded gases and cleaning agents.

Vacuum relays sometimes are considered similar to hermetically sealed relays. However, after closer examination of the difference in results between hermetically sealing as we now know it, usually with a dry inert gas enclosed, and properly processed vacuum sealing with no additive atmosphere, it can be seen that there is little or no comparison. Vacuum relays are in a class by themselves.

Dielectric Increase

Probably the most significant improvement resulting from the proper vacuum process is the extreme increase in dielectric strength over that of air. Up to 5000 v/mil (.001 in.) breakdown in vacuum compared to 300 v/mil air breakdown for the same contact shape and spacing is commonly attained for close spacing of less than 0.005 in. Factors of 15,000 v/mil are theoretically possible. The graph of Fig. 8 shows that this difference of air breakdown and vacuum breakdown approximates ratios up to 30 to 1 for modern vacuum techniques.

Fig. 9: 5 millisec overload circuit breaker using ¼ in. diameter contacts of 50 kv test

A great asset of this high dielectric strength is that repeated sparkovers can occur in properly processed vacuum units without damage and with instantaneous and complete recovery of dielectric strength as soon as the over-voltage is removed.

According to Avogadro's theory of gases there are about 6×10^{23} molecules of gas in a volume of 22.4 liters at 0° C. and 760 mm of mercury pressure. This would indicate about 10^{20} molecules of air in a volume of air of the size of our smaller vacuum enclosures. By reducing this number of molecules to the proper minimum value, perhaps 1 billion or less, and being able to maintain this value, we can get the insulating properties necessary to be able to operate a sealed vacuum switch for millions of operations at currents of over 10 a even at very high voltages without failing. Currents of 10 to over 100 a can be interrupted hundreds of thousands of times or more. Currents of 1000 to over 10,000 a have been interrupted hundreds of times recently without failure. Decrease of vacuum either due to current interruption, aging, or over-voltage sparkovers, is now insignificant during the life of sealed vacuum relays. In fact we are finding that as time passes dielectric strength actually increases with age. This is probably due to selective adsorption of some of the gas molecules left after processing.

This extreme increase in breakdown strength by use of the proper vacuum processes benefits us in several ways. Much less contact opening is required for either high or low voltage current interruption or for voltage hold off. Arc interruption is much more rapid for slower contact opening speeds. Especially important is the fact that at proper opening speeds, deionization occurs at the first current zero of an alternating current with no restrikes. This is especially valuable in switching capacitor loads.

Closely aiding this high dielectric strength is a very low arc resistance maintained while arcing until the proper spacing is attained with dc, or a current zero occurs with ac. At this point, the voltage gradient is reduced sufficiently to stop field emission and the chain reaction of electron emission which permitted continued ionization can no longer continue. The remaining vapors created by the arc then deionize and no longer pass current.

Vacuum Switch

Several theories may combine to add to the explanation for this fundamental vacuum switch principle. Some of these theories are a rapid radial diffusion of current carrying particles, a cooling effect due to metal evaporation in vacuum, and an adiabetic cooling due to sudden

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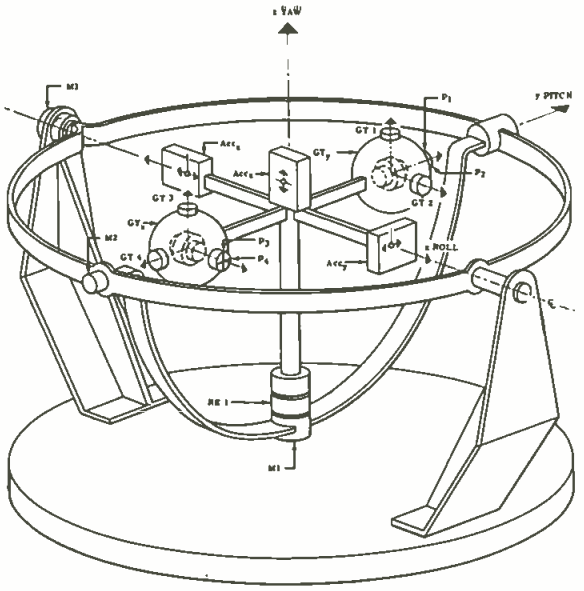

Fig. 1: Inertial platform contains gyros and accelerometers on a gimbal mounting

Inertial Air Navigation Systems

Velocity and position of aircraft are obtained by integrating outputs of three accelerometers, knowing the starting position. No external information is required

An ideal aircraft navigation system, besides being accurate and reliable, should be able to operate anywhere in the world, at any time, and under any conditions, without requiring external information, or radiating a detectible signal. These requirements cannot be met by conventional airborne navigation techniques; however, such a system has been developed from the less widely known inertial techniques.

Inertial navigation is a dead reckoning technique utilizing as its basic information the measured acceleration of the aircraft being navigated. Knowing the velocity vector and position coordinates of the aircraft at its starting point, a continuous reading of subsequent velocity can be obtained by a single integration of accelerometer outputs, and continuous position data is obtained from a second integration.

The arrangement presented here is highly over simplified, but does nevertheless, illustrate the basic concepts of an inertial navigation system. Many different configurations are possible, and the one selected was chosen because it provides a convenient means of illustrating principles and requirements common to substantially all inertial navigation systems. One possible way of measuring the total acceleration vector of a vehicle is, of course, to measure the three components of the acceleration in a three axis orthogonal coordinate system, using three orthogonally mounted accelerometers.

Accelerometers

Early accelerometers were essentially pendulous masses on a pivot bearing and coupled to an electrical pickoff. Acceleration would move them off the vertical, actuating the pickoff. To eliminate the pivot friction, the bearings were replaced by thin metal tape, acting as a spring and obtaining motion proportional to acceleration. Another method, having an output proportional to velocity, employs viscous drag of a damping fluid on the moving assembly to give output proportional to the time integral of acceleration. The frequency deviation of a resonating vibrating system, in which an accelerating force will alter the resonant frequency, is a measure of acceleration. If the total cycles of frequency deviation are counted over a time interval, this is proportional to total velocity change. Application of an accelerating force to an unbalanced gyro, with a servo follow-up platform for the gyro, will cause the precession of the gyro and platform at a rate proportional to the acceleration. The total precession angle will be proportional to velocity.

The accelerometers must be mounted on a stable platform in order to insure against the arbitrary and unpredictable angular motions of the aircraft. Gyroscopes are thus essential components of the system,

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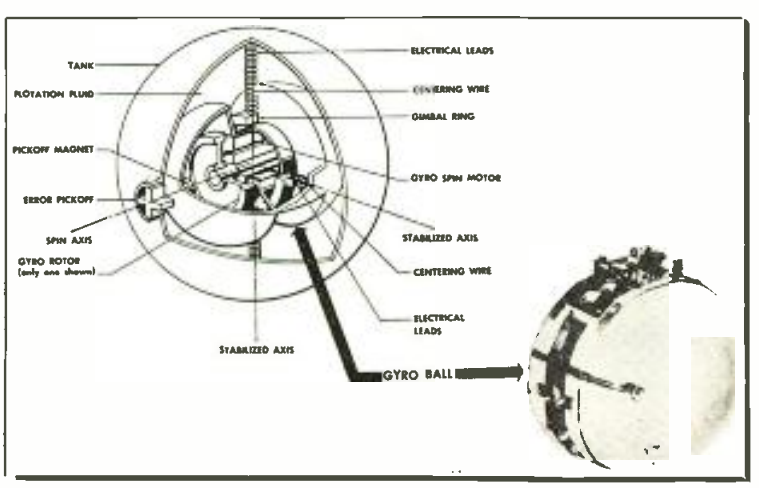


Fig. 2: High precision, fluid immersion gyro contains rotating wheel in a spherical shell, which is then completely submerged in neutral buoyancy in a container of fluid

Continuous Scanning Facsimile Transmitter

By G. M. STAMPS
and M. SCHANKLER

Unit capable of scanning 18.85 in. copy of any length permits continuous scanning of weather maps for transmission on the facsimile weather network. Methods of continuous scanning and the development and construction of a weather map scanner are described

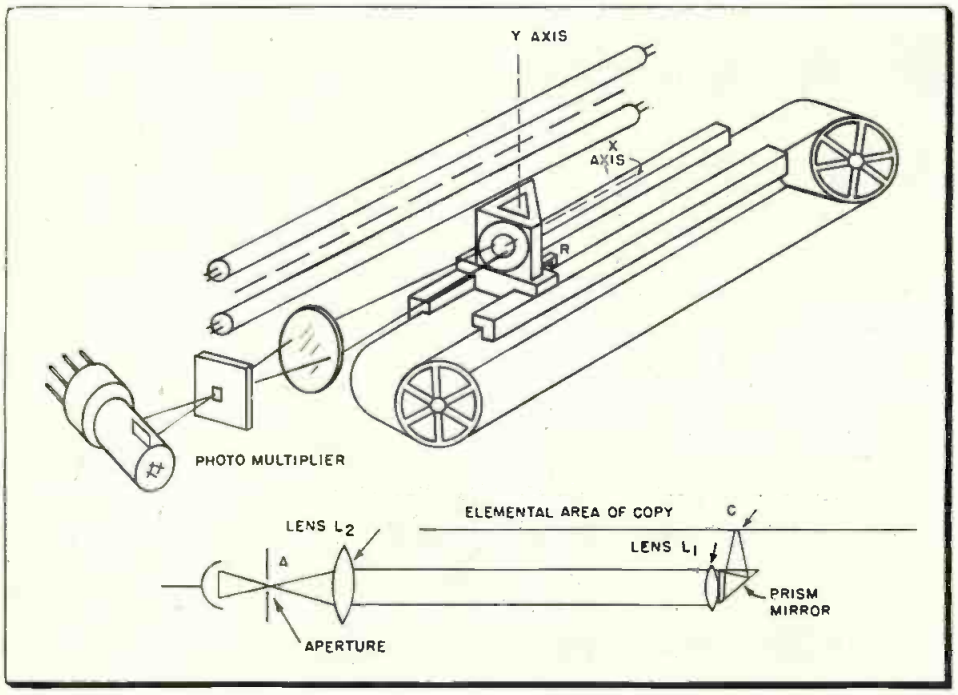
Fig. 1: The X-1x Facsimile Transmitter with weather map feeding past scan line

Continuous scanning of weather maps for transmission on the Facsimile Weather Network has been made possible by the development of a wide copy spiral and slit scanner. Capable of resolving 2,000 elements per sweep, the X-1x Facsimile Transmitter scans 18.85 in. wide copy with straight, flat, linear sweeps, free from jitter. (Fig. 1)

Since copy of any length is accepted by the X-1x, large weather maps 18.85 in. x 36 in. (or more) in size and covering the continental U. S. and its environs in detail can be transmitted. At present the Facsimile Weather Network is limited to maps 12 in. x 18.85 in., a size which just wraps around the revolving drums of World War II type equipment. These weather maps are transmitted to stations throughout the U. S. on a steady 24 hr. basis, aiding weather forecasting for the hundreds of meteorologists who serve the Weather Bureau, the Armed Forces, and others to whom weather is a prime consideration.

The technological bottleneck to transmitting maps of arbitrary length has until now been the lack of a continuous scanner. Continuously printing recorders of two different types have been in existence for some time. Such recorders using a helix and blade and employing electrolytic papers are in extensive use at present, notably in the press service picture operations and in the Canadian weather network (Hogan and Muirhead recorders). Continuous recorders employing styli on endless belts have been used for some time for recording on sparking papers, notably by Western Union on its Teledeltos. Recently such a three stylus recorder was designed by Times Facsimile for use on the weather networks to receive the larger maps.

Fig. 2: Optical heads on an endless belt



Scanning Methods

Various attempts have been made to develop continuous facsimile scanners. (Fig. 3). Spot images projected on the copy from cathode ray tubes have formed the basis for "flying spot" scanners built at RCA by Young, Artzt and their associates[1]. Such scanners are limited in resolution to 800 or 1000 elements per sweep by the cathode ray tubes employed, and hence are not applicable for that fundamental reason to wide copy weather map scanning.

Methods for generating linear sweep scans of flat copy by mechanical-optical means include the spiral and slit[2], and helix and slit (Hogan[3], also Alden), displacement of image by refraction through an even polygon prism (RCA tape facsimile)[4], optical heads travelling on an endless belt (Deuth and Stamps[5]), and slits traveling on endless belts.

The helix and slit method is the analogy in three dimensions to the spiral and slit in a plane. The same arguments which led CBS to prefer color disks to color drums have analogies which apply to facsimile

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scanning. The polygon prism is limited in resolution. Any endless belt method such as travelling heads or slits suffers from the problem of aligning successive heads and balancing their signal output.

Another continuous scanning method is based on tilting a mirror so that a projected spot or aperture image performs a linear sweep. Such scanners using a cam driven mirror for one of its scans have been built by Hogan Labs, Inc.[6] and by Fairchild (Scan-A-Sizer). A similar method uses a polygon of mirrors, using successive mirrors to perform the tilting motion rather than cycling the same mirror. There are several difficulties with adapting this approach to wide copy scanning. When the mechanism is sufficiently complex to make the lens move to compensate for path length changes involved in the tilt, the speed of scan is limited. When such fine corrections are neglected, the resolution and half-tone response are degraded, although the speed of scan becomes adequate for the weather network requirements. In the case of the spinning polygon the sweep is linear for only a short distance.

Investigations

Hogan Labs was asked by the Bureau of Ships to investigate methods of continuous scanning, to select the best one available, and to build a continuous weather map scanner employing the method selected.

The detailed investigation was confined to two continuous scanning methods. The spiral and slit method had been used in an 8 in. sweep scanner developed earlier, and we were encouraged by this to believe that the method could be extended to an 18.85 in. sweep in a straightforward manner. The optical heads on an endless belt method, originally proposed by A. F. Deuth[7], was also selected for further investigation, because techniques had been worked out for avoiding the two difficulties cited earlier as common to endless belt methods.

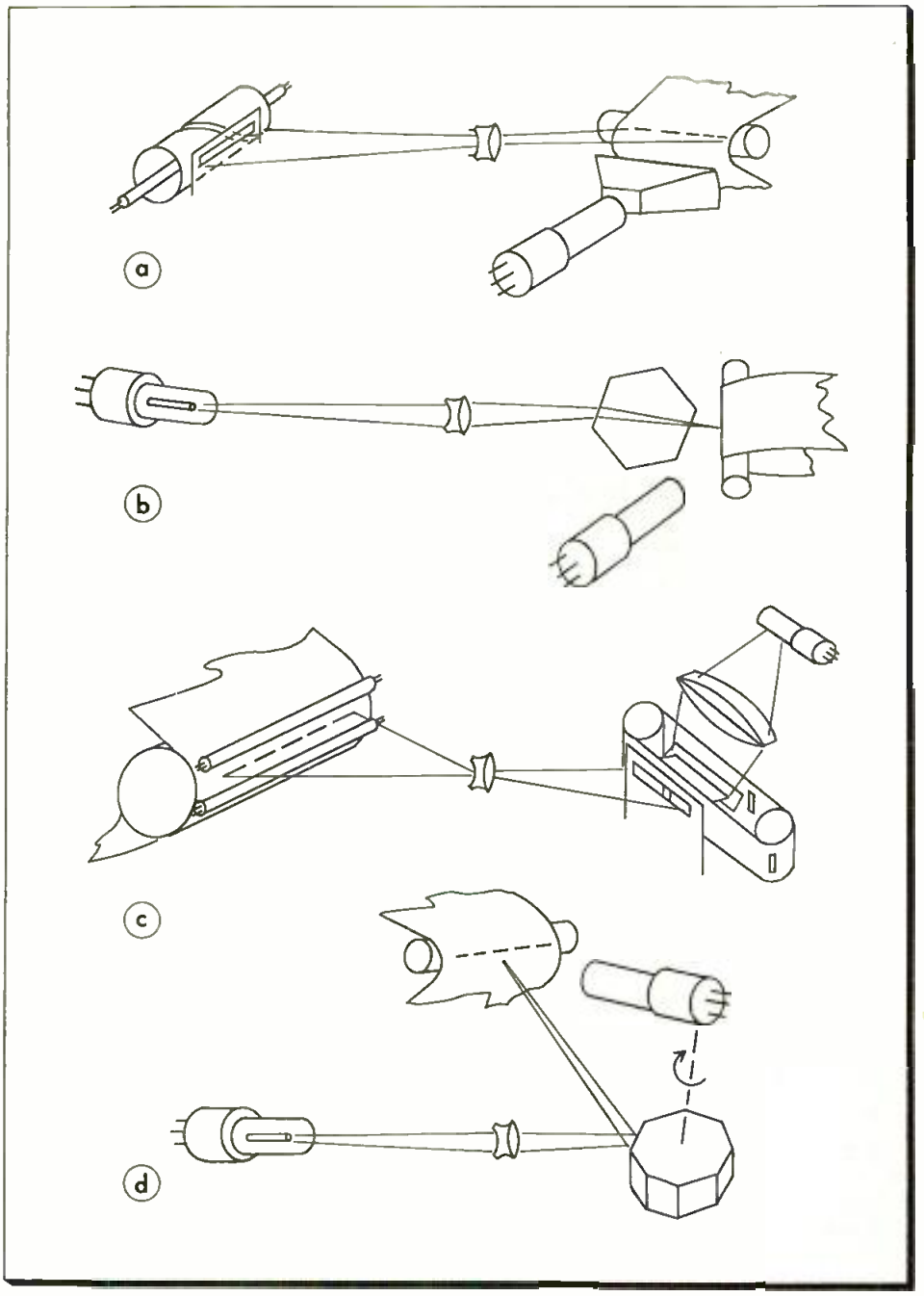
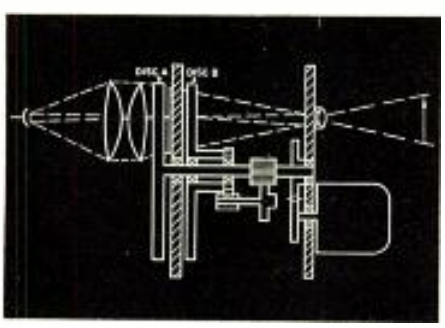


Fig. 3: Scanning methods: a. Helix and slit; b. Refraction through polygon; c. Slits on endless belt; d. Reflection from mirror.

Fig. 4: Disc A selects one of 15 apertures formed by combining disc B and the slit



In addition to obtaining a solution to the scanning problem, the Bureau of Ships was anxious to have the scanner mounted in a standard 19 in. relay rack. Since 18.85 in. copy plus margin runs to 20 in., this requirement at first glance is reminiscent of 6 lbs. of flour in a 5 lb. bag. By placing the copy feed in front of the rack panel, however (See Fig. 1) the optical path eventually used in the X-1x was made to clear the panel sides. While this packaging feature was borne in mind, the primary problem was to scan a weather map continuously.

Optical Head Scanner

Working scanners were put together using optical bench components and breadboard parts to test both of these scanning methods. The optical head on an endless belt method will be described first.

Three optical heads (Fig. 2) were mounted on a steel tape endless belt. One revolution of the drive sprocket wheel advanced the belt through one third of its length, thus driving one optical head across one sweep. The sketch of Fig. 2 illustrates the principles involved. Each optical head contained a lens L_1 and a prism mirror. The copy to be scanned lay in the focal plane of lens L_1, hence all light rays emanating from an elemental area C of the copy were rendered parallel by the lens L_1. This collimated beam was "thrown" parallel to the belt to a second lens L_2, and an image of C

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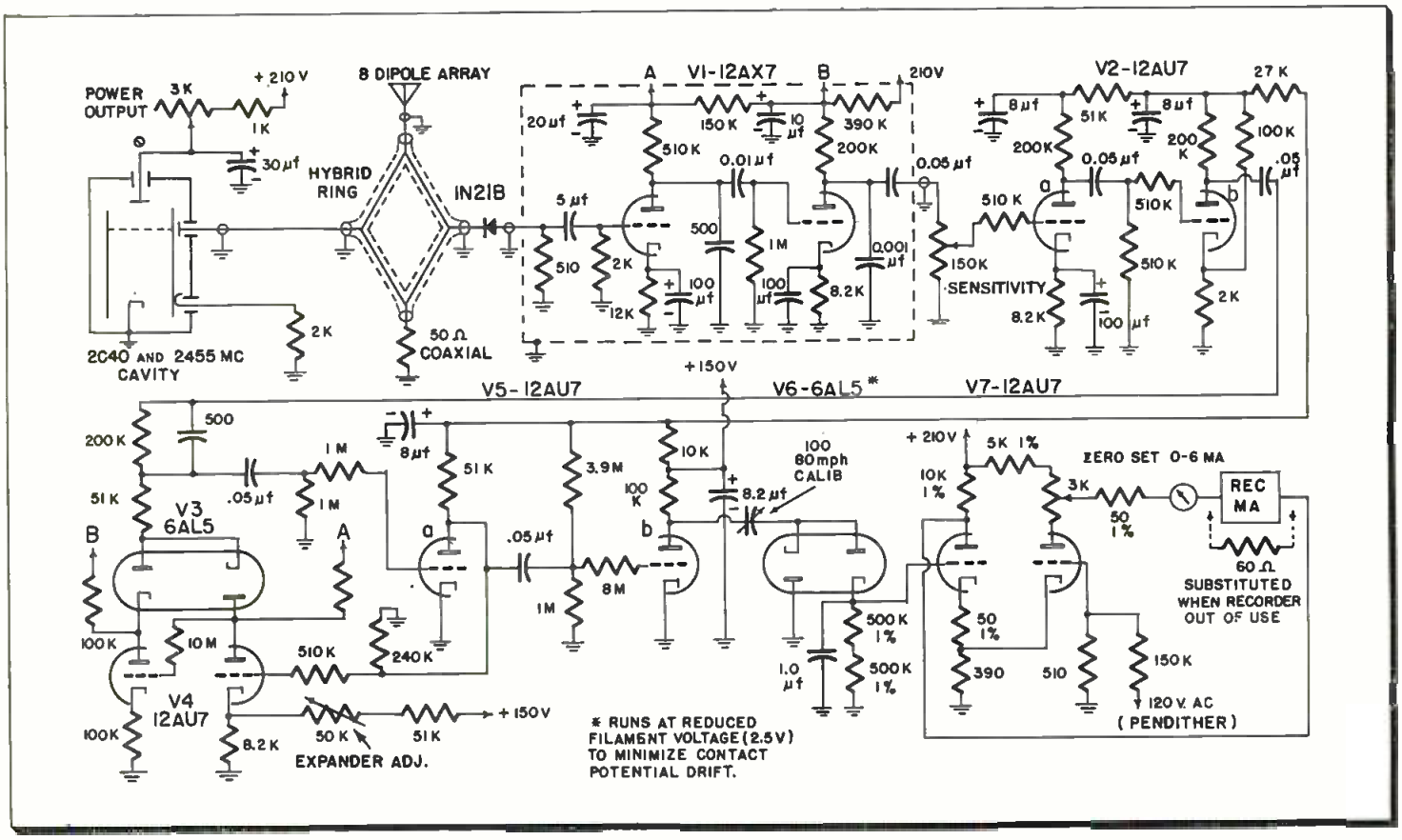

Fig. 1: Schematic diagram of typical radar speed meter. Power supply is omitted

Radar Speed Meters

Circuit and block diagrams are featured in this technical description of radar traffic speed meters, along with test results by a police survey team

By RODNEY W. JOHNSON

THE growing popularity of radar speed meters in law enforcement makes a technical description of these devices timely. The doppler radar principle, upon which these units operate, is well known and needs little elaboration. Since 360° of phase shift of a reflected signal takes place each half wavelength of target movement, the doppler frequency f_d and target velocity v are related by $v=f_d(\lambda/2)$, in consistent units. Radar speed meters operate nominally on an FCC-assigned industrial frequency of 2455MC[1], so that the relation between radial velocity in MPH and doppler frequency in CPS is $v=f_d/7.31$. A speed of 100 MPH thus corresponds to a doppler frequency of 731 CPS.

Equipment Description

A radar speed meter which has been available for about 2 yrs., and which is in growing use by a number of states and cities for both surveys and enforcement, is shown in Figs. 1 and 2.

The transmitter, receiver, antenna, frequency meter and power supply are contained in one light-weight, portable rectangular case 13 x 12¼ x 7⅝ in., capable of tripod or car-trunk mounting. The total weight of the unit is 37½ lbs. Two indicators are provided: one, a 5 in. rectangular dc milliammeter calibrated in MPH (2MPH per division), and the other a 0-6 ma recording milliammeter, with 100 ft. chart capacity and chart speed normally 1½ ips. The range 0-4 ma. is calibrated 0-100 MPH; full scale is 150 MPH.

The transmitter is a cavity-controlled 2C40 oscillator, with a frequency stability stated by the man-

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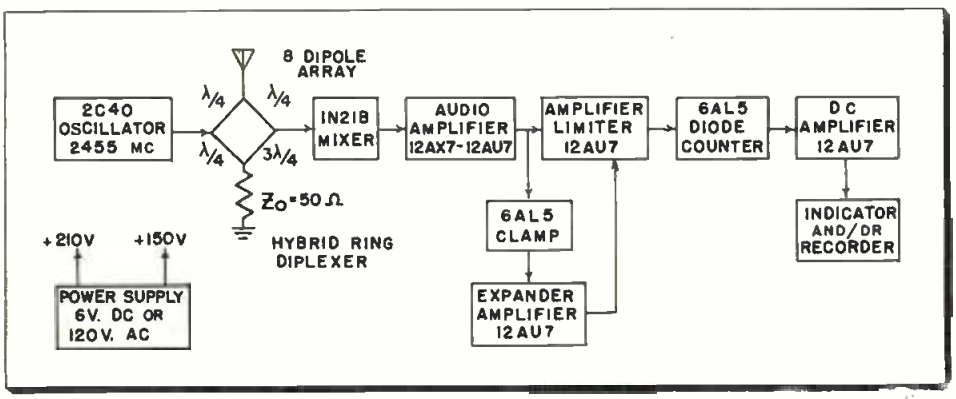
RODNEY W. JOHNSON, 1202 Avoca Ave., Pasadena 2, Calif.

Fig. 2: Block diagram of radar speed meter. Unit works on doppler principle



Page from an Engineer's Notebook

No. 34 — Amplifier Distortion Measurement

Second harmonic distortion of a single-ended Class A amplifier can be read directly from the tube's load line, using the easily-constructed "Adjustable Distortion Rule" described here. Graph relates distortion and ratio of two halves of plate current swing

By D. A. WOLFTHAL

D. A. Wolfthal
The Reflectone Co.,
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Stamford, Conn.

THE use and construction of an adjustable "distortion-rule," described here, will enable electronic circuit designers to read the second harmonic distortion of a Class A, single-ended triode directly from its load line. The limits of the rule described are zero to 25% distortion, but rules covering greater ranges are just as readily constructed.

The basis for the construction of the adjustable rule described below, as well as for a fixed one, is the graph shown in Fig. 1. This graph relates second harmonic distortion and the ratio of the two halves of the plate current swing, (AQ and QB), around the quiescent point. The normalized equation is derived in most texts, and need not be derived here.

The use of the graph is simple. For example, if in Fig. 4, AQ/QB equals 1.22, the second harmonic distortion is 5%.

Fig. 2 shows the adjustable distortion-rule which consists of two transparent plastic parts: a linear scale of any convenient length, and a calibrated wedge derived geometrically from the linear scale. The two parts are riveted together at the zero points so that the wedge is free to rotate.

To use the rule, lay the linear scale along the load line as in Fig. 3, with the zero at the quiescent point. Assume operation is between A and B. Note where B falls on the linear scale—"2." Rotate the wedge until the projection of "2" on the wedge crosses point A, and read directly, at the circumference of the wedge, the second harmonic distortion—"12%."

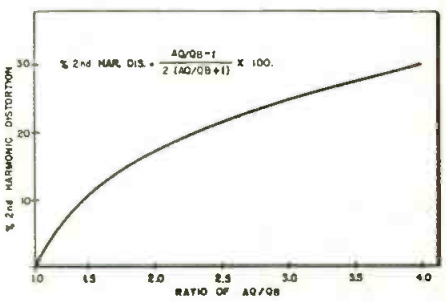


Fig. 1: Second harmonic distortion as a function of plate current swing

Conversely the rule may be used to locate a load line for a given % distortion without a series of numerical computations.

The construction of the rule is shown in construction Fig. 5. Lay out the basic scale OA (subdivisions as desired). Draw the arc AE, and draw OB equal to three times OA, crossing the arc at any arbitrary angle AOB which will determine the thickness of the wedge. The greater the angle, the greater the construction accuracy. Mark the 25% distortion point where OB crosses the arc.

Fig. 2: Amplifier distortion rule

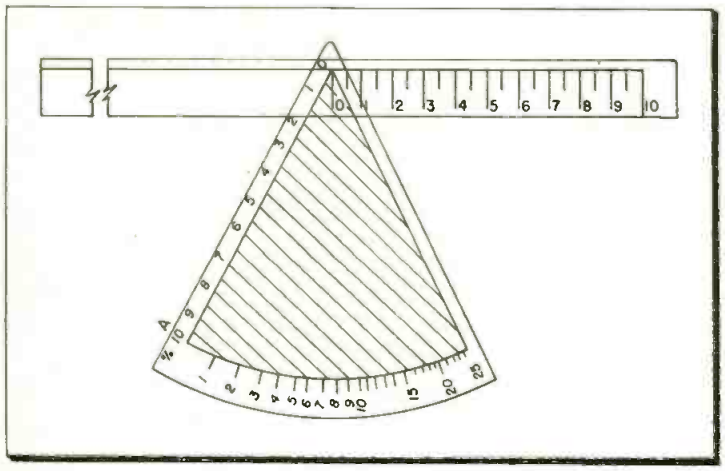
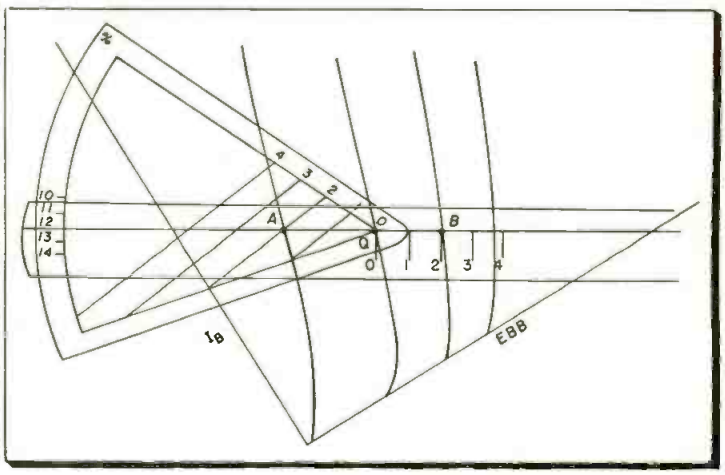


Fig. 3: Applying rule to typical load line



Distortion Measurement

(Continued)

Draw AB, and the projections of the linear scale OA by means of parallel lines from OA to OB. Lay out OC equal to two times OA. Mark 17% where OC crosses the arc. Using the graph of distortion vs. scale ratio, Fig. 1, plot enough additional constructions, as OD, to calibrate the circumference.

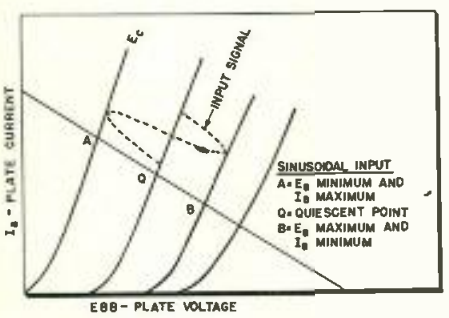


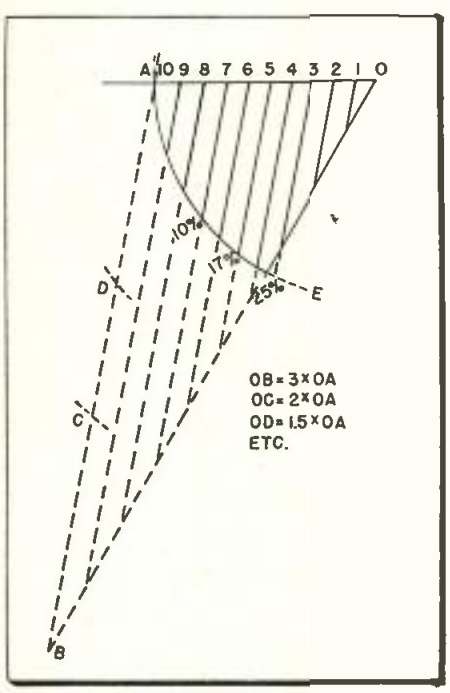
Fig. 4: Typical triode characteristic curve

If it is desired to construct a rule measuring more than 25% distortion, the graph of Fig. 1 must be extended, by solution of the equation from which it is derived, to obtain scale ratios greater than three. The length of OB would be equal to the ratio required for the maximum distortion to be measured.

The rule should be constructed on paper first. The lines can then be scratched into a plastic sheet laid over the drawing and filled in with a grease pencil.

The method of construction of the other half of the rule is self-evident.

Fig. 5: Layout and construction of rule



Low Power L-Band Signal Source

By R. F. SCHWARTZ

THE problem of having a cheap, low power source frequently arises in microwave work. For the higher bands such as S, X, and K the solution is relatively simple because small, probe output klystrons are available, often on the surplus market, that provide sufficient signal strength for many measurements. For the L-band the solution is not so simple. Although lighthouse tubes are readily available, it is costly to utilize them unless one also has available a cavity oscillator structure in which to operate them. Triodes with "built in" cavities such as those built for radiosonde work (i.e. 5794) have a very short life.

However these short-life tubes can be utilized very satisfactorily for limited microwave work if they are run at ratings much lower than those given in the tube manual.

The circuit to be used is as shown in Fig. 2. The plate supply voltage has been reduced from the 135 v. listed in the tube manual to a value of 35-45 v. For long life the filament voltage likewise has been reduced to about 4.5-5.0 v. instead of the 5.2-6.6 v. in the manual. Under these conditions the plate current will be between 5 and 8 ma. and the power output 3 to 5 milliwatts. By derating the tube in this manner the life of the 5794 is raised from the order of merely hours to over 500 hours. The tube tested by the writer has operated well over 500 hours intermittently with only a slight decrease in output and with a downward shift of frequency.

For practical application it may be desired to modulate the output. Amplitude modulation can be secured by applying an audio signal directly to the bias resistor.

The 5794 comes with a probe type of output. It is not difficult to convert this to a conventional coaxial output. Fig. 1 shows the manner in which this was done by the author. To maintain frequency stability the structure shown should be protected with draft shields.

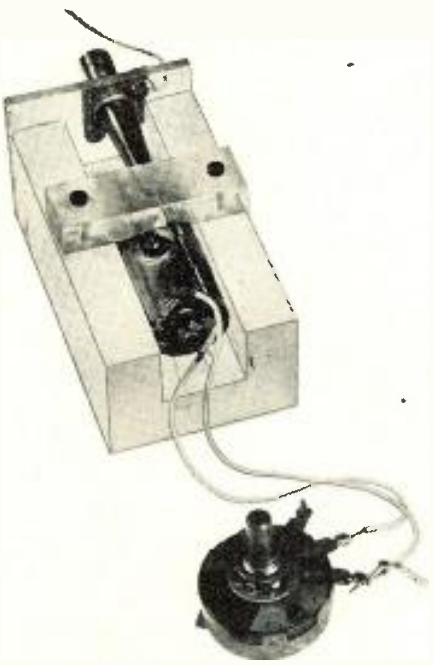
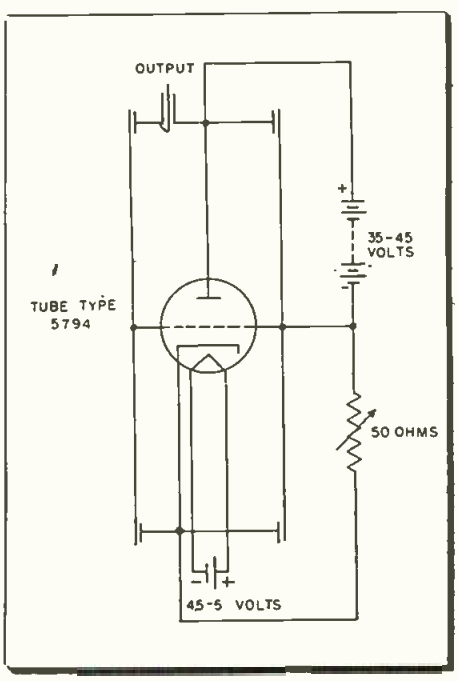


Fig. 1: Converting probe type output of 5794 tube to conventional coaxial output

In conclusion it should be noted that although the use of these tubes will not solve all source problems for the worker in L-band, it will provide one other possibility of limited application to consider.

Fig. 2: Schematic diagram of L-band source



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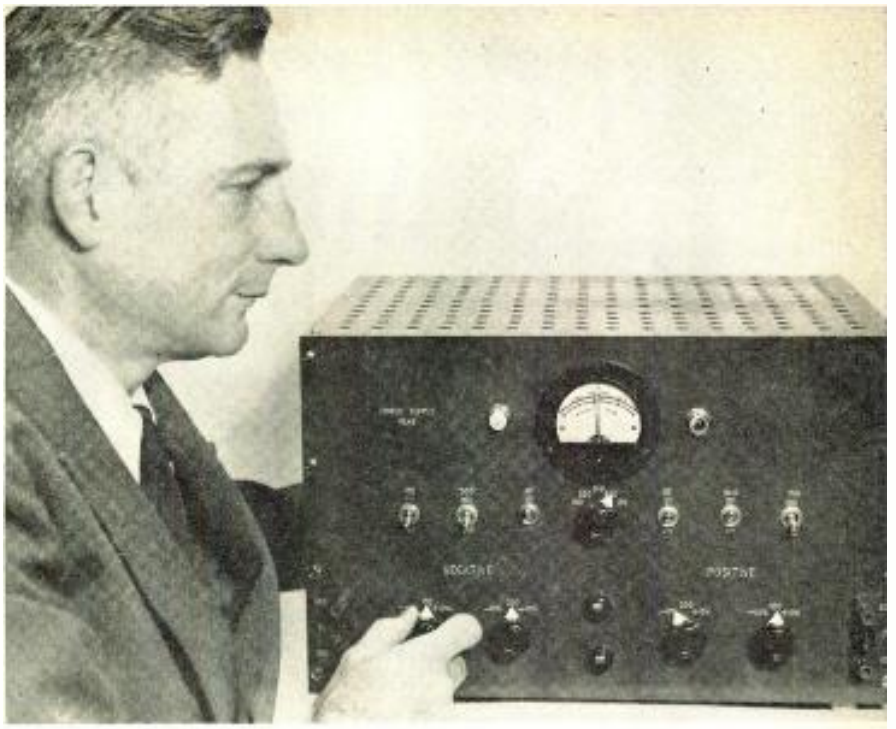
Series tube circuits which combine both high efficiency and high amplification are achieved by employing beam power tubes with separate screen supplies

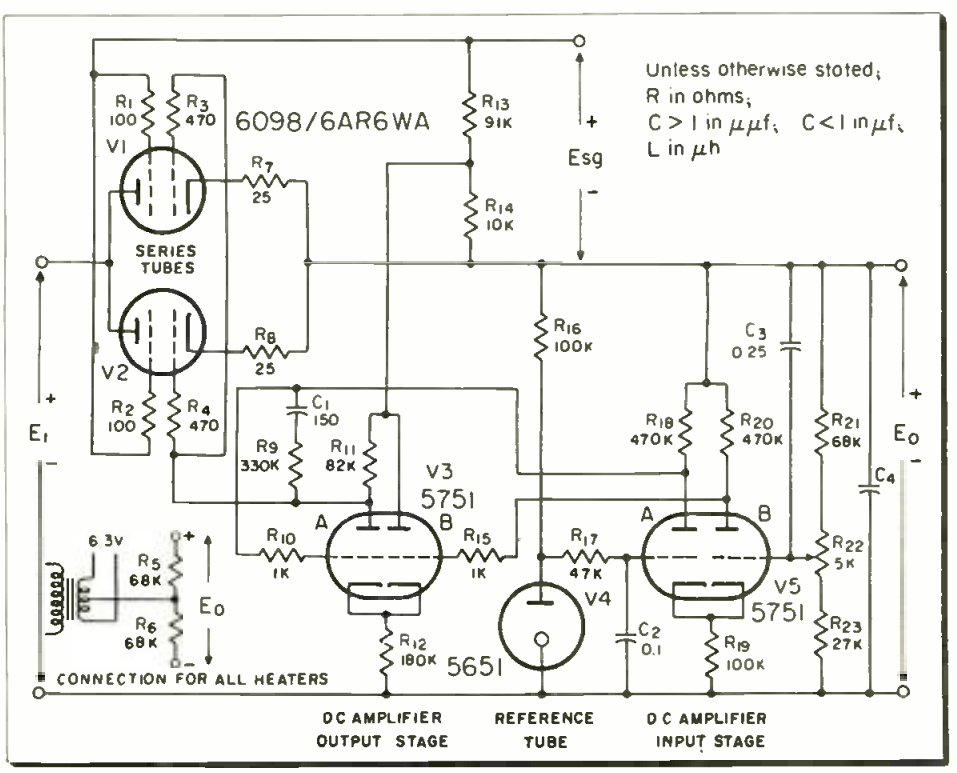


Stabilized voltage regulator in operation at NBS Labs

Stabilizing Voltage Regulators

RELATIVELY simple, highly stabilized voltage regulators have been designed by S. Rubin of the National Bureau of Standards by adding a separate screen supply to beam power series tubes. In these regulators, tubes having low ratios of screen-to-plate current are combined with screen grid supplies using semiconductor rectifiers. As a result, the series tubes of these circuits have slightly lower efficiency but much higher amplification factors than the low-mu triodes usually used in voltage regulators. Several units can be interconnected to supply a number of voltages to a piece of equipment. In this case, the circuit can be simplified by energizing the screen grid of a lower-voltage regulator from the output of a higher-voltage regulator.

Fig. 1: Regulated 300-v. power supply uses pentode-connected series tubes



A voltage regulator usually consists of a series tube, a d-c amplifier, and a source of reference voltage. It is commonly used in conjunction with an unregulated voltage source to deliver a regulated voltage output. Acting as a "variable resistor" connected between an unregulated source and a load, the series tube is controlled by the d-c amplifier. Signals representing the difference between a portion of a load voltage and a reference source are fed to the input of the d-c amplifier, and the amplifier output voltage is used to control the "resistance" of the series tube. For every change in load voltage caused by a change in either line voltage or load current, a corrective voltage is applied to the control-grid of the series tube, resulting in an essentially constant voltage across the load.

Although it is desirable to have a series tube that combines high efficiency with high amplification, an increase in one of these factors can in general be achieved only at the cost of a decrease in the other. Low-mu triodes such as the type 6AS7 are very efficient because, under conditions of zero control grid bias, they can pass a large amount of current with a small plate-cathode voltage drop. On the other hand, a triode-connected (screen grid tied to cathode through a small resistance) beam power pentode has a higher amplification factor but requires a larger plate-cathode voltage drop for the

(*Continued on page* 100)

1955-1956 Statistics of the

ANNUAL BILL OF U. S. FOR RADIO-TV 1955

Sale of Time By Broadcasters	$1,000,000,000
Talent Costs	200,000,000
Electricity, Batteries, etc., to operate 176,900,000 Radio & TV Receivers	750,000,000
12,500,000 Radio Sets, at Retail Value	485,000,000
7,800,000 Television Sets, at Retail Value	1,263,600,000
Phono Records, 242,000,000 at Retail Value	300,250,000
Radio-TV Servicing and Installation: (Retail Value)	
150 Million Replacement Receiving Tubes	255,000,000
2.8 Million Replacement TV Picture Tubes	100,000,000
Radio-TV Component Parts, Antennas, Accessories	620,000,000
Labor	825,000,000
TOTAL	5,798,850,000

RADIO AND TV SETS IN U. S.

	January 1, 1956 Radio	TV
United States homes* with:	52,000,000	34,700,000
Secondary sets in above homes	40,500,000	2,300,000
Sets in business places, institutions	10,000,000	2,400,000
Auto sets	35,700,000	
TOTAL	138,200,000	39,400,000
Total Radio-TV sets in U.S.	177,600,000	

* Note: Caldwell-Clements' figure on "homes" includes every dwelling unit, whether individual or family, and includes permanent residents in hotels, apartment-hotels and apartment houses.

1956 ELECTRONIC MARKETS

Estimated annual purchases by various segments of the electronics industries, including those made within and between these divisions.

Manufacturers	$3,300,000,000
Government	3,000,000,000
Service outlets	910,000,000
Industrial end users	100,000,000
Communications, commercial	60,000,000
Broadcasters	50,000,000
Amateurs, experimenters	45,000,000
Civilian electronic labs	40,000,000
Recording studios	25,000,000

PRODUCTION OF CIVILIAN RADIO SETS—1922 TO 1955

	Total Civilian Radio Sets Manufactured		Total Civilian Tubes* Manufactured		Automobile Sets Manufactured		Auto Sets in Use	Homes with Radio Sets	Total Radio Sets in Use in U. S.	
	Number	Retail Value	Number	Retail Value	Number	Retail Value	Number	Number	Number	
1922	100,000	$ 5,000,000	1,000,000	$ 6,000,000	.....	.....	.....	260,000	400,000	1922
1923	550,000	30,000,000	4,500,000	12,000,000	.....	.....	.....	1,000,000	1,100,000	1923
1924	1,500,000	100,000,000	12,000,000	36,000,000	.....	.....	.....	2,500,000	3,000,000	1924
1925	2,000,000	165,000,000	20,000,000	48,000,000	.....	.....	.....	3,500,000	4,000,000	1925
1926	1,750,000	200,000,000	30,000,000	58,000,000	.....	.....	.....	5,000,000	5,700,000	1926
1927	1,350,000	168,000,000	41,200,000	67,300,000	.....	.....	.....	6,500,000	7,000,000	1927
1928	3,281,000	400,000,000	50,200,000	110,250,000	.....	.....	.....	7,500,000	8,500,000	1928
1929	4,428,000	600,000,000	69,000,000	172,500,000	.....	.....	.....	9,000,000	10,500,000	1929
1930	3,827,800	300,000,000	52,000,000	119,600,000	34,000	$ 3,000,000	.....	12,048,762	13,000,000	1930
1931	3,420,000	225,000,000	53,000,000	69,550,000	108,000	5,940,000	100,000	14,000,000	15,000,000	1931
1932	3,000,000	140,000,000	44,300,000	48,730,000	143,000	7,150,000	250,000	16,809,562	18,000,000	1932
1933	3,806,000	180,500,000	59,000,000	49,000,000	724,000	28,598,000	500,000	20,402,369	22,000,000	1933
1934	4,084,000	214,500,000	58,000,000	36,600,000	780,000	28,000,000	1,250,000	21,456,000	26,000,000	1934
1935	6,026,800	330,192,480	71,000,000	50,000,000	1,125,000	54,562,500	2,000,000	22,869,000	30,500,000	1935
1936	8,248,000	450,000,000	98,000,000	69,000,000	1,412,000	69,188,000	3,500,000	24,600,000	33,000,000	1936
1937	8,064,780	450,000,000	91,000,000	85,000,000	1,750,000	87,500,000	5,000,000	26,666,500	37,600,000	1937
1938	6,000,000	210,000,000	75,000,000	93,000,000	800,000	32,000,000	6,000,000	28,000,000	40,800,000	1938
1939	10,500,000	354,000,000	91,000,000	114,000,000	1,200,000	48,000,000	6,500,000	28,700,000	45,300,000	1939
1940	11,800,000	450,000,000	115,000,000	115,000,000	1,700,000	60,000,000	7,500,000	29,200,000	51,000,000	1940
1941	13,000,000	460,000,000	130,000,000	143,000,000	2,000,000	70,000,000	8,750,000	29,700,000	56,000,000	1941
1942	4,400,000	154,000,000	87,700,000	94,000,000	350,000	12,250,000	9,000,000	30,800,000	59,340,000	1942
1943	.....	.....	17,000,000	19,000,000	.....	.....	8,000,000	32,000,000	58,000,000	1943
1944	.....	.....	22,000,000	25,000,000	.....	.....	7,000,000	33,000,000	57,000,000	1944
1945	500,000	20,000,000	30,000,000	35,000,000	.....	.....	6,000,000	34,000,000	56,000,000	1945
1946	14,000,000	700,000,000	190,000,000	200,000,000	1,200,000	72,000,000	7,000,000	35,000,000	60,000,000	1946
1947	17,000,000	800,000,000	220,000,000	260,000,000	2,500,000	150,000,000	9,000,000	37,000,000	66,000,000	1947
1948	14,000,000	600,000,000	200,000,000	230,000,000	2,800,000	200,000,000	11,000,000	40,000,000	74,000,000	1948
1949	10,000,000	500,000,000	190,000,000	350,000,000	3,500,000	240,000,000	14,000,000	42,000,000	81,000,000	1949
1950	14,600,000	721,000,000	383,000,000	644,000,000	4,760,000	248,000,000	17,000,000	45,000,000	90,000,000	1950
1951	13,000,000	605,000,000	430,000,000	640,000,000	4,800,000	255,000,000	20,000,000	45,850,000	100,000,000	1951
1952	10,000,000	500,000,000	330,000,000	740,000,000	2,750,000	148,000,000	25,000,000	46,000,000	114,500,000	1952
1953	13,400,000	536,000,000	410,000,000	920,000,000	4,800,000	250,000,000	29,000,000	48,000,000	120,500,000	1953
1954	10,000,000	400,000,000	400,000,000	880,000,000	4,300,000	220,000,000	32,000,000	50,000,000	127,000,000	1954
1955	12,500,000†	485,000,000	500,000,000	890,000,000	4,500,000	225,000,000	35,700,000	52,000,000	138,700,000	1955

* Tubes used as replacements accounted for about 25% of total in 1955.
† Estimated retail sales, including carryovers.

PRODUCTION OF PRINCIPAL COMPONENTS USED in RADIO-TV RECEIVERS

Year	Transformers (Iron Core)	Coils	Capacitors, (Electrolytic)	Capacitors, (Mica)	Capacitors (Ceramic)	Capacitors (Paper)	Resistors, (Composition)	Resistors, (Wire Wound)	Loudspeakers	Year
1946	49	149	22	69	284	155	477	29	14	1946
1947	70	193	27	84	349	196	608	37	17	1947
1948	46	250	28	86	357	212	654	42	17	1948
1949	39	196	25	74	310	218	670	50	13	1949
1950	65	332	44	106	417	351	1090	70	22	1950
1951	47	288	38	90	394	284	862	59	19	1951
1952	56	305	42	100	433	312	948	67	17	1952
1953	63	323	43	103	455	325	900	69	21	1953
1954	54	276	37	88	390	278	770	59	18	1954
1955	50	274	51	86	378	338	852	41	24	1955

Figures are in millions of units.

Radio-TV-Electronic Industries

VITAL TELEVISION STATISTICS 1946-1955

	Total TV Sets Manufactured		Receiving Tubes Used in New TV Sets and for Replacements		Total TV Picture Tubes Manufactured		Total Receiving Sets Manufactured	TV Stations on the Air	Total TV Sets in use in U. S.	At Close of
	Number	Retail Value	Number	Retail Value	Number	Retail Value	AM-FM-TV			
1946	10,000	$ 5,000,000	350,000	$ 588,000	20,000	$ 1,000,000	14,010,000	5	8,000	1946
1947	250,000	100,000,000	8,500,000	15,000,000	300,000	15,000,000	17,250,000	20	230,000	1947
1948	1,000,000	350,000,000	32,200,000	53,000,000	1,500,000	75,000,000	17,000,000	44	1,000,000	1948
1949	3,000,000	950,000,000	87,000,000	146,000,000	3,500,000	210,000,000	13,000,000	100	3,800,000	1949
1950	7,500,000	2,700,000,000	225,000,000	378,000,000	8,000,000	400,000,000	22,100,000	107	10,500,000	1950
1951	5,600,000	2,100,000,000	161,000,000	270,000,000	6,000,000	300,000,000	19,100,000	108	15,750,000	1951
1952	6,300,000	2,360,000,000	168,000,000	380,000,000	6,500,000	260,000,000	16,300,000	123	21,800,000	1952
1953	7,300,000	1,675,000,000	210,000,000	400,000,000	9,000,000	360,000,000	20,700,000	350	28,000,000	1953
1954	7,300,000	1,278,000,000	215,200,000	409,000,000	10,300,000	360,500,000	17,700,000	415	33,000,000	1954
1955	7,800,000*	1,263,600,000	220,000,000	407,000,000	10,600,000	371,000,000	20,000,000	457	39,400,000	1955

* Estimated retail sales including carryovers.

Phonographs

Estimated 1955 and 1956 sales of phono players in new units and retail $ volume

1955	
4,000,000	$120,000,000
1956	
4,250,000	$127,500,000

Recorders (non-commercial)

Estimated 1955 and 1956 tape recorder sales in new units and retail $ volume

1955	
325,000	$48,750,000
1956	
425,000	63,750,000

Service

During 1955 the annual retail bill for servicing of home electronic appliances is summarized:

150,000,000 replacement receiving tubes	$255,000,000
2,800,000 replacement picture tubes	$100,000,000
Antennas, components, parts, instruments	$620,000,000
Labor	$825,000,000
Total Servicing Bill	$1,800,000,000

1956 Estimates raise above figures by 10-14%

Broadcast Stations in U. S.

	AM	FM	TV		
Stations on Air	2773	493	337	VHF	Comml
			102	UHF	Comml
			13	VHF	Educ
			5	UHF	Educ
Under Construction (CPs)	271	61	41	VHF	Comml
			103	UHF	Comml
			6	VHF	Educ
			12	UHF	Educ
Applications	220	20	142	VHF	Comml
			19	UHF	Comml

Germanium Diodes

Estimated 1955 sales of point-contact type germanium diodes:

Non-entertainment:	
Equipment Manufacturers	8,200,000
Renewal	450,000
Total	8,650,000
Entertainment:	
Equipment Manufacturers	5,250,000
Renewal	250,000
Total	5,500,000
Grand Total	14,150,000

Estimated unit cost $0.30 ea.

Engineering Manpower 1955-56

Engineering Curriculum	No. of Bachelors Degrees Est. for 1954-55	Est. for 1955-56
Aeronautical	700	900
Ceramic	100	100
Chemical	2,100	2,500
Civil	4,000	4,300
Electrical	4,900	6,600
Engineering Mechanics	*	*
Engineering Physics	200	300
General Engineering	600	800
Industrial	1,400	1,600
Mechanical	6,000	7,100
Metallurgical	400	500
Others	2,900	3,600
Total	23,300	27,800

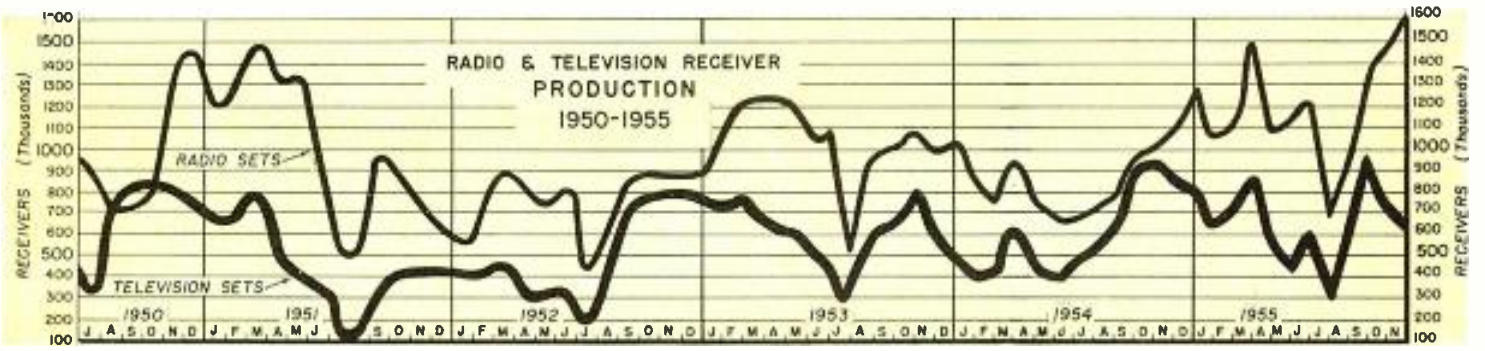
* Less than 50.

From the Engineering Manpower Commission of Engineers Joint Council.

Government Contract Awards

This list classifies and gives the value of electronic equipment purchased by gov't. procurement agencies in Nov. 1955.

Amplifiers, Audio	434,167
Assemblies, Cable	300,762
Assemblies, Magnetic	275,533
Batteries, Disconnect	78,305
Batteries, Dry	4,351,319
Batteries, Storage	144,371
Clutch, Magnetic	91,999
Connectors, Electrical	30,690
Coordinate Data Sets	2,625,000
Crystal Units	65,177
Development, Computers	96,271
Dynamotors	43,816
Facsimile Equipment	483,771
Generators and Regulators	1,631,034
Generators, Signal	360,992
Indicators, Directional	214,455
Lamps,	93,058
Loads, Dummy	44,840
Loudspeakers, Dynamic	25,540
Magnetrons	280,000
Materials, Telephone	47,500
Meters, Audio Level	74,893
Meters, Frequency	28,419
Modulators, Radio	84,412
Motors, Generator Sets	815,366
Power Supplies	41,589
Radios, Beacon	138,758
Recorders and Reproducers	168,997
Recorders, Tape	212,160
Regulators, Voltage	103,942
Relays	58,020
Relays, Solenoid	30,730
Resistors, Variable	116,755
Simulators, Antenna Position	126,412
Simulators, Flight	500,000
Solder	30,509
Suppressors	42,868
Switches	49,675
Switches and Relays	49,619
Switches, Thermostatic	121,516
Synchros	78,585
Telemetry Decommutation System	59,000
TV Broadcast Equipment, Mobile	131,658
Test Equipment, Radar	100,000
Test Set, Distortion	90,622
Trainer, Telegraphic Code	43,757
Transformer, Power	372,805
Transformer, Pulse	23,215
Transmitter, Radio	90,875
Tubes, Carcinotron	40,900
Tubes, Electron	1,977,394
Waveguides	31,697
Wire and Cable	1,004,671



The "Hushed" Transistor Amplifier

Part Two
Of Three Parts

Transistors have been considered to be inevitably more noisy than vacuum tubes. This article contends that the fault lies, not with the transistor, but in improper operation. Described is a mode of operation that results in a noise figure lower than that of low-noise triodes.

By W. K. VOLKERS
and N. E. PEDERSEN

Thermal (or Johnson) noise is generated in the purely resistive elements of a semiconductor device. The thermal noise may be considered to represent the lower limit of noise production. Only by lowering the absolute temperature may this be reduced. At a temperature of absolute zero we can conclude that thermal noise (or total noise, for that matter), would be non-existent. However, the concept of the operation of physical systems at this temperature is meaningless. In low power operation, the temperature increase of the transistor, due to electrical power dissipation, at room temperature, is negligible. We may, therefore, conclude that any observed variations in such low level operation of a semi-conductor device, which produce variations in the overall noise level, are affecting the action of only the 1/f and shot noise producing mechanisms.

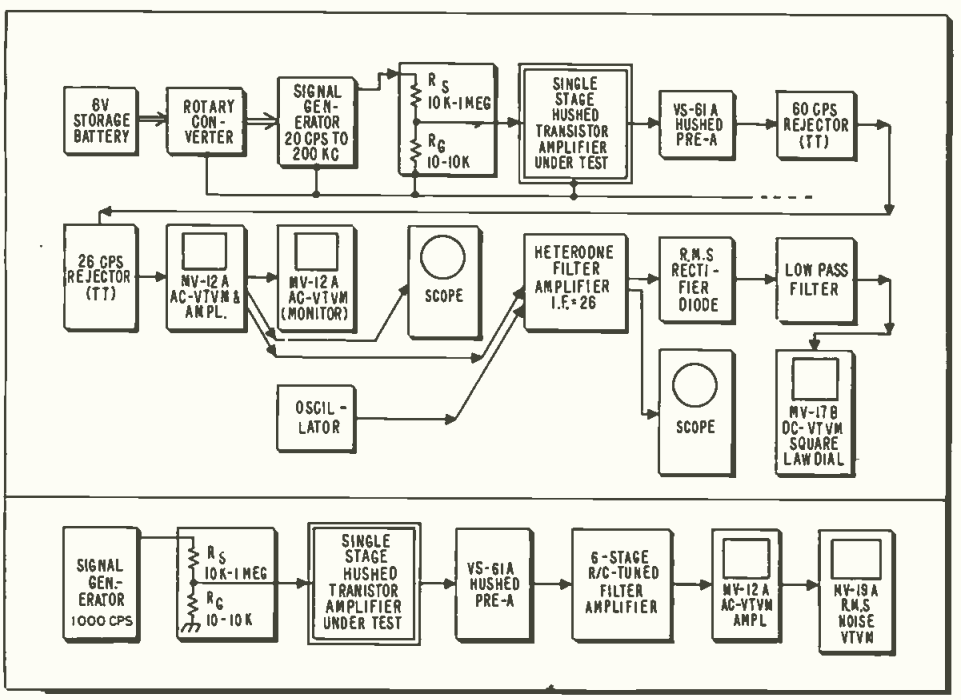
This, however, does not seem to be the whole story, at least as far as the hushed transistor amplifier is concerned. As emitter current is varied, the dc input resistance of the hushed transistor varies considerably, as will be shown later. This dc input resistance must have associated with it a minimum thermal noise voltage. The changes of noise, due to the Schottky equation (and also due to our excess shot noise model), and due to the expected thermal input resistance noise are in opposite directions as emitter current is changed. We shall see later that an emitter current, in the order of a third to two-thirds of a milliampere, is the optimum value for minimum noise voltage vs. emitter current, for typical transistors tested by us.

The main sources of all three types of noise have long been recognized as: the collector junction, the surface directly between the collector junction and the base connection, and the emitter junction. The effects due to the emitter junction are usually two or three orders of magnitude lower than those due to other sources. The main reasons for this are that the usual operating potentials across this junction are relatively small and that its physical area is small.

The basic aim of the "Hushed Transistor Amplifier" is to produce the highest possible signal-to-noise ratios in transistors by eliminating the effects of the major noise sources, and at the same time to maintain some voltage and power gain.

It seems that there is a general belief that, when the high gain properties of a transistor are reduced, its usefulness is correspondingly reduced. As to the question of gain vs. noise figure, it has been suggested by R. E. Skipper[6] that a good operating point would be that one at which the ratio of gain to noise figure is largest. For many applications this may be advantageous; but for a condition requiring the ultimate in low noise operation, it is not entirely satisfactory. A more

Fig. 9: Narrow band input noise voltage measuring equipment. Using 26 cps (l-f) heterodyne filter, $B_{eff} = 16$ cps. (Below) Using RC tuned filter amplifier, $B_{eff} = 223$ cps. (Top)



W. K. VOLKERS, President, Millivac Instrument Corp., 444 2nd St., Schenectady, N. Y. and N. E. PEDERSEN, Rensselaer Polytechnic Institute, Troy, N. Y.

rewarding approach seems to us to be less emphasis on gain and more on signal - to - noise voltage and power ratios. Hence our requisite is smallest possible noise figure. We are willing to use the maximum gain properties of the transistor only after the incoming signal has been amplified to a level where signal-to-noise ratio is not appreciably affected by unhushed operation.

Comparison of Measurements

In order to confirm experimentally the drastic noise reduction which takes place in a given transistor when operating either in an unhushed or in a hushed condition, we selected operating voltage parameters as shown in Fig. 5. The transistor in question was a GE Type 2N 76.

The purpose of our experimental comparison was not to show this transistor at its worst when operated in an unhushed fashion. The rather high noise figure values for this condition are well known and published for each type of transistor. In this particular case, the specification sheet says that the noise figure is 18 db, with possible variations between 30 db maximum and 10 db minimum. There would be little point in comparing measurements, showing a 30 db noise figure in unhushed condition, to be followed by our best noise figure of better than 2 db. Also, it would be unfair to compare our low noise figures with the minimum rated noise figure of 10 db. Furthermore, any designer experienced in transistor circuitry would probably be able to point out that, even without following our recommended procedure of operation (which is with zero collector junction voltage, or reversed collector junction voltage), any transistor circuit can be made less noisy by simply reducing voltages altogether. We have therefore selected,

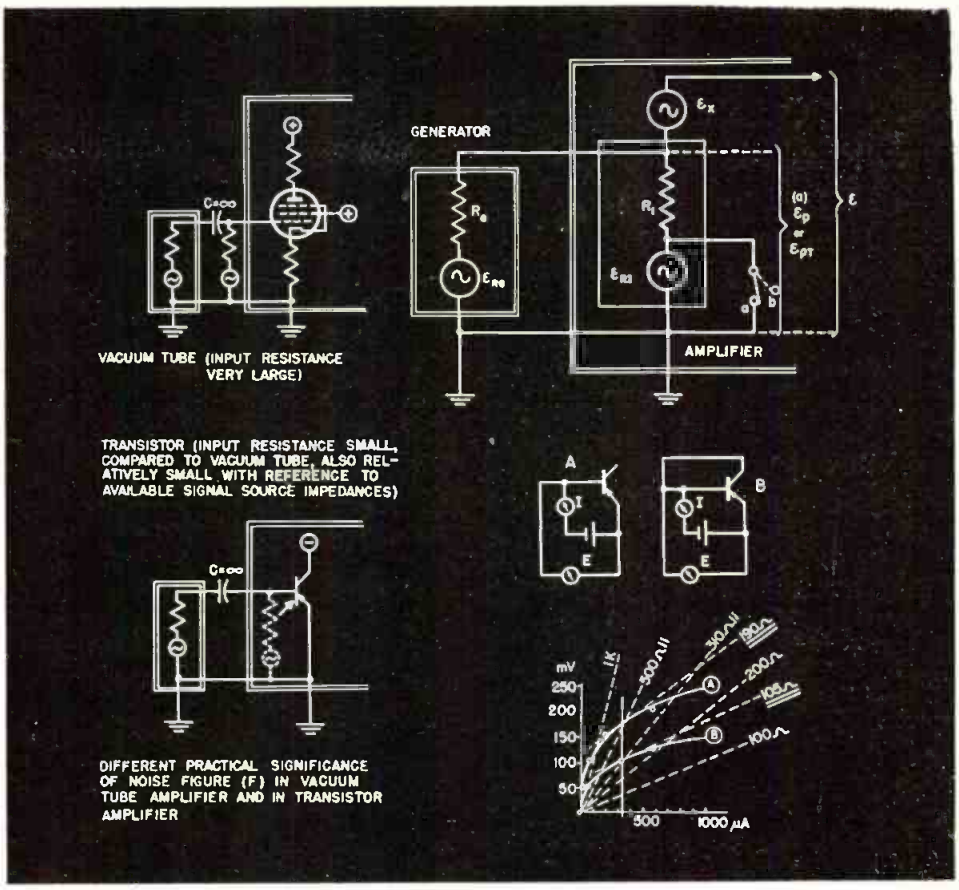


Fig. 11: (Left) Input circuits: of vacuum tube, and transistor, amplifiers. (Top right) Possible interpretations of F, by definition, or according to actual thermal noise conditions in input circuit

as you see here, an unhushed operating condition which, as far as unhushed operation altogether is concerned, is quite favorable towards minimizing noise.

In our selected unhushed condition, the supply voltage was 1.5 v. In other words, we were using only 850 mv across the collector junction which, as far as unhushed transistor operation goes, is fairly low, while, in hushed transistor operation, we would consider it sky-high.

For the hushed condition, we selected a collector supply voltage of 250 mv, a collector voltage of 105 mv, and a base voltage of 115 mv. When biased for this particular voltage distribution, we found that gain was near maximum, being 4, and noise at its minimum. The load resistance was 500 ohms. (Incidentally, our selection of a slightly reversed collector junction voltage, the collector voltage being 105 mv and the base voltage 115 mv, is a typical example of transistor hushing.)

An important reason why we selected for the unhushed condition a supply voltage of 1.5 v and a collector voltage of 1 v, and why we biased the transistor (for near optimum gain) with a 500 ohm load resistance was that we tried to make the unhushed condition as similar to the hushed condition as possible, except, of course, for actual collector junction voltage which is the basic distinction between hushed and unhushed operation. While in the hushed condition it was 10 mv reversed, we used 850 mv forward for the unhushed condition.

With our load resistance identical in both cases, we were assured of practically the same overall frequency response. Our emitter junction voltage was of the same order in both cases (115 mv and 150 mv respectively); and even our input impedance, which we determined by gain measurements with various series-resistors in the input circuit, was approximately identical in both cases, namely, 1.2 K.

In these two conditions, hushed and unhushed, we measured the

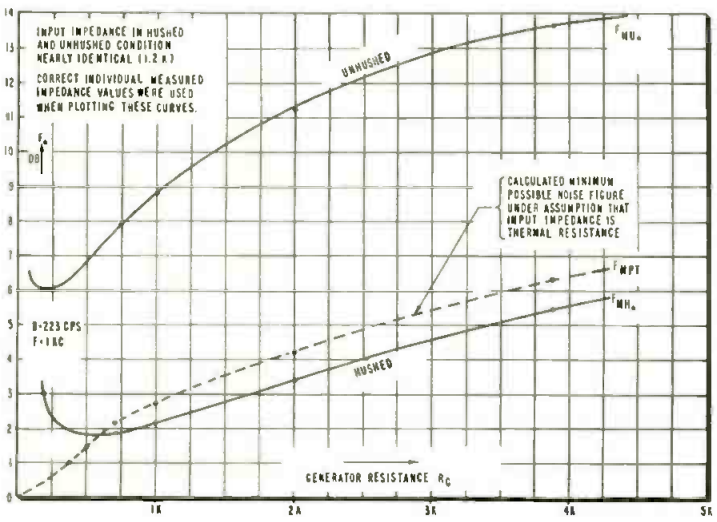


Fig. 10: Noise figure of same transistor in hushed and unhushed condition, measured at 1 kc.

"Hushed" Amplifier (continued)

noise voltage referred to the input with the input shorted, open, and loaded by various generator resistances. Since the input impedance, in each condition, was approximately the same, i.e., nearly 1.2 K, any difference in input noise, with a given generator resistance, between the hushed and unhushed condition, can be attributed directly to the hushed operating condition.

In Fig. 5 is also shown the general strategy of our measurements of noise voltage, noise power, equivalent noise resistance, and noise figure.

Since we had two variables in our measurements, frequency and generator resistance, we decided to make our measurements in a two-dimensional fashion, as illustrated in the upper part of the figure. First we measured carefully and accurately noise voltage and noise figure at 1 KC for various generator resistance values. Then, with different testing equipment, we measured the change of noise voltage and noise figure at varying frequencies with reference to the accurate 1 KC measurements. This enabled us to plot noise voltage and noise figure against frequency with generator resistance being our group parameter, as shown in Fig. 6.

Input Noise Voltage

These are measurements of noise voltage, referred to the input terminals as made with a 223 cycle filter amplifier at a frequency of 1 KC. Wide band noise measurements, with 3.9 KC band-width, closely confirm these readings within better than 0.5 db. The upper curve shows the unhushed transistor and its noise voltage, referred to the input, as it rapidly increases from 31 mμv, with input shorted, to 135 mμv when generator resistance is 3.9K, or roughly 3 times the measured input impedance of the transistor (which was 1.2K).

In the hushed condition below, we start with 25 mμv and rise much more slowly to 51 mμv with 3.9K generator resistance. Of particular interest are the points at which input impedance and generator resistance are matched, that is at 1.2K. Here the hushed transistor shows 43 mμv; and the same transistor in unhushed condition 96 mμv, or worse than twice the noise voltage of the hushed condition.

Input Noise Power

In Fig. 7 we have the same voltage measurements converted into total noise power, referred to the input circuit, as a function of generator resistance. In other words, we squared our measured noise voltage, as referred to the input, and divided it by the parallel resistance of the signal generator and the transistor input. In doing so, we find that the hushed transistor, below the matched value of generator resistance (1.2K) shows a noticeable increase of input noise power, as should be expected: with decreasing generator resistance, converging towards zero, we rapidly decrease our total resistance in the input circuit; on the other hand, the extra noise voltage in the amplifier, referred to the input circuit, converges towards a definite value, which, when squared and divided by the smaller and smaller total resistance in the input circuit, causes the equivalent noise power to increase rapidly until, at zero generator resistance, it becomes infinite.

Altogether, our input noise power in hushed condition is very much lower than in the unhushed condition, for instance 31 x 10^{-19}W when the generator is matched with the input impedance (1.2K), while in the unhushed condition it is 156 x 10^{-19}W, or roughly 5 times larger. The unhushed curve rises rapidly between low generator resistance values and the matched condition, and it keeps rising, though less drastically, afterwards.

The interesting part about the input noise power curve for the hushed condition is that, after the matching point has been reached, it does not rise at all; as a matter of fact, our measurements indicate a slight decline.

Our greatest surprise, however, came when we checked this curve against the thermal noise power in the input circuit under the assumption that only R_G and R_I are creating noise, according to Nyquist's theorem. This would be the thermal noise power in the input circuit under the assumption that the input impedance is a thermal resistance following Nyquist's theorem. Its value, in this particular case, is 35 x 10^{-19}W and is shown as a horizontal dotted line. It is larger than the actually and carefully measured noise power in hushed condition, at all generator resistances above approximately half our measured input impedance. In other words, throughout most of our measurements, observed thermal noise power was lower than the calculated thermal noise power with the assumption that R_I is a thermal resistance. We will return to this observation and explain it later when discussing noise figure.

Measuring Equipment

Whenever results of research are reported which claim a certain progress such as, in our case, noise in transistors being less than in vacuum tubes, or just very low noise voltages, very small equivalent noise resistances, and exceptionally low noise figures, it is essential that the reporter disclose his method of measurement and describe his measuring equipment. Otherwise, reasonable doubt may be cast upon the results claimed.

While we did not have at our disposal the extensive noise measuring equipment which the large research organizations in this country, including and particularly the National Bureau of Standards, pride themselves on, we feel that the simpler, partially standard and partially specially built noise measuring equipment which we had will, upon critical examination, be found to serve the purpose adequately and responsibly.

One criterion of reliable measurements is their reproducibility with different equipment as well as their continuity when converting measurements into plotted curves. We feel reasonably certain that our wide band noise voltage measurements are accurate within better than 0.5 db, also our narrow band noise voltage measurements taken at 1 KC, particularly since both groups of measurements check very well with each other (within 0.5 db after the usual conversion of noise voltage readings from wide band to narrow band, and vice versa, is made). On the other hand, our narrow band measurements at other frequencies are less accurate, though qualitatively quite conclusive.

Fig. 8 shows the instrument which we used for wide band noise voltage measurements. It is the new Millivac MV-19A RMS noise voltmeter which has a total frequency range of 20 CPS to 200 KC. Measurements were made by connecting the input of the hushed transistor amplifier to a calibrated signal generator and its output to the noise

(*Continued on page* 133)

JANUARY 1956

ABSTRACTS & REVIEWS of WORLDWIDE ELECTRONIC ENGINEERING

TELE-TECH's International ELECTRONIC SOURCES

PUBLICATIONS REVIEWED IN THIS ISSUE

Abbreviation	Publication Name
Avto. i Tel.	Avtomatika i Telemekhanika (USSR)
Bul. Fr. El.	Bulletin de la Société Français des Électriciens
Comp.	Computers and Automation
El.	Electronics
El. Des.	Electronic Design
El. Eng.	Electronic Engineering
El. Eq.	Electronic Equipment
El. Rund.	Electronische Rundschau
Elek.	Elektrichestvo (USSR)
Fern. Z.	Fernmeldetechnische Zeitschrift
Freq.	Frequenz
Iz. Akad.	Izvestia Akademii Nauk SSSR (Academy of Sciences, USSR)
J. BIRE	Journal British Institution of Radio Engineers
Onde	Onde Électrique
Proc. BIEE	Proceedings of the British Institution of Electrical Engineers
Proc. IRE	Proceedings of the Institute of Radio Engineers
Rev. Sci.	Review of Scientific Instruments
Tele-Tech	Tele-Tech & Electronic Industries
Vide	Le Vide
Wire. Eng.	Wireless Engineer
Wire. Wld.	Wireless World

Also see government research reports under "U.S. Government."

ANTENNAS, PROPAGATION

A—1/6—1: The Use of a Ring Array as a Skip Range Antenna, by J. Tillman, W. Patton, C. Blakely and F. Schultz. "Proc. IRE" Nov. 1955. 6 pp. Analysis of omnidirectional antenna for shore operation in ship-to-shore communications. Model test results for 30 and 1200 mc are given, with criteria for ground and sky wave use.

A—1/6—2: Long Distance VHF Interference, by T. Bennington. "Wire. Wld." Dec. 1955. 5 pp. Consideration of propagation by sporadic E layer and tropospheric inversion layers. Monthly variations and time-distance curves presented. 500-mile interference area outlined.

A—1/6—3: Radio Communication by Wave Scattering, Editorial. "Wire Eng." Nov. 1955. 3 pp. 287 to 290. This is a report on various investigations on the subject.

A—1/6—4: On the Azimuthal Variations of the Angle of Incidence for Short Wave Communication Paths, by W. Kronjaeger and K. Vogt. "Fern. Z." Oct. 1955. 3 pp. Statistical evaluation indicated that the directional signals received in Eschborn, Germany, from Tanger, Rio de Janeiro and Buenos Aires arrived from the expected direction within the expected error. However, a deviation of 2° and 3°, respectively was observed for Osaka Kawachi and Tokio Nazaki, Japan, situated closer to the pole.

A—1/6—5: The Ionosphere over Central Germany in August 1955, by W. Dieminger. "Fern. Z." Oct. 1955. 1 p. The results of height measurements for the various ionospheric layers are reported.

A—1/6—6: Automatic Recording of the Direction of Arrival of Radio Waves Reflected from the Ionosphere, by J. Thomas and R. McNicol. "Proc. BIEE" Nov. 1955. 6 pp. The recorder measures the phase difference of reflected pulses for two pairs of fixed orthogonal spaced-loop antennas. The vector sum and difference of the signals for each pair of loops in turn are applied to the X and Y plates, respectively, of a cathode-ray tube; a time-base is simultaneously applied to the X-plates.

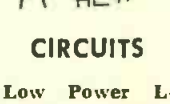
A—1/6—7: Designing Over-Horizon Communication Links, by D. Davidson and A. Pote. "El." Dec. 1955. 6 pp. This article outlines the design of point-to-point over the horizon circuits. 100 to 5000 mc is the frequency range regarded as best suited for these transmissions. The article discusses path loss, antenna considerations, long and short term fading characteristics, transmission noise, site noise and terminal loss.

AUDIO

A—1/6—8: Electronically-Controlled Audio Filters, by L. Dolansky. "Proc. IRE" Nov. 1955. 7 pp. Design theory and experimental results for variable active low-pass and high-pass filters using transistor negative impedance converters. Application to speech sound concentrations, or formants, has cut-off characteristics controlled by incoming audio signal.

A—1/6—9: Audio Standard Generator, by P. Koustas. "El." Dec. 1955. 3 pp. This instrument incorporates tuning fork frequency control and provides simultaneous output voltages at 0.5, 1, 1.5, 2, 3, 5, and 10 kc. Full wave rectifiers are employed as doublers to generate required frequencies.

A—1/6—10: The Division of the Sound Spectrum into Frequency Groups by Hearing, by R. Feldtkeller. "El. Rund." Nov. 1955. 3 pp. It is held that the human ear subdivides a received sound into frequency groups before determining its loudness. Experiments to determine these frequency groups are reported. Threshold of hearing and effect of frequency modulation and amplitude modulation are investigated.



CIRCUITS

A—1/6—11: Low Power L-Band Signal Source, by R. Schwartz, "Tele-Tech" Jan. 1956. 1 p. An inexpensive, easy to construct L-band (390-1550 mc) signal generator for microwave applications is explained.

A—1/6—12: Staggered Triple Crystal Filter, by D. Hildreth, "El." Dec. 1955. 2 pp. Three stagger tuned crystals are employed in this design which operates over a frequency range of 400 kc to 5 mc by interchanging crystals for desired frequencies.

A—1/6—13: Some High Impedance Current Generating Circuits, by J. McGuire, "El. Eng." Dec. 1955. 3 pp. A simple potentiometric high impedance current generating circuit is shown and analyzed. More complex circuits are derived. It is stated that the output current waveform will be constant, with variations in output voltage, to within 4½% for the simple circuit and ¼% for the more complex circuits.

A—1/6—14: A Constant Voltage Amplifier and Oscillator, by G. Patchett, "El. Eng." Dec. 1955. 3 pp. Constant voltage is maintained by a feedback circuit containing a thermistor bridge measuring unit which

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supplies a large output voltage for a small change of input voltage. Design and performance details are given. When operated as an amplifier, the output remains within 0.1% over an input voltage range of 30 db.

A—1/6—15: **On the Principle and Design of a Trigger Circuit of a Signal-Seeking Radio Using "Difference-Voltage,"** by C. Hsu. "Proc. IRE" Nov. 1955. 17 pp. Difference voltage from i-f transformer is expressed in mathematical form. Anticipation is related to mixing index and transformer parameters. Errors are examined in relation to trigger level and tuner nonlinearity, relating them to system operation.

A—1/6—16: **Design of an Accurate New Electromechanical Multiplier,** by G. Pihl and R. Tilley. "El. Eq." Nov. 1955. 1½ pp. System has output voltage acting as direct function of the product of two input signals. Experimental models operate from 20 cps to 50 kc for inputs in 30 db range.

A—1/6—17: **On a Method of Calculating Transient Processes in Circuits Containing Conditionally Nonlinear Elements,** by K. Karandeyev and L. Sinitzky. "Avto. i Tel." Sept.-Oct. 1955. 5 pp. Procedure is based on a change in the nonlinear element, using a bridge stabilizer as example. Possibility of improving the character of the transient process by circuit modifications is demonstrated.

A—1/6—18: **Graphic Analysis Method for the Calculation of the Characteristics of Magnetic Circuits under the Influence of Simultaneous DC and AC Fields,** by I. Lekhtman. "Avto. i Tel." Sept.-Oct. 1955. 9 pp. Construction of characteristic curves is carried out for magnetized material. It is demonstrated that characteristics obtained are different for series and parallel connection of ac windings.

A—1/6—19: **On the Effect of the Feedback Amplification Factor on the Frequency and Amplitude of Self-Oscillation,** by K. Surovikhin. "Avto. i Tel." Sept.-Oct. 1955. 2 pp. Examination of a linear system containing an internal feedback loop which includes a nonlinear element. Exploration of how a change in feedback amplification affects frequency and amplitude of self-oscillation.

A—1/6—20: **New Filter Theory of Periodic Structures,** by W. Lippert. "Wire. Eng." Nov. 1955. 5 pp. Characteristic reflection and transmission factors are introduced to derive a theory of four-terminal networks. These factors, which are a set of functions, permit major simplifications in the theory of loss-free structures; diagrams can be used to a great extent.

A—1/6—21: **Stability of Oscillation in Valve Generators,** by A. Gladwin. "Wire. Eng." Nov. 1955. 7 pp. This is the concluding article of a series of articles on the subject. Several stability criteria are discussed; they are based on a linear theory, i.e., are valid for small disturbances only.

A—1/6—22: **Studies of the DC and AC Behavior of an Eccles-Jordan Circuit with Two Conditions of Stable Equilibrium,** by K. Gosslay and H. Harloff. "Fern. Z." Oct. 1955. 9 pp. This investigation is particularly concerned with admissible tolerances of circuit components and interfering pulses. Numerical examples are included.

A—1/6—23: **Reliable Power Pack Design** by A. Standing. "El. Eng." Dec. 1955. 4 pp. Simple calculations permitting the design of capacitor input power packs are presented. Designs limited by peak anode current and by peak inverse voltage are treated. AC and dc voltages and currents can be evaluated. Numerical examples are included. Among the basic assumptions made in developing the theory is that the voltage falls and rises linearly during discharge and charge, respectively.

COMMUNICATIONS

A—1/6—24: **Continuous Scanning Facsimile Transmitter, by** G. Stamps and M. Schankler. "Tele-Tech" Jan. 1956. 4 pp. Methods of continuous scanning by mechanical-optical means, such as spiral and slit, helix and slit, optical heads traveling on an endless belt, etc., are described, with emphasis placed on the spiral and slit method. A weather map continuous scanner, using this latter method, is developed and constructed.

A—1/6—25: **Wide-Band Amplifier for UHF Receivers,** by R. McWhirt. "El." Dec. 1955. 3 pp. Design and cavity dimensional details for an amplifier designed to operate in the 1100 mc region. A 416 B planar triode is employed. Bandwidth is 200 mc. Input and output impedance is 51 ohms. Gain 5 to 10 db.

A—1/6—26: **The Teletyper Keying Unit "Tg-Fs 127,"** by R. Heidester. "El. Rund." Nov. 1955. 3 pp. After a general introduction containing a survey of bandwidth requirements and attainable writing speeds, the Telefunken teletyper keying unit "Tg-Fs 127" is described in detail. It permits demodulation of any frequency shift in a double-channel frequency-keying radio telegraph system with only one discriminator.

A—1/6—27: **Multiple Frequency Shift Teletype Systems,** by D. Jordan, H. Greenberg, E. Eldredge and W. Serniuk. "Proc. IRE" Nov. 1955. 8 pp. System using several frequencies instead of two conventional mark and space frequencies, allows longer pulses for equivalent transmission rates, making smaller detection bandwidths possible.

A—1/6—28: **Trends in the Development of Modern Communication Systems,** by F. Lucantonio. "Freq." Oct. 1955. 12 pp. (Translation of an article published in "Poste e Telecommunicazioni.") This article traces the recent development of the telephone systems in various countries and compares the point of views responsible for such developments. Economic, performance and design considerations are included.

A—1/6—29: **The Use of Radio-Telephony for the Control of Works Transport,** by E. Farrar and M. O'Dwyer. "J. BIRE" Oct. 1955. 6 pp. The advantages of such installations are pointed out and equipment now in use is described.

A—1/6—30: **Electrical Pulse Communication Systems: 2. Message Encoding and Signal Formation in Pulse Systems,** by R. Filipowsky. "J. BIRE" Oct. 1955. 21 pp. This is the second installment of a survey article. Sources of information, coding systems, and methods of signal formation, are described and their relative merits are evaluated.

A—1/6—31: **60-Signal Voice-Frequency Telemetering, by** M. Clement. "Bul. Fr. El." Sept. 1955. 8 pp. A time-division multiplex code transmission system for 60 messages is described. Each magnitude to be transmitted is first represented by a corresponding number of oscillations. A binary code is used to transmit this number with comparatively high accuracy over a comparatively narrow bandwidth.

A—1/6—32: **Reduction in Cross-Talk for Double-Sideband Transmission,** by W. Hofmann. "Fern. Z." Oct. 1955. 3 pp. A considerable reduction in cross-talk can be obtained in double-side band systems having a common carrier generator by a phase adjustment in the carrier supply terminal equipment.

A—1/6—33: **The AC-Telegraph System with Double Voice Frequency Modulation,** by G. Junga. "Fern. Z." Oct. 1955. 6 pp. It is pointed out that an ac telegraph system with double voice modulation would be best for the short distance telegraph service between branch offices.

A—1/6—34: **An Introduction to some Technical Factors Affecting Point-to-Point Radiocommunication Systems,** by F. Laver. "Proc. BIEE" Nov. 1955. 10 pp. This is an introduction to the extensive bibliography accompanying this article. Signal transmission, distortion, wave propagation, interference, coding, modulation and demodulation and multiplexing are reviewed.

A—1/6—35: **Signalling Systems for Submarine Telegraph Circuits,** by C. Hughes. "Proc. BIEE" Nov. 1955. 4 pp. The characteristics of cables and terminal apparatus are described. Noise spectra for cables are considered. Synchronous systems using the 5-unit teleprinter code are described. The 3-condition and receiving-end suppressed-singles methods are preferred to the fully-formed 2-condition method for loaded cables and duplex unloaded systems.

A—1/6—36: **Traffic Flow in an Exponential Delay System with Priority Categories,** by R. Cox. "Proc. BIEE" Nov. 1955. 3 pp. The behavior of a general system is described by equations; the known homogeneous case, i.e., without priority catergories, is a special case. The expressions were derived with a view to study the effect of using priority categories in automatic and semi-automatic tape-relay systems.

COMPONENTS

A—1/6—37: **Printed Inductors and Capacitors,** by H. Bryan. "Tele-Tech" Dec. 1955. 3 pp. Formulas used to design conventional capacitors and inductances introduce serious errors when applied to the design of printed circuit components. Presented here are empirical design data and equations.

A—1/6—38: **Magnetic Fields in Small Ferrite Bodies with Applications to Microwave Cavities Containing Such Bodies,** by A. Berk and B. Lengyel. "Proc. IRE" Nov. 1955. 4 pp. Mathematical expressions derived for a small sphere and thin circular cylinder are applied to detuning and Q change of microwave resonators. They also provide means to calculate elements of the permeability tensor.

A—1/6—39: **Glass . . . a New Look in Resistors,** by H. Craumer. "El. Eq." Nov. 1955. 1½ pp. Brief survey fundamental glass resistor characteristics, including abrasion and temperature limitations.

A—1/6—40: **Resolution in Precision Wirewound Potentiometers,** by R. Sullivan. "El. Eq." Nov. 1955. 2½ pp. Design criteria which foster effective usage. Contact, resolution, shorted turns and skipping are discussed.

A—1/6—41: **Versatile Selenium Rectifiers,** by J. Cataldo. "El. Eq." Nov. 1955. 2½ pp. Summary of construction and operating characteristics of selenium diodes. Discussion of cartridge and plate types. Self-capacitance and derating curves given.

A—1/6—42: **New Developments in Vacuum Relays,** by H. Ross, "Tele-Tech" Jan. 1956. 5 pp. Applying the vacuum theory to relay contacts results in improved contact life, lower contact resistance, faster current interruption, and dielectric strengths of more than 5,000 kv/in. Applications to both high and low voltage relaying are described.

A—1/6—43: **Dielectric Transformers for X-Band Waveguide,** by I. Olin. "El." Dec. 1955. 2 pp. This article discusses the design of dielectric impedance transformers for a rectangular to circular waveguide transducer and for a pressure seal for circular waveguide. Both elements operate in the 8500-9600 mc region and use 15/16 in. i-d circular waveguide.

A—1/6—44: **The Dimensioning of Rectifier Transformers,** by R. Kuehn. "El. Rund." Nov. 1955. 2 pp. This is the fourth installment of a survey article. Center-tapped, bridge and one-way circuits are treated. Numerical examples are presented. Effect of design alternations are discussed.

COMPUTERS

A—1/6—45: **Electronic Digital Computers,** by A. Robinson. "Wire. Wld." Dec. 1955. 4½ pp. Fundamental circuitry and operation of control circuits discussed. Storage systems and decoding instructions explained, with emphasis on operation of "and" and "or" circuits.

A—1/6—46: **Association for Computing Machinery Meeting.** "Comp." Nov. 1955. 15½ pp. Abstracts of over 115 papers presented at the 1955 meeting of the Association for Computing Machinery held in Philadelphia, Sept. 14-16.

A—1/6—47: **Analog Calculator Pile Simulators,** by P. Braffort. "Onde" Oct. 1955. 10 pp. Review of basic principles of analog calculators, followed by description of simulator used in the study of automatic reactor control.

CONTROLS

A—1/6—48: **Calculation of Pulse Shapes in Discontinuous Regulation Systems,** by Y. Tsitskin. "Avto. i Tel." Sept.-Oct. 1955. 5 pp. Extension of pulse theory to interrupted regulators characterized by a series of equidistant pulses of arbitrary shape.

A—1/6—49: **Magnetic Power Amplifiers of the "MUTRON" Type and their Control Applications, Particularly the Control of Small Alternator Voltage and Frequency,** by M. Butel. "Bul. Fr. El." Oct. 1955. 10 pp. Method of manufacture and properties of a self-saturated magnetic amplifier are described. A control circuit containing the magnetic amplifier is presented and its performance discussed.

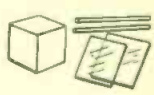
A—1/6—50: **A New Electromagnet-Actuated Multidisc Spring-Pressure Brake,** by K. Decker. "El. Rund." Nov. 1955. 1 p. This brake is designed for the fast braking of rotating machine parts, for instance of machine tools; it can be easily adapted to any type of motor.

GENERAL

A—1/6—51: **Examination of the "Negative Frequency" Concept,** by A. Bolle and J. Bordewijk. "J. BIRE" Nov. 55. 6 pp. Combined use of positive and negative angular frequencies over the current rise of positive angular frequencies is pointed out. A number of examples are given to illustrate this, e.g., complex symbolism for linear fixed and variable networks, the Fourier series and integral, and the calculation of intermodulation noise.

A—1/6—52: **An Approximate Method for Obtaining Transient Response from Frequency Response,** by H. Rosenbrock. "Proc. BIEE" Nov. 1955. 13 pp. A method is proposed for obtaining the transient response of a linear system when its frequency response is given as an analytical function and vice versa. It also permits finding an analytical function representing the behavior of the system from either its frequency or its transient response.

A—1/6—53: **100 Rules For Improving Man-Machine Effectiveness,** by W. Woodson. "Tele-Tech" Dec. 1955. 3 pp. Listing of design "do's" and "don'ts" covers: visual display, control, panel layout, console design, multiple layout, environment, and maintenance. Emphasis is on human engineering; describing the conditions under which the man-machine combination will operate with the greatest reliability.



MATERIALS

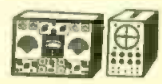
A—1/6—54: **Design Characteristics of Ferrites,** by H. Schlicke. "Tele-Tech" Dec. 1955. 5 pp. Selected idiosyncrasies of ferrites and ferroelectric dielectrics are discussed. Items covered include: magneto- and electrostriction, volume resonance, gyromagnetic resonance, Faraday effect and dimensional resonance. Areas where each are of extra importance are described, and applications to feed through capacitors and TV flyback transformers are discussed.

A—1/6—55: **Electro-Ceramics, Glass and Organic Plastic Materials,** by N. Boroditzki and P. Mulyar. "Elek." Oct. 1955. 5 pp. Presentation of electrical and physical properties of materials employed in electronic devices. Included are dielectric constant, temperature coefficient, density and characteristics at 1 mc.

A—1/6—56: **The Effect of Different Shields on the Decrease in the Disturbances in Communication Lines Caused by Power Lines,** by P. Simon. "Freq." Oct. 1955. 5 pp. The inductive shielding effect of different materials (lead, steel, aluminum, etc.) is investigated. Aluminum shielding is found preferable because of its excellent conductivity. Experimental and computed results are graphically represented. Graphs may be used to estimate the disturbances in a specific set-up.

A—1/6—57: **Materials Used in Radio and Electronic Engineering: 3. Ceramics.** "J. BIRE" Oct. 1955. 11 pp. The mechanical and electrical properties and preferred uses of barium titanate, magnesium titanate, forsterite, rutile, steatite, alumina, cordierite, porcelain, pyrophyllite, zircon, dielectric materials for capacitors, and vitreous ceramics have been gathered from various sources.

A—1/6—58: **Special-Clad Laminates For Printed Circuits,** by W. Hannahs. "Tele-Tech" Dec. 1955. 3 pp. Summarizing specific heat, humidity, shock and stress requirements of printed circuits. Charts and graphs listing technical characteristics are included, also names of manufacturers of each type. Laminates described include: phenolic, melamine, polyester, ethoxylene, glass-bonded mica and silicone.



MEASURING & TESTING

A—1/6—59: **Amplifier Distortion Measurement,** by D. Wolfthal. "Tele-Tech" Jan. 1956. 1 p. "Page from an Engineer's Notebook," describing the design of an adjustable distortion rule, with which a circuit designer may read directly from the load line the second harmonic distortion of a Class A, single ended triode.

A—1/6—60: **Ice Detector for Lighter-Than-Air Craft,** by E. Thurston. "El." Dec. 1955. 3 pp. Three main elements comprise this detection system. These are: piezoelectric vibrators; oscillator circuits; frequency detector and indicator circuit. The piezoelectric unit, composed of two parts, has one cemented to the inside surface of the fabric which covers the top of the unit container. The other part is not affected by ice. Latter part acts as frequency control against which sensing element frequency can be compared.

A—1/6—61: **Transmission Gain Set,** by G. Chinski. "El." Dec. 1955. 1 p. Design details of a precision variable balanced H-type attenuator for audio testing in broadcast studios. The maximum attenuation is 63.5 db in steps of 0.1, 1, and 5 db. Frequency range is 20-20,000 cps. Minimum insertion loss is 2.5 db.

A—1/6—62: **Automatic Colorimeter Checks TV Color Tubes,** by E. Sanford. "El." Dec. 1955. 4 pp. This instrument was designed to parallel the color resolving properties of the human eye, and for use in checking tri-color TV tubes in production. Three meter readings, obtained through selective red, green and blue filters, are obtained within approximately one second, and represent a direct reading of the primary color proportions.

A—1/6—63: **Some Devices for the Stark Modulation Millimeter-Wave Spectrograph,** by A. Okaya. "Rev. Sci." Nov. 1955. 5 pp. To improve performance of the microwave spectrograph, the design of a low-loss K-band Stark cell, wideband frequency multiplier, bridge lock-in detector and square wave generator are offered. New spectral lines may be detected.

High-Resolution Magnetic Spectrometer, by S. Rubin and D. Sachs. "Rev. Sci." Nov. 1955. 5 pp. Construction of 180° point-focusing instrument for high resolution analysis of proton momentum distribution.

A—1/6—64: **A Comparison of Two Radiometer Circuits,** by S. Goldstein, Jr. "Proc. IRE" Nov. 1955. 2½ pp. Thermal radiation detection method uses two receivers, offering greater sensitivity than mechanical modulator at input to superhet. Mathematical model of each is presented.

A—1/6—65: **Calculations of Lumped Electrode Systems in Magnetostrictive Measurements,** by B. Timofeyev. "Elek." Oct. 1955. 4 pp. Analytical study of welded and pressure contact electrodes feeding ac to measure surface elastic stresses in steel specimens.

A—1/6—66: **Needed Electronic Devices for the Atomic Industry,** by V. Parsegian. "El. Des." Nov. 1955. 4 pp. A discussion of the instrumentation needs of atomic laboratories, reactor and processing plants, and in process instruments. Included chart pictorially shows desired measurement vs. the undesirable characteristics of the present measurement techniques.

A—1/6—67: **A Shutter Tester Using a Photo-Electric Integrator**, by R. Hercock and D. Neale. "J. BIRE." Nov. 55, 10 pp. Photo-electric integrator with single sweep oscilloscope is ideal instrument for testing between-lens camera shutters. CRO employs phantastron time base with time markers provided. Integrator measures effective exposure time and CRO shows total open time of the shutter and faults such as sticking or bouncing of shutter blades.

A—1/6—68: **Slotted Section Standing Wave Meter**, by E. Wareham, "J. BIRE" Nov. 55, 25 pp. Formal theory of a single discontinuity developed in complex reflection coefficient terms is extended to cover transmission line having two discontinuities. Measurement techniques for both small and large VSWR ratios are discussed. Electrical and mechanical problems of waveguide slotted section standing wave meters are discussed and some relations evaluated.

A—1/6—69: **Detection of Pulse Signals in Noise**, by D. Tucker and J. Griffiths. "Wire. Eng." Nov. 1955. 7 pp. An attempt is made to correlate the just-noticeable difference in intensity on an intensity modulated visual display medium with the display performance. The total number of just-noticeable differences available in a display medium is of importance, and further investigation is proposed.

A—1/6—70: **A New Perturbation Method for Measuring Microwave Fields in Free Space**, by A. Cullen and J. Parr. "Proc. BIEE" Nov. 1955. 8 pp. A short thin metal rod spinning about an axis perpendicular to its length is used as the perturbing element in an apparatus operating at about 3.2 cm. The experimental results obtained agree with the theory for linearly polarized waves.

A—1/6—71: **Multichannel Switch for Biological Observations**, by R. Woods. "El." Dec. 1955. 3 pp. This instrument, designed to be used in conjunction with a CRO permits a four-channel simultaneous observation to be made on related biological phenomena. The switching frequency between channels is variable between 1 cps to 30 kc. Any number of dc channel amplifiers may be added with five triodes per channel required.

A—1/6—72: **The Measurement of Power at a Wavelength of 3 cm by Thermistors and Bolometers**, by J. Lane. "Proc. BIEE" Nov. 1955. 5 pp. It is concluded that errors of about 10% may occur in typical thermistor and bolometer mounts at 3.2 cm for power levels of about 1mW if the dc calibration is assumed. Operating resistance variations over the range 150 to 300 ohms hardly affect the efficiency.

A—1/6—73: **Precision Digital Delay Generator**, by W. Perzley. "El." Dec. 1955. 4 pp. A 1 mc crystal-controlled master oscillator accurate to 1 ppm is the heart of this signal supply source. Unit supplies a reference pulse followed by other pulses accurately time delayed with respect to reference. Applications include calibration of radar equipment and target simulation. Pulses for these latter applications are through the 1 mc crystal oscillator and flip-flop frequency dividers.

A—1/6—74: **A Magnetic Tape Recorder for Electrophysiology**, by P. Donaldson. "El. Eng." Dec. 1955. 2 pp. A recorder having a dynamic range of 60 db and a frequency response from 0 to 2 kc is described.

A—1/6—75: **An Analog Harmonic Analyzer**, by J. Pottier. "Onde." Oct. 1955. 20 pp. Non-destructive testing of materials used in nuclear reactors consists of oscillating test sample, and performing harmonic analysis of time variation of reactor's power. Apparatus is specially designed for low frequency phenomena.

RADAR, NAVIGATION

A—1/6—76: **Inertial Air Navigation Systems**, "Tele-Tech" Jan. 1956. 2 pp. Abstracted from an IRE paper presented by J. Stassinger and B. Litman, this article describes the principles and instrumentation of a motion measuring navigation system providing accurate guidance for aircraft without requiring external information.

A—1/6—77: **Radar Speed Meters**, by R. Johnson, "Tele-Tech" Jan. 1956. 2 pp. Circuit and block diagrams are included in this technical description of a radar speed meter which works on the Doppler principle, along with test results obtained by a police survey team.

A—1/6—78: **Contributions of "Siemens" to the Electronic Devices Used in Aviation from 1930 to 1945**, by H. Zetzmann. "Freq." Oct. 1955. 9 pp. This is the first installment of a survey article. Design features of radar installations, in particular of radar antennas, and of height indicators are presented.

A—1/6—79: **Determination of the Reflection Coefficient of the Sea, for Radar-Coverage Calculation, by an Optical Analogy Method**, by G. Court. "Proc. BIEE" Nov. 1955. 3 pp. The effect of the reflection of radio waves from a rough sea on the vertical coverage of a radar set is approximated by an optical analogy method. A complete coverage diagram for sea states from 1 to 5 is included. Test-flight results are reported.

SEMICONDUCTORS

A—1/6—80: **Transistor D.C. Converters**, by L. Light and P. Hooker. The Proc. of the Institution of Electrical Engineers, Part B—"Proc. BIEE" Nov. 1955. 12 pp. Operational and design data of a transistor dc converter are presented. A transistor relaxation-oscillator serves as direct-voltage step-up device; the transistor interrupts a low-voltage circuit.

A—1/6—81: **Transistor Power Amplifiers**, by R. Hilbourne and D. Jones. "Proc. BIEE" Nov. 1955. 12 pp. Limitations on the maximum output in sinusoidal applications are studied. The common-collector type arrangement of a push-pull class B operation amplifier is found to have high output power, to provide a useful compromise between gain and distortion, and to permit a simple output transformer design.

A—1/6—82: **The "Hushed" Transistor Amplifier**, Parts 1 and 2, of 3 parts, by W. Volkers and N. Pedersen, "Tele-Tech" Dec. 1955, 4 pp. Jan. 1956. 4 pp. Operating PNP junction transistors at a very low supply voltage is found to greatly reduce collector noise, and results in noise factor lower than that of triode vacuum tubes. Describes typical operation. Both collector and base voltages are identical, eliminating noise normally contributed by collector junction. Voltage gains of 2.5 to 10 are achieved.

A—1/6—83: **Transistors and Electron Tubes**, by H. Hollmann. "El Rund." Nov. 1955. 6 pp. This is the third installment of a survey article. It is particularly concerned with transistor amplifiers. Dc amplifiers in cascade, transistor oscillators, and transistor demodulators are treated. A collection of formulae is supplied.

A—1/6—84: **Junction Transistor Blocking Oscillators**, by J. Linvill and R. Mattson. "Proc. IRE" Nov. 1955. 7 pp. Experimentally verified analysis of fast rise time rectangular pulse generator. Transformer design, triggering requirements and loading effects given.

A—1/6—85: **Theory of Shot Noise in Junction Diodes and Junction Transistors**, by A. van der Siel. "Proc. IRE" Nov. 1955. 8 pp. Theory is based on transmission line analogy. Minority carrier diffusion is represented by distributed noise emf's, and carrier recombination by distributed noise generator in parallel with line.

A—1/6—86: **A Germanium Diffused-Junction Photo-Electric Cell**, by J. Waddell, S. Mayer and S. Kaye. "Proc. BIEE" Nov. 1955. 6 pp. The junction of this type of germanium-junction photo electric cell is manufactured by impurity diffusion. It is of small size, has large output, good sensitivity and stable characteristics; it has a somewhat extended long-wavelength cut-off.

A—1/6—87: **Measurements of Junction-Transistor Noise in the Frequency Range 7-50 KC**, by W. Stephenson. "Proc. BIEE" Nov. 1955. 4 pp. Experiments with junction transistors lead to the conclusions that the noise factor reaches a minimum at about 25 kc, the optimum source resistance is independent of frequency and not directly related to the input resistance, and the noise is independent of collector voltage.

TECHNIQUES, RESEARCH & MFG.

A—1/6—88: **Low-Cost Automatic Assembly System**, by A. Stones. "Tele-Tech" Dec. 1955. 3 pp. Designed to handle printed wiring boards, system described employs standard equipment and tools wherever possible, thus reduces capital expenditure. In simplest form, system comprises three sections—loading, component assembly, and soldering—and requires four operators. Component insertion stations are linked by metal belt conveyor.

A—1/6—89: **Printed Circuits**, by G. Finckbein. "El. Rund." Nov. 1955. 4 pp. This is a survey on the most important methods of the production of printed circuits; advantages and disadvantages of various methods are compared.

TELEVISION

A—1/6—90: **The ABC's of Color Television**, by J. Barstow. "Proc. IRE" Nov. 1955. 9 pp. Fundamental considerations of colorimetry, picture tube operation, signal generation, transmission, reception and spectrum requirements. Requirements briefly compared to monochrome TV.

A—1/6—91: **Television Transmission Without Synchronization Level**, by H. Griese. "Fern. Z." Oct. 1955. 3 pp. A method is suggested which transmits the synchronization pulses within the amplitude range of the picture signal.

A—1/6—92: **High-Quality Receiver for TV Rebroadcasting**, by R. Rosenberg. "El." Dec. 1955. 4 pp. Receiver design for application in commercial rebroadcast service differs from home type TV receiver in that reliability, component accessibility, video i-f

response, local oscillator stability, and interference immunity features have been given increased consideration.

A—1/6—93: **16-mm Tele-Recording for Sequential Television Systems,** by V. Hulme. "El. Eng." Dec. 1955. 6½ pp. A continuous-movement recording system with shutterless gate is described. A diagram of the simplified camera motor control circuit, using negative feedback of phase, velocity and acceleration, is shown. The camera requires between two and three seconds to attain full speed.

TRANSMISSION LINES

A—1/6—94: **Microwave High-Speed Continuous Phase Shifter,** by W. Sichak and D. Levine. "Proc. IRE" Nov. 1955. 2½ pp. Device using circularly polarized helices in circular waveguide is small, has 0.2 db insertion loss. Construction of 9400 mc model rotating at 3600 rpm.

A—1/6—95: **Application of Electron Plasma in the Creation of Valve Systems,** by A. Mikaelyan. "Iz. Akad." July 1955. 11 pp. Study of problems in electromagnetic wave propagation between parallel surfaces and in coaxial lines where a layer of electron plasma is being subjected to a constant magnetic field. It is shown that in principle valve system structure problems may be solved for TEM waves.

A—1/6—96: **Self-Generated Oscillations in Waveguides,** by B. Katzenellenbaum. "Iz. Akad." July 1955. 14 pp. Examination of disturbance to oscillation caused by slight deformation of guide walls, and equivalent limiting conditions relating these deformations, finite conductivity and magnetic currents in non-deformed surfaces. Cause of self-oscillation explored.

A—1/6—97: **Useful Plots of Transmission Line Relations,** by E. Tahan. "El. Des." Nov. 1955. 4 pp. Equations for VSWR, VSWR attenuation and transmission line efficiency are plotted graphically. Ten example problems are provided and use of graphs to facilitate calculations are explained.

A—1/6—98: **The Choice of Impedance for Coaxial Radio-Frequency Cables,** by W. Blackband. "Proc. BIEE" Nov. 1955. 10 pp. Attenuation, voltage rating, power rating, screening efficiency and input impedance of matching stubs are considered. An impedance of 75 ohms for low-loss air-spaced cables and of 50 ohms for general-purpose thermoplastic cables are suggested.

A—1/6—99: **On the Electric Resistance of Joints in Copper Wires,** by K. Sagel. "Fern. Z." Oct. 1955. 3 pp. The electric resistance of twisted, welded and soldered joints is measured and evaluated statistically. Soldered joints are found to have the lowest resistance. A microscopic study explains this result.

TUBES

A—1/6—100: **Heater-Cathode Leakage,** by The Advisory Group on Electron Tubes. "Tele-Tech" Jan. 1956. 3 pp. Current flow between heater and cathode of vacuum tubes is often responsible for the malfunctioning of electronic equipment. Examples of the different types of heater-cathode leakage, and the steps to be taken to minimize them are described.

A—1/6—101: **Stabilizing Voltage Regulators,** "Tele-Tech" Jan. 1956. 2 pp. Series tube, voltage regulator circuits, which combine both high efficiency and high amplification, are achieved by employing beam power tubes with separate screen supplies.

A—1/6—102: **Cathode-Ray Tubes for Shock Wave Testing,** by K. Schwalgin. "El. Rund." Nov. 1955. 2 pp. Twin-beam tubes having a high writing speed up to 10,000 km/s are described. Design details, such as aluminum coating of picture screen, additional ray acceleration, high anode voltage, are discussed.

A—1/6—103: **The Electron Gun of the Cathode-Ray Tube,** by J. Darbyshire. "El. Eng." Dec. 1955. 6 pp. A comparison of the tetrode and triode types of electron guns for cathode-ray tubes as to spot size, beam angle, cathode loading, etc. is presented. The tetrode type is found to be preferable for most television applications; however, in some instances, the use of the triode type is indicated.

A—1/6—104: **Television Picture Tube "The Monoscope,"** by L. Guyot. "Vide" July to Sept. 1955. 5 pp. Details of the structure and performance of a monoscope with a secondary emission screen are given. A resolution exceeding that required for a standard performance is obtained.

A—1/6—105: **The Cascade Backward-Wave Amplifier: A High-Gain Voltage-Tuned Filter for Microwaves,** by M. Currie and J. Whinnery. "Proc. IRE" Nov. 1955. 15 pp. New cascade type of backward-wave amplifier consisting of two helices separated by an arbitrary transducer section overcome inherent disadvantages of single-circuit type. It features high gain far from the oscillation region, high-off-signal rejection and provision for adjusting bandwidth electronically. S-band model is presented.

A—1/6—106: **Ferrite Load Isolators for Pulsed Magnetrons,** by R. Krogh. "El. Eq." Nov. 1955. 2 pp. Resonance absorption isolator employs ferrites attached to guide walls. Ferrite dimensions and Curie ratings are considered.

A—1/6—107: **Running-Voltage / Current Characteristics of Some Glow-Discharge Tubes,** by F. Benson and G. Mayo. "El Eng." Dec. 1955. 3 pp. It is established that most tubes containing neon and argon with no helium have only negative temperature coefficients and the running-voltage/temperature curves are all linear or nearly so. Tubes which contain helium exhibit minima in their running-voltage/temperature characteristics.

A—1/6—108: **A DC Coupled Circuit Using Voltage Stabilizing Valves,** by G. Court. "El. Eng." Dec. 1955. 1½ pp. A chain of voltage stabilizing tubes is used in a microwave link to transfer the detector output to a klystron oscillator. The mean dc detector output is 150 v, the reflector potential about -450v.

U. S. GOVERNMENT

The following reports are available from government agencies at the prices indicated. They are printed (pri), photostat (pho) or microfilm (mic), as indicated by the notation preceding the price. Prepayment is required. Use complete title and parenthesized number following title when ordering. When ordering reports from the Office of Technical Services (designated as OTS after price), make check or money order payable to "OTS, Department of Commerce," and address to Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C. When ordering reports from the Library of Congress (designated as LC after price), make check or money order payable to "Chief, Photoduplication Service, Library of Congress," and address to Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D.C.

A—1/6—109: **Critique of the Variational Method in Scattering Problems (PB 118160),** by D. Jones, New York U. May 1955. 20 pp. Mic $2.40, pho $3.30. (LC) Proposal that reciprocity theorem be used as basis of approximation.

A—1/6—110: **Technical Progress Concerning the Measurement of Radioelectric Interference (PB 118167),** by J. Pfister and J. Buclin. Translated from Swiss by F. Raven. May 1955. 38 pp. Mic $3, pho $6.30. (LC) Covers r-f interference, instruments and spectrographic analysis.

A—1/6—111: **Electromagnetic Wave Propagation on Helical Conductors Embedded in Dielectric Medium (PB 118032),** by S. Olving, Chalmers U. Sweden. 1955. 16 pp. Mic $2.40, pho $3.30. (LC) Constructing helices which allow interaction with low velocity electron beam.

A—1/6—112: **High Voltage Extraction of Electrons from a Plasma (PB 111698),** by C. Coelo, Calif. U. Feb. 1955. 42 pp. Pri $1.25. (OTS) Use of strong electric field in vacuum to obtain beam for eventual traveling-wave amplifier use.

A—1/6—113: **On the Time Dependent Reliability of Networks (PB 118212),** by G. Weiss, Aberdeen Proving Ground. Mar. 1955. 18 pp. Mic $2.40, pho $3.30. (LC) Derives formulae for network survival time, probability of repair.

A—1/6—14: **Phase Difference Variations in 9350 Megacycle Radio Signals Arriving at Spaced Antennas (PB 118163),** by A. Dean and B. Fannin, Texas U. May 1955. 36 pp. Mic $3, pho $6.30. (LC) Report 6-08 of contract AF 19 (604)-494 on frequency measurement and antennas.

A—1/6—115: **2500-Watt Wideband Sonar Frequency Amplifier (PB 118218),** by T. Dixon, Naval Research Lab. June 1955. 18 pp. Mic $2.40, pho $3.30 (LC) Design, construction and operation of unit.

A—1/6—116: **UHF Tailcap Antenna Pattern Characteristics and Their Control (PB 117734),** by A. Ellis, Stanford Res. Feb. 1955. 88 pp. Mic $4, pho $11.50. (LC) Cause of highly lobed pattern traced to radiation current density on vertical stabilizer.

A—1/6—117: **Apparatus for Semi-automatic Transfer of Length-Represented Data to Punched Cards and Charts (PB 118028),** by L. Ericsson, J. Kaufl and C. Olsson, FFA, Sweden. 1955. 12 pp. Mic $2.40, pho $3.30. (LC) Equipment design projects data on movable plate.

A—1/6—118: **Brief Guide to Noise Measurement and Analysis (PB 118036),** by R. Young, Navy Electronic Lab. San Diego. May 1955. 24 pp. Mic $2.70, pho $4.80. (LC) Interpreting noise spectra, calibration procedures.

A—1/6—119: **Ultrasonic Welding of Aluminum (DP-107),** by J. Jones, C. DePrisco and J. Thomas, E. I. du Pont. Feb. 1955. 48 pp. Mic $3.30, pho $7.80. (LC) Atomic Energy report on contract AT-(07-2)-1.

A—1/6—120: **Study of Metal-Ceramic Interactions at Elevated Temperatures, Quarterly Progress Report for Period Ending April 1, 1955 (NYO-4630),** by F. Norton and W. Kingery, MIT. April 1955. 17 pp. Mic $2.40, pho, $3.30. (LC) Atomic Energy report on contract AT(30-1)-1192.

A—1/6—121: **Electronic Devices for Nuclear Physics. Quarterly Report No. 18 (AECU-3006)**, by M. Greenblatt and A. Sommer, RCA. Quarter ending Jan. 1955. 21 pp. Mic $2.70, pho $4.80. (LC) Atomic Energy report on contract W-7405-eng-26.

A—1/6—122: **Wave Propagation in Continuously Loaded Waveguides. I Conditions for Propagation of Pure Electric and Magnetic Wave Types in a Cylindrical System Containing Dielectric or Magnetic Boundaries (UCRL-4462)**, by J. Waddell, U. of Calif. Feb. 1955. 31 pp. Mic $3, pho $6.30. (LC) Atomic Energy report on contract W-7405-eng-48.

A—1/6—123: **Analysis of an Electron Beam Modulated by a Traveling Microwave Field (PB 117775)**, by O. Purl, Illinois Eng. Sta., EE Res. Lab. May 1955. 141 pp. Mic $6, pho $19. (LC) AC velocity content of electrons as function of phase position given on fluorescent screen.

A—1/6—124: **Microwave Noise Study, Final Report (PB 117760)**, by W. Gottschalk and D. Middleton, Raytheon. Jan. 1955. 20 pp. Mic $2, pho $2.75. (LC) Covers contract AF 19(604)-1158. Oscillator, magnetron and klystron noise measurement.

A—1/6—125: **Reduction of Power Line Radio Interference (PB 111666)**, by J. Senn and A. Gosley, Naval CE Res. Lab., Pt. Hueneme, Calif. Feb. 1955. 32 pp. Pri $1. (OTS) Details of construction and test of isolation filter.

A—1/6—126: **Scale Model Measurements of Low Frequency Transmitting Antennas (PB 117748)**, by S. Rosenberg and P. Wilson, Rome Air Dev. Ctr. March 1955. 91 pp. Mic $4.50, pho $12.75. (LC) Evaluation of antenna tower modifications to increase radiation efficiency.

A—1/6—127: **Some Characteristics of Image Orthicon Camera Tubes (PB 111658)**, by H. Wuerffel and D. Webb, Naval Res. Lab. March 1955. 44 pp. Pri $1.25. (OTS) Establish basis for predicting performance under abnormal operation.

A—1/6—128: **Step Discontinuities in Waveguides (PB 117777)**, by W. Williams, New York U. April 1955. 34 pp. Mic $2.50, pho $5.25. (LC) Method developed by Wiener and Hopf applied to cross section of rectangular guide.

A—1/6—129: **Study of the Generation and Detection of Electromagnetic Waves in the Millimeter Wave Region. Report No. 3 under Contract AF 19(604)-1115, Dec. 1, 1954 to Feb. 28, 1955 (PB 117767)**, by J. Rohrbaugh, New York U. March 1955. 43 pp. Mic $2.75, pho $6.50. (LC) Study of bolometers, detectors, spectrometers, wave generation and harmonic functions.

A—1/6—130: **UHF Filtering Networks, Scientific Report No. 3 under Contract AF 19(604)-962, 1 Feb. 1954 to 30 Apr. 1955 (PB 117778)**, by D. Mode, Lehigh U. April 1955. 22 pp. Mic $2.25, pho $4. (LC) Methods for computing voltage breakdown and power handling capacity in a filter structure.

A—1/6—131: **Ultrasonic Propagation in Solid Materials. Interim Research Report No. 3 under Contract AF 19-(604)-1095 from 3 Jan. 1955 to 1 Apr. 1955 (PB 117768)**, Andersen Labs. April 1955. 10 pp. Mic $1.50, pho $1.50. (LC) Ultrasonic radiation, properties of solids and delay line design reported.

A—1/6—132: **Keyed Oscillator for Time-Delay Generation (PB 117789)**, by C. Watterson, Naval Res. Lab. May 1955. 22 pp. Mic $2.25, pho $4. (LC) Design procedure for circuit producing simultaneous sine and cosine wavetrain for each keying pulse.

A—1/6—133: **Variable-Frequency Magnetic-Coupled Multivibrator (PB 117926)**, by R. VanAllen. May 1955. 11 pp. Mic $2, pho $2.75. (LC) Development based on principle that frequency can be controlled in inverse proportion to magnetic flux; experimental results to 800 kc.

A—1/6—134: **A Voltage Calibration System for Accurate Pulse-Height Measurement (ISC-598)**, by W. Rhinehart and D. Zaffarano. Iowa State Col. April 1955. 17 pp. Mic $2, pho $2.75. (LC) Atomic Energy report on contract W-7405-eng-82.

A—1/6—135: **Relay Insulation Studies (ORNL-1916)**, by O. Rudolph, Oak Ridge Lab. June 1955. 13 pp. Mic $2, pho $2.75. (LC) Atomic Energy report on contract W-7405-eng-26.

A—1/6—136: **Analysis and Design of Dense Electron Beams (PB 118245)**, by R. Anand, Ohio State U. April 1955. 26 pp. Mic $2.70, pho $4.80. (LC) Problems of high perveance electron guns, and analog and numerical methods of analysis.

A—1/6—137: **Electron Tubes. Specifications (PB 115149s9)**, ASESA, Ft. Monmouth. July 1955. 82 pp. Mic $4.80, pho $13.80. (LC) Tube specs, including MIL-E-1B.

A—1/6—138: **Experimental Research upon the Electronic Properties of Non-Metallic Crystals. Technical Status Report No. 6 under Contract AF 18(600)-662, for the Period Apr. 1955 to June 1955 (PB 118416)**, by R. Maurer, N. Inchauspe, J. Thomson and R. Miller, Illinois U. June 1955. 3 pp. Mic $1.80, pho $1.80. (LC) Conductivity, diffusion and dielectric loss of various crystal materials.

A—1/6—139: **Hollow Beams in Electrostatic Fields (PB 118349)**, by L. Harris, Minn. U. May 1955. 29 pp. Mic $2.70, pho $4.80. (LC) Trajectories are calculated for edges of tubular beams in radial fields.

A—1/6—140: **Infinite System of Linear Equations Arising in Diffraction Theory (PB 118449)**, by W. Magnus, New York U. June 1955. 25 pp. Mic $2.70, pho $4.80. (LC) Electromagnetic wave theory, mathematical equations and solutions.

A—1/6—141: **Long-Range Propagation of Low-Frequency Radio Waves between the Earth and the Ionosphere (PB 118448)**, by J. Shmoys, New York U. May 1955. 30 pp. Mic $2.70, pho $4.80. (LC) Propagation constant, angle of arrival and group velocity calculated for first modes.

A—1/6—142: **Methods of Determining Long Wave Reflection Coefficients for a Specific Ionospheric Model (PB 118302)**, by J. Gibbons and J. Wolf, Penn. State U. June 1955. 54 pp. Mic $3.60, pho $9.30. (LC) Applies Bailey iterative process to problem of computing 75 kc reflection coefficient.

A—1/6—143: **On the Diffraction of Electromagnetic Waves by a Circular Aperture (PB 118457)**, by H. Chang, Harvard U. March 1955. 113 pp. Mic $6, pho $18.30. (LC) Wave diffraction studied under contract AF 19(604)-786.

A—1/6—144: **Study of Piezoelectric Elements for the Measurement of Transient Forces (PB 111702)**, by Y. Yoler and H. Nagamatsu, Cal. Inst. of Tech. Feb. 1955. 31 pp. Pri $1. (OTS) Report on natural and artificially polarized elements for measuring forces; advantages of ceramic types.

A—1/6—145: **Study of Some Inherent Errors in the Three-Dimensional Raydist System (PB 118458)**, by I. Carswell, Stanford Res. Inst. June 1955. 46 pp. Mic $3.30, pho $7.80. (LC) Expression derived relating aircraft position error to Raydist system parameters.

A—1/6—146: **Topics in Antenna Radiation Theory (PB 118244)**, by A. Kay, Tech. Res. Group, N. Y. June 1955. 8 pp. Mic $1.80, pho $1.80 (LC) Antenna and wave theory.

A—1/6—147: **DC to AC Square-Wave Static Converter and Amplifier (PB 118454)**, by H. Mortimer, Naval Res. Lab. July 1955. 6 pp. Mic $1.80, pho $1.80. (LC) Two devices using combined magnetic amplifier type saturable cores and switching transistors.

A—1/6—148: **Coaxial UHF Noise Source (PB 118451)**, by H. Montague, Naval Res. Lab. Aug. 1955. 22 pp. Mic $2.70, pho $4.80. (LC) Unit uses fluorescent lamp coupled to low impedance helical transmission line.

A—1/6—149: **Magnetic Materials Used in Digital Computer Magnetic Circuits (PB 118505)**, by L. Silva, Aberdeen Prov. Gnd. April 1955. 49 pp. Mic $3.30, pho $7.80. (LC) Compilation of theories and data; performance criteria for selecting materials.

A—1/6—150: **Quarterly Progress Report (PB 118413)**, by R. Blot and R. Fay, June 1955. 42 pp. Mic $3.30, pho $7.80. (LC) Acoustic research, sound absorption and scattering.

A—1/6—151: **Speech Communication in Noise (PB 118446)**, by K. Kryter, AF Cambridge Res. May 1955. 46 pp. Mic $3.30, Pho $7.80. (LC) Speech intelligibility related to test materials and language factor.

A—1/6—152: **Theory and Engineering Application of a Practical Thermoelectric Electromagnetic (TEM) Pump (KAPL-1375)**, by L. Tonks, Knolls Atomic Pwr. Lab. Aug. 1955. 20 pp. Mic $2.40, pho $3.30. (LC) Atomic Energy report on contract W-31-109-eng-52.

PATENTS

Complete copies of the selected patents described below may be obtained for $.25 each from the Commissioner of Patents, Washington 25, D.C.

A—1/6—153: **Radar Apparatus Comprising a Receiver the Gain of Which Varies Periodically, #2,725,557.** Inv. S. Hellings. Assigned Hartford Nat. Bank & Trust. Iss. Nov. 29, 1955. Gain is reduced at instant of pulse emission by sawtooth generator and capacitor charge-discharge arrangement periodically triggered.

A—1/6—154: **Distance and Direction Indicating Equipment, #2,725,556.** Inv. J. Carter. Assigned Westinghouse. Iss. Nov. 29, 1955. Combined search and beacon radar receiver with oscillator-mixer stages for receiving two different frequencies on two channels. Oscillator is tunable.

A—1/6—155: **Automatic Frequency Control, #2,725,555.** Inv. A. Hopper. Assigned Bell Labs. Iss. Nov. 29, 1955. Control of beat frequency oscillator in sync with outgoing pulses of a radio transmitter-receiver is accomplished by demodulation to produce i-f pulses. Rectifying and integrating alternate pulses produce control voltage.

A—1/6—156: **System for Recording Discontinuous Signals in Continuous Sequence, #2,725,554.** Inv. E. Phillips and L. Berman. Assigned Hughes Aircraft. Iss. Nov. 29, 1955. Recording head is energized in sync with discontinuous signals. Drive mechanism with clutch allows recording medium to be advanced, or moved backward during discontinuous of signals.

A—1/6—157: **Coordination Circuit, #2,725,553.** Inv. J. Millman. Assigned U.S. Navy. Iss. Nov. 29, 1955. Pulse selection and switching system prevents interference between radio pulse echo detector and cooperating lobe-switched antenna directional recognition system having one transmitter, one receiver, and common crt indicator.

New Tech Data for Engineers

Resumes of New Catalogs and Bulletins Offered This Month by Manufacturers to Interested Readers

Relays

AEMCO, Inc., Mankato, Minn. has just released a 4-page bulletin covering a wide variety of relay types. Complete specs. are given for each relay; as well as mounting information, type enclosures available, and basic size information. Platings, insulation grades, and finishes are described. (Ask for B-1-1)

Printed Circuits

A new 6-page bulletin describing the manufacture and use of printed circuits has been made available by Synthane Corporation, Oaks, Pa. (Ask for B-1-2)

Radio Interference

The Stoddart Aircraft Radio Co., Inc., 6644 Santa Monica Blvd., Hollywood, Calif., has made available a 37-page bulletin entitled "Measurement of Radio Interference in Accordance with Specification MIL-I-6181B," clarifying certain little-understood portions of A.F. and Navy BuAer spec. MIL-I-6181B. (Ask for B-1-3)

Wavemeters

A 4-page illustrated folder on Precision Broadband Cavity Wavemeters has been published by DeMornay-Bonardi, 780 S. Arroyo P'kway., Pasadena, Calif. The bulletin describes the sealed construction which maintains a dielectric constant, and explains the extremely high accuracy of the units. (Ask for B-1-4)

Analog Computer Programming

Data File 120 from Beckman Instruments, Inc. (Dept. NR 30), 2200 Wright Ave., Richmond, Calif., describes how the direct use of the operational nature of computing elements saves time replacing complex computing circuits with symbolic equations. (Ask for B-1-5)

Radio Communication

Bulletin No. 9 of the Engineering Experiment Station, Univ. of Idaho, Moscow, Idaho, summarizes results of tests completed on car-mobile and hand-portable equipment and on the characteristics of radio communication in the 450-470 mc. band. (Ask for B-1-6)

Tape Recorder

International Radio and Electronics Corp., Elkhart, Ind., has available a bulletin describing their Crown series professional tape recorders, meeting all NRTB standards. (Ask for B-1-10)

Variable Inductors

Electrically variable inductors of the saturable reactor type are described in a 12 page brochure issued by Vari-L Co., Inc., 432 Fairfield Ave., Stamford, Conn. (Ask for B-1-11)

Interference Locator

Brochure describing Model 400 Interference Locator for locating radio and TV sources is available from Sprague Electric Co., North Adams, Mass. (Ask for B-1-12)

Switches

Instrument type switches are described in an 8-page catalog of Cinema Engineering Co., Aerovox Div., Burbank Calif. Illustrations, a complete code system outline, and complete specs. are included in the data. (Ask for B-1-9)

Digital Phase Measurement

An 8-page paper, "A Digital Method for Precise Phase Measurement" along with a description of digital laboratory instrumentation is available from Berkeley Division, Beckman Instruments, Inc., 2200 Wright Ave., Richmond 3, Cal. (Ask for B-1-15)

Miniature Connectors

Two-page bulletin describing new 37 contact Continental Connectors suitable for airborne electronics has been published by Dejur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. (Ask for B-1-16)

Relays

Kurman Elec. Co., 35-18 37th St., Long Island City, N. Y., has available a new 18-page booklet describing all types of relays for electrical, electronic, and industrial use. (Ask for B-1-17)

Recording Oscillograph

New 12-page Bulletin 1521B describing Recording Oscillograph and accessories for use in the dynamic test-measurement field is available from Consolidated Engineering Corp., 300 North Sierra Madre Villa, Pasadena, Cal. (Ask for B-1-18) ffl

Steel

Allegheny Ludlum Steel Corp., has announced a revised Blue Data Sheet on Monimax and Sinimax EM-20 steel. 24-page data sheet gives detailed information and graphs on these specialized steels for use in the electrical industry. (Ask for B-1-19)

Power Supplies

New data sheet, describing four regulated power supplies designed for color and monochrome television use is available from Tarc Electronics, Inc., Urban Ave., Westbury, N. Y. (Ask for B-1-20)

Cord Assemblies

Cat. No. 5-55 of stock molds for caps, connectors, strain-reliefs and other special cord attachments has just been issued by Royal Electric Co., Inc., Pawtucket, R. I. (Ask for B-1-21)

Flexible Couplings

Cat. No. 5694, 12 pages of information relating to the design and use of flexible shafts and couplings, is available from Kupfman Mfg. Corp., 395 State St., Binghampton, N. Y. (Ask for B-1-22)

Voltage Divider

Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia, Pa., has available Data Sheet E-51 (4) describing Type 4395 Precision Voltage Divider for sub-dividing dc voltage within ±.001%. (Ask for B-1-23)

Wire In Product Design

"How Wire Construction Reduces Costs," showing the use of wire in improved product design, is a study of 36 illustrated case histories released by E. H. Titchener & Co., 67 Clinton St., Binghamton, N. Y., design manufacturers of wire forms and welded wire assemblies. (Ask for B-1-24)

NSMPA Buying Directory

1955-56 Buying Directory, listing the location and facilities of all NSMPA members has been published by National Screw Machine Products Association, 2860 East 130th St., Cleveland, Ohio. (Ask for B-1-25)

Competence in Electronics

A 20-page, illustrated booklet describing the current facilities of Litton Industries, 336 N. Foothill Rd., Beverly Hills, Calif., from the conversion of ideas into hardware. (Ask for B-1-50)

Testing Services

A 9-page brochure describing the environmental testing services rendered by General Testing Laboratories, Inc., 58 Washington Avenue, Carlstadt, N. J. (Ask for B-1-51)

Film Badges

New 2-page specification sheet describing film badges for personnel protection against radiation from X-rays or radio-active material has been published by the Nuclear Instruments and Chemical Corp., 229 West Erie St., Chicago, Ill. (Ask for B-1-33)

Plastic Forming

Bakelite Co., Division of Union Carbide & Carbon Corp., 30 East 42nd St., New York 17, N. Y. has made available a periodical dealing with contour extrusion and vacuum forming of vinyl, polyethylene, and styrene plastics. (Ask for B-1-34)

Electronic Equipment

A new 24-page brochure describing the facilities and products of Telectro Industries Corp., 35-18 37th St., Long Island City, N. Y., is available. Products include power supplies, tape and wire recorders, signal generators, PA systems, radar test equipment, etc. (Ask for B-1-35) ffl

Doppler Data Translator

The DDT takes doppler data such as that obtained from radar tracking of a guided missile, digitizes it into a binary code and stores it on a magnetic tape suitable for computer playback. Data sheet by the Potter Instrument Co., Inc., 115 Cutter Mill Rd., Great Neck, N. Y. (Ask for B-1-36)

Foot Switch

Linemaster Switch Corp., 432 Woodstock Terr., Woodstock, Conn., has available a bulletin describing "Clipper" foot switches. Maintained Contact, Momentary Contact, and Impulse Contact arrangements described. (Ask for B-1-37)

Molded Rubber Parts

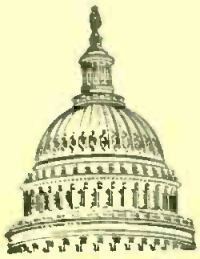
Molded rubber parts, custom produced to specification in a wide-range of compounds, are described in a booklet available from Quality Rubber and Transmission Co., 2203 W. Chicago Ave., Chicago, Ill. (Ask for B-1-38)

"The First Tool Engineer"

Tubalcain, son of Lameck and grandson of Methuselah, has been identified as the father of tool engineering in a 16-page illustrated booklet released by the American Society of Tool Engineers, 10700 Puritan Ave., Detroit, Mich. (Ask for B-1-39)

Lubricants

Revised bulletin, issued by the Alpha Molykote Corp., 65 Harvard Ave., Stamford, Conn., describes 17 types of molybdenum disulfide lubricants. Selector chart describes each lubricant type, the kind of carrier used in it, temperature range, and proper method of application. (Ask for B-1-32)



WASHINGTON
News Letter

Latest Radio and Communications News Developments Summarized by TELE-TECH's Washington Bureau

GOVERNMENT FREQUENCIES—Establishment of an ad hoc committee, headed by Defense Mobilization Director Arthur S. Flemming and FCC Chairman George C. McConnaughey and composed of top officials of frequency-using government departments, together with a continuing review of the government allocations by the Interdepartment Radio Advisory Committee, has inaugurated the most comprehensive and significant analysis ever undertaken of government frequencies which might be made available to television and other civilian radio services. The ad hoc group is conducting its survey aimed towards the request of the FCC to secure more VHF television space but it was stressed (as previously cited in this column) any definitive reallocation action will take anywhere from two to ten years. The IRAC subcommittee is directing its analysis in the area of planning and coordination to aid the ad hoc group in any reallocation of government bands. The survey of government frequencies has been urged by TELE-TECH in several editorials.

WEBSTER REAPPOINTMENT—Reappointment of Commissioner Edward M. Webster, not only because he is the only engineer member of the FCC, but to keep his nearly half-century of broad experience in communications and radio available to the government, is being vigorously supported by federal government and industry leaders in the communications-radio field. The term of Commissioner Webster, who has been a FCC member since 1947, expires next June 30. While he is believed to be receptive to reappointment, he is not working actively on his own behalf. In less than three years he will round out 50 years of government service. He has served with the Coast Guard where he established its extensive communications system and with the FCC as assistant chief engineer and Commissioner. Principal hazard to his reappointment is that he is an Independent politically and the Democrats can claim his post as one for their party. But his distinguished background and qualifications, recognized by Democratic leaders in Congress, might well override the political factors for a merit selection.

OPPOSE ADDED TV CHANNELS—Every effort should be made to put unused frequencies "to work" by the FCC before any changes in the allocation structure are attempted, the National Association of Manufacturers' Committee on Manufacturers Radio Use emphasized in a recent statement to the Commission. The great disadvantage of the principle of nationwide block allocation, the NAM group said, "is that it freezes frequencies in localities where there is little or no prospect that they will be put to use." The NAM body reiterated its stand on the lack of use of frequencies by FM broadcasting and opposed widespread TV spectrum expansion as a threat to all mobile radio services.

FORWARD SCATTER—While "forward scatter" propagation can make an important contribution in communications transmission over considerable distances, FCC Commissioner E. M. Webster has cautioned the radio industry not "to plunge into the non-government utilization of these modes of transmission until we have decided where they are to go in the spectrum and what we are going to do with the existing radio systems which will be replaced." The FCC engineer-member cited the possibility that scatter implementation may require adjustments in the frequency allocation table and that the impact of the new scatter systems on existing service is a matter requiring considerable study by the FCC and the industry.

MICROWAVE GROWTH—An increase of at least ten times the present facilities in microwave operations of major industries of the country—such as electric utilities, petroleum and gas pipe lines, trucking and aviation—looms in the next five years, according to views given TELE-TECH by authoritative FCC and radio industry sources. It was cited that microwave can be used not only for voice communication but for transmittal of all types of intelligence including telemetering, facsimile and industrial television.

ELECTRONICS RECOGNITION—The Navy demonstrated its recognition of the importance of electronics with the appointment of Capt. Rawson Bennett to succeed Rear Adm. Frederick R. Furth, who retires as of Jan. 1st to join the IT&T Corp. Adm. Furth has been a leading figure in electronic research and development. Capt. Bennett, former Asst. Director for Electronics in the Navy's BuShips, has likewise devoted most of his naval service to electronics and radio.

National Press Building
Washington, D.C.

ROLAND C. DAVIES
Washington Editor

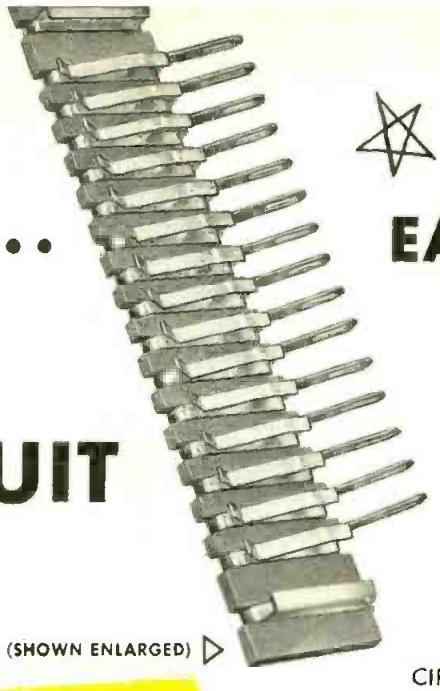
NOW...QUICK...EASY

ASSEMBLY WITH

CINCH EDGE CIRCUIT

(PATENT PENDING)

CONNECTOR—



(SHOWN ENLARGED) ▷

The CINCH EDGE CIRCUIT CONNECTOR provides quick, easy assembly. Eliminates moisture trap. Allows more flexible tolerances. Lower cost. Available in materials for both Military and Commercial use.

PRINTED WIRE BOARD

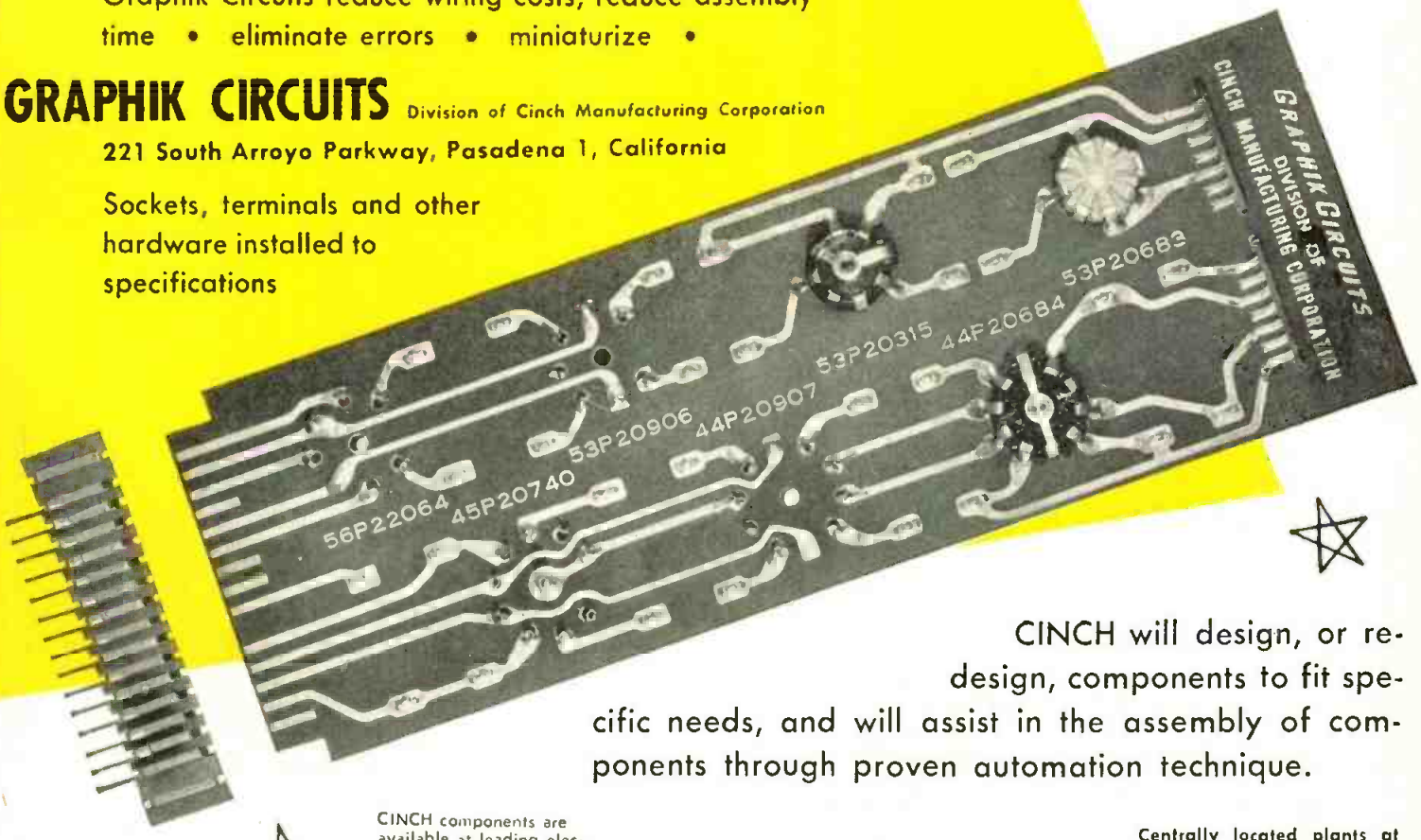
. . . high quality etched circuit boards with 5, 6, 7, and 8 pin subminiatures as well as 7 and 9 pin standard CINCH sockets. Provide flexibility of design and application.

Graphik Circuits reduce wiring costs, reduce assembly time • eliminate errors • miniaturize •

GRAPHIK CIRCUITS Division of Cinch Manufacturing Corporation

221 South Arroyo Parkway, Pasadena 1, California

Sockets, terminals and other hardware installed to specifications



CINCH will design, or redesign, components to fit specific needs, and will assist in the assembly of components through proven automation technique.

CINCH components are available at leading electronic jobbers—everywhere.

Cinch ELECTRONIC COMPONENTS

CONSULT CINCH

Centrally located plants at Chicago, Shelbyville, Pasadena and St. Louis.

CINCH MANUFACTURING CORPORATION

1026 South Homan Ave., Chicago 24, Illinois

Subsidiary of United-Carr Fastener Corporation, Cambridge, Mass.

New Test Equipment

FREQUENCY METER

New 400-cycle frequency meter, Model 6501, features a built in precision calibrator, using a temperature compensated tuning fork. Output terminals permit using the 400 cps ref-

erence freq. in lab. applications or as a secondary freq. standard. Two scales cover the range 395 to 405 cps, and 350 to 450 cps. Measures inputs of 2 to 200 v. Overall accuracy is better than 0.1%; accuracy of calibrator reference freq. is 0.05%. Similar in size and appearance to a small electronic voltmeter. Dimensions: 5¾ in. W., 7⅞ in. H., and 4¼ in. D. **VARO Manufacturing Co., Inc., 2201 Walnut St., Garland, Texas.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-6)

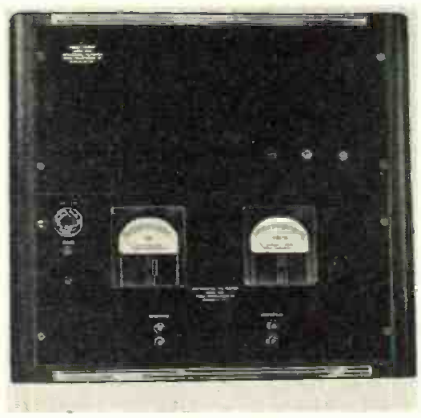
VOLT-OHM METER

"Meter-Matic," a new VT volt-ohm meter, has completely automatic range switching, and gives immediate reading. Calibration is complete without adding zero multipliers. Measurement of ac and dc v. is from 0.1 v. to 1.5 kv. In measuring resistance, automatic reading is from 0.5 ohm to 1,000 megohms in 6 ranges. Instrument is protected from burnout or damage up to

2 kv (up to 300 v. on ohms scale). Single set of probes serves all purposes. Unit operates on 115 vac, 60 cps. Has illuminated 8½ in. scale. $149.50. **Leitch Engineering Corp., Manchester, N.H.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-11)

VOLTMETER

Type 1560 Differential Voltmeter is useful when checking response and attenuation of filters, transformers, amplifiers, etc., where there is a small difference in voltage to be measured, as



it measures differences in voltage levels as low as 0.01%, regardless of their relation. Also useful to observe drift in amplifiers, meters, and filters. Difference voltage range: −10% to +5% in 0.01% increments. Input level: 0.1 v. to 100 v. Freq. range: 30 cps to 20 kc. Input impedance: 500K ohms. Power supply: 115 v., 60 cycles. **Freed Transformer Co., Inc., 1715 Weirfield St., Brooklyn, N. Y.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-2)

VT VOLTMETER

Designed as a VTVM, the Type 346 Sensitive Amplifier-Voltmeter can be used as a broadband amplifier. Readings are from −72 to +52 dbm. Rectifier is fullwave average type, offering highest accuracy when dealing in complex wave forms. Meter range: 1 mv to 300 vac. Accuracy: ±3%, 20 cps to 1 mc; ±5%, 10 cps to 2 mc. Input impedance: 10 megohms shunted by 24

μμf. Amplifier: Max. voltage gain 1000; max. output 1 v. Output impedance 600 ohms; noise 40 db below 1 v. Power supply: 117 vac. ±10%, 50-400 cps, 40 watts. **Allen B. DuMont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-18)

CORONA TEST SET

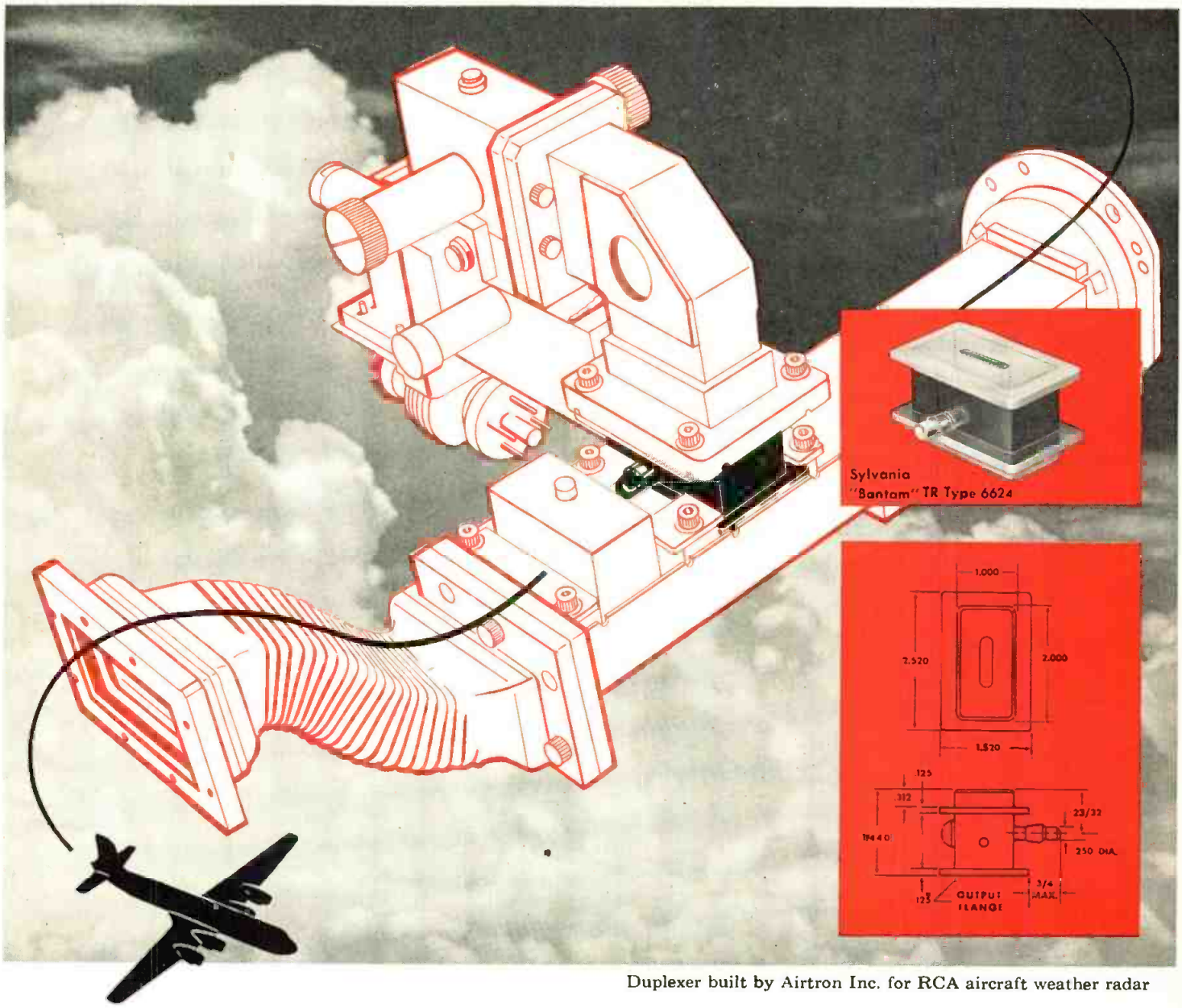
Features are: a continuously adjustable output control which enables the setting of any voltage from zero to max.; a zero start control which prevents application of any voltage until

control is returned to zero; an overload relay which protects the specimen and power unit from a fault or short-circuit; a dual range kilovoltmeter which provides accurate voltage indication. Used on cable, transformers, capacitors and other electrical equipment for non-destructive testing of electrical insulation. **Peschel Electronics, Inc., 13 Garden St., New Rochelle, N. Y.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-7)

MICROWAVE GENERATOR

This new microwave generator is a C.W. microwave source for X-band 8500-9600 mc/sec. The model 10X is an ideal source for Q measurements, phase measurements, or any other measurements requiring a high degree of r-f stability. Condensed specs. include: freq. coverage 8500-9600 mc/sec—X-band; short term deviation one part in 10^8, long term deviation one part in 10^5 re-

lative to reference cavity; power output 10 mw; ½ in. x 1 in. plain flange waveguide; power consumption 50w; size 5¼ x 9 x 10 in.; weight 15 lbs. **Microwave Development Laboratories, Inc., 92 Broad St., Babson Pk., Wellesley, Mass.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-39)



Duplexer built by Airtron Inc. for RCA aircraft weather radar

New "BANTAM" TR tube saves space and weight in airborne weather radar

If your Microwave design includes a branched duplexer, here's a new concept in TR tubes which can produce savings in equipment weight and space and offers simplified mounting with easier maintenance.

These were the primary considerations when Sylvania, in close co-operation with Airtron Inc., developed a special TR tube for use in RCA aircraft weather radar.

The "Bantam" TR type 6624 is the product of this development. Its smaller, more compact design with contact mounting moves the TR a full step toward miniaturization.

The 6624 is a broad-band, fixed tuned TR tube. Operational center is at 5400 mc. Contact mounting is at the input end. The Sylvania ATR type 6591 serves as the companion to the TR 6624.

Write for complete data on the Type 6624 and Sylvania "Bantam" TR tubes for other frequency bands.

"Another reason why it pays to specify Sylvania"

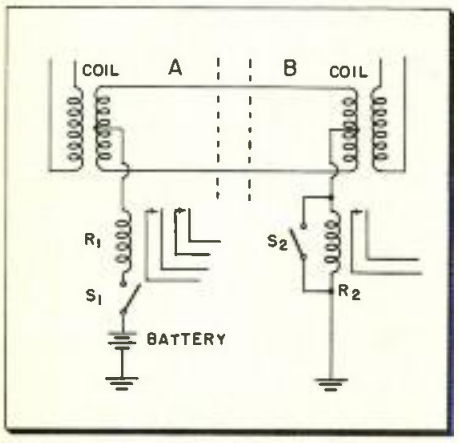
SYLVANIA®

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electronic (Canada) Ltd.
University Tower Bldg., Montreal

LIGHTING · RADIO · ELECTRONICS · TELEVISION · ATOMIC ENERGY

CUES for BROADCASTERS

Practical ways of improving station operation and efficiency



Remote control circuit for audio signalling

Remote Studio Signal Circuit

L. F. BREWER, Tech Superv.
WGAN-TV, Portland, Me.

SOMETIMES in the course of radio broadcast station operations it becomes desirable to operate from studio facilities that are remote from the control location. In such a situation, a means of signalling between the program originating point and the control room is a very desirable feature.

The circuit illustrated herewith may be used for signalling over any audio circuit that is balanced with respect to ground and has no amplifiers between the point of origin and the terminating location. The coils are standard telephone line repeating coils such as the Western Electric 111C unit. R_1 may be any suitable relay with a dc coil resistance of 2500 ohms. Relay R_2 should have a coil resistance of 10000 ohms. S_1 and S_2 may be any suitable switches or auxiliary contacts on microphone or other circuit control switches. For intermittant service the battery may be a 45 v. B battery but a simple selenium rectifier supply is more satisfactory if the circuit is to have frequent use.

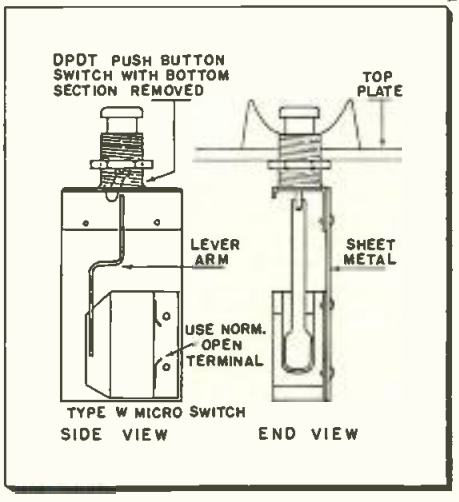
The operation of the circuit is as follows: Closing S_1 allows current to flow through the relays and the line and return through the ground circuit. The resistance of the line and the two relays in series limits the current to 3 or 4 ma. which is sufficient to close relay R_2 and operate any desired ready signal at location B.

Relay R_1, having a much lower resistance than R_2, requires 9 or 10 ma. pull in current, so it will not operate until S_2 is closed, shorting R_2. This reduces the circuit resistance such that the current increases to a value sufficient to close R_1, which will then operate any desired signal at point A.

Ampex Start Button Replacement

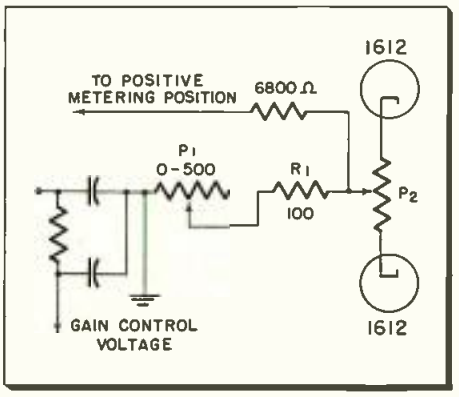
GEORGE O. WUSSOW, Ch. Engr.
KVCV, Redding, Calif.

THE start button on our No. 300 Ampex is a constant source of trouble after a few hundred cycles of operation. To overcome the need of replacing the DPDT switch (Push-Button) used, I removed the bottom and mounted the button and swivel arm on a piece of sheet metal, so as to actuate the lever arm of a Type W Micro-switch which I had salvaged from an old wire recorder. By mounting the micro-switch with the lever arm touching the swivel of the push-button, the action of the swivel, when the button is pressed, causes the micro-switch lever to move slightly and close the switch.



Micro-switch replaces push button switch

A dependable and silent switch is the result. The attached diagram will show the finished product. Incidently, the use of a DPDT switch as a start button on the No. 300 Ampex is not needed, although it comes with one, and the schematic shows it. Close inspection will show the switch is a return for the relay coils only.



Tap off limiter provides remote metering

Remote Metering of Compression Levels

BOB CROSSTHWAITE, Ch. Engr.
KWYO, Sheridan, Wyo.

THE ability to monitor the amount of compression in a level governing amplifier at a transmitter's remote control point is of considerable importance for maintaining uniform program compression when program sources are changed.

KWYO has installed Rust remote control equipment and to avoid using an additional line amplifier, our W. E. 1126C Level Governing Amplifier was left at the transmitter location.

As the remote metering voltages in the Rust system are of the order of ½v., it was decided to try using the cathode voltage of the limiting stage of the W.E. amplifier to provide a remote indication of the compression values.

This gave very satisfactory results. As shown in the diagram, a 6800 ohm resistor connected to the junction of the two cathodes in the limiting stage, provided a positive voltage of the proper magnitude when connected to one of the metering positions in the Rust system. The other side of this metering position was connected to ground. This connects an unbalanced telephone line across the biasing resistors of the limiting stage whenever compression levels are being checked at the remote control point. However, the 6800 ohm resistor, plus the fact that the two 1612 tubes are balanced with potentiometer P2, prevents any noise be-

(*Continued on page* 125)

STORER BROADCASTING COMPANY

top management
and engineering executives
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Stainless

for their tower
of 1100′ overall height,
for WAGA-TV, Atlanta, Georgia

WAGA-TV

ATLANTA, GEORGIA

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100 mw or ONE watt

Buy the Power You Need!

ONLY Raytheon TV microwave links offer you this choice

PLUS THESE FEATURES

- Simultaneous transmission of monochrome or full NTSC color plus program audio
- Rugged, versatile—for portable or fixed installations.
- Available in 6,000, 7,000, 13,000 Mc bands
- Uses stable, long-life klystron

Raytheon KTR-100 series (100 mw RF output) TV microwave links provide reliable, high quality transmission of video and audio at lowest cost. When you need additional power to overcome "grazing" conditions or for longer hops, the extra 10 db power output of the KTR-1000 series (one watt RF output) meets your requirements.

Only Raytheon gives you this choice. You buy the power you actually need; and if lower power does the job, you save up to 25%.

For broadcasters and common carriers Raytheon KTR links provide outstanding service—proved by excellent performance in nearly 200 television installations.

You will be interested in further information on the complete KTR series. Write Dept. 6120 for complete data.

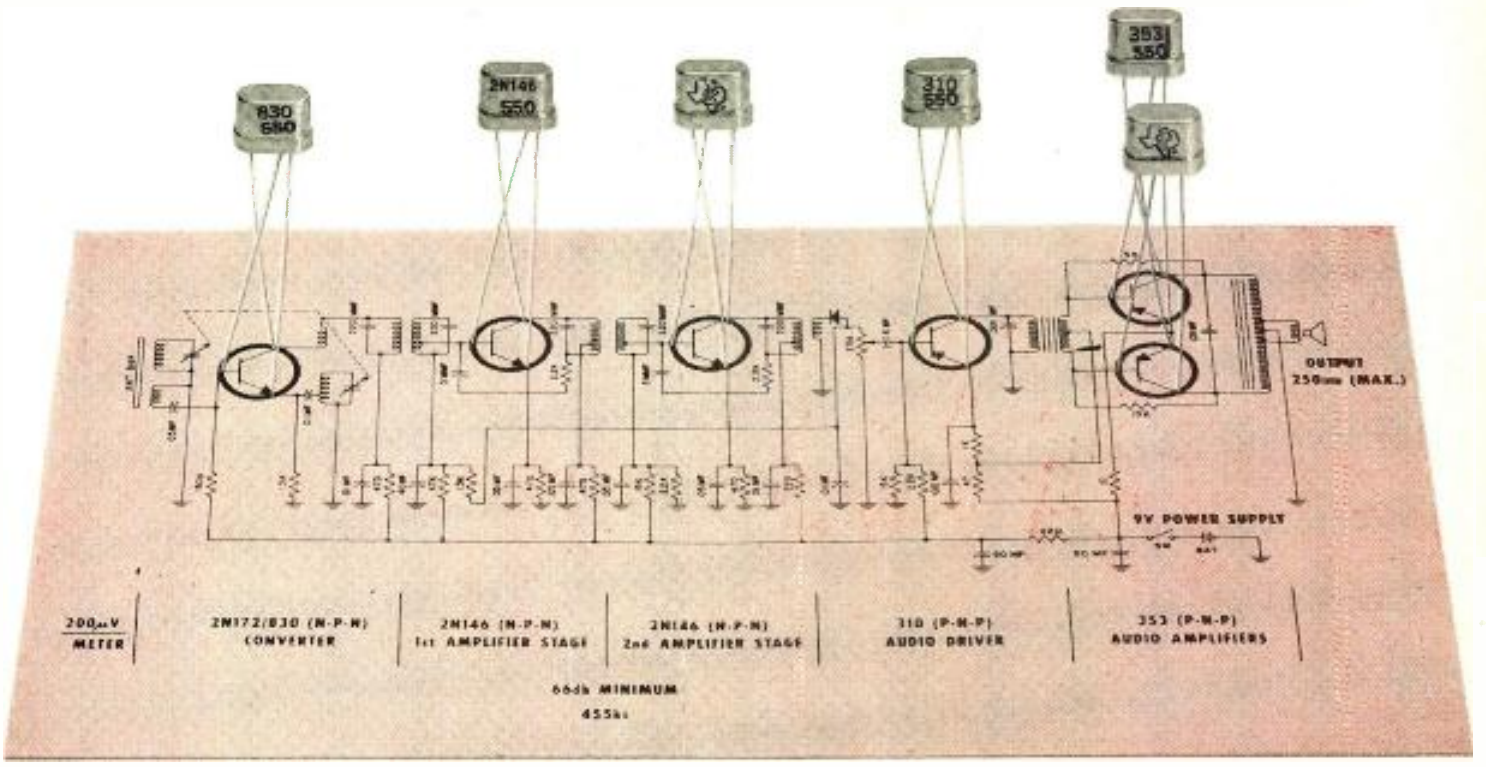
RAYTHEON

RAYTHEON MANUFACTURING COMPANY

Equipment Marketing Department, Waltham 54, Mass.

Excellence in Electronics

Performance . . . not promises!



Texas Instruments germanium transistors are used in 85% of the many brands of transistorized radios now being manufactured! Since TI transistors made possible the FIRST transistorized radios 15 months ago, improved mass production methods have rapidly increased performance and decreased prices.

In less than a year and a half, progress in TI transistors and radio circuits has been so swift that the following improvements are now production realities:

	1954	1955
Sensitivity	2000 μv/m	200 μv/m
Operating Voltage	22½V	6, 9, or 12V
IF Gain & Frequency	31db @ 262 kc	35db @ 455 kc
IF Output Capacity (C_{ob})	30-40 μμf	1 μμf
IF Neutralizing Capacity	Selected	Fixed
Audio Output Power	20mw	250mw
Typical IF Transistor Price (In complete OEM kit)	$2.50	$1.75

IN THE CIRCUIT ILLUSTRATED ABOVE:

Left to right: a 2N172/830 germanium N-P-N graded junction converter, two 2N146 germanium N-P-N graded junction IF amplifiers, a 310 germanium P-N-P fused junction driver, and two 353 germanium P-N-P fused junction outputs. This is a typical TI circuit designed for optimum performance.

Your *own* transistorized product development will also benefit from Texas Instruments progress which gives you proven products, immediate availability in production quantities, and economical prices. *First* with transistors in commercial radios, *first* with high gain, low voltage IF transistors, *first* with high temperature silicon transistors . . .Texas Instruments consistently leads the industry in development and manufacture.

LOOK TO TI FOR: GERMANIUM RADIO AND GENERAL PURPOSE TRANSISTORS • SWITCHING TRANSISTORS • SILICON SMALL SIGNAL AND POWER TRANSISTORS • SILICON JUNCTION DIODES

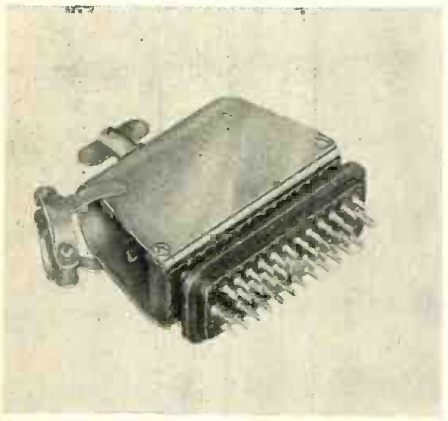
Texas Instruments has produced more radio transistors than any other manufacturer!

TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVENUE DALLAS 9, TEXAS

New Avionic Products

PRESSURIZED CONNECTOR

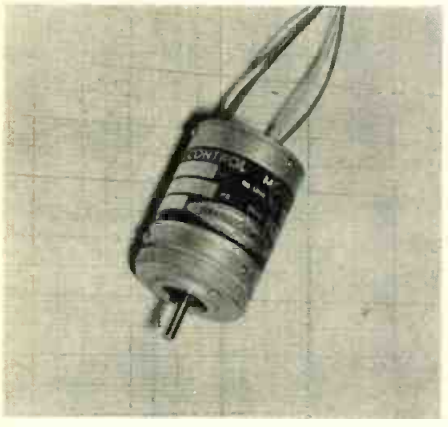
The Series "GA" 40 contact pressurized connector was developed primarily for guided missile applications. A center screwlock, with spring action, permits rapid engaging and disengaging



of the connector while preventing damage often encountered when prying apart or forcing separation of plug and receptacle. Individually spring loaded contacts assure easy release of the connector at all times. Hood, cable clamp, and all hardware are stainless steel. **DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-46)

400 CYCLE SERVO MOTOR

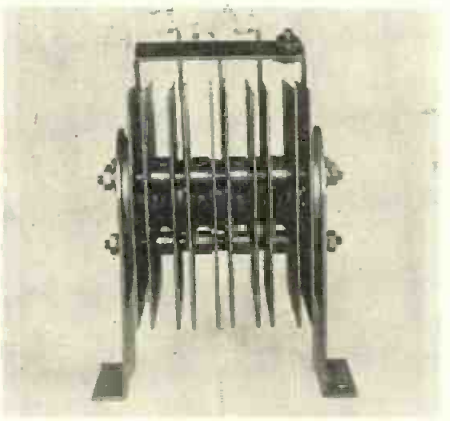
A new high temp. miniaturized servo motor has been designed for operation in high ambient temp. applications. This 3 oz. motor, measures 1 1/16 in. in diameter, and is capable of withstanding continuous Class H operating temps. It is designed for a min. life of 1,000 hrs. of continuous operation at 150°C. ambient temp. Voltage: 115 v./phase; power input—stall, 3.5 w./phase; current—stall,



72 ma/phase; temp. rise—on alum. plate, 65°C; stall torque, 0.4 oz-in.; no load speed, 7200 rpm; max. power output, 0.6 w.; rotor inertia, 1.2 gm-cm.² **Servomechanisms, Inc., Components Div., 625 Main St., Westbury, N. Y.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-31)

SILICON RECTIFIER

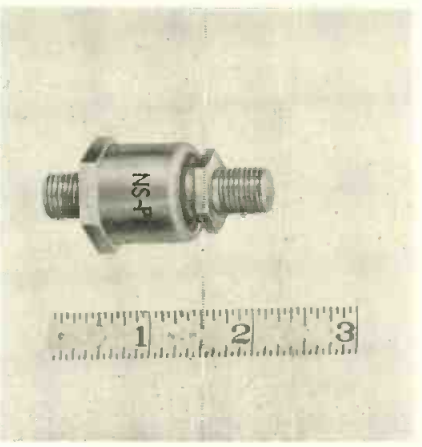
This high power silicon rectifier is being marketed in cells rated at 100 peak inverse v., 14 a. half-wave, and cells can be stacked to achieve desired circuit requirements. It has been de-



signed to function at peak efficiency in a wide range of ambient temperatures up to 100°C. The new rectifier will have important application in the guided missile and aircraft field, by making the overall power supply system weigh less than 50 lbs, and eliminating the need for bulky external cooling equipment. **Bogue Electric Manufacturing Company, 52 Iowa Ave., Paterson 3, N. J.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-19)

POWER RECTIFIER

New silicon power rectifier, NS-P1 operates at ambient temp. up to 200° C. Unit is housed in a shock-proof case 1⅛ in. diameter and 1¼ in. high. Reverse working voltage is 60 v. and min. breakdown voltage is 70 v. Forward current density at 1 v. drop is in excess of 600 a. per sq. in. of junction area.



Suitable for use in supersonic aircraft, guided missiles and landborne vehicles at savings in size and weight. **Hoffman Electronics Corp., 3761 S. Hill St., Los Angeles 7, Calif.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-28)

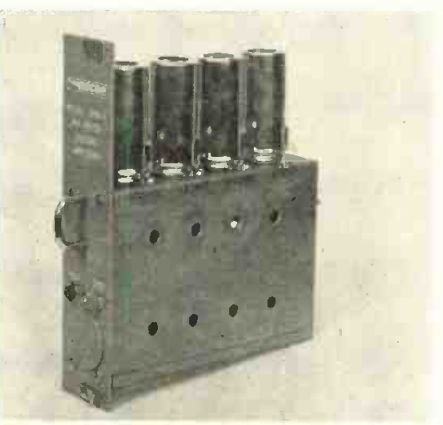
INVERTER TESTER

Aircraft Inverter Tester USAF Type L-1A is designed specifically to test aircraft type inverters that require a dc input voltage in the range of 12 to 29 v., and deliver an ac output voltage in

the range of 26 to 115 v., 400 cps, with rated outputs up to 3 kw. Unit tests output voltage and current, frequency, regulation, and efficiency. Size: 24 x 18 x 33 in. Wt.: 175 lbs. Power input: 28 vdc. **Telectro Industries Corp., 35-16 37th St., Long Island City 1, N. Y.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-45)

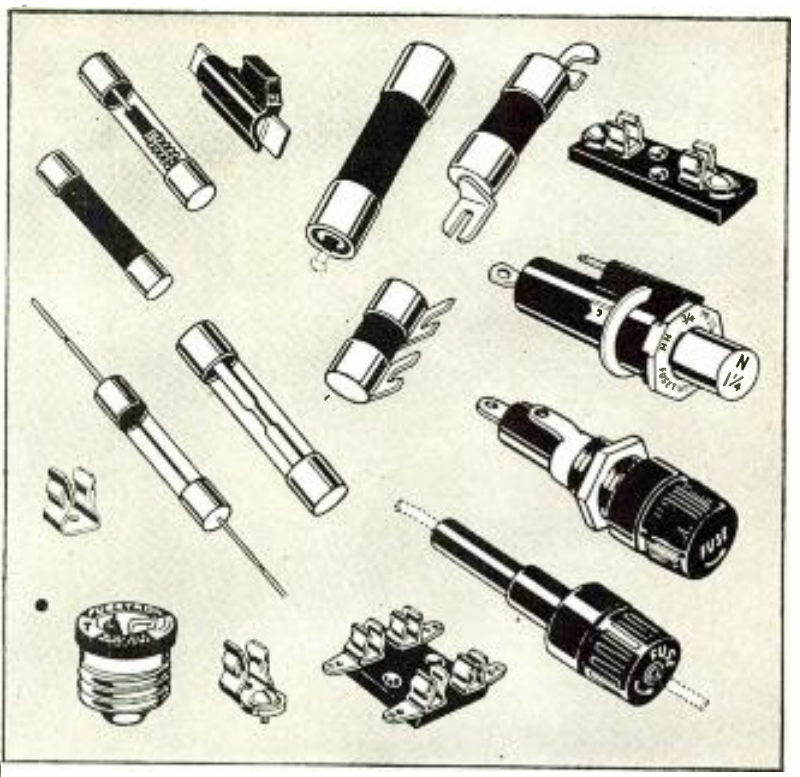
PW KEYER-RECORD AMPLIFIER

Model DKA-1 PW Keyer-Record Amplifier unit is used for PW multicoding and direct recording of numerous data channels onto single track of an Ampex magnetic tape recorder. The unit combines a standard 900 sample/sec. Pulse Width Keyer and a record amplifier in a single unit which is interchangeable with the FM or PWM/AM record strips in the Record Electronics



Assembly of any of the Ampex 800 Recorders. Unit meets all essential functional requirements of MIL-E-5400, and plugs directly into an Ampex 800 Series Airborne Record Electronics Assembly. **Applied Science Corp. of Princeton, P.O. Box 44, Princeton, N. J.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-40)

The unfailing Dependability of BUSS FUSES . .



helps you keep customers satisfied !

By operating properly under all service conditions — BUSS fuses can help safeguard the reputation of your product or service against loss of customer good will.

When there is an electrical fault — BUSS fuses open and prevent further damage to equipment, saving users the expense of replacing needlessly burned out parts.

And just as important, BUSS fuses won't give a false alarm by blowing when trouble doesn't exist. Useless shutdowns caused by poor quality fuses blowing needlessly are not only irritating to customers — but customers' confidence in your product or service could be jolted.

Every BUSS fuse is electronically tested to assure "trouble-free" operation.

Every BUSS fuse normally used by the Electronic Industries is electronically tested. A sensitive device automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

With a complete line of fuses, fuseholders and fuse blocks available — it is just good business to standardize on BUSS.

For more information on FUSETRON and BUSS small dimension fuses and fuseholders . . . Write for bulletin SFB.

Makers of a complete line of fuses for home, farm, commercial, electronic, automotive and industrial use.

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

BUSSMANN MFG. CO.
(Division of McGraw Electric Co.)
UNIVERSITY AT JEFFERSON
ST. LOUIS 7, MO.

156

BUSS FUSES ARE MADE TO PROTECT — NOT TO BLOW

New Broadcast Equipment

TV CAMERA SWITCHER

Model PD-133 Camera Switching Unit permits operation of 4 PD-150 TV cameras from a single camera control unit. Units may be cascaded to provide push-button selection of any number of cameras. Addition of a motor driven timer or a series of thermal activated relays provides automatic sequential switching of any number of cameras, providing completely automatic re-

mote surveillance of an automated production. Has pre-set control of Gain, Blanking, Beam, Target and Focus for each camera. **General Precision Lab., Inc., 63 Bedford Rd., Pleasantville, N. Y.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-29)

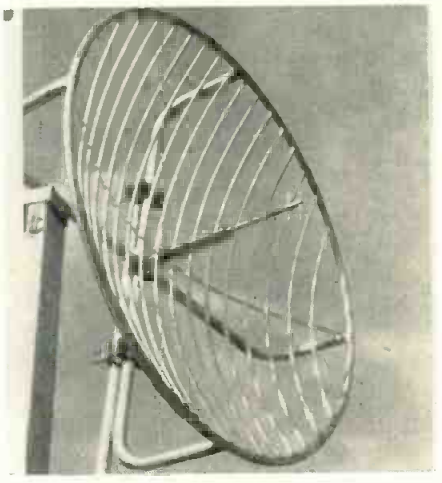
TIME DELAY UNIT

Auto-Vox introduces controlled amounts of delay into audio systems. Providing one output as a reference and a second output with variable delay in two ranges, the unit permits two

signals to be developed in two independent channels with separate or mixed output. Specifications: One output reference; second output in two ranges, (a) —20 to +250 msec. (b) —60 to +750 msec.; third output in two ranges, (a) —50 to +330 msec., (b) +150 to +1000 msec. Other specified ranges are available. **Kay Electric Co., 14 Maple Ave., Pine Brook, N. J.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-25)

PARABOLIC ANTENNAS

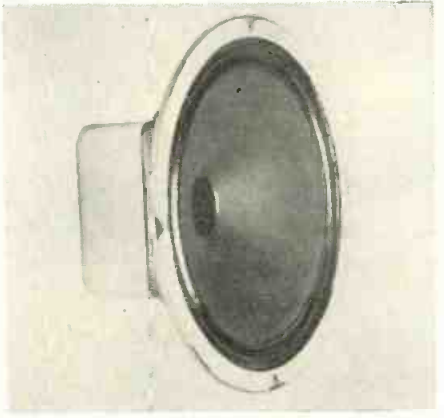
A new series of parabolic antennas for the 890-960 mc and 450-470 mc regions is now in production. Units are available in sizes up to 10 ft. diam. employing a parabolic grid structure. At 960 mc 3 models are available: P-942, P-972, and P-9120 are 42 in., 6 ft., and 10 ft. in diam. and produce gains of 15, 20, and 25 db. respectively over a dipole. At 460 mc 2 units are avail-



able: P-472 and P-4120 are 6 and 10 ft. in diam. and produce gains of 15 and 20 db respectively over a dipole. **Mark Products Co., 6412 W. Lincoln Ave., Morton Grove, Ill.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-32)

LOUDSPEAKER

New Model 401A speaker is an 8" industrial all-range speaker of high quality performance, designed particularly to meet the requirements of public address and various types of commercial



sound systems. The unit has a power capacity of 14 watts, impedance of 8 ohms, with resonance 75 cps. The voice coil diameter is 1 in., and the depth 3⅝ in. Consumer Net Price: $13.20. **Altec Lansing, 9536 Santa Monica Blvd., Beverly Hills, Calif.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-9)

TWO-WAY RADIO

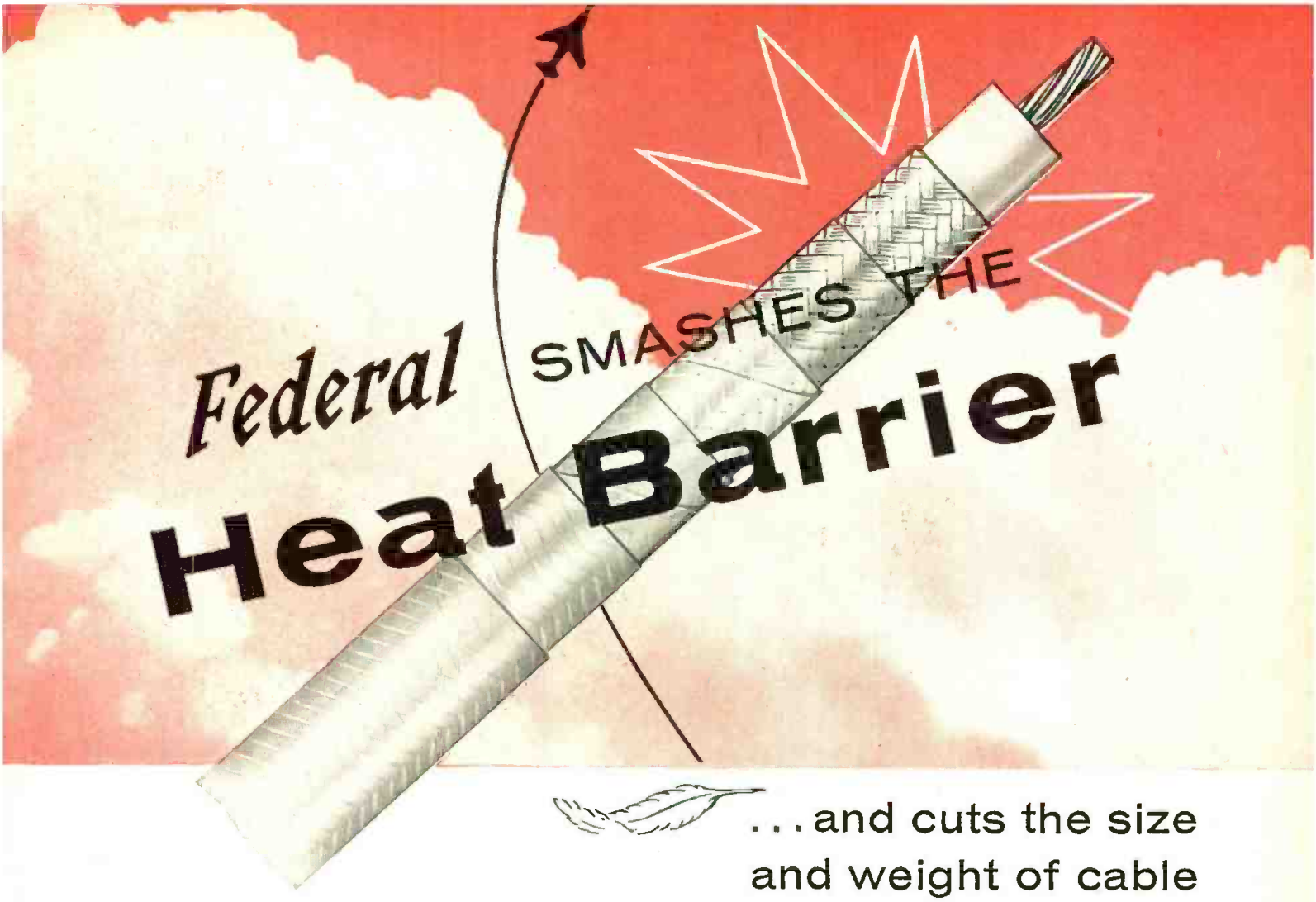
The COMCO Model 278-6/12 airport CONTROLLER is the latest model in the 278 series. It is a VHF-AM two-way radio unit for use in airport vehicles and ground stations. The radio

unit can be moved from a 6 v. to a 12 v. vehicle. All changing is done by a heavy-duty female type plug which is permanently installed in the vehicle. Equipment is powered by a vibrator power supply which permits a low standby battery drain of 8 a. on 6 v. operation. Complete mobile package price is $398. f.o.b. Miami. **Communications Company, Inc., 300 Greco Ave., Coral Gables, Fla.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-34)

TAPE

New "Weather-balanced" magnetic tape offers 50% more recording time than conventional tapes and features a more durable polyester backing. No. 150 tape has one-mil polyester backing made from DuPont "Mylar" film for resistance to changes in temperature and humidity and also for greater strength. Features 3M's exclusive high potency oxide, the firm's patented sili-

cone dry-lubrication and new 7 in. "loop-lok" reel for easier, faster tape threading. Maroon in color, available in lengths of 900, 1800, 3600 and 7200 ft. **Minnesota Mining & Mfg. Co., 900 Fauquier St., St. Paul 6, Minn.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-3)



Federal SMASHES THE Heat Barrier

. . . and cuts the size and weight of cable

Federal's miniature coaxial cables—about ¼ the size of comparable RG types—save critical space and weight in aircraft and instrument uses.

Challenged by the high temperature and minimum weight requirements of jet aircraft and guided missiles, Federal has designed RG cables that perform perfectly at a blistering 500° F.! New Federal miniature coaxials have a top temperature rating of 150° C. . . . up to 200° C. with an impregnated fiber glass jacket!

The key to these new cable developments lies in advanced designs.

Based on utilization of "Teflon," this superior dielectric maintains its excellent low loss and high voltage characteristics through a temperature range of 500° F. to −100° F. "Teflon" has no measurable water absorption; it is chemically inert . . . unaffected by alkalies, acids, aromatic fuels, aromatic organic solvents, and highly corrosive aviation hydraulic fluids.

If your cable problems involve heat, space or weight, it will pay you to consider Federal's new "Teflon" insulated cables. For information, write Dept. D-966.

"TEFLON" HIGH TEMPERATURE CABLES

RG-87 A/U 50 ohms; 69.5% V.P.; 29.5 mmfd/ft. Cap; 4,000 operating volts.

RG-140/U 75 ohms; 69.5% V.P.; 29.5 mmfd/ft. Cap; 1,700 operating volts.

RG-141/U 50 ohms; 69.5% V.P.; 29.0 mmfd/ft. Cap; 1,500 operating volts.

"TEFLON" MINIATURE COAXIAL CABLES

K-256 50 ohms; 29 mmf/ft. Cap; 72% V.P.; 850 V rms Corona; 13 db/100 ft. Atten. at 400 mc; 0.095 O.D. dielectric; 7/30 silver-plated Copperweld conductor; 0.135 O.D. jacket.

K-257 70 ohms; 21 mmf/ft. Cap; 72% V.P.; 850 V rms Corona; 14 db/100 ft. Atten. at 400 mc; 0.095 O.D. dielectric; 7/34 silver-plated Copperweld conductor; 0.135 O.D. jacket.

K-258 93 ohms; 16 mmf/ft. Cap; 72% V.P.; 850 V rms Corona; 15 db/100 ft. Atten. at 400 mc; 7/38 silver-plated Copperweld conductor; 0.135 O.D. jacket.

"TEFLON" HOOK-UP WIRE—Type E, EE and FF Hook-Up Wires meet MIL-W-16878A. Available in all standard colors.

Federal

A DIVISION OF ITT

Federal Telephone and Radio Company

A Division of INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

COMPONENTS DIVISION • 100 KINGSLAND ROAD • CLIFTON, N. J.

In Canada: Standard Telephones and Cables Mfg. Co. (Canada) Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., New York

New Technical Products

"WIRE-WRAP" TOOL

Solderless wrapped electrical connections can be made with this new "Wire-Wrap" tool. Powered by the Keller Air Motor, it makes connections in less than 1 sec. Any solid 14 or 16 gage wire may

be used. Terminals may be made from commonly used metals and may be sq. or rectangular. Max. terminal dimensions are: .132 x .132 in. with a min. .375 in. spacing between terminals. Connection is 11/32 in. long. Tool weighs 2 lbs. An automatic device stops the bit in the correct starting position. **Keller Tool Div., Gardner-Denver Co., Grand Haven, Mich.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-38)

VOLTAGE REGULATOR

The EE100 Distortion Eliminating Voltage Regulator eliminates disturbing harmonics and low frequency noise in 115 v., 60 cps power sources. It furnishes 1-4 KVA of 1% electronically voltage-regulated power with line distortion reduced to less than 0.3%. The recovery time is less than 1/50 cycle, with no phase shift between input and output. Simultaneously, it furnishes an

additional 4 KVA of 1% electromechanically regulated power with a time constant of 0.6 seconds. 230 v. model also available. **Curtiss-Wright Corp., Electronics Div., 631 Central Ave., Carlstadt, N. J.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-22)

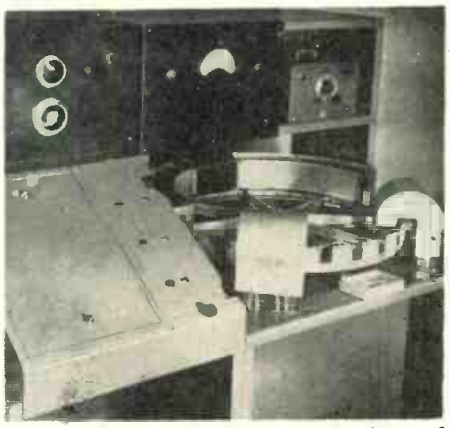
COUNTER DIAL

This dial can be used with multiturn devices where direct reading to hundredths of a turn is desired. It has a driving ratio of 1½ to 1;2. It allows complete continuous rotation, in either

direction, without obstruction. It has a 4-digit counter and affords readings up to 9999, with up to 100 turns. AMERDIAL measures 2¼ in. in diam. and 1¾ in. in depth (including the counter face). **Amerac, Inc., 116 Topsfield Rd., Wenham, Mass.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-42)

CAPACITOR TEMPERATURE COEFFICIENT MEASUREMENT

New automatic production machine measures the temp. coefficient of ceramic dielectric capacitors at a rate of one every 40 sec., with coefficient accuracy of 2 parts per million, and direct capacity measurement exact within 0.0038 μμf. The machine may be operated by unskilled workers. An indexing turntable holding 24 units transports the capacitors to 3 measuring positions automatically, where they are cycled in 10 min. steps from 25°C. ambient to 90°C. back to 25°C. Max. capacity tested is 400 μμf; max. ca-



pacity change during test is 10 μμf. This machine was developed by Companie Generale de Telegraphie Sans Fil, Paris, France. **American Radio Co., 445 Park Ave., N. Y.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-26)

VARIABLE TRANSFORMER

This new variable transformer, incorporated on variable output power supplies, controls input and output voltages. It is spot welded to the power supply and eliminates the need for a

separate variable input transformer. Control dial on the transformer is calibrated in percentages of line voltage, rather than in voltage, to simplify operation. Variable output power supplies are available with transformer which includes an on-off switch, line fuses and cord. **Condenser Products Company, 140 Hamilton St., New Haven, Conn.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-23)

10 MC SCALERS

Designed for high speed nuclear and general counting, the EPIC Model 4101 and 4124 10 mc scalers have a binary or decade scale of 4096 or 1,000 respectively, or larger if desired. Gated decade system features high bias range and reliability approaching that of a binary. Contains a 5 digit electrical reset register with any count predeterterminable, a predetermined timer, a

regulated power supply (0 to 2500 v.) for photomultipliers, and a general purpose 10 mc preamplifier and pulse height discriminator. **Electrical and Physical Instrument Co., 42-19 27th St., Long Island City, N.Y.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-17)

G.E. again helps TV manufacturers cut costs...introduces new 2B3 high-voltage rectifier, with 1.75-v filament!

IN LINE with General Electric policy to help manufacturers cut costs of volume-production TV sets, the new 2B3 rectifier tube saves by eliminating a resistor, associated wiring, plus their share of circuit-assembly expense.

No need for filament-voltage stepdown . . . instead, the new 2B3, supplying power to the picture-tube anode, operates directly from the flyback transformer!

Designed to replace the 1B3-GT for increased circuit economy, G.E.'s 2B3 also outperforms its prototype. A new filament construction gives longer tube life, increases dependability.

Step by step, General Electric tube engineers have cooperated with designers and builders in reducing TV-set costs. In 1954 came the 6CD6-GA and 6AU4-GTA—new G-E sweep tubes with high ratings, usable both for monochrome and color, lower in cost than any color sweep tubes then available.

Also in 1954, the famous "600-series" family of 50 G-E tubes, all with controlled heater warm-up time . . . making possible mass production of reliable, economical series-string TV receivers. Last year, General Electric introduced the 6CN7 duo-diode triode—saving some $.23 over the 6AQ7-GT whose circuit functions it assumed.

Profit from G.E.'s consistent drive to cut TV manufacturing expense with new tubes that save components, circuitry, and labor! Get ratings, characteristics, and prices of the cost-saving 2B3! Address *Tube Department, General Electric Company, Schenectady 5, New York.*

Progress Is Our Most Important Product

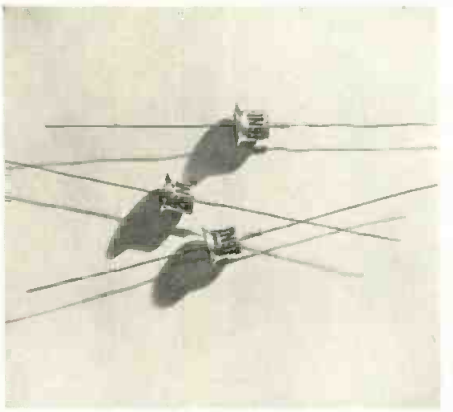
GENERAL ELECTRIC

162-1A1

New Products

POWER DIODES

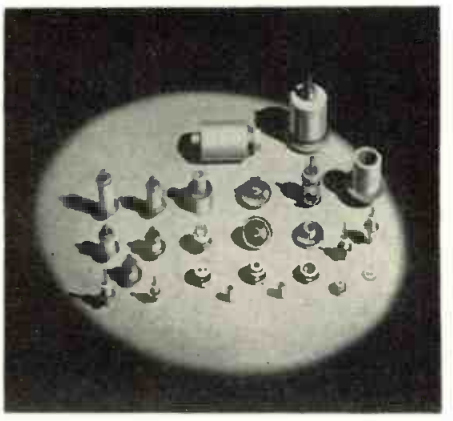
Germanium Junction Power Diodes Types 1N91, 1N92, and 1N93 are designed for use in high level modulation and detection in communications and control, audio frequency switching ap-



plications and rectification in the power range up to 25 w. Features are: miniaturization, high efficiency, and long life. Specs: Peak Inverse Voltages up to 300 v., Peak Forward Currents up to hundreds of ma., Low Full Load Voltage Drops (approx. 0.5 v.), Operating Frequency 50 kc., Storage Temperature 85° C. **Clevite Transistor Products, Div. of Clevite Corp., 241-257 Crescent St., Waltham, Mass.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-48)

TERMINALS

New high-strength, high-temperature Metalized Hermetic Terminals of Alumina ceramic may be installed by silver soldering at temperatures up to 750° C. AlSiMag 576 and AlSiMag 614, teamed with new high temperature metalizing techniques, offer the design engineer: ultra low loss ceramic with an improved glaze of superior surface resistivity; permanent, leak-tight bonding; higher



tensile and impact strengths; greater resistance to spalling and breakage; exceed MIL-T-27A torque requirements. **American Lava Corp., Cherokee Blvd. & Mfgrs. Rd., Chattanooga, Tenn.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-49)

how to select the audiotape best suited to your needs

Standard Plastic-Base Audiotape meets all the requirements of the professional or home recordist to excellent advantage, providing unsurpassed recording quality at minimum cost. It has consistently set the highest performance standards in radio stations, sound studios and record manufacturing companies throughout the world. The standard 1½-mil cellulose acetate base has ample strength for trouble-free operation under all normal operating conditions.

LR Audiotape offers two important advantages which, for many applications, more than outweigh the slight additional cost per foot. First, it gives 50% more uninterrupted playing time on a standard reel. Second, its 1-mil Mylar* base is actually stronger at high humidity than the standard plastic base—and has *far greater* strength than long playing tape on a 1-mil acetate base.

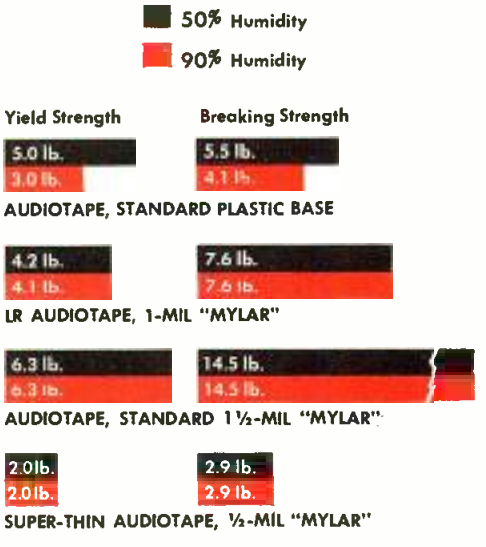
Standard Audiotape on 1½-mil "Mylar" is a premium-quality professional tape that provides the utmost in mechanical strength and immunity to temperature and humidity. Like all "Mylar" Audiotape, it will not dry out or embrittle with age.

Super-Thin Audiotape, on ½-mil "Mylar," doubles the footage obtainable on a standard reel. Its use, however, is limited to special applications where greatly increased playing time justifies a sacrifice of mechanical strength and some increase in print-through.

• • •

Regardless of the base material, there is only *one* Audiotape quality—the finest obtainable. All tapes are precision coated with the same carefully formulated oxide and meet the same exacting professional standards of performance. Every day, more and more professional and home recordists are finding that Audiotape gives the most *faithful* reproduction of the original live sound throughout the entire audio frequency range. For truly fine recording and reproduction, insist on Audiotape — IT SPEAKS FOR ITSELF!

RELATIVE STRENGTH OF TAPE BASE MATERIALS (at 75° F)



Trademark, Du Pont polyester film

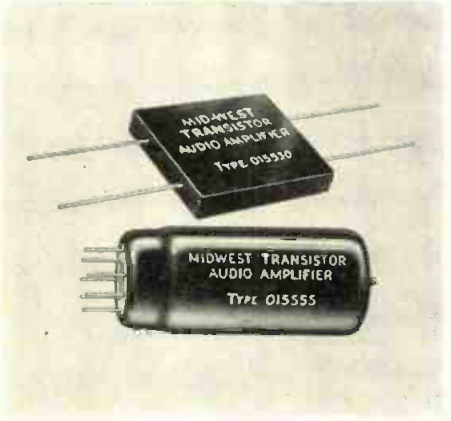
AUDIO DEVICES, Inc.

444 MADISON AVE., NEW YORK 22, N. Y.
IN HOLLYWOOD: 1006 N. Fairfax Ave. IN CHICAGO: 6571 N. Olmsted Ave.
Export Dept.: 13 East 40th St., New York 16, N. Y., Cables "ARLAB"

New Electronic Components

TRANSISTOR AMPLIFIER

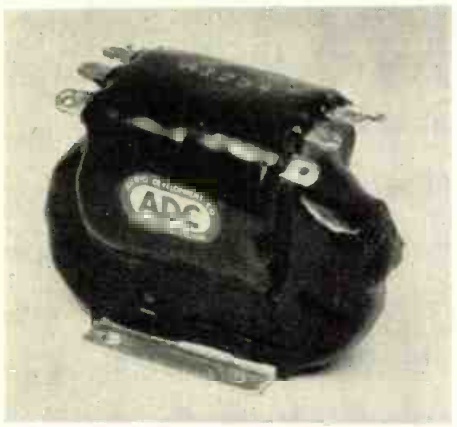
New miniature transistor audio amplifier comes in two styles. Tube type is 1½ in. H. x 11/16 in. D. Flat type is ⅝ x ¾ x ⅛ in. Specs include: high gain; battery drain of 2ma; low distortion;



low noise and hum level; hermetically sealed; selected and matched transistors; easy assembly into circuit. For flat type, 4 leads connected offer sufficient support to withstand severe shock and vibration. **Mid-West Coil & Transformer Co., 1642 N. Halsted St., Chicago 14, Ill.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-44)

ENCAPSULATING RESIN

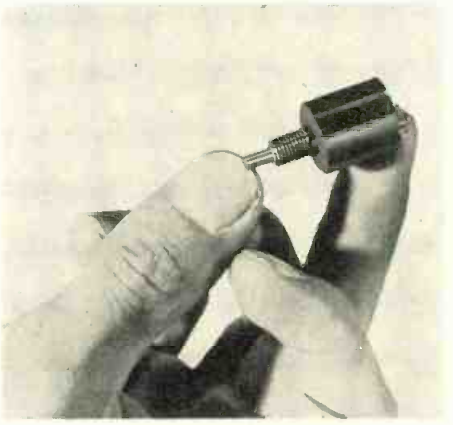
ADCeal is an Epoxide-Plyamide compound. Specifications: specific gravity, 1.05; thermal conductivity, approx. 3 x 10^{-4} cal/sec/cm²/deg. "C"/cm; water vapor transmission, after 10 cycles at 98% RH, @ 65°F to 160°F constant insulation resistance equals 10,000 megohms; adhesion, outstanding on most clean surfaces; volume resistivity, greater than 10^6 megohms/cm; dielec-



tric constant, 3.7; dielectric strength, 600 v./mil; MIL-T-27 Findings, passed requ. of Grade 1, Class A on Moisture, Temp., and Immersion tests. May be used in Class B range (105°-130°C.) **Audio Development Co., 2833 13th Ave. S., Minneapolis, Minn.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-36)

POTENTIOMETER

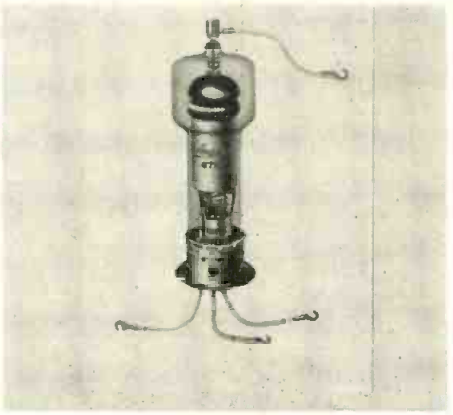
New single turn continuous mechanical rotation potentiometer of high precision has high resolution and low noise level. Housing Dia. ½ in.; housing L. ⅝ in.; shaft diameter ⅛ in.; mechani-



cal rotation, 360°; electrical rotation, 352° ±5°; resistance range, 5 ohms to 25K; standard resistance tolerance, ±10%; standard linearity tolerance, 10%; wattage rating, .8W; ambient temp. range, —55° to +85°C.; 5 oz. wt. per section; starting torque (max.) .75 oz.-in., running torque (max.) .7 oz.-in. **General Scientific Div. of San Fernando Electric Mfg. Co., San Fernando, Cal.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-12)

RECTIFIER

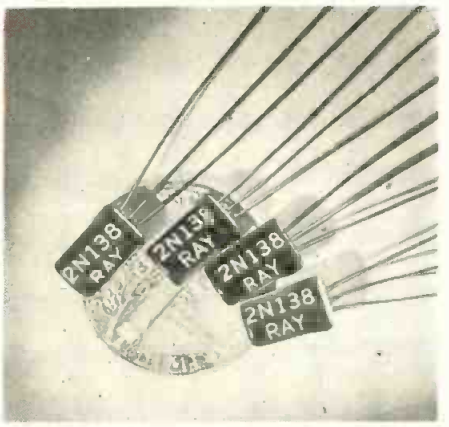
Type 6786 is a new, mercury vapor, rectifier with a peak inverse voltage rating of 15 kv, and an average plate current of 10 a. It is designed for high current power supplies in radio transmitters and industrial RF generators. Under normal ambient temperature conditions, no forced-air cooling is required or necessary. In addition to the unusual high current characteristics,



the 6786 is also grid-controlled. The tube has a "plate" type mounting support base and insulated flexible leads which make installation in equipment rapid and simple. **Amperex Electronic Corp., 230 Duffy Ave., Hicksville, N. Y.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-30)

TRANSISTOR

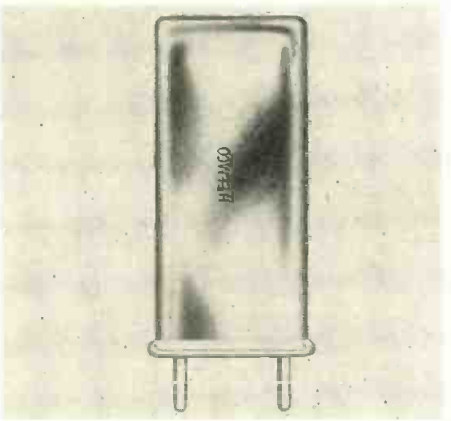
Type 2N138, a new PNP fused junctions germanium transistor for push-pull class B audio output applications is sold only in pairs matched for optimum output and minimum distortion.



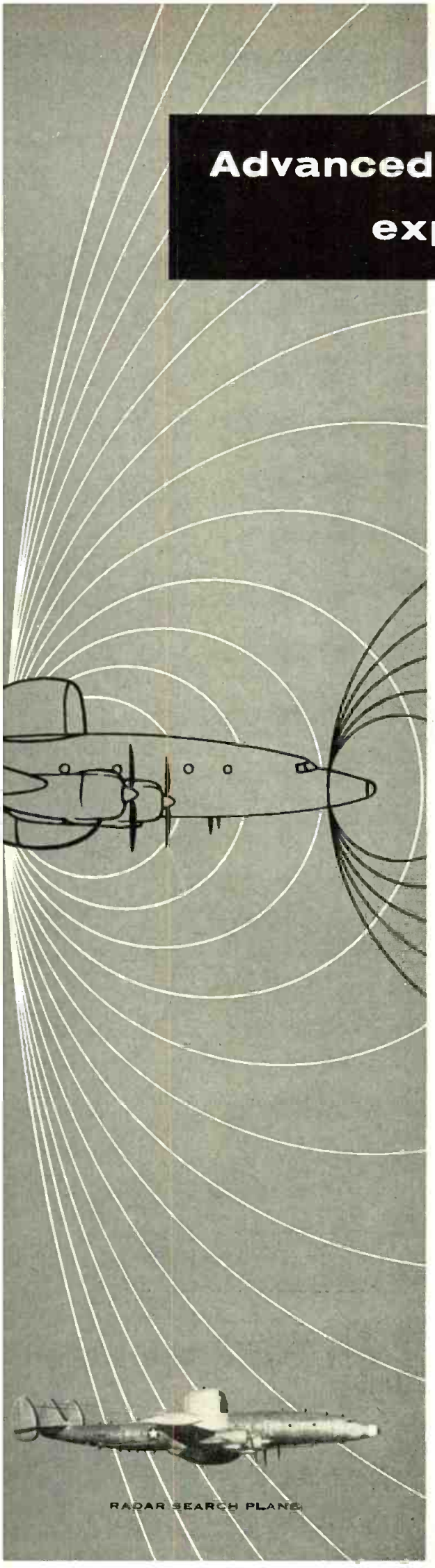
In a typical class B application, using a 4.25 v. supply, the average power output is approximately 50 mw with a power gain of 30 db. Physical dimensions are identical to those of the Type 2N130 series of miniature transistors. **Raytheon Manufacturing Co., 55 Chapel St., Newton, Mass.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-8)

CRYSTALS

A miniature 1.75 to 20 kc audio frequency crystal which is now available in production line quantities. This unit, hermetically sealed in the standard Heemco holder, MIL HC-13/U, shows deviation in frequency of less than ±0.010% over the temperature range of —40°C to +70°C. Meets vibration and shock requirements of MIL-C-3098A. Can also be supplied in —55°C



to +105°C with stability of ±0.25%. Available for production at 800 cps to 1.75 kc with above specs. applying. Holder same as above, except can height is 2½ in. **Hill Electronic Engineering and Manufacturing Co., Inc., New Kingston, Pa.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-16)



New positions for senior engineers:

Advanced Electronics Systems Staff expands at Lockheed

The Advanced Electronics Systems Staff is concerned with all Lockheed aircraft in development and production. To the career-minded engineer, three aspects of the work are significant:

1) Assignments cover virtually every type of aircraft and weapons system; 2) personal initiative is welcomed and encouraged under the Staff's philosophy of operation; 3) the Staff is undergoing continuous expansion because of the growing importance of its work.

Expanding, long-range activities in fields of fighter-interceptors, early warning aircraft and A.S.W. patrol bombers have created a number of positions for Electronics Systems Engineers able to fill senior positions.

Openings are in the following fields:

RADAR
Duties involve developing requirements and specifications after extensive analysis for various radar, display and data handling systems. Monitoring developmental programs is also an important aspect of this position.

COMMUNICATIONS
Duties involve developing long-range communication and data link systems, studying meteorological and atmospheric features and guiding antenna design.

FIRE CONTROL
Duties involve developing requirements of airborne fighter-to-fighter and fighter-to-bomber fire control systems and monitoring programs leading to actual systems to meet the requirements. Strong experience in computer techniques is required.

NAVIGATION
Duties involve developing requirements for advanced, self-contained, high accuracy doppler and inertial systems and implementing programs to obtain these systems. Extensive experience in airborne navigational systems is required.

COUNTERMEASURES
Duties involve developing requirements and monitoring programs for advanced electronic countermeasure systems, including receivers, analyzers and jammers.

ANTENNA DESIGN
Duties involve developing requirements for communication navigation and radar antenna systems and participating in design of the systems. Most of the development work in this field is performed at Lockheed Laboratories.

Moving Allowances – Generous travel and moving allowances enable you and your family to move to Southern California at little or no expense.

Scientists and engineers interested in performing advanced electronic systems work on diversified projects are invited to write E. W. Des Lauriers, Dept. AE-29-1. Please include your home phone number.

LOCKHEED AIRCRAFT CORPORATION

California Division · BURBANK **CALIFORNIA**

RCA AMPLI

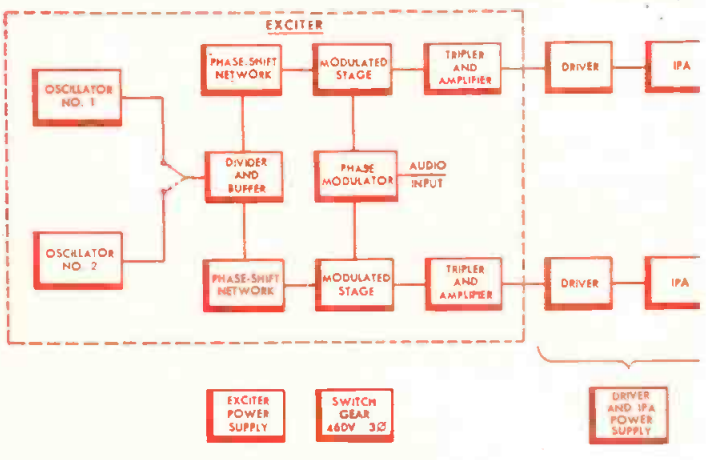
50-KW AM AIR COOLED!

New RCA 50-kilowatt AM Transmitter BTA-50G

DESIGNED WITH AMPLIPHASE MODULATION

HOW IT WORKS!

To produce phase-to-amplitude modulation in the BTA-50G, a carrier wave is developed by a common exciter. This carrier wave is then split and fed to two separate amplifier chains through phase-shift networks that establish a carrier phase difference. These two signals are controlled so that each maintains a prescribed phase relationship with the other in accordance with the intensity of modulating signal. This controlled phase relationship enables the separate 25-kilowatt amplifiers, when feeding their outputs into a combining circuit, to produce a maximum level 50-kilowatt amplitude modulated signal.



SIMPLIFIED BLOCK DIAGRAM—BTA-50G TRANSMITTER

PHASE

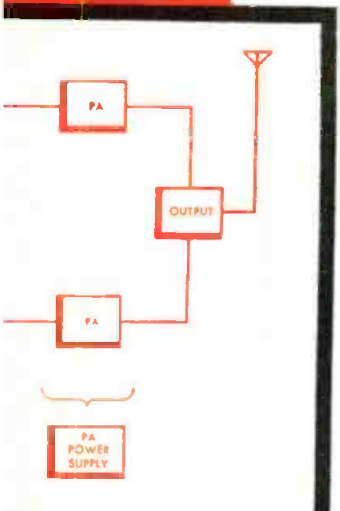
A new concept in AM Broadcasting

. . . introduced in RCA's revolutionary new 50-KW AM transmitter

Here is the most significant forward step in AM transmitters since RCA introduced high level modulation—an entirely new 50-KW transmitter using Ampliphase Modulation. Newest and finest in RCA's long line of distinguished AM transmitter designs, it is further proof of RCA leadership in the broadcast equipment field.

Ampliphase cuts transmitter floor space and operating costs by substantial margins. The BTA-50G is housed in four cubicles. It does away with half of present power tubes . . . along with bulky components such as modulation transformers, reactors and accessories. It requires no underfloor trenches, costly water cooling systems, external blowers. And there's no lost air-time—because the 50-KW Ampliphase is remarkably easy to install while your present transmitter is in operation. Then, in most cases, you may keep your old unit as a stand-by.

For complete technical details . . . and for information on the surprisingly low price . . . call your RCA Broadcast Sales Representative. In Canada, write RCA VICTOR Company Limited, Montreal.



FACTS ABOUT RCA'S NEW 50-KW AM

- Takes less than 80 square feet of floor space. No underfloor trenches required.
- Lowest operating cost of any 50-KW AM transmitter.
- Half the tube cost of other 50-KW AM transmitters.
- Uses famous Long-Life RCA 5671 P.A. tubes.
- No Modulation transformer required.
- Completely air-cooled with internal blowers — no air intake ducts necessary.
- Low distortion, excellent frequency response.
- Splatter-free modulation provided by new Ampliphase design.
- Designed to permit remote-control operation.
- New simplified circuitry. Extremely stable operation.

PIONEERS IN AM BROADCASTING FOR OVER 25 YEARS

RADIO CORPORATION of AMERICA

BROADCAST EQUIPMENT

CAMDEN, N. J.

Voltage Regulators

(*Continued from page 67*)

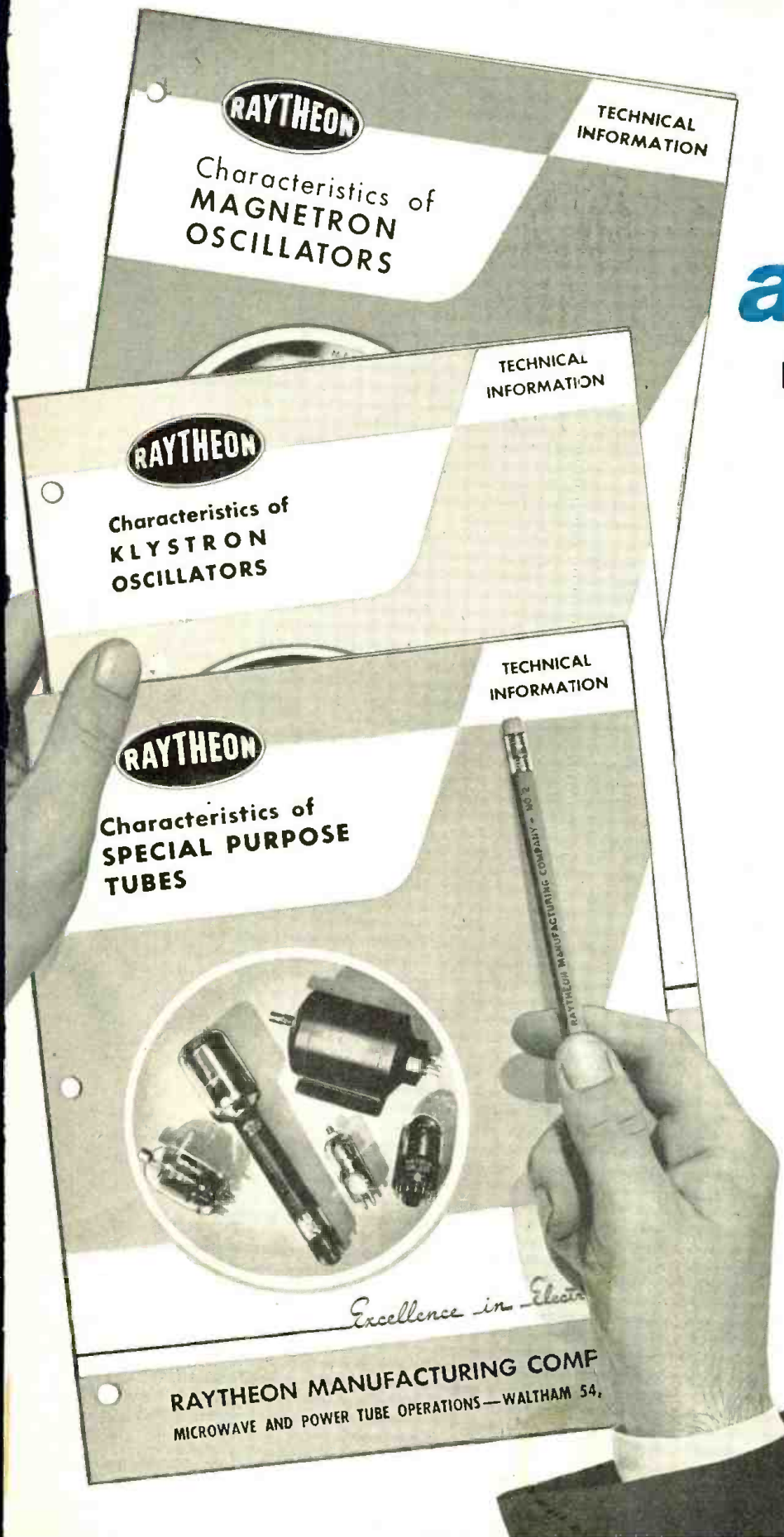
same current and the same grid bias conditions. The addition of a separate screen voltage source provides a unit that has a higher effective amplification factor than a triode-connected beam power tube. The efficiency of the regulator approaches that of a low-mu triode.

A 300 v regulated power supply was constructed at NBS using pentode-connected 6098/6AR6 series tubes and a selenium bridge rectifier-RC filter type unregulated screen supply (Fig. 1). The regulator contains a two-stage d-c amplifier with a type 5751 twin-triode differential amplifier in each stage. Laboratory investigations show that the output voltage has a ripple of 1 mv when the input-voltage ripple is 30 v and the screen-voltage ripple is 1 v. If the same regulator has an input-voltage ripple of 1 v and a screen-voltage ripple of less than 0.5 v, then a change in line voltage from −10% to +10% of nominal value, together with a variation in load from 25% of full load to full load, results in an output voltage variation of less than 0.2 v. During this study, the input voltage was 335 v at full-load current and at minimum line voltage. The load current was 100 ma per tube. There was a drop of 2.5 v in the cathode equalizing resistors inserted between the cathode of each series tube and the regulated output.

The output impedance of a power supply using the regulator is less than 1 ohm from direct current to over 150 kc. This low impedance is achieved with a single RC feedback network in the d-c amplifier and a 4-μf capacitor across the regulated output. Such simplicity in the d-c amplifier section of the regulator is the result of the high gain of the series tube section. This high gain makes it possible to reduce the number of stages in the d-c amplifier to achieve a given magnitude of loop gain, and also to reduce the plate voltage variation (plate swing) requirements of the output stage of the d-c amplifier. Both factors contribute to the simplification of the inter-stage coupling and stabilizing networks that would otherwise be required in such a high-gain feedback control system.

If a piece of electronic equipment requiring more than one voltage incorporates several regulators with pentode-connected beam power series tubes, the output of one supply may be used to feed the screen grid of a lower-voltage regulator series-tube and thus eliminate all but one of the separate screen supplies. Such

Raytheon — World's Largest Manufacturer of Magnetrons and Klystrons



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Raytheon is the world's largest producer of CW and pulse magnetrons, available in either fixed or tunable designs. A compact, efficient source of microwave power, magnetrons are being used in a growing number of applications.

Raytheon klystrons, which can be tuned mechanically or thermally, fit the widest range of requirements from 550 to 60,000 Mc.

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Raytheon makes: Magnetrons and Klystrons, Backward Wave Oscillators, Traveling Wave Tubes, Storage Tubes, Power Tubes, Receiving Tubes, Transistors

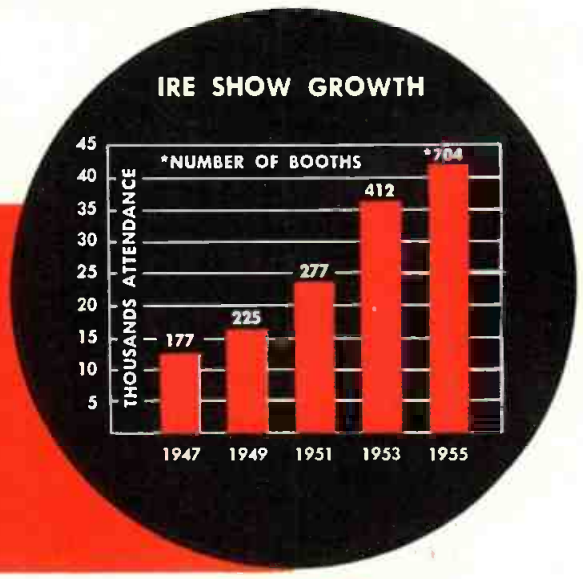
Meet your best prospects in TELE-TECH's March

UP!

UP!

STILL GOING UP!

The MARKET — The chart at the right shows the tremendous growth and continuous expansion of the electronic industries since 1947. It reflects the advances in production of electronic equipment and components over the years . . . from $1.5 billion in 1947, to over $8 billion in 1955 . . . and it's still going up!



IRE SHOW ATTENDANCE — The great significance of the annual IRE Show (March 19-22) to buyers and sellers from every corner of the globe is evidenced in the chart at the right. In 1955, 704 exhibitors displayed new products, techniques, engineering developments, etc, to a record 42,138 people.

TELE-TECH's CIRCULATION — it, too, parallels the industry and IRE show growth. Each year the IRE issue of TELE-TECH carries more and more advertisers' Show Ads directly to its regular readers. These include the "Electronic Chiefs" . . . the Chief and design engineers who look for news of the Show, new products, etc. before, during and after the IRE convention. Each has verified responsibility to buy.

ADVERTISING — The great value of the IRE issue to advertisers, in pinpointing their sales message (and boosting sales) for those who attend or can't, is reflected in TELE-TECH's continuous growth in advertising volume . . . now over 500 advertisers.

from 'round the world IRE Show Issue

March editorial highlights pave the way for effective market penetration and sales impact.

The IRE issue of TELE-TECH *will preview the IRE convention . . . give the convention program . . . technical paper topics . . . symposia and their locations.* It will also publish lists of *IRE show exhibits . . . describe new products scheduled for unveiling and corresponding booth numbers,* plus a master map of booth locations.

EXTRA VALUES OF THE SHOW ISSUE

- Published and distributed in advance of the show.
- Enables you to invite booth attendance.
- Editorial features condition advertising.
- 27,072 circulation: 15,021 in manufacturing; 6,004 in operation; in over 8,000 sales-minded companies.
- EXTRA DISTRIBUTION AT THE SHOW.

With TELE-TECH you reach the men who can specify your product, enlarge your market, increase your sales, build your profits. So . . . put your company and product on display before, during and after the 1956 IRE Show & Convention with the MARCH Show Issue of TELE-TECH.

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San Francisco: Chris Dunkle & Assoc., 3077 Turk Street • EXbrook 2-0377

Voltage Regulators

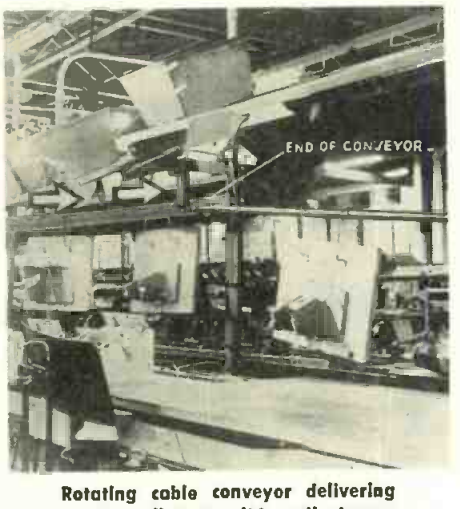
(*Continued from page* 100)

a unit has been constructed at NBS in which the positive 300 v supply feeds the screens of the series tubes in a positive 150 v supply. The positive 150 v supply, in turn energizes the screens in a negative 150 v and a negative 300 v supply. In each case the screen grid to cathode voltage of the tubes was kept at 150 v.

Regulators using the 6CU/6BQ6 type of beam power pentode for the series tube have also been investigated at the Bureau. These tubes will pass 100 ma of plate current when the plate-cathode voltage is approximately 32 v and the screen-cathode voltage is 90 v. Under these conditions the screen grid will draw approximately 12 ma. When the plate cathode voltage is 100 v, 100 ma of plate current and 7 ma of screen current will flow with a screen-cathode voltage of about 90 v. Under these conditions the plate dissipation is 10 w while the screen dissipation is only 0.63 w. This is typical of the extra dissipation due to the separate screen supply.

Automatic Cable Conveyor at Westinghouse

When Westinghouse Electric Corporation's Radio & TV Division, Metuchen, N. J., set up its radio assembly lines, delays were caused by the return of empty pallets to the start of assembly lines. Production



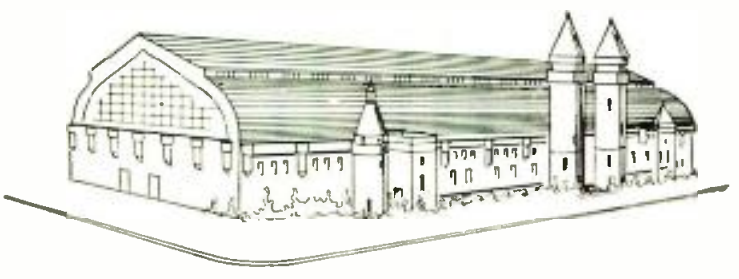
Rotating cable conveyor delivering empty pallets to slide rail storage

engineers solved this problem by ordering a rotating cable conveyor extending the full length of the workers' bench lines, above bench level. The conveyor consists of a flexible screw turning in a retaining rail, open at the top to expose the screw and was designed and installed by M-H Standard Co., 513 Communipaw Ave., Jersey City, N.J.

This year it's KINGSBRIDGE 3

March 19-22
New York City

for the
Radio Engineering Show



For the third year in succession, the great annual IRE Radio Engineering Show will open its doors to the industry for four spectacular days at the Kingsbridge Armory and Kingsbridge Palace in New York City. As in the preceding years, the Show will be filled to capacity with 704 exhibits and displays of the latest and newest developments in radio-electronics.

Is it too big? Not as a true representative of this giant industry. More than 200 papers presented by 22 Professional Groups at the Convention's 55 technical sessions are an accurate index to new research and development... and the 704 exhibitors represent about 80% of the productive capacity of the industry ... not one whit larger than necessary to keep pace with electronic America today!

Plan now to attend the industry's most vitally important Show where

Over 42,000* meet!

*At the 1955 Show, 42,133 men and women from coast to coast and every field of radio-electronics attended the Radio Show. This year, attendance is expected to go even higher. Don't miss it!

Over 700 Exhibitors will show all that is NEW in radio-electronic engineering!

R E ®

THE INSTITUTE OF RADIO ENGINEERS
1 East 79 Street, New York

PERSONAL

Dr. L. L. Wheeler, who has spent a decade in weapon system engineering with emphasis upon armament and bombing equipment, has been named chief engineer at Sperry Gyroscope Company, Great Neck, N.Y.

Robert S. Buritz has been promoted to the newly created post of chief project engineer of the Instrument Div. of Thomas A. Edison Inc. He will report directly to **John J. Dietz,** chief engineer.

Robert S. Buritz

Dr. L. L. Wheeler

Dr. Hans E. Hollmann, internationally-known physicist and research scientist, has been appointed as director of research of the Marvelco Electronics Div. of National Aircraft Corp.

Robert S. Neiswander, formerly associated with Aerojet Corp., is now a member of the technical staff of the Electronics Tube Lab., Hughes Research & Development, Culver City, Calif. **Sidney P. Burke** and **Richard A. Greenblatt** have joined the Field Engineering Staff, and **L. B. Martin,** formerly at Lincoln Laboratories, M.I.T., is a member of the tech. staff of the Ground Systems Laboratories.

Edward J. Lunney has been appointed Chief Engineer in charge of the Research and Analysis Dept. of Barry Controls Inc., Watertown, Mass.

S. S. Price has been appointed Manager-Panelboard and Motor Control Design Engineering in the Distribution Assemblies Dept. of the General Electric Co., Plainville, Conn. **A. H. Adams** has been made Manager-Switchboard and Distribution Center Design Engineering.

Bernard Brain has been appointed Department Head at ESC Corp., Palisades Park, N.J. His new duties will include technical responsibility for the design and development of High Power Pulse Forming Networks.

August F. Schonefeld, Jr. has joined Ampex Corp., Redwood City, Calif., as Field Service Engineer for Ampex's Instrumentation Div. in the N.Y. and Wash. districts.

Making Ultra-High Precision Patterns and Dials

Optical generation equipment of extraordinary precision is in operation at the Precision Photomechanical Corp., 170 S. Van Brunt St., Englewood, N.J., turning out dials, dial masters, complex waveforms, computer coding discs, frequency standards and similar pattern devices. The company reports that a dial, for example, can be generated with 2000 lines per peripheral inch. Angular accuracy is reported to be so great, that an inaccuracy of 1/89,000th of a second would cause 100% error.

This process, which may be uniformly repeated, is considered by company engineers to be a significant advance over conventional means of pattern production. Normally, patterns are drawn on large sheets by draftsmen, and photographically reduced. However, errors inherent in the hand-drawn design are transmitted to the finished pattern.

The system for producing the ultra-high precision patterns is basically as follows: The shape and spacing of a tiny repeating increment of the desired dial is expanded over 360° of a master pattern, which is affixed to a rotating chopper disc. Light is passed through an accurate slit, and on through the pattern and chopper disc to a rotating photographic plate mounted on another rotating disc. The relative rotational speeds of the chopper and photo discs determines the shape and number of times a particular pattern will repeat.

Photographically reproduced replicas are then made on various plastics, metals or glass by contact printing under vacuum.

Much of the success in achieving absolutely uniform, close-tolerance patterns may be attributed to the mechanical refinement of the equipment used. For example, the machine is so perfectly balanced that a small piece of adhesive tape placed on the heavy photo disc at the 9 o'clock position would be enough to bring that location of the massive wheel down to the 6 o'clock position.

H-K Leakage

(*Continued from page 57*)

from the cathode to the heater, resulting in an ac voltage across the cathode resistor. This ac voltage, which may be highly distorted, is then amplified throughout the whole system, since it effectively changes the bias of the tube.

H-K Leakage

(*Continued from page* 107)

Methods of attacking this problem are:

(a) Adequate bypassing of the cathode resistor for the power-supply frequency.

(b) Use of a heater filament transformer with the center tap grounded. This will reduce the voltage excursions between cathode and heater to −6.5 to +2.5 v., with a subsequent reduction in current. A further reduction in current may be realized in this arrangement due to current cancellation because the two halves of the heater are out of phase.

(c) Use of a center-tapped resistor (or a potentiometer) across the heaters with the center tap grounded. The effects will be the same as (b), except a variable resistor (potentiometer) may aid in adjusting to a minimum.

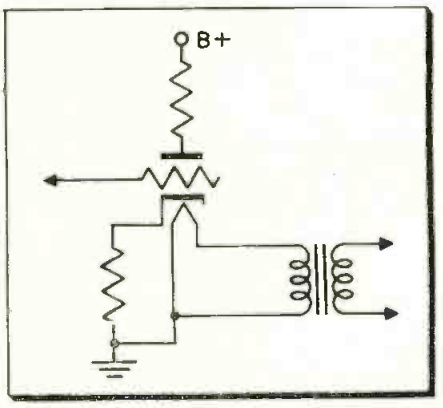


Fig. 6: Class A amp, with grounded heater

(d) Use of dc on the heaters.

(e) Operation of the tube with a dc bias between heater and cathode of approximately 30 v. The bias can be applied in either direction. Operation with this value of bias is beyond the saturation point in the heater-cathode characteristic curves (Fig. 3) Variation in dc potential about the operating point will not introduce a corresponding current change because the current has reached saturation throughout this region.

In the schematic of a low-frequency multivibrator shown in Fig. 7, a variable cathode bias is used in one cathode lead for a fine frequency adjustment for proper synchronization. Because the average cathode current through the tube is low, a high value of resistance is required to provide the proper voltage range. The total resistance is 250k from cathode to ground. In this type of circuit it was noted that:

(a) Some tubes could not be synchronized within the range of the hold control.

(b) Operation at elevated line voltage caused the circuit to go out of the range of the hold control.

(c) The circuit went out of range of the hold control during life.

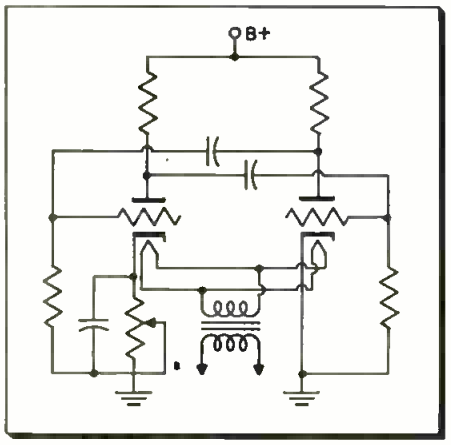


Fig. 7: Multivibrator, using variable bias

The trouble in all three cases was due to heater-cathode leakage forming the equivalent of a shunt resistor across the cathode resistor and lowering the effective cathode bias resistance. The solution to the problem was to change the method of obtaining the bias voltage to that shown in Fig. 8. Use of a voltage divider of low impedance effectively lowers the value of resistance between the cathode and ground so that the shunt resistance caused by the heater-cathode leakage is insignificant. The bypass capacitor can be eliminated in this method of obtaining bias.

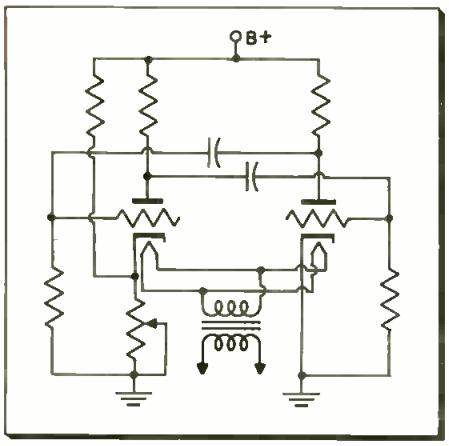


Fig. 8: Voltage divider bias lowers leakage

The schematic diagram for two arrangements of ratio detectors used for FM demodulation is shown in Fig. 2. The two arrangements show a so-called "balanced" circuit and an "unbalanced" circuit. In the balanced arrangement, both cathodes are at a positive potential with respect to ground and the heater-cathode leakage current drawn by the cathodes develops hum in the output at the supply frequency.

In the unbalanced arrangement

H-K Leakage

(*Continued from page* 109)

one cathode is directly on ground. At least a 2 to 1 improvement in hum output is realized by using the unbalanced system. The unbalanced system has the further advantage of recovering twice the AGC voltage.

Other examples of degraded circuit operation due to heater-cathode leakage can, of course, be cited. In general, circuits involving high voltages between heater and cathode should be carefully examined for the effects of heater-cathode leakage. In the same manner, tubes using large cathode resistors should be examined to make sure that the required circuit operation is compatible with MIL-E-1 specifications. Some general rules that can be used concerning the order of magnitude of leakage follow:

(1) The magnitude of heater-cathode leakage shows little difference with regard to heater-cathode polarity when an adequate cross section of the industry's product is examined.

(2) Tubes with higher-wattage heaters tend to have more heater-cathode leakage than those with lower-wattage heaters, as is illustrated in the following tabulation:

Type	E_h Volts	I_h Amps	Heater Power Watts	Max H-K Leakage μamps
5899	6.3	0.15	0.95	5
6100/6C4WA	6.3	0.15	0.95	10
5670	6.3	0.175	1.1	10
5725/6AS6W	6.3	0.175	1.1	10
5750/6BE6W	6.3	0.3	1.9	10
5726/6AL5W	6.3	0.3	1.9	10
5902	6.3	0.45	2.8	15
5727/2D21W	6.3	0.6	3.8	15
6005/6AQ5W	6.3	0.45	2.8	50
6098/6AR6WA	6.3	1.2	7.5	75

(3) Higher heater voltage versions of tubes usually have more heater-cathode leakage than their lower voltage counterpart.

(4) Greater reliability can always be obtained by avoiding the use of heater-cathode voltages approaching the maximum ratings.

NOTES:

1. MIL-E-1B, paragraph 4.10.15 Heater-cathode leakage. "The rated heater voltage shall be applied; for heaters having a rating of less than 35 v., either ac or dc voltage may be used; for heaters having a rating of 35 v. or greater, only ac heater voltage shall be used. 100 v. dc in series with a microammeter shall be applied between the highest numbered heater pin and the cathode. If ac heater-cathode potential is specified, the heater voltage shall be phased to subtract from this heater-cathode potential. The current shall be determined for both negative and positive polarities between heater and cathode, except for rectifiers or rectifier sections of multiunit tubes, in which the measurements shall be made with the heater at a negative potential with respect to the cathode. The absolute value(s) of the leakage current measured shall not exceed the limit specified. All other tube elements, except those internally connected, shall be electrically isolated from the heater during this test. A resistor of not more than 1000 ohms/v. of heater-cathode potential shall be used in this measurement in series with heater-cathode."

Vacuum Relays

(*Continued from page 60*)

expansion of the vapors leaving a relatively high pressure contact area at very high speed. These help to explain the short time, low energy arc and the remarkably small volume of metal evaporated from the contacts. For example, a recent life test was made using ⅜ in. diameter contacts operating at random and cycling a 400 kva bank of over 17 mfd. of capacitance once per second. Normal line current was 51 a at 7,800 v RMS, and 60 CPS. This test showed less than 1/64 in. of total contact loss, less than .008 in. off either contact, after more than 30,000 operations. This was 3 times the required life. Since the capacitors were not discharged at any time, capacitor charging current was extreme on at least 25% of the closings due to random closing and resulting sudden polarity reversals, along with a low source impedance.

Contact welding on closure due to the high charging currents of capacitors, transformers and inductors, and tungsten lamps is a source of difficulty for contacts in many types of atmospheres. In vacuum, welding rarely occurs even with extremely high make currents. Theory may again explain this advantageous result in that at the proper vacuum probably very little actual contact liquefaction takes place. The high temperatures created at the beginning of the arc cause almost complete vaporization in vacuum and perhaps sublimation directly from the solid metal, along with rapid expulsion from the contact surfaces of any liquid particles which could fuse. The sudden cooling effects mentioned previously may also help prevent actual fusion. After interrupting high currents thousands of times contacts still have an unglazed type of surface rather than a glazed, melted appearance, which further indicates lack of formation of fusible surfaces.

Another cycling test of 1 operation per second was performed with 5 kw 110 v dc tungsten lamps. This resulted in a normal current of approximately 50 a dc and the typical high make current of a tungsten load. 70,000 operations were made with ½ in. diameter contacts without showing signs of failure. This was 7 times the required life. The contacts were then examined and appeared to promise many thousands of operations more.

Still another low voltage test under actual operating conditions has been made over a period of 2 years. This is the operation of a

Vacuum Relays

(*Continued from page* 111)

2000° F. electric heat-treating furnace where the resistive heating elements are cycled approximately once every 18 seconds in the heating cycle. This is a 12 kw, 240 v, 60 cycle, 50 a. load transformer supplying current to low voltage carbon resistance elements. The current interruption is taking place on the 240 v primary side of the transformer and therefore includes transformer charging current which is severe for at least 25% of the makes. These relays have operated over the two year period without need for maintenance on the ¼ in. diameter contacts and are still being used daily.

These three actual cases illustrate some of the possibilities of long life contacts for interrupting high currents at both high and low voltages. Fig. 2 shows the general type of externally actuated vacuum contact used for this higher power interruption. This particular contact has a rated test of 50 kv pk with a thermal current rating of 100 a 60 cps for ¼ in. contact diameter and normal operating currents up to 50 a.

Low Power Relay

The vacuum relay is certainly not restricted to high voltage or even high power use. In fact it can be the ideal relay for low power electronics use as the result of the many features that result from a proper vacuum. The absence of contaminants to create contact surface films furnishes new possibilities of contact reliability with consistently low contact resistance of .001 to .00001 ohm and with low noise factors for low voltage relaying. Low contact pressure and extremely close contact spacings can be utilized for sensitive reliable relays which can handle sizeable amounts of current and high voltages if necessary. Hazardous areas requiring a completely sealed arc to prevent explosions are well served both in low and high power use by vacuum relays. There are no inflammable liquids or high gas pressures to maintain. This further reduces the explosion hazard as well as reducing maintenance problems.

Fortunately the usable materials as well as the vacuum medium itself are ideal for r-f as well as 60 cps and dc operation. High skin current conductivity and low contact resistance help many types of vacuum relays work exceptionally well for most r-f currents. Small physical size has made possible a

relay of minimum inductance and very low capacitance—less than 1 mmfd across open contacts for most types. Antenna transfer and antenna tuning are very popular usages. Transmitters from 100 watts to 250 kw are making very good use of ⅛ in., ¼ in., and ⅜ in. contact diameter relays which handle from 20 a and 50 kv at 30 Mc to 100 a and 85 kv at 300 Kc. r-f current interruption is easily done if necessary. Single pole double throw vacuum relays for television transmitter coaxial cable relaying are also becoming useful because of small size and contact reliability. These are designed to maintain proper impedance matching and to be a part of the 3⅛ in. diameter coaxial cable without disturbing the standing wave ratio excessively.

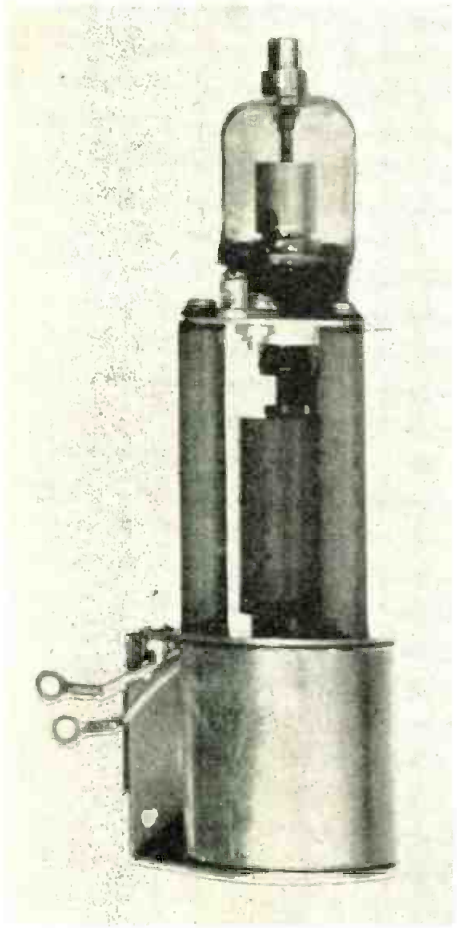


Fig. 10: Contacts of Fig. 2 on 24vdc actuator

Smaller single pole single throw vacuum contacts (Fig. 2) for external actuation, and completely enclosed relays such as in Fig. 3 are becoming very popular for 10 kv radar pulse network selector relays and low power switching. The ⅛ in. diameter contacts in the relay in Fig. 2 test to 30 kv with a 50 a RMS maximum thermal current at 60 CPS and 20 a at 20 Mc.

The vacuum relay in Fig. 3 can operate under oil as part of a sealed radar pulse network selector, and

Vacuum Relays

(*Continued from page* 113)

has a rating of 10 kv pk and 10 a RMS at 30 MC. It is capable of handling and interrupting if necessary continuous 0.3 to 3.0 μ sec peak pulse currents of over 300 a in high power radar transmitters.

Two other significant vacuum relay developments have recently been completed. One is shown in Fig. 4, a single pole double throw unit with a rating of 10 kv and 10 a, at 20 MC. The other is Fig. 5, a 4-pole double throw unit with an internal solenoid action. This has a recommended operating voltage of 12 kv, a test voltage of 18 kv, and a 10 a RMS thermal current rating at 30 MC. Another (Fig. 7) is a complete coaxial unit with an enclosed relay similar to the SPDT unit in Fig. 4. All of these units have easily interchangeable coils which are outside of the vacuum contact enclosure.

It may be well to mention some of the actual applications of vacuum relays where formerly it had either been impossible to accomplish the result or the result was accomplished better in some way than with other types of relays. Some of the applications have been previously mentioned such as high voltage capacitor switching, tungsten load switching, and high temperature resistance furnace cycling.

Overload Protection

Vacuum switches open up a complete new realm in the field of rapid overload protection. This is especially true for installations such as radio transmitters, induction heating, and dielectric heating devices, where 5 to 50 kilowatt loads should be instantly protected from overloads. Many of these loads operate at 230 v ac, 3 phase, representing load currents of about 20 a at 5 kw, and 200 a at 50 kw. Primary overload circuit breakers must be 3 phase and must handle very high currents. Many of these loads represent high voltage power supplies of relatively high impedance which feed those 5 to 50 kw dc loads at 3 to 10 kv dc. At these high voltages a 5 kw load draws less than 2 a at 3 kv and ½ a at 10 kv. A 50 kw load draws less than 17 a at 3 kv and 5 a at 10 kv. If this high voltage side could be interrupted, and interrupted rapidly enough, and in a small enough space, the current carrying capacity of the circuit breaker need not be nearly as large, and need be only a single contact instead of three.

The vacuum switch satisfies these

requirements. With its small contact opening and its short arc time, dc current interruptions in the order of 4 to 12 millisecs are possible at moderate overloads with very small size interrupting apparatus. A newly developed example (Fig. 9) is a 5 millisec overload circuit breaker using ¼ in. diameter contacts of 50 kv test normally used on a 10 kw transmitter.

In the field of ac interruption vacuum arc deionization occurs at or before the first current zero with no restrikes. It is this fact which makes ac capacitor interruption possible without creating serious over-voltages. It also makes ½ cycle overload interruption possible for 60 CPS power. With the short movement required, contacts can be easily timed to open after the first current peak has occurred and tripped the opening mechanism, and just before current zero. Using this method, only slight arcing occurs even on the heaviest of overloads.

This factor of rapid interruption is also useful in some types of pulse forming applications. Oscillographs of interruptions of large inductances showed complete arc interruption could take place in less than 10 μ secs for moderate dc currents and fast contact opening. Transient voltage generation of course was very efficient and in this case very high peaks were the desired result. In many cases where large inductances are being interrupted or power factor is very low, care must be taken in using properly timed contact opening. Slower opening speeds and in some cases transient suppressors are necessary to protect other parts of the circuit from the transient normally created by highly inductive loads.

Still another use has been found for vacuum relays in very high voltage dc relaying in Cottrell dust precipitators. With the increasing requirements for smog control more and more precipators are being installed. Eight or more sections of a precipitator are operated from a single 75 kv dc power supply. Each section must be vibrated every 28 mins. for 2 mins. to remove the quantities of dust and chemicals collected on the plates and the high voltage must be removed in order to prevent short circuiting when the particles fall. The completely enclosed arc in the vacuum switch also prevents any explosion which might be caused in improper dust and vapor laden atmosphere by an open arc. This is a very necessary requirement particularly for oil refinery areas. Fig. 6 shows this all glass insulated relay complete with corona shields.

Vacuum Relays

(*Continued from page* 115)

It tests at 120 kv and has a thermal current rating of 250 a. Although it is only required to break 1 a at 75 kv dc, it is capable of much higher power interruption.

In the smaller vacuum switches this complete arc enclosure in a small size is valuable for transferring the high voltage power used in a guided missile from a ground power supply to its self-contained power supply at takeoff. (Fig. 10 shows the contacts of Fig. 2 mounted with a 24 vdc actuator. Its insulation tests 40 kv pk.)

As a result of these new developments, new standards for vacuum relays must eventually be formulated. With the new vacuum processes, residual gas current need not be tolerated. Voltages can now be raised so high that electron field emission will take place from cold metallic surfaces with no gas ionization current detectable. Dielectric strength will remain high after repeated current interruption or breakdowns due to overvoltages.

Vacuum contacts are now free from high temperature effects. Therefore current ratings by contact temperature rise could be increased. Up to this time 65° C. maximum rise has been used as our own standard thermal current rating temperature for vacuum relays. Our future ambient temperature will probably be 125° C. or higher if coil pull-in voltage changes are taken into consideration.

Contact pressures can now be higher due to more efficient mechanical construction, therefore bounce and vibration effects can be decreased. This is a very important consideration due to the high dielectric strength for even slight contact opening.

INFRA-RED ANALYZER

Model AA1 has been designed to be used in conjunction with the Axler Associates, Inc. narrow band Infra-red, Ultra-violet and Visible filters. It has universal application utilizing the study of gaseous or chemical constituents by the method of emission, transmission or absorption spectroscopy. Spot and rapid analysis measurements can be made by non-technical personnel through the utilization of narrow band filters and simple dial and meter arrangement. The instrument, 8 x 8½ x 13 in., operates on ac and utilizes a Pbs detector and power supply. Axler Associates, Inc., 102-42 43rd Ave., Corona, L.I., N.Y. TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-47)

Air Navigation Systems

(*Continued from page 61*)

since they provide the means whereby a well defined coordinate reference system can be physically realized. A gyroscopically stabilized platform which has three mutually orthagonal accelerometers mounted on it is frequently termed an inertial platform and is the basic sensing element for an inertial navigation system. (See Fig. 1.)

Equations

It is a fundamental principle of mechanics that an accelerometer cannot distinguish between gravitational acceleration and the acceleration due to motion in space. Direct integration of the accelerometer output will not supply the desired velocity information, since the velocity is the integral of vehicular acceleration and the gravity component constitutes an error term. In order to describe the way in which the proper components may be obtained from the accelerometer outputs, consider a reference coordinate system which has a fixed orientation in space. Each component is a function of the position coordinates. If we let the gravitational field components in the x, y, z directions be $g_x(x,y,z)$, $g_y(x,y,z)$, and $g_z(x,y,z)$, respectively; the vehicular accelerations be a_x, a_y, and a_z, respectively; and the accelerometer readings be A_x, A_y, and A_z, respectively; then Eqs. (1) of Fig. 3 are obtained. Inasmuch as the coordinate system maintains a fixed orientation in space, the components of vehicule acceleration are the second derivatives of the displacement components with respect to time (Eqs. (2) of Fig. 3). Eqs. (3), obtained by substituting equations (2) into equations (1), form a set of differential equations and can, theoretically at least, be solved for the displacements x,y,z, and the corresponding velocities $v_x=dx/dt$, $v_y=dy/dt$, and $v_z=dz/dt$, provided the gravity functions are known. Assuming the earth is a perfect, homogeneous sphere, and that the altitude of travel is small compared to the earth's radius, then Eqs. (3) can be shown to assume the form of equations (4) of Fig. 4, where g is the gravitational acceleration of the earth, and r its radius.

Eqs. (4) are second order differential equations with constant coefficients, with the first derivative (the damping term) absent. This implies that the transient portion of the solution is a sinusoid which maintains constant amplitude. A

Air Navigation Systems

(*Continued from page* 117)

computer solving these equations would, if suddenly disturbed, break into oscillation, the amplitude of which (theoretically) would be constant with time. The period of this oscillation is given by Eq. (5) of Fig. 4. The computer shown in Fig. 5 involves two cascaded integrators in a closed loop with no damping connections, and at best is only quasi-stable.

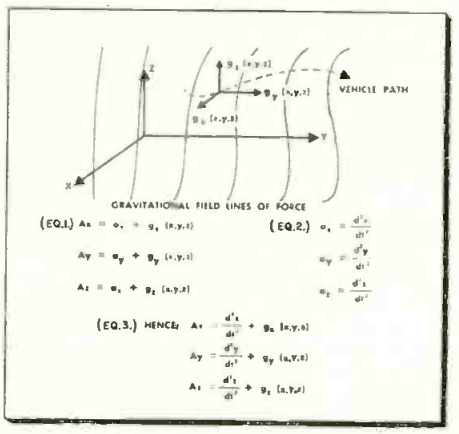


Fig. 3: Equations indicate gravitational and vehicle components of acceleration

The system equations which have been discussed in a theoretical manner can, of course, be set up in more elaborate form to take into account the physical properties and the performance characteristics of the system's components.

Gyroscopes

The principal new component is the high precision fluid immersion gyro. (See Fig. 2). A rotating wheel, with its spin axis mounted on ball bearings, is hermetically sealed in a spherical shell which is then completely submerged in neutral buoyancy in a container of fluid. The spherical shell is centered in the fluid container by very light wire filaments which are maintained at zero angle of twist by an external servo system. Thus torques due to wire twist are kept at a zero level and the friction of conventional pivot bearings is not present. Since the spherical shell is in neutral equilibrium, it is buoyed up completely by the fluid and in accordance with Archimedes' principle this will be true under any accelerating forces. Thus the gyro has no tendency to move and hit the walls of the tank even under extremely high shock loads. This arrangement gives an essentially frictionless suspension for the gyro so that very high accuracies are maintained even with rather small gyros.

Air Navigation Systems

(*Continued from page* 118)

Since the new gyro derives its accuracy by virtue of negligible friction torques, it must not be permitted to drive output devices, platform, etc., which would exert a reaction back on the gyro. Rather, it provides an electrical signal which is then used to actuate a servo drive.

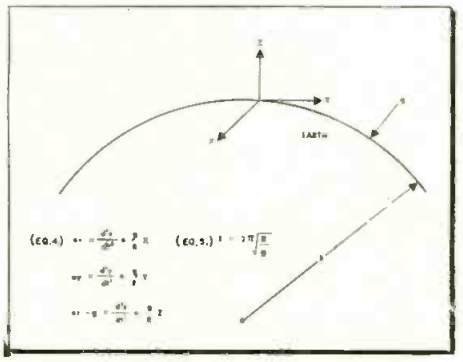


Fig. 4: The earth is assumed to be a perfect sphere of radius R and gravitational acceleration

This signal is obtained from a magnetic type pickoff which measures angular deviation between the gyro (i.e., the spherical shell) and the fluid container. This pickoff employs an exciting winding on the spherical shell to create an alternating magnetic field and a pickoff winding on the fluid container which generates a voltage in proportion to the relative position between the winder and the magnetic field. The pickoff has been designed so as not to create any reaction torques. The fluid container is then mounted on a set of motor driven gimbal pivots (i. e., the platform) and the motor drives are actuated thru amplifiers by the pickoff signal. The motor drives position the fluid container and platform to the point where the pickoff signal is zero. Thus the platform always follows the gyro in angular position and becomes a power driven space stabilized platform of high precision.

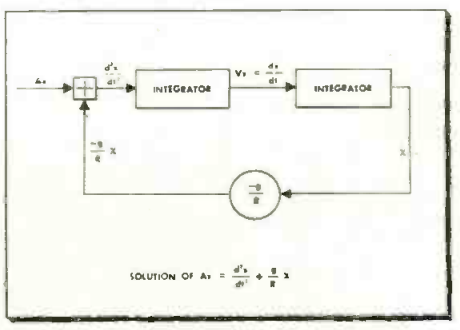


Fig. 5: Simple computer consists of two cascaded integrators in a closed loop system

The pickoff acts as a low impedance, high precision signal source at

Air Navigation Systems

(*Continued from page 120*)

the reference frequency of the system (typically 400 cycles).

Two Axis Design

Since it is possible to observe angular deviations from the spin axis of a gyro in two perpendicular directions, we may double the effective stabilizing ability of a given gyro. For example, a vertical spin axis gyro can detect both roll and pitch motions and a horizontal spin axis gyro can detect azimuth and tilt motions. To accomplish this, the gyro pickoff is built as a two axis device with two windings wound at right angles to each other, each one capable of sensing one of the motions. This arrangement gives rise to the two axis gyro which serves as the heart of the modern inertial navigation system. Each one of the gyro pickoffs operate an appropriate servo drive on the platform.

From a paper presented by Joseph Statsinger[1] and Dr. Bernard Litman[2] to the N. Y. Chapter of the Professional Group on Aeronautical and Navigational Electronics, IRE, Nov. 1955.

1. Head of the Gyroscopic Section of the Research and Development Dept., ARMA, div. American Bosch Arma Corp.
2. Head of the Computer Section of the Research and Development Dept., ARMA, div. American Bosch Arma Corp.

Radar Speed Meters

(*Continued from page 64*)

ufacturer to be ±0.1% or 2.455 MC. The transmitter delivers 120 milliwatts to a hybrid ring, the termination of which dissipates one half of this power (and one half of the reflected signal, for a total loss of 6 db). Thus power of 60 milliwatts is delivered to the antenna.

The antenna is an array of eight horizontal dipoles in phase, arranged behind a plastic radome in one end of the case. Beamwidth is about 20° and gain is about 20 db over a dipole.

The detector consists of a 1N21B crystal, having an estimated noise figure of 15 db, including the first audio stage. Crystal current runs between 1 and 2.5 ma., derived from the transmitter leakage signal. Detected output goes directly to an audio amplifier containing an expander or squelch circuit (V_3 and V_4 operating with V_{2b} and V_{5a}) to minimize noise problems in the absence of signal. A limiter, and diode integrating type of frequency meter complete the receiver. A dc output of 0-4 ma. drives both a large scale meter and the recording milliammeter.

The power supply is designed to operate from either 6 vdc or 120 vac. Power consumption is about 50 watts. A vibrator supply is used when operating from dc. All dc voltages to transmitter and receiver are VR-tube regulated.

Operation

In operation, this equipment must be stationary, and set up about 3-5 ft. from the ground on either its tripod, on the trunk of a car or bed of a truck, or on some other convenient but stable mounting base. The unit should be set up alongside the highway, to minimize geometrical distortion of the radial velocity vector and to help in receiving signals from only the nearest lane of traffic. The manufacturer recommends that the device be set up no more than 10 ft. from the edge of the highway, with 3 ft. being desirable if safety considerations permit. Range of the equipment is about 175 ft. for average automobile targets. The manufacturer states that the equipment is not recommended for operation through glass, making outdoor operation most desirable for best results.

Field Experience

Tests with the equipment above on the Los Angeles freeways have shown it to be only moderately satisfactory on heavily traveled roads. With multiple targets, even the best passive doppler systems will be severely limited.

In a test on a moderately traveled city thoroughfare, the speed meter was set up on the curb by the police survey team, but in order to avoid multiple target saturation it was necessary to aim the unit at an angle of about 40° with the roadway. Since the speed meter measures radial velocity, true velocity requires a secant correction to the speed meter reading. In this particular case, the meter was reading 33 MPH for cars traveling about 40 MPH. A speed test was made with a car using a certified speedometer at 50 MPH, and the speed meter read 42 MPH. With the device re-oriented very nearly parallel with the traffic, the readings were about 6 MPH higher, but multiple targets caused considerably more difficulty.

Selectivity

Radio frequency selectivity of the speed meter is evidently dependent principally upon the bandpass characteristics of the antenna and hybrid

(*Continued on page* 125)

News of MANUFACTURERS' REPS

REPS WANTED

Communications and Microwave Antenna Manufacturer seeks representation in all sections of the country. (Ask for R-1-1)

High Precision Dial and Pattern Company which engineers and produces coding discs for computers, photoelectric controls, etc., seeks reps calling on labs and electronic manufacturers in all states. (Ask for R-1-2)

Trinkle Sales Co., Box 40 A, Hatfield, Pa., and **Jules J. Bressler**, 4808 Bergenline Ave., Union City, N. J., have been appointed to the rep staff of Seco Manufacturing Co., Minneapolis, Minn.

R. A. Waters Co., Inc., Waltham, Mass., has been appointed sales rep in the New England area for Color Television, Inc., San Carlos, Calif.

Samuel Yurman, who has been a member of the firm of Scheffler & Yurman, Manufacturers Representatives, has been named Sales Manager of Kenwood Engineering Co., Inc., Kenilworth, N.J.

The G. S. Marshall Co., 40 S. Los Robles, Pasadena, Calif., has announced their appointment as Sales Rep in Calif. and Ariz. for Century Electronics & Instruments, Inc., Tulsa, Okla.

Norman W. Kathrinus & Co., 4356 Duncan Ave., St. Louis, Mo., is the new rep in the St. Louis terr. for Webster Electric Co., Racine, Wis.

Foster N. Reynolds and Associates, Melborne, Fla., have been appointed southern sales reps for Tenney Engineering, Inc., and will service the following terr.: Fla., Ga., Ala., Tenn., N. Car., and S. Car. including all guided missile and aircraft development projects in this area.

R. L. Pflieger, 28-37th Ave., San Mateo, Calif., has been appointed Northern Calif. sales reps for BOMAC Laboratories, Inc., of Beverly, Mass.

Magnecord, Inc., Chicago, Ill., has announced the appointment of **Gene Rosen Associates, Inc.** as Eastern factory rep for the firm's line of tape recorders, in Del., Md., Va., and Washington, D.C.

John R. Foster has been appointed Sales Rep for Hycon Electronics, Inc., Pasadena, Calif. He will handle jobber and industrial sales in Southern Calif. and Ariz.

Arvin Bell Co., 385 E. Green St., Pasadena, Calif., has been appointed sales rep for Southern Calif. for Burnell & Co., Inc., Yonkers, N.Y.

The Gramer-Halldorson **Transformer** Corp., Chicago, Ill., announces the appointment of the following reps. **J. K. Dooley Co.**, Seattle, Wash. for industrials and distributors in Wash., Ore., and Western Idaho. **C. E. Anderson**, Cincinnati, Ohio, for industrials only in Southern Ohio including Columbus; and Boone, Kenton, and Campbell counties in Ky. **Sheridan Associates**, Cincinnati and Cleveland, Ohio, for industrials only in Northern Ohio and Eastern Pa. **Central Sales Co.**, Fort Wayne, Ind., for industrials only in Indiana, excluding Evansville, and the area bordering Chicago. **Arthur M. Harris**, New York, N.Y., for distributors in met. N.Y., L.I., Westchester County, and N.J. north of and excluding Trenton.

Kaelber & Mack, Manhasset, N.Y., has been named Irish Magnetic Tape rep for met. N.Y. and Northern N.J., ORRadio Industries, Opelika, Ala., announced.

Leonard D. Allen, Inc., Syracuse, N.Y., has been appointed sales rep for the Capacitor Div. of Good-All Electric Manufacturing Co., Ogallala, Neb., to cover the N.Y. terr. excluding met. N.Y.C. **Albert M. Baehr Co.**, Cleveland, Ohio, will represent Good-All in Ohio.

Southwestern Industrial Electronics Co., Houston, Tex., has announced the appointment of the following reps: **J. T. Hill Co.**, San Gabriel, Calif., will handle the Southern Calif. terr. **C. E. Ault Associates**, Menlo Pk., Calif., will cover Northern Calif. and Nev. **R. A. Waters, Inc.**, Waltham, Mass. will service New England.

MacPherson-Thomas, Inc., 5226 N. Keystone Ave., Indianapolis, Ind., will serve both distributor and industrial accounts in Indiana, with the exception of the northern state area, for Advance Relay Co., Burbank, Calif.

The Electromechanical Products Co., Warden Ave., Agincourt, Ontario, Canada, was recently appointed the exclusive manufacturer's rep in Canada of the Perkin Engineering Corp., El Segundo, Calif., line of dc power supplies.

General Transistor Corp., Jamaica, N.Y., has appointed two additional manufacturer's reps. **Jack Geartner Co.**, Miami Beach, Fla., will cover all of Fla. **S. W. Goodman Co.**, Baltimore, Md., has been assigned Southern N.J., Md., Del., Wash., D.C., Eastern Pa., and Va.

Radar Speed Meters

(*Continued from page* 123)

ring. Since both of these devices have fairly low Q, it is to be expected that this speed meter may be very susceptible to adjacent channel interference, particularly from the amateur (and technician class amateur) band ending at 2450 MC, just 5 MC from the nominal frequency of the speed meter. Pulse modulated signals cause no difficulty as long as the pulses are short and the power not too high. In one test, for example, a helical antenna of about 23 db gain and a Hewlett-Packard 616A signal generator were set up about 10 ft. from the speed meter described above. Effective radiated power was about 200 milliwatts. With 10 μsec pulse modulation at 700 pps no discernible meter deflection was obtained. The speed meter audio system will not pass these short pulses to an extent sufficient to affect operation. Similarly, CW radiation, except within 1 KC of the actual frequency of the speed meter, has no effect provided that it is not strong enough to damage the crystal.

It is quite likely, however, that amplitude or broad-pulse modulation in the 2300-2450 MC amateur band would cause appreciable interference if modulation frequency components were below 1000 CPS and r-f power levels were 1 watt or more. Since amateur and technician activity in the 2300-2450 MC amateur band is becoming more widespread as new tubes (such as the GL-6244) are developed, crystal control and increased selectivity of radar speed meters is certainly indicated if interference problems are to be avoided.

Reference

1. The Atlantic City 1947 Radio Regulations (Part 5) allocate the band 2450-2700 MC for "Fixed, mobile, industrial, scientific and medical," for Region 2. FCC regulations provide for licensing of speed measuring devices in the band 2450-2500 MC, provided that harmful interference will not be caused to the fixed and mobile services, and such devices must accept any harmful interference from other services sharing the same frequency band.

Cues for BROADCASTERS

(*Continued from page* 84)

ing introduced into the amplifier when the unbalanced line is connected. There is no measurable increase in noise level in the over-all transmission system when the limiting values are being monitored.

Facsimile Transmitter

(*Continued from page 63*)

was formed in the principal focal plane of L_2. However, it is a property of such an optical system that the size of image formed by L_2 is independent of the distance between L_1 and L_2 for any C in the focal plane of L_1. This condition was maintained, so that the optical heads formed a continuous image, at a stationary point, of what they were scanning. It remained to place an aperture A at the image of L_2 and put a phototube behind it to receive the light in order to have a scanner.

Since the same phototube received the light from each head in turn, the circuit response was always constant. It was possible to get the same amount of light from each head by varying the aperture stops of the three lenses L_1 until the phototube responded equally to all three. The remaining problem was to align the three heads, and this was done optically. Each head was adjustable about two orthogonal axes (Fig. 2). Adjustment of the head about the X axis moved the scanned point C up or down. Motion of the prism mirror about axis Y moved C forward or back along the scanned line. Alignment of the three heads was effected by stopping head No. 1 against an index and observing the image appearing in aperture A. Then head No. 2 was brought up to the same index stop, and adjustments were made about the X and Y axes of the optical head until the same image appeared in A. Then head No. 3 was similarly adjusted.

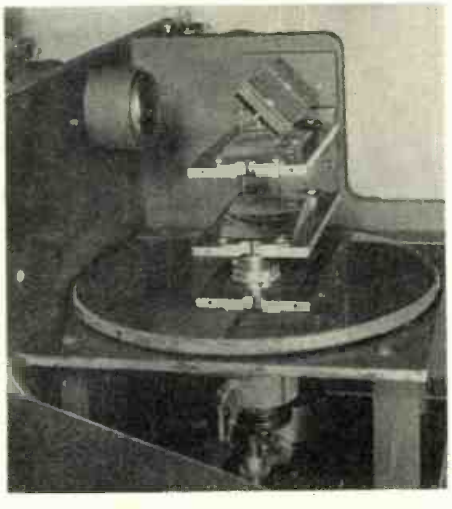


Fig. 5: Rear of X-1x with cover removed, showing fine scan disc, condensing lenses, mirror, and photomultiplier tube

Several difficulties were encountered. At higher speeds there was considerable whip as the heads went around the drive pulleys, and a stabilizing tail R had to be added to damp out head vibrations produced by this whip. Also, a dead time occurred between scans while the head finishing its sweep blocked the optical path to the next head, about 5% of the sweep time.

The elemental area of copy scanned, C, was .007 in. x .010 in. in size. Such a small region is a sufficiently close approximation to a point that the collimation of light produced by L_1 was very good. It appears that the "throw" of light from such a scanning head can be extended to very long lengths. Hence this method of scanning appears to be a practical basis for continuous facsimile scanners of high definition for virtually any sweep length, 60 in., for example.

Spiral-Slit Scanner

The method was not used for the 18.85 in. weather map scanner because the spiral and slit method seemed better. The principal advantages of the spiral over the belt were mechanical stability and simplicity. In addition, although the belt scanner would have occupied a smaller volume, it would not go in a 19 in. relay rack. Had we been asked to scan 36 in. wide maps instead of 18.85 in., however, we would probably have used the belt.

The spiral and slit scanning method has been described elsewhere[2]. Briefly, the scanner is a camera, except that the image falls on a sweeping aperture instead of film (Fig. 4). The aperture is formed by the intersection of a spiral slot and a linear slit, forming a transparent parallelogram through which light in the image can pass. This transmitted light falls on the photocathode of a multiplier phototube and causes a voltage to be developed across an output load resistor. This voltage is inversely proportional to the optical density of that part of the scanner image covering the parallelogram aperture.

The spiral slot is in the shape of the Archimedes spiral $r = K\theta$. When this spiral is rotated uniformly about its origin, its intersection with a radial slit moves at constant velocity. This moving aperture performs a stroke by stroke scan of optical densities of the scanner image. The copy being scanned is fed uniformly so that each new moving aperture stroke scans a new line of the image.

In order to free the scanner from jitter and also to minimize the effects of aperture irregularities, a 15-turn fine spiral was used. (Disk A). There were then 15 intersections between the spiral and the slit, forming 15 apertures which moved

as the spiral disk turned. The disk was rotated at 15 times the scan rate, so that each of the 15 apertures moved at scan rate. Since only one aperture could be used, a single turn coarse spiral rotating once per scan blocked 14 of the apertures and passed light from only one.

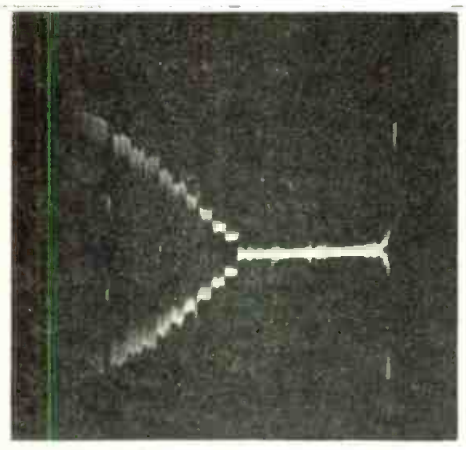
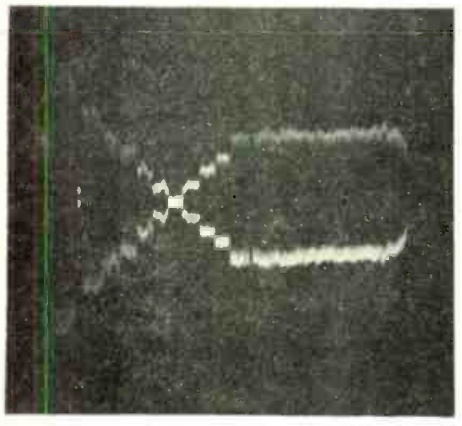


Fig. 6: X-1x response to gray scale
A: (above) Over half of scanned line
B: With modulator balanced on neutral step



Jitter in such an arrangement followed from the fact that any angular perturbations of the rotating fine scan disk per revolution results in a perturbation of the regularity of the aperture's linear motion. However, the perturbation of the linear motion is reduced by a factor of 15 by virture of the spiral's 15 turns. This reduced the jitter to such an extent that we could not detect it at all. From other data on the magnitude of the disk shaft wow and flutter we estimate that the jitter present could easily have been less than one part in 100,000. This does not mean that the aperture velocity was constant to one part in 10^5, because the spiral generation and centering were not nearly this exact. What it means is that the time position locus of the motion of the aperture was exactly repetitive on successive strokes to within one part in 10^5. This is remarkable for such a simple device.

After the successful operation of the multi-turn spiral scanning

(*Continued on page* 129)

Air Power Award

Edward P. Schinman, (r) pres. of Bogue Electric, receives N. J. Wing Air Power Trophy from Gill Robb Wilson, pres. of Air Force Assoc., for his contributions to Air Power in U. S.

Signal Corps Drone Takes Aerial Photos

A small camera-carrying drone, controlled by radio, has been added to the weapons of combat aerial photography by the U.S. Army Signal Corps.

It can take either still photographs or motion pictures from a low altitude range of several hundred ft. up to heights of more than four miles in the air. Tactical commanders can be supplied with aerial surveillance photographs in less than an hour's time. The drone can operate in any area because it is jetted from a launching catapult, eliminating the need for an airfield.

RCA TEX Circuits Link Atlantic & Pacific

Atlantic and Pacific networks of the Overseas Teleprinter Exchange Service (TEX) of RCA Communications, Inc., have been linked through operating terminals in New York and San Francisco.

The newly consolidated facilities now reach more than 27,000 subscribers in 20 countries in Europe, Africa, and the Caribbean and Pacific areas

GE Amends Supply System

The General Electric Co.'s Electronics Div. has inaugurated a new manufacturer to distributor supply system for speeding delivery of replacement parts to radio and TV stations.

Plans call for the new distribution channel to operate through a network of distributors in each of the Division's 15 product-service districts. Formerly suppliers of such equipment depended upon direct factory to station delivery whenever necessary. Distributors under the new supply system will stock such replacement items as transformers, condensers, tubes, resistors, coils, and special assemblies.

Chris J. Witting, formerly pres. of the Westinghouse Broadcasting Co., has been appointed general manager of consumer products for the Westinghouse Electric Corp.

Appointment of **Donald C. Duncan** as general manager of the Berkeley Div. of Beckman Instruments, Inc., Richmond, Calif., has been announced.

Richard M. Osgood has been appointed Manager of Equipment Fabrication at the new Waltham (Mass.) Laboratories of Sylvania Electric Products Inc.

RCA has announced the election of **Dr. Douglas H. Ewing** as Vice-Pres., RCA Laboratories; **Charles P. Baxter** as Vice-Pres. and Gen. Mgr., RCA Victor TV Div.; and **James M. Toney** as Vice-Pres. and Gen. Mgr.; RCA Victor Radio and "Victorola" Div.

Harry A. Ehle and **Jesse Marsten** respectively have been elected to the posts of Executive Vice-President and Senior Vice-President of the International Resistance Company, Philadelphia, Pa.

Harry A. Ehle

Jesse Marsten

Rear Admiral Russell S. Smith, USN Ret., has been appointed as an Associate Director of the Burroughs Corp. Research Activity in Paoli, Pa.

John J. Kaul has been appointed Sales Manager of the Terado Company, St. Paul, Minn.

Norman C. Owen has been appointed Vice-Pres. in Charge of Sales for CBS-Columbia.

John H. Harris has been appointed Vice-Pres. in Charge of Planning for Brush Electronics Company, Cleveland, Ohio. The company has also announced the appointment of **Wallace T. Gray** as General Works Mgr.

The appointment of **Frank W. Guthrie** as Sales Manager for the tape recorder div. of Magnecord, Inc., Chicago, Ill., has been announced.

(*Continued on page* 130)

Facsimile Transmitter

(*Continued from page* 127)

mechanism with a straight optical path, it was necessary to fold the system so that it could be mounted in a 19 in. relay rack. This was accomplished by using three front surface mirrors. It was necessary to mount the copy itself 1½ in. in front of the rack panel so that the optical path could clear the inside panel dimensions.

A feed roller in front of the rack panel face fed the copy, and the line being scanned was brightly illuminated by two F-13T5/G 13-watt fluorescent lamps. These lamps were chosen because of their high efficiency green phosphor (70 lumens/watt) and their close spectral match to the S-9 response of the multiplier phototube. Both the RCA 5819 and the DuMont 6292 photomultipliers were used successfully in the X-1x. It was necessary to operate the lamps on dc to avoid flicker, and the polarities of the two lamps used were reversed so that the cathode dark spaces would not both be at one end.

Tests were made for rf noise from the fluorescent lamps. None was detected in the 150 KC-25 MC range. We concluded that fluorescent lamp noise is mostly due to transients associated with ac operation, which accounted for our freedom from noise using dc.

A reduced image of the illuminated line of copy was formed in the plane of the scanning spiral by an f/4.5 113 mm enlarging lens used as the objective. The spiral disk, shown in Fig. 5, was made of Herculite stressed glass. A coat of Kodalith emulsion was coated on one side of the disk, and a photographic copy from a master spiral was made on the Kodalith. A metal rim was used on the disk to facilitate dynamic balancing.

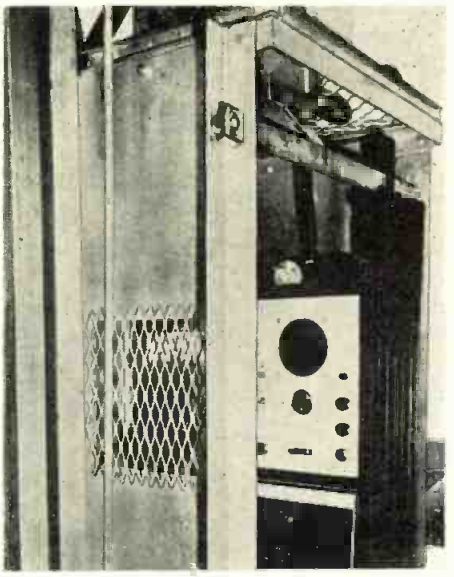
The width of the transmission region of the scanning spiral slot was 0.0017 in. and the width of the linear slit was 0.002 in. At the intersection of spiral and slit an aperture, sensibly a rectangle, was formed. Both spiral and slit were within the depth of field of the image for a circle of confusion small compared to the image of the elemental scan area. For a stroke length of 3½ in. this aperture resolved 2,000 elements.

Since the slope of the spiral-slit intersection was very steep, a considerable length of spiral moved past the slit while the aperture moved a distance equal to its own width. Thus a small speck or other irregularity

(*Continued on page* 131)

TV Tower Elevator

Two passenger elevators which glide up and down inside TV towers are operated by a new inductive elevator control developed by Union Switch & Signal—Div. of Westinghouse Air Brake Co., Pittsburgh, Pa.



Closeup of TV tower elevator, showing control panel

In place of the usual 2-wire electric circuit and related equipment, control is accomplished by means of low-frequency carrier wave on a single, 3-conductor cable. The Union "TVL" system also contains communication equipment that insures constant voice contact between car and tower base.

WATTMETER

New Goerz (Vienna) low power precision wattmeter has current ranges of 10 ma and 50 ma, and voltages of 150, 300, and 450 volts at a full scale accuracy of 0.5%. Unit is particularly

well adapted to the measurement of power consumption in relay coils, voltage coils, etc. **Physics Research Laboratories, Inc., 507 Hempstead Turnpike, West Hempstead, N. Y.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-20)

INDUSTRY NEWS

(*Continued from page* 128)

George W. Keown has been elected a vice-president in charge of sales at Tung-Sol Electric Inc., Newark, N.J.

Orville M. Dunning has been appointed Director of the Engineering and Production Div. of Airborne Instruments Laboratory, Mineola, N.Y.

George W. Keown

Orville M. Dunning

H. F. Penfold has been appointed General Sales Manager of the Rust Industrial Company, Inc., Manchester, N.H. Mr. Penfold will head up the company's sales program from its N.Y.C. office at 41 E. 42nd St.

Seymour D. Gurian has been appointed sales manager of the Engineering Products Div. of the Radio Receptor Co., Inc., Brooklyn, N.Y.

Francis Migge has been named to the newly-created post of Manager of Manufacturing for Eitel-McCullough, Inc., San Bruno, Calif.

Seymour D. Gurian

Francis Migge

Verne G. Rydberg has been appointed manager of industrial tube sales for the Westinghouse Electronic Tube Div. **Clifton Potter** was named manager of the newly-organized commercial engineering dept.

Howard T. Souther has been appointed to the newly-created position of marketing director in the sales div. of Electro-Voice, Inc., Buchanan, Mich.

Facsimile Transmitter

(*Continued from page* 129)

on the spiral which might instantaneously block the aperture created a pulse from the phototube corresponding to a much higher frequency than the element frequency of the scanner. A low pass filter eliminated virtually all of these signals, so that a spiral defect had to be large to be observed.

Condenser lenses behind the scanning disk collected the apertured light and brought it onto the photocathode of a multiplier phototube. This was accomplished by using the condenser to form an image of the objective lens on the photocathode. This reduced spot wobble on the phototube to a residual minimum due to abberations of the condensers.

Signals generated by the X-1x were transmitted to a standard TXC-1 weather map recorder.

Oscillograms

Fig. 6A shows the signal envelope for the scanner output for a single sweep scanning left to right for a ten step density wedge and a white strip. The end of page region begins at left as a full amplitude signal (100% carrier modulation), then the white edge of the test sheet, then the density steps, a signal corresponding to the black margin of the test sheet, and finally a minimum signal corresponding to a white sheet for the rest of the scan.

Fig. 6B shows the signal envelope for the same copy in the X-1x, but with the modulator balanced on the fifth step of the density wedge. The "X" shape of steps shows the linearity of modulation as well as the linearity of density response. The white copy at the right of the page is, of course, overbalanced when a neutral gray is balanced as "white." In both figures the double balanced ring modulator was adjusted for zero balance for a phototube output of 0.6 v. Dynode voltage was varied to change the density of copy which would produce 0.6 v output. In Fig. 6A the dynode voltage on the 5819 tube was 69 v per dynode stage, 185 v cathode to first dynode, dynode #9 grounded, and dynode #10 rendered 0.6 v negative by charge collection at maximum signal. This circuit, which has a logarithmic response to light, produces a response linear with optical density. It has been described by Hogan and Hester[7].

The small irregularities observed in Fig. 6A and Fig. 6B are due to small imperfections present in the

(*Continued on page* 133)

New Products

CAPACITORS

Newly designed Type JCSF vacuum capacitors measure only 1⅝ in. L. x 1⅝ in. D. Available in capacities of 25, 40, 80, 120 and 150 μμfd at voltages of 7½, 10, and 15 kv peak. All-copper

construction makes possible current ratings of 30 amperes rms which can be doubled with the use of forced air cooling. Small size, low inductance, and negligible dissipation factor make them extremely useful for operation at the higher frequencies. **Jennings Radio Mfg. Corp., P. O. Box 1278, San Jose, Cal.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-1)

MAGNETIC AMPLIFIER

The PRD Type R6A5M1 low-level push-pull dc magnetic amplifier amplifies the output of low level devices such as thermocouples, strain gauges, thermistor bridges, photo tubes or crystal detectors so as to operate an insensitive relay or meter. Self-contained, unit requires no external rectifier. Provides push-pull dc output for a reversible polarity dc signal input. Power

gain: 60; low drift: 1μa. Gives 5 mw output with a 300 mv input. Temp. range: —55°C. to +85°C. Units can be cascaded. **Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn, N. Y.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-27)

Facsimile Transmitter

(*Continued from page 131*)

spiral. In each case these are less than one step of gray on the ten step wedge. Noise was 40 db down.

At present additional scanners based on the X-1x[8] are being fabricated for the Weather Network.

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3. J. V. L. Hogan. United States Patent 2,379,438. July 3, 1945.
4. C. J. Young, "Tape Facsimile: Historical and Descriptive Note," *Radio Facsimile*, RCA Inst. Tech. Press, pp. 264-269, Oct. 1938.
5. Report No. 2, NOBsr 57253 Task 2, 14 Sept. 1952.
6. Report 1200-6 AF30 (602)-403, October 1953.
7. J. V. L. Hogan and F. A. Hester, "A Facsimile System Having Response Linear with Optical Density," Conference Paper AIEE Winter Meeting, 1952.
8. Development under BuShips Contract NOBsr-57253, 16 June 1952.

"Hushed" Amplifier

(*Continued from page 72*)

voltage meter. An adjustable input-divider in this instrument reduces amplified signals and amplified noise to a sufficiently low level at which a germanium rectifier-diode operates strictly in its square law region. A sensitive high-impedance DC amplifier then converts the weak, rectified signals from the diode into meter-deflections on a square-law dial, making readings of the ratio between a calibration signal and the RMS noise voltage possible. The noise voltage itself can then be determined.

This instrument is equipped with high pass and low pass filters which make it possible to reduce the band width from a maximum of 200 KC down to a few KC.

However, for our actual narrow band measurements, we did not use this instrument. They were made with the special equipment shown in Fig. 9.

We built these two separate filter-amplifiers. The lower one is a highly stable 6 stage amplifier of the R/C-tuned variety. It is designed for a permanent center frequency of 1 KC. Its band width is 223 CPS. It was carefully determined by plotting the actual response curve and integrating it. With it, we were able to determine, with better than 0.5 db accuracy, noise voltage, equivalent noise resistance, and noise figure of our hushed transistor amplifier at 1 KC, under varying input conditions.

The upper part of Fig. 9 shows our other filter-amplifier, having a heterodyne circuit. It has an effective band width of 16 CPS. It enables us to

"Hushed" Amplifier

(*Continued from page 133*)

make spot noise voltage measurements over a frequency range between 500 CPS and 20 KC. The absolute accuracy of measurements made with this amplifier is somewhat poorer than the accuracy of the other filter-amplifier or the MV-19A noise voltmeter; but it is very useful for quick determination, with approximately 1 db accuracy, of the relative increase and decline of noise voltage below and above 1 KC. The band width of this amplifier is 16 CPS. Since heterodyning, in this particular amplifier, yields both the desired frequency and its image, we are actually measuring, simultaneously, noise voltages in two separate bands, each 8 CPS wide. However, since the centers of these bands are only approximately 52 CPS apart, the interval is small enough to make the difference between the desired spot frequency measurement and the actual measurement of the average of two close spot measurements negligible.

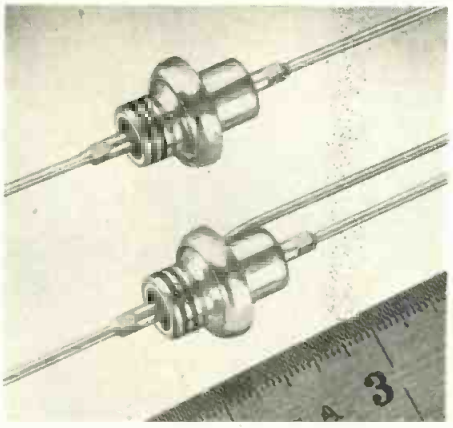
The already reported measurements of input noise voltage at 1 KC were converted by us into noise figure, as shown in Fig. 10. With our hushed transistor, we reached an optimum noise figure (F) of 1.8 db with a generator resistance in the order of 500 ohms. The unhushed transistor, on the other hand, showed an optimum noise figure of 6 db at a measuring point where generator resistance was 150 ohms.

With matched generator resistance, noise figure in hushed condition was found to be 2.5 db; and in unhushed condition, 9.5 db (7 db higher). With a generator resistance of 3.9K (or roughly 3½ times larger than transistor input impedance), we found a noise figure of 5.5 db in hushed and 13.5 db in unhushed condition (an 8 db improvement due to hushing).

As in the case of noise voltage, we found again that the hushed transistor, under certain conditions, may have a noise figure which is lower than can be predicted by pure thermal noise considerations. The dotted curve for F_{MPT}, in Fig. 10 is the calculated "Thermally Possible Minimum Noise Figure", varying with generator resistance. We found that in the hushed condition our measured noise figure stayed consistently at approximately 0.9 db below the calculated minimum possible noise figure, throughout the entire section above 1.2K generator resistance. In other words, whenever generator resistance was higher than

NPN TRANSISTORS

New medium-power N-P-N fused junction germanium transistors are characterized by high gain and low noise figures. Low alpha-crowding effect makes them suitable for such



applications as: computers, switching, audio amplifiers, I-F amplifiers, R-F amplifiers, and oscillators. Max. collector current, 100 ma; collector dissipation, 500 mw. For HA5001, HA5002, and HA5003 respectively, max. current amplification (alpha) is 1.0, 0.965, and 0.99; max. collector-to-base voltage is 30v. 15v. and 20v.; collector cut-off current is 5 μa, 12 μa, and 10 μa. **Hughes Aircraft Co., Culver City, Calif.** TELE-TECH & ELECTRONIC INDUSTRIES (Ask for 1-37)

TELE-TECH ADVERTISERS — JANUARY, 1956

While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

"Hushed" Amplifier

(*Continued from page 134*)

the 1.2K measured input impedance of the hushed transistor, measured noise figure was found to be substantially lower than the "Minimum Possible Thermal Noise Figure."

Since these measurements were made with better than 0.5 db accuracy, and since they are consistently reproducible, it seems worthwhile to investigate the reasons why noise figure, in a hushed transistor, can be lower than the theoretically possible minimum noise figure, based on thermal considerations.

We are accustomed to reports of rather high noise figures in transistors in comparison with vacuum tubes. If we forget, for a moment, that we now have the hushed transistor which bridges the gap between customary low noise figure vacuum tube performance and customary high noise figure transistor performance, it is worthwhile to investigate whether it is really fair to the transistor in general to evaluate its quality by the same figure of merit, called "noise figure", by which we evaluate vacuum tubes.

In the upper left corner of Fig. 11 we see the input circuit of a vacuum tube amplifier and below it the input circuit of a transistor amplifier. The vacuum tube, particularly if it is a pentode, offers a nearly infinite input resistance to its load. Actual impedance matching is quite rare, unless the tube is cathode-fed. The unavoidable grid leak resistor, as far as noise figure measurements are concerned, can very well be incorporated or considered part of the generator circuit, or can be forgotten altogether.

The transistor amplifier finds itself in an unfavorable competing position with the tube. While its bias circuits (not shown) could also be incorporated in, or be made to form part of, the signal source, it has its own unavoidable low input impedance. This impedance, whether static or dynamic, is a thermal noise source which, in contrast to the vacuum tube, can often not be shunted by a very much lower signal source impedance.

How does this difference between the input circuitry of the vacuum tube and the one of the transistor affect noise figure? On the right side of Fig. 11 we have an amplifier having a measured input impedance R_I. Connected in parallel with it a generator resistance R_G. Each of these resistances has, in series with itself, its thermal noise generator ϵ_{RI} and ϵ_{RG}.

(*To be concluded next month*)

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- They protect themselves against abuse and/or mishap.
- They are very flexible—reversible polarity, triple-range metering, 100% voltage control, wide-range trip-out adjustment.
- They are compact and relatively light. They mount in rack or cabinet. They make a striking appearance.
- Their simple, logical design uses the same circuit, the same components, the same techniques over and over again. This means purchasing and mass-production savings, which are reflected in our prices.

As we have said before, with the introduction of our H-line,

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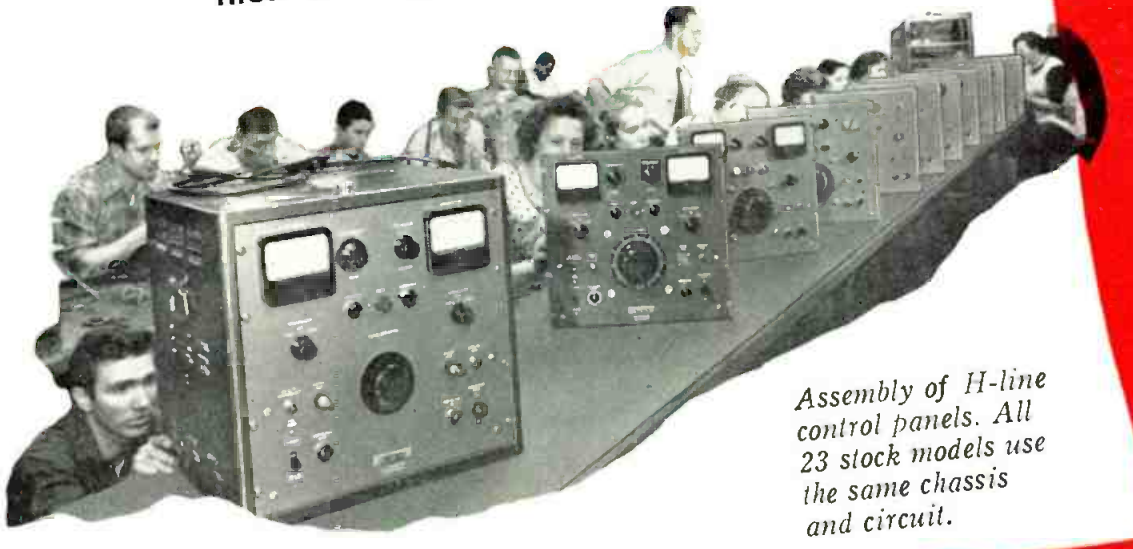

Assembly of H-line control panels. All 23 stock models use the same chassis and circuit.

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...provides high sensitivity and high output voltage at low cost!

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For data on the RCA-6DT6, its series-heater string equivalent, RCA-3DT6, and the new RCA FM-Detector Circuit, call your RCA Field Representative. Or write RCA, Commercial Engineering, Section A-50-Q, Harrison, N. J.

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