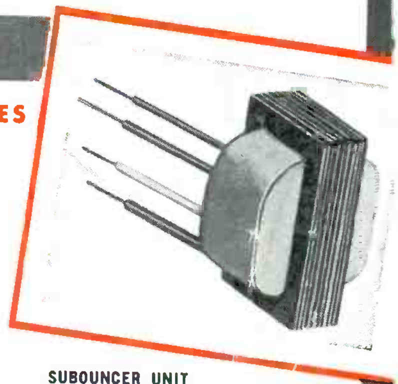

electronics
APRIL · 1951
PRICE 75 CENTS
A McGRAW-HILL PUBLICATION
GUIDED-MISSILE COMPUTER

MINIATURE COMPONENTS FROM STOCK...

SUBOUNCER UNITS

FOR HEARING AIDS...VEST POCKET RADIOS...MIDGET DEVICES

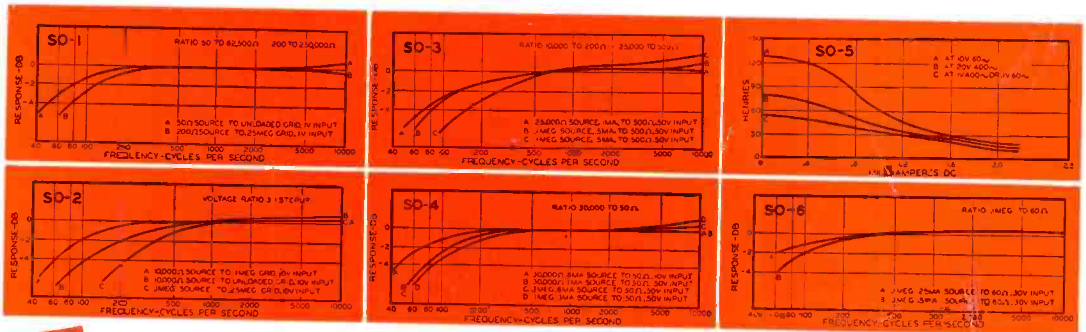


SUBOUNCER UNIT
Dimensions....9/16" x 5/8" x 7/8"
Weight ....03 lb.

UTC Sub-Ouncer units fulfill an essential requirement for miniaturized components having relatively high efficiency and wide frequency response. Through the use of special nickel iron core materials and winding methods, these miniature units have performance and dependability characteristics far superior to any other comparable items. They are ideal for hearing aids, miniature radios, and other types of miniature electronic equipment. The coils employ automatic layer windings of double Formex wire . . . in a molded Nylon bobbin. All insulation is of cellulose acetate. Four inch color coded flexible leads are employed, securely anchored mechanically. No mounting facilities are provided, since this would preclude maximum flexibility in location. Units are vacuum impregnated and double (water proof) sealed. The curves below indicate the excellent frequency response available. Alternate curves are shown to indicate operating characteristics in various typical applications.

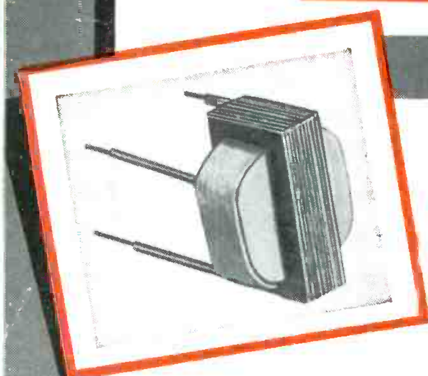
Type	Application	Level	Pri. Imp.	D.C. in Pri.	Sec. Imp.	Pri. Res.	Sec. Res	List Price
*SO-1	Input	+ 4 V.U.	200 50	0	250,000 62,500	16	2650	$6.50
SO-2	Interstage/3:1	+ 4 V.U.	10,000	0	90,000	225	1850	6.50
*SO-3	Plate to Line	+ 20 V.U.	10,000 25,000	3 m l. 1.5 m l.	200 500	1300	30	6.50
SO-4	Output	+ 20 V.U.	30,000	1.0 m l.	50	1800	4.3	6.50
SO-5	Reactor 50 HY at 1 mil. D.C 3000 ohms D.C. Res.							5.50
SO-6	Output	+ 20 V.U.	100,000	.5 m l.	60	3250	3.8	6.50

*Impedance ratio is fixed 1250:1 for SO-1, 1:50 for SO-3. Any impedance between the values shown may be employed.



SUB-SUBOUNCER UNITS

FOR HEARING AIDS AND ULTRA-MINIATURE EQUIPMENT

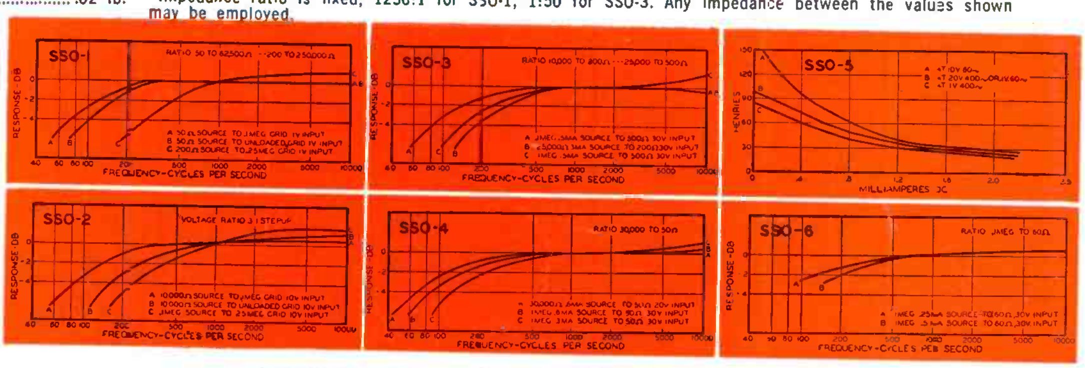


SUB-SUBOUNCER UNIT
Dimensions....7/16" x 3/4" x 5/8"
Weight ....02 lb.

UTC Sub-SubOuncer units have exceptionally high efficiency and frequency range in their ultra-miniature size. This has been effected through the use of specially selected Hiperm-Alloy core material and special winding methods. The constructional details are identical to those of the Sub-Ouncer units described above. The curves below show actual characteristics under typical conditions of application.

Type	Application	Level	Pri. Imp.	D.C. in Pri.	Sec. Imp.	Pri. Res.	Sec. Res.	List Price
*SSO-1	Input	+ 4 V.U.	200 50	0	250,000 62,500	13.5	3700	$6.50
SSO-2	Interstage/3:1	+ 4 V.U.	10,000	0	90,000	750	3250	6.50
*SSO-3	Plate to Line	+ 20 V.U.	10,000 25,000	3 mil. 1.5 mil.	200 500	2600	35	6.50
SSO-4	Output	+ 20 V.U.	30,000	1.0 mil.	50	2875	4.6	6.50
SSO-5	Reactor 50 HY at 1 mil. D.C. 4400 ohms D.C. Res.							5.50
SSO-6	Ouptut	+ 20 V.U.	100,000	.5 mil.	60	4700	3.3	6.50

*Impedance ratio is fixed, 1250:1 for SSO-1, 1:50 for SSO-3. Any impedance between the values shown may be employed.



United Transformer Co.

150 VARICK STREET NEW YORK 13, N. Y.

EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y., CABLES: "ARLAB"

electronics

A McGRAW-HILL PUBLICATION

APRIL • 1951

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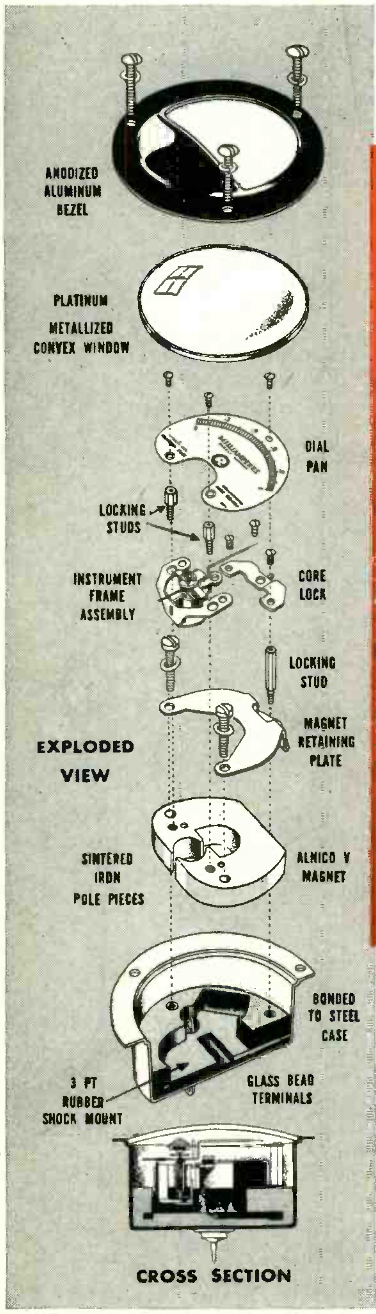
Exceeding Expectations!



NEW marion *ruggedized* meter

Marion Ruggedized Meters introduce a brand new family of panel instruments produced to give outstanding performance under *extreme* conditions of Shock . . . Vibration . . . Mechanical Stress or Strain. Hermetically sealed, they are impervious to the weather conditions of *any* climate.

Marion Ruggedized Instruments give you new freedom of application. They are extremely accurate, highly sensitive meters that may be used in places where no one has ever before *dared* use "delicate instruments." Count on them to exceed your greatest expectations in *any* application.

Send for your free copy of our booklet on the new Marion Ruggedized Meters today. See how Ruggedized Meters meet the dimensional requirements of JAN-I-6 and are interchangeable with existing standard JAN 2½" and 3½" types. Learn why their electrical and mechanical performance far *exceeds* existing JAN requirements. Discover for youself some of the developments that made the ruggedized meter possible.

Manufacturers of Hermetically Sealed Meters Since 1944

Marion Electrical Instrument Company, 401 Canal St., Manchester, New Hampshire

marion meters

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Please seree of charge, your 1951 CATE. 25

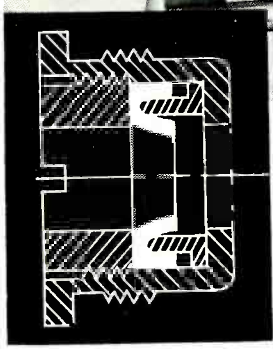
NAME

COMPANY

POSITION

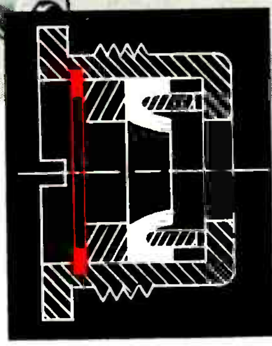
MAILING ADDRESS

4 TRUARC RINGS CUT ASSEMBLY TIME 40%
CUT UNIT COST 25%
PROLONG PRODUCT LIFE 9 YEARS



OLD WAY

A typical air or hydraulic sealing problem: Inadequate or excessive pressure of threaded gland nut on seal caused distortion. Result: binding of piston rod, troublesome leaks, constant maintenance, shortened product life.



NEW WAY

Waldes Truarc Internal Retaining Ring (Series 5000) is held in correct position by pre-determined groove. Proper pressure on seal is insured for life of unit, increasing number of cycles from 10,000 to 100,000!

Using 4 Waldes Truarc Retaining Rings in their Check-N-Spect Air Power Units (for tire inspection and repair) saves Bowes Seal Fast Corp., Indianapolis, 40% in assembly time, 25% in cost. With Waldes Truarc Rings, assembly is simple...maintenance unnecessary. New design increases unit life from 1 to 10 years!

Redesign with Truarc Rings and you too will cut costs. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better job of holding parts together.

Truarc Rings are precision-engineered...quick and easy to assemble and disassemble. Always circular to give a never-failing grip. They can be used over and over again.

Find out what Truarc Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

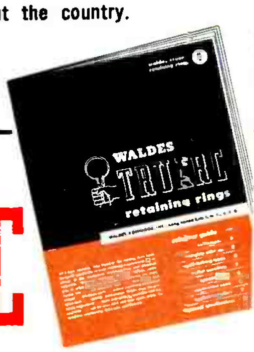
Waldes Truarc Retaining Rings are available for immediate delivery from stock, from leading ball bearing distributors throughout the country.

REDESIGN WITH 4 WALDES TRUARC RETAINING RINGS BRINGS THESE BIG SAVINGS...

- Eliminates skilled-labor milling and threading operations
- Eliminates maintenance
- Gives greater accuracy in positioning seal
- Saves 40% in assembly time .... $.09
- Cost of old-type parts .... .24
- Less Cost of four Waldes Truarc Rings . .08
- Net savings on parts .... .16

TOTAL UNIT SAVING . . . $.25

SEND FOR NEW CATALOG



WALDES
TRUARC
REG. U. S. PAT. OFF.
RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS ARE PROTECTED BY THE FOLLOWING PATENT NUMBERS:
U. S. PATENTS 2,382,948; 2,420,921; 2,411,761; 2,487,803; 2,487,802; 2,491,306 AND OTHER PATENTS PENDING

Waldes Kohinoor, Inc., 47-16 Austel Place E-043
Long Island City 1, N. Y.

Please send selector guide catalog (4k-w) on Waldes Truarc Retaining Rings.

Name____________________

Title____________________

Company____________________

Business Address____________________

City__________ Zone______ State__________ ★

HERMETICALLY SEALED

SOLA *Constant Voltage* TRANSFORMERS

FOR USE ON MIL-T AND JAN PROJECTS

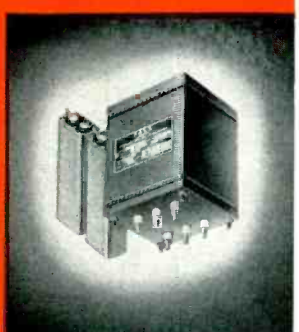
The patented SOLA Constant Voltage Principle provides the following advantages over ordinary transformer design: regulation within ±1% with total primary variations as great as 30% . . . automatic, instantaneous regulation . . . freedom from moving parts, maintenance and manual adjustments . . . self-protection against short circuit. They are available in a complete range of capacities and special types (such as frequency compensated or with harmonic filter).

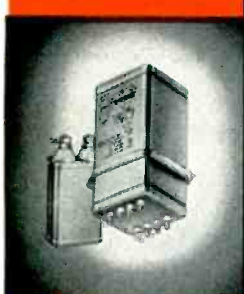
Today's complex electrical and electronic defense equipment requires unfailing accuracy and dependability under extreme conditions of humidity, heat, mechanical shock and other adverse conditions. To meet those needs SOLA voltage regulators can be provided in hermetically sealed housings which conform to defense specifications for grades 1, 2 or 3 hermetic sealing. Splash proof design housings are provided for large units where hermetic sealing is not feasible.

SOLA Constant Voltage Transformers were widely employed during World War II wherever continuous precision performance of electrical and electronic units was mandatory. Typical defense applications include: observation and fire-control, radar, omni-directional ranges and other navigation aids, X-ray equipment, flight and navigation trainers, and photoelectric devices.

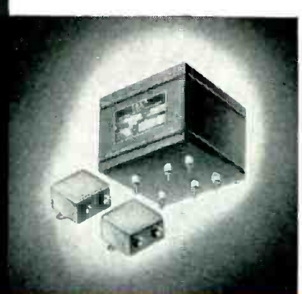
Often the precise voltage input upon which a device's design was predicated is not available. Yet, input voltage level must continuously meet design requirements for satisfactory performance. You can guarantee optimum performance for your unit by stabilizing input voltage with a SOLA Constant Voltage Transformer.

SOLA Constant Voltage Transformers are made under one or more of the following Patents: 2,143,745; 2,212,198; 2,346,621.





Typical types of Hermetically Sealed SOLA Constant Voltage Transformers



The engineers and sales representatives of the SOLA Electric Company will be glad to discuss the application of SOLA Constant Voltage Transformers to your specific requirements. Your phone call or letter will receive our prompt attention.

SOLA *Constant Voltage* TRANSFORMERS

Transformers for: Constant Voltage • Fluorescent Lighting • Cold Cathode Lighting • Airport Lighting • Series Lighting • Luminous Tube Signs Oil Burner Ignition • X-Ray • Power • Controls • Signal Systems • etc. • SOLA ELECTRIC COMPANY, 4633 W. 16th Street, Chicago 50, Illinois

ADVENTURES IN ELECTRONIC DESIGN

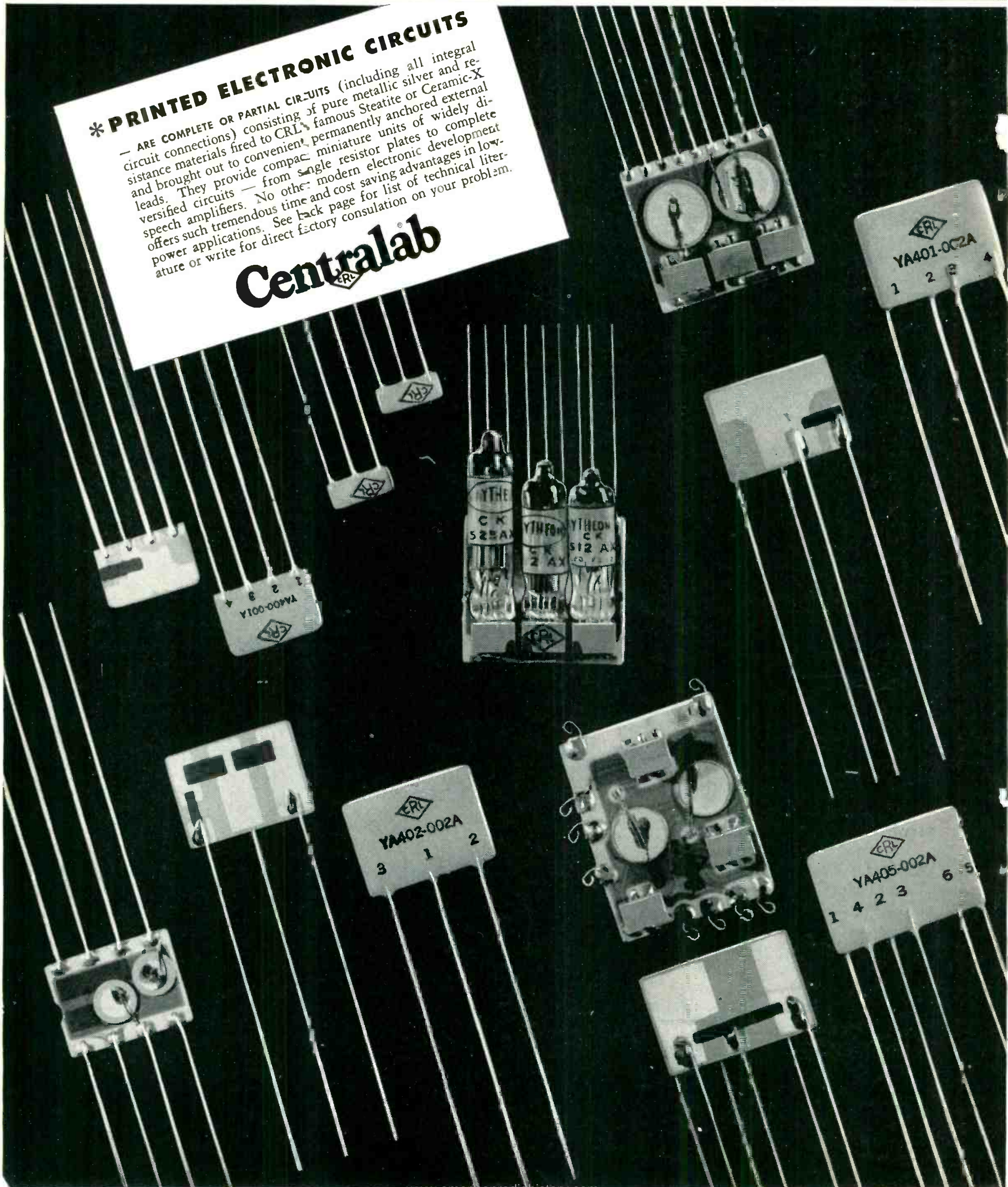
Centralab's Printed Electronic Circuits May Solve a Problem for You

In a busy Washington office during the past war hung a sign which said — "We do the miraculous every day — the impossible takes just a little longer." Today, that sign could hang in the offices of Centralab. For example, someone wanted a *small* speech amplifier Centralab's answer — Ampec, a full 3 stage unit, two of which can fit inside of a regular pack of cigarettes! A radio manufacturer wanted a *small* audio-detection unit. Centralab's answer Audet, a unit one-third size of an ordinary soda-cracker! How were these things done? With Centralab's Printed Electronic Circuits — a pioneered development of Centralab. Yes, and here are some of the benefits that many manufacturers of radio TV sets and other electronic gear have reaped from using PEC's. They've eliminated numerous individual parts their handling, inventory and assembly. They've gotten more consistent and better performance results. They've reduced finished product size and weight. They've eliminated wiring errors and cut down on the number of soldered connections. What's more, they've been able to stretch their resistor supplies . . . an important factor in meeting current volume demands for TV and radio production. Look over your own situation. Want to cut costs? Speed up assembly? Then on the next two pages you may see a Centralab Printed Electronic Circuit unit that will help you do just that! If you don't see what you want — contact us. Tell us your problems. Maybe we can do the miraculous or take a little longer and accomplish the impossible!

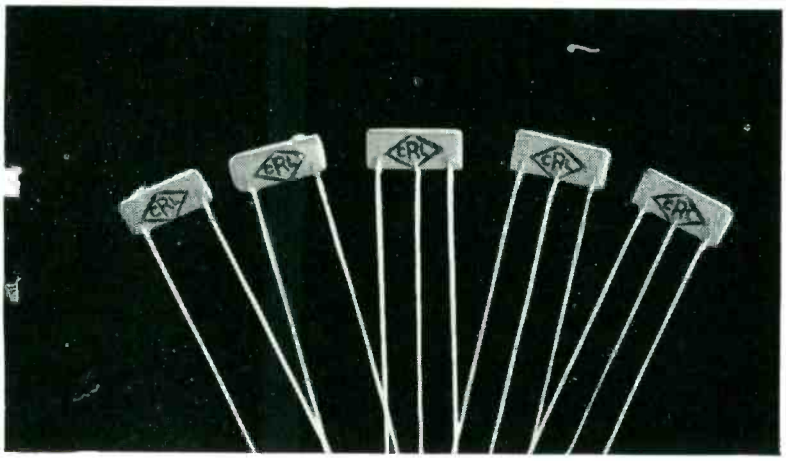
Centralab — **DEVELOPMENTS THAT CAN HELP YOU**

Division of GLOBE-UNION INC., Milwaukee

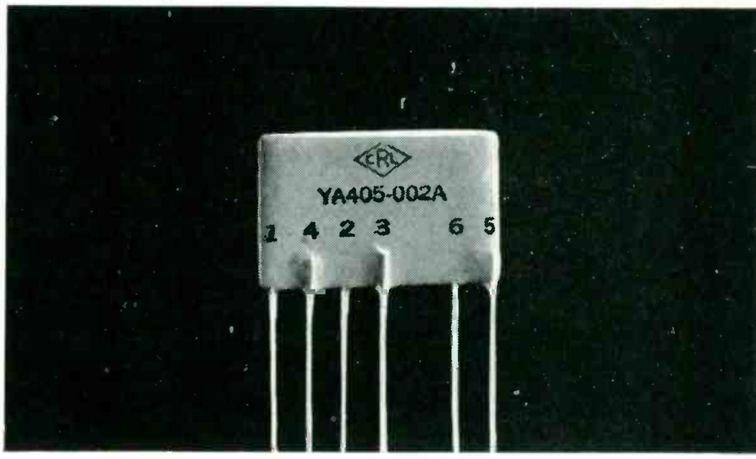
SPEED PRODUCTION...
Use P.E.C.'s *...



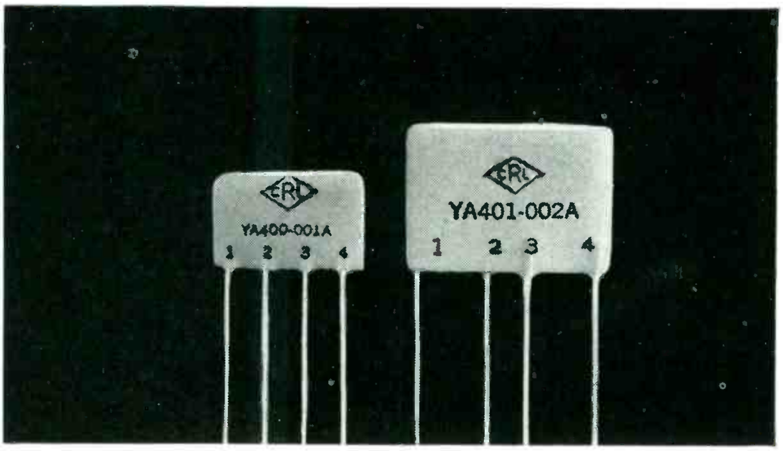
CUT ASSEMBLY COSTS
Conserve Resistors



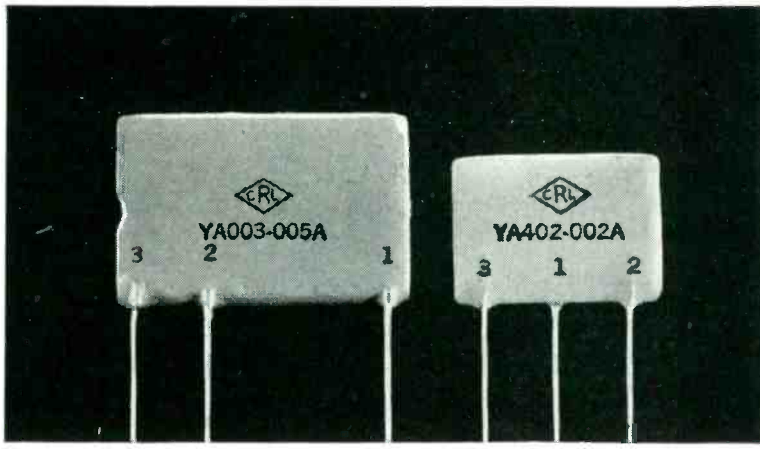
Actual size photo of plate capacitor, resistor, and resistor-capacitor units. Because of size and ease of installation, they easily fit miniature and portable electronic equipment — overcome crowded conditions in TV, AM, FM, and record-player chasses. For complete data, check coupon No. 42-24 — Ceramic Plate Components.



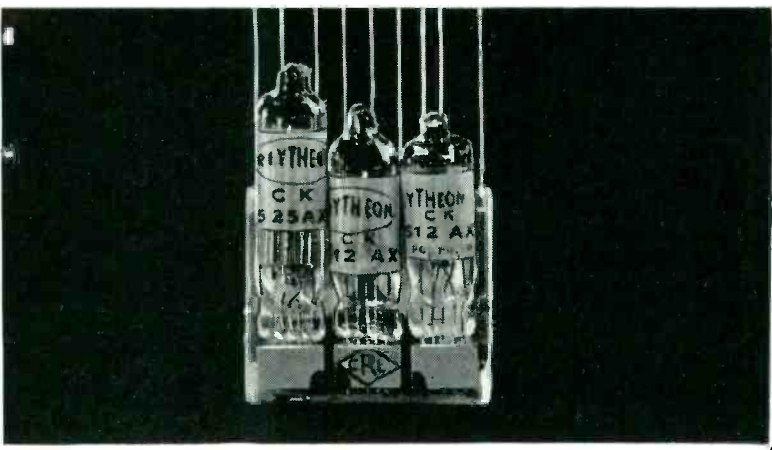
Pentode couplates are complete interstage coupling circuits consisting of 3 capacitors and 3 resistors on a small 6 lead ceramic plate. Compared with old-style audio circuits, they reduce soldered connections 50% — wiring errors accordingly. Big saving in space and weight. For complete data, check coupon No. 999—Pentode Couplate.



Centralab Triode Couplates save space and weight, replacing 5 components normally used in audio circuits. They consist of 3 capacitors and 2 resistors bonded to a dielectric ceramic plate. Available in variety of resistor and capacitor values. For complete data, check coupon No. 42-6 — Couplate, and No. 42-27 — Model 2 Couplate.



Centralab Vertical Integrators give you big savings in assembly costs in TV vertical integrator networks. One type consists of 4 resistors and 4 capacitors brought out to 3 leads . . . reducing formerly required 16 soldered connections to 3! There're less parts handled, too! For complete data, check coupon No. 42-22—Vertical Integrator.



Ampec is a full 3-stage, 3-tube speech amplifier with amazingly efficient, reliable performance. Size $1\frac{1}{4}'' \times 1\frac{1}{8}'' \times .340''$ over tube sockets! Used in hearing aids, mike preamps and similar applications where small size and outstanding performance counts. For complete data, check coupon No. 973 — Ampec.

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Yes—I would like to have the CRL bulletins, checked below, for my technical library!

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Name...

Address...

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frequency measurements accurate to 1 part in 10 Million over a large portion of the RF Spectrum

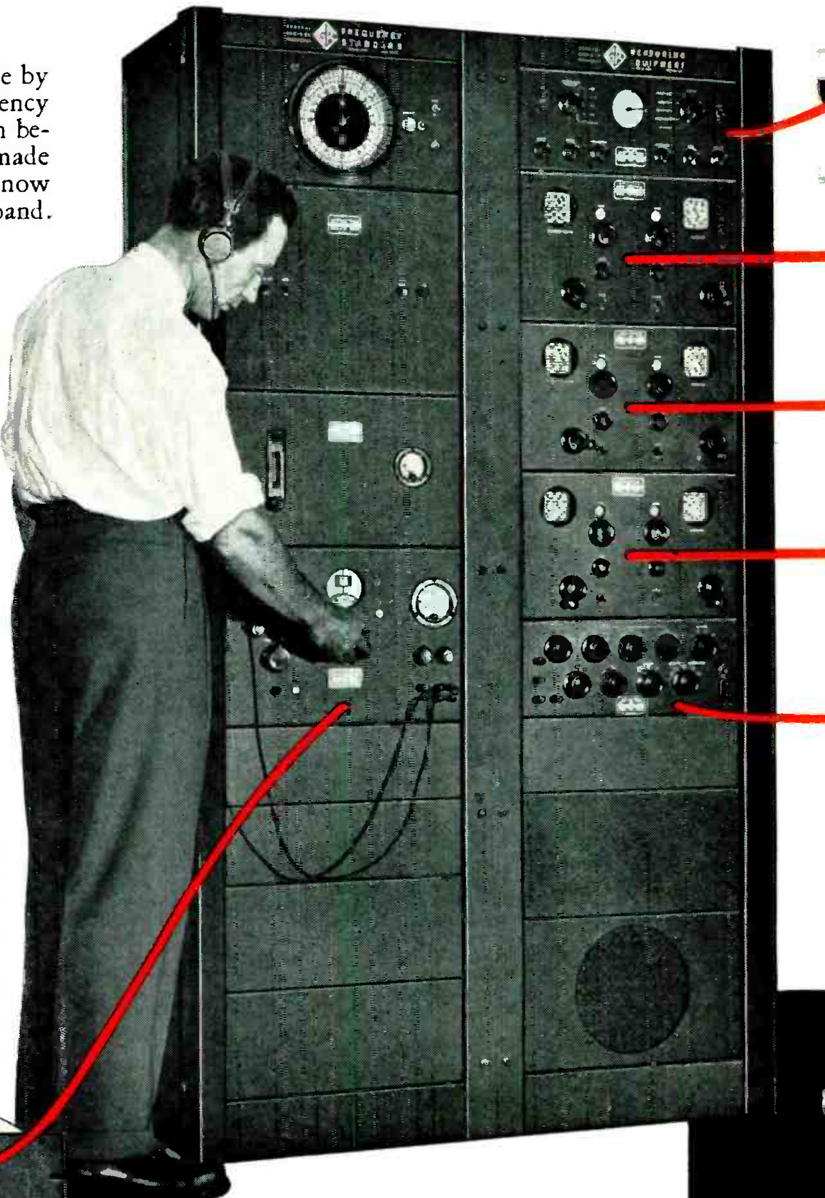
Frequency standards and measuring equipment made by General Radio Company make accurate frequency measurements possible throughout the radio spectrum below 3,000 Mc. Measurements in the v-h-f range can be made with only slightly less accuracy and convenience than is now considered routine in the standard a-m broadcast band.

The Type 1100-AP Primary Standard (*at the left of the large photo*), with its associated Type 110-5A Frequency Measuring Assembly (*at the right*), provides hundreds of known frequencies up to 100 Mc with an accuracy of one part in ten million. With the minimum number of adjustable controls and the maximum of convenience, this equipment is the most accurate commercially-available frequency measuring assembly obtainable.

The Type 1100-AP Primary Standard comprises a 100 kc oscillator, with temperature-controlled quartz bar, multivibrator units for 100 kc, 10 kc, 1 kc and 100 cycles, with a-c operated power supply and a Syncronometer clock with micro-dial arrangement for comparison with standard time signals.

The Measuring Equipment, which operates from the Standard, contains three transfer units each containing a tuned detector and heterodyne frequency meter. Beat frequency differences between the frequency under measurement and the nearest standard frequency harmonic are measured by means of the calibrated interpolation oscillator and the comparison oscilloscope. A circular sweep, with radial deflection, can be used on the oscilloscope in addition to the usual Lissajous figures, for frequency comparisons.

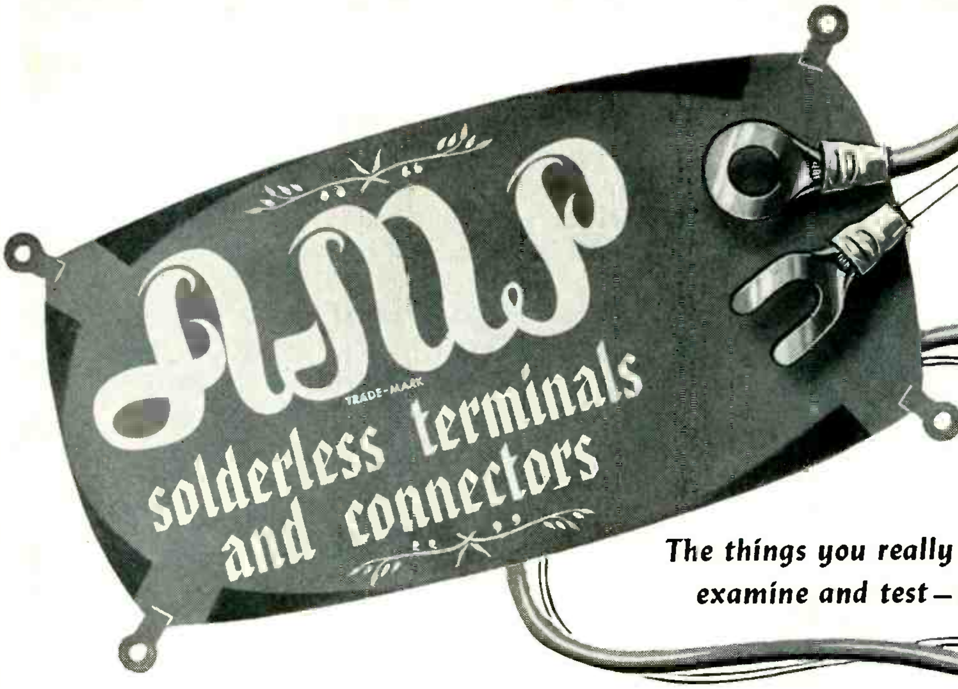
Various combinations of the Primary Standard, Secondary Standard, Interpolation Oscillator and auxiliary measuring equipment are available as catalog items. For complete and detailed information, write us, without obligation of course.



Type 1107-A Interpolation Oscillator is used to measure the difference between the unknown frequency and a known harmonic of the Standard. The direct-reading linear scales of 0 to 5,000 and 5,000 to 10,000 cycles make possible the rapid evaluation of the frequency difference *by addition only*. The actual frequency range is 0 to 5,000 cycles.

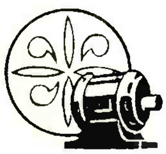
GENERAL RADIO COMPANY

Since 1915 *Designers and Manufacturers of Electronic Test Equipment*



The things you really know — feel — touch — examine and test — are what you can believe in

If you are not using AMP solderless terminals, send for samples, look them over, and discover for yourself why AMP is best



An actual case from the records of an electric motor manufacturer

By installing AMP SOLISTRAND* Butt Connectors on stator leads, a nationally known manufacturer of electric motors was able to achieve electrical balance 70% faster than by previous methods. The uniform weight and size of AMP's connector and its fast application by pneumatic tool, reduced labor costs 55% while eliminating painstaking solder-dipping. In addition, over-all appearance and life of wiring was greatly improved!

No other solderless terminal can boast all of these characteristics!

Shown above: THE AMP PRE-INSULATED DIAMOND GRIP Solderless Terminal (U.S. Patent Nos. 2,410,321; 2,379,567; 2,405,111; 2,468,169; other U.S. Patents Pending.)

This terminal is already insulated! Can be installed in one quick operation. No tape, tubing, or sleeving needed. Color-coded for easy identification in wire ranges 22-10. Insulation support sleeve prevents weakness from sharp bending or frayed insulation. Designed for complete uniform terminations at any application speed up to 3300 per hr.

AMP

AIRCRAFT-MARINE PRODUCTS, INC.
1611 Paxton Street, Harrisburg, Pennsylvania

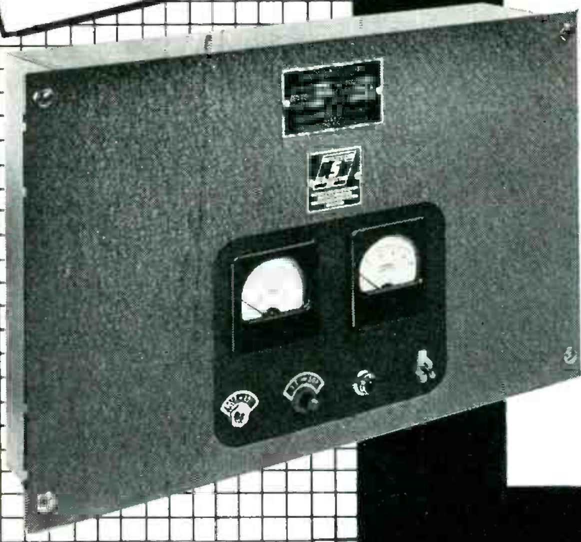
*REG. U. S. PAT. OFF.

Canadian Representative: R. M. HUTCHESON, 10 Nordale Crescent, Hardington, P.O., Toronto 15, Ont., Canada, Elgin 5647

Specify Sorensen

NOBATRONS

(DC VOLTAGE REGULATORS)



MODEL NO. E-6-15

DO YOU WANT the *advantages* of storage battery characteristics without the *disadvantages?* Then equip with Sorensen NOBATRONS! You get adjustable output voltage, stabilized against changing line AND LOAD conditions. You eliminate battery charging and maintenance, gas, acid hazard.

Like all Sorensen regulators, the NOBATRON is a painstakingly engineered combination of fine workmanship and top-quality components. That means accurate, trouble-free operation; long life!

STANDARD MODELS

6-VOLT SERIES	
E-6-5	E-6-40
E-6-15	E-6-100

12-VOLT SERIES	
E-12-5	E-12-30
E-12-15	E-12-50

28-VOLT SERIES	
E-28-5	E-28-70
E-28-10	E-28-150
E-28-30	E-28-350

48-VOLT SERIES

E-48-15

125-VOLT SERIES	
E-125-5	E-125-10

Model numbers indicate voltage and current; for example, E-6-5 indicates 6 VDC with 5 amp total capacity.

COMMON ELECTRICAL SPECIFICATIONS

Input voltage range	95-130 VAC; adapter transformers available for 230 VAC operation*
Output voltage range	Adjustable ± 10%
Regulation accuracy and load range	± 0.2% from 1/10 load to full load
Ripple voltage RMS max.	1%
Recovery time	0.2 second—this value includes charging time of filter circuit for the most severe change in load or input conditions
Input frequency range	50-60 cycles

*Some high current units require three-phase input

Write for Complete Literature

For other regulation problems investigate Sorensen's line of AC Voltage Regulators, Voltage Reference Standards, DC Power Supplys.

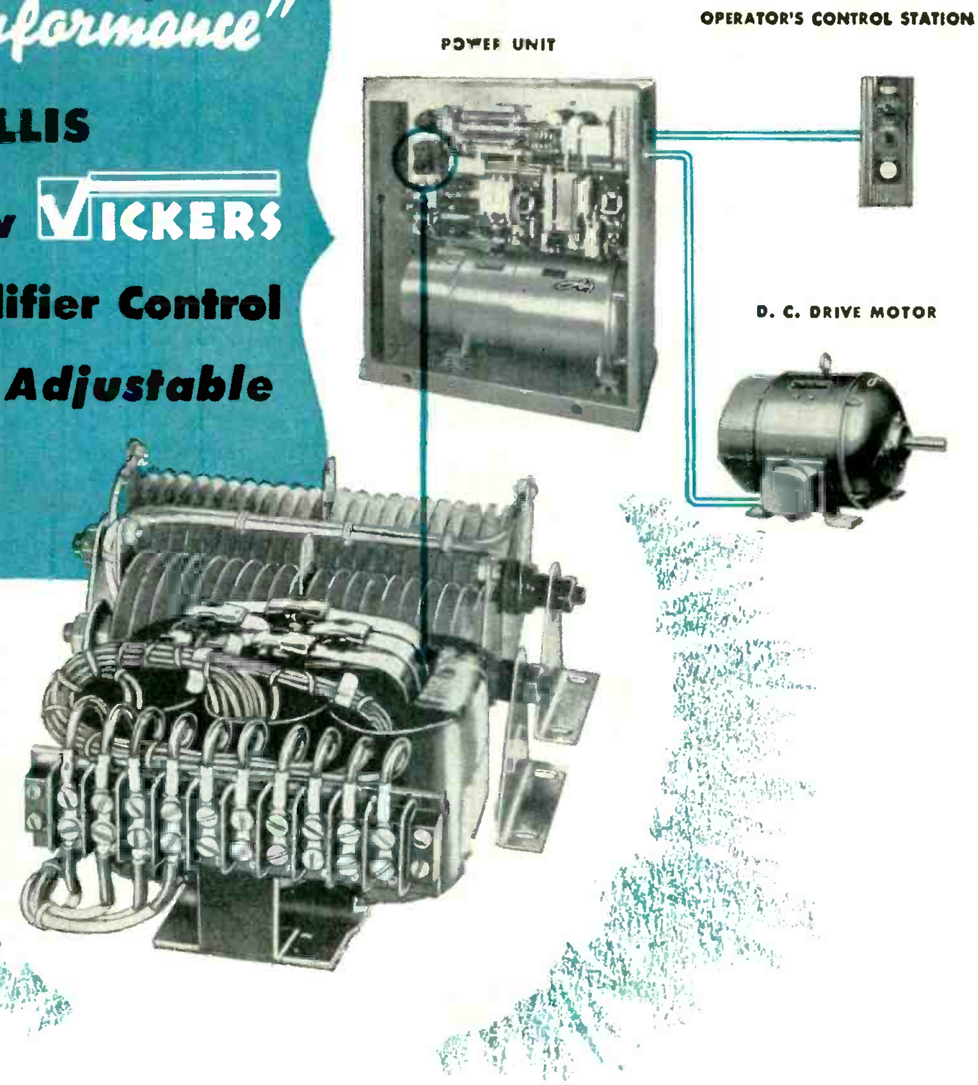
POWER controlled converted

Sorensen and company, inc.
375 FAIRFIELD AVE. • STAMFORD, CONN.

MANUFACTURERS OF AC LINE REGULATORS, 60 AND 400 CYCLES; REGULATED DC POWER SOURCES; ELECTRONIC INVERTERS; VOLTAGE REFERENCE STANDARDS; CUSTOM BUILT TRANSFORMERS; SATURABLE CORE REACTORS

"Superior Performance"

says LOUIS ALLIS about the new VICKERS Magnetic Amplifier Control on their new *Adjustable Speed Drive*



No "warm-up" time . . . extremely fast response . . . no maintenance! These are exclusive control advantages offered by the Vickers Magnetic Amplifier in Louis Allis' Select-A-Spede—a packaged all-electric adjustable speed drive operating from A. C. circuits. Located in the Cutler-Hammer control panel of the power unit, the Vickers Magnetic Amplifier constantly regulates the field current of the generator which supplies adjustable voltage to the drive motor, providing unequalled performance advantages.

Other Vickers Magnetic Amplifier features: A-C or D-C CONTROL, A-C or D-C OUTPUT . . . RESPONDS TO SUM OR DIFFERENCE OF SEVERAL SIGNALS . . . ALLOWS ELECTRICAL ISOLATION BETWEEN CIRCUITS.

There's a VICKERS Standard Magnetic Amplifier for Your Control Needs

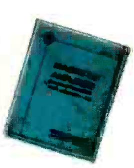
HIGH POWER For 60 cps power sources—27 styles—maximum output powers from 62 watts to 4200 watts.

HIGH PERFORMANCE For 60 cps power sources—28 styles—maximum output powers from milli-watts to 108 watts. For 400 cps power sources—20 styles—maximum output powers from 30 watts to 385 watts.

HIGH GAIN For 60 cps power sources—22 styles—maximum output powers from ½ watt to 1200 watts.

WRITE FOR BULLETIN 20-A

For information on the complete line of Vickers Standard Magnetic Amplifiers. Please make request on your letterhead.



VICKERS ELECTRIC DIVISION

VICKERS Inc.

1801 LOCUST STREET • ST. LOUIS 3, MISSOURI

VHF
UHF

IMPEDANCE MEASUREMENTS

FTL-42A IMPEDOMETER

SPEED AND CONVENIENCE

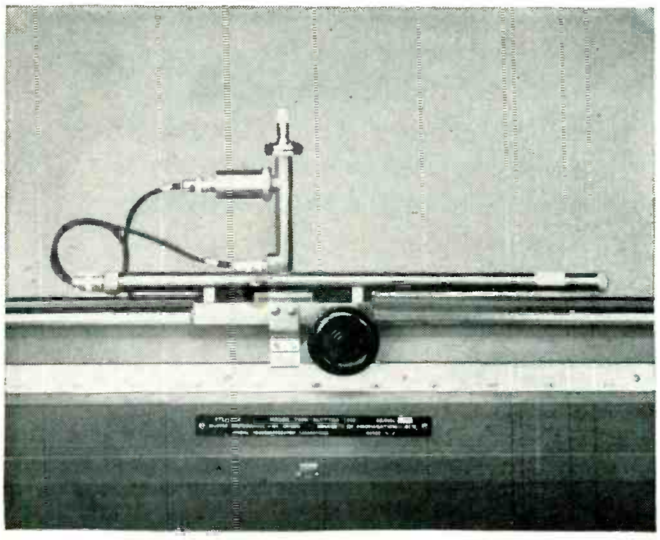
Rapid, accurate measurement of impedance, reflection coefficient and standing wave ratio. Small size, convenient for field use.

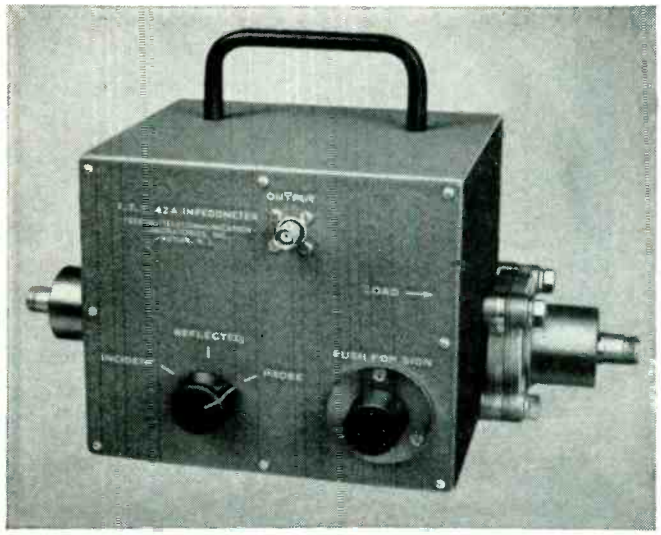
50 to 500 Mc.

Can be inserted in various sizes of solid coaxial line or flexible cables.

Make three readings, plot diagram and read off impedance to ± 5%.

$400.00.





FTL-30A SLOTTED LINE

PRECISION

Precise impedance measurements in the range of 60 to 1000 megacycles per second. Accuracy ± 2%.

1000 to 2000 Mc range covered with slightly reduced accuracy.

Coaxial line 250 centimeters long having a surge impedance of 51.0 ohms ± 0.5 ohms.

$2,495.00.

Write for FTL-30A and FTL-42A brochures.

Federal Telecommunication Laboratories, Inc.

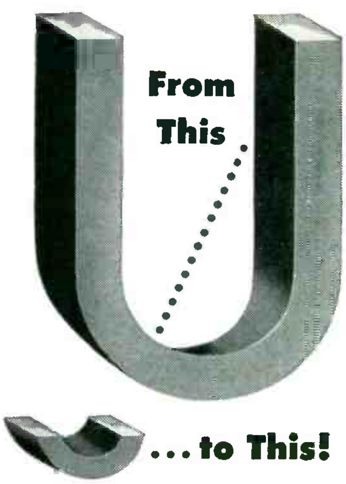
500 Washington Avenue
Nutley 10, New Jersey

INTERNATIONAL TELEPHONE AND TELEGRAPH

FTL

Let INDIANA Magnet Engineers Help Make Your Change-Over Easier

Permanent magnets are indispensable in many types of equipment used by the armed forces. Thus, an early discussion of your plans with INDIANA engineers is advisable. Recent improvements give "packaged energy" even greater utility.



THESE TWO MAGNETS PRODUCE THE SAME AMOUNT OF ENERGY. Above is a chrome magnet, the best of fifteen years ago; below, as made of INDIANA'S exclusive HY-FLUX Alnico V—strongest of today's magnet materials—introduced in 1950.

Quick conversion to Defense Production requires *seeing* problems and solving them without false starts or delay. So, if your "tomorrow's products" involve permanent magnets (or, if permanent magnets would simplify their manufacture or use) confer *now* with the industry's *leading* magnet designers and application specialists . . . The Indiana Steel Products Company's experienced staff of engineers.

INDIANA'S engineers established an enviable record in World War II for their work on permanent magnets used in radar, sonar, ranging equipment, aircraft magnetos, proximity fuses, guided missiles, etc. For example, they aided in the development of the *first* "packaged" magnetron tube, and—working with the Signal Corps—made portable telephones practical by reducing both the size and weight of the ringing generator required.

BENEFITS LIKE THESE CAN BE YOURS

INDIANA Permanent Magnets are components of many mechanical and electrical devices because they are so compact, easy to install, and deliver *uniform energy* without heat or operating parts. And improvements in materials and design have resulted in a wide range of wholly new uses.

INCREASED CAPACITY

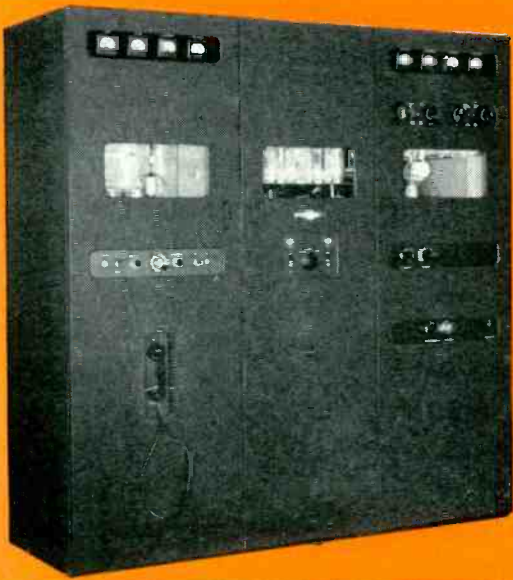
As the world's largest producer of permanent magnets, with the accumulated know-how of more than 30,000 different applications . . . with facilities and personnel that won the Army-Navy "E", *now expanded by 50%* . . . The Indiana Steel Products Company offers you many unequalled facilities. Many types and sizes of magnets are immediately available for experimentation. Write or phone INDIANA today.

INDIANA PERMANENT MAGNETS

THE INDIANA STEEL PRODUCTS COMPANY

VALPARAISO, INDIANA • • • Sales Offices Coast to Coast

SPECIALISTS IN "PACKAGED ENERGY" SINCE 1908



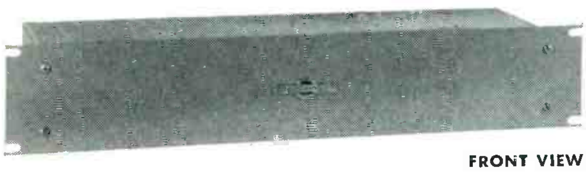
Collins 231D high frequency Autotune* transmitter. The power output is 2.5 to 5 kilowatts, depending on frequency and type of emission.

Collins 16F high frequency Autotune* transmitter. The power output is 300 watts voice or MCW, 500 watts CW.

Collins 716A frequency shift receiving terminal for reception and conversion of single channel or multiplex printer transmissions. Top to bottom: two 51N-4 frequency shift receivers, 706A-2 frequency shift converter, and 707A-1 power supply.

RADIO - CANNY ARINC EMPLOYS COLLINS EQUIPMENT ON THE GROUND

REAR VIEW



FRONT VIEW

Collins 709D frequency shift keyer. A very simple, dependable unit for adapting existing transmitters to frequency shift operation.

Collins 51N-2 high frequency radiophone receiver.

"Canny" means *careful in determining or acting; prudent; knowing; thrifty.* Aeronautical Radio Incorporated is all of that, particularly when it comes to radio communications for the airlines.

So it is significant that ARINC chose Collins equipment of the types shown on this page for both its Pacific and Caribbean networks.

The Pacific net includes ground based facilities at Los Angeles, San Francisco, Seattle, Anchorage, Shyma (Aleutians), Honolulu, Okinawa and Tokyo. This net serves Pan American, Northwest, United, British Overseas, Trans Pacific, Philippine, Chinese National and Air France.

The Caribbean net is based at Houston, New Orleans, Miami, Mexico City, Havana and San Juan. Its facilities are used by Pan American, AAL de Mexico, Eastern, Braniff, Chicago and Southern, LAV, British Overseas, KLM, Avianca and Panagra.

In both areas ARINC conducts large operations connected with the airlines weather, en-route communications and operational dispatches. Collins equipment is used for point-to-point phone, CW and typewriter transmission and reception, and ground-to-air voice communications.

Write us about your requirements in ground based radio communications equipment.

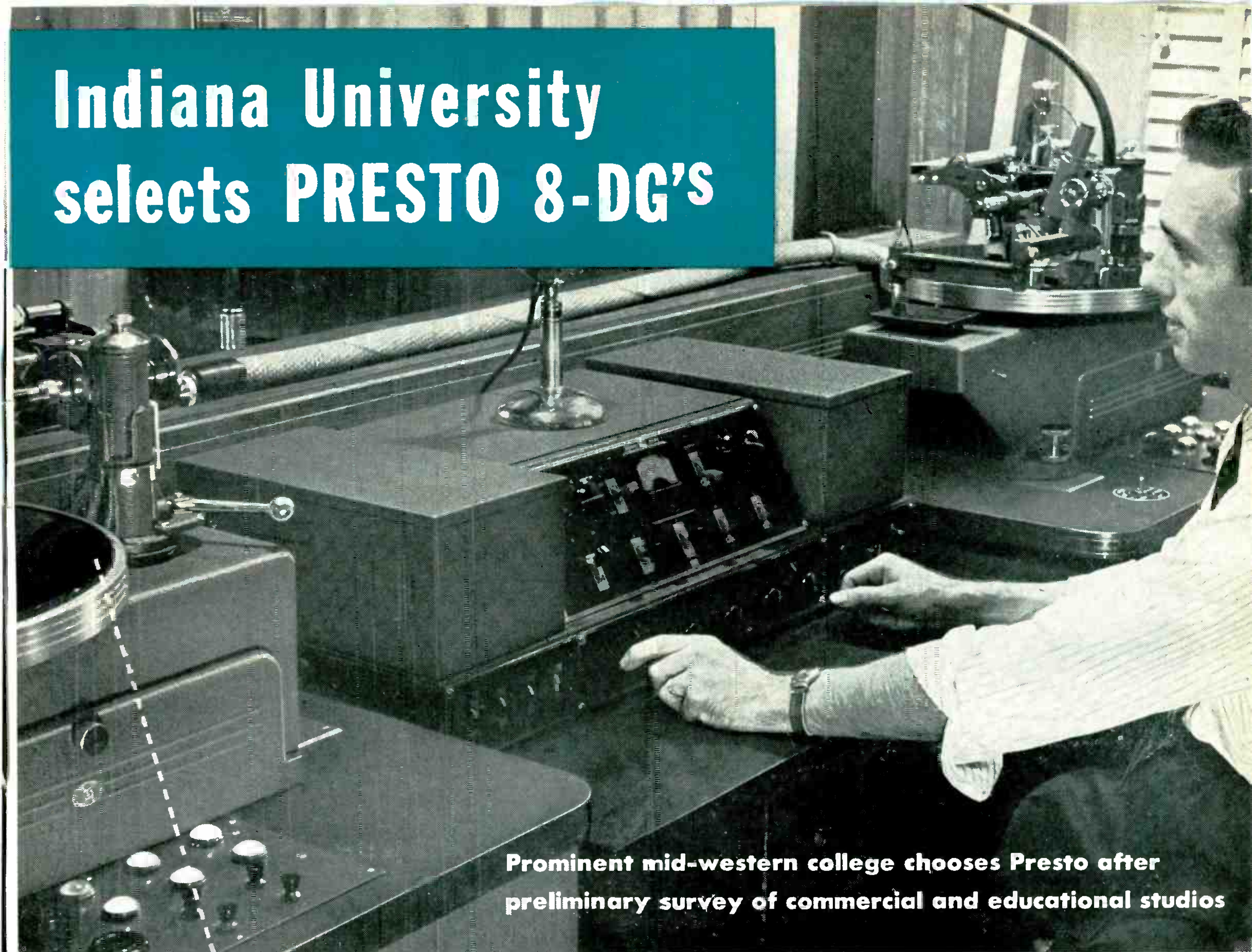
*Reg. U. S. Pat. Off.

IN RADIO COMMUNICATIONS, IT'S . . . COLLINS

COLLINS RADIO COMPANY, Cedar Rapids, Iowa

11 West 42nd Street, NEW YORK 18 — 2700 West Olive Avenue, BURBANK

Indiana University selects PRESTO 8-DG'S



wherever you go . . . there's PRESTO!

The recording room at Indiana U., showing PRESTO disc recorders and reproducers, PRESTO rack mounted amplifiers and the famous PRESTO PT-900 portable tape recorder.

INDIANA UNIVERSITY AT BLOOMINGTON now has a professional-quality recording laboratory in continuous operation.

Made possible by pooling the resources and knowledge of the Department of Radio, School of Music and Audio-Visual Center, this new lab is the result of painstaking care in every detail of planning, purchasing and construction.

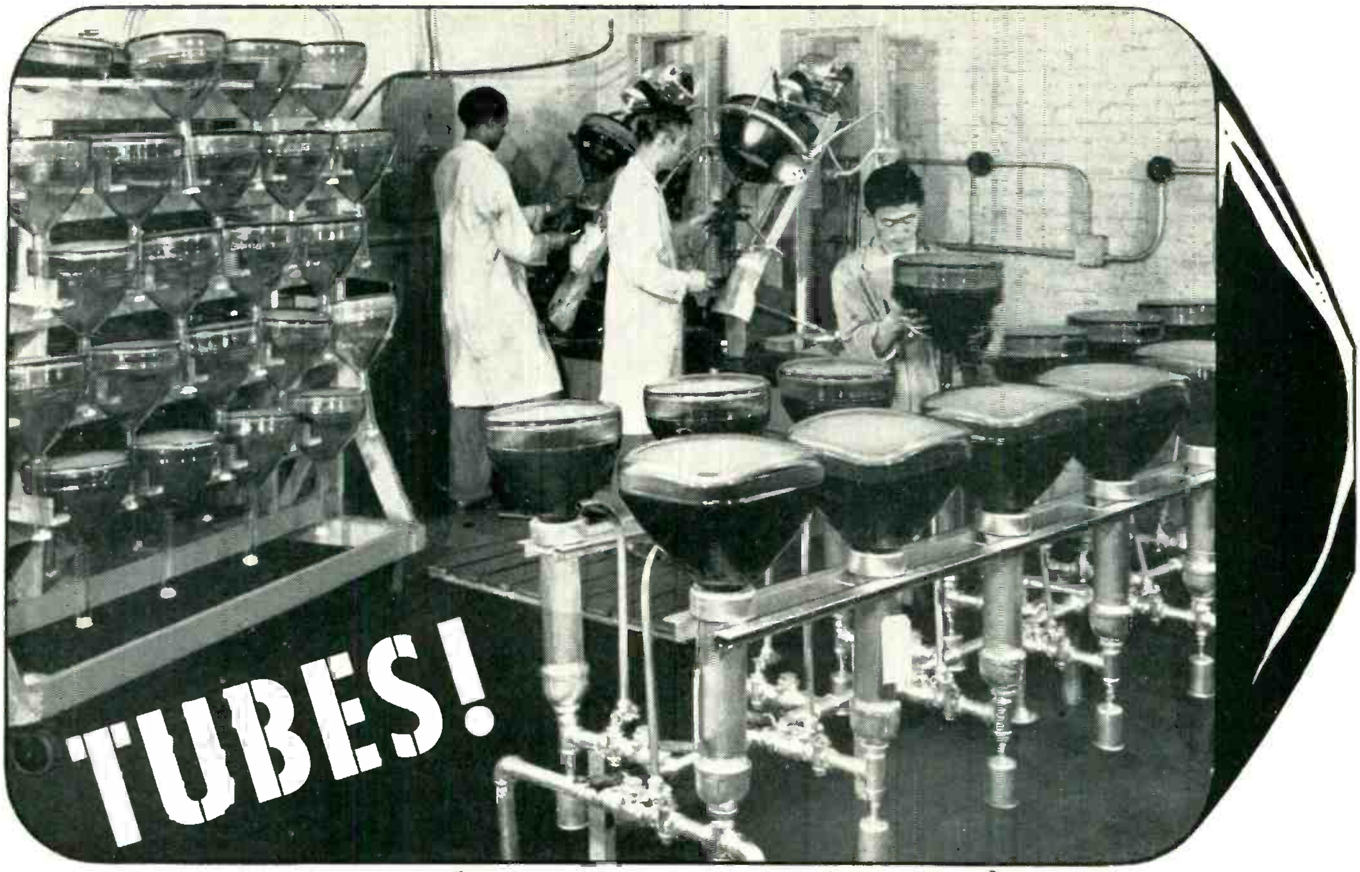
PRESTO was selected as the equipment best suited to the quality and budget requirements. The basic machines are Model 8-DG disc recorders, installed with a specially designed relay control system and operational status lights on each unit. These are supplemented by an 8-D disc recorder, a PT-900 portable tape recorder for studio and on-location use, and a rack containing two 41-A limiting amplifiers and two 92-A recording amplifiers.

The selection of PRESTO equipment was preceded by a study of the facilities of established commercial recording studios, contacting other Universities with simila programs and visiting the Library of Congress recording laboratory. The continu use of the equipment these past months verifies this selection.

PRESTO RECORDING CORPORATION

Paramus, New Jersey. Mailing Address: Box 500, Hackensack, New Jersey

In Canada: Walter P. Downs, Ltd., Dominion Square Bldg., Montreal, Canada • **Overseas:** M. Simons & Son Co., Inc., 25 Warren Street, New York, New Yo



7" through 20"

for immediate delivery

to your humming production lines!

We can fill your tube requirements *now*—round or rectangular, 7-inch through 20-inch size. American Television, a pioneer in TV tube manufacture, supplies leading TV makers throughout the nation. Careful assembly, thorough testing and years of experience assure you of top-notch quality. Join the growing list of users whose orders and re-orders testify to complete satisfaction. Immediate delivery . . . order today!

Send for sizes and prices of tubes in stock

BEHIND THE NAME "AMERICAN"

American Television products are backed by two outstanding pioneers in the television field—U. A. Sanabria, President and Founder of American Television, who is the inventor of the standard interlacing system used by all TV stations and receivers today; and Dr. Lee DeForest, the Director of Research, who has long been associated with the development of radio, long distance telephone, sound movies and television.

ATTENTION JOBBERS!

Cash in on the tube replacement business of dealers and TV service organizations.

write today to: **tube division**

AMERICAN TELEVISION, *inc.*

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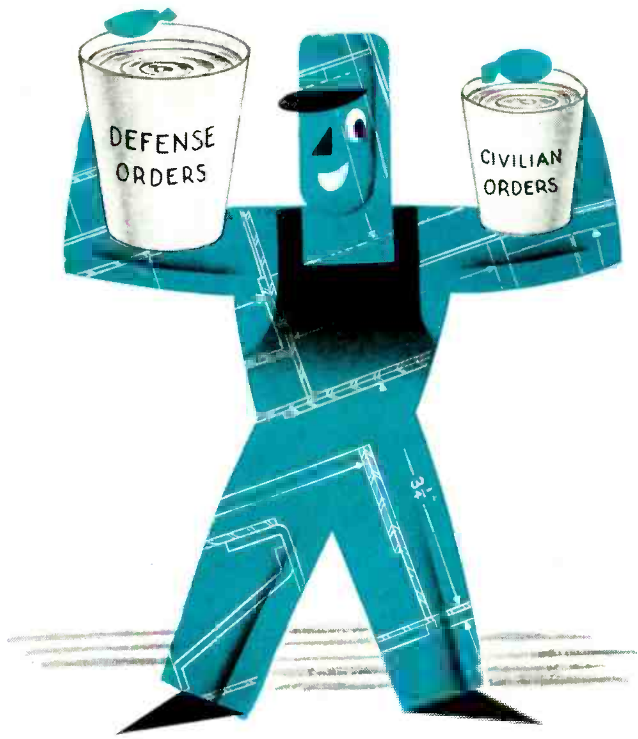


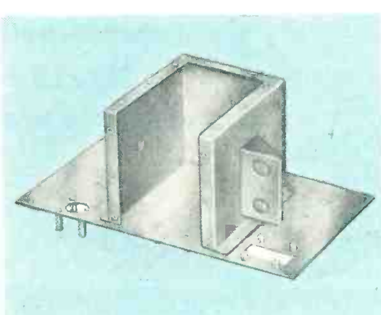
WE'RE PRETTY GOOD AT THIS!

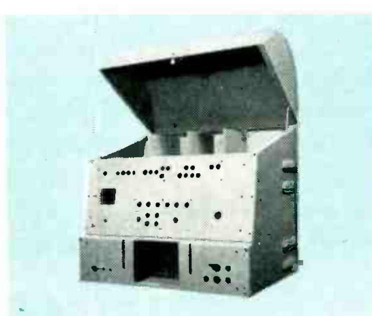
Carrying water on both shoulders is proverbially difficult, but not impossible.

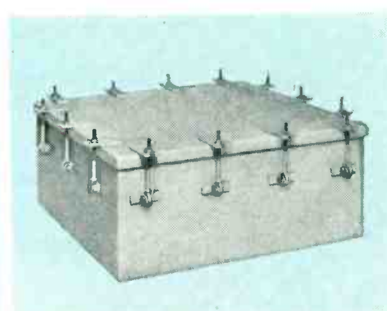
While handling an increasing volume of defense equipment orders, we are still serving our customers who manufacture civilian products, provided such work does not interfere with defense production.

Fortunately most of our customers make products which at this time have definite military uses. These manufacturers are getting more service from us rather than less. Fortunately, also, we can handle defense orders without the delay of plant conversion. Ours is a custom service easily applied to military equipment needs. Our craftsmen and facilities are certified by the Armed Forces.

Tell us your needs in quality sheet metal fabrication.







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ACCURACY

1/2% RESISTORS

COMPENSATED OHMMETER CIRCUIT

LONG HAND-DRAWN MIRRORED SCALES

Designed for the engineer and technician who wants laboratory accuracy. Achieved in Model 630-A by more accurate components and hand-drawn scales that compensate for the average individual characteristic of each instrument. Also includes knife-edge pointer and mirror scale to eliminate parallax.

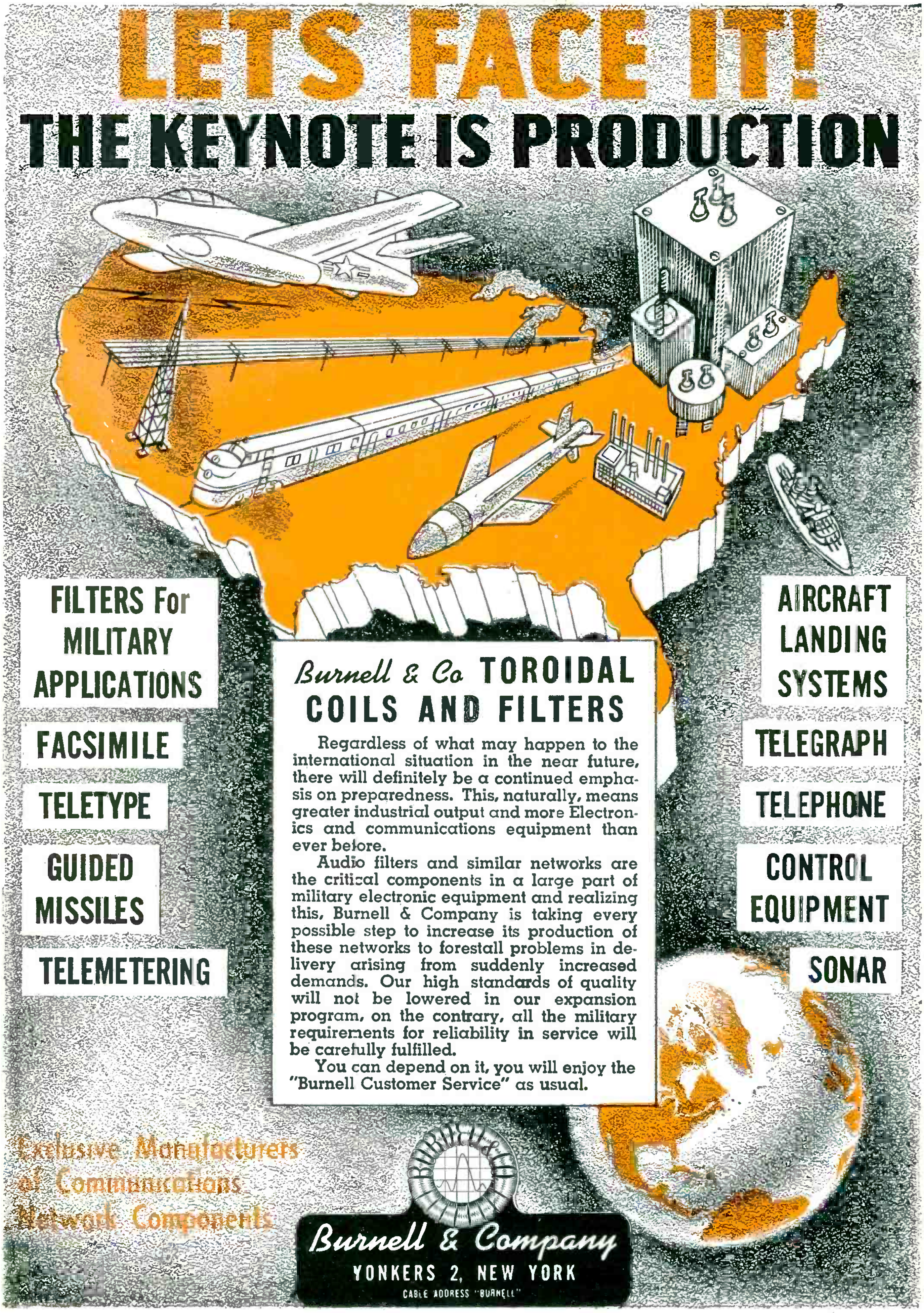
Model 630-A

ONLY $4 .50 AT YOUR DISTRIBUTOR

FOR THE MAN WHO TAKES PRIDE IN HIS WORK

Triplett

TRIPLETT ELECTRICAL INSTRUMENT COMPANY • BLUFFTON, OHIO, U.S.A.



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THE KEYNOTE IS PRODUCTION
FILTERS For MILITARY APPLICATIONS
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TELEGRAPH
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Burnell & Co TOROIDAL COILS AND FILTERS
Regardless of what may happen to the international situation in the near future, there will definitely be a continued emphasis on preparedness. This, naturally, means greater industrial output and more Electronics and communications equipment than ever before.
Audio filters and similar networks are the critical components in a large part of military electronic equipment and realizing this, Burnell & Company is taking every possible step to increase its production of these networks to forestall problems in delivery arising from suddenly increased demands. Our high standards of quality will not be lowered in our expansion program, on the contrary, all the military requirements for reliability in service will be carefully fulfilled.
You can depend on it, you will enjoy the "Burnell Customer Service" as usual.
Exclusive Manufacturers of Communications Network Components
Burnell & Company
YONKERS 2, NEW YORK
CABLE ADDRESS "BURNELL"

ELECTRONICS

Designers

MAKE 16 GROUND CONNECTIONS IN 1 MINUTE!

Low-resistance joints that hold at over 125°C easily made with

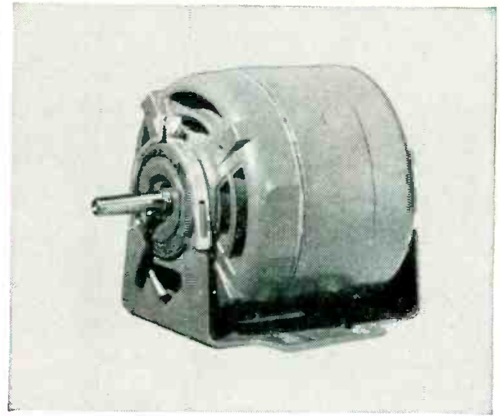
G-E PRECISION CONTROL FOR RESISTANCE WELDERS

Operators are making sixteen ground connections a minute to a television-receiver chassis with G. E.'s precision-control resistance welding method.

The compact electronic spot-welding control shown here has been specifically designed for use in conjunction with small bench welders or tongs and thus is ideally suited for many of the otherwise expensive assembly operations encountered in the manufacture of electronic equipment.

The panel provides for welding-current to control the amount of heat produced in the welds. Once set, successive welding currents remain constant to assure accurate and consistent welding of connections.

Complete data in Bulletin GEA-4175.



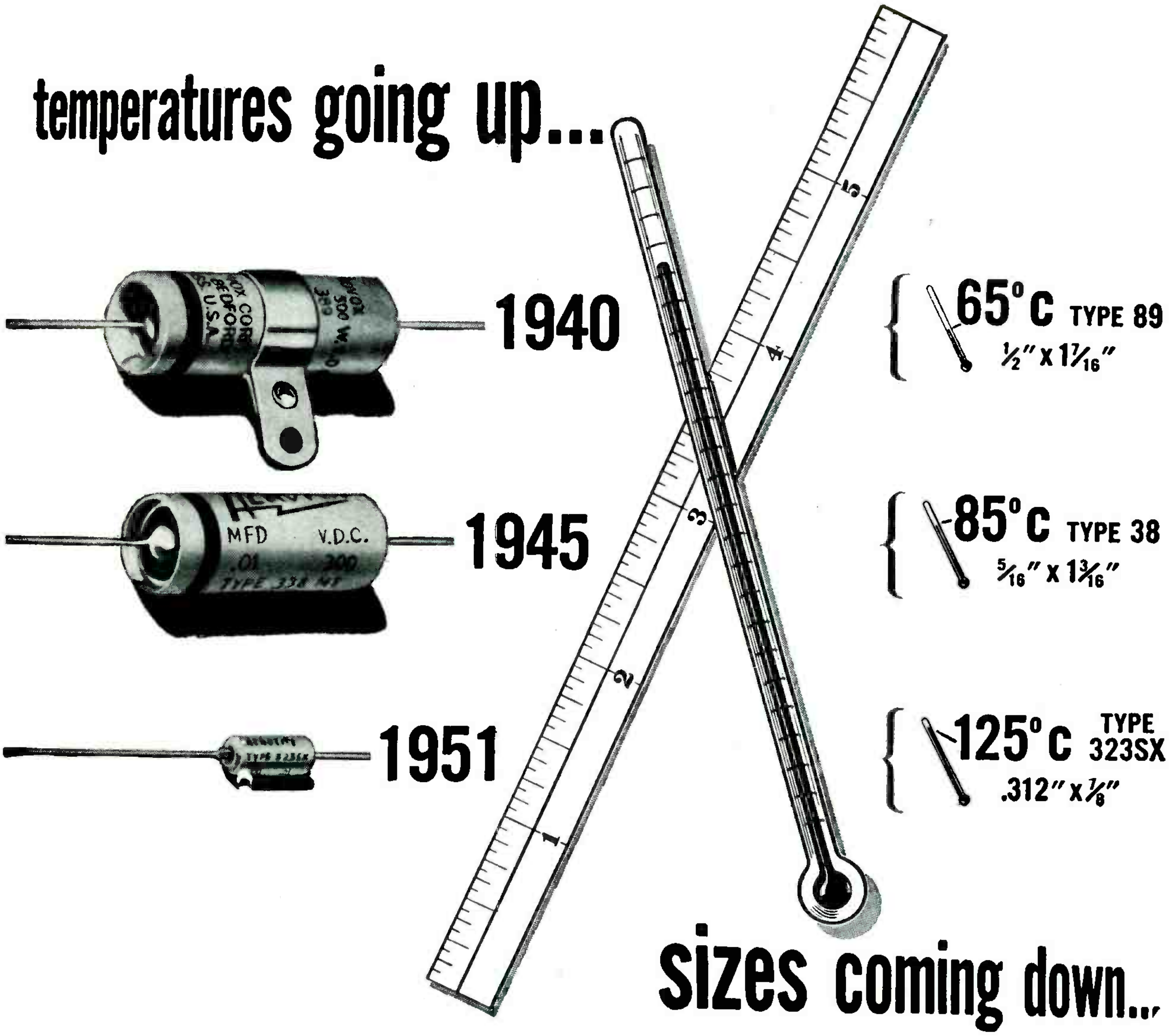
NEW! Unit-Bearing Motor for fans and blowers

- all angle operation
- improved appearance
- provision for 4-way mounting
- quiet operation
- requires no additional lubrication
- adjustable-speed operation available

Available in ratings from 25 millihorsepower to 1/12 horsepower to match many fan or blower sizes, this new G-E unit-bearing motor uses a new lubrication system and bearing design that permit reliable operation in any position. For extremely quiet operation, resilient cradle-base or end-ring mounting may be supplied. Suitable control is available for two-speed or adjustable-speed operation. More data in Bulletins GEA-5338 and GEC-219A.

GENERAL ELECTRIC

667-11



Aerovox Capacitors

● In tune with the trends of the times! That, quite aptly, describes Aerovox progress in meeting today's miniaturization and temperature requirements. Tremendous reductions in capacitor sizes and startling increases in operating temperatures (illustrated above) have resulted from such specialized engineering "know-how." And in many instances Aerovox has found it necessary to develop materials and techniques all its own.

This continuous program of "search and research" is one of the outstanding reasons why Aerovox has the ready answer to your most critical capacitor needs.

Let Aerovox collaborate on your miniaturization and temperature-rating problems. Descriptive literature may be had by writing on your company letterhead.

AEROVOX CORPORATION

THE HOME OF CAPACITOR CRAFTSMANSHIP

AEROVOX CORPORATION, NEW BEDFORD, MASS., U.S.A.

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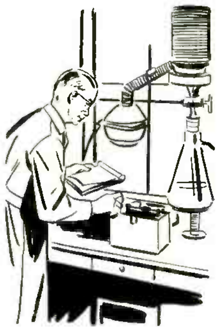
SALES OFFICES IN ALL PRINCIPAL CITIES

ONLY ONE COMPANY CAN PROVIDE

THIS *Unique 4-Point Plastics Service*

1 DEVELOPMENT OF SPECIAL PLASTICS MATERIALS

The Richardson Company maintains complete laboratory facilities for the development of new plastics materials—including various combinations of resin, rubber, and other materials—for special applications.

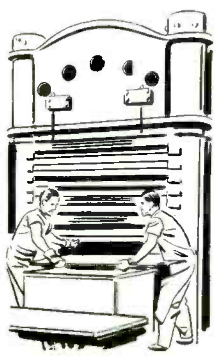


2 ENGINEERING DESIGN OF SPECIAL PLASTICS PARTS

Richardson will handle your plastics problem from beginning to end: analyze your requirements; help design for performance, appearance, and low cost; and develop the material and process best suited to your needs.

3 COMPLETE MOLDING FACILITIES

With its six plants, Richardson is one of the world's largest molders of plastics. Its processes include compression and transfer molding of thermosetting materials and injection molding of thermoplastic materials.



4 COMPLETE LAMINATING FACILITIES

INSUROK laminated plastics are made in all standard grades, plus many exclusive special grades, in sheets, rods, and tubes. Richardson also produces PLASTOK decorative laminate in many patterns, colors, and sizes.

FOR YOUR SPECIAL PLASTICS JOBS *Consult*

For a better plastics part at a lower cost, it pays to consult The Richardson Company. For Richardson is the only large manufacturer in the industry that develops new plastics materials and produces laminated and molded plastics, molded laminates and post-formed laminates. Because of this versatility, Richardson is in a position to help engineer your product for the most efficient and economical method of production.

The RICHARDSON COMPANY

FOUNDED 1858—LOCKLAND, OHIO

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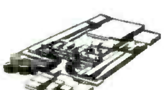
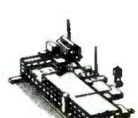


MELROSE PARK, ILL.

INDIANAPOLIS, IND.



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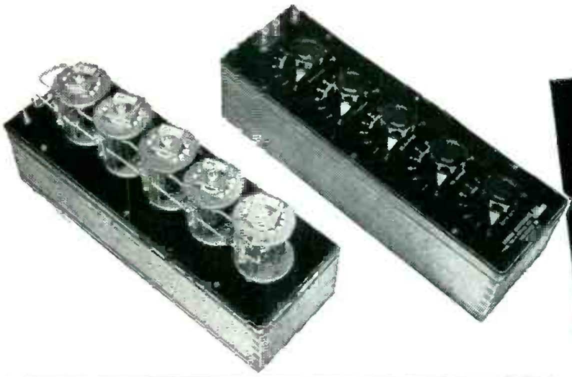
Prime Supplier of Electronic Instruments of Unparalleled Quality, Accuracy and Dependability

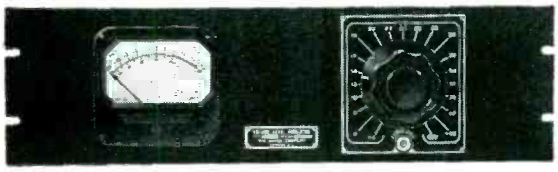
In the manufacturing of sensitive, accurate instruments, the reputation of the Daven organization is world wide. For substantially more than a generation, specialization in electronics, coupled with unexcelled development and engineering personnel, has thrust the Daven Company far in the forefront of producers of instruments of notable quality.

Shown on this page is only a small part of the Daven line. When writing for more complete information on the units illustrated, please identify by name and model number.



DECADE RESISTANCE BOX TYPE 750

HIGH FREQUENCY ATTENUATION BOX TYPE 795



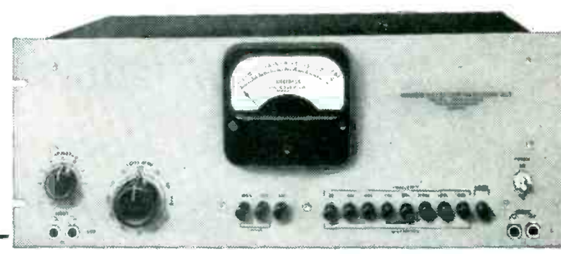
VOLUME LEVEL INDICATOR SERIES 910-911

RF ATTENUATION BOX TYPE 650

FREQUENCY METER TYPE 838A

GAIN SET TYPE 11A

OUTPUT POWER METER TYPE OP-962



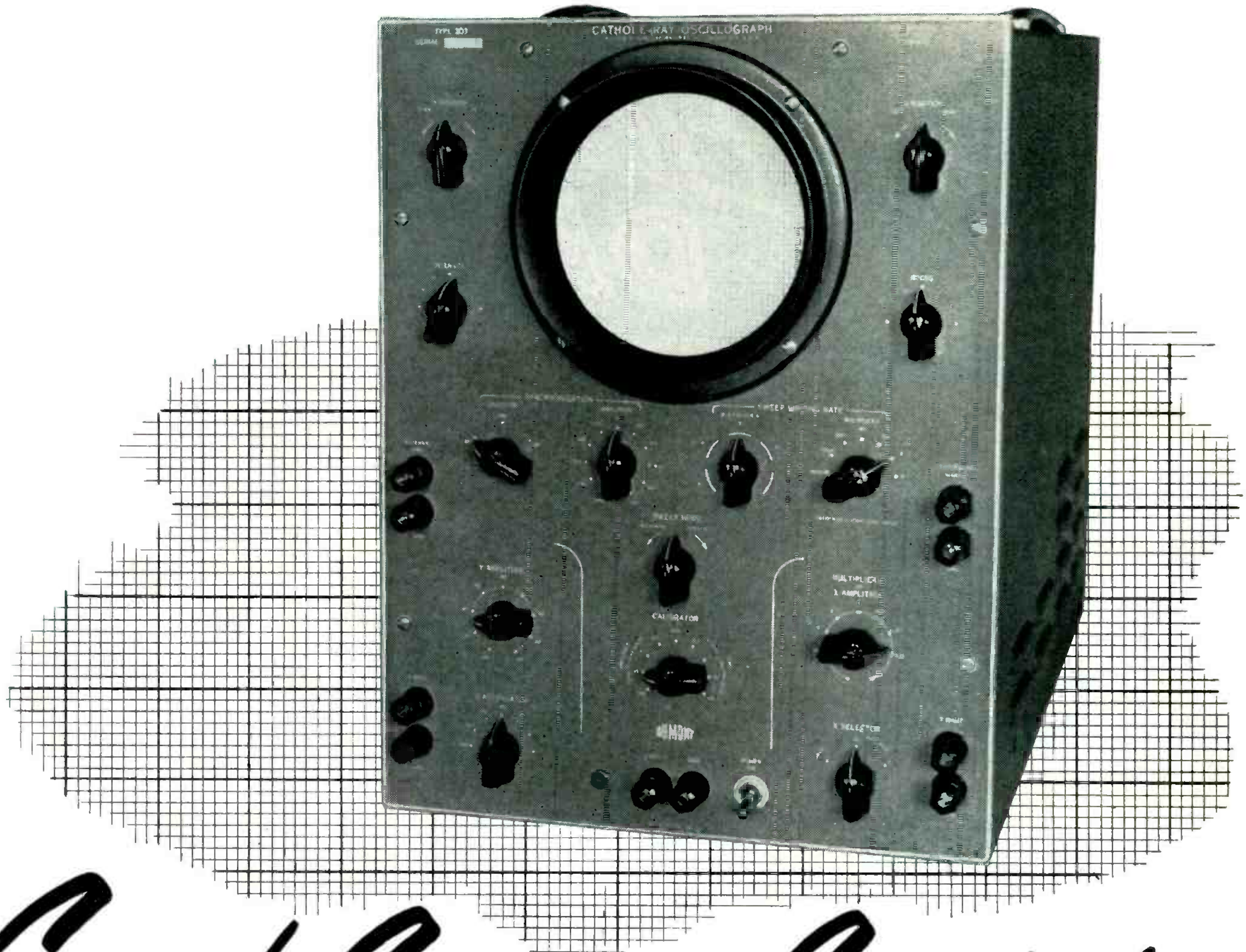
DISTORTION & NOISE METER TYPE 35-A

ATTENUATION BOX SERIES 690

Precision equipment demands the finest components. Always specify Daven Attenuators.

THE DAVEN CO.

191 CENTRAL AVENUE • NEWARK 4, NEW JERSEY



Exceeds Everyone's Expectations

by outperforming its own specifications...

Read the specifications of the Type 303 and you'll call it a 10-megacycle, quantitative instrument: operate the Type 303 and you'll realize you've sold it short. You'll find performance beyond the exacting limits of its specifications!

An exceptionally fine, medium-priced cathode-ray oscillograph, the Type 303 employs the new Type 5YP- Cathode-ray Tube. High sensitivity and an unusually wide range of sweep speeds make the Type 303 especially well suited for the study of high-frequency phenomena.

Using the equivalent of five inches of undistorted deflection on the Y axis, and six times full-screen expansion on the X axis, qualitative analyses can be highly detailed with the Type 303. Time and amplitude calibration add quantitative precision to this analysis, making the performance of the Type 303 unrivaled in the medium-price field.

Specifications

CATHODE-RAY TUBE — Type 5YP-

Y AXIS:

- Sensitivity — 0.1 peak-to-peak volt per inch (down 30% at 10 cycles per second and 10 mc.) down 50% at 15 mc.
- Pulse Rise Time — 0.03 microsecond.
- Available Undistorted Deflection — 5" for symetrical signals and 2½" for unidirectional signals.
- Signal Delay — Sufficient to allow for sweep-starting time.

X AXIS:

- Sensitivity — 0.35 peak-to-peak volt/in. (flat to d-c down 30% at 500 kc).
- Available Undistorted Deflection — 5"

SWEEP SPEEDS — up to 6"/μsec. obtained by expansion.

SWEEP DURATION — Continuously variable from 0.1 sec. to 2 μsecs. Driven or Recurrent operation.

VOLTAGE CALIBRATION — Square wave with peak-to-peak amplitudes of 0.1, 1, 10, and 100 volts. Accuracy ± 5%.

TIME CALIBRATION — Pulsed oscillations corresponding to time intervals of 100, 10, 1, or 0.1 μsec. Accuracy better than ± 3%.

INTENSITY MODULATION — 15 volts peak will blank the beam.

DuMont for Oscillography

INSTRUMENT DIVISION • ALLEN B. DU MONT LABORATORIES, INC., 1000 MAIN AVENUE, CLIFTON, N. J.

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...OR SMALL

WHEN YOU NEED

BRASS OR COPPER

FOR DEFENSE ORDERS

CALL **Chase!**

DON'T let a defense order lag for want of brass or copper. Call your nearest Chase warehouse and inquire about our deliveries.

There are 23 Chase warehouses in large industrial cities from coast to coast, and Chase mills in the east and midwest. Get in the habit of calling on these great Chase facilities for service on your brass and copper requirements for "DO" orders.

Mill shipments are favorable. Warehouse deliveries are usually prompt. In fact, we can oftentimes fill a "DO" order right from warehouse stock.

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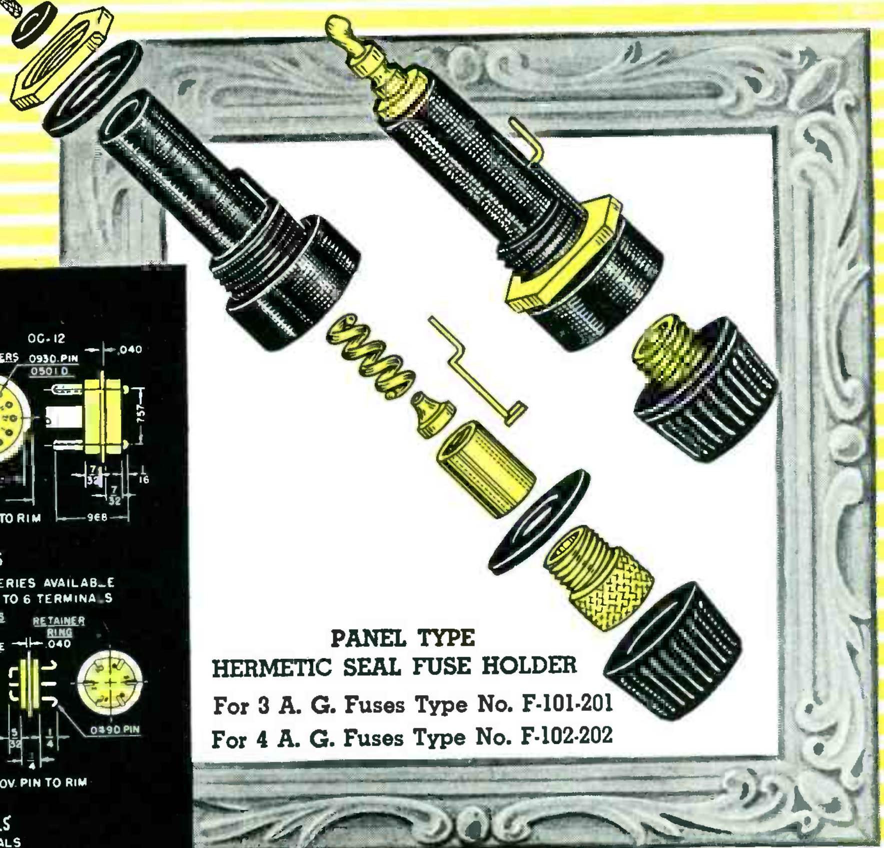
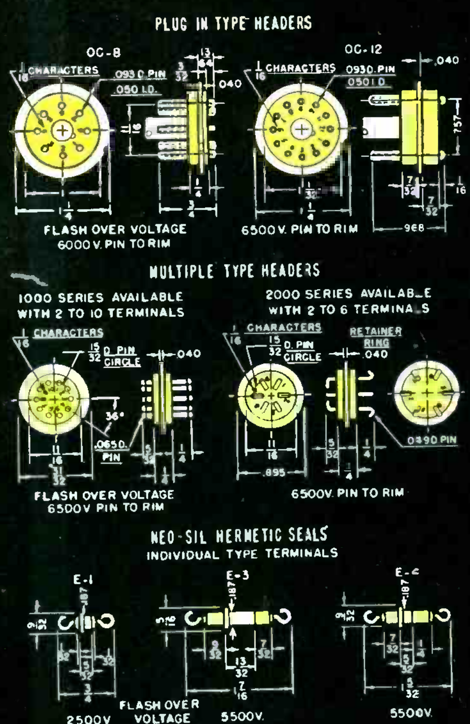
Master Pieces of Hermetic Sealing — Proven to Reduce Rejects!



PANEL TYPE HERMETIC SEAL FUSE HOLDER

For 3 A. G. Fuses Type No. F-101-201

For 4 A. G. Fuses Type No. F-102-202



TEST DATA

The result of the Electrical Testing Laboratories Inc., Report #330655, dated March 18, 1949, on this material shows the following:

Volume Resistivity at 800 Volts d-c

Room Temperature 25°C	R.H. 30 percent
Megohm-inches	*ohm-centimeters*
1.4×10^6	3.5×10^{12}

Dielectric Constant and Dissipation Factor

Dielectric Constant	*Dissipation Factor*	*Loss Factor*
	@ 60 cycles per second	
9.22	.058	5.32
	@ 1 megacycle per second	
6.17	.0455	.28
	@ 50 megacycles per second	
5.35	0.20	1.1

Dielectric Strength at 60 cycles
Volts per mil — 370

Durometer Average — 80 ± 5

Temperature — Rated as a Class A material conservatively + 105° to —70° centigrade.

The Flashover Voltages indicated were taken at a temperature of 68° Fahrenheit, and 47% Relative Humidity.

NEO-SIL proven dependable Hermetic sealing components will reduce your rejects resulting from breakage, strain, cracks, physical shocks, etc. Each NEO-SIL component is pressure checked at 25 lbs. P.S.I. —to meet military requirements. As a unit, NEO-SIL synthetic compound is suitable insulation when bonded to various metals to resist abusive temperature cycling, salt water, high pressure, high vacuum and most acids and alkalies.

In addition to the Panel Type Hermetic Seal Fuse Holder illustrated, NEO-SIL offers many other specialty components: Molded Cable with plugs attached—4 Pin Female Panel Connector—Meter Hermetic Seal Gasket—5 Pin Female Panel Connector—Rotary Hermetically Sealing Panel Bushing.

Your special problems are solicited.

NEO-SIL CORPORATION

26 CORNELISON AVE., JERSEY CITY 4, N. J.

ANOTHER FIRST!

TYPES 5K and 6K DISCAPS

Designed for Filtering Focus Voltage in the New Electro- static Deflection Tube.

The new electro-static deflection tube has created engineering problems which required the development of this new RMC DISCAP.

Designed to withstand peak pulses, Type 5K is rated at 5000 Volts DC and flash tested at 10,000 Volts DC. Type 6K is rated at 6000 Volts DC and flash tested at 12,000 Volts DC. Available in capacities between 100 MMF and 500 MMF ± 10% or ± 20% or GMV.

Their small size and greater mechanical strength provide a unit adaptable to high speed production line use.

Specifications

***Types 5K and 6K* DISCAPS**

Power Factor 1% at 1KC

WORKING VOLTAGE	TEST VOLTAGE
Type 5K 5000 VDC	10000 VDC
Type 6K 6000 VDC	12000 VDC

Insulation Durez Phenolic — Vacuum waxed
Resistance: Initial 7500 Megohms
After Humidity 1000 Megohms
Leads #22 Tinned Copper
Body Size 100 — 200 MMF ½" DIA.
200 — 300 MMF ⅝" DIA.
300 — 500 MMF ¾" DIA.
Capacity Tolerance ± 10% ± 20%

ATTENTION
DEFLECTION YOKE MANUFACTURERS

RMC Type 2K DISCAPS are designed especially for your requirements. Rated at 2000 working volts, they withstand the peak pulses found in deflection yokes. Their smaller size and lower initial cost offer definite production ease and over-all savings.

Every DISCAP is 100% Tested for Capacity, Leakage Resistance and Breakdown

SEND FOR SAMPLES AND TECHNICAL DATA

DISCAP CERAMIC CONDENSERS

RADIO MATERIALS CORPORATION
GENERAL OFFICE: 1708 Belmont Ave., Chicago 13, Ill.
FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.
Two RMC Plants Devoted Exclusively to Ceramic Condensers

FREED

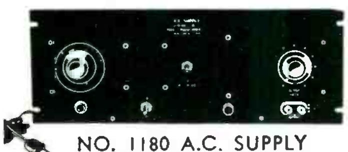
"PRODUCTS OF EXTENSIVE RESEARCH

TRANSFORMERS & INSTRUMENTS

1010 COMPARISON BRIDGE
RAPID TV PARTS TEST

NO. 1030 LOW FREQUENCY
"Q" INDICATOR

NO. 1140 NULL DETECTOR
AMPLIFIER MODEL



NO. 1180 A.C. SUPPLY
.1 VOLT TO 100 VOLTS
AT 60 CYCLES

NC. 1170 D.C. POWER SUPPLY
DIRECT CURRENT UP TO
500 MA

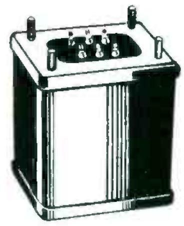
NO. 1110 A INCREMENTAL INDUCTANCE BRIDGE

FOR ACCURATE TESTING OF TELEVISION AND COMMUNICATION COMPONENTS UNDER LOAD CONDITIONS.

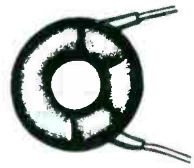
This bridge has an impedance range of one millihenry to 1000 henries in five ranges. The inductance values are read directly from a four dial decade and multiplier switch. Range of this instrument can be extended to 10,000 henries through the use of an external resistance.

The inductance accuracy is within plus or minus 1% through the frequency range from 60 to 1000 cycles. For the largest multiplier at 1000 cycles, the accuracy of the bridge is decreased to 2%. 60 or 50 cycles line frequency is generally used with this bridge.

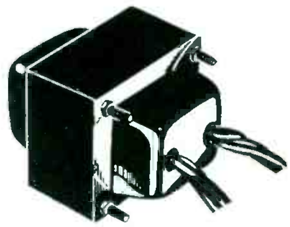
On the 1000 henries range, the D.C. is limited to 20 MA. On the 100 henries range the D.C. is limited to 200 MA. On all lower ranges, the current can be one ampere maximum.



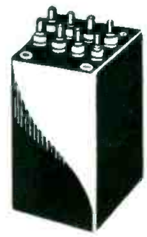
HI FIDELITY
½ DB 20-30000 CYCLES



TOROIDAL INDUCTORS
60 CPS. TO 1 MC.



POWER TRANSFORMERS
COMMERCIAL QUALITY



HERMETICALLY SEALED
TO MEET MIL-T-27 SPECS.

SUB MINIATURE
HERMETICALLY SEALED
TRANSFORMERS

SEND FOR LATEST CATALOG!

FREED TRANSFORMER CO., INC.

DEPT. AE 1718-36 WEIRFIELD ST., (RIDGEWOOD) BROOKLYN 27, NEW YORK

Expanded Facilities Mean –

GREATER AEROCOM PRODUCTION ... SAME HIGH QUALITY!

It seemed that orders for all Aerocom equipment would have to be delayed for about six months – because of a greatly increased volume of orders.

But – Aerocom was able to expand plant facilities and production so that, now, some equipment is available with only small delays.

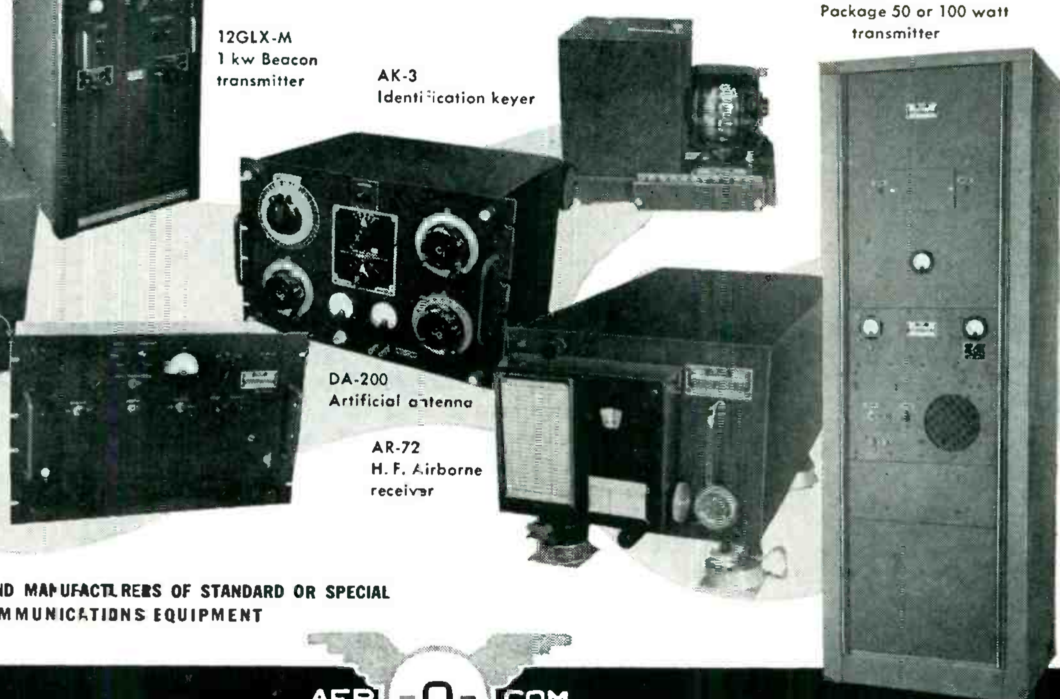
Despite the pressure for new equipment, corners will not be cut . . . Aerocom quality will be maintained.

446
Four-channel,
H. F. transmitter

12GLX-M
1 kw Beacon
transmitter

LMI-72
Line match
indicator

ACA
Autotransfer



AK-3
Identification keyer

BEACON
Package 50 or 100 watt
transmitter

DA-200
Artificial antenna

AR-72
H. F. Airborne
receiver

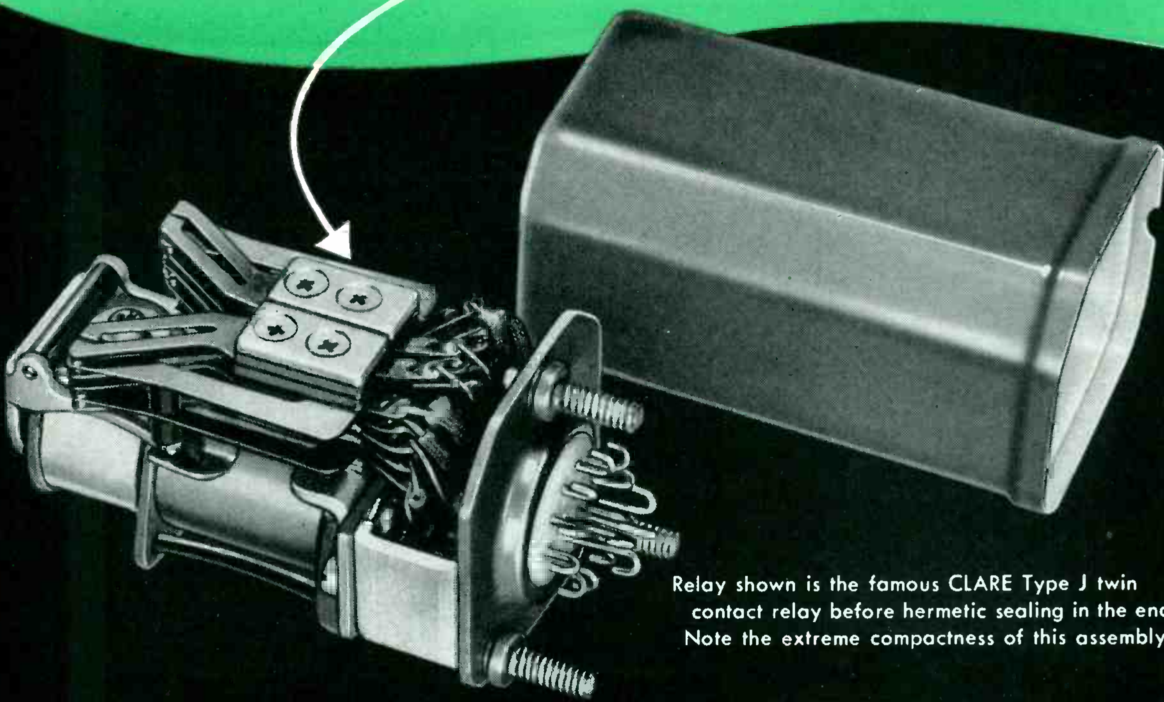
CONSULTANTS, DESIGNERS AND MANUFACTURERS OF STANDARD OR SPECIAL METEOROLOGICAL AND COMMUNICATIONS EQUIPMENT

AER-O-COM
Reg. U. S. Pat. Off.

AERONAUTICAL COMMUNICATIONS EQUIPMENT, INC.
3090 Douglas Road, Miami 33, Florida

...the CLARE way...

Good Hermetic Sealing is important—
Specifying a CLARE RELAY is important, too!



Relay shown is the famous CLARE Type J twin contact relay before hermetic sealing in the enclosure. Note the extreme compactness of this assembly.

HERMETIC sealing, as practiced by C. P. Clare & Co., provides the most perfect seal ever devised to insure ideal relay performance under all conditions.

But equally important to design engineers are the proved performance, long life and dependability of the Clare relays that are contained within the enclosures.

Selection of highest quality materials, precise manufacture and ability to "custom-build" just the relay for a specific requirement have made Clare relays first choice with designers who insist on . . . and get . . . the best.

This ideal combination of time-proved relays, sealed to be immune to every type of climatic and environmental conditions, has made Clare hermetically sealed relays the ideal choice for components of equipment that must not fail.

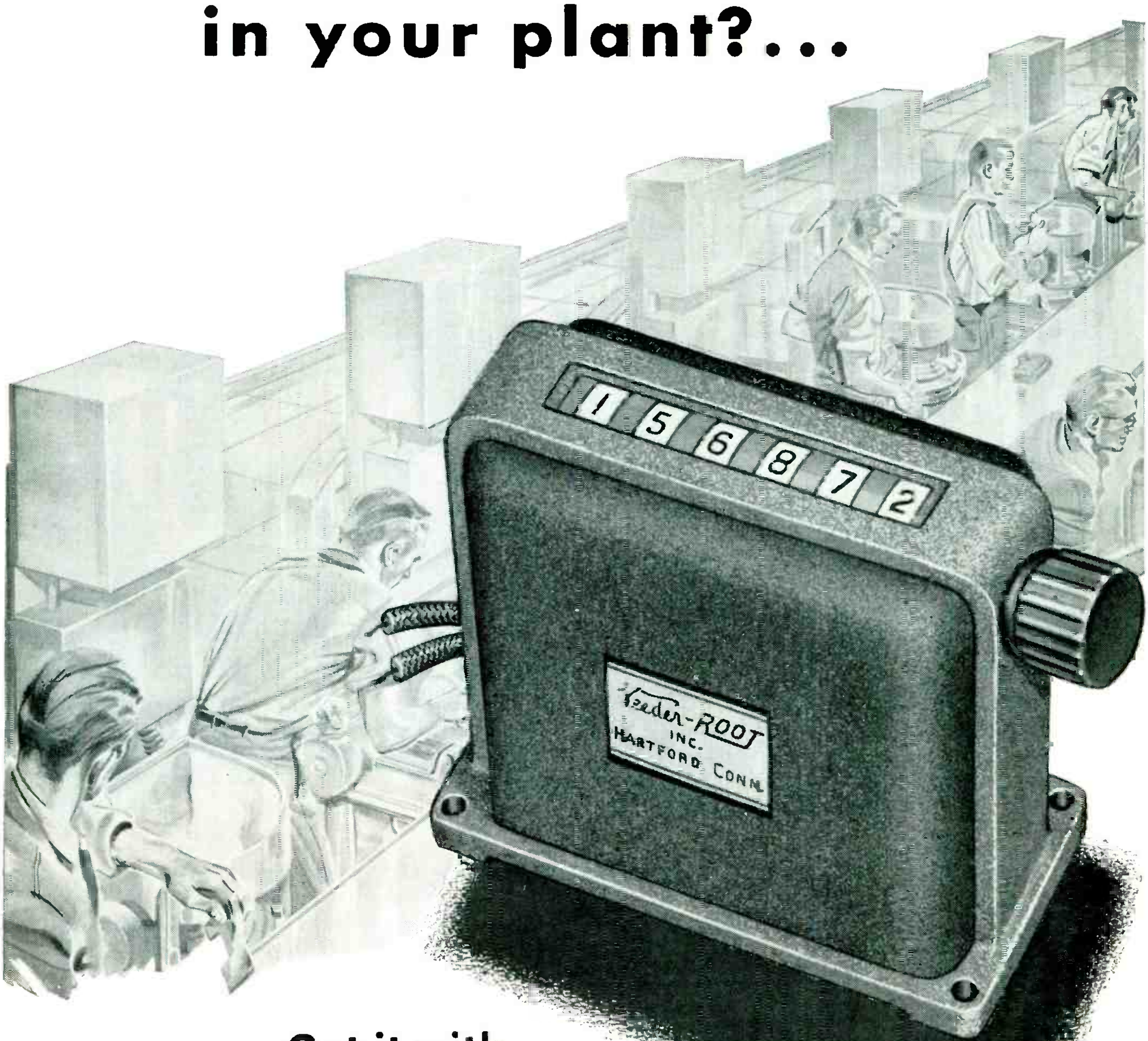
Whatever your relay problem . . . whether it involves hermetically sealed relays or just the best relay for an exacting application . . . contact CLARE first. Sales engineers are located in principal cities to assist you in selecting the relay you need. Look them up in your classified telephone directory or write C. P. Clare & Co., 4719 West Sunnyside Ave., Chicago 30, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable Address: CLARELAY.

Write for 36-Page Clare Bulletin No. 114

CLARE RELAYS

First in the Industrial Field

Need an "Information Center" in your plant?...



...Get it with VEEDER-ROOT COUNTERS

Every production machine *you use* can be made to "report to headquarters" . . . by flashing figures a few feet or many miles to Veeder-Root Magnetic Counters group-mounted on a central board.

And every machine or product *you make* can be made to *count for more*... both for you and your customers... by Veeder-Root Counters built-in as original equipment. Find out how. *Write:*

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News About a CRT Exterior Wall Coating

Electric-furnace graphite of high purity . . . specially processed in a lacquer-base vehicle by Acheson Colloids . . . deserves your investigation as a CRT Exterior Wall Coating.

Easily applied by spraying, "**dag**" Exterior Wall Coating dries so rapidly that tubes can be handled in 2 or 3 minutes after coating. Maximum adhesion is obtained by drying at room temperature for 24 hours...if faster action is desired, infra-red drying at 100° C. will get the same result in ½ hour.

The tough and completely opaque film so formed resists scratching and the loosening action of water, irrespective of the type of glass to which it is applied.

A more complete description of "**dag**" CRT Exterior Wall Coating . . . as well as data on other "**dag**" dispersions for the electronics and electrical industries . . . is contained in a new bulletin available without obligation. Write to Acheson for Bulletin #433-5D.

Acheson Colloids Corporation
Port Huron, Mich.

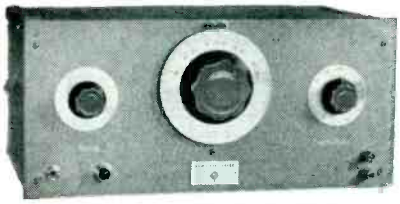
dag DISPERSIONS®

...also Acheson Colloids Limited, London, England

Accurate ac test voltages

½ to 10,000,000 cps

Complete Coverage

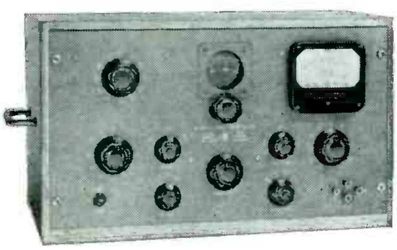


-hp- 200 Series Audio Oscillators

Six standard models, *–hp–* 200A and 200B have transformer-coupled output delivering 1 watt into matched load. *–hp–* 200C and 200D have resistance-coupled output and supply constant voltage over wide frequency range. *–hp–* 202D is similar to 200D, with lower frequency range. *–hp–* 200I is a spread-scale oscillator for interpolation or where frequency must be known accurately.

-hp- 650A Resistance-Tuned Oscillator

Highly stable, wide band (10 cps to 10 mc), operates independently of line or tube changes, requires no zero setting. Output flat within 1 db. Voltage range 0.00003 to 3 volts. Output impedance 600 ohms or 6 ohms with voltage divider.



-hp- 206A Audio Signal Generator

Provides a source of continuously variable audio frequency voltage with less than 0.1% distortion. Very high stability, accuracy 0.2 db at any level. Specially designed for testing high quality audio circuits, checking FM transmitter response and distortion, broadcast studio performance or as a low distortion source for bridge measurements, etc.

INSTRUMENT	PRIMARY USES	FREQUENCY RANGE	OUTPUT	PRICE
-hp- 200A	Audio tests	35 cps to 35 kc	1 watt/22.5v	$120.00
-hp- 200B	Audio tests	20 cps to 20 kc	1 watt/22.5v	$120.00
-hp- 200C	Audio and supersonic tests	20 cps to 200 kc	100 mw/10v	$150.00
-hp- 200D	Audio and supersonic tests	7 cps to 70 kc	100 mw/10v	$175.00
-hp- 200H	Carrier current, telephone tests	60 cps to 600 kc	10 mw/1v	$350.00
-hp- 200I	Interpolation and frequency measurement	6 cps to 6 kc	100 mw/10v	$225.00
-hp- 201B	High quality audio tests	20 cps to 20 kc	3 w/42.5v	$250.00
-hp- 202B	Low frequency measurements	½ cps to 50 kc	100 mw/10v	$350.00
-hp- 202D	Low frequency measurements	2 cps to 70 kc	100 mw/10v	$275.00
-hp- 204A	Portable, battery operated	2 cps to 20 kc	2.5 mw/5v	$175.00
-hp- 205A	High power audio tests	20 cps to 20 kc	5 watts	$390.00
-hp- 205AG	High power tests, gain measurements	20 cps to 20 kc	5 watts	$425.00
-hp- 205AH	High power supersonic tests	1 kc to 100 kc	5 watts	$550.00
-hp- 206A	High quality high accuracy audio tests	20 cps to 20 kc	+ 15 dbm	$550.00
-hp- 650A	Wide range video tests	10 cps to 10 mc	15 mw/3v	$475.00

Data subject to change without notice. Prices f. o. b. factory.

Whatever ac test voltage you need—whatever frequency or magnitude you require—there is an *-hp-* oscillator or generator to provide the exact signal desired.

-hp- oscillators offer complete coverage, ½ cps to 10,000,000 cps. They are dependable, fast in operation, easy to use. They bring you the traditional *-hp-* characteristics of high stability, constant output, wide frequency range, low distortion, no zero set during operation.

-hp- oscillators and audio signal generators are used by manufacturers, broadcasters, sound recorders, research laboratories and scientific facilities throughout the world. For complete details on any *-hp-* instrument, see your *-hp-* sales representative or write direct.

HEWLETT-PACKARD COMPANY

2250A Page Mill Road **Palo Alto, California, U.S.A.**

Sales representatives in principal areas.

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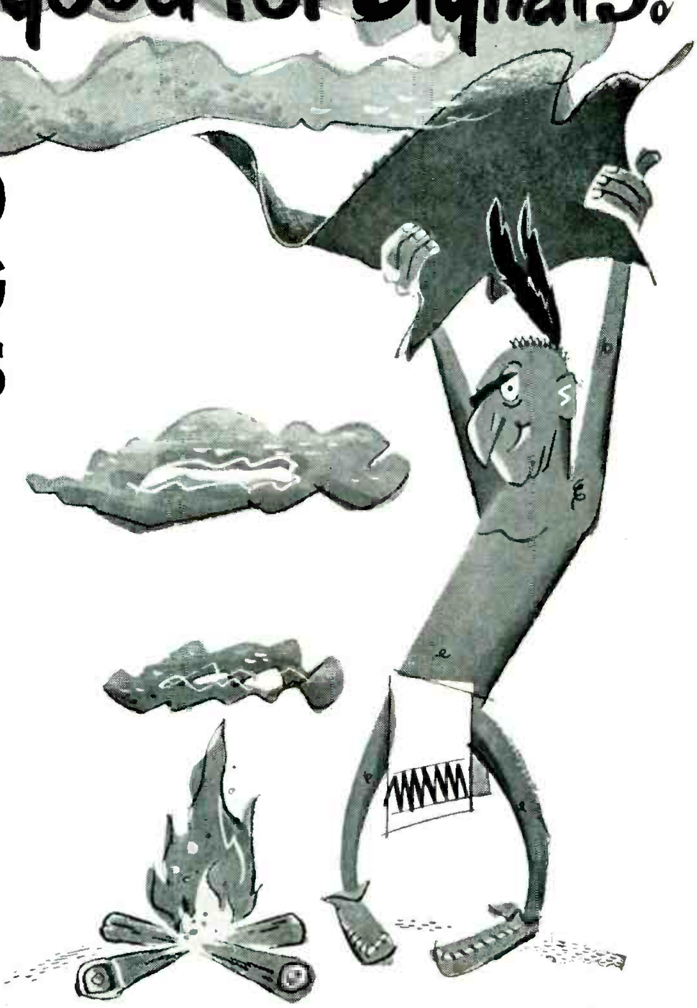
2250

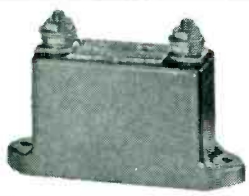
HEWLETT-PACKARD hp INSTRUMENTS

THE LITTLE INDIAN SAYS- **"Heap good for Signals!"**

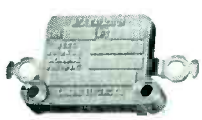


SANGAMO TRANSMITTING MICAS

Type G (*CM 75-80-85-90-95*)



Type F (*CM 65-70*)



Type H (*CM 45-50*)

Type A (*CM 55-60*)

Built to JAN Specifications

Whether you need a certain characteristic or a combination of several performance features, Sangamo Transmitting Mica Capacitors are "heap good" for your specific capacitor applications. You can safely specify them for use in all types of military, radio and electronic equipment—they are built to meet all standards set by joint Army and Navy Specifications JAN-C-5.

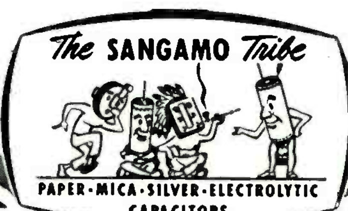
Type G Capacitors are designed for use in medium and high power, high voltage and high current circuits. They are ceramic encased and are frequently connected in gangs to handle heavy loads.

Type F Capacitors are used in similar applications to type G's and are potted in bakelite cases.

Type A and Type H Mica Capacitors are molded in a thermo-setting plastic and are designed for use in low voltage, low power and low current circuits.

Sangamo Transmitting Micas and many other types of Sangamo Mica Capacitors, are fully described in Catalog No. 831. Write for your copy.

Your Assurance of *Dependable Performance*

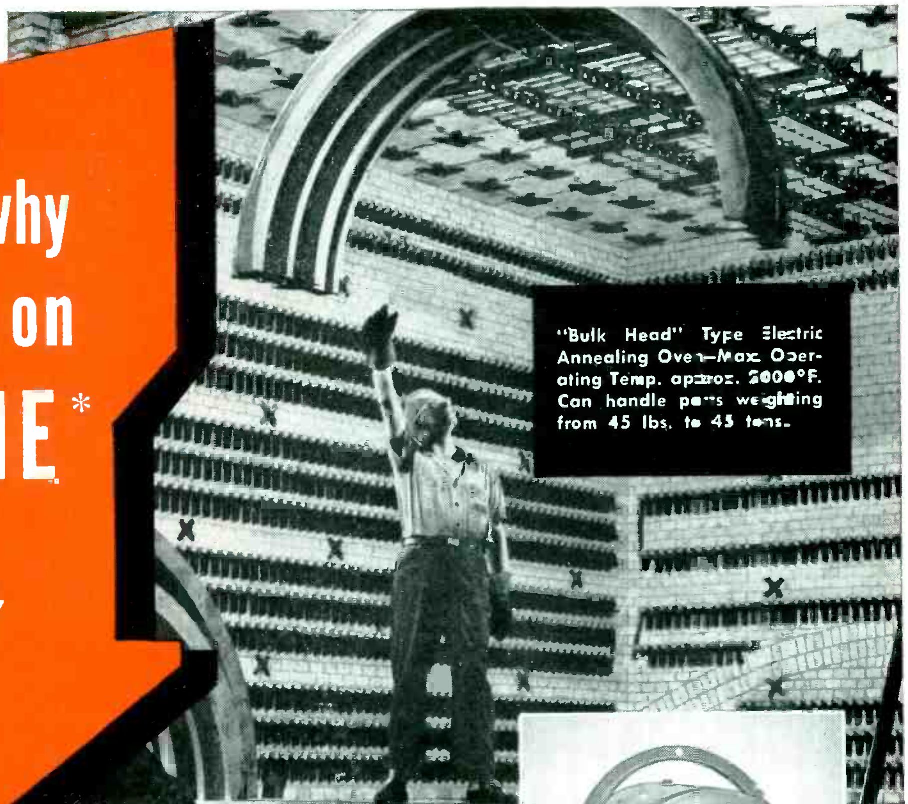


SANGAMO ELECTRIC COMPANY

SPRINGFIELD, ILLINOIS

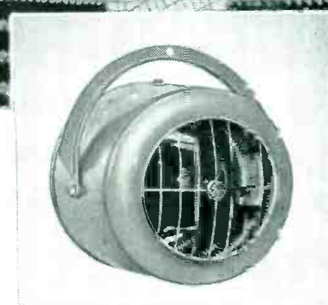
IN CANADA: SANGAMO COMPANY LIMITED, LEASIDE, ONTARIO

5 reasons why you can rely on NICHROME* in your electrically heated products



"Bulk Head" Type Electric Annealing Oven—Max. Operating Temp. approx. 2000°F. Can handle parts weighing from 45 lbs. to 45 tons.

(*Photographs courtesy of General Electric Company*)



Forced-Convection Type Unit Air Heater.

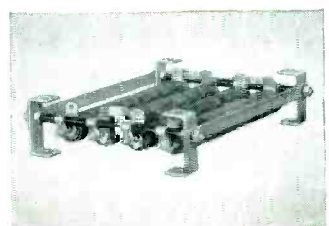
1. Nichrome alloys, meticulously developed over a period of 40 years, meet the need for resistor materials that can perform with exceptional suitability at high temperatures. Their high resistivity and resistance to oxidation at high temperatures dictate their choice for heating elements in a host of different products.

2. Nichrome and Nichrome V are *custom built*—produced to rigid specifications determined by conditions of application and in-use factors. Consequently, *absolute uniformity* is assured from order to order.

3. Nichrome and Nichrome V undergo only negligible changes even when required to meet unusually exacting service demands. Thus delivery of full-rated power is assured thruout a long life of trouble-free operation.

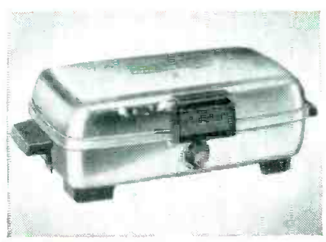
4. Nichrome and Nichrome V afford flexibility of choice, permitting heating elements to be designed economically, with close regard to service requirements. For example: Nichrome is ideal for heating devices, such as cord-connected domestic appliances, operating up to 1700°F.; Nichrome V for electric furnaces, ovens, etc., operating at temperatures in excess of 1700°.

5. Nichrome and Nichrome V are available in different forms—wire, ribbon, strip, sheet and rod. Such variety offers outstanding aid to designer, engineer, and manufacturer.



Edgewise-wound resistor—typical of large industrial applications.

The different examples of products shown here indicate the wide range of application for Nichrome and Nichrome V. For improved performance and longer life in *your* products, remember these peerless Driver-Harris electrical alloys and consult with us. Although the present emergency is making unprecedented demands upon the resources of the Driver-Harris Company, we shall be glad to make recommendations based upon your specific needs, and serve you to the best of our ability.



Waffle Iron and Sandwich Grill—one of many G.E. appliances.

SPECIAL PURPOSE ALLOYS SINCE 1899 — D-H — TRADE MARK REG. U. S. PAT. OFF.

Nichrome and Nichrome V are manufactured only by

Driver-Harris Company

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BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco

Manufactured and sold in Canada by The B. GREENING WIRE COMPANY, LTD., Hamilton, Ontario, Canada

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

The advantages of the octal type key plug-in terminal are now extended to include applications calling for as high as 20 pins. Many additional types of relays and other electrical components may now employ this simple fool-proof combination of hermetic sealing and plug-in connection. Sockets are available.

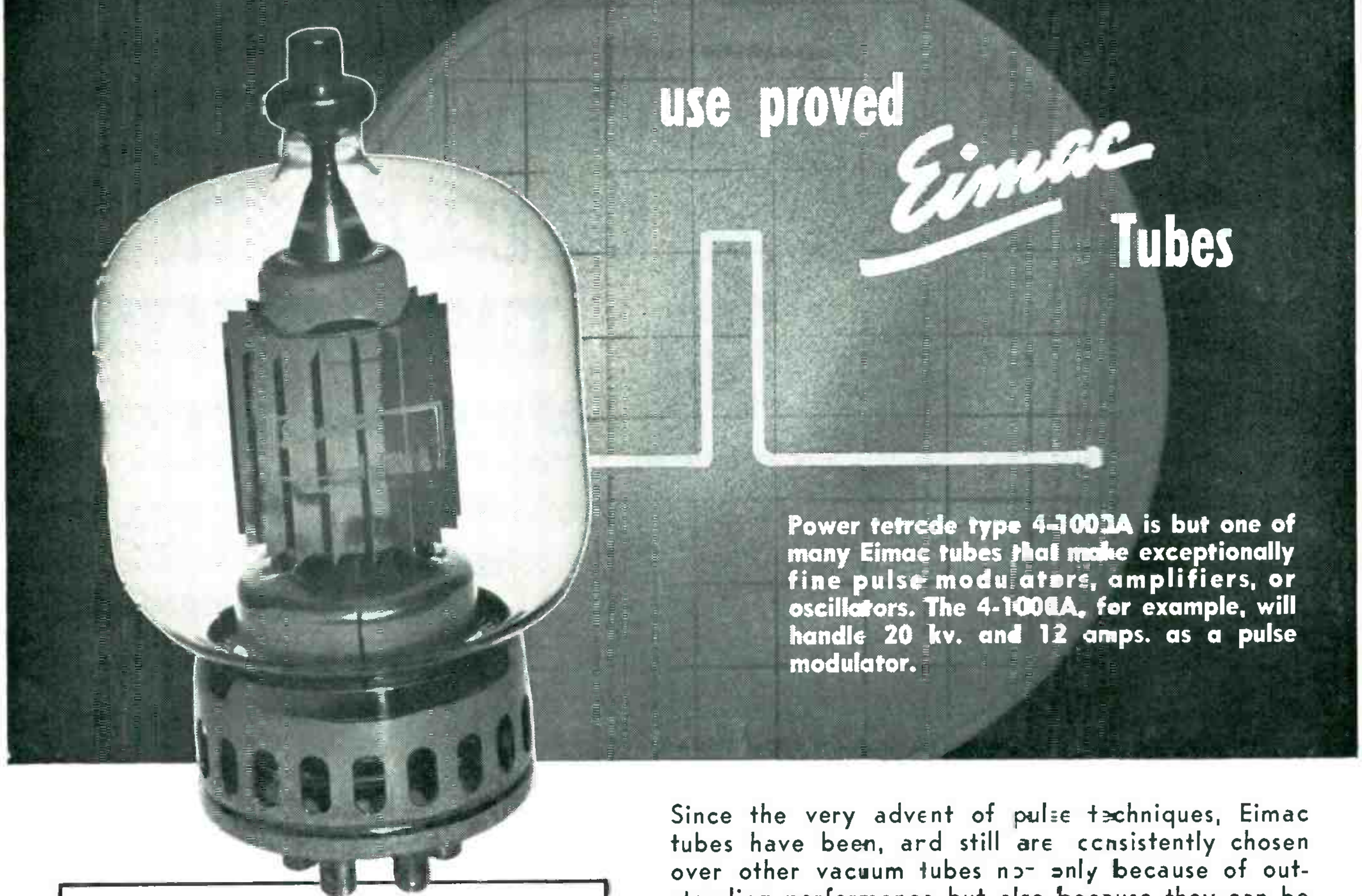
All Fusite Hermetic Terminals are an interfusion of steel and inorganic glass. Write Dept. E for specifications and complete information.

THE FUSITE CORPORATION

CARTHAGE AT HANNAFORD, NORWOOD, CINCINNATI 12, OHIO

FOR PULSE SERVICE . . .

use proved *Eimac* Tubes



Power tetrode type 4-1000A is but one of many Eimac tubes that make exceptionally fine pulse modulators, amplifiers, or oscillators. The 4-1000A, for example, will handle 20 kv. and 12 amps. as a pulse modulator.

4-1000A Typical Operation

Pulse Modulator, peak pulse values except as noted—Per Tube

D-C Plate Voltage	20,000 Volts
D-C Screen Voltage	1500 Volts
D-C Grid Voltage	−600 Volts
Pulse Plate Current	12 Amperes
Pulse Screen Current	3 Amperes
Pulse Grid Current	0.5 Amperes
Pulse Positive Grid Voltage	350 Volts
Load Resistance	1500 Ohms
Duty	.01
Pulse Power Input	240 Kilowatts
Average Plate Dissipation	240 Watts
Pulse Power Output	216 Kilowatts
Pulse Output Voltage	18,000 Volts

Since the very advent of pulse techniques, Eimac tubes have been, and still are consistently chosen over other vacuum tubes not only because of outstanding performance but also because they can be depended upon for exceptionally long trouble-free service.

This leadership is a result of these time-proven Eimac policies:

- Rugged electrodes and electrode supports
- Elimination of troublesome internal insulating materials
- Thorough outgassing of all internal parts
- Oversize electron emitters for reserve emission
- Elimination of volatile getters
- Long, thorough pumping schedules for highest possible vacuum

Put our pulse experience and know-how (over 14 years of it) to work for you. Engineering advice pertinent to your specific problem or a generalized data sheet on how to employ Eimac tubes in pulse service is available . . . write today.

EITEL-McCULLOUGH, Inc.
San Bruno, California

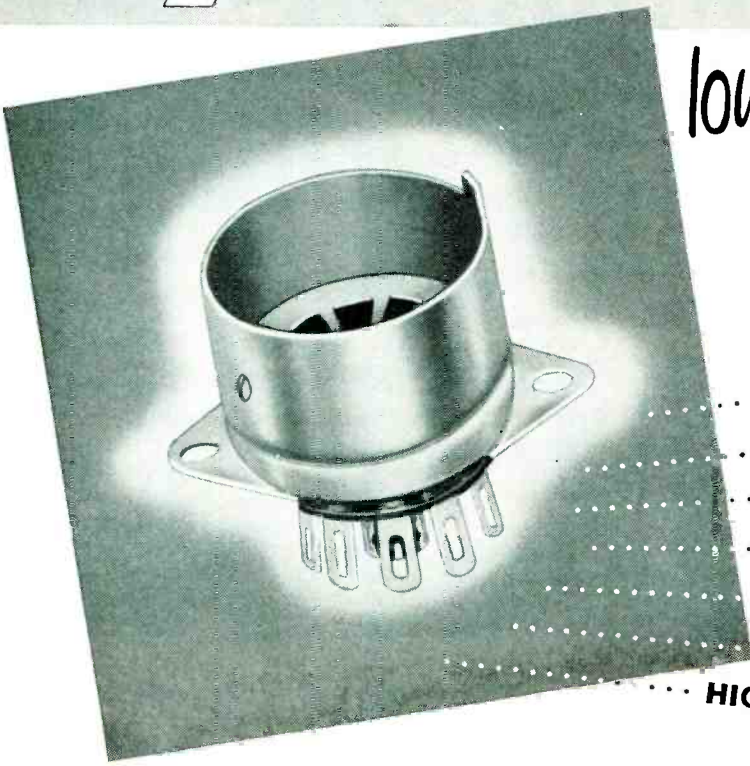
Export Agents: Frazar & Hansen, 301 Clay St., San Francisco, California

Follow the Leaders to Eimac Tubes

281

WRITE FOR BULLETIN NO. 3 "PULSE SERVICE NOTES"

MYCALEX

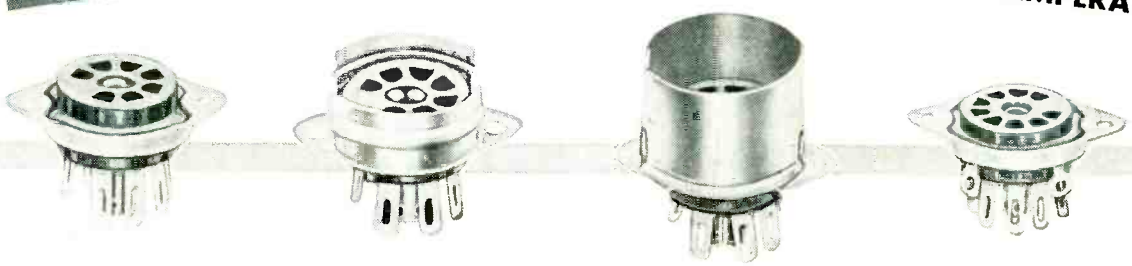


low loss miniature

TUBE SOCKETS

OFFER ALL THESE ADVANTAGES:

- CLOSER TOLERANCES
- LOWER DIELECTRIC LOSS
- HIGH ARC RESISTANCE
- HIGH DIELECTRIC STRENGTH
- GREAT DIMENSIONAL STABILITY
- IMMUNITY TO HUMIDITY
- HIGH SAFE OPERATING TEMPERATURE



-cost no more than

PHENOLIC TYPES

These glass-bonded mica sockets are produced by an exclusive MYCALEX process that reduces their cost to the level of phenolic sockets. Electrical characteristics are far superior to phenolics while dimensional accuracy and uniformity exceed that of ceramic types.

MYCALEX miniature tube sockets, available in 7-pin and 9-pin types, are injection molded with great precision and fully meet RTMA standards. They are produced in two grades, described as follows, to meet diversified requirements.

MYCALEX 410 is priced comparable to mica-filled phenolics. Loss factor is only .015 at 1 mc., insulation resistance 10,000 megohms. Conforms fully to Grade L-4B under N.M.E.S. JAN-1-10 "Insulating Materials Ceramic, Radio, Class L".

MYCALEX 410X is low in cost but insulating properties greatly exceed those of ordinary materials. Loss factor is only one-fourth that of phenolics (.083 at 1 mc.) but cost is the same. Insulation resistance 10,000 megohms.

MYCALEX TUBE SOCKET CORPORATION
Under Exclusive License of
MYCALEX CORPORATION OF AMERICA
30 ROCKEFELLER PLAZA, NEW YORK 20, N.Y.

SINCE 1919
MYCALEX
THE INSULATOR
TRADE MARK REG. U.S. PAT. OFF.

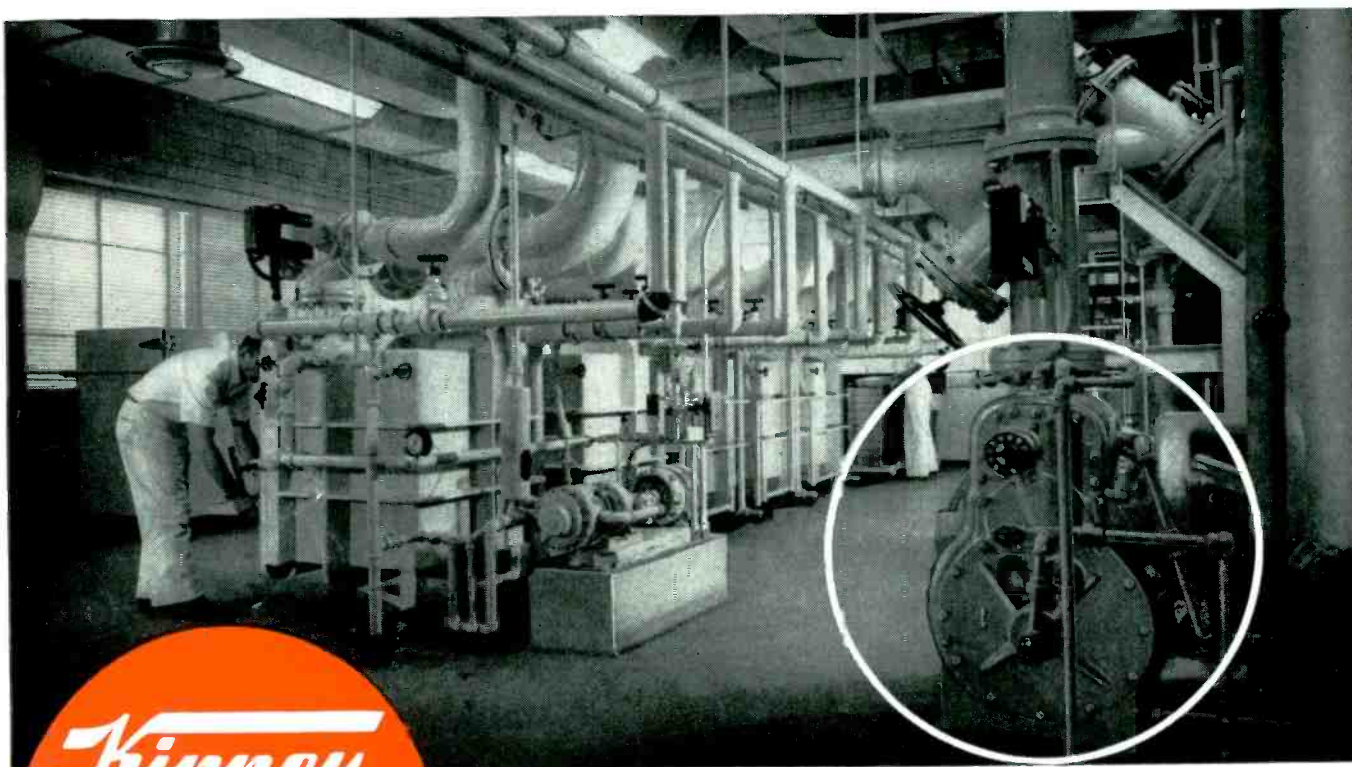
CORPORATION OF AMERICA
"Owners of 'MYCALEX' Patents"
Executive Offices: 30 Rockefeller Plaza, New York 20 • Plant and General Offices: Clifton, New Jersey

PRODUCTION gets a SHOT IN THE ARM with KINNEY VACUUM PUMPS

Here, at The Upjohn Company, Kalamazoo, Michigan, Kinney Vacuum Pumps produce low absolute pressures for freeze-drying penicillin. Here, as in countless other important process plants, vacuum . . . created by Kinney Pumps . . . is the "shot in the arm" that keeps production rolling dependably, smoothly, economically.

Wherever Kinney Pumps are at work— the laboratory, the pilot plant, or the production line — you can count on fast pump down plus complete reliability. It's this combination of speed and stamina which Kinney Pumps bring to industries the world over. Pumps are available in eight Single Stage Models (702 to 13 cu. ft. per min. — for low absolute pressures to 10 microns or better), three Compound Models (46 to 4.9 cu. ft. per min. — for low absolute pressures to 0.5 micron or better). Return coupon today for complete details. KINNEY MANUFACTURING COMPANY, Boston 30, Mass. Representatives in New York, Chicago, Cleveland, Houston, New Orleans, Philadelphia, Los Angeles, San Francisco, Seattle.

FOREIGN REPRESENTATIVES: General Engineering Co. (Radcliffe) Ltd., Station Works, Bury Road, Radcliffe, Lancashire, England . . . Horrocks, Roxburgh Pty., Ltd., Melbourne, C. I. Australia . . . W. S. Thomas & Taylor Pty., Ltd., Johannesburg, Union of South Africa . . . Novelectric, Ltd., Zurich, Switzerland . . . C.I.R.E., Piazza Cavour 25, Rome, Italy.



Kinney

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KINNEY MANUFACTURING COMPANY
3565 Washington St., Boston 30, Mass.

Gentlemen:
Please send illustrated Bulletin V45. We are interested in:

☐ Vacuum exhausting ☐ Vacuum coating ☐ Vacuum distillation
☐ Vacuum metallurgy ☐ Vacuum dehydration

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City.. State..

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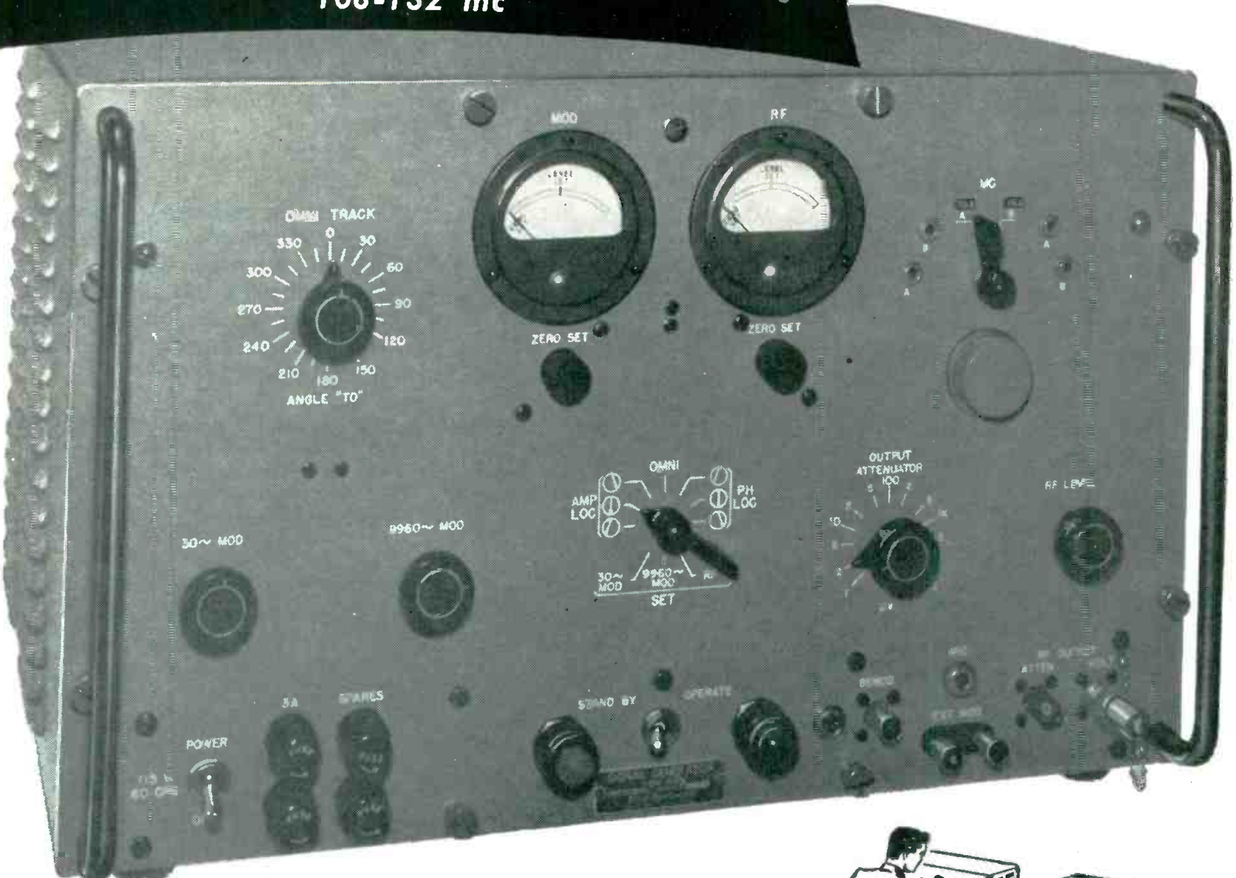
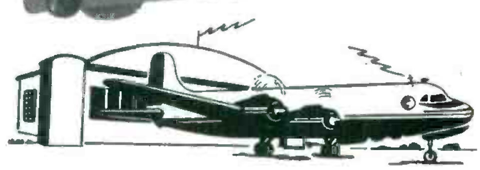
AIRCRAFT RADIO CORPORATION

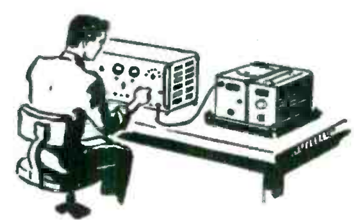
Type H-14 Signal Generator

108-132 mc

A TEST SET FOR AIRBORNE VHF NAVIGATIONAL RECEIVING EQUIPMENTS







for Testing of Equipment in Aircraft

The H-14 Signal Generator provides simulated omni, phase localizer, and tone localizer signals for testing of VHF navigational equipment in one aircraft, or in a squadron of aircraft simultaneously. The instrument will check:

- 24 omni courses
- Left-center-right on 90/150 cps localizer
- Left-center-right on phase localizer
- Omni course sensitivity
- Operation of TO-FROM meter
- Operation of flag-alarms

Simultaneous voice instructions to pilots may be transmitted with the test signals. A limited "go-no go" check requires less than one minute for one aircraft or for a squadron of aircraft.

for Testing of Equipment on the Bench

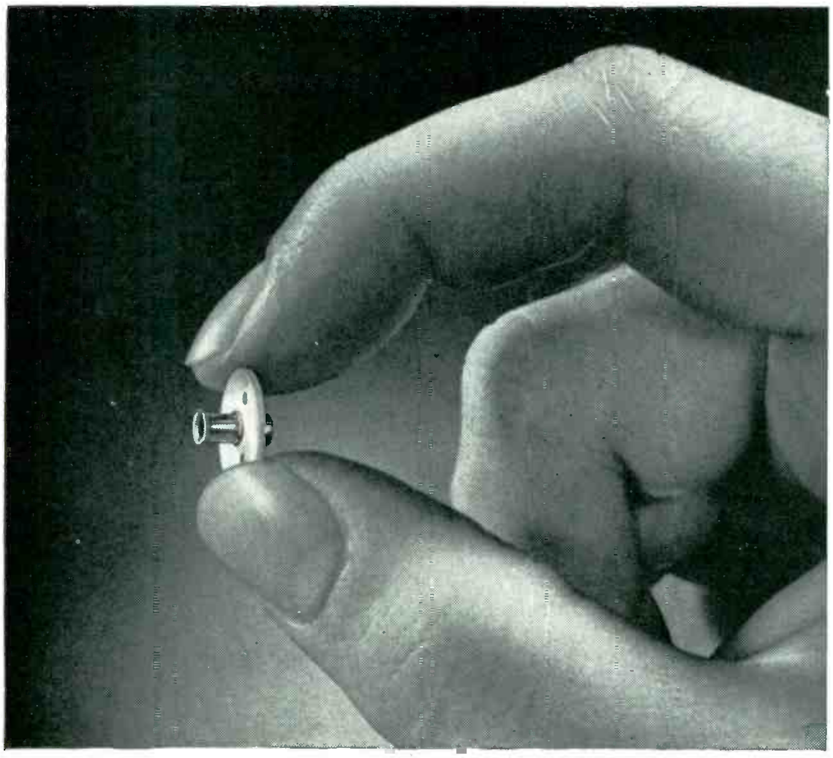
The H-14 Signal Generator provides signals of accurately known frequency, amplitude, and modulation for quantitative tests of VHF navigational receiving equipments on the bench.

Dependable Electronic Equipment since 1928

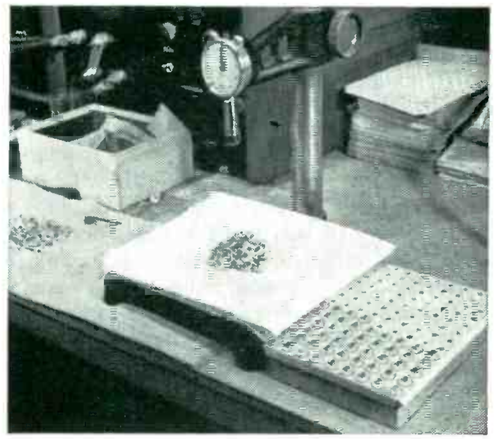
AIRCRAFT RADIO CORPORATION

BOONTON • NEW JERSEY

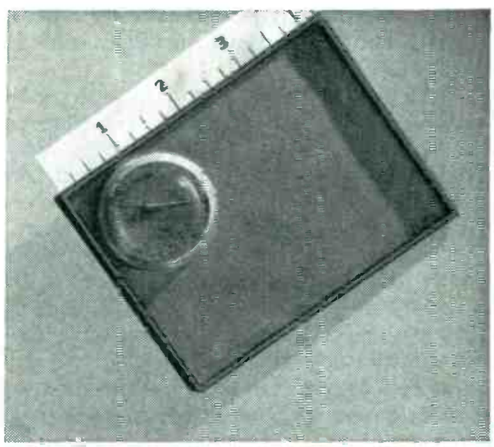
Disc Cathode Speeds Assembly-Improves Performance



Expanded Facilities . . . more space, equipment and trained co-workers help to meet growing demand.



Inspection and Gaging . . . equipment for checking "E" dimensions of Disc Cathodes.



52,600 Seamless Nickel Cathodes, compared under a lens with an ordinary pin.

● Electronics manufacturers find it pays to be a customer of Superior. They receive good service, quality products and the benefits of Superior's methods and metals research that constantly improves upon already good products.

An example is the new, improved Disc Cathode. Investigation proved that a slight flaring of the open end minimized the danger of heater cathode "shorts" caused by scraping of the heater wire coating during insertion, while speeding the operation.

This feature added to an already excellent cathode, resulted in a part that does a better job at a lower cost.

The Disc Cathode is only one of the hundreds of products which Superior supplies . . . but the same program of product improvement is applied to all of them. That's why most manufacturers in the electronics field are already friends and customers. If you are one of the exceptions, it will pay you to find out more about Superior and Superior products. For information, consultation about production problems, design help or research assistance, write today to Superior Tube Company, 2500 Germantown Ave., Norristown, Pennsylvania.

Which Is The Better For Your Application . . .

SEAMLESS . . . ? The finest tubes that can be made. Standard production is .010" to .121" O.D. inclusive, with wall thicknesses of .0015" to .005". Cathodes with larger diameters and heavier walls will be produced to customer specification.

Or LOCKSEAM* . . . ? Produced directly from thin nickel alloy strip stock, .040" to .100" O.D. in standard length range of 11.5 mm to 42 mm. Round, rectangular or oval, cut to specified lengths, beaded or plain.

Superior

THE B E IN SMALL TUBING

All analyses .010" to ⅝" O.D.
Certain analyses (.035" max. wall) Up to 1¼" O.D.

**Mfd. under U.S. Pats.—Superior Tube Company • Electronic Products for export through Driver-Harris Company, Harrison, New Jersey • Harrison 6-4800*

Potter & Brumfield

A TRADE-MARK OF QUALITY

SM series Super Midget Relays

DIRECT CURRENT ONLY

CONSTRUCTION

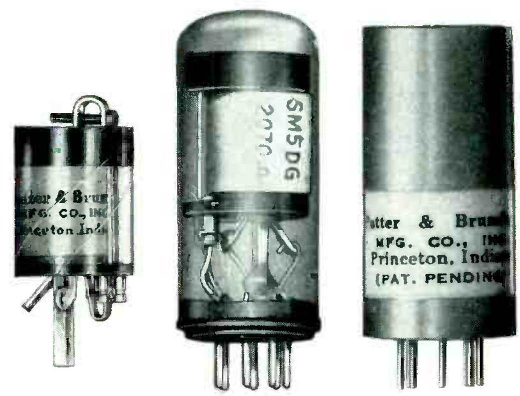
The unique design and rugged construction of the SM series relays assures indefinite life, except possible damage to contacts due to overload. Regardless of sensitivity they are not delicate and no special handling is required. Extremely light weight of the moving armature assures a high degree of resistance to shock and vibration in any position. The SM is ideal for guided missile or aircraft applications as well as general purpose uses. The plate circuit versions have found many applications in electronics. The simplicity of construction provides a thoroughly reliable, ultra-small relay at surprisingly low cost. Samples and quotations will be supplied upon receipt of your specifications and requirements.

SM5D and SM5L are open construction for single screw mounting. A thin transparent plastic sleeve furnishes protection against dust and damage in handling.

SM5DG and SM5LG are hermetically sealed in a miniature tube glass envelope with 7-pin plug-in base to fit standard miniature socket. Max. height 1⅝″ (above socket); max. dia., ¾″.

SM5DS and SM5LS are hermetically sealed in deep drawn steel can. Base and dimensions same as "G" version.

SM—*Actual Size*



Open "G" "S"

Sealed SM's fit into standard miniature tube shield.

SPECIFICATIONS AND DESIGNATIONS

"G" suffix designates hermetically sealed in glass.

"S" suffix designates hermetically sealed in deep drawn steel can.

"D" suffix designates winding that consumes .4 watt or more at rated operating point. Performance range is from 0.3 V. at 1.37 amp to 118 V. at 0.0034 amp. Standard winding draws approximately 0.5 watt at rated voltage with adjustment to pull in at 75% or less of rated voltage. Contact transfer occurs at approx. 35% of pull in voltage.

"L" suffix designates winding for current sensitive operation in which the coil consumes less than .4 watt. Maximum sensitivity of 0.075 watt can be provided with pull in at 2.75 MA minimum on slowly rising current with 10,000 ohm coil or 0.695 amp at 0.108 V. with 0.155 ohm coil. Standard adjustment to pull in at or below specified value and contact transfer during drop out to occur at approximately 50% of pull in value.

All coils of above types will dissipate 1.75 watts without exceeding 90 °C. temperature rise. This permits maximum 3.36 amp at 0.52 V. with 0.155 ohm coil and 13.2 MA at 132 V. with 10,000 ohm coil.

Vibration resistance is improved with increase in coil power. 10G specs may be met in sealed, "G" or "S" versions with 0.2 watt or more in coil when socket mounted. This special construction is provided only when so specified.

SM5D open construction, voltage actuated .3 to 118 V. DC, nominal dissipation .5 watt.

SM5DG glass sealed, same as SM5D.

SM5DS sealed in deep drawn steel can, same as SM5D.

SM5L open construction, current actuated, pull in 2.75 to 675.0 ma. at 25 °C. with .075 watt dissipation, .155 to 10,000 ohm winding.

SM5LG glass sealed, same as SM5L.

SM5LS sealed in deep drawn steel can, same as SM5L.

CONTACT RATING

The contacts are pure coined silver rated at 5 amps for 10 operations, 2.5 amps for 100 operations, 1 amp for 50,000 operations at 24 DC non-inductive load, or .25 amp for 1,000,000 operations at 115 V. 60 Cy. non-inductive load.

CONTACT COMBINATION

One Form "C"—SPDT.

INSULATION

Coil to current carrying elements 1,000 V. RMS 60 Cy.; between contacts 500 V. RMS 60 Cy.

Your Electronic Parts Distributor Stocks Standard P & B Relays

Potter & Brumfield

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EXPORT: 13 EAST 40TH ST., NEW YORK


REPUBLIC FOIL
THE RECOGNIZED STANDARD OF PRODUCT EXCELLENCE WITH ELECTRICAL-ELECTRONICS INDUSTRIES
Fine quality Republic condenser foil, having uniform thickness, surface, and strength, is available in all commercial gauges and widths. Meticulous care is taken to assure close tolerances and clean straight edges free from slivers. Engineered packing insures safe delivery. Orders and inquiries for all types of foil will be given prompt and courteous attention.
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for any and all by-passing requirements

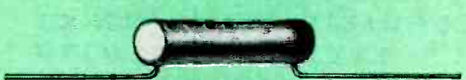
ERIE CERAMICONS®

Erie Ceramicons fulfil all the requisites for efficient by-passing—low inductance, compact design, and conservative 500 volt D. C. rating. Erie Resistor offers the most complete line of ceramic by-pass units available. Each design has been thoroughly proven in domestic and military equipment.

Check the products listed on this page for your future designs. Full description and specifications will be sent on request.

ERIE *Ceramicons*

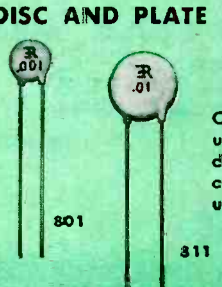
GP MOLDED INSULATED TUBULAR



GP DIPPED INSULATED AND NON-INSULATED TUBULAR

For use where space is at a premium and radial leads are desired. Capacity range 10 to 15,000 MMF. Smallest size .240" x .460" max. with dipped insulation; .200" x .400" max. non-insulated.

DISC AND PLATE *Ceramicons*



Compact, high capacitance units with extremely low inductance. Available in single and multiple capacitors up to .01 mfd per section.

INSULATED STAND-OFF *Ceramicons*

Rugged, molded insulated construction. Mounts with 6-32 nut. Style 323 mounts 19/32" high above chassis. Capacity range 0.5 to 700 MMF. Style 324 mounts 27/32" high. Capacity range 710 to 1,500 MMF. Available with 20 gauge wire lead or post type top terminal.

NON-INSULATED STAND-OFF *Ceramicons*

Style 318 (left) mounts ½" high above chassis, has .032" diameter wire top terminal. Capacity range 1 to 560 MMF. Style 319 (right) mounts .520" high has .067" diameter top terminal. Capacity range 2 to 1,000 MMF. Both styles have 3-48 thread.

SIDE-LEAD STAND-OFF *Ceramicons*

Wire leads are correct height from chassis for shortest possible connection to tube sockets. Style 2322 (left) 45/64" high. Capacity range 5 to 2,500 MMF. Style 2336 (right) 15/16" high. Capacity range 6 to 5,000 MMF.

FEED-THRU *Ceramicons*

By-pass R. F. to ground when feeding through chassis or metal can. Styles 357 (with rigid hooked wire lead) and 362 (with # 20 straight pig-tail wire lead) mount with 12-28 nut, Styles 2404 (with rigid wire lead) and 2405 (no lead) have eyelet for soldering to chassis. Max. capacitance 1,000 MMF for Style 357; 1,500 MMF for Styles 362, 2404, and 2405.

HERMETICALLY SEALED STAND-OFF *Ceramicons*

Style 325 has most efficient design for UHF. Compact and rugged. Easily installed with standard push-on clip or soldered to chassis. Available 10 to 1,500 MMF.

FOR UHF COMMUNICATIONS EQUIPMENT ERIE BUTTON SILVER MICAS

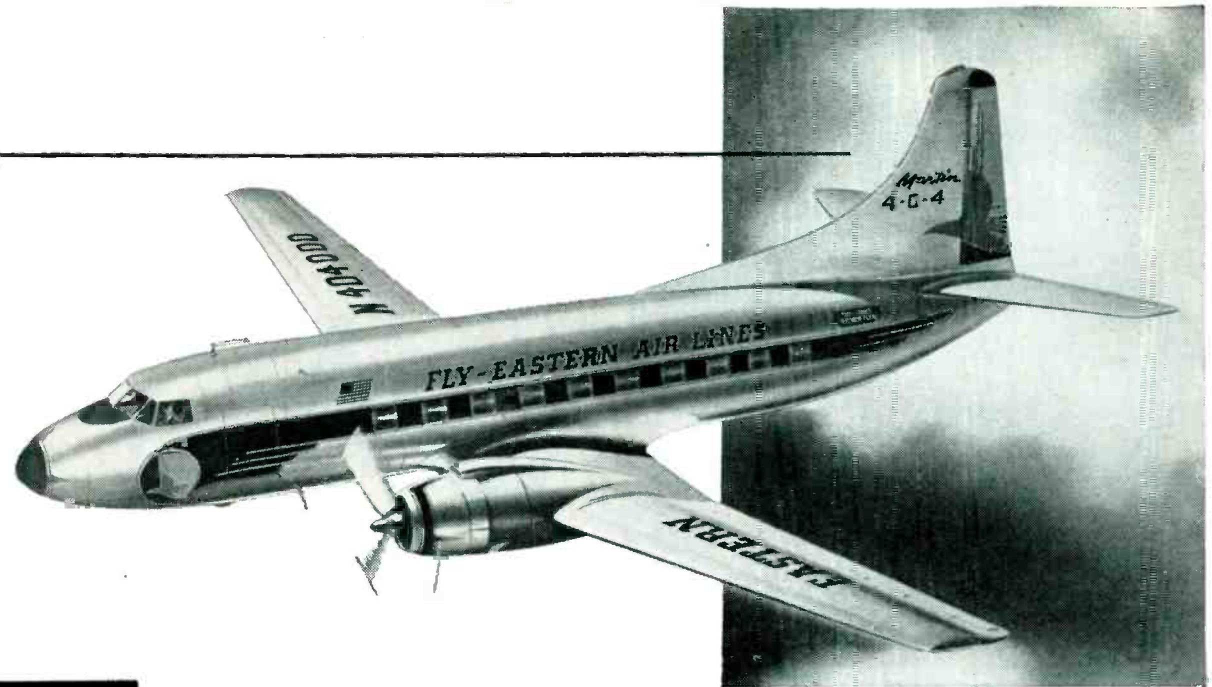
These extremely compact silver mica condensers have 360° current path from short, heavy terminals to ground, providing very low inductance. Made in Stand-off and Feed-thru styles.

Capacity range 15 to 1,000 MMF in .447" diameter, 1,000 to 6,000 MMF in .651" diameter.

Electronics Division

ERIE RESISTOR CORP., ERIE, PA.

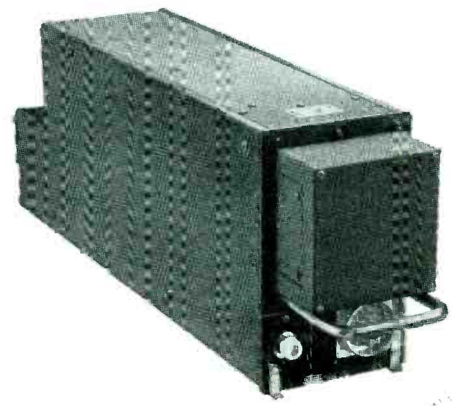
LONDON, ENGLAND . . . TORONTO, CANADA



WILCOX ...*Choice of*

EASTERN Air Lines

Wilcox Type 429A Glideslope Receiver Chosen for EASTERN'S Entire New Fleet of Martin 4-0-4's and Super Constellations



The safety and performance record of Eastern Air Lines' magnificent new fleet will depend upon the flawless operation of their I.L.S. navigation system. In selecting the Wilcox Type 429A Glideslope Receiver as an important part of this system, Eastern paid a great compliment to the dependability and performance of Wilcox equipment.

The Wilcox Type 429A Glideslope Receiver provides 90/150 CPS tone modulated glideslope signals in the 329-335 Mc. range.

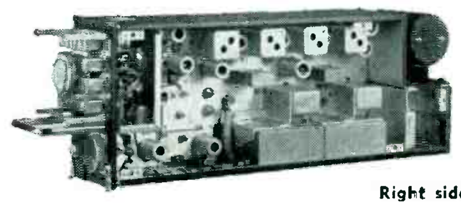
INSTANT ACCESSIBILITY FOR EASY MAINTENANCE

Routine inspection and service is made easy by the careful arrangement and instant accessibility of all tubes, components, and wiring.

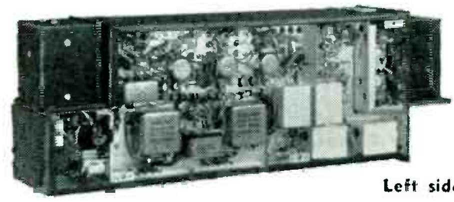
AVAILABLE FOR D.C. OR A.C. POWER

The Type 429A is supplied for operation on either 28-volt D.C. or 110-volt A.C. 400-cycle current. D.C. or A.C. power supply occupies the same physical space interchangeably. The right-side illustration shows the Glideslope Receiver equipped for D.C. operation with dynamotor, and the left-hand photo as supplied for A.C. input. Thus it fits the requirements for all commercial, military, and private use.

Write Today **FOR COMPLETE INFORMATION ON THE WILCOX 429A GLIDESLOPE RECEIVER**



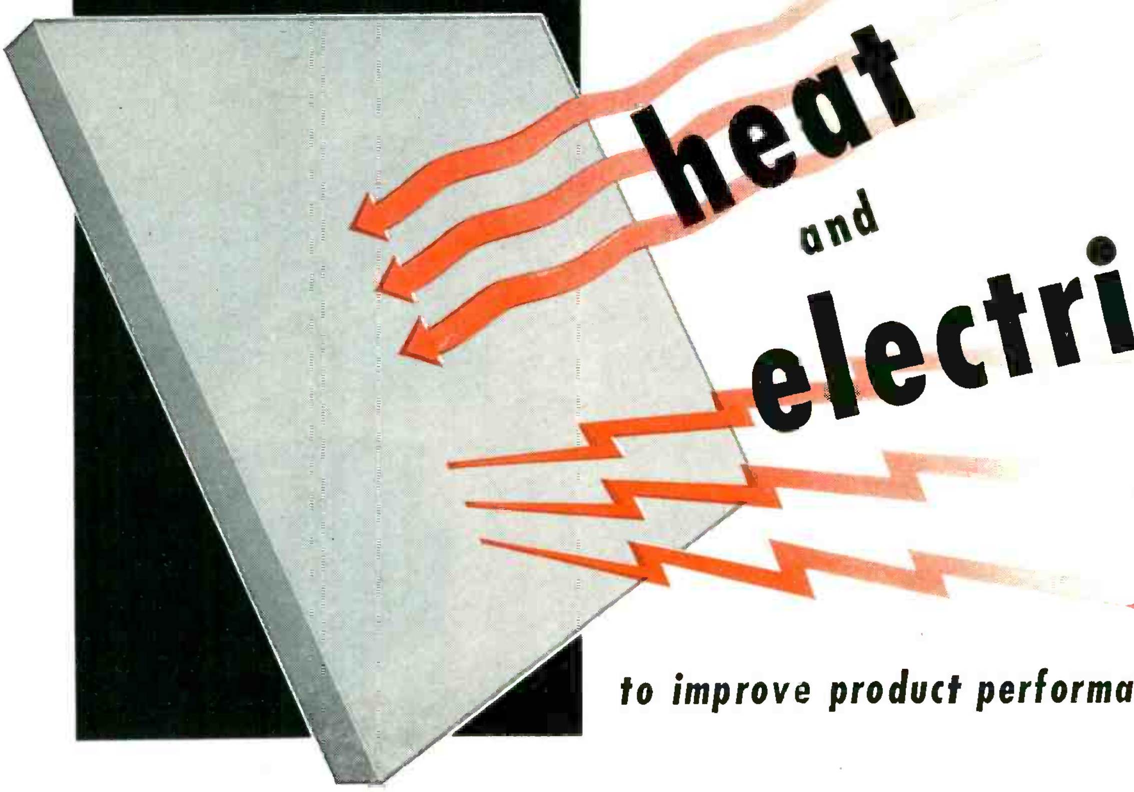
Right side



Left side

WILCOX
ELECTRIC COMPANY
KANSAS CITY 1, MISSOURI, U. S. A.

NEW C-D Silicone Dilecto withstands an inferno of heat and electricity



to improve product performance for you!

There are three new grades of C-D Dilecto* that can withstand temperatures as high as 250°C. They are chemically inert, silicone-glass laminated plastics that offer exceptionally high heat resistance and good arc resistance, extra strength, and positive moisture resistance! At Continental-Diamond we've literally lived and worked with Silicone Dilecto—perfecting it to a point where we believe it can be highly useful in helping to solve your production problems — and improve product performance.

And this remarkable plastic is but one of many in the C-D family. They provide practical combinations of mechanical, electrical, and chemical properties—structural strength, light weight, positive moisture, heat and corrosion resistance. In hundreds of plants, C-D Plastics — Fibre, Vulcoid, Dilecto, Celoron, and Micabond — offer proof that it pays to see C-D first in your search for the right plastic for the job. For interesting, useful information on Silicone Dilecto, and other C-D high strength plastics, call or write your nearest C-D office, soon.

your partner in producing better products

*Dilecto GB—112—S
Dilecto GB—128—S
Dilecto GB—261—S

DE-2-49

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Continental-Diamond FIBRE COMPANY

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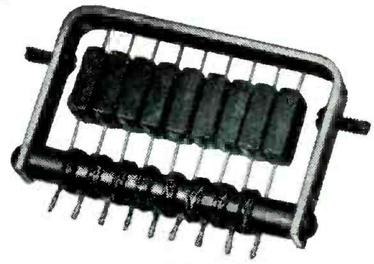
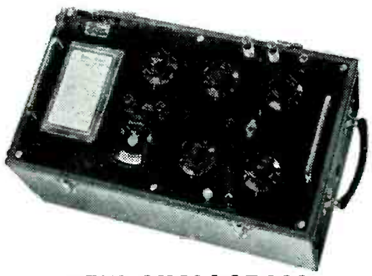
Something New



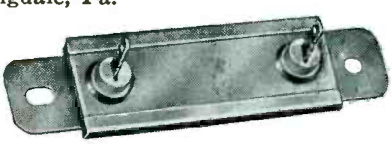
SPECIAL DELAY LINES

Lumped delay lines "tailored" to specific applications have been announced by the Shallcross Manufacturing Co., Collingdale, Pa. A typical unit consists of eight pie-section low-loss filters having a rise time of 0.04 microseconds and a total delay of 0.3 microseconds. Maximum pulse voltage is ± 100 volts and impedance is 500 ohms. Cutoff frequency is 8.5 megacycles and the maximum operating frequency approximately 2 megacycles based on a pulse delay error of not more than 2%. The unit consists of eight universally-wound coils of 3-strand #41 Litz wire and nine low T.C. silver mica capacitors. Many other types can be supplied.



NEW SHALLCROSS WHEATSTONE-MEGOHM BRIDGE

The new Shallcross 635-A Wheatstone-Megohm Bridge is a versatile direct-reading instrument for accurate measurements between 10 ohms and 1,000,000 megohms. It can be used to measure resistance elements and insulation resistance and to determine volume resistivity of materials. The instrument is basically a Wheatstone Bridge used in conjunction with a d-c amplifier. Two built-in power supplies operating on 115 volts, 60-cycles automatically provide the correct bridge voltages for the high and low ranges. Full information is available from the Shallcross Manufacturing Co., Collingdale, Pa.



METAL-ENCASED RESISTORS

Flat, metal-encased, Type 265-A wire-wound power resistors introduced by the Shallcross Manufacturing Company, Collingdale, Pa. are space wound, have mica insulation, and are encased in aluminum. At 175° C. continuous use they are conservatively rated for 7½ watts in still air and 15 watts mounted flat on a metal chassis. Write for Bulletin 122.

(ADV.)

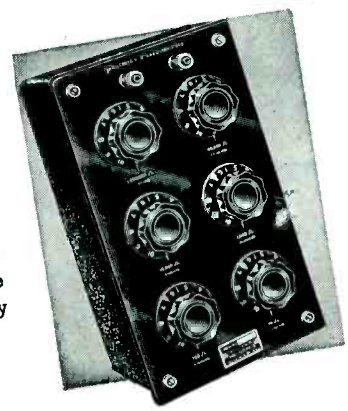
HERE'S *Fast, Accurate* LAB OR PRODUCTION *Testing!*

A QUICK CHECK OF LOW RESISTANCE CONNECTIONS, BONDS, CONTACTS, etc.

Shallcross low resistance test sets greatly facilitate comparison tests between 2 and 800,000 micro-ohms. Their uses range from testing the electrical conductivity of bonds, welds and seals to contacts, filaments, armatures or for making any measurement under 1 ohm. Suitable units are available for either field, laboratory or production line use. Write for Bulletin LRT-1.

KELVIN plus WHEATSTONE RANGES IN ONE HANDY BRIDGE

Why pay for two instruments when one will do *both* jobs? Providing both Kelvin and Wheatstone ranges from 0.0001 ohm to 11.11 megohms, this Shallcross No. 638-R combined bridge is highly accurate and outstandingly convenient. Priced at only a little more than a single bridge with a limited range, it is a typical example of Shallcross instrument efficiency and economy.



DECADE RESISTANCE BOXES TO MATCH YOUR NEED ... exactly

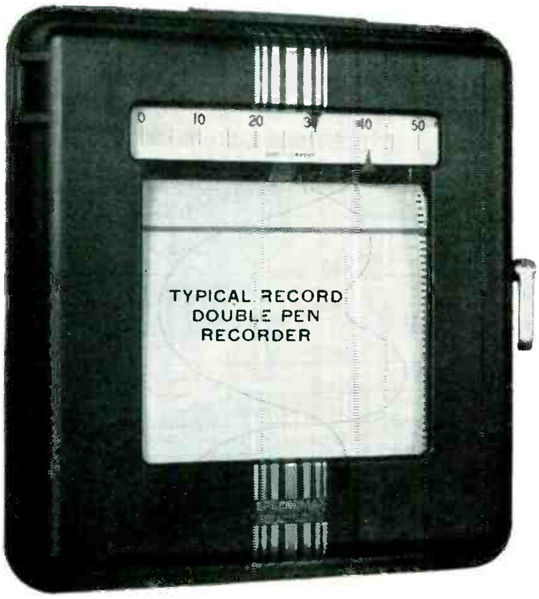
Over 40 Shallcross standard Resistance Boxes provide the widest assortment available today. Types range from 1 to 7 dials from 0.01 ohm to 111 megohms and are available in styles, sizes and prices for practically any laboratory or production testing need. Write for Bulletin.

SHALLCROSS

SHALLCROSS MANUFACTURING COMPANY

Collingdale • Penna.

Four new Speedomax Recorders to plot lab data automatically



To save the researcher from tedious curve plotting, here are 4 new Speedomax Recorders. There's a double-pen recorder to put two continuous curves on one chart . . . there's a recorder for "X-Y" curves . . . there's an adjustable range—adjustable zero recorder for narrow ranges at high levels . . . and there's a recorder for photomultiplier tubes.

These instruments are standard production models, ruggedly built . . . yet remarkably sensitive. Electronic amplification makes Speedomax fast; null-balance measurement insures accuracy. High motor torque keeps response rapid even when auxiliary devices add to shaft load. Pens move across $9\frac{7}{8}''$ scale in 1, 2, or 3 seconds as desired. Thorough shielding and filtering keep out normal stray fields.

Available extras include chart tear-off; sliding window for writing on chart with door locked; fluorescent light; various signalling and shut-off devices, etc.

DOUBLE-PEN RECORDER

is used to compare two related functions when variables change too fast for a two-point recorder. Saving valuable panel space, it plots two continuous curves on the same chart—either "overlapping" or "side-by-side." Any standard range can apply to either pen. Available chart speeds are from 1″ to 1800″ an hour.

X-Y RECORDER

plots any two variables convertible to d-c signals. X corresponds to pen travel; Y to up-and-down chart movement. Instrument can plot vacuum tube characteristics, stress-strain curves, temperature-temperature difference curves, etc. Chart moves 10″ in only four seconds.

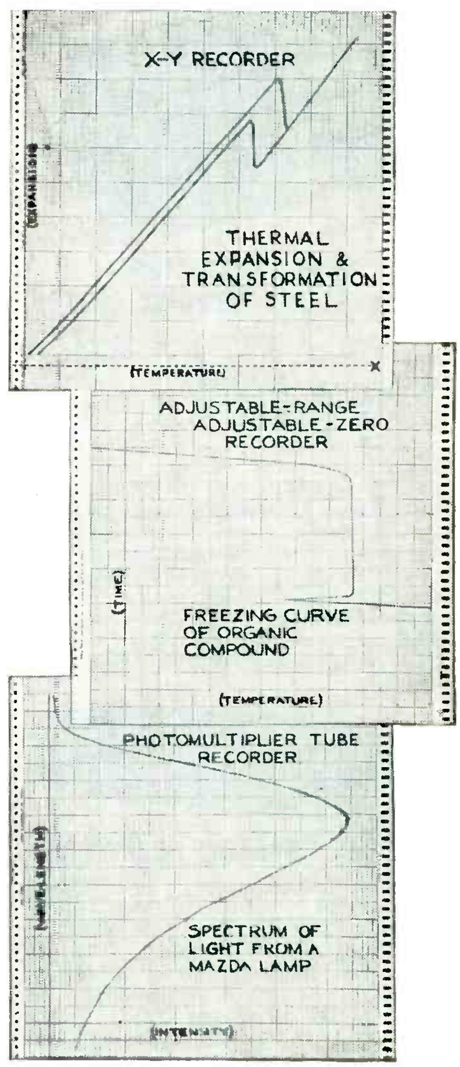
ADJUSTABLE RANGE and ADJUSTABLE ZERO

make this recorder applicable to a wide variety of test measurements. It's used with load cells in strain gage applications; it's used in expanding small changes at various temperature levels; it's used in studying speed changes over narrow bands, etc. Range is −2 to +20 mv maximum; −0.1 to +1 mv minimum. Zero suppression is −50 to +50 mv.

PHOTOMULTIPLIER TUBE RECORDER

for recording light and other low-level radiation. With high-gain amplifier built in, recorder connects directly to current leads from photomultiplier tubes. Lowest range (0 to 0.02 microampere) is consistent with smallest currents. By flicking a switch, higher ranges can be selected. Thus varying intensity spectra are recorded in detail.

If you have a specific problem, we'll be glad to recommend the standard or special Recorder to handle the situation. Address our nearest office, or 4979 Stenton Ave., Phila. 44, Pa.



MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

Jrl. Ad EM9(2)

The Defense Production Problem

To win out in the struggle for freedom into which the Russian Communists have plunged us we must do at least four things. We must:

1. Speedily carry through a program of defense production which, at its peak, is scheduled to take about one-fifth of our national output.

2. Pay for this program as we go, by methods that will enable us to maintain the effort for an indefinite period — as long as may be necessary to insure peace and security.

3. Manage intelligently and endure intelligently a set of direct government controls which, in certain critical departments, will put our national economy for a time in a hateful straight jacket.

4. See that these emergency controls are not fastened upon us permanently thereby presenting to our Soviet antagonists a major victory for collectivism on our home front.

This is the first of a series of editorials designed to present in the simplest terms these key aspects of our struggle to preserve our free institutions.

A Staggering Task

The magnitude of the defense production job staggers the imagination. Over the next year it calls for a larger volume of goods and services than the 20 million people of the states of New York and New Jersey will use for all purposes. The (London) TIMES has observed that, taken alone, the increase of defense expenditures which has been budgeted for the federal government's coming fiscal year (about $30 billion) "is in itself not far short of the total national income of the United Kingdom."

Yet so powerful is the production machine created by free American enterprise that, at the scheduled peak, the defense program will take only about one-fifth of our total national output. The exact form and dimensions of the program will, of course, be hammered out on the anvil of public and congressional debate. But the President's recent estimate of an annual rate of expenditure of $45-55 billion for defense by the end of this year may well turn out to be somewhere near right.

To meet even these vast requirements of defense production we are in better shape technically than we were when we started to prepare for World War II. Our industrial plant and equipment is greatly improved. Over $65 billion has been invested in it since V-J Day. Our working force is about eight million larger than it was ten years ago and much better trained.

The difficulty, and it is a very serious economic difficulty, is that we must fit the defense program into a productive machine that has been almost fully extended to meet the needs of a booming civilian demand. The present plan is to step up defense production during 1951 from about 7% to about 18% of our total national output. Because there is relatively little slack in our economy, this means that civilian production at the outset must be cut back as defense production is stepped up.

The cut-back of civilian goods must be especially severe in the case of products made of metal. This is particularly true of goods that use scarce strategic metals such as aluminum and copper. Of our total defense production program, about half will go for "military hardware" – airplanes, guns, munitions, tanks and the machinery to make them. By the end of 1951 defense requirements are scheduled to absorb most of the metalworking production not required for essential construction and for the spare parts necessary to keep existing equipment running. For a time at least, there will be a sharp cut in the supply of new metal products available to civilian consumers. The defense squeeze on both materials and manpower will also cut sharply into housing and other civilian construction.

For the Short Run — Controls

In the short run there is no answer to the problem of meeting defense production schedules except controls. Sharp reduction of non-defense expenditures by government is essential and would help greatly. But the basic fact is that we cannot increase our total production fast enough to meet immediately both civilian and defense requirements.

Controls are needed, therefore, to switch resources from civilian to defense production, and at the same time prevent the combined demand for critical products from sending prices right through the roof. In the case of many scarce strategic metals such as nickel, copper and cobalt, the task of increasing output is especially difficult because our limited supplies are tucked away deep in the earth in many quarters of the globe.

For the longer pull – and that is what we must face – there is another answer to our defense production problem that is infinitely better than controls. And this time, in contrast to World War II, it is all-important that we get the right answer to our defense production problem for the longer pull and that we get it right now. In World War II we geared our economy to meet the requirements of a relatively short and decisive conflict. Now our leaders, however they may differ as to methods, are well agreed that, at best, "the conditions under which we labor may persist for ten, fifteen or twenty years." That is General Bradley's phrase.

For the Long Pull — More and Better Production

For this longer pull, the constructive answer to our problem of defense production is clearly more and more efficient production all along the line. It is true that overall we now have the most efficient industrial establishment in the world. But, even so, much of it is far short of attainable efficiency. Some plants using up-to-date equipment and methods are as much as six times more efficient than others in the same industry that are lagging in modernization.

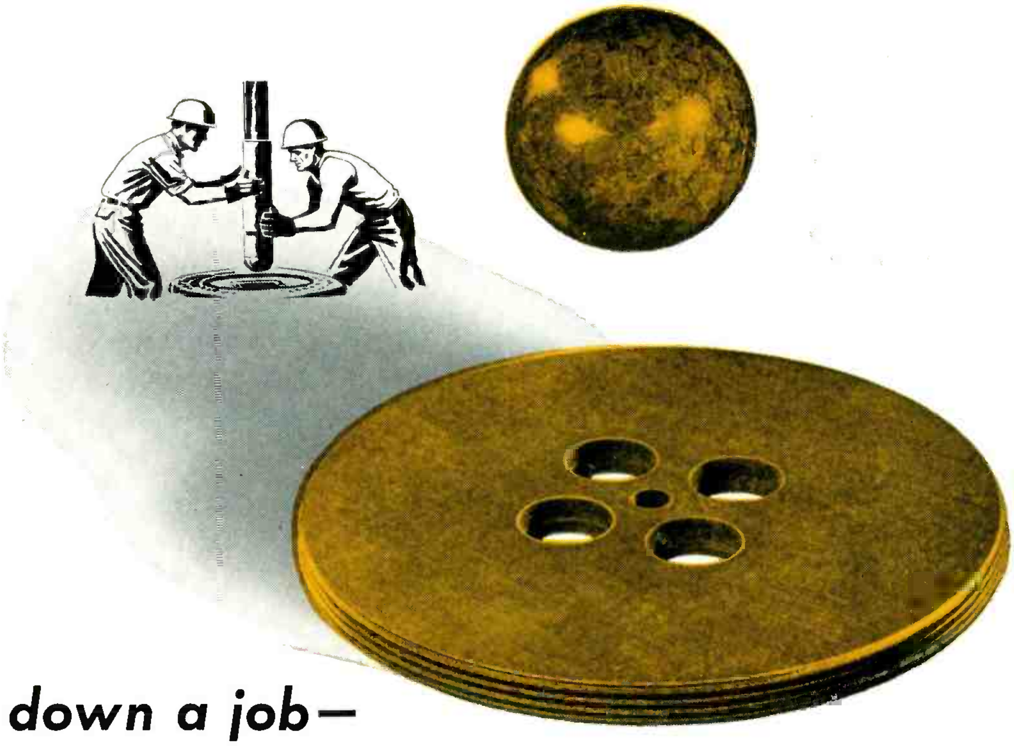
Our Director of Mobilization, Charles E. Wilson, has clearly in mind this problem of increasing our industrial efficiency. The first step in his job, as he conceives it, is to get out an adequate supply of weapons to equip the army, navy, and air forces already mobilized or in process of organization by us and our allies. The second step is to make sure of our capacity to produce both "military hardware" to meet any increased requirements and the maximum possible volume of goods for civilian use.

In concentrating on more and more efficient production, Mr. Wilson is squarely on the beam. We can attain his objective – by sustained effort on the part of each one of us backed by up-to-date industrial methods and equipment.

If we do that, we can maintain indefinitely an adequate defense effort and at the same time enjoy a standard of living higher than any other in the world.

Additional production and more efficient production are our surest safeguards against our two most menacing enemies on the home front – the deadly inflation that can destroy our free economy, and the strangling government controls that can destroy our political freedom.

McGraw-Hill Publishing Company, Inc.



How to hold down a job— in a mile deep hole

When the well drillers have "made the hole" and an oil well is about to come in, a new job arises. And it's a real trick to handle, especially since there's a joker in it.

The job is to pump wet concrete into the hole to seal the sides. The joker appears because the shoe through which the concrete is pumped . . . the shoe that prevents the wet mix from backing up in the hole to seal it off . . . cannot be withdrawn after the mix has set.

The valve ball and thrust plate of the shoe, illustrated above, must be made from a hard, dense, tough material. They must resist the abrasive action of wet cement under considerable pressure. The ball must be dimensionally stable. Both parts must be moisture resistant. What's more, after the job is complete it must be easy to drill-out the working parts of the shoe to form a passageway.

This is a rare set of requirements. The makers of the Turbo Jet Float Shoe found in Synthane the material to meet them.

The Turbo Jet Float Shoe takes advantage of several Synthane properties. Other mechanical properties plus good electrical and chemical characteristics form an unusual *combination* which makes Synthane valuable for a wide range of applications. Synthane may be of help to you. To find out, send for the complete Synthane catalog. Address Synthane Corporation, 6 River Road, Oaks, Pa.

PLASTICS WHERE PLASTICS BELONG **SYNTHANE** S

Amplify the easy way....

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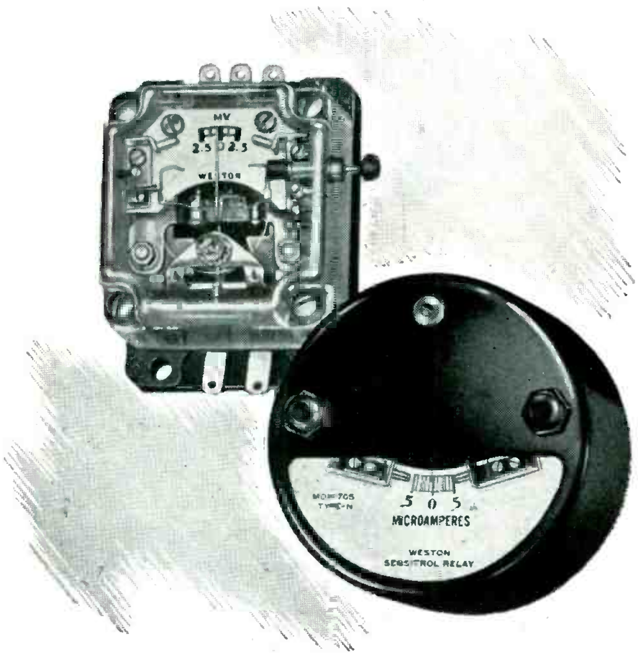

- Operate reliably on values low as 0.00000000006 watt—and control 12 watts.
- No standby power required—no batteries, tubes, transformers.
- No replacements necessary.
- Magnetic contacts assure reliability—not subject to *frying*.
- Available in single and double contact types—manual or solenoid reset.

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A versatile three-in-one instrument which provides a conventional Volt-Ohm-Milliammeter, a high impedance Electronic Volt-Ohmmeter, and a stable, probe type Vacuum Tube Voltmeter for use to 300 megacycles. RF and D-C probe supplied. Complete stability is attained on all ranges from 3 to 1200 Volts and 200 Ohms to 2000 Megohms full scale.

What's new in instruments? For complete information on the very latest developments in instrumentation, and to keep constantly posted on all future developments at the WESTON laboratories, drop a line to WESTON today.

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WESTON ELECTRICAL INSTRUMENT CORPORATION

Manufacturer of Weston and Tagliabue Instruments

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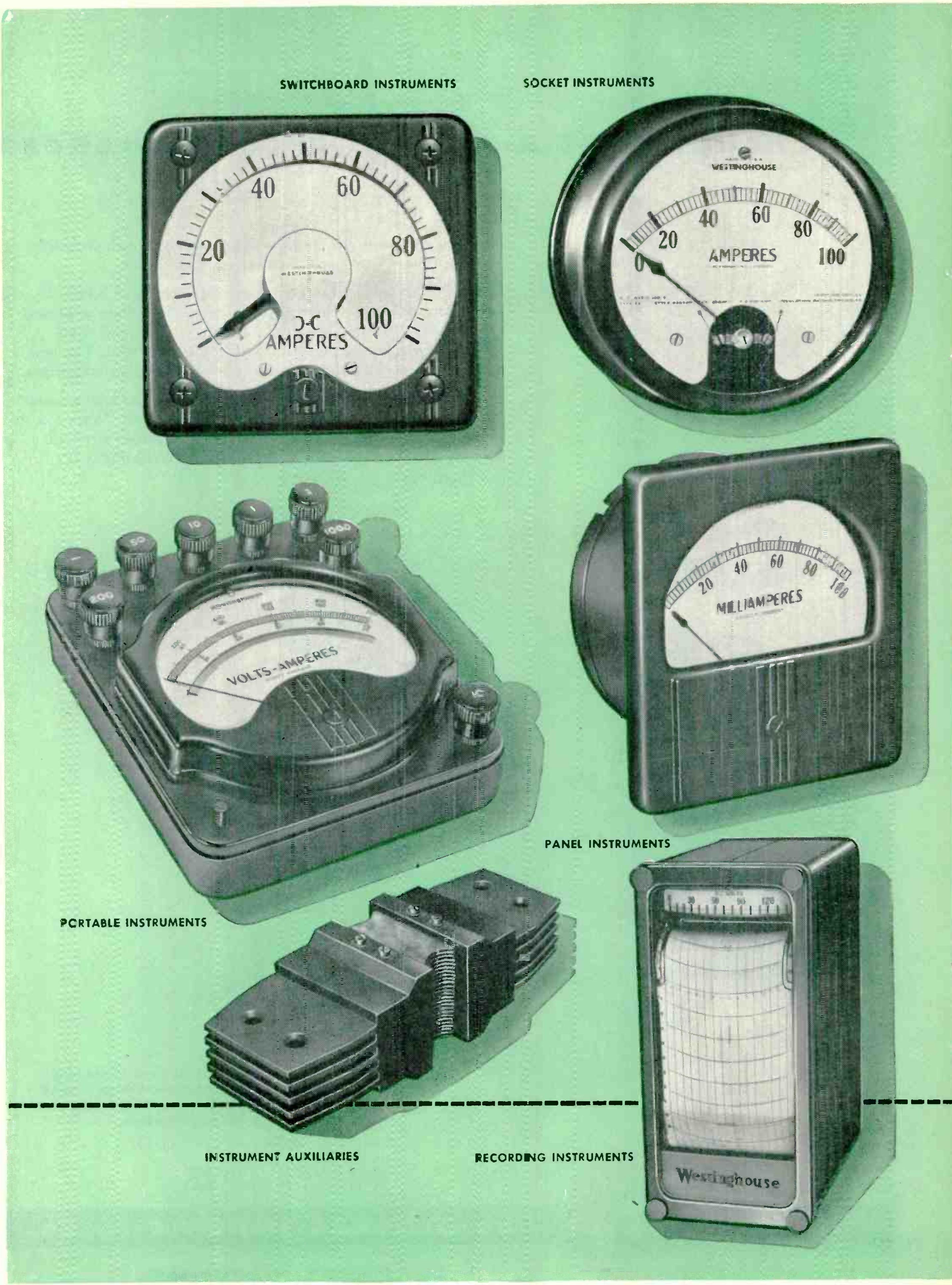
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In the complete line of Westinghouse Electrical Instruments, you're sure to find the *right answer* to your measuring requirements. Moreover, you'll get a wider selection for specific applications, whether it be a-c or d-c current and voltage, single or polyphase circuits, watts or vars, frequency, power factor, synchroscopes, temperature indicators, ground detectors or position indicators.

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YOU CAN BE **SURE**.. IF IT'S

Westinghouse

INSTRUMENTS

Production of GLOBAR brand ceramic resistors is being directed to manufacturers of defense equipment in ever-increasing quantities. These manufacturers must, necessarily, receive first priority if they are to produce critically needed equipment during this national emergency.

However, our productive capacity is such that we are able to meet most needs of producers of civilian equipment—and will continue to do so in every way that does not affect defense production.

The unique characteristics of GLOBAR resistors have resulted in many improvements in circuit designs. Whether you are producing defense or civilian equipment, it will pay you to investigate the many types available. Our complete co-operation is assured. Write Dept. V-31, The Carborundum Company, GLOBAR Division, Niagara Falls, New York.

GLOBAR Ceramic Resistors

BY CARBORUNDUM

TRADE MARK

"Carborundum" and "Globar" are registered trademarks which indicate manufacture by The Carborundum Company, Niagara Falls, N. Y.

NEW! Synchronous Motor Driven SINGLE CAM and MULTI-CAM RECYCLING TIMERS

The new Industrial Cam Recycling Timer continuously repeats a constant cycle consisting of definite ON and OFF periods which can be adjusted from 2% to 98% of the cycle. By means of percentage calibrations on the cam face any desired setting is quickly and accurately obtained. The time cycle itself can also be changed easily by substituting simple gear-rack assemblies. Thus, from one timer, by using different gear racks you can obtain 50 different cycles ranging from the lowest cycle of the timer up to nine times that cycle. The snap action switch operated by the timer is a single pole double throw, totally enclosed 10 ampere type. We can supply 500 different time cycles in this model ranging from one revolution in 15 seconds to one revolution in 72 hours.

The Multi-Cam Recycling Timer is identical to the Single Cam Timer but operates from 2 to 6 circuits and incorporates several additional features. On this timer all cams are mounted on a single driving shaft which assures a common time cycle for all circuits. Each cam, however, is independently adjustable for a specific timing sequence. This is accomplished by actually rotating the cam with finger pressure using the drum calibrations for guidance. Thus a range of timing sequences from 0% to 100% is obtainable on each circuit with ease. The elimination of cam followers and other types of moving parts makes possible this compact unit. 11 models are available with time cycles ranging from one revolution in 1 minute to one revolution in 72 hours.

REMOTE CONTROL FOR SINGLE CYCLE OPERATION AVAILABLE.

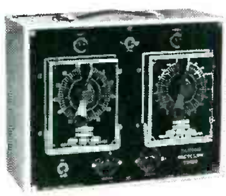
Send today for complete details—or, if you would like to send us specifications, we shall be glad to make recommendations based on your particular needs.

Manufacturers of These and Other Timers and Controls for Industry

TIME DELAY TIMERS

INSTANTANEOUS RESET TIMERS

MANUAL SET TIMERS



TANDEM AUTOMATIC RECYCLING TIMERS

RUNNING TIME METERS

Timers that Control the Pulse Beat of Industry

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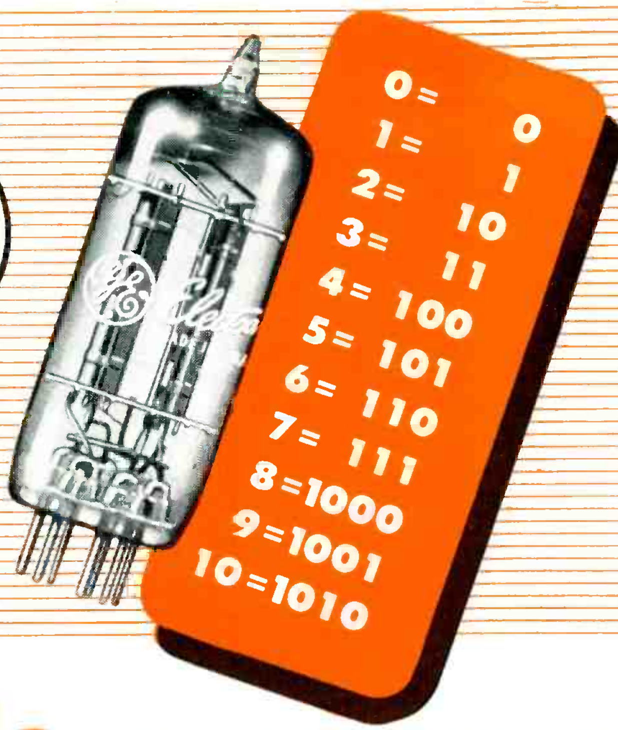


GL-5844 Twin Triode

For "flip-flop" service in binary-system calculators

(Over-all tube length 2⅛")

HERE'S A NEW G-E TUBE FOR COMPUTER USE

GL-5844, first of a series, is specially designed for computers . . . and priced economically!

✔ **Replaces Type 6J6 in most computer applications—but requires much less heater power.**

✔ **Is a true twin triode, specially designed for dependability.**

Here's a great new twin triode engineered for *you* as builder or designer of computers, whether for business or research purposes. Superior reliability, meaning fewer replacements, makes the tube a preferred investment.

You can rely on the GL-5844! This binary-counter type outscores the 6J6 in five important ways:

1. Regular GL-5844 production is 100-percent tested for service in computers. It is not necessary to specially select individual tubes for sharp-cut-off performance.
2. Plate output exceeds that of the 6J6, because of higher perveance.
3. Failure to function after periods of non-conduction while biased to cut-off (often called tube "sleeping sickness") is corrected in the GL-5844 by special cathode design.
4. Cut-off voltage for the two triodes balances within a 1-v limit—a boon to the circuit designer.
5. Heater requirement is a third less than with the 6J6. In a 600-tube computer, this can save more than ½ kw of power . . . important economy . . . plus helping to assure cool operation.

Wire or write for technical-data folder ETD-154. Get the *full* story about this G-E tube "first" in a field of expanding importance! *General Electric Company, Sec. 2, Electronics Department, Schenectady 5, New York.*

GENERAL ELECTRIC

180-K2

BUSINESS BRIEFS

By W. W. MacDONALD

Engineering Manpower may soon be the most critical of all commodities in the mobilization program. If there is any doubt about this in your mind take a look back in the Searchlight Section (classified advertising) of this issue under "Positions Open."

There are a number of reasons for the growing shortage of electronic engineers, and they may be enumerated as follows:

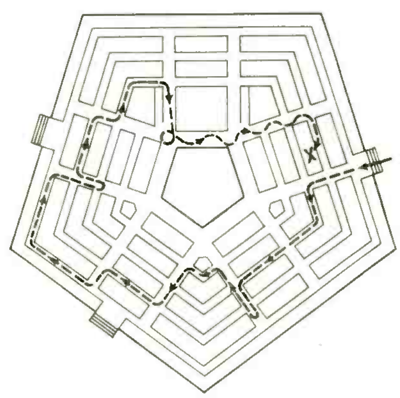
The last war nipped many a college career in the bud. Registration of engineering students remained below normal long after the shooting stopped. And many GI's, older and with family responsibilities, dropped out short of a sheepskin.

Washington officials have so far been preoccupied with three factors. . . Money, Materials and Machines. . . in the rearmament drive. We are just beginning to hear about engineering-manpower studies, and all of them will take time to complete. Meanwhile, there is danger that failure to arrange government research and development projects in order of importance and to postpone some of them so that there will be engineers left over for equipment production may complicate matters. (The Department of Defense has ordered that basic research in military programs be not less than 6 percent of each department's average annual research and development budget for the last five fiscal years.)

The need for electronic engineers on going military projects is already straining the peacetime supply. This fact notwithstanding, departments of some companies just getting under way on military orders are being loaded with engineers from other departments not having military orders in order to protect these engineers from the draft. There is, so far, little tangible evidence in Washington that engineers still working on civilian goods, but who will be needed later on military projects, can be held by other means.

Hiring of engineers for the purpose of obtaining military contracts rather than for the performance of work already on the books (p 78, March) persists, and constitutes a further drain. One manufacturer of our acquaintance is currently delivering $300,000 worth of military electronic gear for every engineer engaged in its production. Another, by contrast, is delivering $30,000 worth.

Pentagon Peregrination



Leader Plans, in which key manufacturers show the way to satellite plants, appear to be applicable to the engineering manpower problem. We know of a factory in which redesign permits highly complex gear that formerly required assembly by top-flight technical personnel to be produced largely by semiskilled labor.

There will be a "before and after" story about this operation in our feature columns soon. . . if we can find a way to tell it without running afoul of classified subjects.

The Speed with which things move in the nation's capital is illustrated by one of our own recent experiences.

We telephoned a top official of the Federal Civil Defense Administration at an address given in a press release received only a few days before, and were promptly invited to a new building in a different part of the city. Arriving there, we found our man after much broken-field running around scaffolding, plaster bags and loose

SYLVANIA ANNOUNCES...

A NEW SUBMINIATURE GERMANIUM PHOTODIODE... TYPE 1N77

Permits construction of small automatic multiple counting, inspecting, and recording systems.

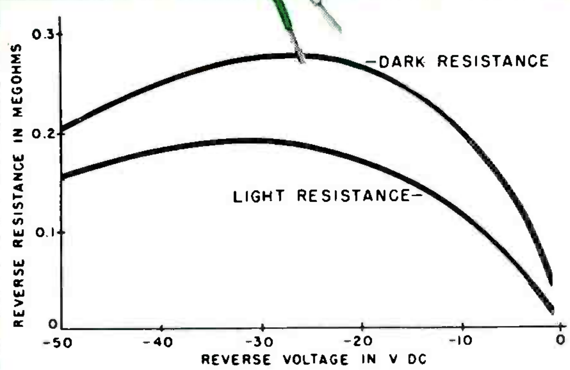
Another Sylvania *first* is this new Type 1N77 Germanium Photodiode.

The electrical characteristics of the 1N77 Photodiode are similar to those of other Germanium Diodes. The reverse resistance, however, changes when light falls on the diode. The 1N77 is responsive to radiant energy near the red end of the spectrum and is especially sensitive to infra-red energy where it peaks at 1.7 microns.

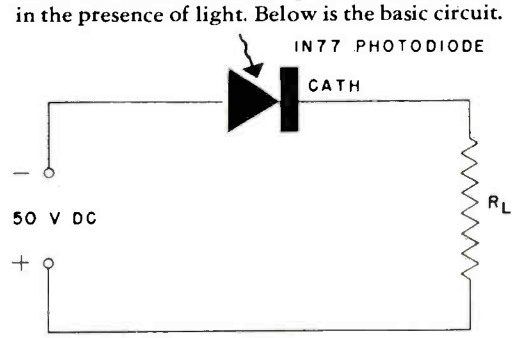
And, its unique design (a small transparent cylinder) facilitates the application of light to the sensitive area.

The Type 1N77 is only .080 inches in diameter. This extremely small size recommends it for use in many applications where space-saving is an important factor. It also permits new engineering concepts in designing efficient and more compact instruments including automatic multiple counting, inspecting, and recording systems.

For new data sheet concerning Sylvania's Type 1N77 Photodiode, write Sylvania Electric Products Inc., Dept. E-1004, Emporium, Pa.



The shape of the reverse resistance curve of the Type 1N77 is similar to that of other Germanium Diodes except that it reaches its peak at a somewhat higher voltage. Above is a typical curve for the 1N77 showing the resistance shift in the presence of light. Below is the basic circuit.



SYLVANIA ELECTRIC PRODUCTS INC. 1901-1951 50th ANNIVERSARY FIVE DECADES OF PROGRESS

SYLVANIA ELECTRIC

ELECTRONIC DEVICES; RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS

BX cable. Then we had to retire to the hall with two camp chairs because hammering associated with the erection of partitions made conversation impossible in the office.

One week later we telephoned our man again. And found that he had moved once more. . .back near the original quarters, where there was more room for expansion.

Speaking Of Agencies, a Washington wag said of one (since superseded by another group) not so long ago that "it has an estimated half-life of two weeks."

Receiver Production in 1950, as reported by RTMA, broke down as follows:

	TV	*Radio*
Jan	438,700	934,900
Feb	479,900	1,059,200
March	686,600	1,349,500
April	542,600	1,254,200
May	486,000	1,244,700
June	502,500	1,491,100
July	327,500	666,000
Aug	720,600	1,303,700
Sept	843,800	1,335,500
Oct	838,300	1,229,900
Nov	738,800	1,215,600
Dec	858,500	1,505,600
	7,463,800	14,589,900

TV picture-tube sales to receiver manufacturers totalled 7,473,614 units valued at $198,737,428. Of these, 72 percent were 16 inches or larger in size.

Radio receiving-tube sales totalled 383,960,599, of which 301,483,350 went to manufacturers of equipment, 69,324,540 were for replacement purposes, 10,767,831 were exported and 1,384,878 went to government agencies.

Industrial Controls employing electronics can be too good.

A friend of ours recently shipped an x-ray thickness gage to a distant rolling mill and then discovered that the ± 4-percent accuracy built in at considerable pain and expense was more of a handicap than a help. The mill works to 10 percent, and the instrument responded distractingly to variations in thickness considered normal.

Similarly, the instrument's undamped indicating meter jiggled more than plant workers were accustomed to. It had to be replaced with one having more internal damping and which was, incidentally, cheaper.

Following Up our recent item (p 60, Feb.) on the use of radiotelephone equipment by highway departments, here's a list of cities, counties and states already operating such gear:

Cities

Cincinnati, O., shared with Water Works
Dist. of Col., shared with Public Works
Keene, N. H., shared with Public Works
Rome, N. Y., shared with Public Works
Worcester, Mass., shared with Public Works

Counties

Brown, Wisc., shared with Police
Burlington, N. J., shared with Police
Chautauqua, N. Y., shared with Police
Chelan, Wash., shared with Police
Columbia, Wisc., shared with Police
Delta, Mich., shared with Police
Door, Wisc., shared with Police
Emmet, Mich., shared with Police
Genessee, Mich., shared with Police
Iosco, Mich., shared with Police
Jefferson, Wisc., shared with Sheriff
Kandiyohi, Minn., shared with Sheriff
Kenosha, Wisc., shared with Police
Kewaunee, Wisc., shared with Police
Kittitas, Wash., shared with Police
LaCrosse, Wisc., shared with Police
Oconto, Wisc., shared with Sheriff & Pol.
Oneida, Wisc., shared with Police
Onondaga, N. Y., shared with Police
Oswego, N. Y., shared with Police
Shawano, Wisc., shared with Police
Suffolk, N. Y., shared with Police
Winnebago, Wisc., shared with Police
Wood, Wisc., Police controlled and oper.

States

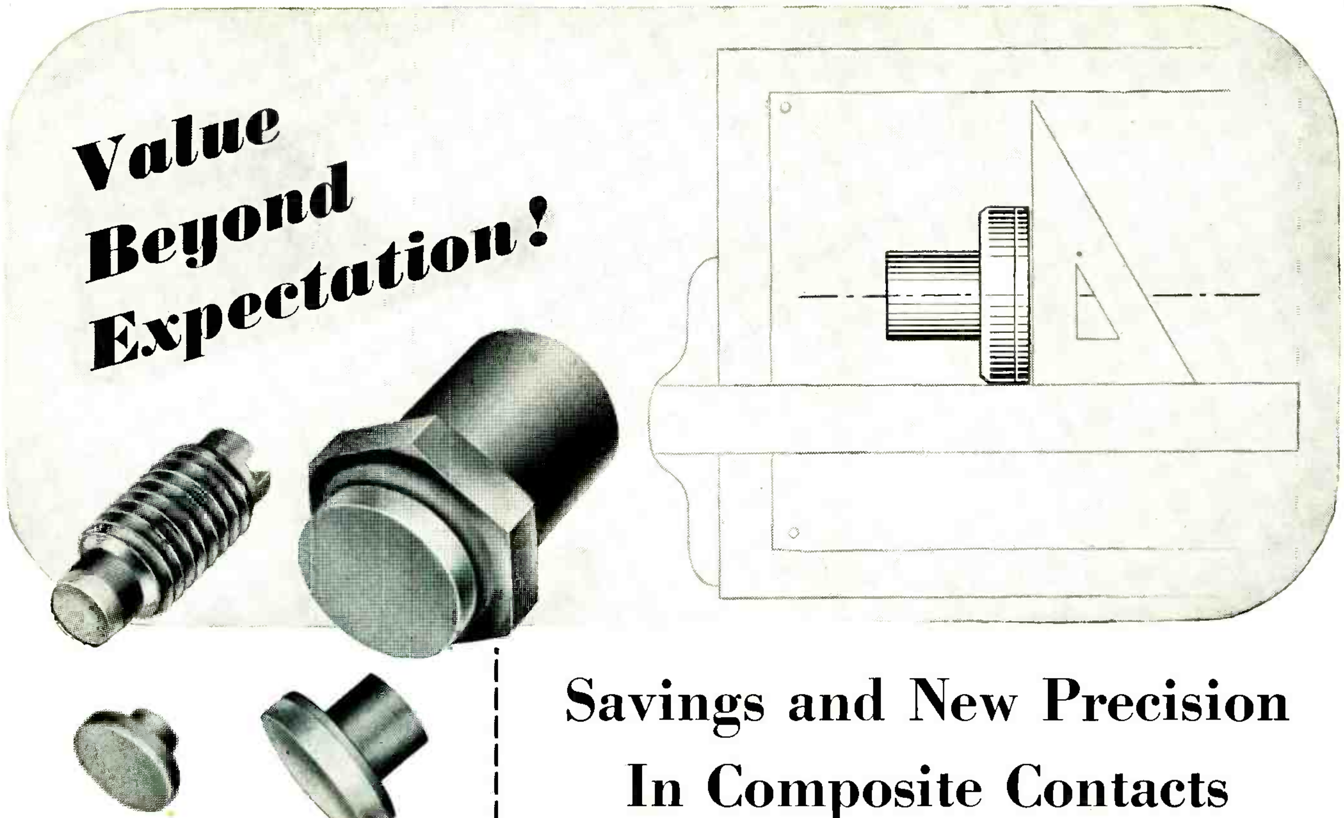
Arizona, shared with Police
Arkansas, shared with Police
California, shared with Police
Delaware, leased Tel. Co.
Idaho, leased Tel. Co.
Kansas, shared with Police
Mississippi, shared with Police
Montana, shared with Police
Oregon, shared with Police
Pennsylvania, shared with Police
South Carolina, shared with Police
South Dakota, shared with other depts.
Utah, shared with Police
Virginia, shared with Police
Washington, shared with Police
Wyoming, shared with Police

Zenith Phonevision sold 2,561 family-movie "tickets" to 300 Chicago subscribers, at $1 per ticket, during a recent one-month test. The average subscriber patronized the service 8½ times. During the first week he saw 3.1 movies; in the following three weeks he saw 1.8 movies per week.

The average picture reached 30 percent of the subscriber audience. The ten lowest-grossing pictures reached 22 percent.

Magnetic Recording Units having a retail value of $15,000,000 were produced during 1950 by the 46 licensees (including 13 foreign) of the Armour Research Foundation.

For Several Months, a certain surplus television camera has been advertised as having 3,350-line resolution. We suspect a misprint for, if true, this degree of resolution would permit delineation of a gnat's eyebrow laid out on a piece of black velvet.



Savings and New Precision In Composite Contacts *Result from Mallory Research*

Better performance and substantial savings for customers have resulted time and again from Mallory pioneering in the metallurgy and fabrication of contacts.

One recent Mallory development is a precision method for brazing silver or silver alloy discs to a base metal backing . . . holding the finished assembly to such close tolerances that machining is not required to square-up the finished piece. Compared with the high material cost of solid silver contacts . . . or the expensive finishing operation usually required in composite assemblies . . . this development permits important cost reductions for Mallory customers.

That's value beyond expectation!

Mallory contact know-how is at your disposal. What Mallory has done for others can be done for you.

In Canada, made and sold by Johnson Matthey and Mallory, Ltd., 110 Industry St., Toronto 15, Ontario

MALLORY SILVER CONTACTS

Fine and coin silver, while having desirable properties for many applications, do not provide the physical properties required for some applications. To cover these applications, Mallory has developed a series of silver base alloys. These alloys have such improved characteristics as greater resistance to wear, less sticking or metal transfer, and greater hardness. Mallory is fully qualified to recommend the best contact material for your design. Write today.

Electrical Contacts and Contact Assemblies

P. R. MALLORY & CO., Inc.

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SERVING INDUSTRY WITH

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Welding Materials

CROSS TALK

▶ **HIGH GEAR . . .** This issue contains five articles directly concerned with our national defense effort: on the situation in Washington (p 82), on the conservation of critical materials (p 84), on quartz crystals for military use (p 96), on subminiature tubes (p 108) and on a cobalt-saving electrostatic-focus picture tube (p 118). At least two dozen other articles are in the works and will be printed as fast as they can be written and edited.

This augmented editorial program on mobilization-period needs and plans is intended to match the pace of our industry. For months, the mobilization effort in the electronics business has been strictly cerebral: lots of thinking and planning, much viewing with alarm, but not much doing. The signs are now clear that the mental phase is about to be supplemented with some powerful muscular effort. We hope to be helpful in channelling the motor impulses from brain to hand. So, from now on, our readers can count on a substantial portion of "defense-effort" copy each month. Those cowering in ivory towers may object to this; but the times we live in leave no choice.

Bill MacDonald, managing editor of ELECTRONICS, has been spending the major part of his time for several months on this program. Much of this time has been spent in Washington (see "Washington Report," starting on next page), interviewing men in the three services, particularly in procurement, quizzing the communications people in civil defense and other agencies in and out of the Defense Department. Bill's story is the first of several to be written by our staff.

We realize that articles on mobilization could represent a dilution of the technical broth we serve each month, but we have no intention of neglecting our established cuisine. We have increased the number of editorial pages by about ten percent in recent months, relative to a year ago. Rest assured that so long as good technical papers are available we'll print them. But we'll also print everything worthwhile we can lay our hands on regarding the mobilization effort. Suggestions from readers on topics needing attention are solicited.

▶ **PRIDE . . .** We are pleased and proud of the record hung up by the television-receiver industry during the past five years, up to and including this month. An advertising executive who should know told us that the television set is the only major consumer product that has, in the face of the great inflationary trend, offered steadily improved performance at lower cost since the war. This trend is so familiar to insiders, and the circuit and component changes that made it possible so well understood, that we take it for granted. Older, better-established items like automobiles and refrigerators (and radio sets, for that matter) can make no such boast.

The recent cause for pride is the way in which industry engineers have found ways to design around shortages without affecting the performance of television receivers. At the moment we have seen only one such redesigned set in operation, the Philco model demonstrated to the press in February. It worked fine; in fact it had us fooled completely in a comparison test with the older, cobalt-incrusted model.

Cynics may argue that it's easy to lower the cost of a device originally priced too high, easy to "design out" components that never should have been designed in. But that's hindsight. It takes plenty of plain old-fashioned ingenuity and hard work to do it. And we're proud of the boys, at Philco and in every other plant, who did it.

▶ **REVERSE . . .** An engineer in the Westinghouse electron-tube organization reminds us that the trend to smaller, higher-performance, lower-cost tubes is a mixed blessing. Industrial users, including the biggest industrial user, the Defense department, still are leery of using tubes in many places where a mechanical or electrical linkage will do the job, albeit imperfectly, because "electron tubes are not sufficiently reliable." Our Westinghouse friend feels that the present urges in tube design development contracts, with a few notable exceptions, aren't making tubes any more reliable. He says a few development contracts should be let for new tube designs with reliability (life and constancy) as the prime objective. Let size, cost and efficiency go hang for once. Let's see what can be done toward making tubes as rugged and unchanging as a crowbar. We'll go along with that. The tube business is big enough to be able to take on a contract or two with a strictly reverse twist. Make the tubes bigger, more costly, lower the transconductance, lower the emission, lower the plate dissipation. But make 'em like the iron wheel of a freight car.

WASHINGTON Report

THE MOBILIZATION PROGRAM has created a number of major problems for manufacturers of electronic equipment. Five questions, in particular, are being asked by industry and realistic answers may constitute the key to 1951 business

By W. W. MacDONALD
Managing Editor
ELECTRONICS

THE AMERICAN ECONOMY may have to function in a state of suspension somewhere between war and peace for an indefinite period. The country's position is not unlike that which applied around June of 1941, with lend-lease well along, mobilization under way and Pearl Harbor off in the indeterminate future.

Suspension between war and peace is considered probable through 1951, though the situation could quickly deteriorate. This would explain why many top men in Washington think as they do . . . . why, for instance, most of them are preoccupied with the urgent business of stockpiling sufficient equipment to fight a major war for a year and only secondarily concerned with civilian problems at this time. It would explain apparent inconsistencies such as the tendency to press for production along certain narrow lines while manufacturers whose productive capacity will almost certainly be needed later are temporarily left to fend for themselves. It would also provide a key to many questions being asked by the electronics industry, such as those that follow:

How Much Military Electronic Equipment Business Will There Be in 1951?

Money available from last year and recently appropriated for use this year exceeds the amount actually spent on electronic equipment in the peak year of World War II. The Services have materially stepped up orders in the past two months by negotiating contracts rather than calling for bids. It must be remembered, however, that the appropriated dollar buys perhaps 50 percent less equipment today than it did in 1944. It should also be appreciated that initially needed military items are not only still in process of design in many cases but are chiefly large, complex and expensive units such as radar rather than the relatively small, simple and inexpensive items most manufacturers are at present equipped to produce for the civilian market. Volume orders for items such as walkie-talkies, which lend themselves to engineering and mass-production techniques similar to those used in the manufacture of television receivers, will come later.

There will be less military equipment business in 1951 than the average manufacturer expects, despite the size of the mobilization program.

How Much Civilian Business Can Be Done During the Year?

Civilian-equipment manufacturing depends upon the availability of materials, and there is a distinct possibility that the Government has arbitrarily slapped on many controls to guard against dissipation of supplies that may or may not turn out to be critical and intends to relax them piecemeal when it is statistically certain this can be safely done. There are already signs of such piecemeal relief, and it may help a little even this year. Some manufacturers, furthermore, have taken a second and less jaundiced look at available supplies and think they may be able to maintain near-normal production through the first six months of 1951 and perhaps into the early Fall. Scrambling from week to week for needed materials is now taking on certain aspects of a "routine emergency."

Substitute materials are at least a topic of active conversation in all branches of the electronics industry as are simplified circuits that employ fewer or less critical component parts. Many manufacturers have such materials and circuits well along in the development stage (see p 84) but it does not at this writing seem that the work is sufficiently advanced throughout industry to give much relief before Fall at the earliest. Meanwhile, maintenance of production is more likely to be accomplished by efficient expediting.

There will be more civilian equipment manufactured and sold during the year than at first seemed possible.

Are Military Orders Likely to Compensate for Lost Civilian Business?

Firms active in the field of electronics are best divided into four categories when seeking an answer to this question: (1) The dozen or so that are highly diversified and mass-produce radios and television sets as just one of many allied activities and who have done research and development work as well as manufacturing for the Services on a more or less regular basis since World War II; (2) The many manufacturers who have specialized almost exclusively in the production and intensive marketing of radios and television sets and who represent a lion's share of the industry's dollar volume in peacetime; (3) Companies primarily engaged in moderate production of popular consumer items but somewhat more diversified than the second group and already doing some business with the Services; and (4) Established firms whose chief interest is in research and development and prototype models rather than mass production.

The first group, considered from a top-management rather than a departmental standpoint, should do reasonably well with respect to overall business; it is in no worse position than the other groups with regard to materials needed for civilian-equipment production and is the first source of supply for the Services. The second group is in the most vulnerable position and little immediate relief is likely from Government; the Services are aware of the long-term desirability of preserving the facilities of this group for future employment on mass-produced military items but are too preoccupied with current needs to do much for it right now. The third group is sufficiently flexible with respect to what it can produce in small as well as large quantities, and with regard to overhead, to weather emergency controls. And the fourth group, not too much bothered by material shortages, is apt to do well; basic research work farmed out by the Services may run three times what it did last year.

Considering the industry overall, military business is not likely to compensate for lost civilian business in 1951.

What Are the Chances of Early Government Relief in Hardship Cases?

The Services have until recently considered it desirable to deal directly with a relatively small number of highly integrated companies in the field of electronics. Although this desire persists, the rapidly increasing need for more equipment is bringing with it new interest in possible secondary sources of supply. Even if this interest were not genuine, civilian agencies associated with the Services under the mobilization program are pressing in that direction, and the Marshall directive that business must be spread around wherever possible cannot be taken lightly.

In several agency offices the preparation of lists of secondary-supply sources amounts at this moment almost to an obsession. The fly in the ointment is the fact that the Services are not yet completely convinced that firms on their own lists, or those on lists prepared by the industry itself, are properly qualified. It will take some time to find out; a combination of engineering ability and production facilities that meets the needs of the military is the immediate need.

Aside from their search for additional prime contractors to back up those already on the books, the Services are starting to insist that some specified percentage of the work involved in prime contracts be subcontracted. There has, so far, been little suggestion or dictation as to who the subcontractors should be. Prime contractors operating under such contracts are for all practical purposes serving as "leaders," much along the lines recommended by certain segments of the electronics industry before the mobilization program went into high gear. Yet it cannot be said that the leader plan represents official Government policy, for it is just one of many methods being used to stimulate military equipment production.

Controlled materials are being released to alleviate individual hardship cases after critical study of each plea for help rather than blanket study of the situation in any particular branch of the industry. The criterion is the percentage of a manufacturer's productive capacity at present devoted to, or quickly capable of being devoted to, production of military equipment currently needed or in the near future likely to be needed by the Services. Where relief is given in such cases some overflow of material may be permitted to go into civilian goods if this seems desirable in order to maintain a fully integrated operation. Plant expansions are approved or disapproved on the same basis. Their immediate and future usefulness in the military program is considered along very specific rather than general lines; consideration of the long-range usefulness of civilian-goods manufacturing facilities may be the next phase of Government planning but it is not much in evidence right now.

The chances of early government relief in hardship cases are slim unless the production of military equipment can be brought into the picture in very concrete terms.

What Can Distressed Manufacturers Do To Hold Their Organizations Together?

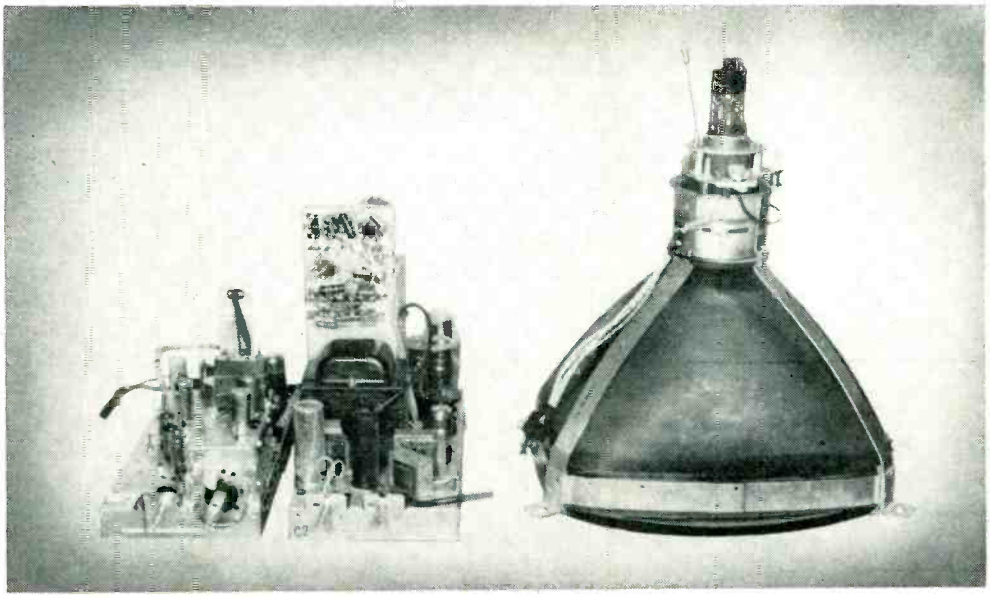
Direct contact with the Services is apt to produce immediate prime contracts only if a manufacturer can give very tangible evidence that he has the right kind of engineering and the right kind of production facilities to handle highly specialized military orders quickly. Neither a hat-in-hand nor a table-thumping approach is likely to get anywhere.

Subcontracts are best obtained by approaching prime contractors; a good word from the Services may help but can't do the whole job. Prime contractors, it should be noted, are being besieged by well-meaning people who have miscellaneous production capacity of a kind that cannot readily be used in the manufacture of currently needed military gear. Spot checks among prime contractors indicate that a certain amount of engineering, as well as productive capacity, is essential in a subcontracting organization despite the fact that overall engineering problems are handled in the leader plant. Good subcontracts for firms in the field of electronics need not, it should also be noted, necessarily be electronic in nature.

Maintenance of civilian-goods production depends almost wholly upon a manufacturer's mental and mechanical agility in devising ways and means of getting around material shortages. Here also it should be noted that it may be possible to utilize an appreciable part of a plant's engineering and productive capacity and, perhaps, even its distribution channels, by supplementing a line such as television sets with some nonelectronic product to which the market is receptive and for which critical materials are not needed.

Prime contracts, subcontracts, a conventional and an unconventional civilian-goods line . . . . at least three of these four may be needed to hold a distressed manufacturing organization together through 1951.

Conservation of



OLD PHILCO TV SET using permanent-magnet-focused picture tube weighed 39-pounds 10-ounces

Electronic equipment manufacturers, aided by component-part and accessory makers, strive to maintain civilian business during the mobilization period with its attendant government controls. Redesign of many items saves scarce metals. New television-receiver circuits provide performance equal or superior to older models

LOOKING AHEAD With RCA

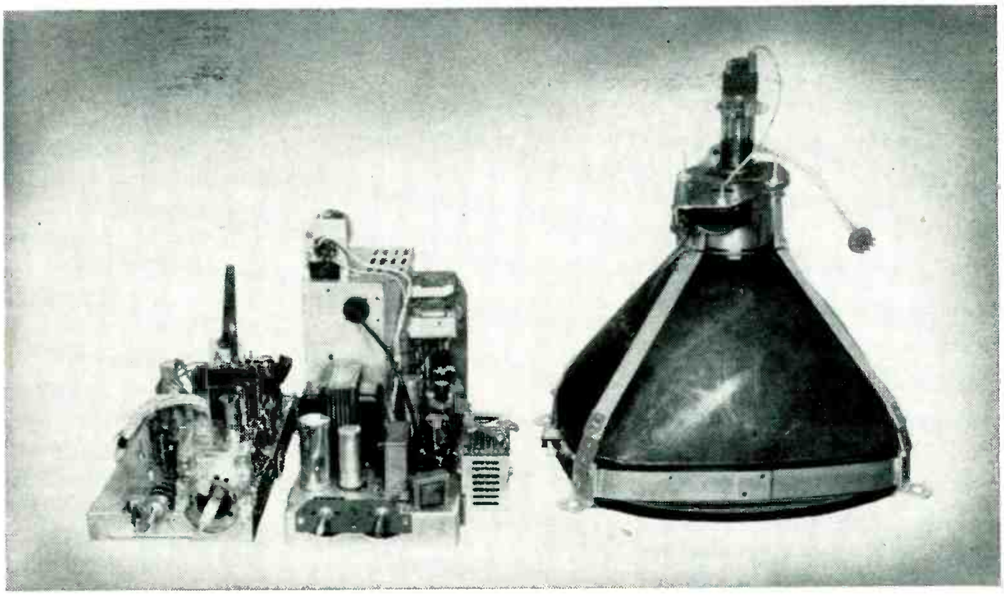
CRITICAL-MATERIAL SAVINGS per million 17-inch tv sets in current production, by comparison with similar models made in the last half of 1950, are shown in regular type. Additional savings expected to result from the use of electrostatically focused picture tubes later in the year are shown in bracketed italic figures

Material	Pounds Saved
ALNICO-5* in Beam Bender	4,400
in Focus Magnet	None *(310,000)*
in 8-inch Loudspeaker	72,000
in 12-inch Loudspeaker	135,000
ALUMINUM in Picture-Tube Protective Cup	62,000
in Shield	100,000
BRASS in Focus Magnet	None *(22,000)*
in 12-inch Loudspeaker	50,000
in Volume Control	12,200

Material	Pounds Saved
COPPER in Hookup Wire	47,000
in Capacitor Leads	11,850
in Power Transformer Shorting Band	190,000
in Tubes	33,000
NICKEL in Ferrite Cores	12,400
in Tubes	33,600
STEEL in Focus Magnet	500,000
STEEL in 12-inch Loudspeaker	142,000
TIN in Solder	50
ZINC in Focus Magnet	None *(310,000)*

* Alnico-5 contains 24 percent cobalt, 14 nickel, 8 aluminum, 3 copper and 51 percent iron

Critical Materials



NEW PHILCO TV SET using electrostatically focused picture tube weighs 27-pounds 8-ounces

FOR NEARLY TWO YEARS manufacturers of electronic equipment, aided by makers of component parts and accessories, have been quietly yet intensively searching for ways and means of holding the quality of their products up . . . in the face of increasing costs . . . without pricing themselves out of the competitive market. This has been particularly true in the field of television, where the prize for the factory that could produce a good set for less money, or a better one for the same money, has dangled tantalizingly ahead like a bundle of hay before a horse's nose for an even longer time.

Korea and the resulting declaration of a national emergency gave the program increased impetus and importance, for it is obvious that circuits which hold costs down do so by conserving materials as well as manpower. And conservation of critical materials is now essential if the industry is to preserve some civilian business without much immediate assistance from the Government. Even if this is done, other factors (see p 82) may still make the going tough in 1951.

Many firms are known to have new designs which conserve currently critical materials at least well along in the development stage, and production models will soon be out in the open for others to study. Philco has already announced a "performance-with-conservation" tv chassis and publicly demonstrated that it provides reception superior to 1950 models. No more costly to produce initially, the new design may actually cut costs at the factory level as much as 20 percent when the production peak is reached. The circuit diagram and other details have been offered to the industry. RCA's announced approach, while not identical, has the same objective of preserving or improving performance while at the same time conserving critical materials. This objective is already being applied to current production. Many ideas have been passed along to licensees, where they may very well set a pattern.

TV, Radio and Phonographs

RCA considered substituting electromagnetic loudspeakers for p-m types which used an average of 2.5 ounces of Alnico-5 but decided against it at this time because the field coil of a satisfactory substitute would have required an additional pound of copper, and copper as well as cobalt is in short supply. Instead, p-m loudspeakers are at present being retained but the largest magnet used weighs 1 ounce and the average weighs 0.75 ounce. Loudspeaker redesign also resulted in savings in associated brass and steel parts.

The average focus magnet for tv picture tubes produced last year contained 5 ounces of Alnico-5. Methods of reducing the amount of Alnico-5 required are being actively investigated and this work may later bear fruit. Meanwhile, a return to electromagnetic focusing has been considered and discarded. It would require the use of a focusing coil employing 2 pounds of copper wire and the direct current flowing in the coil would have to be adjustable. The power supply would have to be enlarged and this would require more copper and iron in the transformer or more electrolytic capacitors and selenium rectifiers, both of which use critical alu-

PHILCO'S NEW TV CHASSIS

ALUMINUM is conserved by

Replacing metal picture-tube frame-assembly straps with fabric.

Replacing metal picture-tube protective cup with Royalite and fibre.

Removing one electrolytic capacitor, unnecessary with electrostatic focusing.

Reducing amount of foil in other electrolytic capacitors, permitted by lowered power-supply voltage.

Saving is 0.563 pound per receiver, or 68 percent.

ALNICO-5 is conserved by

Replacing p-m loudspeaker with electromagnetic type.

Replacing p-m with electrostatic focuser.

Replacing Alnico-5 with Alnico-3 beam bender containing no cobalt.

Saving is 0.476 pound per receiver, or 100 percent.

BRASS is conserved by

Substituting steel for more critical metal in some hardware and screw-machine parts. Reducing amount of critical metal in control bushings.

CADMIUM is conserved by

Changing plating on deflection chassis and other metal parts to noncritical materials wherever soldering requirements permit.

COPPER is conserved by

Removing high-voltage power transformer entirely, employing a voltage-doubling selenium-rectifier system that reduces primary-power requirements 20 percent.

Using a smaller filament transformer.

Reducing amount of wire in audio-output transformer, using compensating circuit to maintain sound quality.

Using 24 instead of 22-gage hookup wire.

Shortening leads on tubular and mica capacitors.

Eliminating width and linearity coils by using new and more efficient deflection circuits.

Reducing size of horizontal-output-transformer coil by using new and more efficient circuit and new type-6V3 damper tube originally designed to facilitate reception of CBS color.

Replacing ribbon-type ground and mounting straps with wire.

Saving is 1.236 pounds per receiver, or 26 percent.

FERRITE is conserved by

Reducing size of horizontal-output-transformer core by using more efficient circuit and 6V3 damper tube.

Replacing deflections-yoke core with flake iron, a newly developed noncritical material.

Using new resistor-type width-control circuit, eliminating both coil and core.

Omitting linearity-control coil and core by using new circuits.

Saving is 0.529 pound per receiver, or 51 percent.

SILICON STEEL is conserved by

Using voltage-doubling selenium-rectifier system eliminating high-voltage power transformer.

Reducing size of audio-output-transformer core.

Saving is 7.399 pounds per receiver, or 58 percent

minum. Instead, a 17-inch electrostatically-focused picture tube has been developed (see p 118) and sets using this tube will be in production in the second quarter of 1951. As the supply of electrostatically-focused tubes increases, changeover is planned for all models. This may be possible **by July.**

Alnico-3, which contains no cobalt, is being used in beam benders in place of Alnico-5.

Nickel oxide is used in the ferrite cores of many radio and tv receiver coils. A change in the ferrite formula from 13 to 10-percent nickel oxide has already been effected and cores using the new material are in use. Laboratory work aimed at further reducing the amount of nickel oxide required contemplates substitution of some magnesium oxide, reducing the nickel-oxide content of cores to perhaps 5 percent. Early tests indicate that this might be possible by Fall.

Copper is being conserved by using a 20-mil-thick shorting band instead of a 40-mil-thick band in power transformers. The band remains 2 inches wide. Hookup wire has been reduced from 22 to 24-gage. Copper-clad steel wire is extensively used in place of pure copper wire for the leads on wire-wound resistors and chokes. The length of copper leads on paper and ceramic capacitors has been reduced. Television deflection yokes use almost as much wire as power transformers. Work now in progress to reduce the amount of copper in such yokes appears promising. The use of smaller wire gages in transformers may be possible due to reductions in power demand brought about by receiver circuit refinements.

Brass is being conserved by substituting steel, particularly in record changers. Shorter brass mounting bushings are being used on some variable controls. Aluminum cups heretofore used to protect the ends of picture tubes protruding from the backs of cabinets have given way to plastic. It may soon be possible to reduce chassis size, which would save steel and plating materials. Further word on this and other conservation measures is expected in May.

Conservation measures are by no means confined to electronic equipment such as television and radio sets. Efforts are also being made to save critical materials elsewhere.

Installation Material Savings

The subsidiary RCA Service Company is conserving critical metals by changing its television installation techniques.

Aluminum used in receiving-antenna masts was reduced 50 percent in the first quarter of 1951 by a number of methods. Conventional 8-foot aluminum masts were replaced by 6-foot steel masts wherever possible. The 12-foot aluminum masts using 1⅜-inch tubing with 0.083-inch wall and weighing 4.75 pounds were replaced by 10-foot aluminum masts using 1⅜-inch tubing with 0.072-inch wall and weighing 3.46 pounds. This saves 1.29 pounds of aluminum per unit, or 27 percent. The 12-foot masts will eventually be replaced by 10-foot masts made of 1⅜-inch, 16-gage steel tubing. Antennas themselves have been lightened by reducing the wall thickness of ½-inch aluminum tubing from 0.042 to 0.035-inch, saving 10.4 percent of the metal per installation. A stronger alloy is used, at slightly increased cost.

Copper is used in substantial amounts in television-receiver transmission lines. The length of the average line has been reduced from 123 feet per installation to 83 feet, which represents a net reduction of 32 percent. This has been accomplished by placing antennas as near as possible to receivers, by measuring required lengths of lines more accurately and by splicing and soldering short lengths. The 300-ohm ribbon used in the past had seven strands of 28-gage copper wire in each conductor and a pound of copper yielded 147.5 feet of line. A new type, considered adequate and soon to be used, employs seven strands of 30-gage wire, which will yield 234-feet of line per pound of copper and achieve a net saving of 33 percent.

Since copper may become still more critical, tests are being conducted on 300-ohm transmission lines using steel wire having a thin skin of copper. While the total weight of the metal would be approximately the same, the major part of the copper would be replaced by steel with a net reduction of 82½ percent in copper usage. Coaxial cable uses even larger amounts of copper. Tests are being conducted in cooperation with Anaconda Copper on thin aluminum-foil sheath to replace the copper-braid shield of such cables. Cable now used in multiple-antenna systems requires 22.5 pounds of copper per 1,000 feet. Twenty pounds of this total are in the shield. The type under development uses 2.5 pounds of copper plus ¾ pound of aluminum per 1,000 feet.

Steel usage will be increased as this metal is substituted for aluminum in receiving-antenna masts. It has, however, been found that such items as roof mounting brackets lend themselves to redesign. In one instance a bracket weighing 7.4 pounds has been replaced by two alternate types weighing 5.75 and 4.9 pounds respectively. The new brackets have adequate strength and save 29½ percent of the required steel.

Zinc is ordinarily used as plating for steel masts and brackets. A plastic coating is now being used and saves 0.32 pound of zinc per installation.

LOOKING BACK

IF the 7,463,800 tv sets produced by all manufacturers in 1950 had been like the new Philco design the following savings would have been realized

2,100 tons of ALUMINUM
440 tons of COBALT
4,600 tons of COPPER
2,950 tons of FERRITE
27,600 tons of SILICON STEEL

Electron Tube Metals

Even in electron-tube manufacturing a number of important conservation measures are being taken. A new anode material has been developed to a point where it seems to meet all the requirements as a substitute for pure nickel strip.

The new material is known as S8S1 and consists of a cold-rolled steel strip which is nickel-plated, coated with nickel oxide and then bonded to a deoxidized aluminum base and carbonized. In some applications a satisfactory carbonized strip can be made without nickel plating, by applying a nickel-oxide coating over plain steel and carbonizing.

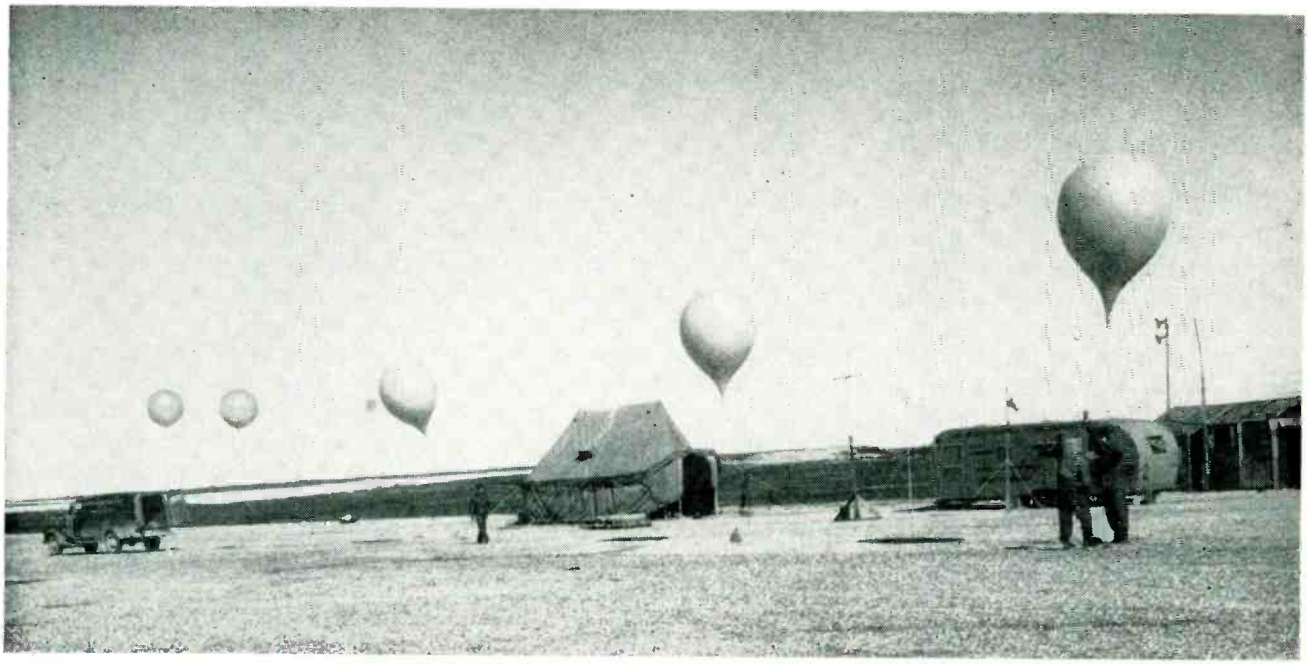
Nickel-plated Armco iron, a steel containing less than 0.05-percent carbon, is being extensively used as a substitute for pure nickel wire. In some instances 18–8 stainless-steel wire is being substituted for 18–12 stainless-steel wire. Possible substitution of 18–8 stainless-steel wire for nickel wire in certain non-critical tube components is being studied. An example would be getter loops.

Copper used in power tubes, which include many transmitting and industrial types, continues to resist substitution measures. The metal is being conserved in the manufacture of conventional receiving types by substituting nickel-plated-iron grid side rods for the copper rods which normally account for 90 percent of the copper used in such types. A 30-percent reduction in the amount of copper used as grid side rods appears possible by May. A further reduction of 19 percent in the amount of copper used in receiving types also seems possible by reducing the diameter of wires connecting tube elements and base pins.

The principal use of copper in cathode-ray tubes is in the exhaust tubulation, which is pinched off after the tube is evacuated. Glass is being substituted for copper tubulations as rapidly as possible.

The percentage of tin used in solder employed in tube manufacturing normally ranges from 35 percent to 60 percent. At the present time it is being held to 35 percent and in the near future nearly all tube production will use 20-percent-tin-content solder.

Additional techniques developed to permit continuance of civilian business will undoubtedly see the light of day in the next few months. The conservation of critical materials is by no means a static condition at this writing.—W.MacD.



Launching a balloon train at Fort Churchill, Manitoba. The balloons are inflated in the tent, out of the wind

Cosmic-Ray Radiosonde

Geiger-Muller counters trigger a multivibrator which keys a uhf transmitter. Received c-w pulses suppress superregenerative receiver hiss and a signal converter operates a recording oscillograph. Altitude and temperature are indicated by modulation intervals and frequency

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CERTAIN CHARACTERISTICS of cosmic radiation can be observed only near the top of our atmosphere. At an altitude of 100,000 feet, only 1 percent of the atmosphere remains overhead so measurements are generally made near this level.

During recent investigations[1] of primary cosmic radiation involving expeditions both to the tropics and to the arctic regions, the policy of confining observations to limited types of measurement per flight was adopted; many simple flights are preferable to a few complicated ones.

Reduction in weight permitted by limitation of instrument function simplifies launching procedure. It becomes feasible to conduct repeated flights with identical arrangements, thereby providing many independent checks. Complications associated with telemetering many types of information simultaneously are avoided. It is also possible to follow the progress of a flight without analyzing a photographic record, and audibly to determine counting rates as frequently as necessary to facilitate preliminary plotting of the results.

Hedging

Finally, the consequences of failure of any essential component are far less serious. Particularly valuable, moreover, is the "hedging" afforded against premature bursting of balloons. A flight which does not attain an altitude sufficiently high to provide all desired data need not be discounted as a total loss. The data may serve quite satisfactorily as confirmation

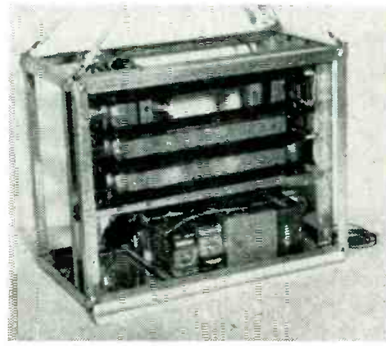


FIG. 1—The balloon-borne instrument without its Pliofilm cover

Joint program with the ONR and the AEC. Field expeditions sponsored by the National Geographic Society.

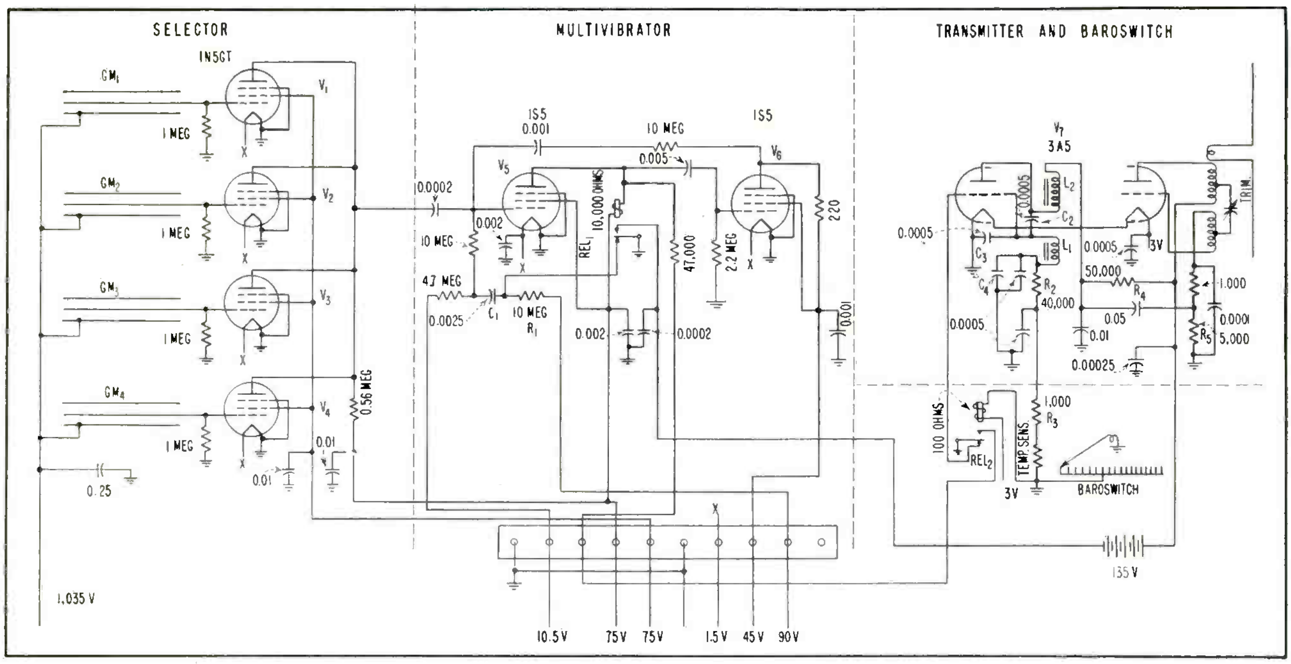


FIG. 2—The complete balloon-borne unit, with dashed lines indicating sub-assemblies

and Telemetering System

of results obtained in another higher ascent.

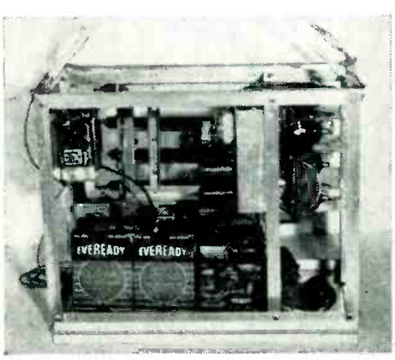
The complete balloon-borne instrument is shown in Fig. 1, while Fig. 2 is the circuit diagram. The assembled apparatus comprises several units, which are constructed and tested separately. These are:

(1) Geiger-Muller counters.
(2) Coincidence selector circuit.
(3) Multivibrator keying unit.
(4) Radio transmitter.
(5) Pressure and temperature elements.
(6) Power supply.

A terminal strip on the multivibrator chassis serves as the junction point between the battery pack and the various circuits. All connections are effected through a single connector plug. In accordance with instructions attached to the instrument, the finder of a landed flight disconnects the batteries, so that upon recovery they may be checked in a condition representative of that prevailing during the flight.

All components are mounted on an aluminum framework. The weight of the complete instrument, exclusive of lead absorber and rigging, is 10.3 lb.

Although temperatures of −55 C prevail in the stratosphere, the gondola is maintained close to room temperature by invoking the "greenhouse effect". A double layer of Pliofilm encases the apparatus, and the interior of the bag becomes heated by solar radiation.



Another view of the instrument pictured at the left

Counters and Selector Circuit

Each instrument contains four G-M counters arranged to record quadruple coincidences.

The individual counters GM_1, GM_2, GM_3 and GM_4 are 20 cm in length and 1 cm in diameter. The filling, consisting of a mixture of 86 percent argon and 14 percent butane at a total pressure of 12 cm of Hg, provides stable self-quenching operation. The counting-rate plateau exceeds 200 volts and is independent of temperature between −60 C and +50 C. The net efficiency of the counters exceeds 99 percent.

Tubes V_1, V_2, V_3 and V_4 comprise a mixing circuit into which counter pulses are introduced for the purpose of selecting fourfold coincidences. Discrimination (ratio of the amplitude of a fourfold coincidence to a threefold event) at normal operating voltages exceeds 50. Time constants are such that when background cosmic-ray intensity attains a maximum value in the stratosphere the rate of chance coincidences between genuine threefold events produced by single particles traversing three counters and a discharge arising from an unassociated particle passing through the fourth counter is negligible.

Multivibrator Keying Circuit

When a negative pulse from each of the G-M counters cuts off all of the associated selector tubes a positive pulse sufficient to overcome the bias appears on the grid of V_5. This positive pulse produces a negative pulse at the grid of V_6, thereby cutting off the latter normally conducting tube. A portion of the positive pulse which is consequently produced at the plate of V_6 is fed back to the grid of V_5, thereby maintaining the latter in the conducting stage for a period dependent upon the associated time constants. Plate current thus flows through the load of V_5, relay REL_1, for a time sufficient to permit the separation of the normally closed contacts. Ungrounding of the junction $C_1 - R_1$ results in the application of a large positive voltage pulse to the grid of V_5, which maintains the flow of current through the relay for a relatively long time interval conveniently adjusted by changing capacitor C_1.

Sufficient time-delay to record a c-w radio signal could be attained with a conventional multivibrator arrangement but the method involving feedback from the keying relay affords a considerable economy in battery drain.

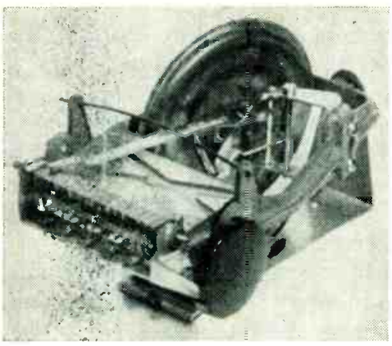


FIG. 3—The baroswitch. It signals height of ascent

Radio Transmitter

The radio transmitter, a modified version of the type utilized in meteorological radiosondes, employs a twin-triode tube, V_7, of which one-half serves as a modulator while the other acts as ultra-high-frequency oscillator. The modulator is of the "trigger" type, oscillating at the frequency of the tuned circuit formed by L_1, L_2 and capacitors C_2 and C_3. The oscillating frequency is approximately 1 megacycle per second. The oscillations are intermittent, being controlled by the resistance-capacitance circuit composed of capacitor C_4 and the resistance network formed by R_2, R_3 and a temperature-sensitive resistor.

The uhf oscillator operates at 72.2 megacycles. Contrary to conventional procedure, oscillations occur only when the modulating oscillator is off. When the latter is on, its plate draws current and a negative voltage appears across resistor R_4. This induces a negative voltage across R_5, which is a portion of the uhf grid resistor. This voltage blocks the oscillator.

The output of the uhf oscillator is coupled inductively to a half-wave vertical antenna by means of a single turn at the center of the antenna adjacent to the plate coil.

Pressure and Temperature Elements

Barometric pressure is measured by a baroswitch. The contact surface, visible in Fig. 3, consists of 80 silver contacts alternated with insulating spacers. Every fifth contact is twice as wide as the others. As the instrument rises through the atmosphere, the evacuated aneroid diaphragm expands, causing the contact arm to move across the commutator. The baroswitch is calibrated under a bell jar, so that the pressure corresponding to any contact number is determined. In the present application, only certain contacts are operative.

Whenever the contact arm passes over one of the retained contacts, relay REL_2 in Fig. 2 is actuated. This ungrounds the grid of the modulating oscillator, permitting it to function with intermittent oscillations, and also closes the transmitter key relay REL_1, thereby applying plate voltage to the uhf oscillator. The frequency of the audible tone which is thus transmitted varies as a function of the temperature of the temperature-sensitive element, which is a resistor composed of semiconducting material having a high negative temperature coefficient. The temperature measurement depends upon the ratio of resistance at one temperature to that at any other. Calibration consists of observing

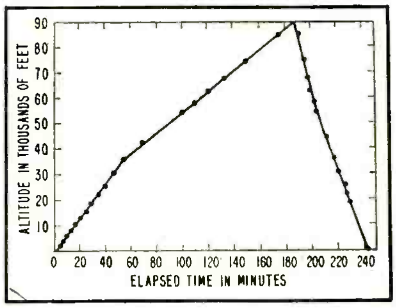


FIG. 4—Time-altitude record of a typical flight

the audio frequency at any single temperature. The frequency is determined by beating the incoming tone in headphones against the output of a calibrated audio oscillator with a continuously variable frequency control and setting the latter for zero-beat.

During a flight, the *on* and *off* times of the contacts are logged and from this the altitude-versus-time curve, Fig. 4, can be plotted. Coding afforded by close-spaced groups permits positive identification in the event that any of the contacts fail to function.

Pressure measurements are reproducible to within ± 1 mm of Hg in the high-altitude regions, and, although any individual reading could be subject to error owing to occasional frictional effects, altitude determinations based upon the plotted curve minimize any such uncertainties.

In the range of normal room temperatures which usually prevail within the instrument during flight the temperature may be determined within ± 1 C.

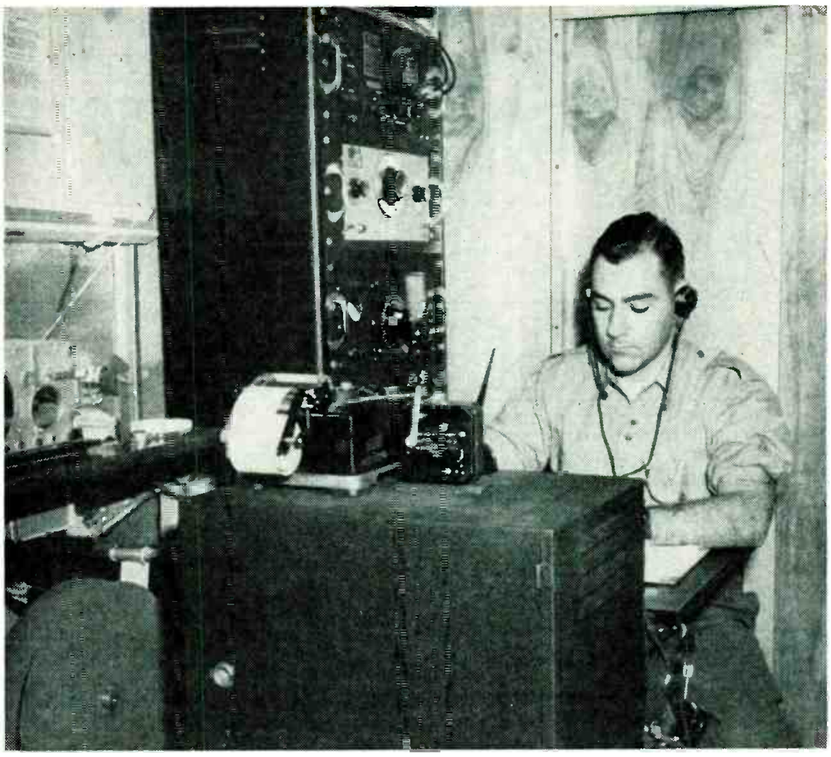
Power Supply and Tests

An assembled battery pack is visible in Fig. 1. Separate supplies are provided for transmitter and counter circuits. The high voltage for the counters is furnished by three Eveready type-493 batteries in series with six type-412 batteries, providing a total of 1,035 volts. With a unit of this type, the apparatus will operate satisfactorily for 12 hours.

Extensive tests are conducted upon each instrument. Each one is operated in a vacuum chamber and indications of corona discharge or sparking are continuously watched for as the pressure is lowered until a value much lower than the minimum encountered in practice is attained. The observations are repeated as air is slowly admitted into the chamber. High voltage breakdown is avoided by the application of Superla wax at points susceptible to arcing.

All tubes are painted prior to assembling of the apparatus, so as to render them opaque. This obviates photoelectric effects, particularly at high altitudes where ultraviolet intensity increases considerably. The instruments are also completely enclosed and masked with tape. Tests of the coincidence-selector circuit are conducted with a generator which furnishes pulses nearly identical with those characteristic of the counters.

Each instrument is required to operate reliably over a wide range of battery voltages. The transmitter is tested with respect to signal strength and frequency-split between tones and counts.



Cosmic-ray radiosonde receiving and recording equipment, inside the trailer

Ground Receiving Station

A block diagram of the ground receiving system is shown in Fig. 5.

Information is transmitted in the form of a c-w radio-frequency pulse corresponding to each selected cosmic ray event, while audio-modulated signals indicate atmospheric pressure and temperature within the gondola.

The c-w pulses suppress the superregenerative hiss of the radio receiver, and, actuated by the signal converter, a direct-inking oscillograph records a mark on a moving paper tape. The audio-frequency oscillator is used for temperature determinations, and the cathode-ray oscilloscope serves for monitoring purposes. The time recorder inserts a pip on the tape every minute, and the manual key permits the entry of coded notations on the moving tape.

Radio Receiver

In addition to simplicity, compactness and sensitivity, the fundamental principle of operation of a superregenerative receiver makes it ideally suited for this particular application.

Inasmuch as the recorder can be actuated only by the interruption of the superregenerative hiss, local interference such as ignition noise does not produce a record on the paper tape. The broadness of tuning is also desirable in view of gradual drift in the transmitter frequency which may occur during the course of a flight, and because of the slight split in frequency between the short c-w pulse indicating counts and the relatively lengthy pressure signals.

The receiver used employs a four-tube circuit consisting of one stage of tuned r-f and a self-quenching detector, transformer-coupled to a first stage of audio which, in turn, is resistance-coupled to a power-output stage.

A motor-driven, vertically polarized folded-dipole antenna with director and reflector constitutes a directional array which provides ample gain for the detection of signals transmitted over distances of several hundred miles under line-of-sight conditions. For measuring signal strength, and orienting the antenna for maximum re-

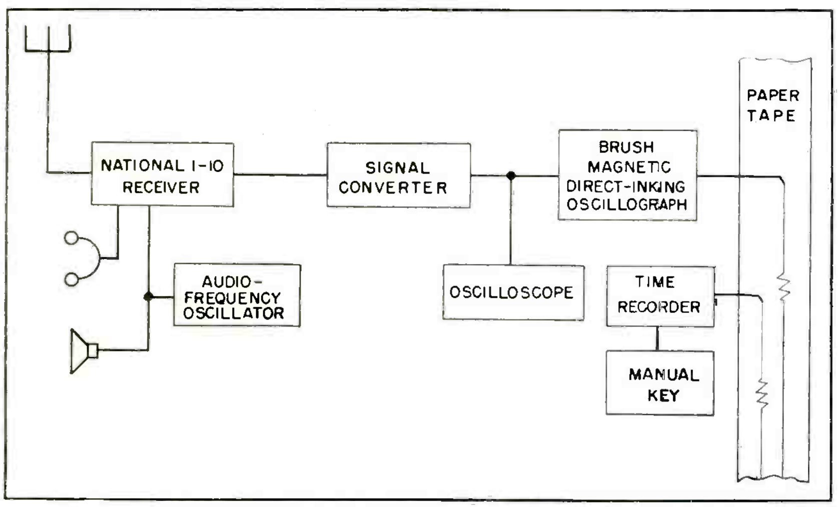


FIG. 5—Receiving and recording setup used on the ground

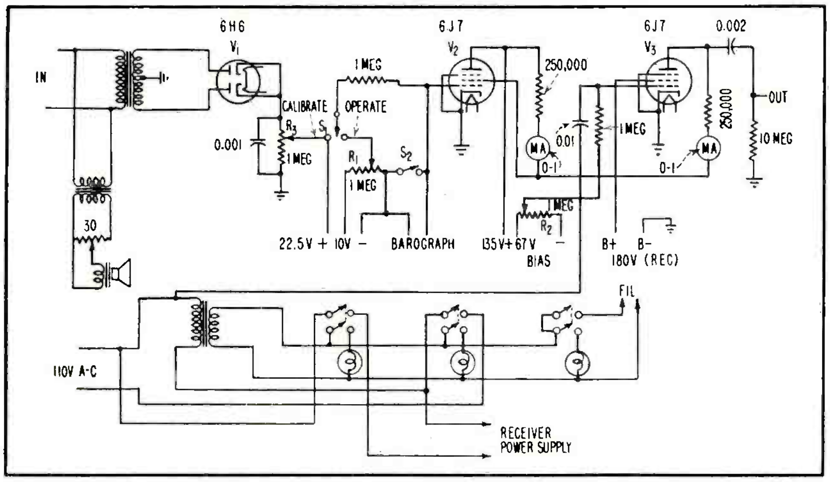


FIG. 6—The signal converter. It translates c-w radio pulses received from the balloon into pulses of 60-cycle power that operate the recorder

sponse, it is switched to a Hallicrafters S-36 superheterodyne. A Panoramic adapter is a useful adjunct.

It is possible to determine the landing point of a flight on the basis of the bearing of the antenna, and the altitude at which signals cease during the descent. Estimates are usually correct within 10 miles.

Signal-Conversion Circuit

Audio output of the radio receiver is fed into the circuit shown in Fig. 6. In the normal state, the hiss noise after fullwave rectification by V_1 provides a positive potential which bucks the negative bias of V_2 by an amount sufficient to maintain only a small plate current. Under these conditions, V_3 is nonconducting.

When superregenerative hiss is suppressed by an incoming c-w pulse, the grid of V_2 swings to a negative voltage greatly exceeding that corresponding to zero plate current, thereby turning V_3 on. This permits a small 60-cycle a-c signal which is fed on to the grid of V_6 to appear at the output of the converter circuit.

It is apparent that the operation of this electronic switch is independent of signal strength, provided only that the latter exceeds a minimum value. Although rarely necessary in practice, the maximum sensitivity of this circuit permits operation on a practically inaudible signal. Sensitivity adjustments are R_1 and R_2.

Although electrical interference cannot produce spurious output pulses, by virtue of the fact that noise increases the positive bias, a sufficiently intense disturbance can inhibit the transmittal of real events to the oscillograph. Compensation for noise background is provided by the adjustment of potentiometer R_3. Counts which may be missed occasionally because of transient interference are inserted manually by depressing pushbutton switch S_2.

Switch S_1 is normally in operate position during operation with the radio receiver. However, the calibration of cyclic barographs of the Olland type necessitates recording on paper tape, and this is accomplished with S_1 in calibrate position and the barograph contacts connected as indicated.

The type-BL201 magnetic oscillograph[2] utilized for continuous recording of signals has been described in detail elsewhere[3].

Field Techniques

A self-contained mobile laboratory serves as the base of operations. A Landola house-trailer contains the ground-station receiving equipment, work bench and living facilities, including toilet, shower, kitchen and four bunk beds. The trailer is completely shielded electrostatically.

Ballooning techniques which cause flights to rise rapidly (approximately 800 feet per minute) through the lower atmosphere and then more slowly from 40,000 feet to the ceiling altitude are used. Rates of rise between 200 and 500 feet per minute in the upper regions, considerably smaller than have been customary, reduce statistical uncertainties. The number of counts recorded by a given instrument is inversely proportional to the ascent rate. It is also advantageous for descent to commence immediately after the ceiling is reached, so that the original curve can be retraced.

Altitudes are determined from measured pressures on the basis of the standard atmosphere[4]. Actually, as far as the cosmic-ray data are concerned the pertinent quantity is atmosphere pressure, which represents the amount of air above the instrument. However, although altitudes are ultimately converted back to pressure in the final analysis, it is convenient to plot the performance curve as a function of time because of the straight-line relationship on a linear scale. The rate of rise in the upper atmosphere is constant, and this permits extrapolation above the highest pressure mark.

The composition of the balloon train depends upon desired performance and weight of the load. For example, four Dewey & Almy type - J1400 neoprene balloons (weight approximately 800 grams) and two J100 balloons (weight approximately 100 grams) may be inflated in such a manner that the larger balloons do not provide sufficient lift to support the instrument initially. The smaller pilot balloons, which provide initial free lift, burst at a relatively low altitude after the larger balloons have been expanded sufficiently by superheating resulting from adsorption of solar radiation to lift the train the rest of the way.

The free lift of each balloon must be controlled carefully if a slow ascent rate is desired, and this can best be accomplished inside a shelter out of the wind.

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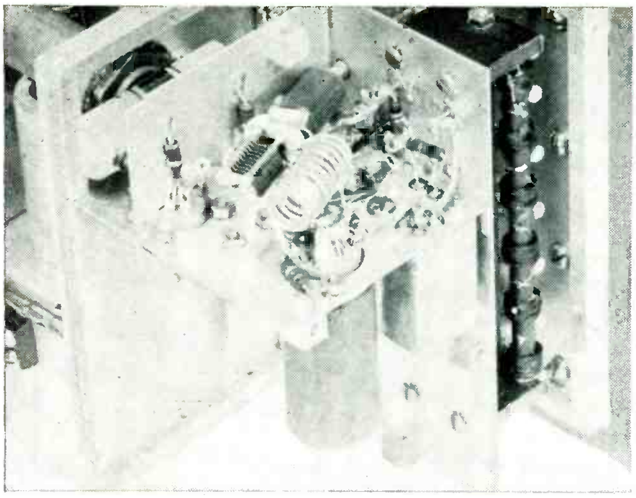
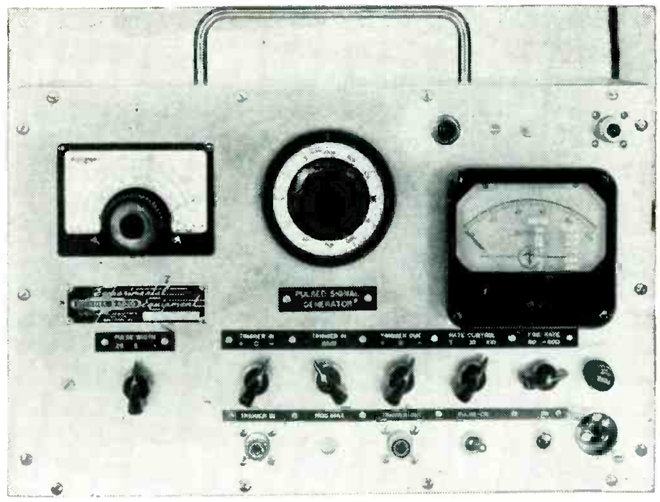


FIG. 1—The r-f section with the shield removed



Front-panel view of the pulsed-signal radar test generator

Radar Test Generator

Triggered or free-running pulses and c-w signals are provided from 47 to 76 mc for testing radar and other wide-band i-f circuits. Output is variable from 0.1 microvolt to 0.1 volt with pulse widths of 0.25, 0.5 and 1 microsecond

By KEEFER S. STULL

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DURING THE DEVELOPMENT of sensitivity time-control circuits for a new radar set, it was found that a special pulsed signal generator with continuously variable output voltage over a wide range and a very low c-w background level was needed. Such an instrument was designed and built for laboratory use and has been employed in many applications.

The generator has either pulsed or c-w output, from 0.1 μv to 0.1 volt, into a 50-ohm load over a frequency range of 47 to 76 mc. It can be triggered or operated free-running and gives output pulses of $\frac{1}{4}$, $\frac{1}{2}$, or 1-μsec duration. The output attenuator is direct reading and the instrument has an output meter for calibration purposes.

Circuit Analysis

The r-f section uses a push-pull variable-frequency Hartley oscillator which is capacitively coupled to a push-pull power amplifier. The amplifier is driven class C and has a self-resonant tank coil which is loaded to give approximately a 15-mc bandwidth with a center frequency of 60 mc. The tank coil is arranged to feed energy into a short section of wave guide operating below cutoff which is used as a calibrated attenuator.

In order to get good energy transfer into the guide with a uniform wave distribution, the coil is wound with a flat face mounted very close to the guide opening. A movable pickup loop in the attenuating guide is made from a 50-ohm resistor to give the proper source impedance to feed a 50-ohm coaxial cable. This cable ends on the front panel and must be externally terminated in a 50-ohm load.

The r-f section is completely enclosed in a tight silver-plated box internally subdivided into four sections. The output tank is carefully isolated in one of these subdivisions to prevent stray oscillator pickup and thus reduce the c-w background level during pulsed operation. All power wires enter the r-f section through button-type feedthrough capacitors and series 60-mc traps which are completely isolated along with the pulse-forming line in another one of the subdivisions. The oscillator and modulator wiring is in the third section while the fourth contains the tubes, each with an individual shield.

Figure 1 shows a view of the r-f section with the shield removed. In the foreground is the inverted oscillator tube with its coil and tuning capacitor directly above it. To the left of the oscillator tube are the

6AS6 amplifier tubes with a shield dividing their bases. This shield prevents coupling around the tubes while they are cut off between pulses, thus keeping down the c-w background level. The output coil can be seen behind this shield. It is wound on a semicircular form with the flat side directly opposite the opening in one end of a short section of circular waveguide.

At the other end of the waveguide, but not visible in Fig. 1, are the rack and pinion which move the 50-ohm pickup loop along the length of the waveguide. A short piece of flexible coaxial cable takes the ouput to the front panel terminal behind which is mounted the crystal rectifier for measuring the output voltage. Directly to the right of the oscillator tube is the pulse transformer. Behind the oscillator tube is the 6D4 modulator, the socket behind the oscillator coil. Part of the pulse-forming line can be seen behind the shield to the right of the pulse transformer.

Output Measurements

A 1N21C crystal and a 200-μa meter with a variable resistor in series, see Fig. 2, are used to measure the output voltage during c-w operation. With the pickup loop in the end of the waveguide near the output coil, the voltage at the output terminal is over 0.1 volt, which is high enough to give a large reading on the output meter. This amount of output can be accurately measured by some external means and then the meter calibrated accordingly.

The meter gives no useful indication for outputs below 0.01 volt and it would be difficult to measure lower output accurately by other means, particularly in the microvolt region. However, if some higher value of output is known exactly, then all lower values can be accurately determined because of the known exponential rate at which a signal decreases in amplitude with distance along a waveguide operated below the cut-off frequency.

The dial which moves the pickup loop can be directly calibrated in output voltage providing its index can be adjusted to give a correct reading at some high value of output.

One good method of measuring the output voltage is with a thermistor bridge. The thermistor must be shunted with a noninductive resistor to give a parallel resistance of 50 ohms for proper termination. The bridge power reading must then be corrected for the power lost in the shunt resistor to give full output power. The voltage is found from the formula $E = \sqrt{PR}$.

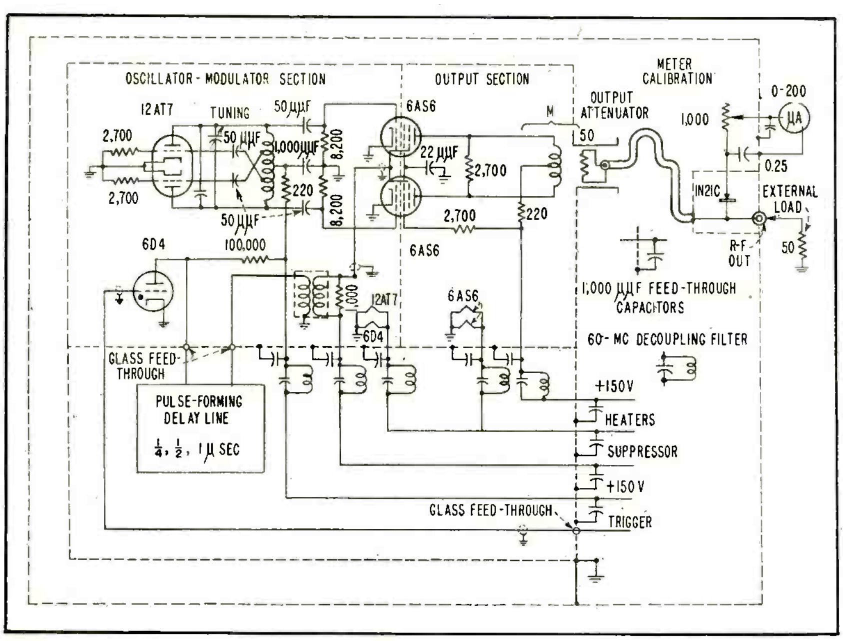


FIG. 2—Schematic diagram of the r-f section of the radar test generator

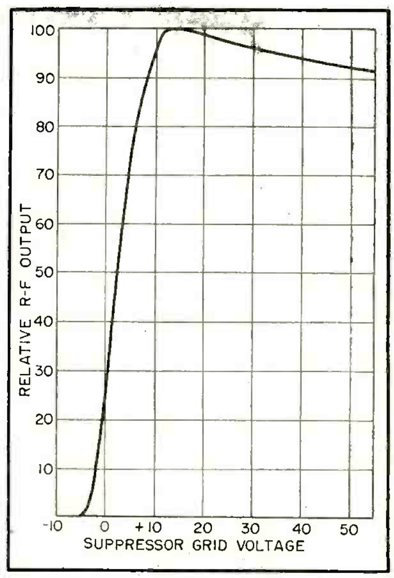


FIG. 3—Characteristic curve of 6AS6 class-C r-f amplifier with constant control-grid excitation

The output meter can also be calibrated without applying power to the signal generator by feeding an audio signal into the r-f output terminal to simulate an r-f signal. If a frequency of about 10 kc is used, it should be high enough to give crystal characteristics corresponding to r-f conditions but still low enough to be measured with a vtvm.

It is necessary to gate the circuit to give a clean pulsed r-f signal of known amplitude. It is not practical to gate the oscillator or amplifier control grids because then there will be a reaction on the oscillator frequency. It is necessary for the oscillator to run continuously under the same load conditions for stable operation. Therefore 6AS6's were chosen for the r-f amplifiers because their high suppressor transconductance permits them to be suppressor modulated.

It was found that when the amplifier grids were being excited by the oscillator, the plate current could be completely cut off with approximately -5 volts on the suppressors and as the suppressor voltage was increased from -5 volts up to $+12$ volts, the plate output would increase almost linearly. Any further increase in suppressor voltage causes only a slight change in output, see Fig. 3. When the suppressors are driven positive there is a flow of current in the suppressor circuit, therefore they must be driven from a fairly low impedance.

Pulsed Output

For pulsed output the 6AS6's have a suppressor bias of −7 volts which keeps the plate current safely cut off. If the suppressors are then gated with a positive pulse having an amplitude greater than 19 volts, the peak output will be fairly constant because of the saturation effect of the suppressor as mentioned previously. This makes it possible to get a measureable peak pulse amplitude, for if the tubes are operated c-w with more than +12 volts on the suppressors the c-w output will equal the peak pulsed output and can be measured, as described previously.

When the amplifier plate current is cut off by the suppressor, the cathode current is not greatly affected, and it all tends to flow to the screen grids. To prevent excessive screen dissipation under these conditions the screen current is decreased by feeding the screens through a series resistor to drop their voltage. However, when an output pulse is required, and the suppressors are driven positive, the screen voltage must rise instantly, thus greatly limiting the size of the screen by-pass capacitor that can be used. A compromise must be reached between r-f degeneration and a screen-circuit time constant which will allow it to follow short pulses.

The modulator consists of a gas triode used to discharge a lumped-circuit pulse-forming line of variable length coupled to the suppressors of the 6AS6's through a pulse transformer. The number of L-C components in the line can be switched from the front panel for pulses of 1, ½ and ¼ μsec duration.

The positive pulse output is sufficient to drive the suppressors well into saturation. The d-c bias on the grid of the modulator can be adjusted from the front panel between the limits of −7 and −33 volts for best operation. The d-c bias for the 6AS6 suppressors is selected by the pulse—c-w switch.

For c-w operation, a bias of +20 volts is obtained from a voltage divider to allow the 6AS6's to operate at suppressor saturation. For pulsed operation a bias of −7 volts is applied, just enough to safely hold the 6AS6 plate current cutoff except when positive pulses are supplied from the modulator.

Trigger and Power Circuits

The remainder of the instrument, consisting of trigger and power circuits, is built on a separate chassis, see Fig. 4. The triggering pulse for the modulator is obtained from a driver in the form of a blocking oscillator which is biased to prevent a free-running condition. The driver is triggered by a cathode follower whose input is the voltage across a ring tank in the plate circuit of a triggering blocking oscillator. The circuit is arranged so that the cathode-follower grid does not swing positive until approximately 3 μsec after the ring tank is excited by the triggering blocking oscillator. This triggering blocking oscillator also drives a phase-splitting tube directly, without delay, to give either a positive or negative external trigger output. This is useful for triggering a synchroscope just before the r-f output pulse so that its effect can be easily observed in a test circuit.

The triggering blocking oscillator can be allowed to run free over a frequency range of approximately 70 to 10,000 cps or a negative bias can be applied to its grid for external triggering. The external positive or negative trigger pulses are fed through a gain control, phase-splitting tube, phase-selector switch, and cathode follower to drive the triggering blocking oscillator. When the pulse—c-w switch is in the c-w position the triggering blocking oscillator is made inoperative by opening its cathode circuit. This switch also chooses proper bias for the 6AS6 suppressors and compensates for the different current requirements of pulsed and c-w operation.

The plate supply uses two 6X4's in parallel in a full-wave rectifier circuit with a capacitive input filter to give +260 direct volts. An OA2 is used to supply +150 volts regulated to the r-f section. The heater winding plus another 6.3-volt winding are connected in series to drive a voltage doubler using selenium rectifiers to supply the negative bias voltages required. The a-c input is fused and passes through a shielded 60-mc filter to prevent r-f from leaking out along the power line.

The author wishes to acknowledge the cooperation of Richard Whitehorn and Malcolm Clark in the design and construction of this instrument.

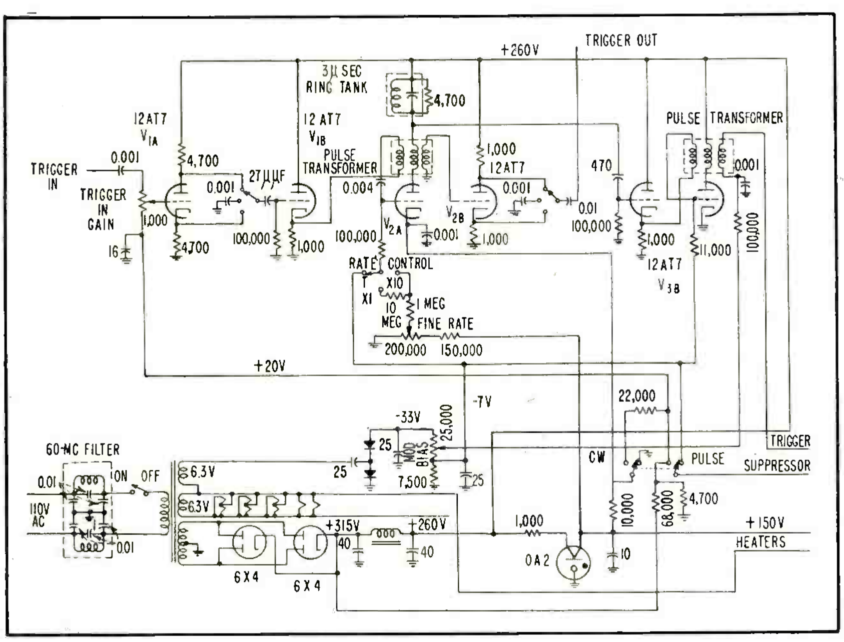
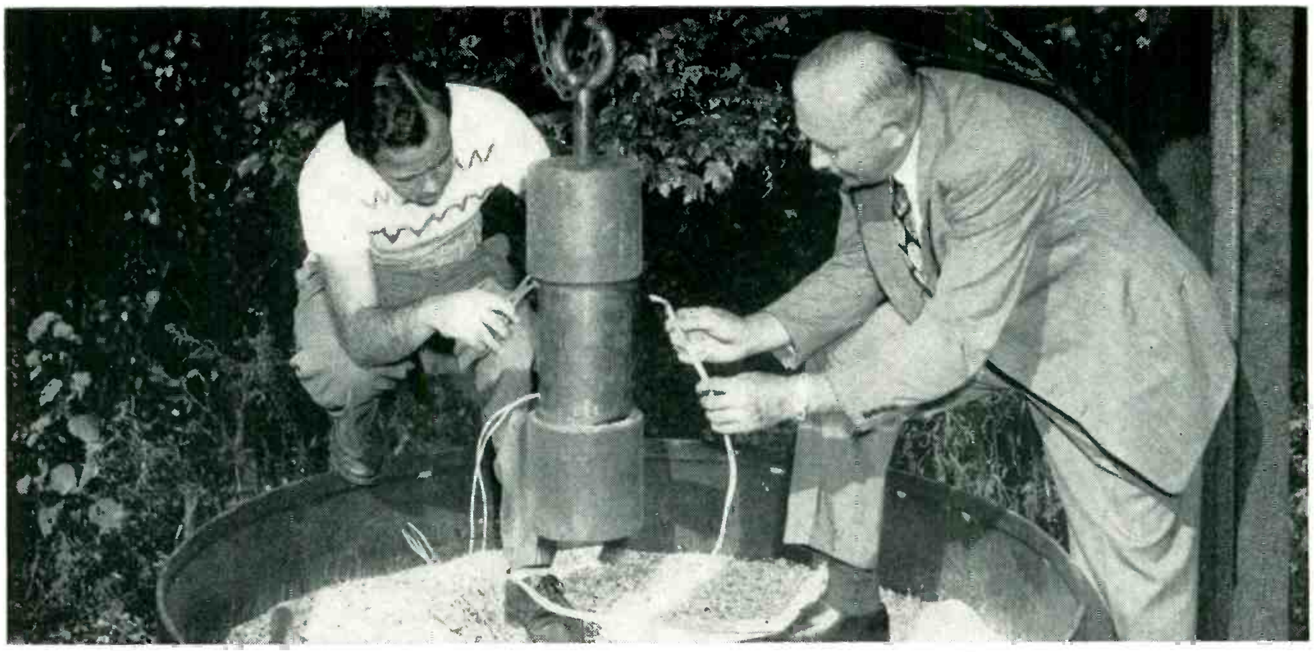


FIG. 4—Schematic diagram of the power supply and trigger chassis for the generator



Harvesting of an autoclave in which quartz crystals have been grown at high temperature and pressure. Operators are removing thermocouples that measured temperature differential along length of steel container. Wire frame in bomb supports wafer-thin quartz seed plates on which crystals grow

Growing Quartz Crystals

Perfected technique gives large, perfect crystals in quantities that mean eventual independence of Brazilian sources. Quartz scrap, alkaline solution and seed plates are sealed into steel bomb by welding, then heated to 400 C to develop 15,000 psi for optimum growth

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Murray Hill, N. J.

OUR COUNTRY is again acutely conscious of shortages of raw materials important to the defense program.

During World War II, one of the most critical shortages of a material necessary for the successful conduct of hostilities was that of natural quartz crystals. Millions of small plates, of the order of one-half inch square and one-tenth of an inch thick, made of quartz free from flaws and twinning, were vital to the operation of mobile radio transmission equipment. After the war, even though the demand for quartz for military use was greatly reduced, the Bell System had difficulty in getting sufficient amounts of the larger-sized quartz crystals for use in telephone communications apparatus.

These circumstances emphasized the need for research in developing commercial procedures capable of producing useful large quartz crystals artificially, so that the government and the communications industries might be independent of sources of supply outside the United States. The fact that the Brazilian government was considering placing an embargo on the export of raw quartz crystals, to conserve one of its more important natural resources, added to the urgency for such research.

Background

Geologists have long speculated on how nature formed large, clear quartz crystals. Their efforts to solve the problem in the laboratory date back about 100 years. A comprehensive review of this work was published by Kerr and Armstrong in 1943.[1] The most significant achievement noted in this summary was that of Spezia in Italy[2], who grew about 5 mm additional length on the ends of a natural Japanese twin quartz crystal. This was accomplished in a pressure vessel in alkaline solution in a period of six months.

After the recent war, reports were received from Germany on the work of Nacken[3] on growing quartz crystals. This geologist, at the University of Frankfort, had worked on various aspects of crystal growth for more than ten years and eventually succeeded in growing quartz by a hydrothermal method. With Nacken's results as a starting point, the Bell Telephone Laboratories[4] and others have made

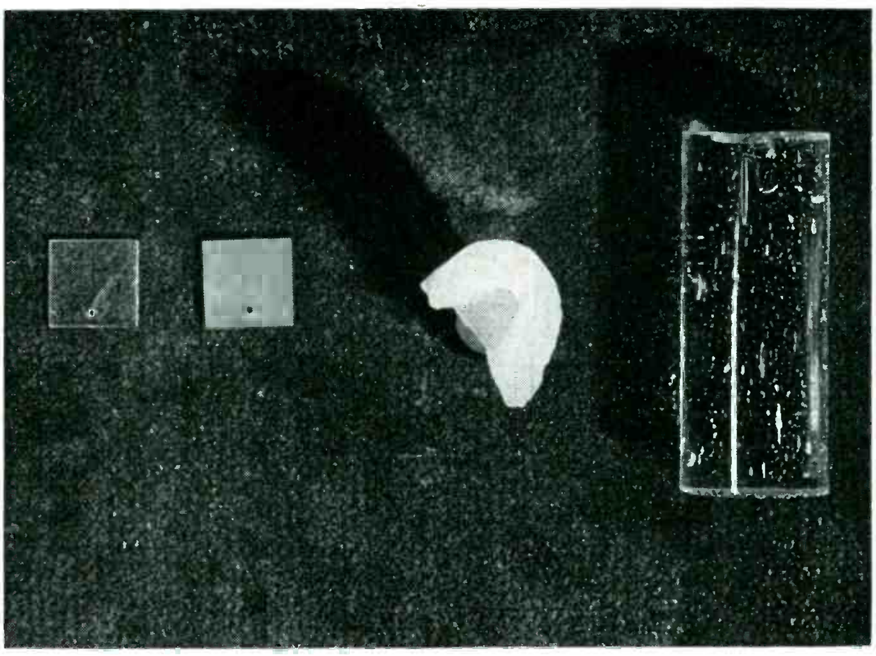
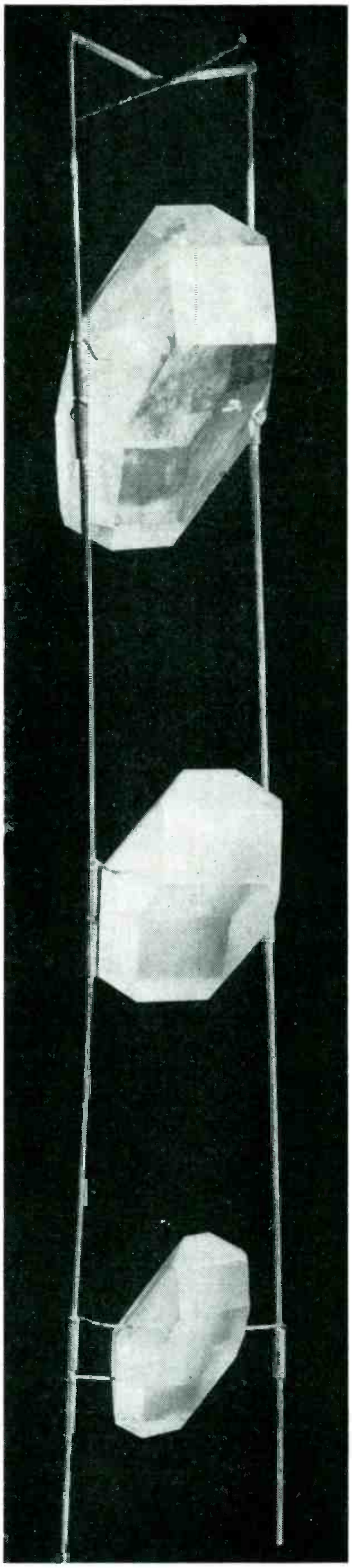


FIG. 1—Quartz crystals grown by Nacken process. Transparent quartz plate at left was grown from seed plate next to it. Rod of clear Vitreosil (amorphous silica) is at right, and partially recrystallized section of this rod is next to it



Examples of large quartz crystals grown by autoclave technique in 32 days. Weights, from top to bottom, are 321 grams, 143 grams and 71 grams

for Military Needs

encouraging progress towards an understanding of the problem. Important contributions to the process of growing quartz hydrothermally have been made by Brush Development Co., Cleveland, Ohio; Prof. A. C. Swinnerton, Dept. of Geology, Antioch College, Yellow Springs, Ohio; Squier Signal Corps Laboratories, Ft. Monmouth, New Jersey; Naval Research Laboratory, Washington, D. C.

To appreciate the significance of the progress made in this work, some of the more important background information, and the steps leading to the success thus far achieved, are outlined.

Nacken's Techniques

One method described by Nacken which seemed promising was based on experiments at constant temperature in alkaline solution at or near the critical point for water, this being at 374.2 degrees C and 3,200 psi. Experiments on the solubility of silica in water or alkaline solution led Nacken to the conclusion that amorphous silica is ten-fold more soluble than quartz at high temperature and pressure. Recent investigators have been unable to verify this. P. H. Egli, in a private communication, suggested that amorphous silica dissolves at a rate tremendously more rapid than the solution can tolerate for single quartz crystal growth.

Whatever the true explanation, Nacken demonstrated that quartz could be grown rapidly, for a short time, under these hydrothermal conditions. Unfortunately the supersaturation increased so rapidly that quartz not only deposited on a suitable seed, but also as spontaneous nuclei on all the internal surfaces of the autoclave. Within about one day growth nearly stopped. What occurred in the sealed high-pressure vessel could not be studied very effectively by visual means, but the growth of quartz from amorphous material may be inferred from an examination of the materials at the end of a test.

In Fig. 1, the clear quartz plate gained about 0.004 inch in thickness on each major face after one day of exposure in a dilute sodium carbonate solution, supersaturated with silica dissolved from amorphous nutrient, under conditions approximating those described by Nacken. Before the test, the quartz plate had ground, opaque surfaces. Initially the amorphous silica was in the form of a clear cylinder of Vitreosil glass, and this was largely converted to a porous mass of fine quartz needles. A small core of transparent amorphous silica remained, as shown in the cross-section of a piece of this nutrient material in Fig. 1. Subsequent check tests showed that the growth on each side of the seed plate, amounting to about 0.004 inch, occurred in the first few hours.

Supersaturation Troubles

As the autoclave approached operating temperature, the solution became so supersaturated with respect to quartz that the seed grew rapidly. Spontaneous seeding also occurred, both on the walls of the container and on the surface of the nutrient material. Within a matter of a few hours the amorphous supply had become covered with quartz needles, the solution lost its supersaturation, and growth practically ceased.

Further solution of the amorphous silica continued under the porous layer of quartz, but it was immediately followed by redeposition at that point. This accounted for the appearance of the cross-section sample shown in Fig. 1. Failure to achieve continuous growth was encountered by Nacken.

To understand the limitations of the method used by Nacken to grow quartz in the vicinity of the critical point for water and to understand the steps taken to overcome these limitations, it is important to consider the liquid-vapor density relations for water at this point. As temperature rises, as shown in Fig. 2, the density of liquid water decreases in a sealed container and the vapor density rises. At the critical point of 374.2 degrees C, the two are equal. The critical density is at the point of intersection of the average-density line with the liquid-vapor density curve.

To attain more rapid growth rates, advantage was taken of an important fact regarding crystal growth. It is generally the case that crystals grow better from solutions having a higher concentration of crystallizable material, than if the substance is only sparingly soluble. For this reason further experiments were made at much higher pressures and somewhat higher temperatures, where the increased density of the alkaline solution was favorable to greater solubility of the silica.[5]

Nacken reported using up to 50 percent filling of the autoclave with alkaline solution. Under these conditions, as the temperature is increased, the density of the solution decreases somewhat, but long before the critical temperature is reached the container is filled with solution and the density remains at about 0.5 with further increase in temperature. At the critical temperature the pressure greatly exceeds the critical 3,200 psi.

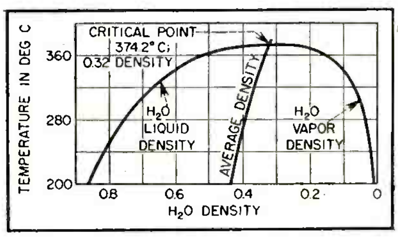


FIG. 2—Liquid-vapor density relations of water near its critical temperature at which density of liquid and vapor are equal

With fillings greater than one-third the free volume at room temperature, it was found better to use a temperature differential method, with the top of the autoclave slightly cooler than the bottom, and to operate at a somewhat higher temperature.

Initial experiments with a 50-percent fill were encouraging, but not until the autoclave was filled to 80 percent of its free volume with alkaline solution and operated at 400 degrees C did satisfactorily rapid growth become a practical possibility. Under these conditions the pressure is about 15,000 psi. It is difficult to hold such pressure with conventional gasket-type seals without a trace of leak. Even a very slight leak seriously alters the operating condition and the rate and quality of growth, because the pressure is developed by the heated solution within the autoclave.

A welded autoclave design capable of withstanding these conditions was developed for use with the temperature gradient method. With this equipment it has been possible to grow quartz crystals at rates as high as 0.05 inch in thickness per day. This thickness is measured on each of the major surfaces of a CT-cut plate. This cut is nearly parallel to the minor rhombohedral faces of the quartz crystal. Growth on such surfaces is known to be considerably more rapid than on the principal or major rombohedral faces of the quartz crystal.

Welded-Liner Autoclave

The apparatus in which quartz crystals have been grown effectively is shown in Fig. 3. Enclosed in a hollow steel tube or bomb, having relatively thick walls to withstand the great pressure developed within it, is a thin-walled seamless steel tube or liner made of ordinary low-carbon steel. Cups are welded into each end of this liner to hermetically seal it. This liner tube contains the ingredients for growing quartz. In the bottom of the tube is a layer of broken pieces of pure quartz, serving as nutrient material. A seed of clear quartz, free from inclusions, misoriented areas or other defects, is hung from a wire frame near the top of the tube, above the nutrient layer. Sufficient aqueous alkaline solution composed of sodium carbonate or sodium hydroxide, or both, is added to fill the free space within the sealed tube to 80 percent of its volume at room temperature.

The liner tube closures at each end are welded with an atomic hydrogen flame where the lip of the cup is in contact with the ends of the tube.

Into each recessed end of the liner is fitted a retainer cap. The difference in length of shell and liner permits clearances between the flanges on the retainer caps and the ends of the outer shell. The screw caps apply enough retaining force to hold the welded rims in the tapered grooves of the retainer caps and thus prevent spreading of the welds. The pressure of the expanding liquid, as the temperature rises, distends the liner so that it fits snugly within the retaining walls at all points, much as though it were a rubber balloon.

The liners are of inexpensive steel and are discarded after each run. It is known that strong alkaline solution causes intercrystalline failure of stainless steel at high pressures in a matter of hours at high temperatures[a]. This design prevents contact of the alkaline solution with the outer stainless steel container. There is no indication that the alkaline solution damages the carbon steel liner tubes under the operating conditions described.

The top retainer cap and screw cap are drilled to provide a safety diaphragm blowout if the pressure exceeds 20,000 psi. The wall thickness of the top cup and the diameter of the hole in the retainer cap in contact with it are such that the liner cup section will rupture at this pressure.

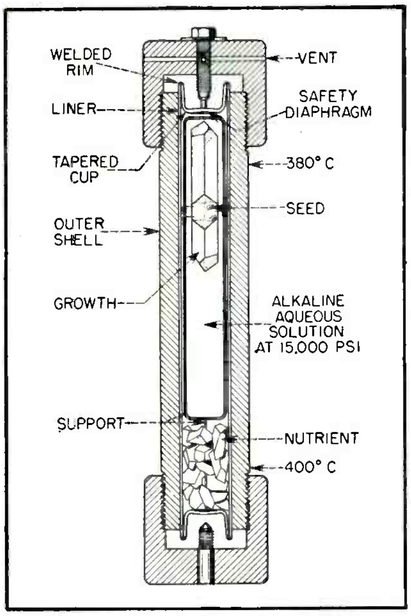


FIG. 3—Cross-section of steel bomb in which quartz crystals are grown

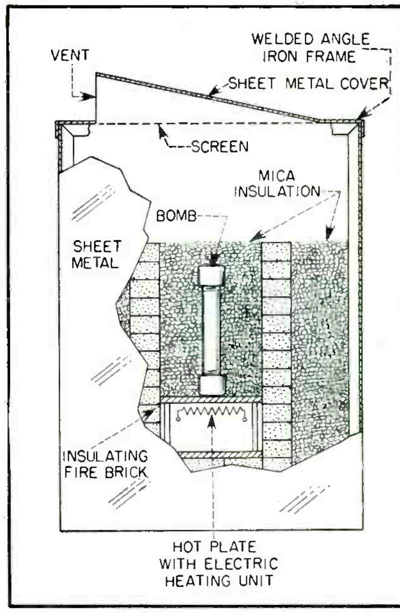


FIG. 4—Cross-section of furnace in which bomb is kept at 400 C

Temperature Gradient Method

The filled autoclave is set on a metal hot-plate in the well-insulated furnace design of Fig. 4. The hot plate is heated to about 425 to 450 degrees C, depending on the size of the autoclave and its length. The temperature at the top of the nutrient layer of quartz is maintained at about 400 degrees C, as measured by a thermocouple strapped to the outside of the autoclave just above the bottom screw cap. Another thermocouple mounted just below the upper screw cap is maintained at a temperature from 10 to 20 degrees below the lower one, by adjustment of the amount of insulation on top of the autoclave. A third thermocouple is usually placed at the midpoint of the tube.

This arrangement is left to cook for several weeks. Growth takes place on the seed in an orderly manner according to the following process: The broken quartz dissolves rapidly at the very bottom of the nutrient layer, and the hot alkaline solution soon is saturated with silica at this point. Movement by convection in the liquid is sufficiently rapid to transport the dissolved silica to all parts of the container and maintain the solution substantially saturated at some temperature between that at the bottom and at the top of the nutrient layer. Therefore the solution is supersaturated at the temperature in the top of the container near the seed crystal. This is the basically important condition for crystal growth, and silica deposits on the quartz seed.

Because of continuous motion in the liquid, the growing surfaces are constantly bathed by fresh supersaturated solution and the partially depleted solution is carried down to the bottom where it is again saturated at the higher temperature. The process continues as long as nutrient material is available for solution in the bottom of the autoclave. All of the free space above the layer of nutrient material is useful growing space, although the crystal farthest away from the nutrient layer grows more rapidly because it is cooler.

Quartz crystals of the size shown have been grown in a high-pressure autoclave 3 inches in inside diameter and 30 inches long. Over one pound of quartz was added to the three seed plates in a period of 32 days. The top crystal weighs 321 grams. The top seed plate was originally $2\frac{3}{4}$ inches long by $1\frac{1}{2}$ inches wide by $\frac{3}{16}$ inch thick. The other two plates were initially $1\frac{1}{2}$ inches square by $\frac{1}{8}$ inch thick.

Much more work is needed to evaluate optimum size of nutrient material, degree of supersaturation and growth rates, as well as influences of impurities on growth rate and stability of the solution. Because tests require from ten days to several months each, they are time-consuming, and interdependence of factors is difficult to evaluate. It is therefore not surprising that few quantitative relations are available thus far.

The accomplished fact is that crystals weighing up to nearly one pound have been produced in about one month. It appears reasonably possible to produce crystals weighing a pound or more in from two to three months, based on a growth rate of only 0.025 inch per day on each growing face. This is well within the limits of controlled growth which have been obtained experimentally, and compares favorably with rates of growth of other useful piezoelectric crystals now being produced commercially.

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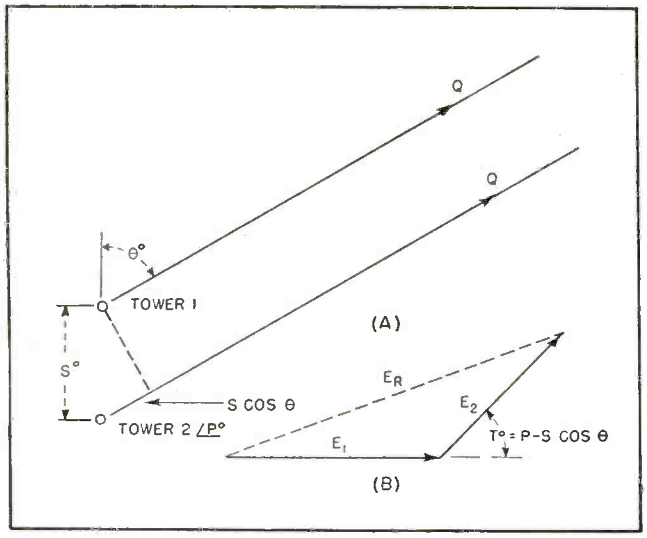

FIG. 1—Basic relationships used in setting up tower equations with spatial relationships shown at (A) and vector addition in (B)

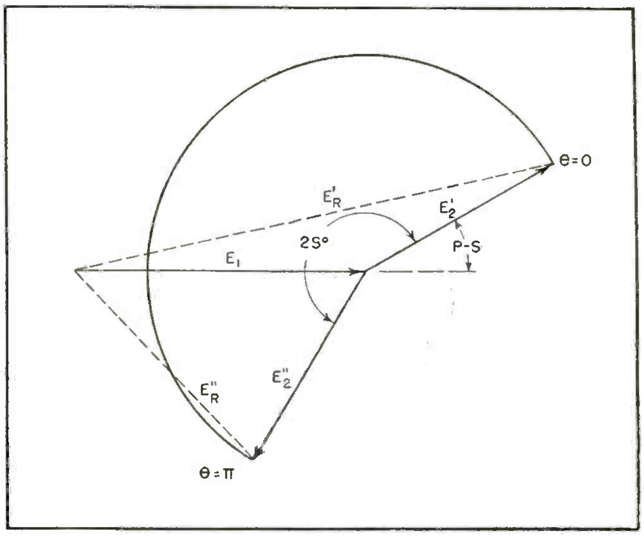

FIG. 2—Vector diagram to show how, if the spacing S between the antenna towers remains fixed, the arc subtended by E_2 can be calibrated in θ

Pattern Calculator for A-M

Graphical method useful for original design work on a pair of a-m broadcast antenna towers is also particularly applicable if a new pattern or change in frequency is necessary. Requires only dividers and transparent overlay

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THE CALCULATION of directional antenna patterns is often a long and tedious job and is usually at best a laborious exercise in trigonometry. The graphical calculator to be described is readily applicable to two-tower arrays and once the antenna spacing has been established it is a simple matter to observe the change in pattern shape with variations of phasing angle and antenna-current ratios. Although this graphical calculator can be used in original designs its obvious merit is evident when the towers are already installed but perhaps a change in operating frequency is necessitated.

The determination of the shape of a pattern is accomplished by the addition of the field vectors from each of the towers in an array. Figure 1A is a graphical illustration of the geometry involved and is used to establish the notation used.

Development

Tower 1 is used as a reference while tower 2 is considered to be spaced at S degrees from tower 1 with a phase angle of P degrees. Movable point Q is sufficiently remote from the array so that the lines from Q to tower 1 and Q to tower 2 are considered as being parallel. The angle θ is subtended between the line of the towers and a line from the movable point Q to tower 1. Thus for any position of point Q the total phase displacement between the field vectors of tower 1 and tower 2 is T degrees where $T = P - S \cos \theta$.

The resultant field at some angle θ is determined by the use of a vector diagram as shown in Fig. 1B where E_1 and E_2 are proportional to the field of towers 1 and 2 respectively. Note that as the angle θ is varied the phase displacement angle T changes and as a result the position of E_2 with reference to E_1 is dependent on the angle θ. Actually the radius vector E_2 describes the arc of a circle.

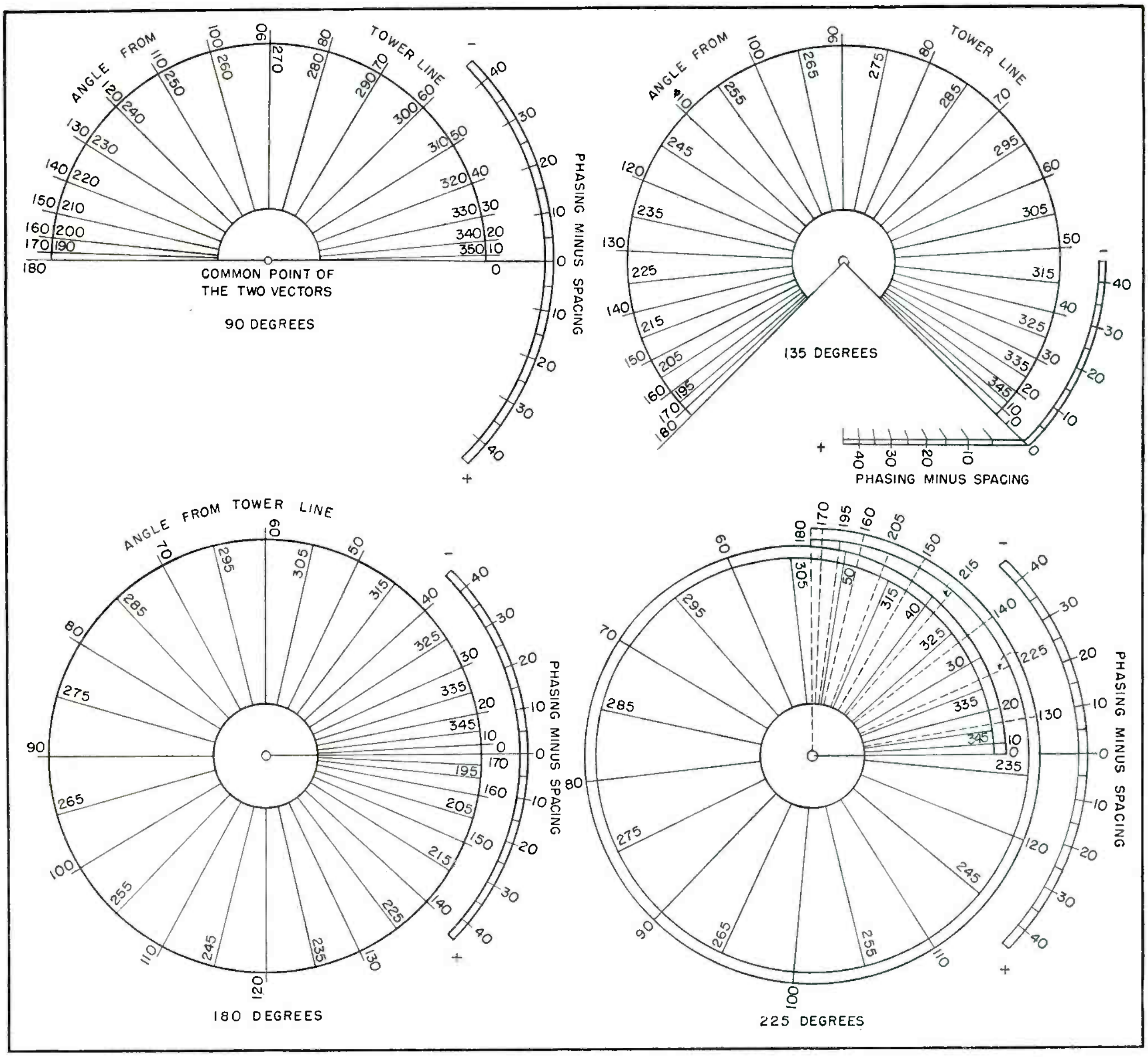


FIG. 3—Patterns can be computed to slide-rule accuracy using enlargements of these calculators. They are given for antenna spacings of 90, 135, 180 and 225 degrees

In Fig. 2 the following relationships become evident. When $T = P - S \cos\theta$, and when $\theta = 0$, $T = P - S$, also when $\theta = 180$, $T = P + S$.

Thus the arc subtended by the rotation of the vector E_2 is $(P + S) - (P - S) = 2S$ degrees. Therefore if the spacing S remains fixed, any such arc whose circumference is calibrated in θ may be used with any combination of current ratio and phasing angle. This calibration of the circumference in θ is also accomplished by solution of the equation $T = P - S \cos\theta$, where θ is the variable.

For purpose of illustration, graphical calculators have been computed for spacing angles 90, 135, 180 and 225 degrees.

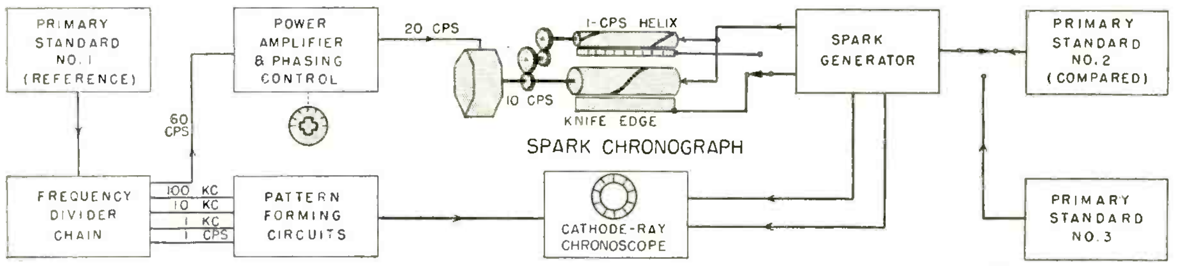
Example

In a determination of the shape of a pattern all that is necessary is a pair of dividers and a transparent overlay sheet. Suppose, for example, we have the following array: $E_1 = 1.0, \angle 0$; $E_2 = 0.5, \angle +60$; $S = 90$ degrees. Note that the phasing angle minus the spacing angle is equal to $60 - 90 = -30$ degrees.

First a straight line is drawn on the transparency that is then placed in register on the pattern calculator (90 degrees) so that the line passes through the common point of the two vectors and through a phasing − spacing angle of −30 degrees.

From the common point measure a distance to the left on the line that is proportional to E_1. With the common point as center, draw a circle with a radius proportional to E_2. The resultant for any angle from the tower line is then the sum of the vectors E_1 and E_2, it being recognized that the position of E_2 at any angle is the intersection of the circle described by E_2 with the line representing that angle from the tower line.

The resultant vector will be in the same units as were used for E_1 and E_2.



Any crystal clock at CRPL (like No. 1) can be used to drive the spark recorder through a frequency-divider chain and power amplifier. The phasing control allows adjustment of the starting point. A waxed-paper chart, calibrated in 0.002-sec strips, is drawn at three inches a day between the lower knife-edge and the spiral helix that rotates ten times a second.

Any other crystal clock or standard of frequency (like No. 2) can be compared with No. 1. An appropriate low-frequency output from No. 2 triggers the spark generator. A spark jumps between the spiral helix and the nearest point on the knife-edge through the paper, melting the wax to produce a visible dot. If the frequency of No. 2 is the same as that of No. 1, a spark will occur each time the same point of the helix passes. The result is a vertical line. Any difference in frequency will result in a slope.

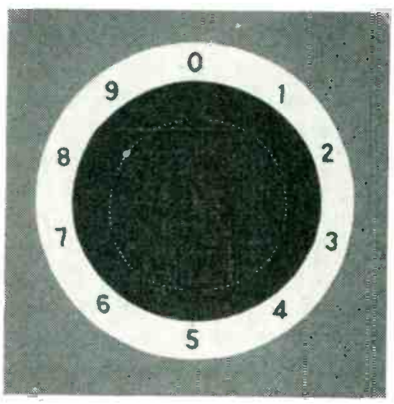
The smaller helix rotates once a second. The point at which a spark jumps between it and the calibrated knife-edge shows which 0.1-second interval is being recorded on the larger helix.

Pattern-forming circuits impress a circle of 100 dots 0.1 millisecond apart on the face of the cathode-ray chronoscope. Each tenth dot is blanked out for ease in counting. The signal from the spark generator produces either a dot between the markers, or it brightens an existing dot.

The chronograph can be read to within 0.5 milisecond and the chronoscope to within 0.02 millisecond

Comparing Outputs from

Intercomparison of crystal clocks by means of an improved spark chronograph, or by cathode-ray chronoscope, to ± 0.5 millisecond and ± 0.02 millisecond respectively. Mechanical and electronic equipment described has other industrial uses and has been modified to standardize chronometers and clocks



Typical pattern display on cathode-ray chronoscope tube. Small dots are 0.1 millisecond apart, with every tenth dot blanked out to facilitate counting dots clockwise from zero to enlarged dot representing time difference

When the National Bureau of Standards decided to improve its equipment for intercomparison of crystal clocks, it was found that the spark chronograph technique, installed in 1939, was still the most practicable. The spark-chronograph is a device that uses a spark to leave a time-mark on a special type of paper—as in certain kinds of facsimile receiving equipment. Increased resolution in new equipment described here results from improvements in pulse-shaping and spark-generating circuits. It is now possible to record time differences to a precision of ±0.5 millisecond. A new cathode-ray chronoscope visually shows up day-to-day changes to better than ±0.05 millisecond.

The equipment shown in simplified form in the box records the change in time kept by a number of clocks in terms of a very stable reference clock used to control the chronograph itself.

In the instrument described, a slope to the right on the chart indicates that the clock supplying the high-voltage pulses is running fast. A line slope to the left indicates that the clock is running slow. The difference in rates may be evaluated by measuring the amount of displacement over a given period. If the spark-generating equipment is switched in turn

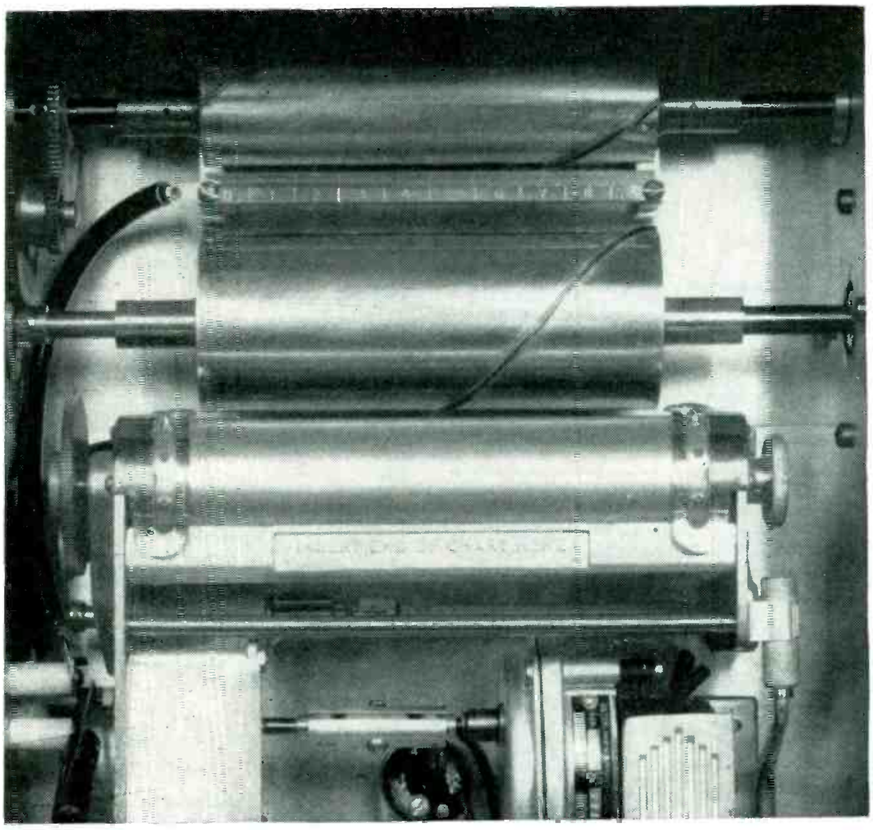
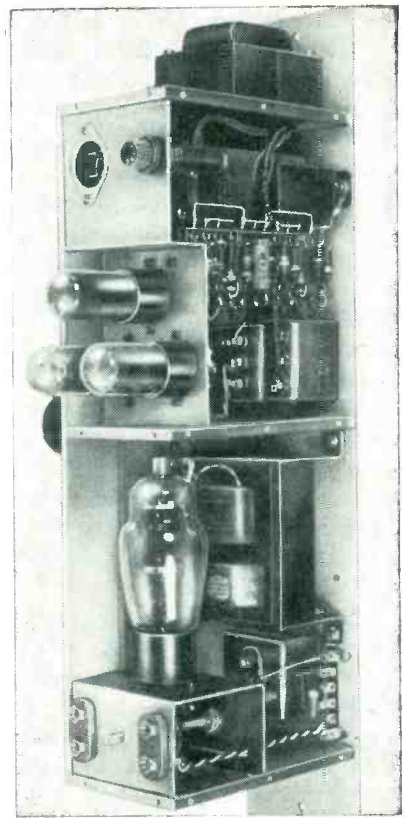


FIG. 1—Remodeled chart recorder for use as a spark chronograph. Special waxed recording paper has been removed to show details



Rear view of spark generator with shield covers removed

Precision Time Standards

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to each of several clocks, the chronograph provides a convenient method of intercomparing and recording their operation.

The complete chronograph installation illustrated also includes two crystal clocks, with the exception of the 100-kc oscillators that are located in separate temperature-controlled compartments. The rack at the left contains all of the equipment essential to the chronograph operation. The right-hand rack contains duplicate dividing circuits controlled by a different oscillator. This equipment constitutes a separate crystal clock that may be connected to drive the chronograph in case of failure of the normal source.

Construction details of the chronograph are shown in Fig. 1. The most difficult task was winding and shaping the raised spirals on the two drums. It was decided that drums of insulating material with stretched wire spirals would not be suitable for continuous operation as the drums might chip, crack, or warp. Taut wire spirals on any type of drum might be subject to displacement or breakage and on a metal drum might not be high enough to ensure the sparks jumping to the spiral instead of to the drum. Therefore the drums were made of stainless steel cylinders pressed onto steel hubs, with a single-turn groove cut in each ⅛ in. wide and $\frac{1}{16}$ in. deep. A steel spline previously sharpened to approximately the desired shape was formed and soldered into each groove, and then the final shaping and grinding was done.

The rotor of the synchronous motor is connected to drive the larger drum at the same speed. A gear train is used to drive the smaller drum at one-tenth the speed of the larger drum. Beneath the smaller drum is a knife-edge divided into ten equal parts, which is useful when reading seconds pulses. As the large drum rotates ten times per second, it does not indicate on which revolution the spark is occurring. By throwing the switch blade (left) to the up position, the high-voltage pulse is transferred to the numbered knife-edge and the spark jumps to the nearest point of the helix on the small drum, giving a visual indication of the proper tenth of a second. The two drums are so geared and synchronized that the distance between two scribed lines on the numbered knife-edge corresponds exactly to one complete revolution by the larger drum. No means of recording this indication is provided because it is only necessary to make such a check when starting or resetting a clock. The incremental changes from day to day are so small that they may be read directly on the chart record.

One difficulty encountered with the smaller drum is worthy of note. As originally constructed, both the knife-edge and the helix were ground to sharp edges. However, when the instrument was tested it was impossible to get a reliable spark with the voltages available. Flattening the edges slightly and thus increasing the area eliminated any further difficulty.

The large drum caused no trouble because the edges are rounded slightly so that the paper will pass freely between the electrodes and the presence of the chart paper aids the discharge.

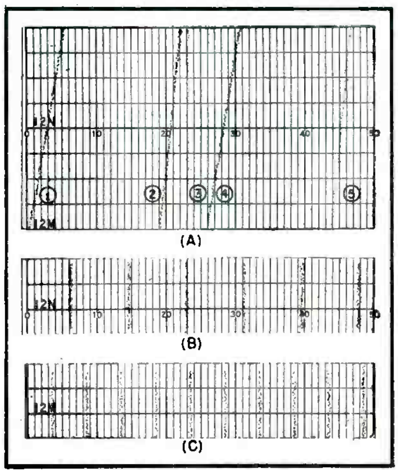

FIG. 2—Normal record (A) shows that signals are faster than reference; at (B) is record of 60-cps signals, and (C) shows 100-cps signals. Chart width represents 0.1-second time difference

The knife-edge beneath the large drum (not visible in the photograph) is mounted on ceramic spacers, directly behind the paper drive roll. The spacers are fastened to the frame supporting the paper-drive mechanism and screw adjustments are provided to shift the whole assembly and thus adjust the gap.

The paper drive was taken from a commercial recording milliammeter. The only changes required were special gears to reduce the paper speed to three inches a day and a reduction of the tension on the spring-driven takeup reel to prevent tearing of the waxed paper, which seems to be a bit weaker than the conventional recording paper.

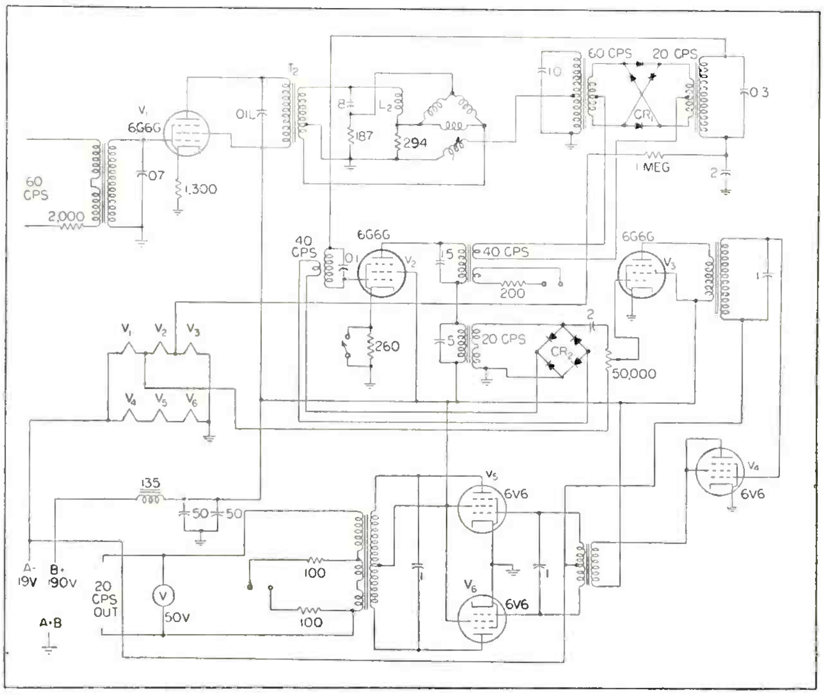

FIG. 3—Schematic of the chronograph power amplifier, with phasing-control selsyn in upper center

The large drum is directly driven at ten revolutions a second, hence one sweep of the helix covers a time interval of 0.1 second. The length of the drum is five inches and the paper is the same width, thus 0.001 second is represented by 0.05 inch across the paper chart. The chart is ruled with ten lines to the inch so that it is easy to interpolate to the nearest millisecond. A sample of the normal record obtained over a twenty-seven-hour interval is shown in Fig. 2. The distance between two vertical ruled lines represents two milliseconds time difference. At the time the record was taken all of the local crystal clocks were running faster than the one controlling the chronograph drum, as indicated by the slope of all the records up and to the right. Lines 1, 2 and 4 were made by 10-cps pulses, while 3 and 5 were made by seconds pulses. Record 3 was made by the radio signal from station WWV. The fact that it runs vertically up the chart shows that the clock controlling the chronograph drum is very closely synchronized with that generating the pulses transmitted by WWV.

The records made by the 10-cps pulses are much darker than those made by the seconds pulses because more sparks occur during the time the signal is applied to the chronograph, thus melting more of the wax. As generally used, each clock is connected in turn to the spark generator input every fifteen minutes by a motor-driven switching arrangement mounted directly below the chronograph. Each signal is applied for only a few seconds so that there is a considerable period when no signal is applied. Pushbuttons are provided for each clock so that a signal may be applied manually, during the period of no automatic signal, to indentify each record without recourse to a coding system. The pushbuttons also make it possible to take daily readings rapidly without waiting for the automatic switch to bring each signal onto the record.

Power Amplifier

Figure 3 is a circuit diagram of the power-amplifier unit. The 60-cps input comes from the clock frequency-divider chain. Tube V_1 is an amplifier at 60-cps to drive the continuous phase shifter, which is a three-phase selsyn. The output of V_1 is first fed to a fixed phase-shifting network to give three voltages approximately 120 degrees apart that are applied to the stator of the selsyn. The output is taken from the single-phase rotor and by varying the position of the rotor the output voltage may be shifted through any desired angle relative to the input voltage.

The output of the phase shifter feeds directly into the 3-to-1 divider stage, V_2. This divider is a fractional-frequency generator[4] used because it has no free-running frequency. Therefore, if the input fails, the chronograph will stop to avoid giving false readings. The 20-cps output of V_2 is fed to a copper-oxide bridge rectifier frequency doubler (CR_2) and the 40-cps component is reflexed through V_2 to increase the level. Then it is mixed with the 60-cps input signal in a copper-oxide ring modulator (CR_1) and the 20-cps difference frequency provides the desired output.

This divider is not self-starting. A pushbutton and pulsing circuit are provided in the cathode lead of V_2 to initiate frequency division after the input signal has been applied. The 20-cps output of V_2 is also fed through a gain control to the grid of V_3, which is a voltage amplifier feeding V_4. This is the driver for the push-pull output stage, which provides from 5 to 7 watts of 20-cps power to the motor. The most suitable coupling was obtained with an ordinary power transformer to give the required 30-volt output. All tubes except V_1 are operated with fixed bias obtained from the 19-volt filament supply.

The spark generating equipment consists of the grounded helix and the insulated knife-edge in shunt with an inductor in the plate circuit of a 6BG6G high-voltage beam-power amplifier V_4, as shown in Fig. 4. When a pulse comes along it suddenly biases the tube to cutoff, causing the field around the coil to decay rapidly. The high voltage generated causes a spark to jump between the knife-edge and the helix. To get a reliable spark and avoid scattering of the record the pulse applied to the grid of the 6BG6G tube must be sharp and of fairly high amplitude. Such a signal is not usually obtainable from the output of the crystal clocks, so suitable pulse-shaping circuits must be provided.

Pulse Problems

Another requirement of the pulse-shaping circuit is that it provide the desired pulse at the grid of V_4 for different types of input signals. For example, the clocks pictured generate seconds pulses of the type broadcast by radio station WWV; that is, five cycles of 1,000-cps frequency repeated once each second. Other clocks give sharp, differentiated output pulses at the rate of ten pulses per second.

Since it has been the custom on the broadcasts from WWV to have the first half-cycle of the five-cycle pulse modulate upward in a positive direction, all of the clock outputs have been polarized the same way, and it is necessary to maintain and sharpen only the leading edge of the pulse. The clock output is applied directly to the grid of V_1, which is biased just below cutoff by a resistor from the plate supply to the cathode. When a signal arrives, the negative portion is clipped off entirely and only the positive portion is transferred to the plate circuit as an amplified pulse of negative polarity.

As it is desired to record only the beginning of each complete pulse, some means must be provided to prevent getting a spark from each succeeding positive half-cycle of the five-cycle seconds pulse. For this purpose an integrating circuit is placed in the grid circuit of V_2 having a time constant of approximately 0.01 second, which is sufficient to prevent the grid of V_2 returning to zero voltage between these pulses, but is also short enough to avoid any adverse effect on the 10-cps pulses. Tube V_2 is also biased by means of a resistor from plate supply to cathode, but only to about two volts above cutoff. The output of V_1 passes the integrating network and becomes a negative pulse with a sawtooth top, driving V_2 beyond cutoff and holding it there until the pulse ends, thus clipping the sawtooth top and giving a pulse in the plate circuit closely approximating a square wave. This pulse could be made sharp enough to trigger the spark tube but it is of the wrong polarity and has insufficient amplitude. Therefore, it is fed through a differentiating network to the grid of V_3, which is also biased slightly below cutoff to clip the negative peak generated in the differentiating cir-

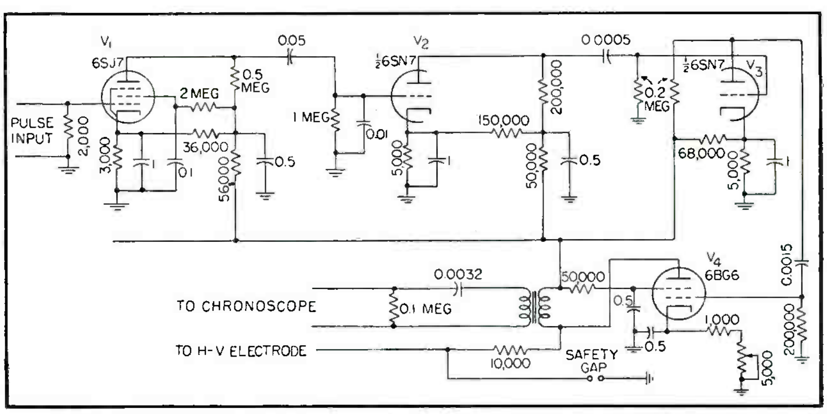

FIG. 4—The spark generator shapes several different kinds of input pulses to form a spark without appreciable scatter

cuit. The output of V_3 is a negative pulse having a peak amplitude of about 130 volts, a sharp leading edge, short duration and very little positive overshoot. This pulse is coupled to the grid of tube V_4 and develops a satisfactory spark for recording. The voltage applied to the spark gap may be varied by adjusting the 5,000-ohm resistor in the cathode of V_4, changing the current through the coil, and thereby changing the voltage induced when the current is cut off. For a current of 10 milliamperes the voltage obtained is approximately 6,000 volts.

When the covers of the spark-generating unit illustrated are in place, all of the high-voltage circuits are completely shielded, thus reducing the radiation to radio-frequency equipment being used in the same laboratory.

Performance

The pulse-shaping circuit makes the chronograph versatile for recording signals other than those already mentioned. Tests with sine-wave input show that the circuit will operate between 10 and 400-cps with less than ten volts rms applied, and over a much wider range with greater input amplitude. Samples of the record obtained with 60-cps and 100-cps sine-wave signals are shown in Fig. 2B and 2C.

There are other possible uses for the chronograph such as checking the stability of oscillators and dividers, or rating clocks and chronometers over fairly long periods of time by recording the drift relative to the primary standard of frequency. As a simple test, a crystal cartridge was used to pick up the ticks of several pocket and wrist watches. The signal was amplified and applied to the chronograph. Most of the watches showed drift rates of ±20 to 30 milliseconds per minute but could be adjusted easily to ±5 milliseconds per minute. An instrument quite similar in principle is widely used by watchmakers for rapid adjustment of watches and clocks.

There was some uncertainty whether running the motor with 20-cps frequency would cause excessive hunting of the drum. However, tests have shown that the hunting is well within allowable limits for this application. One such test made use of a cathode-ray interpolation device, shown to the right of the chronograph in the rack illustration and described below. It permits reading time differences accurately to 0.1 millisecond and estimating to 0.02 millisecond by visual means. From a secondary winding on the spark generating coil a signal is obtained at much lower voltage and fed to the interpolation device. As one observer watches the oscilloscope and notes that the pulses are consistent within ±0.02 millisecond while another watches the spark on the chronograph, it can be determined that the scattering is approximately ±0.25 millisecond. This observation means that the chronograph could be read to the nearest 0.25 millisecond were it not for inaccuracies due to the paper. The only scale is that ruled on the paper, and any shifting on the drive sprockets or shrinking or stretching due to changing temperature or humidity introduces an additional uncertainty of perhaps ±0.25 millisecond, so that the record may be relied upon only to ±0.5 millisecond.

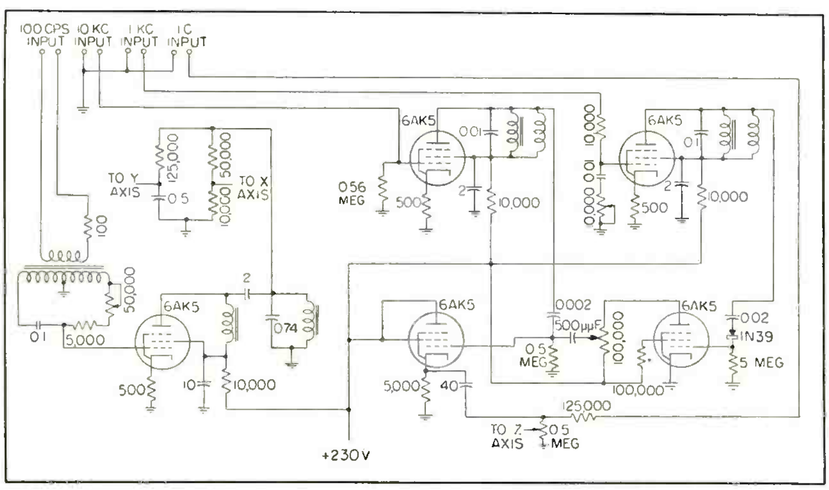

FIG. 5—Pattern-forming circuits in the chronoscope use the same time standard that drives the chronograph

The Chronoscope

To increase resolution a chronoscope can be used to supplement the chronograph. Output from a crystal clock and frequency divider is used to produce a circular sweep with fixed marker dots on the screen of a cathode-ray oscilloscope. A pulse from another crystal clock produces a bright spot on the sweep. By observing the position of this spot in relation to the marker dots it is possible to measure relative time changes within a very small fraction of the interval required for one circular sweep.

By choosing appropriate frequencies for the time base and marker dots, a wide range of time intervals may be covered, or a cascade system may be built to read coarse intervals in the order of 0.1 to 0.01 second on the first cathode-ray tube and vernier readings down to the microsecond range on the following tubes. This discussion will be confined to the instrument as used in conjunction with the spark chronograph.

Because the time-base and marker frequencies are obtained from the same frequency dividers the chronograph and chronoscope are locked in time phase as are the minute and sweep-second hands of a conventional clock mechanism. The circular sweep is obtained by applying 100-cps voltages in phase quadrature to the deflection plates of the cathode-ray tube. A 360-degree sweep is thereby accomplished in 0.01 second. The grid of the cathode-ray tube is biased below cutoff so that no trace appears on the face of the tube except when a positive pulse is applied with sufficient amplitude to let the tube conduct. A 10-kc signal applied to the grid produces a circle composed of 100 dots, each 0.1 millisecond apart.

This scale would be exceedingly difficult to read if no reference points were provided, so a 1-kc sine wave is shaped to give negative pulses just wide enough to blank out every tenth one of the 10-kc dots. The pattern resulting on the face of the tube is illustrated. There are ten groups of nine dots with each group separated by the space of the tenth dot. By so grouping the dots it is easy to evaluate quickly the position of the signal. The numbers surrounding the cathode-ray tube correspond to millisecond readings on the chronograph. Therefore, from day to day the change in relative time as kept by two clocks may be measured within 0.5 millisecond by the change in displacement on the chronograph chart, and within ±0.02 millisecond on the chronoscope.

The signal to be measured is fed to the chronoscope as a positive pulse with about three times the amplitude of the marker pulses. If the spark occurs while the cathode-ray tube is nonconducting, even with the maximum negative voltage due to the marker signals, the tube will be driven to conduction and the signal will appear between the marker dots. Should the spark occur while the tube is conducting, the added positive voltage on the grid will cause enlargement of the dot on the face of the tube as shown.

Figure 5 shows a schematic diagram of the circuits used to obtain the circular sweep and to shape and mix the signals applied to the intensity grid. An oscilloscope trace (Fig. 6) of the voltage applied to the grid shows the nine cycles of 10-kc signal at high amplitude while the tenth cycle is much reduced. A time-signal pulse is also shown to the right but at much lower intensity since its repetition rate is only ten pulses per second.

It has been determined that the instrument described, using a three-inch cathode-ray tube, may be read within ±0.02 millisecond. Should greater resolution be required, it can be obtained by using a larger cathode-ray tube to increase the span between adjacent markers and facilitate interpolation. For greater accuracy, 100-kc markers could be added. Another possibility is to use a second complete chronoscope, starting with either a 1-kc or 10-kc time base and 100-kc or 1-mc markers to permit higher resolution.

Operating Limits

To investigate the possible effects of windage or of pressure variations on the chronograph the complete unit was set up in a low-pressure chamber and the pressure was reduced to about one-third of atmospheric while watching the spark through an observation window. At reduced pressure the spark appeared to be a bit weaker but there was no noticeable shift in reading. After returning to atmospheric pressure the record was examined and it was found that at reduced pressure the scattering was only slightly greater than the normal ±0.25 millisecond.

The chronograph is somewhat sensitive to variations in voltage to the driving motor, which apparently cause the rotor to lock in more or less tightly and thus cause a shift in the spark. However, this effect causes no difficulty in normal operation. Once the amplifier output is adjusted it remains essentially constant unless the d-c supply voltages vary. For a 10-percent change in d-c plate voltage the chronograph reading will change by about one millisecond.

Under normal operating conditions very little maintenance is required. All components are run considerably below rating and no electrolytic capacitors are used, even for the 100-μf types in the power amplifier. During the year that the new instrument has been in operation it has been stopped only for quarterly cleaning, inspection and oiling. It would be possible to run for longer periods except for the coating of wax that condenses on the drum and other metallic parts within the chronograph case. This coating must be removed before it becomes thick enough to cause trouble.

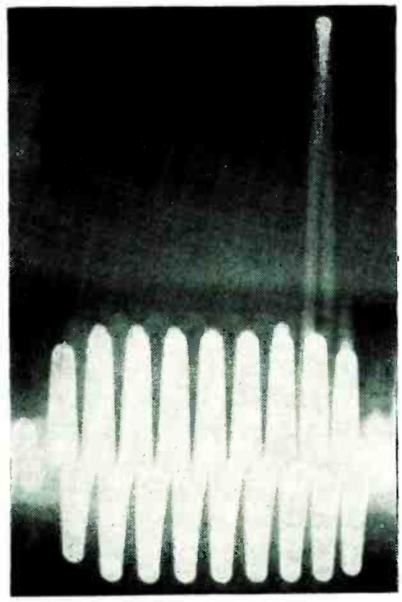

FIG. 6—Oscilloscope trace of voltage applied to grid of the chronoscope. Every tenth wave is attenuated. A 10-pps time signal is at right

Several other types of recording paper were considered to eliminate the wax vapor, but none gave as legible a record of the spark discharge. Contact printing of any kind was not permissible. Because it is desirable to stop the chronograph at intervals for inspection and lubrication, it was felt that the wax removal would not impose any serious limitation. These stoppages are of short duration, a few minutes at most, and the phase shifter permits resetting to exactly the same reading so that continuity of record can be maintained.

The authors wish to thank V. W. Loving of the Bureau's Instrument Shop for his assistance with many of the details of mechanical design as well as for the excellent construction of the instrument, and Alan Horton for the careful wiring of electrical circuits.

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Military Requirements

Conversion to all-out war production would, at present, find the electronics industry facing a serious shortage of subminiature tubes. Current production would be inadequate. Plans for expansion are already under way. Even these may have to be stepped up

By JAMES D. FAHNESTOCK
Assistant Editor
ELECTRONICS

EXPERTS AGREE that any future war will be an electronic war. The electronics industry is, in general, well equipped to meet such an emergency. In most branches manufacturing capacity is adequate, and materials needed for essential work are obtainable.

One important exception lies in the shortage of subminiature tubes that would accompany total mobilization for war. The subminiature tube business may be compared to the munitions business —it rises abruptly at the outbreak of war and drops even more abruptly when the war ends.

Applications

By far the biggest use of subminiatures in the last war was in proximity fuzes. Since four or five tubes were expended with every fuze fired, the demand was enormous. The services have learned to depend on proximity-fuze projectiles, and they are expected to employ them generously in any future war.

The proximity fuze employs filamentary tubes. There are also many "expendable" applications for heater-cathode types. Every guided missile accounts for a large number, and sonobuoys and similar detection devices account for a handful of subminiatures that serve a useful purpose and are then abandoned.

Adding to the requirements are the ever-increasing miniaturizations of standard and special communication equipment to improve mobility and versatility. Subminiature tubes are, of course, specified and used. It has been estimated that these nonexpendable items alone will account for 100,000,000 subminiatures in a war year. This figure, combined with the tremendous requirements for guided missiles and proximity-fuze projectiles, indicates the future of the business in the event of war.

The most obvious advantages of subminiature tubes in military equipment are space, weight and materials conservation. Other advantages of subminiatures include (1) low drain on power-supply equipment, (2) the possibility of soldering tubes into circuits, thus eliminating space and weight usually contributed by sockets, (3) adaptability to unit and packaged design and construction, (4) high resistance to shock—both thermal and mechanical, and (5) smaller physical dimensions with resulting improvement in high-frequency operation.

Most subminiature tubes have lower dissipation ratings than corresponding types in the miniature (T-5½) and GT (T-8) sizes. Their dissipation areas are smaller. This fact is responsible for much research into ways and means for operating circuits at low power levels, and in constructing equipment with facilities for radiating and dissipating excess heat in order to allow the subminiatures to be operated within their prescribed temperature limits. Subminiatures have recently become available with 500-hour life when operated at 250 C, thus offering some relaxation of the previous temperature bugaboo.

Sockets are available for most subminiature types, for applications where plug-in construction is desired. The high shock resistance exhibited by subminiatures lies in the fact that vulnerability to mechanical influences is roughly proportional to the cube of the dimensions of the object. Thus the smaller dimensions are desirable.

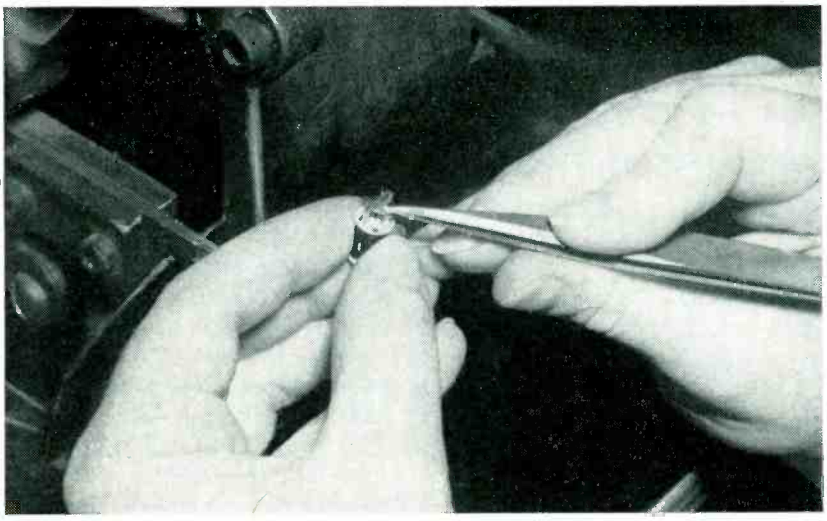
When the idea of the proximity fuze was first conceived, there were no tubes on hand that would fill the requirements of size and ruggedness. Picking small size as the main requirement, engineers launched a series of tests with standard subminiature tubes in projectiles with reduced charges. These shells were fired and the projectiles later recovered. The tubes were then studied for failing parts, and those parts were strengthened, and the improved versions were again fired, but this time with a slightly greater propelling charge. This process progressed until a set of tubes was developed that would withstand full charge and operate properly when the projectile reached the vicinity of the target. From the data collected in these experiments, a set of specifications was written that led to the line of tubes finally used in proximity fuzes. The amazing record achieved by these weapons verifies the success of the cut-and-try tube development program.

Improved Characteristics

Thus subminiatures have, through extensive research and development projects over the past ten years, evolved from an almost novelty-like position in the electronics industry to an essential position of great importance. Today subminiatures are commercially available that will withstand 450 G mechanical shock, have long-life reliability ratings of 5,000 hours, pass fatigue tests at 2.5 G for 96 hours, and can be operated at high altitudes and temperatures.

There are now well over 500 different types of subminiature tubes, many of which were never actually placed in production. Large quantities of information have been collected concerning operation of these

for Subminiature Tubes



Subminiature tube fabrication requires special skill and over 150 different pieces of equipment. Photograph shows tube mount being assembled at Sylvania's plant

BIG NUMBERS—
LITTLE TUBES

• During the second world war 150,000,000 subminiature tubes were made by one company alone. Production experienced an increase of over a thousand times, and at the end of the war subminiatures were being turned out at a rate of 10,000,000 a month by the same company.

• Requirements for a future war are expected to be even greater than last time. If war comes, much of today's tube-manufacturing capacity will have to be turned over to subminiature production — and even that might not be enough

tubes under widely diversified operating conditions, but the data are still insufficient for many users. For instance, the tube that will withstand the tremendous shock of being fired from a gun will not necessarily stand up under a prolonged period of vibration that might be found in a guided missile.

Different Types

The subminiature tube industry is, at present, confronted with a controversy over physical construction. There are those who favor the round-bulb button-socket versions, and there are those who favor the flat-press tubes. In the button type, the tube leads are brought out in a circle around the round base of the tube, whereas in the flat configuration the leads are brought out in line across the tube. Both types offer advantages, to some extent dependent upon application.

In the flat-press plants, the header is sealed by a pair of jaws, much in the same way that electric light bulbs are sealed. The round, or button, bases are fabricated on machines similar to those used in conventional miniature tube manufacture.

The round button base offers a degree of added mechanical rigidity by virtue of more-than-one-plane suspension. The flat-press tubes are longer, but they are considerably narrower in one radial direction because of their flat shape.

The straight-line placement of tube leads on the flat-press type limits the number of leads available to six or seven, while most round types offer eight leads in a standard circular configuration, so that only a relatively few socket diagrams need be remembered. The circular configuration also permits higher interelectrode potentials and operation at higher altitudes, with less leakage, since greater spacing, in general, exists between leads.

Much controversy exists as to the relative ease and expense of manufacture of the two types. Some engineers are confident that present miniature-tube-making machinery can be readily converted to subminiature tube production, and others are skeptical.

Future Outlook

Whatever the configuration, the potential shortage remains. Just as the makers and users of electronic equipment are confused as to the relative merits of the two types of tubes available, so are they confused as to whom they will turn if their requirements suddenly skyrocket.

Unfortunately for the situation in general, subminiature tubes are still finding only a limited place on the civilian market, and present military orders are not yet large enough to warrant sufficient expansion of production facilities to allow subminiatures to compete for most civilian applications on a cost basis.

Manufacturers and government agencies agree that decentralization of subminiature-tube-making facilities is important. Some makers of conventional tubes are already embarked on ambitious programs studying and planning for conversion to subminiatures, and the old-timers in the game are in fact expanding.

The problem will have to be met in case of war. Past experience has demonstrated an excellent probability that the problem will be met successfully and fairly rapidly. However, a great number of tube makers will have to alter their thinking and learn new techniques.

There is some doubt that subminiatures will achieve much general use in television receivers, because of their dissipation difficulties and their high cost. The cheapest tube to manufacture is the tube that is most easily handled. Even the miniatures fall below this optimum point, and subminiatures are far below, with consequent gloomy outlook for any substantial reductions in manufacturing cost, unless new techniques and production methods are developed.

Tube Characteristic Tracer

Pulsing grid voltage permits tracing desired characteristic curve high into positive-grid region. Hundreds of dots, one per pulse, produce continuous curve on cathode-ray screen. Multiple photographic exposures give family of curves

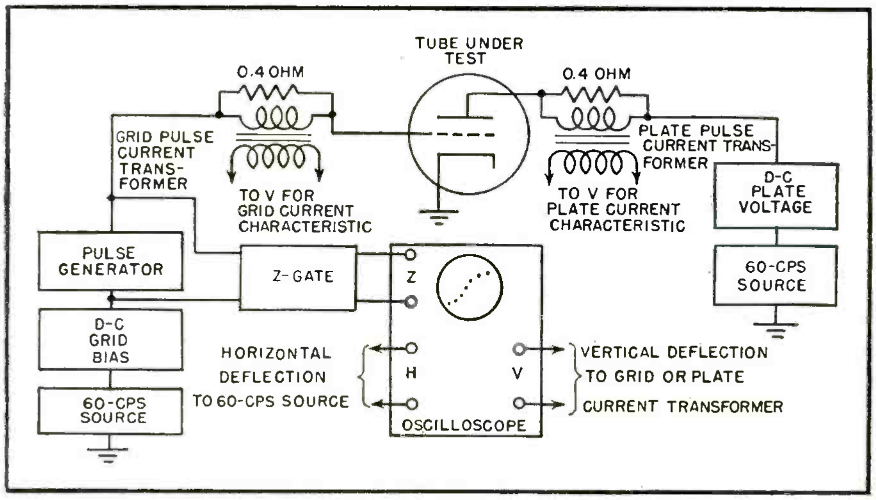


FIG. 1—Plate voltage is swept over desired range by 60-cycle a-c voltage superimposed on d-c voltage, while grid is driven by pulses riding on top of 60-cycle grid voltage. Resulting dots on oscilloscope screen trace out the desired characteristic

VACUUM-TUBE characteristic curves extending up to high peak-power levels in the positive grid region are needed for many radar and television applications but are not ordinarily available. The curve tracer to be described was designed at the Signal Corps Engineering Laboratories to fill this need for a convenient instrument to measure characteristics of small tubes at high pulsed-power levels. Although designed primarily for taking data in the positive-grid region, it also covers negative-grid characteristics. It automatically displays directly on the fluorescent screen of a large cathode-ray tube the complete char-

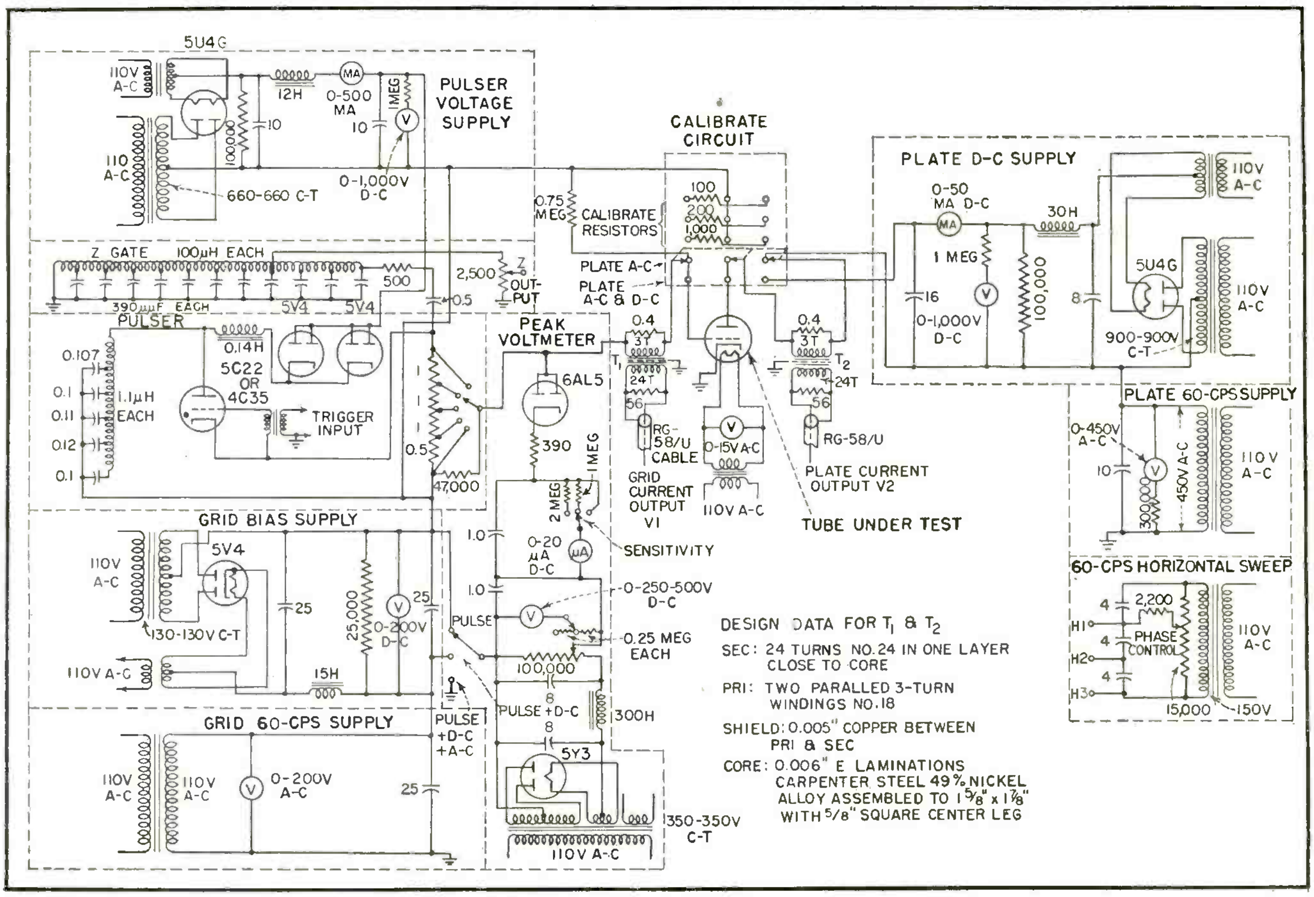


FIG. 2—Complete circuit diagram, including all power supplies since they play a major part in the operation of the tracer

Using Pulse Techniques

By HERBERT M. WAGNER
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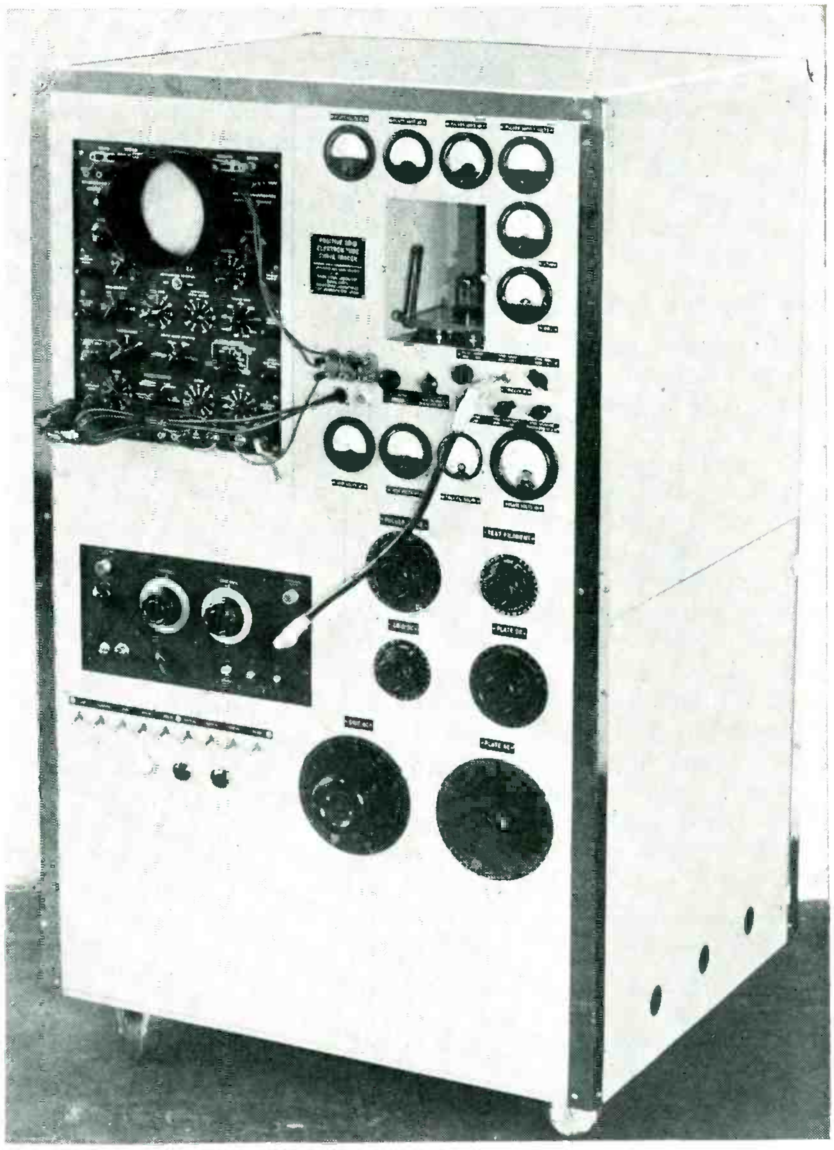

Electron-tube curve tracer using pulse techniques for displaying on cathode-ray screen the characteristics up to high peak power levels in the positive grid region. Tube being tested is in recess at upper right

acteristic of the tube under test.

Figure 1 shows a simplified diagram of the instrument, with a triode as the tube under test. Rectangular pulses of small duty ratio are applied to the grid. The pulser is of low impedance and power supplies are bypassed in order that pulse voltage be substantially independent of grid current up to a few amperes. The tube is normally biased to cutoff and is made conducting only during the pulses.

Measuring Method

The primary of a pulse transformer is connected in series with the electrode whose current is to be measured. Its secondary is connected across the vertical plates of the oscilloscope. The 60-cycle power line frequency is applied to the particular electrode whose voltage is varied and to the horizontal oscilloscope sweep. A 60-cycle transformer in the plate circuit is energized when a characteristic in terms of plate voltage is desired. Likewise, the 60-cycle grid transformer is turned on when a grid voltage characteristic is taken.

The grid variation is achieved with constant-voltage grid pulses riding on top of the 60-cycle wave. This procedure is simpler than direct modulation of the pulse voltage. A point or dot on the tube characteristic appears on the oscilloscope screen for each pulse applied. Pulse repetition rate is made nonsynchronous with 60 cycles so that each pulse plots a different point. Successive pulses rapidly trace the complete curve as a series of closely spaced dots.

Pulse Generator

The pulse generator or pulser used to excite the grid of the tube under test with positive-voltage pulses of adjustable amplitude is shown on the complete curve tracer circuit diagram in Fig. 2. The pulser has a low output impedance so its voltage is substantially independent of grid current and the pulse top is essentially flat for a considerable percentage of the pulse width.

The pulser is a hydrogen-thyratron line type, chosen because of its simplicity and its low-impedance capabilities. Here it is operated directly into a 3.5-ohm resistance. In this case, the 1-ohm resistance of the thyratron during conduction is a significant fraction of the load into which the pulse-forming line discharges.

With the power supply used, the pulser will deliver up to 450 volts at an output impedance of 2 ohms (3.5 ohms in parallel with the line plus thyratron impedance). An output switch provides somewhat lower impedance for lower pulse voltages.

The pulse-forming network is a five-section artificial line calculated to have a characteristic impedance of 3.3 ohms and a delay time of 3.3 microseconds. Capacitor values were adjusted until a level top was obtained on the output pulses, as in Fig. 3A. There is an initial rise for about 0.7 microsecond, after which the pulse height remains almost constant for 2.5 microseconds and then falls to zero in 2 microseconds.

The circuits for charging the pulse network are conventional, and consist of a variable d-c supply, a charging choke selected for d-c resonance charging at approximately 1,000 cps and hold-off diodes. A Measurements Corp. model 79-B pulse generator is used to trigger the main pulser at an adjustable repetition rate.

Oscilloscope Intensifier Gate

The period of approximately 2.5 microseconds during which the grid voltage pulse remains at a constant known level is the interval during which significant measurement of electrode current is made. It is therefore desirable to eliminate from view those portions of the current pulses occurring during the changing pulse voltage outside this interval. This effect is accomplished by setting the intensity control of the oscilloscope for dim or zero brightness and applying pulses to the Z-input of the oscilloscope in order to brighten the trace on the cathode-ray tube during the top flat portion of the grid pulse.

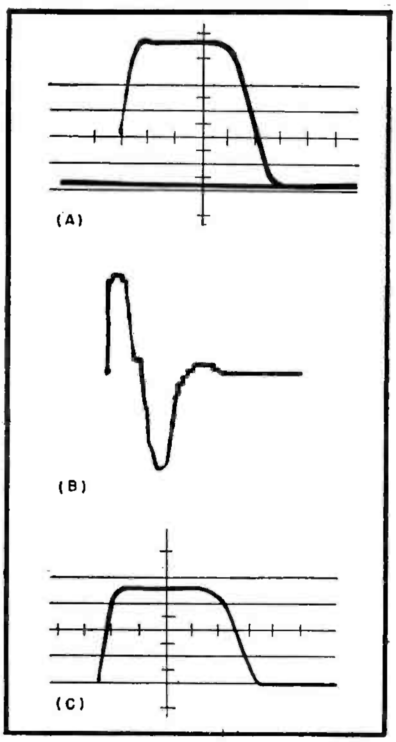

FIG. 3—Voltage waveforms at output of pulse-forming network (A), at Z-output of gate (B), and at secondary of pulse transformer (C)

As shown in Fig. 2, voltage from the pulser is applied to a Z-gate transmission line, which is shorted at the far end. The Z-output is taken at an intermediate position along the line where the pulse arrives after a required delay time and is cut off 2.5 microseconds thereafter by a reflection from the shorted end of the line. The connections to a transmission line and the Z-output wave for idealized conditions of a rectangular pulse and lossless line are shown in Fig. 4. In effect, the positive polarity of the Z-voltage is a rectangular pulse delayed after the original and shortened. The negative-polarity portion merely blanks out the oscilloscope trace more completely after the desired current pulse has been brightened. Figure 3B is an oscillogram of the Z output of this gate when a voltage of the form shown in Fig. 3A is applied to its input.

The gate simplifies the wave-shape requirements of the pulser, eliminates extraneous illumination on the cathode-ray tube and avoids confusion in the displaying and interpretation of the curve. In this regard, the gate is essential in a region of the characteristic where an increase in grid voltage results in a decrease of plate current. In such a region, the plate current rises higher before and after the flat top of the grid voltage pulse, producing pips that would be misleading without the gate.

Grid, plate and other electrode currents may be measured by the vertical deflection on the cathode-ray screen due to the voltage drop across a small impedance in series with the particular electrode. The series impedance should be small so as to avoid appreciable drop in electrode voltage. As shown in Fig. 1, it consists of a 0.4-ohm resistance in parallel with the primary of a transformer. When the transformer primary is matched to the 0.4-ohm resistance, the combined resistance is 0.2 ohm, corresponding to a one-volt drop at 5 amperes electrode current.

Vertical Deflection

The transformer which couples to the vertical deflection input of the oscilloscope is a pulse type and measures only the pulse component

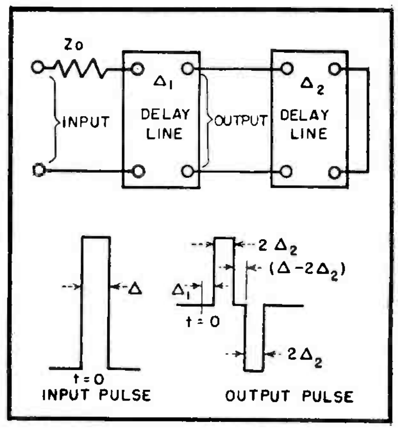

FIG. 4—Transmission line shorted at far end serves as gate that brightens trace during flat-top portion of grid pulse

of electrode current. This component, however, represents the entire current under the test conditions, wherein the tube is cut off between pulses. The transformer provides a needed step-up in voltage to the oscilloscope and isolates it conveniently from the power circuits. The secondary of the transformer is connected to the vertical input of the oscilloscope through a 50-ohm cable, which is matched at the transformer. The grid and plate pulse transformers are identical. The waveform in Fig. 3C of the secondary voltage of the transformer for the pulse of Fig. 3A shows some rounding at the front and back edges of the pulse, but the flat top is reproduced without noticeable droop. Thus the initial desired plateau region is retained.

Horizontal Sweep

A horizontal sweep is required that is proportional to the voltage on the tube electrode for which a characteristic is desired. Sixty-cycle power-line voltage is used to provide electrode potential variation and horizontal signal. A phase adjuster (Fig. 2) consisting of a variable resistance across fixed capacitors is used to set the sweep in phase with electrode voltage variation. Exact phasing is indicated by coincidence of the observed characteristics corresponding to increasing and decreasing a-c electrode voltage.

A separate transformer is used for the sweep circuit even though its waveform may deviate slightly from that of the actual transformer used in varying the electrode potential. The separate transformer is more convenient and permits setting the amplitude of the sweep independently of changes made in the electrode a-c voltage.

Plate-Voltage Curves

To obtain a curve of plate current vs plate voltage, the grid bias is set at a value V_{go} chosen beyond cutoff for the maximum plate voltage V_p for which the characteristic curve is to be taken. The plate milliammeter indicates when cutoff is reached. Plate power supplies are turned up to the desired positive-plate excursion V_p with a-c alone or with a-c and d-c.

With plate a-c alone, the a-c is set at a peak voltage V_p and the plate excursion is from $-V_p$ to V_p. With a-c and d-c the a-c is set at $V_p/2$ peak volts, the d-c is set at $V_{po} = V_p/2$ and the plate-voltage excursion is from zero to V_p. The a-c plus d-c setting is generally preferable because it utilizes the area of the cathode-ray tube more efficiently. By varying the relative proportions of a-c and d-c, the upper and lower limits of the plate voltage curve may be varied so as to view selected portions of the characteristics on an expanded horizontal voltage scale.

The slide-back peak voltmeter is set and switched to measure the peak grid voltage V_g to be used and the pulse generator is turned on and raised until the peak voltmeter just begins to show a reading. This reading indicates that the pulse voltage in series with the grid bias reaches a peak value of V_g volts with respect to the cathode of the tube under test. This adjustment completes the settings.

The plate-current pulse transformer is connected to the vertical input of the oscilloscope. The vertical amplification and horizontal sweep are set to give usable deflections for the characteristic on the cathode-ray screen. Use is made of the phase adjuster to bring phase coincidence of the characteristics resulting from ascending and descending plate voltage.

Calibration of current is obtained by setting the pulser at a given peak voltage and connecting a known resistance in series with the pulser and the pulse-current transformer primary. This calibration is accomplished by the calibrate switch in Fig. 2, which simultaneously disconnects the tube under test. More than one vertical calibration marker should be used if the vertical deflection extends beyond the linear range. No horizontal calibration markers are provided. The voltages at the ends of the horizontal base line are known from the conditions of test, and the intermediate voltages can be determined from uniform division of the line, since the sweep is linear.

Figure 5A shows a reproduction of a plate characteristic family taken for a 6C4 miniature tube at normal heater voltage. During test, the plate potential is varied from zero to 500 volts by means of a 250-volt peak 60-cycle sine wave superimposed upon 250 volts d-c. The grid is pulsed periodically to the fixed positive voltage designated on the curve.

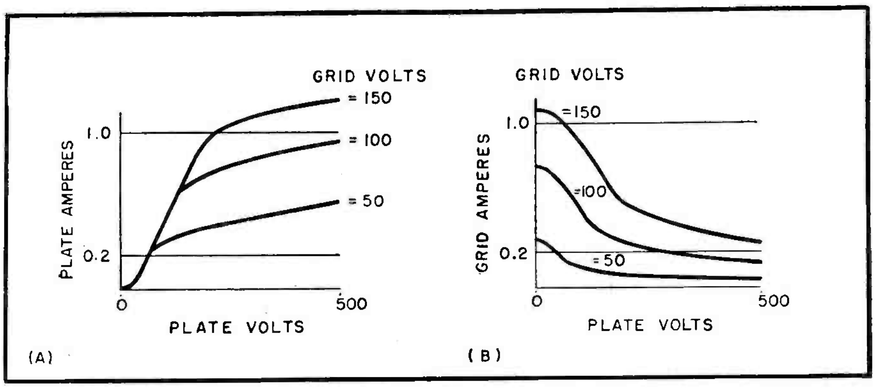

FIG. 5—Examples of families of plate-voltage characteristic curves obtained for type 6C4 miniature tube

Grid Curves

For curves of grid current vs plate voltage the procedure is the same, except that the oscilloscope vertical input is connected to the grid pulse transformer secondary so as to measure grid current. An example of the family of curves thus obtained is shown in Fig. 5B.

For curves of plate current vs grid voltage the variable voltage is on the grid, with all other electrodes at their specified d-c potentials. If the desired grid swing (abscissa of the curve) is to be from V_{g1} to V_{g2}, the grid 60-cycle supply, which establishes the total grid excursion, is set at a crest-to-trough voltage of $V_{g2} - V_{g1}$. The grid drive (peak voltage minus the magnitude of grid bias) is set at $= 0.5 (V_{g1} + V_{g2})$, which is the grid voltage at the center of its excursion. To insure that the tube will be cut off except during the pulses, the grid bias should be equal to or greater than the tube cutoff bias plus $0.5(V_{g2}-V_{g1})$. Grid voltages during tests are shown in Fig. 6A, and resulting curves for a 6C4 tube are in Fig. 6B.

For grid-current curves the procedure is identical except that the vertical oscilloscope input connects to the grid pulse transformer instead of to the plate transformer. Corresponding curves for a 6C4 are in Fig. 6C.

Curves on multigrid tubes may be obtained by using auxiliary d-c power supplies to maintain additional electrodes at fixed voltages. Power requirements are easily satisfied since the d-c drain is small even at high peak currents. Characteristics of elements other than grid and plate can be measured. Negative-grid-region curves are included. Diode curves are measured by connecting the diode plate to the grid terminal and following the procedure outlined for triode grid current vs grid voltage.

Photography of Curves

Exposure time must include enough dots or elements spaced close together to outline the complete curve. For a required N dots, occurring R per second, the exposure time is N/R seconds for a smooth

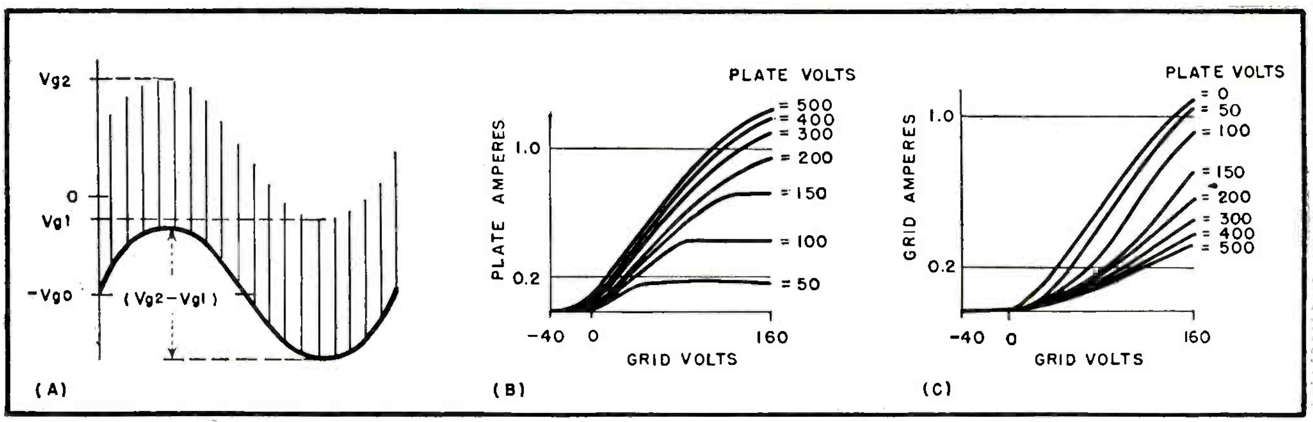

FIG. 6—Method of superimposing pulses on a-c grid voltage, and examples of families of grid-voltage characteristic curves obtained for type 6C4 miniature tube

curve. A limited number of dots will give a dotted outline of the curve. By using a great many dots, the individual elements join and form a solid curve. The number of such elements would be a minimum if they joined without overlap. This number is determined as follows:

The average sweep contains a total of R/F dots, where F is the sweep frequency and R is dots per second. These R/F dots occupy the fraction $R\Delta$ of the sweep time interval $1/F$, where Δ is the dot duration. Hence, complete coverage would require a minimum of $N = 1/F\ \Delta$ dots and exposure time $1/FR\Delta$ seconds.

Taking as an example a sweep frequency F of 60 cycles per second, a repetition rate R of 250 per second and a pulse duration Δ of 2 microseconds, the exposure time is $1/(60 \times 250 \times 2 \times 10^{-6})$ or 33.3 seconds. In this time there will be $1/(60 \times 2 \times 10^{-6})$ dots, or 8,333 in all. Increase in any of the factors F, R and Δ decreases the required exposure time.

Photographing the Traces

Photographs of all of the curves shown were taken with a modified Polaroid Land camera, having an f/3.5 lens and added screw adjustments for focusing. Exposure of about 30 seconds was used for each curve. Multiple exposures on the same film were used to obtain families of curves. The camera develops and prints its picture in one minute after each exposure.

Overall accuracy is considered to be well within practical limits so as to show individual tube characteristics and differences between tubes of the same type. The tracer displays data not obtainable practically using manual point-by-point methods. Reproducibility of data is good. Checks of plate current at corresponding points on plate and transfer curves have shown agreement within ±2 percent.

Distortion of 60-cycle wave form was reduced by inserting a small resistance between the secondary of each power transformer and its capacitive load.

The horizontal deflection on the oscilloscope is the voltage scale and should be linear. Typical 5-inch oscilloscopes show linearity within 1.3 percent when deflection is kept within half of the tube diameter. The vertical deflection indicates electrode current and should be moderately wide-band (1 mc or higher) for the pulse currents measured. Linearity, although desirable, is not essential because current markers are employed. Some stray pulse pickup current is present, about 2 milliamperes with the pulser at full output.

At high pulsed levels of power, changes in tube current at fixed voltages can occur during microsecond intervals. When these changes are large, the characteristic is no longer valid and a tube showing such rapid changes is limited in its suitability for microsecond pulsed applications. An appreciable change in current during the pulse interval manifests itself on the cathode-ray tube by changing the dots to vertical dashes having a height proportional to the change. A characteristic so taken will show a broad instead of a fine line, the thickness of the line vertically indicating the degree of current variation during the pulse interval. The extent and manner of current variation present throughout the entire voltage range can be examined in detail using a synchroscope. The curve tracer thus serves to locate quickly regions where microsecond changes occur and to indicate the magnitude of the effect.

Thanks are due to various members of the Signal Corps Engineering Laboratories who have contributed generously to the project, particularly to W. G. Muessle and G. C. Hooker who carried out most of the experimental phases of the work and designed certain of the components in the equipment, to H. W. Dann and the Instrument Shop for the construction of a developmental model of the curve tracer, and to D. R. Gibbons for helpful discussions in the course of the work.

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Grading Grinding Wheels

Internal flaws are reliably detected and hardness checked nondestructively on factory floor by tapping each wheel with mallet. Resulting ringing tone is measured with direct-reading stroboscopic frequency meter fed by microphone through amplifier

By THOMAS E. DUSTIN

Electronics Division
C. G. Conn Ltd.
Elkhart, Indiana

CRACKS IN GRINDING WHEELS are not always possible to detect by visual inspection. To solve this quality control problem, the Bay State Abrasive Products Co. of Westboro, Mass., makes use of a stroboscopic frequency meter called the Stroboconn[1]. Each grinding wheel in turn is struck with a mallet. The resulting ringing sound is picked up by a microphone, amplified, and fed to a U-shaped neon flashing tube. The tube illuminates twelve rotating disks in the stroboscope. The pitch or frequency is then read and used as a criterion of freedom from flaws and consistency of hardness.

When one of the seven concentric patterns on a disk stands still, the frequency is read directly without computation. If no disk pattern appears stationary, the tuning knob is adjusted until one does appear so and the reading on the tuning dial is added to the frequency value at zero setting. When interested in ratios or comparisons, as in the Bay State application, the reading is obtained directly in small logarithmic units called cents.

The Stroboconn can be used to measure any frequency within the range from 32.703 to 4,186.0 cycles. Higher frequencies can be measured by using an external frequency divider, with no loss of the 0.05-percent accuracy. Lower frequencies can be measured by using frequency multipliers. The signal can be fed into the Stroboconn from a microphone, vibration pickup, photoelectric cell or any other source which will supply 1.5 millivolts.

A card file has been developed over a period of years by the Bay State Abrasive Products Co. giving the correct ringing frequency for nearly every size wheel produced, taking into consideration the diameter, thickness and hole size. As an example, a wheel 1½ inches thick and 42 inches in diameter, with a 12-inch diameter hole and hardness grade K, has a ring of 228 cycles if of acceptable quality.

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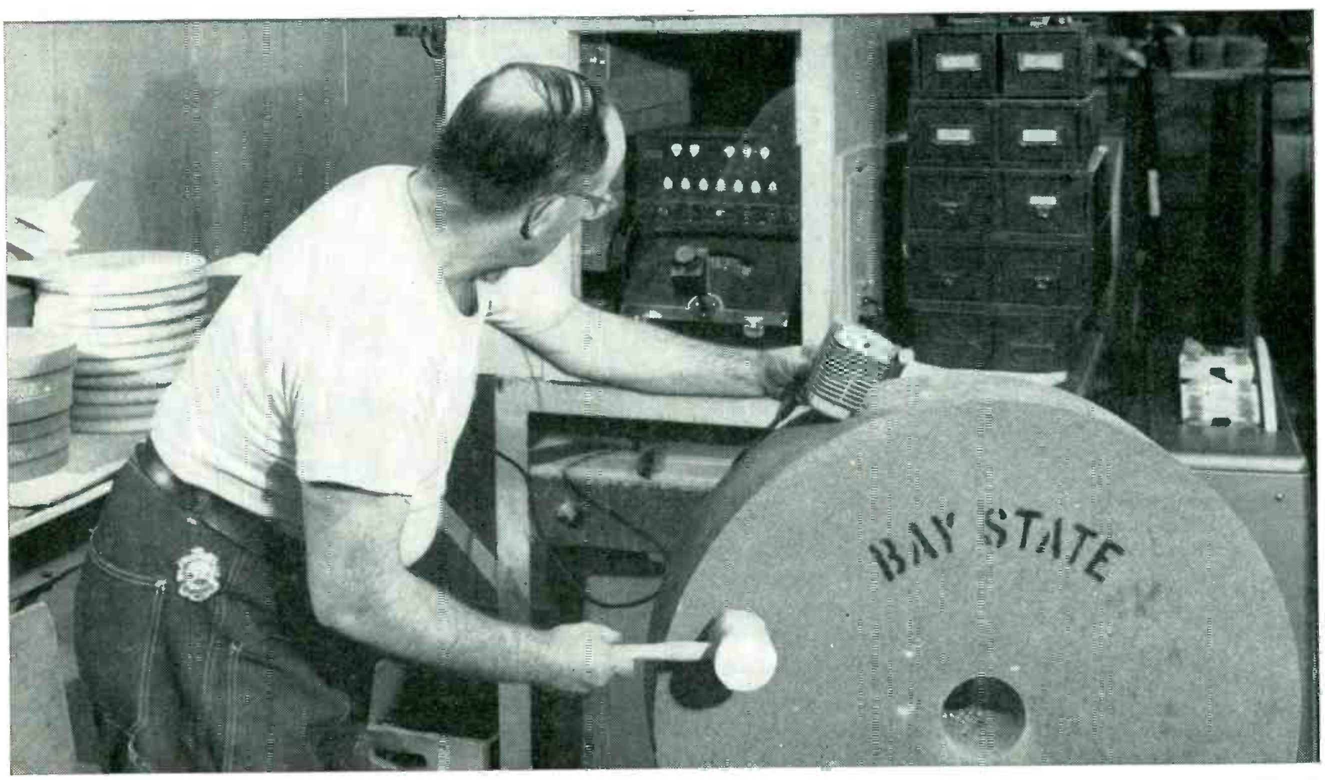

Grinding wheel being tested for flaws by measuring its ringing frequency with a stroboscopic frequency meter. Instrument is enclosed in a temperature-controlled and dust-free compartment, cover of which is open here

Capacitance-

By R. W. THICKENS

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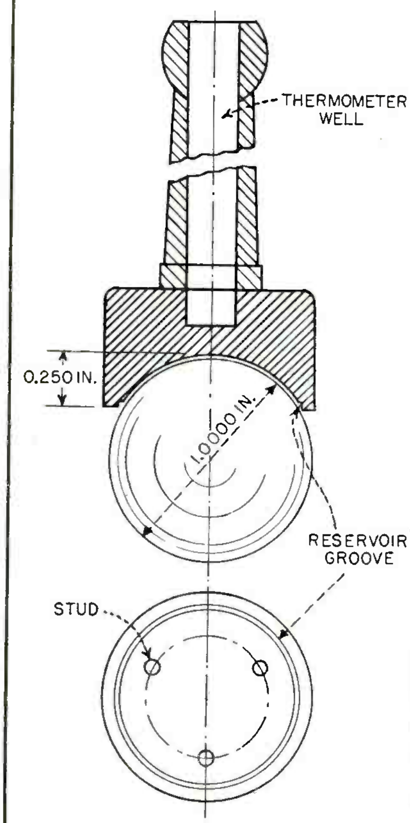


Principle of the Wagner Viscometer

The Wagner cup-and-ball viscometer is a secondary instrument. It consists of a steel ball (usually one inch in diameter) that is forced into a segment of sphere (the cup). In the cup are three studs 0.01 mm long that define the initial spacing between the cup and ball. At the edge of the cup is a small groove, which serves as a constant-pressure reservoir for fluid.

In normal cperation, a few milliliters of the fluid to be tested are poured into the cup and the ball is placed on the pool of fluid. Then the ball is pressed home against the studs so that any surplus flows out of the interspace to fill the reservoir. When the ball is seated the assembly is inverted. The ball is now held in place by capillary forces, but it starts to fall very slowly away from the studs. As it falls away the pressure on the liquid in the interspace decreases, and atmospheric pressure forces the material in the reservoir into the interspace.

When liquid sufficient to decrease critically the capillary forces holding the ball in the cup has flowed from the reservoir, the ball falls free. Viscosity in poises is measured as the product of a previously determined empirical constant and the time necessary for the ball to fall free (Poise, C.G.S. unit of absolute viscosity).

THE EQUIPMENT described here has been designed and built to fulfill the need for a viscometer that is not subject to the limitations involved in the Wagner cup-and-ball viscometer[1]. The apparatus consists primarily of a modified reversed Wagner-type instrument and the newly designed capacitance-change timer. For our purposes, only the relative viscosities are of interest. As a part of this measurement, it is necessary to determine the time required for the ball to move a small predetermined distance.

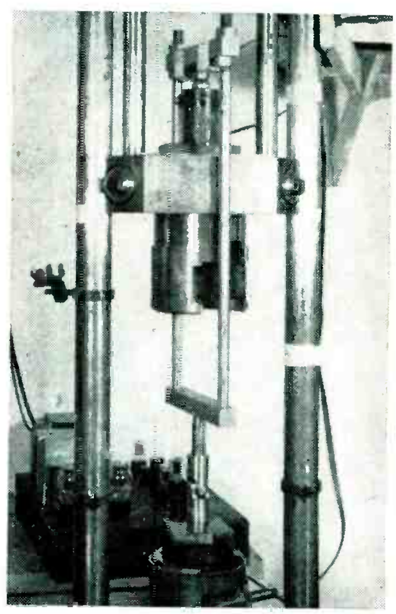
Since the fluids we wished to investigate were known to be dielectrics, it was thought that a convenient and reliable method for measuring the spacing between the cup and ball could utilize the capacitor formed by the cup-fluid-ball combination. The first capacitance arises from the cup-fluid-ball combination at approximately 0.005-inch separation and the second at about 0.003-inch separation. Both are of the order of several hundred micromicrofarads with a dielectric constant of 2.25. A bridge was considered, but rejected because it did not offer the convenience afforded by a variable-frequency oscillator feeding separate isolated tuned circuits.

Circuit Operation

In the complete circuit diagram shown in Fig. 1, the ball and cup, as noted above, are the capacitor in a variable-frequency Hartley oscillator V_1, which feeds the two grids of V_2 through an attenuator and two isolating resistors. Each plate circuit of V_2 is tuned (the top halves—V_{2A}, V_{3A} and V_{4A} will be called the high-frequency channel and the bottom halves V_{2B}, V_{3B} and V_{4B} the low-frequency channel) and responds only to the frequency of the tuned circuit. These two different frequencies represent the two different ball-and-cup spacings. The high-channel plate tank of V_{2A} resonates when the ball passes the 0.005-inch spacing.

The r-f voltage of resonance is applied to the grid of the high-channel tube V_{3A} through an attenuating network. When the peak amplitude of the voltage on the V_{3A} grid is greater than the d-c bias applied, the tank in this section resonates and the signal is applied to the cathode of V_{4A} through the 10-to-1 attenuator. The bias of V_3 is so chosen that the maximum rms voltage output at resonance is 30 volts. The attenuator is adjusted so that the Eccles-Jordan trigger circuit will trip half-way up the high-channel resonance curve. This arrangement gives better reproducibility of the tripping points. Tube V_{4A} is polarized so that it passes only the negative half of the sine wave.

When the high-channel section V_{4A} conducts, it charges the 0.01-μf capacitor; the RC time constant is such that the negative charge is maintained for a period considerably greater than the period of the sine wave. Since the capacitor is in the grid circuit of V_{5A}, which is normally maintained at ground potential by 200,000 ohms to the



Modified Wagner viscometer with timer chassis in background. Cup and ball are shown at top. Conventional yoke and loading press are at center

Change VISCOMETER

Relative viscosity of nonconducting liquids is more quickly and accurately determined by means of a modified cup-and-ball viscometer. Response of tuned amplifiers to radio frequencies controlled by cup and ball operate clock registers

plate of V_{5B}, that grid goes beyond cutoff. When this happens, the plate goes to B+, allowing relay K_1 (normally held open by current flowing through its coil) to de-energize and close its contacts K_{1A} and K_{1B}. When this plate voltage rises, it increases the potential on the grid of V_{5B} through the 200,000-ohm resistor connected to it. This lowers the corresponding plate voltage, which in turn lowers the grid voltage on tube V_{5A} and the second stable condition occurs, closing the contacts K_{2A} and K_{2B} of relay K_2 and turning on the clock. Since the circuit is symmetrical, it is a matter of chance which side will conduct first. Depressing switch S makes V_{5A} conducting by temporarily breaking the negative return. This allows the initial condition to be set, and the circuit will return to its initial condition at the conclusion of each test. Operation of the low-frequency channel is the same as that described above, except that the signal biases the grid of V_{5B} and opens the relay contacts.

The contacts of the two plate relays K_1 and K_2 are connected so that, when tube V_{5A} is conducting and V_{5B} is off, the timing clocks are not energized. When the changeover from one stable state to the other occurs, the clocks are energized and remain so until the ball has moved from the 0.005-inch to the 0.003-inch spacing, at which point the clocks are turned off. Two clocks are used; one is graduated to 0.01 second with a 60-second register and the other is graduated to 0.2 second with a 6,000-second register.

Modified E-J Circuit

The unique portion of the electronic section of this apparatus is the unconventional use of the final stage, the modified Eccles-Jordan trigger circuit. The plate loads are relays with resistances of 5,000 ohms, a value much smaller than normal, and the circuit is tripped with half sine waves rather than with the usual sharp pulses. These half sine waves charge capacitors in the grid circuits whose time constants are such that the grid-voltage change is maintained long enough to trip the flip-flop circuit. Quicker relay operation can be obtained with diodes across the relays to bypass the inductive kick but, for this use, operation is sufficiently fast without them. The cup and ball setup in a press with the timer behind it is illustrated.

This timing method can be used wherever the process to be timed can be related to a capacitance change or, if the flip-flop circuit is omitted, it could be used as a limit indicator.

The reproducibility of the tripping points has been determined and found to be considerably better than one-percent variation.

The author wishes to acknowledge the able assistance and encouragement of J. A. Van den Akker in the design of the equipment.

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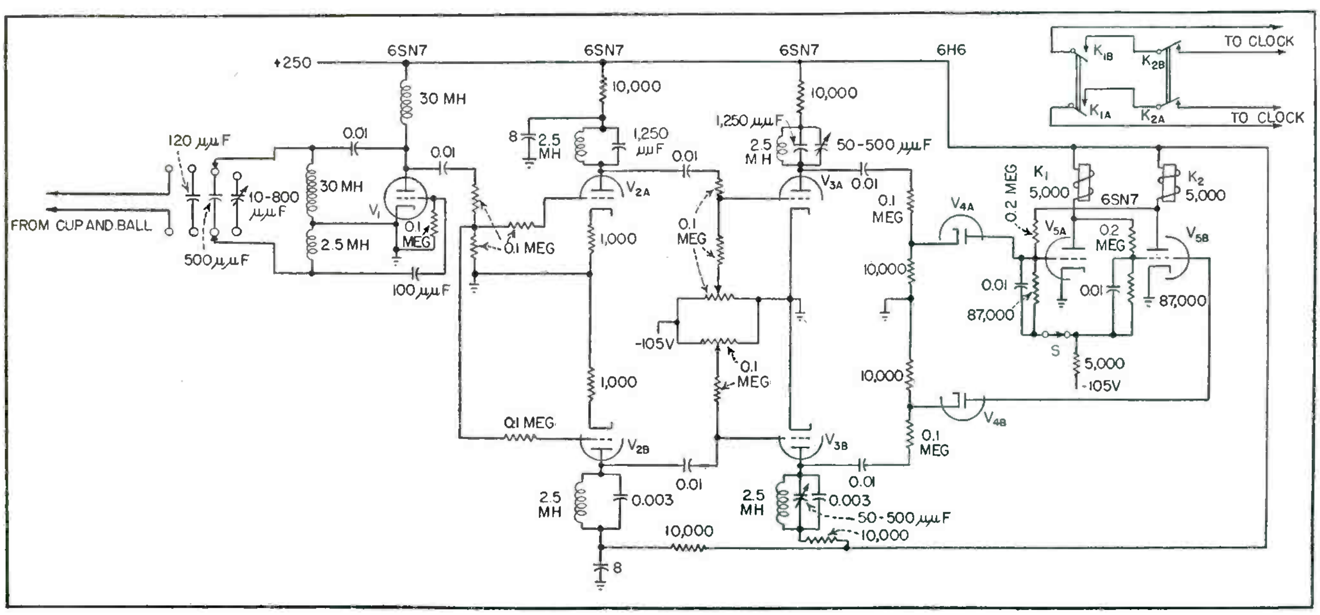

FIG. 1—Complete circuit diagram of the capacitance-change timer

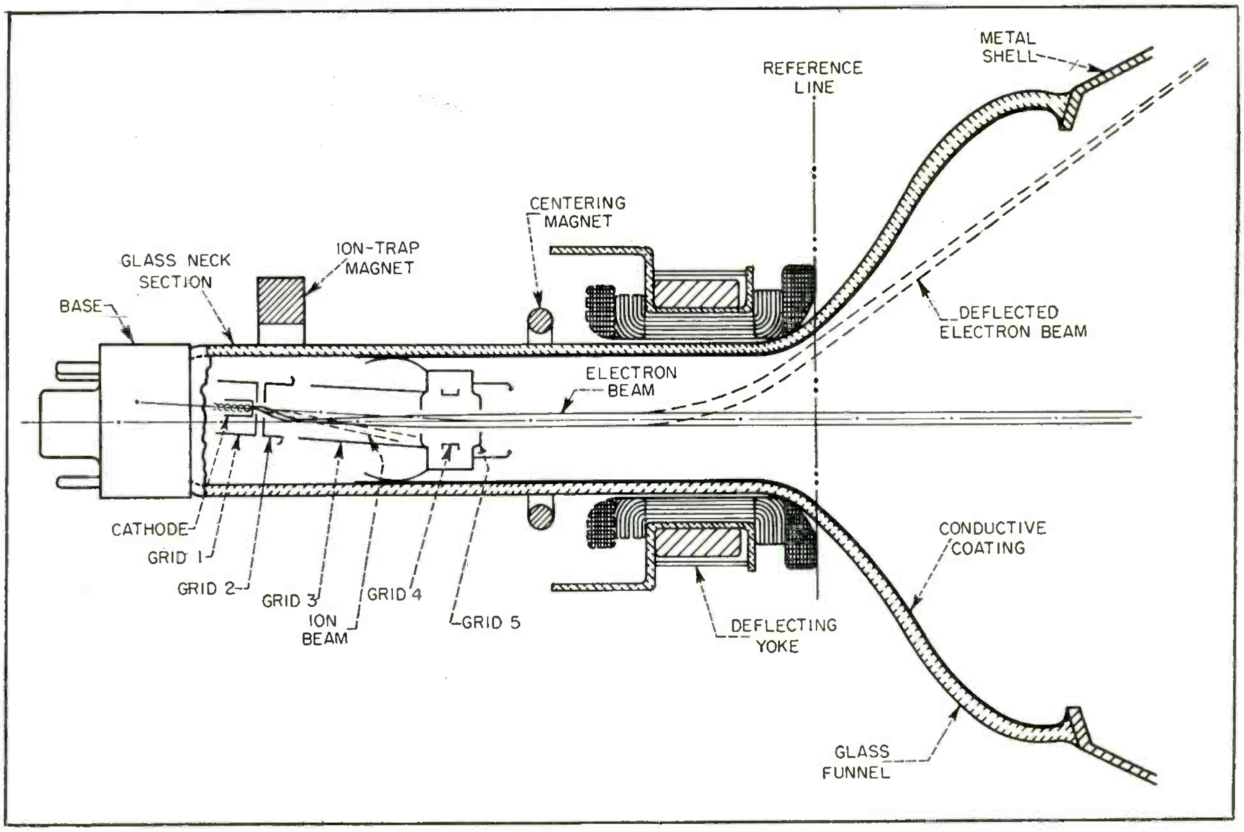

FIG. 1—Cross-section of new electrostatic-focus gun, showing path of electron beam and location of centering magnet

MATERIAL-SAVING

Electrostatic-focus electron gun eliminates magnetic assemblies using critical Alnico-5 and copper. Automatic correction of focus with line-voltage change or brightness adjustment is also provided. Focus voltage is obtained by rectification of pulses at the plate or the horizontal deflection amplifier

A DRASTIC REDUCTION in television receiver and tube production was in prospect near the beginning of the year when orders were issued to conserve critical metals such as Alnico and copper.

Since the focusing magnet uses a relatively large amount of either or both of these critical metals, elimination of this component effects a substantial saving. The use of electrostatic-focus electron guns instead of magnetic-focus guns was immediately considered; but to many, who remembered the comparative tests which resulted in the choice of magnetic focus at the beginning of the post-war television expansion, it appeared that this solution would result in a serious loss of picture quality. Fortunately, an electrostatic-focus gun design was in development which proved to be the equal in performance of the magnetic-focus gun and which gave promise, moreover, of even superior performance.

In the past, two types of electrostatic-focus electron guns have been used. One is exemplified by that in the 5TP4 projection tube and in the prewar 12AP4. In this type of gun the beam is accelerated to about one-fifth the high voltage and then focused by further acceleration to full voltage at the end of the gun.

Focus performance is good, particularly at high voltages, but the gun does not lend itself to the application of an effective ion trap. Moreover, at the voltages normally used in directly-viewed tubes, focus is not satisfactory unless current is drawn by the low-voltage focusing electrode. This current re-

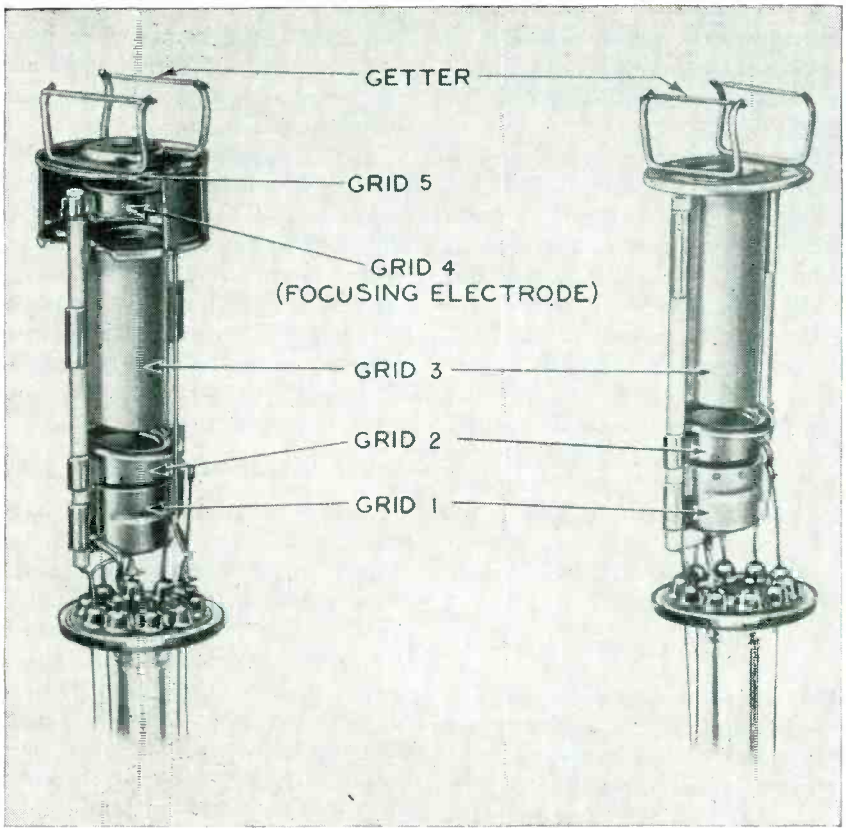

FIG. 2—Structure of electrostatic-focus gun compared with magnetic-focus gun

PICTURE TUBE

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quirement makes the design of the focusing-voltage supply difficult and reduces the signal sensitivity of the picture tube.

In the second type of gun, the beam is accelerated to full voltage and then focused by a short decelerating section at the end of the gun. This type of gun was first introduced for use in electrostatic-deflection oscillograph tubes,[1] and later in electrostatic-deflection kinescopes such as the 7JP4. This gun has a useful focusing field of smaller diameter than that of the previous type, and therefore, requires a corresponding reduction in the size of the beam which can be well focused.

In the electrostatic deflection tubes, the beam is heavily masked to limit deflection defocusing. Because of high-voltage acceleration in the gun, it could, if desired, use the same ion-trap systems devised for magnetic-focus guns. However, when this gun, combined with an ion trap, was used in magnetic-deflection tubes which require a larger beam diameter, focus performance—particularly with regard to deflection defocusing—was poor. It was recently determined that most of this difficulty is due to overlapping of the deflecting field with the low-voltage region of the focus field.

New Gun

The new electrostatic-focus gun also uses a decelerating field for focusing, but overcomes the disadvantages of its predecessors. The gun provides more spacing between the electron lens and the deflecting field, and uses a short focusing field to minimize interaction. Another important improvement over previous designs is the use of the tilted gun introduced by RCA in the 16GP4[2].

This tilted gun gives optimum performance with the usual single-magnet ion trap and provides better alignment of the beam in the focusing fields.

Figure 1 is a schematic cross-section view of the new gun, showing the relative size and position of its electrodes. Figure 2 is a photograph comparing the new gun with the magnetic-focus gun it replaces. The lower parts of the two guns are similar. Both have a tilted-lens electrostatic field between grid 2 and grid 3 which, in combination with the field from an external magnet, serves as an ion trap.

Grid 1 of both guns is offset about one-tenth inch on the stem, thus placing the gun itself on an angle in order to align the beam correctly in the electron lens and deflecting fields.[2] In both guns, grid 3 operates at high voltage and is connected to the conductive coating inside the neck by means of metal bulb spacers. The electrostatic-focus gun has two additional elec-

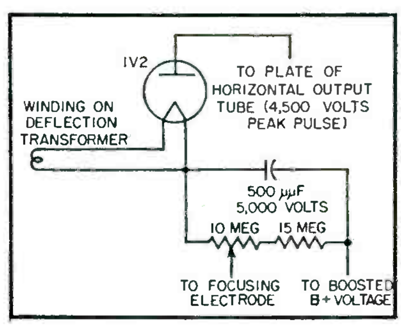
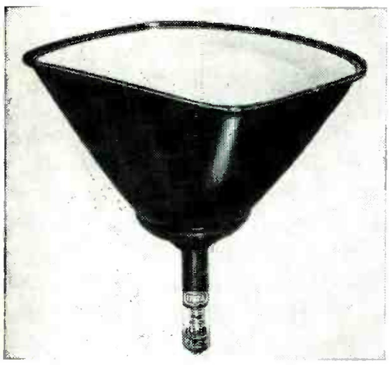


FIG. 3—Rectifier circuit for providing focusing voltage

trodes; grid 4 focuses the electron beam, and grid 5 is connected to grid 3 to complete the deceleration-type focusing lens.

Focusing Voltage

With this deceleration-type lens, the potential at which focus occurs can be designed to be any voltage between a negative value with respect to the cathode and about one-half the high voltage. On the basis of theoretical considerations, it has been proposed that the focusing voltage be set at cathode potential.[3] Such a system, theoretically, would not require any external focusing adjustment. Actually, however, it is very difficult to make electrodes with the precision needed for such a system, and, in any case, adjustment would still be required to compensate for the small changes in focus due to changes in grid 1 voltage.



Seventeen-inch rectangular metal 17GP4, incorporating new electrostatic-focus gun. The electron gun is readily adaptable to all current glass or metal picture tubes. No change is needed in either the deflecting yoke or ion-trap magnet

If a focusing voltage of approximately zero is used, a larger adjustment range is needed than with higher-voltage designs and the focus is a little poorer. If, as will probably always be the case, both focusing voltage and high voltage are obtained from the same circuit, the focusing voltage will be proportional to the high voltage and focus will be maintained automatically.

The focusing voltage selected for the new gun is less than 5,000 volts. The stem and base of picture tubes can easily be insulated for this value and the voltage can readily be obtained from a rectifier system connected to the plate of the horizontal output tube. A suitable rectifier circuit is shown in Fig. 3. This low-cost focusing-voltage supply produces a negligible drop in the high voltage.

This electron gun can be used in all sizes of picture tubes. However, because the gun-to-screen distance varies with tube size, the amount of focusing voltage required also varies. The grid 4 voltage is approximately 20 percent of the high voltage. It will be slightly higher for the larger tubes and slightly lower for the smaller (and shorter) tubes. The focus voltage of the new electrostatic-focus gun and other characteristics affecting interchangeability follow the recommendations of the JETEC Cathode-Ray Tube Committee.

Centering

Because of the difficulty and expense of providing raster centering by means of direct current in the deflecting yoke windings, it has become universal practice in magnetic-focus kinescopes to center the raster by tilting or shifting the magnetic-focus field off the kinescope axis.

Since this method is not practicable in electrostatic-focus tubes, centering can be provided in most cases by the use of a small magnet similar to the ion-trap magnet but of weaker field strength. This magnet is placed just below the deflecting yoke, as shown in Fig. 1, and centering is obtained by adjusting the strength and rotational position of the magnet on the tube neck.

Advantages of New Gun

The focus performance of the electrostatic-focus gun does not depend on a focusing magnet selected and lined up on the tube by the user, but rather on the symmetry of the focusing electrodes built into the tube. Good manufacturing control is needed to provide a well-focused spot but control is not exceptionally critical.

Because both electrostatic and magnetic focusing systems have reasonably low lens aberrations, the focused spot size depends primarily on the geometrical magnification ratio of the electron optical systems. Magnification ratio, and with it spot size, decreases as the gun is lengthened, but because the beam diameter in the deflecting field also increases, additional deflection defocusing results.

The electrostatic-focus gun has been made a little shorter than the magnetic focus gun it replaces to reduce deflection defocusing, at the cost of but a small increase in the size of the spot near the center of the screen. This design helps meet the need for better edge resolution with only a barely perceptible loss in center resolution.

Automatic Focus

In the event the high voltage changes because of line-voltage changes or brightness adjustments, focus is automatically corrected if the focusing voltage is obtained from the high-voltage circuit.

This feature eliminates the need for complicating receiver operation by either providing a user focus control or requiring the service man to make a compromise adjustment.

The service man is not required to make the critical focusing-magnet alignment which in the past has not always been the optimum one. The ion-trap magnet adjustment is also simplified because more space is available and the shunting of its field by the field of the focusing magnet is avoided.

The cost of the components for obtaining the voltage for electrostatic focusing compares favorably with the cost of a focusing magnet.

Elimination of the focusing magnet provides appreciable weight saving, and, as a result, a less rigid tube support can be used at the deflecting yoke.

An additional important consideration is that the electrostatic-focus gun is suitable for use in magnetic-deflection radar indicator applications. In these applications, the reduced weight and the unencumbered neck space available for rotating deflection yokes are of considerable value.

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Independent Control of Selectivity and Bandwidth

Simple R-C amplifier provides a wide range of bandwidth-frequency relationships without affecting selectivity or gain. Can be made to give constant absolute bandwidth in cycles per second for different center frequencies throughout audio range

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NEED occasionally arises for a tunable selective a-f amplifier having constant gain and selectivity but whose bandwidth is some specified function of the frequency to which the amplifier is tuned. A common requirement is for a bandwidth which remains constant as the center frequency is varied over a wide range.

The usual solution is to employ a fixed-tuned selective amplifier and to vary the operating frequency by heterodyne methods. A simple R-C amplifier can be made to give almost any desired bandwidth-frequency relationship when two circuit elements are tuned per stage. The special case of constant absolute bandwidth may be approximated conveniently by varying only one element.

An interesting property of this circuit is the ability to alter bandwidth, at a given operating frequency, without affecting selectivity or gain. (By selectivity is meant the ratio of response at resonance to the response of frequencies very far from resonance.) A single-stage amplifier of this type, adjusted to have a greater-than-normal bandwidth for a given selectivity, will be found to have a response very similar to that of two conventional amplifiers in cascade, except for frequencies far removed from resonance.

This circuit fills the gap between selective feedback amplifiers having bridged-T or equivalent rejection filters in the negative feedback loop, and cascaded conventional amplifiers made selective by suitable choice of coupling-circuit time-constants. The former are too selective for many applications, while the latter are often not selective enough, unless a large loss in mid-band gain is incurred.

The circuit consists essentially of an amplifier provided with a feedback loop having constant amplitude of transmission, but variable phase. At very low and very high frequencies, phase is such that the feedback is negative. At the resonant frequency it is positive and selective amplification results.[1] In such an amplifier, bandwidth may be adjusted not only by altering the magnitude of the feedback voltage, which determines the height of the resonant peak, but also by varying the rate of change of phase with frequency around the feedback loop, which broadens the response curve without affecting the height of the peak.

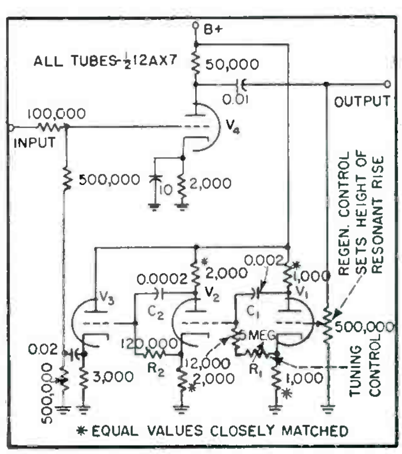

FIG. 1—Selective amplifier tunable with approximately constant absolute bandwidth and constant gain between 300 and 6,000 cycles per second

Phase Control

Control of the rate of change of phase is awkward with the circuits commonly used in selective feedback amplifiers, because the amplitude of transmission through the loop will also change. In the circuit of Fig. 1 this type of control is easily accomplished. In this circuit, V_1 and V_2 are the frequency-determining, phase-shifting stages, and V_3 is a cathode follower for isolation. The condition for positive feedback is that the total phase shift through the feedback loop be

$$2 \tan^{-1} \omega R_1C_1 + 2 \tan^{-1} \omega R_2C_2 = \pi \quad (1)$$

We may solve for ω by noting the identity that

$$2 \tan^{-1} (x) + 2 \tan^{-1} \left(\frac{1}{x}\right) = \pi \quad (2)$$

Thus when ωR_1C_1 is equated to $1/\omega R_2C_2$, the resonant angular frequency is found to be

$$\omega_{res} = \frac{1}{\sqrt{R_1C_1R_2C_2}} \quad (3)$$

An interesting property of this circuit when $R_1C_1 = R_2C_2$ should be pointed out. If Q is defined as the ratio of the response at resonance with feedback, to the response at any frequency with no feedback, it may be shown that the fractional frequency deviation for 70-percent response is approximately

$$\frac{\Delta\omega}{\omega} = \frac{1}{d\phi/d\omega \times Q} = \frac{1}{2Q} \quad (4)$$

where $d\phi/d\omega$ is the rate of change of phase with frequency around the feedback loop. The approximation is within a few percent when Q is greater than five. Note that this is the familiar expression relating Q and bandwidth in ordinary resonant circuits. It is a coincidence that an amplifier having a feedback loop of this sort has a response in the vicinity of resonance which is substantially identical to that of a resonant circuit.

From Eq. 1

$$\frac{d\phi}{d\omega} = \frac{2\,R_1C_1}{1 + \omega^2R_1^2C_1^2} + \frac{2\,R_2C_2}{1 + \omega^2R_2^2C_2^2} \quad (5)$$

At the resonant frequency, if both time constants are equal, $\omega = R_1C_1 = R_2C_2 = 1.0$, and $d\phi/d\omega = 2$ as indicated in Eq. 4. Now let R_1C_1 be increased by some factor r. If ω is to be the same, R_2C_2 must be multiplied by $1/r$. Equation 4 may then be written

$$\frac{d\phi}{d\omega} = \frac{2}{1 + r^2} + \frac{2 \times \dfrac{1}{r}}{1 + \dfrac{1}{r^2}} = \frac{4r}{1 + r^2} \quad (6)$$

Thus for a given resonant frequency, $d\phi/d\omega$ and hence the bandwidth may be varied by multiplying one time constant by r and the other by $1/r$. The ratio of the bandwidth when r is greater than 1 to that when $r = 1$ is $(1 + r^2)/2r$. It is seen that the bandwidth is nearly proportional to r when r is large.

Constant Bandwidth

For a tunable amplifier with constant percentage bandwidth, and with independent bandwidth control, R_1 and R_2 could be ganged, with C_1 and C_2 switchable in such a way that if one is increased by r times, the other is decreased by $1/r$ times. When these capacitors are switched, resonant frequency and gain remain constant, but bandwidth varies.

A physical picture of the way in which different time constants affect the slope of the ϕ—ω curve, and thus the bandwidth, may be had from the phase-frequency curve of Fig. 2A. The center curve shows the variation in each phase-shifting stage when the time constants are identical. The upper and lower curves show the variation per stage when one time constant is 10 times as great, and the other 0.1 as great. It will be seen that the sum of the phase shifts, when $\omega = 1.0$, is still 180 degrees, but that the slopes of the curves are considerably less than that of the center curve.

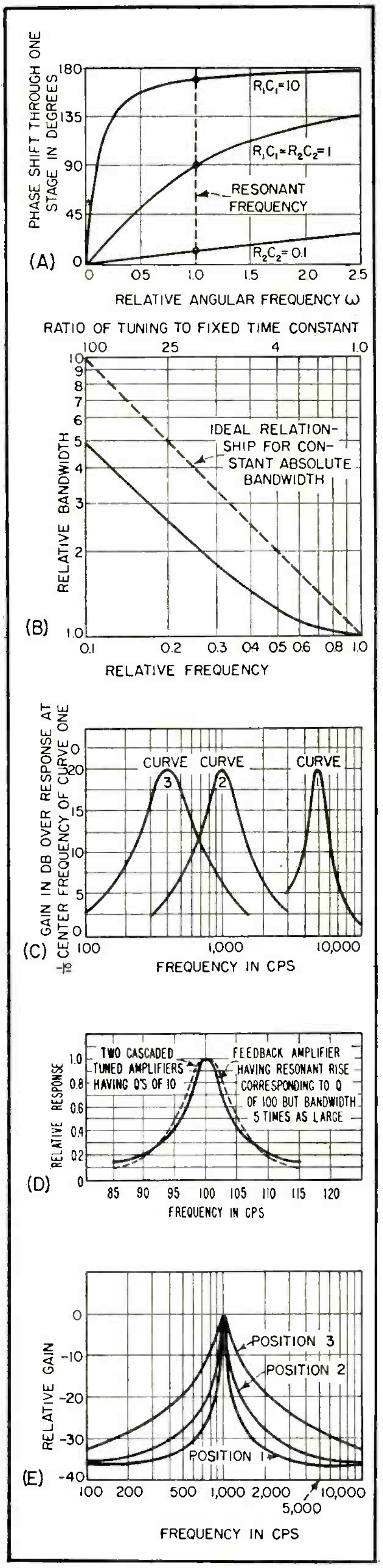

FIG. 2—Curves show operating characteristics of circuits shown in Fig. 1 and Fig. 3

If a tunable amplifier is desired whose absolute bandwidth remains nearly independent of center frequency, it is possible to set the two time constants equal at a frequency somewhat higher than the highest of interest. Tuning may then be done by varying only one time constant; to decrease frequency it is made larger.

Inspection of the equations will show that frequency is inversely proportional to the square root of the ratio of the tuning to the fixed time constant, and that r is directly proportional to the square root of this ratio. The resulting variation of bandwidth versus frequency is shown in Fig. 2B. It is seen that the actual curve approximates the slope of the ideal curve for constant absolute bandwidth very closely when the ratio of time constants is larger than about nine.

An example of the variation of bandwidth with resonant frequency obtainable in a tunable amplifier of this sort is shown in Fig. 2C. If the bandwidth-frequency variation of Fig. 2C is unsatisfactory for any reason, almost any desired variation may be obtained by changing both time constants simultaneously, but by different amounts. The ganged resistors or capacitors may further be so connected that for a given rotation of a common shaft, one time constant increases as the other decreases. If these changes are by unequal amounts, a very rapid increase or decrease in bandwidth can be obtained for a small change of resonant frequency.

The shape of the curve of resonant frequency versus shaft rotation will of course depend on the law of bandwidth variation chosen. This can be taken care of in the dial calibration.

Practical Application

An example of a situation in which the variable-bandwidth property is valuable is an audio-frequency filter for selecting code signals of different pitches. Such a filter might be used in the audio output of a communications receiver equipped with an intermediate-frequency crystal filter to augment the overall selectivity.

In the most selective position, crystal filters have a bandwidth of the order of 100 cycles. This bandwidth is equivalent to a Q of 5,000 at 500 kc, a Q of 50 at 5,000 cps and a Q of 3 at 300 cps. With the selective amplifier of Fig. 1 and identical tuning time-constants, it is not at all difficult to obtain a response equivalent to that of a tuned circuit having a Q of 100 at 300 cps. The selectivity would be desirable, but the associated bandwidth of 3 cycles between 70-percent points is prohibitively narrow for many practical applications.

To make audio selectivity more nearly match i-f selectivity no matter what the pitch of the incoming signal, the tuned amplifier may be so designed that both time constants are equal at the highest audio frequency of interest, say 6,000 cps. Then resonant frequency may be changed by varying one time constant alone. The audio bandwidth will be the same as that of the crystal filter, if the resonant rise is made equal to 60 at 6,000 cps. The bandwidth at 300 cycles will be 10 times as large as at 6,000 cps for the same selectivity. Thus it is half as large as it should be in order for the bandwidth in cycles to be the same at this frequency as at 6,000 cps, but this is close enough for practical purposes and is a great improvement over the equal-time-constant case.

Where large changes in time constant are required, resistance tuning is desirable unless considerable range-switching can be tolerated. The chief practical problem with resistance tuning is the varying impedance of the R-C phase-shift combination which at the higher frequencies acts as a finite load on the phase inverter and causes a reduction in the magnitude of the feedback voltage.

This problem is somewhat worse when only one time constant is to be varied, and tuning is to be over a wide range. The design procedure used with the circuit of Fig. 1 follows. First, a value for C_1 is chosen which makes its reactance at 6,000 cps (the highest frequency) equal to 5 megohms. This value is 5.3 $\mu\mu$f. Since this time constant must be 400 times as large to permit operation at 300 cps, the actual value assigned C_1 is 400 times 5.3 or roughly 0.002 μf. Thus when operation is at 6,000 cps, the resistance of R_1 will be set at 12,500 ohms and the magnitude of the impedance across the cathode follower will be 1.4 times this. A change in the magnitude of the feedback voltage of the order of five percent may accordingly be expected.

To minimize loading on V_2, the fixed resistance R_2 may arbitrarily be made 120,000 ohms. Then C_2 is the capacitance whose reactance is 120,000 ohms at 6,000 cycles, or approximately 200 $\mu\mu$f. Therefore at 6,000 cps, the time constants are equal; at 300 cps, R_1C_1 is 400 times as large.

It is possible to compensate to some extent for reduced feedback voltage at the higher frequencies by deliberately unbalancing the plate and cathode resistors of V_1 or V_2 (Fig. 1).

Expanded Bandwidth

The ability to obtain wider-than-usual bandwidth at maximum selectivity in a single stage is an interesting property of selective feedback amplifiers. The only way to accomplish the equivalent with conventional resonant circuits seems to be to employ more than one, either as a single-stage amplifier employing over-coupled circuits, or as two tuned amplifier stages in cascade.

Figure 2D shows a comparison between a one-stage R-C amplifier having a resonant rise of 100 times and a bandwidth five times normal, and two cascaded L-C tuned amplifiers having Q's of 10. The two response curves are very similar in the neighborhood of the response peak, although it must be pointed out that the response of the resonant circuits will continue to fall off at frequencies very far from resonance, whereas that of the amplifier will level off.

In Fig. 3 is shown the circuit of a laboratory tunable selective amplifier arranged for a constant-percentage-bandwidth variation with tuning, and incorporating a choice of three bandwidths at any desired selectivity.

A combination of positive and negative feedback is used to stabilize the response. Vacuum tubes, identical to those in the tuned positive feedback loop, have been incorporated in the untuned negative feedback loop. Thus changes in gain in one branch due to supply voltage variations are offset by substantially equal changes in the other.

Measured response curves at a single frequency for the three positions of the selectivity control are shown in Fig. 2E.

The work described in this paper was carried out under Contract W-28-099 ac131 between the Watson Laboratories, AMC, and Stanford University. The experimental work was done by Frank S. Holman.

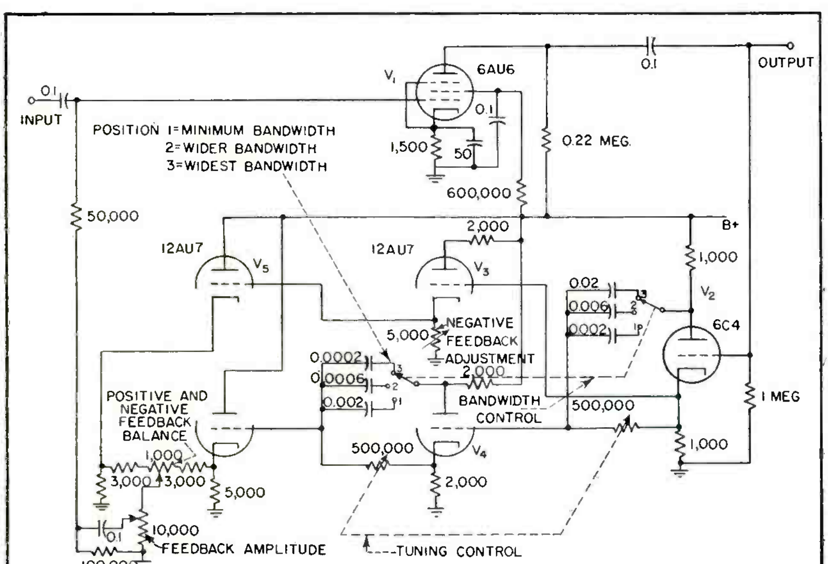

FIG. 3—Tunable audio amplifier with independent bandwidth control and balanced feedback

REFERENCE

(1) O. G. Villard, Jr., Tunable A-F Amplifier, ELECTRONICS, p 77, July 1949.

MIXED FERRITES for Recording Heads

Inexpensive ferrite heads show promise as substitutes for units using critically short nickel. Advantages are simple construction with no laminations, minimized eddy-current losses at high frequencies and reduced head wear in continuous-duty applications

By ROBERT HERR
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HEAD WEAR and eddy-current losses are important problems in the design of ring-type heads for magnetic recording. Playback heads of high-permeability alloys, required for sensitivity, are constructed of thin laminations to minimize eddy-current losses but at the high frequencies now common in pulse recording, computing and telemetering, the required degree of fineness becomes impractical from a manufacturing point of view.

The iron oxide used in recording tapes is several times harder than the high-permeability-alloy head and causes wear. By careful design, this wear has been reduced to a minimum in machines used for intermittent operations but still is an important consideration for continuous-duty equipment.

Improved Magnetic Materials

Within the past decade there have been important advances in magnetic materials, particularly the ferrites[1], which show promise for solving these problems. Some of these materials, for example $ZnOFe_2O_3MnOFe_2O_3$, have permeabilities at room temperature approaching those of high-permeability alloys. These materials are such poor conductors that, depending on the material, eddy-current losses are not detectable below 1 to 30 mc. In addition, they are dimensionally stable substances with a Moh hardness of about seven, or in the same range as iron oxide.

These magnetic materials have become commercially available in this country recently. For example, the North American Phillips Co. supplies several grades of Ferroxcube and the General Ceramics and Steatite Corp. produces several grades of Ferramics, which have been described in detail.[2,3]

Figure 1 shows the components of an experimental head made of Ferramic E or Ferramic G. A magnetic core was obtained by cutting a toroid of ⅞-in. outer diameter in half. After cutting, one gap was reduced in depth and the mating surfaces were smoothed. As the material is too hard to be machined, it must be cut with a silicon-carbide wheel (with water) and can only be ground and lapped by hard materials.

Experimental heads have been carefully tested as record, erase and playback heads, and have given generally excellent results. Ferramic E with the highest initial permeability gives best results in playback. Ferramic G, with high resistivity, may be slightly preferable for record or erase heads, particularly if frequencies in excess of 1 mc are to be used.

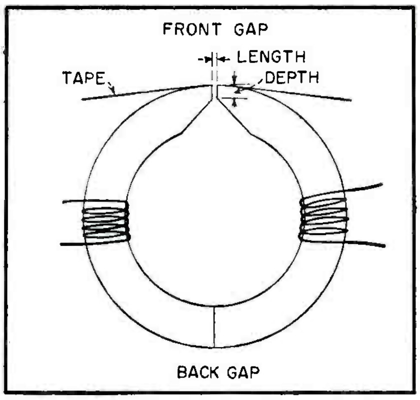
In actual use, magnetic tape will not wear the head material enough in hours of running to be detected microscopically. The abrasion resistance of these heads is so great that new problems in head construction are created. With soft materials, the final lapping of the contact surfaces is often done by the tape during the first minutes or hours of use. In the case of ferrites, the surface presented to the tape must be ground and lapped to perfection because any irregularities will scrape and damage the tape.

Design Features

For good head efficiency, the front-gap depth should be kept as small as possible. With soft materials, a practical limit is reached because the material tends to wear down. Thus, the front-gap depth is frequently made 0.05 to 0.1 inch so that wear of 0.005 to 0.02 inch will not cause too great a change in head characteristics. With ferrite materials, no detectable wear occurs and the core at the front gap may be made as thin as the precision of grinding techniques will allow.

It is desirable to keep the front gap thin because then a greater part of the total flux is useful in magnetizing the tape when recording. Also, in playback a greater fraction of the flux generated by the tape passes through the pickup coils instead of being shunted across the front gap. A thin front gap makes possible more turns and thus greater sensitivity while keeping the inductance low and the resonant frequency high. This is a decided advantage for use at high frequencies. A good discussion of these factors of head design is given in a recent paper by Rettinger[4].

In the heads such as shown in Fig. 1, 250 turns were wound on each leg and the inductance at 1,000



Typical magnetic recording head showing how the front gap is reduced in depth

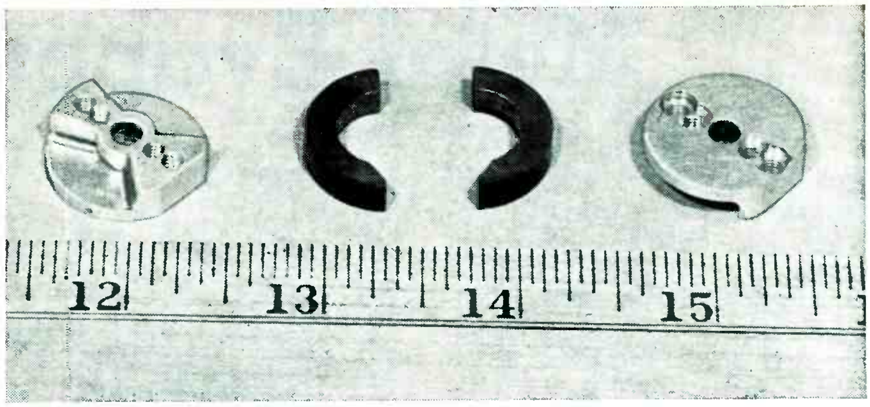


FIG. 1—Components of an experimental magnetic recording head using a core made of Ferramic E or Ferramic G. Core was obtained by cutting a toroid of ⅞-in. outer diameter in half and then reducing one gap in depth

cycles was measured. The back gap, full cross section, was closed as well as possible and the front gap was spaced 0.0005 inch. For Ferramic E cores with a 0.050-inch front-gap depth the inductance was 44 mh, 11 mh for each coil, indicating negligible leakage flux. For cores with a 0.015-inch front-gap depth, the inductance was only 19 mh. These heads had the same signal sensitivity in pickup. For Ferramic G the inductances and sensitivities are about one-half as great.

Results of Tests

In tests at audio frequencies, heads of Ferramic E have performed in a manner substantially indistinguishable from more conventional ones with one exception to be discussed later. The loss at high frequencies is less with Ferramic E heads, with the frequency at which the difference becomes appreciable depending upon the laminations of the metallic head.

The exception mentioned previously concerns short-wavelength response as distinguished from high-frequency response. These two terms can only be used interchangeably at a given tape velocity. Some of the effects which limit high-frequency response of a recorder are true frequency effects such as eddy-current losses and stray capacitance while other factors such as head alignment, gap resolution and tape-to-head contact depend directly on wavelength.

Ferrite structures tested have shown a granular structure that is coarser than is desirable in magnetic heads and leads to less perfect gaps than are customarily obtained with metallic alloys. Coarseness of the basic particles makes the edge of the gap rough.

The best results were obtained by polishing with Arkansas hard stone which yielded gap edges with many irregularities of about 0.0003 inch and some larger. Such heads are less sensitive than metal heads to wavelengths of less than about 0.002 inch. However, it should be mentioned that these structures were made for inductance cores and pulse transformers, where this degree of coarseness is of no importance. There is nothing in the nature of the ferrites that precludes their being made in a much finer particle size.

Only preliminary measurements have been made and more definite advantages or shortcomings may appear as the heads are used in varying applications. For example, some materials are more affected than others by mechanical stress or temperature and some may become permanently magnetized more easily than others. These factors must be evaluated after use in different head mounts. From the magnetization characteristics of the best of the ferrite materials, one should expect a lesser tendency toward permanent magnetization, and a greater temperature coefficient, than in metal heads.

Conclusions

Ferrite heads show definite promise in continuous-duty machines, high-frequency recording, computing and telemetering and in erase heads to operate at higher frequencies than are now practicable without excessive heating. In addition, it seems that ferrite heads could be made roughly the equal of metallic heads in routine applications. If this proves to be true, ferrite heads may be used in everyday audio applications as well as special uses.

If cost alone is the determining factor, ferrite heads have a decided advantage. Molding and grinding a single piece is cheaper than punching, insulating and assembling dozens of laminations, and no annealing is necessary.

Ferrites are composed for the greater part of iron and oxygen with only small amounts of scarcer metals. Metallic alloys, on the other hand, consist of a high percentage of these scarce metals, particularly nickel. If the present shortage of nickel should become more severe, manufacturers may find themselves forced to develop ferrite heads regardless of any drawbacks they may have.

The author wishes to thank S. M. Rubens of Engineering Research Associates, St. Paul, Minn., for early and continuing discussions of the possibilities of the ferrite materials in this application.

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(2) C. L. Snyder, E. Albers-Schoenberg and H. A. Goldsmith, *Electrical Manufacturing*, Dec. 1949.

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(4) M. Rettinger, *SMPTE Jour.*, 55, p 377, Oct. 1950.

Metal Evaporator Uses

THE PROBLEM of putting polished metallic finishes on nonconducting materials has, until recently, been solved for only a few combinations of base substance and metal. Chemical silvering of glass has made possible nearly all of the mirrors in use. On such silver coatings other metals can be plated, but the variety is limited. If plastics are used instead of glass, further difficulties arise in coating because of chemical reactions which occur in processing and the effects of heat on the plastic.

One satisfactory method of metallizing unplatable materials is to condense metal onto their surfaces from the vapor state. This technique has become standard in many plants manufacturing metal-coated plastics. Only a few metals, notably zinc and cadmium, do not form good mirrors when condensed on a polished surface at room temperature. Mirrors of rare metals may economically be made since the metal coating is very thin and only a small amount of metal is required.

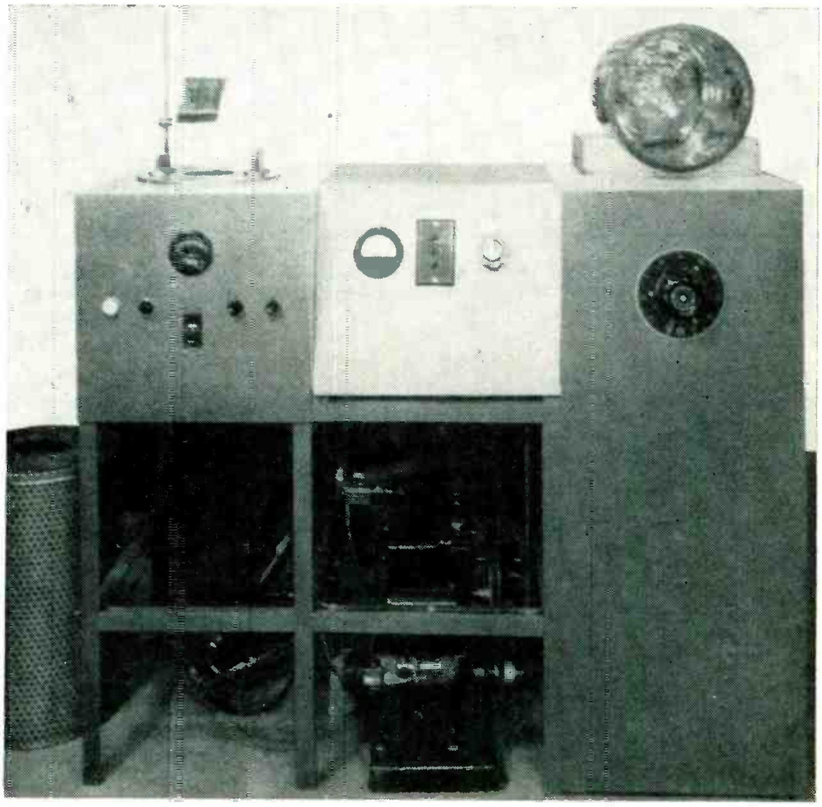

FIG. 2—Laboratory evaporator modified to use high-frequency induction heating instead of the more conventional filament method of converting metals to the vapor state

Filament-Type Evaporators

If bright mirror surfaces are to be produced, evaporation must take place in a high vacuum, 0.001 mm of Hg or less. In typical vacuum-coating equipment the bell jar in which work is done is evacuated by mechanical and vapor diffusion pumps. The jar rests on a base plate that provides a smooth seat for the sealing gasket attached to the rim of the jar. Power for heating the metal until it evaporates is brought through the base plate by means of vacuum-tight insulated bushings.

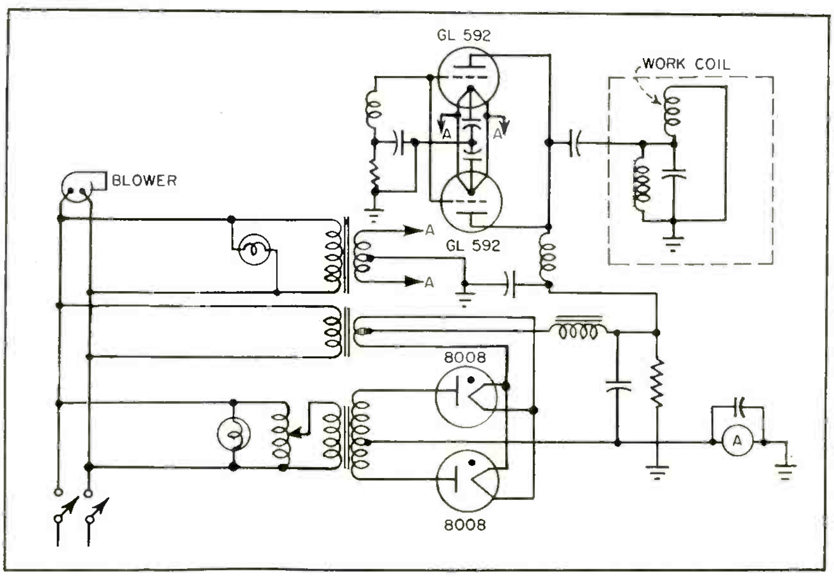

FIG. 1—Circuit of the high-frequency metal evaporator. Protective contactors are not shown

In most vacuum evaporators the metal is placed within a helical or conical filament made of high-melting-point metal such as tungsten or tantalum. The filament is heated from the power lines through a step-down transformer, usually with an autotransformer in the primary to permit close control of heating current. This method is satisfactory for many uses, but has certain disadvantages which limit its applications and produce unsatisfactory results for some metals:

Some metals have such high melting points that the directly heated filament burns out before much material can be evaporated.

A great many metals, when melted by heat from the fila-

High-Frequency Heating

Elimination of conventional metal-heating filament makes it possible to convert more metals to the vapor state and deposit them on nonconducting materials. Surface contamination is avoided. Further progress depends on the development of better crucibles

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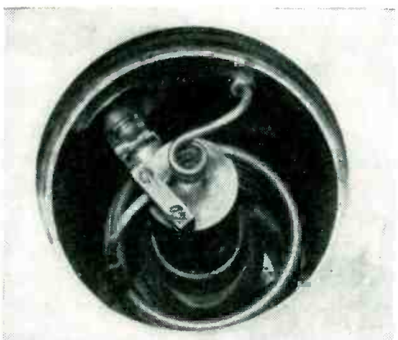

FIG. 3—Looking down into the vacuum chamber, showing the small water-cooled work coil, the larger resonant-circuit coil with its tuning capacitor and, at the upper left, the coaxial connector

ment, react with the filament and destroy it before evaporation takes place.

Many metals do not wet the filament well when molten, and hence do not evaporate well.

Even when a molten charge does wet the filament wires, most of the heating power is dissipated by the filament and a relatively small percentage goes into the metal to be evaporated, a situation which is particularly serious for metals that are difficult to evaporate.

Some filament material evaporates simultaneously with the charge, and the resultant condensed surface is chemically impure.

H-F Induction Type

All of the above problems are solved if the directly heated filament is eliminated. In order to accomplish this, a laboratory evaporator was modified to use high-frequency induction heating to melt and evaporate the metal charge.

A number of new problems arose immediately. The efficiency of energy transfer from the r-f generator to the metal charge depends on how closely the two may be coupled. Because the charge to be heated was only a few cubic millimeters in volume, the frequency used for heating had to be much higher than that conventionally used in induction equipment (10-to-500 kc). Calculations showed that for satisfactory energy transfer the operating frequency would have to be greater than 50 mc. At the same time a substantial amount of power was needed so that the metal could be brought to a high temperature quickly and not dissipate the heat to surrounding materials by conduction and radiation.

In addition to the electrical problems, several mechanical complications had to be resolved. First, a special vacuum-tight connector had to be designed to conduct high-frequency power into the vacuum chamber. This connector had to be of the coaxial type to operate at the frequency involved and had to have the outer conductor at ground potential to simplify connection to the vacuum unit. The insulating spacer was required to meet rigid mechanical, electrical and vacuum specifications. Second, a small water-cooled vacuum-tight work coil was needed to hold the metal charge and its container. Finally, crucibles capable of holding the metal at the high temperature at which evaporation takes place had to be investigated.

General Arrangement

The completed model uses an electronic generator which operates at 70 mc with 1-kw output. The simplified schematic diagram is shown in Fig. 1. Incoming 115-volt 60-cycle single-phase power is controlled by operation of a switch. This switch is equipped with a magnetically operated cutout which provides protection in the event of a heavy overload. Protection for the mercury-vapor rectifier tubes is provided by the time-delay relay. This relay (not diagrammed) is adjusted to insure a time delay of 30 seconds between the application of power to the filament circuits and

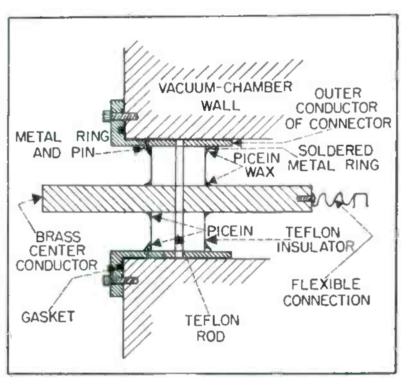

FIG. 4—Cross section of the coaxial connector, part of which is visible in Fig. 3

the application of high voltage to the rectifier tubes.

The radio-frequency circuit is fixed-tuned and consists of two type GL592 tubes connected for parallel operation in a tuned plate-tuned grid circuit. High voltage d-c for the oscillator tubes is obtained from a full-wave rectifier in which two type 8008 mercury vapor tubes are employed. Ripple is removed by the filter network in the output circuit of the rectifier. The output voltage of the rectifier is controlled by an input-circuit Powerstat, is continuously variable from zero to maximum and is the means for control of r-f power and, hence, of heating.

Figure 2 shows a view of the laboratory-model evaporator. The right-hand section houses the d-c power supply and control. The center section above the mechanical pump contains pump operating switches and filament supply transformers. The left-hand section houses the diffusion pump, baffles, base plate for the bell jar (shown lying on top of the unit at the right) and the r-f generator.

Attached below the base plate and forming a part of the vacuum system is a section of 4-inch-diameter tubing which houses the resonant circuit and the closely coupled work coil for heating the metal. Both coils, and the resonant-circuit capacitor, are shown in Fig. 3.

Design Details

The work coil is made of ⅛-inch copper tubing. It may be replaced by draining cooling water, removing the anchoring block and unsoldering the two joints visible in Fig. 3.

The vacuum-tight coaxial connector is shown in cross-section in Fig. 4. A Teflon plug comprises the insulator and support for the inner conductor. The problem of vacuum sealing this plug was solved by using Picein wax, which wets both the Teflon and the brass conductors and appears unaffected by the high-frequency currents. A ring, soldered at the high-vacuum end of the plug, supported it against atmospheric pressure and a Teflon rod through the entire assembly prevented slipping of the inner conductor. The position of the plug was chosen so that metal evaporated could not strike the Teflon. The generator end of the connection may be seen in Fig. 5, above the coupling capacitor.

Difficulty was experienced in obtaining suitable crucibles for holding the metal charge during evaporation. The problem has not yet been entirely solved. Unglazed ceramics were rapidly permeated by molten metal and destroyed. Glazed ceramics were little better, because the temperature of the metal usually exceeds the melting point of glazes. Sapphire crucibles offered some encouragement, but usually broke after one heating of the higher-melting-point metals. The best crucibles tried so far are small thimbles of fused quartz. These are cheap, easy to make, and can be depended on to last throughout an evaporation. Platinum and other difficult-to-evaporate metals have been satisfactorily vaporized from these quartz thimbles.

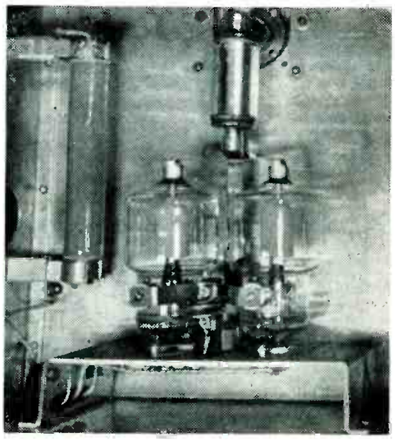

FIG. 5—The r-f oscillator provides 1-kw output at 70 mc. The two tubes are connected in parallel as shown in the circuit diagram of Fig. 1

Operation and Experience

In operation, a small crucible is placed within the water-cooled work coil but not touching it (to minimize thermal shock to the crucible) and metal is placed in the crucible. The surface to be metallized is positioned above the crucible, the bell jar is placed on the base plate and the pumps are started. After a vacuum of the order of 10^{-4} mm of Hg is obtained, the r-f power is applied and evaporation proceeds. An extremely good vacuum is needed because of the intense high-frequency fields existing in the jar. If the pressure exceeds 10^{-4} mm of Hg, these fields will ionize the residual gas in the chamber, dissipating the power in the gas instead of heating the metal.

Power should be applied to the metal rapidly so that it is heated and evaporated quickly and losses by conduction to the crucible are minimized. Some metals, however, have large quantities of adsorbed gas, and these must first be outgassed at low heat so that sizeable droplets of molten metal will not later be spattered by the rapidly expanding gas. If the metal gives up much gas upon heating, this gas will ionize in the high-frequency field and the metal will cool as power is transferred from it to the ionization process.

The evaporator as constructed has worked satisfactorily for a wide variety of metals. Its rated power of 1 kw at 70 mc has proved adequate. The results obtained with it show that all of the objections due to directly-heated filaments have been overcome. Uncontaminated surfaces of any metal may now be produced. In addition, the use of a crucible produces a well-defined beam of metal vapor rather than distribution over a 4π solid angle and results in a more efficient coating process. Furthermore, those areas of the bell jar not in line with the molecular beam remain uncoated, permitting observation of many evaporations without the necessity of having to clean the jar after each observation.

The process has some disadvantages when compared to direct-heating evaporators. The high-frequency generator is more complex and more expensive, and it must be shielded to prevent radio interference. The efficiency of heating drops as the metal evaporates and the charge gets smaller, and it is virtually impossible to evaporate a charge to completion. However, for the many cases where it is essential to evaporate metals which, for one reason or another, burn out filaments rapidly, or where uncontaminated metal surfaces must be obtained, the high-frequency evaporator is recommended.

Lattice-Type Crystal Filter

Crystal filters of the type described can easily be made for any frequency at which good crystals are obtainable. The attainable bandwidth is proportional to the center frequency, but can be made wider by coils or narrower by capacitors. Requirements for crystals, capacitors and terminating devices are not stringent

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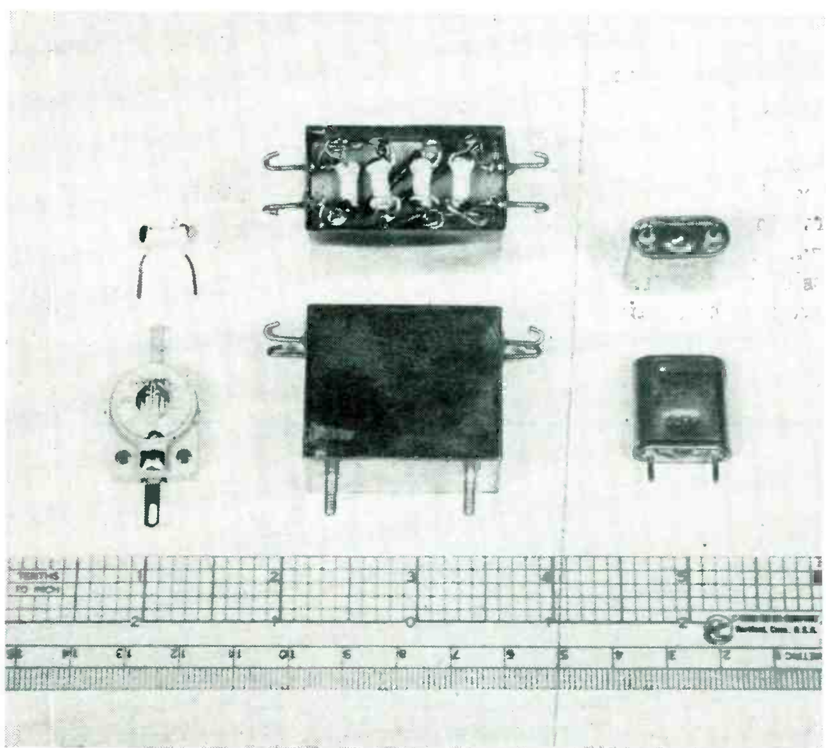
THE selection of an intermediate frequency for a low-frequency, wide-range superheterodyne receiver presents many vexing problems. If a frequency below the lowest input frequency is chosen, image rejection becomes difficult at the higher input frequencies. If an intermediate frequency above the highest input frequency is chosen, good skirt selectivity is difficult to obtain, and oscillator instability is aggravated.

A recent design of a receiver to cover the 100 kc to 1.75-mc range in the smallest practical volume met this dilemma, not by the use of two different low intermediate frequencies, one for the low band and one for all other bands, as is now standard practice, but by the use of an intermediate frequency higher than the highest input frequency. Oscillator instability, it was believed, could be cured by taking adequate pains, but the high intermediate frequency chosen to eliminate bulky i-f transformers required special attention to the skirt selectivity problem. The potential simplicity of the lattice-type crystal filter led to its trial in this application, despite warnings in the literature on the subject that construction of such units for frequencies as high as 0.5 megacycle was fraught with difficulties. The success obtained, once a good source of crystals was discovered, has been most encouraging.

The filter described below is a band-pass filter centered at 2 mc with a pass band of approximately 4,000 cycles. This is effectively a highly selective voice filter, but the bandwidth may be altered for other applications. The design of such a filter is fairly simple, but several practical details must be given attention to assure a good response.

Design Theory

A lattice circuit is used to obtain a symmetrical curve and maximum



Components making up the filter are familiar. Zero-temperature-coefficient capacitors are used. High-grade variable capacitors can be used to determine parameters

The work described was performed at Melpar, Inc., Alexandria, Va., for Air Materiel Command under contract AF33-(038)-3581.

selectivity. A schematic of the circuit is shown in Fig. 1. The frequency of the series-arm crystals is 2,000.0 kc while that of the shunt arm crystals is 1,997.5 kc. The pass band extends from 1,997.5 kc to 2,001.5 kc. Although the difference between the series resonant frequencies of the two crystals is 2,500 cycles, a bandwidth of twice this, or 5,000 cycles, may theoretically be attained when they are used in a lattice circuit. The practical bandwidth is about 80 percent of the theoretical maximum.

Figure 2 shows the reactance curves of two crystals whose series resonant frequencies are 2,500 cycles apart. When these crystals are in the arms of a lattice, balance is obtained at the points where the reactances are equal in magnitude and of the same sign. This occurs at points *A-A*. Zero attenuation or complete lack of balance occurs when one crystal is capacitive and the other inductive, such as in the region B to C. From the reactance curves, a plot of the attenuation versus frequency can be drawn as shown by the dashed lines when the crystals are in a lattice circuit. For a uniform attenuation in the pass-band region, the parallel-resonant frequency of the lower-frequency crystal must be the same as the series-resonant frequency of the higher-frequency crystal. The parallel-resonant frequency may be lowered by placing a small trimmer capacitor in parallel with the crystal. Trimmer capacitors also allow the shape of the attenuation curve to be varied outside the pass band. High-rejection peaks are possible; or a gradually widening curve may be obtained if the greatest attenuation is desired at frequencies far from resonance.

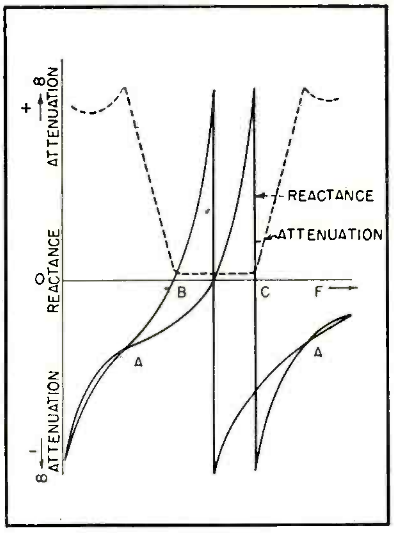


FIG. 2—Reactance curves (solid lines) for crystals in the lattice network and the attenuation curve shown by a dashed line

For any one crystal, the separation of the series and parallel-resonant frequencies is a function of the series and shunt capacitances of the crystal. Since the series capacitance is fixed by the series-resonant frequency, it is customary to specify the shunt capacitance. The bandwidth is given by the formula $BW = f_r c/C_o$, where c is the series capacitance, C_o is the shunt capacitance, and f_r is the series-resonant frequency. This formula is developed from the equivalent circuit of Fig. 3. The parallel resonant frequency is

$$f_p = f_r + \Delta f = 1/2\pi\,(LC^1)^{1/2} \quad (1)$$

where $C^1 = cC_o/(c + C_o)$ (2)

and $L = 1/(2\pi f_r)^2 c$

From Eq. 1 and Eq. 2

$$1/C^1 = (f_r + \Delta f)^2/(f_r)^2 c \quad (3)$$

$$\frac{(f_r + \Delta f)^2}{(f_r)^2} = \frac{C}{C_o} + 1 = \left(1 + \frac{\Delta f}{f_r}\right)^2 \quad (4)$$

From Eq. 4, $c/C_o = 2\Delta f/f_r$ (5)

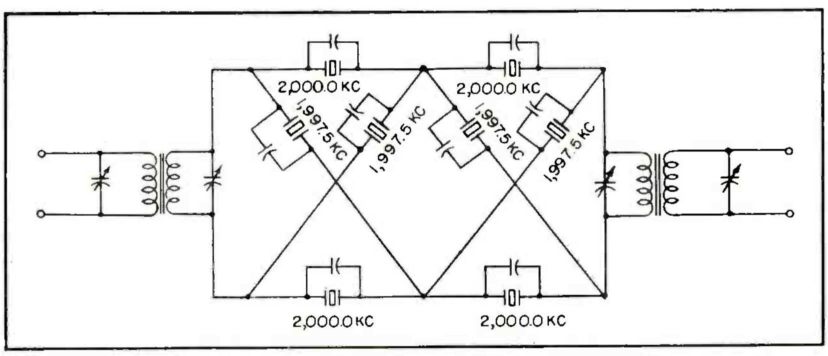


FIG. 1—Circuit for the 2-mc filter using eight crystals

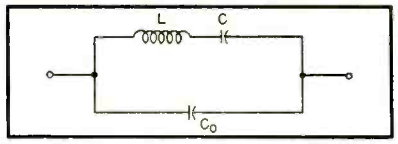


FIG. 3—Equivalent circuit of the crystal as evaluated in the equations

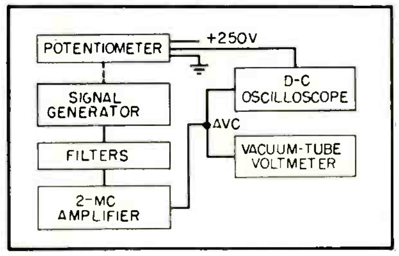


FIG. 4—Test equipment used to adjust the filter. The potentiometer and signal generator are driven simultaneously by hand

or $\Delta f = f_r c/2C_o$ (6)

The bandwidth is twice Δf

$$BW = f_r c/C_o \quad (7)$$

Equation 7 gives the theoretical maximum bandwidth. The ratio of C_o/c is about 138 for a −18.5-degree X-cut crystal, and about 250 for an AT cut. A wider bandwidth may be obtained with a smaller ratio. However, a crystal cut for a low ratio may not satisfy the requirements of temperature stability, spurious response or Q.

Practical Design

The crystals used were accurate to within ±20 cycles and were free of spurious resonances within 50 kilocycles of resonance. The use of split-plating crystals was not deemed advisable at 2,000 kc because of possible spurious responses. For sharp selectivity, the Q of the crystals should be as high as possible. The crystals used had a Q of 130,000. For a conservative design, resonant frequencies of the crystals should not be separated by much more than 40 percent of the value given in Eq. 7. The attainable bandwidth is about 1.6 times the separation between the resonant frequencies of the crystals. For example, if a bandwidth of 1,500 cycles at 1,000 kc were desired, then two crystals might be ordered at 999 kc and two at 1,000 kc for each lattice. The pass band will then extend from 999 kc to about 1,001 kc if no external capacitance is added. From Eq. 7, the C_o/c ratio necessary for a bandwidth of 1,500 cycles is 667. Since c is fixed, if the crystal C_o/c is 250, additional capacitance will have to be added in parallel with the crystal in order to reduce the bandwidth. (A wider bandwidth can be obtained by using a coil with each crystal, as shown by Mason[1]). This capacitance is also necessary to adjust the shape of the curve at the larger values of attenuation. If the bandwidth cannot be reduced enough without harming the selectivity, crystals with narrower frequency separation should be used. The frequency, temperature, and spurious response requirements determine the cut of the crystal. The cut determines the C_o/c ratio, which fixes the attainable bandwidth.

The capacitors used across the crystals must have a very high Q for sharp selectivity. Ceramic or mica capacitors are satisfactory, but some of the less expensive variable ceramics are not. After the shape of the attenuation curve has been adjusted with trimmer capacitors, the capacitors can be measured and replaced with fixed capacitors. The values are not critical.

Test Setup

If an oscilloscope is used in a test setup as shown in Fig. 4, the process of trimming the crystals and then installing fixed capacitors can be accomplished for a filter in a half hour. The frequency control on the signal generator of the test setup is geared to a 10-turn potentiometer that supplies a voltage proportional to signal-generator frequency for horizontal deflection. The avc voltage is used for vertical deflection. A P7 screen in the oscilloscope permits observation of the trace left by the slowly moving spot and permits hand cranking of the signal-generator tuner.

A fairly wide range of adjustment of the attenuation curve may be obtained with only two trimmer capacitors across adjacent bridge arms. This simplifies the adjustments and makes a more compact filter. Occasionally a filter will have a good curve with no capacitors at all across the crystals. In this case the bandwidth approaches the theoretical maximum. The wiring capacitance should, in any case, be kept as small as possible, although its effect on attenuation can be balanced out.

The photograph shows a lattice filter with a fixed capacitor across each crystal. These crystals make neat, small packages. A fixed and a variable capacitor are shown to the left of the filter box. On the right, two views of a sealed crystal unit are shown.

The correct value of terminating impedance has been determined by trial to be about 8,000 ohms, which may be obtained by using series resistors or a tuned circuit. Either the input or output of the filter must be free from ground. The best results using two filters occur when the input and output terminals are both isolated from ground by double-tuned transformers as shown in the circuit of Fig. 1. The transformers also serve to keep insertion losses low. The resonant impedance of these transformers was designed to be approximately 8,000 ohms.

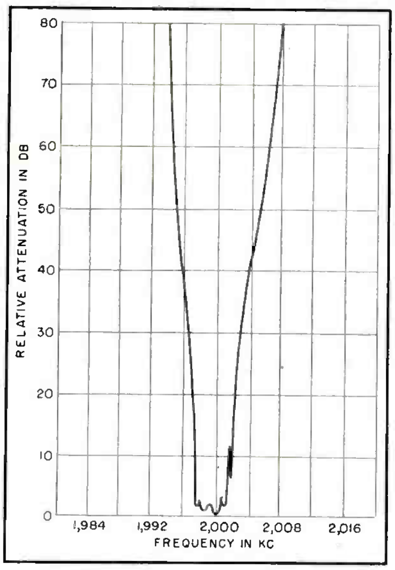


FIG. 5—Selectivity curve for a typical crystal filter

It has been found that any capacitive unbalance to ground of the ungrounded terminals causes a poor response curve. It is important that the capacitances both between windings and to ground be small for these transformers. Shielding of the filter is important where large attenuation is desired. Much less trouble was experienced in obtaining a good response curve when transformers were used instead of resistors. However, the transformers must be tuned to the center of the pass band.

If two filters are used in series, a transformer between the two gives a flat pass band that is somewhat narrower than when the filters are coupled directly together. Direct coupling gives pass-band irregularity of 2 to 3 db, which may be partially smoothed out by an H-pad if use of a transformer is not desirable. An occasional sharp peak in the pass band is probably due to the crystal pairs not being of exactly the same frequency. The crystals should be held to a frequency tolerance of at least 0.001 percent.

A typical frequency response of the two-section filter is shown in Fig. 5. The bandwidth is 3,900 cycles in the pass band and is 12,000 cycles at 60-db attenuation. A maximum attenuation of 80 db was measured before the curve began to widen rapidly. The voltage insertion loss, including that of the transformers, was not greater than 10 db for a two-section filter.

The main effect that a 115-degree C heat test had on the curve was an overall narrowing of about 400 cycles. Zero temperature coefficient capacitors were used in the filter.

This filter was designed to give good adjacent-channel selectivity in a receiver using an intermediate frequency of 2,000 kc. Other applications for such a filter are numerous. The frequency need not be limited to 2,000 kc but could be made considerably higher or lower if desired.

J. R. Schulman was in charge of the design of the receiver using this filter, T. F. Burke did preliminary filter design and consulting, and W. G. Tuller suggested the crystal-filter approach. The Reeves-Hoffman Co. cooperated in designing the required crystals to make them free of spurious responses.

REFERENCES

(1) W. P. Mason, "Electromechanical Transducers and Wave Filters", D. Van Nostrand Co., Inc., Second Edition, p 258.
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Mixer Harmonic Chart

Chart speeds identification or prediction of spurious frequencies resulting from beating of various harmonic terms in mixer output when one input frequency is variable as in wide-band signals for tv, f-m and military communication

By THOMAS T. BROWN

Aircraft Transmitter Development Section Marconi's Wireless Telegraph Co. Ltd. Writtle, Essex, England

In many applications involving the mixing of two frequencies to produce a third, a major difficulty often encountered is the generation of spurious frequencies by beating together of harmonics. When near coincidence with the required terms, these spurious frequencies cause audible modulation of the required frequency that cannot be removed by subsequent selective circuits.

When there are only two fixed frequencies, it is fairly simple to write down all the combination terms involved. If one of the input frequencies varies, however, a graphical method is to be preferred, as this enables the immediate identification or prediction of the various beats and facilitates the choice of frequency ratios free from modulation or spurious frequencies adjacent to the wanted terms.

It was in dealing with such a problem that the accompanying chart was devised. It is based on the fact that the expression for the value of any combination frequency is $F_s = mF_o \pm nF_x$, where m and n are the orders of the harmonics of the two frequency sources F_o and F_x respectively, F_x being the higher of the two frequencies.

To use this chart, trace upward from the ratio F_o/F_x of the two primary frequencies to the heavy difference line $F_x - F_o$ or the heavy sum line $F_x + F_o$, depending on which output component is being used. From this intersection, trace up and down to the nearest slant lines; from each one, trace left to read the F_s/F_x value for that spurious combination frequency. Alternatively, the spurious frequencies can be figured from the identifying notations on the two nearest lines. Where intersections of two slant lines are nearest to the desired intersection, a beat audio modulation equal to the frequency difference will be produced.

Some problems may require the use of an expanded region of the chart showing higher combination terms. This may readily be constructed to any scale without plotting the whole curve from the origin. Assuming that the boundary limits of the required region are F_{s1}/F_x for the lower frequency limit and F_{s2}/F_x for the upper limit, the corresponding limits on the abscissa are F_{o1}/F_x and F_{o2}/F_x. Now

$$F_s = mF_o \pm nF_x \quad (1)$$

$$F_o/F_x = [(F_s/F_x) \mp n]/m \quad (2)$$

Substituting the four known boundary limits in Eq. 2 gives four equations involving m and n. Substituting for these the harmonic orders of the combination frequencies which it is desired to plot, two points are obtained which are connected by a straight line. This procedure is repeated for the main sum or difference frequency ($m = n = 1$) and other desired pairs.

A preliminary scrutiny of the structure of the general chart will be found helpful in quickly showing what order of combination frequencies are likely to be encountered in the particular region concerned.

Example of Use

In the design of a repeater station for a vhf relay, it is common practice to receive the transmission at a given frequency and retransmit at a slightly higher or lower frequency to reduce feedback difficulties. Rather than convert the input to the output frequency directly, it is convenient to convert down to a lower intermediate frequency, which may then be amplified more easily and reconverted to the output frequency.

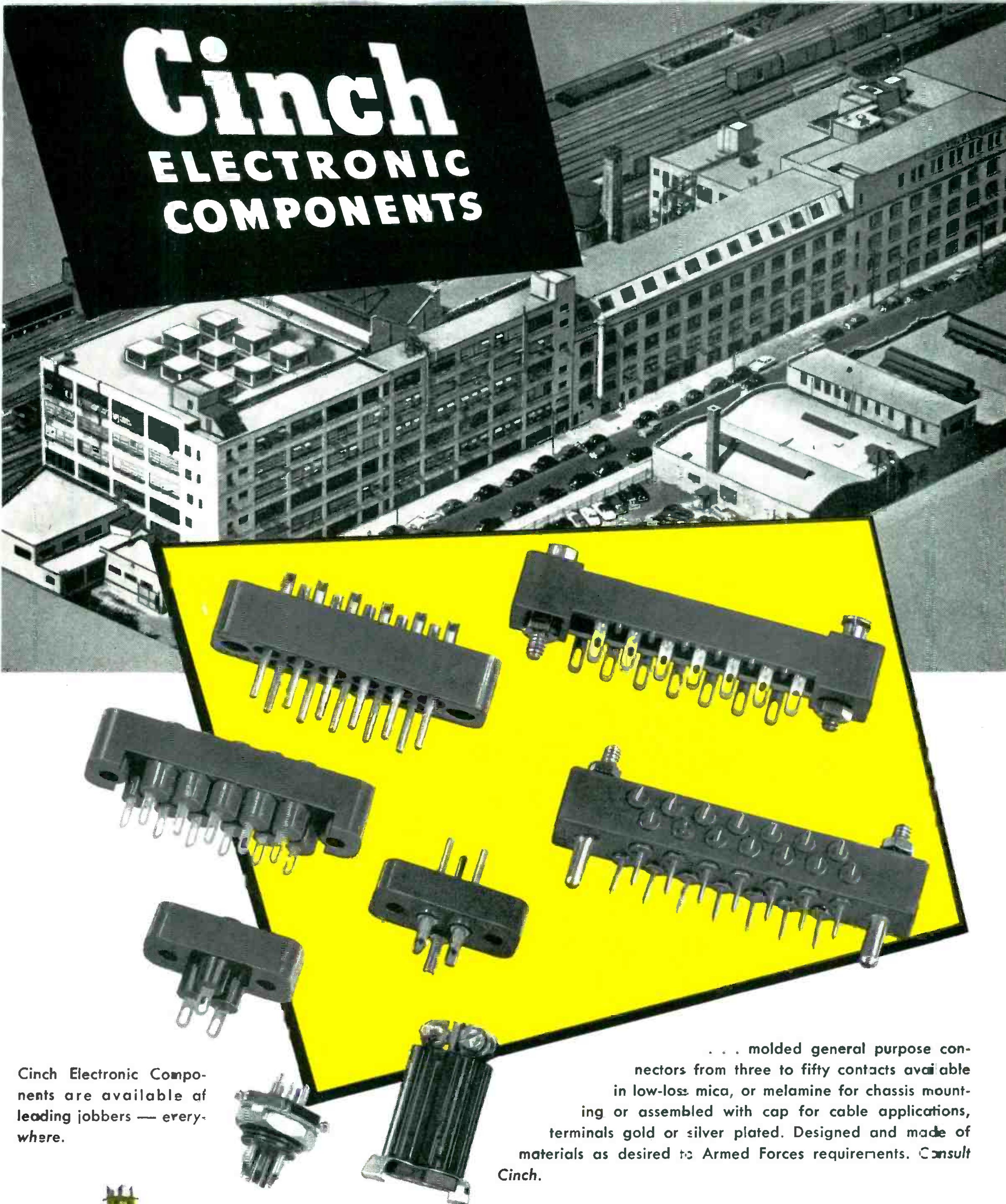
Assume an input frequency F_x of 250 mc with a 3-mc bandwidth, and a required output frequency of 240 mc. A convenient intermediate-frequency value for F_s would be in the order of 50 mc. The problem is to choose local oscillator frequencies that will avoid radiation of spurious frequencies and minimize intermodulation distortion.

Trying first 50 mc for F_s, the local oscillator value F_o becomes 200 mc and F_o/F_x for this is 0.8. Tracing upward, this is immediately seen to be a bad choice, because the desired main difference frequency line $F_x - F_o$ intersects both the $4F_o - 3F_x$ and $5F_x - 6F_o$ lines at this point.

By inspection, the nearest value of F_o/F_x that it is in a clear space on the heavy $F_x - F_o$ line is 0.775, which corresponds to an i-f value of about 55 mc. Tracing vertically up and down from the intersection of the 0.775 ordinate with the $F_x - F_o$ line, we find that the nearest spurious frequencies occur at $F_s/F_x = 0.33$ and 0.12. Their values are quickly figured as $F_s = 0.33 \times 250 = 83.5$ mc and $F_s = 0.12 \times 250 = 30$ mc. If the bandwidth of F_x is 3 mc, these 83.5-mc and 30-mc beats will be easily filtered out of a 55-mc i-f system by the tuned circuits.

Now converting up again, let F_o be 55 mc and let F_x be the

(Continued on p 134)



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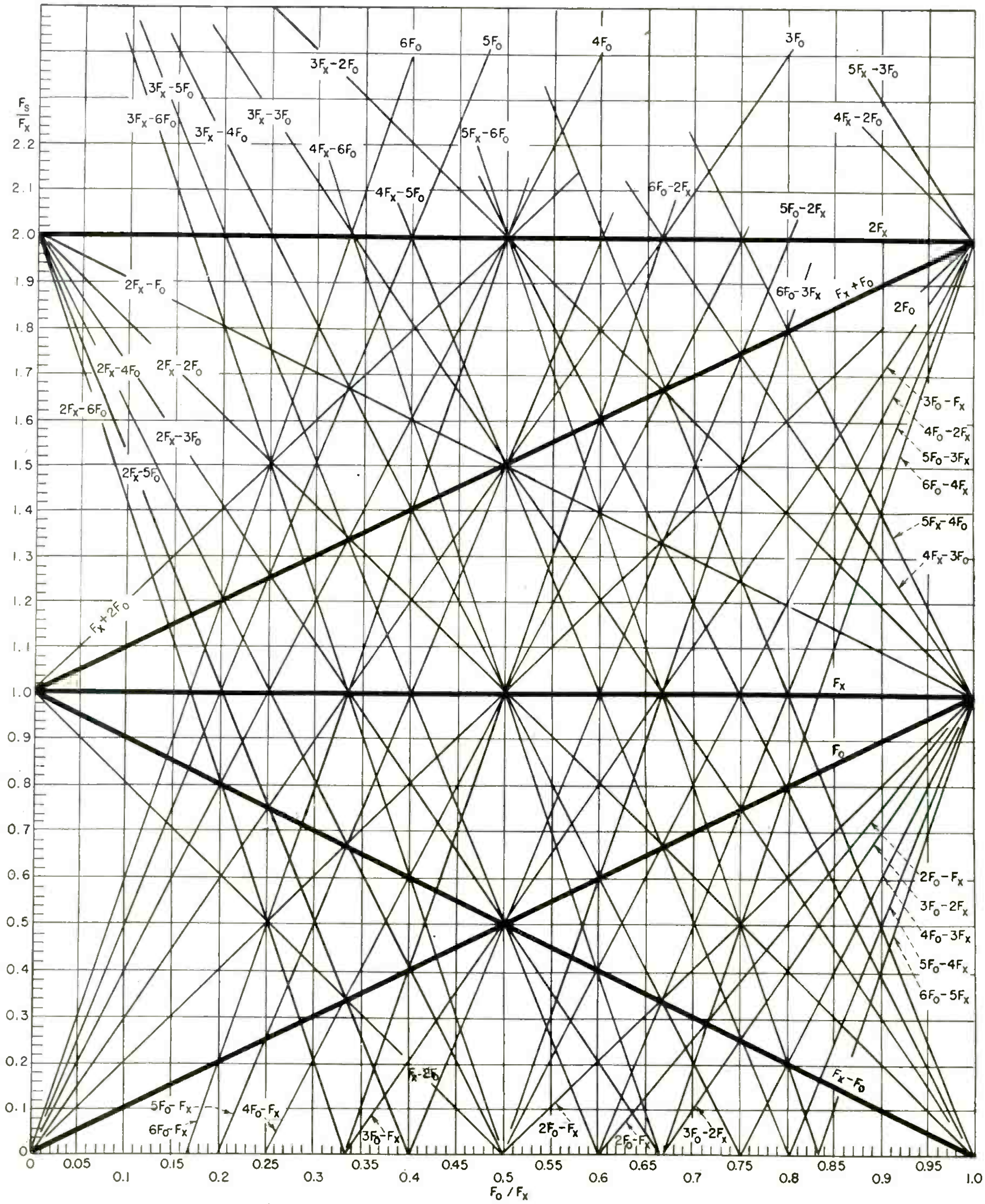
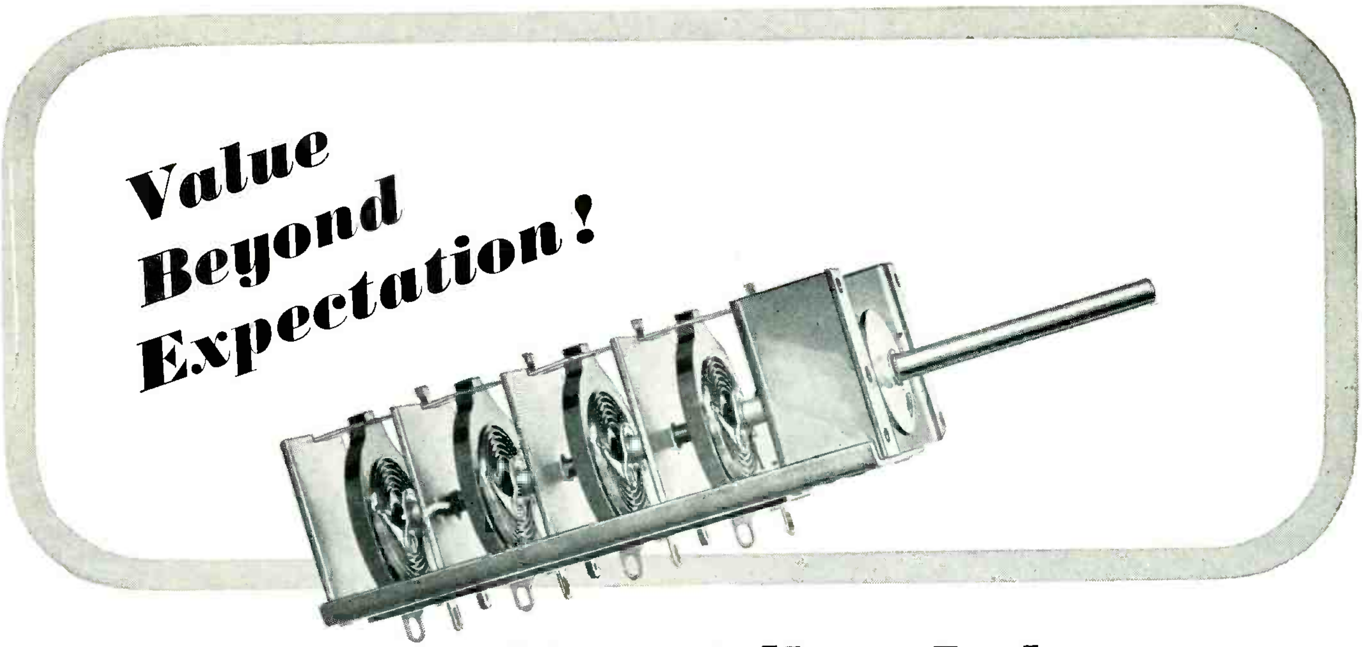
Mixer Harmonic Chart (Continued from page 132)

desired 240-mc output frequency, so that $F_x = 240 - 55 = 185$ mc, the frequency required of the second local oscillator to get a sum-frequency output. Then F_o/F_x is 0.298. Tracing up from this value to the sum line $F_x + F_o$, the two nearest spurious frequencies to this intersection are at $F_s/F_x =$ 1.4 and 1.2. For 1.4, the output is $1.4 \times 185 = 259$ mc due to the combination $2F_x - 2F_o$. For 1.2, we have both $4F_o$ and $3F_x - 6F_o$ giving $1.2 \times 185 = 222$ mc. Since the bandwidth is 3 mc, adequate selectivity should not be difficult to provide at 240 mc to discriminate against these 259-mc and 222-mc spurious components.



Mixer chart, with F_o and F_x as mixer input frequencies (with F_x the higher) and F_s as desired output frequency. Lines intersected when tracing straight up from value of F_o/F_x represent combination frequencies, values of which can be found either from labels on lines or from scale of ordinates. Only intersections near desired combination (sum or difference) need be considered. When F_x is fixed, ordinate scale can be marked to give frequency directly.



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TUBES AT WORK

Including INDUSTRIAL CONTROL

Edited by RONALD K. JURGEN

Simplified Electronic Switch for Oscilloscopes

BY L. N. VAN ALLEN
Field Engineer
Philco Corporation
Philadelphia, Pa.

TWO SIMULTANEOUS traces showing different phenomena can be obtained on a single cathode-ray oscilloscope by means of a simple electronic switch, which is triggered by the horizontal sweep generator in the oscilloscope. By this means, cleaner traces are provided since changeover occurs only at the ends of the lines.

Only three miniature tubes are required and plate current drain is negligible being less than five ma. These features make it possible to install the device in many existing types of oscilloscopes.

Referring to the schematic diagram of Fig. 1, V_1, a 12AU7, is a conventional Eccles-Jordan multivibrator triggered by the flyback from the left-hand horizontal deflection plate of the cathode-ray tube. Outputs of the multivibrator alternately key in the two sections of V_3, also a 12AU7, used as gated cathode followers to couple in the two input signals.

Only signal *A* or signal *B* will appear at the output at any one time since the other signal will be feeding into a triode without plate voltage. An output balancing potentiometer is provided to adjust the amount and direction of separation of the traces.

The 6AL5 diodes are used to discharge the coupling capacitors, C_1 and C_2, during the negative half cycle of the square wave on each plate.

If desired, 6SN7's may be used for V_1 and V_3 and a 6H6 for V_2. Alternately, a 6J6 may be used for V_1. Crystal diodes are not recommended for the clampers. Plate voltage is not critical and may be any value between 250 and 400 volts.

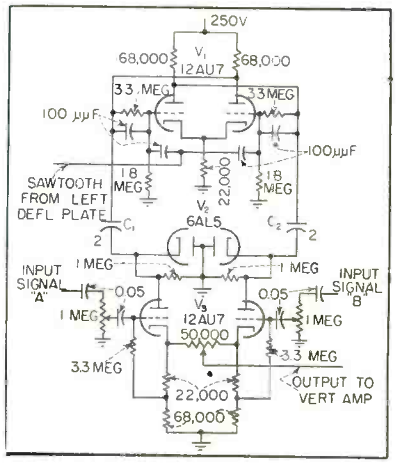
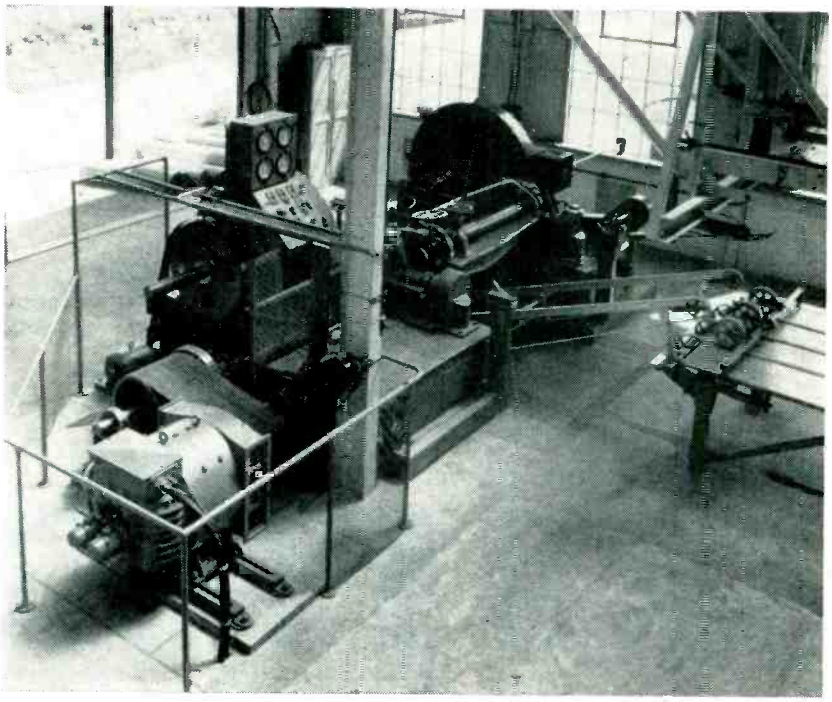


FIG. 1—Circuit of electronic switch used to obtain two simultaneous and independent traces on an oscilloscope

Electronic Control of Veneer-Peeling Lathes

BY J. H. JUPE
Middlesex, England

MOTOR SPEED variation is essential in cutting the hard and soft wood veneers used extensively in the manufacture of plywood because of the nature of production methods. The usual method is to peel a



General view of the veneer-peeling lathe at the Forest Products Research Laboratory, Princes Risborough, England

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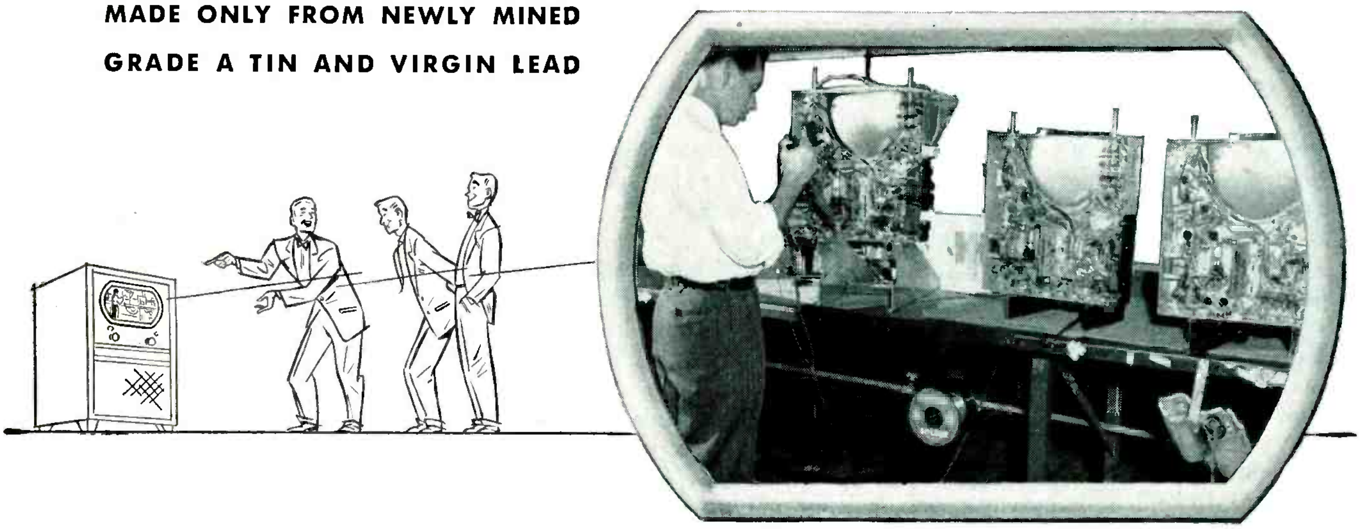

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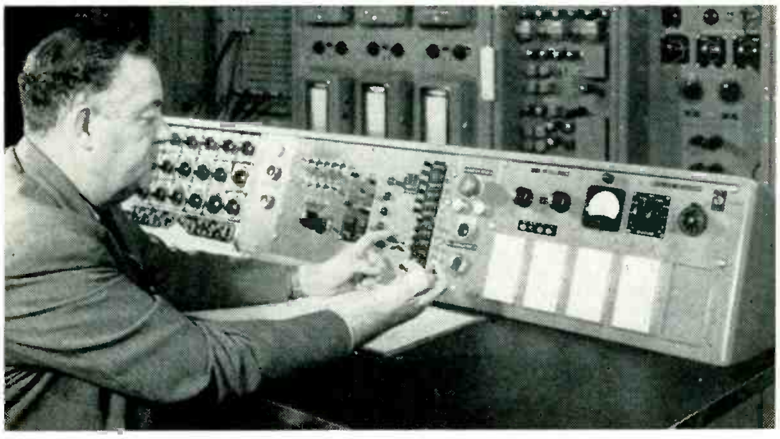
THE FRONT COVER



THE COVER PHOTOGRAPH this month dramatizes one important application of the 4,000-tube Project-Typhoon electronic analog computer—determining the optimum trajectory of a radar-controlled, rocket-propelled guided missile for interception of an attacking bomber target with minimum waste of time and fuel. The models identify the paths traced by the inking pens on the elevation plotting board that shows results. If the two pens hit each other, interception is possible.

Designed and built by engineers of RCA Laboratories for the Navy Bureau of Aeronautics, the computer permits solving any missile problem over and over, with characteristics varied each time, until the desired results are obtained. This keeps to a minimum costly scale-model or actual-size experiments involving expensive missiles, airplanes and ships. The Special Devices Center of ONR, at Port Washington, N. Y., was responsible for the Navy's part in the development.

The new computer is essentially a hybrid between analog and digital computers, designed to give a combination of flexibility and accuracy not obtainable from either system alone. Actual construction was preceded by three years of research and development work directed by Arthur W. Vance, head of the Electronic Computer Section of RCA Laboratories, shown at the control console in the accompanying photograph. Once the problem has been set up on the approximately 100 dials and 6,000 plug-in switchboard connections mounted on the floor-to-ceiling panels surrounding the computer room, the computer can be started from this master control. Knobs at the left permit changing important variables between runs of a problem, to vary such major factors as amount of fuel carried and time of launching the missile.

The two plotting boards, used to produce a permanent record of the progress of an attack or dog-fight in elevation and azimuth respectively, are Variplotter units made by Electronic Associates, Inc. In addition, a three-dimensional trajectory model provides a visual picture of progress by making two suspended fluorescent balls travel the identical courses of missile and target in space. While a problem is in progress, 12 recording voltmeters record such factors as positions of missile fins, acceleration, velocity, rate of spin, and remaining distance between missile and target.

continuous layer from the circumference of a suitable log by means of a special lathe.

At the start of the operation, when the log is large, the rotational speed of the lathe must be relatively low in order to handle the veneer. When the log has been reduced to a smaller diameter, however, a higher speed is necessary to maintain a reasonable production rate.

An electronic method of achieving the desired motor-speed control has been developed by General Electric Company of England. The control system utilizes a method in which the voltage output of one of two tachometer generators is compared with a standard reference voltage. The difference voltage is used to correct any speed discrepancy present in the system.

The first tachometer generator, gear driven from the main driving motor, gives a voltage output proportional to lathe spindle speed. This generator is used for revolution control by presetting the spindle speed. The second generator, gear driven from a roller which in turn is driven by the log, is used to control peeling at a constant rate.

Voltage Standard

The standard voltage is derived from a speed-setting potentiometer connected across a transformer designed to maintain voltage output constant to ± 5 percent for an input variation of ± 10 percent. The magnitude of the standard voltage with which the tachometer output voltage is compared is therefore determined only by the speed-setting potentiometer and is independent of fluctuations in the supply.

The difference voltage is fed to a two-stage push-pull amplifier which is balanced initially by means of a bank of resistors and a potentiometer connected in the grid circuits of the input stage. The anodes of the tubes in the output stage are joined together through two telephone-type relays connected in parallel. The relays are energized from half-wave rectifiers of opposite polarity and the lack of balance between the output tubes produced by an incoming signal will cause either relay to operate.

Each relay is provided with two

(Continued on p 156)

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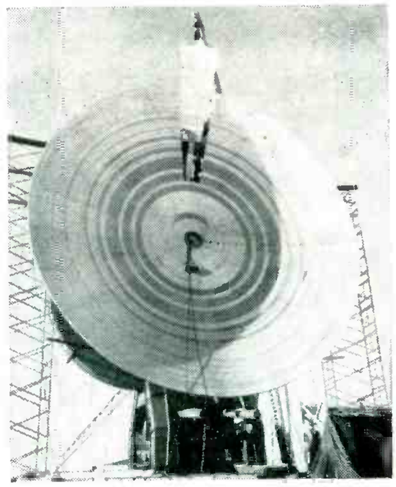

Fifty-foot radio telescope parabola is fabricated from thirty pieces of carefully-machined aluminum

New Navy Radio Telescope Nears Completion

GALACTIC RADIATIONS will be studied by the 600-inch parabola shown in the accompanying photographs. Mounted atop a building at the Naval Research Laboratory, the radio telescope will be used to receive radio-frequency signals that emanate from the sun, moon and stars.

The earth's atmosphere blocks much of the energy radiated by these bodies. Only two bands of energy can successfully penetrate through to the earth—those radiations falling in the visible spectrum, and a band of frequencies from about 30 meters up to a few millimeters. The radio telescope sees energy radiated at the latter wavelength.

The longer wavelengths of the radio-frequency signals provide a resolution somewhat less than that available with the light telescope. The shorter the wavelength used, the greater the resolution obtainable. This unit will initially employ wavelengths of 3, 10 and 30 centimeters. The resolution afforded by a wavelength of 30 centimeters is expected to yield valuable information about different portions of the sun.

The radio telescope is mounted on one of the navy's five-inch gun mounts. It is arranged to rotate a full circle in the horizontal plane and from the horizon to five degrees beyond zenith in elevation. An axis converter corrects for the inclination of the earth's axis and permits the reflector automatically to track the sun in its path across the sky.

The amount can be controlled manually, or connected to a five-inch light telescope by remote control. If desired, the mount can also be controlled from the mount itself.

The reflector itself consists of thirty aluminum sections bolted together to form the solid surface, which was machined to a tolerance of $\frac{1}{32}$ inch with a special boring machine.

The system was designed by the Naval Research Laboratory and engineered and constructed by Collins on a Navy contract. The overall installation weighs approximately 75 tons; the 50-foot dish weight is only about 14 tons, the rest being the weight of the gun mount.

The reflector is already installed, but the system has not yet been placed in operation. First the sections of the parabola will have to be accurately aligned and the exact focus determined for placing the receiving antenna.

In addition to the program at the Naval Research Laboratory research by radio astronomy using microwaves is being conducted at the National Bureau of Standards and at Cornell University.

Total weight of antenna and five-inch gun mount used to position it is about 75 tons

Amplification at 50,000 Megacycles

HELIX-TYPE traveling-wave tubes have been built, operated and applied to certain communication systems up to about 4,000 mc. Experimental tubes have been developed that are capable of amplifying 1.25 centimeter waves, and theory indicates that, up to some practical limit, amplifiers for

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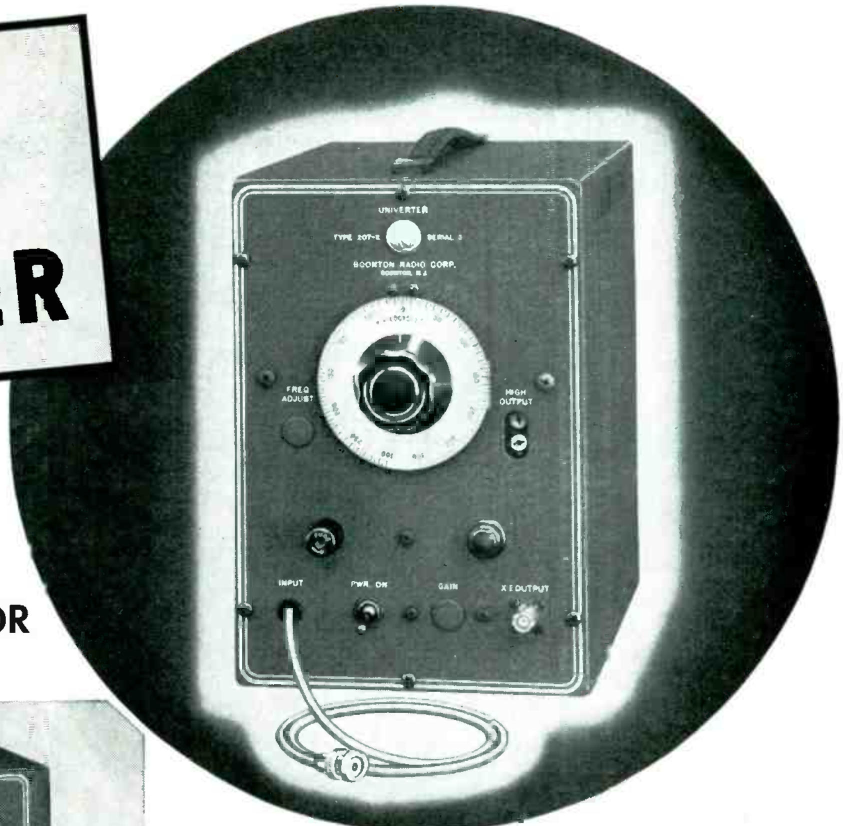
TYPE 202-B



FM-AM SIGNAL GENERATOR

TYPE 202-B

This instrument has become the standard signal source for the FM and Television Industry.

The Type 207-A Univerter described at the right was developed to extend its useful frequency range down to 100 kc. without changing the signal level or modulation characteristics shown below.

SPECIFICATIONS:

RF RANGES: 54-108, 108-216 mc.
FREQUENCY DEVIATION: 0-24 kc., 0-80 kc., 0-240 kc.
FM DISTORTION: Less than 2% at 75 kc. deviation
AMPLITUDE MODULATION: Continuously variable 0-50%.
RF OUTPUT VOLTAGE: 0.1 microvolt to 0.2 volt.

UNIVERTER

TYPE 207-A

The Type 207-A Univerter fills the widespread need for an FM-AM source in the frequency range of from 0.1 to 55 mc. This instrument is a unity gain frequency converter which subtracts 150 mc. from a signal derived from the Type 202-B FM-AM Signal Generator to produce an output of from 100 kc. to 55 mc. This is accomplished without change of signal level or of modulation and with negligible spurious frequencies. Thus the Type 207-A Univerter when used with the Type 202-B Signal Generator shown at the left will provide complete FM-AM Signal Generator coverage from 100 kc. to 216 mc.

In addition to the unity gain output, the Type 207-A Univerter provides a high level output of about 7.5 times the input thus making about 1.5 volts available for high level tests.

In order to facilitate band-width measurements, the Univerter is provided with an incremental frequency dial which is calibrated in 5 kc. increments over a range of ±300 kc. This permits selectivity curves to be taken on even the most selective mobile receivers.

The power supply is well regulated to prevent change of gain or output frequency with line voltage variation from 95 to 130 volts.

Complete specifications, price, and delivery information will be furnished on request.

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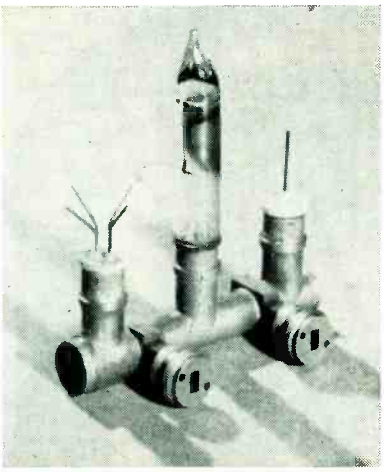


FIG. 1—Special BTL tube for amplification at 48,000 mc

higher frequencies may be designed by scaling down linear dimensions.

The photograph in Fig. 1 shows an experimental tube, developed by the scaling technique, that is capable of amplifications of a few db at frequencies as high as 48,000 mc.

For the starting point in this development, as described by J. B. Little in the January 1951 issue of *Bell Laboratories Record,* the structure of an existing 4,000-mc helix was chosen. A photograph of this tube is shown in Fig. 2 Ceramic rods are visible running parallel to the axis of the helix. These are included in the 4,000-mc tube to maintain constant spacing between the helix and the walls of the tube.

One of the first modifications, applied to extend the physical limit of the scaling-down technique, was to eliminate the parallel ceramic spacing rods. This was done by choosing a helix construction such that the helix itself is self-supporting by means of two tiny radial fins, one at each end. This change not only enhances the mechanical design, but enables electrons to flow on both the inside and outside of the helix with a consequent improvement in the possible electronic gain. This suspension system would not serve for larger tubes, because a larger helix would tend to sag.

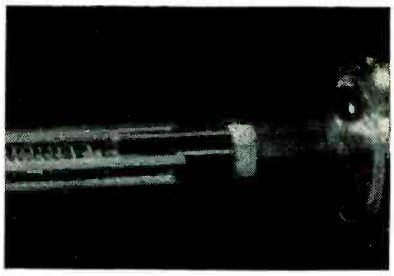


FIG. 2—Close-up view of 4,000-mc traveling-wave tube from which 48,000-mc tube was scaled

The second modification was to make the input and output waveguides an integral part of the tube envelope. This eliminates certain hard-to-fabricate glass fittings and permits rugged metal construction. All metal parts must be nonmagnetic to avoid distortion of the magnetic field which is employed to keep the electron beam parallel with the axis of the helix.

A third modification eliminated the necessity for altering the pitch of the helix to facilitate matching of the waveguides to the helix. In the new type, matching is accomplished by terminating the helix in a cylinder formed by brazing the end turns of the helix together and properly orienting this junction in the wave-guide structure.

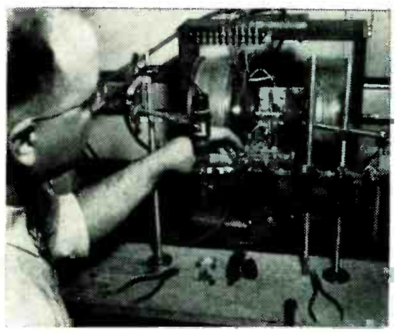


FIG. 3—The amplifier tube is placed between the poles of a large magnet that furnishes the required uniform field

The helix was wound with 0.003-in. wire on a 0.030-in. mandrel and stretched to 0.0065-in. pitch. The tube is operated at 1,000 volts and has a beam current of 1 milliampere. Figure 3 shows the tube fixed between the poles of the necessarily large magnet that furnishes the uniform field that controls the electron beam.

The signal source used was a 1.25-cm reflex oscillator feeding a crystal harmonic generator. Means were provided for passing the proper harmonic either through the tube or directly to the detecting device for purposes of gain measurement. The measuring equipment consists of a pad, a wavemeter, a calibrated variable attenuator and a crystal diode. The source is modulated by a square wave which the crystal recovers and furnishes to a preamplifier and thence to an oscilloscope for comparison.

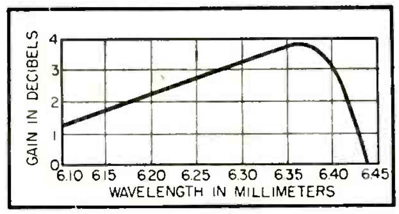


FIG. 4—Curves show the gain of the new tube as a function of wavelength

Results of measurements on sevral such tubes are shown in Fig. 4. Gain is dependent on wavelength, but it should be noted that the frequency bandwidth between 6.3 and 6.4 cm wavelength is approximately 750 mc.

Amplitude of Vibration in Piezoelectric Crystals

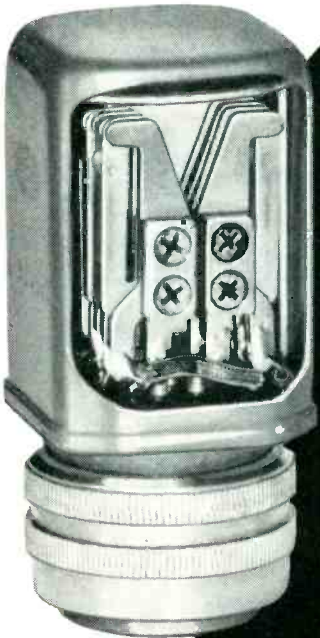
E. A. GERBER
Signal Corps Engineering Laboratories
Fort Monmouth, New Jersey

THE AMPLITUDE OF VIBRATION of a piezoelectric crystal has some influence on the parameters of such a crystal. First, vibration creates heat due to external and internal friction. This heat causes a change in frequency which depends upon the amplitude of vibration. Second, as has been observed by the Signal Corps Engineering Laboratories and by others[1], the equivalent resistance of a crystal changes with the amount of excitation, probably due to nonlinear effects of the mounting structure. This resistance change is accompanied by a frequency change which apparently is instantaneous and not caused by heating.

For these reasons, it is important to know what excitation level can be permitted in crystals, either to prevent changes of the parameters or, in the case of very thin crystal plates, to avoid rupture. The excitation (the amplitude of vibration) is proportional to the r-f current through the crystal unit. Therefore, current can be used as a measure of amplitude. However, it is not stressed sufficiently in the literature that the ratio of ampli-

(continued on p 204)

AN approved (3303-1)



R-B-M

ELECTRONIC AND COMMUNICATION RELAYS

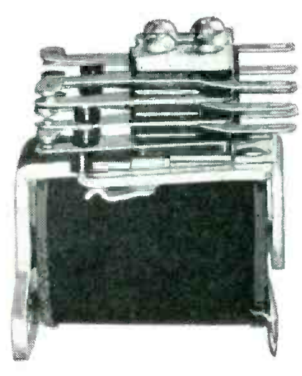
Now Hermetically Sealed

AN approved (3304-1)

● Hundreds of thousands of R-B-M telephone type relays saw Government service in World War II. Now most of these relays are available in hermetically sealed enclosures designed to meet AN specifications.

R-B-M hermetically sealed telephone type relays are available in contact forms up to and including 4-pole, double throw, 3 ampere, 28 Volts D.C. construction. Also 10 ampere rating up to and including 2-pole double throw at 28 Volts D.C. All relays available with approved AN plug connector, or solder connections.

Engineers! What is YOUR hermetically sealed relay requirement? R-B-M is developing new and smaller relays to meet Armed Services requirements. Perhaps one of these will solve your problems. Write giving complete relay specifications, application, quantity and AN specifications applying. Address Dept. F-4



R-B-M Production and Engineering facilities in two plants, located in different states, (over a quarter million square feet), can assist you in the development and production of special electro-magnetic devices for Armed Services application.

RBM

R-B-M DIVISION ESSEX WIRE CORP.
Logansport, Indiana

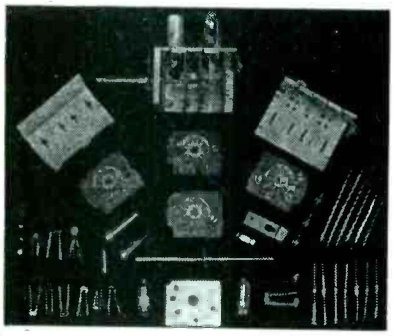
MANUAL AND MAGNETIC ELECTRIC CONTROLS—FOR AUTOMOTIVE, INDUSTRIAL, COMMUNICATION AND ELECTRONIC USE

NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

Stamped TV Tuner

FRANKLIN AIRLOOP CORP., 43-20 34th St., Long Island City 1, N. Y., has developed a television station selector having an intermediate-frequency output of 41.25 to 45.75 mc.



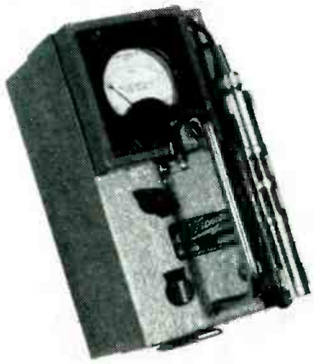
Use of this i-f results in greater immunity to image and f-m interference. The tuner is of the rotary switch type employing inductances for each of the 12 channels. Inductances and wiring are die stamped on low-loss Bakelite wafers. Tuned circuits are employed in the input, r-f, oscillator and mixer circuits. The r-f stage uses a 6BC5 tube while the mixer and oscillator uses a 6J6, resulting in a high-sensitivity unit.

Hermetic Sealing Components

NEO-SIL CORP., 26 Cornelison Ave., Jersey City 4, N. J., has developed its hermetic sealing components to a point where rejects resulting from breakage, strain, cracks, physical shock and the like are reduced to a minimum. As a unit Neo-Sil synthetic compound is suitable insulation when bonded to various methods to resist abusive temperature cycling, salt water, high pressure, high vacuum and most acids and alkalies. Components will pass the grade one, class A requirements for Army, Navy and aircraft military equipment.

Radiation Survey Meter

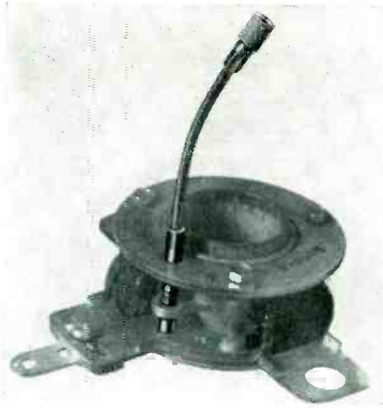
EL-TRONICS, INC., 2649 No. Howard St., Philadelphia 33, Pa. Model PR-3 radiation survey instrument is specifically designed for portable and field use in measuring radiation intensities (beta or gamma) from all radioactive elements where a source of a-c power is not available.



The unit is waterproof, fungus-proofed and has a provision for plug-in phones. The instrument, which features a vibrator power supply, operates from two 1½-volt low-cost batteries.

Flexible-Shaft Remote Control

KUPFRIAN MFG. CO., 218 Prospect Ave., Binghamton, N. Y. Representative of the many new applications for flexible-shaft couplings in the aircraft, radar, electronic and instrumentation fields is the illustrated nonmagnetic type prepared for the control of permanent-magnet type focusers for tv tubes. The reluctance of the magnetic circuit



is varied by a sliding steel collar controlled by a lead screw at the output end of the flexible shaft. The shaft is formed of high-strength bronze, and is sometimes enclosed within an insulating plastic or braided cotton sleeve. While normally controlled from the rear of the set, some units are designed to operate from the front panel.

Time-Measuring Unit

AMERICAN CHRONOSCOPE CORP., 316 W. First St., Mt. Vernon, N. Y. Model 110 high-speed chronoscope has 8 scale ranges for measuring time of 0 to 1, 0 to 3, 0 to 10, 0 to 30, 0 to 100, 0 to 300 milliseconds, and 0 to 1, 0 to 3 seconds. It operates on the principle that a charged capacitor will always lose a definite percentage of its charge when connected across a resistor for a definite period of time. The chronoscope has electronic circuits to do this and the percentage of charge lost is determined very accurately by a self-balancing potentiometer. Absolute accuracy is better than ±1 percent of full scale on any range. It is possible to measure directly the duration of an open circuit,

TOUGH!

RAYTHEON

TOUGH SERVICE TUBES

FOR MILITARY, INDUSTRIAL AND TRANSPORTATION SERVICE

Type	Description	Typical Service	Prototype	Construction	Heater Volts	Heater Amps.	Plate Volts	Plate Ma.	Grid Volts	Screen Volts	Screen Ma.	Amp. Factor	Mut. Cond.
2C50	Dual Power Triode	Aircraft Control Equip.	—	Bantal	12.6	0.3	300	12.5	−24	—	—	9.5	1750
2C52	Dual Amplifier Triode	Aircraft Control Equip.	—	Bantal	12.6	0.3	250	1.3	−2	—	—	90	1900
6AK5W	Pentode RF Amplifier	Military Ruggedized	6AK5	7 pin miniature	6.3	0.175	120	7.5	Rk 200	120	2.5	—	5000
6AL5W	Dual Diode	Military Ruggedized	6AL5	7 pin miniature	6.3	0.3	Max. Peak Inv. 330 Volts Max.			Io 9 ma. dc. per plate			
6AS6W	Pentode RF Mixer	Military Ruggedized	6AS6	7 pin miniature	6.3	0.175	120	5.2	−2	120	3.5	—	3200
6C4W	RF Power Triode	Military Ruggedized	6C4	7 pin miniature	6.3	0.15	250	10.5	−8.5	—	—	17	2200
6J5WGT	General Purpose Triode	Military Ruggedized	6J5GT	Bantal	6.3	0.3	250	9	−8	—	—	20	2600
6J6W	Dual AF-RF Triode	Military Ruggedized	6J6	7 pin miniature	6.3	0.45	100	8.5	Rk 50	—	—	38	5300
6SA7WGT	Pentagrid Converter	Military Ruggedized	6SA7GT	Bantal	6.3	0.3	250	3.5	Rg 20000	100	8.5	—	450 Conv. Cond.
6SJ7WGT	Pentode RF Amplifier	Military Ruggedized	6SJ7GT	Bantal	6.3	0.3	250	3.0	−3	100	0.8	—	1650
6SN7WGT	Dual Triode	Military Ruggedized	6SN7GT	Standard glass	6.3	0.6	250	9	−8	—	—	20	2600
6X4W	Fullwave Rectifier	Military Ruggedized	6X4	7 pin miniature	6.3	0.6	Max. Peak Inv. 1250 Volts Max.			Io 70 ma. dc.			
12J5WGT	General Purpose Triode	Military Ruggedized	12J5GT	Bantal	12.6	0.15	250	9	−8	—	—	20	2600
CK5654	Pentode RF Amplifier	Commercial Aircraft Ruggedized	6AK5W	7 pin miniature	6.3	0.175	120	7.5	Rk 200	120	2.5	—	5000
CK5670	Dual Triode	Commercial Aircraft Ruggedized	2C51	9 pin miniature	6.3	0.35	150	8.2	Rk 240 per sect.	—	—	35	5500
CK5686	AF-RF Output Pentode	Commercial Aircraft Ruggedized	—	9 pin miniature	6.3	0.35	250	27	−12.5	250	5	—	3100*
CK5694	Dual Power Triode	Industrial AF Amplifier	6N7G	Standard glass	6.3	0.8	294	7	−6	—	—	35	3200
CK5725	Pentode RF Mixer	Commercial Aircraft Ruggedized	6AS6W	7 pin miniature	6.3	0.175	120	5.2	−2	120	3.5	—	3200
CK5726	Dual Diode	Commercial Aircraft Ruggedized	6AL5W	7 pin miniature	6.3	0.3	Max. Peak Inv. 330 Volts Max.			Io 9 ma. dc. per plate			

*2.7 watts Class A output. 10 watts Class C input power to 160 mc.

Note: All dual section tube ratings are for each section.

The Raytheon Tubes described above are engineered and manufactured for critical services where a single tube failure might lead to serious loss of life, time or property. Reliability and superior stamina are built into these Tubes.

Over 300 Raytheon Special Purpose Tube distributors stand ready to serve you. Application information on tough service tubes is available at Newton, Chicago and Los Angeles.

RAYTHEON MANUFACTURING COMPANY

SPECIAL TUBE SECTION • Newton 58, Massachusetts

SUBMINIATURE TUBES, GERMANIUM DIODES and TRIODES • RADIATION COUNTER TUBES • RUGGED, LONG LIFE TUBES

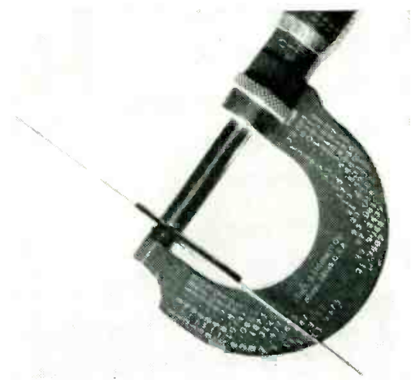
RAYTHEON

Excellence in Electronics

short circuit or voltage pulse (of 6 volts or more). The model 211 input adapter, used in conjunction with the chronoscope, separates the functions of starting and stopping the measurement of time intervals between the operation of one component and the subsequent operation of another, without stopping the system or synchronizing the indicating device.

Tiny Rectifiers

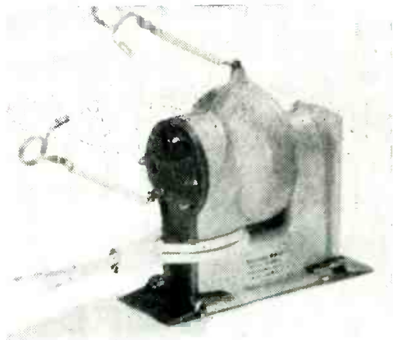
HARDY INSTRUMENT CO., 104–18 Metropolitan Ave., Forest Hills, N. Y., announces a new line of Microstak subminiature selenium rectifiers. The rectifier illustrated has an outside diameter of less than 3/32 in. for a completely insulated, or if desired, a hermetically sealed assembly. Length will vary according to voltage requirements. The plates are only 1/16 in. in diameter and are available for such applications as direct mounting into the



base of a printed circuit, or other usages where an enclosed unit is not required. These units can deliver 300 μa of current for an indefinite period of time. Companion units with ferrule or pig tail leads and current ratings up to 25 ma are also available. From the smallest to the largest, voltage ratings up to 25,000 volts are standard, and ratings beyond that can be provided as special units if required.

Horizontal Output & H-V Transformer

SQUARE ROOT MFG. CORP., 391 Saw Mill River Road, Yonkers, N. Y. The Coronasealed horizontal output and high-voltage transformer illus-



trated has transformer, coil and core entirely encased in a molded plastic form. The high dielectric strength of the plastic provides greater protection against corona discharge and the resultant fire hazards. Reduction of acoustical radiation is another important feature. When used in a high-efficiency 66 to 70-deg circuit, it will provide full deflection and up to 14-kv anode potential.

Electrostatic-Focus Tube

TEL-O-TUBE CORP. OF AMERICA, East Paterson, N. J., has announced an electrostatic focus magnetic deflection tv picture tube, completely free of corona effect. The new development incorporates a unique spot welding operation performed on the focus electrode of the electron gun mount that completely eliminates stray emission, the chief cause of corona effect in other brands of electrostatic focus tubes. The line currently includes all sizes from 14 in. to 20 in., both round and rectangular, with all available for immediate delivery.

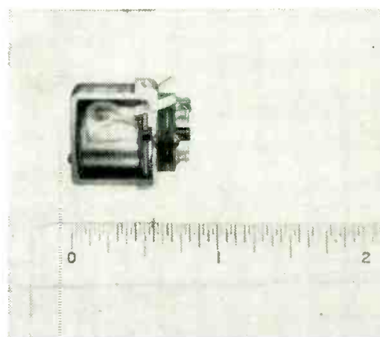
Wide-Range Oscillator

SOUTHWESTERN INDUSTRIAL ELECTRONICS CO., 2831 Post Oak Road, Houston 19, Texas. Model M-2 os-

cillator covers the frequency range of 1 to 120,000 cps in five overlapping bands. The circuit is an improved version of the bridge stabilized type oscillator that affords a means of reducing to a minimum the influence of amplifier parameters on the frequency of oscillation. The dial is calibrated to within 1.5 percent plus 0.1 cps. Two output circuits are provided, one of which delivers from 0 to 20 v rms into a 1,000-ohm load; the other has a constant internal impedance of 300 ohms with a terminal voltage variable from 0 to 1.0 volt rms. Power consumption is 125 w at 115 v and 60 cps.

Subminiature Relay

HUFCO INDUSTRIES, 2815 West Olive, Burbank, Calif. Model 1001 subminiature relay, weighing less than 1/3 ounce, was developed and manufactured to meet the specialized requirements for aircraft and missile installations. The unique design of



the dynamically balanced armature provides the 1001 with high resistance to vibration and shock and sudden changes in acceleration and direction. It is a spdt 28-volt d-c relay with contacts rated at one ampere noninductive load.

Audio Oscillator

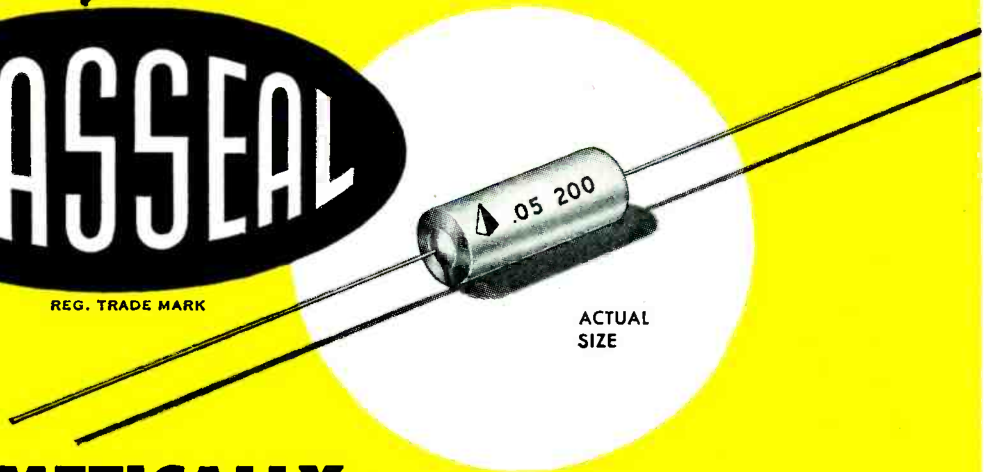
EL-TRONICS, INC., 2649 No. Howard St., Philadelphia 33, Pa. The TE200K laboratory-type wide-range audio oscillator is designed for continuous trouble-free operation under the most adverse conditions. Special features are: electronically regulated power supply for stable operation under varying line-volt-

(continued on p 239)

Announcing

GLASSEAL

REG. TRADE MARK



ACTUAL SIZE

HERMETICALLY-SEALED *Miniature* TUBULAR PAPER CAPACITORS by PYRAMID

Pyramid Type PG "GLASSEAL" miniature paper capacitors are assembled in metal tubes with glass-metal terminals. They will fully meet the most exacting demands of high vacuum, high pressure, temperature cycling, immersion cycling and corrosion tests.

TEMPERATURE RANGES: −55° to +125°C.

CAPACITANCE RANGE:	.001 mfd. to 1.0 mfd.
VOLTAGE RANGE:	100 to 600 v.d.c. operating

Your inquiries are invited

PYRAMID Electric Company

GENERAL OFFICES and PLANT NO. 1
1445 HUDSON BLVD. • NORTH BERGEN, N. J.

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155 OXFORD ST. • PATERSON, N. J.

NEWS OF THE INDUSTRY

EDITED by WILLIAM P. O'BRIEN

JETEC Begins Critical Materials Study

A SPECIAL task committee on critical materials used in the manufacture of radio-television tubes has been established by the Joint Electron Tube Engineering Council. The group was set up because of the need for a complete study of materials used in vacuum tubes in light of the modern concepts of the automatic control of many technical tasks in military operations.

A joint industry investigation of possible substitute materials and methods for handling them without impairing the reliability or specific characteristics required of the tubes is one of the objectives of the JETEC task group. Data is now being assembled on several materials in short supply, especially nickel and cobalt alloys and some steel alloys.

One important program already has been initiated by the industry in an effort to conserve critical materials. This is a change in the focusing system of c-r tubes which permits a substantial reduction in the uses of copper and cobalt.

Chairman of the special task committee is A. C. Gable of General Electric Co.; secretary is R. R. Batcher, chief engineer of the RTMA.

Role of F-M in Capital's Defense Plans

A PLAN for an air-raid warning system to blanket the entire District of Columbia in case of an emergency, through the use of a supersonically controlled broadcast and amplification system, has been announced by the Communications Advisory and Planning Committee of the D. C. Office of Civil Defense.

When completed, the air-raid warning system will cover the District of Columbia through the use of a 250-watt f-m radio transmitter, already on order, and 34 supersonically controlled f-m receivers equipped with high-power amplifiers. Three radio frequencies in the 40 to 50-mc band, made available to the Office of Civil Defense by the FCC, will be used. One frequency will connect the Command Center with 34 remote-controlled receivers equipped with high-power amplifiers and will be used for public air-raid warnings and for mutual aid purposes in extreme emergencies. The system will permit warning by voice as well as sound. A second frequency would permit communication between the Command Center and four Control Centers. These four centers will be equipped with 50-watt f-m transmitters for this purpose. The third frequency will be reserved for special services such as communication with pack receivers and other mobile equipment.

Although the 34 receivers and amplifiers will be located in the District of Columbia proper, surrounding communities have been consulted and invited to hook up with the D. C. network through similar receiving and amplifying equipment. Permission would also be granted to private industry upon application.

CIVIL DEFENSE PARLEY AT ELECTRONICS PARK

Robert R. Burton (third from left), head of communications for the Federal Civil Defense Administration in Washington, recently visited General Electric's Electronics Park at Syracuse, N. Y. He met with members of a new Civil Defense committee of the GE Electronics Department to discuss possible applications of two-way mobile radio for civil defense. The committee is directing a broad program of assistance in the electronics field to civil defense organizations. Present at the meeting, from left to right, are Neal F. Harmon, Lacy W. Goostree, R. R. Burton, Paul L. Chamberlain, Ellis M. Trefethen and Roy D. Jordan

Component Parts Reclassified

At the request of the Munitions Board, a reclassification of all electronic component parts was recently completed by the Radio-Television Manufacturers Association. The new categorical breakdown will enable the military and the electronics industry to identify readily component parts by listing them in one of eleven major groups requiring common production facilities, manpower, material and know-how. Thus, it is now possible for the Department of Defense to ascertain easily the industry's ability to produce any type of component. This important information had not been available to the military or to the electronic industry before.

New classifications are as fol-

lows: transducers, transducer accessories, antennas, circuit interrupters, resistors, capacitors, transformers, housings, piezoelectric frequency control devices, plugs, connectors and hardware.

The RTMA is working to complete similar breakdowns at an early date. The remaining reclassifications will cover electronic end equipment, electron tubes and devices and electronic test equipment.

MEETINGS

MARCH 27–28: Joint Meeting of the Association for Computing Machinery and the Industrial Mathematics Society, Wayne University, Detroit, Mich.

APR. 14: Fifth Annual Spring Technical Conference of the Cincinnati Section of the IRE, Engineering Society Headquarters, Cincinnati, Ohio.

APR. 16–18: Spring Meeting of the U.S.A. National Committee of the URSI and the Professional Group on Antennas and Wave Propagation of the IRE, at the National Bureau of Standards, Connecticut and Van Ness Sts., N. W., Washington, D. C.

APR. 19–20: Armed Forces Communication Association National Convention, Drake Hotel, Chicago, Ill.

APR. 20–21: Southwestern IRE Conference, Southern Methodist University, Dallas, Texas.

APR. 21: Fifth Annual New England Radio Engineering Meeting, Copley Plaza Hotel, Boston, Mass.

APR. 30–May 4: SMPTE Spring Convention, Hotel Statler, N. Y.

MAY 21–23: 1951 Parts Distributors Show, Hotel Stevens, Chicago, Illinois.

MAY 23–24: Fifth National Convention, American Society for Quality Control, Hotel Cleveland, Cleveland, Ohio.

MAY 23–25: 1951 IRE Technical Conference on Airborne Electronics, Biltmore Hotel, Dayton, Ohio.

JUNE 18–22: ASTM Annual Meeting, Atlantic City, N. J.

JUNE 25–29: AIEE Summer General Meeting, Royal York Hotel, Toronto, Ontario, Canada.

AUG. 15–18: 1951 APCO Conference, Everglades Hotel, Miami, Florida.

AUG. 28–SEPT. 8: Eighteenth British National Radio Show, Earls Court, London, England.

RTMA Appoints Policy Committee

WHILE PRESIDENT of the RTMA, Robert C. Sprague appointed a policy committee to cooperate with national defense agencies in the conservation of critical materials in the radio-television industry. Establishment of the committee was authorized by the board of directors at a meeting in Chicago at which industry problems resulting from the shortages of critical materials were discussed at length.

Members of the committee are Benjamin Abrams of Emerson Radio & Phonograph Corp.; W. R. G. Baker of General Electric Co.; Paul V. Galvin of Motorola Inc.; L. F. Hardy of Philco Corp.; Leslie F. Muter of The Muter Co.; A. D. Plamondon, Jr. of The Indiana Steel Products Co.; Robert C. Tait of Stromberg-Carlson Co.; R. G. Zender of Lenz Mfg. Co.; and Robert C. Sprague of Sprague Electric Co.

The next meeting of the RTMA board of directors will be held on April 12 and 13 at the Seaview Country Club, Absecon, N. J., at which time the RTMA officers and directors will be hosts to the directors of the Radio Manufacturers Association of Canada.

AIEE AND IRE HONOR NBS

Award presentation to the National Bureau of Standards by the AIEE and IRE in recognition of the Bureau's contributions to science and engineering in the past 50 years. Scrolls were presented during the recent Conference on High-Frequency Measurements in Washington, D. C. Standing from left to right are: T. G. LeClair, president of the AIEE; E. U. Condon, director of the NBS; I. S. Coggeshall, president of the IRE; and E. Weber, chairman of the Joint AIEE-IRE Committee on High-Frequency Measurements

Southwestern IRE Conference

THE 1951 Southwestern IRE Conference will be held on the campus of Southern Methodist University in Dallas, Texas, on April 20 and 21. Keynoter of the conference, which has as its theme New Frontier in Electronics, will be Donald G. Fink, editor of ELECTRONICS; banquet speaker will be George E. Sterling of the FCC.

The tentative technical program is as follows:

The Radiation of a Cylindrical Antenna, by C. Lonczos of the National Bureau of Standards.

Microwave Refractometer and Its Application to the Studies of

(Continued on page 267)

These leading TV set makers use Sylvania Picture Tubes

We're PROUD of this picture!

Today's sales picture shows that 75% of the leading television set manufacturers use Sylvania picture tubes.

This popularity is no accident. It's based on a sure foundation of outstanding performance. For, Sylvania picture tubes have won their prized position through years of research and quality production techniques developed during more than a quarter of a century of leadership in radio, electronics, and lighting.

Remember, too, when you choose Sylvania picture tubes, you choose products of nationally recognized excellence . . . products that carry prestige and sales appeal when listed among your sets' specifications.

Send today for new folder giving complete descriptions and ratings of all Sylvania TV Picture Tubes. Simply write a postal card to Sylvania Electric Products Inc., Dept. R-1104. Emporium, Penna. *Sylvania Representatives are also located in all foreign countries. Names on request.*

SYLVANIA ELECTRIC PRODUCTS INC. 1901-1951 50th ANNIVERSARY FIVE DECADES OF PROGRESS

SYLVANIA ELECTRIC

RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC PRODUCTS; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS

NEW BOOKS

Transmission Lines and Filter Networks

BY JOHN KARALASH. *The MacMillan Company, New York,* 1950, 413 *pages,* $6.00.

THIS new book deals with the elementary theory of transmission lines, transmission line networks and electric wave filters. The treatment is applicable from voice frequencies through the microwave range. Written by a Lehigh University professor with a background of practical teaching experience, this book should serve nicely as a text for students of electrical communication. The quantitative viewpoint which characterizes the book should also make it a useful source of reference material for the practicing engineer.

RELEASED THIS MONTH

F-M Simplified; M. S. Kiver; Van Nostrand; 2nd edition; $6.50.

Theory and Application of Industrial Electronics; J. M. Cage; McGraw-Hill; $4.75.

The book is divided into four main sections. The first section deals with conventional transmission line theory, augmented through the use of modern transmission line charts which assist in its understanding and also facilitate calculations.

The next two sections consist of an introductory approach to network theory and a consideration of various transmission parameters, together with a treatment of electric wave filters of the several basic types. Zobel's early contributions to the development of ladder-type filters are indicated and Foster's reactance theorem is introduced to serve as the basis for synthesizing two-terminal reactance components of K-filters. Somewhat different from the usual procedure, though considerably more direct, is the application of the matrix operator involving the so-called "ABCD" or general network parameters to investigations of high-

(Continued on p 278)

At last

all 27 volumes of the M.I.T. Radiation Laboratory Series now published

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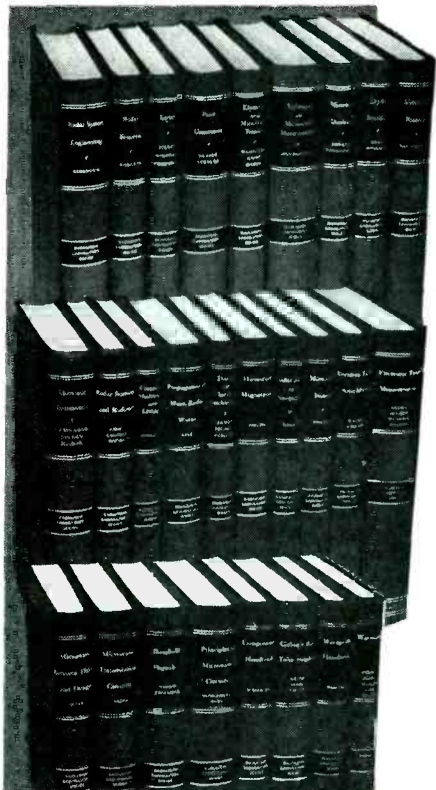

Available at a special price and terms

This series of 27 titles was written and edited principally by members of the Radiation Laboratory, maintained during the war at the Massachusetts Institute of Technology. The usefulness of the Series extends over all the fields—communication, television, industrial instrumentation and control, research in biological and physical sciences, and radar—in which electronic techniques are of great applicability and importance.

★ Upon request, we will send you an 8-page circular describing the 27 volumes of this set in greater detail.

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The books in this series total $206.50 in price. If all 27 volumes are purchased at once, a library price of $186.00 applies, affording a savings of about 10%. In addition, the amount may be paid in installments, first payment $36.00, ten days after receipt of books, and the balance $30.00 monthly.

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Vol. 1. RADAR SYSTEM ENGINEERING. Outlines general principles of radar systems, and discusses basic design considerations. Edited by L. N. Ridenour, U. of Penn. 408 pages, $8.50

Vol. 2. RADAR AIDS TO NAVIGATION. Describes the advantages and limitations of the use of radar in navigation and pilotage. Edited by J. S. Hall, Amherst Coll. 389 pages, $5.00

Vol. 3. RADAR BEACONS. Survey of the design of radar responder beacons and their use in navigation and identification. Edited by A. Roberts, State U. of Iowa. 409 pages, $6.50

Vol. 4. LORAN. Complete account of the design and use of the long-range pulse navigation system known as Loran. By J. A. Pierce, Harvard U., A. A. McKenzie, Electronics, and R. H. Woodward, Harvard U. 468 pages, $6.00

Vol. 5. PULSE GENERATORS. Covers the theoretical and practical aspects of the generation of power pulses. By G. N. Glascoe, Rensselaer Polytechnic Inst., and J. V. Lebacqz, Johns Hopkins U. 737 pages, $9.00

Vol. 6. MICROWAVE MAGNETRONS. Theoretical and practical aspects of multicavity magnetrons in the frequency range from 1000 to 24,000 Mc/sec and in the power output range from 10 watts to 3,000,000 watts. Edited by G. B. Collins, U. of Rochester. 769 pages, $9.00

Vol. 7. KLYSTRONS AND MICROWAVE TRIODES. Discusses low power microwave triodes and klystrons. Edited by D. R. Hamilton, Princeton U., J. K. Knipp, Iowa State Coll. and J. B. H. Kuper, Brookhaven Nat'l. Lab. 534 pages, $8.00

Vol. 8. PRINCIPLES OF MICROWAVE CIRCUITS. Describes guided electromagnetic waves. Edited by C. G. Montgomery, Yale U., R. H. Dicke, Princeton U., and E. M. Purcell, Harvard U. 479 pages, $6.50

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Backtalk

This department is operated as an open forum where our readers may discuss problems of the electronics industry or comment upon articles which ELECTRONICS has published.

Color Code

DEAR SIRS:

I HAVE, in the course of many years, acquired many copies of ELECTRONICS, and I usually file a note of the information they contain, as they are purchased. But when I see the copies on the bookshelf, and when only their spines are visible, it seems that you could introduce something new in technical journalism. The color printing system you use for the front cover should enable you to introduce a color-code system whereby colored bars on the spine will indicate the subject matter of the contents. It only requires a well-thought-out code to be drawn up in the first place, for a very useful system to be evolved; the color, width, and disposition of the bars could convey quite detailed information as to the contents of the particular issue.

R. S. ROBERTS
London, England

Editor's Note: Roberts' idea is being considered. Any comments or suggestions from other readers will be appreciated.

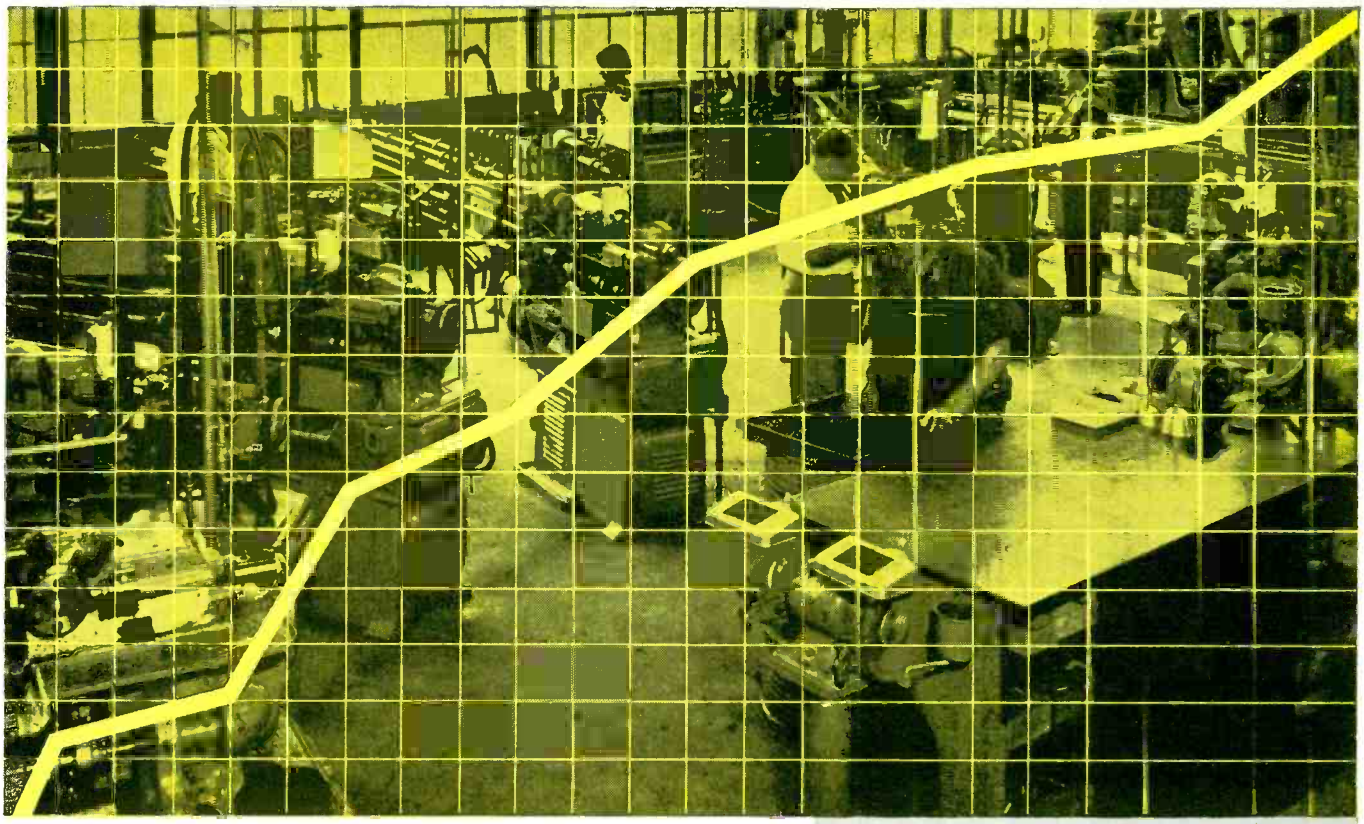
Design Formulas

DEAR SIRS:

WE refer to the article "Wideband Series-Parallel Transformer Design" by Vincent C. Rideout which appeared on page 122 in *The Electron Art* department of ELECTRONICS (July 1950).

It will certainly be of interest to you to know that our company has been engaged in the design of such transformers for matching transmission lines in accordance with general formulas since 1944. The

(Continued on p 292)



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TUBES AT WORK

(continued from p 138)

sets of normally open contacts. One set of contacts closes the pilot contactors of the appropriate motor-operated potentiometer, thereby varying either the field or armature supply of the main driving motor in such a manner as to oppose the speed fluctuation which produced the initial signal.

The second set of contacts cuts out sufficient bias resistance from the input circuit of the amplifier to restore the balance of the output tubes for small out-of-balance voltages. This action releases the armature of the relay concerned and the main driving motor is prevented from hunting.

The small out-of-balance voltages produce a rhythmic operation of one or the other of the telephone relays and the frequency of this operation can be controlled by adjusting the capacitors in the grid circuits of the first stage of the amplifier.

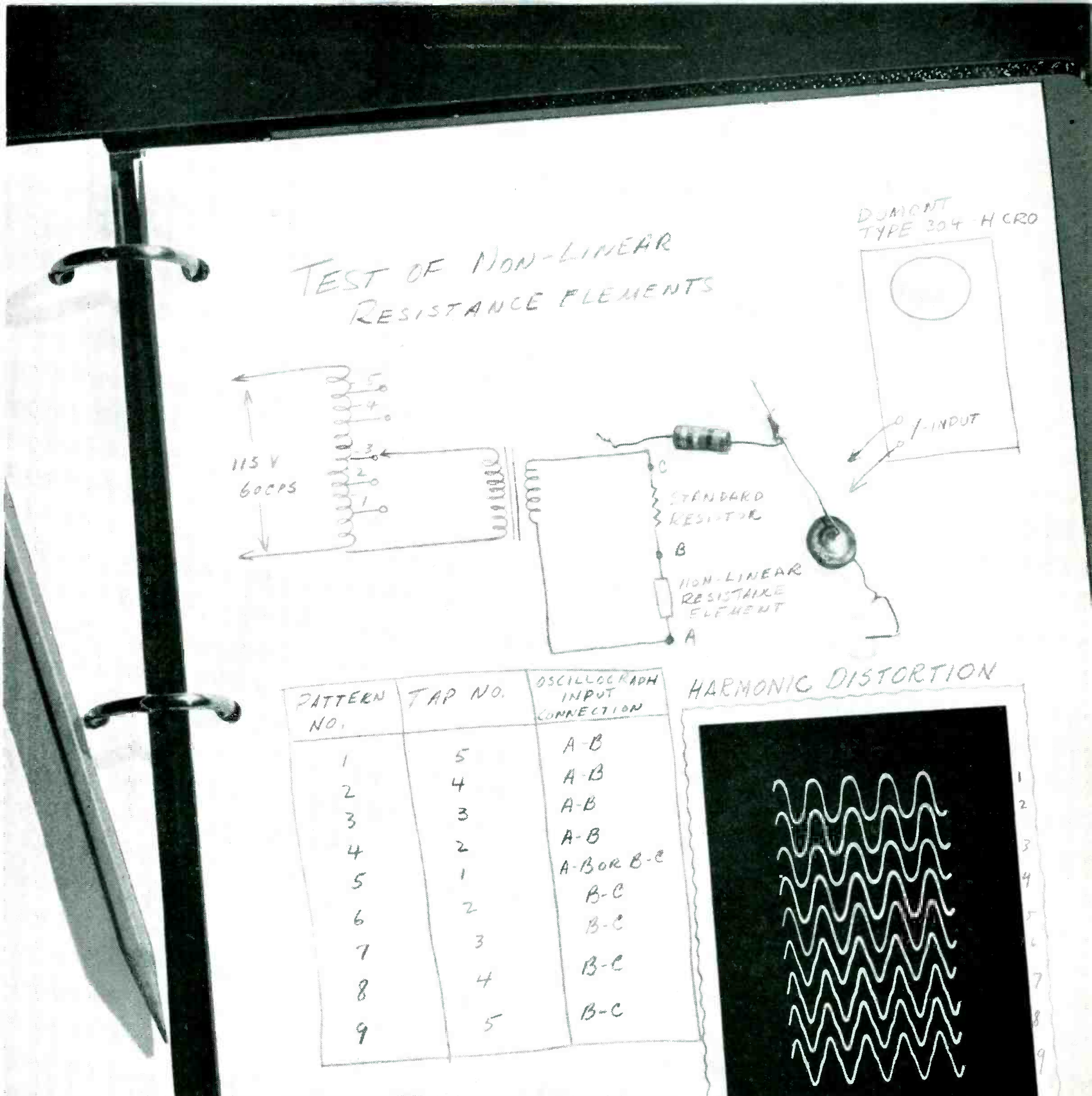
Veneer-Peeling Procedure

After the log has been mounted in the lathe, it is revolved slowly by means of inching buttons mounted on the control panel. At this time, surface flaws are removed with a hand tool.

The revolution-control potentiometer is set to a suitable low speed for the rounding operation. As soon as a continuous veneer is evolved, the clutch is disengaged and the end of the veneer is wrapped around the take-up spool. The clutch is then re-engaged for a few revolutions to start the spooling.

The peeling operation is started next under revolution control and, if desired, can continue under this form of control at any selected spindle speed. Alternatively, the take-off control button can be pressed and peeling will then proceed at the selected peripheral speed.

The take-off control can only be engaged when the roller is in contact with the log and the log is revolving. Changeover from revolution control is effected by a relay which, in its normal nonenergized condition, is in the revolution-control position. A protective relay is connected across the log-speed tachom-



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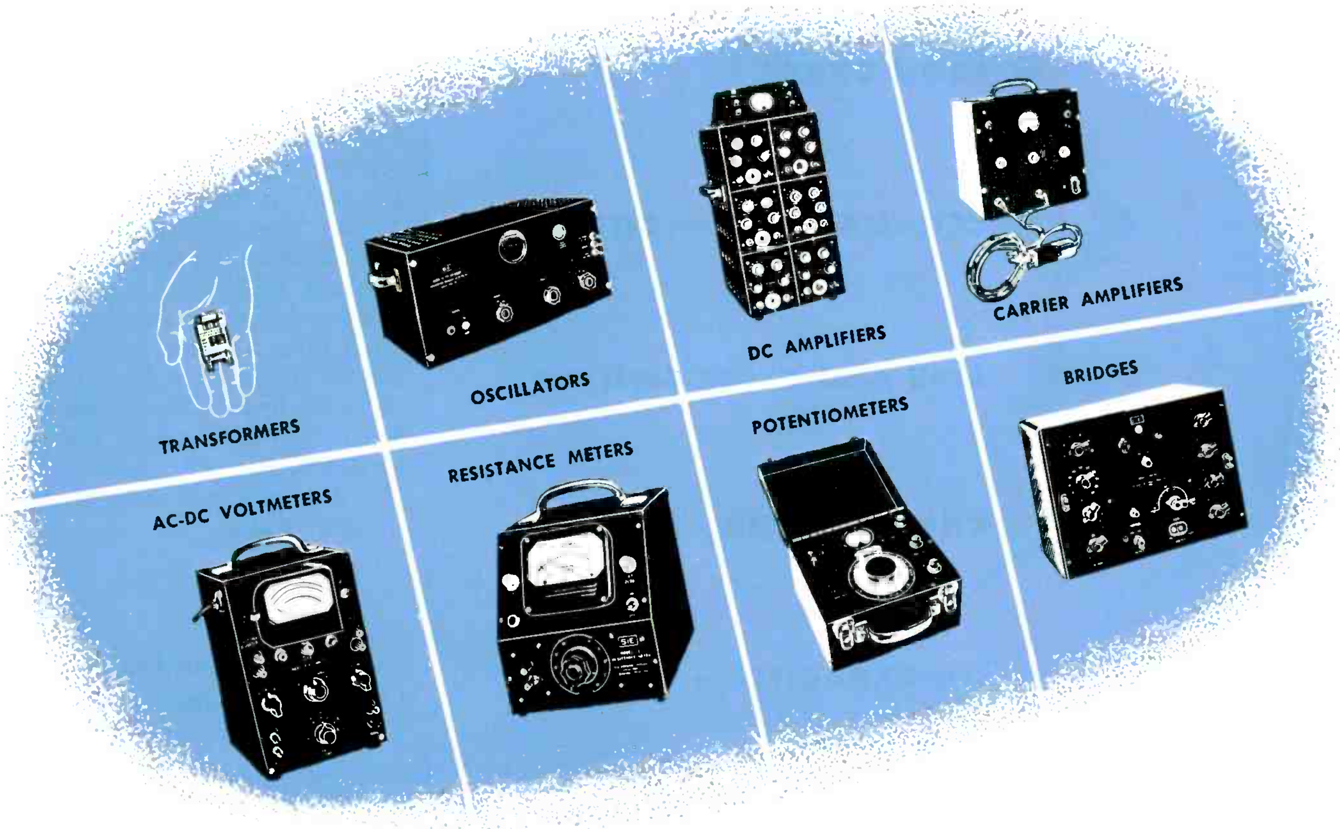

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2831 POST OAK ROAD • P. O. BOX 13058 • HOUSTON 19, TEXAS eter generator. Only when the voltage of this generator is sufficient to close the protective relay will operation of the take-off control push button cause the changeover relay to move to the take-off position. If at anytime the log tachometer generator becomes disengaged from the log, the protective relay opens and automatically returns the changeover relay to the revolution-control position.

A general view of the peeling lathe in the British Government's Forest Products Research Laboratory at Princes Risborough, England, is shown in the photograph. The main driving motor, rated at 60 hp, is a compound-wound machine with separately excited fields and a speed range of 25 to 2,700 rpm. A 65-kw motor-generator set provides the d-c supply for the main motor. For speeds up to 900 rpm, Ward-Leonard control is employed. Higher speeds are obtained by means of field control of the main motor.

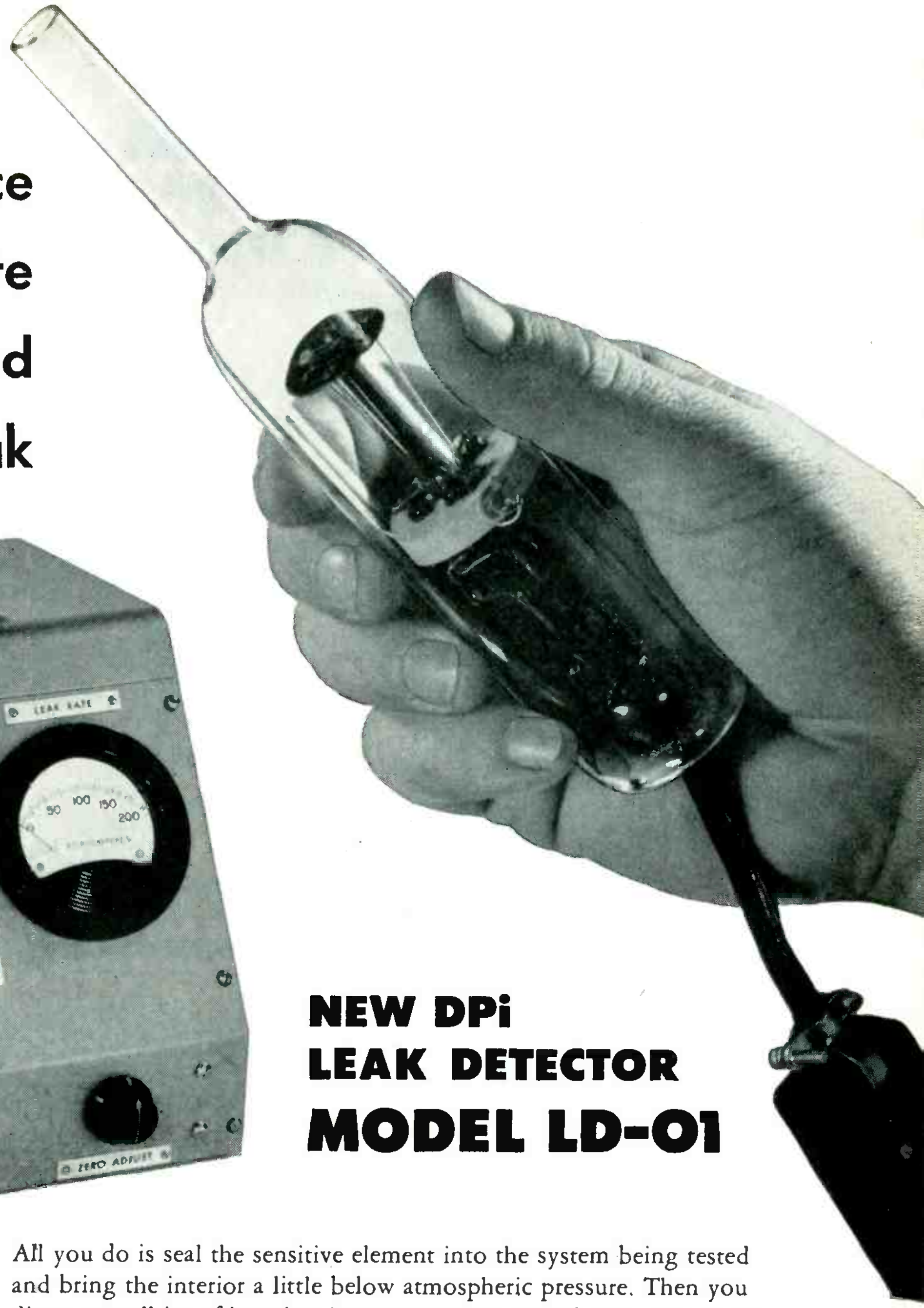
Electronic Counting of Old Paper Money

AUTOMATIC electronic machines for counting old paper money are to be put in use soon at the Treasury Department. The counters, developed at the National Bureau of Standards, will count as many as 30,000 bills per hour.

Removing worn-out bank notes from circulation before substituting new ones involves the redemption of about eight tons of currency every day. The bulk of this currency—about $5,000,000 worth—consists of one-dollar bills. Old money, which is often wrinkled, dog-eared or gummed together, has been a problem to count in the past.

Unfit paper currency retired from circulation is cut in half by Federal Reserve banks and branches before shipment to the Treasury. The lower halves are counted by the Bureau of the Public Debt. The new machine counts these halves in packets of 100 notes and automatically rejects those with more or less than 100 into one chute.

here's a simple device to locate almost any kind of leak



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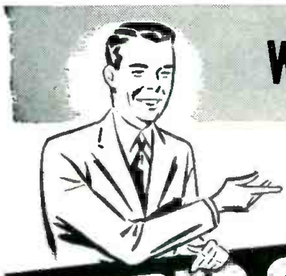

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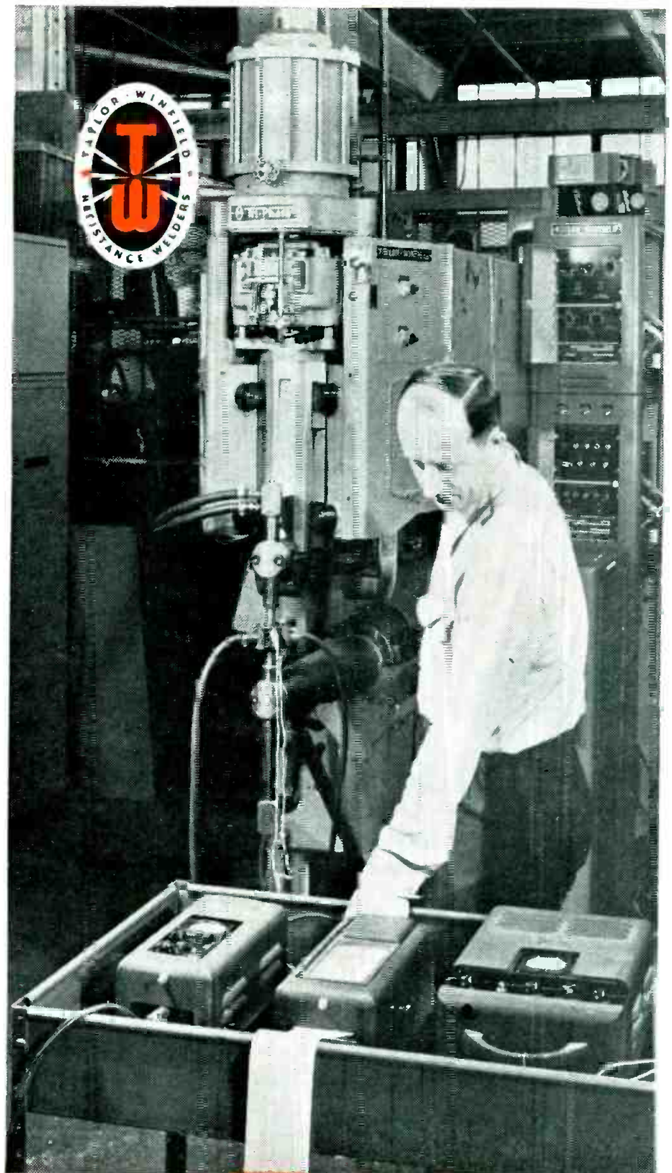

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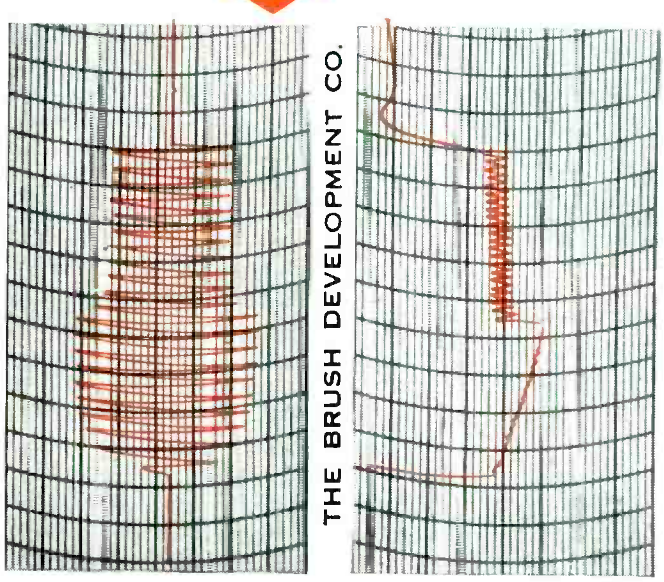

Chart of welding cycle on Taylor Winfield welder shows 60-cycle A-c input current at left, D-c welding current at right. This Brush Analyzer consists of A-c amplifier, D-c amplifier, direct-writing oscillograph.

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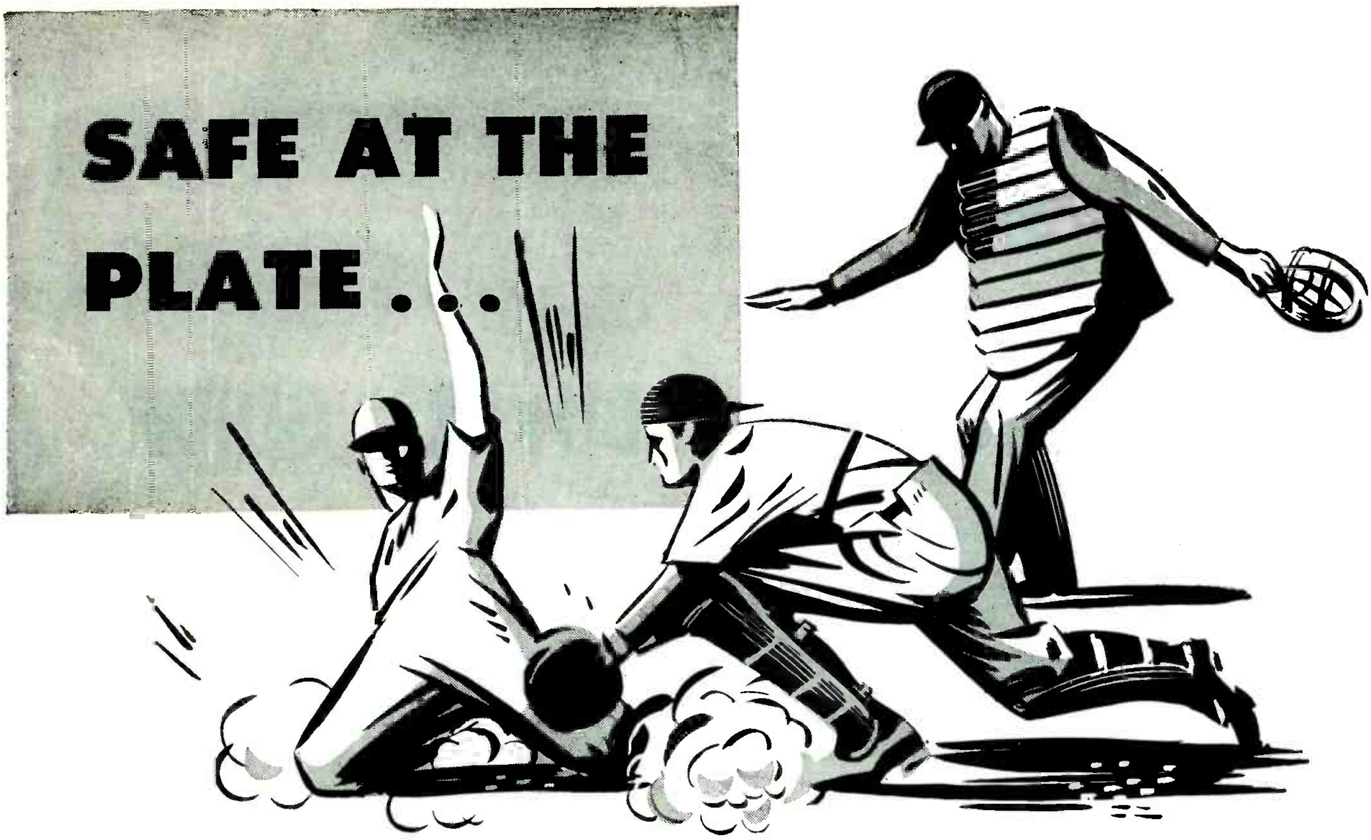
Electronic currency counter to be used by Treasury Department. Packets of lower halves of bills enter machine in trough at top right. Left chute on front of machine is for rejected packets and right chute is for correct ones

and the correct ones into another.

Packets of stapled half-notes are placed on an inclined trough. When the counter is turned on, a metal finger pulls the bottom packet into the machine. The stapled end is grasped by metal jaws and the packet is wrapped tightly around a spindle, spreading the outer edges of the notes against a curved metal plate. The spindle then rotates the ends of the notes while a jet of air separates the notes from the packet.

Counting is achieved by using an electronic sensing device consisting of a beam of light and a phototube system. As the notes are unfurled, interrupting the beam of light, the phototube senses the interruptions of the beam. Impulses from the phototube are fed to a binary counter which tallies the individual impulses. The sum of these impulses is used to actuate a sorting vane. If the count is correct, the sorting mechanism automatically sends the packet into an acceptance bin, if the count is not what it should be, the packet is automatically ejected into a reject bin.

At the beginning of each counting cycle, a feeder mechanism pushes each packet endwise from the inclined trough into the opening between the spindle jaws. When a packet reaches this position, a limit switch is actuated which causes the spindle jaws to clamp and



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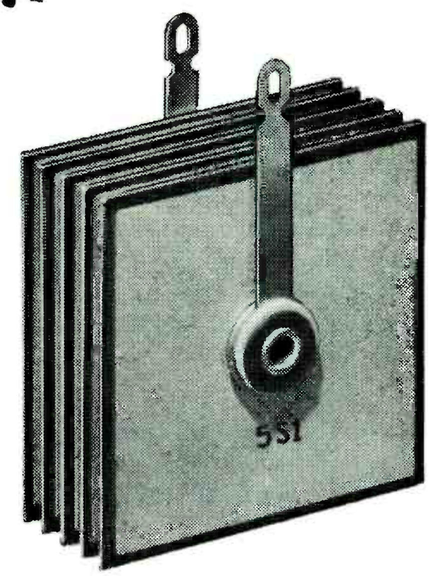

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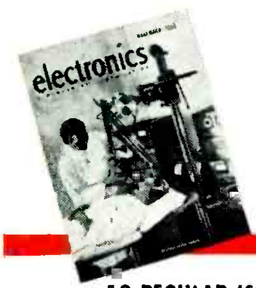

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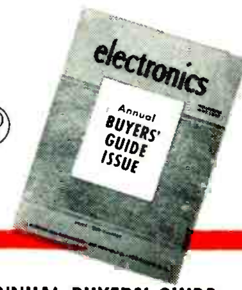

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rotate, rolling the packet around the spindle for counting. The jaws then release and the packet is cleared from the counting head by an additional revolution of the spindle.

The released packet falls on a sheet-metal sorter vane which has been tilted to the correct or the rejection position by an electromagnet responding to the count. The spindle jaws, together with an electromagnet which operates them, are carried in a rotating element of a turn table assembly on top of the unit.

A high degree of reliability is attained in the counter through the use of the light-beam technique. An optical assembly including a lamp, condensing lens and two small adjustable mirrors deflects a light beam across the path of the sheet ends as they are blown by the air jet.

Design Features

Mechanical details of the pusher which holds the end of the friction band against the contour of the rolled-up sheets are rather critical. It was found that a knife-edged bearing offered the best solution to the problem of releasing only individual sheets. Another critical design feature was the position of the air jet nozzle relative to the end of the friction band. Its opening was placed as close as possible to the contour of the surface and set to produce an airstream tangential in direction. This proved to be the only arrangement which would give the proper swinging motion to the ends of the notes as they passed the light beam.

The electronic counter is relatively conventional. A cathode follower applies the phototube impulses to a trigger circuit for conversion to sharp uniform-amplitude pulses. These pulses are, in turn, applied to a binary electronic counter. The 8-stage counter is set to indicate the desired count for a correct packet of 102, 100 half-notes plus the wrapper sheet on each side. In ordinary production use by the Treasury, the actual numerical count for each packet is not of any material interest but for necessary maintenance purposes the they may look alike, *but:* there is only one C-D

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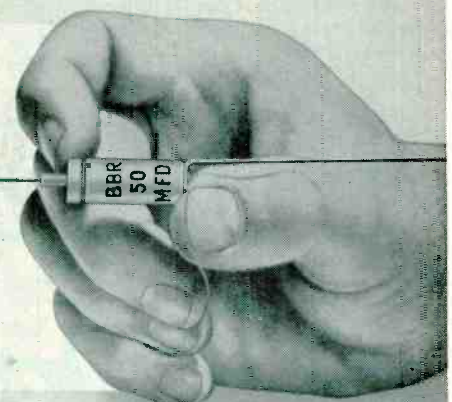

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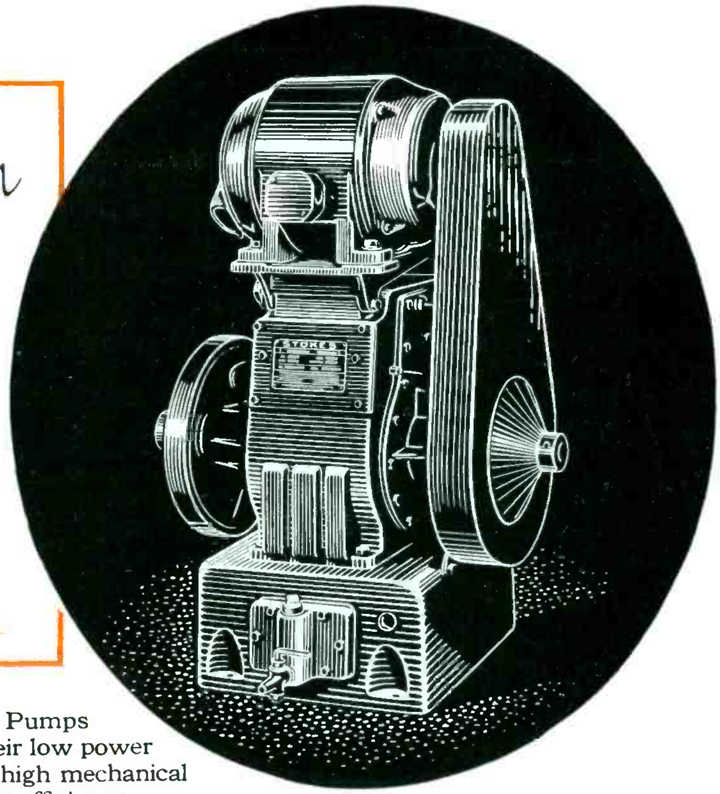

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Stokes Microvac Pumps, air-cooled in the small sizes and water-cooled in five larger sizes, range in capacity from 15 to 500 cfm.

Stokes is the only manufacturer of equipment for complete vacuum systems, including Microvac mechanical pumps, oil diffusion pumps, McLeod Gages and Valves.

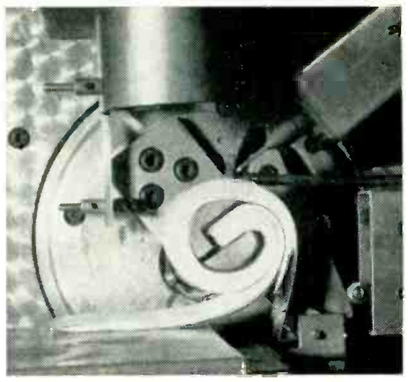
Consult with Stokes on the application of vacuum to rotary exhaust machines, house vacuum systems, vacuum impregnation, vacuum furnaces, vacuum metallizing, and to other applications in which vacuum deserves exploration.

STOKES MAKES

Plastics Molding Presses,
Industrial Tabletting
and Powder Metal Presses,
Pharmaceutical Equipment,
Vacuum Processing Equipment,
High Vacuum Pumps and Gages,
Special Machinery

STOKES

F. J. STOKES MACHINE COMPANY, 6046 TABOR ROAD, PHILADELPHIA 20, PA.



Package of half-notes firmly locked in jaws of spindle (center). Combined action of friction band (curled around outer contour of packet) and air jet (air hose, center) cause each note to break light beam of phototube (left)

total is indicated by a series of neon lights located just below the output chutes.

In the event a packet of half-notes tangles around the spindle, a limit switch stops the automatic feed until the machine is cleared by hand. Other limit switches stop the machine after it runs out of packets and interlock the motion of the turntable with that of the feeder mechanism.

A study of optimum spindle speeds was made to determine the effect of varying speeds on accuracy of count. The advantage of increased accuracy at low operating speeds was compared with the cost of a greater number of machines. As a result of the study, the spindle speed adopted is 15 rpm but this is subject to revision upward on the basis of anticipated larger scale tests which will accompany early production operation. Since the spindles are belt-driven revision of speed is a simple matter.

Implosion Effect on TV Picture Tube

DAMAGED IN SHIPMENT, this television receiver presents a clear picture of implosion force on the picture tube. This picture, believed to be the first clearly illustrating implosion effect, was taken in cooperation with General Electric Supply Corp. in New York City. It shows how the safety glass in front of a 14-in. picture tube was shattered by why

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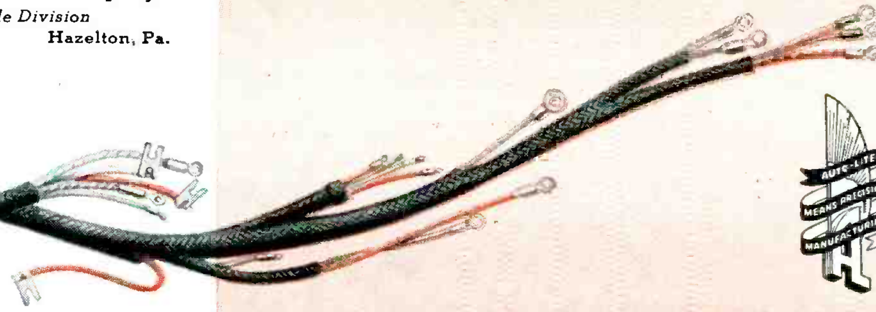

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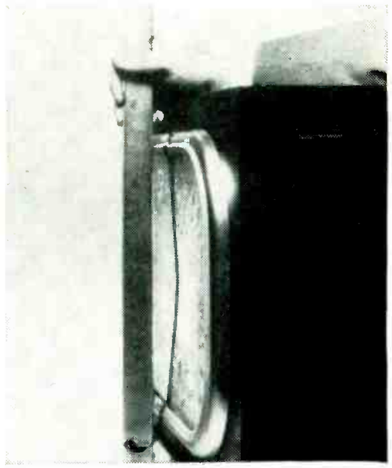


Steel rule held in front of safety glass shows degree of bending caused by air pressure inward

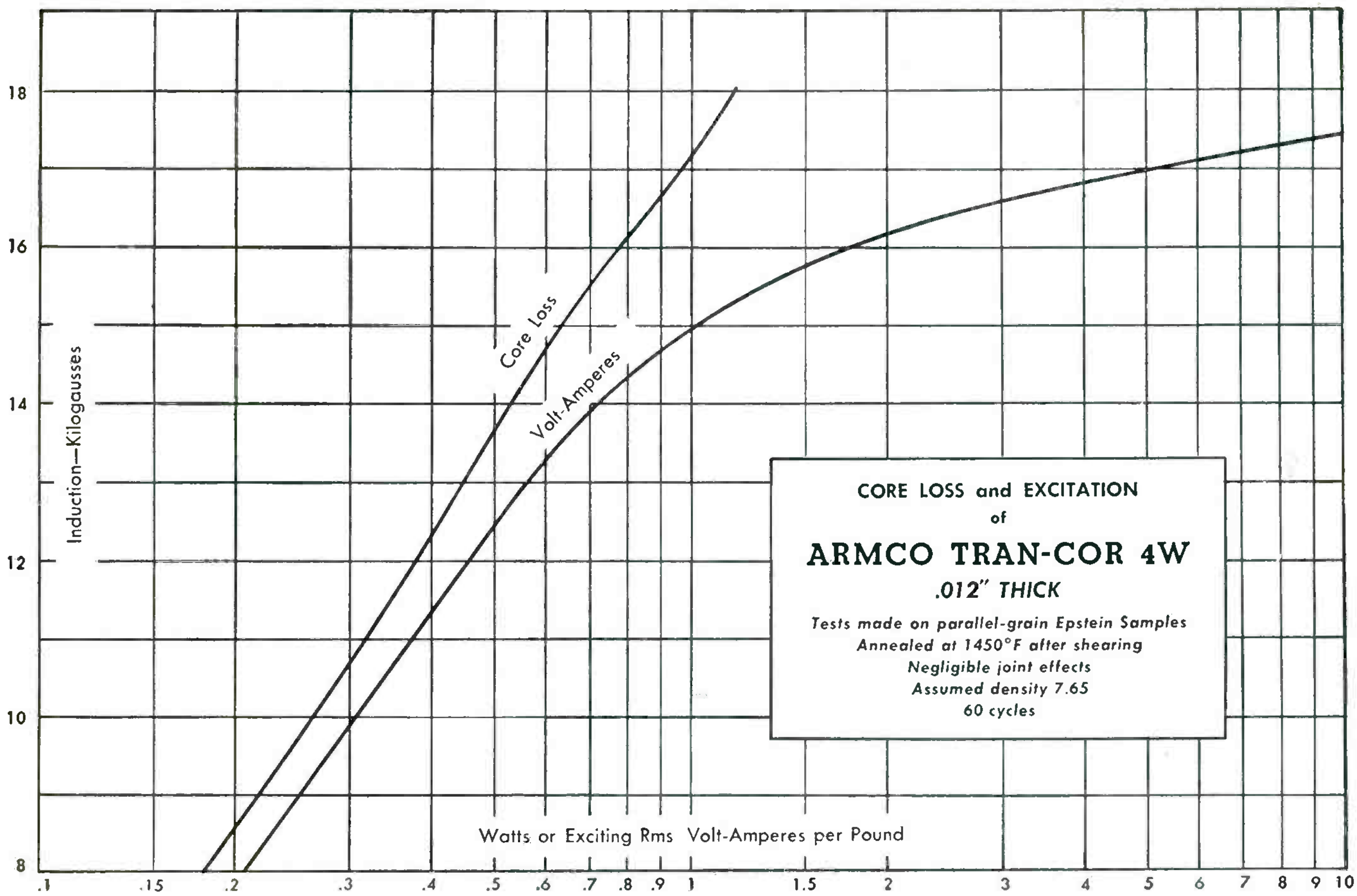
implosion of the tube. The fragments of glass held together but were drawn inward. Masking tape was added to the glass to show the degree of curvature. No damage was done to the cabinet or chassis as a result of tube implosion.

Autopilot for Guiding Jets in Combat

JET fighter planes can be guided through combat maneuvers with split-second accuracy by means of an electrical copilot developed by the Westinghouse Electric Corporation together with the Air Materiel Command's Armament Laboratory, Control Equipment Branch.

The midget device, one-third the weight of conventional automatic pilots, will be installed in the F94C fighter plane being built for the Air Force by the Lockheed Aircraft Corporation. Not only will the autopilot guide a plane through intricate combat maneuvers but it will also take complete control of the plane during level flight.

Maneuverability is achieved through the use of three gyroscopes rotating at 12,000 rpm. The gyros are locked to the plane and stay on the job no matter what evasive tactics the plane employs. Conventional autopilots contain gyros that would send the airplane into a series of dangerous gyrations if the pilot put his plane through intricate maneuvers. Former gyros re-



They're new!

.012" Armco Oriented Electrical Steels for Wound Cores

Armco is producing two new oriented electrical steels that offer these important advantages to manufacturers of distribution transformers:

Improved magnetic properties for high operating inductions.

They are only .012" thick—more easily wound into transformer cores.

They make possible redesigns that should permit smaller cores and a saving of copper.

The new grades are known as Armco TRAN-COR 3W and TRAN-COR 4W with core loss limits at 15 kilogausses of .71 and .64 watts per pound respectively. The symbol "W" indicates they are designed for use in wound cores only. Armco Oriented Electrical Steels designated as TRAN-COR 3X and TRAN-COR 4X are recommended for punched laminations or stacked cores.

All Armco Oriented Electrical Steels must be given a stress-relief anneal after forming the cores. This is necessary to get best results from improved magnetic qualities.

Economies resulting from top-notch efficiency in the new Armco "W" series offer many advantages in wound cores of distribution transformers. They save time and money in production, often require less copper, and assure unusually low core loss in operations at high inductions.

ARMCO STEEL CORPORATION

2661 Curtis Street, Middletown, Ohio • Plants and Sales Offices from Coast to Coast. Export: The Armco International Corporation

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Solve your Hermetic Seal Problems

WITH

RUGGED STEATITE TERMINALS

STEATITE OFFERS:

- EASY ASSEMBLY
- SUPERIOR STRENGTH
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- PERMANENT SEALING
- RESISTANCE TO HEAT
- EXTREMELY LOW-LOSS

Specify General Ceramics and Steatite for complete dependability in critical applications

General Ceramics low-loss Steatite sealed leads feature superior mechanical strength that insures permanent, positive hermetic sealing under practically any operating condition. Immune to severe thermal shock, they are easily soft-soldered to closures without developing the strains that are an incipient cause of trouble in many other types of leads. There are no rubber or plastic gaskets to deteriorate. Resistance to mechanical shock and vibration is excellent. The types shown are standard and can be supplied promptly from stock. For complete information on these and for consultation on custom-made terminals to your specification, phone, call or write today.

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GENERAL OFFICES and PLANT: KEASBEY, NEW JERSEY

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Watch Master

Frequency Standards

GUARANTEED ACCURACY
1 part in 100,000
(.001%)

Uses

Time bases, rate indicators, clock systems, chronographs, geo-physical prospecting, control devices and for running small synchronous motors.

Features

1. **Bimetallic, temperature-compensated fork, no heating or heat-up time is required.**
2. **Fork is hermetically sealed, no barometric effects on frequency.**
3. **Precision type, non-ageing, low coefficient resistors used where advantageous.**
4. **Non-linear negative feedback for constant amplitude control.**
5. **No multi-vibrators used.**
6. **Synchronous clock simplifies checking with time signal.**

Specifications

Accuracy—1 part in 100,000 (.001%).
Temperature coefficient—1 part in 1,000,000 per degree centigrade (or better).
Outputs—

1. **60 cycles, sine wave, 0-110 volts at 0 to 10 watts (adjustable).**
2. **120 cycle pulses, 30 volts negative.**
3. **240 cycle pulses, 30 volts positive and negative. Pulse duration, 100 micro-seconds.**

Type 212

TERMINATION
Front and Rear
CONSTRUCTION
Standard 8¾" x 19" Panel
HOUSING
8¾" x 19" x 8" Metal Cabinet
WEIGHT
25 pounds

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580 Fifth Avenue **New York 19, N. Y.**

Operating under patents of the Western Electric Company

sponded only to changes in angle of the plane but the new autopilot is sensitive to the rate at which such changes take place.

Operating Procedure

Control is provided by a single spherical-shaped metal disk or control knob which can be turned or moved three ways to achieve the desired maneuver. For normal flying, the autopilot is arranged for completely coordinated flight. To climb, the pilot pulls the disk back and the plane will climb at a constant rate regardless of external conditions. To turn, he rotates the disk either right or left. The rate of turn depends on the amount the knob is turned and the correct bank angle is automatically achieved. To dive, he pushes the disk forward.

For combat tactics, the pilot switches the autopilot to a stage of complete maneuverability. To complete a loop-the-loop, for example, the pilot draws back the control knob and holds it there until the maneuver is achieved. To roll the plane, he pushes the control knob to the right or left. With the autopilot switched to this stage, coordination of the plane depends largely on the pilot.

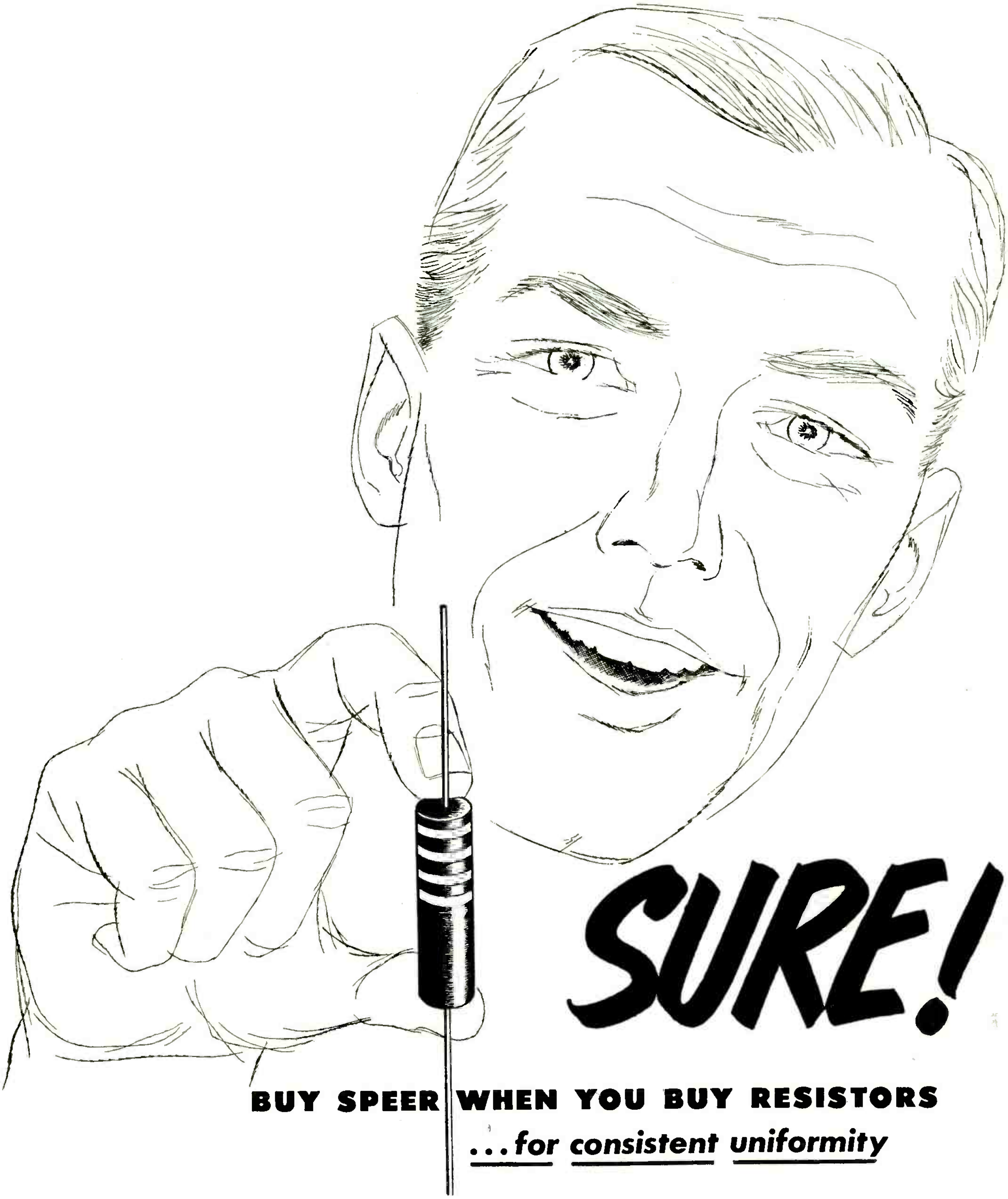
The autopilot is suitable not only for military aircraft but also for large and small commercial planes. Radio-controlled, it can serve to direct the flight of guided missiles and pilotless aircraft.

D-C VTVM With Two-Stage Feedback

By L. Fleming
Falls Church, Va.

To obtain high precision in an electronic voltmeter requires, in general, negative feedback over more than one stage. This principle has been applied successfully in several commercial a-c instruments but in the field of d-c measurement has been done only with indifferent success.

Two battery-operated instruments with high precision and high voltage sensitivity appeared transiently on the market, but they suffered from zero drift and the in-



BUY SPEER WHEN YOU BUY RESISTORS

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7566

convenience of a multiplicity of batteries.

A step in the right direction is an a-c operated meter circuit with negative feedback over two stages. Full-scale sensitivity of 0.5 volt is attainable with about 34 db of feedback. This circuit was designed for incremental measurements without provision for zero drift compensation. If a voltage stabilizer is used on the filament supply, however, the drift is negligible.

The basic idea of the circuit shown in Fig. 1 is that of a two-stage direct-coupled amplifier in which the input signal is applied between the grid of the first stage and the cathode of the second. Feedback is controlled by a resistor in the second-stage cathode circuit.

The first stage uses a 6AU6 pentode which provides a voltage gain, before feedback, of about 100. This tube is potentiometer coupled by resistor R_5 and R_6 to the second stage, V_2, a 6C4 triode which functions as a current amplifier to operate the indicating meter.

In the cathode circuit of V_2 is the feedback resistor R_n. The high side of the input is returned to this resistor, which determines the sensitivity of the instrument. With a 1-ma indicating instrument and R_n equal to 600 ohms, the over-all full-scale sensitivity is 1 volt.

Supply Voltages

Since the circuit is nonsymmetrical, the high-voltage supply is regulated by means of a gas tube. In order to keep down the number of tubes, it is desirable to limit the total high voltage to 150 volts. If ground is taken as the low side of the input, 100 volts will be available for plate supply for the tubes and 50 volts as a negative supply

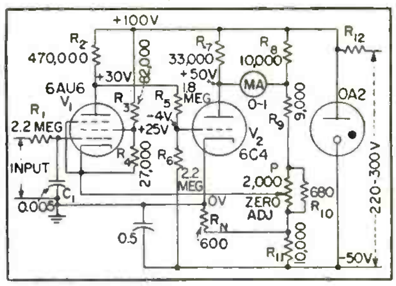
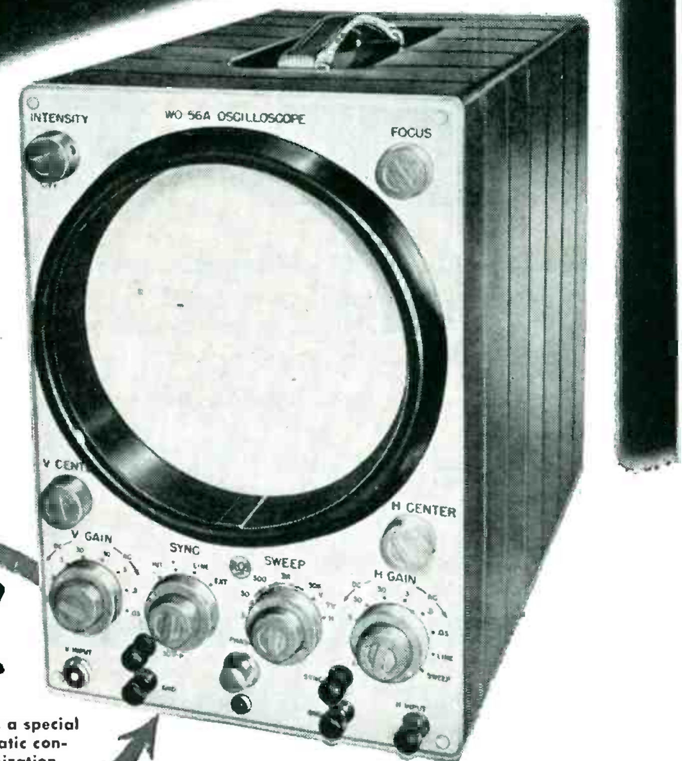


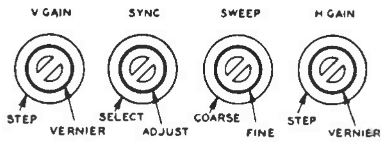
FIG. 1—Circuit diagram for d-c vtvm with feedback over two stages

The 7" TV scope for professionals

RCA WO-56A



DUAL CONTROLS FOR "COARSE" AND "FINE" ADJUSTMENTS



No hunting or fumbling for controls when adjusting Vertical Amplifier Gain, Sweep Frequency, Sync Injection, and Horizontal Amplifier Gain.

NEW!

The WO-56A has a special circuit for automatic control of synchronization over a wide range of input-signal levels.

Supplied with direct probe, low-capacitance probe, and ground cable.

FEATURING—

- Giant RCA 7JP1 cathode ray tube.
- Direct-coupled, 3-stage, push-pull, vertical and horizontal amplifiers.
- Frequency-compensated and voltage-calibrated attenuators on both amplifiers.
- A set of matched probes and cables.
- Panel source of 3 volts peak-to-peak calibrating voltage.
- Identical vertical and horizontal amplifiers with equal phase-shift characteristics.
- Retractable light shield for maximum visibility.
- New filter-type graph screen with finely ruled calibrations.
- Magnetic shield enclosing CR tube to minimize hum-pickup from internal and external fields.

SPECIFICATIONS—

- Vertical Deflection Sensitivity: 10.6 rms millivolts per inch.
- Frequency Response: Flat within -2 db from dc to 500 kc; within -6 db at 1 Mc; useful beyond 2 Mc.
- Input Capacitance: Less than 10 uuf with WG 216A Low-Capacitance Probe.
- Square-Wave Response: Zero tilt and overshoot using dc input position. Less than 2% tilt and overshoot using ac input position.
- Linear Sweep: 3 to 30,000 cps with fast retrace.
- Trace Expansion: 3 times screen diameter with corresponding centering control range.
- Power Supply: 105-125 volts 50/60 cycles; power consumption 65 watts.
- Size 13⅜" h, 9" w, 16⅜" d. Weight only 31 pounds (approx.).

ADVANCED SWEEP FACILITIES—

- Preset fixed sweep positions for vertical and horizontal television waveforms.
- Positive and negative syncing for easy lock-in of upright or inverted pulse waveforms.
- 60-cycle phase-controlled sweep and synchronizing.

Built for laboratory, factory, or shop use, the WO-56A combines the advantages of high-sensitivity and wide-frequency range in a *very small* instrument with a *large* cathode-ray tube.

Designed with the user in mind, this new 'scope can be depended upon to provide sharp, bright, large, and accurate pictures of minute voltage waveforms over the entire useful surface of the 7JP1 screen.

The amplifier selector switches are provided with both "AC" and "DC" positions so that measurements can be made with or without the effects of any dc component.

Square-wave reproduction is excellent, whether the application is low-frequency TV sweep-alignment or observation of high-frequency steep-fronted sync and deflection voltage waveforms.

A special sync-limiter circuit automatically maintains proper synchronization of the sweep oscillator over a wide range of input-signal levels without the need for manual adjustment of the sync-vernier control.

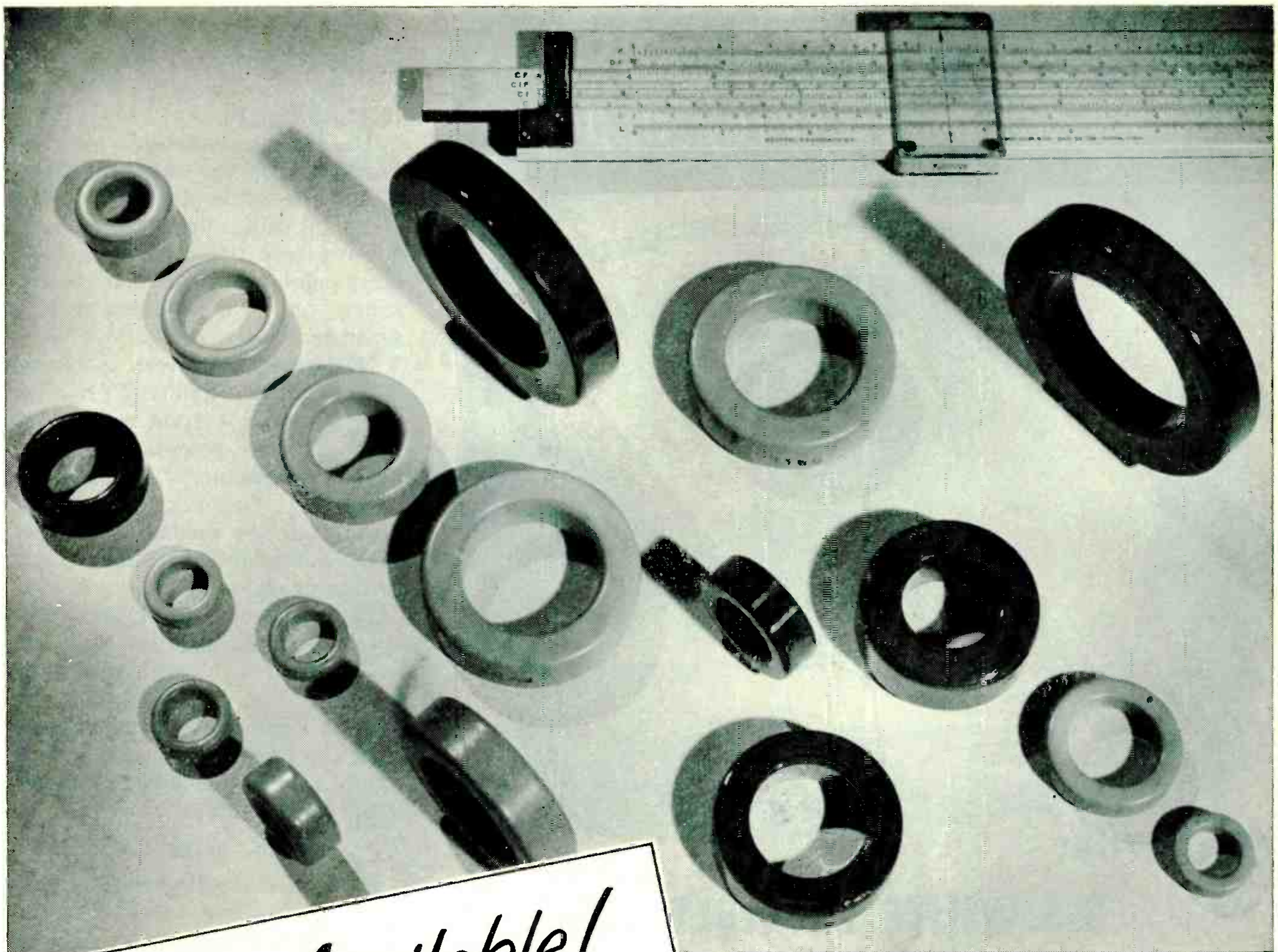
The excellent linearity and fast retrace of the sweep or time base are functions of the Potter-type oscillator. Undistorted reproduction of the sawtooth waveform is assured by use of a horizontal amplifier with a wide-band characteristic. The preset sweep positions provide rapid switching between vertical and horizontal TV waveforms.

Truly, the WO-56A is a most useful and practical instrument for everyday work in the fields of television, radio, ultra-sonics, audio, and a wide array of industrial applications.

For details, see your **RCA Distributor,** or write RCA, Commercial Engineering, Section 42DX, Harrison, N. J.

RADIO CORPORATION of AMERICA

TEST EQUIPMENT **HARRISON, N. J.**



Now Available! MOLYBDENUM PERMALLOY POWDER CORES*

HIGH Q TOROIDS for use in Loading Coils, Filters, Broadband Carrier Systems and Networks— for frequencies up to 200 KC

COMPLETE LINE OF CORES TO MEET YOUR NEEDS

★ Furnished in four standard permeabilities — 125, 60, 26 and 14.

★ Available in a wide range of sizes to obtain nominal inductances as high as 281 mh/1000 turns.

★ These toroidal cores are given various types of enamel and varnish finishes, some of which permit winding with heavy Formex insulated wire without supplementary insulation over the core.

For high Q in a small volume, characterized by low eddy current and hysteresis losses, ARNOLD Moly Permalloy Powder Toroidal Cores are commercially available to meet high standards of physical and electrical requirements. They provide constant permeability over a wide range of flux density. The 125 Mu cores are recommended for use up to 15 kc, 60 Mu at 10 to 50 kc, 26 Mu at 30 to 75 kc, and 14 Mu at 50 to 200 kc. Many of these cores may be furnished stabilized to provide constant permeability (±0.1%) over a specific temperature range.

* *Manufactured under licensing arrangements with Western Electric Company.* W&D 2930

THE ARNOLD ENGINEERING COMPANY

AL ARNOLD

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois for the Nyquist-type interstage coupling circuit.

The indicating meter is returned to a point on the voltage divider, R_8-R_{11}, chosen to draw about five times the full-scale meter current. Biasing potentials are taken from other points on this divider. Screen supply for V_1 is obtained from a separate divider, R_3-R_4.

If the pentode screen is tapped onto the main divider R_8-R_{11}, the effect of meter current reacts back on the screen potential in a regenerative manner. At very low values of feedback the circuit breaks into d-c oscillation and becomes a flip-flop circuit having only two stable states.

The positive feedback, in combination with the negative feedback, might possibly do more good than harm. It does, however, make the positive feedback ratio dependent upon the impedance on the power-supply side of the voltage divider which is undesirable.

Choice of Pentode

In view of the limited B supply available for the tubes and the properties of the Nyquist coupling circuit (the lower the quiescent d-c potential at the plate of V_1, the less signal lost in the divider R_5–R_6), it is necessary to choose a tube for V_1 which will give adequate gain at low plate voltages and still operate with enough bias to avoid grid current.

The lowest control-grid bias that will safely prevent any grid-current flow is about 1.2 volts. High-mu triodes draw too little plate current at the plate voltage desired and medium-mu triodes give too little gain. The pentode has the advantage that the effect of a chosen bias can be somewhat modified by changing the screen voltage. The disadvantage of the pentode is that its gain is much more dependent on cathode temperature and plate-supply voltage than is the triode.

With overload characteristics in mind, the plate-load resistor R_7 for the tube operating the meter is chosen so that the plate current at balance is about 1.5 times the full-scale meter current. If a 500-μa instrument were to be used, R_7 should be doubled in value.

The usual a-c filtering is incor-

porated at the input R_1C_1. Zero adjustment is effected by returning the cathode of V_1 to a potentiometer P having a resistance high enough to provide good resolution. The potentiometer is shunted by R_{10} to narrow its range.

Calibration of the circuit is not sensitive to changes in tube characteristics or to any components except the feedback resistor.

Ultrasonics Sweep Chicago Harbors

ULTRASONIC sound waves are now being used to locate under-water harbor obstacles in the Chicago area. The new method requires less time and fewer men than conventional bar-sweeping systems, is more accurate and provides an automatic record of the sweeping.

Three outboard oscillator units were used simultaneously in conjunction with a single recorder in field trials of the system, see Fig. 1. The oscillator units were mounted as shown on a catamaran made from two 16-foot flat-bottomed skiffs.

The effective cone of sound projection and reception of the outboard oscillators used was about 15 degrees and channel depth in the Chicago district area ranges from 18 to 28 feet. With the units spaced on 5.25-foot center, the sound cones overlap at a depth of about 19 feet and give coverage of a path about

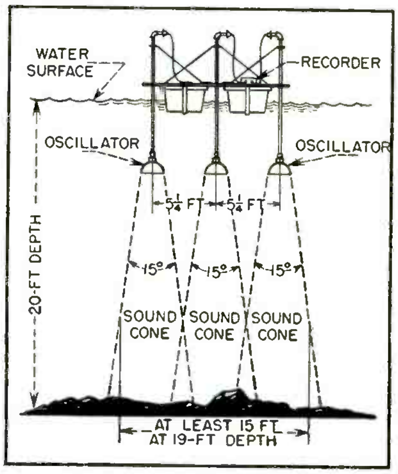


FIG. 1—Sweeping system employing three ultrasonic oscillators connected in parallel

15 feet wide. The oscillators may be mounted closer together for shallower operation.

The three oscillators are connected in parallel so that each one transmits a sound impulse at the same instant when an electrical impulse discharged by the recorded is carried to the oscillators. The three receivers are connected in parallel with the recorder.

Because the shallowest point within the three sound cones reflects the first echo, that echo is received and printed by the recorder first. The width of the record band absorbs the later echoes.

Sweeping courses are laid out to provide for about a 50-percent overlap to furnish a check on complete coverage of the bottom. Since the equipment can be operated at about eight mph, the overlap sweeping can be done rapidly.

Formerly, Chicago harbors were swept by suspending a long bar or series of bars under a boat and running the boat over the channel course. If the bar hit an obstruction, the crew would mark the location, determine the height and extent of the obstacle and record the information. An area often had to be reswept several times at successive depths for an accurate record.

Ignitron Rectifiers for Electric Railroads

TUBES MAY FIND future application in permitting locomotives to operate from a-c power using d-c motors for their most useful features in railroading.

In appraising the economic results on many railroad electrifications which have occurred during the last half century, especially those installations where traffic is unusually heavy, the supremacy of the a-c single-phase transmission system has been established.

Both the motor-generator and diesel-electric types of locomotives have proved that the system of supplying low-voltage d-c power, generated on each locomotive, to d-c series traction motors has been eminently successful. The d-c traction motors provide the necessary high value of starting tractive for compactness . . . low temperature coefficient . . . low inherent inductance . . . and high R. F. conductivity

use

UNITED
Vacuum Capacitors

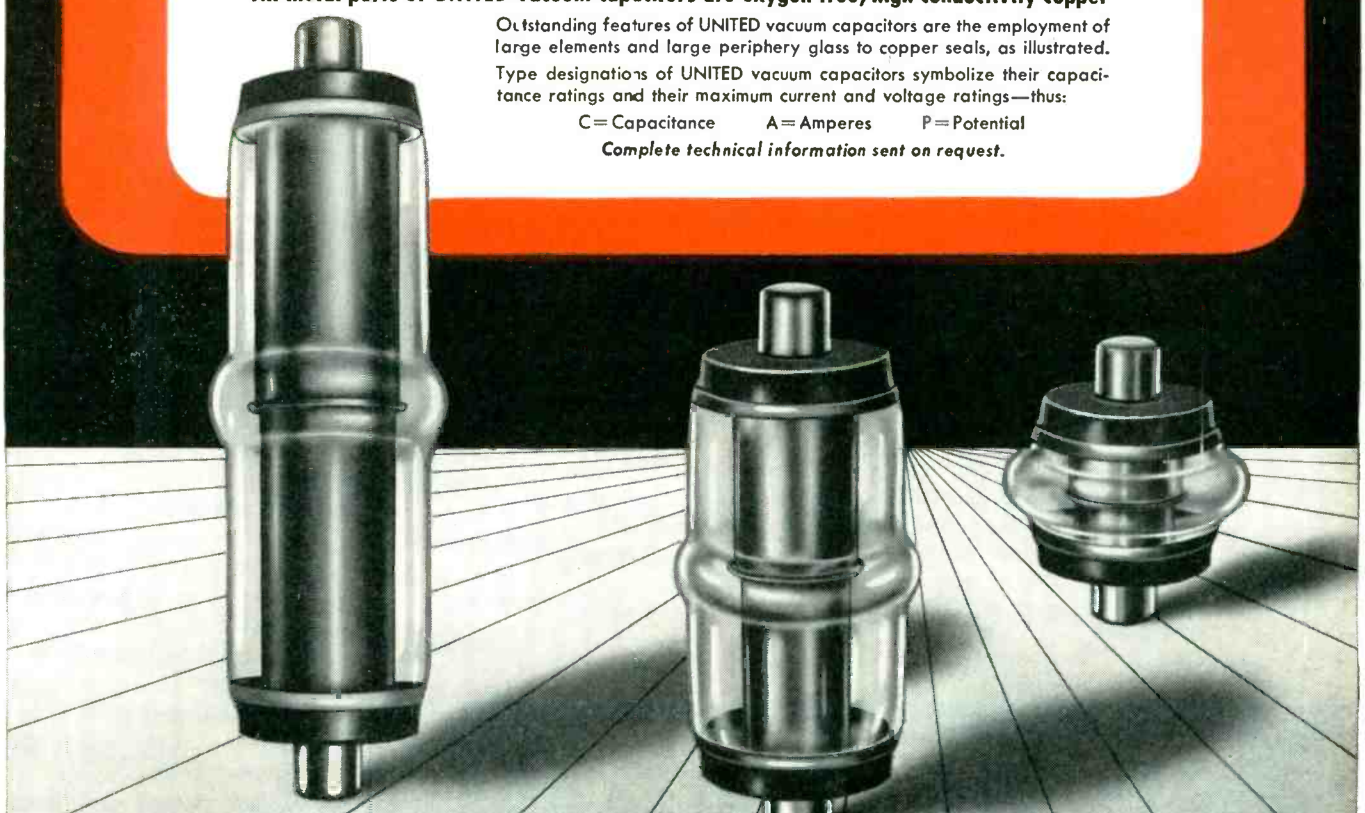
Type	Capacitance uuf	Maximum Current	Peak R.F. Voltage	Overall Dimensions Length	Overall Dimensions Width	Capacity Tolerance
CAP-6/30/20	6	30 amps.	20 KV	3-11/16"	3"	± ½MMFD
CAP-12/30/20	12	30 amps.	20 KV	3-11/16"	3"	± 1MMFD
CAP-25/60/20	25	60 amps.	20 KV	3-11/16"	3"	± 1MMFD
CAP-50/60/20	50	60 amps.	20 KV	3-11/16"	3"	± 1MMFD
CAP-50/60/25	50	60 amps.	25 KV	4-1/2"	2-5/8"	± 2%
CAP-6/30/35	6	30 amps.	35 KV	6-19/32"	2-13/16"	± ½MMFD
CAP-12/30/35	12	30 amps.	35 KV	6-19/32"	2-13/16"	± 1MMFD
CAP-25/60/35	25	60 amps.	35 KV	6-19/32"	2-13/16"	± 1MMFD
CAP-50/60/35	50	60 amps.	35 KV	6-19/32"	2-13/16"	± 1MMFD
CAP-75/60/35	75	60 amps.	35 KV	6-19/32"	2-13/16"	± 2%
CAP-100/60/35	100	60 amps.	35 KV	6-19/32"	2-13/16"	± 2%
CAP-150/60/35	150	60 amps.	35 KV	6-19/32"	2-13/16"	± 2%
CAP-200/60/35	200	60 amps.	35 KV	6-19/32"	3-1/16"	± 2%
CAP-250/60/35	250	60 amps.	35 KV	6-19/32"	3-1/16"	± 2%
CAP-450/60/20	450	60 amps.	20 KV	8-15/32"	3"	± 2%
CAP-500/60/20	500	60 amps.	20 KV	9-7/32"	3"	± 2%

All metal parts of UNITED vacuum capacitors are oxygen free, high conductivity copper

Outstanding features of UNITED vacuum capacitors are the employment of large elements and large periphery glass to copper seals, as illustrated. Type designations of UNITED vacuum capacitors symbolize their capacitance ratings and their maximum current and voltage ratings—thus:

C = Capacitance   A = Amperes   P = Potential

Complete technical information sent on request.



UNITED ELECTRONICS, 42 Spring Street, Newark 2, N. J.

(TRANSMITTING TUBES EXCLUSIVELY Since 1934)

effort as well as a suitable tractive effort at continuous rating.

The use of ignitron rectifiers as conversion means from 25 or 60 cycle a-c to a desirable direct voltage combines the advantages of a high-voltage a-c supply and of tractive effort from low-voltage d-c traction motors.

The Pennsylvania Railroad has made road tests with an ignitron system in a multiple-unit car. Results showed that no trouble was encountered from turbulent mercury in the ignitrons, there was little noticeable difference between temperature tests with the rectified current and similar tests made with generated d-c having no ripple and commutation was satisfactory. During the tests, the car ran approximately 2,500 miles on the Pennsylvania test track at Wilmington and on the main line.

Telephone Interference Tests

A series of telephone interference tests were made to determine the extent of interference not only on the rectifier car but also on existing single-phase series a-c motor equipment. Test results indicated that practical filters could be produced which would permit the use of electrified railroad power supplies for individual traction units of an electric railroad system paralleling associated commercial communications circuits.

Following the original tests, the car was placed in revenue service, running from Philadelphia to Lancaster and return in the morning and from Philadelphia to Parkesburg and return in the afternoon, a distance of 225 miles per day. The car was later released to pool service and operated in multiple-unit trains on various other sections of the railroad.

One difficulty commonly experienced with rectifier tubes is arc back, however, in a long series of tests in the laboratory, on the car and subsequently in revenue service, there was no evidence of arc back. It seems that single-phase rectification is less subject to arc back than multiphase rectification.

To obtain an idea of tube life, a study was made of three typical stationary installations used in mining service. Each installation employs six tubes operated 24 hours

a day, six days a week. The average life of each tube, when tested, was 3¼ years. Eighteen of the 24 tubes had been in service for four years and four of the 18 had operated for five years and ten months.

Simple Trigger Generator

By R. S. Richards

Defense Section
National Research Council
Ottawa, Canada

In practically every laboratory it is sometimes necessary to find a source of short trigger pulses without tying up expensive test equipment. Figure 1 is the circuit diagram of a simple and inexpensive type of blocking oscillator which solves this problem.

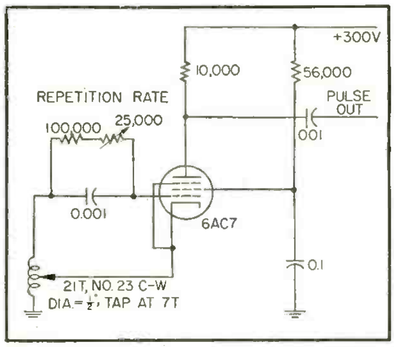


FIG. 1—Schematic diagram of simple blocking-oscillator trigger generator

The trigger generator consists essentially of an electron-coupled oscillator in which the grid drive is sufficient to bias the tube well beyond cutoff to initiate the blocking action. A single-layer coil is all that is required instead of a special iron-cored transformer.

The waveforms shown in Fig. 2 are typical. The measured values of duration and voltage were ob-

Values of C and R for Different Repetition Rates

C μf	R ohms	Freq (pps)
0.1	10,000,000	1
0.01	10,000,000	10
0.003	10,000,000	30
0.003	1,200,000	250
0.001	1,200,000	750
0.001	100,000	7,000
0.0001	100,000	70,000

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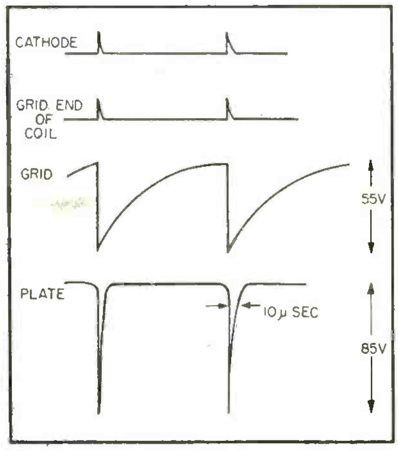

FIG. 2—Typical waveforms of blocking oscillator for component values given in Fig. 1

tained with the component values given in Fig. 1.

A wide range of repetition rates may be obtained by making suitable changes in the values of the grid capacitor and resistor. A few of the possible combinations are given in the accompanying table. The value of resistance has little effect on pulse length whereas the capacitor value controls both pulse length and repetition rate.

Geiger-Counter Pulse Simulator

By M. A. Pomerantz
Bartol Research Foundation
The Franklin Institute
Swarthmore, Pa.

In order to test a Geiger-Mueller counter coincidence circuit under conditions approximating as closely as possible those encountered in actual operations, it is desirable to provide a controllable source of artificial pulses simulating those produced by the discharge of the counter tubes.

The circuit shown in Fig. 1 has been useful in testing various types of cosmic-ray apparatus in the laboratory and has been especially valuable in facilitating last-minute checking of balloon-borne cosmic radiosondes[1] immediately prior to release.

A neon-tube relaxation oscillator produces triggering pulses at a repetition rate determined by the associated RC time constant. The ranges covered by the coarse and fine adjustments are selected ac-

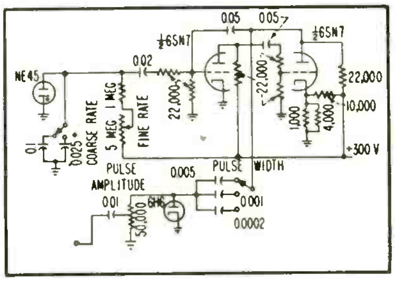

FIG. 1—Circuit of the test generator for simulating Geiger-counter pulses

cording to the specific applications for which the instrument is intended.

A multivibrator circuit consisting of both halves of a 6SN7 is normally stable but oscillates through one cycle each time the neon tube flashes. The resulting flat-topped pulse, with a sharp rise, is long compared with a Geiger-counter pulse. Moreover, its form is independent of the nature of the triggering pulse.

After passing through the pulse-width network, the multivibrator pulse provides a negative pulse which can be made to simulate any Geiger-counter pulse by choosing appropriate circuit constants. A diode chops off the positive backswing which is characteristic of the pulse-forming circuit.

The output, consisting of negative pulses of the desired width and amplitude at any uniform repetition rate, is applied to the several elements of the coincidence circuit for performing certain tests.

Among the characteristics of the circuit which require checking are:

(1) Discrimination—the selector circuit must respond only to N-fold coincidences and must reject (N−1)—fold coincidences;

(2) Sensitivity—the circuit must function over a range of pulse amplitudes and widths;

(3) Dead time—the finite time required for the operation of a keying circuit or recorder should not exceed some specified length;

(4) Voltage range—all of the above characteristics must be preserved over a wide range of applied voltages.

REFERENCE

(1) M. A. Pomerantz, Cosmic-Ray Radiosonde and Telemetering System, ELECTRONICS, 24, p 88, April 1951.

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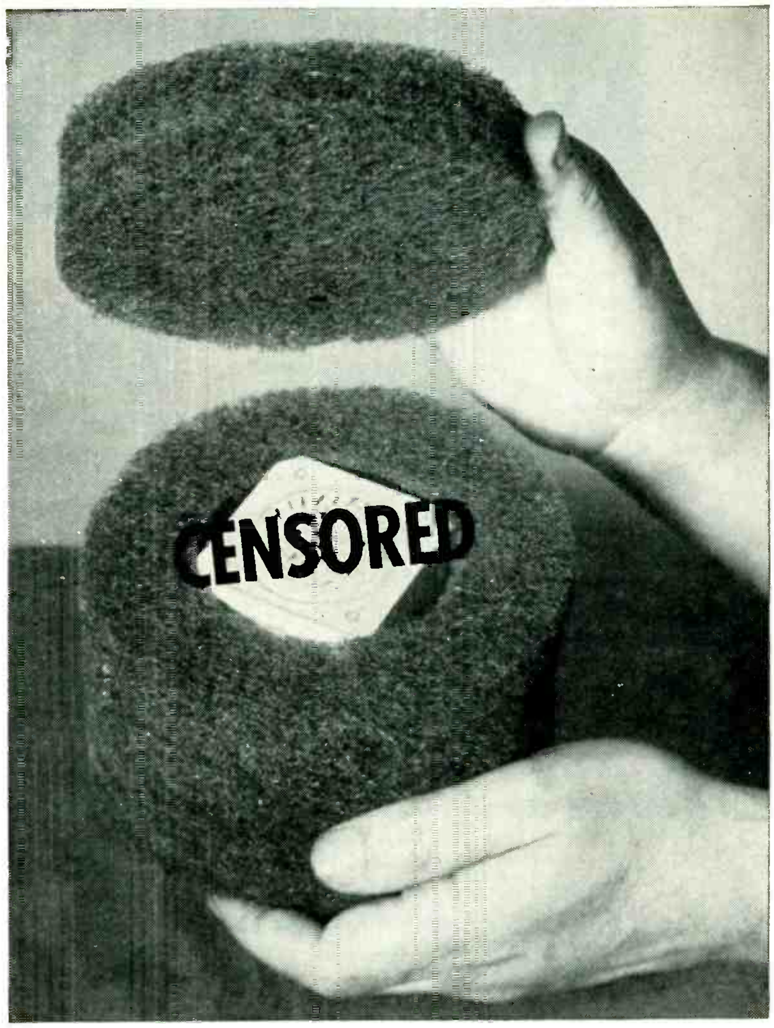

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THE ELECTRON ART

(continued from p 142)

tude to current (and amplitude to voltage) depends to a high degree upon the operational frequency of the crystal, and that this fact must be taken into account in every correlation of crystals in oscillators.

It is the purpose of this paper to first derive, in a simple way, equations for these ratios; second, to describe measurements which prove these formulas; third, to compare these results with more elaborate general theories of a vibrating piezoelectric plate. Considerations will be limited to thickness modes; the results can be used, however, for other modes of vibration. The calculation of the ratios, amplitude to voltage and amplitude to current, is done by using the crystal unit impedance derived from its simple equivalent circuit.[2] Therefore, at larger currents and voltages, the results will be an approximation only due to the mentioned possible change of crystal unit parameters with the amplitude of vibration.

Calculation of the Ratios

For the purpose of obtaining the above expressions, we make use of the piezoelectric equation connecting the electric displacement D with the field strength E and the strain S[3].

$$D = e\,S + \epsilon^s E \qquad (1)$$

where e is the piezoelectric stress constant and ϵ^s the dielectric permittivity at constant strain. Instead of Eq. 1, we can write.

$$D = e\,\frac{2\,\xi}{b} + \epsilon^s\,\frac{V}{b} \qquad (2)$$

where ξ is the amplitude of vibration of the major surfaces of the crystal blank, b its thickness, and V the peak voltage across the crystal unit. If we differentiate Eq. 1 with respect to time, assuming a simple harmonic motion, and integrate over the area A of the crystal (which is assumed to be equal to the area of the electrodes), we have for the peak current I

$$I = i\,\omega\,\frac{2\,e}{b}\,\xi\,A + i\,\omega\,\epsilon^s\,\frac{V}{b}\,A$$

or (3)

$$I = i\,\frac{1}{X_o}\,\frac{2\,e}{\epsilon^s}\,\xi + i\,\frac{1}{X_o}\,V$$

where X_o is the reactance of the static capacitance C_o of the crystal unit.

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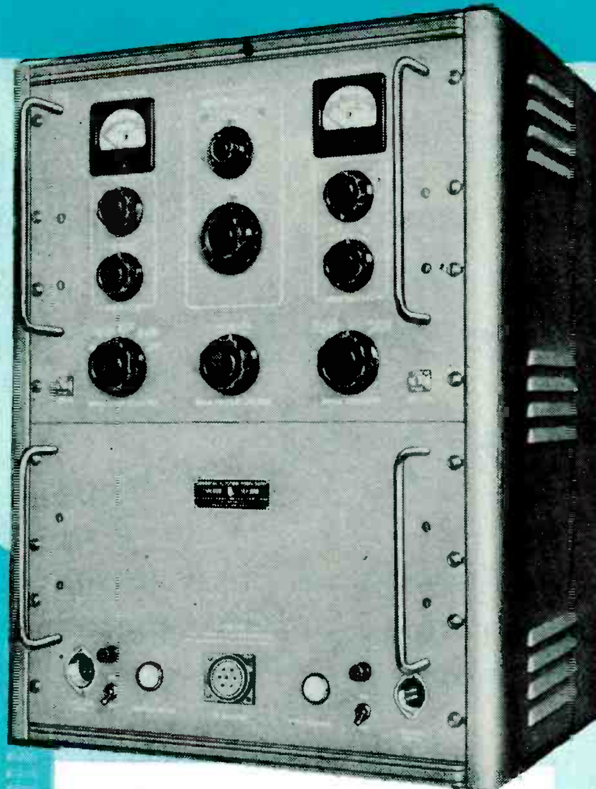

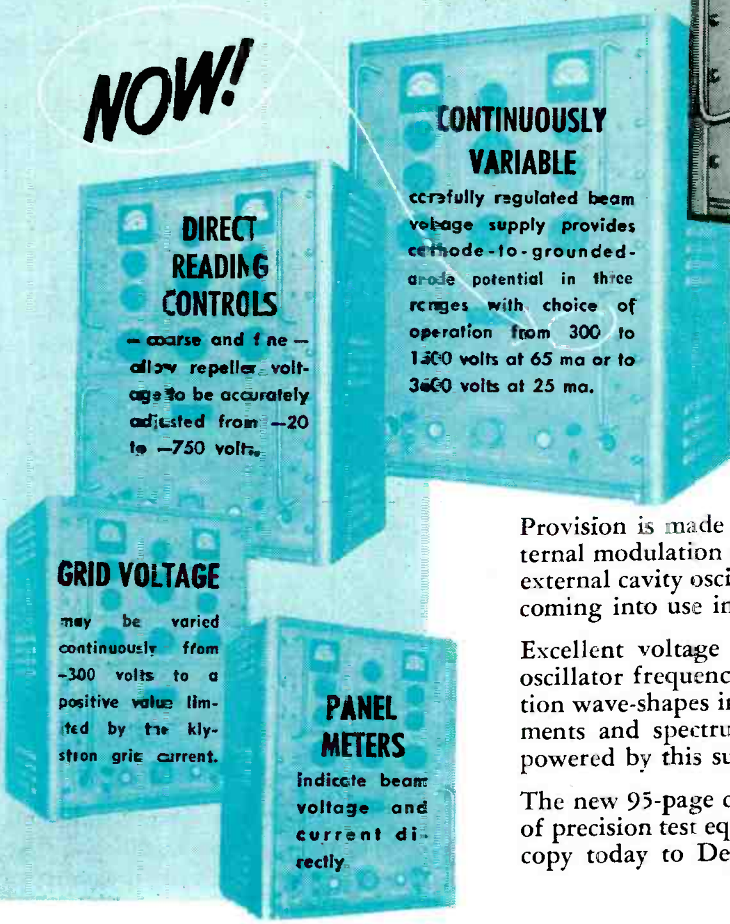

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the crystal unit impedance $Z = V/I$ into Eq. 3, this equation can be solved either in terms of V or of I and thus yields the desired results.

$$V/\xi = -\frac{2e}{\epsilon^s}(a - i\,k) \quad (4)$$

$$I/\xi = -\frac{2e}{\epsilon^s}\frac{1}{X_o}\left[k - i(1-a)\right] \quad (5)$$

The meanings of the symbols k and a are

$$k = R_s/X_o$$

$$a = \frac{f^2/f_s^2 - 1}{C_s/C_o} \approx \frac{f - f_s}{f_A - f_s} \quad (6)$$

where f is the operational frequency of the crystal unit, f_s its series resonant frequency and

$$f_A = \tfrac{1}{2}\left(L_s\frac{C_oC_s}{C_o + C_s}\right)^{-\frac{1}{2}}$$

its antiresonant frequency, C_s its series capacitance and R_s its series resistance.

Table I shows the values of $\xi/|I|$ and $\xi/|V|$ at series resonance and antiresonance, and some useful approximations.

The values at series resonance and antiresonance differ by the factor $K_o/R_s = 1/k$ (if $k^2 < 1$ which is usually the case). The ratio $1/k$ is the ratio of the reactance of the static capacitance to the series resistance of the crystal. This ratio can be large; therefore, the amplitude can be very different at series and antiresonance for the same current or the same voltage. If we take, for instance, an average 1-mc crystal with a series resistance of 200 ohms and a static capacitance of 7 $\mu\mu$f, we have for $1/k$ the value of 113. This means, that if this crystal is operated in an oscillator circuit close to its series resonant frequency, the current through the crystal and the voltage across it differ for the same amplitude of vibration by the factor 113.

Measurements

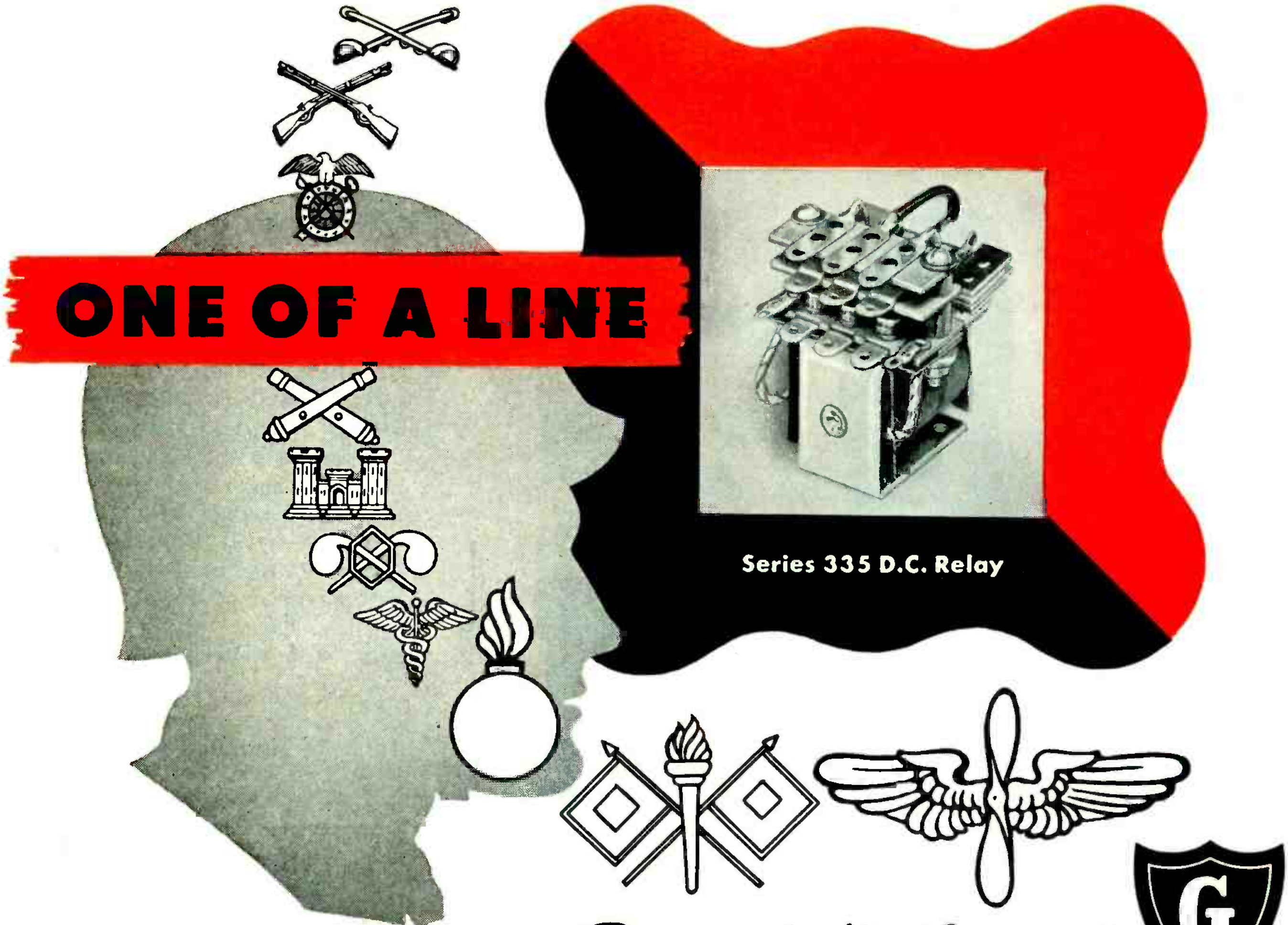
As stated previously, a vibrating crystal generates heat. The energy per second N, transposed into heat, is given by

$$N = b_1\,|\,I\,|^2 = b_2\,\xi^2$$

where b_1 and b_2 are constants. If we assume that the freqency change is linear with temperature, we have

$$\frac{\Delta f}{f} = b_3\,N = b_4\,\xi^2$$

(continued on p 208)



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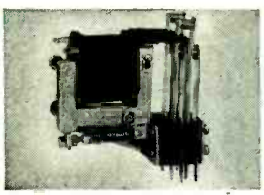

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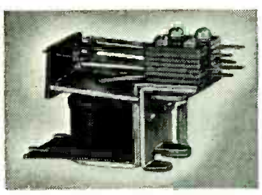

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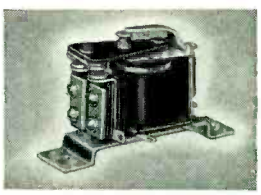

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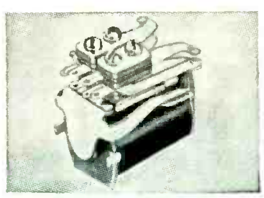

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We divide this equation by $|I|^2$, and obtain, together with Eq. 7a (Table I)

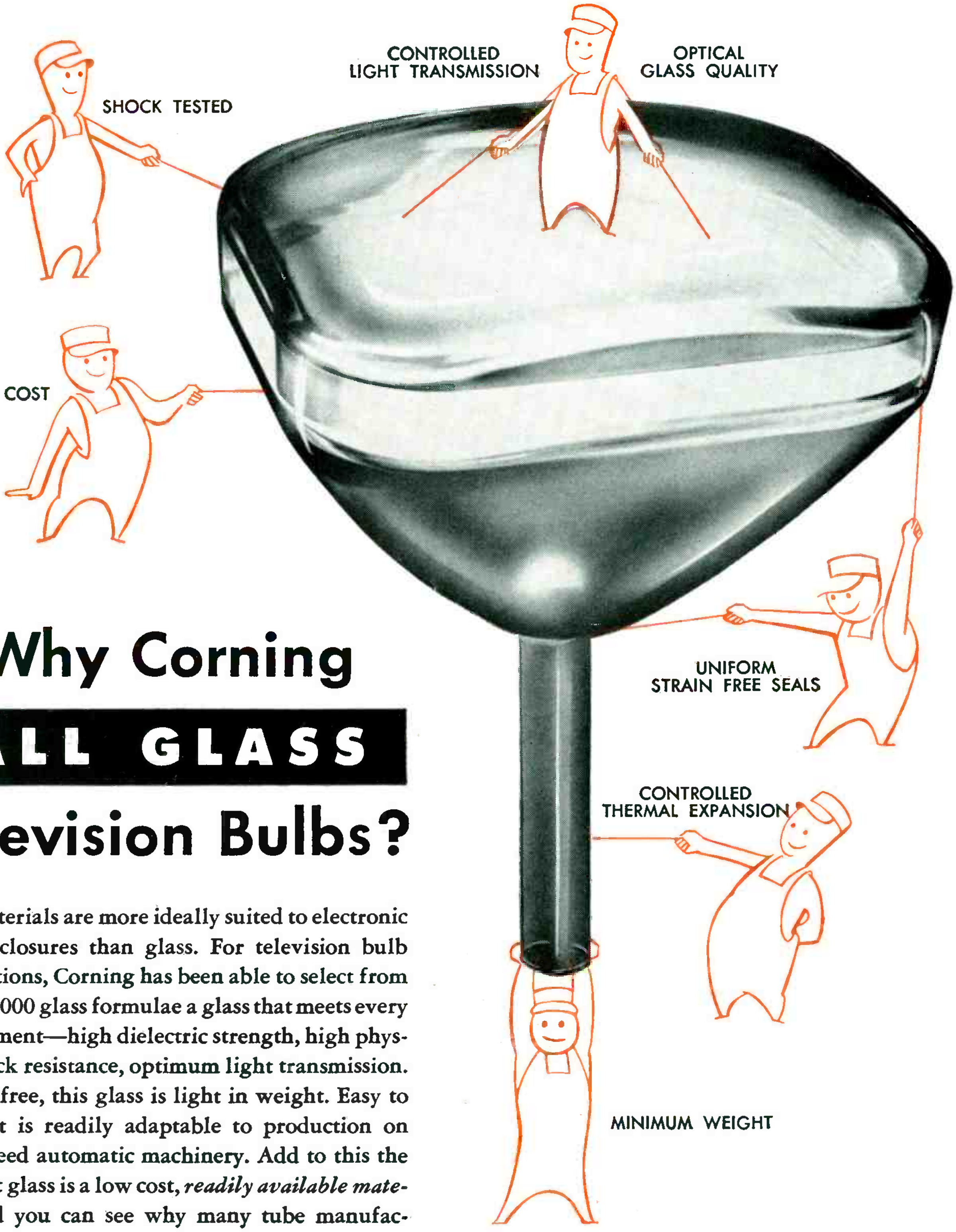
$$b_5 \frac{\xi}{|I|} = \left(\frac{\Delta f}{f}\,\frac{1}{|I|^2}\right)^{\frac{1}{2}} = \frac{b_6}{1-a} \quad (12)$$

b_3, b_4, b_5, and b_6 being constants.

As we see from Eq. 12, $(\Delta f/f \; 1/|I|^2)^{\frac{1}{2}}$ must be constant for a determined a. In proof of this, measurements[4] have been carried out with a 777-kc circular crystal plate made from ammonium dihydrogen phosphate, cut (zxw) 45 deg, and used in its thickness shear mode. It has a very high temperature coefficient of frequency which was linear in the temperature range employed[5], and it is assumed that any nonlinear effects of voltage on the frequency of operation—as mentioned previously—are negligi-

Table I—Formulas for Amplitude-to-Current and Amplitude-to-Voltage Relationships

$\xi/\lvert I\rvert \left(\frac{\text{meter}}{\text{ampere}}\right)$	$\xi/\lvert V\rvert \left(\frac{\text{meter}}{\text{volt}}\right)$
GENERAL	
$\frac{\epsilon^s}{2e} X_o \left[(1-a)^2 + k\right]^{-\frac{1}{2}}$ (7)	$\frac{\epsilon^s}{2e} \left[a^2+k^2\right]^{-\frac{1}{2}}$ (8)
$\frac{\epsilon^s}{2e} X_o \left[1-a\right]^{-1}$ (7a) (near f_s, where $k^2 < (1-a)^2$)	$\frac{\epsilon^s}{2e} a^{-1}$ (8a) (near f_A, where $k^2 < a^2$)
SERIES RESONANCE	
$\frac{\epsilon^s}{2e} X_o \left[1+k^2\right]^{-\frac{1}{2}}$ (9)	$\frac{\epsilon^s}{2e} k^{-1}$ (10)
$\frac{\epsilon^s}{2e} X_o$ (9a) (holds if $k^2 < 1$)	
ANTIRESONANCE	
$\frac{\epsilon^s}{2e} X_o k^{-1}$ (10)	$\frac{\epsilon}{2e} \left[1+k^2\right]^{-\frac{1}{2}}$ (11)
	$\frac{\epsilon^s}{2e}$ (holds if $k^2 < 1$)
$k = R_s/X_o$	$a \approx (f-f_s)/(f_A-f_s)$



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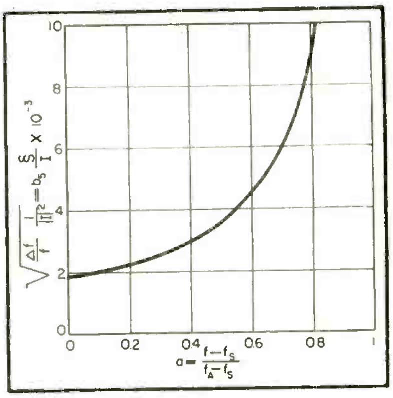

FIG. 1—Ratio of amplitude to current for ammonium dihydrogen phosphate crystal cut *(zxw)* 45 deg, thickness shear mode

ble in comparison with the large heating effect.

The crystal was placed in a thermally insulated holder and operated in different Miller and Pierce circuits, and therefore had various operating frequencies. These operating frequencies were measured in terms of their distances from the series resonant frequency. For each operating frequency, the frequency change Δf due to a change of the crystal current was measured, and the ratio $\delta f/f \ |I|^2$ calculated. This ratio was found to be indeed fairly constant for one operating frequency. Table II shows an example of actual measurements at a distance from the series resonant frequency f_s of $f - f_s = 82$ cps.

The results for different operating frequencies are shown in Fig. 1 which can be represented by the equation

$$b_6 \frac{\xi}{|I|} (1 - a) = 1.8 \text{ ampere}^{-1}$$

which is in agreement with Eq. 7a and 12.

Figure 2 shows $\xi/|V|$ and $\xi/|I|$ for the AT and BT cuts of quartz, as calculated by means of the formulas in Table I. Fortunately, the piezoelectric constants are, in both cases, almost the same, namely 0.095 columb per sq. meter.[6] Together with the dielectric permittivity $\epsilon^s = 4.5 \ 1/36\pi \times 10^{-9}$ farad per meter, we obtain for $\epsilon^s/2_e$ the value of 2.1×10^{-10} meter per volt. It is possible to use only one curve for $\xi/|V|$ and $\xi/|I|$ by multiplying the latter ratio by $1/X_o$ and by plotting the abscissa in opposite

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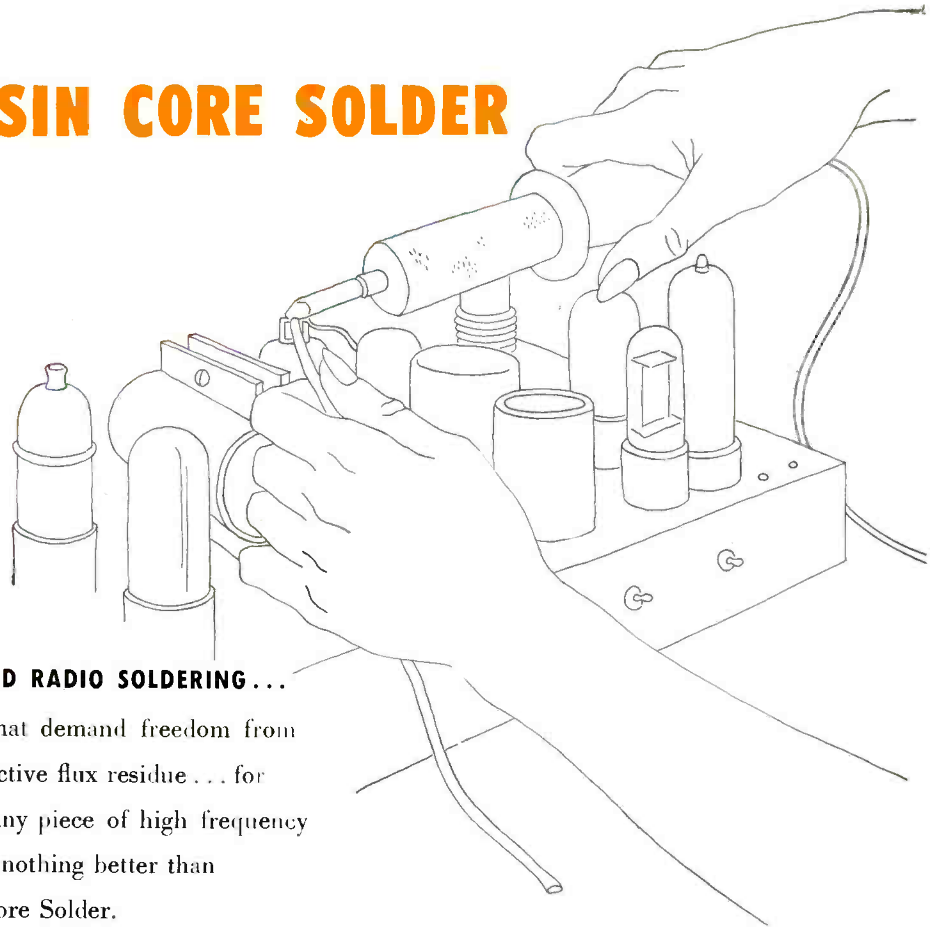

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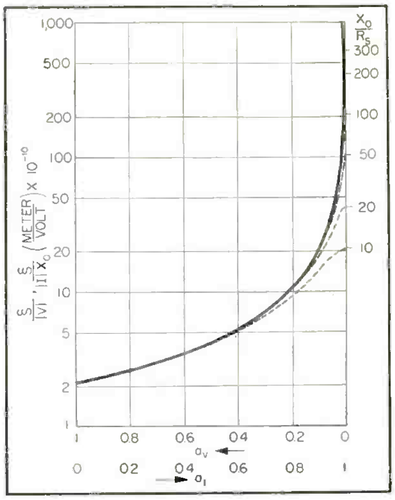
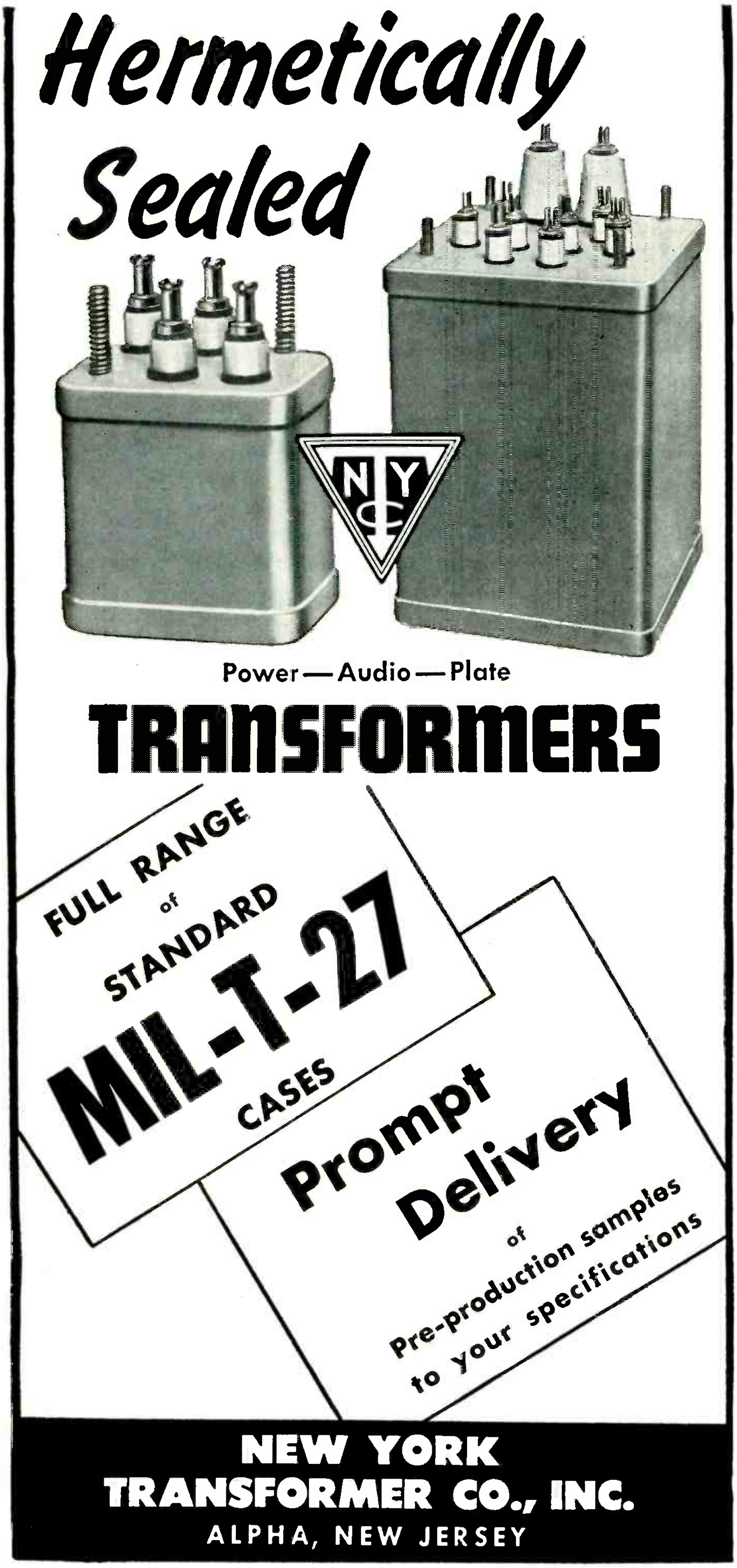


FIG. 2—Amplitude-to-voltage and amplitude-to-current ratios as functions of a for AT and BT cut quartz crystals

directions for the voltage and the current readings. The full curve is calculated by means of the approximate Eq. 7a or 8a and the dashed curves by means of the complete Eq. 7 or 8. The different marks at the right side of the graph give the values of $\xi/|V|$ at series resonance and of $\xi/|I|$ at antiresonance for different values of X_o/R_s. The higher this ratio, the more closely does the approximate curve come to exact values of $\xi/|V|$ and $\xi/|I|$. For practical use of this curve, we have to remember that the value of unit for a corresponds to the antiresonant frequency of the crystal alone. If the crystal is looking into the load capacitance presented by a Miller or Pierce oscillator circuit, for instance, the antiresonant frequency of the combination becomes lower; thus a will no longer reach unity, and its range becomes smaller.

Comparison with Theories

The derivations of these formulas are made under the assumption that the amplitude of vibration is uniform across the whole crystal plate. This is only an approximation because there is evidence that in the amplitude distribution pattern obtained by several investigators[1] with quartz plates vibrating in thickness shear modes, the amplitude falls off towards zero at least in certain directions. Furthermore, Hok[7] theoretically derived an expression for the amplitude distribution of a rectangular (yzw) cut



quartz crystal vibrating in thickness shear mode. He found a sinusoidal distribution of the displacement along the X axis, and a distribution along the Z′ axis which may be uniform or may be any part of a symmetrical sinusoidal distribution.

Van Dyke and Gordon[8] worked out, both experimentally and theoretically, the formulas for the motional capacitance of partially plated AT and BT cut crystals of certain geometrical shapes. Their results confirm and complete Hok's derivation concerning the amplitude distribution. From the foregoing it is apparent that, at least for rectangular (*yzw*) cut crystals, the distribution of amplitude can assume either of the two extreme values of complete uniformity or that of a sine curve or can assume any value between these extremes.

The ratios of amplitude to voltage and amplitude to current for the sinusoidal form can be derived from Van Dyke's and Gordon's papers. The ratio of amplitude to voltage is found to be:

$$\frac{\xi}{|V|} = \frac{\pi^2}{4} \frac{\epsilon^s}{2e} \left[a^2 + k^2\right]^{-\frac{1}{2}} \qquad (13)$$

and the ratio of amplitude to current to be:

$$\frac{\xi}{|I|} = \frac{\pi_2}{4} \frac{\epsilon^s}{2e} X_o \left[(1 - a)^2 + k^2\right]^{-\frac{1}{2}} \qquad (14)$$

As it can be seen, we obtain the equations tabulated in the first line of Table 1, except divided by $\pi^2/4$. This factor apparently accounts for the sinusoidal distribution of amplitude. Therefore, we have a complete agreement between the several results. The assumption of different amplitude distributions does not change the character of the $\xi/|V|$ and $\xi/|I|$ curve, but only changes the values of the ordinate by a constant factor.

Conclusion

It can be stated (see Table 1) that two crystals of the same cut have the same amplitude of vibration only if the voltages across the crystals and the ratios $(f - f_s)$ $(f_4 - f_s)$ (Eq. 6) are the same. The latter expression shows that it is not sufficient to have the same frequencies, rather it is necessary that

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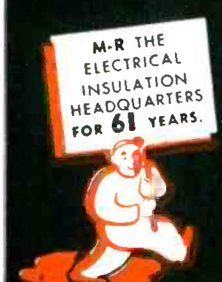

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$$f^2 = f_s^2\left(1 + a\,\frac{C_s}{C_o}\right)$$

If the currents through the crystals are used as a measure for the amplitude, the additional requirement exists that the static capacitances be equal. These rules do not hold in the neighborhood of series resonance (a small) for voltage measurements and in the neighborhood of antiresonance (where $(1 - a)$ is small) for current measurements. In these two cases, the relations become more complicated because the series resistances are entering the picture. For this reason, and

Table II—Measurements 82 CPS from Series Resonance

Current I (ampere)	Frequency Shift (cps)	$\frac{\Delta f}{f} \cdot \frac{1}{I^2}$ (ampere^{-2})
0.002	−14	4.48
0.003	−30	4.28
0.004	−55	4.43
0.005	−85	4.34
0.006	−119	4.26
0.007	−163	4.28
0.02	−1,394	4.49
		4.36 (average)

because the slopes $d(\xi/|V|)/da$ and $d(\xi/|I|)/da$ are small (see Fig. 2), it is recommendable to use current measurements close to series resonance and voltage measurements close to antiresonance. Especially, voltage measurements close to or at antiresonance are preferable since, according to Eq. 11a constants of the crystalline material only, and not parameters of the crystal unit, determine the relationship between voltage and amplitude of vibration in this case, provided k^2 is small in comparison with unity which is usually the case.

References

(1) Reports of the Department of Physics, A&M College, Fort Collins, Colorado, on Contract No. W36-039-sc-32083.

(2) W. G. Cady, "Piezoelectricity" McGraw-Hill Book Company, New York, p 325, 1946.

(3) "IRE Standards on Piezoelectric Crystals, 1949" *Proc. IRE*, 37, p 1,378, Dec. 1949.

(4) Measurements and evaluations made by H. Drodofsky, at the Carl Zeiss Works, Jena, Germany, 1945.

(5) E. A. Gerber, High-Frequency Vibrations of Plates made from Isometric and Tetragonal Crystals, *Proc. IRE*, 38,

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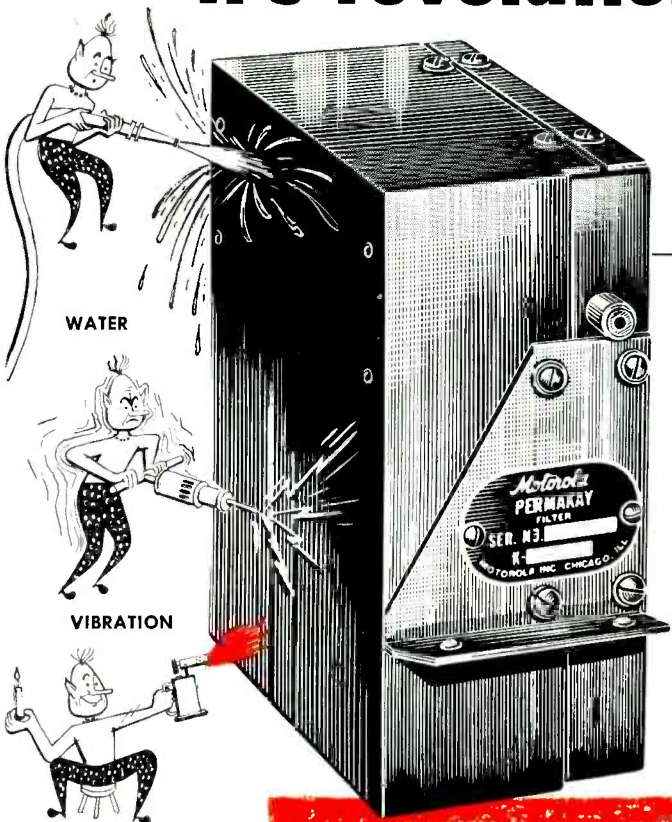

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p 1,073, Sept. 1950.
(6) W. G. Cady, l.c., p 459.
(7) Gunnar Hok, Thickness-Shear Vibrations of Thin Anistropic Plates, *Jour. Acoust. Soc. Am.* 20, p 406, July 1948.
(8) Eighth, Ninth, and Tenth Report of Wesleyan University, Middletown, Connecticut, Contract No. W28-003-sc-1556.

Adjustable Temperature Coefficient Capacitor

IN SOME special radio-frequency circuits where a high degree of thermal stabilization is crucial, a capacitor with an adjustable temperature coefficient of capacitance may serve a vital purpose.

Commercially available fixed capacitors may be used in conjunction with high-quality inductors to produce tuned L-C circuits with some degree of thermal stability if proper care is taken in selecting compensating capacitors. In those cases where further refinement in frequency stabilization is necessary, it may well be advisable and practical to use a capacitor with a constant total capacitance and an adjustment shaft which will allow a wide variety of temperature coefficients to be selected at will. Such a capacitor should allow temperature coefficients (T-C values) over a rather large range and provide both positive and negative T-C values.

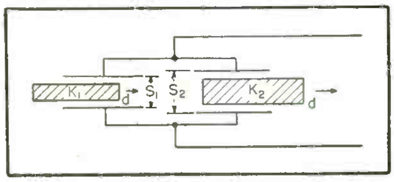

FIG. 1—Basic idea of adjustable temperature coefficient capacitor

The principles upon which a capacitor of this type may operate are illustrated by Fig. 1. Two parallel capacitors are coupled electrically and mechanically so that a change of the amount of dielectric in one capacitor is accompanied by a compensating (opposite) change in the second capacitor. The dielectric constants K_1 and K_2 and plate geometrics are chosen to keep the total shunt capacitance constant. Assuming that the mechanical displacements d and the corresponding changes in effective electrode areas are the same for both capacitors, the total shunt capacitance will

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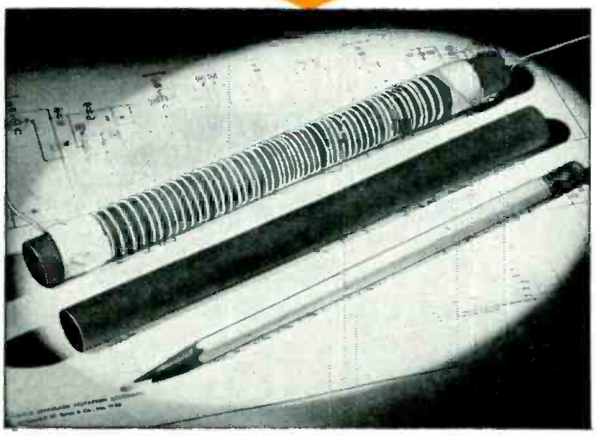

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remain constant when

$$\frac{K_1}{S_1} = \frac{K_2}{S_2}$$

where S_1 and S_2 are the plate separations corresponding to K_1 and K_2.

Since a capacitor may be made in which two different dielectrics contribute to the total shunt capacitance, two materials with different temperature coefficients of dielectric constant may be selected. If the materials have coefficients of opposite sign, a capacitor of this type may be designed to have an adjustable T-C value over a wide range—possibly even passing through a condition of zero T-C.

The reliability of the ceramic trimmer type of adjustable-T-C capacitor leaves much to be desired. This type of capacitor ordinarily employs fired-on silver electrodes and a ceramic-to-silver rubbing contact acts to bring more or less of the active dielectric into the circuit. Mechanical abrasion effects often act to deposit small amounts of the silver electrodes on ceramic surfaces which should be ground flat and kept clean. Thus, erratic capacitance variations are often observed when such capacitors are used in circuits where a large number of capacitance adjustments are necessary. For many trimmer-capacitor applications relatively few adjustments are needed and variable ceramic capacitors given satisfactory service.

The temperature coefficients of many variable ceramic capacitors are difficult to control adequately. These T-C inconsistencies often arise as a result of the relatively high-K materials used as a dielectric. In many cases, inconsistencies are found in T-C and Q values of these capacitors as a result of moisture being trapped between rotor and stator elements even for capacitors employing only moderately high-K dielectric materials. It thus appears that for the maximum degree of consistency the variable-ceramic capacitor type of construction should be avoided in favor of an air-capacitor arrangement.

It will be shown how a (fixed capacitance) variable-T-C capacitor can be designed without involving the difficulties inherent in any

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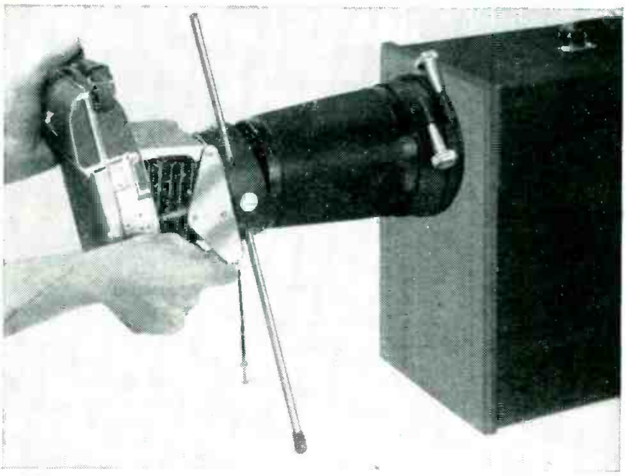

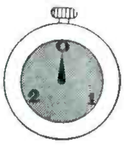

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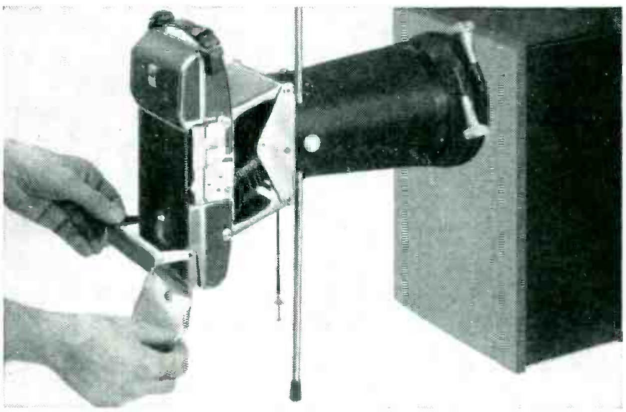
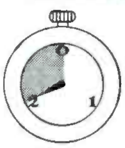
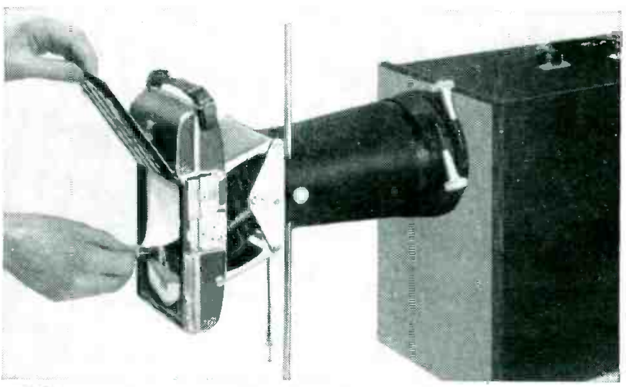
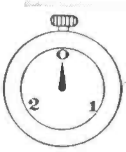




Pull the tab to finish exposed print. After a snap of the shutter, the exposure is made and you're ready to finish the print. If you want two exposures, it's easy to move the camera body down and make a second exposure. To finish the print, you merely pull tab at back of camera.





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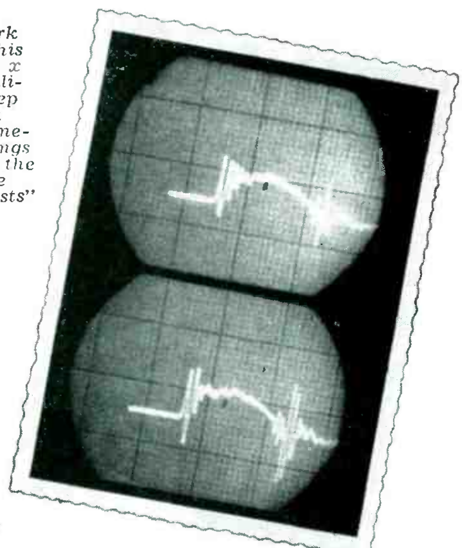

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solid-dielectric variable capacitor of the ceramic-trimmer variety.

Proposed Capacitor

A four-element combination of capacitors can be made in such a way as to provide an equivalent capacitor which will maintain a constant total capacitance and provide an adjustable value of T-C. The adjustable elements of this device can be air-dielectric capacitors, thus avoiding the difficulties encountered with ceramic-dielectric capacitors. In this scheme four capacitors are connected in series-parallel as shown in Fig. 2. One element in each series leg is a variable air-dielectric capacitor. These two capacitors C_x and C_y are mechanically coupled so that, when they vary with respect to each other in accordance with a predetermined law, the equivalent capacitance (of the four-element combination) remains constant.

If the series capacitors C_1 and C_2 have vastly different T-C values, their individual effects in producing an equivalent T-C depend upon the relative amplitudes of C_x and C_y. For example, if the T-C of C_1 is positive and the T-C of C_2 is negative the total circuit will have a positive or negative T-C depending upon the contribution to the total by C_x or C_y. With this arrangement a capacitor can be designed which will be capable of maintaining its capacitance and yet be adjustable in T-C from a relatively large positive value to a relatively large negative value.

It is apparent intuitively from a study of Fig. 2 that for the widest latitude of variation in T-C, C_x and C_y must have the largest possible range of adjustability. In addition, it may seem fruitful to reduce the

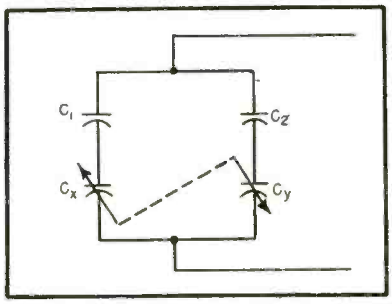
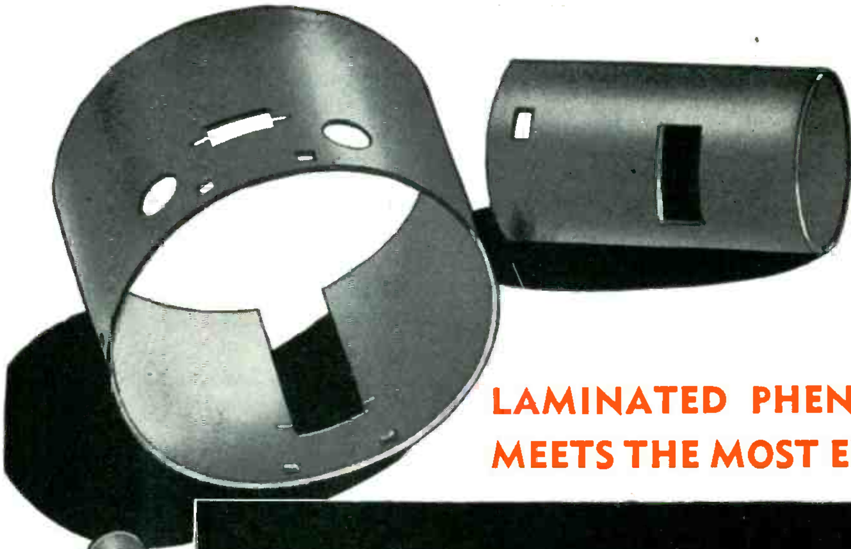


FIG. 2—Schematic representation of arrangement for obtaining continuously variable temperature coefficient capacitor with constant value of capacitance



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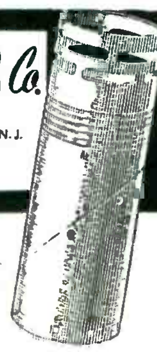

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magnitudes of C_1 and C_2 to an absolute minimum and yet maintain large T-C values for these elements. This procedure introduces difficulties, however, since capacitors having small capacitances and large T-C values are less predictable in the practical case. This results from the fact that these elements often employ relatively high-K materials which carry into any electrical circuit some undesirable instabilities.

For our purposes it appears to be most conservative to select a circuit of the kind proposed, such that

$$C_x = C_y = C_1 = C_2 = C$$

where C_x and C_y are the nominal (mid-range) values of capacitance for the respective variable air-dielectric capacitors. For this case it can be shown that the condition for constant equivalent circuit capacitance is given by

$$\Delta C_x = \frac{-\Delta C_y}{1 + \frac{\Delta C_y}{C}}$$

where

ΔC_y = any change in C_y made to change the equivalent T-C value, and

ΔC_x = the corresponding change in C_x necessary for a constant-capacitance condition.

This equation describes the conditions for tracking (maintenance of a constant equivalent capacitance) in a capacitor of the proposed design. If a parallel-plate construction is to be used, one air-dielectric capacitor can have linear capacitance variation with shaft rotation. In such a case the other variable capacitor would have to be designed with plates shaped in accordance with the tracking equation. A further refinement would involve plate shaping to make the two variable air capacitors identical in contour.

In order to test the foregoing theory, a capacitor was made which is capable of being adjusted in T-C value. Figure 3 shows a commercial capacitor modified for this purpose; its T-C can be adjusted to assume a large range of values. Tracking was not attempted in this test capacitor, the T-C variations being the point of main concern.

The total capacitance per unit volume for a capacitor of this type will ordinarily be about one-fourth that of a conventional air-dielectric capacitor. The fixed capacitor ele-

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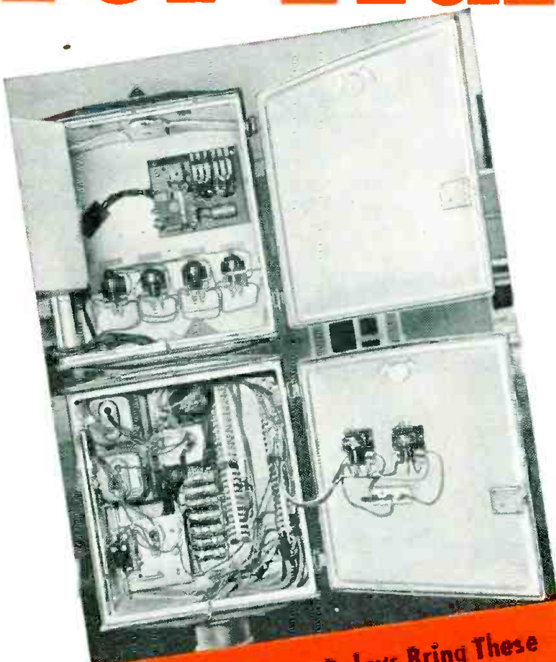

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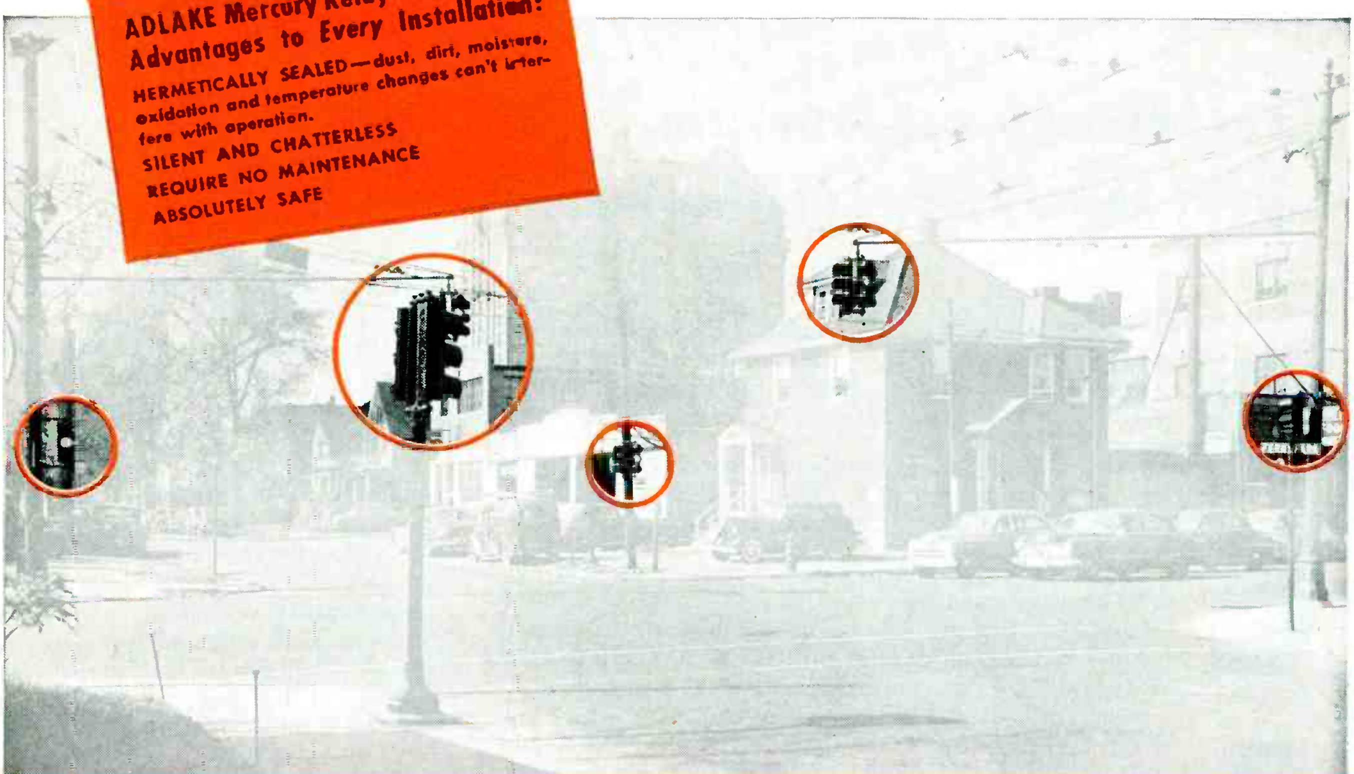

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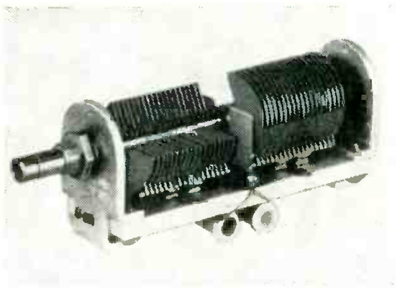

FIG. 3—As the capacitance of one section increases, that of the other decreases, but the total capacitance remains fixed. The fixed positive and negative temperature coefficient capacitors are mounted under the modified two-section variable

ments of the proposed four-capacitor combination can be fixed ceramic capacitors which will add a negligible volume to the total. The air capacitors, however, must be individually set to their mid-values (in order to allow a T-C variation in two directions),

In some circuitry problems it may be possible to use the general scheme described without going to any effort to achieve mechanical tracking through the use of a common shaft or drive mechanism. A simple four-capacitor network can be employed and capacitance constancy indicated by a frequency-measuring technique. The network will be applicable to the individual circuit where it is used but no simple T-C characteristics can be attached to it unless the capacitance tracking condition is satisfied. Such a network will have the advantage of using only commercially available components and may find some application in critically stabilized L-C circuits.

The information presented here was taken from NRL Report 3689, by John A. Connor. The original report includes mathematical derivations for the tracking equation and for an expression for the effective temperature coefficient of four capacitors in series parallel. Figure 3 is an official U. S. Navy photograph.

Measuring Thickness of Thin Coatings By Backscattering

BETA-RAY thickness gages have certain limitations, the most serious of which is the necessity for placing the radioactive source and the detecting head on opposite sides of

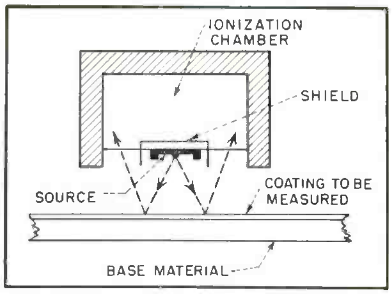

FIG. 1—Thickness of thin coatings can be measured by measuring amount of radiation reflected by a surface

the material being measured. This precludes the measurement of thin coatings of certain materials on other materials by standard beta-ray techniques. The thickness of such coatings can, however, be measured nondestructively by the backscatter of radiation if the atomic number of the coating differs from that of the base material. This system is illustrated in Fig. 1.

Through the use of this system, the following measurements are made possible, which would not be feasible with conventional means: tin or zinc on steel, paint or lacquer on metallic surfaces, rubber and plastic on calendering rolls, selenium on aluminum or other backing materials, barium coating on photographic paper, chromium or brass on steel, fillers in paper and plastics, porcelain coatings, metal platings, such as nickel or chromium, superimposed on other metal surfaces, and plastic coatings on wire.

As shown in Fig. 1, the source is housed in the same container as the detector, which is an ionization chamber. The source is shielded from the detector in such a way that the only radiation reaching the detector is that which is reflected from the surface of the coating being measured.

The amount of radiation reflected depends on the atomic number of the coating material and on its thickness. As the thickness of the coating is increased, a point is finally reached where the maximum beta ray energy of the source is insufficient to allow particles to pass through the thickness of the material and return to the detector. If a coating of another material is placed on the first material, this steady current value, known as infinite thickness current, will change,

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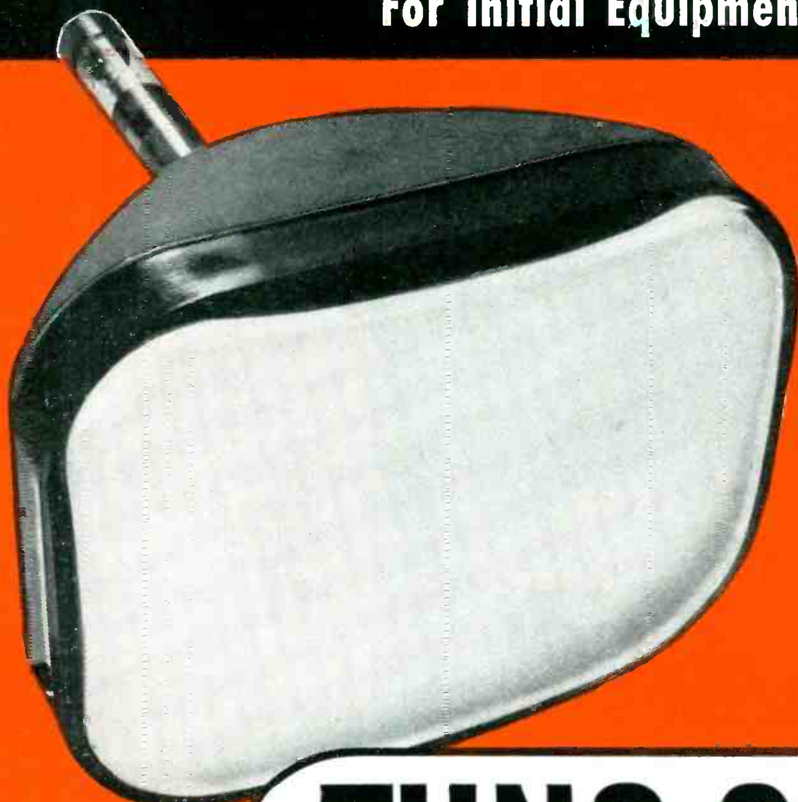

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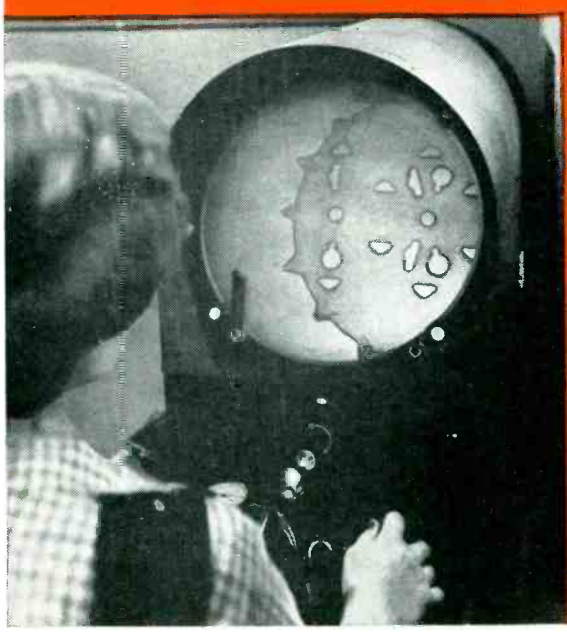

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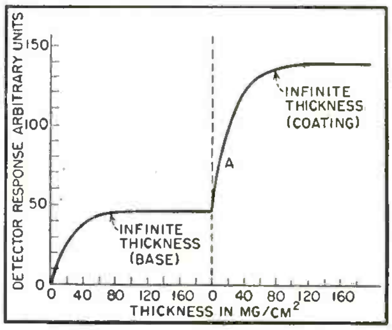

FIG. 2—In making coating-thickness measurements, only linear portion of curve (A) is used

as illustrated in Fig. 2. If the atomic number of the coating material is greater than that of the base material, the infinite thickness value will rise, and vice versa. In making measurements of coating thickness, only the relatively straight portion of the rise (or fall) of the backscattering absorption curve is used.

This system is especially applicable to making average thickness measurements. Best results are obtained if the indicating instrument is damped to have a time constant of several seconds. Additional details on this method may be obtained by reference to the article from which this description is abstracted, "Measuring the Thickness of Thin Coatings With Radiation Backscattering" by Clark, Carlin, and W. E. Barbour, Jr., in the January 1951 issue (p 35) of *Electrical Engineering*.

Constant-Current Sine-Wave Stimulator*

By L. H. Montgomery and James W. Ward

Department of Anatomy
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Determination of strengths of alternating current employed in physiological experiments has been a perplexing problem for many investigators because of several inherent variables. These variables, if physiological factors are excluded, revolve about a single physical factor—the effective resistance across the output of the stimula-

* This investigation was supported (in part) by a research grant from the Division of Research Grants and Fellowships of the National Institutes of Health, U. S. Public Health Service.

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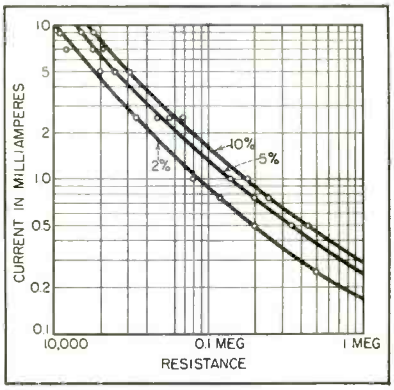


FIG. 1—Curves showing the limits of regulation. For all resistance lines which intersect the desired current line below the 2-percent curve, the current will change less than 2-percent from the present value. Similar manipulation applies to the 5 and 10-percent curves

tor. It is impossible to get accurate indications of impedance of a circuit by determining its resistance with an ohmmeter. Not only does the passage of small currents through the tissues produce polarization manifest by altered resistance, but the inertia of the ohmmeter precludes its giving an instantaneous initial resistance value. The calculated values of current based on the resistance thus obtained, and the applied voltage are therefore usually in error.

The use of cathode-ray tubes for the determination of the impedence of the output circuit through tissues shows that the impedence is variable, dependent apparently on the current density and duration. Finally, since the contact resistance of the electrodes acts as the series arm of a voltage divider of unknown (and variable) value, it is impossible to calculate the current actually passing through the tissues if a fixed voltage is used. While it is possible to use an alternating-current milliammeter and a constant voltage supply, as Myers[1] did, the method is cumbersome and the current will change with any alteration in the total effective resistance of the circuit. With certain electrodes this change is very rapid, as high as 50 percent in 3 or 4 cycles.

An electronic stimulator was therefore devised delivering 60-cycle sine wave currents. This stimulator can be preset at a chosen constant value, regardless of the resistance variations in the output circuit (see Fig. 1 for limits of

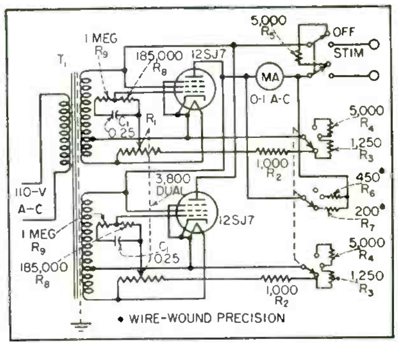


FIG. 2—Circuit diagram of the constant-current stimulator

current regulation).

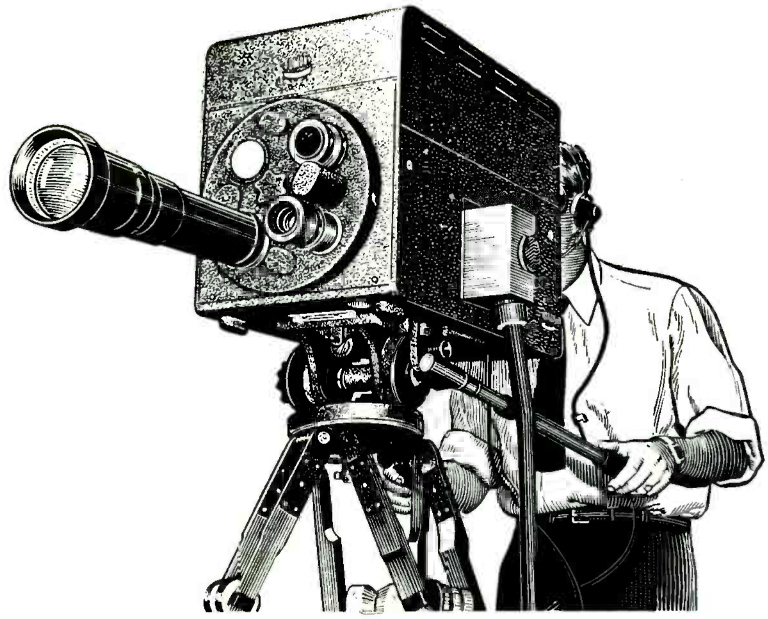
Figure 2 is a diagram of the circuit. All of these parts except the power transformer are available as standard radio equipment. The transformer is available as Ferranti No. 6861. This special transformer was necessary to reduce stray capacitive coupling. The minimum current which was present due to this coupling could be just felt on the tongue when applied through small closely spaced bipolar leads; it was in the range of 0.03 milliamperes. This amount of current was too small to elicit responses from the cortex of the motor region or the gyrus cinguli in the unanesthetized cat[2].

The 12SJ7 was selected because of its constant current characteristics. It requires a 12-volt filament supply which may also be used on the control grid to set the current value at which the tube will regulate.

The resistance-capacitance combination in the grid circuit is the source of a bias voltage which compensates for the curvature of the lower end of the plate current-voltage curve. Without this additional circuit the current output departs significantly from a sine wave in this lower range.

In operation with the output switch in the off position, R_5 is across the output terminals, so that the desired current value can be set by adjustment of the variable resistors R_1. The switch is so arranged that the contact with R_5 is broken only after contact with the circuit through the animal is made. In this way no surge of current due to stray capacitance occurs, comparable to that described by Coppée[3].

We have studied the output char-



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acteristics of the stimulator with a variety of electrode types. Even high-resistance capillary electrodes filled with saline may be used without distortion of the current wave form. Their high effective resistance (100,000 ohms) limited the current output of the apparatus to about 0.8 milliamperes (see Fig. 1).

In summary, an electronic device delivering 60-cycle sine-wave currents of constant, predeterminable values for use in physiological experiments is described.

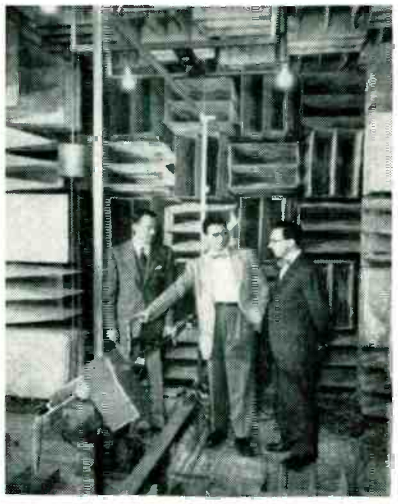
REFERENCES

(1) John A. Myers, A Convenient and Reliable Instrument for Electrical Stimulation Experiments, *J. Lab. and Clin. Med.*, 21, p 949, 1936.

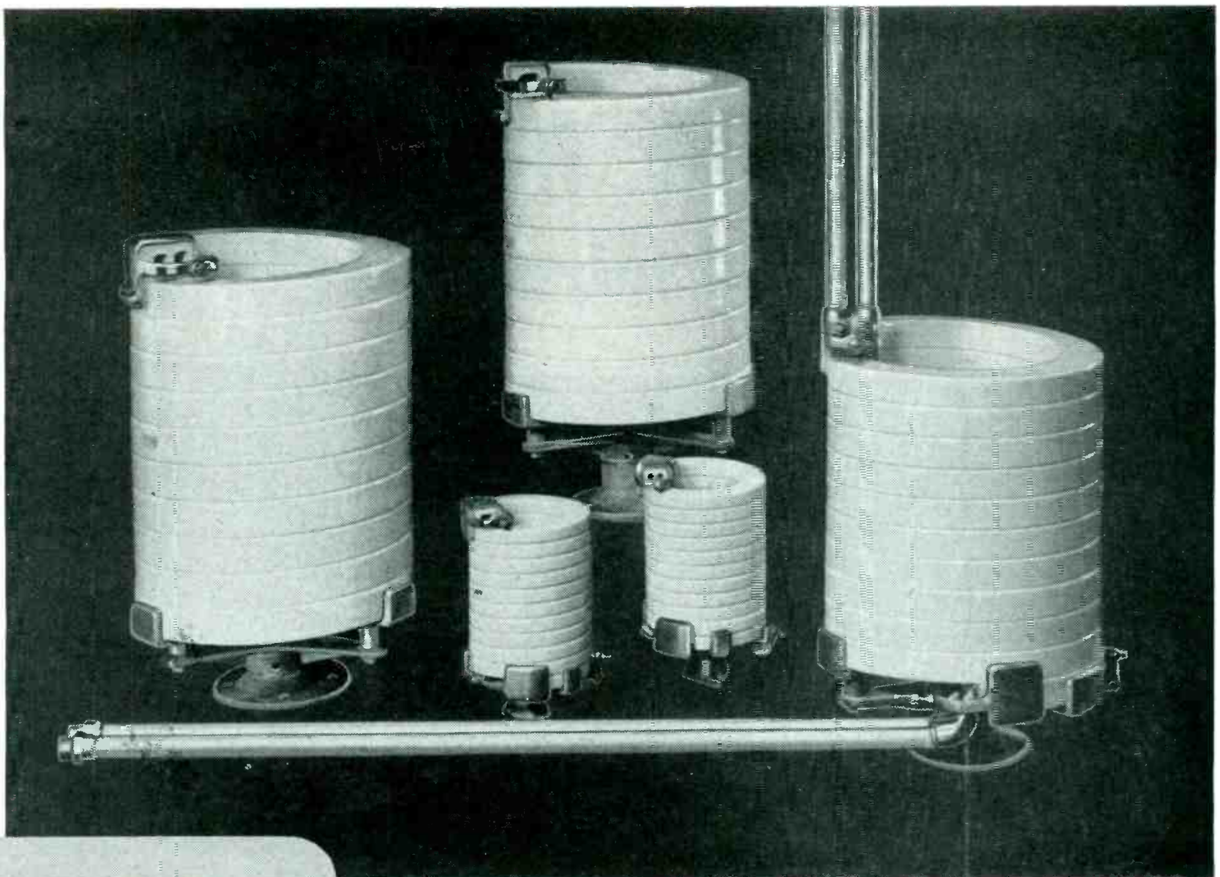
(2) James W. Ward and Virgil S. LeQuire, (unpublished data).

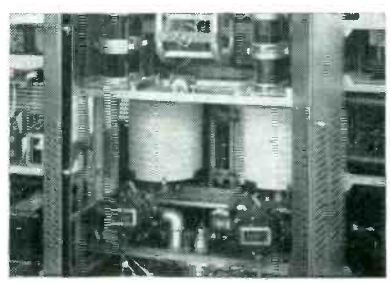
(3) George Coppée, Stimulation by alternating current, *Symposia of Quantitative Biology*, 4, p 150, 1936.

SOUND-MAPPING AIDS NOISE-REDUCING STUDIES



In the acoustics laboratory at the Massachusetts Institute of Technology, studies are being made to find methods for producing quieter, more restful homes and offices with the aid of the sound-mapping equipment shown. Room shown above contains 256 loudspeakers capable of duplicating the noise made by a field-artillery battallion. Sensitive microphone moves back and forth to cover space in test room, and equipment below plots a sound contour map showing sound levels at different positions





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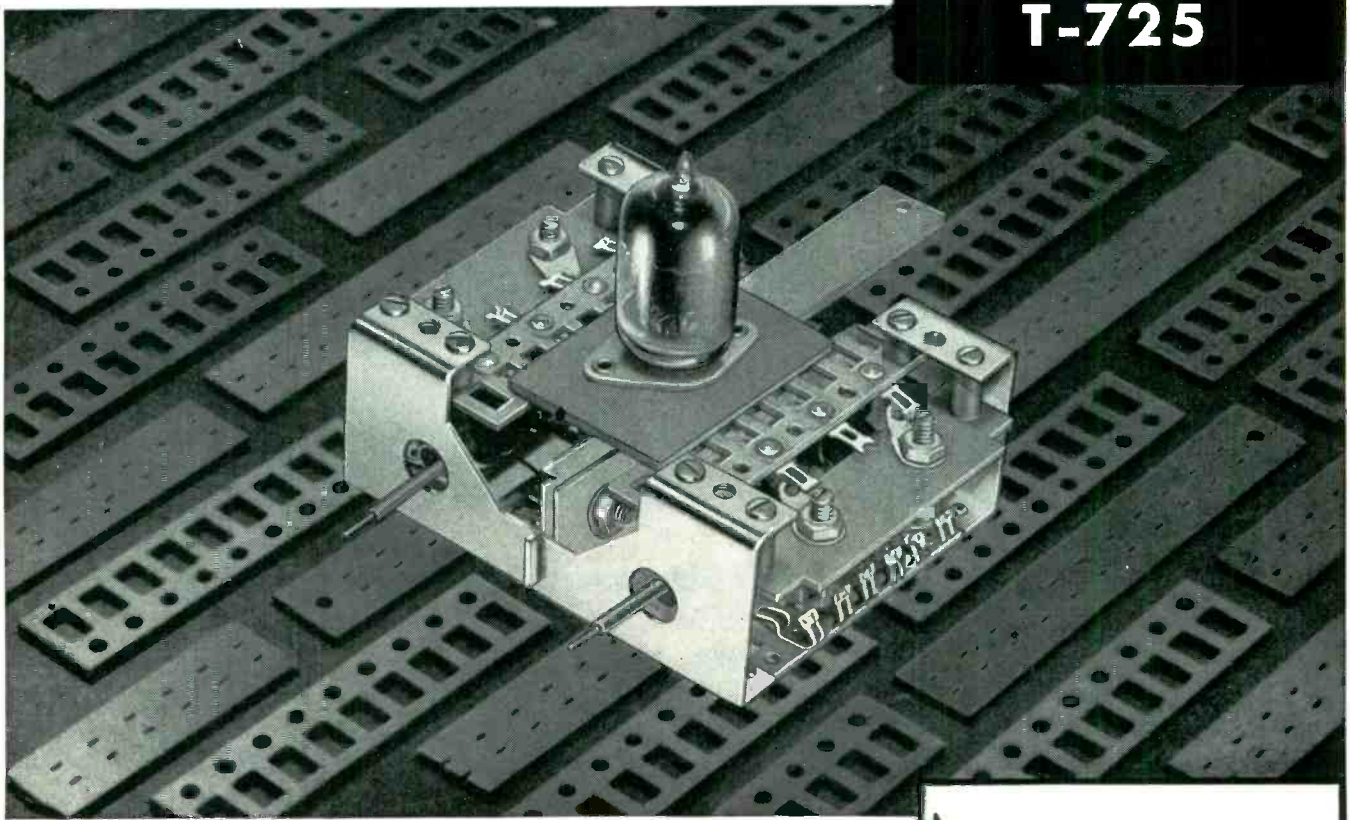

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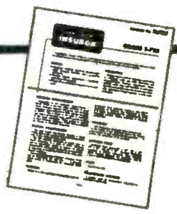
†DIVISION OF GLOBE-UNION INC., MILWAUKEE



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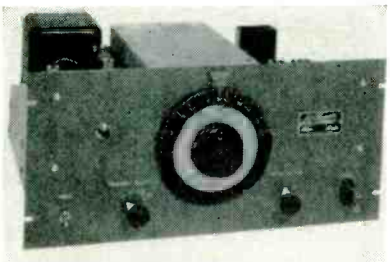
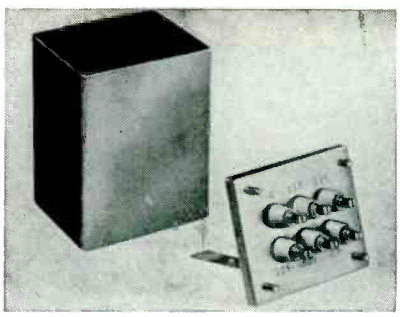
NEW PRODUCTS
(continued from page 146)



age conditions; no electrolytic capacitors used; all capacitors are hermetically sealed in oil or mica. Its chief uses are: amplifier testing, broadcast transmitter audio response, loudspeaker resonance tests, signal generator modulation, and ultrasonic voltage source.

Transformer Cans

HELDOR METAL PRODUCTS CORP., 85 Academy St., Belleville, N. J. Tooling on all standard sizes of MIL-T-27 transformer cans has been completed and most sizes are al-



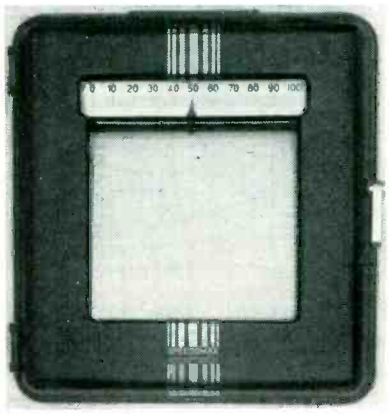
ready in stock. The cans can be supplied with or without brackets, weld studs, blind inserts, compression-type hermetic seal bushings and stamped ratings. Price lists and complete data are available.

Electrostatically-Focused Rectangulars

NATIONAL UNION RADIO CORP., Orange, N. J., has announced a series of electrostatic-type picture tubes that achieve focusing through the use of a new gun design having a zero-current focusing electrode operating at approximately 22 percent of the second-anode potential. In new set designs these tubes will replace the equivalent magnetically-focused tubes and provide a saving of about 2 pounds of copper. Type NU-14GP4 is a 14-inch rectangular tube that is magnetically deflected (70-deg diagonal angle) and has a second-anode potential rating of 14,000 volts maximum. The focusing electrode requires approximately 2,500 volts d-c. Type NU-17FP4 is a 17-in. rectangular with a second-anode potential rating of 16,000 volts maximum. Type NU-20FP4, a 20-in. rectangular, has a focusing-electrode potential of approximately 3,000 volts for a second-anode potential of 14,000 volts.

Test Data Recorder

LEEDS & NORTHRUP CO., 4934 Stenton Ave., Philadelphia 44, Pa., has announced a new Speedomax electronic recorder featuring a range continuously adjustable over a 20 to 1 ratio, and zero suppression adjustable over more than twice the maximum range. Typical uses include measurements with strain gages, temperature difference meas-



urements with thermocouples, and speed measurements. Calibrated d-c millivolt range is adjustable from a minimum across-chart span of 1.1 mv to a maximum range span of 22 mv. Uncalibrated coarse and fine rheostats provide maximum zero suppression of −50 or +50 mv, continuously adjustable between these limits.

Stabilized Broadcast Unit

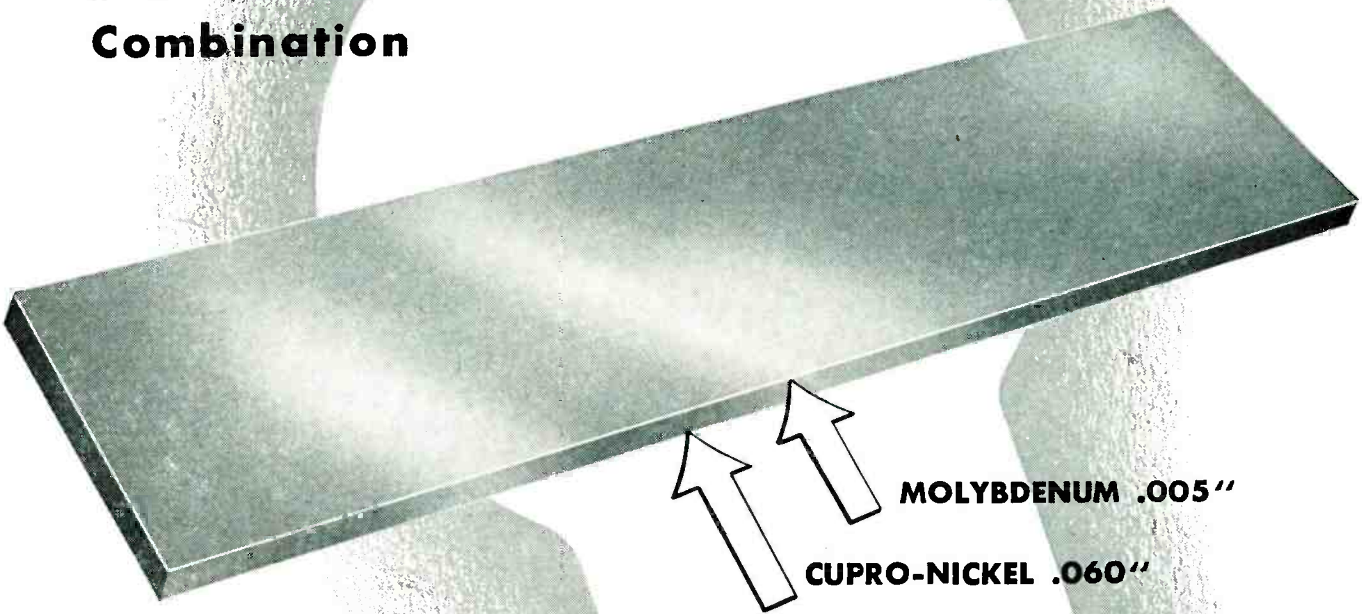
THE JAMES KNIGHTS CO., 131 South Wells St., Sandwich, Ill. The JK-57MT stabilized broadcast unit is unlike conventional crystals (where the electrode turns with change

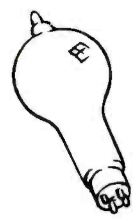
PROBLEM:

How to Prevent Contact Sticking in a Vacuum Tube

GENERAL PLATE:

Provided the Solution with a Composite Metal Combination





A leading manufacturer of radio and industrial tubes and electronic equipment was faced with a problem of finding the right metal for use as a sliding contact in vacuum tubes.

Copper provided a mechanical problem because it tended to gall.

Molybdenum was ideal but was too thick to form and too costly to machine out of solid material.

The problem was presented to General Plate whose engineers quickly found the solution by bonding *two metals into one* . . . a thin layer of molybdenum (.005″) to a thicker layer of cupro-nickel (.060″).

The result was a General Plate *Composite Material that was easily fabricated, gave the performance of solid molybdenum, reduced costs considerably.*

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General Plate Products include — Precious to base metal laminations . . . Base metal laminations . . . Alcuplate (copper and Aluminum) . . . Silver solders . . . Laminated contacts, buttons, rivets . . . Platinum-fabrication-refining . . . Age-hardening Manganese Alloy 720.

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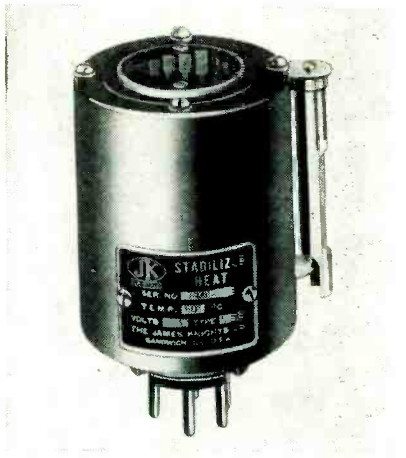
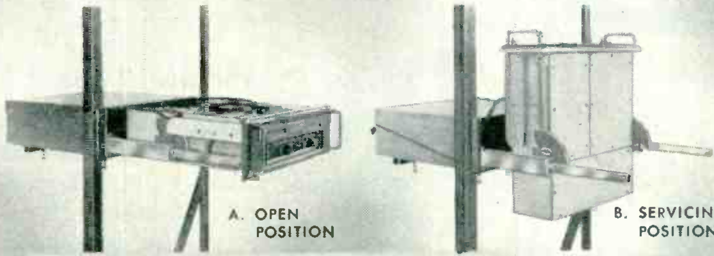


in frequency) in that the variable electrode only moves up and down in guides like a piston. Frequency range is from 400 kc to 1,750 kc. Nominal temperature is 60 deg ± 1 deg. Adjustable frequency is ± 0.01 percent. It features a 6.3-volt, 1-ampere heater. The unit can be supplied with octal base with or without thermometer, and can be factory set for operation at specific temperatures.

D-C Millivoltmeter

MILLIVAC INSTRUMENTS, P. O. Box 3027, New Haven, Conn. Model MV-17B d-c millivoltmeter has been redesigned to give improved performance and accuracy with a variation in calibration of less than 1 percent for 20-percent line-voltage change. The first stage of the carrier amplifier has a gain of over 1,000 and is directly coupled to the second stage. Sensitivity is 1 mv full scale with 6 megohms input impedance and ranges up to 1,000

ELECTRONIC SLIDES



A. OPEN POSITION

B. SERVICING POSITION

A. Featuring Smooth continuous action. Closely fitted slide parts assure minimum of play. Locking device holds slide when fully extended, permitting easy access to all parts.

B. Quadrant for pivot support and tilting provision is equipped with simple tripping mechanism for servicing. Lever operated, it releases chassis and allows movement to open and closed positions.

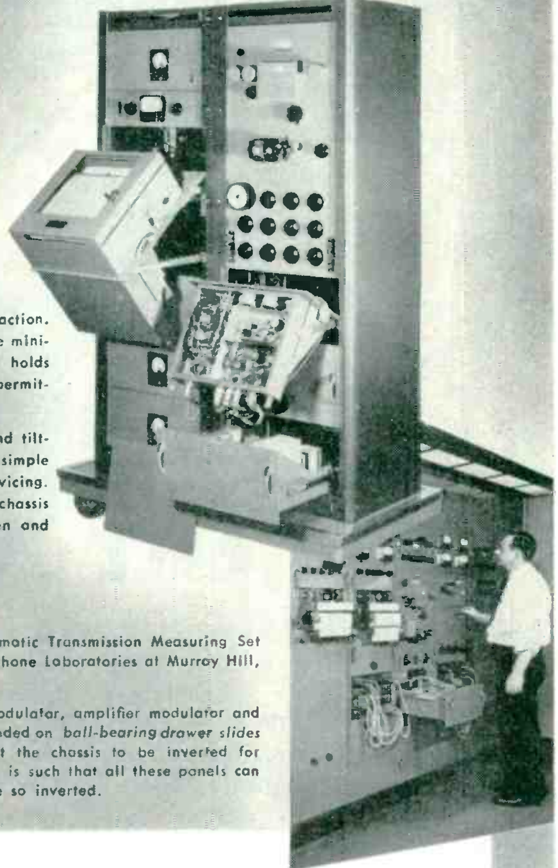
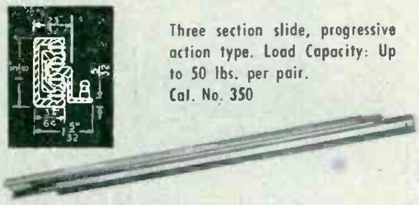


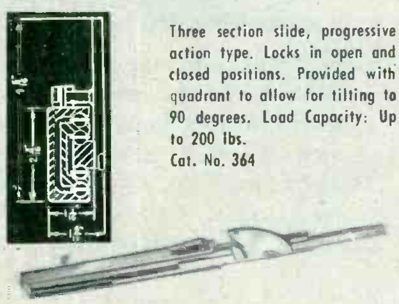
Illustration shows an Automatic Transmission Measuring Set as developed by Bell Telephone Laboratories at Murray Hill, New Jersey.

The receiving amplifier, modulator, amplifier modulator and recorder panels are suspended on *ball-bearing drawer slides* and are pivoted to permit the chassis to be inverted for servicing. The arrangement is such that all these panels can be kept in operation while so inverted.

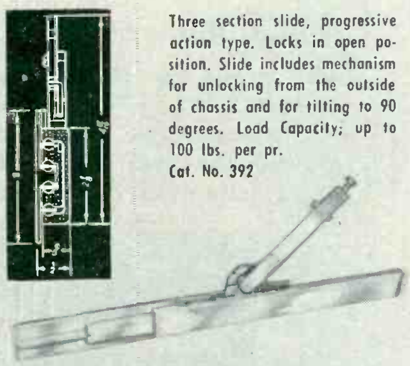
Three section slide, progressive action type. Locks in extended position only. Tripping mechanism controls unlocking. Load capacity: Up to 200 lbs.
Cat. No. 375



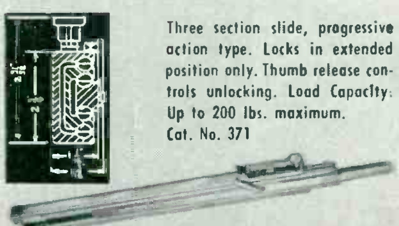
Three section slide, progressive action type. Load Capacity: Up to 50 lbs. per pair.
Cat. No. 350



Three section slide, progressive action type. Locks in open and closed positions. Provided with quadrant to allow for tilting to 90 degrees. Load Capacity: Up to 200 lbs.
Cat. No. 364



Three section slide, progressive action type. Locks in open position. Slide includes mechanism for unlocking from the outside of chassis and for tilting to 90 degrees. Load Capacity; up to 100 lbs. per pr.
Cat. No. 392



Three section slide, progressive action type. Locks in extended position only. Thumb release controls unlocking. Load Capacity: Up to 200 lbs. maximum.
Cat. No. 371

The present preparedness program requires that manufacturers be absolutely certain of the precision and dependability of all component parts. Over 50 years of dependability lie behind Grant Pulley & Hardware Co. Our extensive engineering and research department is constantly planning new and improved sliding devices. This department is available for consultation on individual specifications, and also provides engineering liaison from inception to conclusion of production. Chassis, Consoles, Racks, any device where access to parts or motion of equipment is desired should be equipped with Grant Slides. Wherever the installation, laboratory, tank, bomber, ship, mobile or stationary unit . . . you save time and manpower when you use Grant Sliding Devices.

Grant Slides are adaptable for many military uses, and Grant customers with Government contracts can rely upon the dependability of Grant cooperation and delivery.

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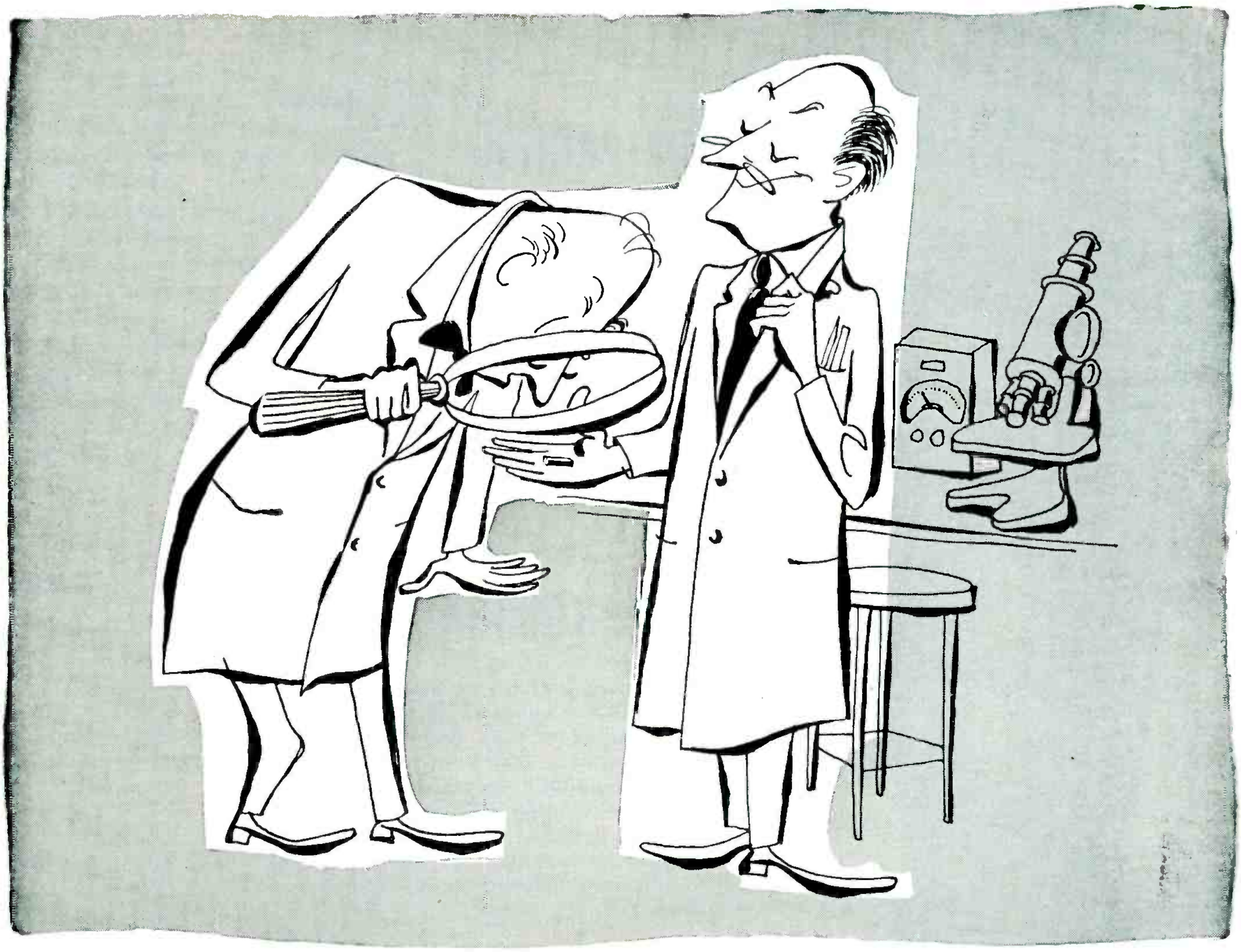
Large TV Picture Tube

GENERAL ELECTRIC Co., Schenectady, N. Y. The 20CP4, a 20-inch rectangular picture tube, is a magnetic-focus and deflection, direct-view, all-glass type for tv applications. Screen area is 217 sq in. It features an electron gun designed to be used with an external single-

field ion-trap magnet for the prevention of ion-spot blemish. Maximum ratings include: anode voltage, 18,000 v; grid-No. 2 voltage, 410 v; grid-No. 1 voltage, negative-bias value, 125 v; positive-bias value, 0 v; positive-peak value, 2 v.

Output Power Meter

THE DAVEN CO., 191 Central Ave., Newark 4, N. J. Type OP-962 output power meter is designed to measure the actual power delivered by an audio signal system to a given



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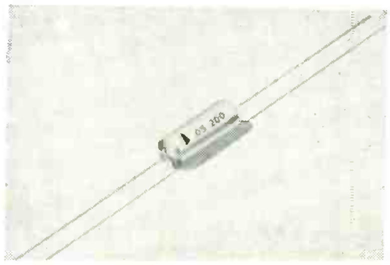
load. It is also suited to such applications as the determination of characteristic impedance of an a-c source, effects of load variation on a signal system, transmission line equalization measurements and radio receiver measurements. The meter covers the range from 0.1 mw to 100 watts. It features 40 selected impedances between 2.5 and 20,000 ohms and an accuracy of ± 2 percent of the 30 to 10,000-cycle range. The indicating meter is calibrated from 0.01 to 0 watt and from -10 to $+10$ db. Zero level is 1 mw.

Miniature Paper Capacitors

PYRAMID ELECTRIC CO., 1445 Hudson Blvd., North Bergen, N. J. Type PG Glasseal miniature paper capacitors are assembled in metal tubes with glass-metal terminals. They will fully meet the most exacting demands of high-vacuum,



high-pressure, temperature-cycling, immersion-cycling and corrosion tests. Temperature ranges are from -55C to $+125$C; capacitance range, from 0.001 μf to 1.0 μf; and voltage range, from 100 to 600 volts d-c operating.

Power Amplifier

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Type 1233-A power amplifier is a wide-frequency range aperiodic am-

plifier providing a maximum of 15 watts output with less than 0.2 volt input. In addition to its use as a general laboratory or testing amplifier it has specific applications in the driving of supersonic generators, the exciting of broadcast antennas for measurements with deflection-type instruments, and for use as an oscilloscope deflector amplifier. Three output combinations are available with a maximum frequency range from 20 cycles to 3 mc. Output transformers furnish low-impedance output up to 1.5 mc. Noise and distortion are low on all ranges. Readings of output voltage are given on a 3-range panel vtvm.

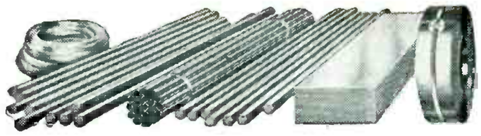
Oscilloscope Calibrator

TENSOR ELECTRIC DEVELOPMENT CO., INC., 343 Classon Ave., Brooklyn 5, N. Y. The A-42F oscilloscope calibrator is essentially a source of continuously variable monitored voltage from 0.0005 volt to 100 volts rms. When used with any oscillo-

scope it enables the operator to make measurements of voltages within this range. It has the added feature of being calibrated directly in peak to peak volts and decibels as well as rms volts. Price is $24.95 complete with tube and instructions.

Electromagnetic Shielding Metal

AMERICAN CLADMETALS CO., Carnegie, Pa. Electroshield metal sheets are recommended for such uses as eliminating electromagnetic disturbances causing interference



BRIDGEPORT BRASS COMPANY

COPPER ALLOY BULLETIN

"Bridgeport" MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

Good Tools and Methods Ease Machining of Copper, Bronze

The broad use of copper, phosphor bronze and other high-copper alloys pose a problem to products, methods and tool engineers in the electronic field from a machinability standpoint.

Oxygen-free copper, for example, has one of the lowest machinability ratings of any of the copper products, yet precision dimensions and high finishes are expected. At the same time, the mounting preparedness program calls for high production.

On much of the electronic production, the use of sulphur in the coolant-lubricant is ruled out due to its attack on the metal with subsequent discoloration. Sulphur-free mineral oils and soluble oils are employed. Normally, when using a soluble oil, the 20-1 ratio of water to the oil is cut to 10- or 15-1 since lubrication is a greater factor than cooling with the lowered surface speeds and feeds used on copper and high-copper alloys.

Controlled Coolant Important

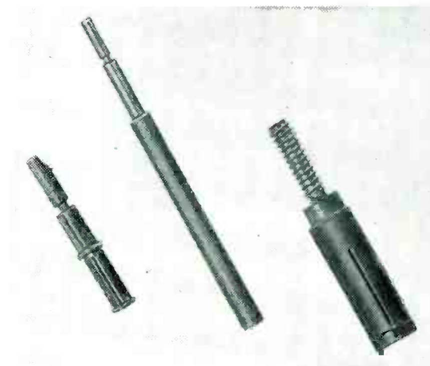
Of utmost importance is a well-directed, heavy supply of cutting compound. Care must be taken to insure the stream hitting the tool and the work and not splashing off into space. Sometimes a lower pressure will be the answer, as well as using two or more streams.

In drilling and tapping the cutting compounds should be so directed as to wash away the chips.

Carbides Reduce Problems

The use of carbide tools is strongly advised not only from the standpoint of longer tool life and increased speeds and feeds but from the finish requirements. They will more than pay for themselves in reduction of downtime and good results.

Tungsten carbide does not "load" up as rapidly as tool steels when machining copper. On highly ductile metals, rake angles of 2-8 degrees are normally recommended with clearance angles of about 7 degrees. However, these angles should be held to the lowest point possible to give added strength to the cutting edge yet carry the chip away. Tools should be set on center or slightly above rather than below the centerline of the work. Too large a radius will cause chattering and too small is likely to produce a threaded appearance.



Phosphor bronze terminals for micro-wave equipment turned in Swiss screw machines.

Surface speeds of 200 to 300 feet per minute can be used depending on the depth of the cut. On finishing cuts, care should be exercised in the amount of stock left for the finishing tool. Sufficient metal must be left to permit the tool to cut rather than drag the chip off.

Hard-Chrome Plate Helpful

Fast spiral drills, polished and hard-chrome plated, give excellent results, especially from the standpoint of chips welding to the cutting edges.

Carbide inserts have also proved worthwhile in producing good finishes with drills.

In chasing threads, cemented carbide has also helped to improve tool life as well as finish and accuracy of threads. Some concerns have used high-speed chasers which have been chrome plated.

Much has been written on the choice of taps for copper and the high-copper, non-leaded alloys.

Polished Flutes Suggested

Two things are pretty much agreed upon: polished flutes and chrome plate. Not only is welding reduced but the frictional load is diminished.

On through holes, "gun" or "chip driver" taps are normally recommended. On blind holes, except when there is sufficient clearance between the tap and the bottom, chip drivers should not be used. Either two or three or four flutes are normally selected.

Tap breakage can result from running a tap too slowly or through dullness. Sharp taps are essential.

Machining of phosphor bronze rod for various terminal pins and connectors of both male and female types in Swiss screw machines is generally done with cemented carbide tools. High finish, concentricity and accuracy are normally required in these parts.

Flat Carbide Drills Used

Surface speeds between 200 and 300 fpm. are used. Flat drills of solid carbide are generally preferred to twist or fast spiral drills. Finishes with flat drills usually are equivalent to a reamed hole on this small work.

In cutting copper and phosphor bronzes, rigidity of tools and machines is important to eliminate chatter and "hogging in" and to maintain dimensional stability.

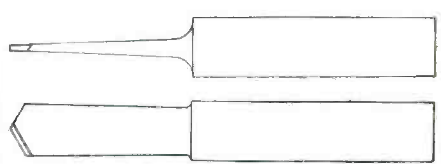
Cleanliness Essential for Plating

The majority of parts in micro-wave equipment is silver plated. Cleanliness is about half the battle in obtaining an intimate bond between the base metal and the silver.

Many types of cutting compounds are difficult to remove thoroughly. It is advisable to consult cleaner supply houses on the best method to remove the specific coolant.

Not only does an unclean surface on the base metal lead to blistering, flaking and peeling, but the plating baths may be contaminated.

Thorough rinsing after cleaning and plating is imperative. Failure to rinse after plating may lead to staining as will failure to dry the parts after rinsing.

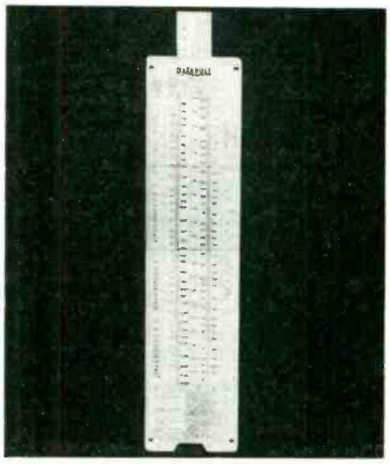


Solid sintered carbide flat drill used in automatic machines on phosphor bronze. (6444)

with tv, radio and radar; or interference with delicate electronic instruments such as used in the aviation industry or medical laboratories; or in shielding apparatus such as diathermic equipment to prevent interference with neighboring communications equipment. Specifically it is indicated for such applications as: high-quality, low-level microphone input transformers; shielded rooms; coaxial shielding of l-f transmission lines; or enclosures for specialized electronic test equipment. It is available in standard metal gages and sizes, and may be welded, brazed, silver soldered, spun, drawn, stamped or punched. Electroshield sheets also feature a conservation of copper.

Electrical Apparatus Computer

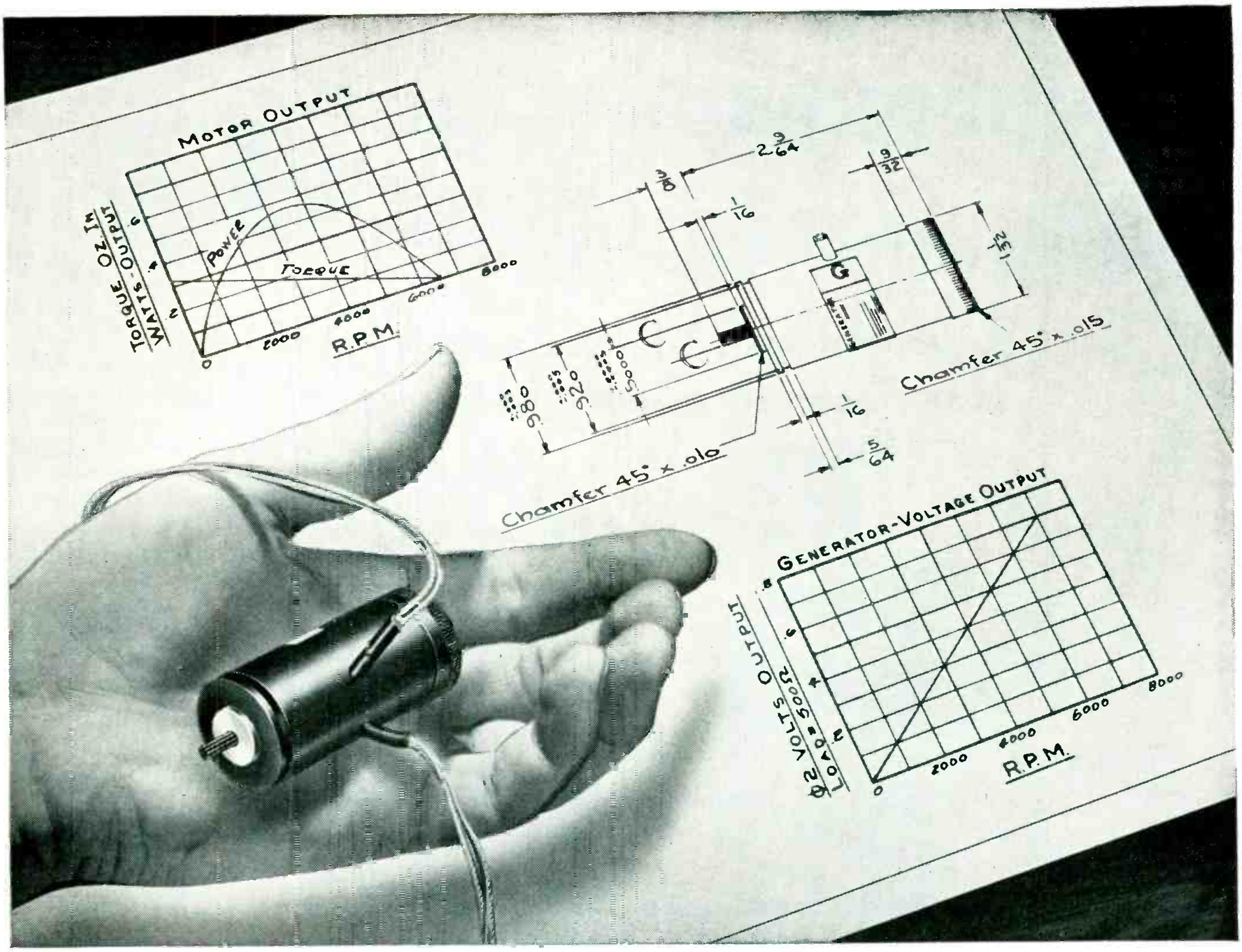
BROWNELL DISTRIBUTORS, 308 Canal St., New York, N. Y. Of interest to the maintenance engineer, motor design engineer, transformer engineer and motor rebuilder is a new



slide rule, the Datarule, illustrated above. In making any type of change in the coils or winding—whether in the form of frequency, voltage, number of turns, connection, speed or size of wire—or in testing or determining the effect of such a change in existing design, the Datarule indicates the effects of such change on the other related factors in coil or winding design.

Sweeping Oscillator

KAY ELECTRIC CO., Pine Brook, N. J. The Super-Sweep, a new



Remarkable new compactness in precision control

The extreme compactness of the new Type 1623 Motor-Driven Induction Generator has been achieved with no sacrifice of general performance characteristics. Like its "bigger brothers" in the Kollsman line, the Type 1623 combines, in a single frame, motors of high torque/inertia ratio with generators offering *linear voltage vs. speed* over a wide range.

Where size and weight are prime considerations, this 4.2-ounce unit will prove the solution to many precision control problems. Separate induction motors and generators are also available in the same diameter frame.

For further information on the 1623 and others in the complete Kollsman group of miniature special purpose AC motors—or if you require a unit to your own specifications—write: Kollsman Instrument Corporation, 80-08 45th Avenue, Elmhurst, New York.

Type 1623 Motor-Driven Induction Generator

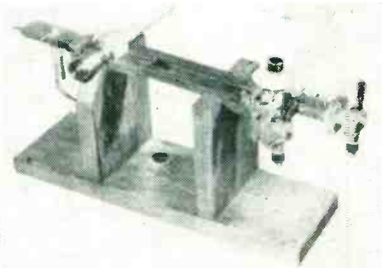
Motor characteristics: Maximum torque at stall—smooth-running (will not "cog")—fast-reversing—operates from two-phase source, or from single-phase with phase-shifting condenser—available for 60 or 400 cycle operation.

Generator characteristics: Low residual voltage and voltage "spread"—constant frequency output—amplitude directly proportional to speed.

Unit characteristics: Both rotors mounted on same shaft, assuring positive alignment—stainless steel housing—hardened beryllium copper shaft—corrosion-resistant nickel steel laminations—high temperature insulation (up to 200° C. total temperature)—stainless steel precision ball bearings—weight: 4.2 ounces.

KOLLSMAN INSTRUMENT CORPORATION

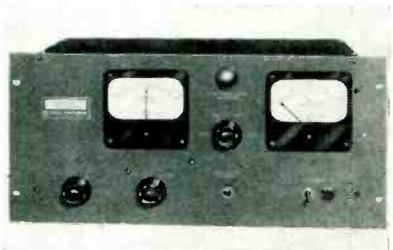
ELMHURST, NEW YORK • GLENDALE, CALIFORNIA



sweeping oscillator for the uhf and microwave ranges, has the following features: frequency range, 500 to 2,000 mc and up; sweep width, 30 mc and up; output approximately 0.5 volt maximum from a 50-ohm internal impedance. It has an accurate absorption-type wavemeter for measuring and setting frequency, and includes a variable output attenuator covering a range of 30 db. Output is flat within 0.1 db per mc while sweeping. Price is $2,500 complete.

F-M Communications Monitor

HEWLETT-PACKARD CO., 395 Page Mill Road, Palo Alto, Calif. Model 337A low-cost f-m communications monitor requires no adjustment during operation. No i-f calibration is required because the i-f is low (30kc) and circuits are not sensitive to signal level changes. The unit gives continuous indication of frequency and modulation swing, and monitors by transmitter output sampling or antenna pickup. It includes a peak modulation indicator



and an audio output for aural monitoring. Frequencies from 30 mc to 175 mc may be monitored, and the instrument is sensitive enough to monitor mobile units some distance away.

Laboratory Amplifier

HERMON HOSMER SCOTT, INC., 385 Putnam Ave., Cambridge 39, Mass. Type 210-B Dynaural laboratory

For Temperature Ranges from 500° F. to -85° F.

Varglas Silicone Electrical Insulating Tubing and Sleeving

Lead Wire and Tying Cord

VARGLAS SILICONE is a sensational new electrical insulating sleeving and tubing developed by our laboratory and pilot plant during the last war. It is a product which combines Varglas and Silicone to bring revolutionary possibilities to electrical insulation.

VARGLAS SILICONE is efficient under a wide temperature range . . . to 500° F. or more in some applications, yet remains completely flexible at —85° F. It has excellent resistance to moisture; is flame resistant and self-extinguishing.

VARGLAS SILICONE, pioneered by VARFLEX CORPORATION, is the first and only *Class H* insulation with these features:

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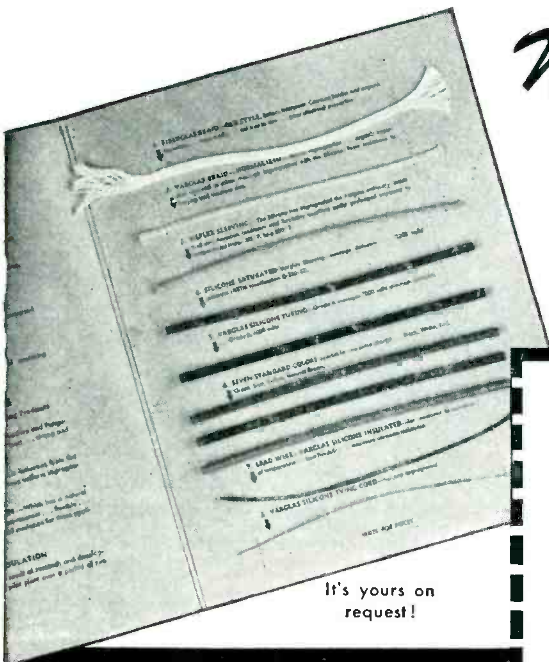
3. **SILICONE HIGH TEMPERATURE RESIN** — Which has a natural affinity for the Fiberglas, renders it abrasion-resistant, flexible and non-fraying.

VARFLEX CORPORATION, manufacturers of electrical insulating tubing and sleeving, are insulation specialists. If you require special insulation, write us about your problems. We will gladly quote on your individual requirements or NEMA specifications. We have a complete line of sleeving and tubing, based on Fiberglas, cotton, and extruded plastics.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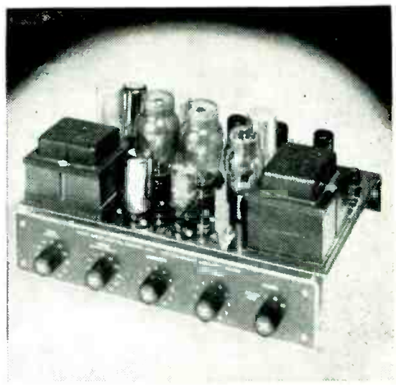

amplifier has a frequency response flat from 12 to 22,000 cycles; harmonic distortion less than 0.5 percent at full 20-watt output; first-order difference-tone intermodulation less than 0.1 percent at full output; and hum level of 84 db or more below full output. It also features a noise suppressor which virtually eliminates record scratch and rumble without affecting the music response.

Literature

Relay Catalog. Price Electric Corp., Frederick, Md., has available a 60-page thoroughly-illustrated and technically descriptive catalog covering a line of 42 relays and controls for electronic and industrial applications. It contains a new section on hermetically sealed relays, as well as an index and cross-reference table.

Measurement Instruments. Kay Electric Co., Pine Brook, N. J., has ready for distribution the 1951 edition of its catalog containing 64 pages and covering 35 electronic instruments and accessories for audio to microwave measurements including the following: sweeping oscillators, marker oscillators, analyzers, attenuators, frequency meters, reflectometers and other specialized units for civilian and military uses.

Research & Analysis Instrumentation. Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa. The acceleration of research through the use of industrial and related instruments and apparatus is the subject of a recently published 84-page book, a compendium

of data sheets. The well-illustrated book describes many types of equipment which, alone or in combination with other apparatus, are being used in research and analytical instrumentation. Individual data sheets are available in limited quantities for use by engineering schools, colleges, and in research training programs.

Carrier Amplifier. Consolidated Engineering Corp., 300 North Sierra Madre Villa, Pasadena 8, Calif. Bulletin CEC-1522 covers the type 1-118 carrier amplifier, which, when combined with a recording oscillograph, presents a system of four channels for dynamic recording measurement. The instrument described will be of particular interest to engineers engaged in mechanical-industrial design and development, as it greatly simplifies analysis and evaluation of the physical factors involved in successful product performance.

Power Resistors. Clarostat Mfg. Co., Inc., Dover, N. H. Engineering bulletin 113 contains general specifications for the type H30N power resistors with insulated safety knob and convenient Edison screw base. The line described is being used as an easily replaceable resistor or heater, particularly in the tropics and where high humidity is a working condition. The resistor in question has a wide range of wattages and resistances, terminals and mountings, whereby the user can select such features as will best meet his particular requirements.

Strip Chart Recorder. Wheelco Instruments Co., 847 W. Harrison St., Chicago 7, Ill. Bulletin C2-2 describes the Capacilog line of electronically operated strip chart recorders. Besides explaining how direct-deflection, Wheatstone-bridge circuit and pneumatic-control types of operating systems are applied to Capacilogs, the publication also lists model numbers and specifications of the various recorders and record-controllers. A separate price list supplements the bulletin.

Stamped-Wiring Technique. Franklin Airloop Corp., 43-20 34th

St., Long Island City 1, N. Y., has just published a 16-page illustrated booklet dealing with mass production dies stamping of wired circuits. Included are a detailed analysis of the procedure, chief advantages, applications and a full-page bibliography on the subject.

Current Measurements. Columbia Electric Mfg. Co., 4519 Hamilton Ave., Cleveland 14, Ohio. A recent 8-page folder covers the Tong Test a-c and d-c current measuring device. With the unit described ampere readings can be taken without breaking the circuit, scraping the insulation or even touching the conductor under test. Features, chief uses, typical scale ranges, many illustrations and a price schedule are included.

Metal-Shell Rectangular. Radio Corp. of America, Harrison, N. J., has published a 12-page folder on its 17CP4 metal-shell rectangular tv picture tube. Employing magnetic focus and magnetic deflection, the tube described features an improved design of funnel-to-neck section which facilitates centering of the yoke on the neck and, in combination with better centering of the beam inside the neck, contributes to the good uniformity of focus over the entire picture area. Complete technical description, installation and application data, dimensional outlines and socket connections are given.

Coil Winding. Universal Winding Co., P. O. Box 1605, Providence 1, R.I., has available a reprint of the first eighteen issues of its one-page bimonthly leaflet telling how to get the most from coil winding. The well-illustrated booklet contains some descriptive literature pertaining to the use and operation of coil-winding machinery and also some articles regarding coil-winding procedures in general.

Engineering Achievements. Westinghouse Electric Corp., Box 1017, Pittsburgh 30, Pa., in its January 1951 issue of the *Engineer*, lists and describes many new developments including: Thermalastic insulation for generators; a circuit breaker with a 10-million kva

interrupting capacity; a new protective coating for distribution transformers that doubles the life of previously used finishes; a selenium-rectifier d-c welder; an ignitron rectifier locomotive; and an x-ray image amplifier that gives the doctor a fluoroscope picture 100 times brighter.

Germanium Crystal Diodes. Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y., has issued an eight-page folder dealing with a line of 19 types of germanium crystal diodes. General description, typical static characteristics charts, ratings and characteristics in tabular form, application notes and mechanical specifications are included.

Ground Testing Instruments. James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa., has published bulletin 25–14 on Megger ground testing instruments for measuring resistance of earth to ground connections and for measuring earth resistivity. Aids to proper selection, application, typical tests, drawings and illustrations all help to make this a valuable booklet for those engaged in grounding surveys, geophysical prospecting, electrical power and communication grounding problems, soil corrosion, electrolysis cathodic protection.

Induction Heaters. Sherman Industrial Electronics Co., Belleville, N. J., has available a catalog covering the new Megacycle line of induction heaters and including an induction heating data sheet. The publication contains numerous application photos of particular interest to production engineers at this time. Automatic soldering and brazing steups are shown, using h-f heaters plus either a turn-table or a conveyor table. The catalog also makes a free trial offer on the processing of sample parts.

Glow Modulator Tubes. Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y. A single-sheet bulletin discusses the types 1B59/R1130B and R1131C cold-cathode light modulating tubes designed for use in facsimile equipment, oscillograph timing markers,

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20 MC VIDEO AMPLIFIER
Model V

- Flat frequency response from 100 cps to 20 mc ± 1.5 db.
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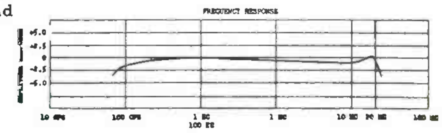
- Gain of 50 db.
- Frequency compensated high impedance attenuator calibrated in 10 db steps from 0-50.
- Fine attenuator covers a 10 db range.
- Phase Linear with frequency over entire band.

This unit is designed for use as an oscilloscope deflection amplifier for the measurement and viewing of pulses of extremely short duration and rise time, and contains the Video Amplifier Unit, Power Unit and low-capacity probe.



Specifications

Input Impedance: Probe—12 mmf + 470,000 ohms; Jack—30mmf + 470,000 ohms; Output Impedance 18mmf + 470,000 ohms each side push pull; Max. Input Volts 500 peak to peak with probe; Max. Output Volts 120 volts peak to peak (push pull); Power: 115 volts 50/60 cps AC Line; Size 19¼"x22"x14¾".

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Write for Catalog 49-E, describing Louthan Insulations.

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stroboscopes, seismograph recorders, photoelectric counters and photoengraving. Electrical ratings, mechanical specifications, a typical circuit and average performance curves are given.

Picture Transmitter, Muirhead & Co., Ltd., Beckenham, Kent, England. Bulletin B-668-B discusses the type D-601-A picture transmitter. Specifications, illustrations and principal characteristics of the unit described are included. The bulletin also announces the availability of literature on a dozen of the company's other products.

Selenium Rectifier Handbook. Sarkes Tarzian, Inc., Rectifier Division, 415 North College Ave., Bloomington, Ind., recently published a 64-page handbook containing practical information on power conversion and suggested applications of selenium rectifiers. In addition to complete information on selenium rectifiers that have found wide use in radio and tv receivers, the handbook contains data on power rectifiers for high-current applications and high-voltage enclosed rectifiers for low-current applications. Price is 25 cents.

High-Intensity Polariscope. West Shore Laboratories, P. O. Box 117, Marblehead, Mass. Outstanding features, illustrations and applications of the model B high-intensity Polariscope for production line use and laboratory investigations are shown in a recent 4-page brochure. It should be noted that with the instrument described strains in glass and plastic appear in colors of blue and yellow, and that the lenses are ground flat so that the unit may be placed under a microscope or on the production line. The polariscope in question is in use at the present time in several radio tube factories.

Video Sweep Generator. Manufacturers Engineering and Equipment Corp., 2115 Stratford Ave., Willow Grove, Pa. An eight-page bulletin describes and illustrates the Sweepmaster I video sweep generator, a radio-frequency generator designed to be used in conjunction with any standard cro when align-

ing wide-band amplifiers or, more generally, when observing a frequency-response characteristic. Frequency of the unit discussed in the bulletin is varied sinusoidally at a 60-cps rate, and its range is controlled between 150 kc and 14 mc.

Voltage-Regulated Power Supplies. Kepco Laboratories, Inc., 149-14 41st Ave., Flushing, N. Y., has published four brochures on models 315, 510, 515 and 500R voltage-regulated power supplies. Each contains an illustration and complete technical specifications for the unit described.

Vehicular Capacitors. Cornell-Dubilier Electric Corp., South Plainfield, N. J., has available bulletin NB-140 covering a line of bypass and feed-through vehicular capacitors designed for the suppression of r-f interference. The capacitors described are hermetically sealed and built to withstand extremes of vibration and shock, and for operation over the temperature range from −55 to +85 C.

Vector Measurement. Advance Electronics Co., P. O. Box 2515, Paterson, N. J., has issued a single-page bulletin illustrating and describing the type 201 Vectorlyzer, and instrument capable of measuring vector relations of alternating voltages from 8 cps to 500 mc. Other uses and specifications of the versatile unit are shown.

Shorted-Turn Indicator. Kartron Inc., Box 472, Huntington Beach, Calif. Bulletin 42 describes common troubles in unmounted electrical coils and how these troubles may be identified and thereby eliminated through the use of the shorted turn and open circuit coil checker. Basic circuit, chief features, operation data and complete description are given.

Testing Devices. Samwell & Hutton, Combine Works 1, Goodmayes Road, Ilford, Essex, England. Technical details and illustrations for a line of test and measuring instruments may be found in a series of releases enclosed in a cardboard folder. The instruments covered are the type 30 short-cir-

S·S·White MOLDED RESISTORS

The "All-Weather" Resistors

Photo Courtesy Photovolt Corp., New York, N. Y.

ARE USED IN THIS ULTRA SENSITIVE ELECTRONIC PHOTOMETER

in this instrument—designed for measurement of very low light values—S.S.White Resistors serve as the grid resistance in the all-important high-gain D.C. amplifier circuit. The manufacturer, Photovolt Corp., New York, N. Y., reports that the resistors "work very satisfactorily"—which checks with the experience of the many other electronic equipment manufacturers who use S.S.White resistors.

S.S.WHITE RESISTORS
are of particular interest to all who need resistors with inherent *low noise level* and *good stability* in all climates.
HIGH VALUE RANGE
18 to 10,000,000 MEGOHMS
STANDARD RANGE
1000 OHMS to 9 MEGOHMS

WRITE FOR BULLETIN 4906

It gives essential data about S.S.White Resistors, including construction characteristics, dimensions, etc. Copy with price list on request.

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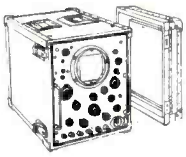
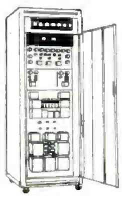
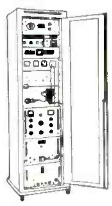


Special Test Equipment



Regulated Power Supplies



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Plant facilities comprise laboratories; model, welding and machine shops; paint, anodizing, and test departments; assembly and tool rooms; foundry and other contributing functions of production.

A few of the many products the Concern has manufactured are illustrated here.

More detailed information will be furnished on request.

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Long Branch, New Jersey

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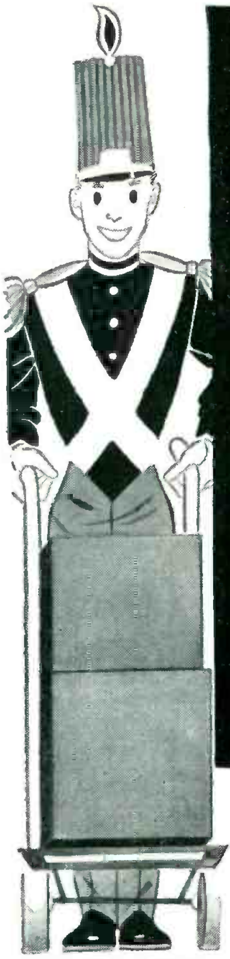
cuited turns tester, type 31Q meter, types 36 A, 41 and 42 television wobbulators and type 37A turns checker.

Hot-Pressed Tungsten Carbides, Sintercast Corp. of America, 134 Woodworth Ave., Yonkers 2, N. Y. Engineering bulletin SP-101 contains timely information and data on Sinterforge carbides. The carbides described offer closer grain structure, greater uniformity, better properties and closer tolerances than the sintered tungsten carbides. Chief uses, shape and size limitations, various grades and their typical applications are shown.

Antenna Bulletin. Andrew Corp., 363 E. 75th St., Chicago 19, Ill. Bulletin 38-C outlines six reasons why the folded Unipole antenna is ideal for fixed station application in the emergency communication services. Mechanical features, specifications, outline dimensions and transmission line requirements are shown.

Recording Equipment. Radio Corp. of America, Camden 2, N. J. Form 2J-6895 is a 20-page brochure describing the latest professional-type disc recording equipment, and including technical information on recording, fine groove techniques and studio recording installations. The booklet is illustrated with more than a score of photographs, as well as many block diagrams, graphs and schematic drawings.

Variable Trimmer Capacitors. JFD Mfg. Co., Inc., 6101 Sixteenth Ave., Brooklyn 4, N. Y. Complete technical details and illustrations of a line of piston-type variable trimmer capacitors are given in a single-sheet bulletin. The units described are 1 in. long, offer very low capacity, and can make and maintain smooth retracking and precise settings despite strong vibrations. Models discussed are the No. VC3 (3$\mu\mu$f), No. VC5 (5 $\mu\mu$f) and No. VC11 (11 $\mu\mu$f). Illustrations include a photograph of the capacitor, a characteristic curve and linear results indicated in direct relation to settings of adjusting screw.



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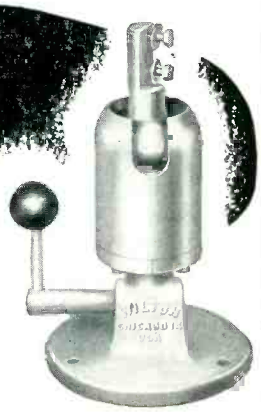

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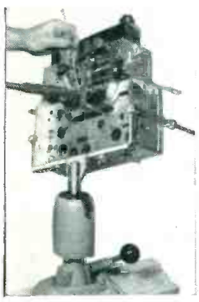
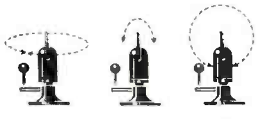


POWRARM cuts costs by increasing every worker's productivity. It gives the worker a powerful *third hand* to hold work while two hands produce. That's why POWRARM works on the most efficient assembly lines in America today, and *belongs on yours*. Write us about your production "headache" . . . we'll show you how POWRARM can cure it.



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(continued from page 150)

the Structure of the Lower Atmosphere, by C. Crain of the U. of Texas.

A Correlation Computer and Applications to Radio Propagation, by F. E. Brooks and H. W. Smith of the U. of Texas.

Seismometer Design, by J. T. Woods of the Atlantic Refining Co.

An Electronic Fourier Analyzer, by F. McDonal of the Magnolia Petroleum Co.

The Instrumentation of Radiation Effects, by A. Reed of the U. of Texas.

Contribution Which Engineering Must Make for Medicine to Progress, by H. I. Kantor of the U. of Texas.

Tornado Tracking and Identification, by H. L. Jones of the Oklahoma Institute of Technology.

Modern Trends in the Design of Navigation Systems, by N. Marchand and M. Leifer of Sylvania Electric Products Inc.

Radio Astronomy, by C. R. Borrows of Cornell U.

Time Domain Concept of Communication, by H. G. Lindner of Coles Signal Laboratories.

Electronic Miniaturization Technique in Airborne Equipment, by R. Scal of the National Bureau of Standards.

Cincinnati IRE Conference

THE FIFTH annual Spring Technical Conference of the Cincinnati Section, Institute of Radio Engineers, will be held on April 14, 1951, at the Engineering Society Headquarters in Cincinnati, Ohio.

Papers to be presented include the following:

Results of RCA, NBC, UHF Television Studies in the Bridgeport, Connecticut, Area, by R. F. Guy of NBC.

Analysis of Television Reception at Ultrahigh Frequencies, by R. G. Clapp of the Philco Corp.

Color Television Colorimetrics, by H. L. Brouse of Avco Mfg. Corp.

Methods of Adding Color to Television Images, by R. B. Dome of General Electric Co.

Some Fundamental Considerations in Color Television, by A. V. Loughren of Hazeltine Electronics Corp.

The Ultrahigh Frequency Mega-

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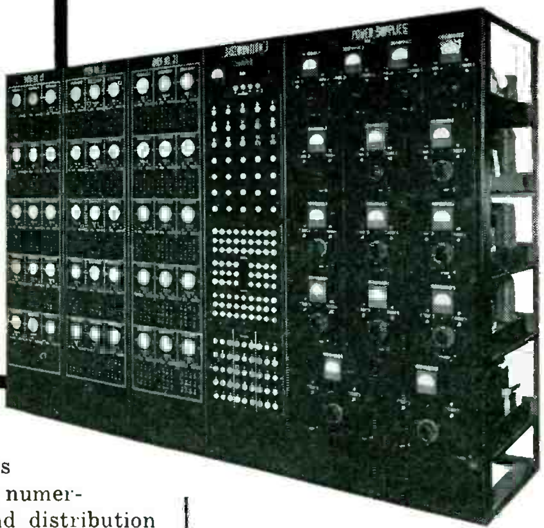
TEST AND CONTROL PANELS



For many years Standard has engineered, designed and built numerous types of test, control and distribution panels for a great variety of industries. These are custom-built to meet the client's individual requirements.

We maintain a corps of skilled engineer consultants who are glad to meet with prospective users of this equipment, and — without obligation — present suggestions, layouts and costs of their needs. We solicit your inquiries and can arrange an appointment to suit your convenience.

This special board was built by us for Sprague Electric Company, North Adams, Mass., for use in making life tests on all types of condensers where high voltages (up to 5000 DC) and precision timing (up to 1000 hours) were requisites.

Right section of the board contains several electronic power packs of different voltages; the left end contains a number of our 1000-hour timers. Particular stress was laid upon safety features.

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Announcing: AN IMPORTANT ADDITION TO THE E-I FAMILY OF SEALED LEADS—

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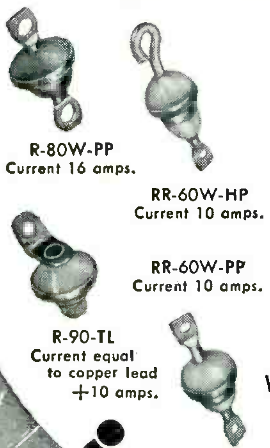

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Current 16 amps.

RR-60W-HP
Current 10 amps.

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Current 10 amps.

R-90-TL
Current equal to copper lead +10 amps.

A completely new line of double barrel terminals that provide added protection against flashover without any appreciable increase in terminal size. The double barrel results in a longer leakage path on both ends of the terminal while the upper barrel increases the mechanical strength of the terminal and facilitates soldering. For information call or write today.

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850 — Hermetically Sealed Headers
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Circuit-Half-Wave. In 9/16" OD Phenolic Tube with ferrule at each end for insertion in Fuse Clips. Overall length varies to 9" depending on the DC output voltage rating.

PARTIAL LIST OF TYPE V-HF SERIES RECTIFIERS AVAILABLE

DC Output Voltage	Rectifier Part No.	DC Output Voltage	Rectifier Part No.
40	V2HF	800	V40HF
80	V4HF	1500	V75HF
200	V10HF	2500	V125HF
600	V30HF	4000	V200HF

TYPE Y-HP SERIES

11 MILLIAMPERES DC

Circuit-Half-Wave. In 9/16" phenolic tube with pigtail leads. The overall length of rectifiers in this series varies up to 9", depending on the DC output voltage rating.

PARTIAL LIST OF Y-HP SERIES RECTIFIERS AVAILABLE

DC Output Voltage	Rectifier Part No.	DC Output Voltage	Rectifier Part No.
20	Y1HP	1000	Y50HP
60	Y3HP	2000	Y100HP
100	Y5HP	3000	Y150HP
400	Y20HP	4000	Y200HP

TYPE V-HM SERIES

5 MILLIAMPERES DC

Circuit-Half-Wave. In 3/8" metallic case with pigtail leads, the negative lead being grounded to the case. Overall length varies to 0.890", depending on the DC output voltage rating. Also available in hermetically sealed units.

PARTIAL LIST OF TYPE V-HM SERIES RECTIFIERS AVAILABLE

DC Output Voltage	Rectifier Part No.	DC Output Voltage	Rectifier Part No.
20	V1HM	160	V8HM
60	V3HM	200	V10HM
80	V4HM	220	V11HM
120	V6HM	240	V12HM

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Cell Type No.	U	V	Y	Z	W
Cell Diam. (In.)	1/8	1/4	3/8	1/2	1
Current Rating (ma.)	1.5	5	11	20	75

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cycle Meter and its Application, by J. B. Minter of the Measurements Corp.

Advance registration and reservations for the luncheon and banquet may be made by mail. Registration fee is $1.50.

RTMA Increases Membership

TWELVE radio-television manufacturers were admitted to RTMA membership by the board of directors at a recent meeting in Chicago. These applications bring current membership total to 319. Following are the new members:

Arthur Ansley Mfg. Co., Doylestown, Pa., Bell Sound Systems, Inc., Columbus, Ohio; Cosmic Radio Corp., New York, N. Y.; Fada Radio & Electric Co., Inc., Belleville, N. J.; Forbes & Wanger, Inc., Silver Creek, N. Y.; General Vacuum Tube Corp., Ardsley, N. Y.; Pioneer Electronics Corp., Santa Monica, Calif.; Product Development Co., Inc., Arlington, N. J.; Radio Apparatus Corp., Indianapolis, Ind.; The Rodefer Glass Co., Bellaire, Ohio; Taylor Tubes, Inc., Chicago, Ill.; and Technology Instrument Corp., Acton, Mass.

BUSINESS NEWS

BENDIX AVIATION CORP. has opened new development laboratories for electronics research and development in Burbank, Calif. An enlarged development program on missiles, instrumentation and other electronic projects will be pushed in the new quarters.

CURTISS-WRIGHT CORP., Wood-Ridge, N. J., has established an electronics division to meet the increased demand for flight simulators, trainers and other products now being developed.

RADIO MATERIALS CORP., Chicago, Ill., recently opened a new plant in Attica, Ind., to increase production of ceramic capacitors.

GENERAL ELECTRIC CO. has begun construction on a new four-story tube manufacturing building located at the rear of its tube plant in Owensboro, Ky.

ELECTRO-CONNECTOR MFG. CORP., producer of electronic and television components, has increased facilities approximately five-fold by the completion of a new plant at 190 W. Glenwood Ave., Philadelphia, Pa.

OLYMPIC METAL PRODUCTS CO., INC., manufacturers of metal housings for transformers and other components, recently completed an enlargement of plant and tooling facilities in Phillipsburg, N. J.

THE J. M. NEY CO., manufacturer of precious metal alloys and component parts for industrial, electrical and electronic applications, has acquired a new plant in East Hartford, Conn., where production facilities are being expanded to meet increasing needs.

THE SESSIONS CLOCK CO., Forestville, Conn., has purchased Tyniswitch Inc., Middletown, Conn. The name will be changed to Tyniswitch Div. of Sessions Clock Co., with manufacturing facilities located in Forestville.

THE RADIAN INSTRUMENT CO., formerly known as the Geotronics Laboratories, Inc., has established its offices and manufacturing plant

New Radian Instrument Co. plant

at 1707 Cedar Springs Ave., Dallas, Texas, to engage in the design, manufacture and sale of geophysical and electronic equipment.

CONDENSER PRODUCTS CO., manufacturers of high-voltage power supplies and capacitors, recently moved to new and larger quarters at 7517 North Clark St., Chicago, Ill.

THORDARSON-MEISSNER DIVISIONS, Maguire Industries, Inc., manufacturers of tuners and coils, have expanded production by bringing to Chicago all the surplus facilities of the Mt. Carmel plant.

GENERAL ELECTRIC CO. has begun building its new million-dollar elec-

tronics plant at Auburn, N. Y., for its Receiver Division.

OWENS-CORNING FIBERGLAS CORP., manufacturer of yarns for electrical insulation, is building a 175,000-sq-ft plant in Anderson, S. C.

DAYSTROM ELECTRIC CORP. is the new name of the electronics equipment manufacturing firm of Frederick Hart & Co., Inc., Poughkeepsie, N. Y.

BENDIX RADIO has leased Pimlico Airport in Baltimore, Md., to meet added space requirements of its production program. The buildings will be remodeled for use as laboratories and classrooms where Air Force ground personnel will be trained to maintain military electronic equipment.

PERSONNEL

ALLAN EASTON, formerly with Teletone Radio Corp. as chief engineer of the production engineering division, has been appointed chief of the microwave section of Radio Receptor Co., Inc., Brooklyn, N. Y.

R. M. BOWIE, formerly manager of the Physics Laboratories of Sylvania Electric Products Inc., Bayside, N. Y., has been appointed to the staff of the company's vice-president of engineering as director of engineering.

R. M. Bowie

E. S. Lee

EVERETT S. LEE, formerly executive engineer of the GE General Engineering Laboratory, Schenectady, N. Y., has been appointed editor of the *General Electric Review,* the company's monthly engineering magazine.

WILMER T. SPICER has been promoted from section chief of the technical publications department to chief engineer of maintenance

services by Bendix Radio Division of Bendix Aviation Corp., Baltimore, Md.

JOSEPH A. DESPRES, for the last 13 years president and chief engineer of Bernard Rice Sons, electronic industry metal fabricators, has joined the staff of the engineering and production division of Airborne Instruments Laboratory, Mineola, N. Y., as administrative assistant in the vice-president and director's office.


J. A. Despres


R. P. Clausen

R. P. CLAUSEN was recently promoted from assistant chief engineer to chief engineer of the radio tube division, Sylvania Electric Products Inc., Emporium, Pa.

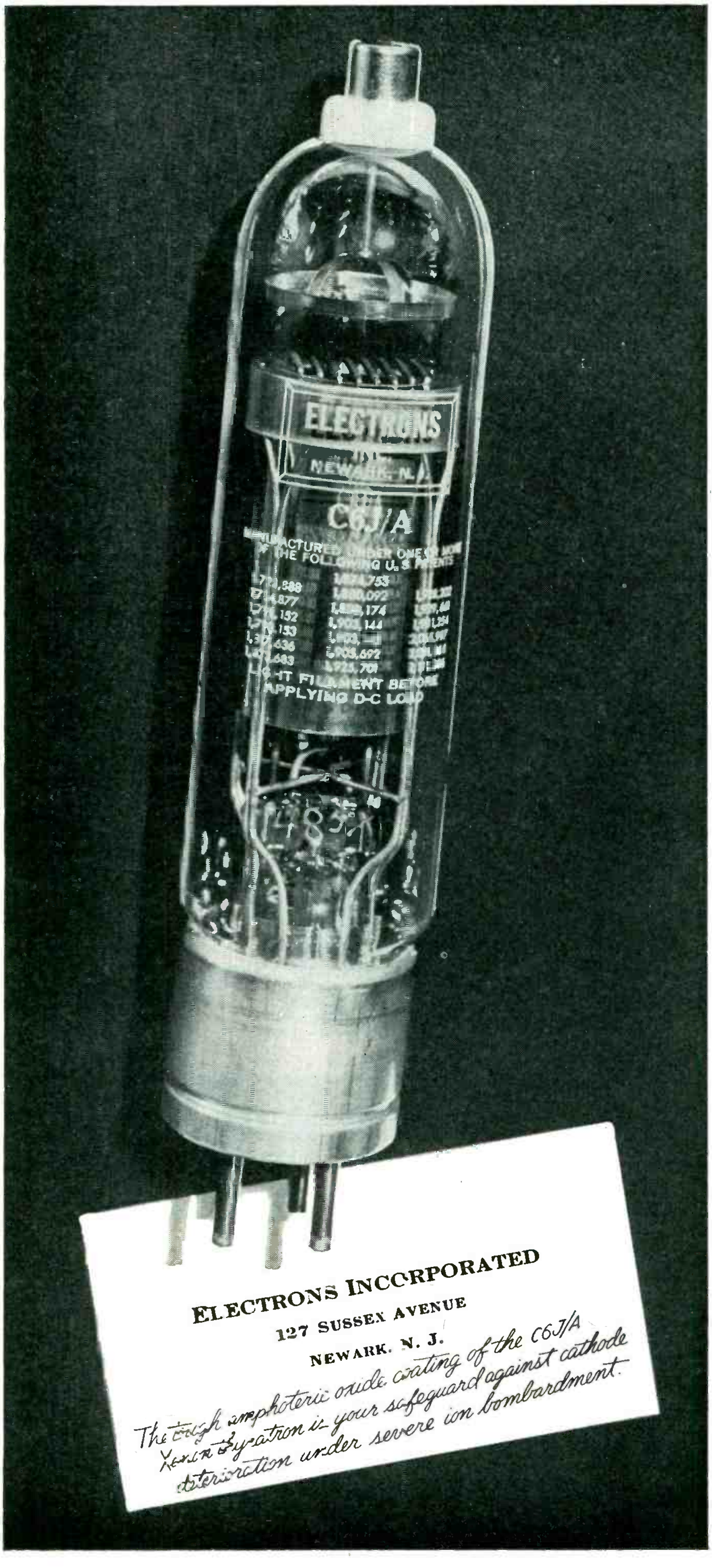
E. A. LEDERER, formerly on the engineering staff of RCA at Harrison, N. J., has been made manager of engineering for the newly-created electronic tube division of Westinghouse Electric Corp., Bloomfield, N. J.

W. NOEL ELDRED of Hewlett-Packard Co. has been appointed chairman of the newly established Palo Alto, Calif., subsection of the IRE.

WILLIAM CRAWFORD, formerly in electrical maintenance, engineering, and the research laboratory of Cannon Electric Development Co., Los Angeles, Calif., was recently appointed to the company's sales engineering staff.

STANLEY WEBSTER, member of the American Standards Association committee that drew up the present specifications for audiometers, has been appointed chief engineer of the Beltone Hearing Aid Co., Chicago, Ill.

JOHN R. SMITH, assistant to vice-president for communications of the Southern Railway System, has been elected 1951 chairman of the



communications section of the Association of American Railroads, Washington, D. C.

GLEN MCDANIEL, vice-president of RCA, was recently elected first full-time paid president of the RTMA.

EDWARD S. WHITE, previously associated with the RCA Industry Service Laboratory engaged in communications development work, was recently appointed assistant chief of advanced development of Air King Products Co., Inc., Brooklyn, N. Y.

WILLIAM HARGREAVES, formerly engaged in the development of servo motors, has been appointed vice-president in charge of engineering for Transicoil Corp., New York, N. Y.

ROBERT F. FIELD, after 21 years' work in impedance standardization, electrical measurements, particularly with bridge circuits, and the study of dielectric materials, has retired from the General Radio Co. engineering department.

R. F. Field

D. B. Harris

DONALD B. HARRIS, formerly executive assistant to the director of research of Collins Radio Co., Cedar Rapids, Iowa, was recently named technical assistant to the president of Airborne Instruments Laboratory, Mineola, N. Y.

JOHN L. DOONER recently left the antenna laboratories of Amy, Aceves and King to join the Brach Mfg. Corp. of Newark, N. J., a division of General Bronze Corp., as antenna research engineer.

CHARLES BANGERT, JR. has been promoted from assistant manager to manager of engineering for the Trumbull Electric Mfg. Co., Plainville, Conn.

NEW BOOKS
(continued from p 152)

frequency transmission line networks and filters. Matrix algebra, a necessary tool in this approach, is reviewed for the benefit of the uninitiated and for the sake of completeness in a separate appendix.

In the final section an introduction to Maxwell field equations is given, including some applications thereof to electromagnetic wave propagation along wave guides. In keeping with current practice, the rationalized mks units are used in presenting the field equations.

Although a great deal of information is already contained in this book, it would seem to this reviewer that some improvement would be possible in a subsequent edition through an expansion of the section on wave guides.

The text is nicely illustrated throughout with descriptive diagrams, charts and circuits. Illustrative problems are given at the conclusion of each chapter.—PHILLIP H. SMITH, *Military Electronics Dept., Bell Telephone Laboratories.*

Transmission Lines and Networks

BY WALTER C. JOHNSON. *McGraw-Hill Electrical and Electronic Engineering Series, McGraw-Hill Book Company, Inc., New York,* 1950, 361 *pages,* $5.00.

THIS is the first edition of a book presenting, in two parts, the basic principles of transmission lines and four-terminal networks, respectively. Although basically a textbook for undergraduate students, the material covered should be of considerable interest to practicing engineers in both the power and communication fields. In writing this book Professor Johnson has been able to draw on a backlog of material developed through practical classroom experience at Princeton University to produce a very readable text.

In general, the subject matter is preceded by a qualitative discussion which permits a clear physical understanding in advance of the mathematical analysis. The physical viewpoint is maintained

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Anti-Corona high heat-resistant compounds for Fly Back Transformers.

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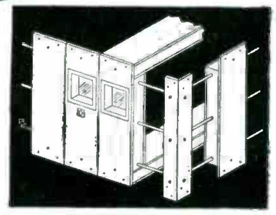

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throughout the entire volume.

Part one of the book discusses distributed constants and traveling waves, followed by general transmission line theory as applied to both power and communication frequencies, the latter extending into the radio-frequency range. Also included in Part one is an illuminating chapter discussing the development of modern transmission-line charts, with typical examples of their use. Following the presentation of general material, considerations are given, separately, to special problems in connection with radio-frequency lines, telephone and telegraph lines, and power lines.

Part two of the book, comprising the last third, deals with four-terminal networks including attenuators, impedance-matching networks and filters. A review of network principles and theorems precedes the more specific analysis of these devices. The treatment is entirely conventional, Kirchhoff's laws being used, for example, as the basis for setting up the equations which describe network performance. The two final chapters discuss the theory, design and application of elementary types of electric wave filters.

This book is, on the whole, outstanding from the standpoint of clarity of presentation of the subject matter. Examples are worked out in detail at various points throughout the text which are of considerable help in this respect.—PHILLIP H. SMITH, *Military Electronics Dept., Bell Telephone Laboratories.*

Introduction to Industrial Electronics

BY R. RALPH BENEDICT, *Professor of Electrical Engineering, University of Wisconsin. Prentice-Hall, Inc., New York,* 1951, 436 *pages,* $6.35.

AS THE author says in his preface, industrial applications of electronic devices have multiplied rapidly during the last decade, with the result that interest among industrial engineers and engineering students in the subject of electronics has increased. This book is aimed at starting such students and engineers on the right path in their

study and applications of tubes to industrial problems. It is in fact an introductory course in general electronics, with a rather special and not too detailed attention to some fundamental industrial applications.

The first 260 pages deal with tubes themselves and their basic circuits. Then follow chapters on induction and dielectric heating, electronic relay circuits, welding control, motor control and industrial instrumentation.

The book is not too large either in format or in number of pages and is, therefore, easy to handle and to use.—K.H.

Encyclopedia on Cathode-Ray Oscilloscopes and Their Uses

By John F. Rider and Seymour D. Uslan. *John F. Rider Publisher, Inc., New York*, 1950, 992 *pages*, $9.00.

ALTHOUGH the authors explain in the foreword to this book that some readers having special interest may find that it has limited coverage, the book quite adequately backs up its title for the average reader. Nearly all of the chapters are descriptive and consist of running text rather than a dictionary style of unrelated definitions. The authors assume that the reader has a general background in electricity, magnetism and vacuum-tube theory and desires to know the inner workings of the oscilloscope and methods of using it in conjunction with electronic devices. More than a third of the pages are devoted to applications of the oscilloscope and auxiliary equipment to measuring, testing and adjusting communication and industrial electronic gear.

A 106-page section is devoted to the circuits of commercial oscilloscopes and descriptions of special circuits they contain. Nearly all of these contain values of components. This data should prove useful not only for maintenance of a particular model but also for study of special features of other models that are desirable to adopt in present equipment.

Early in the text, a thorough description is given of the various types of construction employed in

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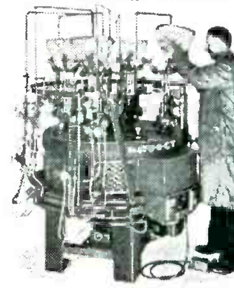

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The JK Stabilized H-17 Crystal fully meets CAA requirements as well as JAN Specifications MIL-C-3098. Rugged and dependable despite small size and light weight, the H-17 is intended for the compact communications equipment of tomorrow.

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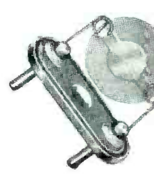

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When designing military equipment be sure to consult MIL-C-3098 Crystal Specifications. Copies of condensed version are available from JAMES KNIGHTS.

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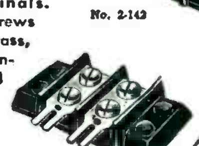

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No. 2-142-Y

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Six series meet every requirement: No. 140, 5-40 screws; No. 141, 6-32 screws; No. 142, 8-32 screws; No. 150, 10-32 screws; No. 151, 12-32 screws; No. 152, ¼-28 screws.

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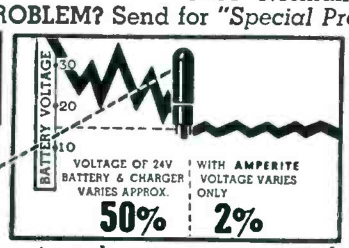

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cathode-ray tubes from the gas-focused Western Electric 224 of the early 20's up to the present 16 and 19-inch tubes. The J-scan type of radial deflection used in war-time radars is included. Special-purpose cathode-ray tubes are discussed in a separate chapter. These include the image orthicon, iconoscope, monoscope, graphecon, image dissector, transcriber kinescope, isocon, skiatron and tuning-eye tubes.

A novel aid to the reader is a collection of synthesized waveform patterns, a total of 1,580 extending over 79 pages. These are provided for those readers who do not have a harmonic wave analyzer available. The patterns are printed in black on a white background and are limited to those most likely to be encountered in practice. They consist of three types of combinations: fundamental and one harmonic (2nd to 8th); fundamental plus two harmonics (2 and 3, 2 and 4, 3 and 5); and two harmonics, no fundamental (2 plus 3, 2 plus 5, 3 plus 5, 4 plus 5 and 5 plus 6). Five amplitude intervals are used in each case.

Because this waveform section is a distinct innovation, the response received from readers will determine whether this illustrative material will be expanded in later volumes or appear in a separate volume. A complete set of synthesized waveforms could easily amount to more than 50,000 units, a monumental work.—V.Z.

Microwave Electronics

BY JOHN C. SLATER. *D. Van Nostrand Co. Inc., New York*, 1950, 406 *p*, $6.00.

PROFESSOR SLATER has written a remarkable book on the fundamental theories of microwave electronics. In fourteen chapters the book extensively covers the more basic microwave structures (especially cavities) and the fundamental theory of all the modern microwave tubes (up to and including the traveling-wave tube) and particle accelerators.

There are 60 pages on fundamentals, covering the wave guide, reflection and standing waves, and power and energy relations. There are 130 pages on the theory of resonant cavities, the resonant cavity with one output, the cavity with

two outputs, the cavity with several outputs and coupled cavities, and the periodically loaded wave guide. The second half of the book (200 pages) discusses fundamental principles of electronic devices, the klystron, the linear accelerator, the traveling-wave amplifier, the magnetron oscillator, and the cyclotron and synchrotron.

This book is written on a high mathematical level. The reader will look in vain for design formulas and charts. Instead, he will find a rigorous and highly mathematical treatment in which Prof. Slater, disregarding equivalent circuits and analogies with lumped circuit theory, uses orthogonal functions (normal modes of oscillation) to treat microwave circuits, thereby providing a more satisfying and systematic approach. Thus, the book is intended for the engineer with advanced training and for the physicist. A knowledge of electromagnetic theory and advanced calculus is required. The omission of intermediate mathematical steps provides Prof. Slater with space for extensive discussions which are clear and concise. The book contains so much interesting information that the reader will make slow progress if he wishes to assimilate all of it.

Many readers will recognize part of the material as having previously been published in the *Review of Modern Physics* (1946) and in MIT Radiation Laboratory and Bell Telephone Laboratories reports.

Professor Slater uses a relation between the Q's which is somewhat more general than the one usually found. His definition (p 76) is:

$$\frac{1}{Q_{Loaded}} = \frac{1}{Q_{Unloaded}} + \frac{g}{Q_{External}}$$

where g is essentially the normalized load conductance. Slater's $Q_{External}$ is still the usual one, being defined as the ratio of energy stored in the cavity to energy dissipated in the matched load, but his formula holds whether the load is matched or not. For $g = 1$ the formula of course reduces to the usual one which holds for a matched load only.

The book can be greatly recommended not only to the microwave circuit engineer but also to the

microwave tube engineer. The reader who prefers to skip the mathematics will still find the tremendous amount of basic material in this book of great interest.—FRANK R. ARAMS, *Tube Department, RCA, Harrison, N. J.*

Photons and Electrons

BY K. H. SPRING. (*A Methuen monograph*) *John Wiley & Sons, Inc., New York,* 1950, 108 *pages,* $1.75.

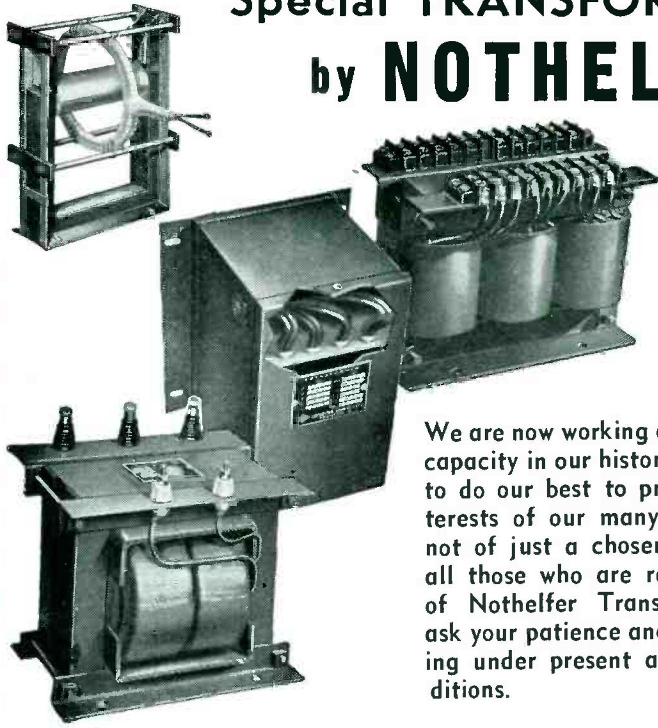
THIS MONOGRAPH is concerned with the general problem of the interaction of radiation with matter, and specifically with the interaction of photons and electrons, primarily at the high energies encountered in x-ray, nuclear and cosmic-ray phenomena. The key experimental facts are presented and analyzed in terms of the quantum theory of radiation.

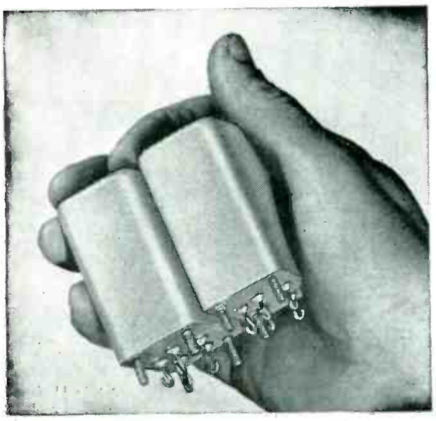
The book is obviously intended for the researcher in high-energy physics. It will doubtless prove valuable to students embarking on a research program in this field, since it assembles in a small package a quantity of material that has heretofore been scattered through the literature of physics. The reader will find a background of graduate study in modern physics indispensable. The book lives up to the usual high standards set by other Methuen monographs on physical subjects.—R. C. RETHERFORD, *Asst. Prof. of Elec. Eng., Univ. of Wisc.*

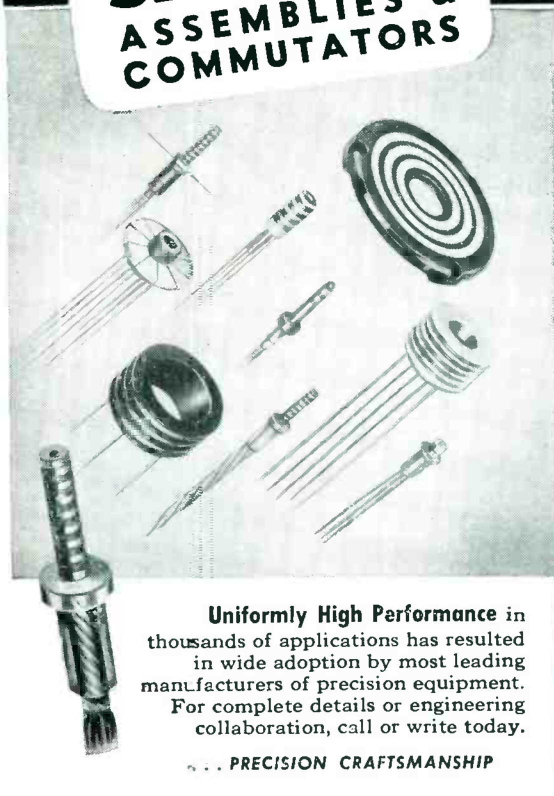
Mobile Radio Handbook

EDITED BY MILTON B. SLEEPER, J. COURTNEY AND R. ALLISON. *FM-TV Magazine, Great Barrington, Mass.,* 1950, 190 *pages,* 8¾ *x* 11½ in., $2 *(paper) or* $4 *(cloth).*

THIS FIRST EDITION of a book addressed to company executives and public officials as well as to communications engineers begins to fill a growing need for information about the equipment and the uses for mobile radio. The chapter headings give a clear index to the many interrelated topics that are covered. Included are: basic system planning, FCC rules and frequency allocations, license application pro-







cedure, available commercial equipment specifications, selective calling, adjacent-channel operation, antenna design, guyed-tower erection, radio relay systems, maintenance, operator licensing and general f-m theory.

What faults the book may have arise from the problem of including everything of importance within two covers. While one might wish for a broader treatment of such items as selective calling, adjacent-channel operation and guyed-tower erection, it is recognized that broad, definitive treatments are very hard to come by.

In common with any manual that attempts to summarize and clarify rules and regulations, this one will doubtless be subject to early obsolescence. However, the great strength of the book is its many summaries of legal and technical information.

The typical "Milt Sleeper diagrams" and the added historical notes are the personal hallmark of the editor who has evidently labored to insure good value for workers in this important and growing field.
—A. A. McK.

THUMBNAIL REVIEWS

PROCEEDINGS OF THE NATIONAL ELECTRONICS CONFERENCE, 1950. National Electronics Conference, 852 East 83rd St., Chicago 19, Ill., $4.00. Complete presentation of sixty papers presented at the conference, bound in hard covers.

MAKING MONEY IN TELEVISION SERVICING. By Eugene Ecklund. Howard W. Sams & Co., Inc., Indianapolis, 1951, 136 pages, $1.25. Practical chapters on planning, starting and operating a television service organization, with emphasis on such business aspects as accounting procedures, service charges and customer relations.

RADIOFILE. Richard H. Dorf, Publisher, 255 W. 84th St., New York 24, 1950 annual issue, 22 pages, $0.50. Subject index to technical articles published during 1950 in 15 radio and electronic periodicals, including ELECTRONICS.

TV MASTER ANTENNA SYSTEMS. By Ira Kamen and R. H. Dorf. John F. Rider Publisher, Inc., New York, 1951, 356 pages, $5.00. Installation, maintenance, usage, manufacture and merchandising, as applied to 14 major types of nonamplified and amplified master antenna systems now available for apartment houses, hotels and other buildings. Nonamplified systems covered are: Amy, Aceves and King; Brach Mul-Tel; Lynmar; TEC. Amplified systems covered are: RCA Antenaplex; Intra-Video; Lynmar; Transvision Amplitel; Brach Mul-Tel; RMS; TACO; Multitenna; TEC; Jerrold Mul-TV. Guest and Hotelevision video distribution systems are covered in a separate chapter.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BACKTALK
(continued from page 154)

formulas indicated by Rideout can be obtained by applying our formulas with particular values.

Our calculation is based on the assumption that the mismatching factor at the cutoff frequencies is equal to the mismatching factor at the mid-frequency. We assume the ratio between input impedance at the cutoff frequencies and input impedance at the mid-frequency to be r^2.

The characteristic impedance of the transmission line to be matched is the geometric mid-value of the two aforementioned impedances.

We calculate from the conceded value r^2 and the required bandwidth $\Delta f / f_m$

$$Q = \frac{f_n \sqrt{r^2 - 1}}{\Delta f}$$

By this term the design formulas for the matching transformers may be expressed:

$$C_1 = \frac{1}{\omega_m R_1} \cdot \frac{r}{Q}$$

$$L_1 = \frac{R_1}{\omega_m} \left(\frac{r}{Q} + \frac{Q}{r} \right)$$

$$R_2 = \frac{Q}{\omega_m C_2}$$

$$L_2 = \frac{1}{\omega_m^2 C_2}$$

$$K = \frac{1}{\sqrt{1 + \frac{Q^2}{r^2}}}$$

Substituting the above formulas by setting in $r^2 = 2$, the formulas indicated on page 160 of the above-mentioned article in ELECTRONICS are obtained.

The formulas applied by us produce a greater bandwidth at equal gain or a higher gain at equal bandwidth in the event a greater mismatching factor is conceded.

FRITZ STEINER
*United Telephone and Telegraph Works Ltd.
Vienna, Austria*

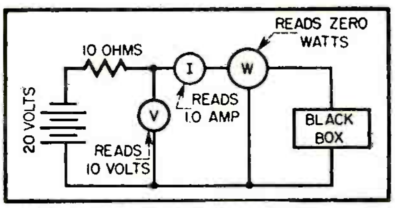
Electronics Quiz

THIS month's quiz problem was furnished by T. W. Nelson, of Alexandria, Virginia. Readers are encouraged to submit problems (with correct solutions) for use in this department. For each problem pub-

lished, the contributor will receive our check for five dollars.

This Month's Problem

Consider the circuit diagram shown. The battery supplies 20 volts d-c with no internal resistance. The voltmeter, ammeter and wattmeter are average or rms indicating, and for this problem they require no power to operate.



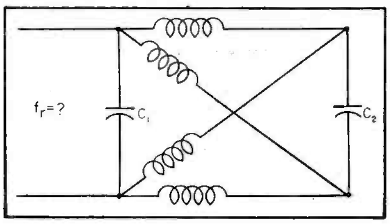
The apparent power dissipation in the black box is 10 watts according to the voltmeter and ammeter, but the zero wattmeter indication is a contradiction of this. What is in the little "black box?"

Answer will appear next month.

Last Month's Solution

THE PROBLEM published last month was as follows:

What is the resonant frequency of the circuit shown?



All inductances are 50 mh, and both capacitors have values of 0.01 μf.

Solution. Since C_2 is connected between two points of equal potential, no current will flow through it, and it will have no effect on the rest of the circuit. Omitting C_2, we consider the inductances to be in series parallel. This is equivalent

to a single inductance of 50 mh in parallel with C_1. Thus $f = 1/2\pi\sqrt{LC} = 7{,}120$ cps.

Equivalence

DEAR SIRS:

IN REFERENCE to the article "Resistance-Coupled Amplifier Bandwidth" by B. A. Lippmann, in the January 1951 issue of ELECTRONICS, it is only fair to point out that the equivalence of the R-C coupled amplifier to a single-tuned circuit has been discussed at least four years previously by J. Roorda, Jr. of Holland, in the October 1946 issue of *Radio* (now *Audio Engineering*). I should point out that the practical example in the *Radio* article contained a decimal-point error, which is not Roorda's slip, but the editor's.

R. G. MIDDLETON
Woodside, N. Y.

Cross Correlation

DEAR SIRS:

IN THE LAST FEW YEARS, ever since Norbert Wiener advanced his ideas in the field of Cybernetics, we have been hearing a lot of discussion on the subject of cross correlation and its use in the detection of signals when obscured by noise. However, nowhere do we see any public mention that cross correlation is simply a fancy name for a technique whose extraordinary ability to extract signals from noise was recognized and used long before Wiener et al, came into public notice.

This technique is the detection of a signal in a phase detector followed by a low-pass or long-time-constant filter to average the output of the detector. This technique is used in many types of radar; in the omni-directional beacons; in c-w range-measuring equipment and in other equipment where a phase-coherent reference can be obtained. Even the single-side-band-exalted-carrier system exhibits some of these same characteristics.

It can be shown that a mathematical analysis of the phase detector filter combination leads directly to

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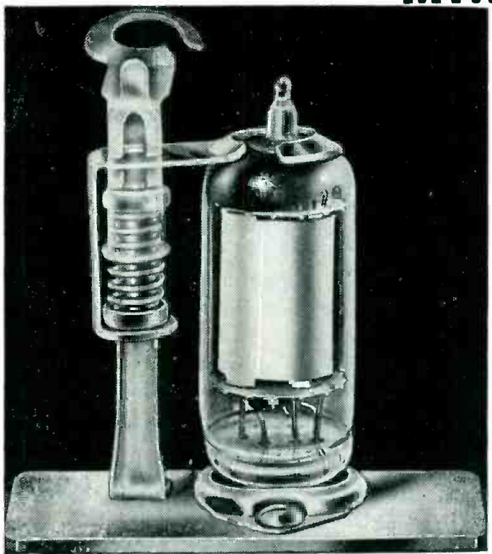

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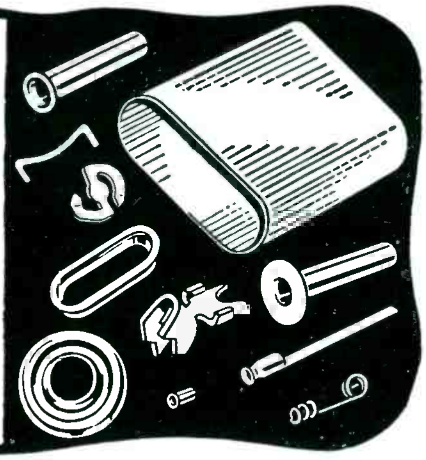

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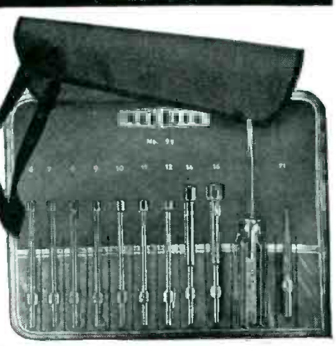

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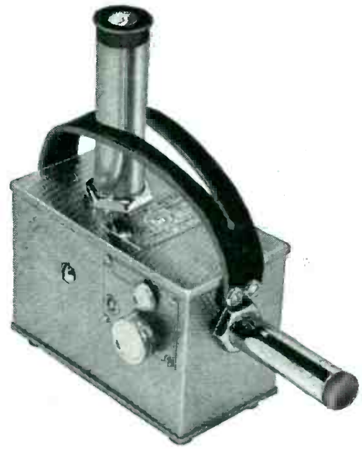

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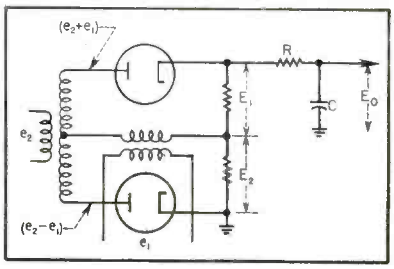
the cross-correlation integral. Consider a phase detector followed by an R-C filter as in the figure. If we



consider the phase detectors to be square law, then the d-c voltages appearing across the load resistors will be, respectively

$$E = a_0 + a_1(e_1 + e_2) + a_2(e_1 + e_2)^2$$
$$E = a_0 + a_1(e_1 - e_2) + a_2(e_1 - e_2)^2$$

The output of the detector is the difference of these two voltages, hence expanding them and combining terms gives

$$E_1 - E_2 = 2a_1e_2 + 4a_2e_1e_2$$

The R-C circuit can be considered to be a reasonably good integrator if properly designed for the type of signals to be received, hence the system output will be

$$E_0 = K_1 \frac{1}{t} \int_0^t e_1(t)\,dt + K_2 \frac{1}{t} \int_0^t e_1(t)\,e_2(t)\,dt$$

If we consider e_2 to be the local reference whose average value is zero, then only the second integral term remains, which is the cross correlation integral.

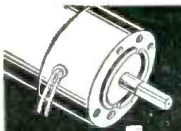
To reach this conclusion, it was necessary to assume square-law detectors and that the R-C network will produce a reasonably true average. Both considerations are normally satisfied in physically realizable equipment.

WINSLOW PALMER
West Hempstead, N. Y.

A Briton Speaks

DEAR SIRS:

IN THE August 1950 issue of ELECTRONICS you published an article by Major Chang Sing describing a "Series Sawtooth Oscillator". The author states that there has been no circuit of relaxation oscillators employing tubes in series. May I



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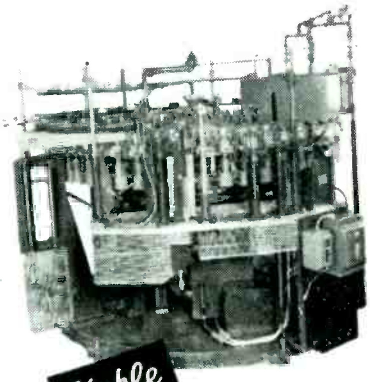

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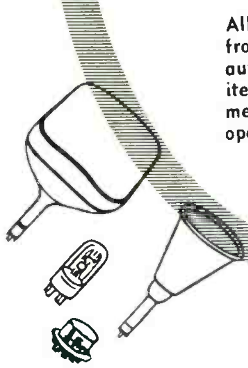

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point out that the firm of A. C. Cossor of this country produces a double-beam oscillograph, No. 1035, using such a circuit, which has several extra features, one being that it has the *stroke* triggered, and another that it can be made single-stroke or self-running very simply. I have no connection with Cossor.

May I also say how much I enjoy your publication and remark on the improvement in circuit diagrams over the past few years. American journals generally still have a long way to go to catch up to British practice but you now nearly always have B + lines at the top and B – lines at the bottom which is a great help. It is, however, a bit odd to refer to metres as meters, and I personally expect a "two-meter receiver" to have two meters (those devices which measure).

There is a small error on page 106 of the August issue, in Fig. 6. The slider of the 250,000 (we would denote it 250K) potentiometer is connected to B –, and as one end goes to B + there would be unpleasant effects if the control should be set at that end, and, of course, in any case the unit could not work with the control set anywhere. The short line between the slider and B – should obviously be a capacitor.

International Television

The summary of the demonstrations of television seen by the study group on television standards, by D. G. Fink, was very interesting indeed to me. In such a study there will inevitably be a certain amount of opinion that one's own system is best and that the "others" must see the arguments and agree to changes; 25 or 30 frames per sec was a typical example where each wanted to be tied to mains frequency. It is difficult to make a *cheap* receiver operate on a different frequency and it is the cheap receiver which has to be made cheaply. It is relatively easy to make an expensive receiver.

For the same reason f-m for sound is a great disadvantage and it is a pity that the group did not take advantage of an experiment being carried out by our B.B.C. and which has been going on for

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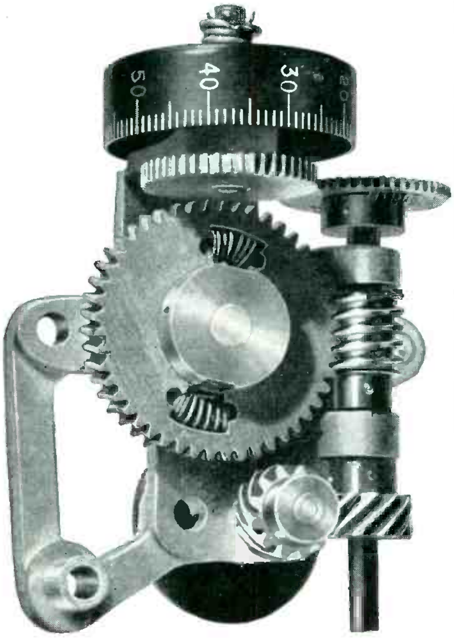

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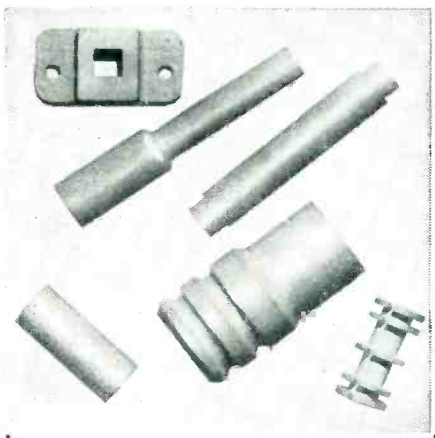

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several years so far—broadcast of the same programme, at about 90 mc, on f-m and a-m from the same site. By this means we are able to test the relative merits of the two methods. I have attended a number of tests and know of a great number more, and personally cannot tell the difference between the two programmes by fidelity or interference tests, provided the a-m receiver has a noise limiter consisting of a diode, or at the most a double diode. Nor have I met anyone else who can. When one considers the relative complexity of the f-m receiver in manufacture, tuning and servicing, I think there are strong reasons for a-m.

Positive Modulation

The fact that f-m on vhf is so often compared to a-m on m-f is very misleading. The B.B.C. experiment is much more instructive. The white dots experienced from interference on positive modulation systems can be inverted to black dots very simply or, more generally, limited to peak white, and the additional effort required is very much less that that to make the time bases run stably in the negative and less stable system.

The argument that such complexity is required to protect the scanning generators from thermal noise is baseless as few receivers can be operating at such high sensitivity. If they do, such receivers must be complicated in any case, but that is no reason why people with better signals shouldn't have a much cheaper receiver.

It is extremely rare for hold controls to be adjusted in modern British receivers, and most manufacturers tuck them out of the way so that they will not be accidently touched.

I could go on with what I consider to be overwhelming arguments for vertical polarization, 405 lines, and 2.75 mc in a system which caters for both the very cheap and the very expensive receiver, but will conclude by stating that a modern British design using a total of 13 tubes has a sensitivity such that noise is just visible on full sensitivity (no extra sensitivity is therefore profitable), has but one tube each for horizontal and vertical

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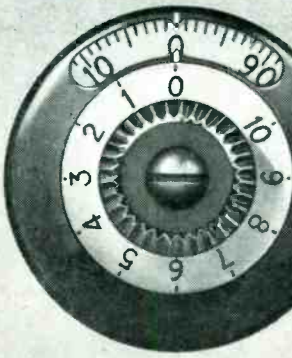

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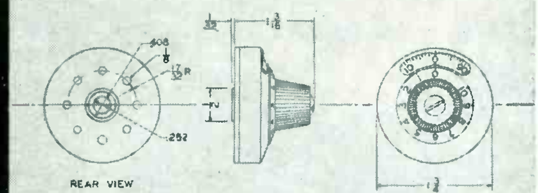

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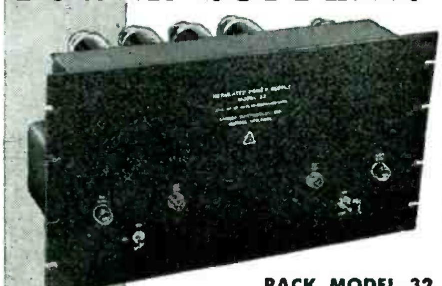

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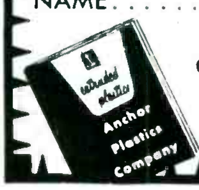

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C. H. BANTHORPE
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Errata

DEAR SIRS:

THERE are several important errors in your printing of my article, "Thyratron Grid Circuit Design" (p 106, March, 1951).

Figure 1B, which is a sketch of anode current, should appear directly above that of initial inverse voltage to show their time relation.

Near the bottom of the first column on page 107 the reference should be to the circuit drawing labeled Fig. 2F, not 2G. Figure 2D caption does not apply to the drawing shown, but to the drawing shown as Fig. 2E. The correct caption for Fig 2D is "Discharge of stored energy in a capacitor charged negatively during the negative anode half cycle". Figure 2G title does not apply to the drawing shown, but to the drawing shown as Fig. 2F. The correct caption for Fig. 2G is "Recent developments in small magnetic amplifiers make possible another means for thyratron grid control. In the milliwatt power output range such amplifiers have response times sufficiently fast to be useful, as shown in the

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accompanying diagram".

In Fig. 4 the extra pair of grid resistors should be omitted.

The caption for Fig. 7C should read "Stray capacitance charging current flow through high-impedance transformer produces noise on the grids of the off tubes".

JAMES H. BURNETT
Electrons Incorporated
Newark, New Jersey

DEAR SIRS:

PLEASE NOTE the following error in my article as published in your March issue (p 140). The word frequency, which was erroneously inserted in the title, the preceding index and the captions, should read "voltage". The title, for example, should read "Transistor Voltage-Multiplying Circuit" and not Transistor Frequency-Multiplying Circuit". As the circuit function denoted is entirely erroneous, I would appreciate publication of this correction.

W. B. BOWERS
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Nothing New

DEAR SIRS:

THERE IS really nothing novel about the broadcast-band converter circuit shown in connection with the article "Gain-Doubling Frequency Converters" on page 95 of the January issue. It is merely the old suppressor-gird - autodyne converter, which was used extensively in the early 1930's before the development of the penta-grid tube. At that time, it was abandoned due to its inefficiency and unreliability. However, it is possible that the increased suppressor transconductance of the tube which Aske used served to overcome those disadvantages. In such a case, the tube and not the circuit should receive the credit for the good performance that is observed.

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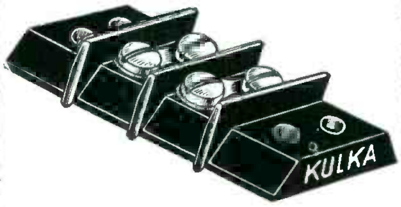

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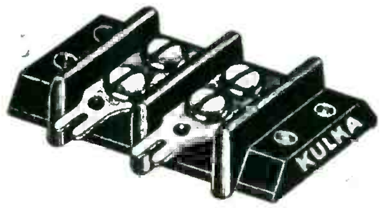

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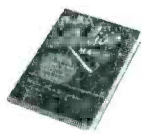

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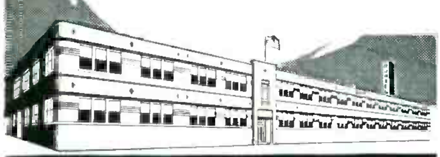

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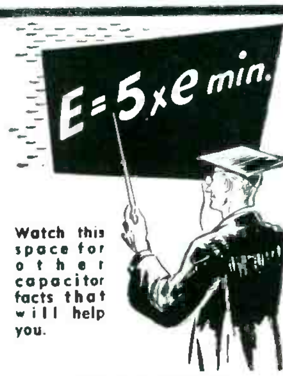

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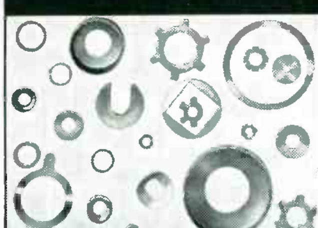

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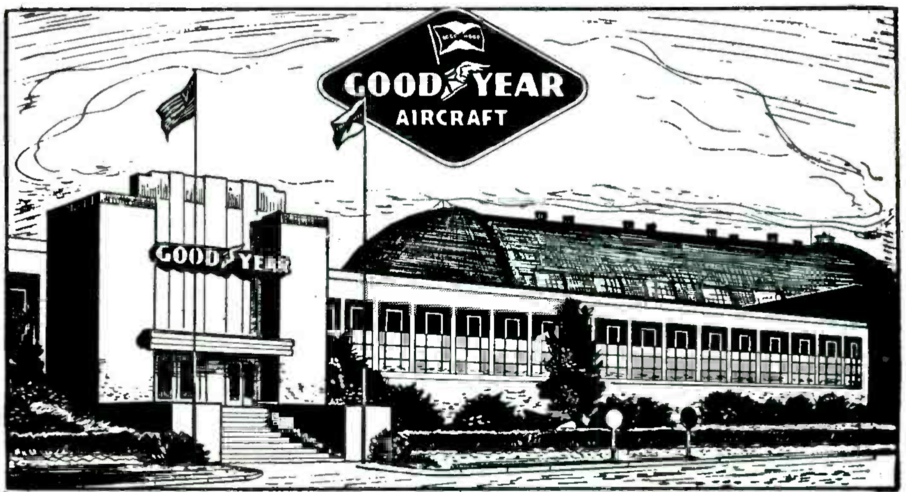

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720CY
725-A
730-A
728
700
706

KLYSTRONS

723A
707B
417A
2K41

TEST SETS

TS 12
TS 33
TS 35
TS 36
TS 45/APM 3
TS 62 3CM
TS 108

SCR 584 PARTS AVAILABLE

BC1056A
BC1058A
BC1086B
RA71A
BC1090A
BC1090B
BC1096A
BC188B
BC105BB
BC1094A
BC1088A

SONAR SYSTEMS

QBF
QBG
QC
QCJ
QCL
QCO
QCS
QCU
WEA

3000 MC. BENCH TEST PLUMBING

SIGNAL GENERATOR, using 417A klystron, 2700-3300 mc. Output approx. 50 mw. 115 vac power supply. With tubes, new.....$425

10 CM RF PACKAGE, using 2J22 magnetron, freq. range 3267-3333 mc, complete with power supply and pulser giving apx. 20 kv @ 30 A, 1 usec, 1000 PPS. Power output 265 kw. 7/8" rigid coax plumbing thruout. Uses 417A klystron mixer, 6Ac7 preamp. Pulser is 715 B HARD TUBE. Complete RF unit, pulser unit, receiver front end, new, with tubes. Requires 115v, 400 cy ac primary source $385

RECEIVER POWER SUPPLY for GL 446 type lighthouse tubes (2C40, etc.) 115 vac, 60 cycles. Panel mounting. Less tubes $32.50

10 CM DISH AND DIPOLE ASSY: apx. 30" parabola, with 360 deg. rotating mechanism, and approx. 10 deg. tilt mechanism. Operating from 24 vdc. With selsyn.....$85

10 CM LOW POWER tunable load with circ. cover.....$225

COAX. CRYSTAL MOUNT, type N connectors.....$17.50

RT-39/APG-5 10 CM light house RF head c/o Xmtr.-Recvr-TR cavity, compl. rcvr & 30 MC IF strip using 6AK5. (2C40, 2C43, 1B27 lineup) w/Tubes.

721A TR BOX complete with tube and tuning plungers.....$12.50

McNALLY KLYSTRON CAVITIES for 707B or 2K28. Three types available $4.00

F 29/SPR-2 FILTERS, Type "N" input and output.....$12.50

WAVEGUIDE to 7/8" rigid coax "Doorknob" Adapter, Choke Flange, Silver Plater Broad Band.....$32.50

WAVEGUIDE DIRECTIONAL COUPLER, 27 db. Navy type CABV 47AAN, with 4 in. slotted section.....$32.50

SQ. FLANGE to rd choke adapter, 18 in. long OA 1½ in. x 3 in. guide type "N" output and sampling probe.....$27.50

AN/APR5A 10 CM ANTENNA equipment consisting of two 10 cm waveguide sections, each polarized 45 degrees.....$5.00 per set.

POWER SPLITTER: 726 Klystron input dual "N" output.....$5.00

MAGNETRON COUPLING FOR TYPE 720 MAG. to 1½" x 3" Waveguide $35.00

10 CM WAVEMETER WE type B43549 Transmission type. Type N Fittings Veeder Root Micrometer dial, Gold Plated W/Calib. Chart P/o Freq. Meter X66404-A. New.....$99.50

AS14A/AP-10 CM Pick up Dipole with "N" Cables.....$4.50

LHTR. LIGHTHOUSE ASSEMBLY Part of RT39 APG 5 & APG 15. Receiver and Trans Cavities w/assoc. Tr Cavity and Type N CPLG. To Revr. Uses 2C40, 2C43, 1B27. Tunable APX 2400-2700 MCS. Silver Plated.....$49.50

BEACON LIGHTHOUSE CAVITY 10 cm with miniature 28 volt DC FM motor. Mfg. Bernard Rice.....$47.50 ea.

MAGNETRON TO WAVEGUIDE Coupler with 721A Duplexer Cavity, gold plated.....$45.00

7/8" RIGID COAX.—3/8" I. C.

7/8" RIGID COAXIAL TUNING STUBS with vernier stub adjustment. Gold Plated $17.50

7/8" RIGID COAX ROTARY JOINT. Pressurized. Sperry #810613. Gold Plated $27.50

DIPOLE ASSEMBLY. Part of SCR-584.....$25.00 ea.

ROTARY JOINT. Part of SCR-584.....$35.00 ea.

RIGHT ANGLE BEND, with flexible coax output pickup loop $8.00

SHORT RIGHT ANGLE BEND, with pressurizing nipple.....$3.00

RIGID COAX to flex coax connector.....$3.50

STUB-SUPPORTED RIGID COAX, gold plated 5" lengths. Per length $5.00

RT. ANGLES for above $2.50

RT. ANGLE BEND 15" L. OA $3.50

FLEXIBLE SECTION. 15" L. Male to female.....$4.25

MAGNETRON COUPLINGS to 7/8" rigid coax, with TR pickup loop, gold plated $7.50

FLEX COAX SECT. Approx. 30 ft.....$16.50

CG 54/U—4 foot flexible section ¼" IC pressurized.....$15.00

7/8 RIGID COAX. Bead Supported.....$1.20

SHORT RIGHT ANGLE BEND.....$2.50

6000 Mc to 8500 Mc BENCH TEST PLUMBING
1½" x ¾" Waveguide

KLYSTRON MOUNT, DB356 complete with shield and tunable termination $125.00

FLAP ATTENUATOR, DB361 .....$45.00

VARIABLE STUB TUNER $90.00

WVGD. TO TYPE "N" ADAPTER $18.50

WAVEMETER TEE. DB352 .....$32.50

MAGIC TEE $80.00

DIRECTIONAL COUPLER, two hole 25DB coupling, type "N" output $25.00

PRECISION CRYSTAL MOUNT. Equipped with tuning slugs and tunable termination $125.00

TUNABLE TERMINATION. Precision adjust $70.00

LOW POWER LOAD.....$35.00

4000 to 6000 Mcs BENCH TEST PLUMBING
2" x 1" Waveguide

FLAP ATTENUATOR...$48.00

VARIABLE STUB TUNER AND LOW POWER TERMINATION $48.00

WAVEMETER TEE $48.00

ADAPTERS:
Choke to choke.....$18.00
Cover to cover.....$14.00
Choke to cover.....$16.00

WAVEGUIDE TO TYPE "N" ADAPTER $45.00

DIRECTIONAL COUPLER. Two hole type "N" output $48.00

KLYSTRON MOUNT. Equipped with tunable termination and micrometer adjust. Klystron antenna tuning $110.00

CRYSTAL MOUNT. Equipped with tunable termination and micrometer adjust crystal tuning $125.00

TUNABLE TERMINATION. Precision adjust $90.00

23,000 to 27,000 Mc BENCH TEST PLUMBING
½" to ¼" Waveguide

LOW POWER LOAD....$20.00

SHUNT TEE.....$35.00

WAVEGUIDE LENGTHS. 2" to 6" long, gold plated with circular flanges and coupling nuts .....$2.25 per inch

APS-34 ROTATING JOINT $49.50

RIGHT ANGLE BEND E or H Plane, specify combination of couplings desired $12.00

45° BEND E or H Plane, Choke to cover.....$12.00

MITERED ELBOW, cover to cover $4.00

TR-ATR-SECTION. Choke to cover $4.00

FLEXIBLE SECTION 1" choke to choke $5.00

"S" CURVE CHOKE to cover $4.50

ADAPTER, round to square cover $5.00

FEEDBACK to Parabola Horn with pressurized window..$27.50

90° TWIST $10.00

"K" BAND DIRECTIONAL COUPLER .....$49.50 ea.

8500—9600 Mc Bench Test Plumbing
1" x 1½" Waveguide

3 CM SIGNAL GENERATOR and thermistor bridge, using 723AB oscillator, calibrated variable attenuator, direct reading power meter; reg. 115 vac 60 cy power supply. Complete with tubes $425

3 CM SLOTTED LINE, with probe, and including accessories, i.e. low power load, adapters, etc. TS 12/Unit 2.....$385

AN/APS-15A "X" Band compl. RF head and mod. inch 725-A mag and magnet, two 723A/B klystrons (local osc. & beacon) 1B24, TR, rcvr ampl. duplexer, HV supply blower, pulse xfmr. Peak Pwr Out: 45 KW apx. input: 115, 400 cy. Modulator pulse duration .5-2 microsec., apx. 13KV. PK. Pulse, with all tubes incl. 715B, 829B, BKR 73, two 72's. Complete pkg.....$375

COMPLETE 3 CM. RADAR SYSTEM. 40 KW peak transmitter, pulse modulator, receiver, using 723AB, power supply operating from 115V 800 Cycle, antenna system. Complete radar set neatly packaged in less than 16 cubic feet, Less receiving Type Tubes, but including all others, in used but excellent condition—$350.00. This price for laboratories, schools, and experimental purposes only.

AN/APQ — 13 RADAR
MANY PLUMBING COMPONENTS AVAILABLE

2J42 PULSE MODULATOR, 14 Kw max. rating, 7kw min. Plate voltage pulsed 5.5 kv, 6.5 amp, .001 duty cycle, 2.5 usec pulse length max, filament 6.3 v, .5 amp. Includes magnetron mtg. and blower. Requires 3C45 and 2-3B24.....$75

3 CM SECTOR SCANNING ANTENNA, 18" dish, cutler feed dipole. 24 vdc drive motor.....$75

APS-3 RADAR, new and complete, using 725A magnetron....$950

TS 36 X BAND POWER METER 1½" x 5/8" waveguide; thermistor bridge with indicating meter, complete.....$175

TS 33 X BAND COAX FREQ. METER with resonance indicating meter crystal mount, type N fitting.....$225

WAVEMETER, 8500 to 9400 Mcs., with calibration. Micrometer adjust head. Reaction type $85.00

90 DEGREES ELBOWS. E or H plane, 2½" radius.....$12.50

90 DEGREE TWIST. 6" long $8.00

BULKHEAD FEED-THRU ASSEMBLY $15.00

PRESSURE GAUGE SECTION 15 lb. gauge and press nipple $10.00

PRESSURE GAUGE. 15 lbs $2.50

DUAL OSCILLATOR-BEACON MOUNT. P/O APS10 Radar for mounting two 723A/B klystron with crystal mts. matching slugs, shields $42.50

DUAL OSCILLATOR. MOUNT. (Back to back) with crystal mount, tunable termination attenuating slugs $18.50

DIRECTIONAL COUPLER. UG-40/U Take off 20 DB $17.50

ROTARY JOINT Choke to Choke $10.00

2K25/723 AB RECEIVER local oscillator Klystron Mount, complete with crystal mount. Iris coupling and choke coupling to TR $22.50

TR-ATR DUPLEXER section for above $8.50

CU 105/APS 31 Directional Coupler 25 DB.....$25.00

723AB MIXER — Beacon dual Osc. Mnt. w/xtal holder $12.00

TR-ATR SECT APS 15 for 1B24 w/724 ATR cavity w/1B24 & 724 Tubes. Complete...$21.00

STABILIZER CAVITY with bellows $21.50

3 CM 180° BEND, with pressurizing nipple .....ea. $6.00

3 CM. 90° BEND, 14" long 90° twist with pressurizing nipple .....ea. $6.00

3 CM. "S" CURVE 18" long .....ea. $5.50

3 CM. "S" CURVE 6" long .....ea. $3.50

3 CM. RIGHT ANGLE BENDS. "E" plane 18" long cover to cover .....ea. $6.50

3 CM. CUTLER FEED DIPOLE. 11" from parabola mount to feed back .....ea. $8.50

3 CM. DIRECTIONAL COUPLER. One way waveguide output .....ea. $15.00

CIRCULAR CHOKE FLANGES, solid brass .....55¢

SQ. FLANGES. Flat Brass ea. .....55¢

APS-10 TR/ATR DUPLEXER section with additional iris flange $10.00

"X" BAND PREAMPLIFIER, consisting of 2-723 A/B local oscillator-beacon feeding waveguide and TR-ATR Duplex sect. incl. 60 pic. IF amp....$47.50

15 DEG BEND 10" choke to cover $4.50

5 FT. SECTIONS choke to cover. Silver plated.....$14.50

18" FLEXIBLE SECTION $17.50

TR CAVITY for 724 A TR Tube $3.50

724 TR Tube (41 TR 1)..$2.50

SWR MEAS. SECTION, & L with 2 type "N" output probes MTD full wave apart. Bell size guide. Silver plated $10.00

ROTARY JOINT with slotted section and type "N" output pickup $17.50

WAVEGUIDE SECTION 12" long choke to cover 45 deg. twist & 2½" radius, 90 deg. bend $4.50

TWIST 90 deg. 5" choke to cover w/press nipple $6.50

WAVEGUIDE SECTIONS 2½ ft. long silver plated with choke flange $5.75

ROTARY JOINT choke to choke with deck mounting.....$17.50

3 CM. MITRED ELBOW "E" plane unplated $12.00

1¼" x 5/8" WAVEGUIDE

TUNABLE TERMINATION. Precision adjust $65.00

LOW POWER TERMINATION $25.00

MAGIC TEE $45.00

90 DEGREE ELBOWS. E or H plane $12.50

WAVEGUIDE LENGTHS. Cut to size and supplied with 1 choke, 1 cover, per length .....$2.00 per ft.

BI DIR-COUPLER WG output calibrated —25 db nominal $17.50

FLEX SECTIONS, 12" Rubber Coated $14.50

MITRED ELBOW H Plane UG51-UG52 .....$12.00

6" ST. SECT. choke to choke $3.50

APQ 13 Constant Z Rotat Jnt. $22.50

CG 98B/APQ 13 12" Flex. Sect. 1¼" x 5/8" OD.....$10.00

WAVE GD. RUN 1¼" x 5/8" Gd. consists of 4 ft sect. w/RT angle bend on one end, 2" 45 deg bend on other end...$8.00

X BAND WAVE GD. 1¼" x 5/8" O.D. 1/16" wall aluminum Per ft. 75¢

SLUG. TUNER ATTENUATOR W.E. guide. Gold Plated..$6.50

WAVEGUIDE

½" x ¼" ID	$1.00 per foot
1" x ½" OD	$1.50 per foot
5/8" x 1¼" OD	$1.65 per foot
5/8" x 1¼" OD Aluminum	.75 per foot
1½" x 3" OD	$3.00 per foot
2½" x 3" OD	$3.50 per foot
1" x ½ OD Flexible	$4.00 per foot
7/8" rigid coax ¼" IC	$1.20 per foot
(Available in 10FT to 15 ft. lengths or smaller.)	$8.50 each

APS-2
APS-3
APS-4
APS-6
APS-6A
APS-10
APQ-13
APS-15
APS-31
CPN-8
CEXH
FD MK 4
MARK 10
SA
SC
SD
SE
SF
SG
SJ
SK
SL
SM
SN
SO
SQ
SW
SCR 518
SCR 520
SCR 533
SCR 545
SCR 663

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MIN. ORDER $3.00 **COMMUNICATIONS EQUIPMENT CO.** MIN. ORDER $3.00

131 Liberty St., New York, N. Y. Dept. E4 P. J. PLISHNER **Phone: Main 4-8373**

DUE TO CURRENT NATIONAL EMERGENCY AND THE CRITICAL RECEIVING TUBE SHORTAGE, TUBES WILL BE SHIPPED AT PREVAILING PRICES. WE WILL QUOTE ON LARGE OR SMALL QUANTITIES.

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Reliance Specials

WIRE WOUND PRECISION RESISTORS
2% OR BETTER

¼ Watt—30¢

2	10.84	13.52	62.54	301.8
2.5	11	13.89	79.81	366.6
3.5	11.25	14.98	105.8	414.3
5	11.74	15.8	123.8	705
6.68	12.32	16.37	125	2,193
10.48	13.02	32	147.5	59,148
			220.4	100,000

½ Watt—30¢

.250	13.15	260	4,000	8,000
.334	46	270	4,300	8,500
.502	52	298.3	4,451	14,825
.557	55.1	400	4,500	15,000
.627	75	723.1	5,000	15,750
.76	97.8	855	5,900	17,000
1.01	125	1,500	6,500	30,000
1.53	180	2,500	7,000	37,000
2.04	210	2,850	7,300	50,000
11.1	235	3,427	7,500	100,000

1 Watt—35¢

.5	15	3,000	9,000	55,000
1.01	270	3,300	10,000	65,000
2.58	420	7,000	12,000	70,000
3.39	1,000	8,250	23,000	84,000
5.21	2,000			

1 Watt—45¢

100,000	128,000	158,000	270,000	500,000
105,000	130,000	200,000	296,000	520,000
120,000	132,000	260,000	320,000	522,000
			348,000	600,000
				700,000

1 Megohm, 1 Watt, 1%—65¢; 5%—45¢

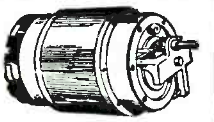
2 Watt—60¢

2,000 4.385 5,000 6,000

UNIVERSAL JOINT
3/16" hole x 3/8" O.D.
1 1/8" long
Steel or Aluminum
50¢

2J1G1 SELSYNS
BRAND NEW
400 Cycle
Can be used on 60 cycle
$1.90

DIFFERENTIAL
115 V., 60 Cyc.
#C78249
3⅝" dia. x 5⅝" long
$3.95 ea.



Used between two #C78248's as dampener. Can be converted to 3600 RPM Motor in 10 minutes. Conversion sheet supplied. (Converted)......$4.50

Mounting Brackets — (Bakelite) for selsyns, and differentials shown above.................35¢ pair

JONES BARRIER STRIPS

Type	Price	Type	Price	Type	Price
2-140Y	$0.13	4-141W	.30	9-141W	.64
3-140¼W	.19	5-141	.26	9-141Y	.64
6-140	.25	5-141¼W	.37	17-141Y	1.17
10-140¼W	.53	7-141	.36	3-142	.21
2-141	.13	7-141¼W	.49	2-150	.39
3-141¼W	.24	8-141¼W	.58	3-150	.54
3-141W	.24			4-150	.70

DELAY NETWORK—ALL 1400Ω

T 113—Approx. 1.2 micro sec. delay.........
T 114—Approx. 2.2 micro. sec. delay........
T 115—Similar to T 114 with tap brought out
} 95¢ each

CHOKES

30 Henry 80 ma..................................$1.29
6 Henry 80 ma.................................. .79

3AG FUSES

AMP	Per 100	AMP	Per 100	AMP	Per 100
⅛	$4.00	1½	$3.00	6	$3.00
¼	4.00	2	3.00	10	3.00
¾	4.00	5	3.00	15	3.00
½	4.00				

Fuse Holder—for 3AG Fuse. (Littlefuse or Buss)...25¢

4AG FUSES

AMP	Per 100	AMP	Per 100	AMP	Per 100
1/8	$4.00	2	$2.00	10	$2.50
1/4	3.50	3	2.00	15	2.50
1/2	3.50	3.2	2.00	25	2.50
1	2.00	5	2.00		

Fuse Holder—For 4AG Fuse. (Littlefuse)..........25¢

Brand New METERS—Guaranteed

0-1 Amp, R.F. 2½".............................$3.29
0-300 V.D.C. 2½"............................. 3.50
0-80 Amp, D.C. 2½"........................... 2.25
0-7.5 V. A. C. 3½"........................... 3.46

AN CONNECTORS
IMMEDIATE SERVICE
PHONE! WIRE! WRITE! YOUR NEEDS

CAPACITORS
POSTAGE STAMP MICAS

MMF	MMF	MMF	MMF	MMF	MFD	MFD
8.2	43	100	250	580	.0013	.006
10	47	110	300	600	.00136	.0062
15	51	120	330	620	.0015	.0065
20	56	125	350	680	.001625	.0068
22	60	130	370	800	.002	.007
24	62	150	390	820	.0026	.0075
25	68	160	400	910	.0027	.008
26	75	175	430	MFD	.003	.0082
30	82	180	470	.001	.0033	.01
35	85	220	500	.0011	.0051	
39	90	240	510	.0012		
40			560			

Price Schedule

8.2 MMF to .001 MFD..............................5¢
.0011 MFD to .002 MFD............................7¢
.0026 MFD to .0082 MFD..........................12¢
.01 MFD...22¢

SILVER MICAS

MMF	MMF	MMF	MMF	MMF	MMF	MFD
10	51	120	270	470	815	.00282
18	60	125	325	488	820	.002826
22	62	150	330	500	875	.003
23	66	180	360	510		.0033
24	68	200	370	525	MFD	.0039
30	75	208	390	560	.001625	.005
39	82	225	400	680	.0022	.0051
40	100	240	410	700	.0023	.0056
50	110		430	750	.0024	.006
	115		466		.0028	.0082

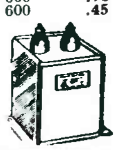
Price Schedule

10MMF to .001625MFD.............................10¢
.0022MFD to .0028MFD............................20¢
.00282MFD to .0082 MFD..........................50¢

OIL FILLED

MFD	V. D. C.	Price	MFD	V. D. C.	Price
.125	35,000	$29.95	4	1,000	$1.39
.125	27,000	22.95	3	1,000	.80
.03	16,000	1.95	2	1,000	.65
.1	7,500	1.69	1	800	.39
.1-.1	7,000	1.69	10	600	1.95
.02-.02	7,000	1.25	8	600	1.60
1	6,000	5.25	4	600	.98
.01	6,000	.95	2	600	.45
.03-.03	6,000	1.25			
2	5,000	4.50			
2	4,000	3.95			
2	3,000	3.15			
.25	3,000	1.10			
8	2,000	3.95			
4	2,000	3.65			
2	2,000	2.50			
.5	2,000	1.25			

2 mfd
4,000
V.D.C.
G.E.
SPECIAL
$3.95



FILAMENT TRANSFORMERS

Pri., 115V., 60 Cyc.—Secondary: { 6 V. @ 35 A. / 12 V. @ 18 A. / 24 V. @ 9 A. } **$6.50**

PULSE TRANSFORMERS

D161310, 50 Kc to 4 Mc, 1¾" dia. x 1⅞" high. 120 to 2350 ohms.... **$1.75**

KS9800, Ratio, 1:1:1, 2:1, Freq. range 380 to 520 C.P.S........... **$3.50**

D106173, W.E. Freq. resp. 10KC to 2 MC.. **$9.80**

800 KVA, G.E. #2731, 28,000 Volt peak output: Biflar: one microsecond pulse width.... **$37.50**

Wrapped—BALL BEARINGS—New

Mfg	ID	OD	Width	Price
Fafnir 33K5	3/16"	1/2"	5/32"	$0.25
MRC .205R	63/64"	2 3/64"	19/32"	1.10
N.D. 5202C13M	1/2"	1 3/8"	1/8"	1.00
Fafnir 7308W	1 87/64"	3 9/16"	5/16"	2.00
SKF466430	6"	8"	1"	5.00
TIMKEN	4 5/16"	6 1/4"	29/32"	4.25

NEEDLE BEARINGS

B108 1/2" wide 5/8" 13/16" 30¢

ALLEN SET SCREWS

4-40 x 1/8 8-32 x 1/8 8-32 x 5/16
4-40 x 3/16 8-32 x 3/8
ALL SIZES $1.50 per 100

VERNIER DIAL or DRUM (From BC-221)

DIAL—2⅝" dia. 0-100 in 360°. Black with silver marks. Has thumblock. DRUM—0-50 in 180°. Black with silver marks ....either, 85¢

BLOWER & MOTOR

Blower #1½, motor 27½ V.D.C., 1/100 H.P., 8,500 R.P.M. Continuous duty. Has mounting brackets. Navy inspected $3.50

PRECISION CAPACITOR—W.E.

D-161270. 1 mfd @ 200 VDC; −40° to +65°C......$8.50

SELENIUM RECTIFIERS

Full Wave—200 ma., 115 V.......................$1.79
Half Wave—100 ma., 115 V....................... .91

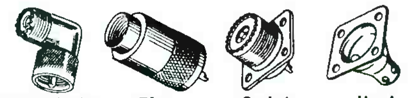
Minimum Orders $3......All orders f.o.b. PHILA, PA.

COAXIAL CABLES
GUARANTEED!! NEW!!

	Ohms	Price per 1,000 ft		Ohms	Price per 1,000 ft
RG-6/U	76	$150	RG-35/U	71	$450
RG-7/U*	97.5	65	RG-37/U	55	40
RG-15/U	76	160	RG-39/U	72.5	180
RG-21/U	53	100	RG-41/U	67.5	550
RG-22/U*	95	110	RG-54/U	58	65
RG-24-U	125	240	RG-55/U	53.5	65
RG-25/U	48	575	RG-57/U*	95	100
RG-26/U	48	75	RG-58/U*	53.5	60
RG-27/U	48	290	RG-59/U*	73	70
RG-29/U*	53.5	50	RG-77/U*	48	100
RG-34/U	71	175	RG-78/U	48	80

*No minimum order—others 250' minimum
Add 25% for orders less than 1,000 feet

COAXIAL CABLE CONNECTORS



Angle Adapter	Plug	Socket	Hood
30¢	45¢	40¢	9¢
M-359	PL-259	SO-239	83-1H
83-1AP	83-1SP	83-1R	

83-1AC	$0.42	UG-13/U	.63	UG-87/U	.79
83-1F	1.30	UG-19/U	.73	UG-103/U	.48
83-1J	.80	UG-21/U	.67	UG-104/U	.85
83-1SP	.45	UG-22/U	1.10	UG-167/U	2.00
83-1SPN	.50	UG-24/U	.67	UG-171/U	1.33
83-1T	1.12	UG-25/U	.60	UG-175/U	.15
83-22AP	1.10	UG-27/U	.68	UG-176/U	.15
83-22R	.48	UG-33/U	14.80	UG-197/U	1.33
83-168	.15	UG-34/U	16.00	UG-206/U	.63
83-185	.15	UG-58/U	.63	UC-255/U	1.22
UG-7/AP	2.14	UG-85/U	.88	UG-264/U	1.74
UG-12/U	.63			UG-281/U	.60

CERAMICONS

2 MMF	30 MMF
5.6	35
12	45
15	62
20	82
22	110
	150
	200

$6.50 per hundred

500 VOLT CERAMIC CONDENSERS

MMF	MMF	MMF	MMF
2	18	56	150
3.44	22	62	180
4.7	27	68	200
12	30	82	220
13	33	91	270
15	40	100	300
16	47	140	1000

$5.00 per hundred

SOUND POWERED HANDSET

Brand New!
Includes 6 ft. cord. No batteries or external power source used.
$8.92 ea. ....$17.60 pr.

Sound Powered
Chest Set
RCA—With 24 Ft. Cord
$17.60 per pair

TIME DELAY RELAY

Raytheon CPX 24166 KS 10193-60 Sec. • 115 V., 60 Cycle • Adj. 50-70 Seconds • 2½ second recycling time—spring return • Micro-switch contact, 10A • Holds ON as long as power is applied • Fully cased • ONLY $6.50

DELAY LINES

W.E. Delay Line #D163169. 5 micro-second delay, 680Ω $50.00

W. E. Delay Line #D165997. 1¼ micro-second delay, 470Ω $7.50

400 CYCLE INVERTER

Leland Electric Co. #10800. IN, 25-28 V.D.C. 92 A, 8,000 RPM. OUT, 115 V., 400 cyc., 1 phase, 1,500 V.A., 90 PF $12.50

TIMING MOTOR 8 RPM

115V., 60 cyc., E. Ingraham Co.....................$1.79
45 V., 60 cycle, E. Ingraham Co....................$1.79

TYPE "J" POTENTIOMETERS

Ohms	Shaft	Ohms	Shaft
110	S.S.	6,500	3/8"
200	1/2"	7K	S.S.
300	5/8"	10K	S.S.
400	3/8"	15K	3/8"
500	S.S.	25K	5/8"
1,000	S.S.	30K	S.S.
1,500	S.S.	50K	3/8"
2,000	S.S.	80K	S.S.
2,500	S.S.		
3,000	S.S.	100K	7/16"
4K	3/8"	250K	S.S.
5K	5/8"	1 meg.	S.S.

$1.00 Each

DUAL TYPE "JJ" POTENTIOMETERS

Ohms	Shaft	Ohms	Shaft
1K	S.S.	3K-90K	1/4"
10K	5/16"	1 meg.	S.S.
15K	S.S.		

1.50 Each

VARIAC—General Radio. 100 watts. Removed from equipment $10.00

PLUG IN CAPACITOR

8-8 MFD 600 V.D.C.—Oil Filled. Plugs into standard 4 prong socket......................................$2.25

CARBON MIKE—T-17, slightly used, guaranteed. Has 5 foot cord and PL68.................................89¢

RELIANCE MERCHANDIZING CO.

Arch St. Cor. Croskey Phila. 3, Pa. Telephone RIttenhouse 6-4927

STANDARD BRANDS ONLY

TUBE SPECIALS

BRAND NEW FIRST QUALITY

COMPLETE STOCK OF RECEIVING, TRANSMITTING, CATHODE RAY, THYRATRON, IGNITRON, MAGNETRON, KLYSTRON, PHOTOCELL, T-R & ATR TUBES.
QUOTATIONS UPON REQUEST

MAGNETRONS

2J21A	$9.95	2J39	24.50	700C	18.90
2J22	8.95	2J40	24.50	700D	18.90
2J26	7.80	2J41	132.50	706AY	45.00
2J27	13.70	2J48	14.95	706BY	45.00
2J31	19.90	2J49	39.50	706CY	26.95
2J32	19.90	2J61	45.20	706FY	45.00
2J33	19.90	4J50	197.00	706GY	45.00
2J34	19.90	4J52	197.00	714AY	6.95
2J36	85.00	5J23	14.20	720B/C/DY	75.00
2J37	13.70	5J29	14.20	725A	8.95
2J38	12.70	700B	18.90	730A	10.95

KLYSTRONS

2K23	$37.50	2K33	295.00	707B	17.50
2K25	27.50	2K54	135.00	723A	6.95
		2K55	135.00	723A/B	14.95
2K28	32.50	417A	10.65	726A	8.50
				726B	29.50
2K29	29.95	707A	7.22	5611	135.00

OIL-FILLED HIGH VOLTAGE ISOLATION TRANSFORMERS

Pri. 460V 60 cy, Sec. 115V 200VA Insulated for 50KV DC—G. E. Form EIR—36H x 13"D........$125.00
Pri. 115V 60 cy, Sec. 115V 250VA Insulated for 35KV DC—G. E. Form EIR—29"H x 12½"D.....$125.00

VOLTAGE DIVIDER

G.E. Cat. 8248886G-1 and 9001934G-1 17.246.400 ohms 35KV 70:1 ratio wire wound shielded oil-filled 40"H x 12"D..........$77.50

2φ LOW INERTIA SERVO MOTORS

KOLLSMAN Type 936-0240—85/68V 100cy 5 watts 2650 RPM—new $12.95
DIEHL Type FPE-25-11 75V 60cy 4 watts—new $34.50

OIL FILLED CONDENSERS

MFD	VDC	Price	MFD	VDC	Price
2	600	$ .45	2	2000	$2.70
4	600	1.05	4	2000	3.95
4	600 (R'd)	1.05	.1	2500	.49
8	600 (R'd)	1.39	1-1	2500	3.85
10	600	1.95	32	2500	15.80
10	600 (R'd)	1.52	1	5000	4.88
8-8	600	1.49	.01-.03	6000	1.65
1	1000	.62	.1	7000	1.79
2	1000	.89	2	12500	28.95
3.5-.5	1000	1.39	.045	16KV	4.70
1	1500	.89	.05	16KV	4.95
4	1500	2.95	.075	16KV	8.95
.1-.5	2000	.87	.25	20KV	18.95
.5	2000	.95	50	220VAC	3.95
1	2000	1.50	7	660VAC	3.35

HIGH VOLTAGE TRANSFORMERS

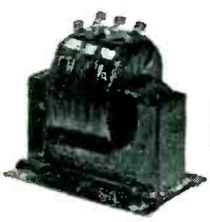
G.E.—Pri. 115V 60 cy Sec. 6250V 80 MA—12.5 KV Ins..........$18.50
G.E.—Pri. 115V 60 cy. Sec. 6250/3850/2600V 56 MA 12.5 KV Ins..........$18.50
Raytheon—Pri. 115V 60 cy Sec. 8500/6450V CT 43 MA Hermetically sealed..........$22.50

CRYSTAL DIODES

1N21	$1.19	1N23	$1.49	1N34	$ .79
1N21A	1.69	1N23A	2.55	1N45	.94
1N21B	3.25	1N23B	5.25	1N52	1.05
1N22	1.09	1N27	1.79	1N63	1.39

ANTENNAS

AT-38A/APT (70 to 400MC)..........$13.70
AT-49/APR-4 (300 to 3300MC).......... 13.70
DZ-2 Loop antenna with pedestal.......... 14.50
AN-74B (125 to 150MC).......... 1.65
AN-65A (P/O SCR-521).......... .95
AN-66A (P/O SCR-521).......... 1.15
AIA-3CM conical scan..........125.00
ASB Yagi—5 element 450 to 560MC.......... 7.00
ASB Yagi—Double stacked 6 element.......... 12.70
ASA Yagi—Double stacked 370 to 430MC.......... 29.40



WESTINGHOUSE HYPERSIL TRANSFORMER

PRI-115V. 60CY ¾ KVA
SEC #1 - 240V - 1.56A
SEC #2 - 240V - 1.56A
WT. 30 LBS.

$14.50 EACH

Terms 20% cash with order, balance C. O. D. unless rated. All prices F.O.B. our warehouse, Phila., Penna., subject to change without notice.

COAXIAL CONNECTORS

83-1AC	$ .42	83-1J	$ .80	83-1T	$1.12
83-1AP	.30	83-1R	.40	83-22AP	1.10
83-1F	1.30	83-1SP	.45	83-22R	.48
83-1H	.10	83-1SPN	.45	83-22SP	.85

FULL LINE OF JAN APPROVED COAXIAL CONNECTORS IN STOCK

UG-7	UG-23	UG-37	UG-102	UG-175	UG-236
UG-12	UG-24	UG-57	UG-103	UG-176	UG-254
UG-18	UG-27	UG-58	UG-104	UG-181A	UG-255
UG-19	UG-27A	UG-83	UG-106	UG-185	UG-264
UG-21	UG-29	UG-85	UG-108	MX-195	UG-274
UG-21B	UG 30	UG 86	UG-109	UG-197	UG-275
UG-22	UG-33	UG-87	UG-167	UG-201	UG-290
UG-22B	UG-34	UG-88	UG-171	UG-206	UG-306

M-358	MC-277	PL-259A	PL-325
M-359	MC-320	PL-274	SO-239
M-359A	PL-258	PL-284	SO-264
M-360	PL-259	PL-293	TM-201
93-C	49120	D-163950	ES-685696-5
93-M	49121A	D-166132	ES-689172-1

AN/APA-23 RECORDER

Sweeps any receiver through its tuning range and permanantly records frequency and time of received signals on paper chart. Power input—(motor) 27V DC 1.5A, and (recorder) 80/115V AC 60-2600 cy 135W.

Originally designed to record pulse or sine-wave modulated signals received by AN-APR-1, AN/APR-2, AN/APR-4, AN/APR-5, BC-348, S-27, SX-28
BRAND NEW $147.50

TYPE "J" POTENTIOMETERS
$1.25 each

Resis.	Shaft	Resis.	Shaft	Resis.	Shaft
100	SS"	10K	½"	50K	SS
200	SS"	10K	SS	100K	5/16"
500	½"	15K	⅛"	100K	⅜"
650	½"	15K	SS	100K	7/16"
1K	SS	20K	SS	100K	SS"
5K	¼"	25K	1½"	150K	½"
5K	SS	25K	SS	500K	SS
6500	SS"	30K	1⅛"	1 MEG	SS
10K	⅜"				

Dual "JJ" Potentiometers..........$1.60 each
50 Ω SS 100 Ω SS 250 Ω SS 330 Ω SS
Triple "JJJ" Potentiometers..........$1.95 each
100K/100K/100K—⅜" 20K/150K/15K—⅜"
All shaft lengths beyond bushing—SS (screw slot)

METERS

3 MA DC 2½" R—Simpson black scale..........$3.35
500 Microamps, DC—2½" round—Sun.......... 4.30
1 ma. DC Fan type—4" scale (rem. from equipt) 3.95
500 ma. DC 2½" R.—General Electric.......... 2.95
2 amp. RF 2½" Sq.—Simpson.......... 3.15
5 amp. AC 4½ R.—JBT.......... 4.11
50 VAC 3½" R.—General Electric.......... 2.95
10 amp. RF 3½" R.—Simpson.......... 4.95
50 amp AC 3½" R.—General Electric.......... 4.11

SOUND POWERED TELEPHONES

U. S. NAVY TYPE M HEAD AND CHEST SETS
U.S.I. A-260 W.E. D-173013
A.E. GL832BA0
ANY TYPE—$14.88 EACH

TS-10 Type Handsets..........$8.92 ea.

CONSTANT VOLT. TRANSFORMERS

Federal—Input 95-135V 60 cy. Out 115V 210W $34.00
Sola—Input 95-125V 60 cy. Out 15.8V 285VA..$24.70
Sola—Input 105-125V 60 cy. Out 115V 80VA..$15.95

F.W. BRIDGE SELENIUM RECTIFIERS

AC VOLTS INPUT - 18 DC VOLTS OUT - 14.5		AC VOLTS INPUT - 40 DC VOLTS OUT - - 34	
1.2 Amps	$2.90	0.6 Amps	$3.30
2.4	3.38	1.2	3.78
6.4	4.50	3.2	5.66
13.0	8.44	6.0	10.25
17.5	9.56	9.0	11.05
26	16.86	12	20.50
39	25.30	18	22.13
52	33.74	24	39.56
65	42.26	36	45.36

130 VAC ½ WAVE STACKS

75MA	$ .88	150MA	$1.30	250MA	$1.75
100MA	1.10	200MA	1.57	400MA	2.60

GENERATORS

- Eclipse-Pioneer type 716-3A (Navy Model NEA-3A) Output—AC 115V 10.4A 800 to 1400 cy. 1 φ; DC 30 Volts 60 Amps. Brand New..........$38.50

TEST EQUIPMENT

- I-222A Signal Generator..........* $79.50
- I-72K Signal Generator..........$48.50
- Vibrotest Mod. 218 Megger..........* $45.00
- TS-263/TPS-10—3CM FM Test Set..........* $325.00
- TN-1B/APR-1 Tuning Unit..........$95.00
- C-D Quietone Filter Type IF-16 110/220 V AC/DC 20 Amps..........* $9.00
- TS-127/U Freq. Meter w/spares..........$69.50
- TS-143/CPN Oscilloscope..........* $95.00
- Dumont 175A Oscilloscope..........* $225.00
- LM-20 Frequency Meter..........* $49.50
- Gen. Radio 757-PI Power Supply..........* $27.00
- Gen. Radio 670-F Decade..........* $38.00
- I-130 A Signal Generator..........* $70.00
- TS-6/AP Frequency Meter..........* $42.00
- L & N KS-9470 Null Volt Test Set..........* $60.00
- A.W. Barber Labs. VM-25 VTVM..........* $86.00
- TS-10A/APN Delay Line Test Set..........$45.00
- TS-19/APQ-5 Calibrator..........$75.00
- REL W-1158 Frequency Meter 160-220 MC..$32.95
- CWI-60AAG Range Calibrator for ASB, ASE, ASV and ASVC Radars..........$39.95
- CRV-14AAS Phantom Antenna for Transmitters up to 400 MC..........$11.7
- TS-146/AP X-Band Test Set..........$595.00

All Items New Except Where Noted * (Exc. Used Condition)

MISCELLANEOUS EQUIPMENT

Amperex 1B98 Gamma Counter..........$ 9.87
Powerstat 1226—115/230V input—0-270V out @ 9 amp.......... 37.00
G.E. 2CV2A1 Servo Amplifier.......... 6.95
Sperry A-3 Hydraulic Servos.......... 3.95
EIMAC 35 TG Ionization Gauge.......... 5.95
ATR Inverters 6VDC to 110 VAC 60 cy 75W... 19.95
ID-6/APN-4 Indicator.......... 29.50
R-7/APS-2 Receiver.......... 49.50
R-78/APS-15 Receiver.......... 49.50
SCR-522 Transceiver.......... 36.95
RT-7/APN-1 Transceiver—less tubes.......... 6.95
FL-8 1020 cycle filter.......... 1.37
RM-29 remote control unit.......... 8.95
RM-14 remote control unit.......... 8.95
RTA-1B 12/24 V dynamotor.......... 40.00
BC-1206-CM2 Receiver.......... 7.95
CY-230/MPG-1 Radar Console..........575.00
G.E. Type JP-1 portable current transformer.. 32.50
ASB-4 Radar equip. Complete.......... 69.75
AN/APS-13 less tubes.......... 12.95
T-9/APQ-2 less tubes.......... 16.50
BC-645A complete.......... 18.95
RCA AVR-15 Beacon Recvr.......... 15.50
TBY Trans-Recvr.......... 29.95
Pioneer Type 800-1B Inverters—28VDC to 120V 800 cy 7 amp AC (used).......... 22.65
G.E. Inverter — 28VDC to 120VAC 800 cy 750VA 1 φ (new).......... 39.50
Navy SD-3 Radar complete..........$1200.00
Navy DP-14 complete..........$385.00

PULSE TRANSFORMERS

Utah 9262	Philco 352-7150
Utah 9340	Philco 352-7071
Utah 9278	Philco 352-7178
G.E. 68G828	Raytheon UX-7350
G.E. 68G-627	W.E. D-161310
G.E. K-2469A	W.E. D-163247
AN/APN-9 (901756-501)	W.E. D-163325
AN/APN-9 (901756-502)	W.E. D-164661
AN/APN-9 (352-7250)	Westinghouse 132-AW
AN/APN-9 (352-7251)	Westinghouse 232-AW2
AN/APN-4 Block Osc.	Westinghouse 232-BW2
Philco 352-7149	

SPRAGUE PULSE NETWORKS

7.5 E3-1-200-67P. 7.5 KV. "E" Circuit 1 microsec. 200 PPS. 67 ohms Imped. 3 sections..........$4.30
7.5 E3-3-200-67P, 7.5 KV, "E" Circuit 3 microsec. 200 PPS, 67 ohms imped. 3 sections..........$6.75
7.5 E4-16-60-67P 7.5 KV, "E" Circuit 4 sections, 16 microsec. 60 PPS. 67 ohms imped..........$8.25
15 E4-.91-400-50P. 15KV "E" circuit .91 microsec. 400 PPS, 50 ohms imped, 4 sections..........$12.00
15-A-1-400-50P, 15KV, "A" Circuit, 1 microsec. 400 PPS. 50 ohms imped..........$37.50
15 E7-2-200-50P, 15KV "E" Circuit, 2 microsec. 200 PPS. 50 ohms imped.. 7 sections..........$42.00

SYNCHROS

Size 1, 3, 5, 6. 7 and 8 generators, motors, control transformers, differential generators, and differential motors in stock.

1F	6DG	X	C-78248
5B	6G	2J1F1	C-78249
5CT	7DG	2J1G1	C-78410
5D	7G	2J1H1	C-78411
5DG	A	C-4460A-2	C-78415
5F	B	C-56701	C-79331
5G	M	C-69405-2	C-78254
5N	N	C-69406-1	C-78670

LECTRONIC RESEARCH LABORATORIES

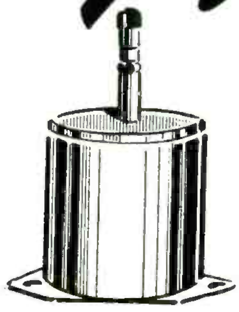
1021-A CALLOWHILL ST. PHILA. 23, PA.
Telephones - MARKET 7-6590 and 6591

TRANSMITTING *Mica* CONDENSERS

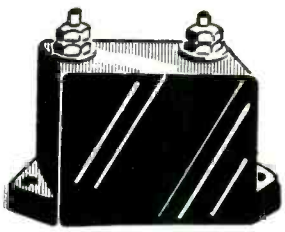
SPECIAL LOW PRICES FOR IMMEDIATE SALE AND DELIVERY

We have literally hundreds of thousands of these top quality standard type transmitting mica condensers in stock for immediate delivery at a fraction of their original cost. Every condenser is brand new and carries the name of a fine nationally known manufacturer.

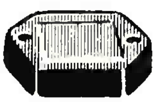
Despite the unusually low prices, these mica condensers, like all Wells Components, are fully guaranteed. Be sure to order sufficient quantities for your requirements.



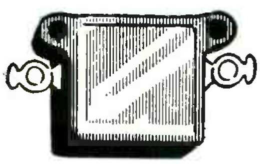
STYLE "A"



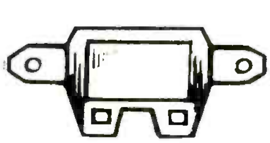
STYLE "B"



STYLE "C"



STYLE "D"



STYLE "E"

NOTE:

Order by capacity and type number

TYPE A

CAPACITY	WORKING VOLTAGE	MFG. LEGEND	UNIT PRICE
.000025	10MV	8	$1.95
.000025	7MV A.C.	2	1.95

TYPE B

CAPACITY	WORKING VOLTAGE	MFG. LEGEND	UNIT PRICE
.00007	1140	6	$ .85
.00015	5000	8	1.45
.0002	1430	6	1.05
.0002	5000	1-8	1.50
.00025	2500	7	1.35
.00025	5000	1-7	1.55
.0004	5000	2-7-8	1.65
.0004	6000	1	1.75
.00052	2000	7	1.35
.00055	5000	3	1.90
.0006	2500	7	1.35
.00072	5000	2	1.85
.00075	2500	2	1.40
.0008	5000	2	1.85
.001	5000	7	1.95
.0011	5000	7	1.95
.002	3000	2	1.75
.002	6000	6	2.20
.0024	1500	3	1.45
.003	2000	7	1.55
.004	3000	8	1.75
.005	2000	2	1.70
.005	3000	8	1.95
.006	3500	8	2.00
.0068	3000	8	1.95
.008	3000	7-8	1.95
.01	2000	3	1.85
.015	2000	1	1.75
.02	500	7	1.50
.02	2000	8	1.95
.024	1500	3	1.85
.033	1500	3-7	2.10
.056	1000	3-7	2.10
.06	1000	8	2.20
.1	1000	8	2.25

TYPE B (Small Size)

CAPACITY	WORKING VOLTAGE	MFG. LEGEND	UNIT PRICE
.00003	2000	2-7-9	$1.10
.00005	3000	2-7	1.20
.00008	3000	9	1.25
.00009	3000	2-7-9	1.25
.0001	3000	2-7-9	1.30
.000107	3500	1	1.75
.000110	3000	8	2.10
.000175	1500	8	1.30
.0002	3000	7-8	2.05
.0004	3000	2-7-9	$1.45
.0005	3000	3	1.55
.00055	3000	7	1.75
.000625	3000	2-7	1.95
.0008	3000	7	1.70
.00125	2000	1-2-7	1.65
.0024	3000	8	1.95
.0025	2000	1-2-7	1.85
.00275	2000	1-7	1.90
.005	2000	2	1.75
.006	2000	8	1.85
.006	2500	7	2.10
.01	1000	7	1 65
.01	2000	1	1.85

TYPE C

CAPACITY	WORKING VOLTAGE	MFG. LEGEND	UNIT PRICE
.000005	2500	2	$ .50
.0001	600	2-7	.35
.0001	1200	6	.45
.0001	2500	6-7-8	.60
.0002	600	2	.35
.0002	2500	7	.50
.0003	2500	7	.60
.00039	2500	7	.75
.0004	2500	2-7	.55
.0005	600	7-8	.45
.0005	1200	2-7	.55
.0005	2500	2	.75
.001	600	8	.45
.001	1200	2-7	.50
.001	2500	2	.75
.0035	2500	7	.85
.004	2500	2-7	.75
.0046	500	9	.55
.0047	2500	8	.80
.005	600	2	.45
.005	1200	7	.55
.0051	2500	8	.85
.0056	2500	8	.85
.006	600	7	.50
.006	1200	2	.75
.008	600	8	.65
.01	600	1-8-9	.50
.01	1200	1-2-7-8	$ .65
.01	1250	9	.70
.01	2500	7	.80
.0115	600	8	.65
.013	1200	3	.65
.015	1200	7	.65
.015	2000	8	.75
.0175	1200	2	.80
.02	600	7	.45
.04	600	7-8	.45

TYPE D

CAPACITY	WORKING VOLTAGE	MFG. LEGEND	UNIT PRICE
.00005	1200	1-7	$ .35
.00005	2500	2-7-8-9	.40
.0001	1200	7	.40
.0001	1250	1	.45
.00015	2500	6	.50
.0002	2500	2-9	.45
.00024	2500	6	.50
.00025	1200	8	.35
.00025	2500	8	.45
.0005	1200	7	.40
.00051	2500	1	.50
.0007	600	2	.35
.001	600	1-2-7	.35
.001	1000	9	.40
.001	1200	5-8	.45
.001	2500	2-6-8	.55
.0011	2500	8	.55
.002	600	1-7-9	.35
.002	1200	1-2-7-8	.45
.0022	1200	7-8	.45
.0022	2500	7	.55
.0025	1200	1-2	.40
.0027	600	1	.35
.003	1200	1-6-7	.40
.0033	1200	6	.45
.004	1200	8	.45
.0044	600	8	.35
.0047	2500	6	.50
.005	600	6	.35
.005	2500	2	.45
.006	750	1	.40
.01	300	1-4	.30
.01	600	2-8	.35
.01	1100	6	.45
.01	1200	6-8	.50
.01	1250	1	.55
.02	600	1-2-4	.35
.022	600	7	.40
.025	600	7	.35
.027	600	1-7	.40
.03	600	1-2-7	.45

TYPE D Lug Mtg.

CAPACITY	WORKING VOLTAGE	MFG. LEGEND	UNIT PRICE
.004	2500	3	$ .30
.01	1200	3	.25
.03	600	3	.20

TYPE E

CAPACITY	WORKING VOLTAGE	MFG. LEGEND	UNIT PRICE
.00025	500	5-7	.25
.0008	750	2	.30
.001	500	5	$ .25
.001	750	7	.30
.002	750	7	.30
.003	750	7	.30
.004	500	7	.30
.005	1000	5	.40
.006	750	5-7	.30
.01	500	5	.30
.01	1200	7	.40

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FT-241. A holder ½" pin spacing, for ham and general use. Xtal controlled Signal Generators, marked in army Mc harmonic frequencies—Directions for deriving fundamental frequencies enclosed. Listed below by fundamental frequency, fractions omitted.

370	424	472	505	537	447
372	425	473	506	390	448
374	426	474	507	391	450
375	427	475	508	392	451
376	429	476	509	393	453
377	430	477	511	394	454
379	431	479	512	395	455
380	433	480	513	396	456
381	434	481	514	397	457
383	435	483	515	398	463
384	436	484	516	400	465
385	437	485	518	401	498
386	438	486	519	402	500
387	440	487	520	403	501
388	441	488	522	404	538
412	442	490	523	405	540
413	443	491	525	406	each
414	444	492	526	407	$1.49
415	445	493	527	408	
416	458	494	529	409	
418	459	495	530	411	
419	461	496	531	each	
420	462	497	533	69¢	
422	469	503	534		
423	470	504	536		

POWER TRANSFORMERS
COMB. TYPE

Item	H.V.	Amp.	Filaments	Price
CT-861	2100VCT	.175	7.5VCT/4A, 2.5V/10A	$10.95
CT-80A	150 230VCT	2 .077	6.3/2A, 6.3/.6A	6.95
CT-43A	1200	.08	2.5VCT/6A, 6.3VCT/	8.95
CT-142	645VCT	.060	5V/2A, 6.3V/1.2A	4.25
CT-825	360VCT	.340	6.3VCT/3.6, 6.3VCT/3A	3.95
CT-076	600V	.100	2x12.6V/1	1.95
CT-626	1500V	.160	2.5/12, 30/.100	9.95
CT-15A	350VCT	.070	6.3/.6, 6.3/1.8 3 lbs.	2.95
CT-071	110V	.200	33/.200, 5V/10, 2.5/10	4.95
CT-378	2300V	4MA	2.5/2	6.95
CT-367	580VCT	.050	5VCT/3A	2.25
CT-721	550VCT	.100	6.3/1, 2.5VCT/2	2.95
CT-99A	2x110VCT	.010	6.3/1A, 2.5VCT/7A	3.25
CT-91A	726V	.100	5V/3A, 6.3/3.5	3.25
CT-328	115V	2.2	40V/2.2A, 115V/2.2A	4.49
CT-441	50V	.200	5V/2.4, 5V/1.2	2.29
CT-408	350VCT	.026MA	5V/3A	2.75
CT-931	585VCT	.086	5V/3A, 6.3V/6A	4.25
CT-610	1250	.002MA	2.5V/2.1A, 2.5V/1.75A	4.95
CT-137	350VCT	.026MA	5V/3A	2.75
CT-866	330V	.065	6.3V/1.2, 6.3V/600MA	1.75
CT-319	330VCT	.085	5V/2, 6.3/7.5, 6.3/.3	3.25

Filament Transformers—115V/50–60 cps input

Item	Rating	Each
FT-599	78V/.300, 6.3V/2A	$1.95
FT-719	1.3V/6A	.79
FT-029	13.5V/1.11A	.79
FT-367	5VCT/3A, 58VCT/40A	1.10
FT-346	5VCT/13/5, 5VCT/6.75, 5VCT/6.75	5.95
FT-781	866 Trans. 2x2.5/5A	2.25
FTG-31	2.5V/2.5, 7V/7A (Tape @ 2.5V/2.5A), 16 lbs.	9.95
FT-674	8.1V/1.5A	1.10
FT-157	4V/16A, 2.5V/1.75A	2.95
FT-391	6.4V/3A	1.10
FT-736	2x6.3VCT/3.2–1.2A	1.49
FT-461	2x6.3VCT/1A	1.10
FT-899	2.5V/5.5A 29000 Rms	12.95
FT-418	6.3VCT/1A, 6.3VCT/7A	1.95
FT-735	6.3VCT/5A, 6.3VCT/1A	1.79
FT-101	6V/.25A	.79
FT-738	6.3VCT/1, 2.5V/2	1.69

Plate Transformers—115V/50–60 cps input

Item	Rating	Each
PT-976	Auto: 120VCT/10MA	$ .69
PT-31A	2x300V/5MA	.79
PT-46A	4080VCT N.L. 3% to 1 8" Hx6" Wx7" L 20 lbs.	29.95
PT-033	4150V/400MA 11½x9¼ Wx9" D 70 lbs.	49.95
PT-75-2	3780/3446/3112VCT/77MA	10.95
PT-28-1	4600VCT/.077	12.95
PT-403	Auto: 70V/1A	2.29
PT-160	1120VCT/770MA, 590VCT/82MA, 25 lbs.	24.95
PT-170	Auto: 156/146/137/128—.71A	3.29
PT-139	42V/46V/50V/55V/15.2A 7¾x7" Wx 6¼" H	10.95
PT-31A	2x300V/5MA	.79
PT-976	120VCT/10MA	.79
PT-67-1	62V/3.5A	2.95
PT-12A	280VCT1.2A	2.95
PT-997	78V/.00754KVA	1.49

SPECIAL TYPES

Item	Pri.	Output	Price
STF-946	210/220/230	2.5V/4A 3½"Hx2¼"x2¼"D	$1.29
STF-05A	115/230	2x5V/7.5 7"Hx7"x5"D	4.25
STF-682	220	30–25–20V/1MA	.69
STF-968	230	2.5V/6.5A	1.10
STF-405	230/115	5V 12/9A	2.95
STF-370	220/440	3x2.5V/5A, 2.5V/15A, 5½x5x4½	5.25
STF-619	110/220	2.5V/500A, 7x5¼x5	19.95
STF-11A	220	2x40V/.05/2x5V/6A, 12.6/1A	2.95
STF-085	220/440	2.5VCT/60A 1780 Test	24.75
STF-631	230	2x5V/27A 2x5V/9A, 103/ 4Hx5x7 30 lbs.	24.95
STF-96B	230	2.5V/6.5A	1.95
STF-608	220	24V/600, 5V/3A, 2x6.3V/1A	2.25
STF-45A	43/78/90 115/180/230	2x2.5/6.5, 6.3V/4 ? Few	3.25
		PL TRANSFORMER	
STP-405	220/440	117/79V, 13.05A	$17.95
STP-961	220/440	136VCT/3.5A	10.95
STP-945	210/20 30	1100VCT/300 5¼x4x3½	5.95
STP-444	230/460	230/105/115/12515 lbs. 5½x6x4½	14.95
STP-613	230V	2x230/.05	1.29
STP-780	82V	4000V/.002	1.29
STP-08B	50V	2x750V/1MA	.98
STP-311	30/35 40	95NL-50VFL .1 Amp.	.59
		COMB.	
STC-627	230V	1500/160, 110V/.200, 3.3V/.200, 5V/10, 2.5-1.4/10	5.95
STC-611	230V	200V/200, 4x6.3V/9	2.95
STC-16A	220V	260V/.03, 100V/1, 6.3V/4.2	2.95
STC-607	220V	700VCT/75MA, 40VCT/.100, 15/10/15V/100MA	3.95
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PULSE EQUIPMENT

MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp). Duty Ratio: 001 max. Pulse duration: 5, 1.0, 2.0 microsec. Input voltage: 115 v. 400 to 2400 cps. Uses: 1-715B, 4-829-B, 3-'72's, I-'73. New................$110.00

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BC 758A Pulse modulator....................$395.00

APS-10 Low voltage power supply less tubes....$18.50

725A magnetron pulse transformers..........$18.50 ea.

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15A—1-400-50: 15 KV. "A" CKT, 1 microsec 400 PPS, 50 ohms imp.................................$42.50

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DM416	14	6.2	330	.170	RU 19
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DM36	28	1.4	220	.080	SCR 508
DM25	12	2.3	250	.050	BC 367
	28	1.25	275	.070	BC 348
DM33A	28	7	540	.250	BC 456
DM42	14	46	515	.110	SCR 506
			1030	.050	
			2/8		
PE101C	13/26	12.6	400	.135	SCR 515
		6.3	800	.020	
BD AR 93	28	3.25	375	.150	
23350	27	1.75	285	.075	APN-1
ZA-0515	12/24	4/2	500	.050	
ZA-0516	12/24	8/4	12/275	3/110	
B-19pack	12	9.4	275	.110	Mark II
			500	.050	
DA-3A	28	10	300	.060	SCR 522
			150	.010	
			14.5	.5	
5053	28	1.4	250	.060	APN-1
PE73CM	28	19	1000	.350	BC 375
DM21	14	3.3	235	.090	BC 312
CW21AAX	13	12.6	400	.135	
	26	6.3	800	.020	
			9	1.12	
BD 77KM	14	40	1000	.350	BC 191
PE94	28	10	300	.200	SCR
			150	.010	522
			14.5	.5	

PE 86 DM 32A DY 22 ARC 3 DAG 33A

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115 V 400 CYCLE INPUT

Ratings	Price Each
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6.4V/8a, 6.4V/1A	1.95
6.3V, 9.1A, 6.3VCT/6.5a, 2 x 2.5/3.5a	2.49
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5V/15A, 5000V Ins.	3.95
6.3/2.7, 6.3/.66, 6.3VCT/21A	5.95
760V, 6.3V, 6.3V, 5V, 320V, 6.3V/20A 6.4/7.5, 6.4/3.8, 6.4/2.5	2.95
592V/118Ma, 6.3/8.1a, 5V/2 W.E.	4.95
6.3V/9.1, 6.3VCT/.65a, 2 x 2.5V/3.5A	2.95
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1034VCT/.111a, 6.9V/10, 2 x 6.3V/1, 5V2, 6.3/2, 63/1	6.49
526VCT/.05a, 6.3VCT/2a, 5VCT/29	3.49
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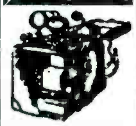
Complete stock of Relays available for immediate shipment. All sold at surplus prices. Write for Latest Relay List. Now Available.

UPRIGHTS

Mfd.	Volt	Type	Cat. No.	Price
.0025	1500	2TT	D164209	30¢
.03	600	2ST	RO3	25¢
2x.0515	600	2TT		45¢
.05	400	2BT	616M	25¢
.05	600	2BT	C51481918-20	28¢
.05	600	2BT	7700BR	28¢
3x.05	300	3BT	NJOCA195	30¢
3x.05	300	3BT	CA196	30¢
.125-.05	400	2TT	CMR481380-10	25¢
.1	600	2BT	616M-14842	35¢
.1	600	2BT	R11-616MB	35¢
.1	400	2BT	418CB	30¢
.1	600	2BT	7701BR	35¢
.1	600	2BT	CP69B1AF104K	35¢
.1	400	2BT	XMRBW4-.1	30¢
.1	600	2BT	C69B1AF104	35¢
2x.1	600	2BT	P9711	39¢
3x.1	400	3BT	CA255	39¢
3x.1	400	3TT	ROBC	39¢
3x.1	400	3BT		39¢
3x.1	600	3TT	C168B5EF104V	42¢
3x.1	600	3BT	7710BR	42¢
3x.1	600	3BT	CD516	42¢
2x.125	400	2TT		
.25	800	2WTT		69¢
.4	600	2BT	M-7725BR	30¢
.25	600	2BT	C168B1EF254K	30¢
.5	600	2BT	SO1	32¢
.5	600	2BT	PO8	32¢
.5	400	2TT	416T	30¢
.5	600	2BT	616MB	32¢
2x.5	250	2TT	A-8B515	30¢
2x.5	400	3BT	418MCB	35¢
2x.875	400	2BT	CWS-P-72076-503	39¢
1	400	2TT	305-1605S	35¢
1	600	2BT	616MCB	38¢
1	600	2BT	YAB6100	38¢
1	250	2TT	CBV48553-15	30¢
1	100	1BT	104M59	25¢
1	600	2BT	616MCB	38¢
1	400	2BT	418MCB	35¢
1.75	50	2TT	CRV48661	45¢

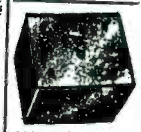
COAX CABLE
RG8U
RG9U
RG57U
RG23U
RG28U
RG35U
MANY OTHERS



EE89A Telephone Repeater

Used to extend range of field telephones. Simplex Teleg. and 20 cycle ringing possible over lines equipped with unit. Supplied w/ 305 tube. Phone supplied. (Featherweight) $9.59

COLLINS ART-13 FREQ. MULT. UNIT
2-18 Mc for two 1625 Tubes. Comp. Assy less Tubes & Coils w/ ckt dia Price..$8.95



400 MA 12 HY Choke
90 ohms Herm. sealed. Special $3.75

CHOKE SWINGING
9/60Hy .400/.05 Amp. 10000V ins. Mfg. Super. Elect. $7.95

1% RESISTORS PRECISION

.6	7500
1.01	8500
5	10,000
5.05	10,000
10.1	10,000
18	12,000
43.5	12,000
50	17,000
75	17,300
82	20,000
120	25,000
125	30,000
128	33,000
150	40,000
128	55,000
250	57,000
300	75,000
430	84,000

30¢ ea.

468	100,000
800	120,000
920	120,000
1100	150,000
4300	220K
5000	

40¢ ea.
1 Meg. 75c ea.
10 Meg. $2.10 ea

RL9 or RL7 Interphone Amplifier Convert to High Fidelity Phone Amp. or Spch. Amp. Comp. w/ 12A6, 12SL7, 2 Choker 1 XRFRMR, DYN. for 24 operation, etc $2.29

INVERTER PE 218
IN: 28VDC 92A. Out: 115V, 500— 1500 VA.
NEW..$49.50
USED, EX. $35

PRECISION RESISTORS

D-164886A	2.65 ohms
D-164886AA	3.83 ohms
D-167026	13,500/10,500 ohms
D-162025AT	1400/135/270 ohms
D-164285	40,600/1500 ohms
D-166860FL	1155 ohms
D-162707CY	2500 ohms
D-171862	279 ohms
D-171863	591 ohms
D-164286	10,000/15,000/62,000 ohms
D-164284	100,000/50,000 ohms
D-172241	400/600/700/750 ohms

@ $1.00 ea.

MOUNTINGS
MT-5/ARR2
MT-7/ARR2
MT-171A/U
FT-265A
FT-340
MT-167/U
FT-308A
FT-282A
MT-80/ARC5
FT-141
MT-85/ARC5
MT-78/ARC5
MT-62/ARC5
FT-225A
FT-229A
FT-232A
FT-234A

SHOCK MOUNTS
No. 1 Square
No. 2 Square & Diamond
No. 4 Square & Diamond
No. 6 Square
No. 8 Square & Holder
No. 12 Square & Holder
No. 15 Square & Holder
No. 20 Square & Holder
No. 33 Square
No. 35 Square & Holder
No. 10 Square & Holder
No. 25 Square & Holder
No. 45 Holder
No. 55 Holder
Write for More Data

POCKET TESTERS

Model 542 Supreme Sensitivity. 5,000 Ohms/v 3" square meter. Reads: D.C. volts, 6-150-300-1,500; AC Volts 6-30-150-600; D C ma., 0.3-6-30-150; Ohms, 2,000 - 20,000 - 200,000, 2 megs; db. —6 to +50; Output, 6-30-150-600 volts. Bakelite case, 5-7/8 x 3 1/16 x 2-1/8" Shpg. wt. 2 lbs. ....$8.95 ea. Model 442 Rad City. Same as above.........$8.95 ea. Model 666—SC 56J Triplet VDC 3/30/300/600/1500 VDC ohms 1000/10000/100000/1 meg. Price ....$7.95 ea. All above meters are sold as is. No refund minor repairs required.

Panel Meters
0-30V DC Meter Westing. Type AX Aircraft type. Price $4.95

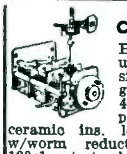
Weston 3½" Rnd. Bake 0-500 Ma. RF Thermocouple Model 425 Res.—1.3 ohms....$9.95 IS-110 Double range 0.3 & 0.75 V Internal Res....$4.75 Triplett Model 221 2½" rnd. 0-500 Ma. ....$3.95 2½" rnd. Bake G. E. Model ADF—10 type DW 51 0-500 Ma. ....$3.95 McClintock 3½" Rnd. Tuning Ind. for S-37 FM Tune, etc. DB over S9.............$5.95 2½" rnd. 0-5 ARF Weston 507 ....$3.95 3½" rnd. Bake 0-1V Marked 0-100 and 0-250 Ma. General Electric model VY 412.$4.95 IN1909 3½" rnd. Bake, 0-3AAC basic. Marked 0-120 A. A. C. Western Electric type NA 35 ....$6.49

0-1MA 3½" Rd. DeJure Mod S-310. Price ea. $4.75
0-1MA 3½" Rd. Same as above. Mfg. Sun Mfg. Mod 3AP259. Price ea. $3.95
0-10MA 3½" Rd. DeJure Mod S-310. Price ea. $4.65
0-10MA 3½" Rd. Same as above. Mfg. Sun Mfg. Mod 3AP236. Price ea. $3.95

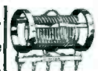
Multimeter Mvmt. 0-100 Meg. 0-600/50/14VDC (0-5 Ma Basic) 3" Rd Metal Sim to Sipson #23 ......$3.95

METERS
0.5Ma SQ 2" Metal Case or 0-10 volt movement readrite meter ....98¢

SELSYN TESTER
Magnesyn Instrument Field Tester AAF 43G23330 Spec. 40772 To test individual mag. Ind. & Xmitters. for isolating Faults in magnesyn systems. Brand new $99.00



VFO Capacitor
High grade unit consists of 3 gang cap. 420 MMF per sect. ceramic ins. low drift; w/worm reduction gear 120:1 w/ext. shaft and 4 digit Veeder counter $3.95



XMTR COILS AIR WOUND
Regular Both Boxed
80 MTR
160 MTR
40 MTR
80 MTR
160 MTR
500 watt
500 watt
150 watt
150 watt
150 watt
$1.49 each

GIBSON GIRL

The Emergency Radio Transmitter. Sends S O S signals automatically on 500KC. 150-mile range. No batteries required. Has hand-driven generator, tubes, wire. New. It's only $4.25

PHOTO PRINT-DRYERS
Consists of microme element insulated from open frame 9¾"x10" 110V 60 cy.........................75c

CAPACITORS

XMTG. Micas Tapped Holes

Mfd.	Price
2500 V Test	
.00001	$0.29
.000025	.29
.00003	.29
.00005	.29
.000075	.29
.0001	.29
.00015	.29
.00025	.29
.0003	.29
.0004	.29
.0005	.35
.00075	.35
.00085	.35
.001	.35
.0015	.35
.0016	.35
.0017	.35
.002	.50
.0023	.50
.003	.50
.004	1.79
.005	1.79
.006	1.79
.0063	1.79
.0069	1.79
.007	1.79
.0075	1.79
.0076	1.79
.008	1.79
.01	1.10
.015	1.10
.02	1.10
.015	1.10
.027	1.10
.03	1.10
5000 V Test	
.0015	1.75
.002	2.00

XQ Solder Lugs

2500 V Test	
.01	.85
.015	.85
.02	.85
.04	.85
.001	.60
.0015	.60
.002	.60
.0022	.60
.0023	.60
.0024	.60
.0025	.60
.0027	.60
.003	.60
.004	.60
.005	.60
.0056	.60
.006	.60
.0063	.60
.0075	.80
.0076	.80
.008	.80
.0085	.80
.0005	.60
.0005	.60
.00015	.60

Oil Condensers Famous Makes Brand New

Mfd.	Volt	Price
15	220AC	$2.00
.5.5	400	.50
1	600	.45
6	600	.98
7	600	1.05
.5	750AC	1.69
.5	1K	.69
1.5	1K	.75
2	1K	.99
4	1K	.98
.25	1.5K	1.05
1	1.5K	.89
1.5	1.5K	.95
2	1.5K	1.05
6	1.5K	2.25
1	2K	.98
.1	2.5K	1.20
.15	4K	2.95
.1.1	4.8K	2.95
.4	5K	2.95
.1	6K	2.79
.15.15	6K	3.95
1.5	6K	9.75
.1.1	7K	3.39
.1	7.5K	2.95
1	7.5K	12.95
.15.15	8K	4.95
.1	10K	14.95
.0016	15K	7.95
1	15K	70.00
.015	16K	6.95
.25	20K	16.95
.5	25K	75.00
1	25K	125.00
4	50	.29
1	100	.15
2.5	100	.23

BATHTUBS

Mfd.	Volt	Type	Cat No.	Price
.01	600	2ST		25¢
.02	600			
.1	400	2ST	HC 3755	30¢
.02	1600	2ST	BA31227-E	45¢
.03	1000	2ST	W3-94	45¢
.06-.1	1500	2TTins	305-1526S	50¢
3x.05	600	3ST	CP50BSOFSO3V	30¢
.05	600	2TT	CSF-481391-10	30¢
.05	600	2ST	DYR 6005	30¢
2x.05	600	3ST	CGF48315B-10	40¢
2x.05	600	3ST	DYR 60055	40¢
.1	600	2ST	A-8B-373	25¢
.1	600	2TT	630T	25¢
.10	600	1ST	NDN	25¢
.1	1000	2ST	CAW48197-B10	30¢
2x.1	400	2BT	1574	25¢
2x.1	400	2TT	1572	25¢
2x.1	600	3ST		30¢
2x.1	400	2TT	CBY48678	25¢
2x.1	600	3BT	305-1133	30¢
2x.1	600	2BT	CSF48680-A20	30¢
2x.1	200	2ST	CP-204D P11	20¢
2x.1	600	3ST	CQU48313-B10	30¢
2x.1	600	2ST	CGF48712B-10	30¢
2x.1	600	3ST	DYR6011	30¢
2x.1	600	2ST	CQU-48712-B10	30¢
2x.1	600	3BT	305-1133	30¢
2x.1	600	3ST	2XDMRW6-.1	30¢
2x.1	600	3ST	CP50B4EF104UX	30¢
2x.1	600	3BT	305-1133	30¢
2x.1	600	3BT	305-1133	30¢
3x.1	600	3TT	7890481-P1	35¢
3x.1	600	3ST	CQU48713-B10	35¢
3x.1	600	3TT	305-1683S	35¢
3x.1	600	3BT	22F462	35¢
3x.1	600	3TT	3XDRTMW6-.1	35¢
3x.1	400	3BT	CAW48709	30¢
3x.1	600	3ST	A-18933-1	35¢
.13	600	2TT	630MT	25¢
.25	400	2TT	430T	30¢
2x.25	400	2ST	7253775	40¢
2x.25	100	2TT	K-7101880	25¢
3x.25	400	3BT	CAW-481372	35¢
.5	120	2TT	C226806-2	20¢
.5	600	2TT	305-1154	25¢
.5	400	1TT		23¢
.5	200	2ST	XDMR2-.5	20¢
.5	600	2ST	DYR6050G	25¢
.5	400	2ST	14862	23¢
.5	600	2BT	CSF48704-A20	25¢
.5	400	2TT	RO5	23¢
.5	400	2ST	48205A	23¢
.5	200	2ST	8A31231-C2	20¢
.5	400	2TT	1573	23¢
3x.5	100	3ST	B-215563-5	25¢
2x.5	250	2TT	A8B-515	25¢
2x.5	400	2ST	Z1065A	30¢
2x.5	300	3TT	541B	25¢
2x.5	400	2BT	1575	30¢
3x.5	400	3BT	CBY48703	30¢
.7	200	1TT	7157	30¢
1	200	1ST	55907	25¢
1	600	2ST		35¢
1	600	2BT	305-1391	35¢
1	400	2ST	A-8B-361	33¢
1	600	2TT	305-1507SNDO	35¢
1	600	Test 2ST	NDPS	30¢
1	400	2ST	A-8B-1104	30¢
1	600	2ST	W5-13	35¢
2x1	200	4ST	W226671-1	35¢
2x1	200	4ST	W-226671-2	35¢
2.5	100	2ST	K7101881-P1	30¢
4	50	2ST	678687-5	25¢
8	500	2ST	55844	79¢
30	150	2ST	D11206	1.15
25		2BT		
5-20		3TT	5417	
.025	600	2ST	NCN	35¢
2x1	400	3TT	P8887	25¢
2x.1	600	3TT	CP61B4EF104V	30¢
2x.1	600	3BT	CP52B4EF104V	30¢
2x.1	400	3ST	NKP8	25¢
3x.1	600	3TT	CMR-48849-A	35¢
3x.1	400	3ST	CP50BSEE104V	30¢
3x.1	400	3ST	CP505BEE104X	30¢
3x.1	600	3BT	CSF48709-A20	35¢
.1	400	2TT	CD-1066-11V	23¢
.1	600	2BT	NKP	25¢
.5	600	1TT	7283	30¢
6	400	2TT	CE64B060Q	1.00

ARC/5 BATHTUBS

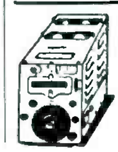
3x.05	300	3TT	5414	08¢
.05-.01-.05	300	3TT	5415	08¢
3	300	1TT	7582	05¢
3x.22	300	3TT	692643 NAO	20¢

Universal Output Transformer

Amertran Silcor. PRI: 20,000/16,000/5000/4000 ohms. Sect. 500/15/7.5/5/3.75/1.25 ohms. 30 db. contin. Flat to 17,000 CY. w/Diag. $4.75

Loading Coil C114
Same as WE No. 632 but in waterproof case to counter balance cap. in line gives clearer signal. Army used W/ W110 & W130 wire. ..85¢ ea.

ARC-5
Mod. X F M P P-P 807 to P-P or PAR 807's #9446 ...$1.65



Xmfrs VFO Drivers 40 Watts Output 274N (ARC5)

4-5.3 MC $5.95
5.3-7 MC $5.95
7-9.1 MC $13.95
Used Good Cond.

FUSES

Amp.	Volt	Type	Size	Price
1	250V	F2-9	2"x¼"	12¢
10	250V	GN50	2"x¼"	15¢
3	250V	Indicator GX-31	2"x¼"	22¢
30	250V	1130NC44	2"x¼"	15¢
1	1000V		3"x¼"	15¢
1	250V	1110	2"x¼"	15¢
5	250V	Indicator GX-32	2"x¼"	22¢
½	1000V	Cartridge	3"x¼"	15¢
1½	2500V	Cart	4¼"x¼"	18¢
1½	2500V	HVP	4¼"x¼"	18¢
2	3000V	HVC	5¼"x¼"	20¢
½	1000V	Cart	3"x¼"	15¢
1	1000V	Cart	3"x¼"	15¢
1.1	2500V	SP111	4¼"x¼"	18¢
.5	1000V	Cart	3"x¼"	15¢
1	3000V	2114	5¼"x¼"	20¢
½	2500V	Cart	4¼"x¼"	18¢
1	250V	F29	2"x¼"	15¢
2	250V	FK-65 Indicator	2"x¼"	22¢
1	1000V	HVA	3"x¼"	15¢
6	250V	Indicator HV76	2"x¼"	22¢
4	250V	Indicator FK67	2"x¼"	22¢
1½	1000V	Cart	3"x¼"	15¢
½	3000V	Cart	5¼"x¼"	20¢
1	2500V	Cart	4¼"x¼"	18¢
½	2500V	Cart	4¼"x¼"	18¢
1	1000V	HVA1	3"x¼"	15¢
1	1000V	78X481	3"x¼"	15¢
150	250V	Clamptype HBO	1½"x¼"	35¢
70	125V	Clamp type ACK	2½"x1"	30¢
90	250V	Knife Blade NEC	3½"x1" blade	less 40¢
1	250V	4AB	1¼"x¼"	7 for 25¢

T. U. for BCAR230 or 430
3.2—4MC
5—6.2MC
1.2—1.5MC
1—1.2MC
Price 95c ea.
4—5MC w/ 4495KC
XTAL $1.69

MS49 and MS50 Fish Pole Antenna 74" long. Both for 49¢

ARC 5 MODULATOR
MD7/ARC5 w/ dynamotor complete w/Tubes 1-12J5, 2-1625, 1-UR50. Good cond.
Price $8.95

SCR274
Screen Mod. XFRMR for pair of 807's PP — PP or Paril Sidetone Wndg. ....95¢

CONDENSER TUNING UNITS FOR BC 191 or 375
Write up in OCT QST for Conv to vhf freq meter
TU 5— 1500 to 3000 KC
TU 7— 4500 to 6200 KC
TU 8— 6200 to 7700 KC
TU 9— 7700 to 10000 KC
TU 26— 200 to 500 KC
Price $2.49 ea.

TUNING UNITS FOR BC 223 XMITTR
TU17A 2000-3000Kc. $2.75
TU18 3000-4500Kc. 2.25
TU25 3500-5200Kc. 2.25

ANTENNA MAST
Are you in a dead spot. If you can't get a good T. V. Picture. Here is a Sig. Corp. Ant. mast 30' high of rugged plywood construction to solve your problem. It telescopes into 3 ten ft. sect. for easy stowage. Easy to Mnt. Comp. with stakes & rods. Ea. $19.95.

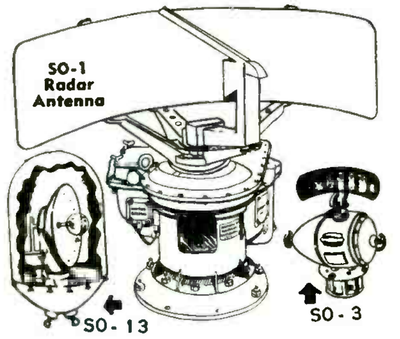
AMPLIFIER
AM-32/PRSI less batt w/carry case for Mine Detector AN/PRSI.
Price ea. $7.95

All merch. guar. Mail orders promptly filled. All prices F.O.B. N. Y. C. Send MO or Chk. Only shipping chgs. sent C.O.D. Rated concerns send P. O.

MIN. ORDER $3.00 **COMMUNICATIONS EQUIPMENT CO.** MIN. ORDER $3.00

131 Liberty St., New York, N. Y. Dept. E-4 Chas. Rosen Phone: Digby 9-4124

RADAR ANTENNAS



Type SO-1 (10 CM.) Complete assembly with reflector, waveguide nozzle, drive motor and synchros, etc. New in original cases..................$279.50

Type SO-3 (3 CM.) Surface Search type complete with reflector, drive motor, synchro, etc., but less plumbing. New in original cases..................$189.50

Type SO-13 (10 CM.) Complete assembly with 24" dish with feedback dipole. Complete with synchros, drive motor, gearing, etc. New in original cases. $149.50

Also in stock—spare reflectors, nozzles, probes, right angle bends for SO-1 antennas.

400 CYCLE TRANSFORMERS

AUTO. 400 cy. G.E. Cat No. 80G184 KVA .945S—.520P. Volts 460/345/230/115. New $4.95

FILAMENT. 400/2600 cy. Input: 0/75/80/85/105/115/125V. Output: 5V3A/5V3A/5V3A/5V3A/5V6A/5V6A/6.3V6A/6.35A. New $2.95

THYRATRON POWER. 400/1600 cy. Raytheon UX-8876. 400/1600 cy. Pri: 115. Sec: 50-0-50V at 0.5A, 6.3V at 1.2A. Test r.m.s. 1780. New....$2.75

PLATE WECO KS9560. 400/800 cy. Pri: 115V. Sec: 1350-0-1350 at .057A (2700 V Total). Elecstat shlded. Wt. 2.3 lbs. New..........................$2.95

Plate. Thordarson #T46889. 1650 VA. Pri: 105-120V. 500 cy. I PH. Sec: 5600V. Center tapped. 7.5KV insulation. Brand new..............$49.50

SCOPE PL. & FIL. WECO 9556. 400/2400 cy. Pri: 115. HV. Wdg. 1125V at .008A. Fil. Wdgs. 6.4V4A/2.5V1.75A/6.4V.6A. Elecstat shlded. Wt. 1.4 lbs. New $2.75

FILAMENT. 400/2400 cps. WECO KS9553. Pri: 115V. Sec: 8.2V1.25A/6.35V1.5A Elecstat shlded. Wt. 0.5 lbs. New $1.95

PLATE & FIL. 400/2600 cy. Pri: 0/80/115V. Sec #1=1200VDC at 1.5MA. Sec #2=400VDC at 130MA. Fil. Secs: 6.4V4.3A/6.35VO.8A. (ins. 1500V)/5V2A/5V2A $4.95

RETARD. 400 cy. WECO KS9598. 4 Henry 100MA $1.75

60 CYCLE TRANSFORMERS

FILAMENT. Raytheon Hypersil Core. Pri: 115V. Sec: 6.3V22A/6.3V2.4A/6.3V2.25A/6.3VO.6A Ins. for 1700V $5.95

High Reactance Trans. G. E. type Y-3502A.—60 cy., Voltage 11200-135. Inductance H.V. Winding 135 Henries. Output Peak Voltage 22.8KV. Cat. 8318065G1. New $89.50

High Voltage Trans. Westinghouse 7,500 volt or 15000V Voltage Doubler at 35MA............$24.50

PULSE TRANSFORMERS

PULSE. WECO KS-9563. Supplies voltage peaks of 8500V from 807 tube. Tested at 2000 Pulses/sec and 5000V peak. Wdg. 1-2=18 ohms. Wdg. 1-3=72 ohms. L of Wdg. 1-3=.073-.082H at 100 cps..........$5.50

PULSE, WECO KS-161310, 50 KC, to 4MC. 1¾" Dia. x 1⅞" high. 120 to 2350 ohms. New.....$3.95

SOUND POWERED BATTLE PHONES

Western Electric No. D173312, Type O. Combination headset and chest microphone. Brand new including 20 ft. of rubber covered cable........$17.50

Automatic Elec. Co. No. GL843AO. Similar to above but including Throat microphone in addition to chest microphone. Brand new with 20 ft. rubber covered cable $13.50

U. S. Instrument Co. Navy Type M. Dr. No. A-260 ALT. 1. Complete with 20' cable and navy plug. Brand new $17.50

MICROWAVE RECEIVERS

AN/APR-1 Receivers and tuning units TN-1 (38 to 95 MC) TN-2 (76-300 MC) TN-3 (300-1000 MC)

AN/APR-4 Receivers and tuning units TN-16 (38-95 MC) TN-17 (76-300 MC) TN-18 (300-1000MC)

AN/APR-5A Receivers. 1000 to 6000 MC Range.

LAVOIE FREQ. METER

375 to 725 MCS

Model TS-127/U is a compact, self-contained, precision (± 1 MC) frequency meter which provides quick, accurate readings. Requires a standard 1.5V "A" and 45V "B" battery. Has 0-15 minute time switch. Contains sturdily constructed HI-"Q" resonator with average "Q" of 3000 working directly into detector tube. Uses 957, LS6 and 3S4 Tubes. Complete, new with inst. book, probe and spare kit of tubes. Less batteries. Write for descriptive circular.................................. **$69.50**

PARABOLOIDS

Spun Magnesium dishes 17½" dia. 4" deep. Mounting brackets for elevation and azimuth control on rear. 1½ x 1⅝" opening in center for dipole. Brand new per pair.......................... **$8.75**

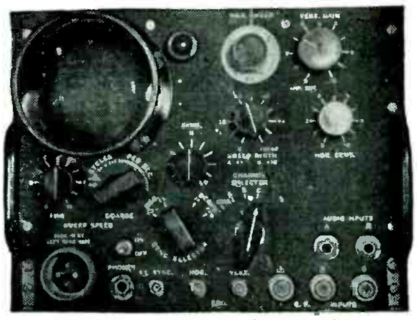
SWEEP GENERATOR CAPACITOR

High speed ball bearings. Split stator silver plated coaxial type 5/10 mmfd. Brand new...... **$2.50**

RAYTHEON VOLTAGE REGULATOR

Adj. input taps 95-130V., 60 cy. 1 Ph Output: 115V., 60 Watts, ½ of 1% Reg. Wt. 20 lbs. 6⅛" H x 8¾" L x 4⅝" W. Overload protected. Sturdily constructed. Tropicalized. Special........... **$14.75**

MODEL AN/APA-10 PANORAMIC ADAPTER



Provides 4 Types of Presentation:
(1) Panoramic (2) Aural
(3) Oscillographic (4) Oscilloscopic

Designed for use with receiving equipment AN/ARR-7, AN/ARR-5, AN/APR-4, SCR-587 or any receiver with I.F. of 455kc. 5.2mc. or 30mc.

With 21 tubes including 3" scope tube. Converted for operation on 115 V. 60 cycle source.

PRICE **245.00**

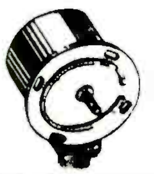
AN/APA-10 80 Page Tech Manual......... **$2.75**

G. E. SERVO AMPLIFIER

Type 2CV1C1 Aircraft Amplidyne control amplifier. 115 volts—400 cycles. Dual channel. Employs 2-6SN7GT and 4-6V6GT tubes. Supplied less tubes. New $22.50

LINEAR SAWTOOTH POTENTIOMETER

W.E. KS-15138



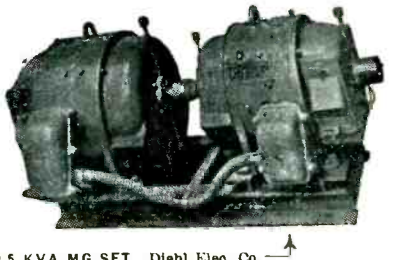
Has continuous resistance winding to which 24 volts D.C. is fed to two fixed taps 180° apart. Two rotating brushes 180° apart take off linear sawtooth wave voltage at output.

Brand New $5.50

HIGH VOLTAGE CAPACITORS

.25 MFD., 20KV	$26.50
.25 MFD., 15KV	22.50
.5 MFD., 25KV	34.50
1 MFD., 15KV	34.50
1 MFD., 7.5KV	12.50

MOTOR GENERATORS DYNAMOTORS, INVERTERS, ETC.



2.5 KVA MG SET. Diehl Elec. Co. 120V DC to 120V AC, 60 cy. 1 Ph. Complete with Magnetic Controller, 2 Field Rheos and Full Set of Spare Parts including Spare Armatures for Generator and Motor. Full specs. on request. New. $285.00

2 KVA MG SET. O'Keefe and Merritt. 115V DC to 120V AC, 50 cy. Idles as 3 Ph. syncs motor on 208V, 50 cy. New. Export crated..$165.00

1.25 KVA MG SET. Allis-Chalmers. 230 DC To 120 AC, 60 cy. 1 Ph. Fully enclosed, Splashproof Ball Bearings, centrifugal starter.
NEW $150.00
Kit of Spare Parts........................ 25.00

MG Set. Onan MG-075. Navy type PU/11. Input 115/230, 60 cy, 1 Ph. Output 115, 480 cy, 1 Ph, 5.3 amps and 26V DC at 3.8 amps. New......$198.50

MG Set. Onan MG-215H. Navy type PU/13. Input 115/230, 60 cy, 1 Ph. Output 115, 480 cy, 1 Ph, 1200W and 26V DC at 4 amps. New........$295.00

MG SET FOR NAVY TBS TRANSMITTER. Type CG-21302. 440V AC, 60 cy, 3 Ph, 1500 VA to 875V DC and 300V DC. New..............................$69.50

DYNAMOTOR. Navy Type CAJO-211444. 105/130V-DC to 13V DC at 40A or 26V DC at 20A. Radio filtered. Complete with Line Switch. New. $69.50

DYNAMOTOR. Elcor. 32V DC to 110V AC, 60 cy. 1 Ph, 2.04 Amps. New......................$24.50
Also available for 64 volts input. Same price.

DYNAMOTOR. Elcor. 32V DC to 110V AC, 60 cy. 1 Ph, 0.43 Amps. New.......................$17.50

DYNAMOTOR—Type PE94C. For use with SCR522 Transmitter-Receiver. Brand new in export cases. $9.50

AMPLIDYNE—G. E. Model 5AM21JJ7. 4600 R.P.M. Motor Compound wound. 150 Watts. Input: 27V. DC. Output: 60V. DC Sig. Corps. U. S. Army MG-27-B. New $26.50

AMPLIDYNE—Edison type 5AM31NJ18A. Input: 27 volts 44 Amps., 8300 RPM. Output: 60V DC at 8.8 amps. 530 Watts. New.................$22.50

INVERTER—G. E. Model 5D-21NJ3A. Input: 24V. DC. Output: 115V. 400 cy, 485 Va. New.....$49.50

INVERTER—Leland Elec. Co. Model PE206A. Input: 28V. DC, 38 Amps. Output. 80V., 800 cy. 485 VA. New $17.50

PE 218 INVERTER—G. E. J8169172. Input: 28V. DC, Output: 115V, 400 cycles at 1.5 KVA....$50.00

GENEMOTOR—Carter 6V DC to 400 V DC at 375 mils. New $49.50

D. C. MOTOR—G. E. Model 5BA 50LJ2A 0.5 HP. Armature: 27V. at 8.3 Amps. Field: 60V. at 2.3 Amps. R.P.M. 400. New....................$22.50

Synchro Differential Generator

Ford Inst. Co. Type 5SDG. Brand New........$22.50

WESTERN ELECTRIC CRYSTAL UNITS

Type CR-1A/AR

Available in quantity—following frequencies
5910—6350—6370—6470—6510
6610—6670—6690—6940—7270
7350—7380—7390—7480—7580
9720—Kilocycles

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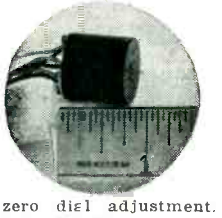
MINIATURE DC SELSYN INDICATOR

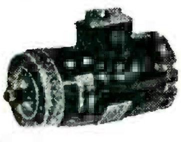


Miniature indicator. 24 v. d-c operation with G.E. Position Transmitter or with Ohmite 360° type potentiometer. Has iron plug for zero dial adjustment. Stock #SA-268. **Price $14.50 each.**

MOTOR SPECIALS

G.E. 5BA25AJ31A and 32A. Dual field reversible gear head shunt wound. 24 v. @ 2.9 amps. 9 rpm. 10 min. time rating. Aircraft type. Magnetic brake. Stock #SA-298. **Special Price $19.50 each.**

G.E. 5PS56HC18 — Split field series reversible motor. 60 v. d-c at 1.4 amperes. 5500 rpm. 3" diam. x 5" lg. Ideal for servo applications. Stock #SA-273. **Price $12.75 each.**



Aircraft Generator Eclipse NEA-3

Output 115 VAC; 10.4 amps. 800 cycles at 2400 rpm. Also 30 VDC at 6 amps. Stock #SA-306. **Price $19.50 each.**

SWEEP GENERATOR CAPACITOR

Hi-speed bearings. Split stator. Silver-plated coaxial type. 5-10 mmf.

Stock #SA-167 **Price $2.75 each**

FORD INS'T SERVO MOTOR

115 volt 60 cycle two phase low inertia motor. 15 watts output. BuOrd. 207927. Stock #SA-291. **Price $49.50 each.**

ANTENNA TILT INDICATOR

D-C Selsyn type tilt indicator. G.E. 8DJ29AAK. 24 volt. Stock #SA-296. **Price $3.75 each.**

Gyro and Housing Mirror Assembly. For K-14A sighting head. Gyro stabilized mirror assembly. Stock #SA-294. **Price $6.75 each.**

SYNCHROS

Navy Types

1G, 1CT, 5G, 5CT, 5DG, 5HCT, 5SF, 5HSF, 5SDG, 6DG, 7G, etc.

Prices on Request

ALSO IN STOCK

Subfractional Horsepower AC Motors

Haydon 36228—115 v. 60 cy. 1 rpm.
Eastern Air Devices-J-72B—115 v. 400 cy. 1/50 hp. Cont. duty. 4700 rpm.
E. A. D. J-31—115 v. 400 cy. 1/100 hp.
E. A. D. J-49B—115 v. 400 cy. 1/250 hp.
Diehl FBF-24-1—115 v. 400 cy. 1/100 hp.
Synchron-600—110 v. 60 cy. 1 rpm.
E. A. D. J-33—115 v. 3 ϕ 400 cy. Int. duty.

400 CYCLE AC BLOWERS

E. A. D. J-151—115 v. 400 cy. 22 c.f.m.
Westinghouse Type FL—115 v. 400 cy. 17 c.f.m.

DC MOTORS

Haydon-0666. ½ rpm. 29 v. d-c. 100 ma.
Delco 5069625—120 rpm. Gov. cont. 27 v.
General Electric 5BA50LJ66—½ hp. 27 v. field. Arm. v. 60. Amplidyne controlled.
Delco-A-7155—1/30 hp. 3600 rpm. Gov. cont.
W. E. KS-5603-LO2—1/100 hp. 4 lead shunt.
National Mineral—90600. 1 hp. Int. duty. Fan cooled.
Diehl FDE-53-5—3600 rpm. Gov. cont. 1/30 hp.
G. E. 5BA25MJ409—24 v. 7500 rpm. Cont. duty.
Airsearch—Actuator—25800-24. 2" travel.
Barber Colman—Actuator—YLc-2066-2. 200 in/lb. 135 degrees in 45 seconds.
Airsearch—Actuator (Manual Flap) 25080.
Airsearch—Actuator—(Automatic Flap) 25040.
Holtzer Cabot—RBD-2220—½ hp. 27 v. 3600 rpm.
Arma Latitude Motor — 8413-30 (Step motor)
Elinco B-64—1/165 hp. 3100 rpm. 27 v. f. 80 v. armature. (Thyratron control)
John Oster—A-21E-12R—Split field series reversible. 28 v. 0.4 amps. 2 watts output.
General Electric 5PS56HC18 — Split field series rev. 60 v. 1.4 A. 5500 rpm.

AC SERVO MOTORS

Kollsman—776—01—400 cy. 2 ϕ drag cup type.
Diehl FP-25-3—2 ϕ 60 cy. 20 v. 2.5 watts out.
Pioneer CK-2—2 ϕ 400 cy. 1.05 in/oz. stall.
Pioneer 10047-2A—2 ϕ 400 cy.
Minneapolis Honeywell G303AY2CA4. Built in gear reduction. 2 ϕ 400 cy.

AUTOSYNS (Pioneer)

B-9A—Dual Oil Pressure Indicator (6007-4F-7A)
B-9A—Oil Pressure Transmitter. (4150-3B3)
Pioneer Types—AY-1, AY-14, AY-54, 2320, AY-20,851, etc.
C-14A—Fuel Pressure Transmitter.
Pioneer I-81A and I-82A Compass Indicators.

MAGNESYNS

Pioneer Type C1-3. 6 power.
Pioneer 1006-1E-B1 Indicator. AN-5730-2.
General Electric Selsyns 2J1G1, 2J1F1, 2J1H1, 2J1F3, 2J5FB1, 2J5R1, 2JD5R1, etc.
Army Ordnance Synchros 1V, V, X, 11. V11, XV, XV111, XX1, etc.
400 Cycle Synchros Kollsman 775-01, 1F (special. W. E.KS-5950-LO-2.
Aircraft Amplidynes General Eelectric 5AM31NJ18A and 5AM31NJ9A.

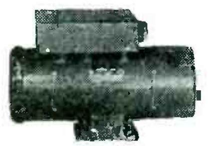
INVERTERS

Pioneer 12117-2, 12117-5, 12128-1, 12130-4.
Wincharger PU-7/AP, PU-16, (MG-750).
Holtzer Cabot—MG-149F, MG-149H, MG-153, MG-153F.
Leland—10285. PE-218.
General Electric—PE-218D, 5AS131JJ11A, 5D21NJ3A, etc.

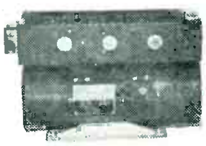
C-1 AUTOPILOT COMPONENTS
A-5 AUTOPILOT GYROS
GENERAL ELECTRIC D-C SELSYNS
AC and DC RATE GENERATORS

INVERTERS

Wincharger PU-7/AP Input 28 VDC at 160 amps. Output 115 v. 400 cy. 1 ϕ at 2500 VA. Voltage and frequency regulated. Cont. duty. Stock #SA-164. **Price $89.50 each.**



G.E. 5AS131NJ3 (PE-118) Input 26 VDC at 100 amps. Output 115 v. 400 cy. 1 ϕ at 1500 VA. PF 0.8 W.E. Spec. KS-5601L1. Stock #SA-286. **Price $29.50 ea.**



PE-218EInverters Russel Electric and Leland. Input 28 VDC at 92 amp. Output 115 v. 400 cycles at 1500 VA. PF 0.9. Stock &SA-112A. **Price $49.50 each.**

Pioneer 12130-4-B Input 28 VDC at 14 amps. Output 120 v. 400 cy. Single Phase at 1.15 amps. (140 VA.) Voltage and frequency regulated. Made 1949. Stock #SA-304. Price $89.50 each.

MAGNETIC AMPLIFIER ASSEMBLY

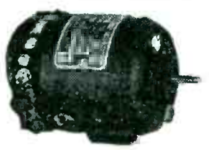
Sperry 661824. Saturable reactor type output transformer. Designed to supply one phase of 400 cycle servo motor. Stock #SA-266. Price $6.75 each

Autosyn Indicator

I-82F Compass Indicator. 0-360°-5 in. dial. 26 v 400 cy. 8-12 v. 60 cy. Ideal position indicator. Stock #SA-284.

Price $6.50 each

DC SERVO MOTOR



Elinco Type B-64. 1/165 hp at 3100 rpm. Field volts 27.5 Max. armature voltage 80. Ideal for thyratron servo control Stock #SA-211. Price $16.50 each.

MICROWAVE ANTENNA

AS-217-APG 15B, 12 Cm dipole and 13 inch Parabola housed in weatherproof Radome 16" dia. 24 v. DC spinner motor for conic scan. Stock #SA-95. Shipping wt. 70 lbs. **Price $14.50.**

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UNUSED

AN PLUGS
AN RECEPTACLES

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Pieces	Part No.	Insert
53	AN3100-8S-1P	M
10	-8S-1S	M
15	-10SL-3P	B
81	-12S-3S	B
650	-12-5P	B
2098	-12-5S	B
586	-14S-1S	B
69	-14S4P	B
141	-14S-6P	M
73	-14S-6S	M
65	-14S-7S	B
96	-14S-7S	
328	-16S-4S	B
41	-18-4S	B
99	-18-8S	B
448	-18-12S	B
314	-18-12S	
28	-18-15S	
70	-18-22P	M
50	-20-21S	M
92	-22-2S	M
698	-22-5S	B
16	-22-14P	M
32	-22-21P	M
15	-24-2S	M
14	-24-5P	M
65	-24-5P	M
37	-32-6P	B
45	-32-7P	B
98	-PR32-7P	M
314	-32-7S	M
281	-32-14P	B
132	-32-14S	B
26	-36-7P	M
358	-36-19P	B
77	AN3102-8S-1P	M
440	-10S-2S	B
828	-10S-2S	M
31	-10S-8S	M
577	-12S-3P	M
70	-12S-3S	B
172	-12S-3S	M
34	-16S-1P	
330	-16S-5P	B
32	-16S-8S	M
10	-16-11S	B
734	-16-13P	B
1428	-18-4S	B
1607	-18-5S	B
38	-18-12S	M
25	-18-22P	M
1122	-20-3P	B
17	-20-5P	B
16	-20-14P	M
207	-22-1S	B
227	-22-5S	B
349	AN3102-24-1S	B
82	-PR28-1P	M
20	-28-11P	
34	-28-11S	B
70	-32-1P	B
154	-32-1S	B
66	-32-6P	M
20	-32-6S	M

M—Melamine
B—Bakelite

Pieces	Part No.	Insert
38	-32-7P	M
62	-32-15P	M
34	AN3106-8S-1P	M
61	-8S-1P	B
12	-8S-1S	M
116	-8S-1S	B
809	-10S-2P	M
275	-10S-2P	B
177	-10S-2S	B
50	-10S-2S	M
466	-10S-2S	B
500	-10SL-3S	B
2737	-10SL4S	B
248	-12S3S	
373	-12S-4P	B
351	-12S-4P	M
13	-12-4S	B
22	-12S-4S	B
250	-12S-4S	M
191	-12-5S	B
10	-14S-4P	M
68	-14S-7S	B
138	-16-2S	B
12	-16S-4P	B
62	-16S-4S	B
200	-16S4P	M
45	-16-13S	M
200	-18-1S	B
269	-18-5P	B
32	-18-5S	M
4711	-18-6S	B
278	-18-10S	M
20	-20-5P	B
828	-20-12S	
12	-20-23S	B
49	-20-25S	M
56	-20-27S	B
20	-22-3P	B
12	-22-5P	M
510	-22-19P	B
72	-22-27S	B
14	-24-2P	B
78	-24-3P	B
38	-28-12P	B
22	-32-7P	M
173	-32-7S	
155	-32-14S	B
43	-32-16S	M
25	-36-10S	M
68	-44-1P	B
146	AN3108-8S-1S	B
324	-8S-1S	M
1013	-10S-2S	M
815	-10S-2S	B
36	12S-3S	B
72	-12-5P	B
13	-12-5S	M
102	-14S-2P	M
1062	-14S-2S	B
12	-14S-7S	M
14	-14S-10P	M
438	-16S-1S	B
411	-16S-4P	B
1759	-16S-4P	M

M—Melamine
B—Bakelite

Pieces	Part No.	Inser
32	-16S-4S	B
450	-16S-5P	B
65	-16S-5S	M
152	-16-11S	M
137	-16-11S	B
2947	-18-4P	B
12	-18-4S	B
147	-18-4S	M
1437	-18-5P	B
11	-18-5S	B
404	-18-6S	B
233	-18-9P	B
97	-18-11S	M
35	-18-20P	M
38	-22-14S	B
556	-22-19P	B
30	-24-2S	B
19	-24-9S	B
15	-24-10P	M
25	-24-10S	B
42	-28-1S	M
26	-28-2P	M
235	-28-12S	
106	-28-16P	B
169	-28-17S	M
20	-32-1S	M
24	-32-6P	M
70	-32-7S	B
54	-32-13S	M
40	-32-13P	M
152	-32-14S	B
30	-36-6P	B

M—Melamine
B—Bakelite

UNUSED

ELECTRONIC COMPONENTS

Pieces	Part No.	Description
35	RA-10-DB	Receiver
20	TA12B	Transmitter
150	DA-1F	Dynamotor
162	3611-B	Amplifier
35	MR-9B	Control Box
7	AS27A/ARN-5	Antenna
9000	45	Bulb
11000	1667	Bulb
1000	987	Bulb
300	AN3135-1	Bulb
87	MR16D	Filter
97	FT213	Mount
54	FT293	Mount
80	BX42-7	Dynamotor

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TELEPHONE: CURTIS 3300

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HIGH FREQUENCY CONVERSION EQUIPMENT

LELAND-MURRAY MG SET. Motor: 5 H.P. 220/440 Volts 3 phase, 60 Cy. directly connected to Alternator: 3 KVA. 120/208 Volts, Wye connected. 400 c.p.s. Price $525.00

HOLTZER-CABOT MG149F. Input: 24 VDC, 36 amp. Output: 26 Volts, 400 cycles, 250 VA. Also secondary output of 115 Volts, 400 cycles. 500 VA. Completely rebuilt and guaranteed. Price $25.50
Brand New Units, Price $49.50

HOLTZER-CABOT MG153F. Input: 28 Volts DC at 52 Amp. Output: 115 Volts, 400 cps. 3 phase, 750 va.; .9 P. F. also secondary output of 26 Volts, 400 cycles, single phase at 250 va.; voltage and frequency regulated. **REBUILT LIKE NEW** $65.00

GE MG UNITS. Motor: 110 Volts, D.C. 31.5 Amperes, in a single compact unit with output of 120 Volts, 20.8 Amp. single ph. 500 cycles. Like New. Price...$95.00

500 CYCLE MG SETS. British made motor generator, 8 KW, 2 bearing unit, input 180-240 VDC, output 180 volts, 1 ϕ weight app. 1000 lbs. Price $425.00

OUR OWN SPECIAL 400 CYCLE MG SET. Made in our own shop employing 7½ H.P. Motor V belted to Alternator with output of 4.5 KVA, 115 V. 400 cycles. Excitation supplied is selenium rectifier external to unit. With single phase motor, Price $695.00
with 3ϕ Motor $645.00

ONAN 400 CYCLE MG SET. Motor: 7½ H.P. operative at 220/440 V. 3ϕ, 60 cy. V belted to self-excited alternator with output of 4 KVA. 115 Volts, single ph. 400 C.P.S. Alternator is self-excited with secondary output of 14 VDC 40 Amp. With Voltage Regulator built-in. Price $592.00
With single phase Motor $642.00

ELECTRIC SPECIALTY FREQUENCY CHANGERS Type BFS52/BFRS354 Input: 220 Volts, 3 Ph. 60 cy. 3600 RPM. Output: 250 Volts, 20 Amp. single ph. 180 Cyc. 5000 VA. 3000 Watts. Brand New. Compact ball bearing units for operation of Hi-cycle equipment. SPECIAL PRICE $160.00

ONAN 800 CYCLE MG UNIT. Employing 5 H.P. Motor operative at 220/440 Volts, 3ϕ, 60 Cy. V belted to self-exc. generator with output of 1.5 KVA. 115 Volts, single ph. 800 CPS. and secondary output of 500 Watts, 28.5 VDC 17.5 amperes. PRICE....$289.00

GENERAL ELECTRIC MG SET. 4 Bearing unit directly coupled consisting of Motor of 5 H.P. operative at 220/440 V. 3ϕ, 60 cy. Alternator: 2.5 K.V.A. 115 Volts, single ph. 420 CPS. Brand new factory built units. Price $469.00

INVERTER UNIT PE206A. Input: 27.5 VDC. 38 amp. Output: 80 Volts, single ph. 800 CPS, 500 VA. Price $19.00

KINGSTON-CONLEY MG SETS. Motor: 15 H.P. 220/440 V. 3ϕ, 60 Cy. on which there is flange mounted aero generator with output of 120/208 Volts, 9 KVA 3 Phase, 300 Cycles. Also available for 600 Cycle output. Blast cooled. Completely rebuilt. Either type, price $799.50

G. E. HIGH FREQUENCY MG UNITS. Motor operative at 115 Volts, DC. Generator: 2.5 KW. 24/32 Volts, 78 Amp. D.C. Alternator: 120 VAC, 20.8 amp. .9 PF, single ph. 720 cycles. All three components in a single compact housing. Price $200.00

800 CYCLE UNIT. Operate at 440 V. 3ϕ, 60 cy. directly connected to self-ex. alternator with output of 120 Volts, single phase, 6.6 amp. .8 K.W. 800 Cycles. Price $119.75

CROCKER-WHEELER 500 CYCLE MG SET. Compact 2 bearing Unit. Operative at 120 VDC, 7.3 amps. Output: 250 Volts, 5 amp. 500 cycles. Rebuilt. Price $88.88

RLX DUAL GENERATORS. Flange mounted. Output: 500 Watts. 1300-2600 Cycles, also 12-14 VDC 750 Watts. Price $25.50

HOMELITE 400 CYCLE MG UNIT. Consist of motor and self excited alternator mounted on common bed plate, V belted. Motor: 5 H.P. 220/440 Volts. 3ϕ, 60 Cycles. Alternator: 120 Volts, 11.7 amperes, single phase, 400 cycles. Also output of 28 VDC., 14.3 amps. PRICE $224.00

HOLTZER-CABOT HIGH FREQUENCY MG Sets. Compact 2 bearing units with input of 120 VDC, 7 amps. Output: 120 Volts, 3ϕ 320 Cycles. Has shaft extension permitting use as dual generator. Price $112.90

WESTINGHOUSE HIGH FREQUENCY UNITS. Operate with input of 115 VDC to deliver 17 VAC. 1050 to 1650 cycles. An excellent value $25.50

ESCO DUAL FREQUENCY UNITS. Motor operates at 120 VDC. 10 amperes. Delivers 70 Volts at 120 Cycles or 200 Volts at 720 Cycles. Price $95.00

ESCO 500 CYCLE UNITS. Operate at 100 VDC and deliver 110 VAC 1.38 amp. 150 VA. 500 C.P.S. Price $25.00

WESTINGHOUSE 180 CYCLE ALTERNATORS. 750 V.A. Output: 110 Volts, 3 Phase, 180 C.P.S. 3000 R.P.M. Separately excited at 110 VDC. Price..$44.00
Also available with built-in exciter. Price $78.00

ELECTRIC SPECIALTY HIGH FREQUENCY CONVERTER UNIT. Primary: 32 VDC, 16 amperes, 3000 R.P.M. Ball Bearings. Secondary: 350 volts, 1500 cycles, .75 amps. 275 V.A. Single Ph. Built-in frequency control. Specially Priced at $30.00

GENERAL ELECTRIC HIGH FREQUENCY UNIT. Operating at 440-3-60 .75 amp. Output: 70 Volts, 3 ph. 148 cyc. 220 Watts, 1.8 ampheres. An ideal unit for experimental work or for operation of equipment. SPECIAL PRICE $34.50

GE HIGH FREQUENCY MG SETS. Motor: 250 VDC. 4 amp. Alternator: 600 watts, 125 single ph. 4.8 amp. 500 cycles. Brand new. Price $90.00

BENDIX-ECLIPSE 800 CYCLE AERO UNIT. Input: 24-28 VDC, 75 amps. Output: 115 V. 10.5 Amp. 800 C.P.S. Complete filter system mounted thereon. Price $22.50

CROCKER-WHEELER 500 CYCLE SET. Operate at 110 Volts, D.C. 29.6 Amps. Output: 120 Volts, single ph. 500 cycles 2.5 KW. Price $146.95

WESTINGHOUSE HIGH FREQUENCY UNITS. Input: 115 Volts, D.C. 2.7 Amps. Output: 14.4 Volts. .139 Amp. 450-2550 Cycles. Frequency variation is obtained with built-in controller on end of unit. Price $48.50

GE DUAL OUTPUT MG SETS. Consist of Motor rated 3 H.P. 220-440 V. 3ϕ, 60 Cy. directly coupled to 2 generators. Output: .5 K.W. 220 Volts, 2.27 Amp. 525 Cycles. Also .5 K.W. 110 Volts, D.C. 4.55 Amp. 3 separate units mounted on common bed plate. Price $150.00

ESCO HIGH FREQUENCY UNITS. Operate at 120 Volts, D.C. 25 Amp. 4 H.P. Output: 2 K.V.A. 115 Volts, 17.4 Amp. 2 K.W. Price $175.00

KINGSTON-CONLEY MOTOR GENERATOR SETS. Employs Continental Motor rated at 15 HP. 220/440 Volts, 3 ph. 60 Cy. directly coupled to aero type self-excited alternator rated at 9 KVA with output of 120/208 Volts. 3 Ph. 400 Cycles. Vent blower is provided for blast cooling. An exceptionally fine unit, completely rebuilt like new. Price $1120.00

ONAN 2 BEARING MG UNITS. Motor: 115/230 Volts, single phase, 60 cy. Generator: .6 KVA 115 Volts, 5.3 Amps. 480 C.P.S. Price $165.00

ESCO HV-HF UNITS. Operative at 11.5 VDC 28 Amp. Output: 575 VDC. .25 Amp. also 55 VAC. .91 Amp. 1ϕ, 500 Cycles. Price $39.75

ONAN 800 CYCLE ALTERNATORS. Brand New. Mounted on base with guard for V Belts. Alternator is self-excited, rated at 1.5 KVA. 115 Volts, single ph. 800 Cyc. 2666 RPM. Also output of 28.5 VDC 17.5 Amp. 500 Watts. Price $199.00

GENERAL ELECTRIC 400 CYCLE UNITS. Operate at 27 VDC 100 Amp. Output: 115 VAC 1ϕ, 400 CPS. 1500 V.A. With filter system built-in. Price...$29.50

HOLTZER-CABOT 500 CYCLE MG SET. Motor: 110 VDC. GENERATOR: 5 KVA. 230 VAC, 1ϕ, 500 Cyc. Rebuilt. Price $271.50

MARCONI MG UNITS. Operative at 110 VDC to deliver 500 VAC. 6 Amp. 3 K.W. 240 CYCLES. Extending shaft permits driving complete unit to obtain dual self-excited generator. Price $99.00

LOUIS ALLIS FREQUENCY CHANGER SETS. We have 3 sizes in stock, all brand new. (1) Pri: 220/440-3-60; Sec: 30 K.W. 306 Volts, 2 Ph. 500 Cyc. .8 P.F. Units are belted on common bed plate. Price $1250.00
(2) Pri: 25 H.P. 220/440-3-60; Sec. 15/10.8 K.W. 3300/2200 RPM. 306/220 Volts 35/35 Amps. 2 ph. 500/360 C.P.S. Price $1050.00
(3) Pri: 10 H.P. 220/440-3-60; Sec: 7.5 K.W. 440/220 V. 17/8.5 Amp. 3000/1200 RPM. 360/180 Cycles. 2 ph. Price $750.00
We can supply these units for 400 cycle output and with transformers to supply 3 phase, wye output. Write for further information.

ECLIPSE 800 CYCLE GENERATORS. Flange mounting with spline shaft. Output is 115 VAC 10.4 Amp. 90% P.F. 800 Cycles. 1200 V.A. with secondary output of 28.5 VDC. 60 Amperes. Self excited. Price $39.00

BRITISH MADE 500 CYCLE MG SETS. Motor: 230 Volts, 3 PH.—50 Cycles, XX-Alternator: 5 K.W. 180 Volts. 27.8 Amp. 500 Cycles, Excitation—110 VDC. When used at 60 Cycle current. Output is 600 cycles. 220 Volts. Price $353.00

WINCHARGER PU-7/AP; Input: 28 VDC, 160 Amps. Output: 115 VAC, single ph. 2500 V.A. 400 C.P.S. Frequency and Voltage regulation built-in. Price $87.00

HOMELITE 400 CYCLE POWER PLANTS. PU-6/tps-1 Single cylinder engine, air-cooled governed to operate at 4000 RPM. Generator rated at 1400 Watts, 120 Volts. 400 Cycles also secondary output of 27 VDC, 400 watts. Brand new in original cases with instruction book, and complete spare parts. An exceptional unit to procure 400 cycle current or to be used as a lighting plant. Price $150.00

HERE IS EXCEPTIONAL VALUE

Robins and Myers Motor Generator Units. Operate at 110 Volts, AC, single phase, 60 cyc. and deliver 32/40 Volts, DC. Can be used with field rheostat to supply 24/28 VDC for the operation of aero equipment from lighting line. Rated at 40 watts but will deliver 200 watts for intermittent operation. Gear head built into one end rotates external shaft at 225 RPM. An exceptional value at $18.75 each. With field rheostat $20.00. Also available for operation at 115 VDC at $12.50 and with rheostat at $13.75 each. Both units have 1/4 HP Motor. Stock up on these sets while they are available. Special price on quantity. Rebuilt.

CENTURY MOTOR GENERATOR SETS

7.5 KVA: 230 Volts, DC to 115 Volts. AC, single phase, 60 Cycles. Complete with automatic controller and push button station $445.00

ALLIS-CHALMERS MOTOR GENERATOR

Input: 115 VDC at 14 amp. 3600 RPM. Ball Bearings. Output: 1.25 KVA; 80% PF 120 Volts, AC, 1 Ph. 60 cyc. 10.4 amp. Centrifugal automatic controller permits line start operation. Fully enclosed. **Brand New $99.95.** Also available for 230 VDC operation at the same price.

GENERAL ELECTRIC DC/AC MG SETS

Four Bearing Marine Units: 25 HP 230 Volts, DC coupled to alternator 18.75 KVA; 80% PF; 1800 RPM Output: 115 Volts, AC. Single Ph. 60 cycles. Ball Bearings. 4 bearing set; marine duty. Brand New. $545.00

GEN. ELECTRIC AMPLIDYNES

Model 5AM78AB47; 750 watts; Input: 440-3-60; Output: 250 Volts, DC; 3 amperes; 3450 RPM $185.00

Model 5AM49AB30 Input: 440 Volts, 3 phase, 60 cyc. 1 amp. output: 115 Volts, D.C. 3.25 amp. 3450 RPM $88.00

Model 5AM49AB3; Input: 440 Volts, 3 ph. 60 cyc. 1 amp. Output: 250 Volts, D. C. 1.5 amp. 375 watts. $99.00

Model 5AM73AB58; Input: 110/220 volts, single phase, 60 cyc. Output; 250 Volts, D. C. 1.5 amp. 375 watts. 3450 RPM $100.00
Input: 27 VDC, 44 amp. 8300 RPM. Output: 60 VDC. 8.8 amp. 530 watts $12.95

Model 5AM78AB10; Input: 32 VDC, 60 amp. 2 H.P. 2200 RPM; Output: 250 Volts, D.C. 3 amperes; 750 Watts $190.00

Model 5AM73AB89; Input: 115 VAC, 1ϕ, 60 cyc. 9 amp. Output: 375 K.W. 250 VDC. 1.5 amp $86.00

Model 5AM65FB2A; Input: 115 VAC, 3ϕ, 60 cyc. 5 amp. Output: 500 watts, 250 Volts, 2 Amp $144.00

Model 5AM73AB62: Input: 115/230 VAC 6.2/3.1 Amp. 60 cyc. Output: 250 watts, 125 volts, 2 amp $65.00

WESTINGHOUSE TRANSFORMERS

399 VA; 115/240 Volts; Brand New.
SPECIAL PRICE $4.90

ESCO DC/AC MG SETS. Motor: 115 Volts, 1½ HP line start; built in voltage regulator, frequency control, filtered; ideal for television, radar or any application requiring constant voltage and frequency. Output: 115 V.A.C. 1ϕ, 60 Cyc. 460 V.A. Brand New $120.00

JANETTE ROTARY CONVERTERS

110 VA. Input: 110 VDC; Output: 110 VAC, single phase, 60 cycles; 3600 speed. With filter for elimination of radio interference. Reliably rebuilt. Special Price $19.95

INDUCTION VOLTAGE REGULATOR

Type IRT, form M. 1.64 KVA, 3 phase, 60 cycles, cont. duty. Outdoor service. Primary: 208 V., 10.5 load amps. Oil-filled. Wgt. 365 lbs. 33 x 17" x 14" $90.00

G. E. MOTOR CONTROLLED VOLTAGE REGULATOR

Cat. #837625, Type 'Tirs', Form — .568 KVA, cont. duty, 60 cy., Primary volts 115. Load Amps 16.2. Indoor service. Voltage controlled by mtr. 120/1/60/1/40 HP $39.50
Send for list of other sizes in stock.

Westinghouse Transformer Controller contains 300 watts 120-220 volt transformer with multi-taps. The transformer with tap switch alone is worth more than the special price $7.50

TAPE WINDERS

These tape winders consist of a motor operative at 110 volts D.C., .6 amperes; 1800 speed. A motor which is separable from the rest of the unit and which can be employed for a multitude of purposes, alone or with the gear reduction box to which it is connected. Motor is shunt wound and the speed thereof is controlled by a built-in rheostat. This makes an invaluable laboratory unit. Special Price $10.99

PINCOR ROTARY CONVERTERS

300 VA; Filtered; Brand New. Input: 115 VDC, 4.2 Amp. Output: 220 VAC, 1.36 Amp.
SPECIAL PRICE $38.00

IF IT'S FROM ONE FREQUENCY TO ANOTHER; FROM DC TO AC OR AC TO DC, IF IT'S FROM ONE VOLTAGE TO ANOTHER, THEN CALL ON US.

Established in 1922 — **WILLIAM I. HORLICK COMPANY** — *Tel. HAncock 6-2480*
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TEST EQUIPMENT!
Complete Line!

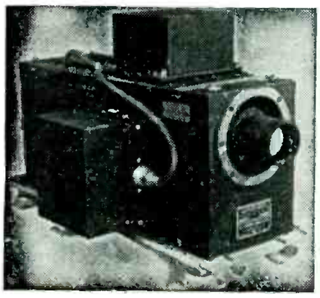
DUMONT 224-A OSCILLOSCOPE

TS-36/AP	TS-102A/AP
TS-108	TS-184A/AP

1-77 HICKOK TUBE CHECKER
UPM-1 COMPLETE TS-250/APN
BC-221 FREQUENCY METER
RPC MODEL 644 MULTIMETER
FERRIS MICROVOLTER MOD. 188

TS-111/CP	I-212
TS-117/GP	TS-5/AP
TS-3/AP	TS-19/APQ-5
TS-100/AP	TS-61/AP
TS-170/ARN-5	TS-10B/APN
TS-182/UP	TS-375 U
TS-127/U	TS-15A/AP

TELEVISION CAMERA



3350 line resolution. Easily converted to present RMA standards. Circuits available with camera. Complete, like new.

RC-184 IFF EQUIPMENT
BRAND NEW, COMPLETE
SCR-584 PARTS

APS-4 RADAR COMPLETE

APS-6 RADAR COMPLETE
MARK 16 RADAR COMPLETE

MG19A NEW

MK20A/UP, NEW, INDIVIDUALLY BOXED

BC-1100-A TRANSMITTER
WITH REMOTE CONTROL. 125 W. 115 VDC OR AC.

WE WANT THIS EQUIPMENT:

BC-348	ART-13
BC-611	ARC-1
RTA-1B	ARC-3
BC-1000	R5A/ARN7

COLUMBIA ELECTRONICS LTD.
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LOS ANGELES 13, CALIF.

11816 VENTURA BLVD.
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Cable Address: COELECT

All items subject to prior sale

TEST EQUIPMENT

X Band Spectrum Analyzer 8500-9600 Mc., calibrated linear below cut-off attenuator, calibrated frequency meter, tuned mixer, 4 i.f. stages, 3 video stages overall gain 125 db., reg. power supply.

S Band Spectrum Analyzer 2700-3900 Mc., similar to above.

K Band Test Load, low power....$20.00

X Band Test Load, 50 watts, average power ½" x 1" waveguide. Sand load TS 108 ....$35.00

HI POWER X BAND TEST LOAD, dissipates 350 watts of average power for ⅝" x 1¼" waveguide, VSWR less than 1.15 bet. 7 and 10 KMC........$150.00

S Band Test Load TPS-55P/BT, 50 ohms $12.00

HI POWER S BAND TEST LOAD, dissipates 1000 watts of average power, for 1½" x 3" waveguide. Range 2500 to 3700 MC.

Dummy Load, DA-21/U, X Band, High Power Load, VSWR less than 1.15.7 to 10 KMC. Dissipates 280 watts average power.

Dummy Load, TS-338/U2, S Band, High Power Load, 2500 to 3700 mc. Dissipates 600 watts average power. For 1½" x 3" waveguide.

X Band VSWR TEST SET, TS-12/AP, complete with linear amplifier, direct reading VSWR meter, slotted wave guide with gear driven travelling probe, matched termination and various adapters, with carrying case.

X Band Pick-up Horn, AT-48/UP with coaxial fitting $10.00

X Band Below Cut-Off Wave Guide Attenuator, with calibrated dial, type N input connector, output connects to ½" x 1" wave guide $55.00

TS-62 X Band Echo Box with r.f. cable and pick-up antenna.

TS-33 X Band Frequency Meter, 8500-9600 Mcs. Crystal detector and 50 micro-amp. meter. Indicates Resonance. Connection for scope available.

TS-45A-APM-3 Signal Generator, 8700-9500 mc., 110 V. 60-800 cps.

30 MC I.F. STRIP, VIDEO, and AUDIO AMPLIFIER AND 110 Volt 60-2600 cps POWER SUPPLY, Bandwidth 10 mc, new, part of SPR-2 Receiver.

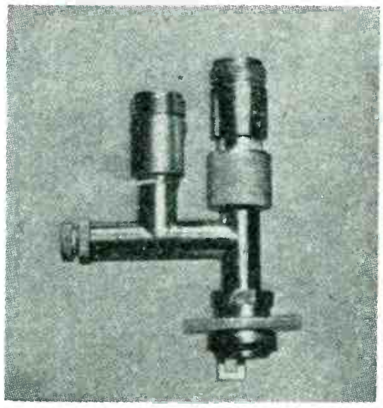
AMPLIFIER STRIP AM-SSA/SPR-2 contains I.F. amplifier, detector, video amplifier, pulse stretcher and audio amplifier and Rectifier Power Unit PP-155A/SPR-2 bandwidth 10 mc, center frequency 30 mc, sensitivity 50 microvolts for 10 milliwatts output. Power supply 80/115 V ac, 60-2600 cps 1.3 amps. Send for schematic...$65.00 less tubes

S Band Signal Generator Cavity With Cut-Off Attenuator, 2300-2950 mc., 2C40 tube, with modulator chassis....$30.00

UPN-1 S Band Beacon Receiver-Transmitter $75.00

TS-155 S BAND SIGNAL GENERATOR and Power Meter.

S Band Mixer, tunable by means of slider, type N connector for the R.F. and local oscillator input, U.H.F. connector for the I.F. output, variable oscillator injection. $30.00



S Band Crystal Mixer, variable oscillator injection, illustrated $17.50

TS-110 S Band Echo Box 2400-2700 mc, portable $110.00

X Band Thermistor Mounts, VSWR less than 1.4 8500-9600 MC Fixed triple tuned, ½"x1" waveguide.......$40.00
Fixed triple tuned ⅝"x1¼" waveguide $50.00

Frequency Meter, 8500-9600, variable, absorption type for either ½'x1" or ⅝"x 1¼" waveguide, with calibration, ± 4 MC, precision ground thread...$150.00

X Band Crystal Mount, ½"x1" waveguide $25.00

X Band Attenuator, double van type, VSWR less than 1.4 8500-9600 MC 0-30 db, calibrated for 1¼"x⅝" waveguide $80.00

½"x1" to ⅝"x1¼" adapter, UG80/U $5.00

TS-203/AP CALIBRATED SELSYN..$10.00

GENERAL RADIO PRECISION WAVEMETER TYPE 724A, range 16 kc to 50 mc. 0.25% accuracy, V.T.V.M. resonance indicator, complete with accessories and carrying case NEW....$175.00

HEWLETT-PACKARD-AUDIO SIGNAL GENERATOR 205A $230.00

ESTERLINE Angus recording Milliameter 60 cycles, 110V. AC 1 ma full scale. $150.00

TS-89 Voltage Divider for measuring high video pulses, ratios 1:10 and 1:100 transmission flat within 2 db 150 c.p.s. to 5 mc., with cable for attaching to syndroscope $30.00

Waveguide Below Cut-off Attenuator L 101-A U.H.F. Connectors at each end calibration 30-100 db $15.00

WAVEGUIDE BELOW CUT-OFF ATTENUATOR same as above except input is matched in range of 2200-3300 mc. VSWR less than 1.2............$54.00

PULSE TRANSFORMER 132-AWP...$8.00

HYPERSIL CORE CHOKE, 1 Henry, Westinghouse L-422031 or L 422-32....$3.00

PULSE INPUT TRANSFORMER, permalloy core, 50 to 4000 kc., WE-D161310, impedance ratio 120 to 2350 ohms..$3.00

ELECTRO IMPULSE LABORATORY
62 White Street Red Bank 6-0404 Red Bank, N. J.

BRAND NEW U. S. GOV'T. SURPLUS GUARANTEED

POWER RHEOSTATS

Ohms	watt	ea.	Ohms	watt	ea.
.5	25	1.24	200	25	1.24
.5	50	2.34	200	100	3.29
.5	150	4.45	225	50	2.10
1	50	2.34	250	25	1.86
2	50	2.34	250	50	1.49
2	100	3.51	300	50	2.11
2	225	4.95	300	100	3.29
2	300	6.32	350	25	1.24
3	100	3.51	350	100	3.28
3	225	4.95	370	25	1.24
3 x 3	300	29.70	378	150	4.95
4	225	4.95	400	25	1.24
5	25	1.24	400	75	2.95
5	100	3.51	500	25	1.24
6	25	1.86	500	75	2.95
6	50	2.10	500	50	1.49
6	75	2.95	500	100	3.29
7	25	1.24	500	150	3.51
8	50	1.49	585	150	4.95
10	25	1.86	750	25	1.86
10	100	3.28	750	150	4.45
12	25	1.86	1000	25	1.24
12	50	1.49	1000	150	4.45
15	25	1.24	1200	225	5.40
15	75	2.95	1250	50	2.22
22	50	2.10	1250	150	4.45
25	25	1.86	1500	25	2.11
25	100	3.29	1500	50	2.22
25	150	4.21	1800	150	4.68
50	25	1.24	2000	25	2.10
50	50	1.49	2000	50	1.49
60	25	1.24	2250	150	4.95
75	25	1.24	2500	150	4.95
75	75	2.95	2500	25	2.11
75	100	3.29	2500	50	2.22
75	150	4.21	2500	100	3.51
80	50	2.10	3000	25	1.24
80	500	9.13	3000	100	3.51
100	25	1.24	5000	25	2.22
100	50	1.49	5000	50	2.34
100	100	3.29	5000	100	3.75
125	25	1.86	7500	50	2.34
125	500	9.13	7500	100	3.98
150	50	2.10	10000	50	2.34
			10000	100	4.21
175	25	1.87	15000	25	2.67
185	25	1.24	20000	150	6.32

Specify whether shaft required is for knob or screwdriver adjust.

SELECTOR SWITCHES

Pole	Pos.	Deck	Type	Each
1	11	1	Bak-n/shtg	.60
1	21	3	Bak-n/shtg	.89
2	2	1	Cer-shtg	.50
2	6	2	bak-n/shtg	.60
2	11	2	bak-shtg	.75
3	4	2	bak-n/shtg	.58
5	8	2	Cer-n/shtg	.98
6	11	6	bak-n/shtg	1.95
10	5	5	cer-shtg	2.25
16	2	4	bak-n/shtg	1.35

(Many other types in stock)

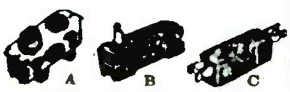
"AN" CONNECTORS

Large Variety Available At Great Savings

Send your specs and let us quote

BIRTCHER TUBE CLAMPS

#926-A, #926-A1, #926-A14, #926-B, #926-B1, #926-B7 **35c.** #926-B22, #926-C, #926-C1, #926-C5, #926-C10, #926-C24

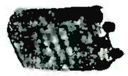


A B C

MICROSWITCHES

A-#Y2-RS13 SPST "S" plunger, metal housing norm. op. .... .59
B-#B-RS10 SPDT type "S" plunger, 2-circuits: one op and one cl .59
#WZ-RL8 (not illus.) SPST leaf actuator, norm. cl. .... .59
#R-RL2T (not illus.) SPST 10a 125 vac roller plunger, norm. closed .... .59
C.G.E. SWITCHETTE 10a/115voltsAC
#CR1070-C103A3 SPST closed .. .59
#CR1070-C103E3 SPST open .... .59
#CR1070-C103R3 SPST closed ... .59
#CR1070-C123C3 DPST op/cl ... .59
(Many other types in stock)

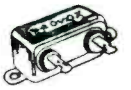
OIL CONDENSERS



Mfd.	Voltages Avail.
.1	3-6-20K
.25	2-3-3½-4-5K
.5	600-1½-3K
1	600-1-1½-2-5-6K
2	400-600-1-1½-2-3-4K
4	600-700-1-1½K
6	400-600-1½-2K
8	600
10	600-2½K
15	600-1K
30	90-vac. 3-ph
100	230-vac. 3-ph
3x4	500
3x8	600
4x3	600
4x8	600
3x10	90-vac

Special Prices on Request

BATHTUBS



Mfd.	Voltages Avail.
.033	400
.05	2-4-600
.1	4-6-1K
.15	600
.25	2-4-600
.35	400
.5	4-6-1K
.75	600
1	1-2-4-6-1K
2	4-600
4	50-100
8	500
25	25-50-75
40	25
50	25
100	15
200	12
300	6
2x.01	2-400
2x.02	6-1500
2x.045	600
.046x.055	600
.2x.05	6-1500
.1x.05	200
.1x.5	400x50
2x.1	4-600
2x.16	600
2x.2	600
2x.25	4-600
.3x.5	500
2x.5	4-600
1.x.05	500
1.x.1	300
1.x.5	200
2x1	600
2x10	25
2x200	9
3x.001	600
3x.05	600
3x.1	4-600
3x.25	4-600
3x.5	100-600
.015x.03x.045x.06x.12/	600

Also available CHANNEL Types. Special Prices on request.

SHOCKMOUNTS

100P-1	1 lb.	.15
100P2	2 lb.	.15
100PR-2	2 lb.	.15
100P-3	3 lb.	.15
100P-6	6 lb.	.20
150P-4	4 lb.	.20
150PH-8	8 lb.	.45
150PH-15	15 lb.	.49
156P-6	6 lb.	.35
200PD-15	15 lb.	.59
200PHN-35	35 lb.	.75
204P-112	112 lb.	.98

TERMINAL BOARDS

5 terminal	.98
8 terminal	1.67
12 terminal	2.49

TYPE "J" POTENTIOMETERS

TYPE "J" $1.50 — TYPE "JJ" $2.50

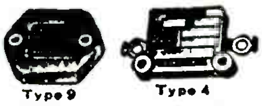
ohms	ohms	ohms	ohms	ohms
50*	2500*	100K*	500-500*†	130 K-130K*
65*†	4000†	100 K†	600-600†	150 K-150K†
200†	5000†	125 K*	1500-1500†	250 K-250K†
300†	10 K*†	200 K*	2000-2000*†	350K-5K†
400*†	15 K*†	250 K*	2000-50K*	350K-25K†
500†	20 K*†	250 K†	2200-24K†	300K-300K†
600*†	25 K*†	500k*†	20K-2000†	350K-350K*
750†	30 K*†	1meg*	25K-10K†	800K-75K*
1000*†	50 K*†	1meg†	35K-5000†	2meg-2meg†
1500*†	80K†	2meg*	50K-50K*	4meg-4meg†
2000*†		2meg†	100K-100K*	5meg-5meg†

TYPE "JJJ" $4.95

ohms	ohms
20K-200K-20K†	750K-750K-750K†
45K-27K-2500†	800K-800K-800K†
700K-700K-700K†	1meg-1meg-1meg†

* ⅛" screwdriver slotted shaft.
† Knob type shaft.

TRANSMITTING MICAS



Type 9 — Type 4

mfd	vdcw	type	ea.	mfd	vdcw	type	ea.
.00001	600	4	.18	.00162	600	4	.18
.00003	600	4	.18	.002	600	4	.20
.00005	600	4	.18	.002	1200	4	.48
.00005	2500	9	.31	.0022	2500	9	.78
.0001	600	4	.18	.0025	600	4	.23
.0001	2500	9	.31	.003	600	4	.25
.000152	600	4	.18	.0039	600	4	.25
.0002	600	4	.18	.005	600	4	.25
.00025	600	4	.18	.005	1200	9	.60
.0005	600	4	.18	.005	2500	9	1.18
.0051	2500	4	.43	.0062	600	4	.30
.0007	600	4	.18	.01	600	4	.40
.0008	600	4	.18	.01	600	9	.49
.0009	600	4	.18	.01	1200	9	.98
.001	600	4	.18	.0142	600	4	.45
.001	1200	4	.31	.02	600	4	.55
.001	1200	9	.31	.02	1250	9	1.36
.0013	600	4	.18	.027	600	4	.66
.0015	600	4	.18	.043	600	4	.99

(Many other types in stock)

"UG" and "UHF" CONNECTORS

UG-9/U	UG-25/U	83-1SPN
UG-10/U	UG-27/U	83-22R
UG-12/U	UG-27/AU	83-22SP
UG-14/U	UG-57/U	83-2R
UG-15/U	UG-58/U	83-2SP
UG-16/U	UG-123/U	
UG-18/U	83-1AC	
UG-19/U	83-1AP	
UG-20/U	83-1D	
UG-21/U	83-1R	
UG-22/U	83-1RTY	
UG-24/U	83-1SP	

PRICES QUOTED ON REQUEST

Jones Connectors

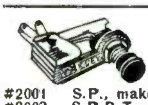
P-101-¼	.25
P-101-⅜	.30
S-101-D-MOD	.33
S-302-AB	.13
S-304-CCT	.25
P-306-AB	.16
P-306-CCT-L	.33
S-306-FHT	.24
S-308-AB	.21
P-312-AB	.24
P-312-CCT-L	.42
P-315-FHT	.40
P-315-EB	.30
P-315-CCE	.40
S-315-AB	.36
S-318-AB	.43
P-324-FHT	.74
P-324-EB	.58
S-330-AB	.84
S-404-AB	.33
P-406-AB	.33
S-406-CCT	.58
S-408-CCT	.69
S-2408-SB	.53
P-2412-SB	.61
S-2412-CCE	.87
S-502-DB	.97
P-508-CE	2.55
P-510-CE	3.04
P-512-CE	3.52
S-512-CE	3.95

Jones BARRIER STRIPS

2-140-Y	.13
6-140-Y	.33
10-140-¾W	.53
10-240	.38
13-140	.48
18-240	.66
4-141-W	.30
4-141-¾W	.30
7-141-Y	.49
11-141-Y	.76
12-141-Y	.82
13-141-Y	.89
15-141-Y	1.02
2-142-Y	.20
4-142-Y	.36
8-142	.48
3-150	.53
4-150-Y	.83
4-151	1.30
5-151	1.60
4-152	1.89
2002	.04
2008	.07
8-54	.22
8-6	.18

Many other types in stock

MALLORY PUSH SWITCH



#2001	S.P., make cont., non-L	.45
#2003	S.P.D.T., non-lock	.48
#2003L	S.P.D.T., lock	.48
#2004	D.P., make 2 non-L	.55
#2004L	D.P., make 2 lock	.55
#2006	D.P.D.T., non-lock	.65

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TUBE SPECIALS

1625	$ .39	807	1.89
1626	.39	813	8.95
211	.59	837	1.19
805	3.29	860	4.95

CATHODE RAY TUBES

3FP7	$1.95	5BP4	3.95
3GP1	1.95	5FP7	1.95
4AP10	1.95	5GP1	3.95
5BP1	3.95		

T23/ARC5 Brand New Transmitter for VHF $29.95

MISCELLANEOUS SPECIALS

	Used	New
RA 10 DA Receiver	$17.50	$24.95
RT7/APN 1 Transceiver	6.95	9.95
BC 347 Interphone Amplifier	—	2.95
APS 13 UHF Antenna, Pair	—	.98
FL 8 Filter		2.95
I-97 Bias Meter	3.95	4.95
RL 42 Antenna Gearbox Motor and Reel	4.95	7.50
BC 709 Battery operated lightweight interphone amplifier. Complete with tube and shock mount, but less battery	—	3.95
C-18—Antenna coil assembly slug tuned used in BC 603 receiver. Frequency range 20-27.9 Mc.—fully shielded		New 10 for $1.95
I 82 F—Five Inch 360 degree compass indicator and Selsyn receiver		$4.95
A-81-2 Transmitter Selsyn for I82 indicator	—	2.45

(Both 82F & Trans. Selsyn for $7.00)

TEST EQUIPMENT

No. M-652 Jackson Audio Oscillator.... used $29.50
No. 155 A RCA Oscilloscope.......... used 75.00
No. M-840 Triumph Oscilloscope....... used 49.50

PRICES UPON REQUEST

I-98-A	TS3/AP
I-114 P/O RC-68	TS10A/APN
I-135 P/O IE-17	TS16/APN
I-167 Weston Anal. #772	TS19/APQ5
I-183 Freq. Meter	TS27/TSM-1
I-185 Oscillator	TS36/AP
I-187 Synchronizer	TS59/APN-1
I-189 Calibrator	TS62/AP
IE-19	TS126/AP
	TS-251 Less Xtal

CONDENSERS

Each
1 mfd 6000 VDC. OIL FILLED.............$1.98
.00025 mfd. 25000 VDC OIL FILLED....... 2.95
50 mmfd—5KV—5 AMP. Vacuum Cond..... 1.19

AS-138/ARN—10 INCH STREAMLINE LOOP as used with direction finding receivers. Fixed position, is ideal for planes, boats, automobiles New $1.95

RA 52—RECTIFIER

A Transtat controlled rectifier to produce high voltage DC from a 110 VAC 60 cycle source. Up to 12,500 volts DC at 50 atts. Metered high voltage (0-15 KV) and current (0-20 MA) New....$74.50

SCR 625—Famous Army Mine Detector

Complete kit, brand new in original suitcase style carrying case. Less Batteries.............$79.50

TS/10 Sound powered phones—Brand New—$10.00 ea. 2 for $17.95

CABINET CH-118

Olive drab in color, this cabinet has a full length interlock access door on the rear. The front takes the standard 19" panels with 60 inches of height and 20 inches deep. It is shock mounted on a heavy steel platform and has a two inch protrusion fully covering one side to accommodate wave trap and wiring. Louvered vents allow air circulation top and bottom.........$34.50 ea. F.O.B. Chicago

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BRAND NEW GUARANTEED SURPLUS "BUYS"!

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15 VOLTS, WEST. NA-35, 3½" Round flush bakelite case (JAN type MR35W015ACV) @ $5.50
40 VOLTS, WESTINGHOUSE NA-33, 2½" Round flush metal, black scale luminous markings (These were originally calib. for 400 cycle use but have been adj. for 60 cycle)........@ $3.95
75 VOLTS, WESTON 517, 2" Round flush metal, ring-clamp type mtg. non-flanged.......@ $2.95
300 VOLTS, TRIPLETT 232-C, 2½" Round flush metal case ....@ $6.00

A. C. AMMETERS

100 MILLIAMPERES, WESTON 476, 3½" Round flush bakelite case 400 cycles...........@ $6.50
150 MILLIAMPERES, GENERAL ELECTRIC AO-22, 3½" Round flush bakelite case........@ $4.95
500 MILLIAMPERES, WESTON 476, 3½" Round flush bakelite case, 400 cycles...........@ $7.50
50 AMPS, WESTINGHOUSE NA-35, 3½" Round flush bakelite case, 25 to 500 cycles......@ $5.50
60/120 AMPS, DUAL RANGE, BURLINGTON 32xC. 3½" Round flush bakelite, 5 Amp movement, external current transformer...............@ $7.50
75 AMPS, BURLINGTON # 32xC, 3½" Round flush bakelite case......................@ $4.95

RADIO FREQUENCY AMMETERS

120 MILLIAMPS, SIMPSON 125, 3½" Round flush bake. arbitrary linear sc. calib. 0-10 with caption output units, ext. thermocouple....@ $7.50
1 AMP, GENERAL ELECTRIC DO-44, 3½" Round flush bakelite ....@ $11.00
1.5 AMP, GENERAL ELECTRIC DW-52, 2½" Round flush metal case, black scale......@ $3.50
2 AMPS, SIMPSON 137, 2" Square flush bakelite made for Collins Radio Company........@ $4.50
2 AMPS, WESTON 425, 3½" Round flush bakelite case ....@ $8.50
2.5 AMPS, McCLINTOCK MD3001, 3½" Round flush bakelite case, Signal Corps IS-111 @ $4.50
3 AMPS, WESTON 425, 3½" Round flush bakelite case, with external thermocouple........@ $9.50
3 AMPS, WEST. NT-35, 3½" Round flush bakeite case, (JAN type MR35W003RFAA) @ $6.00
8 AMPS, WEST. RT-35, 3" Square flush bakelite ....@ $7.50
10 AMPS, WESTON 425, 3½ Round flush bakelite case ....@ $8.50

MICROAMMETERS

100 MICROAMPERES, WESTON 643, 4½ Round flush bakelite case (red line at 99)....@ $21.00
500 MICROAMPERES, G. E. DO-41, 3½" Round fl. bake. sc. calib. 0-20 Kilovolts D.C. approx. 250 ohms resistance ....@ $5.95

D. C. MILLIAMMETERS

1 MILLIAMP, WEST. NX-33, 3½" Round flush bakelite, black scale, calib. 140 v., 500 MA @ $3.00
1 MILLIAMP, WESTINGHOUSE NX-35, 3½" Round fl. bake. (JAN type MR35W001DCMA) approx. 53.7 ohms resistance............@ $7.50
5-0-5 MILLIAMPS, WEST. ELEC. D-165647, 3½" Round fl. bakelite concentric style movement, approx. 160° deflection sc. calib. 50-0-50 @ $4.00
15 MA., SIMPSON 26, 3½" Round flush bakelite case (JAN type MR25W015DCMA)....@ $6.00
50 MA., G. E. DO-41, 4½" Round fl. bake @ $4.95
150 MA., G. E., DO-53, 3" Square fl. bake @ $5.50
200 MA., MARION, 3½" Round flush bake Knife Edge pointer ....@ $4.00
200 MA., G. E. DO-41, 3½" Rd. flush bake @ $5.50
300 MA., G. E., DO-53, 3" Square fl. bake @ $5.50
500 MA., G. E. DO-53, 3" Square flush bakelite case ....@ $5.50
500 MA., DEJUR AMSCO 312, 3" Square flush bake ....@ $5.00
800 MA., G. E. DO-41, 3½" Round flush bakelite (JAN type MR35W-800DCMA).........@ $5.50

USN CV49598 ADAPTER KIT
For OD and O Test Sets

This adapter Kit consists of 4 special adapters and clip lead to enable the model OD and OQ Transconductance Tube Testers to accommodate radar tubes 316A, 703A, 707A & B, 713A, 446 and similar tubes. Complete in portable oak chest (approx. 7" x 4" x 3") with instruction sheet and test data. Weston Model 9999. ....ONLY $9.50

PORTABLE TACHOMETER
Multiple Range Continuous Indicating

This unit is of the centrifugal mechanical type and is designed to show INSTANTANEOUSLY and CONTINUOUSLY the speed or change in speed of any revolving shaft or surface. No stop watch or other mechanism required.

- Three ranges in R.P.M. and three in F.P.M.
  - LOW RANGE 300—1,200 (Ea. division equals 10 R.P.M.)
  - MEDIUM RANGE 1,000—4,000 (Ea. division equals 10 R.P.M.)
  - HIGH RANGE 3,000—12,000 (Ea. division equals 100 R.P.M.)
- Large open dial 4 diameter
- Ruggedly constructed for heavy duty service
- Ball bearing and oilless bearings-
- Readily portable—Fits neatly into hand
- Gear shift for selecting low, med., high ranges.

Made by Jones Motorola, Stamford, Connecticut. 7⅛" L x 4" H x 5" W..........YOUR COST $37.50

BC-1161-A RADIO RECEIVER

150 to 210 Megacycles. Operates off 115 volt 60 cycle Power Supply Inductance tuning for R.F. Antenna, dector and oscillator. With a few modifications this unit makes an ideal F.M. Receiver. Each set complete with circuit diagram and the 14 following tubes: 1-6SN7 Cathode Follower; 1-6H6 second Detector; 2-6SH7 1st and 2nd R.F. Amp; 1-6SH7 Video Amp; 3-6AC7/1852 1st, 2nd, 3rd IF Amp; 2-6AB7/1853 4th, 5th IF Amp; 1-9006 Mod; 1-6J5 Osc.; 1-5U4G Recr.; 1-6E5 Tuning Indicator.
Complete in a metal cabinet 10" high 16½" wide and 15" deep ....@ $34.50

BC-1160-A TRANSMITTER

157 to 187 Megacycles. Operates off 117 Volt 60 cycle. Contains 115 volt, 1525 R.P.M. Blower General Radio 200 B 1.5 Amp. Variac 10 tubes, 0-5 Kilovolt 3½" meter transformers, relays, circuit breakers too numerous to list. Complete in metal cabient 17⅝" x 18½" x 18" with circuit diagram............@ $29.50

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Model Gn-3-24

An internal combustion type heater, which will give 15,000 B.T.U. of heat per hour. Ideally suited for use with equipment, farms, boats, bungalows, cabins, trailers, work sheds, darkrooms, mobile equipment, transmitter stations, etc. and any place where a quick heat is required in volume.
Very economical in operation—tank holds one gallon of gasoline which is sufficient for 6 hours operation. Uses any grade gasoline.
This unit is designed primarliy for aircraft installation, 24-28 volts DC, but it can be readily adapted for a 115 or 230 Volt 60 cycle power supply by use of a transformer and rectifier. Simple circuit diagram for adaption to 115 or 230 Volts 60 cycle use supplied with each unit. Can be used on 32 Volt farm or boat systems as is without the installation of additional transformers. Power consumption approximately 75 to 100 watts.
Approximately 12" long x 9⅛" high x 9¼" wide. Complete with technical manual and parts list. Made by Galvin (Motorola) Mfg. Co.
YOUR COST ONLY $22.50

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20 VOLTS, McCLINTOCK MD2001, 2½" Round flush bake., 1000 ohms per Volt (MR25W020-DCVV) ....@ $4.50
35 VOLTS, SIMPSON 125, 2½" Round flush metal, approx. 110 ohms per Volt, made for Homelite Corporation ....@ $4.00
300 VOLTS, SUN 2AU346, 2½" Round flush bake., 1000 ohms per Volt.......................@ $6.00

We specialize in electrical Instruments. Over 75,000 meters in stock. Send for our latest circular showing our complete line of Surplus-New-Guaranteed meters.

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WE HAVE LARGE QUANTITIES OF RADIO TUBES

TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE
1A5GT	2E22	6AQ5	6C6	6SG7	12SG7	OZ4A	807
1G6GT	2X2	6B8	6H6	6SH7	12SH7	VR150/30	808
1LD5	3AP1	6B8G	6J5	6SK7	12SK7	42	813
1LN5	6AB7	6BE6	6J5GT	6SK7GT	12SR7	357A	830B
1R5	6AC7	6C21	6K6GT	6SS7	35Z4GT	803	866A
1S4	6AK6	6C4	6K7GT	7Q7	50L6GT	805	9005
1T4	6AL5	6C5GT	6N7GT	12A6		Prices on Request	

All tubes are brand new standard brands. This offer subject to change without notice and prior sale. Terms: 25% deposit with order, balance C.O.D. $25.00 minimum order.

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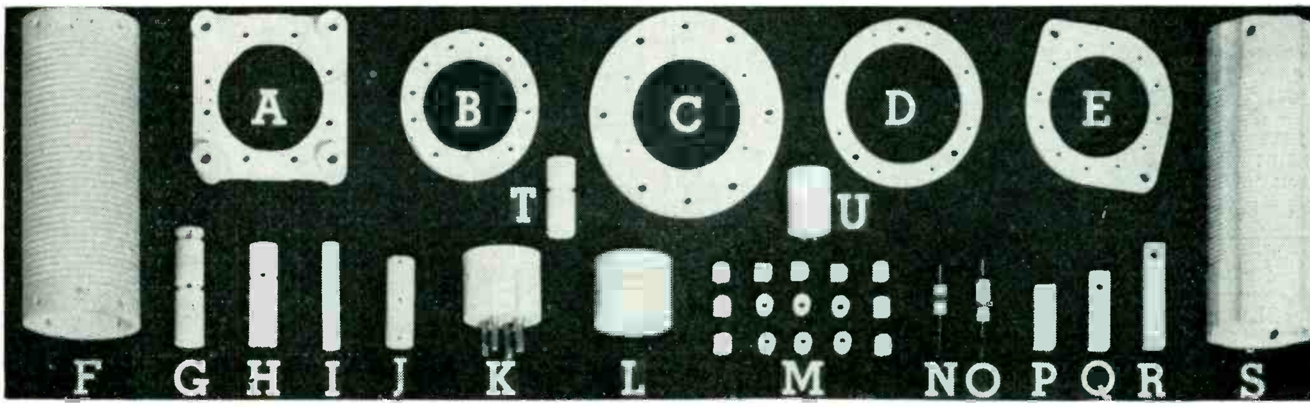
"GIGANTIC" Ceramic CLEARANCE



TYPES A,B,C,D,E BASES FOR VARIOUS TUBE SOCKETS YOUR CHOICE .05
F - COIL FORMS 2" DIA 4 7/8" LONG. 35 GROOVES - - - - - - - .10
G - STANDOFF INS. 1/2" x 2 7/8" THREADED HOLE ONE END - - - - - .02
H - STANDOFF INS. 1/2" X 1 5/8" AND 1/2" X 2" THREADED HOLE BOTH ENDS .02
I - INSULATED SPACERS 5/16" X 1 3/4" THREADED HOLE BOTH ENDS -.015
J - COIL FORMS 1/2" X 1 1/2" 28 GROOVES - HOLLOW - - - - - - .02
K - 4 PRONG TUBE BASES - STANDARD - - - - - - - - - - - - .10
L - 4 PRONG TUBE BASES LESS ALL PINS - - - - - - - - - - - .05
M - COAXIAL BEADS 5/16 X 3/8" - 1/8" HOLE (PER 1000) - 1.50
N - HIGH VOLTAGE FEED THRU INSULATORS 1/2" LONG 1 1/2" OVERALL - .02
O - HIGH VOLTAGE FEED THRU INSULATORS 3/4" LONG 1 5/8" OVERALL - .03
P - SQUARE INSULATED SPACERS 3/8" X 1" THREADED BOTH ENDS - .02
Q - SQUARE INSULATED SPACERS 3/8" X 1 1/4" THREADED ONE END - - .02
R - SQUARE INSULATED SPACERS 3/8" X 1 3/4" THREADED ONE END - - .02

S - THREADED COIL FORMS
YOUR CHOICE 10¢ EACH

Dia.	No. of Ribs	Winding Length	Overall Length
2"	9	1-3/4"	5"
2"	14	1-3/8"	5"
2"	6	1"	5"
2"	34	1-7/8"	5"
2"	11	1"	5"
2"	13	2-1/2"	5"
2"	9	1-5/8"	5"
2"	15	1-3/4"	6-3/8"
3"	55	4-1/2"	5-1/4"

SEND FOR OUR LATEST BULLETIN ON CURRENT SPECIALS

T - ROUND INSULATED SPACERS 1/2" X 1 1/4" THREADED BOTH ENDS - .02
U - ROUND INSULATED SPACERS 3/4" X 1" THREADED BOTH ENDS - .03

SAMPLES SENT TO BONA-FIDE MFG. ONLY
MINIMUM ORDER 10.00

UNIVERSAL RADIO SUPPLY CO.

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OVER 200,000 RELAYS

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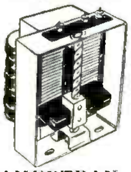
HERE ARE A FEW MORE—

AUTOLITE B4 SOLENOIDS 24 VDC, 100 Amp. Contacts, Double Make....$4.50 ea.
CLARE type K—A16280 24 VDC, 300 ohm, 4 PST, N. O. ....$1.25 ea.
LEACH 1077BF-WM1 ANTENNA SWITCHING 28 VDC, DPDT, 265 ohm, Ceramic Insul. ....$2.95 ea.
GM 12566 6 VDC, 40 ohm, 3 PDT $1.79 ea.
STROMBERG D-4353 (telephone type) 12 VDC, 200 ohm, DPST, N. O. ..$1.25 ea.

• • •

AMERTRAN TRANSTAT VOLTAGE REGULATORS



90 to 130 V, 50-60 cy. 17.4 Amps. ....$17.50 ea.

103 to 126 V, 50-60 cy. 2.17 Amps. ....$9.95 ea.

AMERTRAN FILTER REACTOR .5 hy at 2.5 Amps. DC 2.3 ohms., 2.5 KV insul., 5½" x 7" x 8" overall..........$12.95 ea.

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Brand New Standard Brand RADIO TUBES

1B3	5U4G	6AL5	6J6	7F8	19T8
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Converted to 27 megacycle dielectric heating unit. Complete. 5 K.W. output. $500.

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EAGLE ADJUSTABLE TIME DELAY RELAY. 110 volt 60 cy with double throw Micro Switch. Can be set from 1½ to 58 minutes. Includes attractive 3¼" x 4½" x 2¾" black cover.

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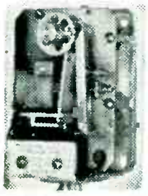

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POWER SUPPLY, PE204A. Radiart to operate from 12 volts DC to supply plate & screen & DC filament volts to telephone repeater EE99 & TY14. Sealed in original packing cases with spare vibrator, cable, schematic, etc. $9.95

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25 WATT WIRE WOUND POTENTIOMETERS

Refer to Jan. Electronics for description. 2, 3-3, 15, 20, 25, 30, 50, 75, 100, 350, 500, 800 ohm—reg. $3.12. SALE PRICE..................$1.04
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Leading Manufacture, Wire Wound 10, 12 ohm #301 ....$1.20
1.5K ct. 2K, 5K, 20K-8 watt................ 1.70
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CTS Wirewound POTENTIOMETERS

These excellent controls were made to sell for $2 each. They are the finest ww potentiometers made in the two and four watt size. The four watt has a 1-9/16" dia. x 11/16" metal body. The two watt has a 1-¼" x 9/16" bakelite body. Both use DUAL wipers for extra quiet action. SPECIAL PRICE ....$.45
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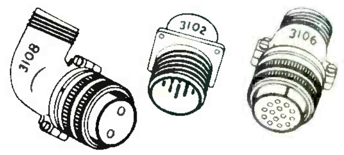
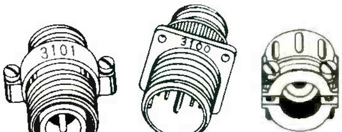


3100, 3101, 3102, 3106, 3108 with any of following suffixes:



3057

Insert	14S-12P	18-8P	20-9S	22-5P	22-29P	28-3P	32-9P
	16S-1S	18-9S	20-9P	22-6S	22-30S	28-4S	32-10S
8S-1S	16S-1P	18-9P	20-10S	22-6P	22-30P	28-4P	32-10P
88-1P	16-2P	18-10S	20-11S	22-8S	22-36S	28-5S	32-16S
10S-2S	16S-3S	18-10P	20-11P	22-8P	24-1S	28-5P	32-16P
10S-2P	16S-3P	18-11S	20-13S	22-9S	24-1P	28-6S	32-20S
19SL-3S	16S-4S	18-11P	20-14S	22-9P	24-2S	28-6P	32-20P
10SL-3P	16S-4P	18-12S	20-14P	22-10S	24-2P	28-7S	36-1S
10SL-4S	16S-5S	18-12P	20-15S	22-10P	24-3S	28-7P	36-1P
10SL-4P	16S-5P	18-13S	20-15P	22-11S	24-3P	28-8S	36-3P
12S-3S	16S-6S	18-13P	20-16P	22-11P	24-4S	28-8P	36-7S
12S-3P	16S-6P	18-16S	20-17P	22-12S	24-4P	28-9S	36-7P
12S-4S	16-7S	18-16P	20-18P	22-12P	24-5S	29-9P	36-8S
12S-4P	16-7P	18-20S	20-19S	22-13S	24-5P	28-11S	36-9P
12-5S	16S-8S	18-20P	20-19P	22-13P	24-7P	28-11P	36-10S
12-5P	16S-8P	18-22S	20-20S	22-14S	24-9S	28-12S	36-10P
14S-1S	16-9S	18-22P	20-21P	22-14P	24-9P	28-12P	36-11P
14S-1P	16-9P	18-30S	20-22S	22-15S	24-10S	28-15S	36-15S
14S-2S	16-10S	18-30P	20-22P	22-15P	24-10P	28-15P	36-15P
14S-2P	16-10P	18-31S	20-23S	22-16S	24-11S	28-16S	36-19S
14-3S	16-11S	18-31P	20-23P	22-16P	24-11P	28-17S	40-1S
14-3P	16-11P	20-1S	20-24S	22-17S	24-12S	28-17P	40-1P
14S-4S	16-12S	20-1P	20-24P	22-17P	24-14S	28-18S	40-2P
14S-4P	16-12P	20-2S	20-26S	22-18S	24-14P	28-18P	40-9S
14S-5S	18-1S	20-2P	20-26P	22-18P	24-15S	28-19S	40-11S
14S-5P	18-1P	20-3S	20-27S	22-21S	24-15P	28-19P	44-1S
14S-6S	18-2S	20-3P	20-27P	22-22S	24-16S	28-20S	44-1P
14S-6P	18-2P	20-4S	20-28S	22-22P	24-16P	28-20P	44-4S
14S-7S	18-3S	20-4P	20-28P	22-23S	24-17S	32-1S	44-4P
14S-7P	18-3P	20-5S	20-29S	22-23P	24-18P	32-1P	44-9S
14S-9S	18-4S	20-5P	22-1S	22-24S	24-19P	32-6S	48-3S
14S-9P	18-4P	20-6S	22-1P	22-25S	24-20P	32-6P	
14S-10S	18-5S	20-6P	22-2S	22-25P	24-21S	32-7S	3057-3,
14S-10P	18-5P	20-7S	22-3S	22-26S	24-28S	32-7P	4, 6, 8,
14S-11S	18-6S	20-7P	22-4S	22-26P	28-2S	32-8S	10, 12,
14S-11P	18-6P	20-8S	22-4P	22-27S	28-2P	32-8P	16, 20,
14S-12S	18-8S	20-8P	22-5S	22-27P	28-3S	32-9S	24.

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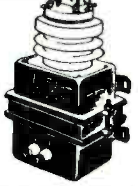
Another Shipment of

FILAMENT TRANSFORMERS



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BRAND NEW $9.95

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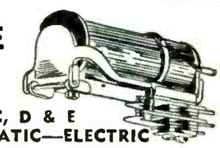

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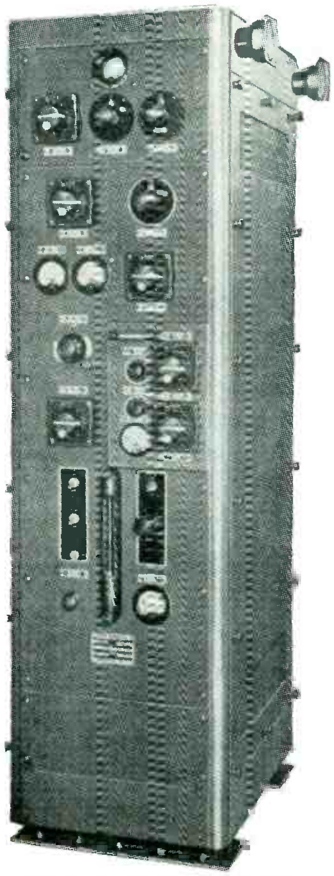
RCA Model MI-8167

All NEW packed for export, LARGE QUANTITIES AVAILABLE for IMMEDIATE DELIVERY.



Freq. Range: 2000 to 20,000 Kcs.
Output: 350 Watts C. W.
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Input: 190 to 250 Volts AC 50/60 cps.

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CD307A with PL55 and JK26..........69¢ each

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Brand New—Original Packing—Made by G.E. Contains the following parts, mounted on a chassis 2" high, 2½" wide, 8" long.
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POWER UNIT 103A with Ballentine Dynamotor

Input	Duty	Output
6V 21A	Continuous	500V—.16A
12V 11A	Continuous	500V—.16A

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.0001 @ 5000 V..........49¢ each
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AM-99/APX-15 Amplifier with 10 tubes (5—6SN7, 2—6SL7, 1—VR105, 1—VR150, 1—5Y3). Excellent condition..........$19.95

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Output: 115 VAC; single phase PF 90; 380/500 cycle; 1500 VA.
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AY-1..........26 volt-400 cycle **$4.95**
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(Has hollow shaft) *Postpd*

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NAVY TYPES: 5F, 5SF, 5G, 5CT, 5HSF, 5DG, 5SDG, etc.

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For immediate delivery, while they last, a large quantity of nationally known glyptal dipped and hermetically sealed condensers, 10 mfd, 400 volts, measuring 3-5/16 x 2 x 3-25/32; these are rated at 600 volts at an operating temperature of 40°C and 400 volts at an operating temperature of 72°C. Extremely low in dialectric leakage, these oil-filled paper condensers cost but 45¢ in quantities of 24 per carton. Smaller lots at 57¢. Samples upon request.

Weston Laboratories Weston 93, Massachusetts

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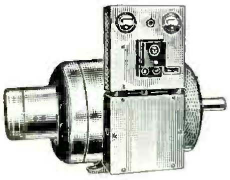
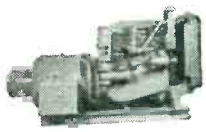


Three 400-cycle, 40 KW, three-phase, AC generators, 1714 rpm, $850.00.



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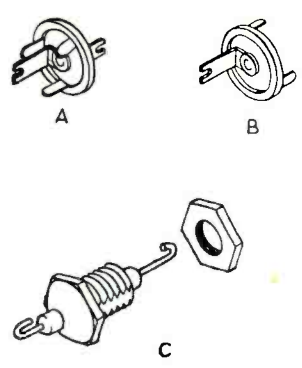

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14A7/12B7 1.08
14AF7/XXD 1.18
14B6 1.08
14B8 1.10
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14C7 1.20
14E6 1.10
14E7 1.33
14F7 1.10
14F8 1.29
14H7 1.17

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50C5 1.03
50C6 1.49
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50X6 1.10
50Y6GT .90
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53 .78
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56 .85
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6E5 1.10
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6F5 .83
6F6 1.04
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6J4 6.98
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6K5GT 1.16
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6K7 .85
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6L6G 3.15

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7E7 1.10
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7H7 2.00
7J7 1.33
7K7 1.33
7L7 1.33
7N7 2.65
7Q7 .95
7R7 1.07
7S7 1.33
7T7 1.03
7V7 1.33
7W7 2.65
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7Z4 .87
10Y .79

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14R7 1.29
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14W7 1.33
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19 .69
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723A/B 18.98
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726C 69.98
730A 9.89
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803 3.00

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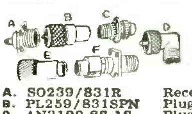

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A. SO239/831R Receptacle .....65¢
B. PL259/831SPN Plug .....65¢
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D. M359/CSX48192 Angle Adapter ..65¢
F UG22/U Panel Jack $1.49

Write for Connector Listing

STAND-OFF INSULATORS

Glazed Ceramic—USN Specs—Tapped

Ht.	Dia.	Ea.	10	Ht.	Dia.	Ea.	10
½"	⅜"	8¢	$.72	2"	½"	29¢	$2.61
½"	½"	9¢	.81	2"	¾"	33¢	2.97
1⅛"	½"	10¢	.90	2"	1"	37¢	3.33
1"	⅜"	15¢	1.35	3"	¾"	43¢	3.97
1"	¾"	18¢	1.62	4"	1¼"	59¢	5.31
1¾"	¾"	24¢	2.26	6¾"	1"	75¢	6.75

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3AG: ⅛, ¼, ¼A Ea. 9¢; 100/7.98
3AG: 1, 1½, 2, 3, 4, 15, 20A Ea. 6¢; 100/4.98
3AGSlo-Blo: 10, 20A Ea. 18¢; 100/16.98
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HCM Holder 3 AG ....3/$1
HKM Holder 3AG, 4AG .....5/$2

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6-12-24-115vdc & 115/230vac, $1.98; 2 for 3.49

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900v/35ma, 2x2.5v/2a, excellent 1800 V'Dblr,two 2x2 fil wndgs H'sld HiVins 2.49
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Image-Converter Tube HiSensitivity simplified design 2" dia.. Willemite screen—Resolution up to 350 lines/in. Complete data & tube..........each $4.98 2 for $9.49

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175 CFM 220vac .. 11.98

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G.E.788V/200Ma,210V/15Ma,5V/2A 4.95
G.E. 6.3V/7A, 6.7A/.9A, 6.3V/.3A 3.98
WEco 6.3V/4.65A, 6.3V/.3A..... 3.49
WEco 6.3V/3A, 5V/2A......... 2.49
WEco 6.3V/1A.$1.95; 6.3V/.6A. 1.49

LINE FILTERS

10Amp/130vacdc Csd USN 0.1 to 1000 Mc's....$1.29
30Amp/250vacdc Csd USN 0.1 to 1000 Mc's .... 3.98 2 for 6.00
50Amp/600vdc/250vac. Fltrs both sides of line. SOLAR "Elim-O-Stat." New $9.98; 2/$18; 5/$39
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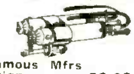
Microwave Lighthouse Assy 2,500 Mc $29.95



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100,000 ohms/20 position..........1.98
7470&1063ohms/12 step WEco......1.98

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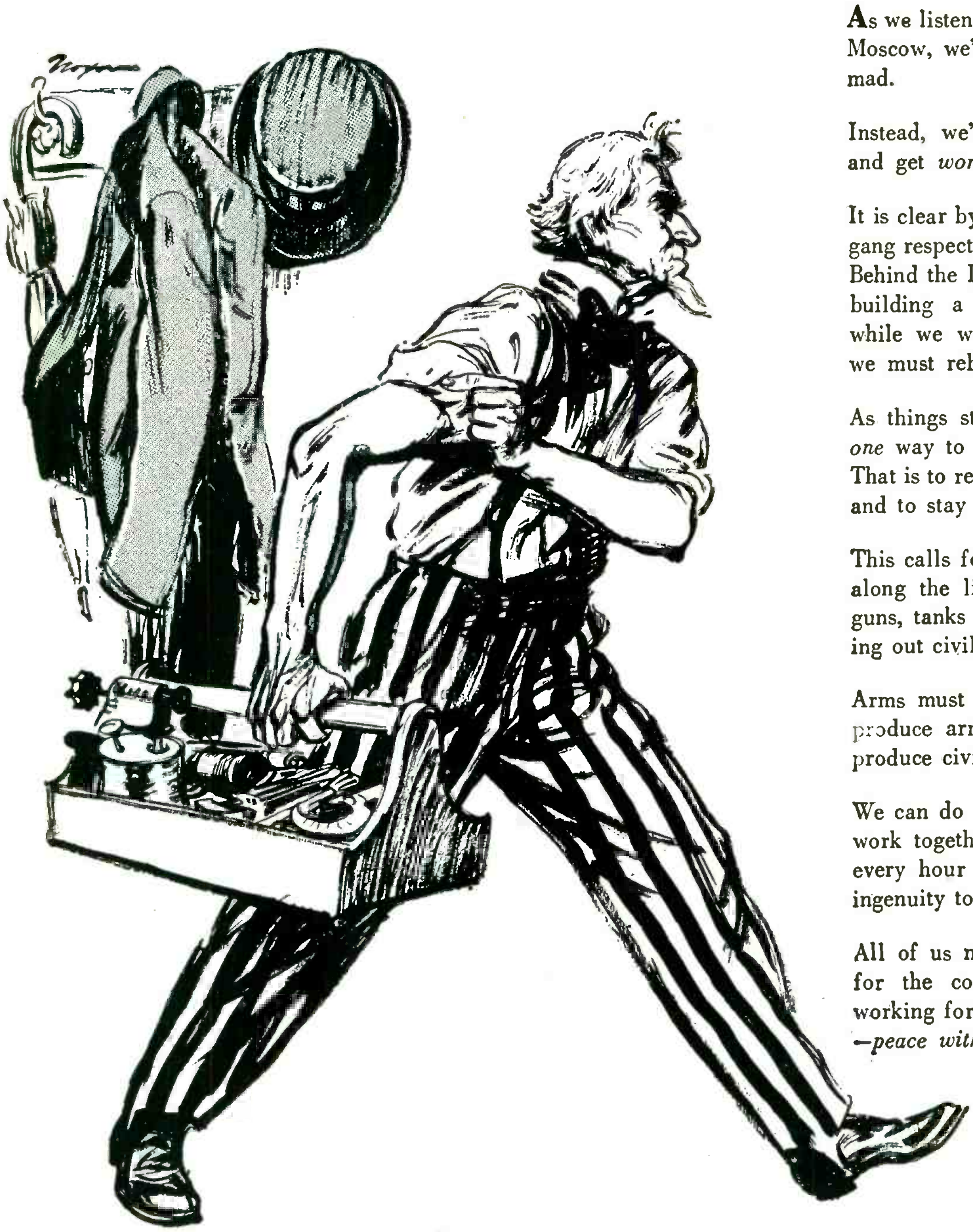
It's time we got *working* mad!



As we listen to the latest insults from Moscow, we're likely to get fighting mad.

Instead, we'd better use our heads and get *working* mad.

It is clear by now that Stalin and his gang respect just one thing—strength. Behind the Iron Curtain they've been building a huge fighting machine while we were reducing ours. Now we must rebuild our defenses—*fast.*

As things stand today, there is just *one* way to prevent World War III. That is to re-arm—to become strong—and to stay that way!

This calls for better productivity all along the line. Not just in making guns, tanks and planes, but in turning out civilian goods, too.

Arms must come first. But we must produce arms *at the same time* we produce civilian goods.

We can do this double job if we all work together to turn out more for every hour we work—if we use our ingenuity to step up productivity.

All of us must now make sacrifices for the common good. But we're working for the biggest reward of all —*peace with freedom!*

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SEARCHLIGHT SECTION
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ADVERTISERS INDEX

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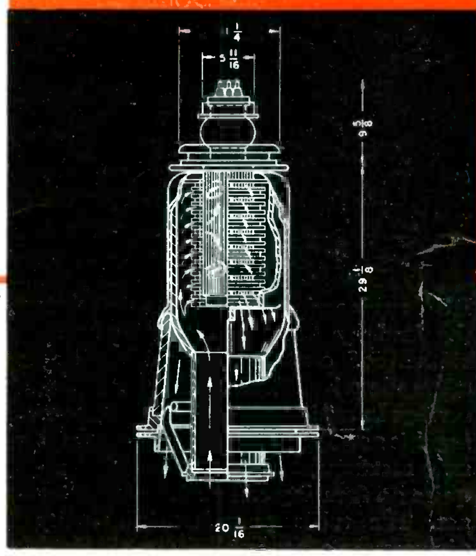
...AIR COOLING PRINCIPLE*

Another exclusive AMPEREX "first" now operating in some of the world's largest transmitters.

Type AX9906R/6078, unquestionably the Highest Power air cooled tube in the world...yet it weighs only 66 pounds ...because of this new high efficiency cooler

Power outputs up to 108 kw.

Maximum plate dissipation 45 kw.



*Patented Dec. 5, 1950—No. 2,532,858

Filament	Thoriated Tungsten
Voltage	18 v.
Current	196 a.
Inter-electrode Capacitances	
Plate — Filament	3.4 mmfd.
Grid — Plate	85. mmfd.
Grid — Filament	115. mmfd.

Class C Telegraphy

	Maximum Rating	Typical Condition	
d.c. Plate Voltage	13.5	12	kv.
d.c. Grid Voltage	—1200	—1000	v.
d.c. Plate Current	12	12	a.
d.c. Grid Current	3.0	2.25	a.
Plate Dissipation	45	36	kw.
Power Output		108	kw.

Also available as water cooled Type AX9906/6077. Data sheets for either or both types will be supplied on request.

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The Fountainhead of Modern Tube Development is RCA

...to conserve critical materials

RCA engineering has once again taken the lead by developing an improved method of electrostatic focusing that offers the television industry important savings in critical materials. Incorporating this new RCA development are three new rectangular picture tubes that require no focusing coil or focusing magnet. The tubes provide high-quality pictures on a par with those obtained from kinescopes employing electromagnetic focus.

Featuring electrostatic focusing, the RCA types 14GP4, 17GP4, and 20GP4 use an electron gun of improved design that provides good uniformity of focus over the entire picture area. Furthermore, focus is maintained automatically with variation in line voltage and with adjustment of picture brightness. Need for alignment of a focusing magnet is eliminated and, therefore, tube installation and adjustment for optimum performance are simplified.

Because the electron gun is designed so that the focusing electrode takes negligible current, the voltage for the focusing electrode can be provided easily and economically. In other respects, the RCA 14GP4, 17GP4, and 20GP4 are similar to magnetically focused types—the 14EP4, 17CP4, and 20CP4.

RCA Application Engineers are ready to co-operate with you in adapting the 14GP4, 17GP4, 20GP4 and associated components to your present designs. For further information, write RCA, Commercial Engineering, Section 42DR, Harrison, N. J.

Another **RCA-developed component**

A new Horizontal-Deflection-Output and High-Voltage Transformer designed particularly for use with the new electrostatic-focus picture tubes will be available shortly.

RADIO CORPORATION of AMERICA

ELECTRON TUBES **HARRISON, N. J.**