

APRIL 1951

PRICE 75 CENTS

electronics

M c G R A W - H I L L P U B L I C A T I O N

GUIDED-MISSILE COMPUTER



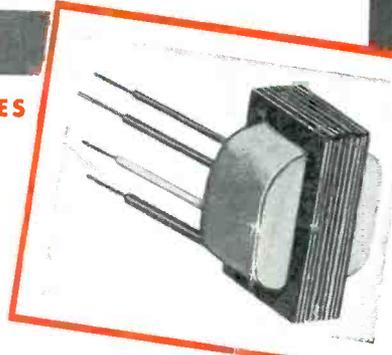


MINIATURE COMPONENTS FROM STOCK...

SUBOUNCER UNITS

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

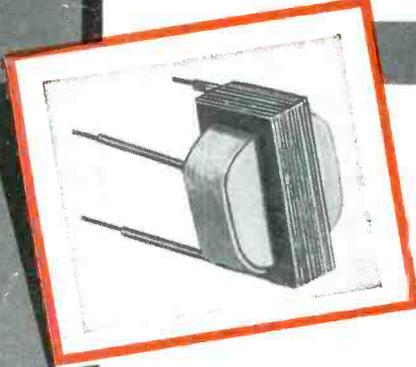
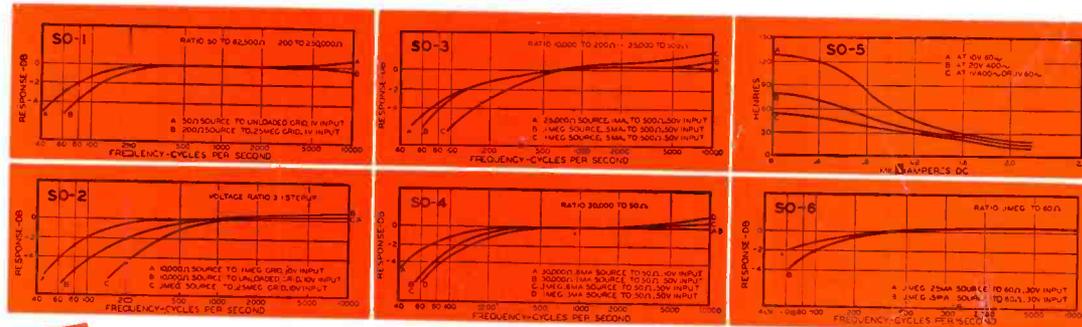
UTC Sub-Ouncer units fulfill an essential requirement for miniaturized components having relatively high efficiency and wide frequency response. Through the use of special nickel iron core materials and winding methods, these miniature units have performance and dependability characteristics far superior 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 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.



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

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	4.5	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.



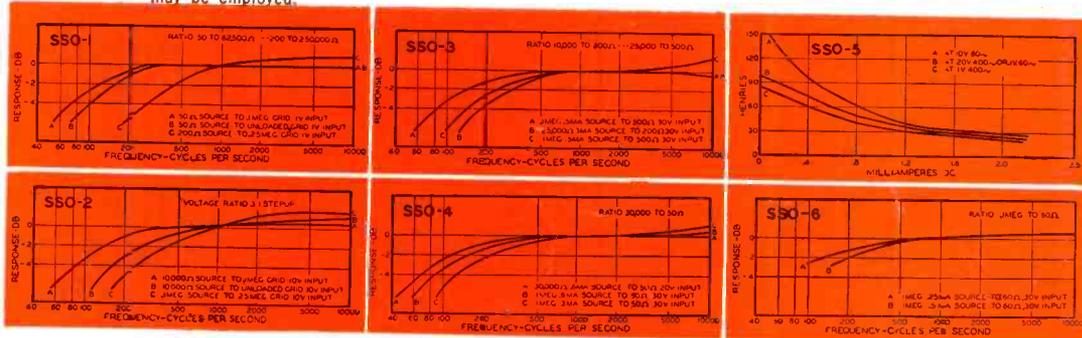
SUB-SUBOUNCER UNITS

FOR HEARING AIDS AND ULTRA-MINIATURE EQUIPMENT

UTC Sub-Sub-Ouncer units have exceptionally high efficiency and frequency range in their ultra-miniature size. This has been effected through the use of specially selected Hyperm-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	Output	+ 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.



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

United Transformer Co.

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

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April, 1951

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Member ABC and ABP

Vol. 24, No. 4



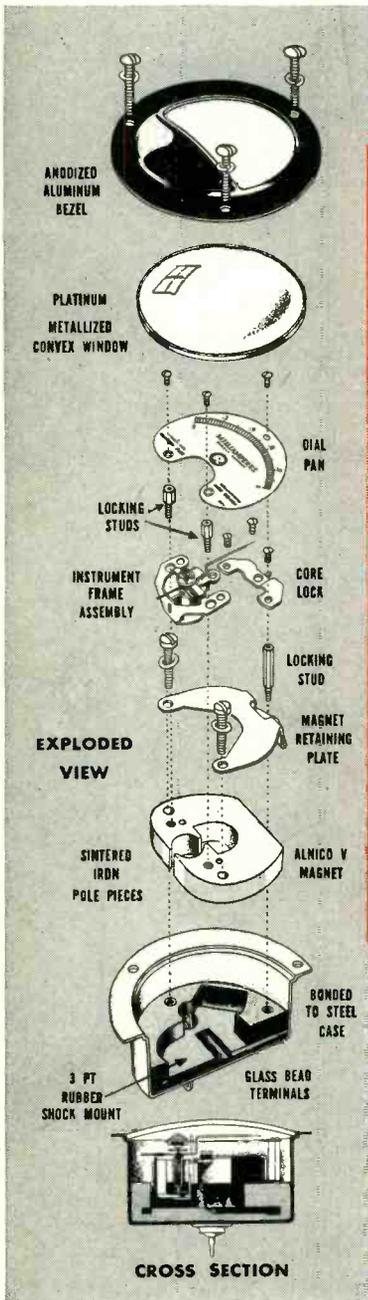
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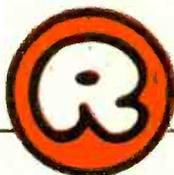
Marion Ruggedized Instruments give you new freedom of application. They are extremely accurate, highly sensitive meters that may be used in places where no one has ever before *dared* use "delicate instruments." Count on them to exceed your greatest expectations in *any* application.

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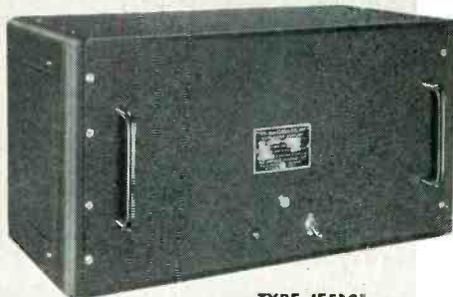
TYPE IE51002R



TYPE
IE51005



TYPE IE5101R



TYPE IE5101

Manufacturers faced with the need for increased production and lower costs are becoming extremely conscious of the importance of maintaining constant voltage to electrical apparatus. The Superior Electric Company's line of STABILINE Automatic Voltage Regulators offers equipment to suit the needs of each application. Two types are available: Type IE (Instantaneous Electronic) and Type EM (Electro-Mechanical)

STABILINE Type IE is a completely electronic unit with no moving parts. . . is used where instantaneous and extremely close correction required. It maintains a constant output voltage regardless of line variations at no load, full load or any intermediate load. The output voltage is held to within ± 0.1 volts of nominal for wide line variations; within ± 0.15 volts of nominal for any load current change; load power factor change from lagging .5 to leading .9. Maximum waveform distortion never exceeds 3%.

Standard models are available in cabinets or for relay rack mount in numerous ratings as listed below. In the event you have a special requirement involving other frequencies or ratings, SECO control engineers will study your specific problem and make recommendations without obligation.

INSTANTANEOUS ELECTRONIC CABINET MODE

Input Voltage Range	Output Voltage Range	Frequency In Cycles	Load Range In Amperes	Load Power Factor Range	Rated Output KVA	Type
95-135	110-120	60 \pm 10%	0 - 2.2	.5 lagging	0.25	IE510
195-255	220-240	60 \pm 10%	0 - 1.1		0.25	IE520
95-135	110-120	60 \pm 10%	0 - 4.5		0.5	IE510
195-255	220-240	60 \pm 10%	0 - 2.2		0.5	IE520
95-135	110-120	50 \pm 10%	0 - 4.5		0.5	IE515
195-255	220-240	50 \pm 10%	0 - 2.2		0.5	IE525
95-135	110-120	60 \pm 10%	0 - 8.5	to .9 leading	1.0	IE510
195-255	220-240	60 \pm 10%	0 - 4.5		1.0	IE520
95-135	110-120	50 \pm 10%	0 - 8.5		1.0	IE515
195-255	220-240	50 \pm 10%	0 - 4.5		1.0	IE525
95-135	110-120	60 \pm 10%	0 - 22.0		2.5	IE510
195-255	220-240	60 \pm 10%	0 - 11.0		2.5	IE520
95-135	110-120	60 \pm 10%	0 - 11.0	.9 leading	2.5	IE515
195-255	220-240	50 \pm 10%	0 - 11.0		5.0	IE510
95-135	110-120	60 \pm 10%	0 - 43.5		5.0	IE515
195-255	220-240	60 \pm 10%	0 - 22.0		5.0	IE520

* Also offered in rack models.

REMEMBER, STABILINE TYPE EM (ELECTRO-MECHANICAL) UNITS ARE ALSO AVAILABLE. RATINGS FROM 2 TO 100 KVA. LITERATURE ON REQUEST.

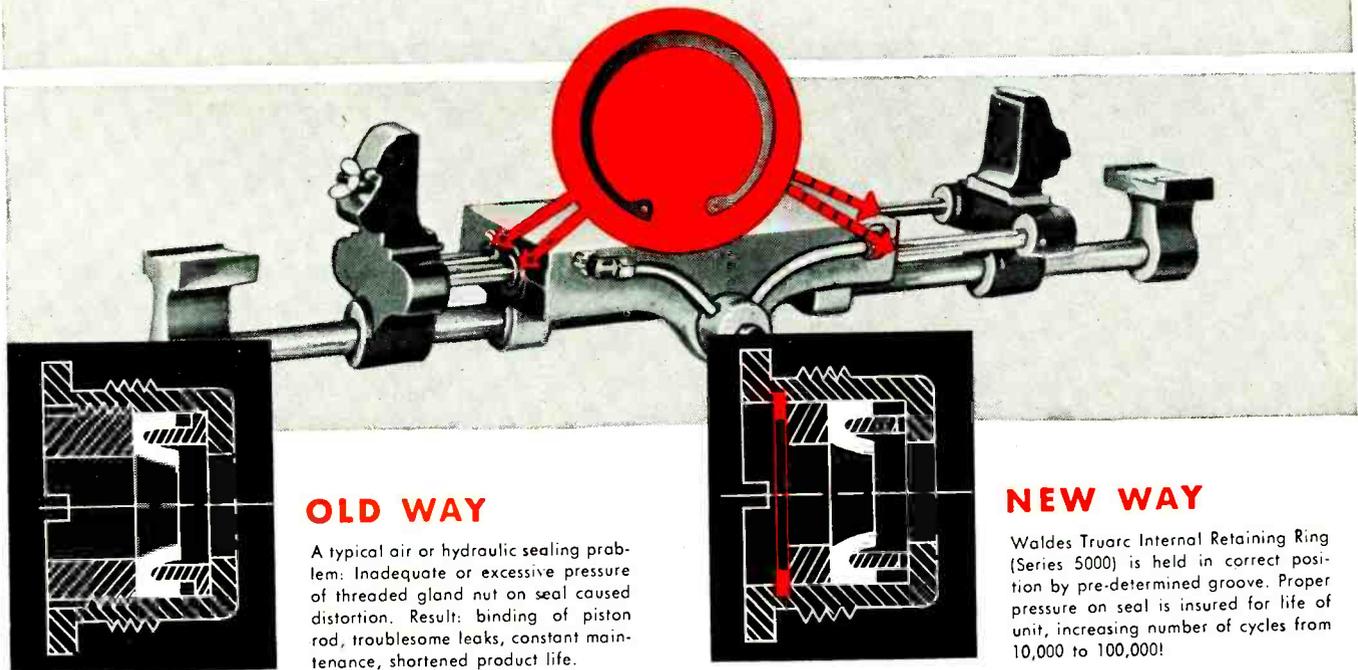
There's a STABILINE Automatic Voltage Regulator for every need. So today for literature and specific information. Write The Superior Electric Co., 404 Church St., Bristol, Conn.

THE SUPERIOR ELECTRIC CO.
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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.

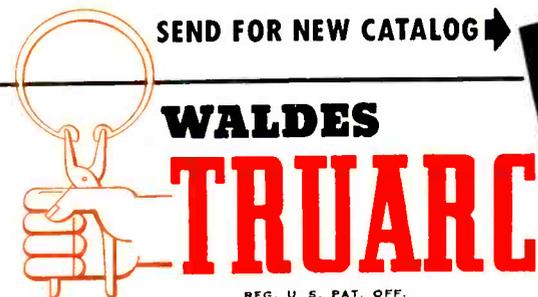
Waldes Truarc Retaining Rings are available for immediate delivery from stock, from leading ball bearing distributors throughout the country.

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

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- Net savings on parts16

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U. S. PATENTS 2,382,948; 2,420,921; 2,431,761; 2,487,803; 2,487,802; 2,491,306 AND OTHER PATENTS PENDING



Waldes Kahinaar, 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.

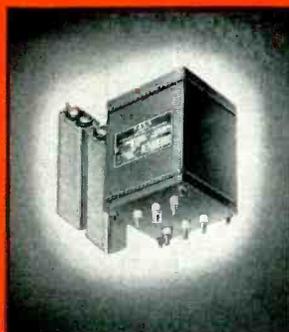
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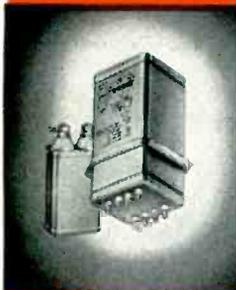
SOLA Constant Voltage Transformers are made under one or more of the following Patents: 2,143,745; 2,212,198; 2,346,621.



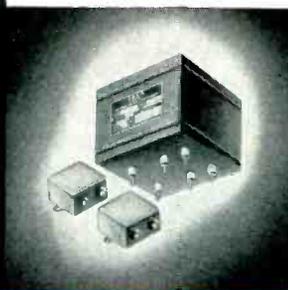
Today's complex electrical and electronic defense equipment requires unfailing accuracy and dependability under extreme conditions of humidity, heat, mechanical shock and other adverse conditions. To meet those needs SOLA voltage regulators can be provided in hermetically sealed housings which conform 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 photo-electric 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.



Typical types of Hermetically Sealed SOLA Constant Voltage Transformers



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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

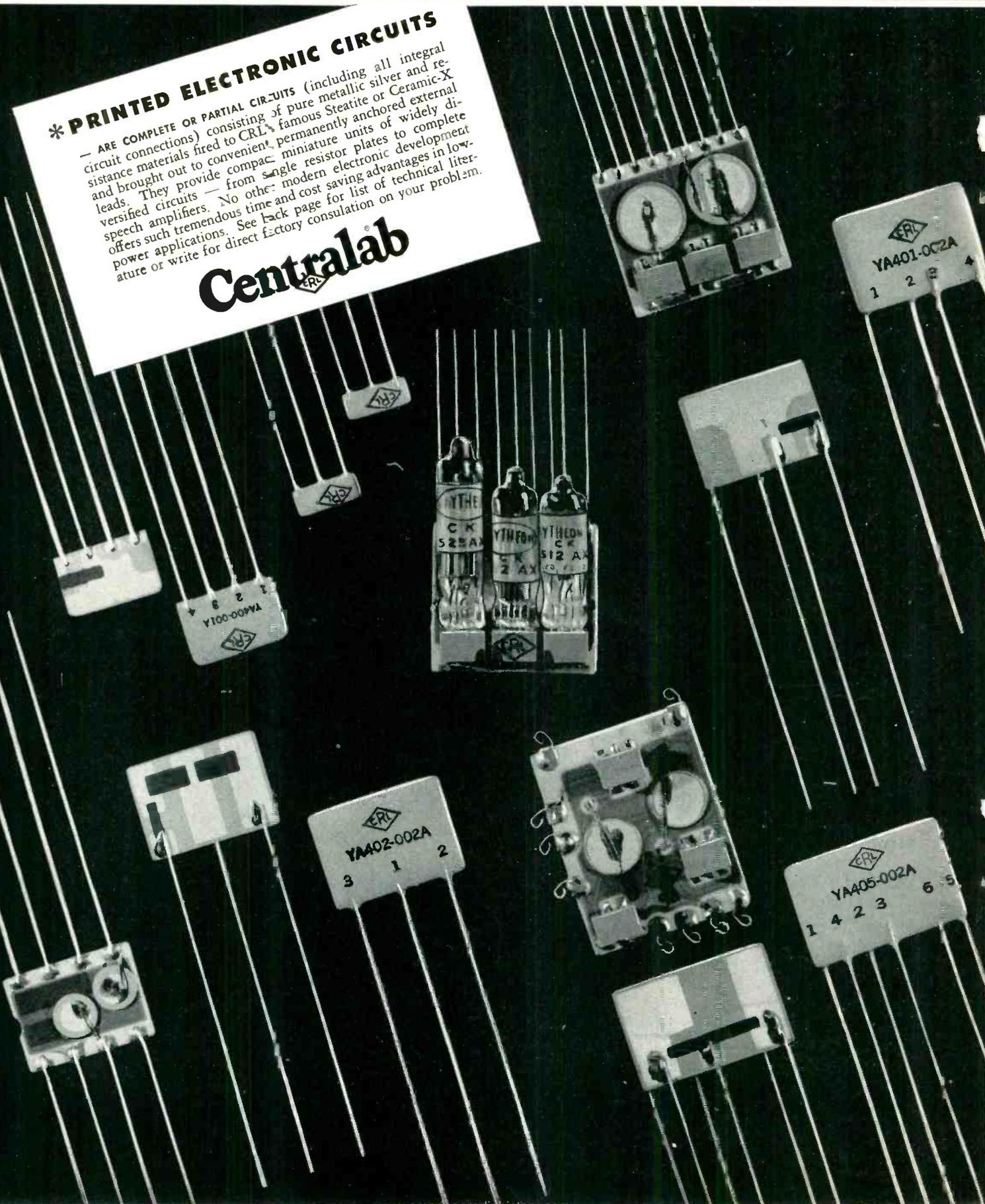
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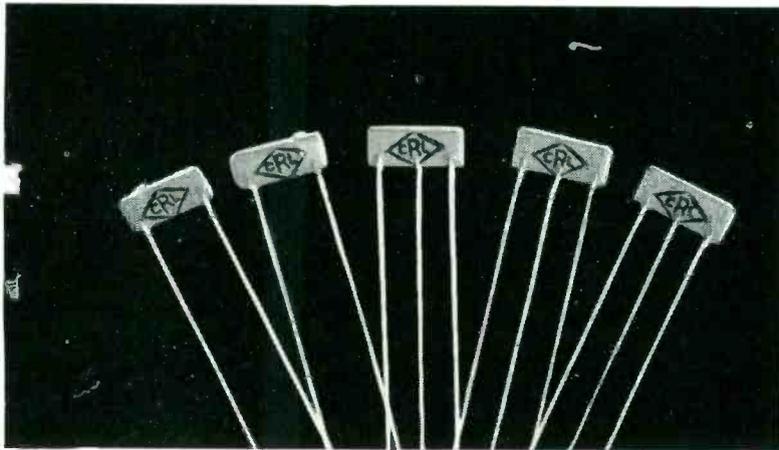
* PRINTED ELECTRONIC CIRCUITS

— ARE COMPLETE OR PARTIAL CIRCUITS (including all integral circuit connections) consisting of pure metallic silver and resistance materials fired to CRL's famous Steatite or Ceramic-X and brought out to convenient permanently anchored external leads. They provide compact miniature units of widely diversified circuits — from single resistor plates to complete speech amplifiers. No other modern electronic development offers such tremendous time and cost saving advantages in low-power applications. See back page for list of technical literature or write for direct factory consultation on your problem.

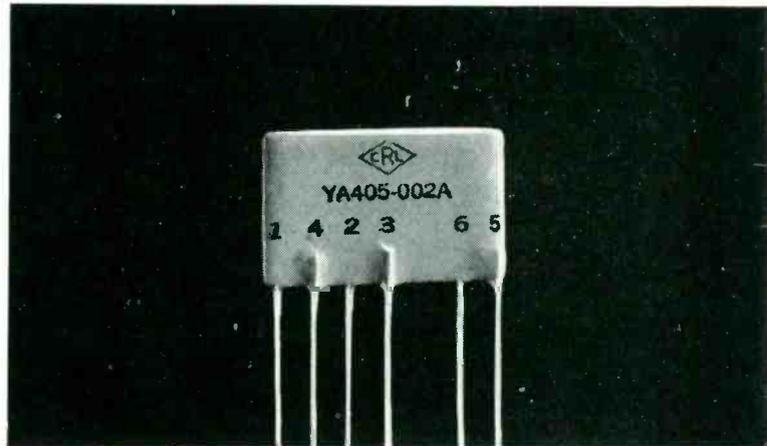
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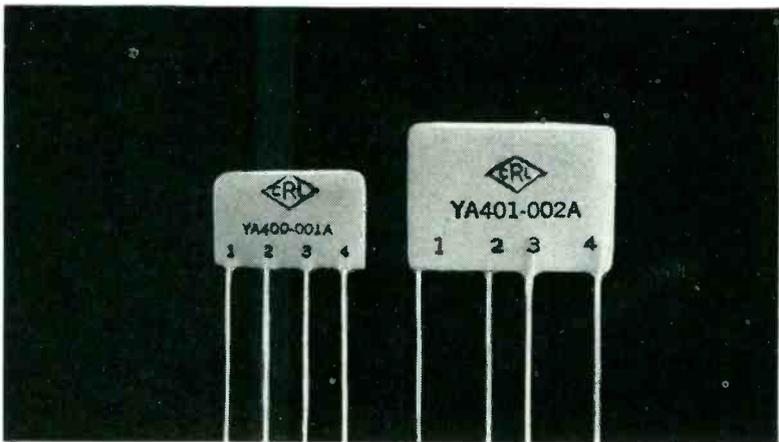
CUT ASSEMBLY COSTS Conserve Resistors



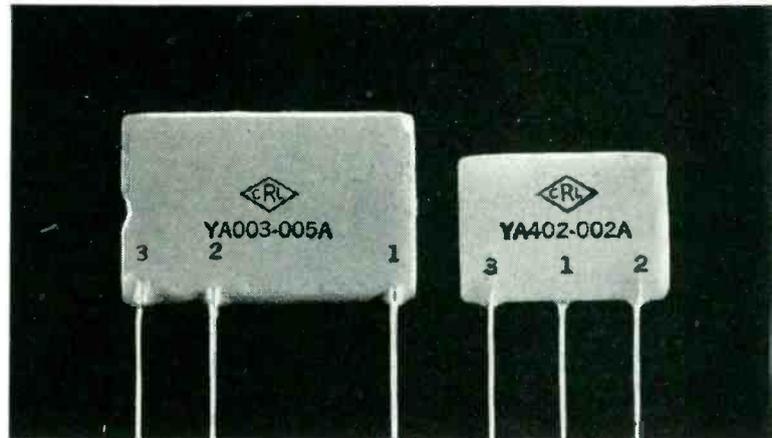
Actual size photo of plate capacitor, resistor, and resistor-capacitor units. Because of size and ease of installation, they easily fit miniature and portable electronic equipment — overcome crowded conditions in TV, AM, FM, and record-player chassis. For complete data, check coupon No. 42-24 — Ceramic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



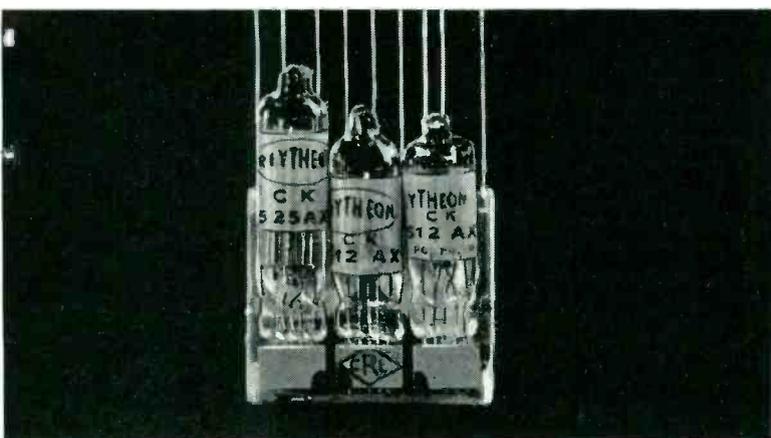
Pentode couplates are complete interstage coupling circuits consisting of 3 capacitors and 3 resistors on a small 6 lead ceramic plate. Compared with old-style audio circuits, they reduce soldered connections 50% — wiring errors accordingly. Big saving in space and weight. For complete data, check coupon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



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Ampec is a full 3-stage, 3-tube speech amplifier with amazingly efficient, reliable performance. Size 1¼" x 1⅛" x .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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frequency measurements accurate to 1 part in 10 Million over a large portion of the RF Spectrum

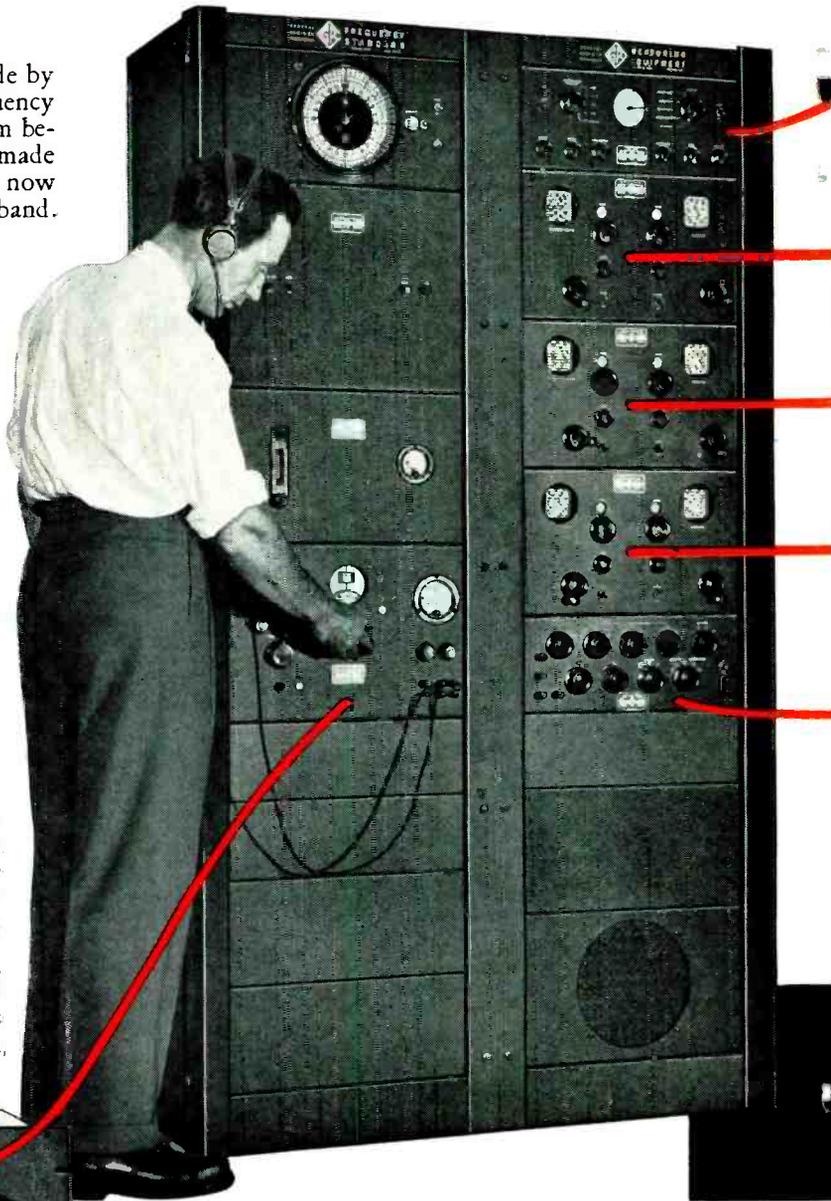
Frequency standards and measuring equipment made by General Radio Company make accurate frequency measurements possible throughout the radio spectrum below 3,000 Mc. Measurements in the v-h-f range can be made with only slightly less accuracy and convenience than is now considered routine in the standard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



Since 1915

Designers and Manufacturers of Electronic Test Equipment

Type 1109-A Comparison Oscilloscope is used as an aid in making interpolations, or in

checking calibrations with high accuracy. It contains a 3-inch, radial deflection cathode-ray tube and its power supply. Circular sweeps can be obtained at power line, 0.1, 1 and 10 kc from the Standard, and at variable frequencies from the Interpolation Oscillator. A radial deflection amplifier is provided for showing the input signal on the circular sweep base.



Type 1106-A Frequency Transfer Units, of which there are three, contain a heterodyne frequency meter and heterodyne detector, with direct-reading scales. The ranges of the three units are: 100 kc to 2,000 kc; 1 Mc to 10 Mc and 10 Mc to 100 Mc. Harmonic output of the frequency meter can be used at frequencies considerably higher than those covered by the dial ranges.



Type 1108-A Coupling Panel provides a centralized control panel for quickly and conveniently interconnecting those units of the equipment used in a particular measurement. It carries the necessary switches and volume controls for all operations in making frequency measurements. The bottom panel contains a Type 1105-P1 Speaker for audible monitoring of beat frequencies.



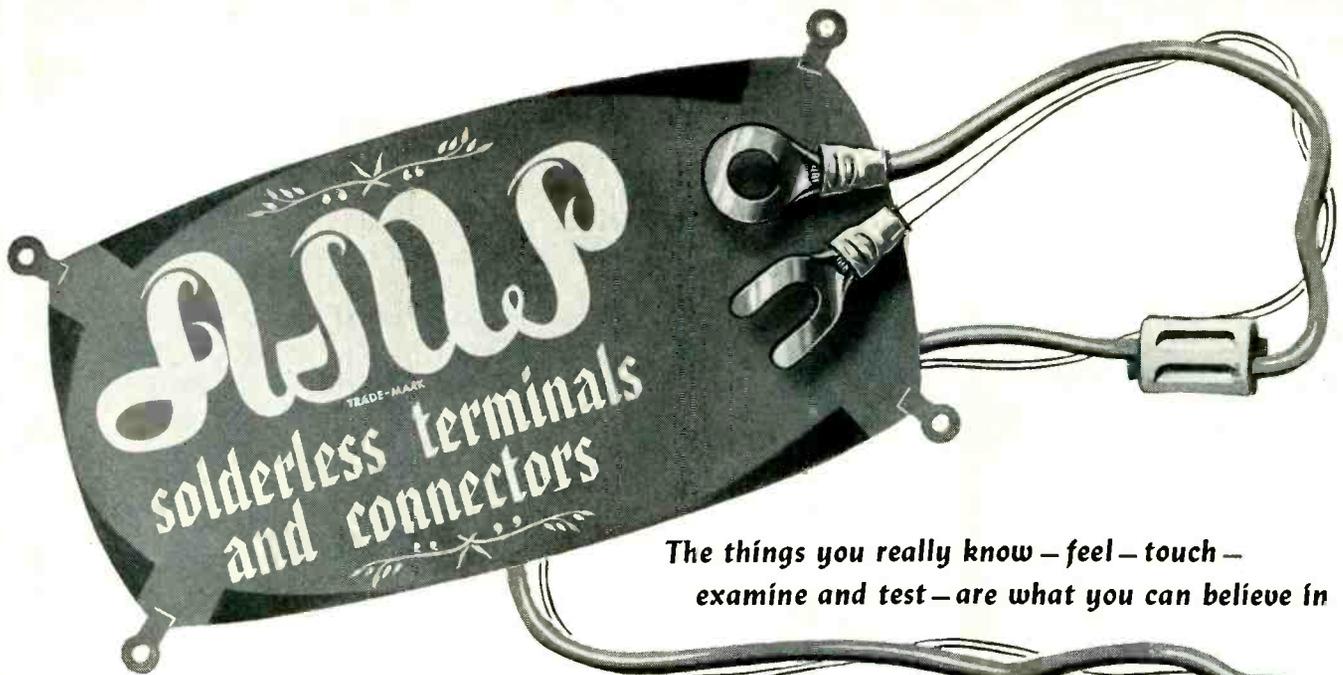
GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Mass.

90 West Street NEW YORK 920 S. Michigan Ave. CHICAGO 1000 N. Seward St. LOS ANGELES

A number of years ago General Radio Company instituted a continuous research program looking to the development of an improved primary frequency standard, a commercial standard requiring little attention or maintenance and supplying usable frequencies of high and known accuracy over an extremely wide frequency range. The current G-R standard and associated measuring equipment are known the world over for their reliability and high accuracy.

In addition to the equipment shown here, G-R manufactures a number of auxiliary frequency measuring devices such as an interpolation frequency standard, heterodyne frequency meters, frequency deviation monitors, f-m monitors, audio-frequency meters, precision tuning forks and general-purpose wavemeters.



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



**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!

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

**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.



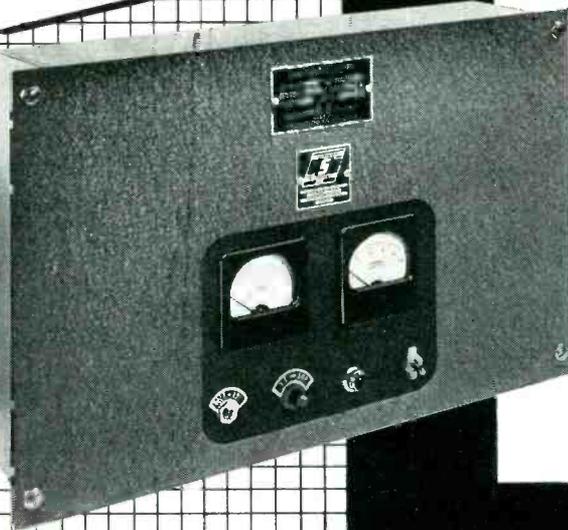
AIRCRAFT-MARINE PRODUCTS, INC.
1611 Paxton Street, Harrisburg, Pennsylvania

*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 $\pm 10\%$
Regulation accuracy and load range	$\pm 0.2\%$ 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 Supplies.



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"

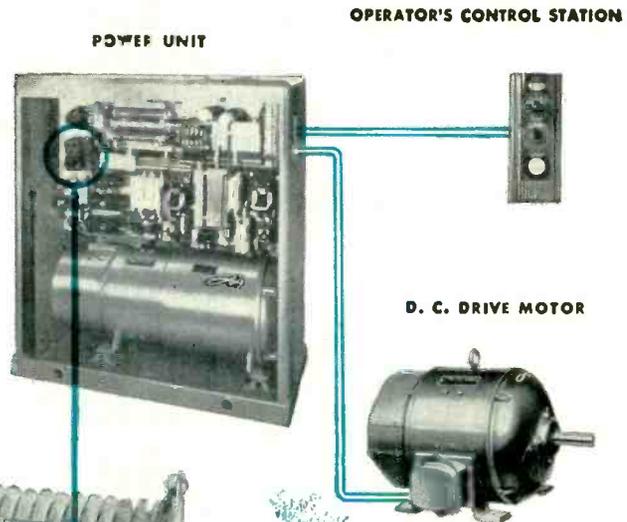
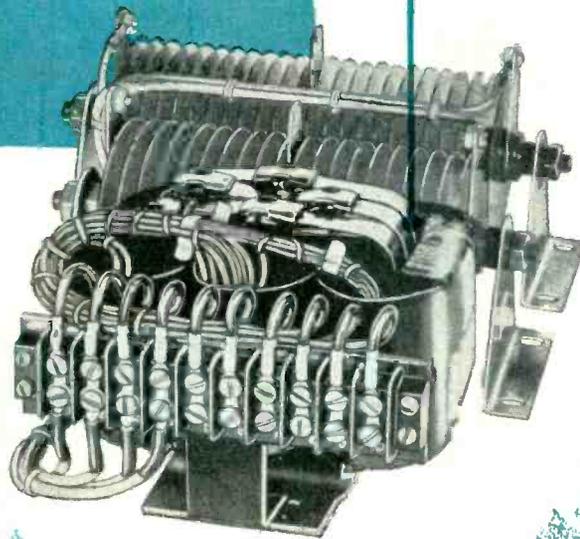
says **LOUIS ALLIS**

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.

1301 LOCUST STREET • ST. LOUIS 3, MISSOURI

VHF
UHF

IMPEDANCE MEASUREMENTS

SPEED AND CONVENIENCE

FTL-42A IMPEDOMETER

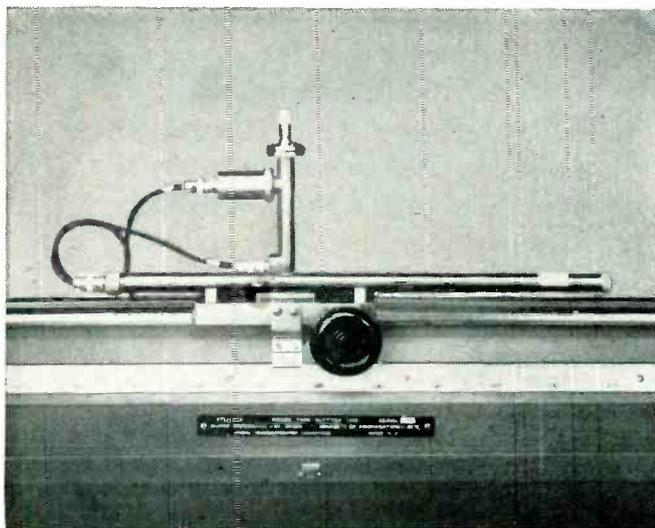
Rapid, accurate measurement of impedance, reflection coefficient and standing wave ratio. Small size, convenient for field use.

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 $\pm 5\%$.

\$400.00.



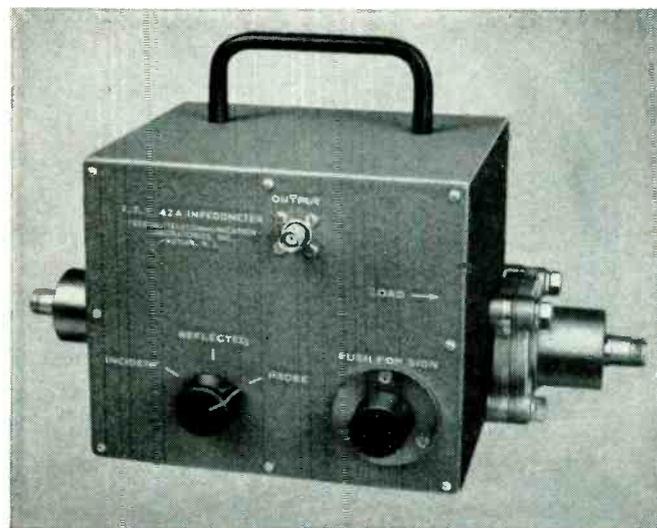
FTL-30A SLOTTED LINE

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

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.



PRECISION

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

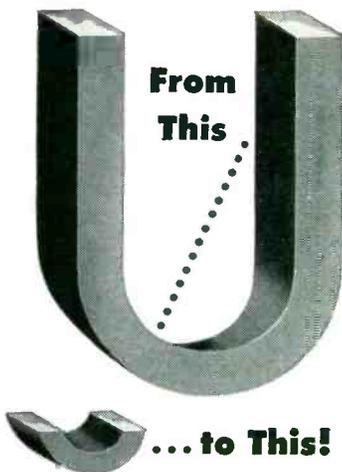
Federal Telecommunication Laboratories, Inc.

500 Washington Avenue
Nutley 10, New Jersey



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

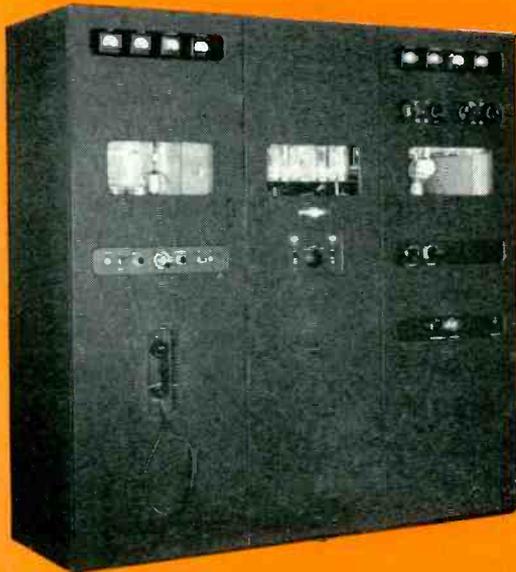
As the world's largest producer of permanent magnets, with the accumulated know-how of more than 30,000 different applications... with facilities and personnel that won the Army-Navy "E", *now expanded by 50%*... The Indiana Steel Products Company offers you many unequalled facilities. Many types and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

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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.

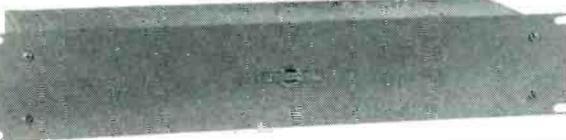
Collins 16F high frequency Autotune[®] transmitter. The power output is 300 watts voice or MCW, 500 watts CW.

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

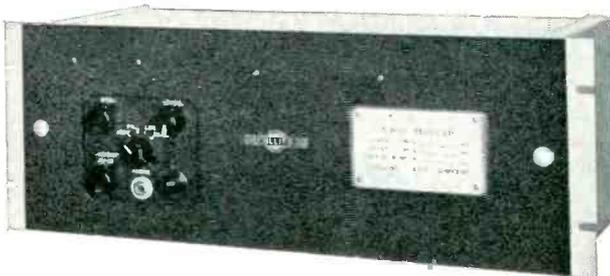
REAR VIEW



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.

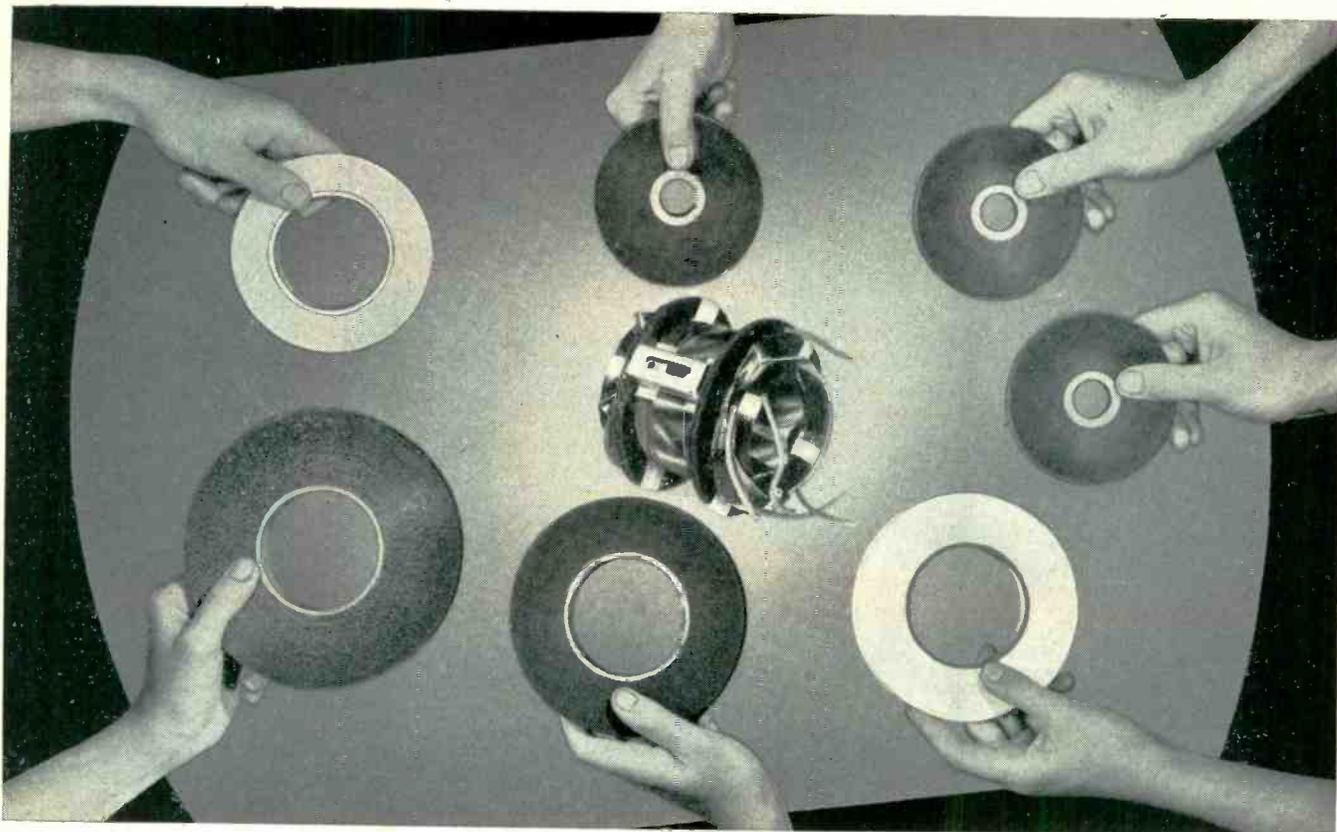
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COLLINS RADIO COMPANY, Cedar Rapids, Iowa

11 West 42nd Street, NEW YORK 18

2700 West Olive Avenue, BURBANK





7 super-thin tapes in this compact TV coil!

**Eight feet of tape holds and
insulates 3 miles of crowded wiring**

Crowded TV deflection coils get complete insulation with "SCOTCH" Electrical Tapes. At the Crosley Division of AVCO Manufacturing Corp., Cincinnati, Ohio, ninety-six inches of 7 different types of "SCOTCH" Electrical Tape protect *three miles* of wire inside the coil housing!

You get high dielectric and mechanical strength combined with thin caliper in "SCOTCH" Electrical Tapes. They're pressure-sensitive, clean to handle,

take up little room. There are over 30 different tape formulations—many types of backings and electrical type adhesives, including vinyl plastic, acetate, cloth, treated paper, glass cloth and neoprene. In addition, there is new No. 880 Filament Tape—practically unbreakable, with strong fibers running lengthwise. It holds the channel retainer and nut in place—takes the place of a steel band—rapidly and easily applied. For full information mail coupon to Dept. ES-451.

MINNESOTA MINING & MFG. CO.
900 Fauquier Ave.
St. Paul 6, Minnesota

Please send full information on "SCOTCH" Electrical Tapes for use in television coils.

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FIRM _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____



The term "SCOTCH" and the plaid design are registered trade marks for the more than 100 adhesive tapes made in U. S. A. by MINNESOTA MINING & MFG. CO., St. Paul 6, Minn., also makers of "Scotch" Sound Recording Tape, "Underseal" Rubberized Coating, "Scotchlite" Reflective Sheeting, "Safety-Walk" Non-Slip Surfacing, "3M" Abrasives, "3M" Adhesives.

General Export: DUREX ABRASIVES CORP., New Rochelle, N. Y. • In Canada: CANADIAN DUREX ABRASIVES LTD., Brantford, Ontario

Indiana University selects PRESTO 8-DG'S



Prominent mid-western college chooses Presto after preliminary survey of commercial and educational studios

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 similar programs and visiting the Library of Congress recording laboratory. The continued 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 York

www.americanradiohistory.com

Do You Know?

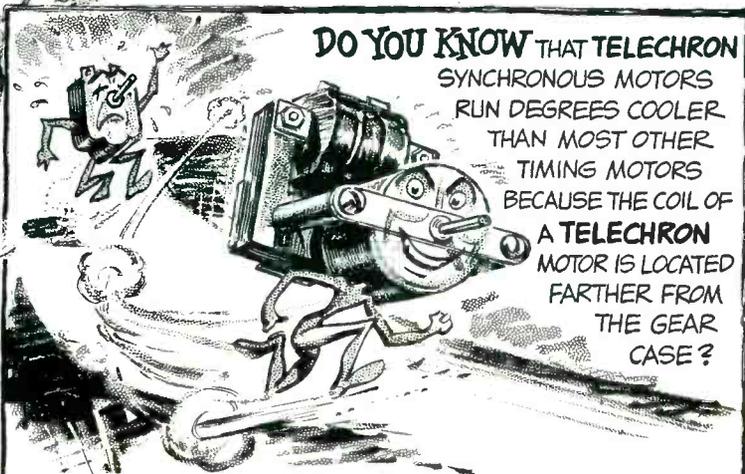


DO YOU KNOW THAT AIRCRAFT FLIGHT RECORDERS WHICH CHART A CONTINUOUS LOG OF VARIABLE CONDITIONS DEPEND FOR THEIR ACCURATE TIMING ON **TELECHRON** SYNCHRONOUS MOTORS ?



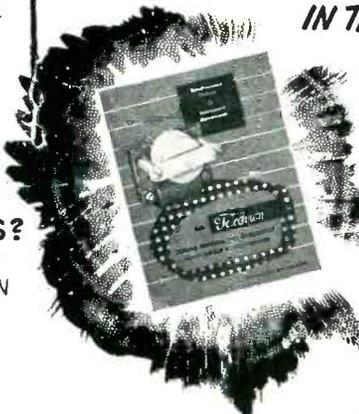
DO YOU KNOW THAT THE ROTOR SHAFTS OF MANY **TELECHRON** SYNCHRONOUS TIMING MOTORS HAVE MADE MORE THAN **30 BILLION** CONTINUOUS REVOLUTIONS AND THAT THE MOTORS ARE STILL OPERATING AS ACCURATELY AND DEPENDABLY AS WHEN THEY WERE NEW ?

NEED SKILLED HELP ON "EMERGENCY" CONTRACTS ? TELECHRON INC. HAS AVAILABLE CAPACITY FOR DEFENSE ORDERS. NEW BROCHURE, "PRECISION ON THE PRODUCTION LINE," GIVES A QUICK PICTURE OF PERSONNEL CAPABILITIES AND MASS PRODUCTION FACILITIES. **WRITE FOR YOUR COPY TODAY.**



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READ ALL ABOUT TELECHRON MOTORS IN THIS BULLETIN



WRITE FOR BULLETIN IS-110 WHICH CONTAINS CHARTS, TORQUE RATINGS AND COMPLETE SPECIFICATIONS ON **TELECHRON** SYNCHRONOUS MOTORS FOR USE IN TIMERS, TIME SWITCHES, RECORDING AND CONTROLLING INSTRUMENTS, COST RECORDERS, CYCLE CONTROLLERS, ETC. **TELECHRON INC., 44 UNION ST., ASHLAND, MASS. A GENERAL ELECTRIC AFFILIATE.**

Telechron
®

ALL TELECHRON TIMING MOTORS ARE

INSTANTLY...CONSTANTLY SYNCHRONOUS

50th YEAR

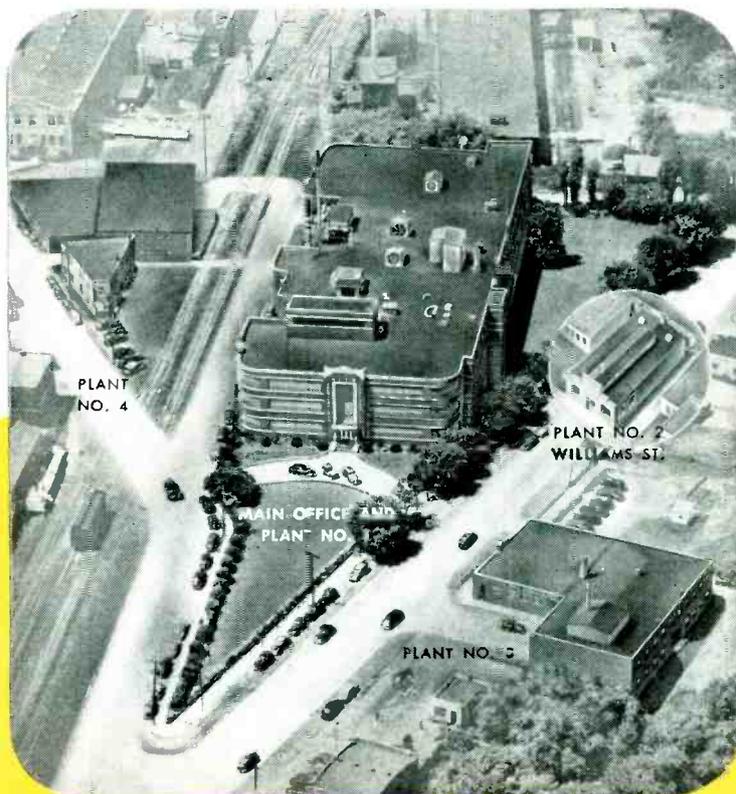
OF CERAMIC LEADERSHIP



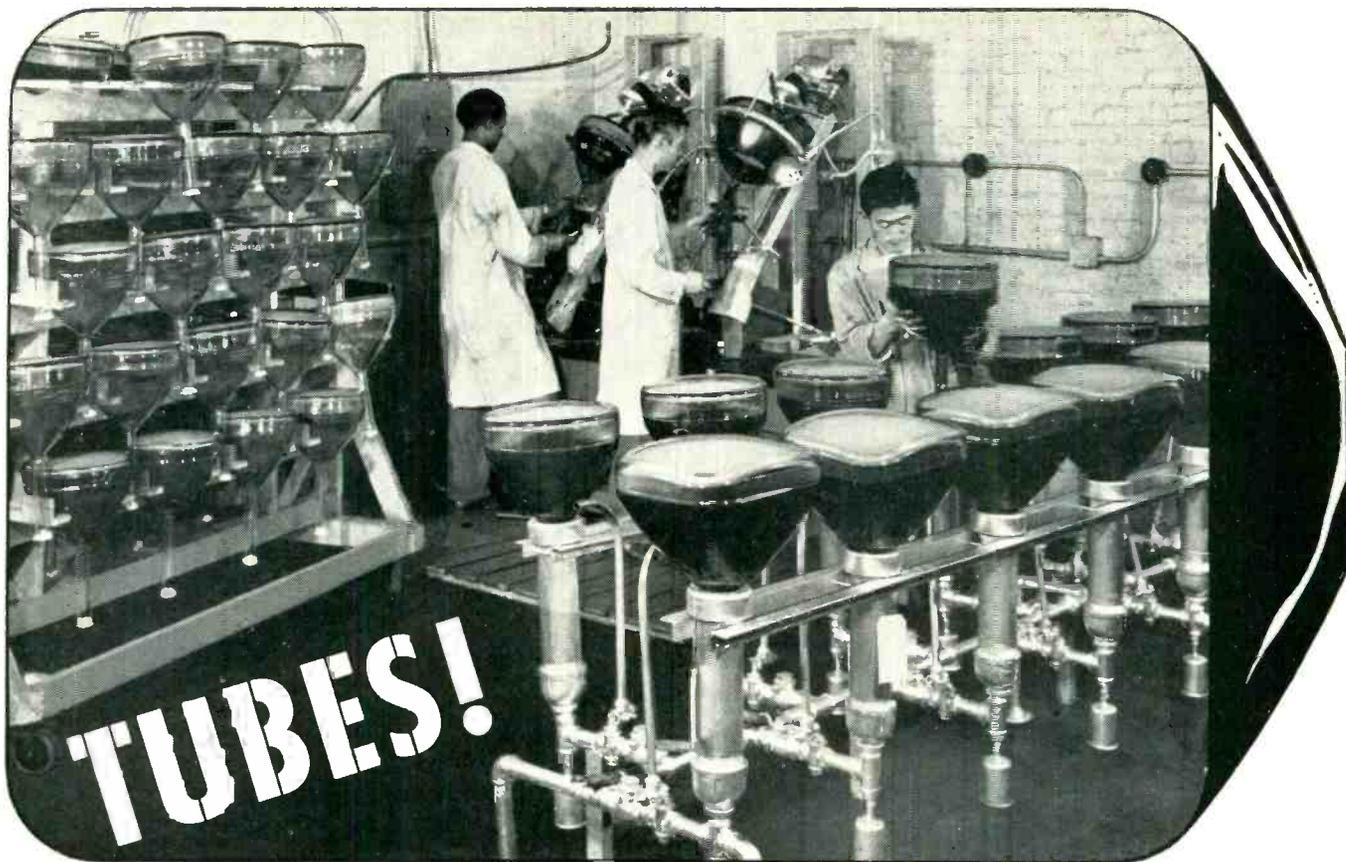
APRIL, 1951, marks the beginning of the 50th year of American Lava Corporation's ever growing services to users of custom made technical ceramics. We are proud of this record and are genuinely grateful to the customers who have made this growth possible. To our customers we dedicate our future to a continuance of the type of services and quality of products that will contribute to the success of expanding American industries.

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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.

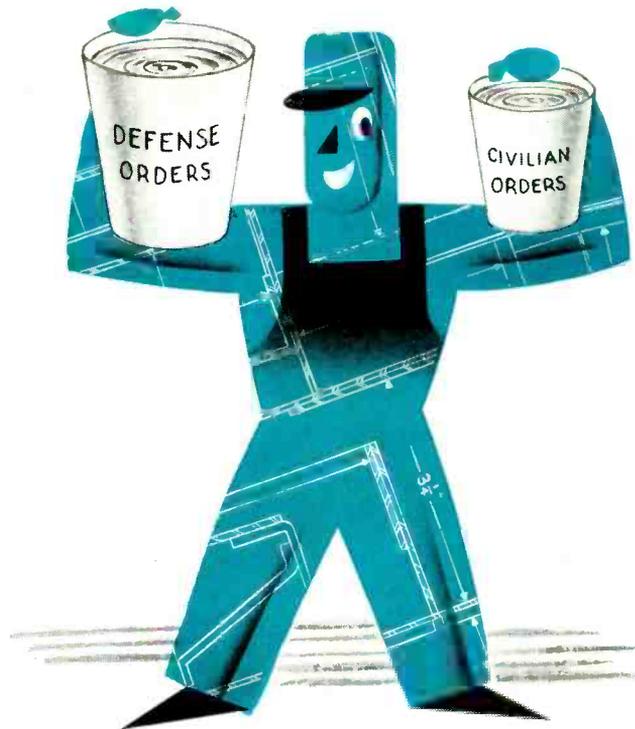
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write today to: **tube division**

AMERICAN TELEVISION, inc.

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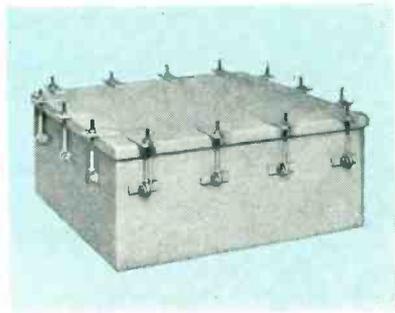
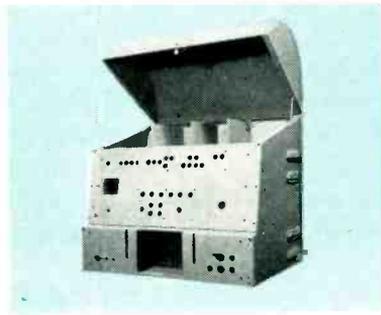
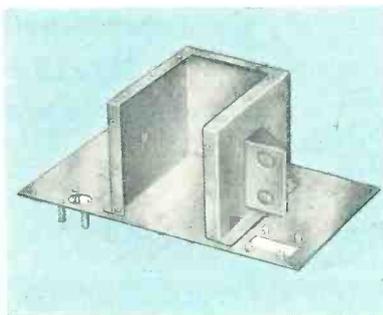
Carrying water on both shoulders is proverbially difficult, but not impossible.

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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Specialists in Fabricating Sheet Metal for Industry

NEW



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.

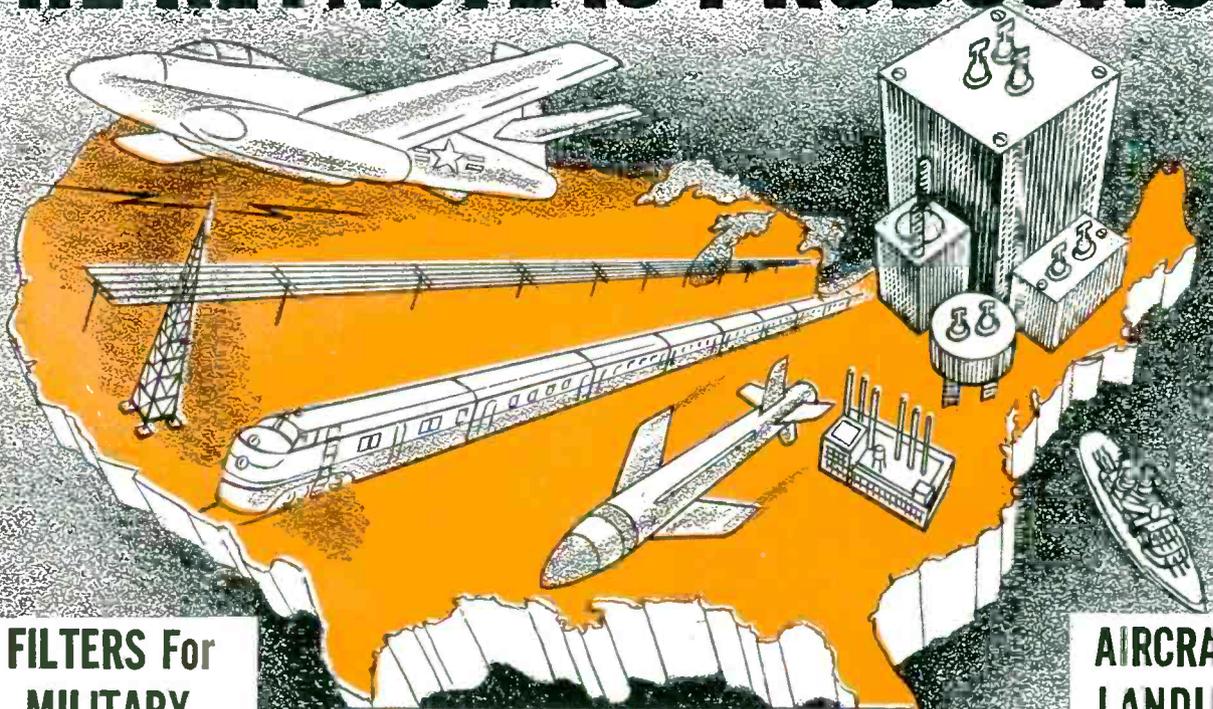
Model
630-A

ONLY \$4 .50 AT YOUR DISTRIBUTOR



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THE KEYNOTE IS PRODUCTION



**FILTERS For
MILITARY
APPLICATIONS**

FACSIMILE

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**GUIDED
MISSILES**

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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.

**AIRCRAFT
LANDING
SYSTEMS**

TELEGRAPH

TELEPHONE

**CONTROL
EQUIPMENT**

SONAR

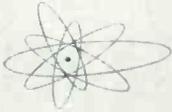
*Exclusive Manufacturers
of Communications
Network Components*



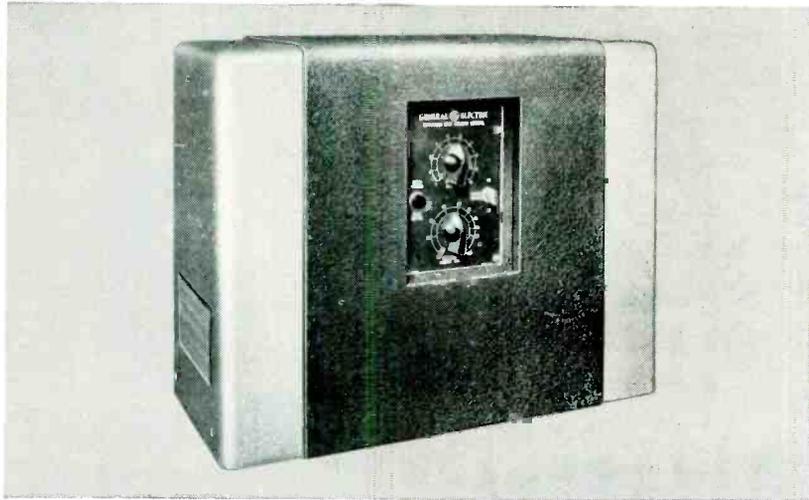
Burnell & Company

YONKERS 2, NEW YORK

CABLE ADDRESS "BURNELL"



Designers



MAKE 16 GROUND CONNECTIONS IN 1 MINUTE!

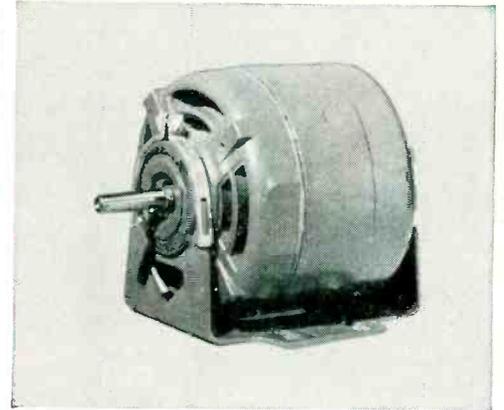
Low-resistance joints that hold at over 125°C easily made with **G-E PRECISION CONTROL FOR RESISTANCE WELDERS**

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

Digest

TIMELY HIGHLIGHTS ON G-E COMPONENTS



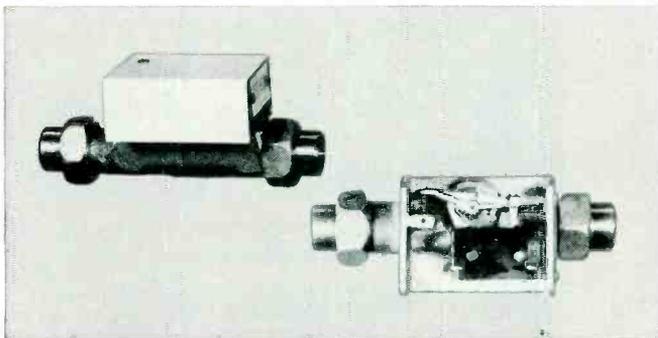
replace tubes **BEFORE THEY FAIL!** —record life with G-E time meters

A vacuum tube can usually be replaced *before* it fails if you have an accurate indication of operating time on the electronic device on which the tube is used.

G-E time meters, with dependable Telechron* motor drive, record operating time in hours, tenths of hours, or minutes, and are supplied for 115-, 230-, or 460-volts. The molded Textolite† case harmonizes with other G-E 3½-inch instruments mounted on the same panel. For more information, including dimensions, write for Bulletin GEC-472.

*Reg. T. M. Telechron, Inc.

†Reg. T. M. General Electric Co.



sure protection against overheating!

This G-E flow interlock opens the electric circuit of your water-cooled components when water flow is lower than a preset minimum, closes it when flow is above this point.

Depending on adjustment, the interlock will actuate the electric contact for any flow between ½ and four gallons per minute. Cut-in, cut-out differential is 0.1 gpm.

Ratings: 10 amps, 120 or 240 volts a-c; maximum water-line pressure is 125 lb./sq. in. Unit is bronze with standard ½-inch fittings, is easy to install and adjust. See Bulletin GEC-411.



select **10** ranges **INSTANTLY** with this **HIGH SENSITIVITY VTVM**

CALIBRATED RANGES: .001 to 300 volts (10 cycles to 1.5 mc.); —52 to +52 db (ref. level —1 mw at 600 v.)

Just about everything you could ask for in a high-sensitivity vacuum tube voltmeter! Frequency range of this G-E Type AA-1 instrument is substantially flat from 10 cycles to one megacycle with voltage ranges of 0-.01, 0-.03, 0-0.1, 0-0.3, 0-1.0, 0-3.0, 0-10, 0-30, 0-100, 0-300, decibels from —52 to +52 in 10 ranges.

Ten-position pushbutton switch instantly selects range without passing through intermediate stages. This vacuum-tube voltmeter is stable, has high impedance input, uses full-wave rectification, and has an amplifier output of 3 volts. More in Bulletin GEC-461.

General Electric Company, Section D 667-11
Apparatus Department, Schenectady 5, N. Y.

Please send me the following bulletins:

- | | |
|-------------------------------------|--|
| Indicate | <input type="checkbox"/> GEA-4175 Welding control |
| V for reference only | <input type="checkbox"/> GEA-5338 Fan motors |
| X for planning an immediate project | <input type="checkbox"/> GEC-219A Fan motors |
| | <input type="checkbox"/> GEC-411 Flow interlock |
| | <input type="checkbox"/> GEC-461 Vacuum-tube voltmeter |
| | <input type="checkbox"/> GEC-472 Time meters |

Name _____

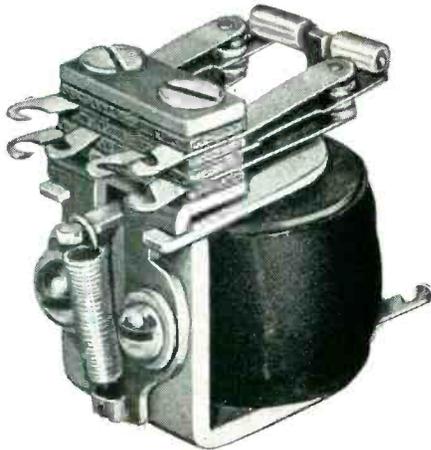
Company _____

Address _____

City _____ State _____

NEW Minipower Relay

TYPE
ME
RELAY



HERE ARE THE FACTS AND FIGURES

- DIMENSIONS:** 1-3/16 x 13/16 x 1-3/8
- CONTACTS:** 5 arr. standard. 28 volts D.C., 115 volts A.C. Up to 4 P.D.T. D.C. and up to D.P.D.T. A.C.
- SENSITIVITY:** D.C. 0.7 watts D.P.D.T. (0.1 watt in special applications)
A.C. 3 volt-amperes (operating range: 80% to 110% of nominal voltage)
- COIL:** Available for A.C. or D.C.
- HEAT RISE**
- D.C. 50°C Rise—2 watts
85°C Rise—3.5 watts
- A.C. 45°C at nominal voltage
65°C at 10% overvoltage
- MOUNTING:** One-screw mounting with locating pin.
- HERMETICALLY SEALED DATA**
- DIMENSIONS OF CAN:** Base 1" x 1-1/8"
Height above chassis: 1-11/16"
Lugs: 3/8"
- Available with solder terminals or special miniature plug-in base.

VERSATILE — FROM SIGNAL TO 5 AMP. POWER

This latest addition to Allied's line of quality relays will meet the vibration, shock and environmental requirements for air, marine and ground applications.

BULLETIN ME GIVES COMPLETE DETAILS. SEND FOR YOUR COPY TODAY

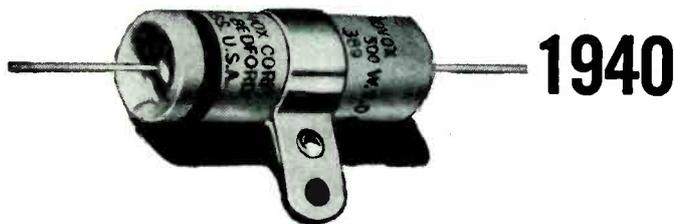
Also, be sure to send for your copy of Allied's Relay Guide. It gives engineering data for 27 Allied relays in a concise tabular form for easy reference.



ALLIED CONTROL COMPANY, INC., 2 EAST END AVE., NEW YORK 21, N.Y.

AL 145

temperatures going up...



1940

65° C TYPE 89
½" x 1 1/16"



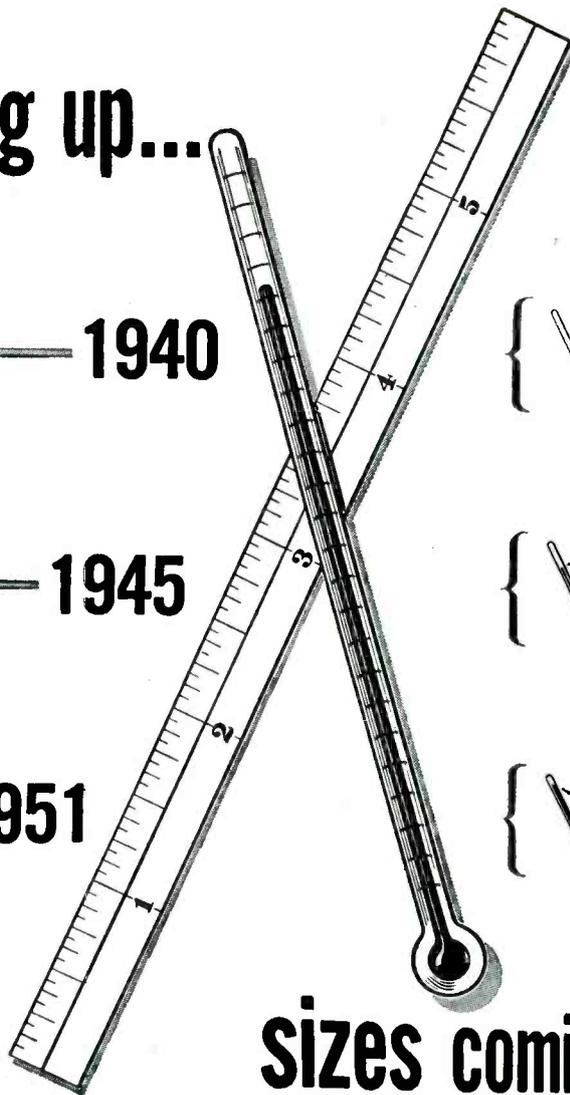
1945

85° C TYPE 38
5/16" x 1 3/16"



1951

125° C TYPE 323SX
.312" x 1/8"



sizes coming down...

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.



THE HOME OF CAPACITOR CRAFTSMANSHIP

AEROVOX CORPORATION, NEW BEDFORD, MASS., U.S.A.
Export: 41 E. 42nd St. New York 17, N.Y. • Cable: AEROCAP N.Y. • In Canada: AEROVOX CANADA LTD., Hamilton, Ont.

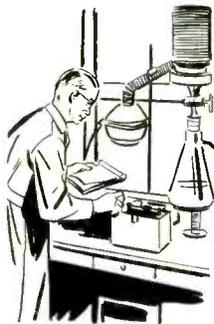
SALES OFFICES IN ALL PRINCIPAL CITIES

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

The RICHARDSON COMPANY

FOUNDED 1858—LOCKLAND, OHIO

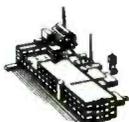
2797 Lake Street, Melrose Park, Illinois (Chicago District)



MELROSE PARK, ILL.



INDIANAPOLIS, IND.



NEW BRUNSWICK, N. J.



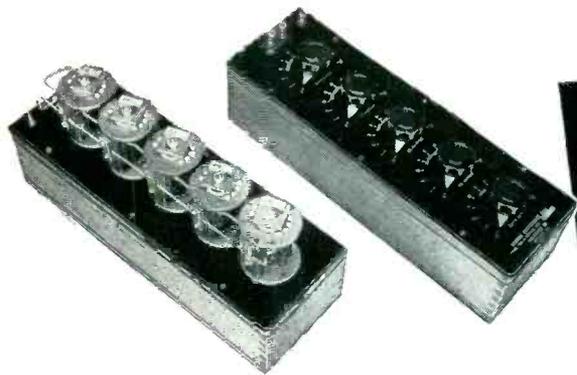
NEWNAN, GA.



TYLER, TEX.



OGDEN, UTAH



DECADE RESISTANCE BOX TYPE 750

FIRST CALL ON DAVEN

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.

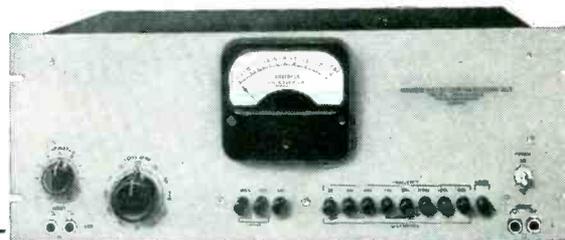
Shown on this page is only a small part of the Daven line. When writing for more complete information on the units illustrated, please identify by name and model number.



HIGH FREQUENCY ATTENUATION BOX TYPE 795



OUTPUT POWER METER
TYPE OP-962



DISTORTION & NOISE METER TYPE 35-A



VOLUME LEVEL INDICATOR SERIES 910-911



RF ATTENUATION BOX TYPE 650



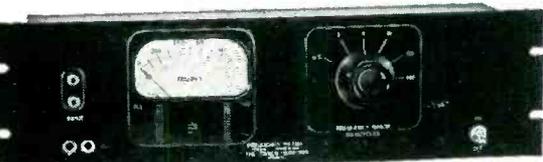
ATTENUATION BOX
SERIES 690



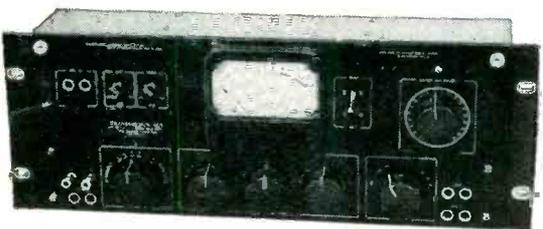
Precision equipment demands the finest components. Always specify Daven Attenuators.

THE **DAVEN** CO.

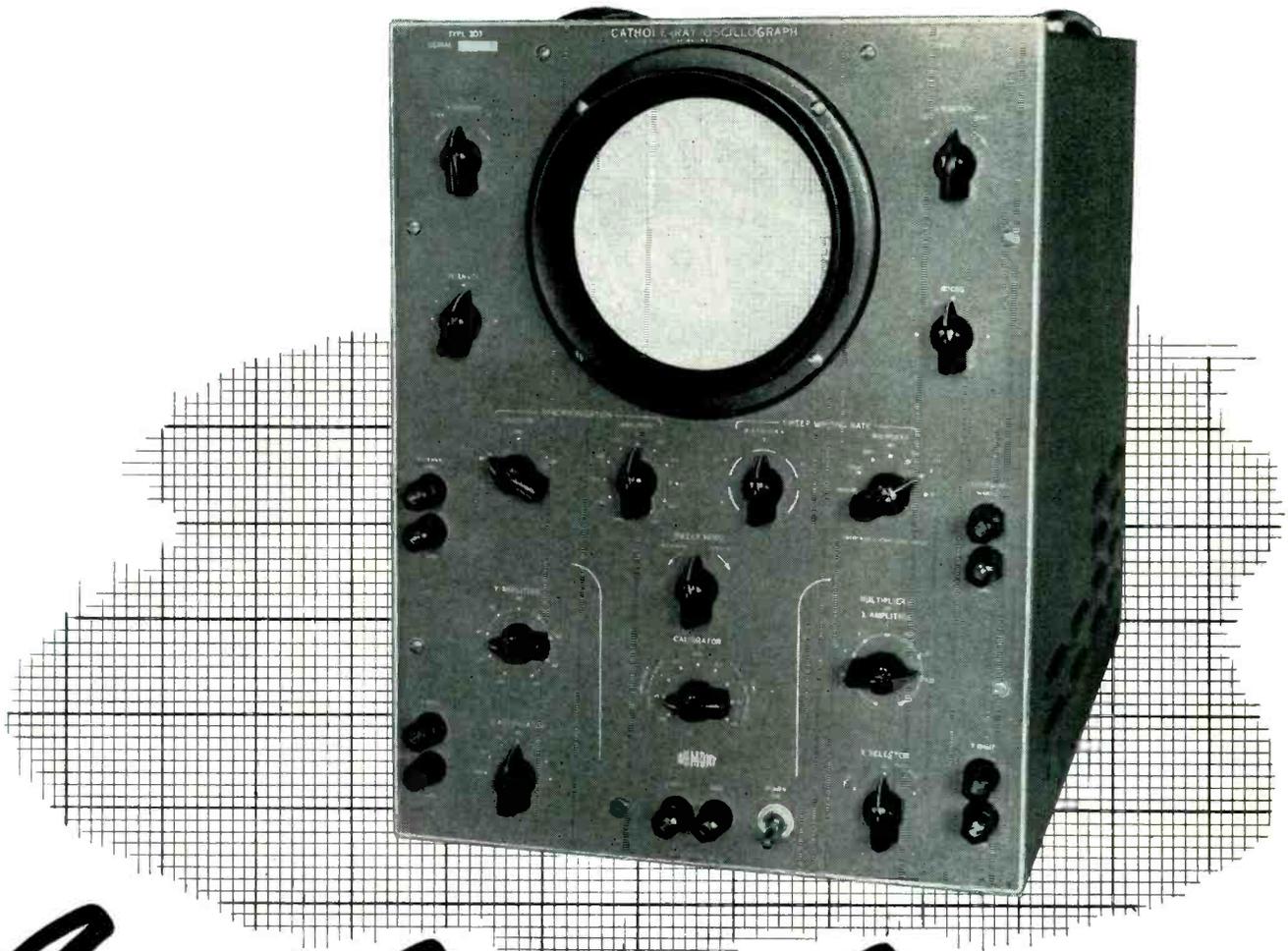
191 CENTRAL AVENUE • NEWARK 4, NEW JERSEY



FREQUENCY METER TYPE 838A



GAIN SET TYPE 11A



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 oscilloscope, 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 symmetrical 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.

Know Your Plastics

IT MAY MEAN BETTER AND FASTER PRODUCTION...AT LOWER COST

BAKELITE thermosetting Polyester Resins are combinations of styrene monomer and complex polyesters developed for contact pressure and low pressure molding, laminating, and casting. Polymerization is brought about

by the use of catalysts, application of heat, or both. The resins are supplied as pale liquids in varying viscosities. They are produced in several grades, principal among which are detailed below.

This message deals with "BAKELITE" POLYESTER RESINS

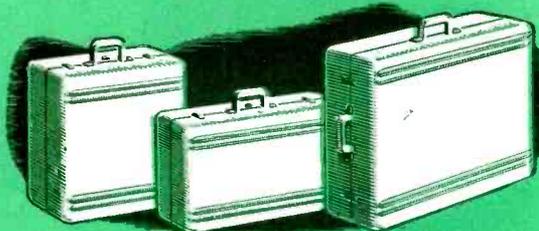
"BAKELITE" QRS-81 GENERAL PURPOSE

This general-purpose, liquid resin was developed for structural applications. It is particularly serviceable for matched-die molding because of its excellent moldability and easy flowing quality. Also readily formed with plaster, wood, and sheet-metal molds. Applicable to rubber-bag molding. Cures at room or elevated temperatures with standard catalysts. Does not preclude. Retains excellent mechanical strength and electrical values at operating temperatures under 150 deg. F.



"BAKELITE" QRS-136 FLEXIBLE

This is a flexible resin sold as a non-plasticized liquid. It can be used alone for certain applications requiring a high order of toughness and flexibility, as in the production of tubing. However, it has been most useful to date as a modifier for other Polyester Resins to impart toughness and impact resistance in structural laminates and moldings. Compatible with most other Polyester Resins. Recommended for mechanical applications or where electrical insulating requirements are not critical.



"BAKELITE" QRS-17560 HIGH VISCOSITY (4000-6000 est.)



Formulated for producing castings or moldings with fewer inherent stresses and strains than with other grades of Polyester Resins. Provides non-crazing pieces of high resin content, with or without filler. Where fillers are called for, smaller quantities are required. Because of versatility of this resin it is particularly satisfactory for the production of castings made from glass-fiber preforms.

"BAKELITE" QRS-140 MEDIUM VISCOSITY (300-600 est.)

This is a medium viscosity resin developed especially to meet the insulating requirements for high-frequency electronic apparatus and components (9375 megacycles per second). In electrical properties it approaches BRS-16631, so widely used in World War II for radomes and other vital equipment. It is easier to handle than BRS-16631 because of improved moldability.



The development of BAKELITE Polyester Resins for molding reinforced plastics is a continuing operation of the Bakelite Laboratories. Formulations can be varied almost infinitely, and tailored to your particular jobs. Some of these jobs... chiefly with glass fiber cloth or mat... include boat hulls, radomes, refrigerator panels, housings, luggage, to which they give light weight, high impact, tensile, and flexural strength, and resistance to moisture, many chemicals, and heat. Superior electrical insulation values are attainable. For instance, laminates made with these resins have relatively low power factors throughout the 60 to 10⁶ cycles range. They eliminate the need for costly molds, high heat, and high pressures. Engineers and designers interested in BAKELITE Polyester Resins are urged to outline their needs *in fullest detail* for a thorough, confidential analysis. Write Dept. BV47.

BAKELITE
TRADE-MARK
POLYESTER RESINS

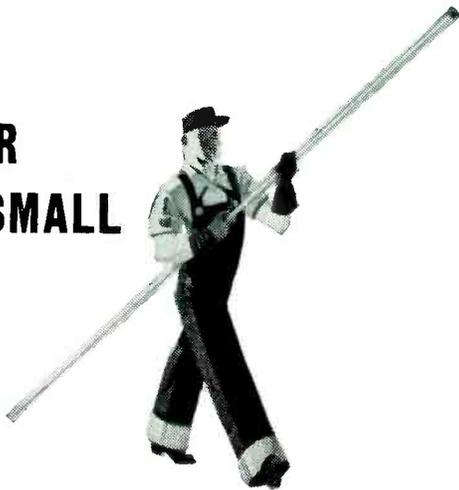


BAKELITE COMPANY
A Division of
Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.

BIG JOB



...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.

Chase  **BRASS & COPPER**

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

• *The Nation's Headquarters for Brass & Copper*

Albany†	Cleveland	Kansas City, Mo.	New York	San Francisco
Atlanta	Dallas	Los Angeles	Philadelphia	Seattle
Baltimore	Denver†	Milwaukee	Pittsburgh	Waterbury
Boston	Detroit	Minneapolis	Providence	
Chicago	Houston†	Newark	Rochester†	(†sales office only)
Cincinnati	Indianapolis	New Orleans	St. Louis	



**Master Pieces of Hermetic Sealing
-Proven to Reduce Rejects!**

PLUG IN TYPE HEADERS

OC-8
CHARACTERS
0.930 D. PIN
0.50 I.D.
FLASH OVER VOLTAGE
6000V PIN TO RIM

OC-12
CHARACTERS
0.930 D. PIN
0.50 I.D.
6500V. PIN TO RIM

MULTIPLE TYPE HEADERS

1000 SERIES AVAILABLE WITH 2 TO 10 TERMINALS

2000 SERIES AVAILABLE WITH 2 TO 6 TERMINALS

CHARACTERS
1.5 D. PIN CIRCLE
0.40
FLASH OVER VOLTAGE
6500V PIN TO RIM

CHARACTERS
1.5 D. PIN CIRCLE
RETAINER RING 0.40
0.930 PIN
6500V. PIN TO RIM

**NEO-SIL HERMETIC SEALS
INDIVIDUAL TYPE TERMINALS**

E-1
FLASH OVER VOLTAGE
2500V

E-3
FLASH OVER VOLTAGE
5500V

E-4
FLASH OVER VOLTAGE
5500V

TEST DATA

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

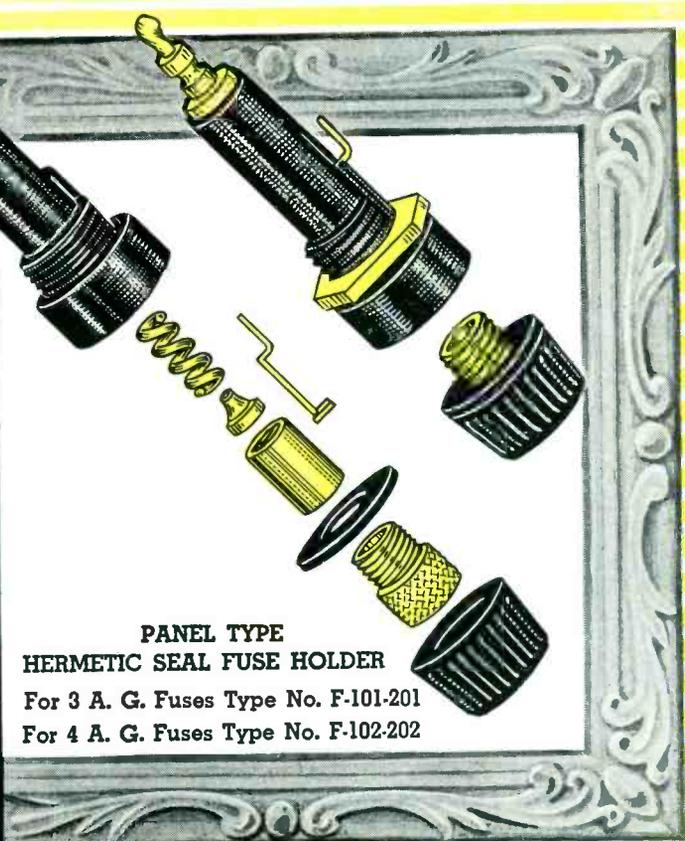
Volume Resistivity at 800 Volts d-c
Room Temperature 25°C R.H. 30 percent
Megohm-inches 1.4×10^8 ohm-centimeters 3.5×10^{11}

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



**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

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 alkalis.

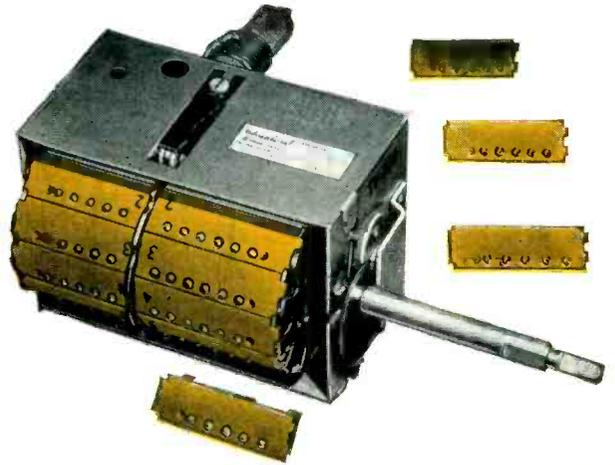
In addition to the Panel Type Hermetic Seal Fuse Holder illustrated, NEO-SIL offers many other specialty components: Molded Cable with plugs attached—4 Pin Female Panel Connector—Meter Hermetic Seal Gasket—5 Pin Female Panel Connector—Rotary Hermetically Sealing Panel Bushing.

Your special problems are solicited.



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

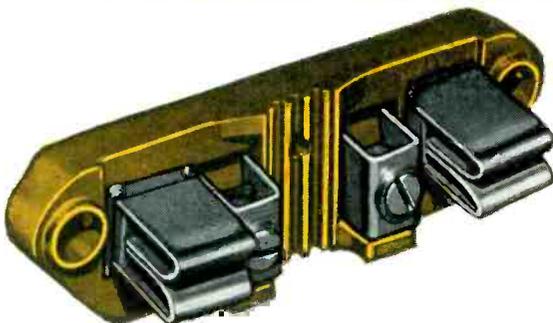
16 PRECISION PARTS EVERY 30 SECONDS! Here is an outstanding example of the high-speed production possible through the use of quick-curing Plaskon Alkyd. And these parts used in television tuners must be held to precision tolerances as close as .0005". Molded for Standard Coil Products Co., Chicago, by Wilcox Plastics, Los Angeles; Mayfair Molded Products Co., Chicago; and Trans-Matic Plastics Co., Chicago.



HIGH-SPEED MOLDING YIELDS BIG SAVINGS! Sangamo Electric Company, Springfield, Ill., achieved a new high-production molding record turning out Plaskon Alkyd parts for its motor starting capacitors on a battery of 13 small presses. Sangamo has reported: "This speed really shows up where it counts most — in savings!"

**more evidence of increased production with
PLASKON ALKYD**

FASTER PRODUCTION CONTRIBUTES TO 50% COST SAVING! Barber-Colman Company, Rockford, Ill., realized a saving of 50% in unit cost when it switched to Plaskon Alkyd for molding parts for rotors used in J. I. Case tractors. And the higher production rate achieved with Plaskon Alkyd was an important contributing factor!



HIGH PRODUCTION RATE ON AUTOMATIC PRESSES! Molding its watt-hour meter bases with Plaskon Alkyd, Blakeman Bros. Electric Mfg. Co., Los Angeles, cites the following results: "We have found that Plaskon Alkyd lends itself very well to automatic molding, giving us a high production rate on automatic presses."

WOULD

300 to 400% faster molding of parts

IMPROVE YOUR PROFIT PICTURE!

From a wide variety of applications comes mounting evidence that Plaskon Alkyd can be molded *three to four times faster* than conventional thermosetting molding materials with appropriate modification of molding equipment. Molder or manufacturer . . . if you have any small parts which lend themselves to compression molding, here could be the way to step up their production tremendously!

And the amazing, quick-curing plastic which has created new concepts of speed in compression molding helps in other ways to improve profit figures. It can be molded on high-speed automatic machines, saving labor. It can be molded at lower pressures with simpler dies. And it can improve the general efficiency of molding room operation because it is less sensitive to variations in pressure, temperature and time.

Thanks to its remarkable properties, particularly its electrical properties, Plaskon Alkyd can be successfully used in parts which it was never before practical to make of plastics. And it can improve the performance of many parts now made of conventional thermosetting materials!

Investigate Plaskon Alkyd more completely—*now*.

mold it better and faster with

PLASKON DIVISION • LIBBEY • OWENS • FORD GLASS CO.

Toledo 6, Ohio

In Canada: Canadian Industries, Ltd., Montreal, P. Q.

Branch Offices: Boston, Chicago, New York, Los Angeles, Rochester

Manufacturers of Molding Compounds, Resin Glues, Coating Resins

PLASKON[®]

ALKYD

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 $\pm 10\%$ or $\pm 20\%$ 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 1/2" DIA.	
200 - 300 MMF 5/8" DIA.	
300 - 500 MMF 3/4" DIA.	
Capacity Tolerance $\pm 10\%$ $\pm 20\%$	

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



NO. 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



NO. 1170 D.C. POWER SUPPLY
DIRECT CURRENT UP TO
500 MA

NO. 1110A INCREMENTAL INDUCTANCE BRIDGE

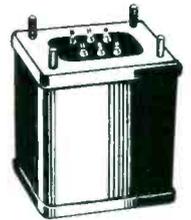


FOR ACCURATE TESTING OF TELEVISION AND
COMMUNICATION COMPONENTS UNDER
LOAD CONDITIONS.

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
1/2 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., (RIDGWOOD) 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

AK-3
Identification keyer

BEACON
Package 50 or 100 watt
transmitter

LMI-72
Line match
indicator

ACA
Auto transfer

DA-200
Artificial antenna

AR-72
H. F. Airborne
receiver

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



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

...the **CLARE** way...

**Good Hermetic Sealing \wedge 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.

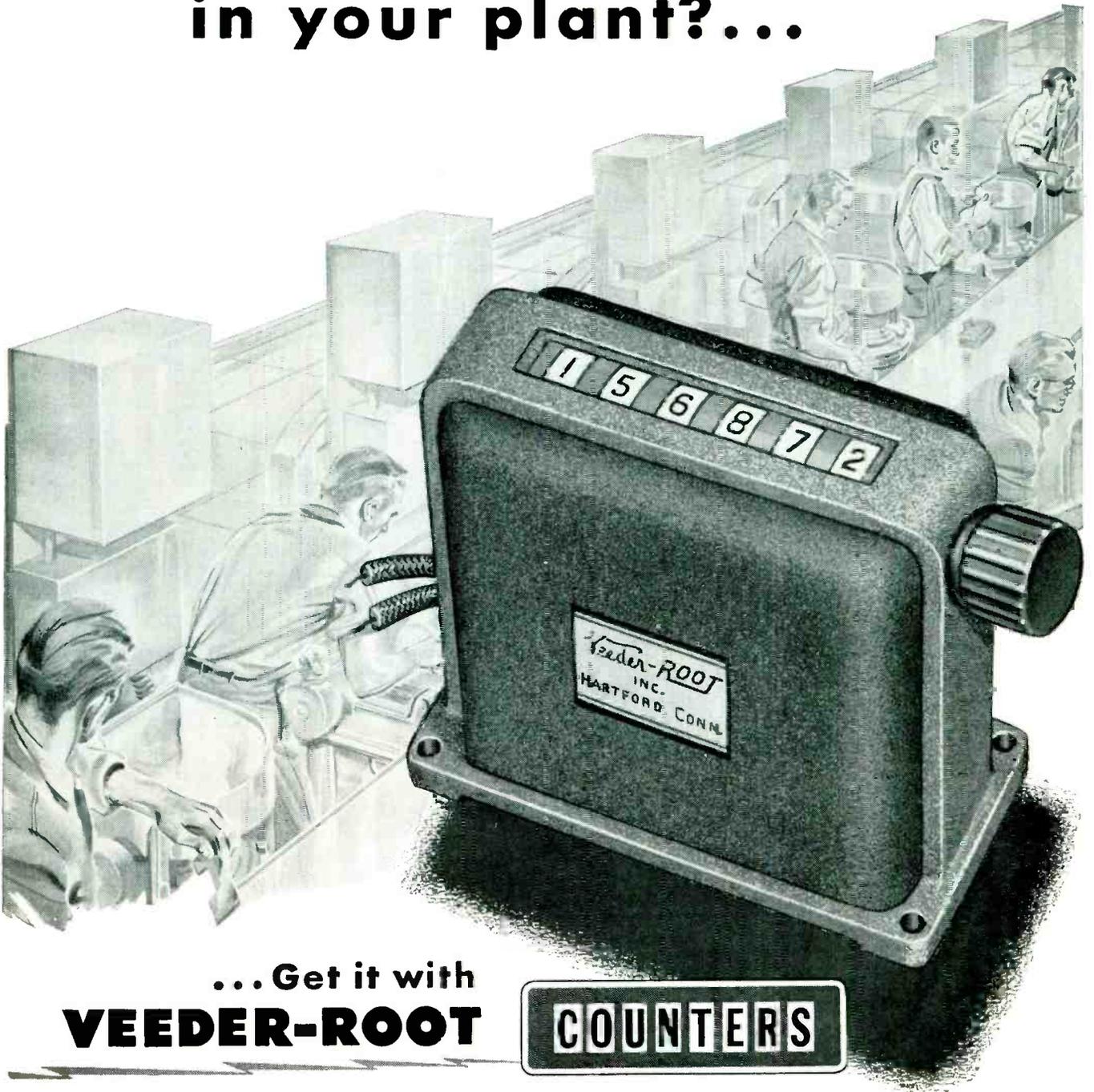
Whatever your relay problem . . . whether it involves hermetically sealed relays or just the best relay for an exacting application . . . contact CLARE first. Sales engineers are located in principal cities to assist you in selecting the relay you need. Look them up in your classified telephone directory 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:*

**VEEDER-ROOT INCORPORATED
HARTFORD 2, CONNECTICUT**

Montreal, Canada • Dundee, Scotland • Offices and Agents in Principal Cities

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.



... also Acheson Colloids Limited, London, England

AN OLD COMPANY TAKES A NEW NAME

FREDERICK HART & Co., Inc., *becomes* DAYSTROM ELECTRIC CORPORATION

Frederick Hart & Co., Inc., which has been manufacturing precision products at Poughkeepsie, New York, for more than 57 years, will henceforth be known as Daystrom Electric Corporation.

This action follows a change in the name of our parent company from ATF Incorporated to Daystrom, Incorporated.

The use of the name *Daystrom* offers distinct advantages in the introduction of new products. This name was chosen because it has become familiar to millions of people through national advertising of our companion subsidiary, Daystrom Furniture Corporation—world's larg-

est producer of tubular steel furniture. Adding *Electric* to our name better identifies us with the type of products we make.

The advantage of this name will become even more apparent when fulfillment of contracts for the military services allows us to resume production of our normal peacetime products, such as the Hartron Sound Recorder-Reproducer.

Daystrom is new to the electronics industry in name alone. From Daystrom in the future — as from Hart in the past — will come new developments and new products to contribute to better living,

Meet the DAYSTROM Family

DAYSTROM, INCORPORATED

ELIZABETH, NEW JERSEY

Subsidiaries:

Daystrom Electric Corporation — *sound recorders and electronic devices, Poughkeepsie, N. Y.*

American Type Founders — *letterpress, offset and gravure presses, joundry type and other printing equipment, Elizabeth, N. J.*

Daystrom Furniture Corporation — *chromed steel, wood and plastic furniture, Olean and Friendship, N. Y.; Western Division, Fullerton, Calif.*

Daystrom Laminates, Inc. — *plywood and lumber products, Daystrom, N. C.*

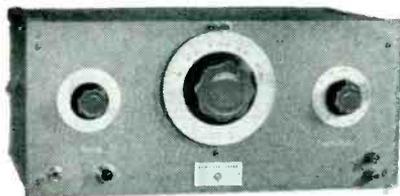
DAYSTROM ELECTRIC CORPORATION

POUGHKEEPSIE, NEW YORK

Accurate ac test voltages

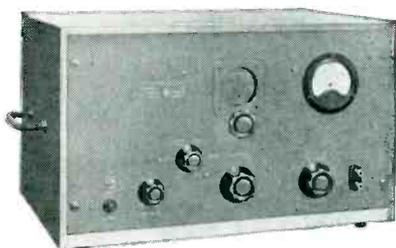
1/2 to 10,000,000 cps

Complete Coverage



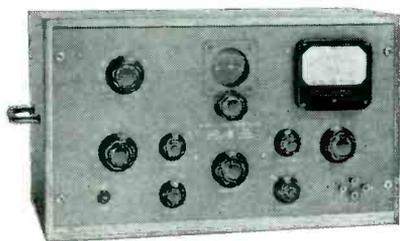
-hp- 200 Series Audio Oscillators

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	1/2 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, 1/2 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

2250 A Page Mill Road

Palo Alto, California, U. S. A.

Sales representatives in principal areas.

Export: Frazar & Hansen, Ltd., San Francisco, New York, Los Angeles

2250

HEWLETT-PACKARD INSTRUMENTS



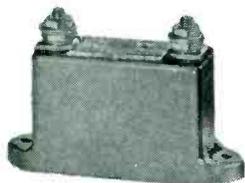
THE LITTLE INDIAN SAYS.

"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 fre-

quently 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



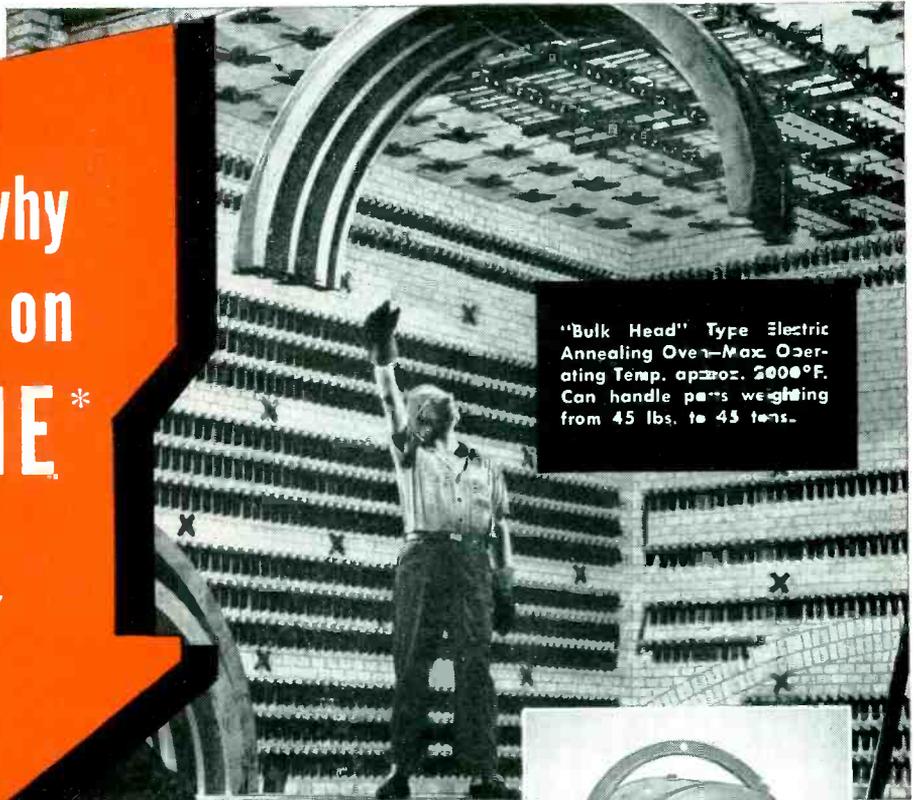
Dependable Performance

SANGAMO ELECTRIC COMPANY SPRINGFIELD, ILLINOIS

IN CANADA: SANGAMO COMPANY LIMITED, LEASIDE, ONTARIO

EC2-3

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)



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.



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.



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.



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°.

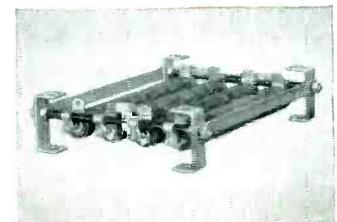


Nichrome and Nichrome V are available in different forms—wire, ribbon, strip, sheet and rod. Such variety offers outstanding aid to designer, engineer, and manufacturer.

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.



Forced-Convection Type Unit Air Heater.



Edgewise-wound resistor—typical of large industrial applications.



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



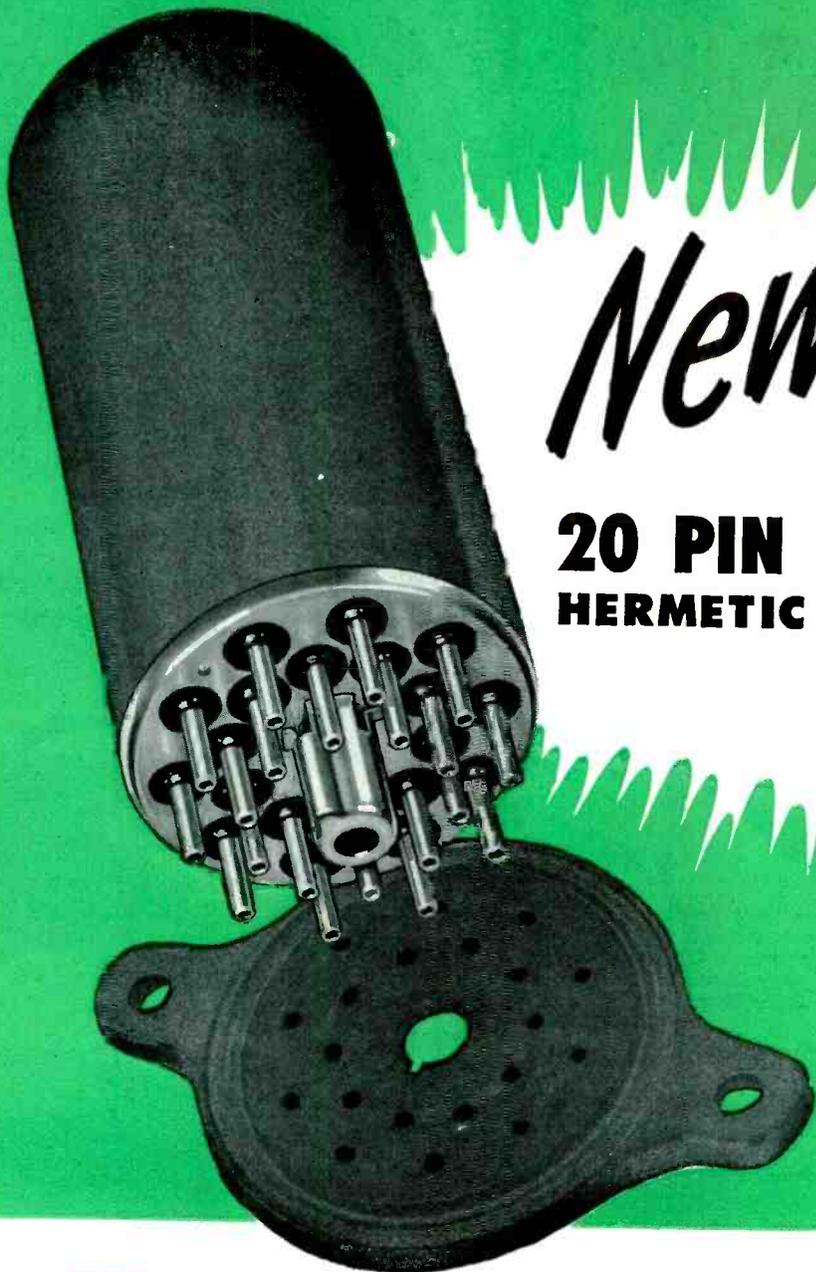
Nichrome and Nichrome V are manufactured only by

Driver-Harris Company
HARRISON, NEW JERSEY

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

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

*T.M. REG. U. S. PAT. OFF.



New!

20 PIN PLUG-IN HERMETIC TERMINAL

TERMINAL ILLUSTRATED
IS #232OHTO

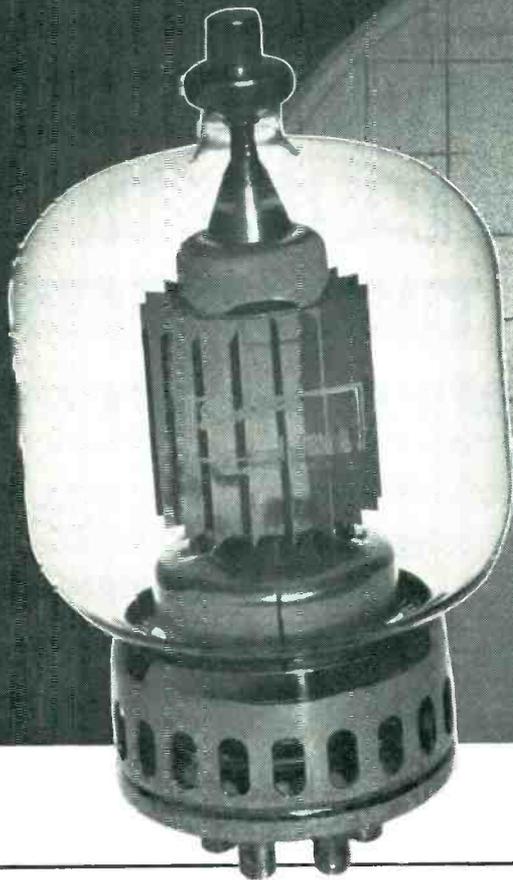


The advantages of the octal type key plug-in terminal are now extended to include applications calling for as high as 20 pins. Many additional types of relays and other electrical components may now employ this simple fool-proof combination of hermetic sealing and plug-in connection. Sockets are available. 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: Frazer & Hansen, 301 Clay St., San Francisco, California

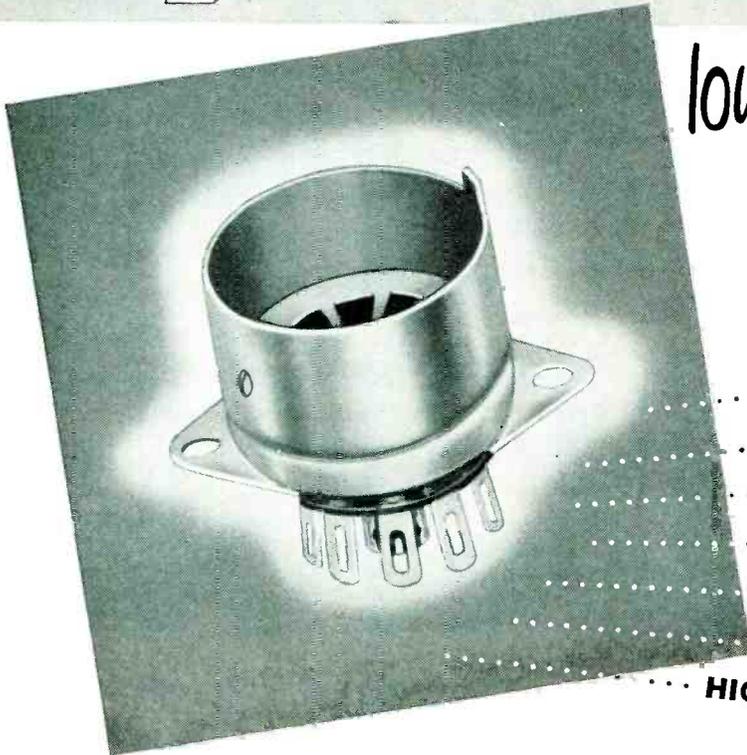
Follow the Leaders to

Eimac
TUBES

281

WRITE FOR BULLETIN NO. 3 "PULSE SERVICE NOTES"

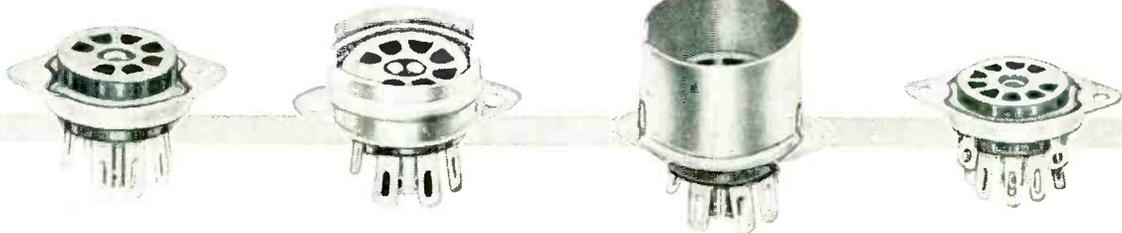
MYCALEX



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.



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

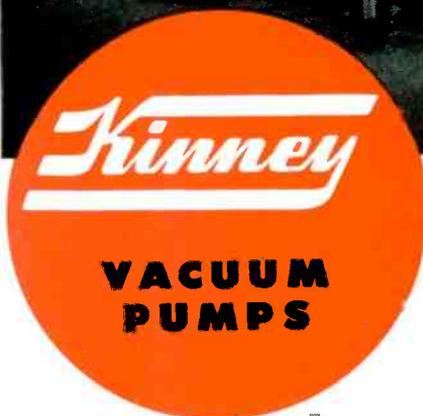
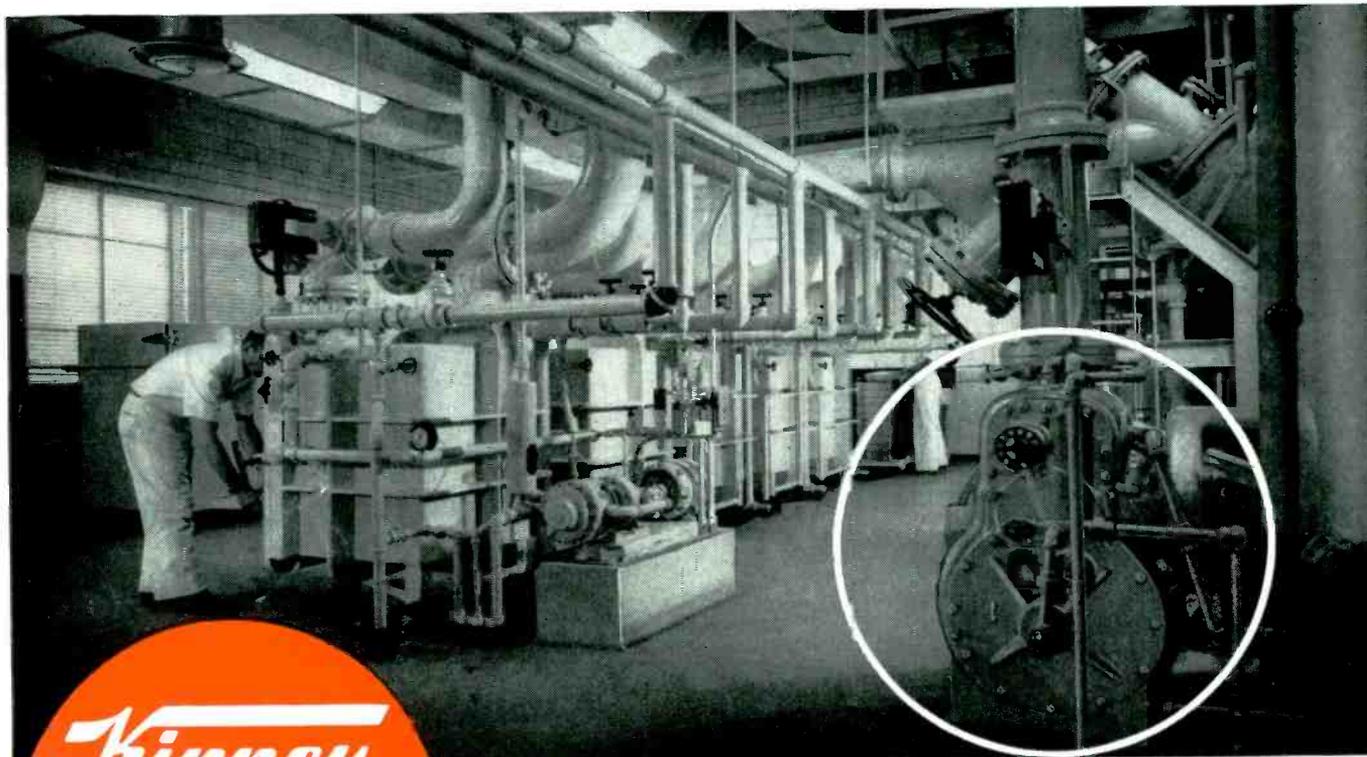


Here, at The Upjohn Company, Kalamazoo, Michigan, Kinney Vacuum Pumps produce low absolute pressures for freeze-drying penicillin. Here, as in countless other important process plants, vacuum . . . created by Kinney Pumps . . . is the "shot in the arm" that keeps production rolling dependably, smoothly,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



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 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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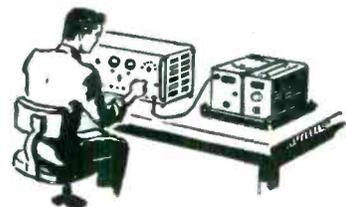
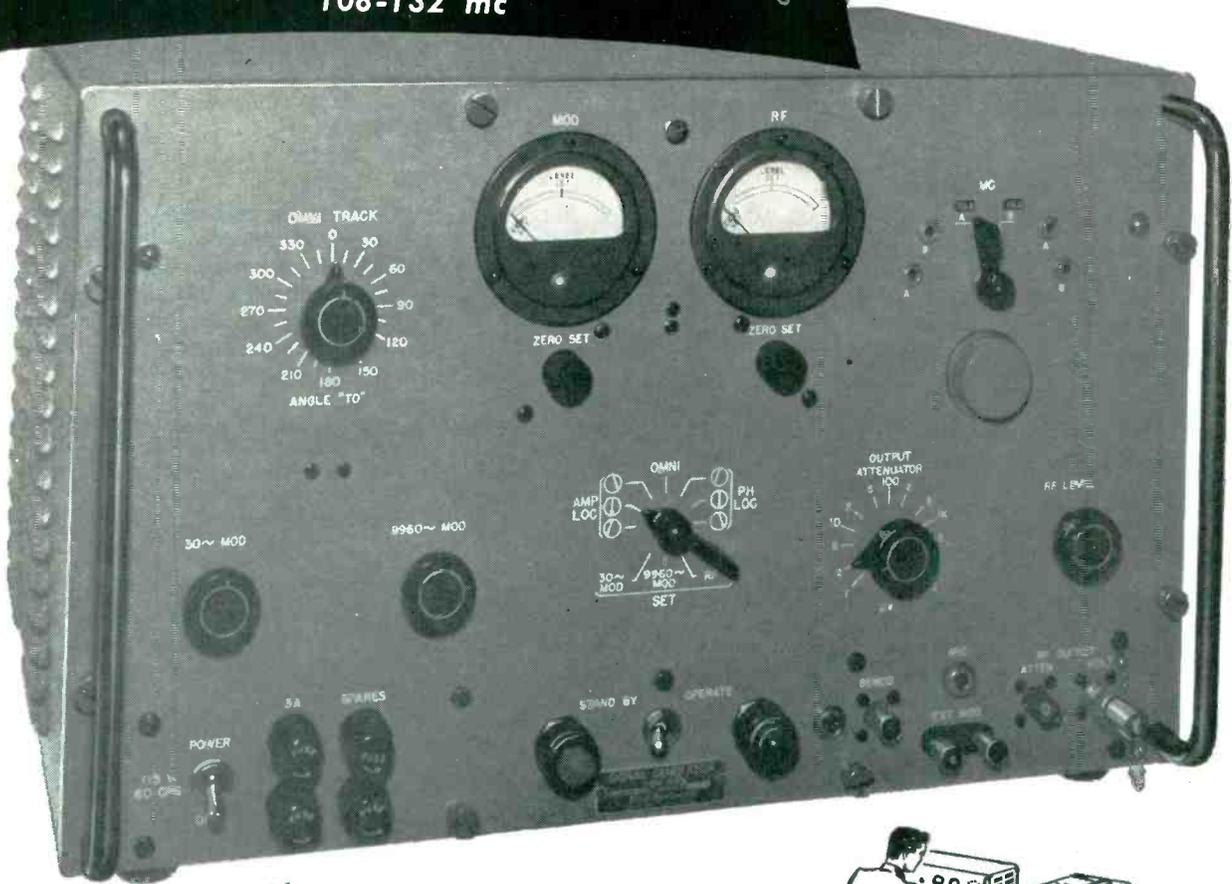


RADIO CORPORATION

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



● 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 . . .

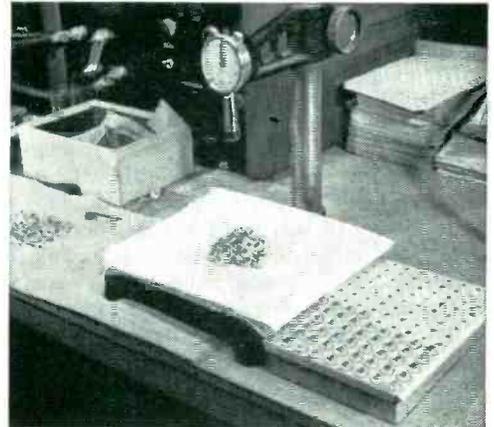
SEAMLESS . . . ? The finest tubes that can be made. Standard production is .010" to .121" O.D. inclusive, with wall thicknesses of .0015" to .005". Cathodes with larger diameters and heavier walls will be produced to customer specification.

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.

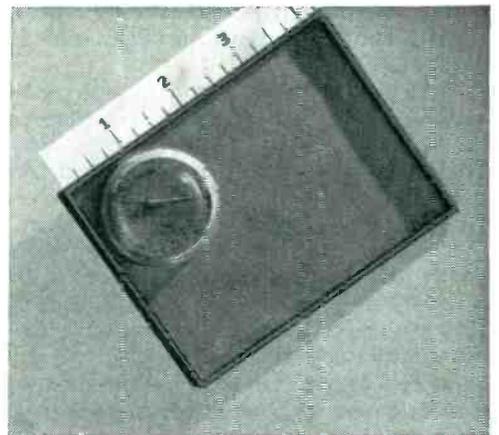
*Mfd. under U.S. Pats.—Superior Tube Company • Electronic Products for export through Driver-Harris Company, Harrison, New Jersey • Harrison 6-4800



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.

Superior
THE BEST IN SMALL TUBING

All analyses .010" to 3/4" O.D.
Certain analyses (.035" max. wall) Up to 1 1/4" O.D.



Potter & Brumfield

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 1 5/8" (above socket); max. dia., 3/4".

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

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.

SM—Actual Size



Open

"G"

"S"

Sealed SM's fit into standard miniature tube shield.

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

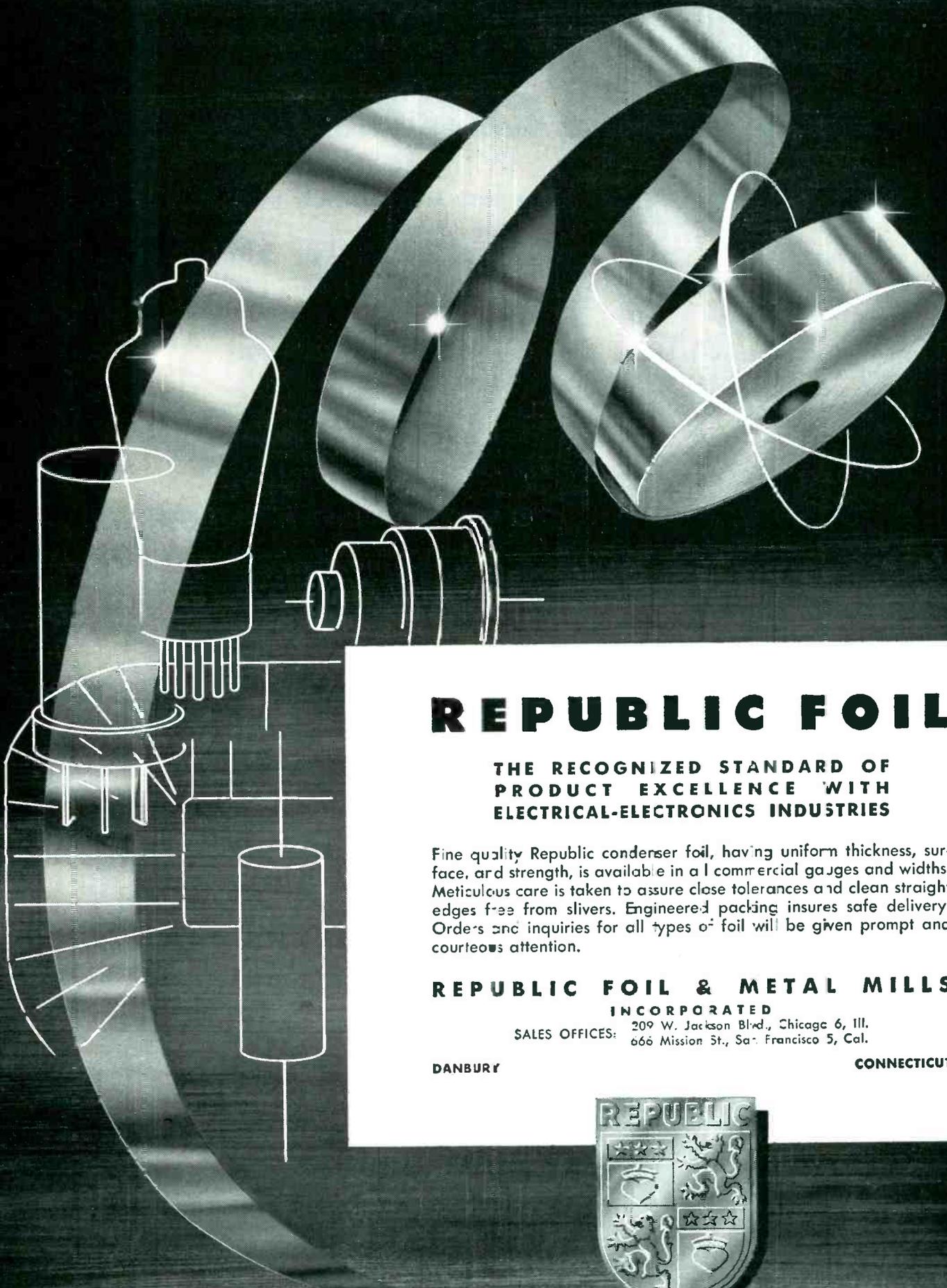
Coil to current carrying elements 1,000 V. RMS 60 Cy.; between contacts 500 V. RMS 60 Cy.

Your Electronic Parts Distributor Stocks Standard P & B Relays

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PRINCETON, INDIANA

EXPORT: 13 EAST 40TH ST., NEW YORK



REPUBLIC FOIL

THE RECOGNIZED STANDARD OF
PRODUCT EXCELLENCE WITH
ELECTRICAL-ELECTRONICS INDUSTRIES

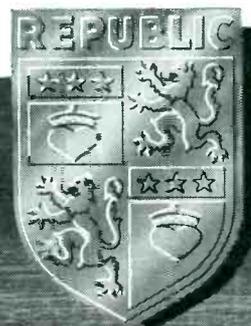
Fine quality Republic condenser foil, having uniform thickness, surface, and strength, is available in a commercial gauges and widths. Meticulous care is taken to assure close tolerances and clean straight edges free from slivers. Engineered packing insures safe delivery. Orders and inquiries for all types of foil will be given prompt and courteous attention.

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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



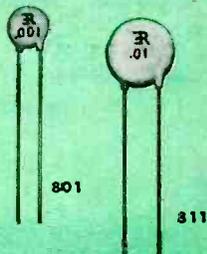
GP MOLDED INSULATED TUBULAR



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 1/2" 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.

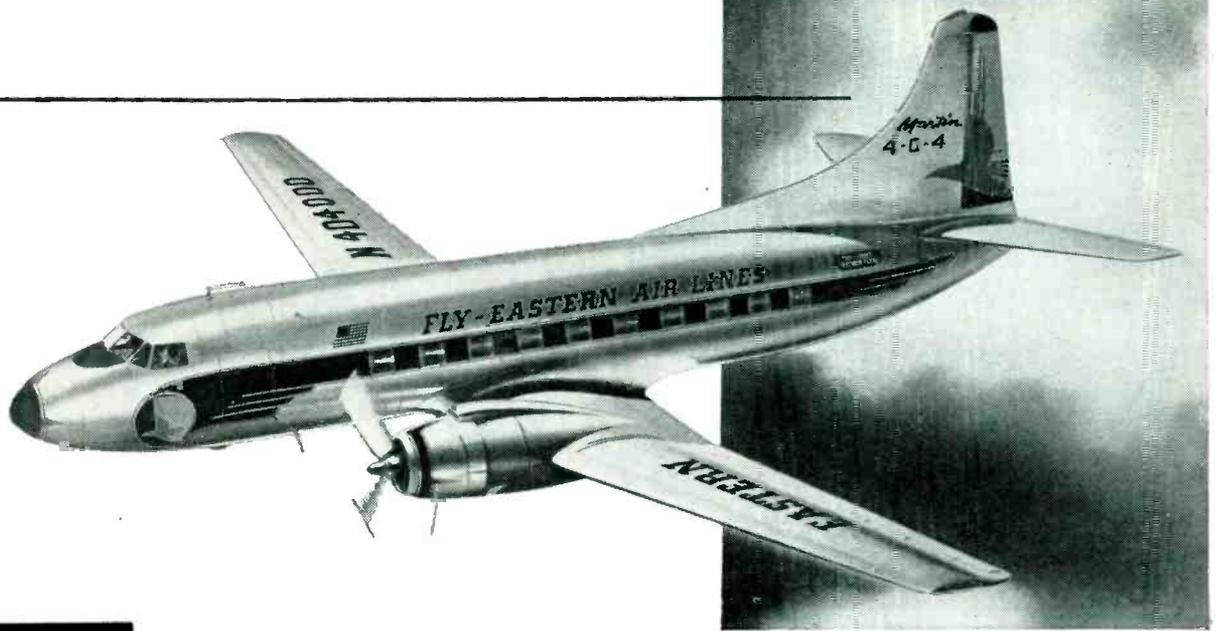
Capacity range 15 to 1,000 MMF in .447" diameter, 1,000 to 6,000 MMF in .651" diameter.



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-O-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.

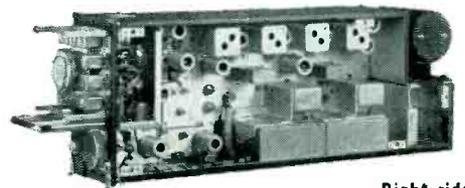
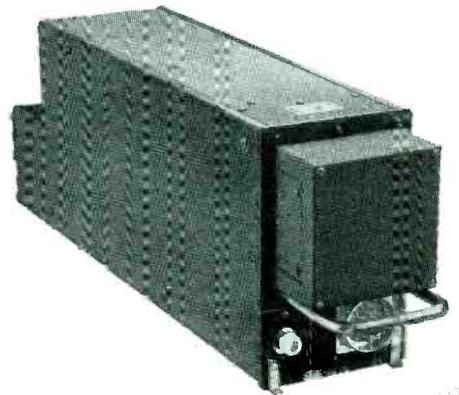
INSTANT ACCESSIBILITY FOR EASY MAINTENANCE

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

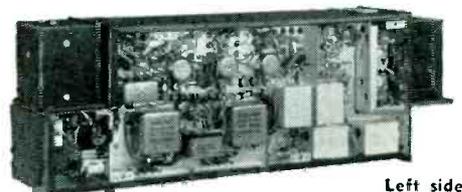
AVAILABLE FOR D.C. OR A.C. POWER

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



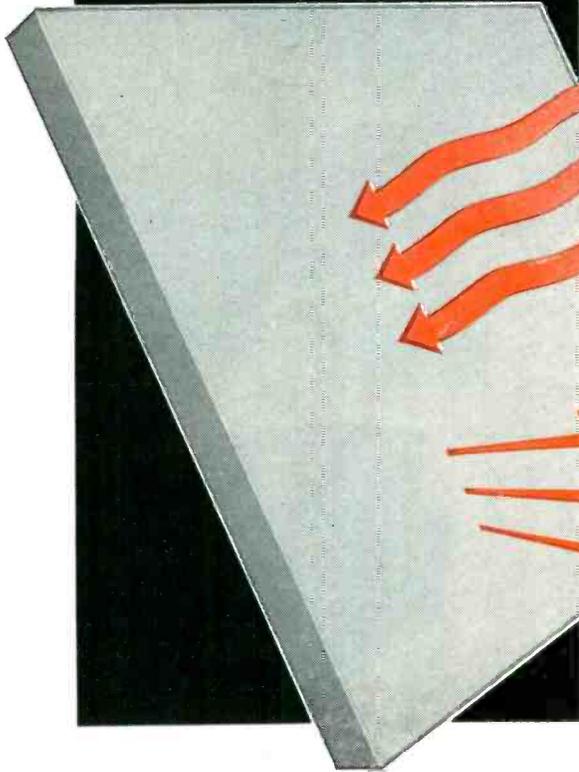
Left side

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, Vulcoide, 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

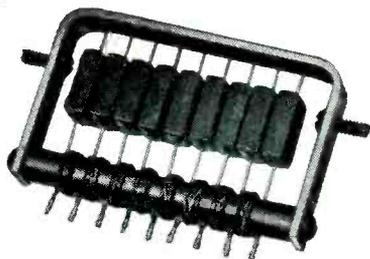
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WEST COAST REPRESENTATIVE: MARWOOD LTD., SAN FRANCISCO 3 • IN CANADA: DIAMOND STATE FIBRE CO. OF CANADA, LTD., TORONTO 8

Continental - Diamond FIBRE COMPANY

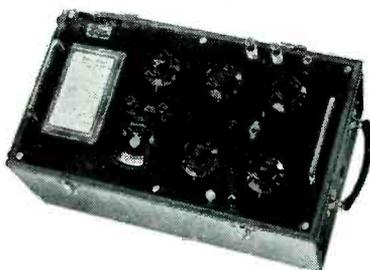
Established 1895. Manufacturers of Laminated Plastics since 1911—NEWARK 16 • DELAWARE

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.)

ELECTRONICS — April, 1951

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.



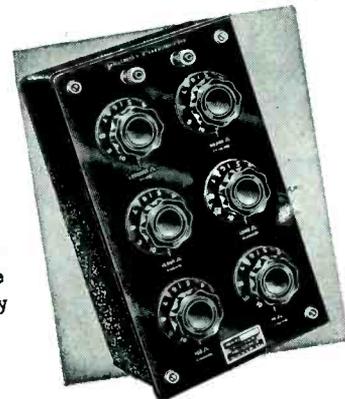
KELVIN plus WHEATSTONE RANGES IN ONE HANDY BRIDGE

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

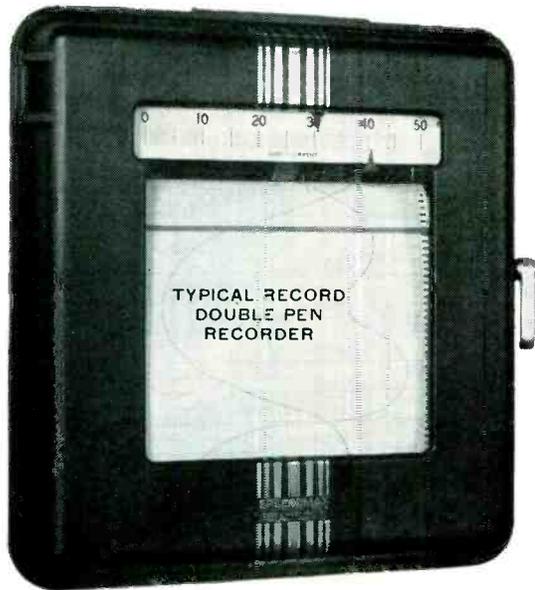
Over 40 Shallcross standard Resistance Boxes provide the widest assortment available today. Types range from 1 to 7 dials from 0.01 ohm to 111 megohms and are available in styles, sizes and prices for practically any laboratory or production testing need. Write for Bulletin.



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.

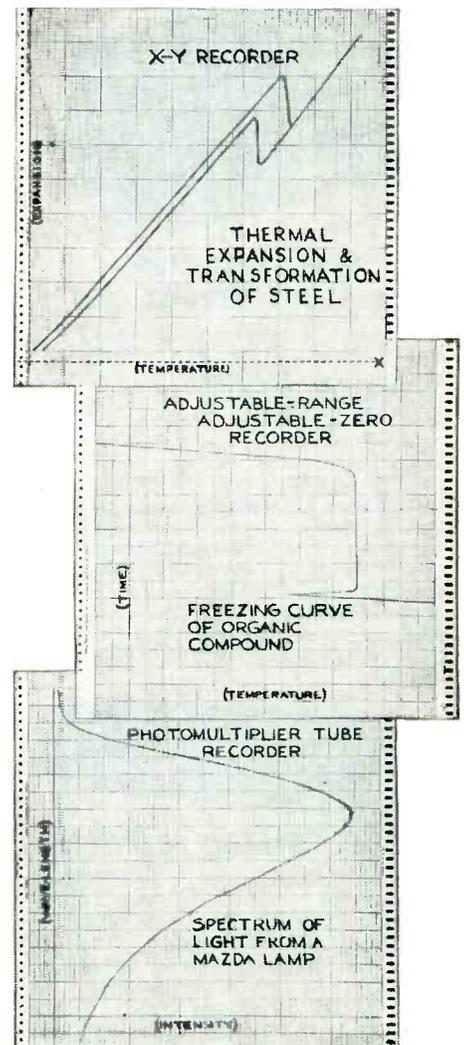
ADJUSTABLE RANGE and ADJUSTABLE ZERO

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.



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.

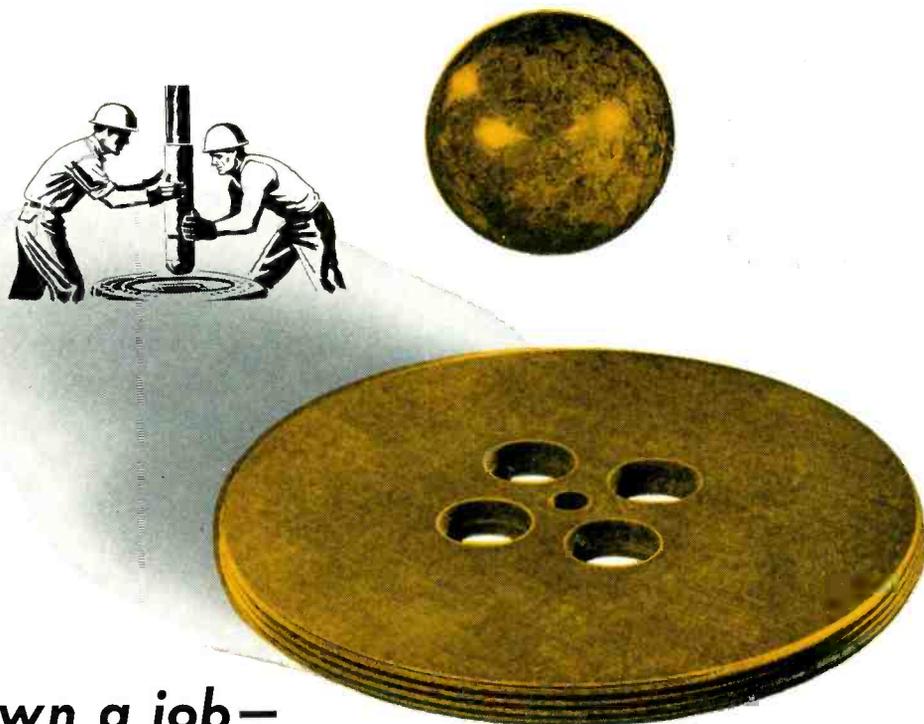
Our Director of Mobilization, Charles E. Wilson, has clearly in mind this problem of increasing our industrial efficiency. The first step in his job, as he conceives it, is to get out an adequate supply of weapons to equip the army, navy, and air forces already mobilized or in process of organization 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.

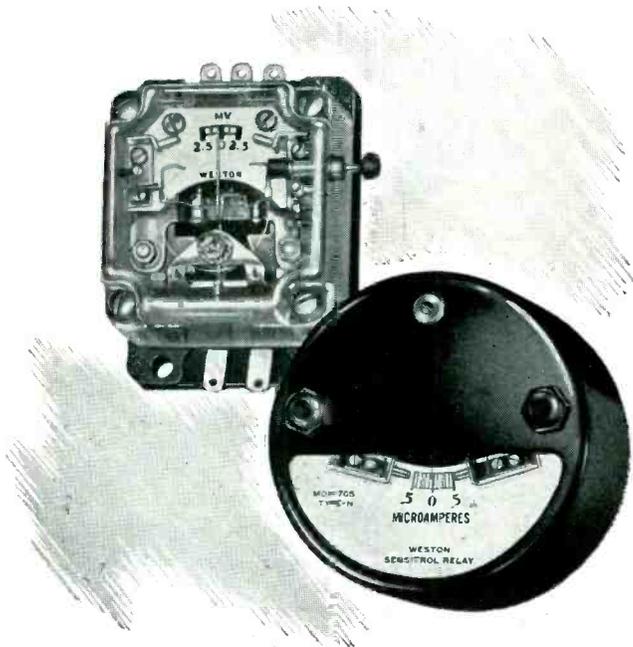
The Turbo Jet Float Shoe takes advantage of several Synthane properties. Other mechanical properties plus good electrical and chemical characteristics form an unusual *combination* which makes Synthane valuable for a wide range of applications. Synthane may be of help to you. To find out, send for the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

PLASTICS WHERE PLASTICS BELONG

SYNTHANE
S

Amplify the easy way....

with **WESTON SENSITROL[®] RELAYS**



- ◆ 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.

WESTON High Frequency Electronic Analyzer

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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Manufacturer of Weston and Tagliabue Instruments

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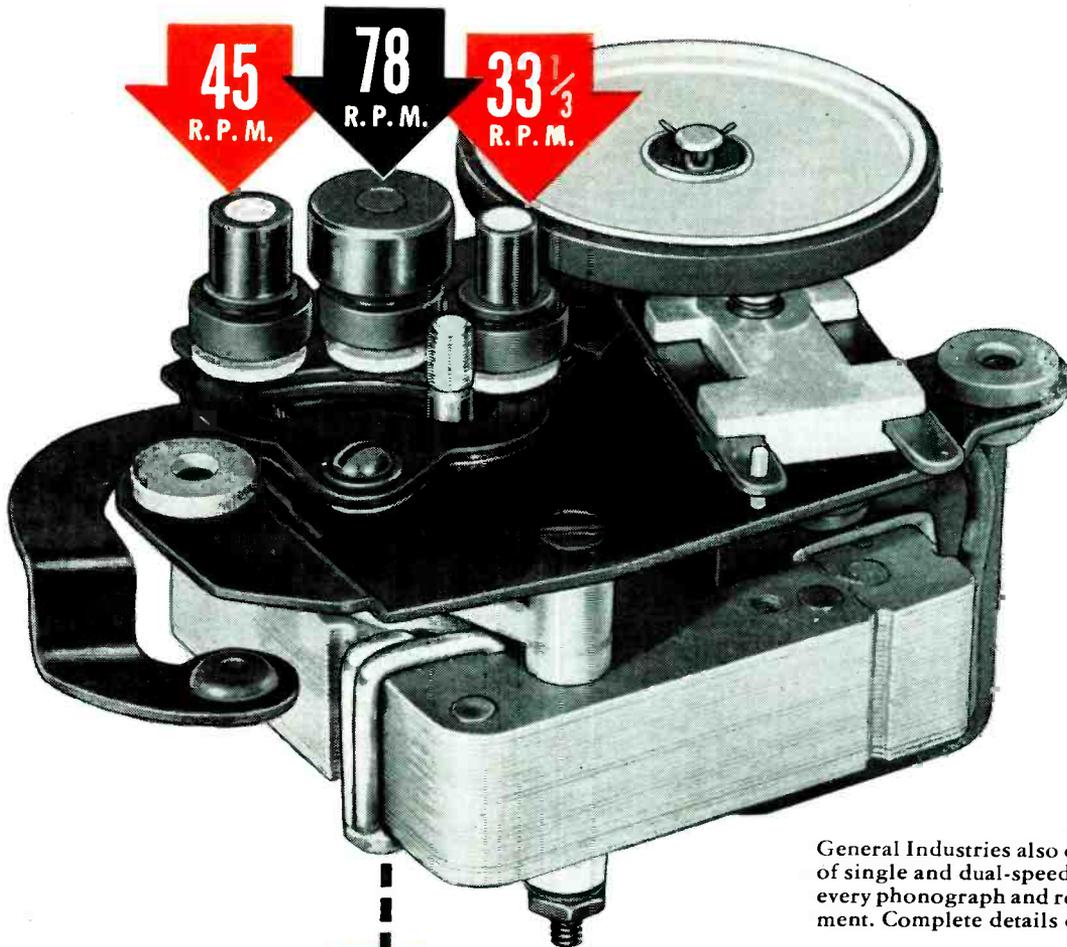
WESTON *Instruments*

HEART  OF A *good* RECORD-CHANGER

It's General Industries' turret-type, 3-speed motor, currently being supplied to record-changer manufacturers.

In this highly efficient design, turntable speeds of $33\frac{1}{3}$ —45 and 78 RPM are secured through three separate pulleys mounted on a turret plate. By means of a simple lever, the desired pulley is brought into contact with the idler wheel. The two pulleys not in contact with the idler wheel remain stationary.

In addition to this turret-type motor, General Industries also offers the popular Model TR turret-type, manual 3-speed motor, as well as the Model TS belt-drive 3-speed motor for both manual and record-changer applications. Write today for full information on all models.



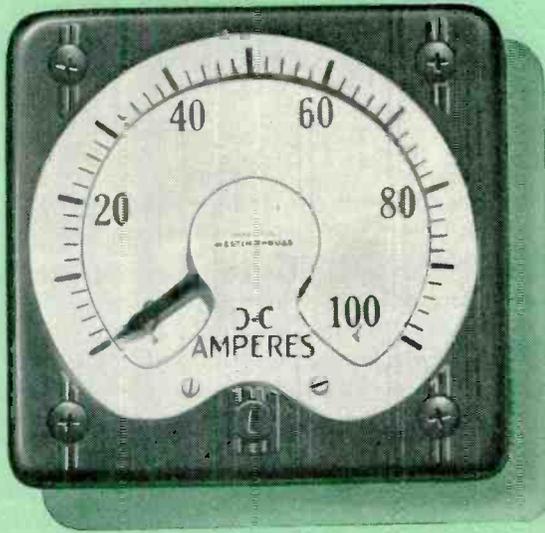
General Industries also offers a complete range of single and dual-speed phonomotors to meet every phonograph and record-changer requirement. Complete details on request.



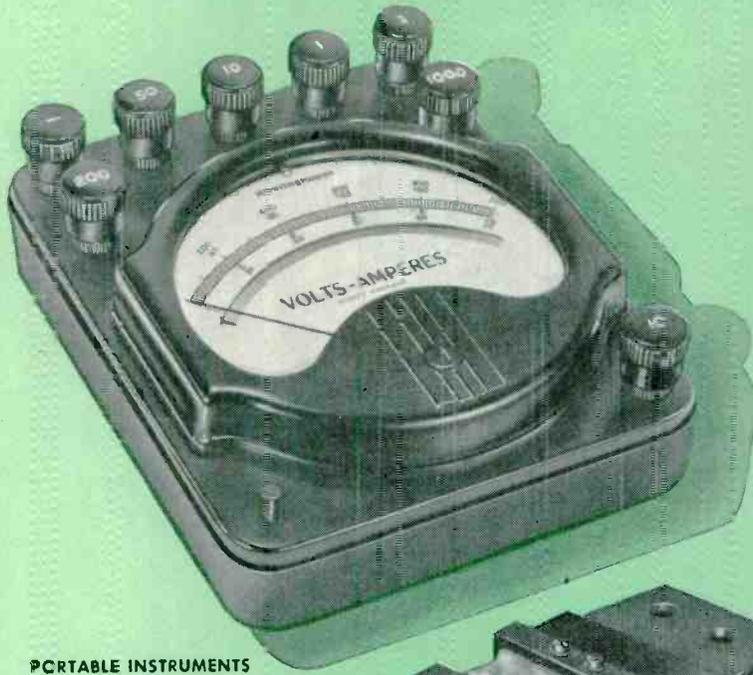
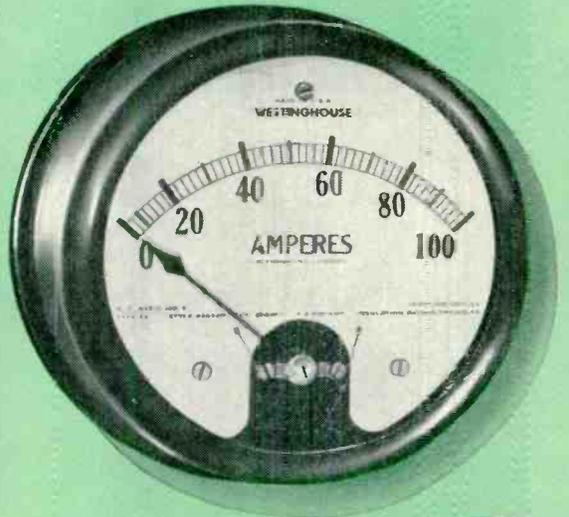
The GENERAL INDUSTRIES Co.

DEPARTMENT B • ELYRIA, OHIO

SWITCHBOARD INSTRUMENTS

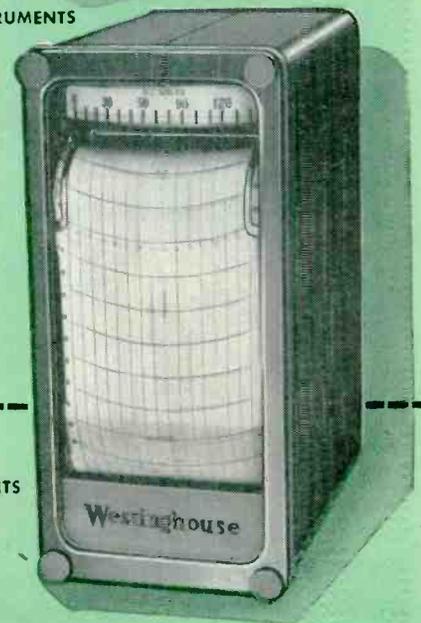
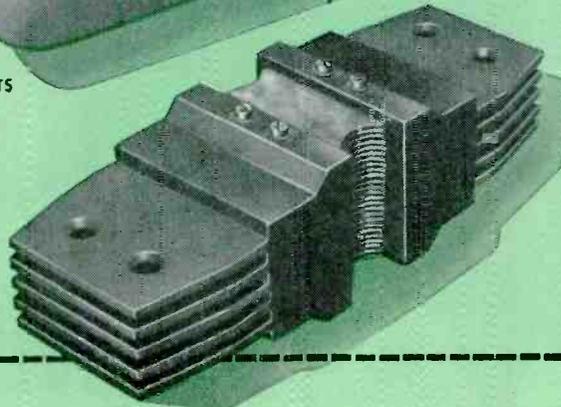


SOCKET INSTRUMENTS



PORTABLE INSTRUMENTS

PANEL INSTRUMENTS



INSTRUMENT AUXILIARIES

RECORDING INSTRUMENTS

The most complete line in the industry!

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, synchrosopes, temperature indicators, ground detectors or position indicators.

For laboratories, production lines, power plants, field service, or military operations—whether the requirement is for recording or indicating—for portable or permanent application—Westinghouse Instruments give you lasting accuracy.

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Every Westinghouse Instrument is built to meet the rigid performance requirements of the American Standards Association. No more exacting guarantee of an instrument can be made.

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Westinghouse Instrument Application Engineers are available to help you in selecting and applying the proper instruments for your application. Simply call your nearest Westinghouse office.

For complete information on Westinghouse Instruments write for Booklet B-4696. Address: Westinghouse Electric Corporation, P. O. Box No. 868, Pittsburgh 30, Pennsylvania.

J-40406

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

INSTRUMENTS



Defense needs are claiming a larger share



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

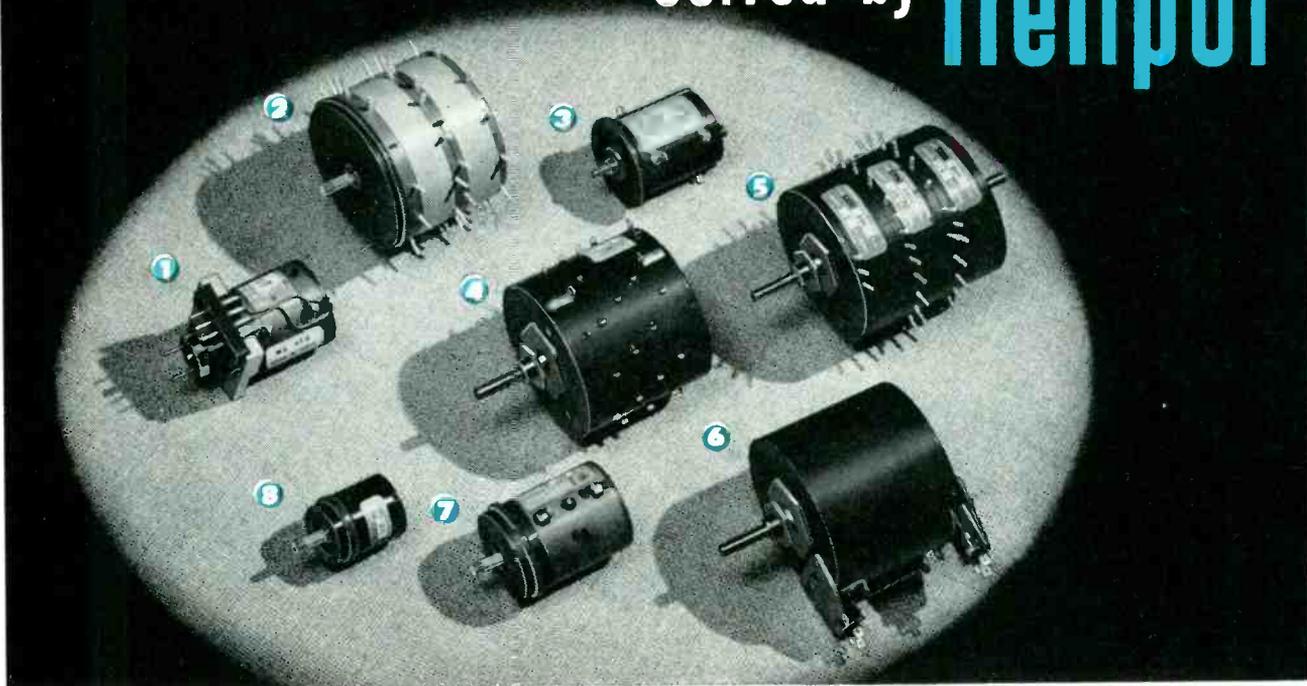
BY CARBORUNDUM

TRADE MARK



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

Typical of the TOUGH POTENTIOMETER JOBS solved by Helipot



Maximum Versatility + Space-saving Compactness

The potentiometers illustrated above are typical examples of the tough problems HELIPOT engineers are solving every day for modern electronic applications. If you have a problem calling for utmost precision in the design, construction and operation of potentiometer units—coupled with minimum space requirements and maximum adaptability to installation and operating limitations—bring your problems to HELIPOT. Here you will find advanced “know-how,” coupled with manufacturing facilities unequaled in the industry!

The HELIPOTS above—now in production for various military and industrial applications—include the following unique features . . .

① This 10-turn HELIPOT combines highest electrical accuracies with extremes in mechanical precision. It features zero electrical and mechanical backlash...a precision-supported shaft running on ball bearings at each end of the housing for low torque and long life . . . materials selected for greatest possible stability under aging and temperature extremes . . . special mounting and coupling for “plug-in” convenience . . . mechanical and electrical rotation held to a tolerance of $\frac{1}{2}^\circ$. . . resistance and linearity accuracies, $\pm 1\%$ and $\pm 0.025\%$, or better, respectively.

② This four-gang assembly of Model F single-turn potentiometers has a special machined aluminum front end for servo-type panel mounting, with shaft supported by precision ball bearings and having a splined and threaded front extension. Each of the four resistance elements contains 10 equi-spaced tap connections with terminals, and all parts are machined for greatest possible stability and accuracy.

③ This standard Model A, 10-turn HELIPOT has been modified to incorporate ball bearings on the shaft and a special flange (or

ring-type) mounting surface in place of the customary threaded bushing. This HELIPOT also contains additional taps and terminals at the $\frac{1}{4}$ - and $9\frac{3}{4}$ -turn positions.

④ This standard Model B, 15-turn HELIPOT has a total of 40 special tap connections which are located in accordance with a schedule of positions required by the user to permit external resistance padding which changes the normally-linear resistance vs. rotation curve to one having predetermined non-linear characteristics. All taps are permanently spot-welded and short out only one or two turns on the resistance element—a unique HELIPOT feature!

⑤ This six-gang assembly of standard Model F single-turn potentiometers has the customary threaded bushing mountings, and has shaft extensions at each end. The two center potentiometers each have 19 equi-spaced, spot-welded tap connections brought out to terminals. Each tap shorts only two turns of .009" diameter wire on the resistance element.

⑥ This Model B, 15-turn HELIPOT has been modified to incorporate, at the extreme

ends of mechanical and electrical rotation, switches which control circuits entirely separate from the HELIPOT coil or its slider contact.

⑦ This 10-turn HELIPOT has many design features similar to those described for unit No. 1, plus the following additional features . . . a servo-type front end mounting . . . splined and threaded shaft extension . . . and a center tap on the coil. All components are machined to the highest accuracy, with concentricities and alignments held in some places to a few *ten-thousandths* of an inch to conform to the precision of the mechanical systems in which this HELIPOT is used. Linearity accuracies frequently run as high as $\pm 0.010\%$!

⑧ This single-turn Model G Potentiometer has been modified to incorporate a ball bearing shaft and a servo-type front end mounting. Special attention is given to contact designs and pressures to insure that starting torque does not exceed 0.2 inch-ounces under all conditions of temperature.

The above precision potentiometers are only typical of the hundreds of specialized designs which have been developed and produced by HELIPOT to meet rigid customer specifications. For the utmost in accuracy, dependability and adaptability, bring your potentiometer problems to HELIPOT!

Representatives in all major areas of the United States. Export agents: Frathom Co., 55 W. 42nd St., New York 18.

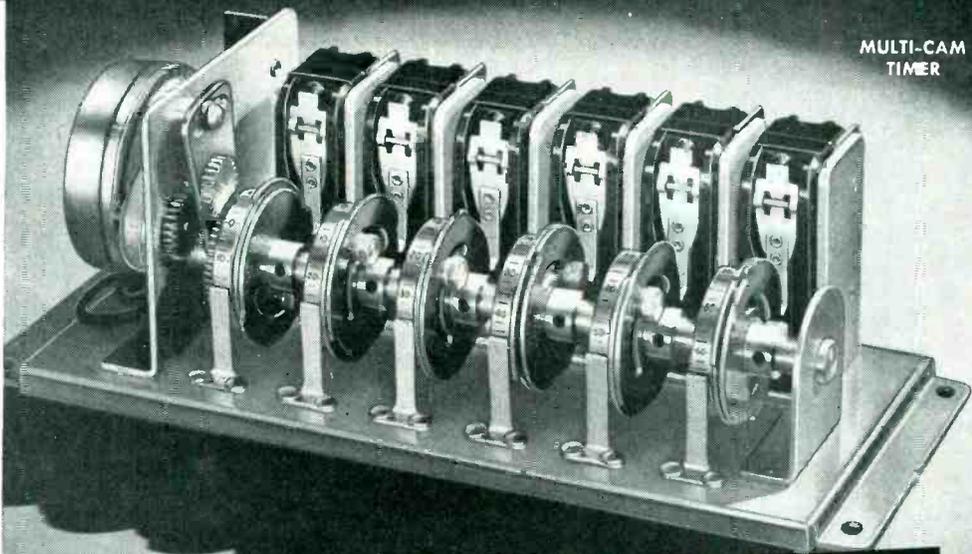
THE Helipot CORPORATION, SOUTH PASADENA 2, CALIFORNIA



SINGLE CAM TIMER



CAM ADJUSTMENT



MULTI-CAM TIMER

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



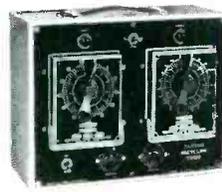
TIME DELAY TIMERS



INSTANTANEOUS RESET TIMERS



MANUAL SET TIMERS



TANDEM AUTOMATIC RECYCLING TIMERS



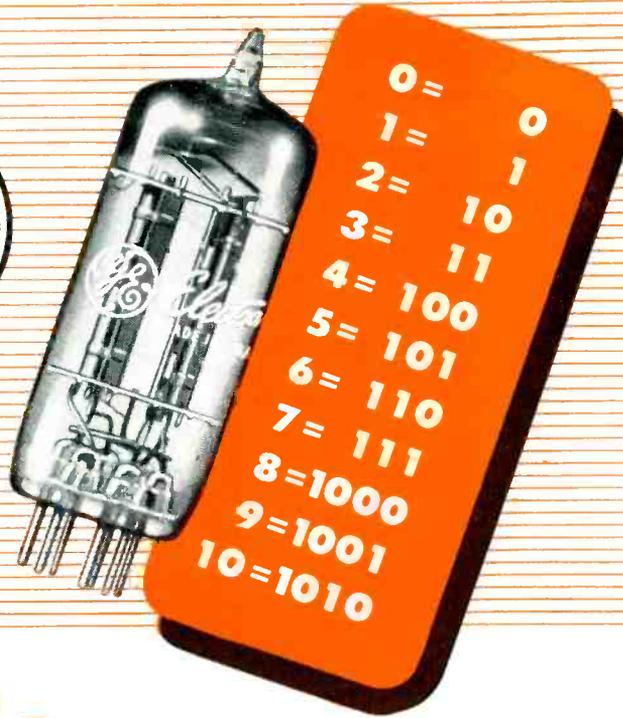
RUNNING TIME METERS

Timers that Control the Pulse Beat of Industry



INDUSTRIAL TIMER CORPORATION

115 EDISON PLACE, NEWARK 5, N. J.



GL-5844 Twin Triode

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

(Over-all tube length 2 1/8")

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 outcores 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 1/2 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

new!



PYRAMID TINY TYPE 85LPT TUBULAR PAPER CAPACITORS

Fit anywhere!

**Suitable for
85°C. operation!**

CAPACITANCE RANGE:
.0001 TO .5 MFD.

VOLTAGE RANGE:
200 TO 600 V., INCLUSIVE

Sturdily built in phenolic-impregnated tubes. Ends are plastic-sealed.

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Representatives and Distributors
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PYRAMID ELECTRIC COMPANY

1445 Hudson Boulevard
North Bergen, N. J., U. S. A.

TELEGRAMS: WUX North Bergen, N. J.
CABLE ADDRESS: Pyramidusa

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.

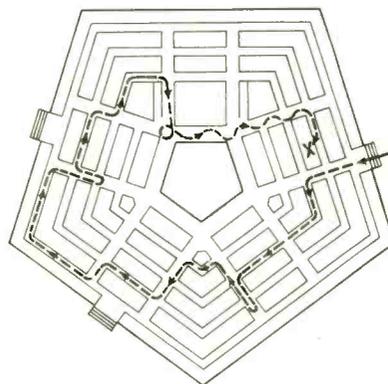
Washington officials have so far been preoccupied with three factors. . . Money, Materials and Machines. . . in the rearmament drive. We are just beginning to hear about engineering-manpower studies, and all of them will take time to complete. Meanwhile, there is danger that failure to arrange government 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 con-

tracts 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.

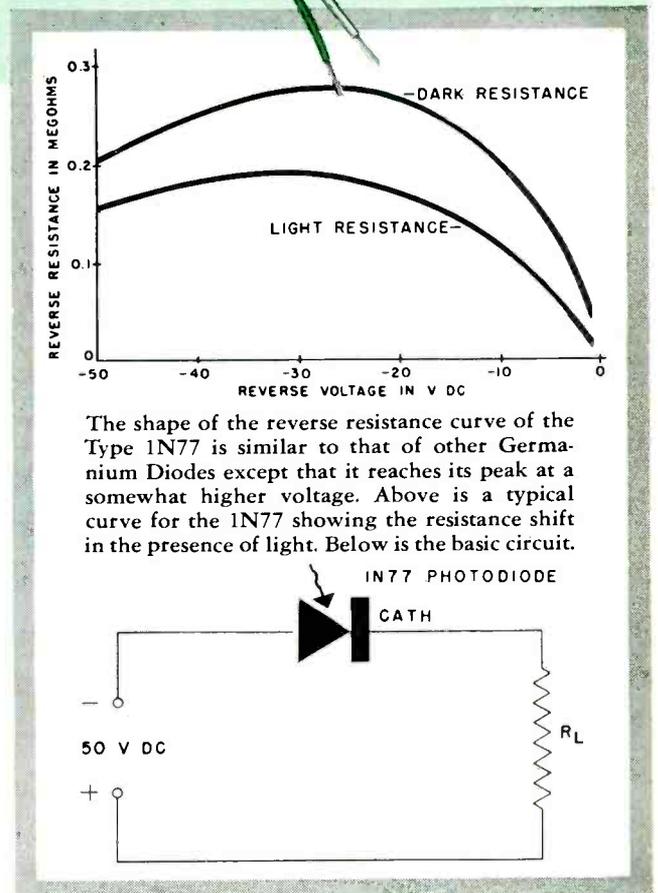
Another Sylvania first is this new Type 1N77 Germanium Photodiode.

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.



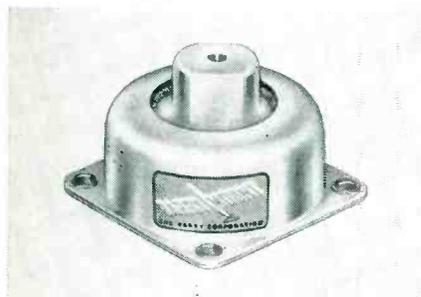
SYLVANIA ELECTRIC

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

SHOCK and VIBRATION NEWS

BARRYMOUNTS FOR ASSURED CONTROL OF SHOCK AND VIBRATION

NEW ALL-METL BARRYMOUNTS for Unusual Airborne Applications



These new Barrymounts provide the aircraft and electronic engineer with a vibration isolator designed to meet the unusual temperature and environmental conditions encountered in high-altitude, high-speed flight. Employing no organic materials, these mountings are not subject to temperature influences that may affect the performance of other mountings.

ALL-METL Barrymounts offer a wide load range with uniform performance. They have a natural frequency of about 7½ cycles per second, with low horizontal stiffness for maximum isolation of horizontal vibration. Transmissibility at resonance is only 4½. There is no snubber contact nor resonance carry-over when ALL-METL Barrymounts are vibrated at government-specified amplitudes.

These mountings are designed especially for unusual military conditions. They meet the vibration requirement of JAN-C-172A, MIL-E-5272 (USAF), and MIL-T-5422 (BuAer). For details of sizes, ranges, and construction of unit mounts and bases using ALL-METL Barrymounts, see catalog 509.

FREE CATALOGS

- 502 - Air-damped Barrymounts for aircraft service; also mounting bases and instrument mountings.
- 509 - ALL-METL Barrymounts and mounting bases for unusual airborne applications.
- 504 - Shock mounts and vibration isolators for marine, mobile, and industrial uses.
- 607 - How to cut maintenance costs by using Barrymounts with punch presses.

STANDARD MOUNTINGS ISOLATE VIBRATION Available for Aircraft, Marine, Mobile, Instrument, and Industrial uses.

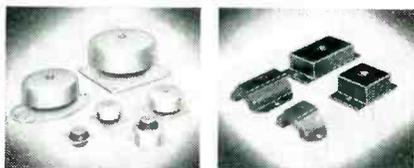


Standard bases built to meet government specifications can be furnished by Barry; special bases can be supplied in sizes and load ratings to fit customers' exact requirements, including miniaturized bases. See catalog 502 and data sheets 605 and 606.



Aircraft vibration isolators designed to meet Army, Navy, and CAA requirements are available in ¼-pound to 45-pound unit ratings; also miniature mounts to 0.1 lb. See catalogs 502 and 509 and bulletins 605-6.

Instrument mountings are furnished for electronic components, tiny, fractional-HP motors, record changers, dictating machines, and other light-weight apparatus. See catalogs 502 and 504.



Shock mountings for mobile, railroad, and shipboard service also give vibration isolation at frequencies above 2000 c.p.m.; useful for general sound isolation. See catalog 504.

Industrial mountings isolate vibration from fans, motor-generator sets, transformers, punch presses, and other heavy industrial equipment. Bulletin 607 tells how to cut maintenance costs with Barrymounts.

BUSINESS BRIEFS

(continued)

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	833,300	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.

THE **BARRY** CORP.

707 PLEASANT ST., WATERTOWN 72, MASSACHUSETTS

SALES REPRESENTATIVES IN

New York Rochester Philadelphia Washington Cleveland Dayton Detroit
Chicago Minneapolis St. Louis Seattle Los Angeles Dallas Toronto

Following Up our recent item (p 60, Feb.) on the use of radio-telephone 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

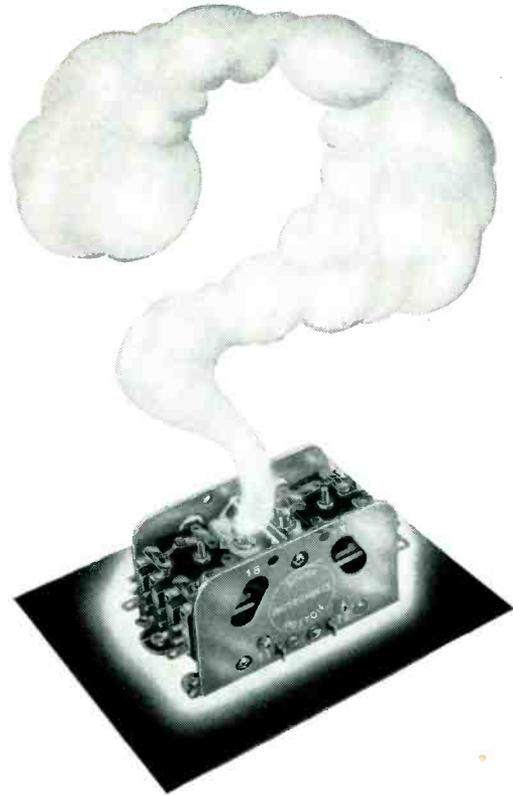
Arizona, shared with Police
 Arkansas, shared with Police
 California, shared with Police
 Delaware, leased Tel. Co.
 Idaho, leased Tel. Co.
 Kansas, shared with Police
 Mississippi, shared with Police
 Montana, shared with Police
 Oregon, shared with Police
 Pennsylvania, shared with Police
 South Carolina, 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.



LINK OR KINK

If it is true that a sensitive relay is an ordinary design in which common principles and dimensions have been "squeezed" in order to gain performance, it logically follows that even as features of merit are accentuated, so also will be an occasional weakness.

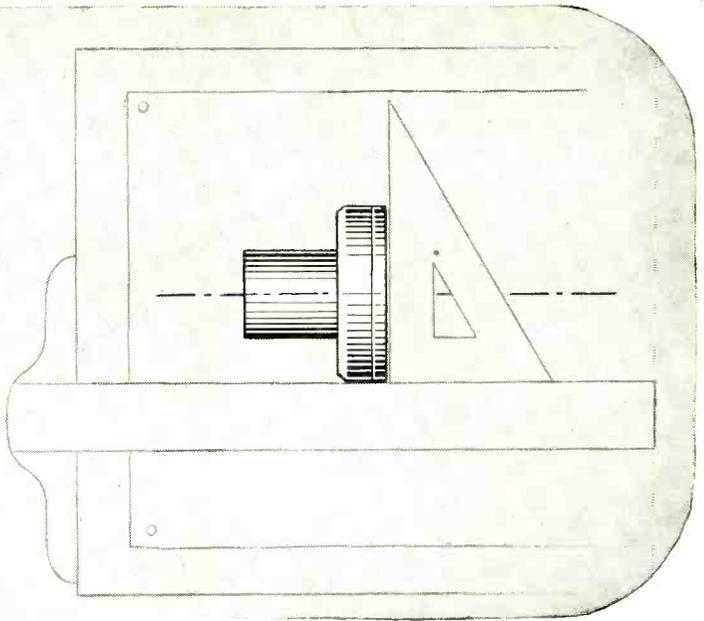
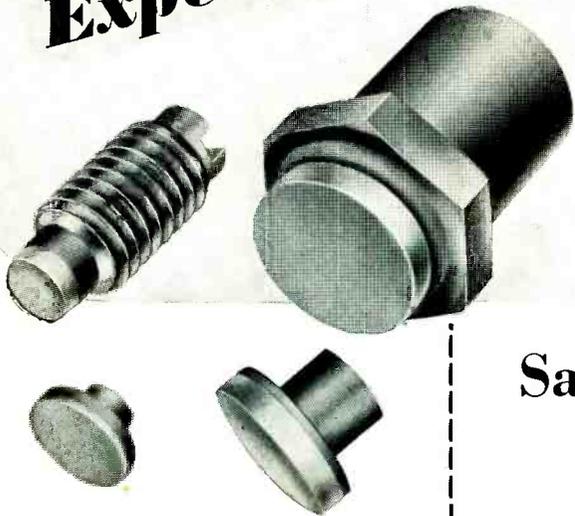
An engineering group charged with the task of making sensitive relays successfully perform a variety of jobs (us) can obviously assist other groups having specific relay-using jobs to finish (you) as much by highlighting weakness as by tub-thumping strong points. For one thing, we are very well aware both of the weaknesses and of the best defenses against them. For another, we have the greatest possible interest in seeing you the user avoid trouble. Naturally, the more fully you describe your intended use of our product, the better we can help you get the benefit of its advantages.

It does not occur to us as either wise or useful to "catalog" weaknesses where they have restricted importance, or are complicated to understand, or are not fully evaluated. By the same token, we are perhaps only human if we call attention only to those apparently having a bearing on the problem at hand. But if you tell us what you are trying to accomplish, we can tell you of more pitfalls and how to dodge them in a five-minute telephone conversation than you are apt to find out in a month of study on any single application.

SIGMA

SIGMA INSTRUMENTS, INC., 62 CEYLON STREET, BOSTON, MASS.

**Value
Beyond
Expectation!**



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

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.

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 Mutchey and Mallory, Ltd., 110 Industry St., Toronto 15, Ontario

Electrical Contacts and Contact Assemblies

P. R. MALLORY & CO. Inc.
MALLORY

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

SERVING INDUSTRY WITH

Electromechanical Products
Resistors Switches
TV Tuners Vibrators

Electrochemical Products
Capacitors Rectifiers
Mercury Dry Batteries

Metallurgical Products
Contacts Special Metals
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?

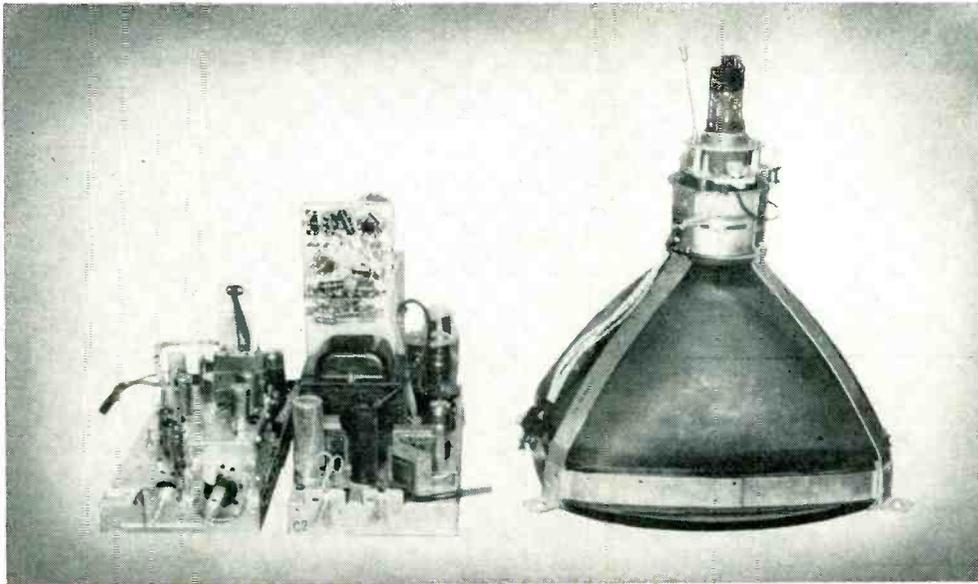
Direct contact with the Services is apt to produce immediate prime contracts only if a manufacturer can give very tangible evidence that he has the right kind of engineering and the right kind of production facilities to handle highly specialized military orders quickly. Neither a hat-in-hand nor a table-thumping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

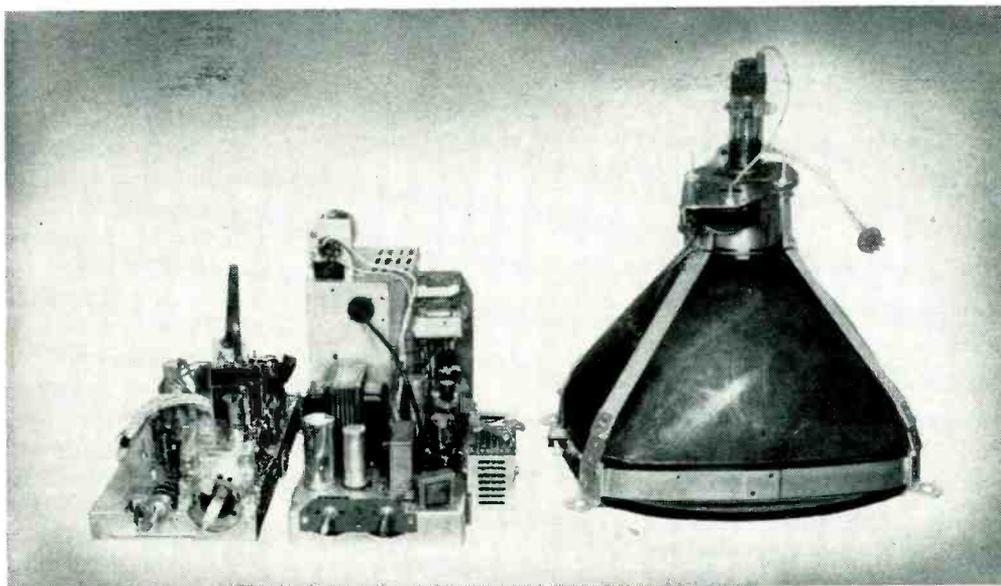
LOOKING AHEAD With RCA

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	Material	Pounds Saved
ALNICO-5* in Beam Bender	4,400	COPPER in Hookup Wire	47,000
in Focus Magnet	None	in Capacitor Leads	11,850
	(310,000)	in Power Transformer Shorting Band	190,000
in 8-inch Loudspeaker	72,000	in Tubes	33,000
in 12-inch Loudspeaker	135,000	NICKEL in Ferrite Cores	12,400
ALUMINUM in Picture-Tube Protective Cup	62,000	in Tubes	33,600
in Shield	100,000	STEEL in Focus Magnet	500,000
BRASS in Focus Magnet	None	STEEL in 12-inch Loudspeaker	142,000
	(22,000)	TIN in Solder	50
in 12-inch Loudspeaker	50,000	ZINC in Focus Magnet	None
in Volume Control	12,200		(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 1½-inch tubing with 0.083-inch wall and weighing 4.75 pounds were replaced by 10-foot aluminum masts using 1½-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 1½-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

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

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.

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.

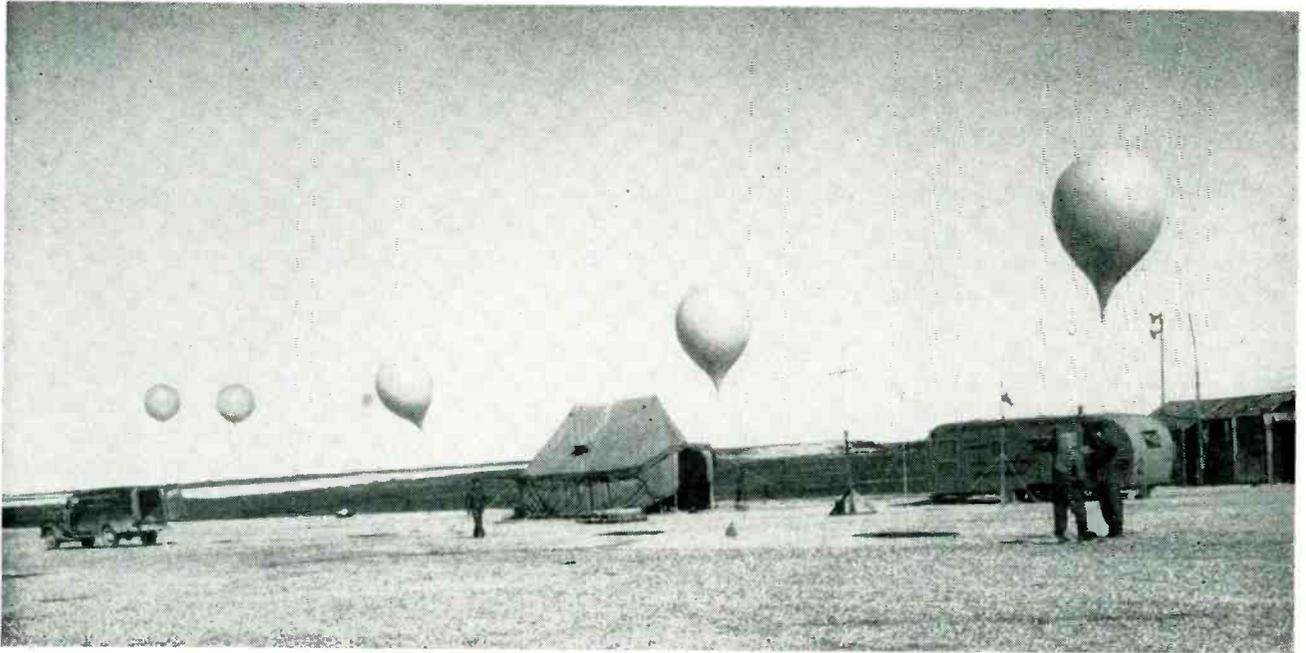
Nickel-plated Armco iron, a steel containing less than 0.05-percent carbon, is being extensively used as a substitute for pure nickel wire. In some instances 18-8 stainless-steel wire is being substituted for 18-12 stainless-steel wire. Possible substitution of 18-8 stainless-steel wire for nickel wire 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

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 investigations¹ 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.

¹Joint program with the ONR and the AEC. Field expeditions sponsored by the National Geographic Society.

By **MARTIN A. POMERANTZ**

*Bartol Research Foundation
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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

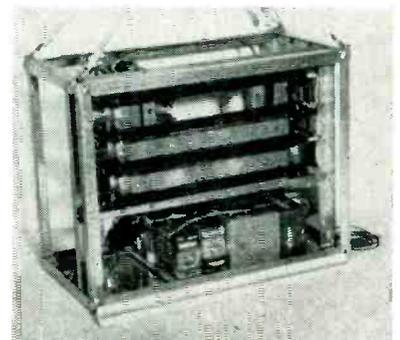


FIG. 1—The balloon-borne instrument without its Pliofilm cover

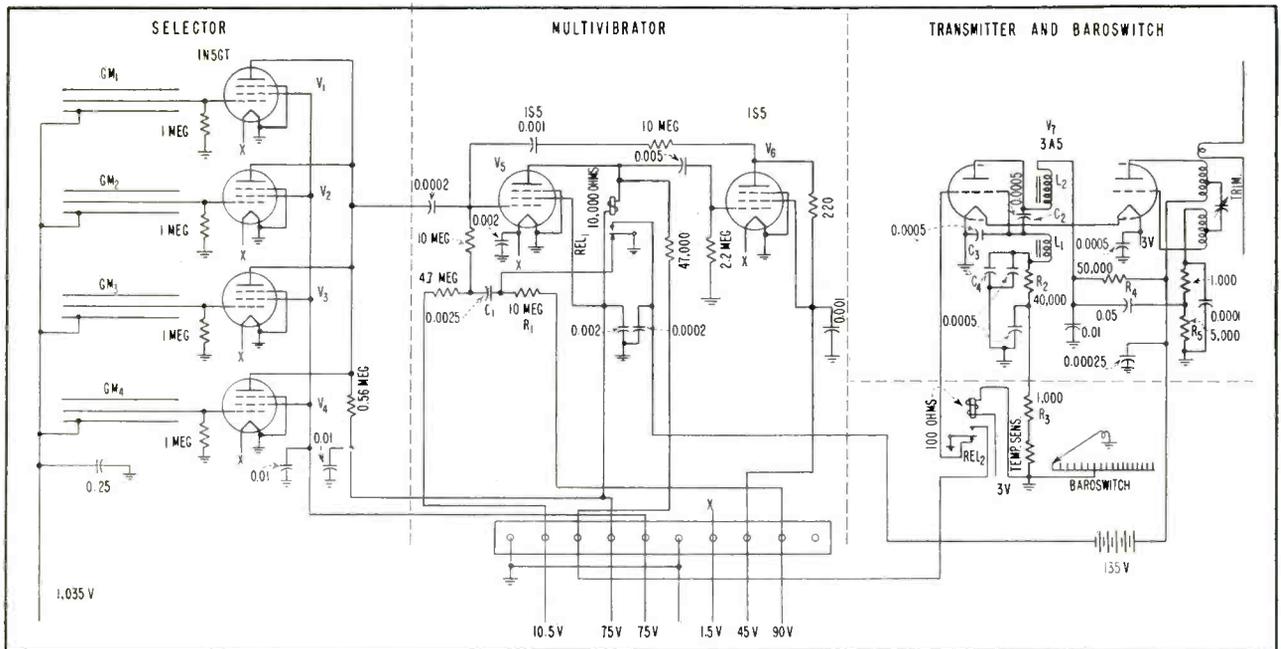


FIG. 2—The complete balloon-borne unit, with dashed lines indicating sub-assemblies

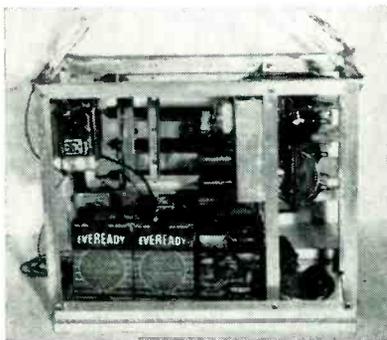
and Telemetering System

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 con-



Another view of the instrument pictured at the left

nections 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.

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 $+50^{\circ}\text{C}$. 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_6 . 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_6 , 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_6 , 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_6 , 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

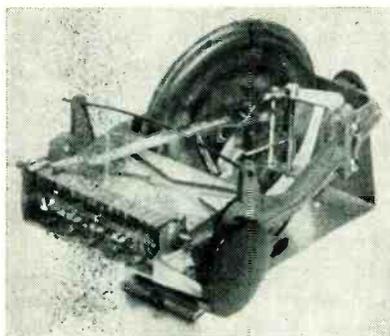


FIG. 3—The baroswitch. It signals height of ascent

affords a considerable economy in battery drain.

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

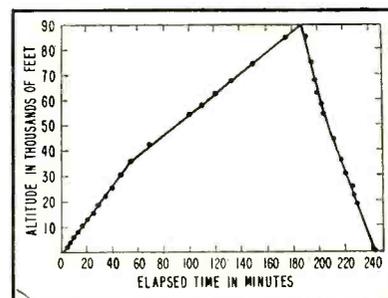


FIG. 4—Time-altitude record of a typical flight

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 oscillo-

graph 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 funda-

mental 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-

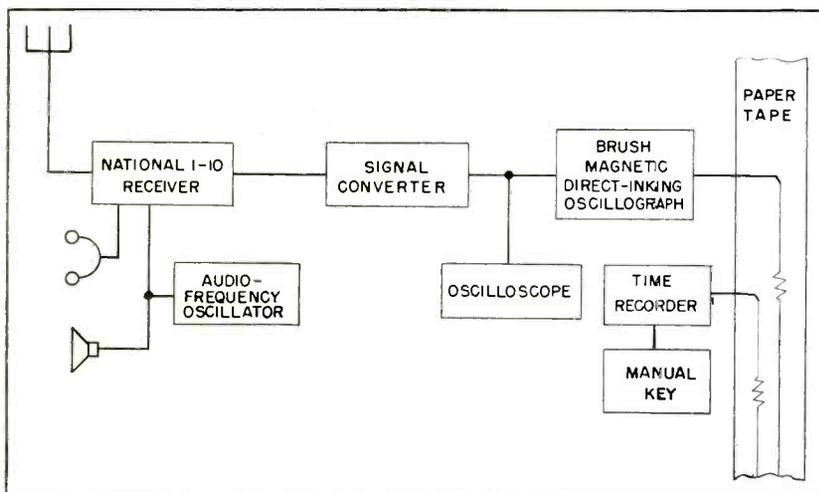


FIG. 5—Receiving and recording setup used on the ground

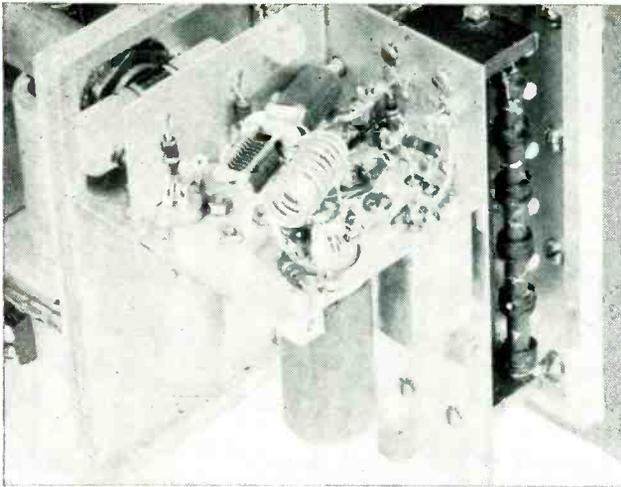
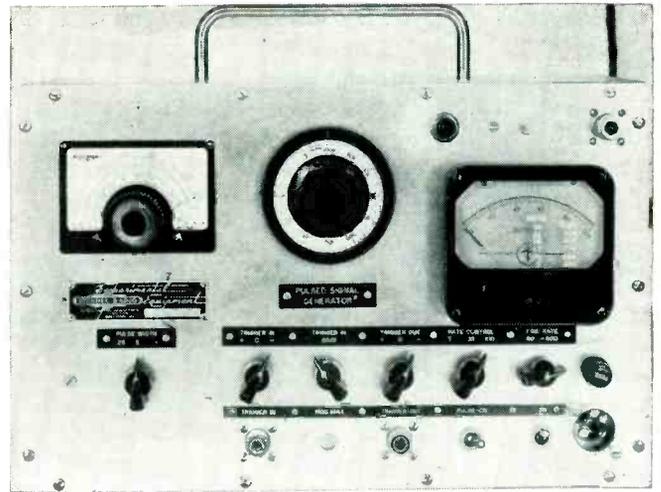


FIG. 1—The r-f section with the shield removed



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

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 μ v 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- μ sec 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

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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 feed-through 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 output 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- μ a 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 out-

put 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 micro-volt 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

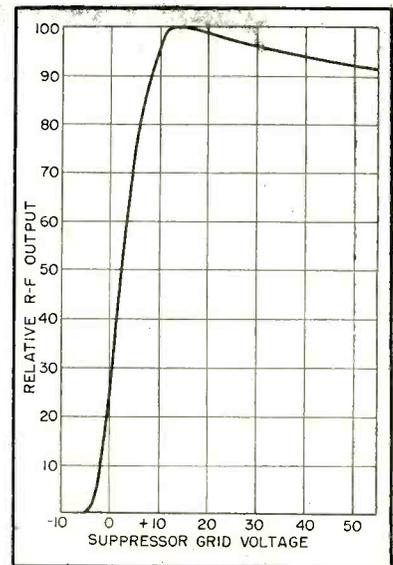


FIG. 3—Characteristic curve of 6AS6 class-C r-f amplifier with constant control-grid excitation

found from the formula $E = \sqrt{PR}$.

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

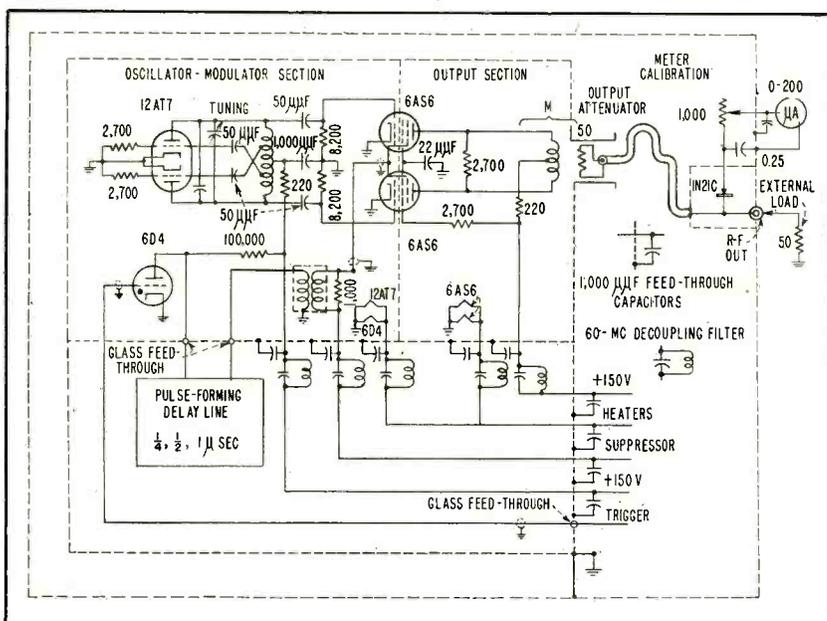


FIG. 2—Schematic diagram of the r-f section of the radar test generator

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 , $\frac{1}{2}$ and $\frac{1}{4}$ μ sec 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 3μ sec 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.

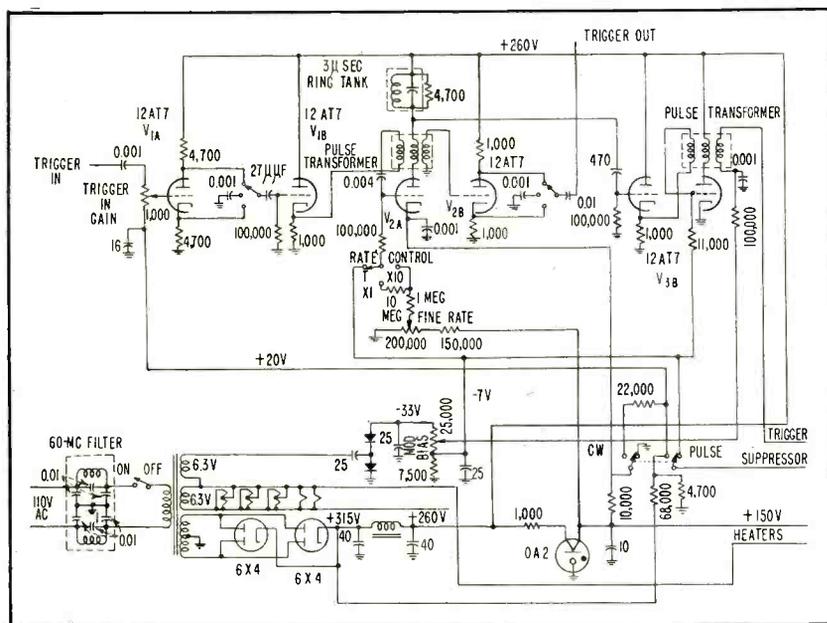
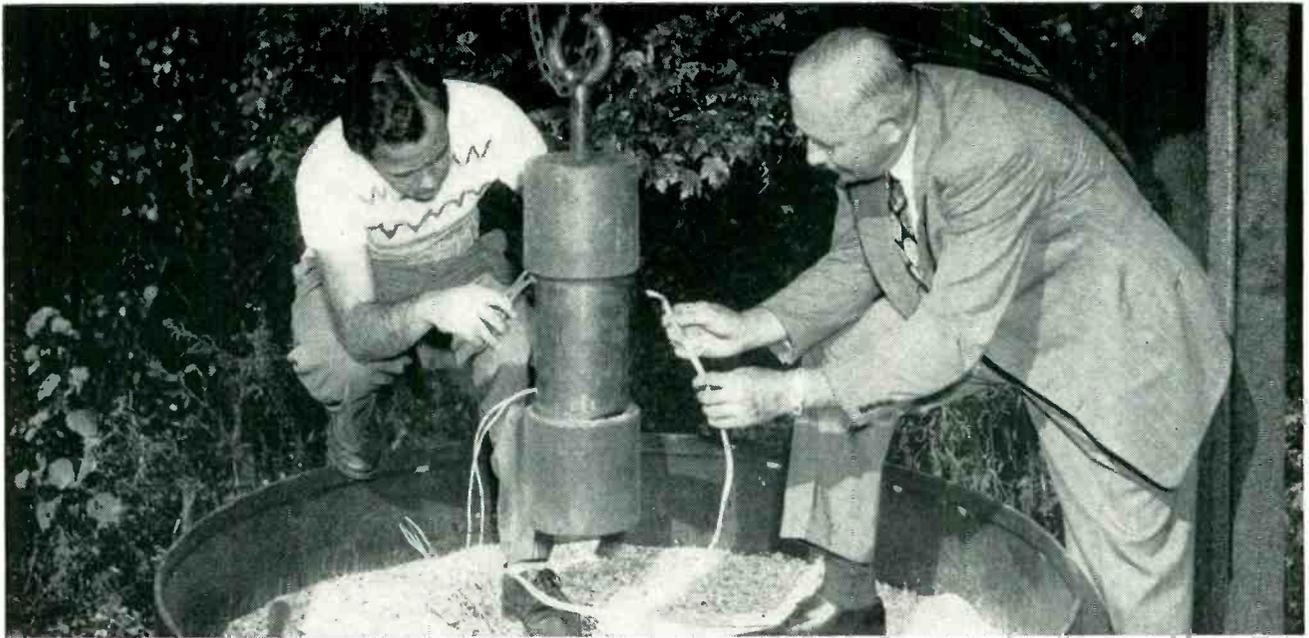


FIG. 4—Schematic diagram of the power supply and trigger chassis for the generator



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

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

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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 Italy², 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 Nacken³ on growing quartz crystals. This geologist, at the University of Frankfurt, 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 Laboratories⁴ and others have made

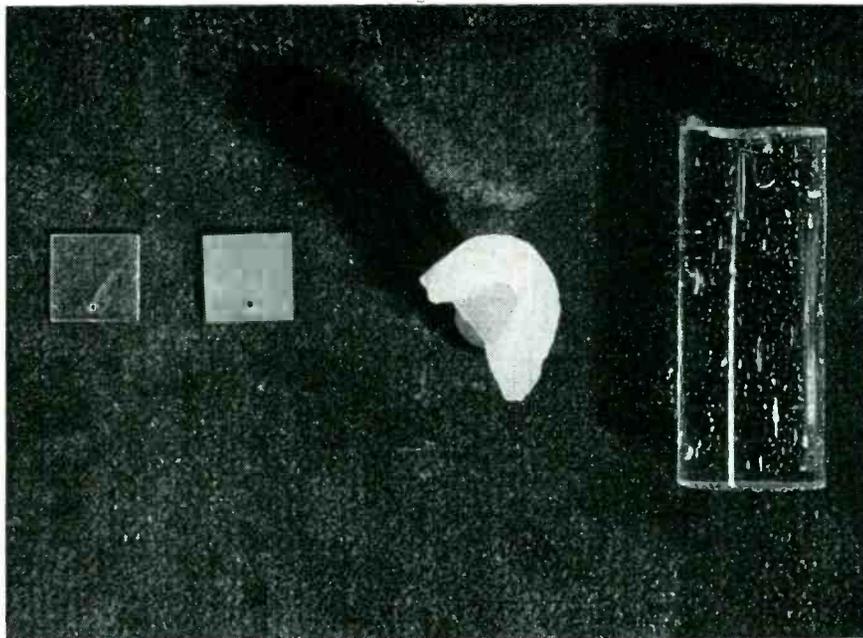


FIG. 1—Quartz crystals grown by Nacken process. Transparent quartz plate at left was grown from seed plate next to it. Rod of clear Vitreosil (amorphous silica) is at right, and partially recrystallized section of this rod is next to it

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.

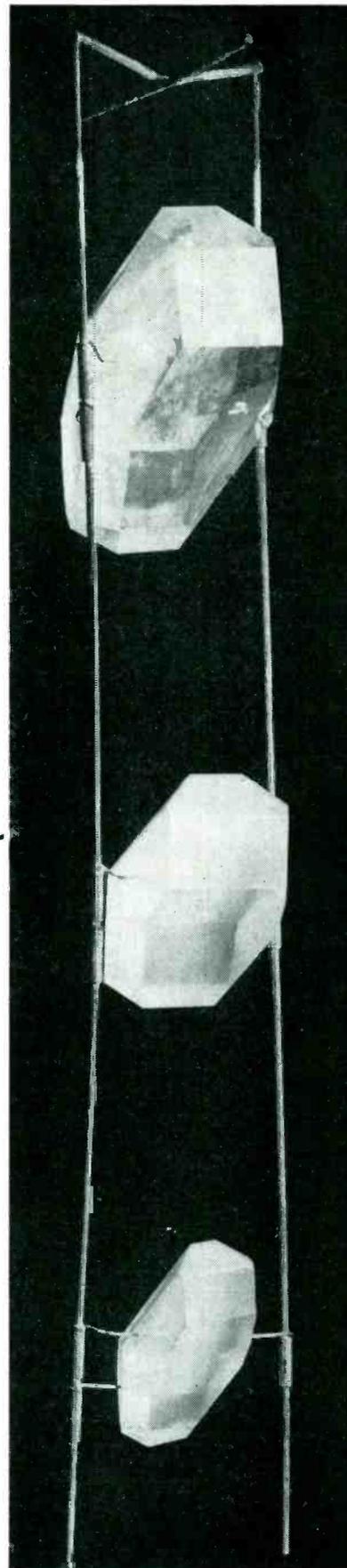
Nacken's Techniques

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 thick-



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

ness 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

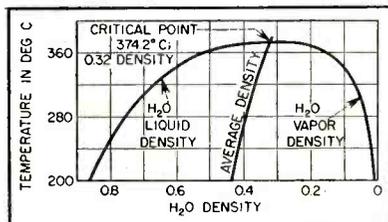


FIG. 2—Liquid-vapor density relations of water near its critical temperature at which density of liquid and vapor are equal

temperature the pressure greatly exceeds the critical 3,200 psi.

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 rhombohedral 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 temperatures⁶. 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.

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 dis-

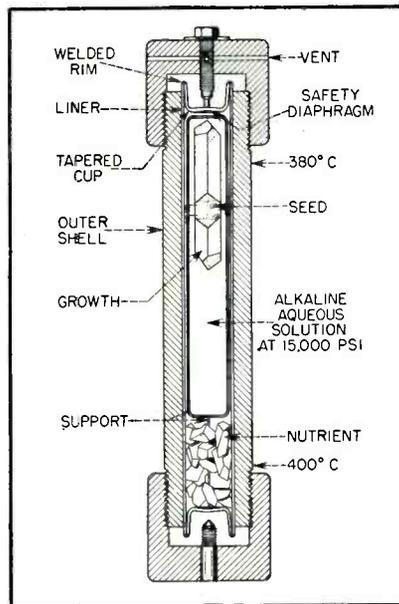


FIG. 3—Cross-section of steel bomb in which quartz crystals are grown

solved 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 2½ inches long by 1½ inches wide by ⅜ inch thick. The other two plates were initially 1½

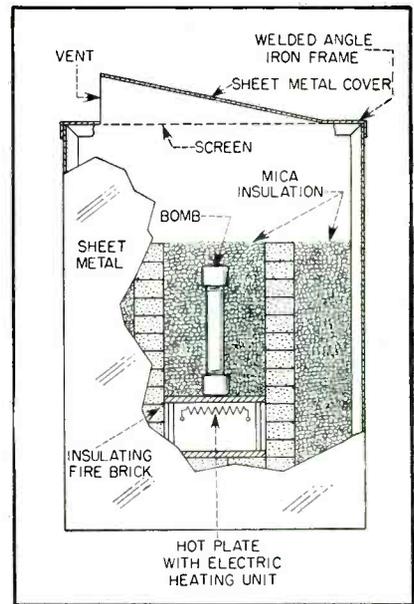


FIG. 4—Cross-section of furnace in which bomb is kept at 400 C

inches square by ⅓ 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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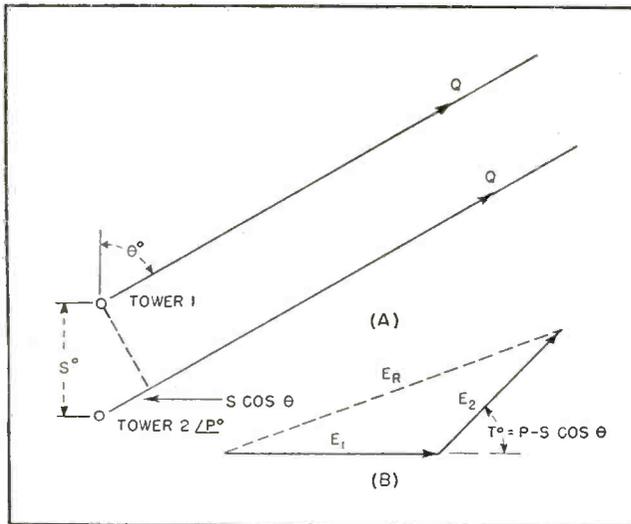


FIG. 1—Basic relationships used in setting up tower equations with spatial relationships shown at (A) and vector addition in (B)

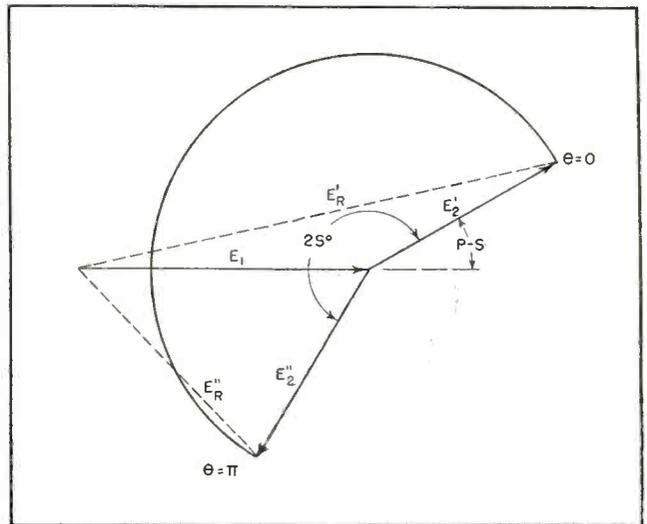


FIG. 2—Vector diagram to show how, if the spacing S between the antenna towers remains fixed, the arc subtended by E_2 can be calibrated in θ

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.

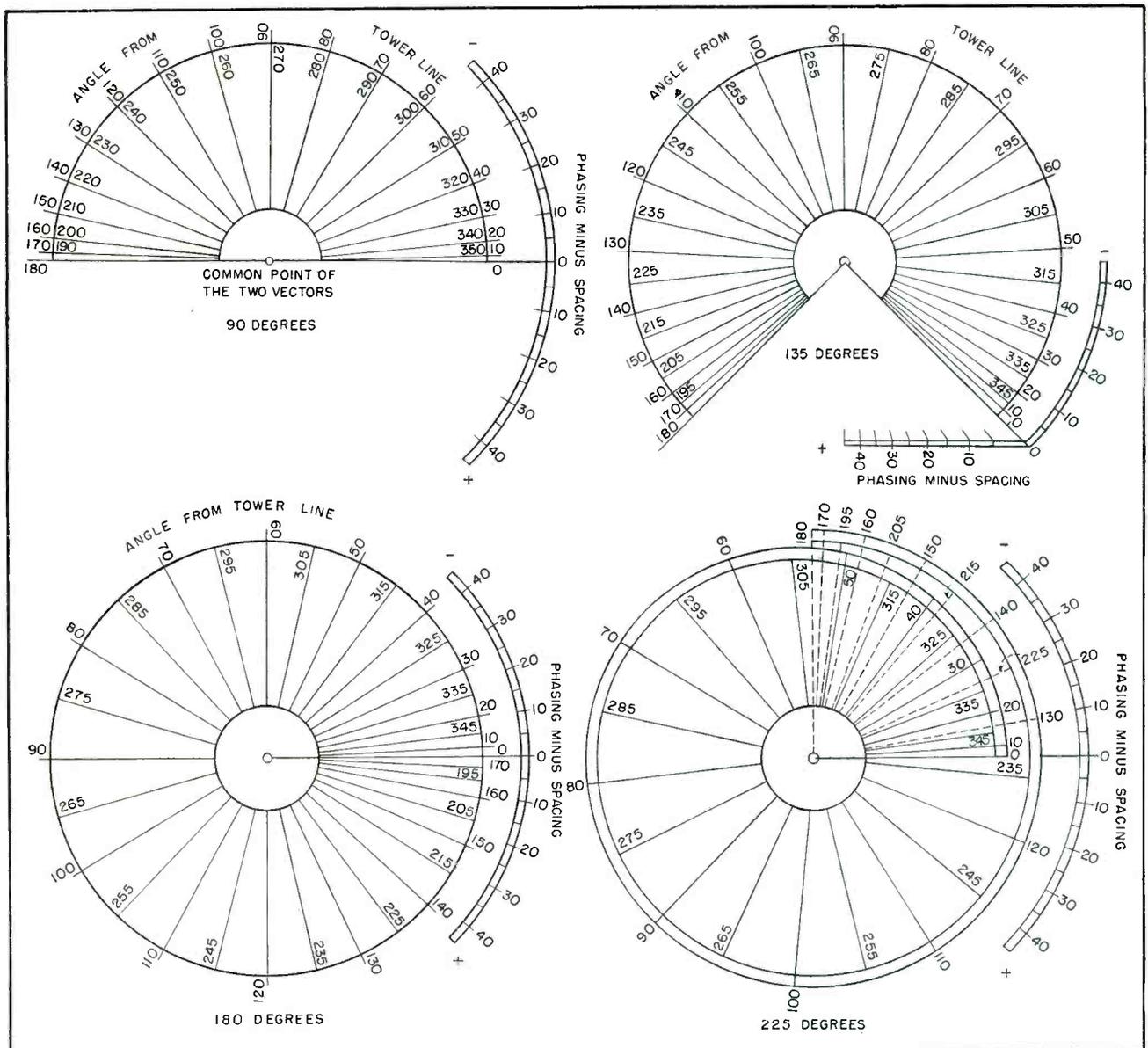


FIG. 3—Patterns can be computed to slide-rule accuracy using enlargements of these calculators. They are given for antenna spacings of 90, 135, 180 and 225 degrees

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 com-

puted for spacing angles 90, 135, 180 and 225 degrees.

Example

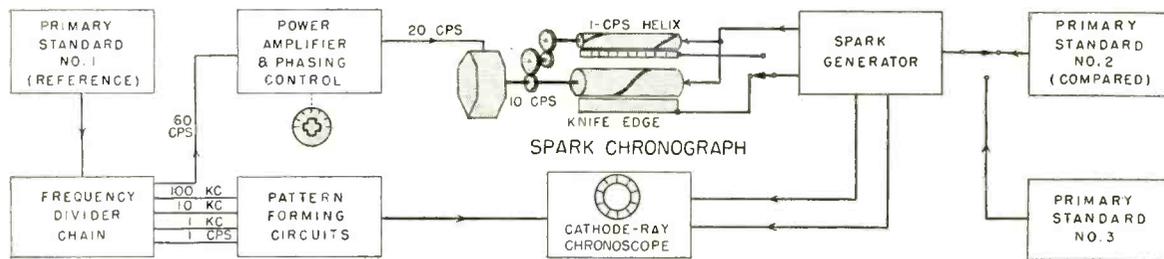
In a determination of the shape of a pattern all that is necessary is a pair of dividers and a transparent overlay sheet. Suppose, for example, we have the following array: $E_1 = 1.0, < 0$; $E_2 = 0.5, < +60$; $S = 90$ degrees. Note that the phasing angle minus the spacing angle is equal to $60 - 90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

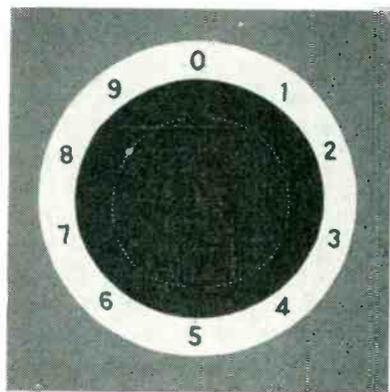
The smaller helix rotates once a second. The point at which a spark jumps between it and the calibrated knife-edge shows which 0.1-second interval is being recorded on the larger helix.

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 millisecond 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

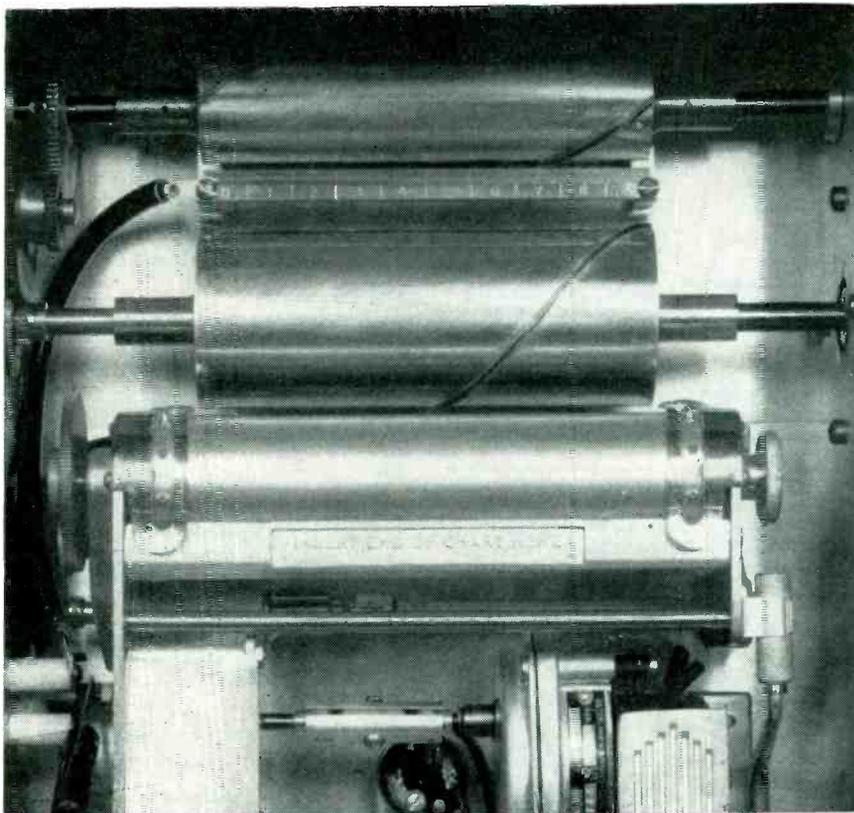
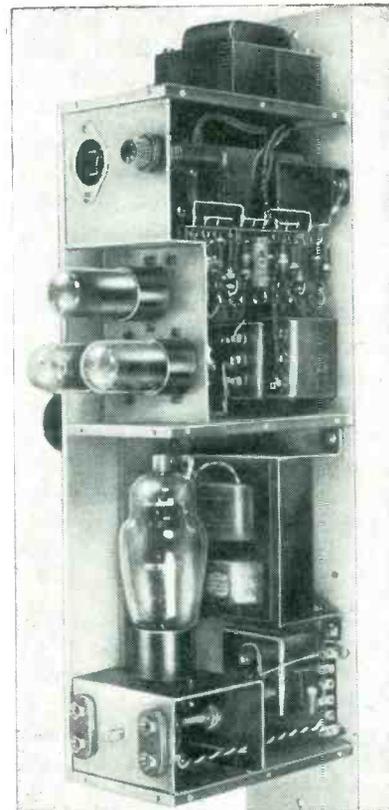


FIG. 1—Remodeled chart recorder for use as a spark chronograph. Special waxed recording paper has been removed to show details



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-ke 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 $\frac{1}{2}$ in.

wide and $\frac{1}{8}$ 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

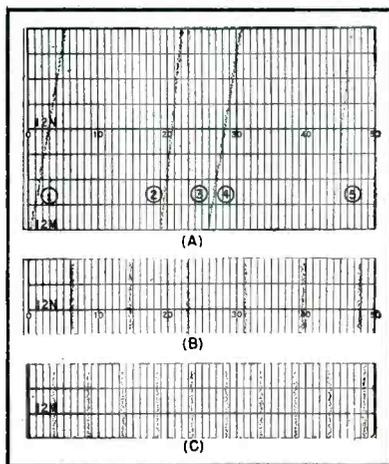


FIG. 2—Normal record (A) shows that signals are faster than reference; at (B) is record of 60-cps signals, and (C) shows 100-cps signals. Chart width represents 0.1-second time difference

the presence of the chart paper aids the discharge.

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.

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 identify

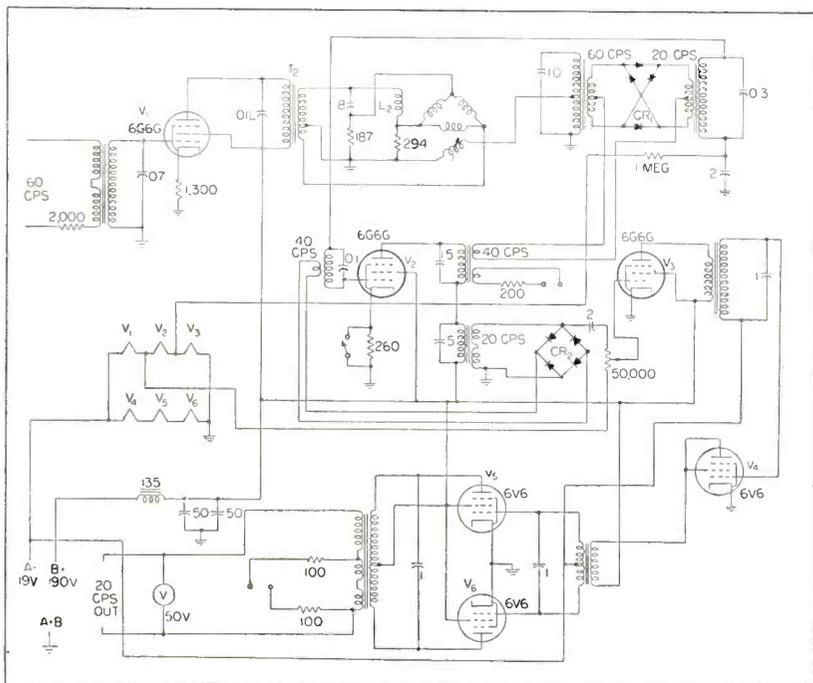


FIG. 3—Schematic of the chronograph power amplifier, with phasing-control selsyn in upper center

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- μ f 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 chrono-

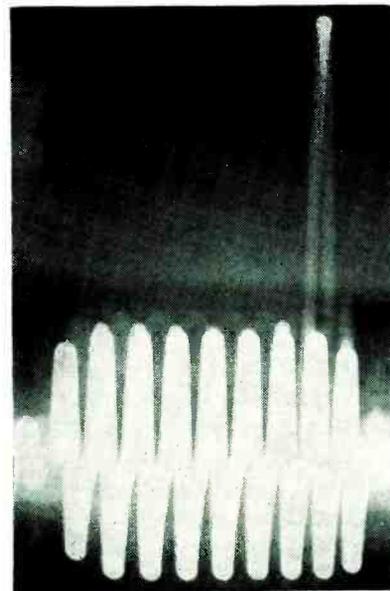


FIG. 6—Oscilloscope trace of voltage applied to grid of the chronoscope. Every tenth wave is attenuated. A 10-pps time signal is at right

graph case. This coating must be removed before it becomes thick enough to cause trouble.

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

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 mis-

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siles 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.

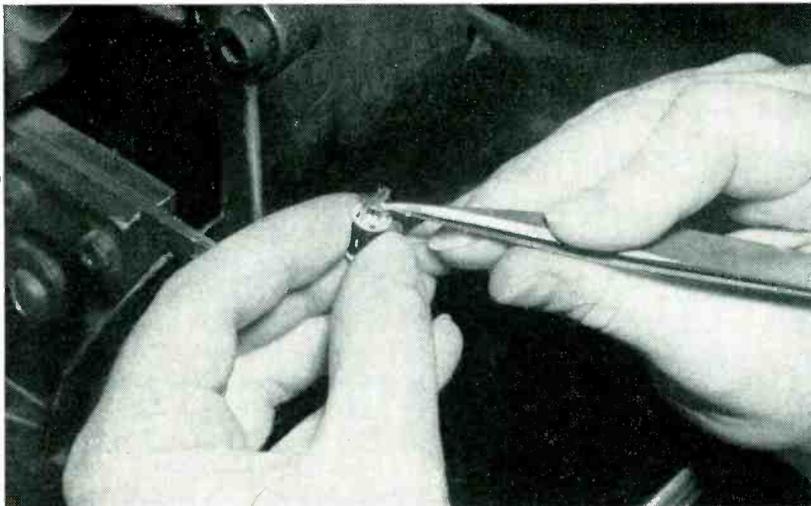
When the idea of the proximity fuze was first conceived, there were no tubes on hand that would fill the requirements of size and ruggedness. Picking small size as the main requirement, engineers launched a series of tests with standard subminiature tubes in projectiles with reduced charges. These shells 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

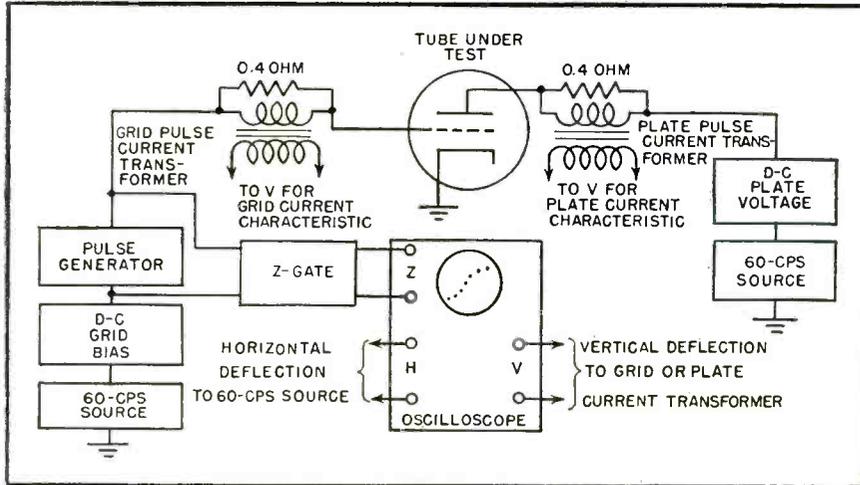


FIG. 1—Plate voltage is swept over desired range by 60-cycle a-c voltage superimposed on d-c voltage, while grid is driven by pulses riding on top of 60-cycle grid voltage. Resulting dots on oscilloscope screen trace out the desired characteristic

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-

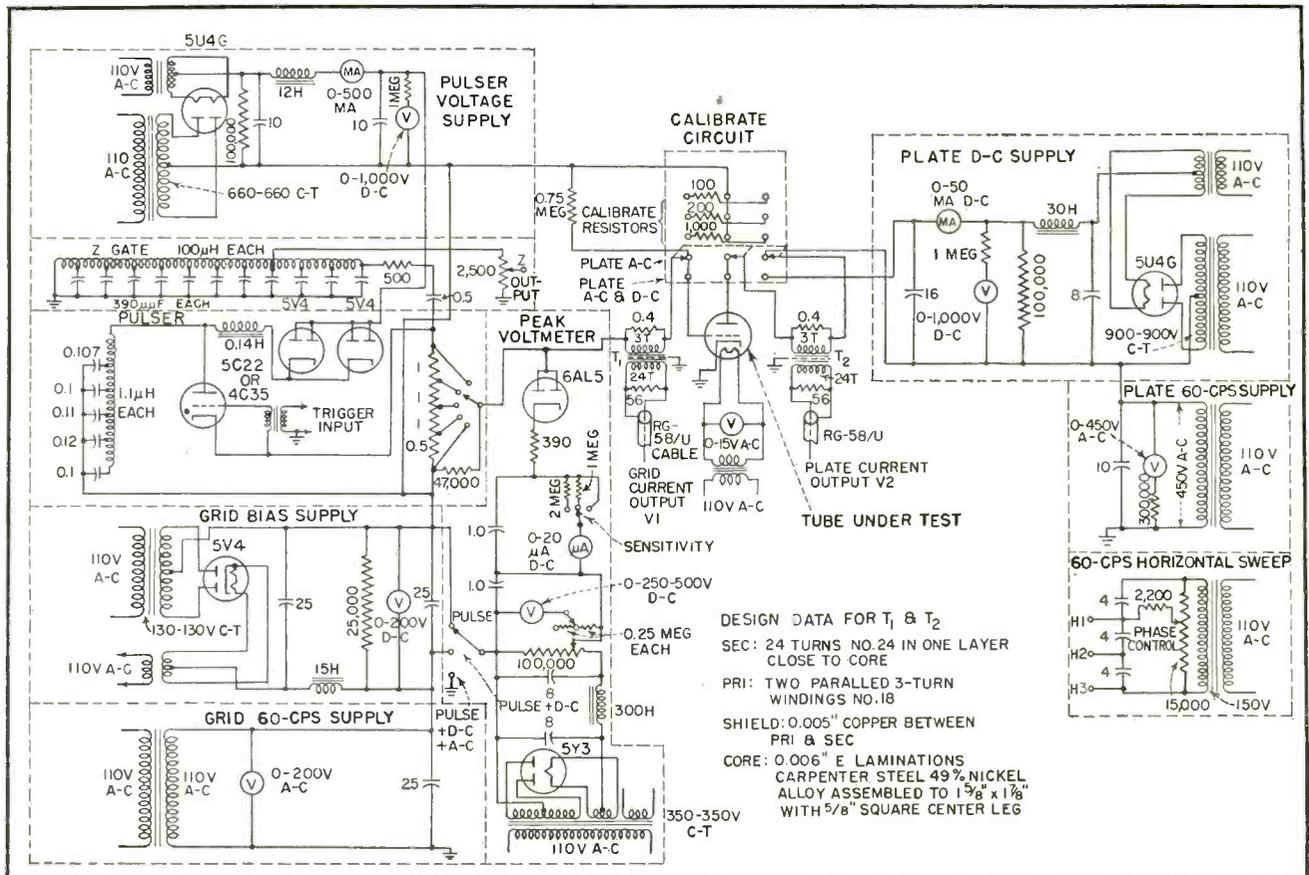


FIG. 2—Complete circuit diagram, including all power supplies since they play a major part in the operation of the tracer

Using Pulse Techniques

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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.

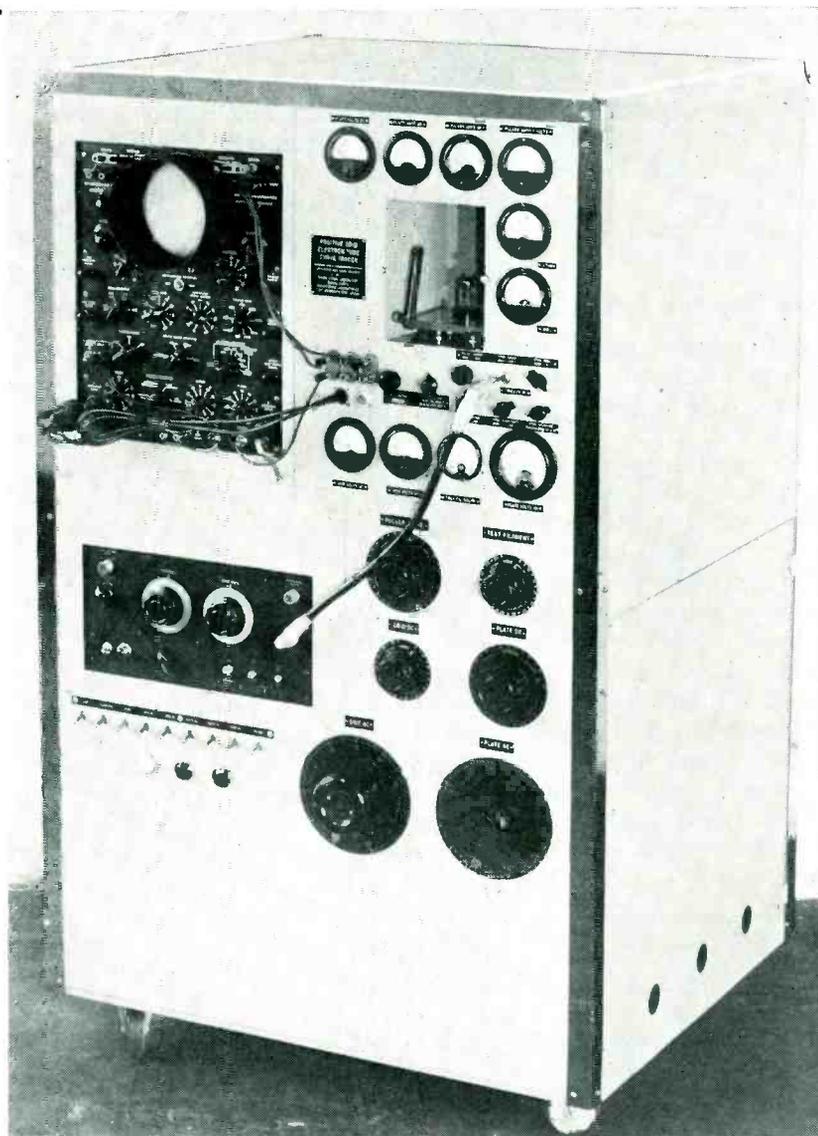
Measuring Method

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



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

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 al-

most 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.

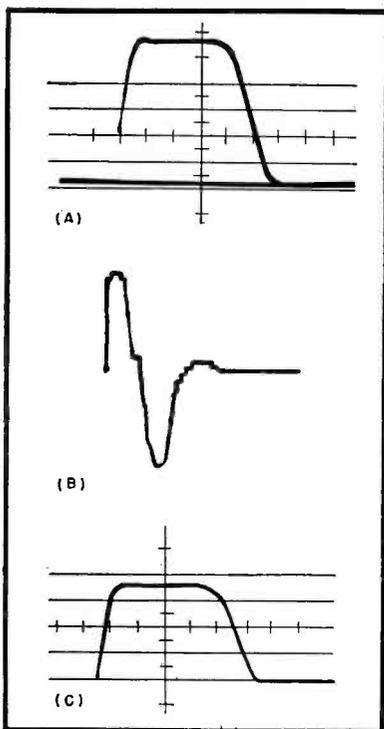


FIG. 3—Voltage waveforms at output of pulse-forming network (A), at Z-output of gate (B), and at secondary of pulse transformer (C)

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

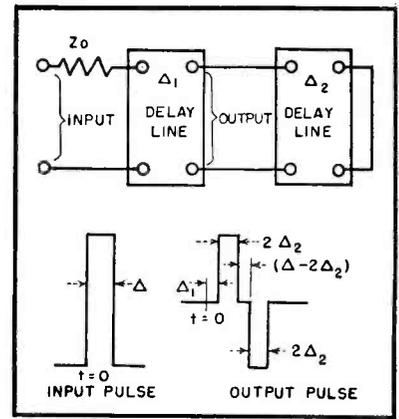


FIG. 4—Transmission line shorted at far end serves as gate that brightens trace during flat-top portion of grid pulse

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_{p0} 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 $V_{p0} = V_p/2$ 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,

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.

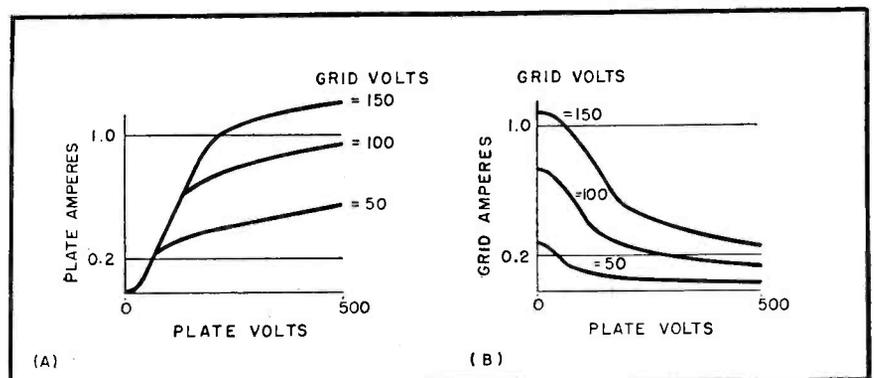


FIG. 5—Examples of families of plate-voltage characteristic curves obtained for type 6C4 miniature tube

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.

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

Corresponding curves for a 6C4 are in Fig. 6C.

Curves on multigrad 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

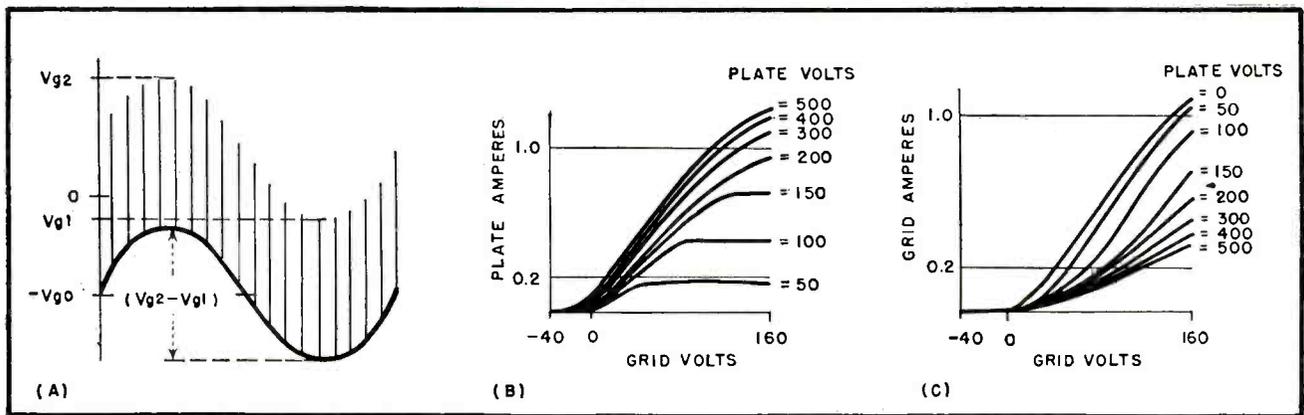


FIG. 6—Method of superimposing pulses on a-c grid voltage, and examples of families of grid-voltage characteristic curves obtained for type 6C4 miniature tube

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. Muesse 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

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 Stroboconn¹. 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 ap-

By **THOMAS E. DUSTIN**

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

pears 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.

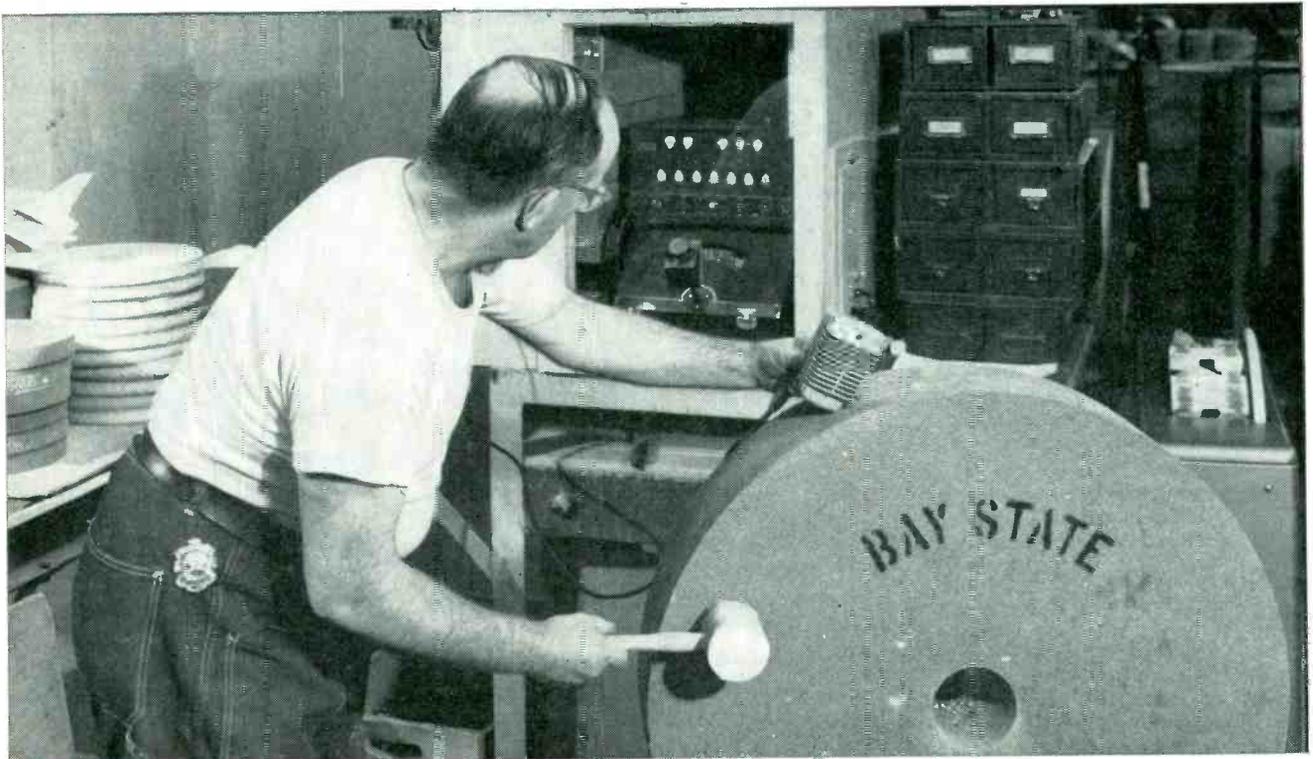
The Stroboconn can be used to measure any frequency within the range from 32.703 to 4,186.0 cycles. Higher frequencies can be measured by using an external frequency divider, with no loss of the 0.05-percent accuracy. Lower frequencies can be measured by using

frequency multipliers. The signal can be fed into the Stroboconn from a microphone, vibration pick-up, 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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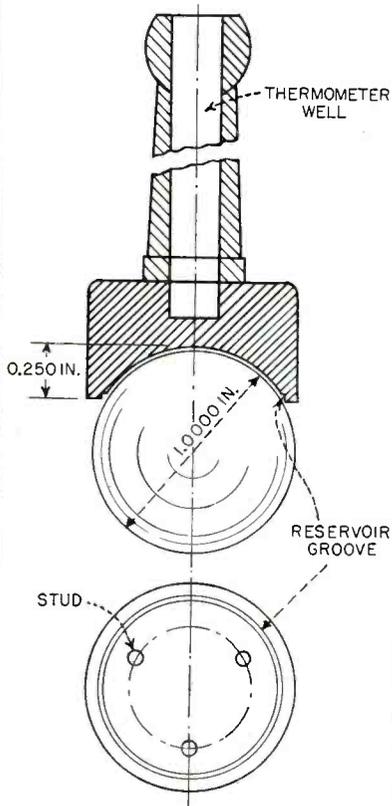


Grinding wheel being tested for flaws by measuring its ringing frequency with a stroboscopic frequency meter. Instrument is enclosed in a temperature-controlled and dust-free compartment, cover of which is open here

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 operation, 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 viscometer¹. 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.

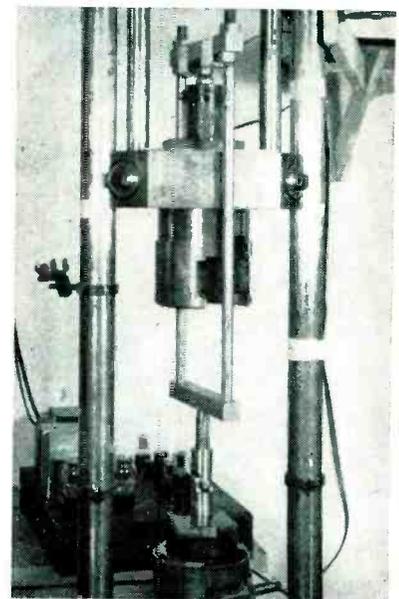
Circuit Operation

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- μ f 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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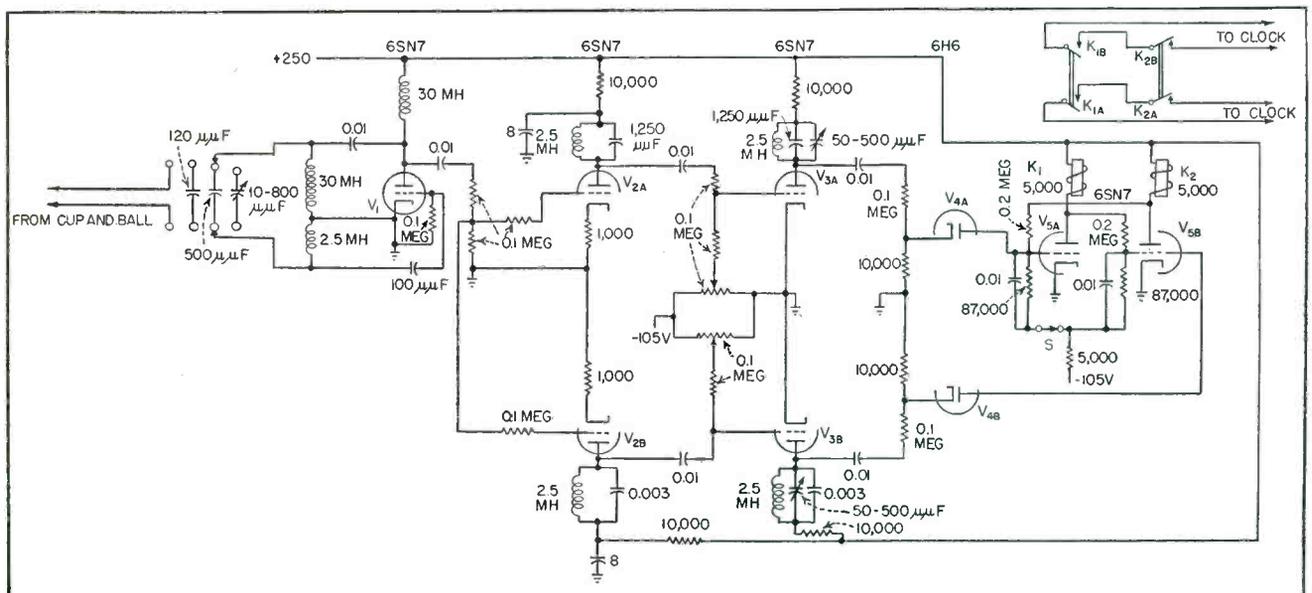


FIG. 1—Complete circuit diagram of the capacitance-change timer

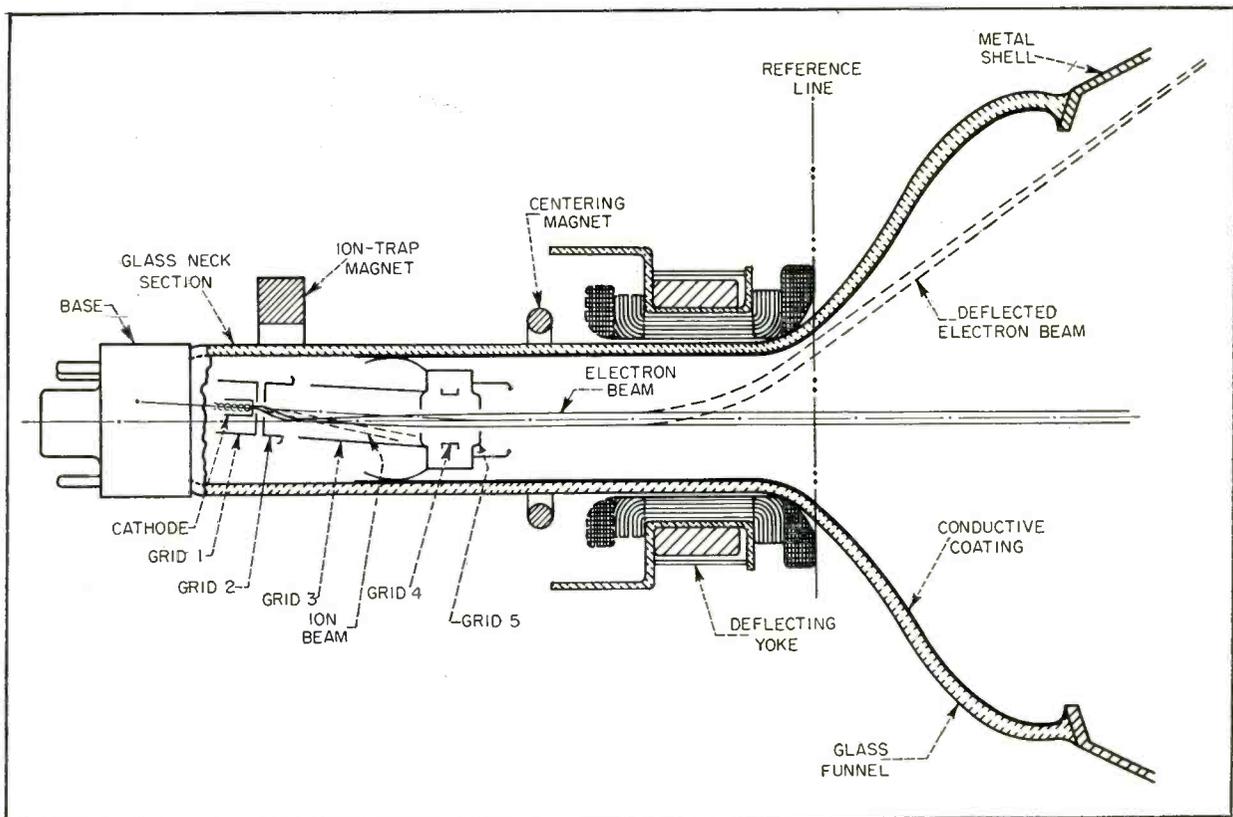


FIG. 1—Cross-section of new electrostatic-focus gun, showing path of electron beam and location of centering magnet

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-

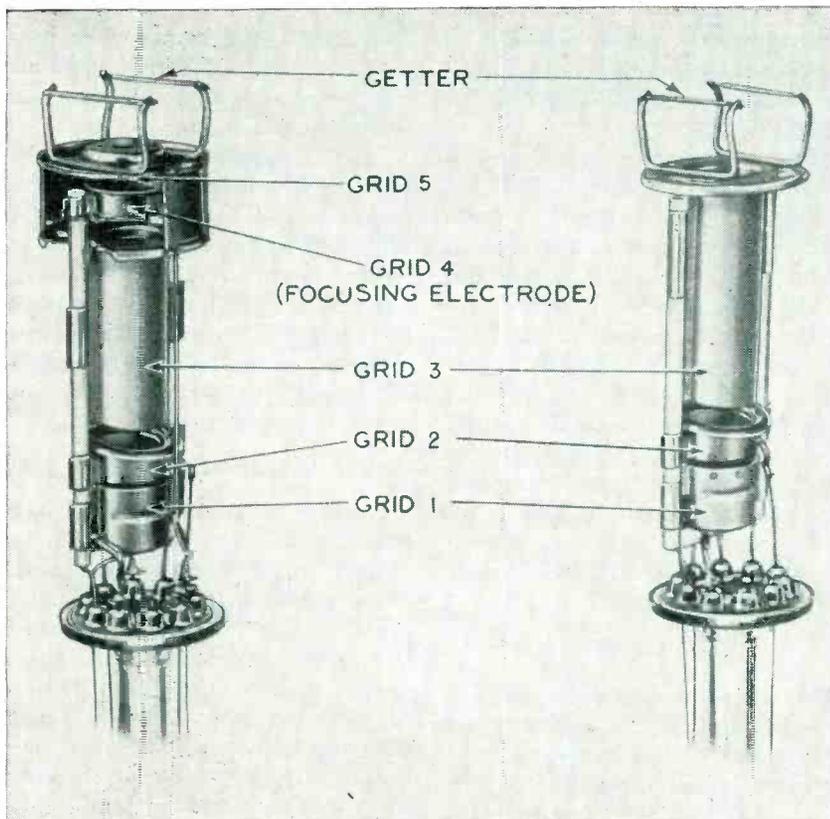


FIG. 2—Structure of electrostatic-focus gun compared with magnetic-focus gun

PICTURE TUBE

By L. E. SWEDLUND and R. SAUNDERS, Jr.

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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 16GP4².

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.³ 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-

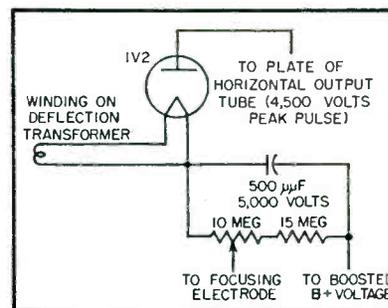


FIG. 3—Rectifier circuit for providing focusing voltage

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, adjust-



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

ment would still be required to compensate for the small changes in focus due to changes in grid 1 voltage.

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 hori-

zontal 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

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 selec-

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tive 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.

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

$$2 \tan^{-1} \omega R_1 C_1 + 2 \tan^{-1} \omega R_2 C_2 = \pi \quad (1)$$

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 $\omega R_1 C_1$ is equated to $1/\omega R_2 C_2$, the resonant angular frequency is found to be

$$\omega_{res} = \frac{1}{\sqrt{R_1 C_1 R_2 C_2}} \quad (3)$$

An interesting property of this circuit when $R_1 C_1 = R_2 C_2$ 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

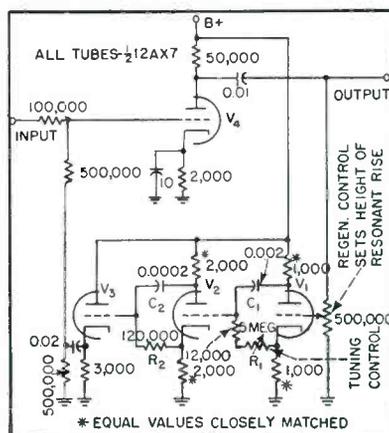


FIG. 1—Selective amplifier tunable with approximately constant absolute bandwidth and constant gain between 300 and 6,000 cycles per second

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

$$\frac{d\phi}{d\omega} = \frac{2R_1C_1}{1 + \omega^2R_1^2C_1^2} + \frac{2R_2C_2}{1 + \omega^2R_2^2C_2^2} \quad (5)$$

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

$$\frac{d\phi}{d\omega} = \frac{2}{1 + r^2} + \frac{2 \times \frac{1}{r}}{1 + \frac{1}{r^2}} = \frac{4r}{1 + r^2} \quad (6)$$

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 $\phi-\omega$ 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

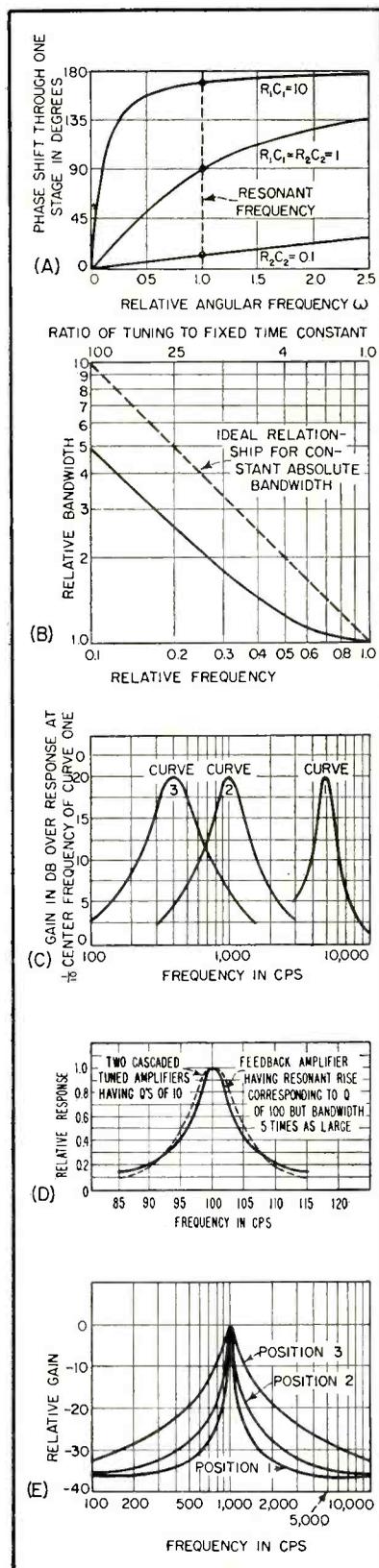


FIG. 2—Curves show operating characteristics of circuits shown in Fig. 1 and Fig. 3

considerably less than that of the center curve.

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 $5.3 \mu\text{f}$. 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 $0.002 \mu\text{f}$. 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 $200 \mu\text{f}$. 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.

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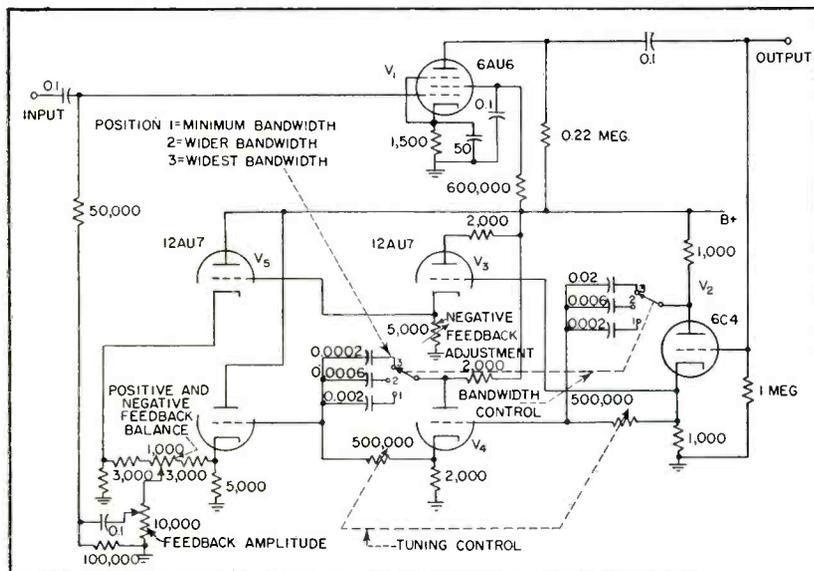


FIG. 3—Tunable audio amplifier with independent bandwidth control and balanced feedback

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

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H EAD 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 ferrites¹, 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 Mohr hard-

ness 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 $\frac{7}{8}$ -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

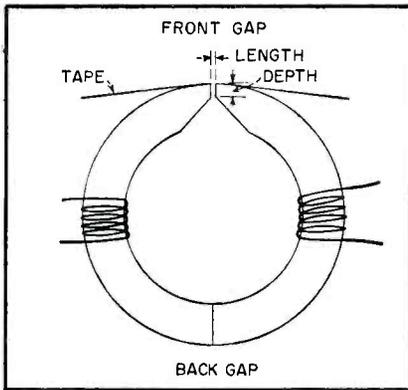
hours of use. In the case of ferrites, the surface presented to the tape must be ground and lapped to perfection because any irregularities will scrape and damage the tape.

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 Rettinger⁴.

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

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 mag-

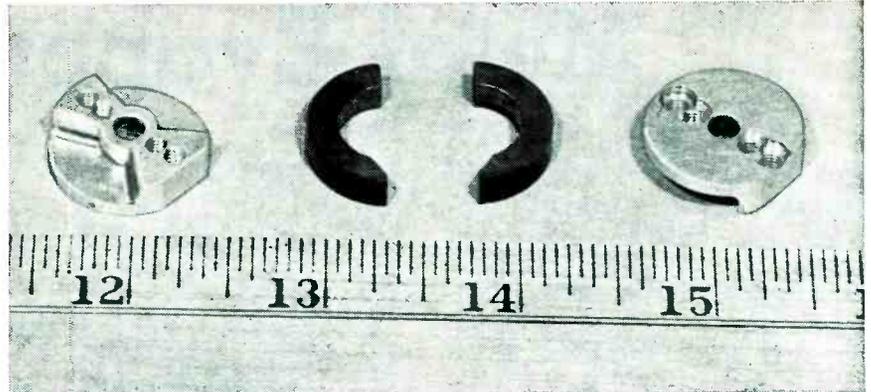


FIG. 1—Components of an experimental magnetic recording head using a core made of Ferramic E or Ferramic G. Core was obtained by cutting a toroid of $\frac{1}{8}$ -in. outer diameter in half and then reducing one gap in depth

netic 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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Metal Evaporator Uses

THE PROBLEM of putting polished metallic finishes on non-conducting 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.

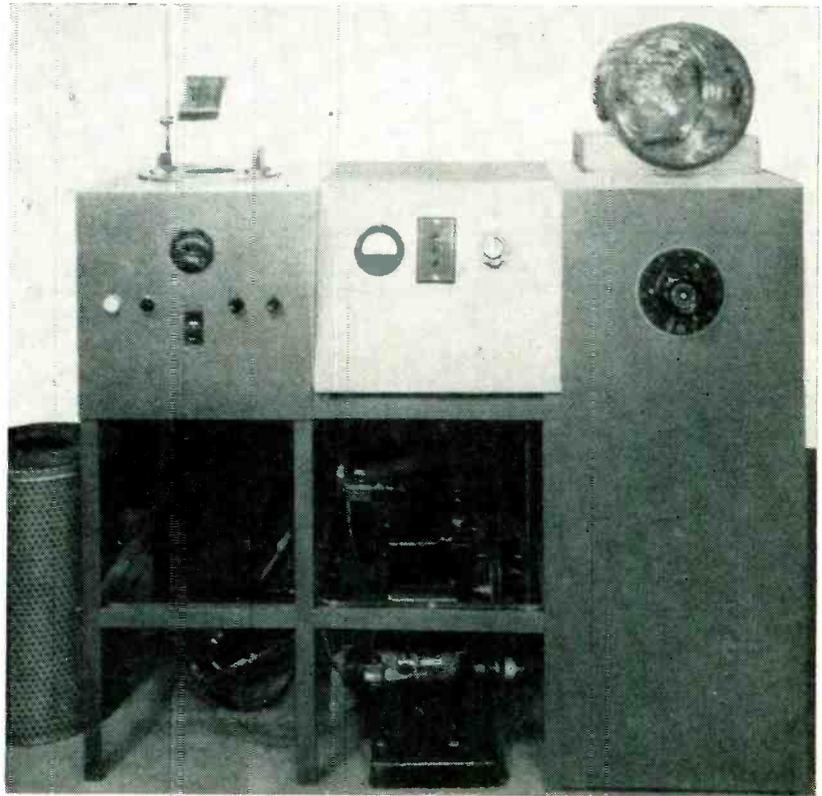
One satisfactory method of metallizing unplatable materials is to condense metal onto their surfaces from the vapor state. This technique has become standard in many plants manufacturing metal-coated plastics. Only a few metals, notably zinc and cadmium, do not form good mirrors when condensed on a polished 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.

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 heat-

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



ing the metal until it evaporates is brought through the base plate by means of vacuum-tight insulated bushings.

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-

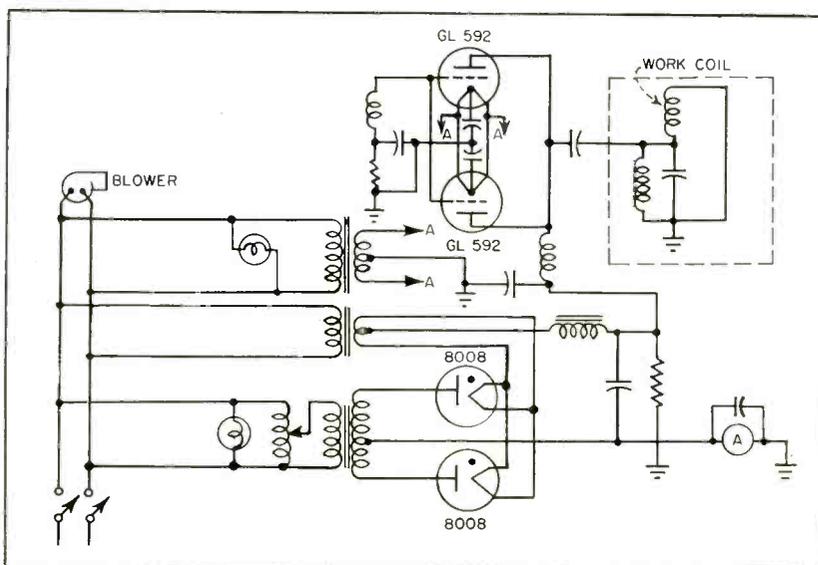


FIG. 1—Circuit of the high-frequency metal evaporator. Protective contactors are not shown

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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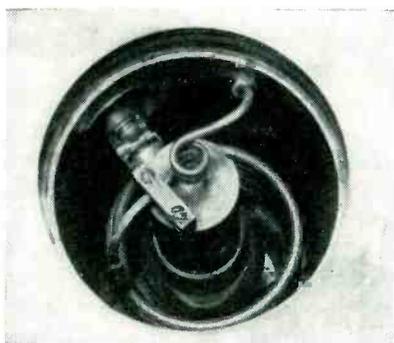


FIG. 3—Looking down into the vacuum chamber, showing the small water-cooled work coil, the larger resonant-circuit coil with its tuning capacitor and, at the upper left, the coaxial connector

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 ac-

complish 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

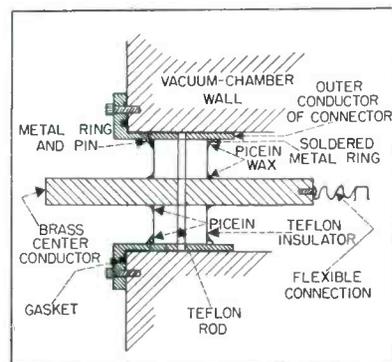


FIG. 4—Cross section of the coaxial connector, part of which is visible in Fig. 3

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 $\frac{1}{8}$ -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

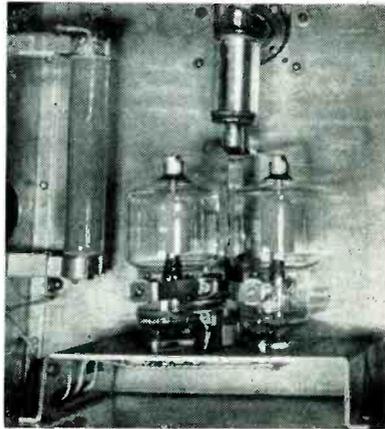


FIG. 5—The r-f oscillator provides 1-kw output at 70 mc. The two tubes are connected in parallel as shown in the circuit diagram of Fig. 1

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.

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 out-gassed 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

By RICHARD LOWRIE

Annandale, Va.

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 con-

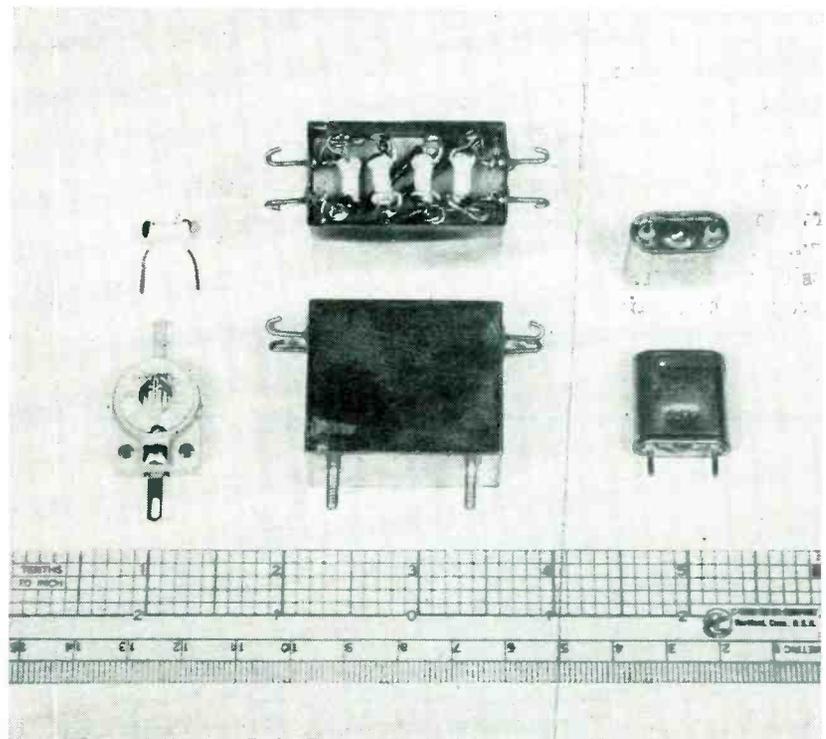
struction of such units for frequencies as high as 0.5 megacycle was fraught with difficulties. The success obtained, once a good source of crystals was discovered, has been most encouraging.

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 fre-

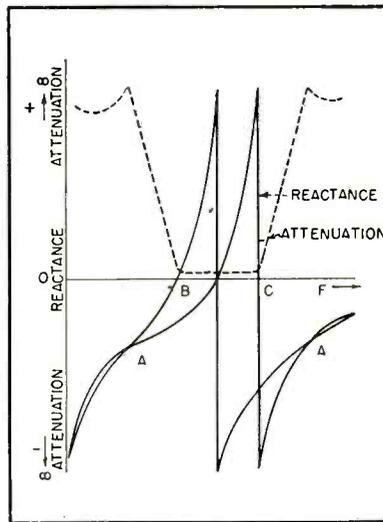


FIG. 2—Reactance curves (solid lines) for crystals in the lattice network and the attenuation curve shown by a dashed line

quencies far from resonance.

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

$$f_p = f_r + \Delta f = 1/2\pi (LC^1)^{1/2} \quad (1)$$

$$\text{where } C^1 = cC_o/(c + C_o) \quad (2)$$

$$\text{and } L = 1/(2\pi f_r)^2 c$$

From Eq. 1 and Eq. 2

$$1/C^1 = (f_r + \Delta f)^2 / (f_r)^2 c \quad (3)$$

$$\frac{(f_r + \Delta f)^2}{(f_r)^2} = \frac{C}{C_o} + 1 = \left(1 + \frac{\Delta f}{f_r}\right)^2 \quad (4)$$

$$\text{From Eq. 4, } c/C_o = 2\Delta f/f_r \quad (5)$$

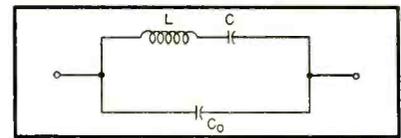


FIG. 3—Equivalent circuit of the crystal as evaluated in the equations

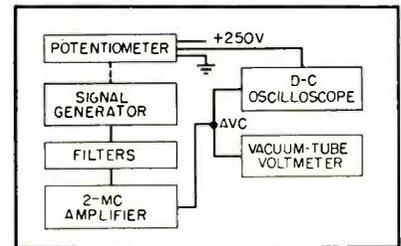


FIG. 4—Test equipment used to adjust the filter. The potentiometer and signal generator are driven simultaneously by hand

$$\text{or } \Delta f = f_r c / 2C_o \quad (6)$$

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

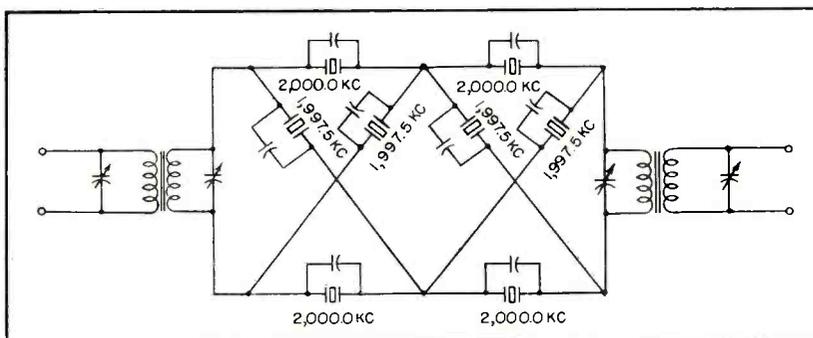


FIG. 1—Circuit for the 2-mc filter using eight crystals

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 Mason¹). 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 theo-

retical 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

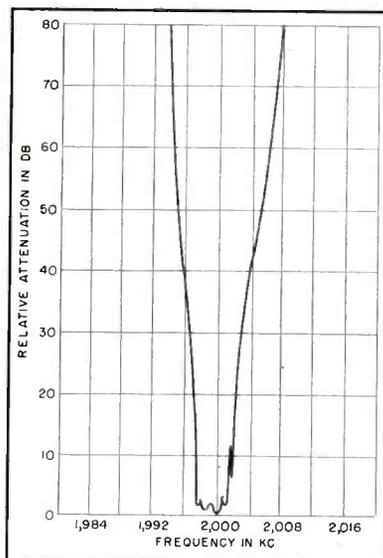


FIG. 5—Selectivity curve for a typical crystal filter

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.

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.
- (2) Paul K. Taylor, Single Sideband Crystal Filters, *ELECTRONICS*, p 116, Oct. 1948.

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

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_o 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 near-

By **THOMAS T. BROWN**

*Aircraft Transmitter Development Section
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Writtle, Essex, England*

est 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_{o1}/F_x for the lower frequency limit and F_{o2}/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 trans-

mission 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_o 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_o , 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.

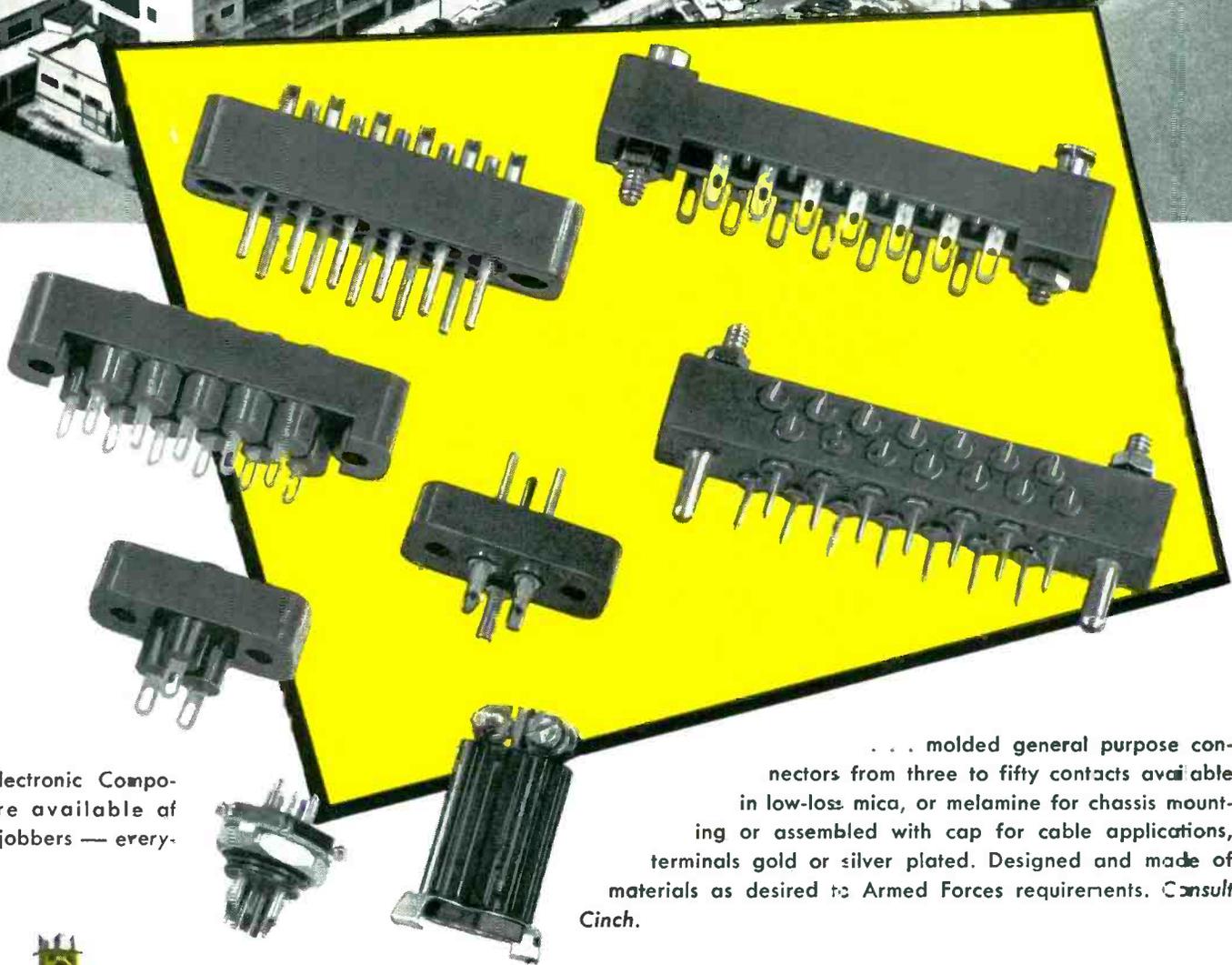
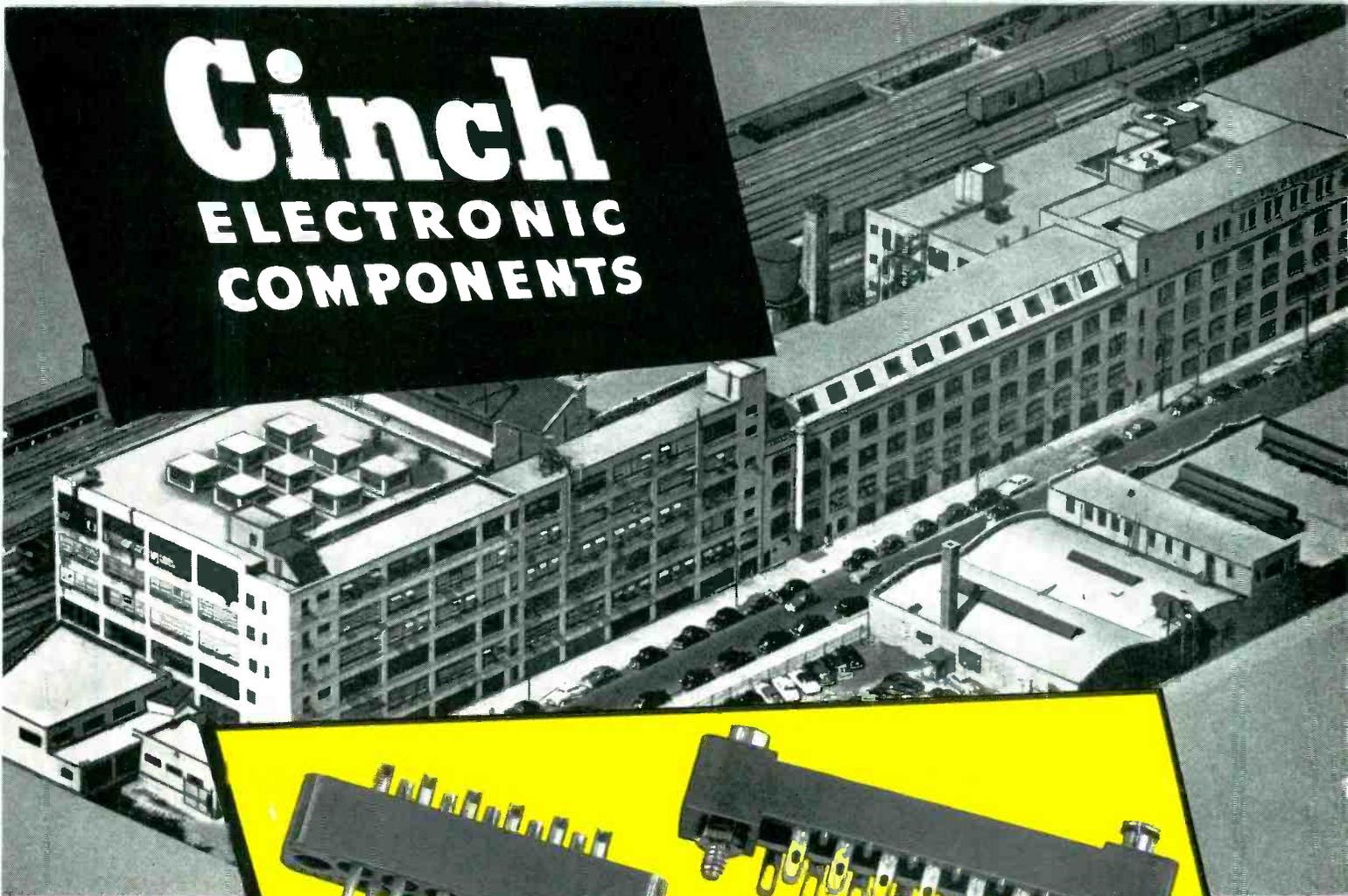
By inspection, the nearest value of F_o/F_x that it is in a clear space on the heavy $F_x - F_o$ line is 0.775, which corresponds to an i-f value of about 55 mc. Tracing vertically up and down from the intersection of the 0.775 ordinate with the $F_x - F_o$ line, we find that the nearest spurious frequencies 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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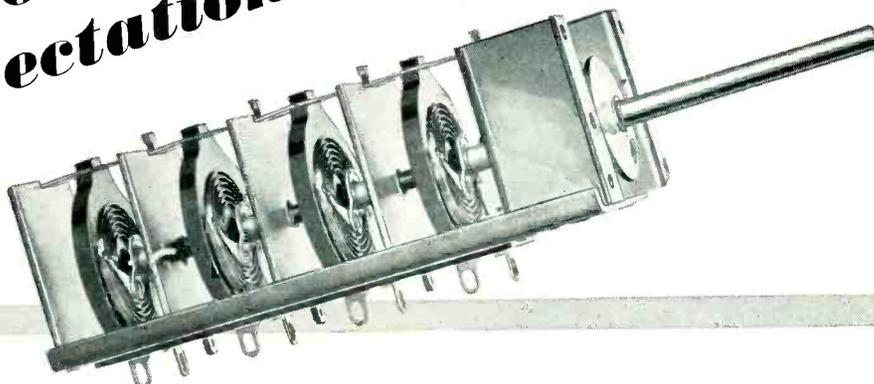
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TUBES AT WORK

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Edited by RONALD K. JURGEN

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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 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 recom-

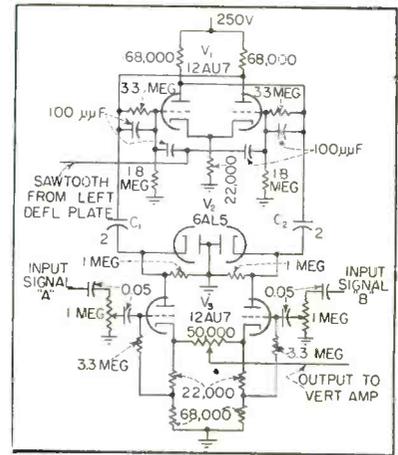


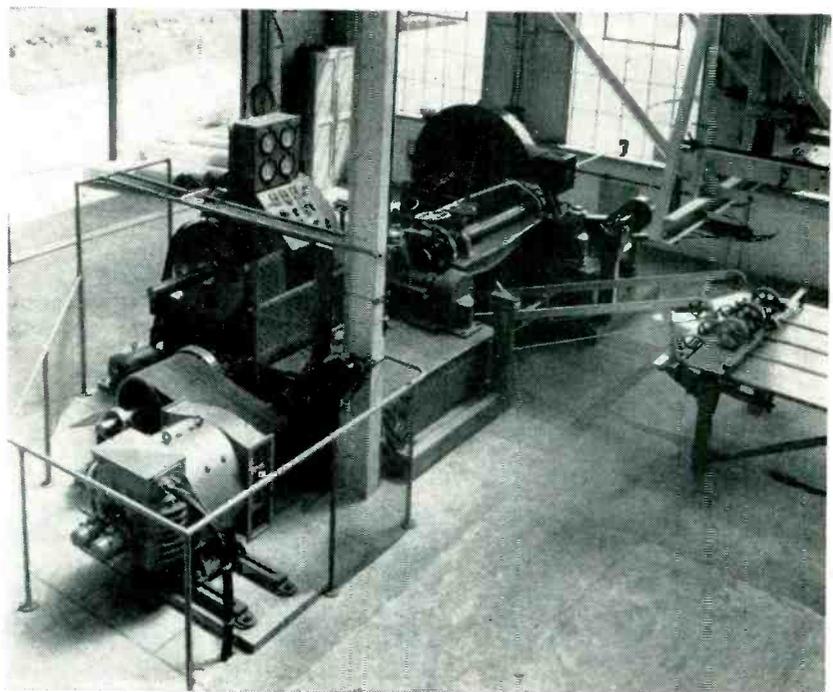
FIG. 1—Circuit of electronic switch used to obtain two simultaneous and independent traces on an oscilloscope

mended for the clampers. Plate voltage is not critical and may be any value between 250 and 400 volts.

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

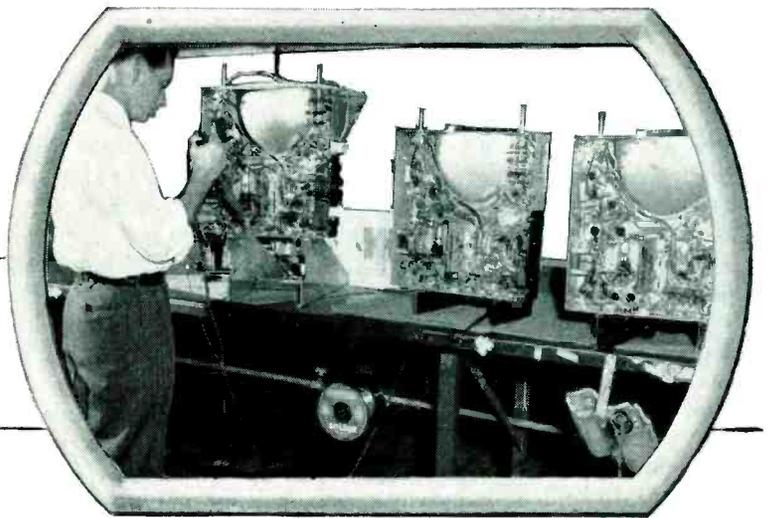
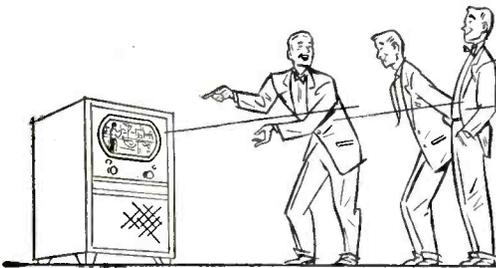


General view of the veneer-peeling lathe at the Forest Products Research Laboratory, Princes Risborough, England

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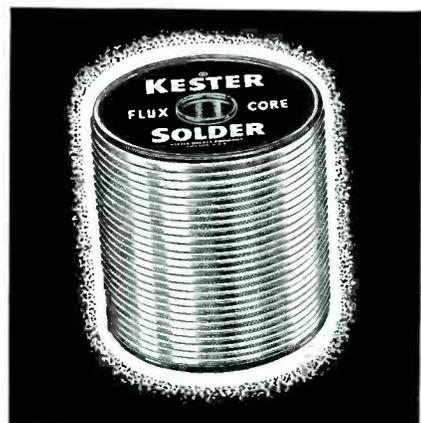
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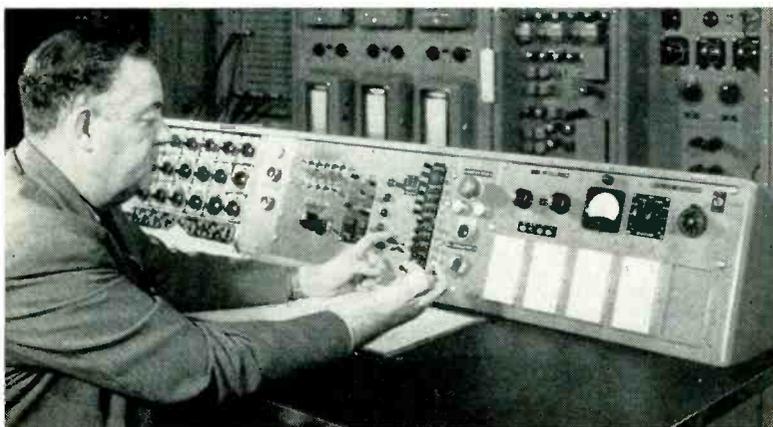
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THE FRONT COVER



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 di-

rected 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 switch-board 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 dis-

crepancy 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)



ACE HIGH • for miniaturization, mounting, and temperature problems

Here they come, right off the top of the deck, to fill in what's been needed—new ways of mounting subminiature capacitors in military electronic equipment!

You'll find side stud, end stud, threaded neck, and two types of side bracket capacitors in Sprague's new 16 page Engineering Bulletin **213-B**.

These new Sprague-pioneered designs make even broader the world's most complete line of solder-seal terminal metal-

encased subminiature paper capacitors.

And they're now available as standard in a 125°C. temperature rating Vitamin Q® capacitor series. Voltage ratings range from 100 to 1000 volts in both inserted tab and extended foil constructions.

And remember, Sprague Capacitors are the standard of dependability for critical electronic circuits. Write for your copy of Bulletin **213-B** which gives the complete Sprague Subminiature Story.

SPRAGUE

PIONEERS IN SPRAGUE ELECTRIC COMPANY

NORTH ADAMS, MASSACHUSETTS

ELECTRIC AND ELECTRONIC DEVELOPMENT

THE ELECTRON ART

Edited by JAMES D. FAHNESTOCK

New Navy Radio Telescope Nears Completion	140
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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



Fifty-foot radio telescope parabola is fabricated from thirty pieces of carefully-machined aluminum

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.

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

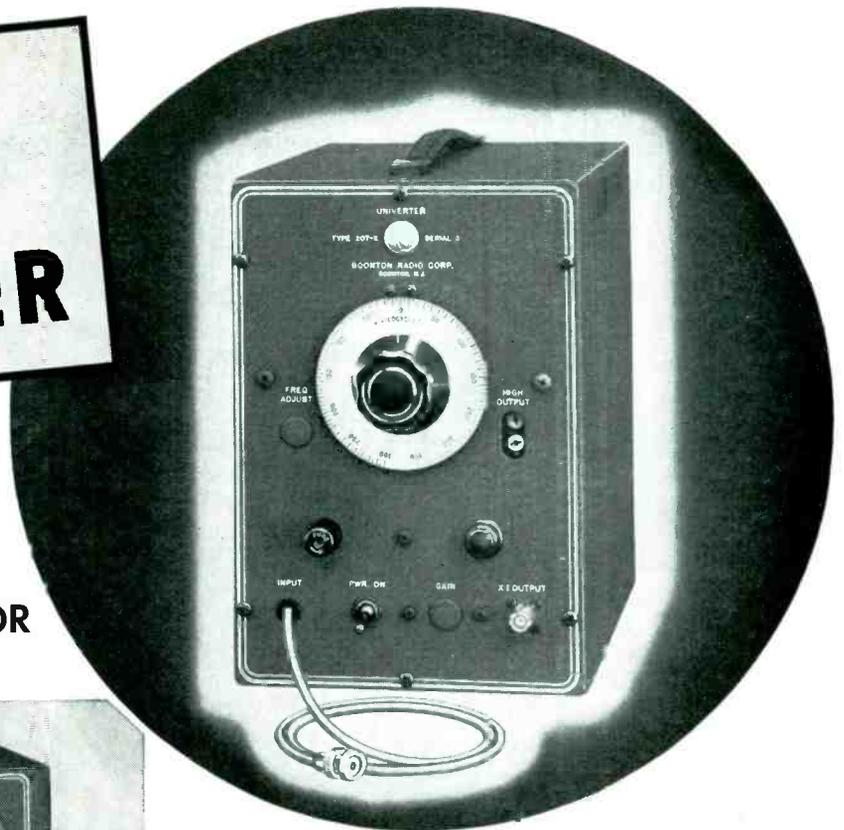


Total weight of antenna and five-inch gun mount used to position it is about 75 tons

Announcing a **NEW** **UNIVERTER**

**Continuous Coverage
0.1 to 216 mc.**

Accessory for the
FM-AM SIGNAL GENERATOR
TYPE 202-B



UNIVERTOR
TYPE 207-A

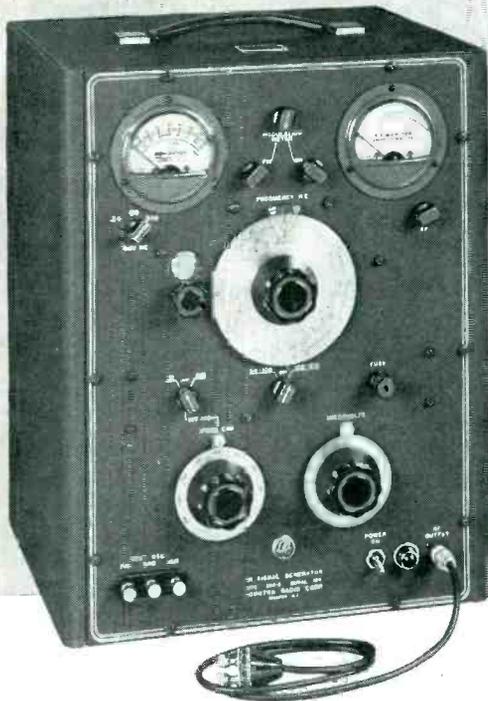
The Type 207-A Univertor fills the widespread need for an FM-AM source in the frequency range of from 0.1 to 55 mc. This instrument is a unity gain frequency converter which subtracts 150 mc. from a signal derived from the Type 202-B FM-AM Signal Generator to produce an output of from 100 kc. to 55 mc. This is accomplished without change of signal level or of modulation and with negligible spurious frequencies. Thus the Type 207-A Univertor 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 Univertor 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 Univertor 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.



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 Univertor 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.

BOONTON RADIO
BOONTON, N. J. U.S.A.



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FREQUENCY MODULATED SIGNAL GENERATOR • BEAT FREQUENCY
GENERATOR AND OTHER DIRECT READING INSTRUMENTS

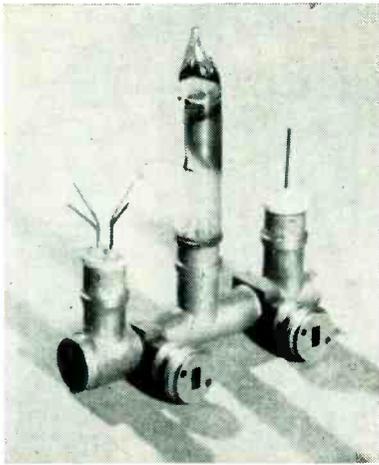


FIG. 1—Special BTL tube for amplification at 48,000 mc

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

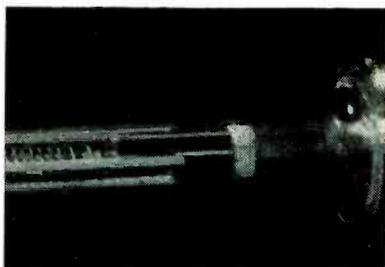


FIG. 2—Close-up view of 4,000-mc traveling-wave tube from which 48,000-mc tube was scaled

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.

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

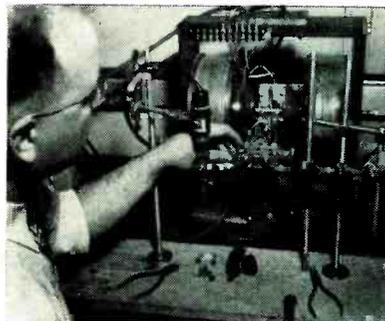


FIG. 3—The amplifier tube is placed between the poles of a large magnet that furnishes the required uniform field

properly orienting this junction in the wave-guide structure.

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 milliamperes. 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 modu-

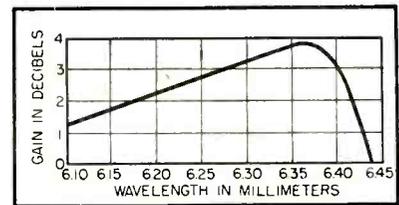


FIG. 4—Curves show the gain of the new tube as a function of wavelength

lated by a square wave which the crystal recovers and furnishes to a preamplifier and thence to an oscilloscope for comparison.

Results of measurements on several 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

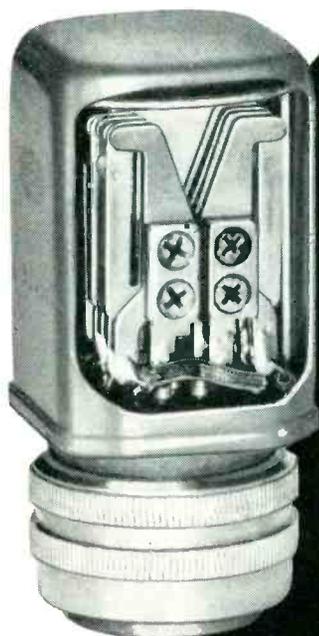
Signal Corps Engineering Laboratories
Fort Monmouth, New Jersey

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 others¹, 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.



R-B-M DIVISION ESSEX WIRE CORP.
Logansport, Indiana

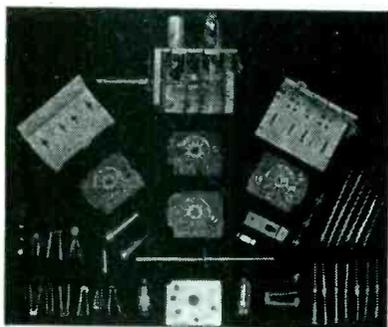
MANUAL AND MAGNETIC ELECTRIC CONTROLS — FOR AUTOMOTIVE, INDUSTRIAL, COMMUNICATION AND ELECTRONIC USE

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

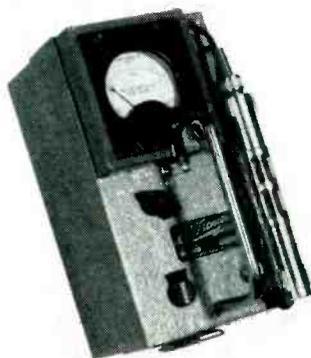
NEO-SIL CORP., 26 Cornelison Ave., Jersey City 4, N. J., has developed its hermetic sealing components to a point where rejects resulting from breakage, strain, cracks, physical shock and the like are reduced to a minimum. As a unit Neo-Sil syn-



thetic 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		Plate		Grid	Screen		Amp. Factor	Mut. Cond.
					Volts	Amps.	Volts	Ma.	Volts	Volts	Ma.		
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.	—	—	10 9 ma. dc. per plate	—	—	—
6A56W	Pentode RF Mixer	Military Ruggedized	6A56	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. 1650
6SJ7WGT	Pentode RF Amplifier	Military Ruggedized	6SJ7GT	Bantal	6.3	0.3	250	3.0	-3	100	0.8	—	2600
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.	—	—	10 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. -12.5	—	—	35	5500
CK5686	AF-RF Output Pentode	Commercial Aircraft Ruggedized	—	9 pin miniature	6.3	0.35	250	27	—	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	6A56W	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.	—	—	10 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.

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SPECIAL TUBE SECTION • Newton 38, Massachusetts

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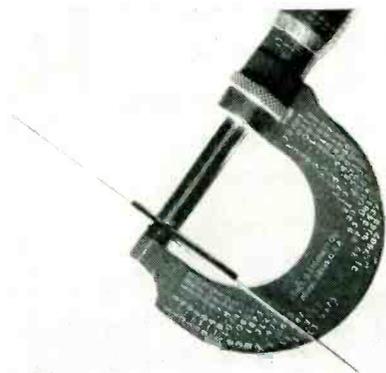


Excellence in Electronics

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

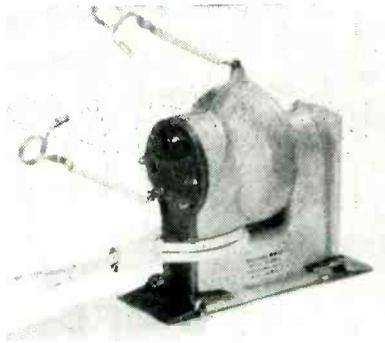
HARDY INSTRUMENT Co., 104-18 Metropolitan Ave., Forest Hills, N. Y., announces a new line of Microstak subminiature selenium rectifiers. The rectifier illustrated has an outside diameter of less than 3/32 in. for a completely insulated, or if desired, a hermetically sealed assembly. Length will vary according to voltage requirements. The plates are only 1/8 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 μ a 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

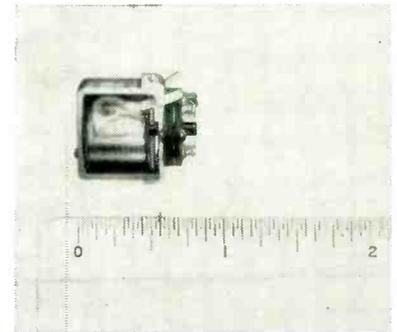
SOUTHWESTERN INDUSTRIAL ELECTRONICS Co., 2831 Post Oak Road, Houston 19, Texas. Model M-2 os-



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

HUFCA INDUSTRIES, 2815 West Olive, Burbank, Calif. Model 1001 subminiature relay, weighing less than 1/2 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

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**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 $+125^{\circ}\text{C}$.**

CAPACITANCE
RANGE: .001 mfd. to 1.0 mfd.

VOLTAGE RANGE: 100 to 600
v.d.c. operating

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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 Dis-

trict 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



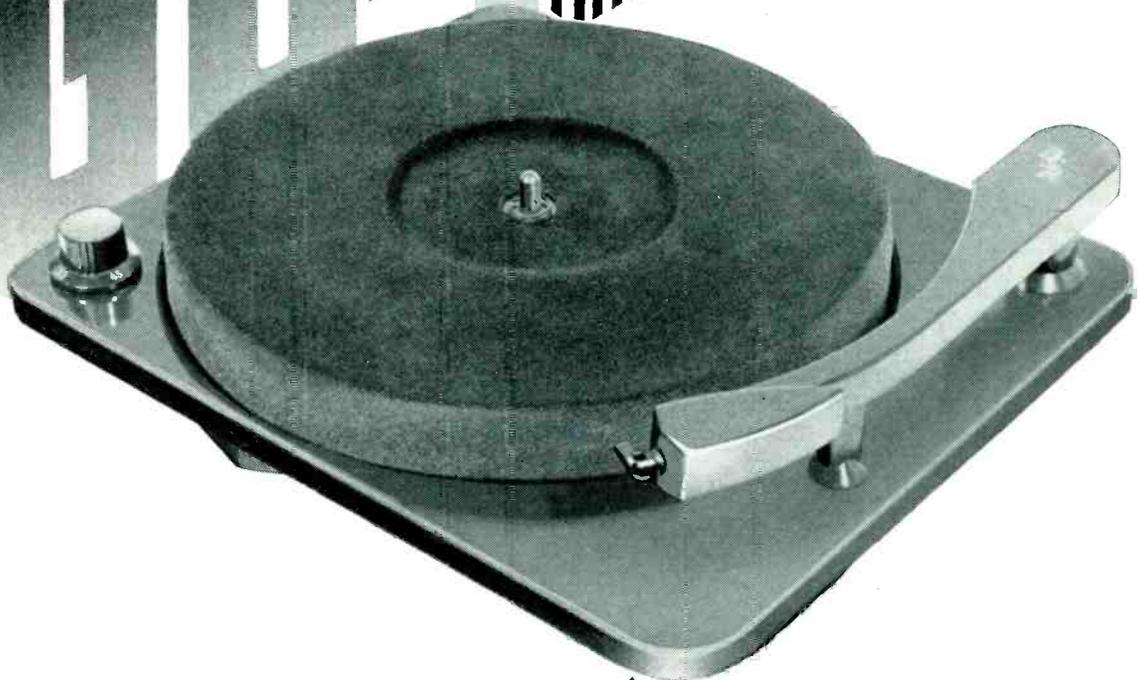
Robert R. Burton (third from left), head of communications for the Federal Civil Defense Administration in Washington, recently visited General Electric's Electronics Park at Syracuse, N. Y. He met with members of a new Civil Defense committee of the GE Electronics Department to discuss possible applications 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-

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This is the G.U.4 Phonograph, incorporating the B.S.R. 'Rotocam' instantaneous speed change . . . 78, 45 and 33 $\frac{1}{3}$ R.P.M. at the turn of a switch.

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The M.U. 14 Three Speed Turntable satisfies the demand where auto-stop and pick-up are not required.

Made by Birmingham Sound Reproducers Ltd., Old Hill, Staffs. England Grams: 'Electronic Old Hill, Cradley Heath.'

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.

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

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.

Southwestern IRE Conference

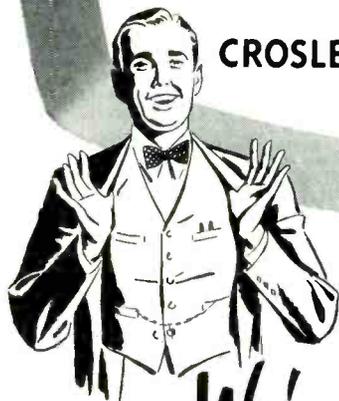
THE 1951 Southwestern IRE Conference will be held on the campus of Southern Methodist University in Dallas, Texas, on April 20 and 21. Keynote of the conference, which has as its theme New Frontier in Electronics, will be Donald G. Fink, editor of *ELECTRONICS*; banquet speaker will be George E. Sterling 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)



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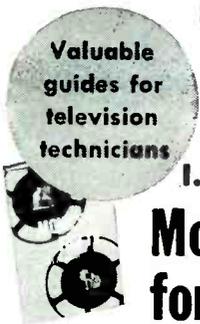
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SYLVANIA ELECTRIC

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Check the ones that can help you most and see them on approval

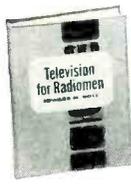
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2. Television & FM Antenna Guide

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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. Cagle; 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)

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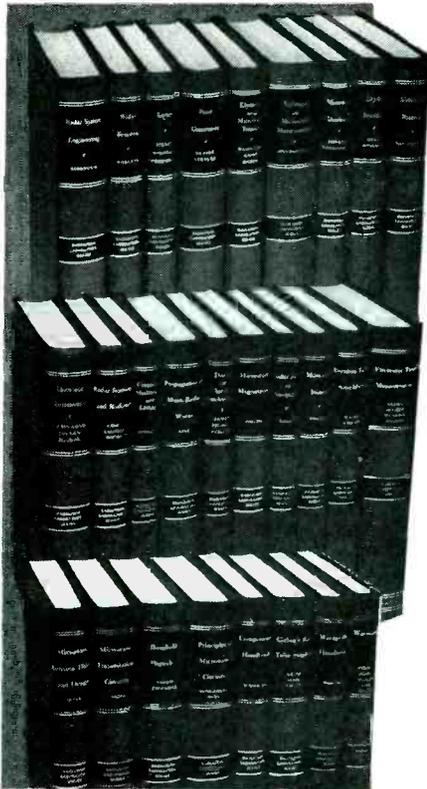
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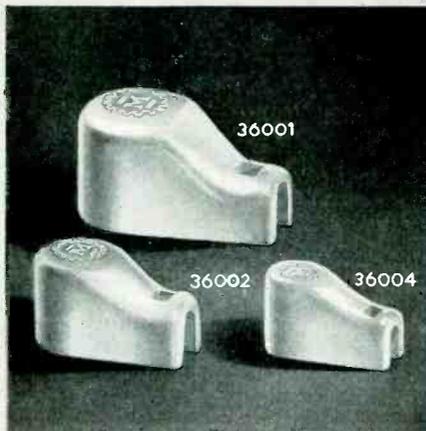
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Color Code

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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

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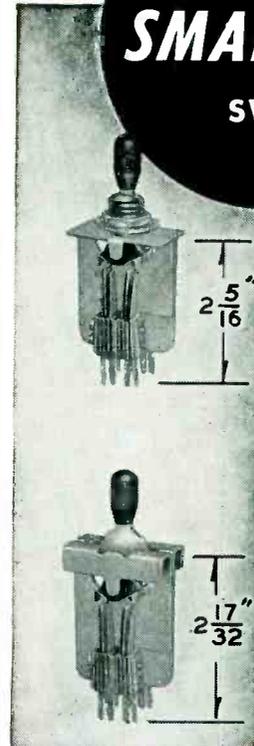
WE refer to the article "Wide-band Series-Parallel Transformer Design" by Vincent C. Rideout which appeared on page 122 in *The Electron Art* department of **ELECTRONICS** (July 1950).

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(Continued on p 292)

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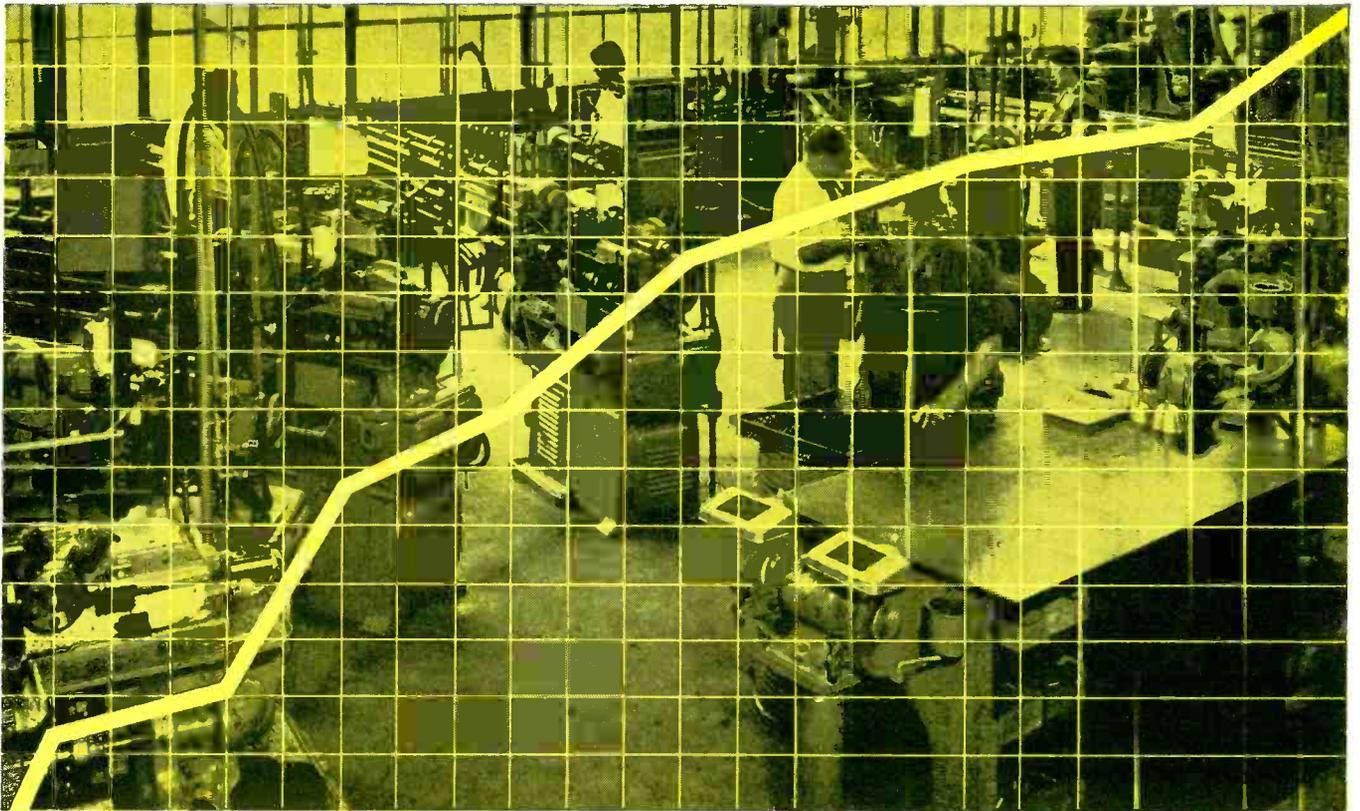
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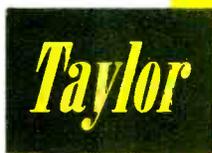
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TUBES AT WORK

(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.

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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.

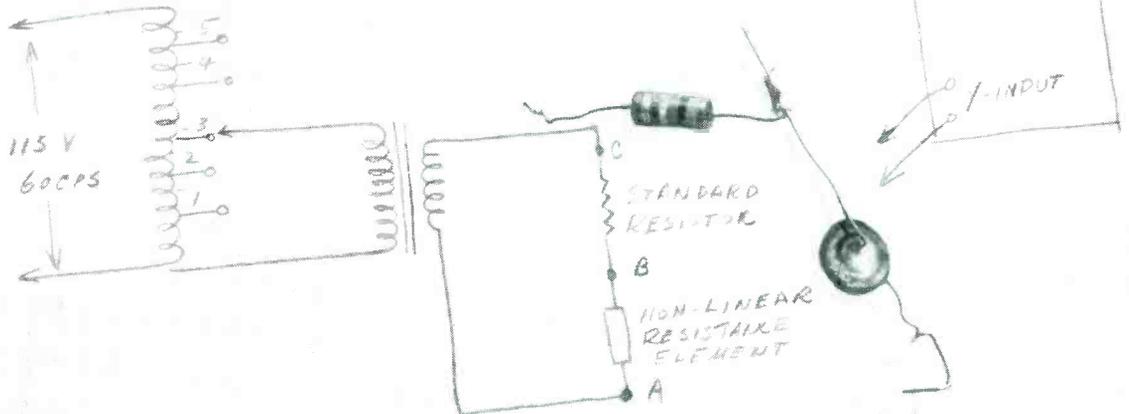
The revolution-control potentiometer is set to a suitable low speed for the rounding operation. As soon as a continuous veneer is evolved, the clutch is disengaged and the end of the veneer is wrapped around the take-up spool. The clutch is then re-engaged for a few revolutions to start the spooling.

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-

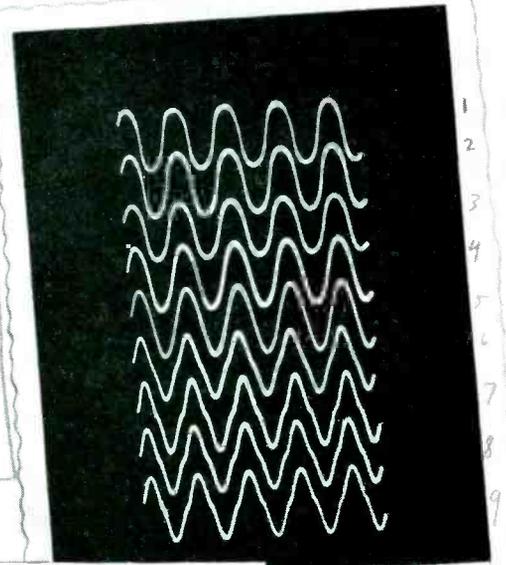
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DUMONT
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PATTERN NO.	TAP NO.	OSCILLOGRAPH INPUT CONNECTION
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2	4	A-B
3	3	A-B
4	2	A-B
5	1	A-B or B-C
6	2	B-C
7	3	B-C
8	4	B-C
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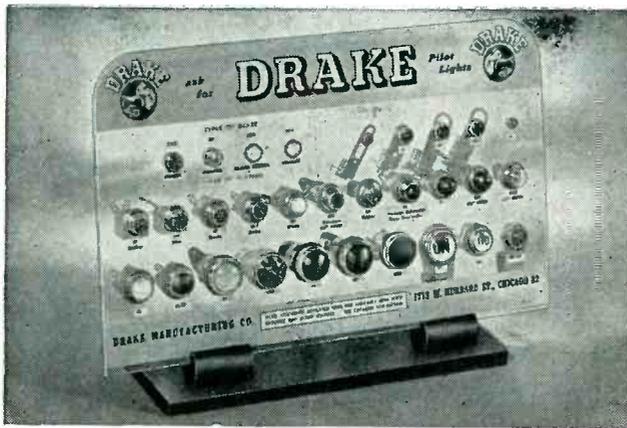
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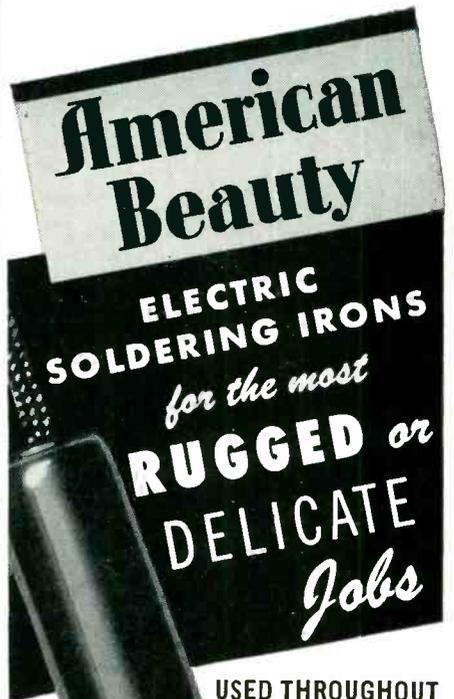
LOW ATTEN TYPES	IMPED OHMS	ATTEN db/100ft of 100 Mc/s.	LOADING μ w	OD"
A1	74	1.7	0.11	0.36
A2	74	1.3	0.24	0.44
A34	73	0.6	1.5	0.88
LOW CAPAC TYPES	CAPAC mmf/ft.	IMPED OHMS	ATTEN db/100ft/100Mc/s.	OD"
C1	7.3	150	2.5	0.36
PC1	10.2	132	3.1	0.36
C11	6.3	173	3.2	0.36
C2	6.3	171	2.15	0.44
C22	5.5	184	2.8	0.44
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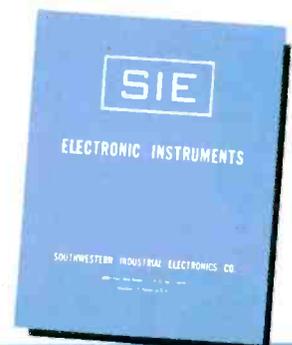
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STACKPOLE CARBON COMPANY
St. Marys, Pa.

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.

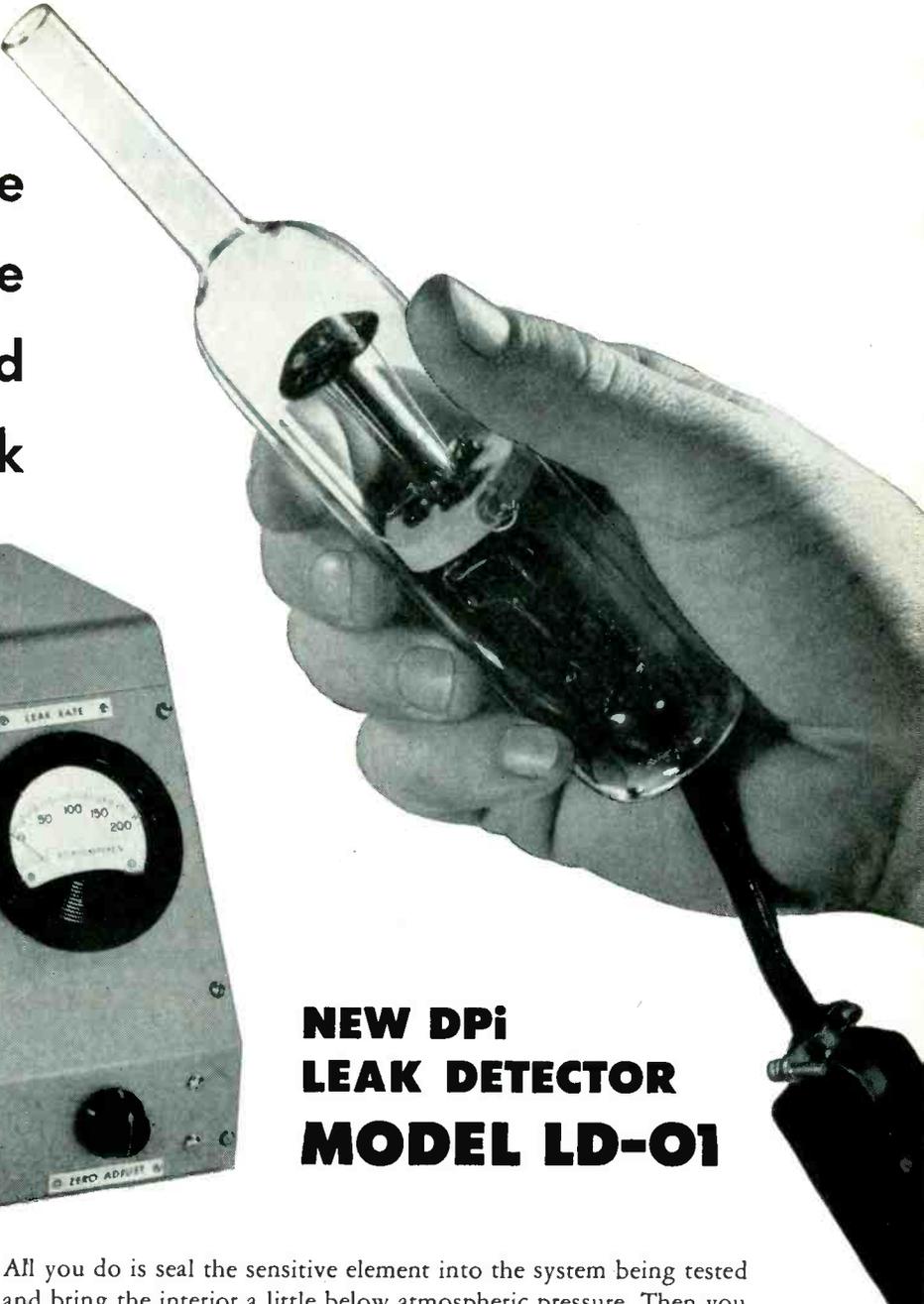
Electronic Counting of Old Paper Money

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.

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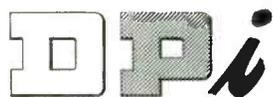


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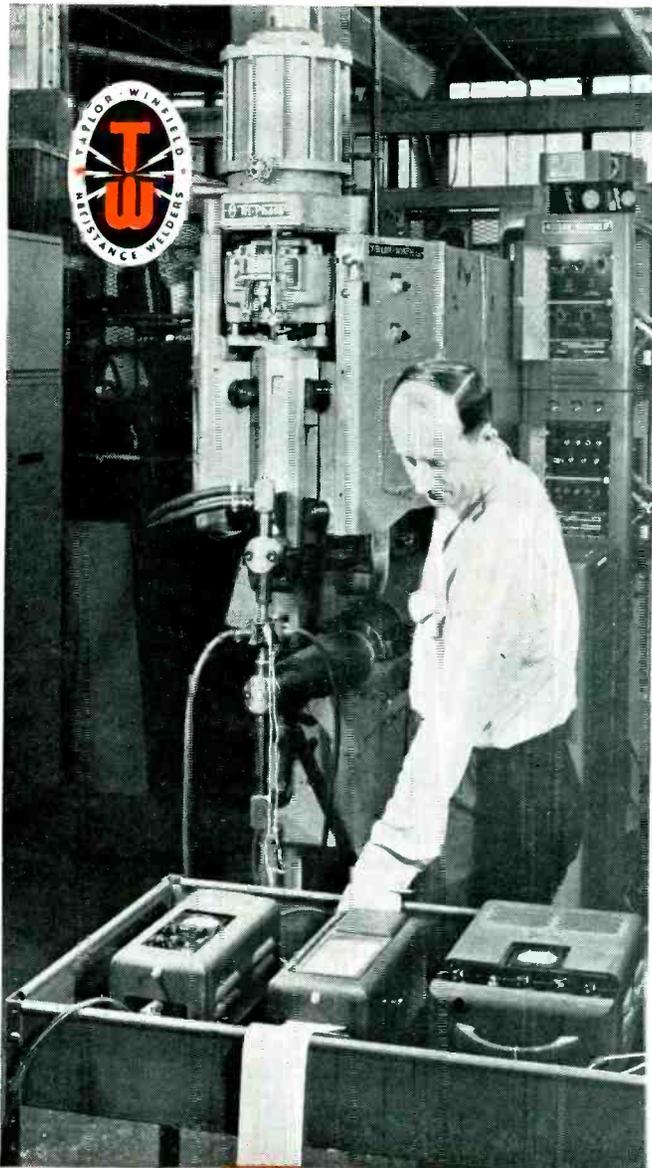
Included are complete descriptions and specifications on wire wound resistors of all types and sizes. Each is precision wound to close tolerance, and many feature special moisture-proofing to assure proper functioning under severest climatic conditions. INRESCO Resistors —available for IMMEDIATE DELIVERY—are supplied in standard or custom types to meet the most unusual design or operational requirements, and are offered at prices that benefit from mass production facilities. A copy of the new INRESCO catalog will be helpful; write for it today. Prices, samples and estimates promptly on other than standard resistors.



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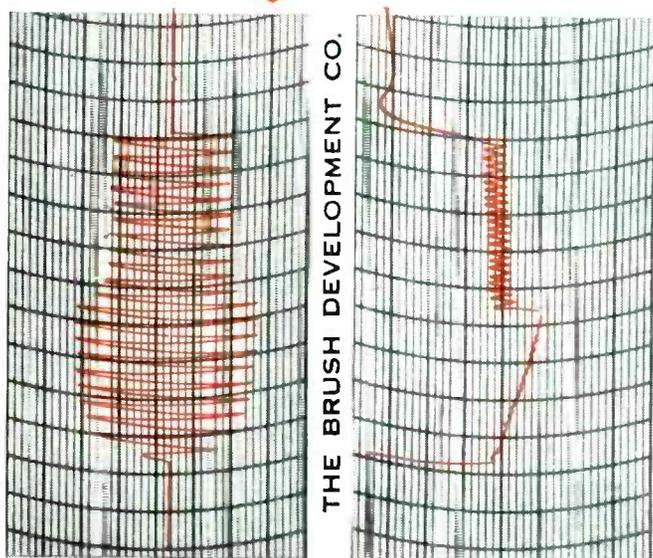
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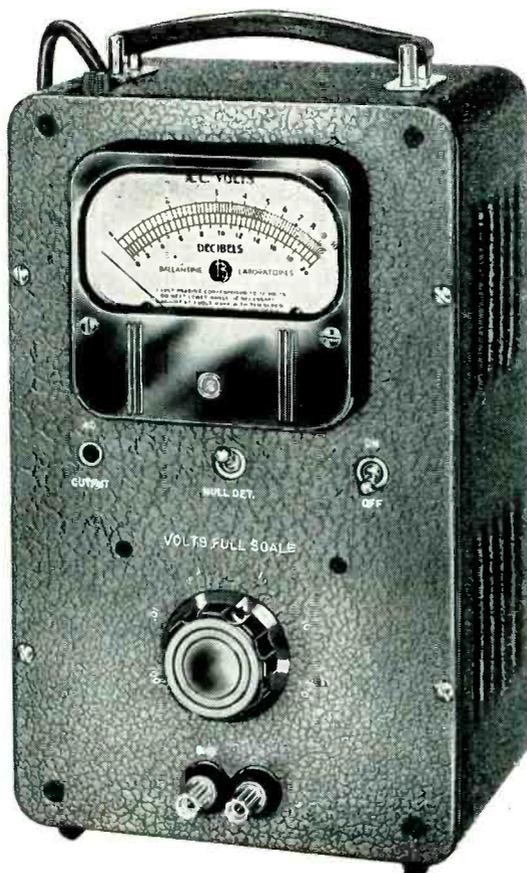
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BALLANTINE LABORATORIES, INC.

100 FANNY ROAD, BOONTON, NEW JERSEY



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.

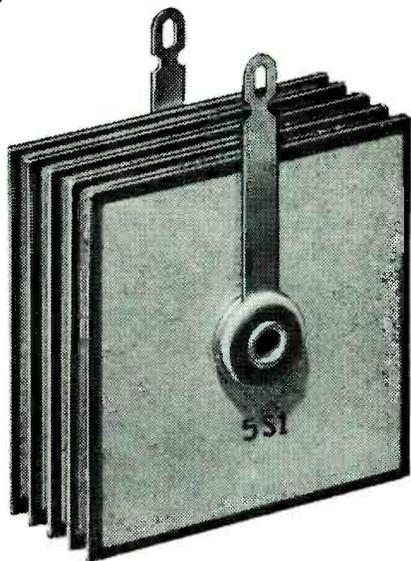
Counting is achieved by using an electronic sensing device consisting of a beam of light and a phototube system. As the notes are unfurled, interrupting the beam of light, the phototube senses the interruptions of the beam. Impulses from the phototube are fed to a binary counter which tallies the individual 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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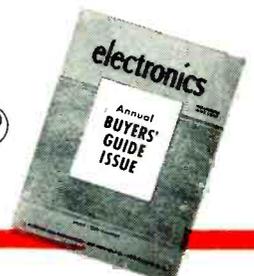
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When you consider that there are more than 2,000 widely diversified products sold to manufacturers and users of electronic equipment, the engineers' need for, and the sales-making success of the "Guide" witnessed to by the quotes on the opposite page become readily understandable.

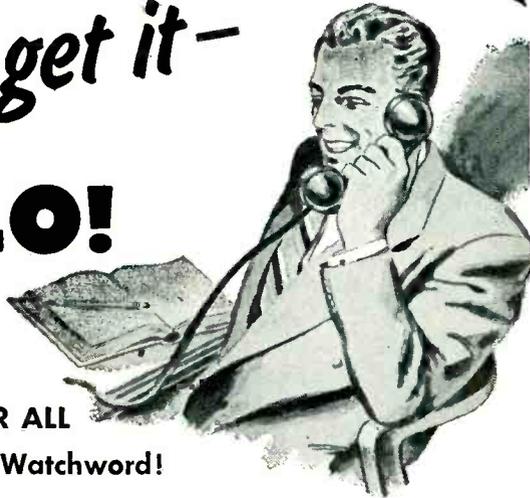
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rotate, rolling the packet around the spindle for counting. The jaws then release and the packet is cleared from the counting head by an additional revolution of the spindle.

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

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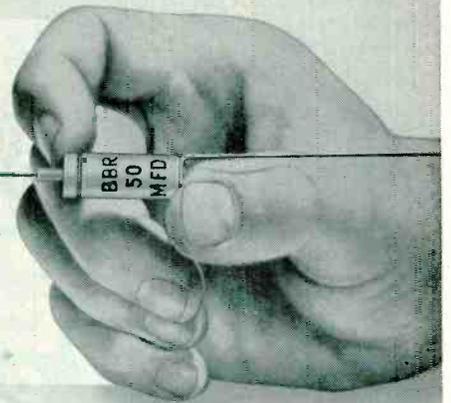
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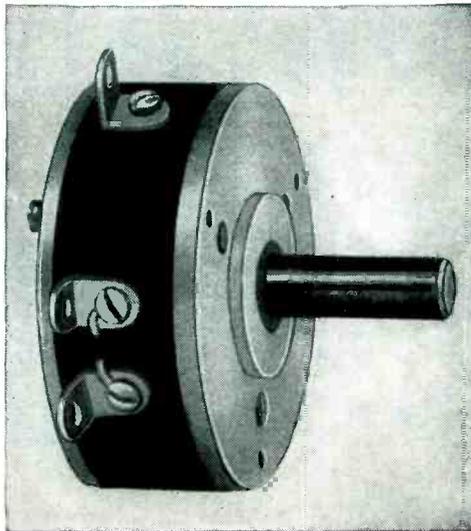
PRECISION POTENTIOMETERS

The linear Type RL-275 illustrated is one of a series ranging from 1 1/4" to 5" in diameter, with resistance ranges of 80 ohms to 500,000 ohms.

GAMEWELL Potentiometers are precision instruments in every respect. They feature extremely close limits in electrical characteristics and mechanical construction, low electrical noise, low torque, and long life—far in excess of 1,000,000 cycles of operation.

All types will operate within specified limits of performance at temperatures —55°C. to +55°C., 95% relative humidity at altitudes up to 50,000 feet. Corrosion resistant materials are used throughout and all insulating parts are fungicided. Our potentiometers meet AN-E-19 specifications.

We invite your inquiries and will gladly study and quote on special requirements.



Write for Bulletin F-68.

THE GAMEWELL COMPANY

Newton Upper Falls 64, Massachusetts



PRECISION PAPER TUBES...



... meet your COIL FORM REQUIREMENTS

YOUR SPECIFICATIONS . . .
round, oval, square, rectangular, any size, any ID or OD, any length. We will give you Precision Paper Tubes to exactly fit your coil form specifications.

YOU CHOOSE THE MATERIAL . . .
finest dielectric Kraft, Fish Paper, Cellulose Acetate or combinations. We will supply whatever material or combination you prefer for your Precision Paper Tubes.

WE'LL GIVE YOU FINER COIL FORMS!
Spiral winding and die-forming under heat and pressure assure stronger, lighter coil forms. Precision Paper Tubes resist moisture better, too—provide better heat dissipation and insulation.

LET US MAKE UP A SAMPLE FOR YOU!
Write today, giving us your requirements, for a free sample. And ask for our new Mandrel List of 1,000 sizes.

PRECISION PAPER TUBE CO.

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are offered excellent working conditions and opportunities for advancement in our **Aerophysics Laboratory**. Salaries are commensurate with ability, experience and background. Send information as to age, education, experience and work preference to:

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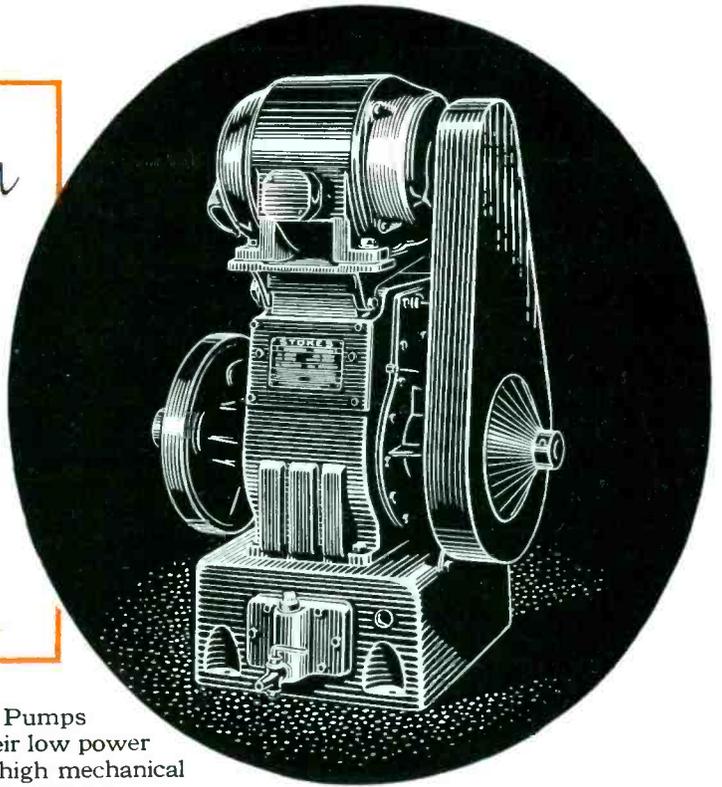
Box No. K-4, 12214 S. Lakewood Blvd.

DOWNEY, CALIFORNIA

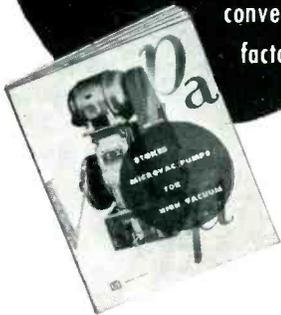
STOKES vacuum
equipment...

efficient,

durable,
economical



Send for Catalog 700,
"Stokes Microvac Pumps
for High Vacuum", now a standard
reference work on High Vacuum,
containing charts, graphs, diagrams,
schematics, typical problems,
tables, formulas, constants,
conversion
factors.



Stokes Microvac Pumps
are known for their low power
consumption...high mechanical
and volumetric efficiency.

Long trouble-free service can be expected from Stokes
Microvac Pumps, perfected during more than 40 years of practical
experience in the development of complete vacuum processing systems.

The four simple moving parts are easily accessible. All parts are
precision-finished, standard, and interchangeable. Lubrication is fully
automatic to all friction surfaces.

The large full-opening exhaust valve of corrosion-resistant Teflon is
highly sensitive to pressure differential... exhausts air completely at each
stroke without re-expansion.

An Oil Clarifier and a Devaporizer are available for continuous purification of
lubricating oil when dirt and solvent vapors are present.

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 ap-
plications in which vacuum
deserves exploration.

STOKES

STOKES MAKES

Plastics Molding Presses,

Industrial Tableting

and Powder Metal Presses,

Pharmaceutical Equipment,

Vacuum Processing Equipment,

High Vacuum Pumps and Gages,

Special Machinery

F. J. STOKES MACHINE COMPANY, 6046 TABOR ROAD, PHILADELPHIA 20, PA.



MULTI-CONTACT terminal board, below, is a typical example of C.T.C. custom-designing.

Let C.T.C. experts design and make your special terminal boards

Special boards for electronic units are required by many government contracts. Specifications are so severe and standards so rigid, these boards must be fabricated to fit the job.

C.T.C.'s Custom Engineering Service is well-equipped to fill these specifications for you. We are thoroughly familiar with the JAN-approved materials in accepted usage by government agencies and the armed forces. This, combined with assembly know-how developed over many years of supplying electronic components and equipment to the government and to electronic manufacturers, enables us to meet your needs.

C.T.C. can supply any size or shape terminal board with practically any terminal arrangement desired . . . in any production quantity.

SPECIAL CONSULTING SERVICE

To aid you in securing exactly the *right* components to meet the requirements of your designs, prototypes, etc., C.T.C. maintains a staff of thoroughly experienced component engineers. These experts will work closely with you for the most economical and satisfactory results—and where standard parts are not suitable will design special units. *This service is always available to you — without cost!*

C. T. C. Products Include:



NEW! SLUG TUNED COIL FORM — TYPE LS-8 — Here's a brand new slug tuned coil form featuring silver-plated phosphor bronze clip terminals which cannot loosen. Height, 23/32". Maximum diameter, 1/2". Mounts in "D" punched hole or in 1/4" round hole. Coil form is of grade L-5 silicone impregnated ceramic. Slug is provided with a spring lock. All metallic parts except clips are cadmium plated. Supplied complete with slug and all mounting hardware.

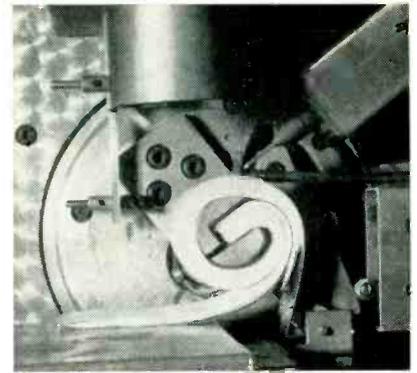
CAMBRIDGE THERMIONIC CORPORATION
437 Concord Avenue, Cambridge 38, Mass.

- Please send me more information on special terminal boards.
- More information on C.T.C.'s cooperative engineering service.
- More information on the following C.T.C. products:

Name Position
 Firm
 Street
 City Zone State



custom or standard . . . the guaranteed components



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
FIBERGLAS* *Yarns* HERE...

IN RADIO AND TELEVISION WIRE?

- Because*
- Fiberglas yarn braid won't burn, resists soldering heat
 - Fiberglas yarns are tough even in small diameters . . . that means thinner, easier to handle wire
 - Fiberglas yarns won't rot . . . even in tropical climates
 - Competitive in price with conventional wire braiding!

Specify Fiberglas Yarn braid when you order Radio and Television wiring.

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FIBERGLAS IS IN YOUR LIFE... FOR GOOD!

Please send me the booklet "Specify Fiberglas Yarns in Wire or Cable."

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"NO CARTONS?" SCREAMED THE VP

"Look," he growled, "I asked for 5,000 cartons marked XY2 last Monday!" "And here it is Tuesday," flared the Stock Head. "Even if the printer had worked all night, we still wouldn't have room for them. Not with those 50,000 cartons marked AB4 still lying around—the ones you ordered three months ago."

"Well, this order has to get out tonight," sputtered the VP. "Have somebody with good handwriting mark the numbers on the cartons."

* * *

Know how that problem could have been avoided? With a Markem box printer or carton marker. These versatile machines let electronic manufacturers imprint their own cartons, labels, envelopes with swift, professional neatness. They're designed for flexibility—quick changes of variable

data, easy to operate, fast-drying inks in many colors. Our harassed Stock Head could have run off exactly the number of cartons the VP needed, with the latest designation, in a couple of hours if only he'd had a Markem machine handy. Best of all, he would have eliminated inventories and outside printing bills.

Maybe a Markem machine is the answer to your problems. Why not write us today, sending samples of what you imprint, and find out the facts?



KEENE 27, NEW HAMPSHIRE

Compact

dependable instruments

Heiland
DENVER

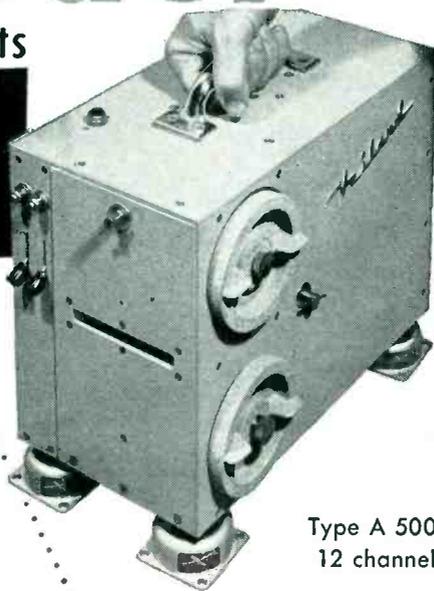
Portable
OSCILLOGRAPH
Recorder

Designed and developed for applications where a minimum of space and weight are required. Small size...6 3/4" x 9 7/8" x 12 3/4". Lightweight...33 lbs. Versatility of operation...for the recording of strain, vibration, displacement, acceleration, pressure and temperature.

The Heiland A 500 Portable Oscillograph Recorder has many features found only in larger instruments... easy loading...four quick-change paper speeds...trace identification...simultaneous viewing and recording...zero mirror...film movement indicator...up to 12 channels.

Write for complete detailed information

HEILAND RESEARCH CORPORATION
133 E. Fifth Avenue Denver, Colorado



Type A 500
12 channel

6 3/4" x 9 7/8" x 12 3/4"

REK-O-KUT

Turntables are now being specified on Gov't. Contracts for this particular type of equipment!

We particularly call your attention to the new

REK-O-KUT

Continuously Variable-Speed Turntable Model CVS-12



MODEL-CVS 12
Chassis, Motor and Turntable Assembly Plays all records from 6 to 16 inches.

\$84.95 net

Plays at any speed from 25 to 100 R.P.M. without wow. Meets the following Government Specifications for operation and power requirements!

POWER	VOLTAGE	FREQUENCY
Nominal	115 V.	60 Cycles
Upper Limit	122 V.	65 Cycles
Lower Limit	108 V.	55 Cycles

Specifications on Equipment:

Equipment shall rotate records at 78, 45 and 33 1/2 and shall be arranged so that those speeds can be established and maintained on the specified power supply, and any slow rate variations, and also within the limit specified as above.

The new REK-O-KUT CVS-12 is the ONLY 12 inch Turntable to our knowledge which will meet these Government Specifications.

Operates on 50 or 60 cycles . . . no pulleys to add or idlers to change. The only Turntable to use in areas of fluctuating voltage, frequency, or with portable power plants.

SPECIFICATIONS

Speed Changes: Continuously Variable
(a) 110V—60 Cycles, Range: 25 to 100 R.P.M.
(b) 110V—50 Cycles, Range: 20 to 85 R.P.M.
Turntable—12" cast aluminum, hardened and ground shaft.
Motor—constant speed, 4 pole.
Drive—exclusive Rek-O-Kut VARI-CON* self-sealing rim drive.
Noise Level—30db maximum below recording level.
Dimensions—16" L., 12" W., 5" below chassis.
Available at your regular parts distributor. Manufacturer's discounts on request.

REK-O-KUT CO.

38-23 Queens Boulevard
Long Island City 1, N. Y.

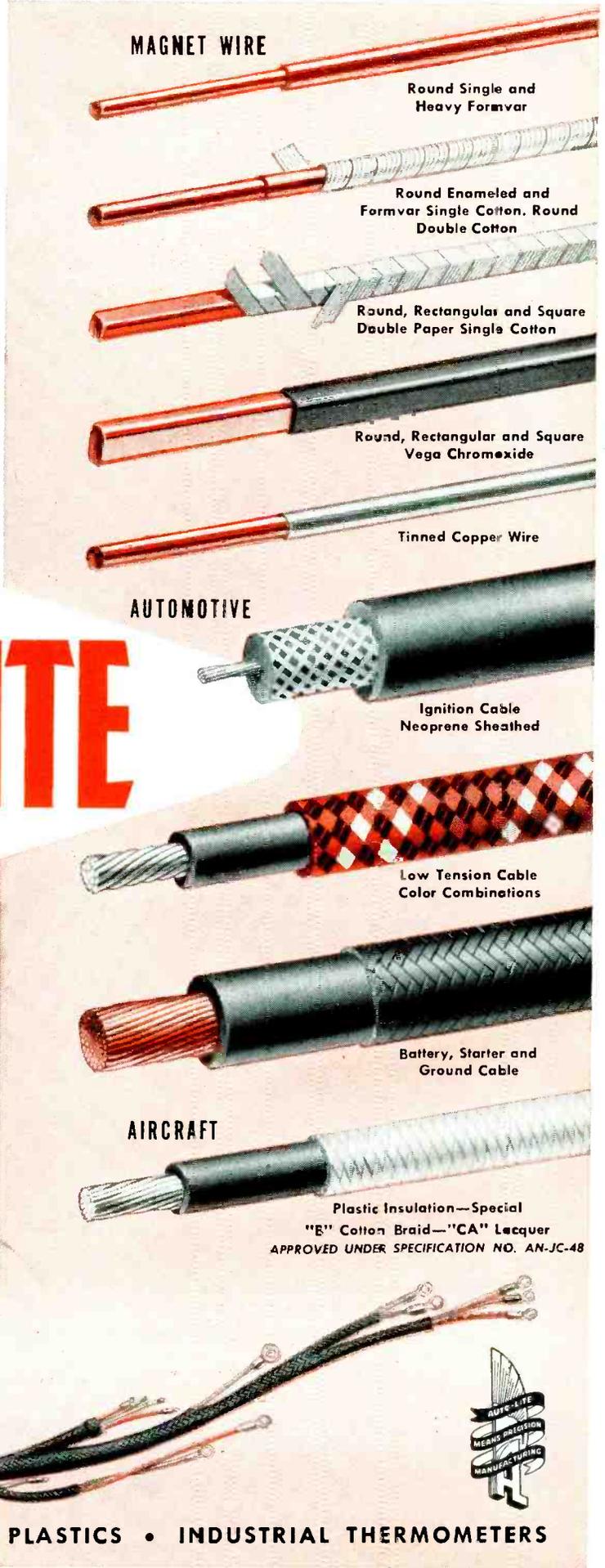
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right
with**

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Industrial Wire & Cable

• The quality of Auto-Lite Wire and Cable is the result of nearly 40 years of experience, research and advanced laboratory tests. This, plus the tremendous output possible in Auto-Lite plants at Port Huron, Michigan and Hazelton, Pa., makes Auto-Lite a logical source of supply for wire to fit every need. Address inquiries to:

The Electric Auto-Lite Company
Wire and Cable Division
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MAGNET WIRE

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Round Enameled and Formvar Single Cotton. Round Double Cotton

Round, Rectangular and Square Double Paper Single Cotton

Round, Rectangular and Square Vega Chromoxide

Tinned Copper Wire

AUTOMOTIVE

Ignition Cable Neoprene Sheathed

Low Tension Cable Color Combinations

Battery, Starter and Ground Cable

AIRCRAFT

Plastic Insulation—Special "E" Cotton Braid—"CA" Lacquer
APPROVED UNDER SPECIFICATION NO. AN-JC-48



WIRE & CABLE • DIE CASTINGS • PLASTICS • INDUSTRIAL THERMOMETERS

Leach RELAYS

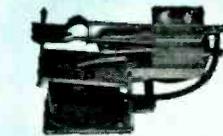
**TROUBLE-FREE
PERFORMANCE**

"as specified"

Because all *Leach* Relays are *quality engineered* for dependable duty... they are specified *first* by leading manufacturers of industrial equipment of all types. If your equipment demands relays that are first and foremost, more dependable and longer lasting, specify *Leach* Relays... they're more dependable... *performance proves it*. Whatever your relay control problem... it's a challenge to *Leach*. Illustrated are but a few of the wide selection *Leach* provides industry, as standard equipment.

RELAYS SHOWN ABOVE CAN BE SUPPLIED WITH VARIOUS CONTACT ARRANGEMENTS. WRITE FOR DETAILS.

BETTER CONTROLS THROUGH BETTER RELAYS



✓ MOTOR STARTING RELAY



✓ OVERLOAD TRIP LIGHT DUTY



✓ HERMETICALLY SEALED



✓ MIDGET LATCHING RELAY



✓ RADIO AND HIGH VOLTAGE



✓ ANTENNA TRANSFER



✓ MULTIPOLE RELAY



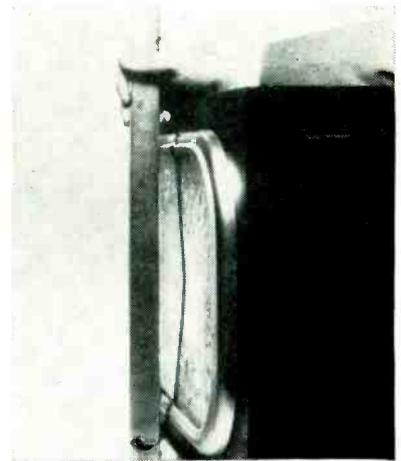
✓ MIDGET RELAY



✓ CIRCUIT CONTROL

TUBES AT WORK

(continued)



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

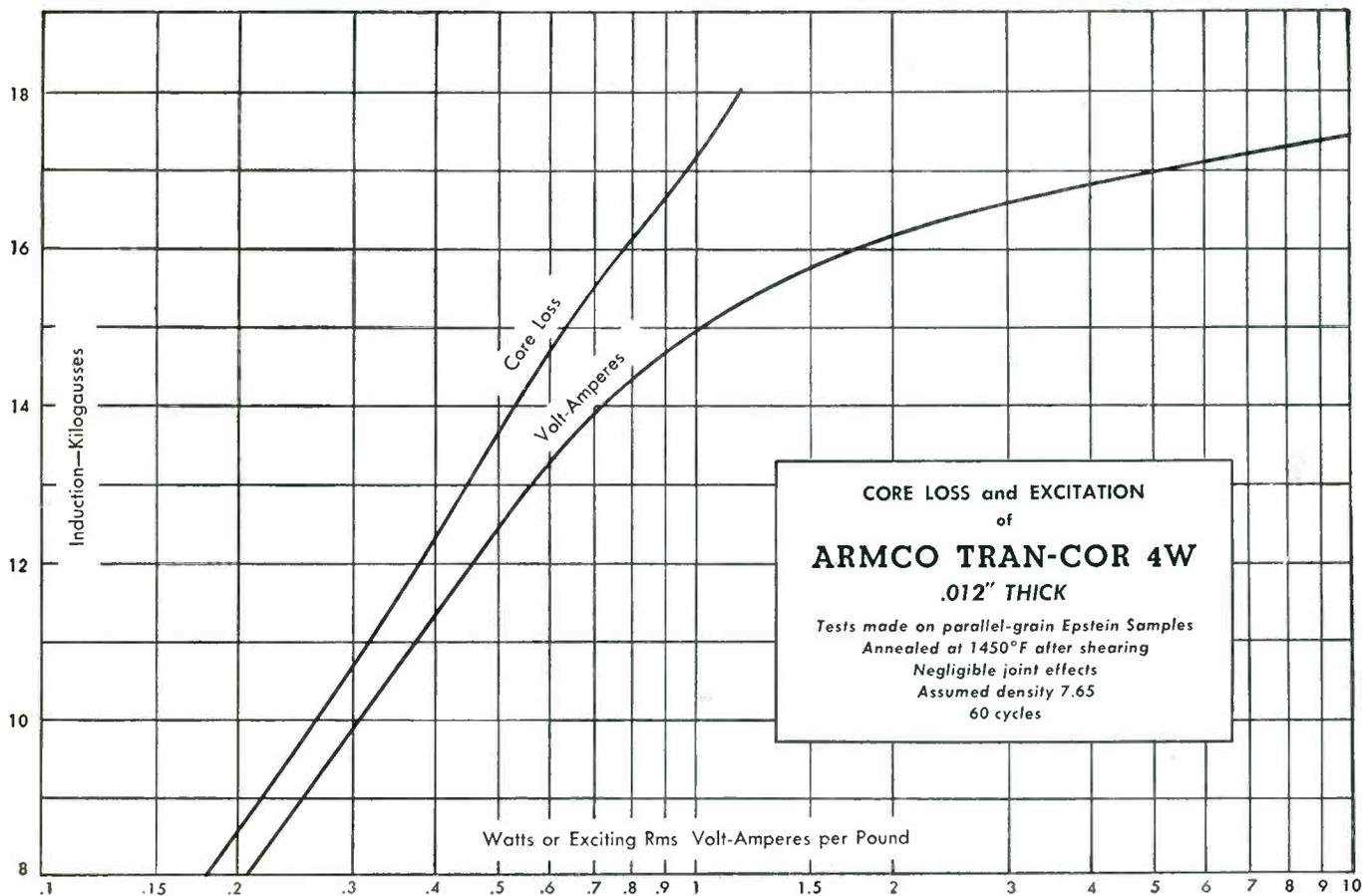
JET fighter planes can be guided through combat maneuvers with split-second accuracy by means of an electrical copilot developed by the Westinghouse Electric Corporation together with the Air Materiel Command's Armament Laboratory, Control Equipment Branch.

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-

LEACH RELAY CO.

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CORE LOSS and EXCITATION
of
ARMCO TRAN-COR 4W
.012" THICK
Tests made on parallel-grain Epstein Samples
Annealed at 1450°F after shearing
Negligible joint effects
Assumed density 7.65
60 cycles

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



ECONOMY ACCURACY STABILITY COMPACTNESS

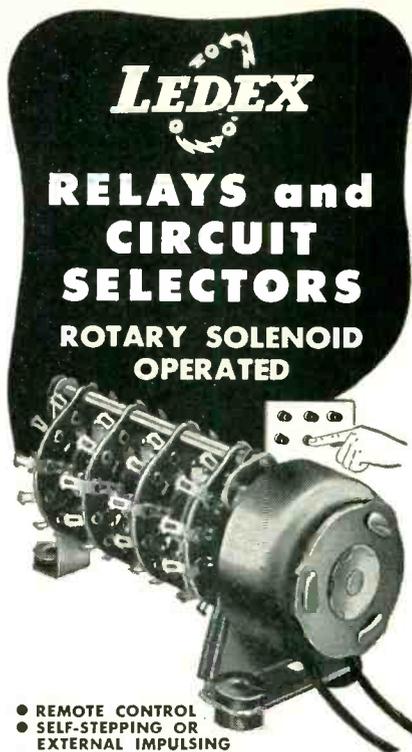
★ ★ ★

Have your Cake . . . and Eat it, too, with JELLIFF ALLOY 1000 RESISTANCE WIRE

The new high in Resistivity—1000 ohms/cm—plus an impressive array of important electrical and physical characteristics, make our new ALLOY 1000 the most desirable material for windings in compact, precision resistors of all types. And the best thing about it is that you don't gain one characteristic at the cost of serious losses elsewhere. Write today for Bulletin 17, with the full story and technical data on JELLIFF ALLOY 1000 RESISTANCE WIRE



IN PRECISION RESISTORS



- REMOTE CONTROL
- SELF-STEPPING OR EXTERNAL IMPULSING
- POSITIVE DETENT ACTION

for REMOTE CONTROL of MULTIPLE COMPLEX CIRCUITS

Many versatile designs of stepping, counting, adding and subtracting, latching, and *circuit selecting* relays are made possible by the combination of the Ledex Rotary Solenoid and wafer type rotary switches. Self-stepped or externally impulsed, the device is immediately adaptable to many remote control applications. A choice of wire sizes permits a wide range of operating voltages and power requirements. Various types of mountings further increase its adaptability. In addition to its positive control of multiple, complex circuits, a reserve of mechanical power is available for the performance of duties other than switching operations.

We supply to quantity users and solicit the opportunity to be of assistance in solving multiple circuit relay problems.

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G. H. Leland INC.

118 WEBSTER STREET

DAYTON 2, OHIO

on NEW Design

MONOSCOPE AND SYNCHRONIZING SIGNAL GENERATOR SYSTEM

A new high for Stability, Performance and Versatility

TYPE 2300 MONOSCOPE

- Produces standard "Indian Head" test pattern with greater than 450 line resolution.
- Provisions for mixing "sync" in the unit.
- Output polarity Black Negative. Output voltage 2 volts P-P into 75 ohm load. Price . . . \$1,200

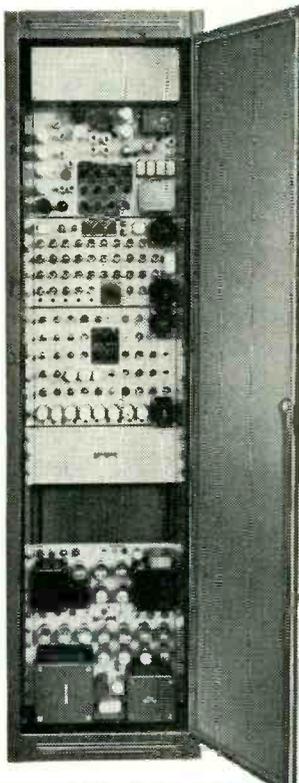
TYPE 2200 SYNCHRONIZING SIGNAL GENERATOR

- All binary dividers. No blocking tube or locked oscillators. Complete freedom from "rolling" at critical moments.
- Meets all R.T.M.A. and F.C.C. specifications with wide margin to spare.
- Built-in bar and dot generator for sweep linearity checking. Price . . . \$1,995

COMPLETE SYSTEM AS SHOWN . . .
CBS color standard Monoscope and
Synchronizing generator, Type 2301
and 2201, also available.

\$3,195 F.O.B.
PLANT

Write for Type 2200 and 2300 Data Sheets.



Manufacturers of a complete line of TV and Radar Test Equipment

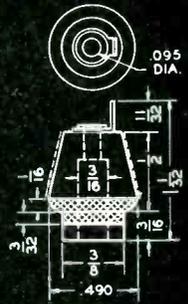
Tel-Instrument Co. Inc.

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Solve your Hermetic Seal Problems

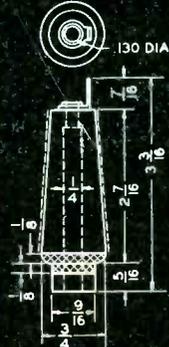
WITH

RUGGED STEATITE TERMINALS

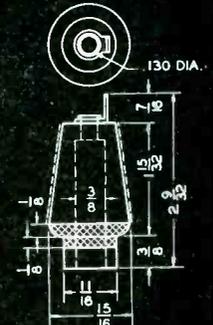


D 3342

GLAZE ----
TINNED SURFACE [cross-hatched pattern]



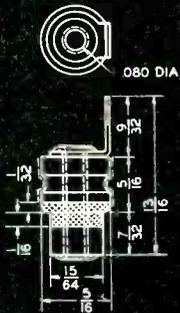
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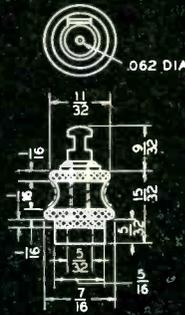
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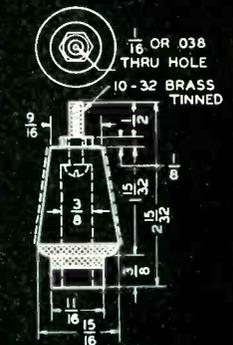
D 3346



D 3405



D 3540



D 3638

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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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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.

product of

**AMERICAN TIME PRODUCTS
INC.** New York 19, N. Y.
Operating under patents of the Western Electric Company

Type 212

TERMINATION

Front and Rear

CONSTRUCTION

Standard 8 $\frac{3}{4}$ " x 19" Panel

HOUSING

8 $\frac{3}{4}$ " x 19" x 8" Metal Cabinet

WEIGHT

25 pounds

American Time Products, Inc.,
580 Fifth Ave., New York 19, N. Y.

Gentlemen:

Please send descriptive folder, No. 212'

Name.....

Company.....

Address.....

City..... State.....

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-

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High Fidelity Tape Recorders for Industry



NOISE ANALYSIS • PROCESS CONTROL

VIBRATION TESTS • TELEMETERING

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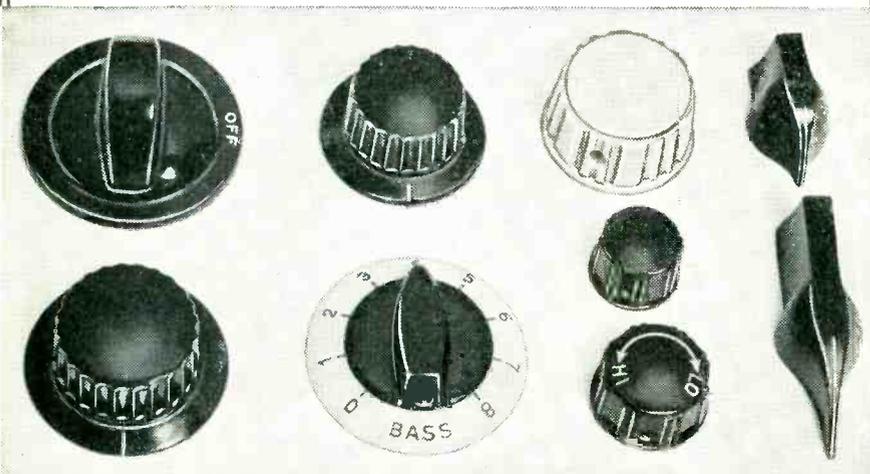
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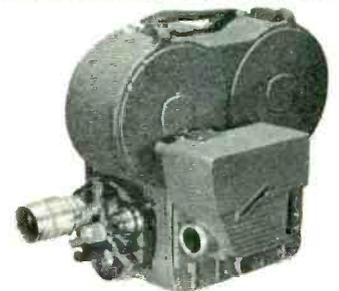
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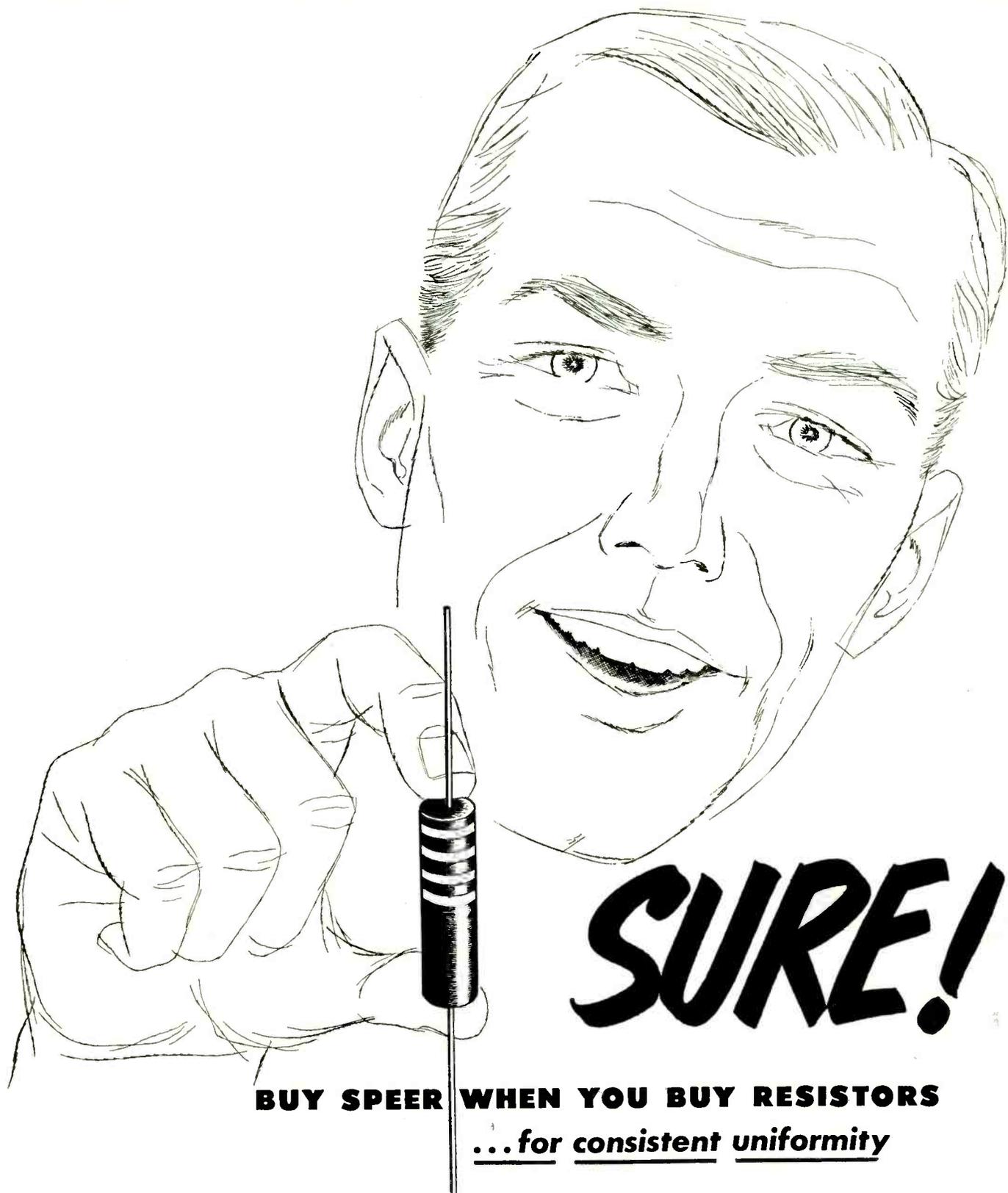
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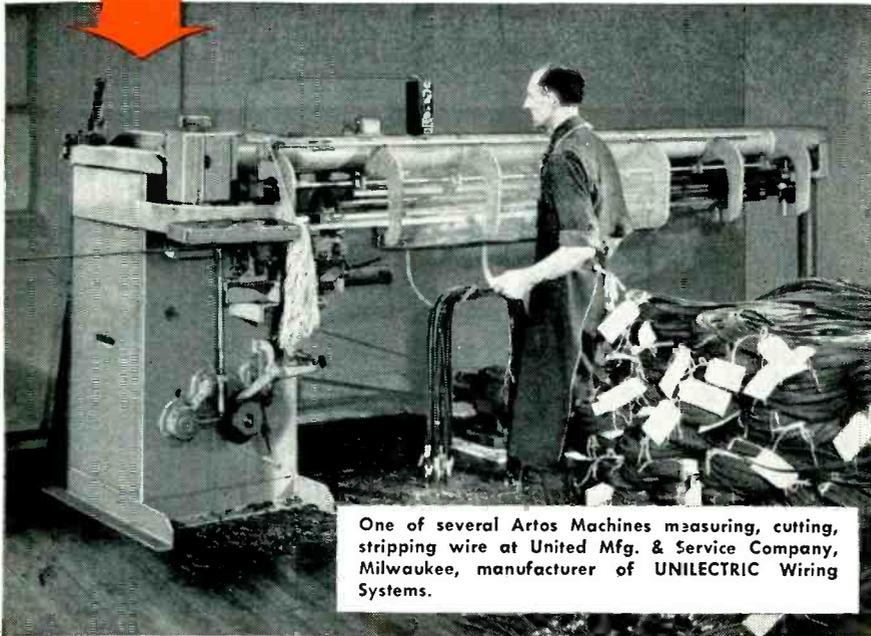
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TUBES AT WORK

(continued)

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

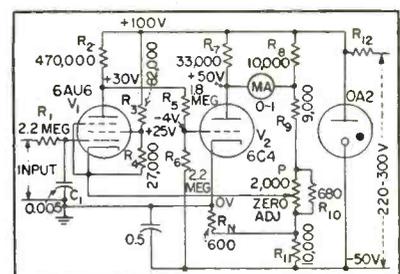
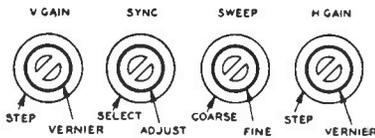


FIG. 1—Circuit diagram for d-c vtvm with feedback over two stages

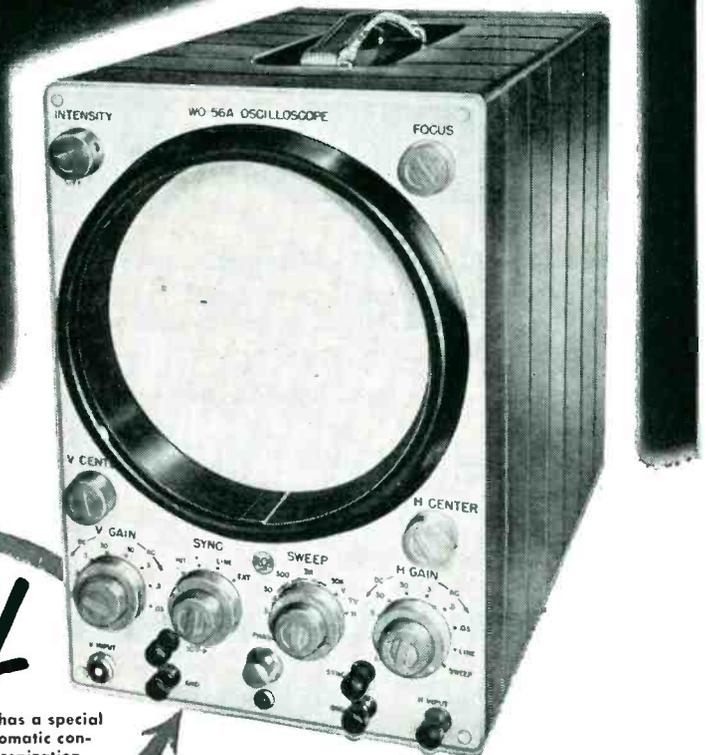
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- Identical vertical and horizontal amplifiers with equal phase-shift characteristics.
- Retractable light shield for maximum visibility.
- New filter-type graph screen with finely ruled calibrations.
- Magnetic shield enclosing CR tube to minimize hum-pickup from internal and external fields.

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- 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.
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- 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 13 3/8" h, 9" w, 16 3/8" d. Weight only 31 pounds (approx.).

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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.

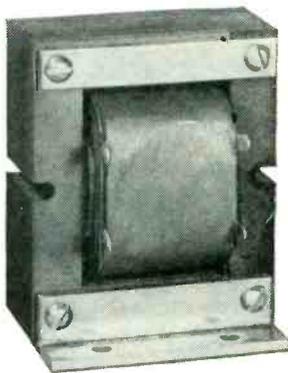


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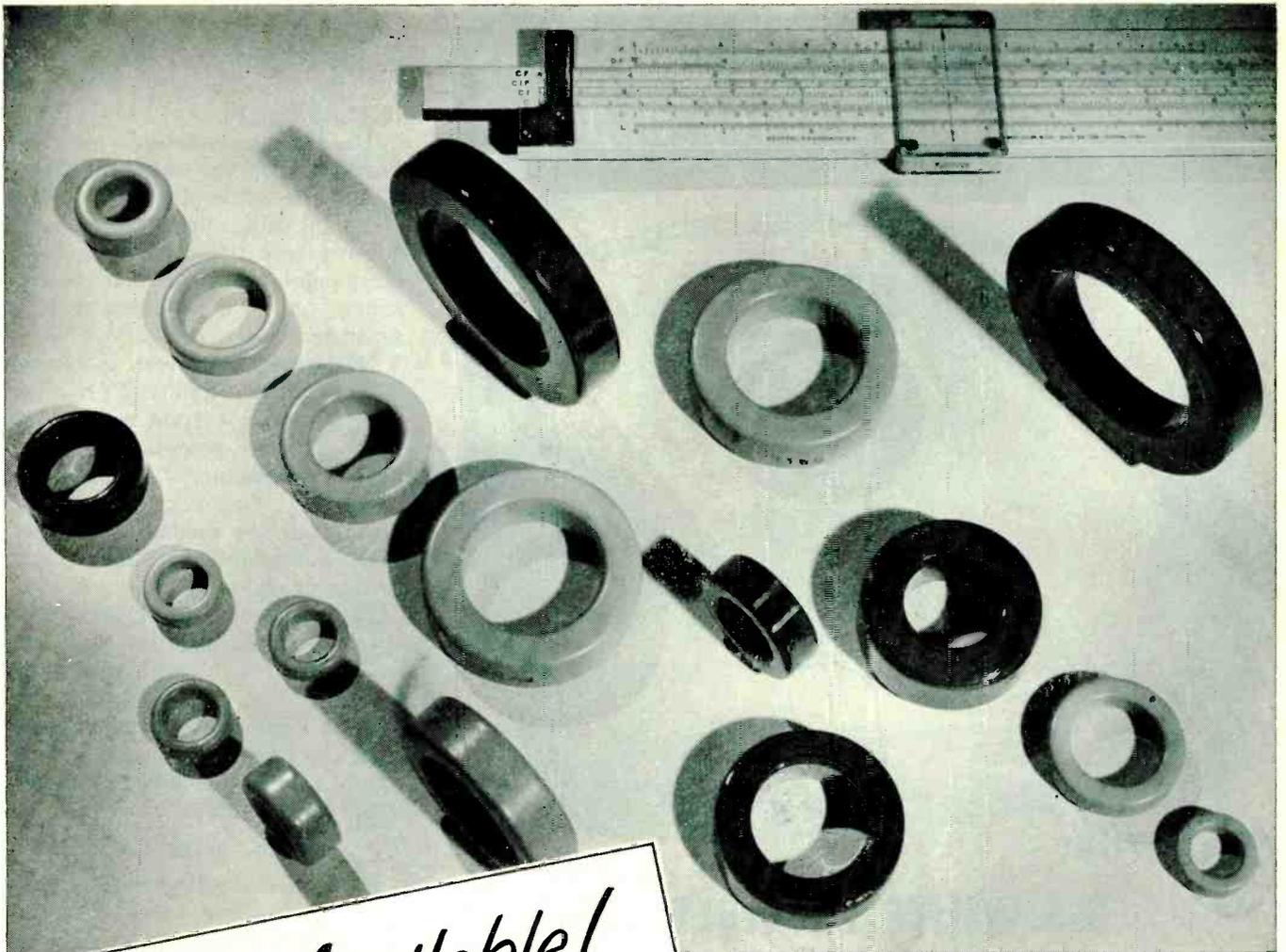
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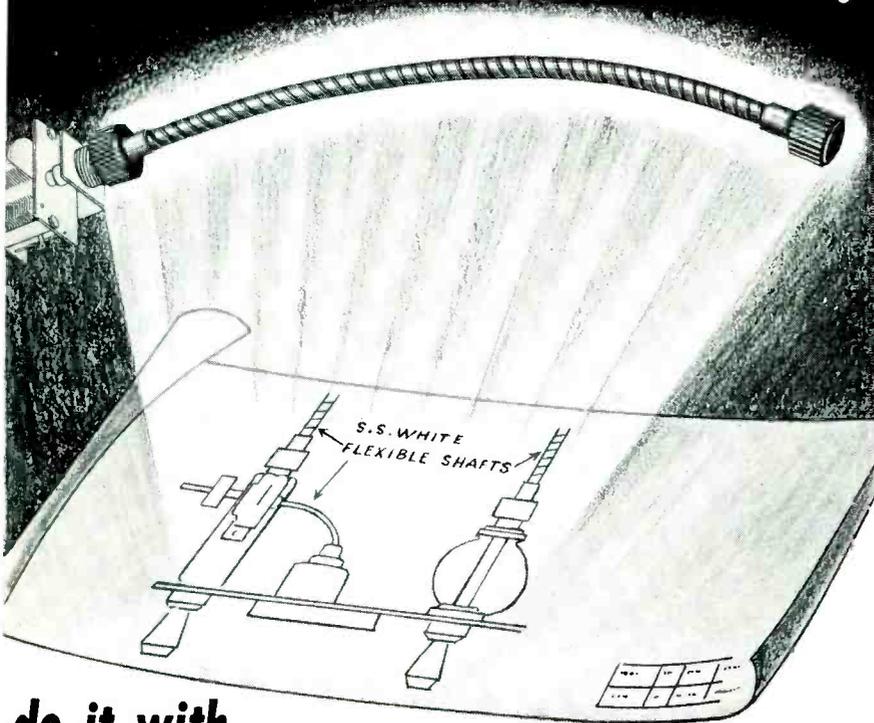
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for the Nyquist-type interstage coupling circuit.

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_5-R_6 .

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.

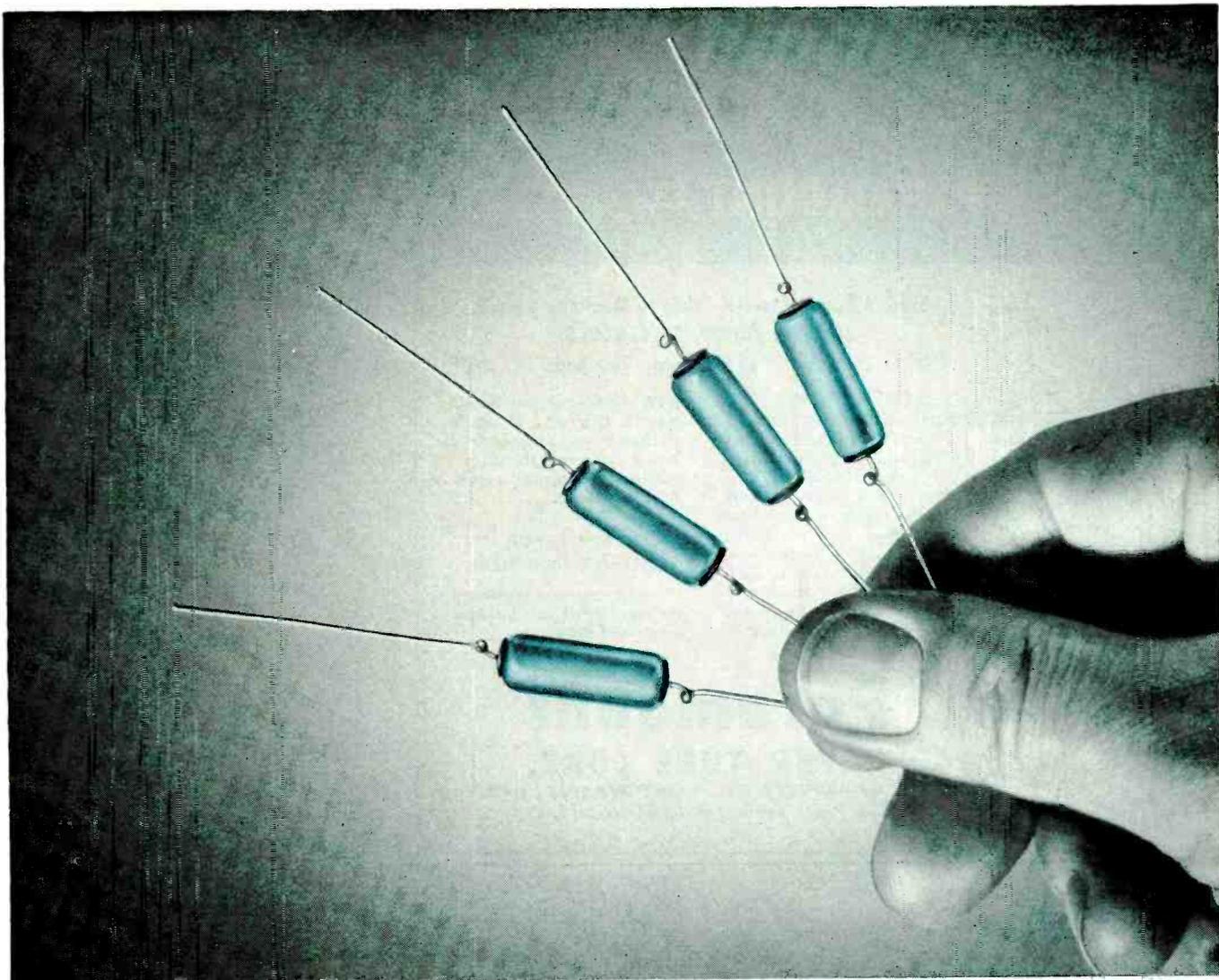
Choice of Pentode

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_8-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- μ triodes draw too little plate current at the plate voltage desired and medium- μ 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- μ a instrument were to be used, R_7 should be doubled in value.

The usual a-c filtering is incor-



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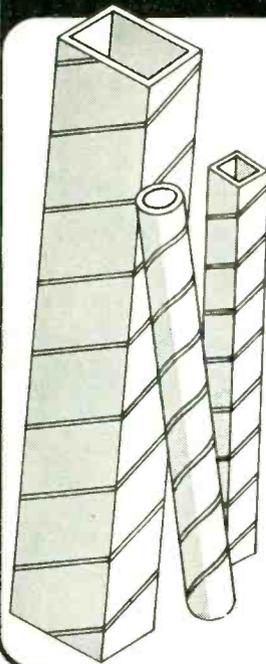
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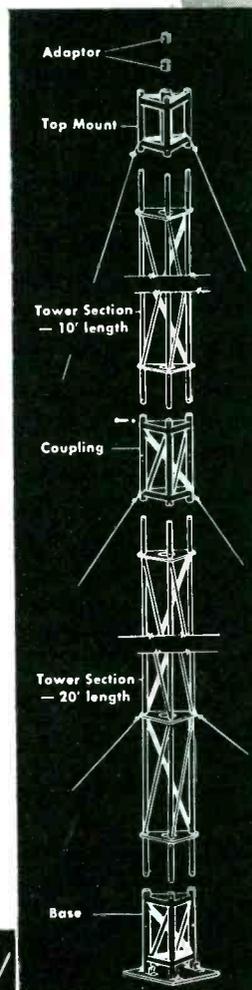
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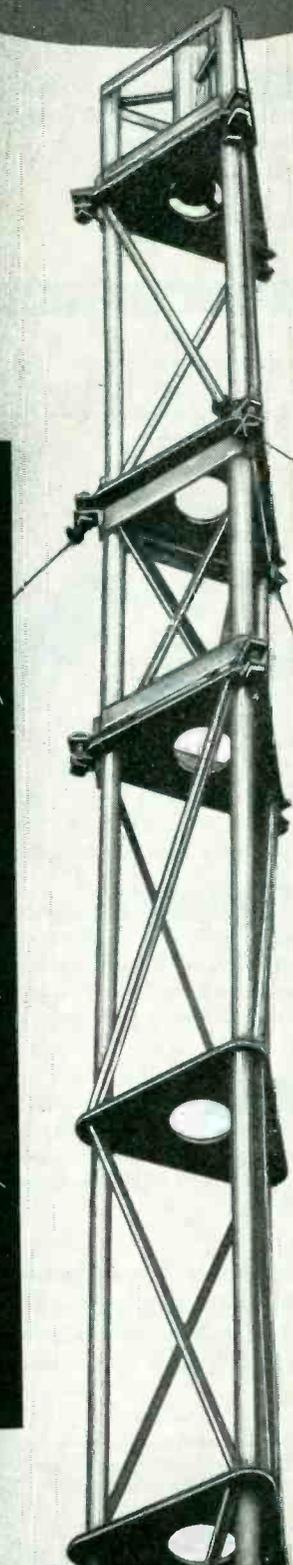
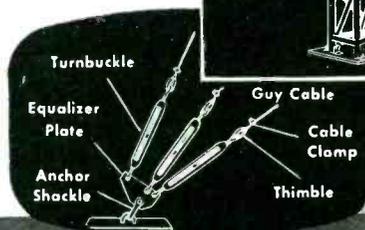
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TUBES AT WORK

(continued)

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_0 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

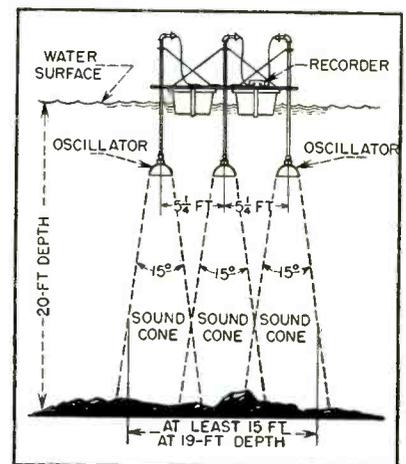


FIG. 1—Sweeping system employing three ultrasonic oscillators connected in parallel

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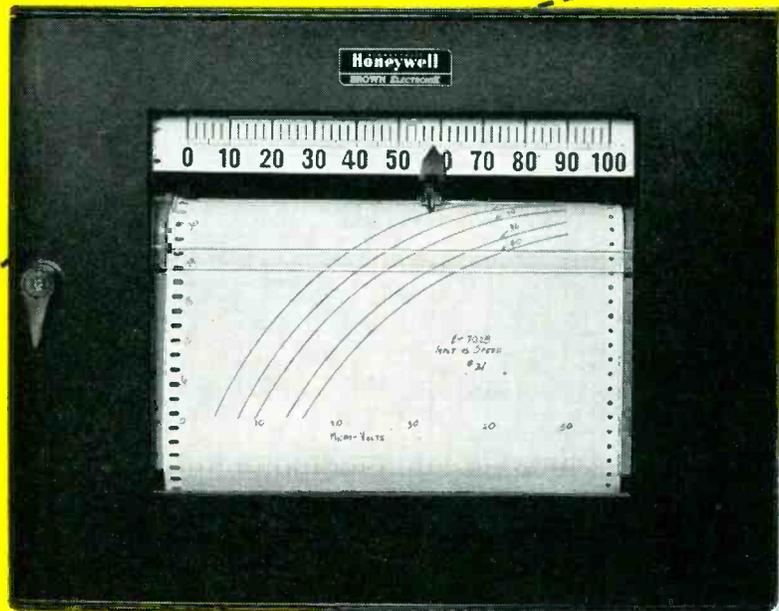
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GONE are the days of labored hand plotting . . . logging countless readings . . . missing many in-between values . . . consuming valuable time. Now you can automatically record a precise and continuous curve representing the relation of any two variables, that can be reduced to a dc voltage, by connecting them to the new *Elektronik* Function Plotter. Every point of the curve will be recorded *exactly as it is measured*.

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For uniformly low distortion, for response curves that are truly flat over the full frequency range, use these famous CHICAGO Sealed-in-Steel input and output units. Get the facts on the BO-6 (P-P 6L6's to 6/8 or 16/20 ohm speaker), the BO-7 (600/150 ohm line to 6/8 or 16/20 ohm speaker), and the full line of CHICAGO full frequency units—years ahead in audio transformer design—tops for performance.

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CHICAGO P.A. range units are geared to today's public address circuit requirements and to latest tube types. Line and voice impedances used in the advanced Sealed-in-Steel output designs meet RMA standards. The 4, 8, and 16-ohm voice coil impedances can also be used with 3.2, 6 and 20-ohm speakers without appreciable mismatch. Available in a complete range of perfectly matched driver and output units.

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

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				Length	Width	
CAP-6/30/20	6	30 amps.	20 KV	3-11/16"	3"	± 1/2MMFD
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"	± 1/2MMFD
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

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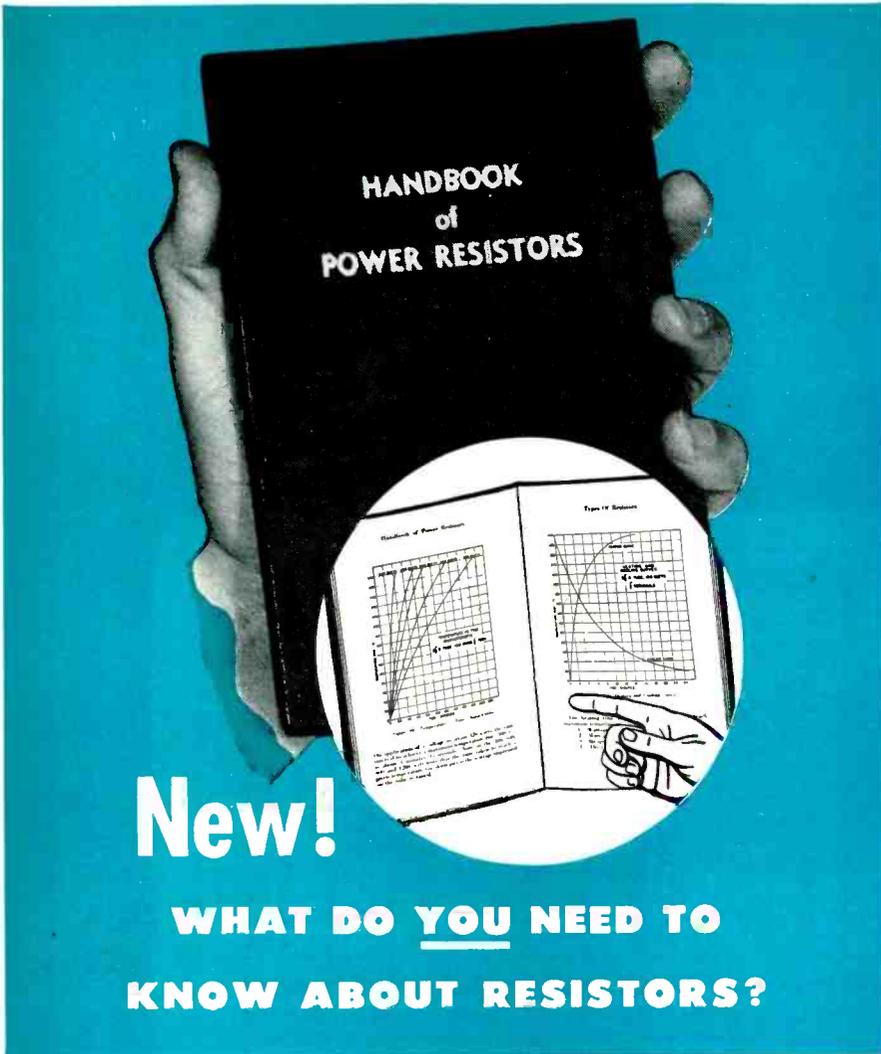
C = Capacitance A = Amperes P = Potential

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TUBES AT WORK

(continued)

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.

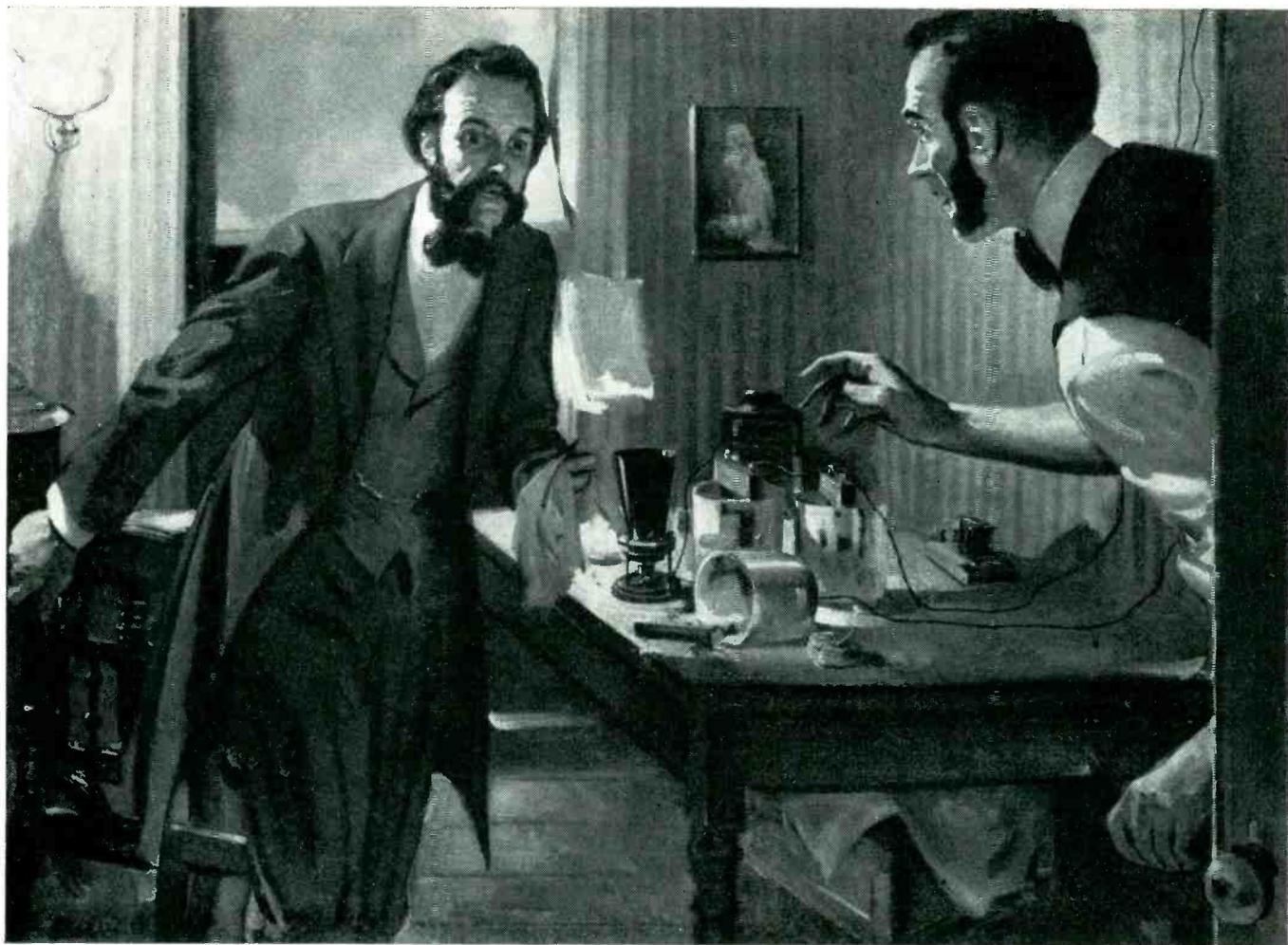
Telephone Interference Tests

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 Parkersburg 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



"Mr. Bell, I heard every word you said — distinctly!" Thus, on March 10, 1876, Alexander Graham Bell (left) learned that his invention had transmitted the first intelligible speech.

75 Years of Tomorrows

Like today's telephone, Alexander Graham Bell's invention was a product of research. For several years Bell had been investigating speech and hearing, and devising methods and apparatus for the electrical communication of intelligence. No one had transmitted speech sounds electrically but Bell saw that it must be possible—given the proper instruments.

One day, while experimenting with his harmonic telegraph, Bell's alert ear caught an unexpected sound in the re-

ceiver. His trained mind told him that here at last was the proof that sound waves could travel as their facsimile in electric waves. Then followed a year of development, and in 1876, as shown above, he transmitted the first intelligible speech by telephone.

During the next three-quarters of a century, the telephone research which Bell started has grown and expanded to serve your telephone system . . . often fruitfully overflowing into other fields of electrical communication. In today's

Bell Telephone Laboratories, promising ideas find the right skills to bring them to life. Through skilled manufacturing by Western Electric Company and skilled operation by the telephone company they are brought to the service of the telephone user.

The high quality of your telephone today, its fine, swift service at reasonable cost, are the products of work in the telephone laboratories in the past. The greater value you may expect in the future is taking form there already.



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Bold face listings are illustrated; light face listings are similar except for size. "H" indicates height of ceramic above mounting surface.

Cat. No.	Material	H
135-20	Steatite	1-9/16
-22		1
-24		5/8
135-22J	Steatite, jack type	1
-20J		1-9/16
135-503	Steatite cone	2
-500		5/8
-501		1
-502		1-1/2
-504		2
135-66	Porcelain, metal base	2-3/4
-67		4-1/2
135-68	Porcelain, metal base	2
-65		1-3/8
135-42	Steatite	7/8
-40		1-1/4
-44		5/8
135-42J	Steatite, jack type	7/8
-40J		1-9/16
135-50	Steatite	1/2
-51		13/16
-52		1-1/8
135-53	Porcelain*	1-3/4
135-54	Porcelain**	4
*** Mounting Flanges not included		
135-90	Mtg. flange for 135-53	
-91	Mtg. flange for 135-54	
135-15-0	Glass lead-in bowl, 6-15/16 O. D., 4-3/8 high, 11/16 hole. Also furnished with mounting flange, gaskets, and studs, singly or in pairs.	
N.P. Brass Studs, 1/4-20 thread, with nuts and washers. For -53 and -54 insulators or other uses.		
115-240	8"	115-241 10"
	115-242 15"	

a day, six days a week. The average life of each tube, when tested, was 3 1/2 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

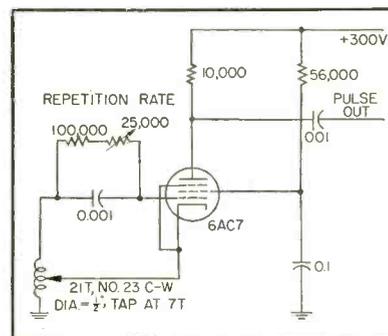


FIG. 1—Schematic diagram of simple blocking-oscillator trigger generator

simple and inexpensive type of blocking oscillator which solves this problem.

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 μ f	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



“It always happens on Ironing day”

The breakfast dishes done, Mrs. Gilbert starts to work her way through a mountain of things to be ironed . . . It seems she has no more than started when—Pfft—something blows and the iron is dead as a mackerel . . . Mr. Gilbert has the car, so Mrs. Gilbert and her iron take the bus to town . . . An hour later, they are in Mr. George's shop . . .

It's the same old story—in order to save a few pennies the manufacturer had used an electrical insulation that just wasn't tough enough to stand the strain! . . . Mrs. Gilbert was glad to have her iron fixed—but she is certainly mad at the manufacturer.

Twist it . . . bend it . . . there is no splitting or cracking because no hardening varnish or lacquer is used in BH Extra Flexible Fiberglas Sleeving. It is “always as flexible as string” from -50°F to 1200°F , with color retention up to 300°F . Tough and long lasting, it

resists abrasion and wear—unaffected by oil or grease.

Assembly time is speeded with the easy-to-handle tubular shape and unusual non-fraying qualities. Cut BH Extra Flexible Fiberglas Sleeving as short as you want—spread it over knobs and terminals—it will not fray! Add the feature that it doesn't support combustion and you know why this versatile electrical insulation is finding new applications every day.

BH Extra Flexible is one of a family of BH insulations, each designed to meet particular conditions in service. Give us a few facts about your requirements—product, temperatures, voltages. We will furnish production samples for testing.

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TUBES AT WORK

(continued)

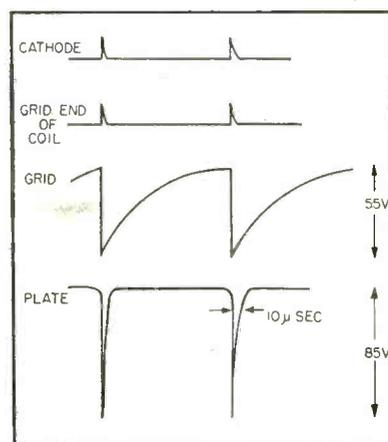


FIG. 2—Typical waveforms of blocking oscillator for component values given in Fig. 1

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.

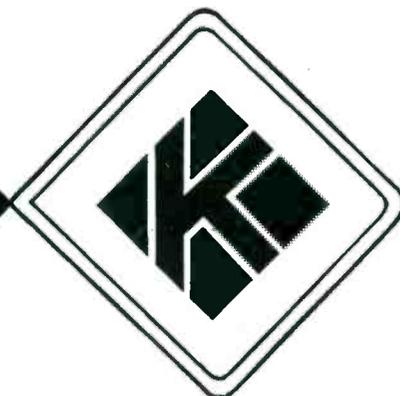
IN ORDER to test a Geiger-Mueller counter coincidence circuit under conditions approximating as closely as possible those encountered in actual operations, it is desirable to provide a controllable source of artificial pulses simulating those produced by the discharge of the counter tubes.

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 radiosondes¹ 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-

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Commercial Equivalent of AN/URM-17.

Frequency range includes Citizens Band and UHF color TV Band.



These instruments comply with test equipment requirements of such radio interference specifications as JAN-I-225, ASA C63.2, 16E4(SHIPS), AN-I-24a, AN-I-42, AN-I-27a AN-I-40 and others.

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TUBES AT WORK

(continued)

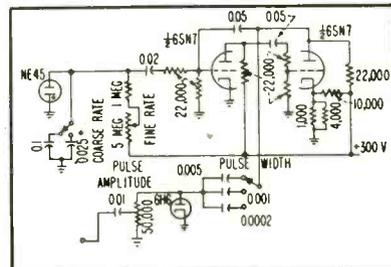


FIG. 1—Circuit of the test generator for simulating Geiger-counter pulses

ording 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.

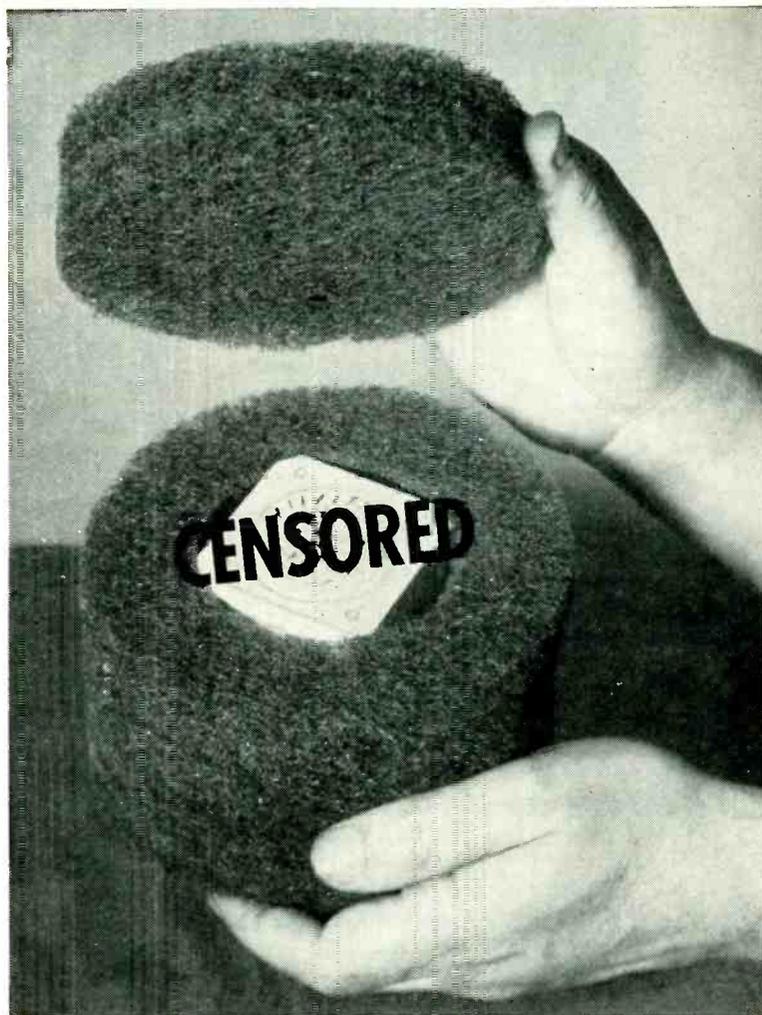
REFERENCE

(1) M. A. Pomerantz, Cosmic-Ray Radiosonde and Telemetering System, ELECTRONICS, 24, p 88, April 1951.

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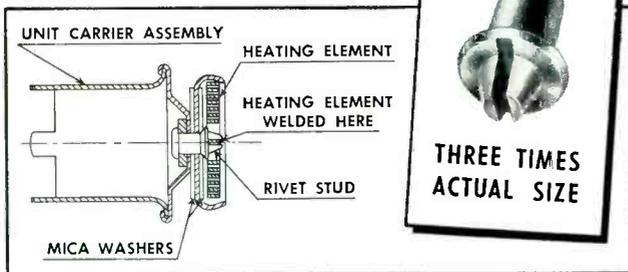
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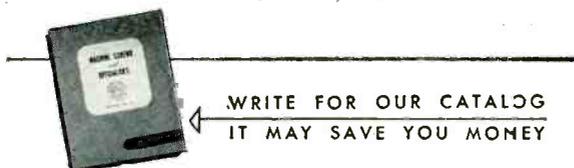
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THE ELECTRON ART

(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 .

$$D = eS + \epsilon' E \quad (1)$$

where e is the piezoelectric stress constant and ϵ' the dielectric permittivity at constant strain. Instead of Eq. 1, we can write.

$$D = e \frac{2\xi}{b} + \epsilon' \frac{V}{b} \quad (2)$$

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

$$I = i\omega \frac{2e}{b} \xi A + i\omega \epsilon' \frac{V}{b} A \quad (3)$$

$$I = i \frac{1}{X_0} \frac{2e}{\epsilon'} \xi + i \frac{1}{X_0} V$$

where X_0 is the reactance of the static capacitance C_0 of the crystal unit.

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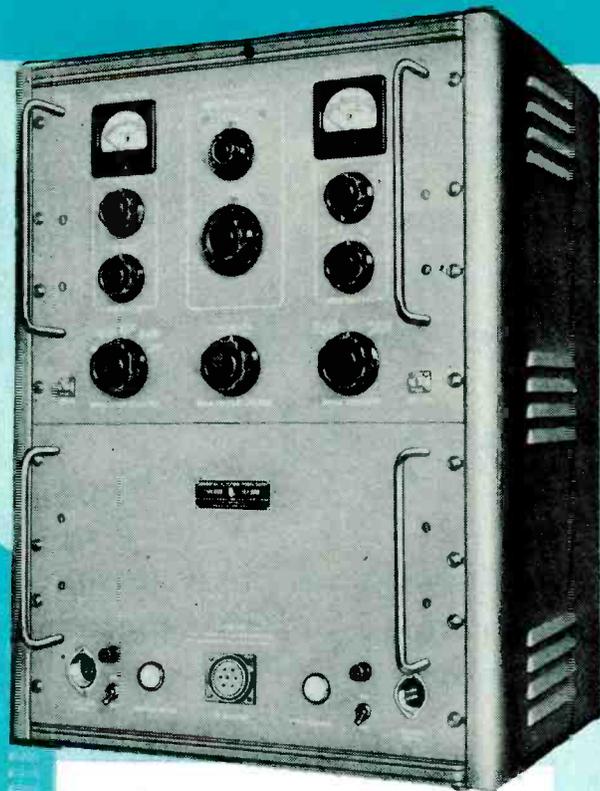
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continuously from
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the crystal unit impedance $Z = V/I$ into Eq. 3, this equation can be solved either in terms of V or of I and thus yields the desired results.

$$V/\xi = -\frac{2e}{e^s} (a - ik) \quad (4)$$

$$I/\xi = -\frac{2e}{e^s} \frac{1}{X_o} [k - i(1 - a)] \quad (5)$$

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

$$f_A = \frac{1}{2} \left(L_s \frac{C_o C_s}{C_o + C_s} \right)^{-1/2}$$

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 $7 \mu\mu\text{f}$, 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

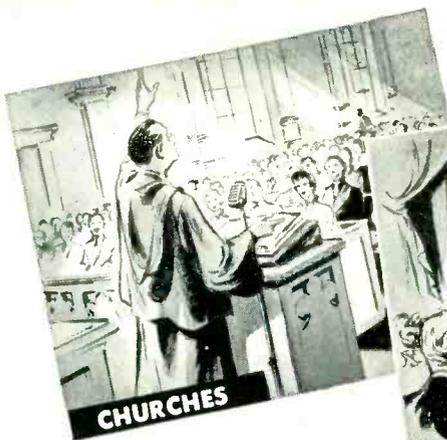
As stated previously, a vibrating crystal generates heat. The energy per second N , transposed into heat, is given by

$$N = b_1 |I|^2 = b_2 \xi^2$$

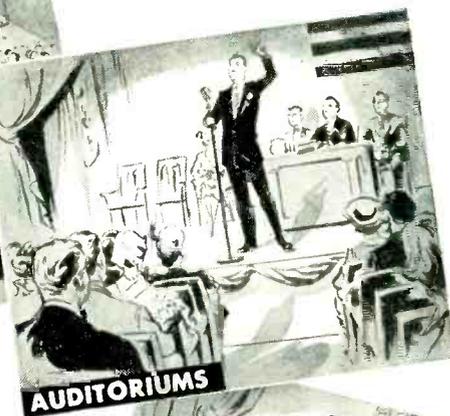
where b_1 and b_2 are constants. If we assume that the frequency change is linear with temperature, we have

$$\frac{\Delta f}{f} = b_3 N = b_4 \xi^2$$

(continued on p 208)



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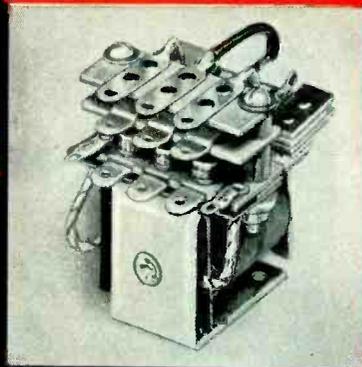


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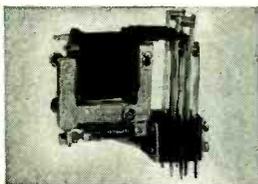
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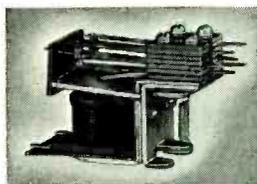


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We divide this equation by $|I|^2$, and obtain, together with Eq. 7a (Table I)

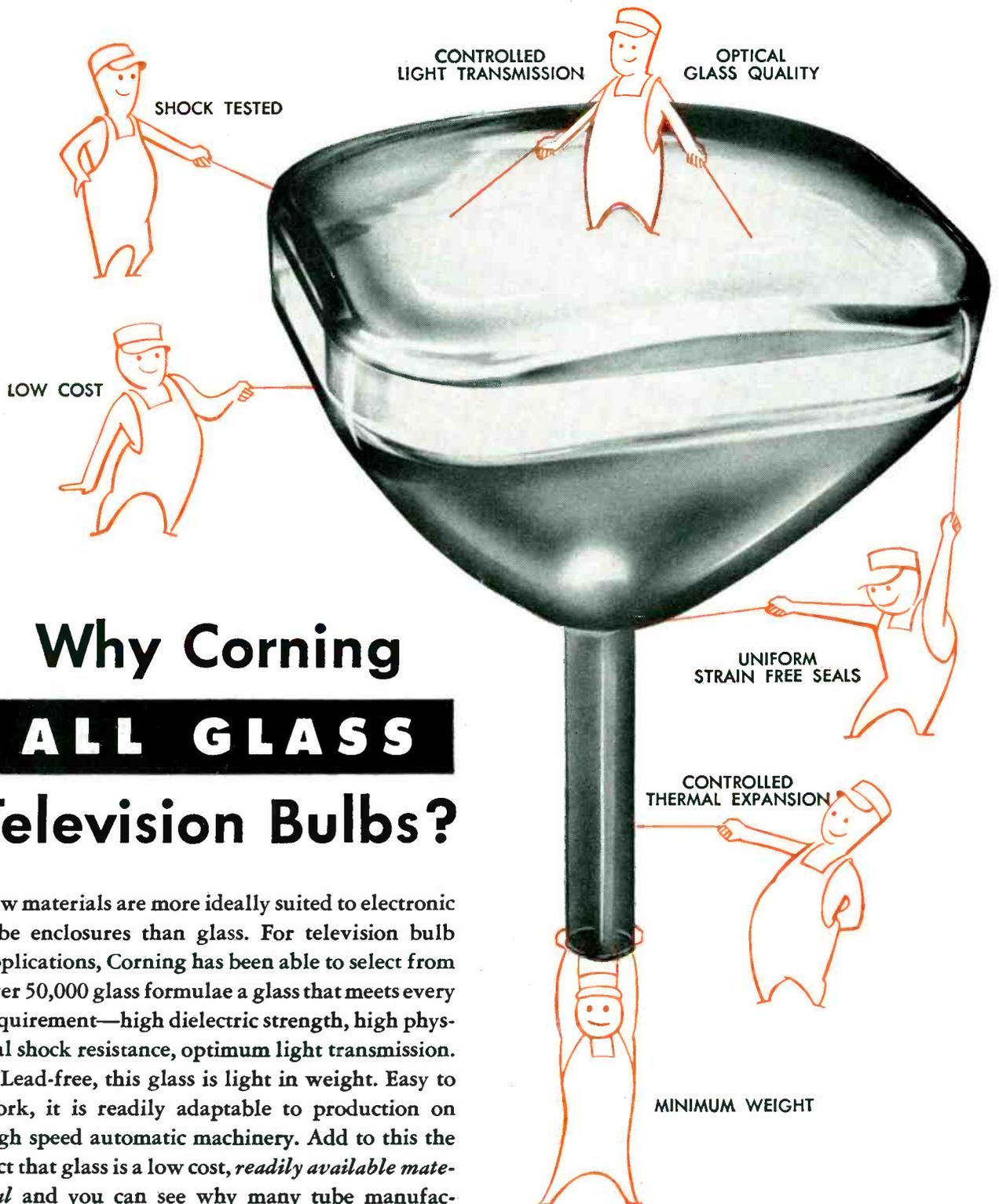
$$b_5 \frac{\xi}{|I|} = \left(\frac{\Delta f}{f} \frac{1}{|I|^2} \right)^{\frac{1}{2}} = \frac{b_6}{1-a} \quad (12)$$

$b_3, b_4, b_5,$ and b_6 being constants.

As we see from Eq. 12, $(\Delta f/f) 1/|I|^2$ must be constant for a determined a . In proof of this, measurements⁴ 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 employed⁵, and it is assumed that any nonlinear effects of voltage on the frequency of operation—as mentioned previously—are negli-

Table I—Formulas for Amplitude-to-Current and Amplitude-to-Voltage Relationships

$\xi/ I $ (meter/ampere)	$\xi/ V $ (meter/volt)
GENERAL	
$\frac{\epsilon^a}{2e} X_0 \left[(1-a)^2 + k \right]^{-\frac{1}{2}}$ (7)	$\frac{\epsilon^a}{2e} \left[a^2 + k^2 \right]^{-\frac{1}{2}}$ (8)
$\frac{\epsilon^a}{2e} X_0 \left[1-a \right]^{-1}$ (7a)	$\frac{\epsilon^a}{2e} a^{-1}$ (8a)
(near f_a , where $k^2 < (1-a)^2$)	(near f_A , where $k^2 < a^2$)
SERIES RESONANCE	
$\frac{\epsilon^a}{2e} X_0 \left[1+k^2 \right]^{-\frac{1}{2}}$ (9)	$\frac{\epsilon^a}{2e} k^{-1}$ (10)
$\frac{\epsilon^a}{2e} X_0$ (9a) (holds if $k^2 < 1$)	
ANTIRESONANCE	
$\frac{\epsilon^a}{2e} X_0 k^{-1}$ (10)	$\frac{\epsilon^a}{2e} \left[1+k^2 \right]^{-\frac{1}{2}}$ (11)
	$\frac{\epsilon^a}{2e}$ (holds if $k^2 < 1$)
$k = R_s/X_0$	$a \approx (f-f_a)/(f_A-f_a)$



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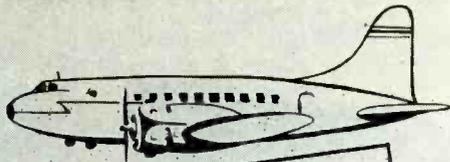
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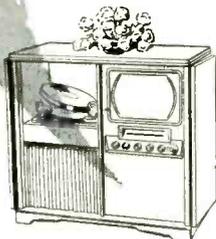
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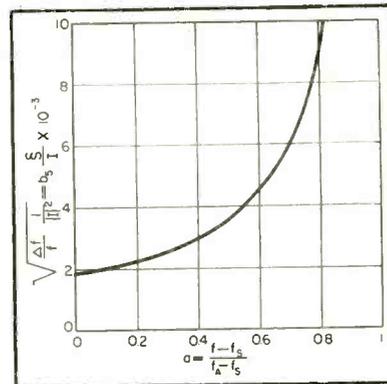


FIG. 1—Ratio of amplitude to current for ammonium dihydrogen phosphate crystal cut (zxw) 45 deg, thickness shear mode

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.

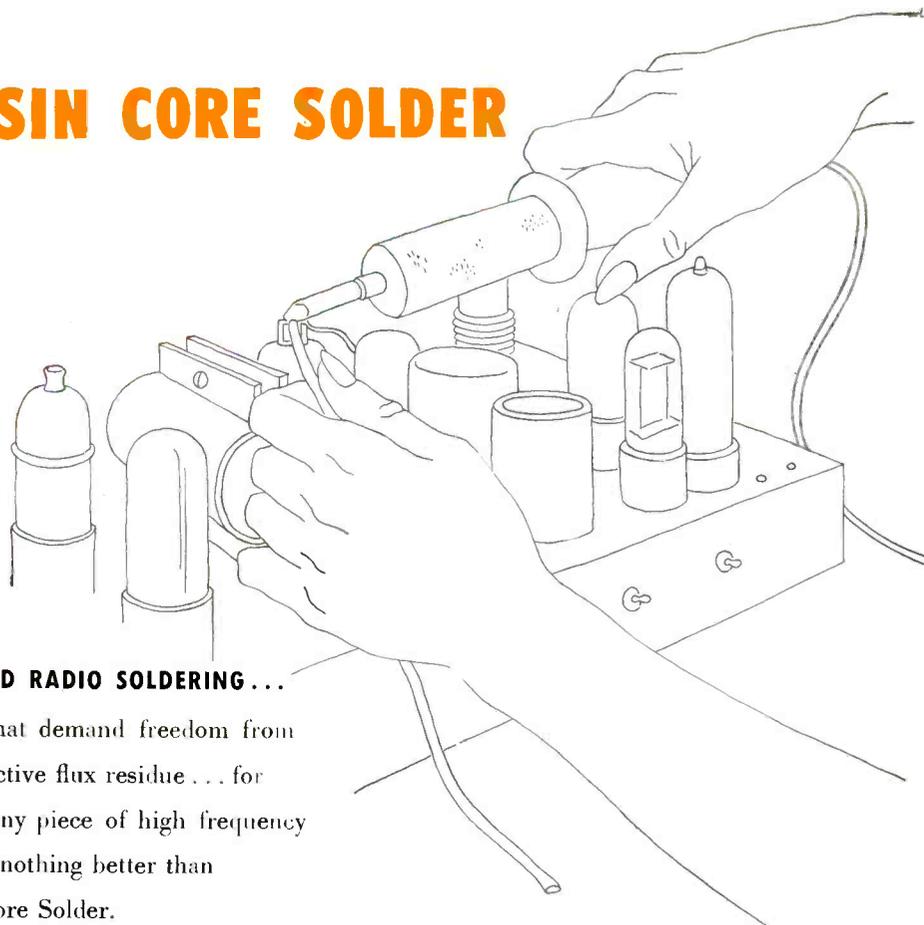
The results for different operating frequencies are shown in Fig. 1 which can be represented by the equation

$$b_0 \frac{\xi}{|I|} (1 - a) = 1.8 \text{ ampere}^{-1}$$

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 coulomb per sq. meter.⁹ Together with the dielectric permittivity $\epsilon' = 4.5 \cdot 1/36\pi \times 10^{-9}$ farad per meter, we obtain for $\epsilon'/2$, 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 $1/X$, and by plotting the abscissa in opposite

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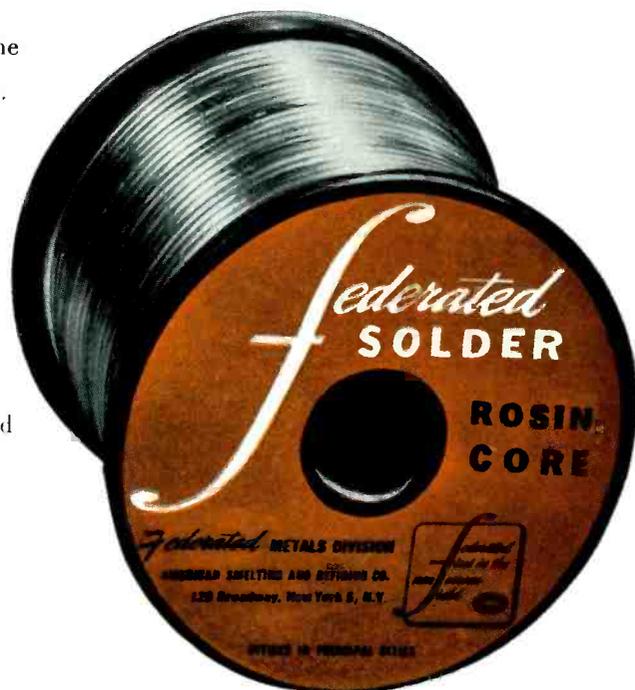


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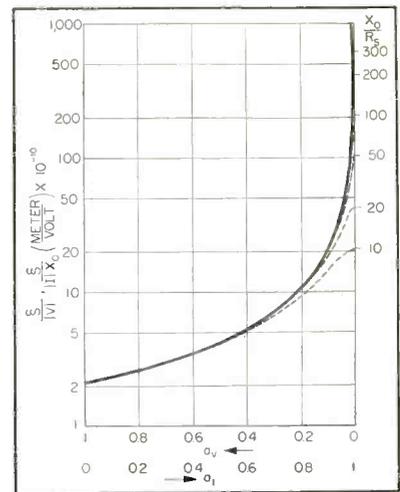


FIG. 2—Amplitude-to-voltage and amplitude-to-current ratios as functions of a for AT and BT cut quartz crystals

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_0/R_0 . 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 investigators¹ with quartz plates vibrating in thickness shear modes, the amplitude falls off towards zero at least in certain directions. Furthermore, Hok² theoretically derived an expression for the amplitude distribution of a rectangular (yzw) cut



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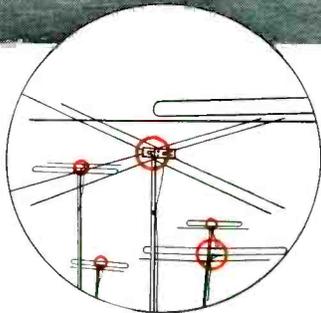


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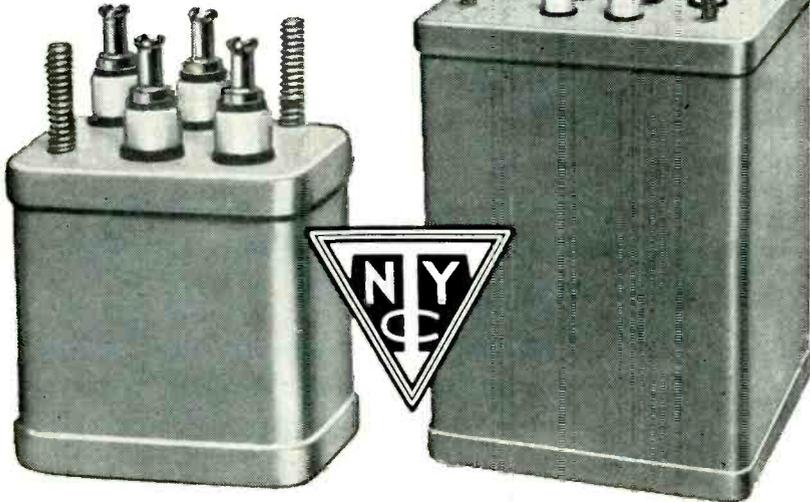
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quartz crystal vibrating in thickness shear mode. He found a sinusoidal distribution of the displacement along the X axis, and a distribution along the Z' axis which may be uniform or may be any part of a symmetrical sinusoidal distribution.

Van Dyke and Gordon⁸ 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:

$$\frac{\xi}{|V|} = \frac{\pi^2}{4} \frac{\epsilon^e}{2e} [a^2 + k^2]^{-\frac{1}{2}} \quad (13)$$

and the ratio of amplitude to current to be:

$$\frac{\xi}{|I|} = \frac{\pi^2}{4} \frac{\epsilon^e}{2e} X_0 [(1-a)^2 + k^2]^{-\frac{1}{2}} \quad (14)$$

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 $(f - f_s)$ $(f_s - f_s)$ (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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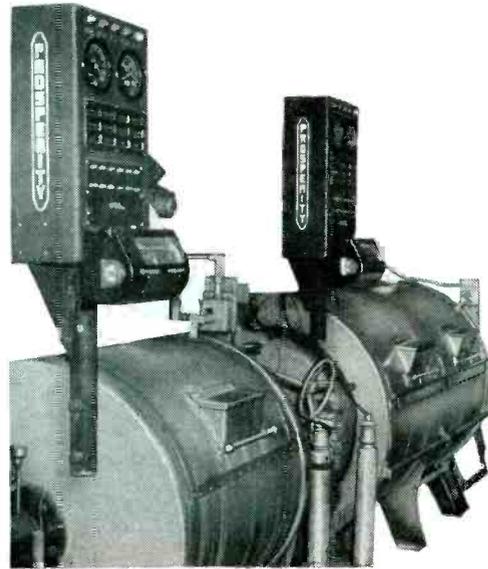
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the frequencies obey the equation:

$$f^2 = f_0^2 \left(1 + a \frac{C_s}{C_0} \right)$$

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)

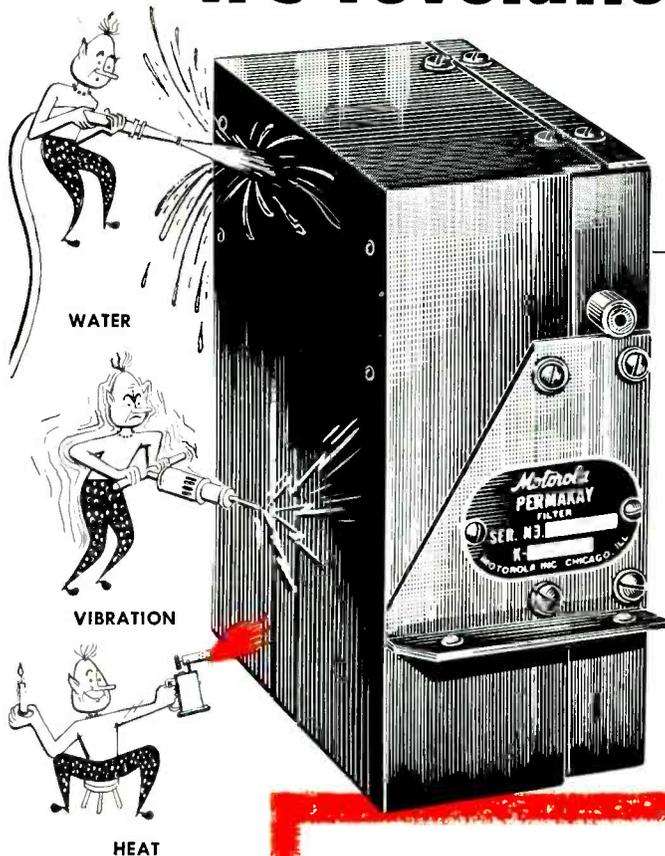
because the slopes $d(\xi/V)/da$ and $d(\xi/I)/da$ are small (see Fig. 2), it is recommendable to use current measurements close to series resonance and voltage measurements close to antiresonance. Especially, voltage measurements close to or at antiresonance are preferable since, according to Eq. 11a 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.

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- (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.
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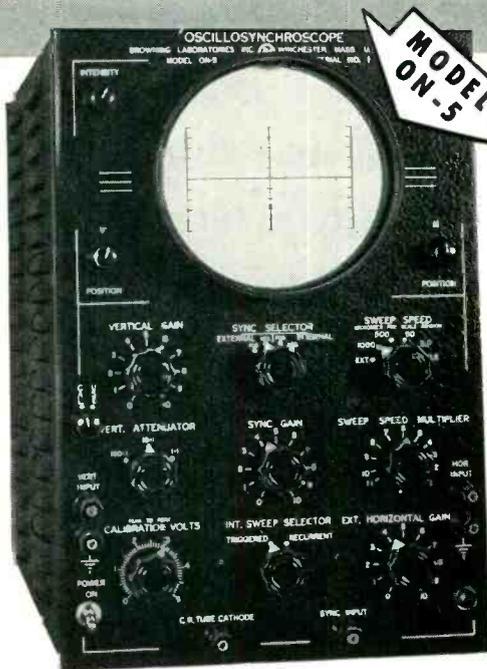
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p 1,073, Sept. 1950.

(6) W. G. Cady, I.c., p 459.

(7) Gunnar Hok, Thickness-Shear Vibrations of Thin Anisotropic 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.

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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.

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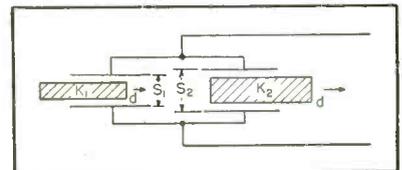


FIG. 1—Basic idea of adjustable temperature coefficient capacitor

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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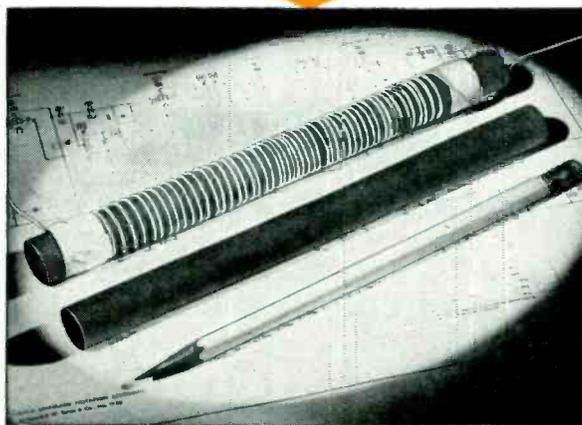


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remain constant when

$$\frac{K_1}{S_1} = \frac{K_2}{S_2}$$

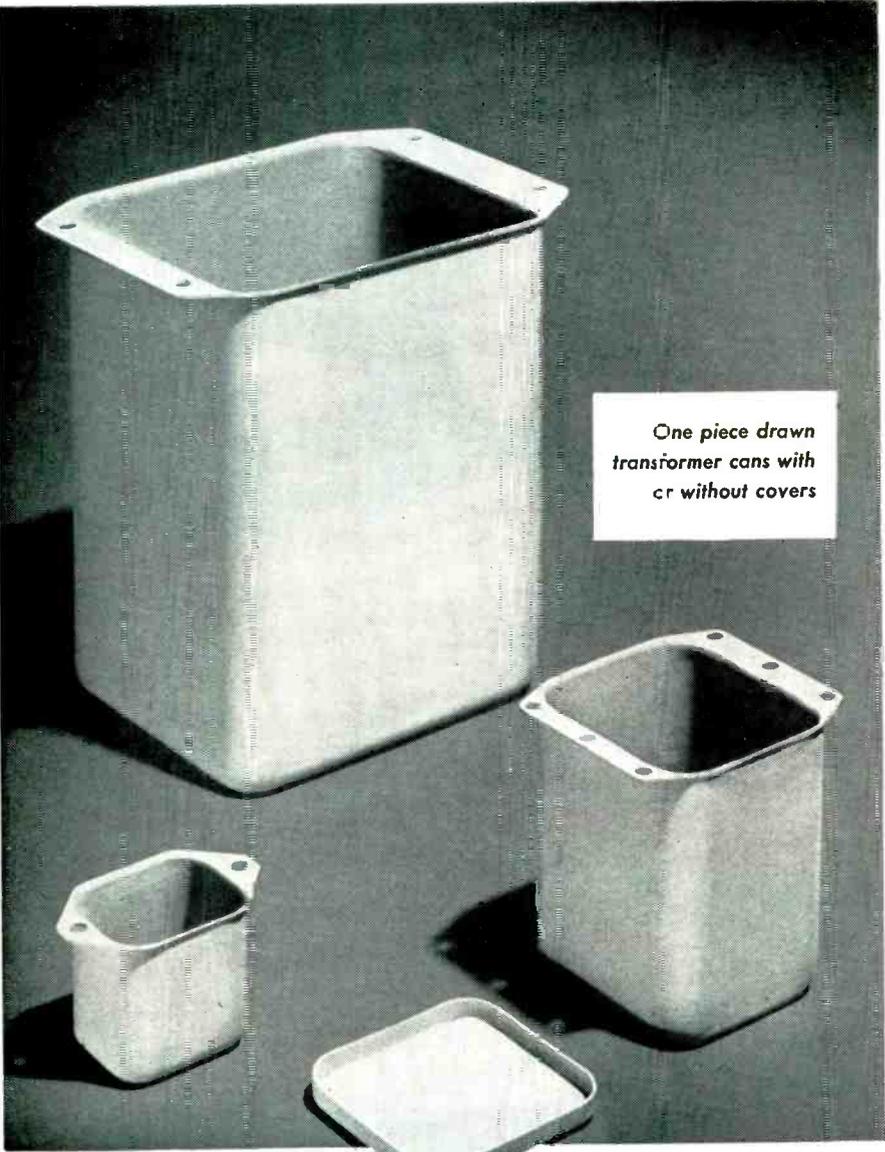
where S_1 and S_2 are the plate separations corresponding to K_1 and K_2 .

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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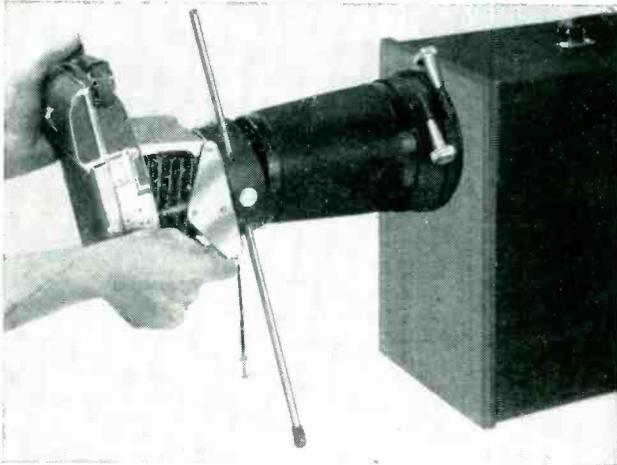
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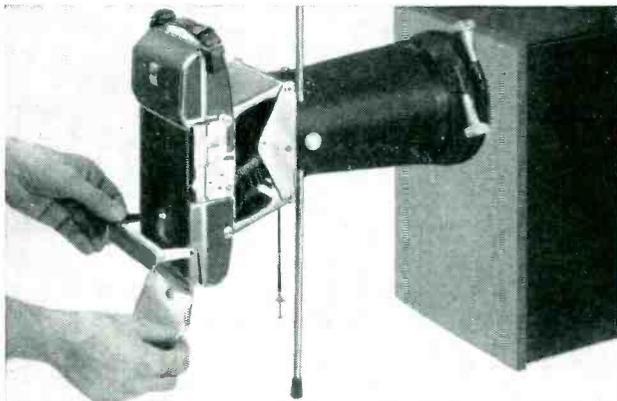


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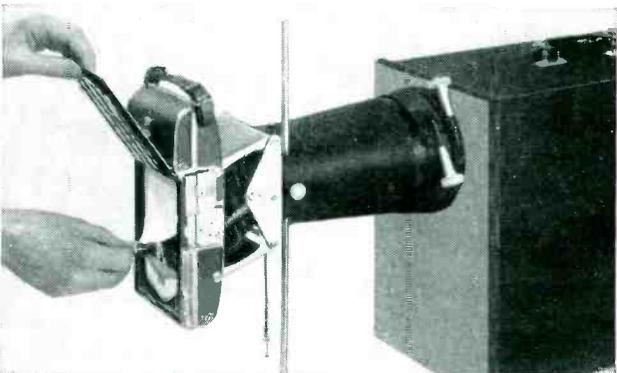
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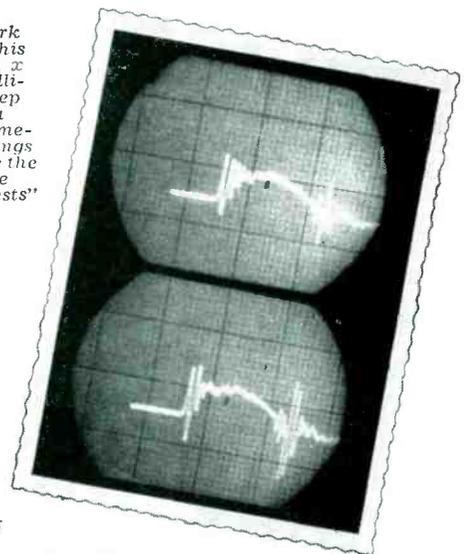
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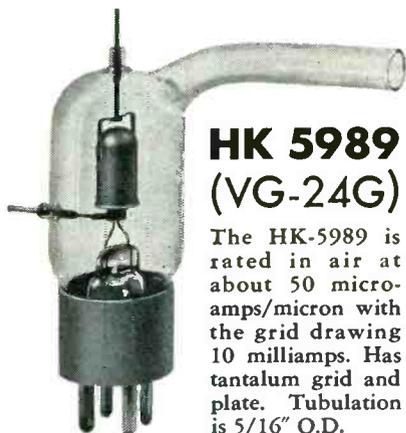
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Proposed Capacitor

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

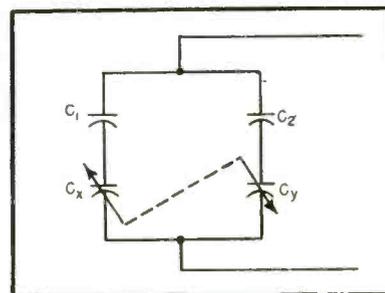


FIG. 2—Schematic representation of arrangement for obtaining continuously variable temperature coefficient capacitor with constant value of capacitance

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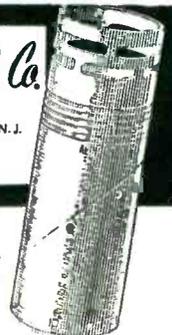
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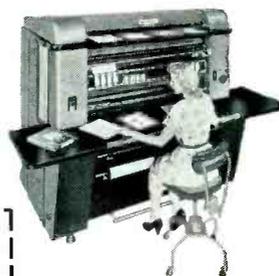
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magnitudes of C_1 and C_2 to an absolute minimum and yet maintain large T-C values for these elements. This procedure introduces difficulties, however, since capacitors having small capacitances and large T-C values are less predictable in the practical 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.

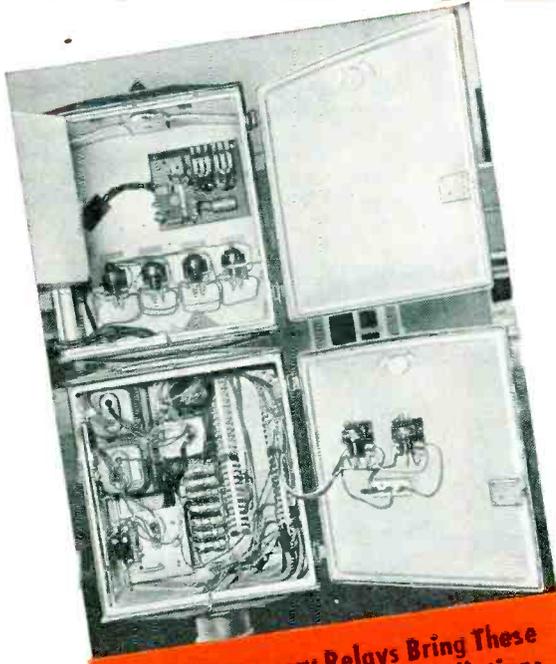
This equation describes the conditions for tracking (maintenance of a constant equivalent capacitance) in a capacitor of the proposed design. If a parallel-plate construction is to be used, one air-dielectric capacitor can have linear capacitance variation with shaft rotation. In such a case the other 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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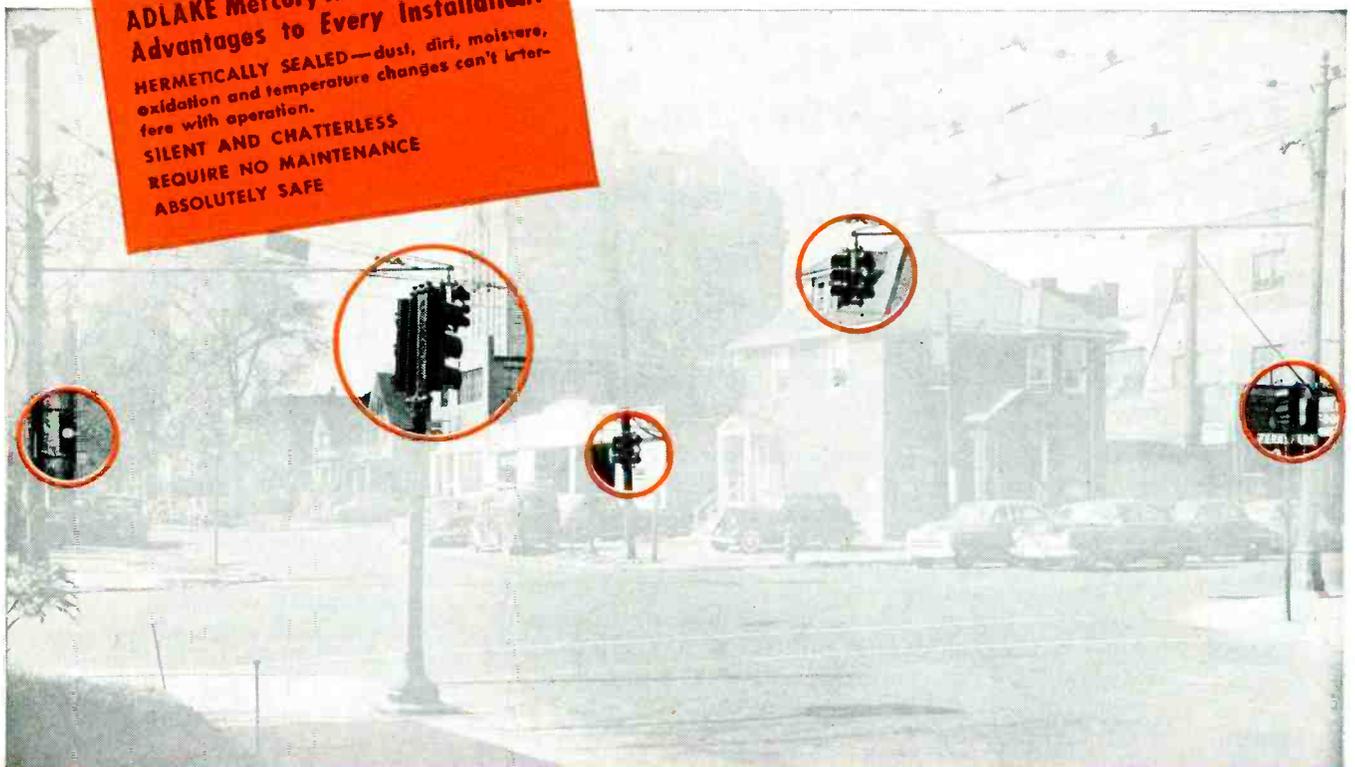
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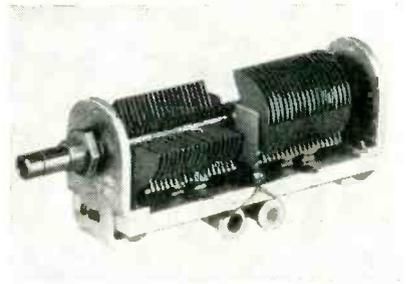


FIG. 3—As the capacitance of one section increases, that of the other decreases, but the total capacitance remains fixed. The fixed positive and negative temperature coefficient capacitors are mounted under the modified two-section variable

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.

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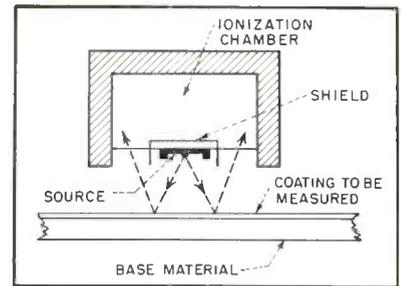


FIG. 1—Thickness of thin coatings can be measured by measuring amount of radiation reflected by a surface

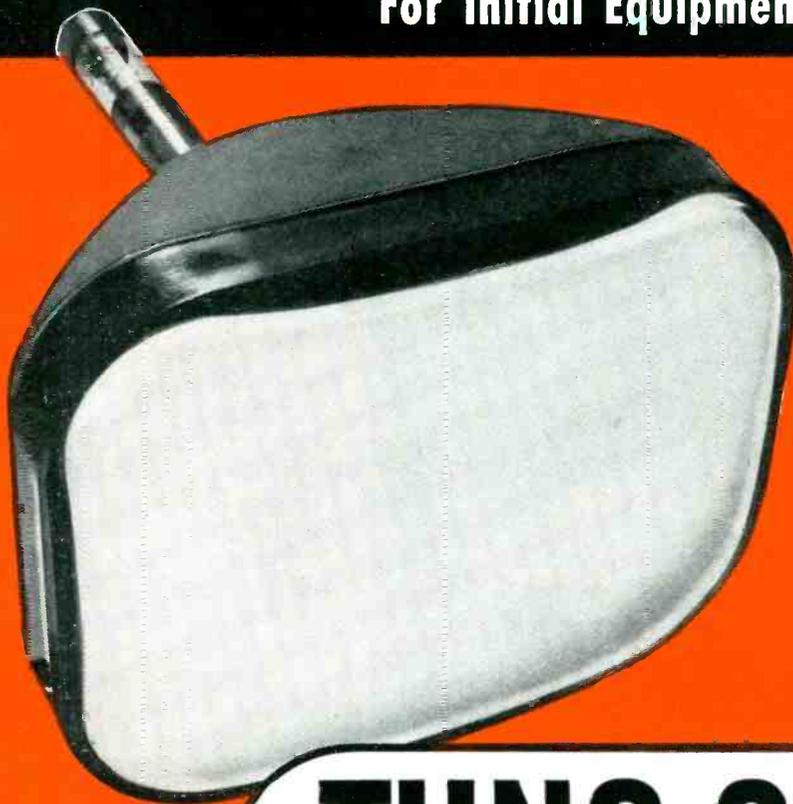
the material being measured. This precludes the measurement of thin coatings of certain materials on other materials by standard beta-ray techniques. The thickness of such coatings can, however, be measured nondestructively by the backscatter of radiation if the atomic number of the coating differs from 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 calendaring 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.

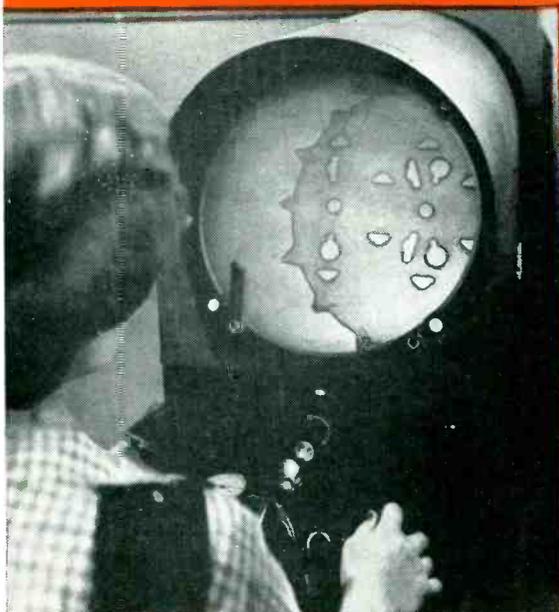
The amount of radiation reflected depends on the atomic number of the coating material and on its thickness. As the thickness of the coating is increased, a point is finally reached where the maximum beta ray energy of the source is insufficient to allow particles to pass through the thickness of the 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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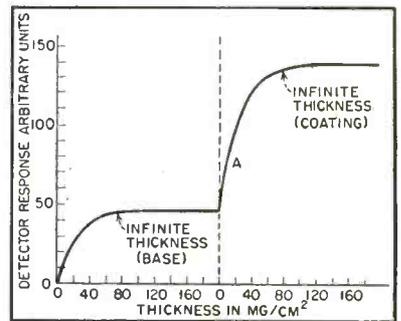


FIG. 2—In making coating-thickness measurements, only linear portion of curve (A) is used

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 absorp-tion 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
Vanderbilt University Medical School
Nashville, Tennessee

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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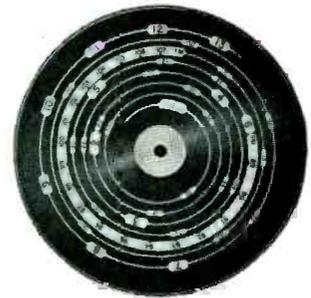
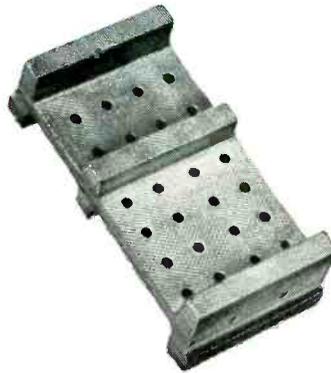
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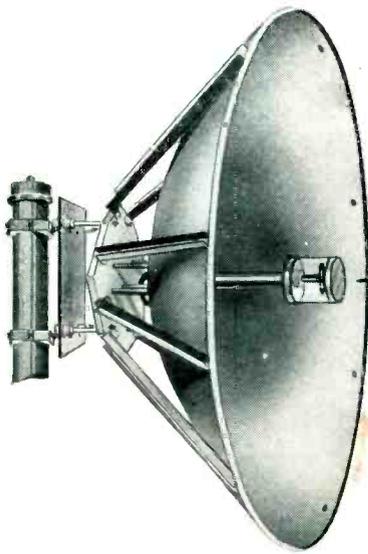
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	1002	1004	1006	1010	2002	2004	2006	2010
Type Number	1002	1004	1006	1010	2002	2004	2006	2010
Diameter of Parabola feet	2	4	6	10	2	4	6	10
Gain Over Half Wave Dipole Decibels	10	15	20	25	15	20	25	29
Beam Width, Half Power Points, Degrees	36°	22°	16°	11°	18°	10°	7°	5°
Net Weight, Pounds	10	64	150	380	10	65	150	380
Thrust Due to Wind Loading at 30 Pounds/FT Pounds	127	509	1145	3200	127	509	1145	3200



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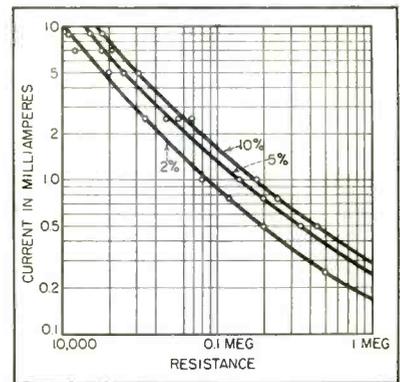


FIG. 1—Curves showing the limits of regulation. For all resistance lines which intersect the desired current line below the 2-percent curve, the current will change less than 2-percent from the present value. Similar manipulation applies to the 5 and 10-percent curves

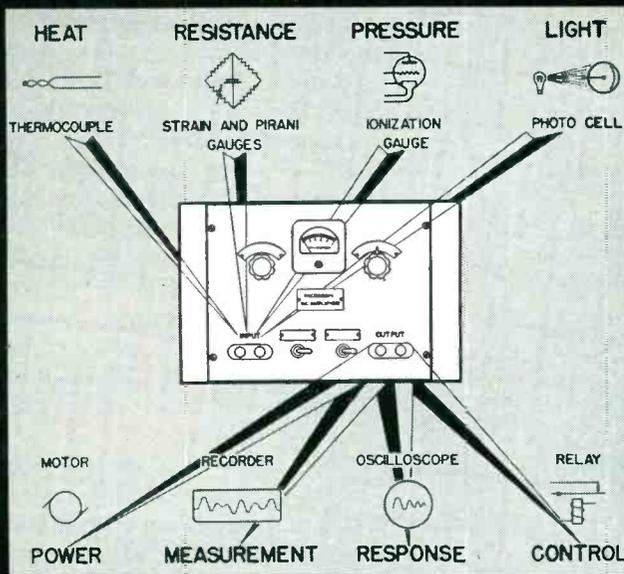
tor. It is impossible to get accurate indications of impedance of a circuit by determining its resistance with an ohmmeter. Not only does the passage of small currents through the tissues produce polarization manifest by altered resistance, but the inertia of the ohmmeter precludes its giving an instantaneous 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 impedance of the output circuit through tissues shows that the impedance 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' 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

1. Designed for stable, accurate amplification that is simple in operation and low in cost, the Microsen D.C. Amplifier can help you solve your d.c. amplification problems. Covering an exceptionally wide range of applications, the versatility of this instrument makes possible new approaches in engineering research and process development.

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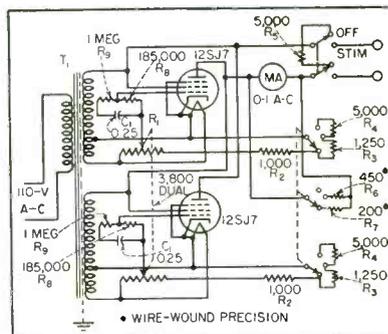


FIG. 2—Circuit diagram of the constant-current stimulator

current regulation).

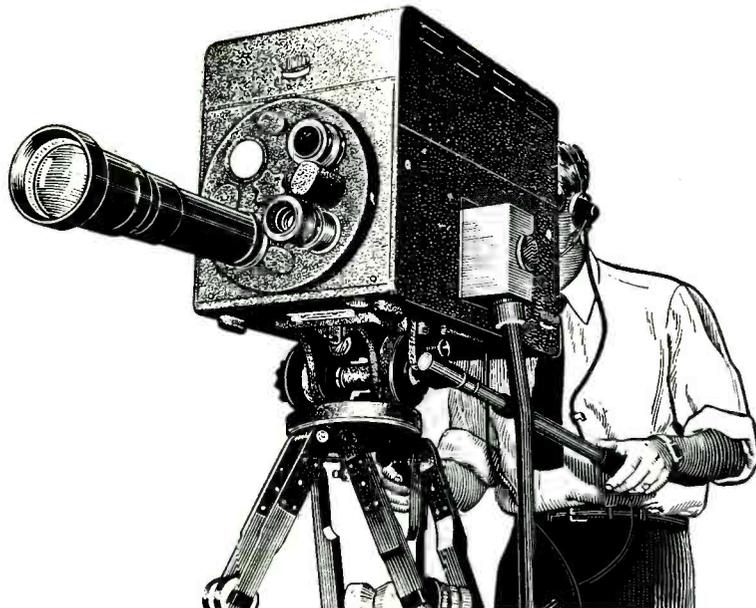
Figure 2 is a diagram of the circuit. All of these parts except the power transformer are available as standard radio equipment. The transformer is available as Ferranti No. 6861. This special transformer was necessary to reduce stray capacitive coupling. The minimum current which was present due to 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.

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.

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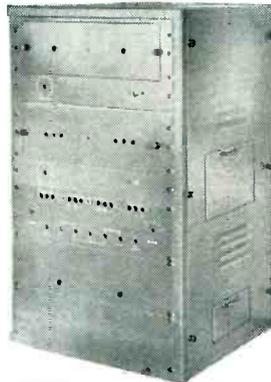


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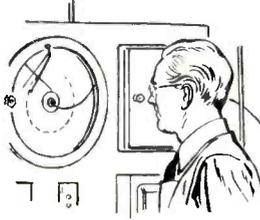
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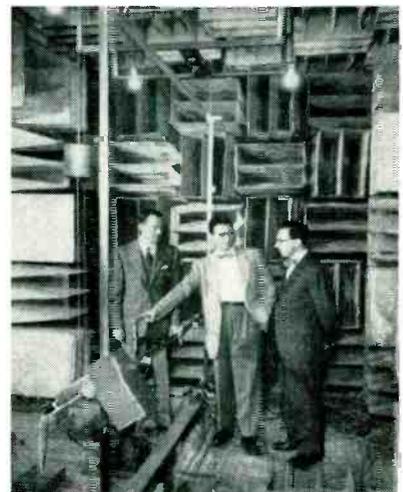
acteristics of the stimulator with a variety of electrode types. Even high-resistance capillary electrodes filled with saline may be used without distortion of the current wave form. Their high effective resistance (100,000 ohms) limited the current output of the apparatus to about 0.8 milliamperes (see 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

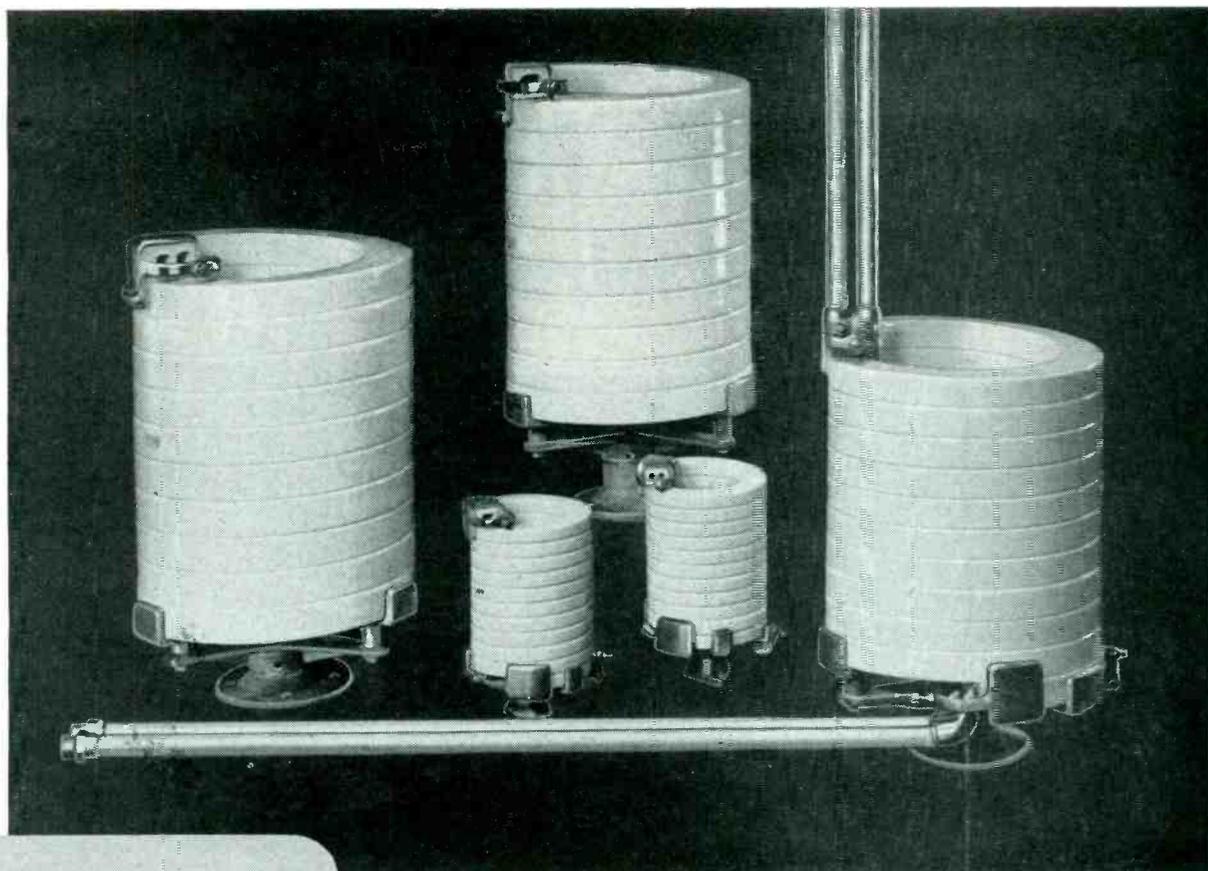
- (1) John A. Myers, A Convenient and Reliable Instrument for Electrical Stimulation Experiments, *J. Lab. and Clin. Med.*, 21, p 949, 1936.
- (2) James W. Ward and Virgil S. LeQuire, (unpublished data).
- (3) George Coppée, Stimulation by alternating current, *Symposia of Quantitative Biology*, 4, p 150, 1936.

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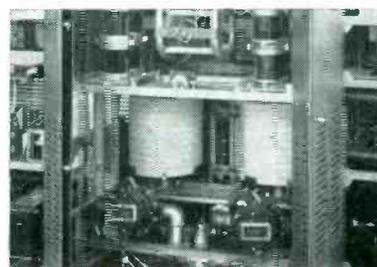
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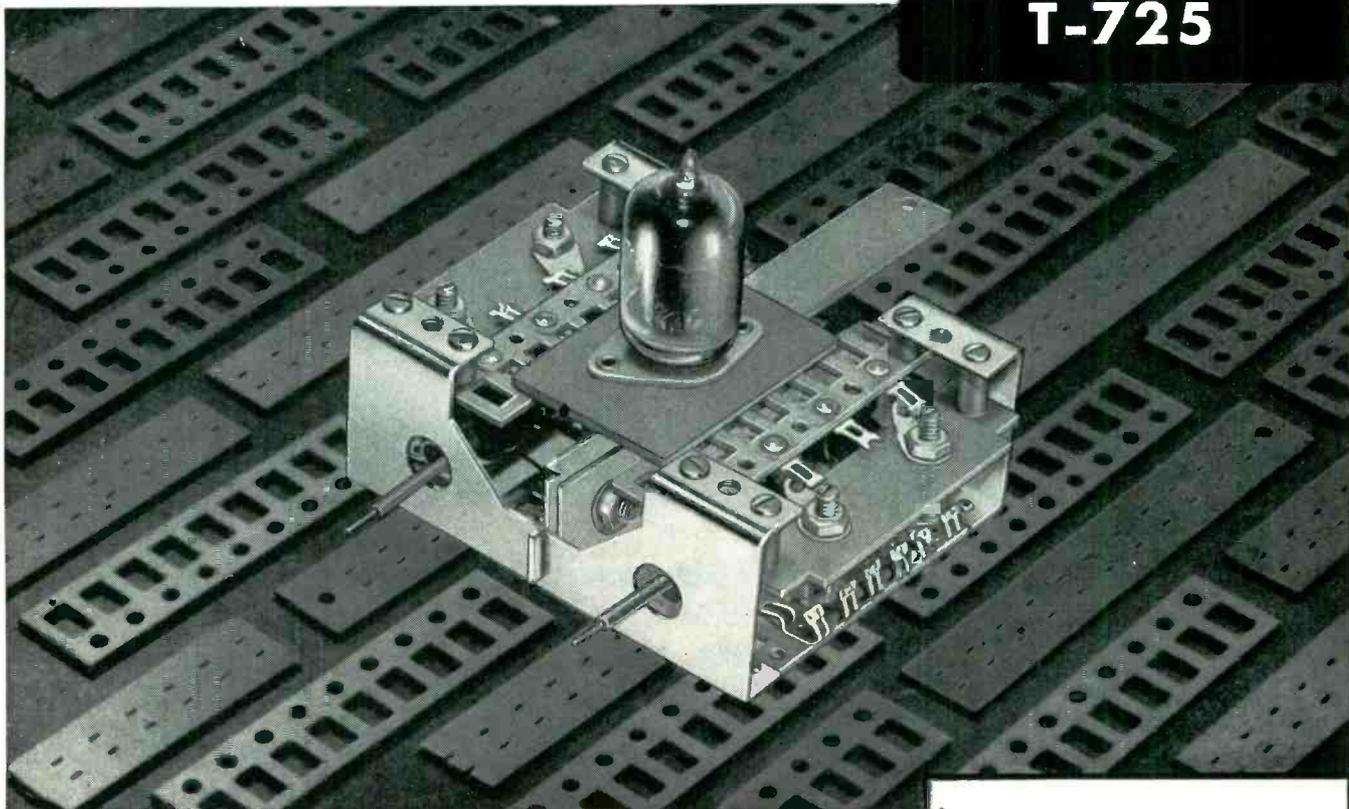
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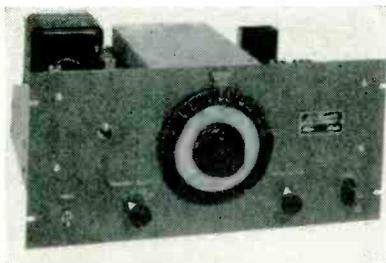
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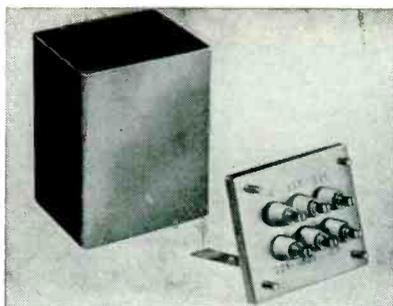
(continued from page 146)



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.

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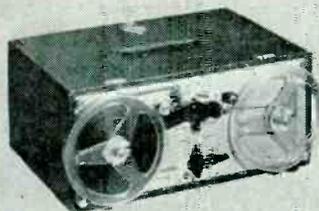
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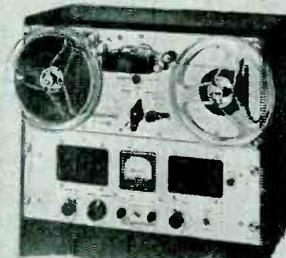
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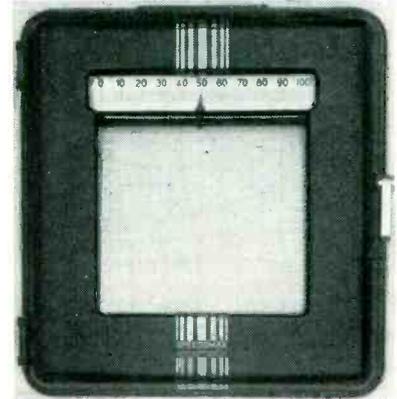
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ing of about 2 pounds of copper. Type NU-14GP4 is a 14-inch rectangular tube that is magnetically deflected (70-deg diagonal angle) and has a second-anode potential rating of 14,000 volts maximum. The focusing electrode requires approximately 2,500 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

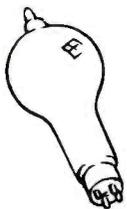
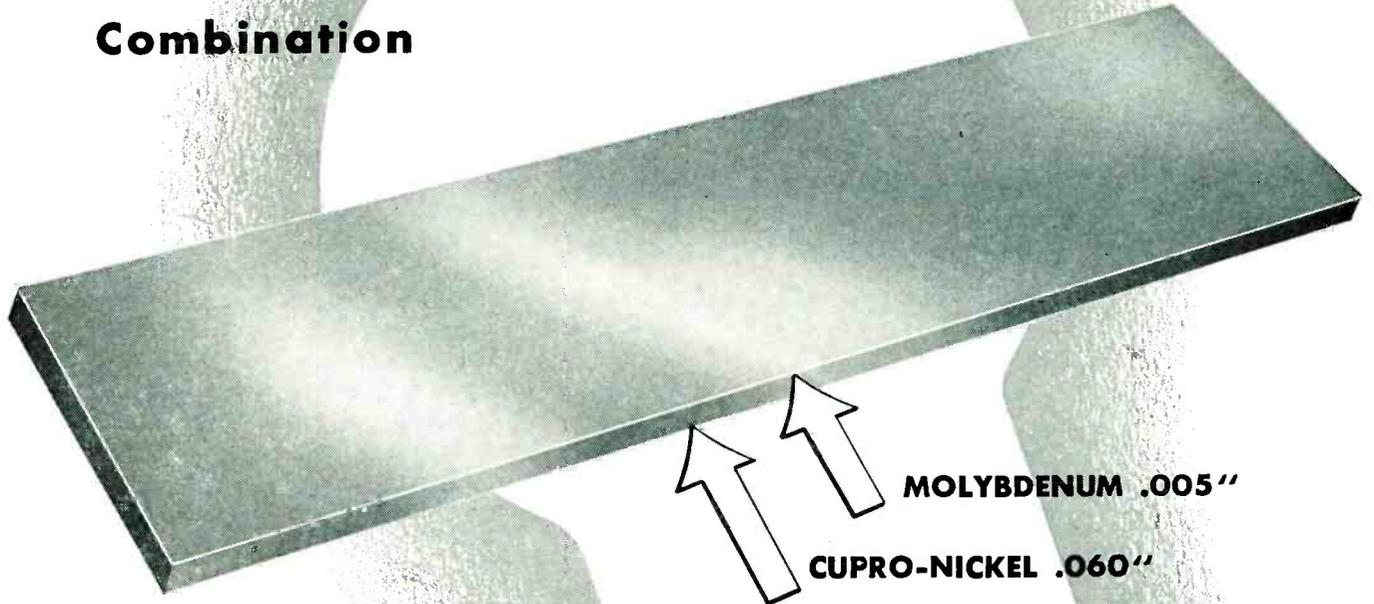
THE JAMES KNIGHTS Co., 131 South Wells St., Sandwich, Ill. The JK-57MT stabilized broadcast unit is unlike conventional crystals (where the electrode turns with change

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.*

No matter what your problems, it will pay you to *check with* General Plate. Their vast experience in combining precious to base metals or base to base metals can overcome your problems . . . often reduce costs.

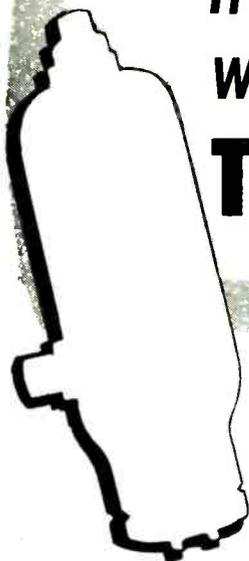
General Plate Products include — Precious to base metal laminations . . . Base metal laminations . . . Alcuplate (copper and Aluminum) . . . Silver solders . . . Laminated contacts, buttons, rivets . . . Platinum-fabrication-refining . . . Age-hardening Manganese Alloy 720.

**Have You a Composite Metal Problem?
General Plate can solve it for you**

GENERAL PLATE

Division of Metals & Controls Corporation
34 FOREST STREET, ATTLEBORO, MASS.

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When It's Powered with
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 Memphis 4, Tennessee

J. M. Cartwright & Son
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As always, Taylor is producing tubes of superior quality and outstanding performance. The Taylor Representative nearest you is ready and willing to discuss your particular requirements. Call on him for information any time.

Taylor HEAVY **CUSTOM BUILT** DUTY **Tubes**

TAYLOR TUBES INC., 2312-18 WABANSIA AVE., CHICAGO 47, ILL.



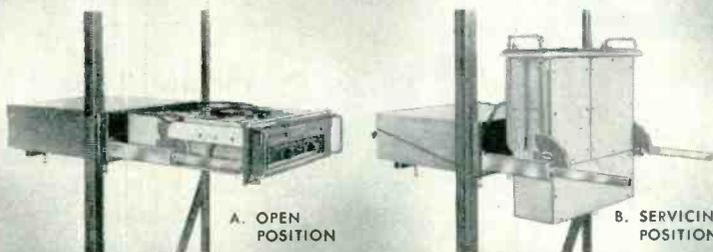
in frequency) in that the variable electrode only moves up and down in guides like a piston. Frequency range is from 400 kc to 1,750 kc. Nominal temperature is 60 deg \pm 1 deg. Adjustable frequency is \pm 0.01 percent. It features a 6.3-volt, 1-ampere heater. The unit can be supplied with octal base 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

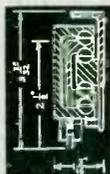


ELECTRONIC SLIDES

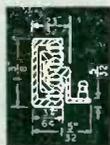


A. OPEN POSITION

B. SERVICING POSITION



Three section slide, progressive action type. Locks in extended position only. Tripping mechanism controls unlocking. Load capacity: Up to 200 lbs. Cat. No. 375



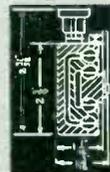
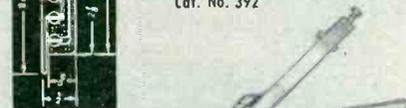
Three section slide, progressive action type. Load Capacity: Up to 50 lbs. per pair. Cat. No. 350



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



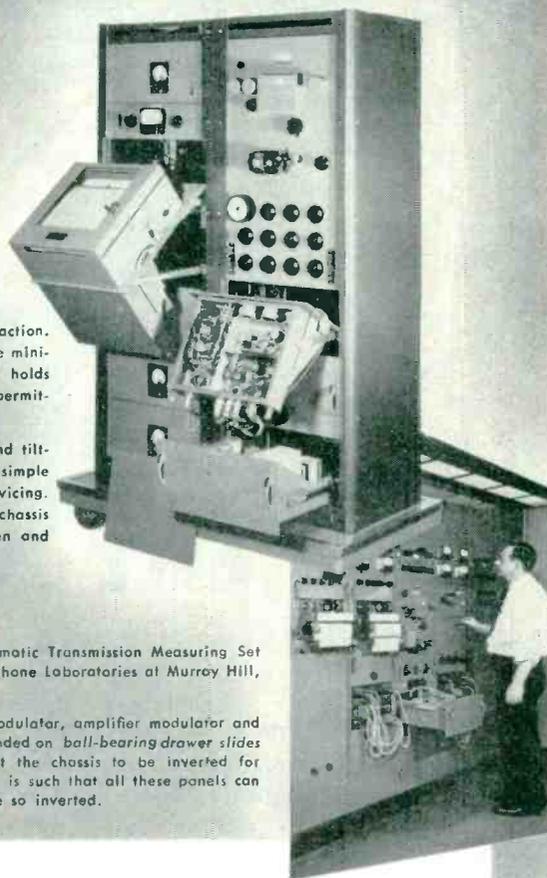
Three section slide, progressive action type. Locks in extended position only. Thumb release controls unlocking. Load Capacity: Up to 200 lbs. maximum. Cat. No. 371



- 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.



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.

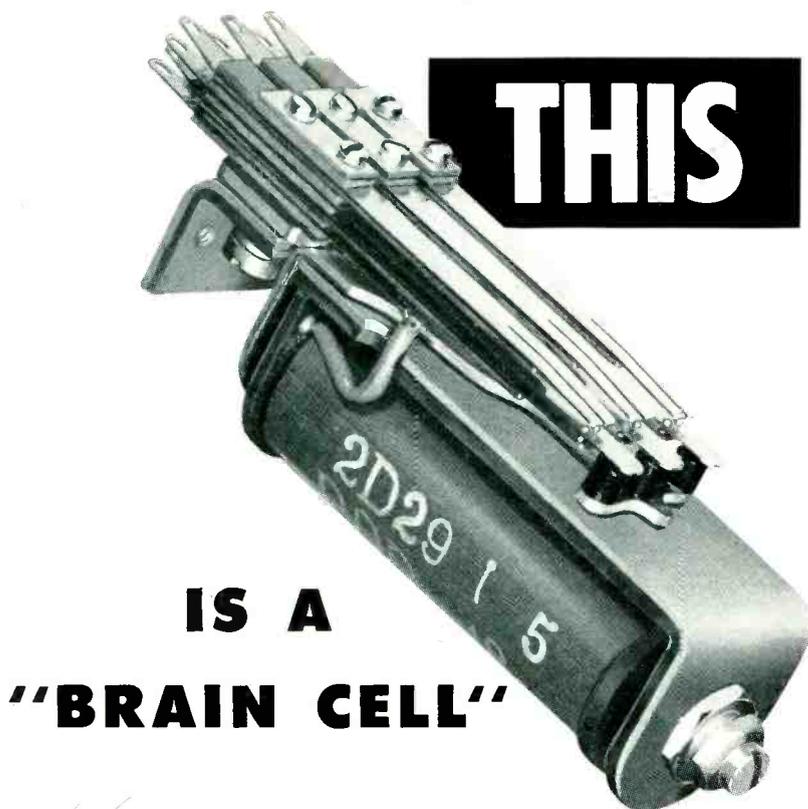


FOR FURTHER INFORMATION WRITE
ELECTRONIC ENGINEERING DIVISION

GRANT PULLEY & HARDWARE CO.

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The foremost name in Sliding Devices



THIS IS A "BRAIN CELL"

THE caption is more than a figure of speech. This sensitive, fast-acting North Relay is one of a large variety made by North Electric Manufacturing Company. Their jobs involve "thinking through" orders flashed to them electrically in all kinds of remote control circuits, from simple power transfer to elaborate counting sequences, as in tabulating machinery or automatic telephone control without mechanical switches. The fact that this particular relay was originally developed for telephone work is indicative of the extra precision and quality you can expect from North Relays. You can also expect to get from North a relay that will exactly fill YOUR needs, either from stock or from special engineering. If you are designing circuits in which dependability is a must, specify

NORTH RELAYS

Ask for the new
informative North Relay Catalog



THE NORTH ELECTRIC MANUFACTURING COMPANY

Originators of ALL RELAY
Systems of Automatic Switching
1438T, South Market Street, Galion, Ohio, U.S.A.

v d-c at 60 megohms. It may also be used as a micromicroammeter with a separate shunt box, type MV-171.

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-

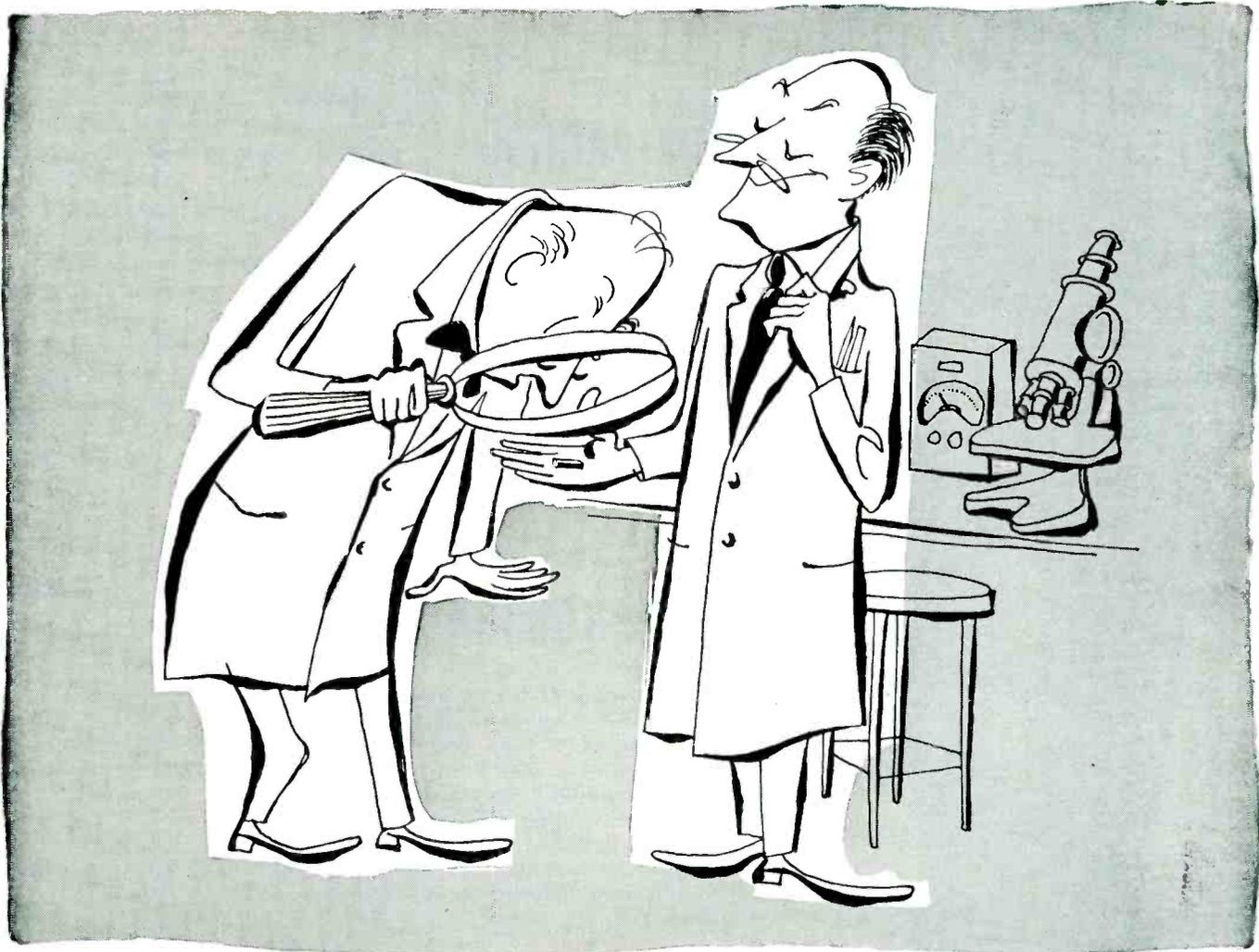


field ion-trap magnet for the prevention of ion-spot blemish. Maximum ratings include: anode voltage, 18,000 v; grid-No. 2 voltage, 410 v; grid-No. 1 voltage, negative-bias value, 125 v; positive-bias value, 0 v; positive-peak value, 2 v.

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





How to make a Magnetic Core that's really small?

...use **PERMENDUR!**

Write for
BLUE SHEETS
on Allegheny Ludlum
Electrical Materials

Complete, laboratory-certified data on each grade—its physical properties, electrical characteristics, uses, methods of handling, etc. Write for Blue Sheets on the materials in which you are interested.

ADDRESS DEPT. E-16

When the conditions of service make it imperative for you to hold the size and weight of magnetic cores at an absolute minimum, that's the place to use Permendur. With this material you can push the flux density up to 20 kilogausses, and practically eliminate weight as a consideration.

Along with its suitability for cores wherever the premium is laid on compactness, Permendur is just the thing for sonar magnetostriction applications, too. We maintain proper annealing facilities for this alloy. Write for technical data on it, and let our engineers help you to cash in on its possibilities.

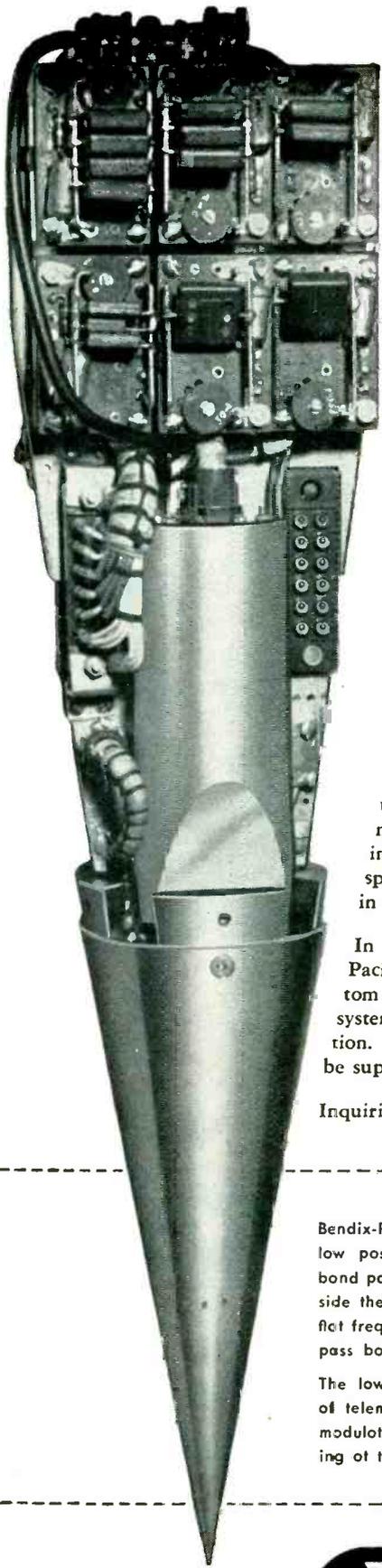
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STEEL CORPORATION
Pittsburgh, Pa.

*Steel Makers
to the*
**ELECTRICAL
INDUSTRY**



W&D 2603



BENDIX-PACIFIC TELEMETERING EQUIPMENT PROVIDES COMPLETE INSTRUMENTATION

Bendix-Pacific standard telemetering components can be combined into a compact, highly efficient assembly to meet *exactly* your specified requirements. This extreme flexibility has been accomplished through the use of the building-block principle which permits the purchaser to assemble readily an instrumentation system exactly suited to his specific needs—thus effecting the utmost economy in volume, weight and cost.

In addition to its standard components Bendix-Pacific provides application engineering and custom system design, fabrication and test of complete systems, installation and field test and data reduction. Complete receiving station facilities can also be supplied.

Inquiries are invited.

Bendix-Pacific has recently developed new bond pass and low pass filters for telemetering receiving stations. The bond pass filters are characterized by high attenuation outside the pass-band by low insertion loss and by extremely flat frequency response and constant phase-shift within the pass band.

The low pass filters are designed to improve the quality of telemetering recordings through the reduction of intermodulation noise and by providing ideal electrical dampening of the input of the recording galvanometer.



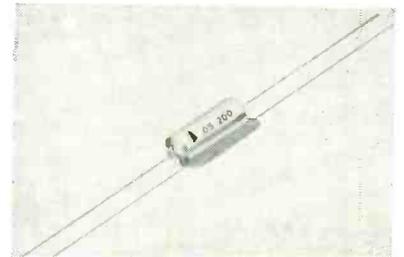
TO MEASURE...TO INDICATE...TO WARN AT A DISTANCE

EASTERN ENGINEERING OFFICE: 475 FIFTH AVE., NEW YORK 17, N.Y.

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 $+125\text{C}$; capacitance range, from $0.001 \mu\text{f}$ to $1.0 \mu\text{f}$; 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-



HOW ALDEN CAN HELP YOU IN THE DAYS AHEAD

Now, more than ever, it is tremendously important that each component on your line fall into place with maximum ease and speed, using a minimum of highly skilled labor. Don't eat up thousands of precious man-hours with bulky, awkward parts that slow down and often stop an entire assembly line. . . . Don't get stuck with an impossible design that needlessly taxes the patience and skill of assemblers, and which, when finally assembled, presents further problems of check and service.

It is extremely necessary in the critical days ahead to hurdle production pitfalls and produce the best and fastest way possible. Using components of ALDEN Design will help you to avoid stumbling blocks and bottlenecks of bulky, poorly engineered components and enable you to manufacture equipment with maximum ease and efficiency.

To get real production design, one has to know and appreciate the production problems—For over 15 years we have been engineering and manufacturing electrical and electronic components that have become standard for many applications because of both good engineering principles and practical working production design. We use these components in many of our own designs; therefore we actually anticipate and take into consideration the end use. We test and judge each new component by how it will save you time, material, and money; how it will add to the performance of your product; and how it will fall into standard production assembly techniques.

ALDEN is set up with extremely flexible production facilities and has readily available many techniques not generally found under one roof. The diversity of skills and combined technical and practical knowledge of engineering and manufacturing enables us to supply you with a whole series of components production designed to prevent headaches and save valuable man-hours of engineering, planning, purchasing, and manufacturing departments.

Save time, save money, eliminate waste—Know ALDEN design.

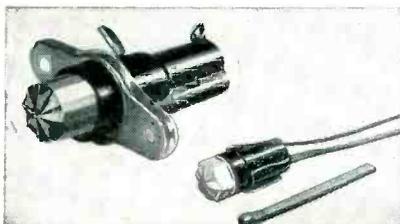
Send for descriptive folder, "What's New at Alden's"



ALDEN PRODUCTS COMPANY

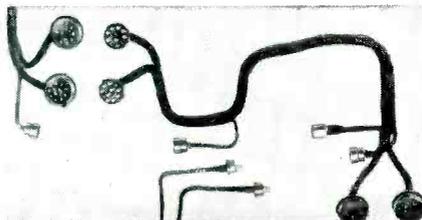
117 N. Main St., Brockton 64E, Mass.

MINIATURIZED COMPONENTS



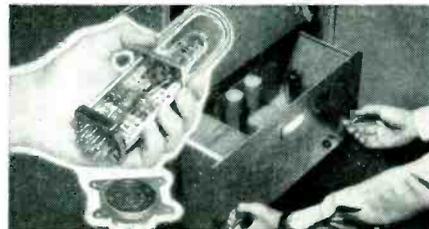
Squeeze without sacrificing efficiency or performance—ALDEN has long anticipated the trend to miniaturization and has been conducting extensive work for both government and commercial applications—already has a wide line of components developed which can become standard to help meet many of your limited space requirement needs. Connectors, indicator lights, fuseholders, terminals, plugs and sockets all take a minimum of space, and yet, good practical engineering design has eliminated possible assembly bottlenecks. Carefully designed ALDEN components readily fit into your production techniques using standard production tools.

UNIT CABLING



ALDEN performance proven unit cabling is designed specifically for the job it is to be used on Here is what ALDEN engineers do for you—take your prototype model, engineer to your specific requirements cables which incorporate years of technical design and development of connectors and wire services. You get cables that are economic and efficient units which allow instant continuity checks and rapid replacement in the field. ALDEN unit cabling solves the problems of malfunctions, time delays, excessive production costs and high service cost in the field caused by cables designed as an *afterthought*.

PLUG-IN COMPONENTS



ALDEN is pioneering a whole series of components for plug-in unit construction . . . Accessible, back connected, slide-in lock-in chassis, rugged color-coded back connectors for slide-in plug-in chassis, dress up housing and rugged bases for plug-in units, and quick acting, easily operable fastenings and locks for plug-in units. ALDEN design is tremendously popular and is fast becoming the standard for plug-in construction.

Sturdy plug-in chassis design gives you quick and positive insertion and removal. ALDEN color-coded back connectors make and break electrical connections smoothly and efficiently—rapid check, service and changeover of chassis unit is completed with ease.

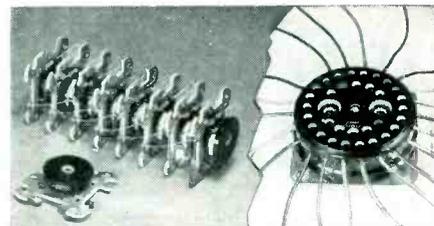
Extremely flexible plug-in kits allow you to design circuits and mount components as ultra-compact plug-in units . . . on a production assembly basis.

TOP CONNECTED CONTACT CONNECTORS



Here are connectors that you can't afford not to be acquainted with. From single wire to multi-wire connectors you get these exclusive performance design features. ALDEN famous top connected contacts which allow ultra compact connector design requiring less space, less material—lead is attached directly to forward end of the contact; No metal is wasted; No bulky housing is necessary. 100% molded insulation around each clip and lead—no danger of insulation pull-back and no need of insulating tubing around wiring. Individual strain relief on each lead—lead held without the use of cable clamps or Underwriters' knot. Wire is crimped firmly to contact at solder joint and capillary action gives perfect connections without danger of cold solder joint.

COMPUTER COMPONENTS

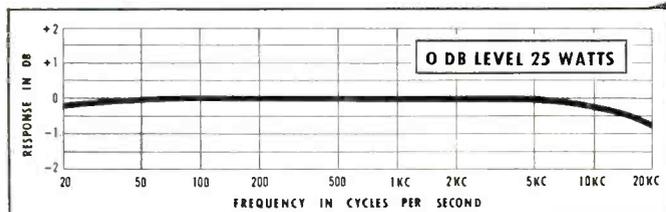


Imagination and ingenuity—skill and production facilities are combined at ALDEN to manufacture computer components that are standard production items. ALDEN is working with laboratories and other manufacturers developing computer components—taking them from the idea stage, designing them into components embodying working production design principles and getting into volume manufacture.

Recent developments include a new storage and pulse handling component, the Static Magnetic Memory, designed and manufactured in conjunction with the Harvard Computation Laboratory, and a multiple connection socket for the RCA SB256 Memory Tube. ALDEN'S skill and ingenuity at setting up assembly line techniques greatly reduces costs and makes available practical components that permit the profitable application of many new ideas in the computer field.

STANCOR

High-Fidelity Output Transformers



Curve represents an average response of the ten transformers in this series. Units used for this test were drawn at random from current Stancor stock.

±1db FROM 20 TO
20,000 cps

Premium Quality at Low Cost

Stancor has taken advantage of the most advanced design and manufacturing practices to bring you a series of output transformers combining outstanding audio response with very moderate cost.

Extensively interleaved "trifilar" windings, extremely tight coupling, and careful electrical balance result in audio fidelity to please the most critical specialist. An inexpensive, but thoroughly practical, type of mounting is used since elaborate shielding is not required at the audio output power level.

Listed part numbers have a maximum power level rating of 50 watts and provide a wide selection of impedances for popular amplifier applications.

PART NO.	PRI. IMP. (P-P) IN OHMS	SEC. IMP. IN OHMS*	MAX. PRI. D. C. PER HALF	NET PRICE
A-8050	1500	8, 16	200 ma	\$10.86
A-8051	2500	8, 16	150 ma	10.86
A-8052	3000	8, 16	175 ma	10.86
A-8053	5000	8, 16	150 ma	10.86
A-8054	9000	8, 16	100 ma	10.86
A-8060	1500	500	200 ma	10.86
A-8061	2500	500	150 ma	10.86
A-8062	3000	500	175 ma	10.86
A-8063	5000	500	150 ma	10.86
A-8064	9000	500	100 ma	10.86

For complete specifications and prices of more than 450 stock part numbers, including other high fidelity transformers, see the current Stancor catalog. Ask your distributor for a copy or write direct.



STANDARD TRANSFORMER CORPORATION

3578 ELSTON AVENUE, CHICAGO 18, ILLINOIS

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



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

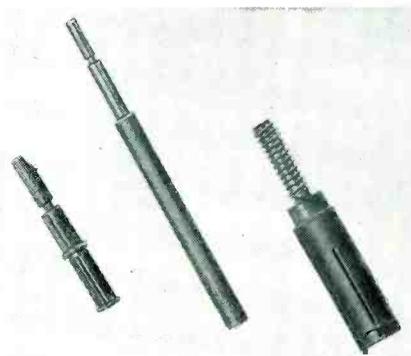
Of utmost importance is a well-directed, heavy supply of cutting compound. Care must be taken to insure the stream hitting the tool and the work and not splashing off into space. Sometimes a lower pressure will be the answer, as well as using two or more streams.

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



Phosphor bronze terminals for micro-wave equipment turned in Swiss screw machines.

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.

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.

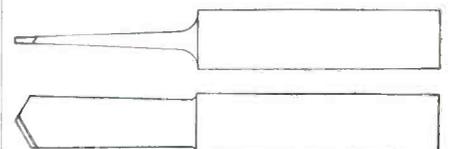
Cleanliness Essential for Plating

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.

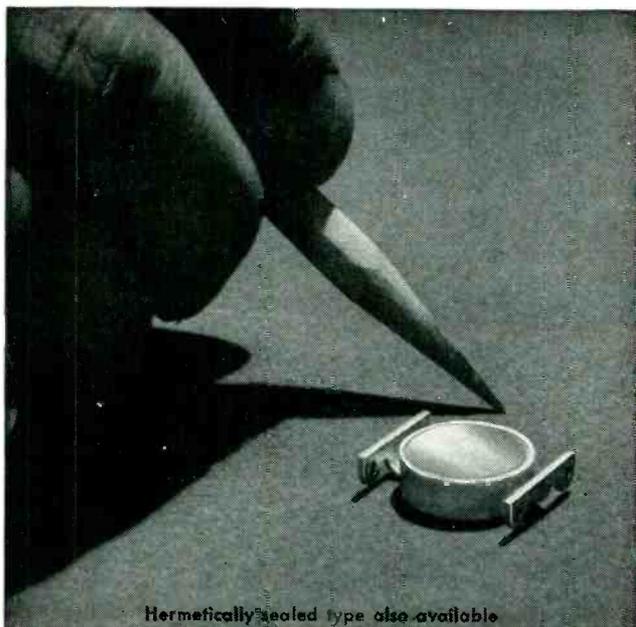
Not only does an unclean surface on the base metal lead to blistering, flaking and peeling, but the plating baths may be contaminated.

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)

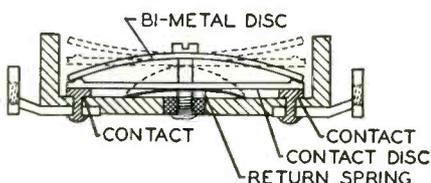
NEW STEVENS THERMOSTAT



fast response • close temperature control



Specifically engineered for electronic, appliance and apparatus applications, compact Type M Stevens Thermostats assure *fast response and close temperature control*—characteristics of larger Stevens Thermostats.



Action of new Type M thermostat is extremely precise because bi-metal element is electrically independent. Bi-metal disc rests on top of rigid Monel-backed contact disc, which carries current on its silver side because of minimum electrical resistance. Since bi-metal carries no current, artificial cycling and life-shortening "jitters" are eliminated.

Double, heavy-duty silver contacts in series minimize arcing, further increase thermostat life. Heat-resistant stainless steel or Inconel return spring assures positive On or Off position. Silver-plated brass or steel terminals, mounted on non-conducting Alsi-mag base, are furnished in standard or special shapes.

Get faster response and closer temperature control on small current differentials. Specify Stevens Type M Thermostats on your appliances and industrial apparatus—for *better performance, longer life.*

A-2289

STEVENS manufacturing company, inc.
MANSFIELD, OHIO

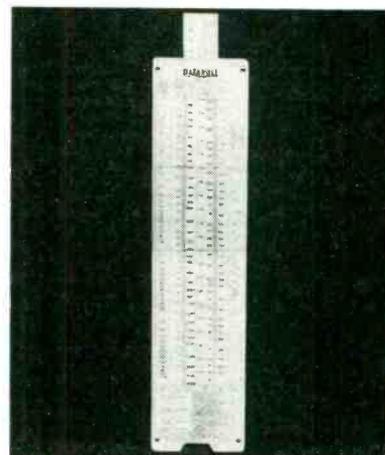
NEW PRODUCTS

(continued)

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

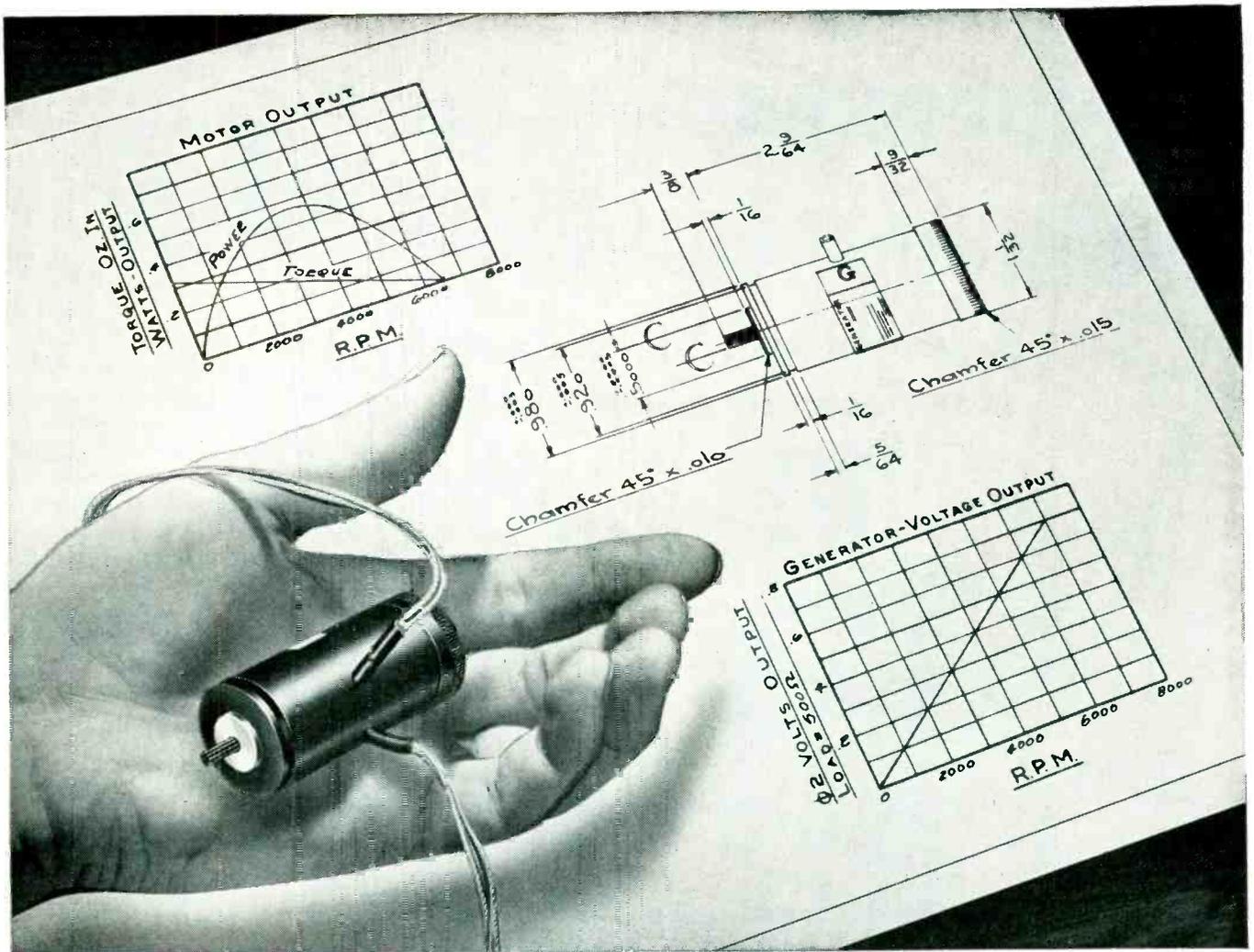
BROWNELL DISTRIBUTORS, 308 Canal St., New York, N. Y. Of interest to the maintenance engineer, motor design engineer, transformer engineer and motor rebuilder is a new



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

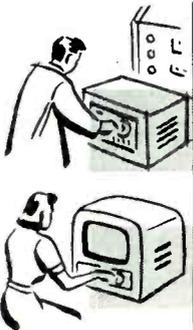
Motor characteristics: Maximum torque at stall—smooth-running (will not "cog")—fast-reversing—operates from two-phase source, or from single-phase with phase-shifting condenser—available for 60 or 400 cycle operation.

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

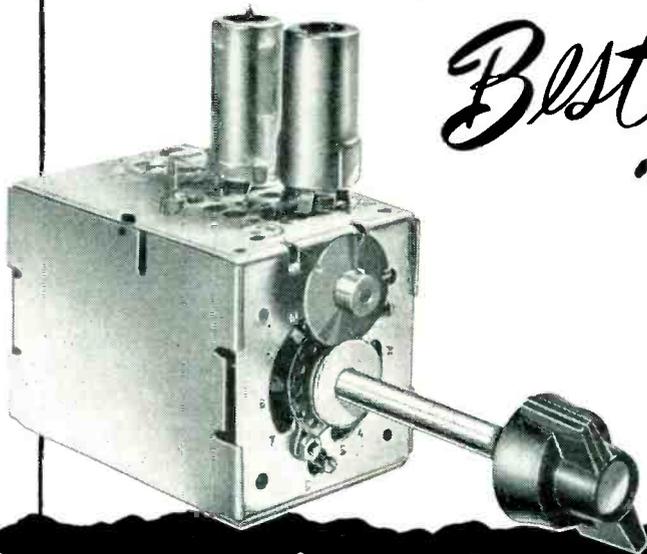


In the laboratory...

In the field...

Repeated tests by leading set manufacturers prove it to be

Best!



the Tarzian Tuner

Tops in overall performance
High in quality
Low-priced — offering maximum performance per dollar cost

Manufacturers are invited to:

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- 3 Write for prices and availability
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 TUNER DIVISION
 Bloomington, Indiana

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Selenium Rectifiers

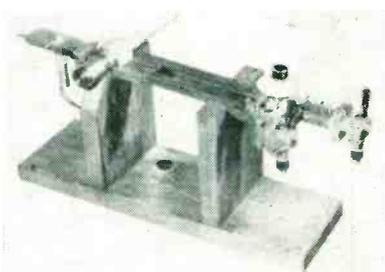


Air Trimmers



Cathode-Ray
Tubes

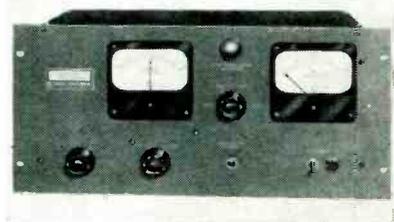
STATIONS WTTS (5000 WATTS) AND WTTV (CHANNEL 10)
OWNED AND OPERATED BY SARKES TARZIAN IN BLOOMINGTON



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**

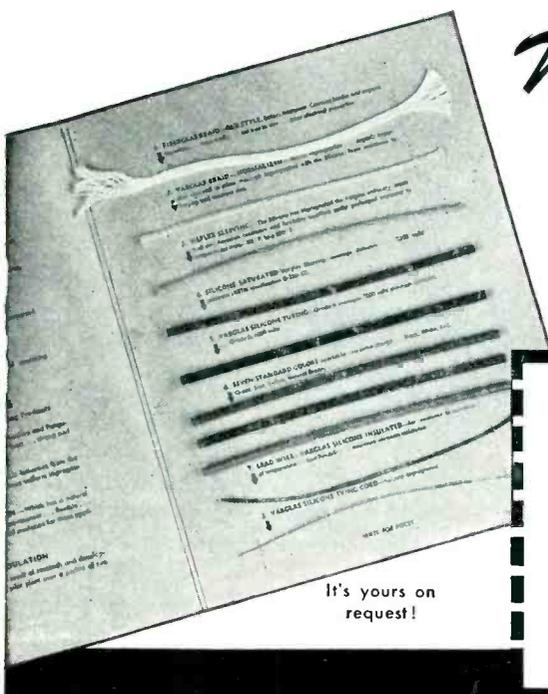
VARGLAS SILICONE is a sensational new electrical insulating sleeving and tubing developed by our laboratory and pilot plant during the last war. It is a product which combines Varglas and Silicone to bring revolutionary possibilities to electrical insulation.

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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2. **NORMALIZING** — Removes binder and organic inclusions from the Fiberglas — improves electrical qualities and allows uniform impregnation.
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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How to keep Line "FEATHERS" out of your hair !

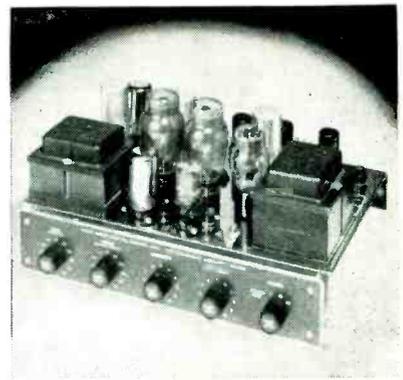
It was a clean, sharp line till it had to be erased. But when it was re-inked, brother how it feathered and "blobbed"!

Feathering lines are one of the things you *don't* have to worry about with Arkwright Tracing Cloth. Even erased surfaces will take a neat, sharp line. What's more, you'll never find pinholes, thick threads or other imperfections in Arkwright cloth. You'll never have to fear that your drawings will discolor, go brittle or become opaque with age. A drawing on Arkwright Tracing Cloth will yield clean, clear blue-prints years after you make it.

Aren't your drawings worth this extra protection? Arkwright Finishing Co., Providence, R.I.

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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

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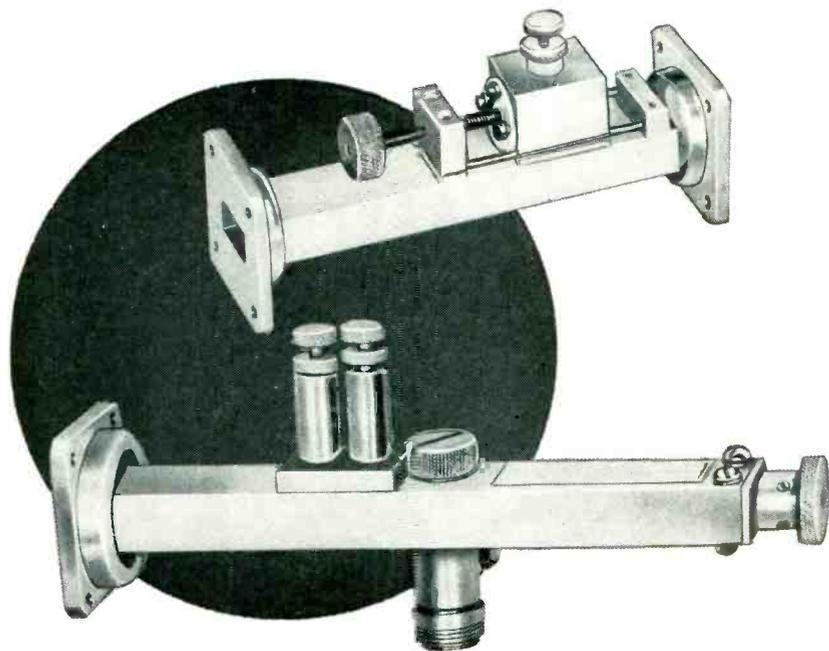
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Microwave Equipment



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50 Marbledale Road, Tuckahoe 7, N. Y.
an affiliate of Kings Electronics Company, Inc.

NEW PRODUCTS

(continued)

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.

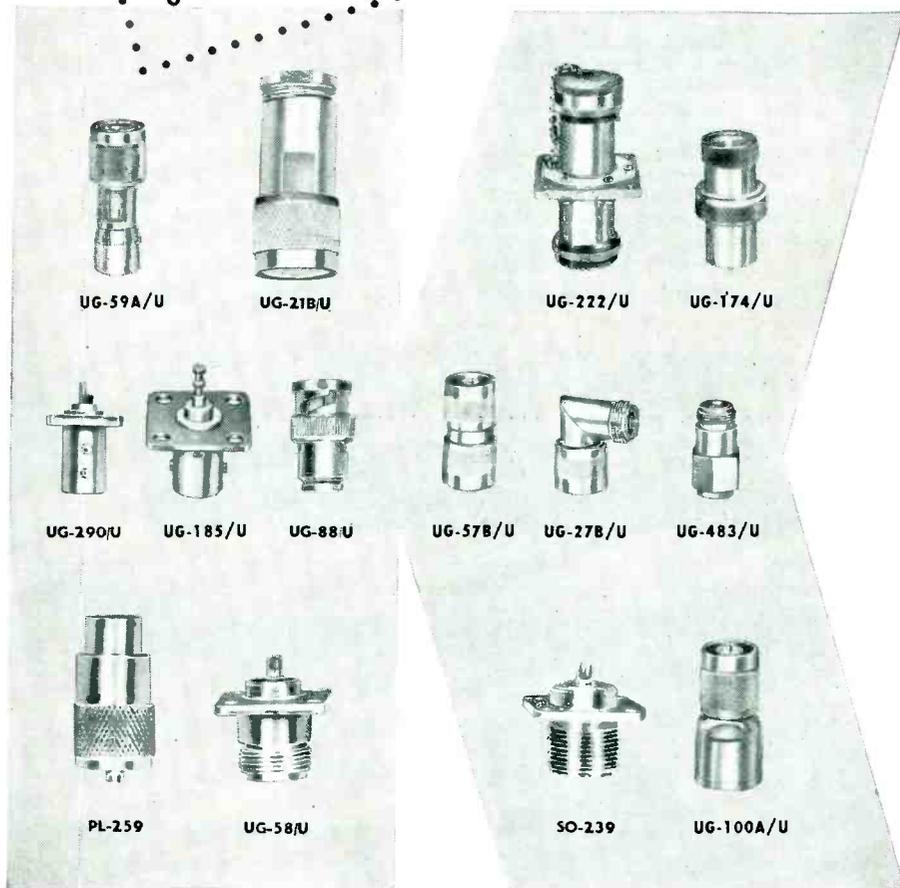
Current Measurements. Columbia Electric Mfg. Co., 4519 Hamilton Ave., Cleveland 14, Ohio. A recent 8-page folder covers the Tong Test a-c and d-c current measuring device. With the unit described amperage readings can be taken without breaking the circuit, scraping the insulation or even touching the 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

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preferred by engineers everywhere

From coast-to-coast, engineers in all fields look to Kings Electronics for the finest coaxial connectors.

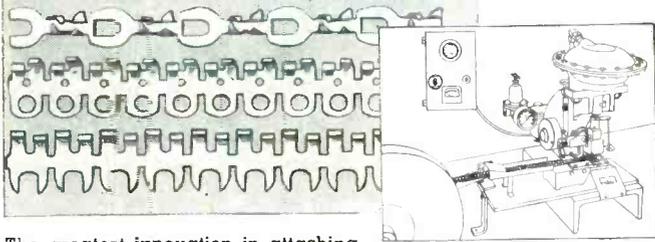
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The greatest innovation in attaching terminals to wires is now available to the industry . . . "Pre-soldered" TANDEM TERMINALS! Made in various sizes and types, these remarkable, production-proved terminals (supplied on reels) can be applied at rates up to 1200 per hour by a new Terminal Attaching Machine that cuts off, clinches and solders terminals in one instantaneous operation. Handling of loose terminals, solder and flux are eliminated to reduce costs and boost production on long runs. Standard types available. Send for detailed information tion, enclose sample of wire and terminal now used. Address Dept. E.

For ordinary runs in moderate quantity we continue to produce

SEPARATE TERMINALS for ELECTRIC WIRES

We also make SMALL METAL STAMPINGS Exact to Customer's Prints. Modern Plant and Equipment. Moderate Die Charges. Precision Work. Prompt Service.

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HF and UHF power leakage
positively and economically
controlled by
new gasket material

The unique combination of controlled resiliency, stability and conductivity found in Metex "Electronic Weather Stripping" makes it particularly effective as a shielding material for such electronic applications as radar equipment, high frequency heating, television broadcasting and high frequency communication.

It is available in strips or in die-formed gaskets of the shape, size and volume required by the particular application. Economical in cost, the use of this material permits further savings in assembly time and eliminates much costly machining of closure surfaces that would normally be required.



"Electronic Weather Stripping"

The base material is a knitted—not woven—wire mesh which is made from any metal that can be drawn into wire. Knitting produces a mesh consisting of a multiplicity of interlaced loops which increase the normal resiliency of the wire and, by their hinge-like action, permit freedom of motion without loss of stability.

These characteristics are retained even when multiple layers of this mesh are compressed to form gaskets or strips. The result is a compressible, resilient, cohesive, conducting material with a large internal surface area. Where hermetic sealing is also required, these gaskets are made in combination with neoprene or similar materials.

Applications

Among the varied applications where Metex "Electronic Weather Stripping" has already proved its effectiveness and economy are: Air craft pulse modulator shields, waveguide choke-flange gaskets, shielding metal housings, replacing beryllium-copper fingers and springs on TR or ATR tubes, and ignition shielding to prevent radio noise interference. The facilities of our engineering department are available at any time to assist you in determining the possible adaptability of "Electronic Weather Stripping" to your specific requirements. A letter, addressed to Mr. R. L. Hartwell, Executive Vice President, and outlining briefly your particular problem will receive immediate attention.

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FOR THE RIGHT CABIN PRESSURE

The AiResearch Rate of Change Control regulates the rate at which pressure in the airplane's cabin changes. An A. W. Haydon Motor was chosen to drive the instrument because of its proved performance record in scores of important aircraft applications. Other functions for which similar A. W. Haydon Motors are used include controls for wing and propeller de-icing, propeller feathering, camera intervalometer, hydraulic bypass, fuel tank purging as well as recorder chart drives, trim control, telemetering and destructor control, etc.

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Design and Manufacture of Electrical Timing Devices

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 steps 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,



Miniature Multipole Relays for Jet-Propelled Jobs!

AIRCRAFT OR GUIDED MISSILE

These miniature d-c relays—only $1\frac{1}{4}''$ D x $1\frac{9}{32}''$ H (excluding terminals and mounting studs)—insure faithful performance when subjected to extremely severe operating conditions such as encountered in missiles and aircraft.

Specifically designed to meet the requirements of USAF specification MIL-R-5757, they are supplied for use in 200°C. (type A) and 85°C. (type B) ambient temperatures.

Available in contact combinations of 2, 3, 4 and 6 poles and rated 2 amperes, 26.5 volts D.C. and 115 volts, 400 cycles A.C.

Write for Data Bulletin 2420 for detailed information.

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STRUTHERS-DUNN, INC., 150 N. 13th ST., PHILADELPHIA 7, PA.

BALTIMORE • BOSTON • BUFFALO • CHARLOTTE • CHICAGO • CINCINNATI
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POLARAD

LABORATORY Equipment

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20 MC VIDEO AMPLIFIER Model V

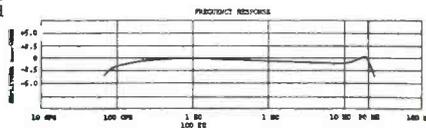
- Flat frequency response from 100 cps to 20 mc \pm 1.5 db.
- Uniform time delay of .02 microseconds.
- Gain of 50 db.
- Frequency compensated high impedance attenuator calibrated in 10 db steps from 0-50.
- Fine attenuator covers a 10 db range.
- Phase Linear with frequency over entire band.



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 19 1/4" x 22" x 14 3/4".



Polarad
Electronics Corporation
100 Metropolitan Ave. Brooklyn 11, N. Y.

Write Dept. E-4 for complete details



Steatite

for ELECTRONIC Applications

You can specify LOUTHAN low-loss Steatite products with complete confidence in the high quality and dimensional accuracy of the parts. Made to exacting standards, Louthan Steatite insulations have the mechanical and electrical characteristics needed for electronics applications and other electrical service. They are formed to meet your needs and made to close tolerances. Surfaces are smooth, hard, clean and non-absorbent.

Write for Catalog 49-E, describing Louthan Insulations.

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Rocket Motors,
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Salaries Commensurate with training & experience.
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INC.
12214 LAKEWOOD BLVD.
DOWNEY, CALIFORNIA

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-

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4E27

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-

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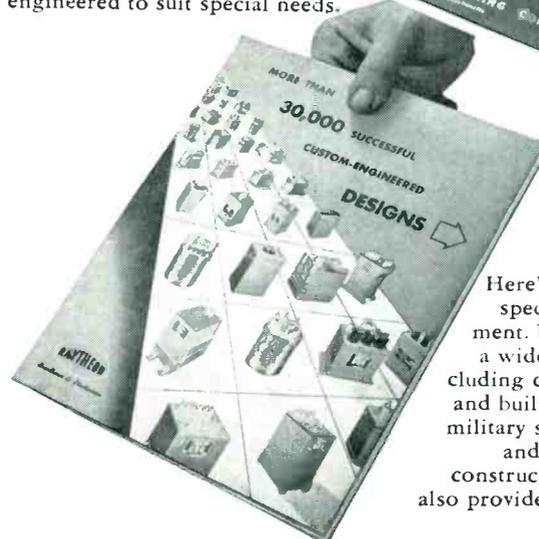
VOLTAGE STABILIZERS

This new bulletin provides the application data, performance facts, operating characteristics, graphs and detailed specifications you need to specify a voltage stabilizer for any electrical or electronic product. Raytheon Voltage Stabilizers are available in a wide range of catalog types or custom-engineered to suit special needs.



CUSTOM BUILT TRANSFORMERS

Here's the help you need in visualizing special transformers for your requirement. Units illustrated are selected from a wide range of types and capacities including chokes and transformers designed and built to government specifications for military service. Data includes dimensions and VA ratings of all frequently used construction types. Time-saving forms are also provided to help you specify your needs.



Other Raytheon products include FATHOMETERS*; marine radiotelephone; television receivers; tubes; television equipment; WELDPower* welding equipment; voltage stabilizers; transformers; RectiCharger* and RectiFilter*^s; Microtherm* diathermy; fractional h. p. motors; and other electronic equipment. *®



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The *All-Weather* Resistors



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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.

WRITE FOR BULLETIN 4906

It gives essential data about S.S. White Resistors, including construction characteristics, dimensions, etc. Copy with price list on request.



S.S. WHITE RESISTORS are of particular interest to all who need resistors with inherent *low noise level and good stability* in all climates.

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18 to 10,000,000 MEGOHMS

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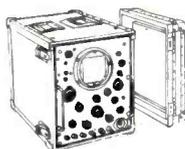
THE S.S. White INDUSTRIAL DIVISION
DENTAL MFG. CO.



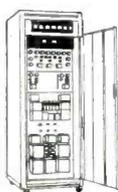
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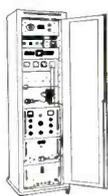
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A few of the many products the Concern has manufactured are illustrated here.

More detailed information will be furnished on request.

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If it's **VOLUME** you need on small tubular metal parts similar to these, be sure to look into Bead Chain's **MULTI-SWAGE** Process. Send the part (up to $\frac{1}{4}$ " dia. and to $1\frac{1}{2}$ " length) and your specs for a quotation. Chances are you'll find a new way to effect important savings.

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As terminals, contacts, bearing pins, stop pins, male-female connections, etc., in a wide variety of electronic and mechanical products:—Toys . . . Business Machines . . . Ventilator louvers . . . Radio and Television apparatus . . . Terminal-boards . . . Electric Shavers . . . Phono Pick-ups, etc. For **DATA BULLETIN**, write to



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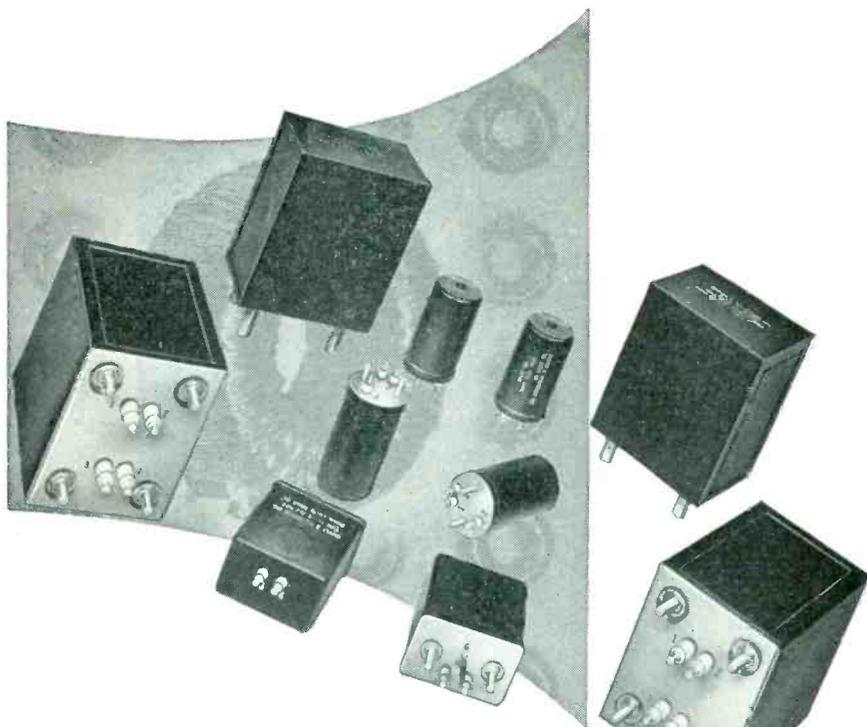
cuted turns tester, type 31Q meter, types 36 A, 41 and 42 television wobblers and type 37A turns checker.

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 ($3\mu\text{mf}$), No. VC5 ($5\mu\text{mf}$) and No. VC11 ($11\mu\text{mf}$). 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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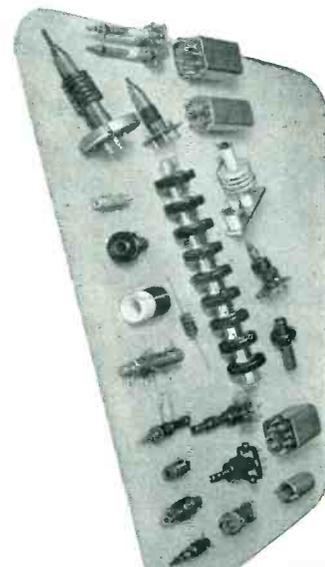
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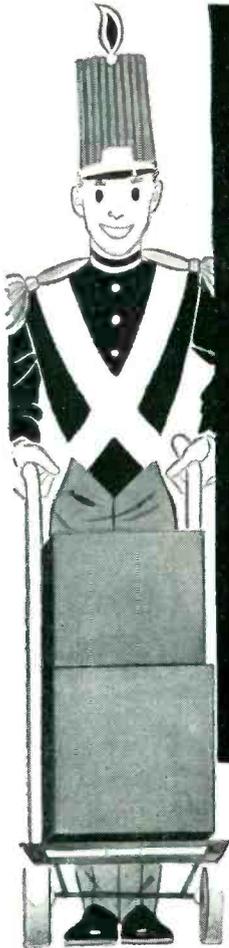
B & W coils in standard or special types range from single layer solenoid coils to universal units with single, multiple pie or progressive windings; RF, IF and oscillator coils; traps, discriminators, filters, RF and delay line chokes and others. For detailed information write to B & W Department EL-41.



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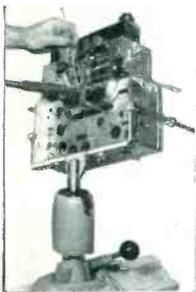
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NEWS OF THE INDUSTRY

(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. Borrow 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.

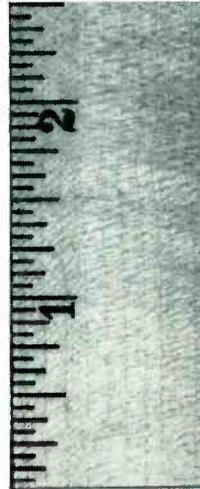
Methods of Adding Color to Television Images, by R. B. Dome of General Electric Co.

Some Fundamental Considerations in Color Television, by A. V. Loughren of Hazeltine Electronics Corp.

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A New Advance IN HERMETICALLY SEALED, MINIATURE Aircraft Type Relays

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greatest of its type, 50 G.

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PLUS THESE OTHER IMPORTANT SPECIFICATIONS:

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- COIL VOLTAGE:** 18 to 250 V, D. C.
- TERMINAL ARRANGEMENT:** soldered connections; plug-in optional.
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To meet exacting requirements of missiles, rockets and other air, ground, and marine applications, this new relay incorporates a hitherto unmatched combination of characteristics. The combination is achieved through several unique design features developed by The Hart Manufacturing Company, producer of dependable electrical controls and devices for more than half a century.

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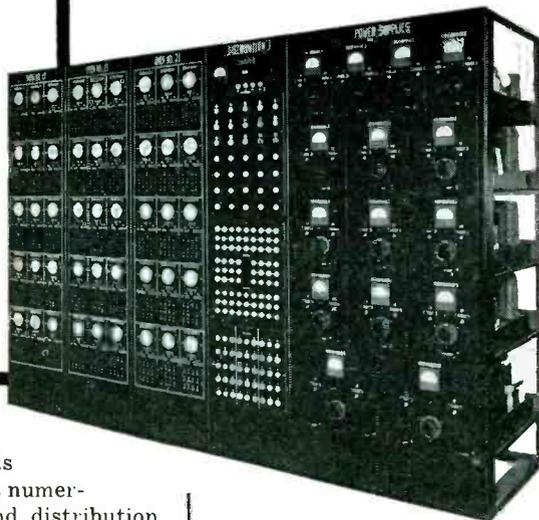
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Circuit-Half-Wave. In 9/16" OD Phenolic Tube with ferrule at each end for insertion in Fuse Clips. Overall length varies to 9" depending on the DC output voltage rating.

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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.

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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
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- Write for These Descriptive Bulletins:
- 849 — Hermetically Sealed Terminals
 - 850 — Hermetically Sealed Headers
 - 851 — Gasket Type Bushings

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44 SUMMER AVENUE • NEWARK 4, N. J.

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.

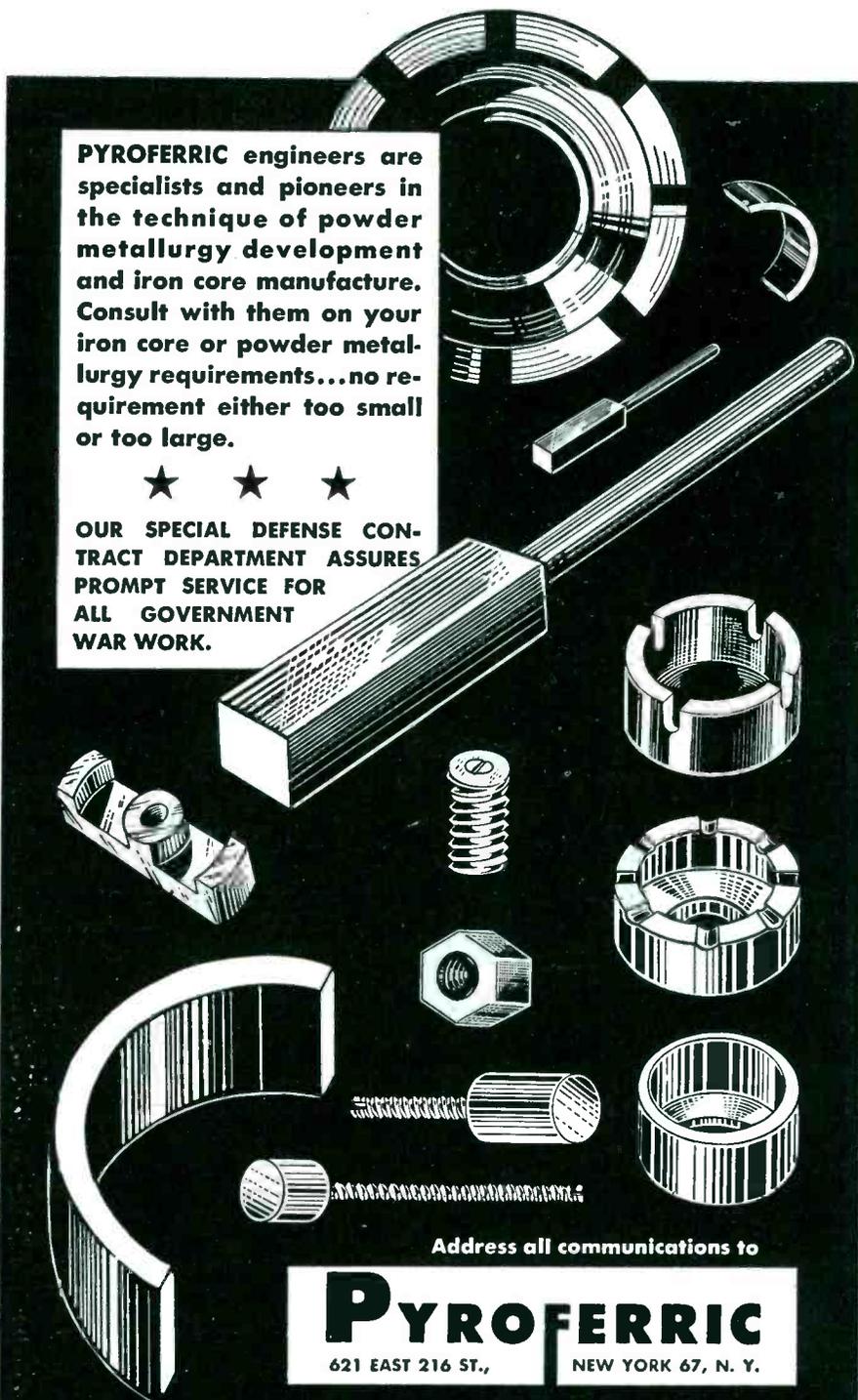
RADIO MATERIALS CORP., Chicago, Ill., recently opened a new plant in Attica, Ind., to increase production of ceramic capacitors.

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.

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● With a new and second plant at 14 North Bleeker Street, Mt. Vernon, N. Y., PYROFERRIC is able to meet the increasing demands for iron cores and powdered metallurgy development.

MANUFACTURERS AND DESIGNERS OF CONTINUOUSLY VARIABLE REGULATED DC SUPPLIES

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- ✓ **DUAL regulated outputs, continuously variable, 0 to 600 volts.**
- ✓ **Maximum current 200 milliamperes each, or 400 combined.**
- ✓ **Regulation better than .5%.**
- ✓ **6.3 volts AC at 10 amperes center-tapped.**
- ✓ **Ripple voltage less than 10 millivolts.**
- ✓ **Stabilized bias supply.**
- ✓ **Request Bulletin 53 for Detailed Information.**

MODELS A3 AND A3A



- ✓ **Continuously variable, 0 to 350 volts.**
- ✓ **Ripple voltages less than 10 millivolts.**
- ✓ **Regulation better than .5%.**
- ✓ **Maximum current 200 milliamperes.**
- ✓ **Stabilized variable bias supply.**
- ✓ **6.3 volts AC at 5 amperes.**
- ✓ **Request Bulletin 52 for Detailed Information.**

Oregon ELECTRONICS
MFG. CO.
206 S.W. WASHINGTON ST., PORTLAND 4, ORE., U.S.A.

ion 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.

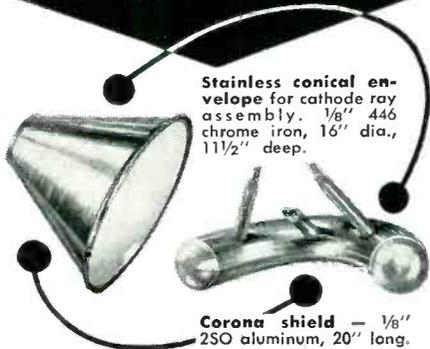
CONDENSER PRODUCTS Co., manufacturers of high-voltage power supplies and capacitors, recently moved to new and larger quarters at 7517 North Clark St., Chicago, Ill.

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-

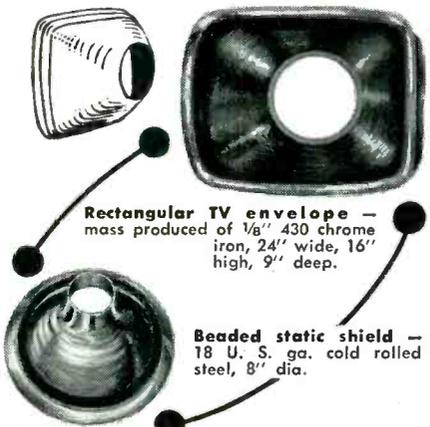
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SKILL WILL DO IT®

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Electronic Parts**



Stainless conical envelope for cathode ray assembly. $\frac{1}{8}$ " 446 chrome iron, 16" dia., 11 $\frac{1}{2}$ " deep.

Corona shield — $\frac{1}{8}$ " 250 aluminum, 20" long.



Rectangular TV envelope — mass produced of $\frac{1}{8}$ " 430 chrome iron, 24" wide, 16" high, 9" deep.

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STUDY these illustrations of Spincraft "engineering" — interesting examples of a high order of ability to "work" metal by spinning and fabricating. Best of all, these methods pay off in time gained — and substantially lower costs, both on large and small runs.

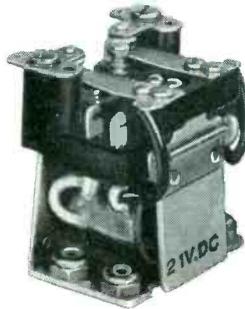
Progressive new Spincraft techniques may help simplify your production problem in any metal — just as they have helped others in the electronics industry. Your inquiry is welcome — and you are invited to send for the new Spincraft Data Book, a stimulating source of ideas for engineers, designers and plant production men. Write today.



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THIS LIGHTWEIGHT, COMPACT RELAY CAN HANDLE POWER LOADS USUALLY DEMANDING LARGER, HEAVIER UNITS

Tiny . . . but powerful! This general-purpose relay meets rigid aircraft requirements, and also has wide industrial application. Coils are normally rated at 2.5 watts d. c., or 3 watts, 60 cycle a. c., for voltages up to 230 volts d. c. or 440 volts a. c. Maximum standard contact combination, double-pole double-throw — others on request. Contact rating, 15 amps — at 115 volts a. c. non-inductive or 32 volts d. c. Weight, 4 oz. Size, 1-7/8" high, 1-5/8" wide, 1-13/32" deep.



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FOR INTERVIEW, WRITE COMPLETE RESUMÉ TO:

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Test, Grade, or Match Resistors

*"as fast as you
can pick 'em up!"*



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\$585.00
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with the new **Clippard** PR-5
RESISTANCE COMPARATOR

Just place the "unknown" resistance across the terminals of this precision, production Clippard tester. Even unskilled operators can process up to 17 resistors (of all types) *per minute*. Working to an accuracy of better than $\pm 1\%$ through the entire range of 100 ohms to 100 megohms, the PR-5 is a companion instrument to the famous PC-4 Automatic Capacitance Comparator. With it, radio, electrical, resistor manufacturers and large part jobbers save time and money and assure unerring accuracy of inspection.

Completely self-contained, the PR-5 requires no outside attachments other

than the Standard Resistor against which unknowns are checked. Operates on 110 Volt—60 Cycle AC. Range: 100 ohms to 100 megohms; reads deviation from standard on any of three scales: -5% to $+5\%$, -25% to $+30\%$ or -50% to $+100\%$. Size: 18" x 12" x 12". Weight: approx. 32 lbs. For complete details, write for Catalog Sheet 4-E.

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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 Tele-tone 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., Bay-side, N. Y., has been appointed to the staff of the company's vice-president of engineering as director of engineering.



R. M. Bowie

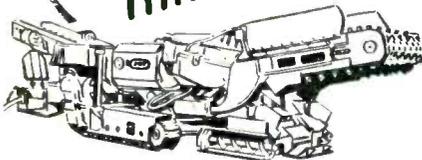


E. S. Lee

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

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SPECIFIC COILS
CAN DO
THIS JOB-**



The monstrous Joy Continuous Coal Miner "snakes" through the earth gathering 2 tons of coal per minute. This production miracle is dependent on highest quality components. Not the least of these is the rugged 2½ lb. solenoid coil, shown below, which actuates the controls and is made from non-corrosive and inert materials to withstand the extreme voltage differentials, moisture, dampness, and acidity encountered in operation.



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Model 10 EL
10,000 watts

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**PORTABLE A.C. ELECTRIC PLANTS
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Supply power for transmission at scene of events. Can be carried by hand or in trunk of car. Take up only a few square inches of space in mobile unit. Weigh as little as 80 pounds. Lightweight models: 350 to 3,000 watts. Other models to 35,000 watts.

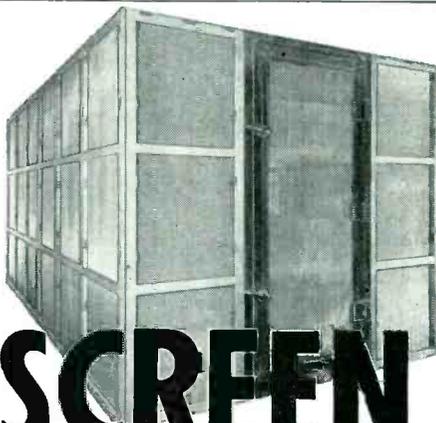
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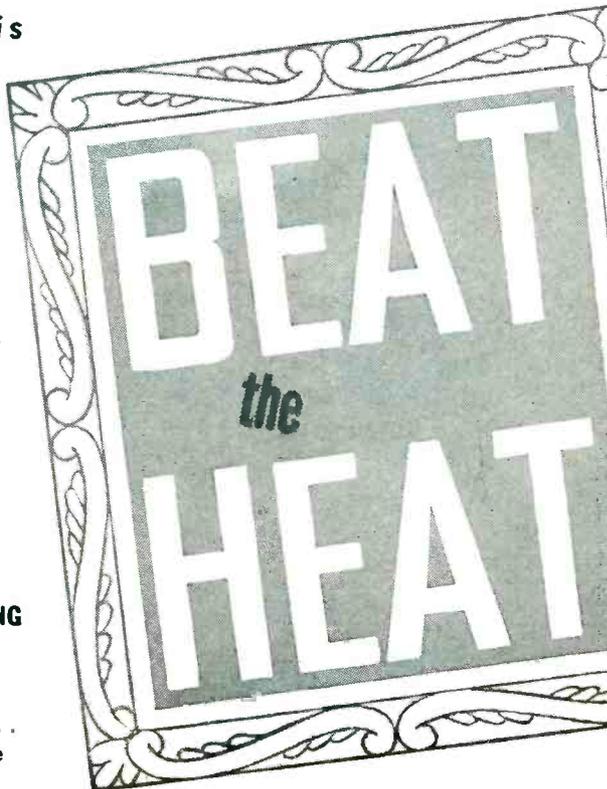
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making it an ideal wire
for use in connection
with coil and trans-
former leads



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No "Nicking" problem in using this proven wire. Not being an extruded plastic, its diameter uniformity can be absolutely guaranteed. This eliminates nicking of conductors and constant re-setting of blades in the cutting process. Available in all sizes, solid and stranded, in over 200 color combinations . . . "NOFLAME-COR" assures maximum output and minimum rejects.

No "blobbing" of insulations under soldering heat, because "NOFLAME-COR" is NOT an extruded plastic. Production executives specify it as the most efficient heat-resistant wire yet developed. Save time, money and assembling headaches. Investigate!

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MANUFACTURERS OF QUALITY WIRES AND CABLES FOR THE ELECTRICAL AND ELECTRONIC INDUSTRIES

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

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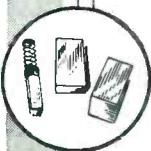


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- for high current density
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Type "QRE" has Two Special Features:

- 1 QUICK DISCONNECTING
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(Two large diameter guide pins.
These also assure proper polarization.)

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The TYPE MRC-12 6-ELEMENT SELF-POWERED STRAIN GAGE CONTROL UNIT, and the TYPE S15-A 6-ELEMENT SELF-POWERED RECORDING OSCILLOGRAPH together make up a complete dynamic strain measuring laboratory which you can carry with you for field use ANYWHERE where electrical power is not available.

With standard SR-4 resistance strain gages, a frequency response from static to 500 cycles per second can be obtained. Magnifications are adequate for all practical needs for static-dynamic strain recording on structural members and machine parts.

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Write for Technical Bulletin SP-177G and SP-193G

Hathaway
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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.



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NEWARK, N. J.

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Perfect straight lengths to 12 ft.
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SMALL METAL STAMPINGS

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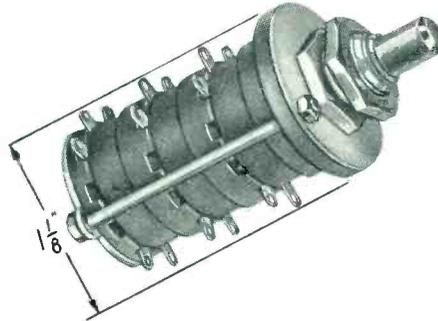
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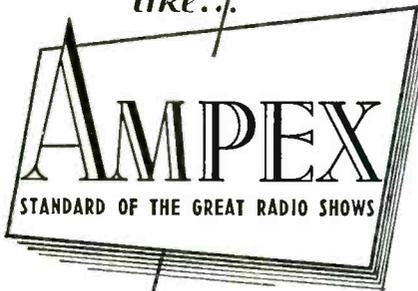


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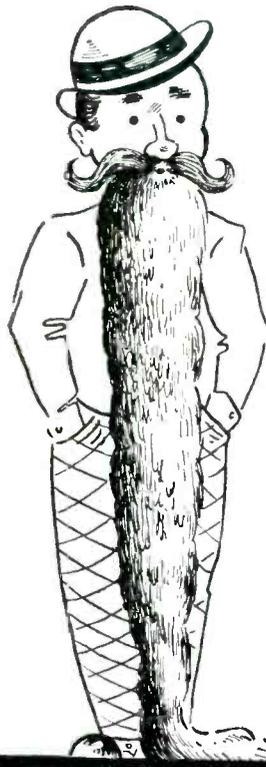
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7 1/2 inches per second tape
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AX-34



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Keeps your beard out from under your feet — prevents tripping and lawn mower accidents — but you haven't any beard and we haven't any Beard Supporter, so let's get modern and talk about something up to date — Pel-X Water Repellent Tracing Cloth.

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You do the same thing and get Pel-X — it's the best water-resistant tracing cloth on the market today. Want to give us an argument — eh? Well, write for testing samples now. Won't cost you a cent to get the evidence that ends arguments.



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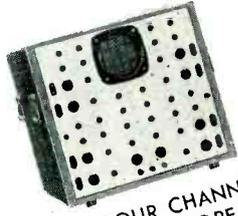
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PEL-X is backed by Holliston's 50 years of leadership and experience in developing special purpose cloths for industry.

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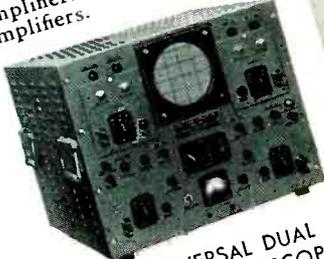
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Indicates 2 independent signals simultaneously. Sensitivity better than 0.085 Vdc/in. (30 MV rms/in.)



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Offers choice of any combination of high sensitivity dc amplifiers or wide band ac amplifiers.



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Designed for strip-film recording of up to 4 variables on a single 5" tube. Readily portable.



H-22 UNIVERSAL DUAL CHANNEL OSCILLOSCOPE
Plug-in ac or dc amplifiers. Two independent channels on a single tube register phenomena from dc to 1 megacycle.



H-81 EIGHT CHANNEL OSCILLOSCOPE
A unique design originally developed for film strip recording of seismographic phenomena. Frequency response 20 to 150,000 cps. ADC model with sensitivity of 2 MV dc/in. also available.



MULTI-GUN CATHODE TUBES
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Multi-Channel Oscilloscopes

As specialists in multi-channel 'scopes, ETC offers a broad line for critical testing, production and research needs. In addition to standard types incorporating 2, 4, and 5 wave forms on a single tube, many special designs and adaptations are regularly produced for specific uses. Full details on any type will gladly be sent on request.

electronic tube corporation
PHILADELPHIA 18, PENNSYLVANIA

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

ZOPHAR

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Anti-Corona high heat-resistant compounds for Fly Back Transformers.

Waxes and compounds from 100° F to 285° F Melting Points for electrical, radio, television, and electronic components of all types.

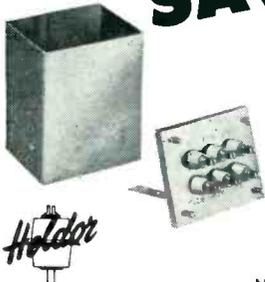
Pioneers in fungus-resistant waxes.

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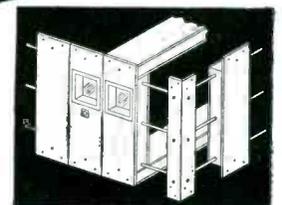
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Hot or Cold WALK-IN ROOMS

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These new modular panels by Bowser now furnish all-purpose

all-weather enclosures easy to assemble, knock down or transport. Controlled temperatures from -100°F. to +200°F. and relative humidity simulation from 20% to 95%. Bowser Walk-In Rooms are universally accepted for the storage and testing of foods, biologicals, equipment, etc. They feature metal clad interiors and exteriors and are of light weight hermetically sealed construction. Rooms can be expanded by the use of additional panels. With the addition of auxiliary instrumentation they will meet all Government test specs including MIL-T-27. Smaller rooms can be pre-assembled at the factory.

Also by Bowser, standard environmental simulation chambers. Wide range of sizes, performance ratings.

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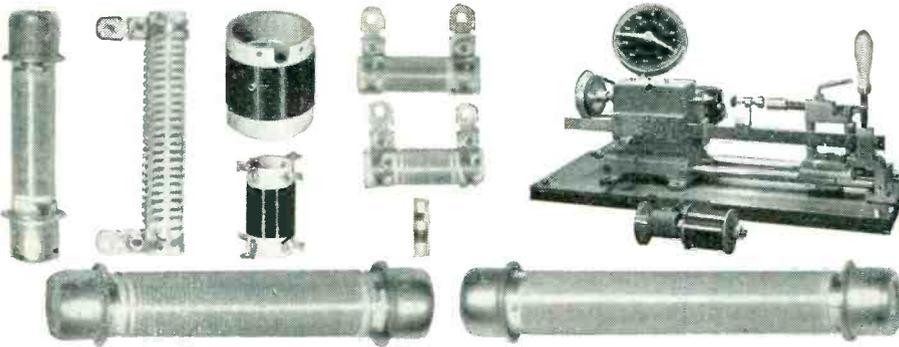
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throughout the entire volume.

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



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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.

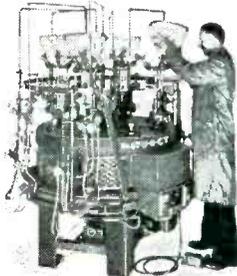
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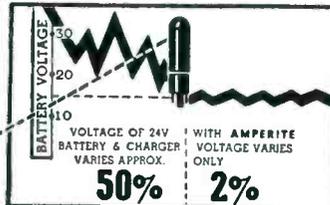


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A novel aid to the reader is a collection of synthesized waveform patterns, a total of 1,580 extending over 79 pages. These are provided for those readers who do not have a harmonic wave analyzer available. The patterns are printed in black on a white 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.

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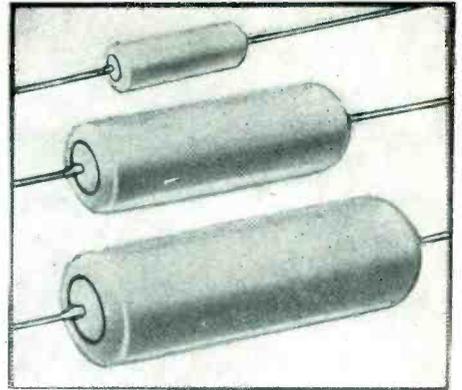
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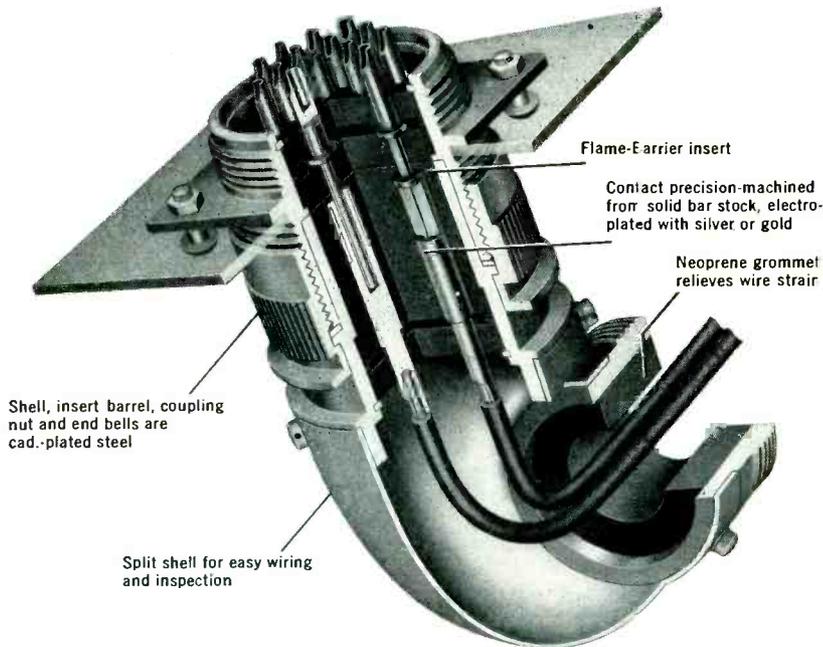
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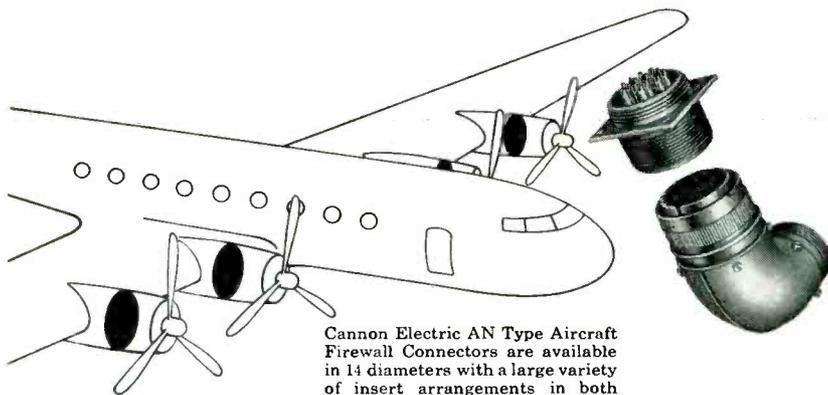
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two outputs, the cavity with several outputs and coupled cavities, and the periodically loaded wave guide. The second half of the book (200 pages) discusses fundamental principles of electronic devices, the klystron, the linear accelerator, the traveling-wave 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:

$$\frac{1}{Q_{\text{Loaded}}} = \frac{1}{Q_{\text{Unloaded}}} + \frac{g}{Q_{\text{External}}}$$

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

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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, 8½ x 11½ in., \$2 (paper) or \$4 (cloth).

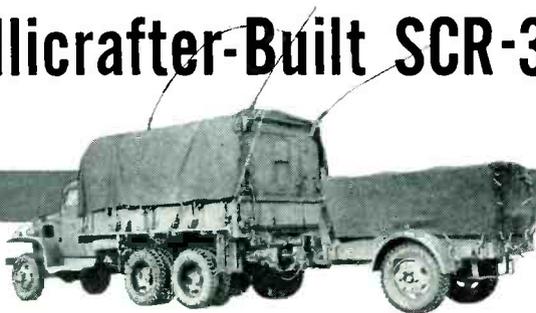
THIS FIRST EDITION of a book addressed to company executives and public officials as well as to communications engineers begins to fill a growing need for information about the equipment and the uses for mobile radio. The chapter headings give a clear index to the many interrelated topics that are covered. Included are: basic system planning, FCC rules and frequency allocations, license application pro-

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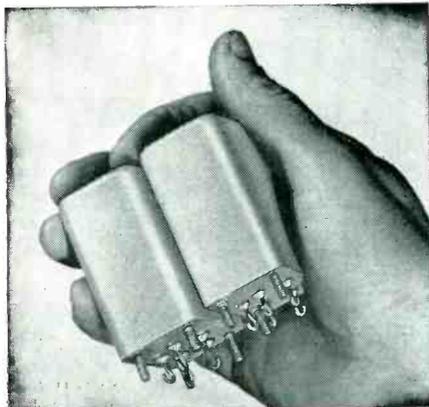
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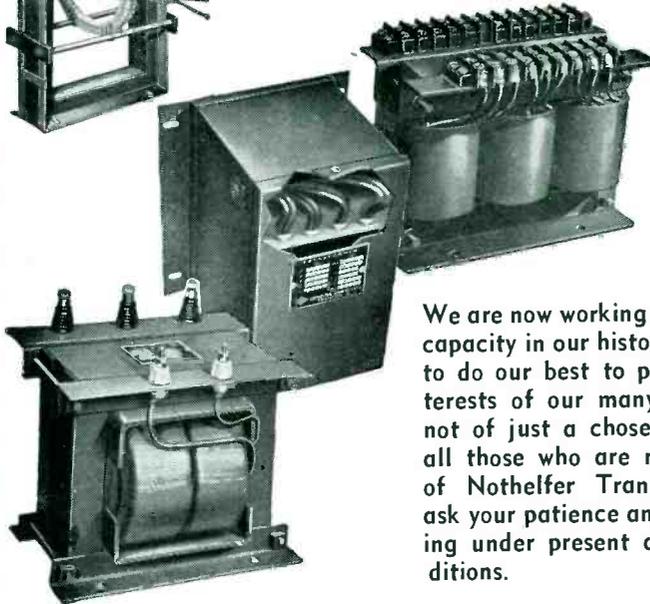
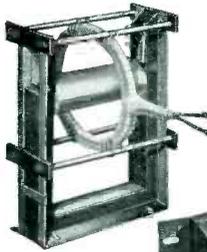
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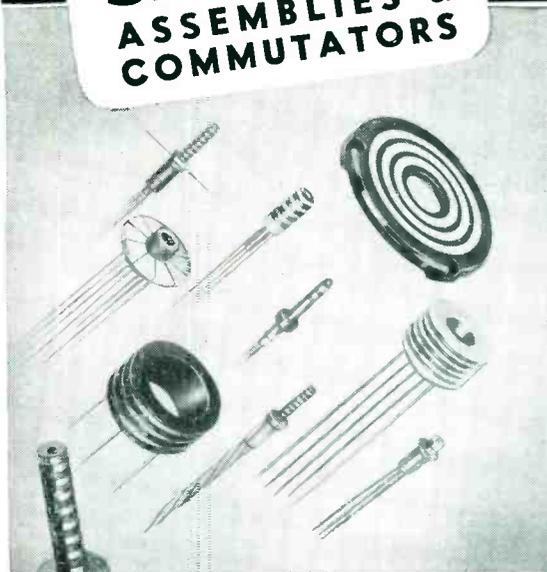
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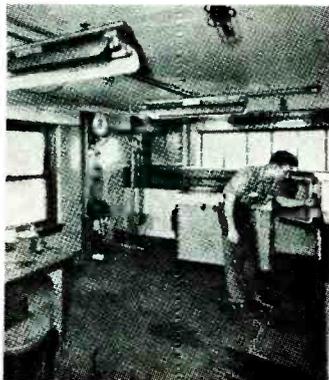
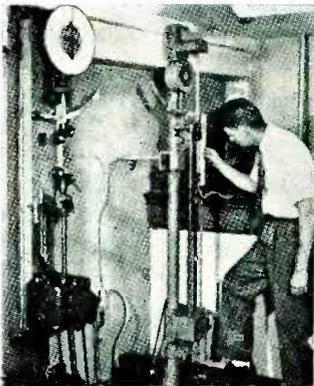
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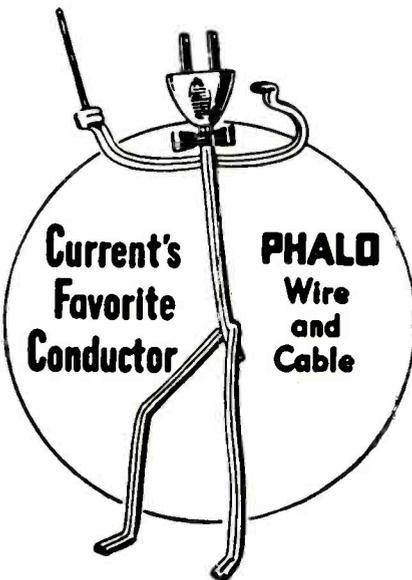
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NEW BOOKS

(continued)

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 Ampitel; 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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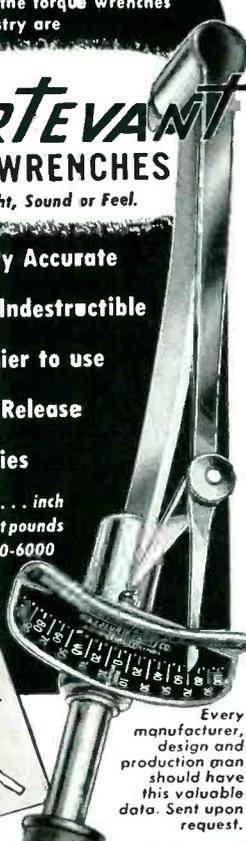
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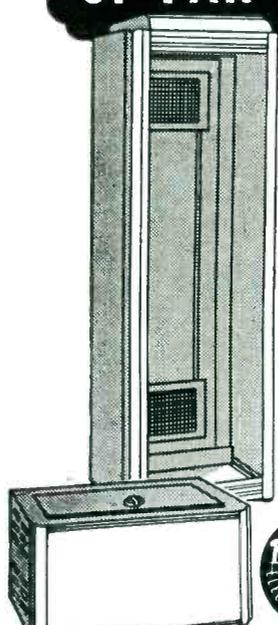
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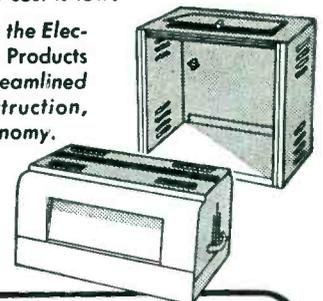
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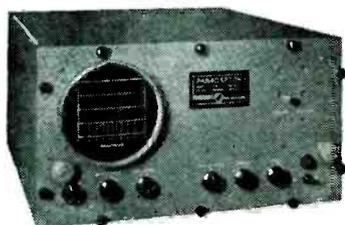
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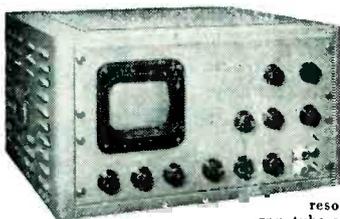


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BACKTALK

(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
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Electronics Quiz

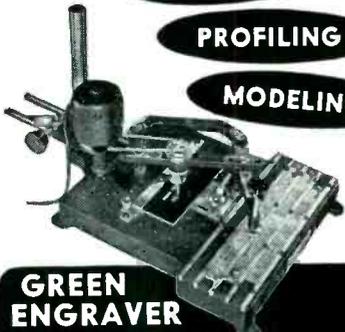
THIS month's quiz problem was furnished by T. W. Nelson, of Alexandria, Virginia. Readers are encouraged to submit problems (with correct solutions) for use in this department. For each problem pub-

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APRIL 2

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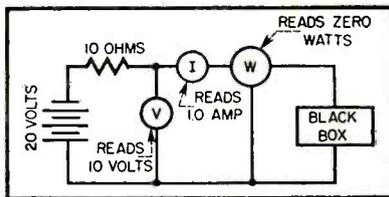
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lished, the contributor will receive our check for five dollars.

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.



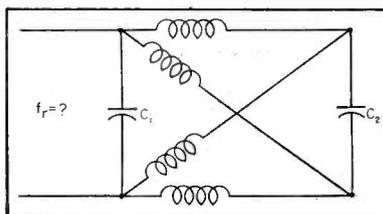
The apparent power dissipation in the black box is 10 watts according to the voltmeter and ammeter, but the zero wattmeter indication is a contradiction of this. What is in the little "black box?"

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 μ f.

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

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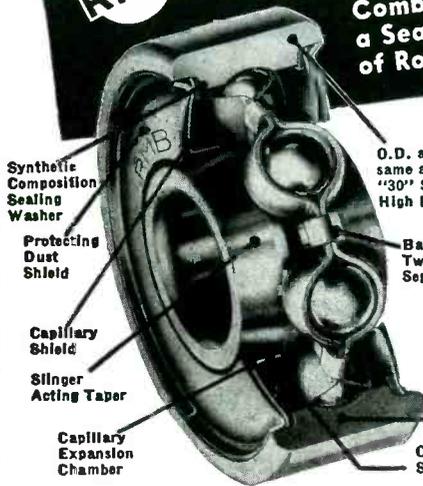
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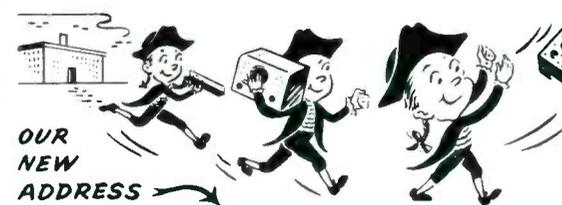
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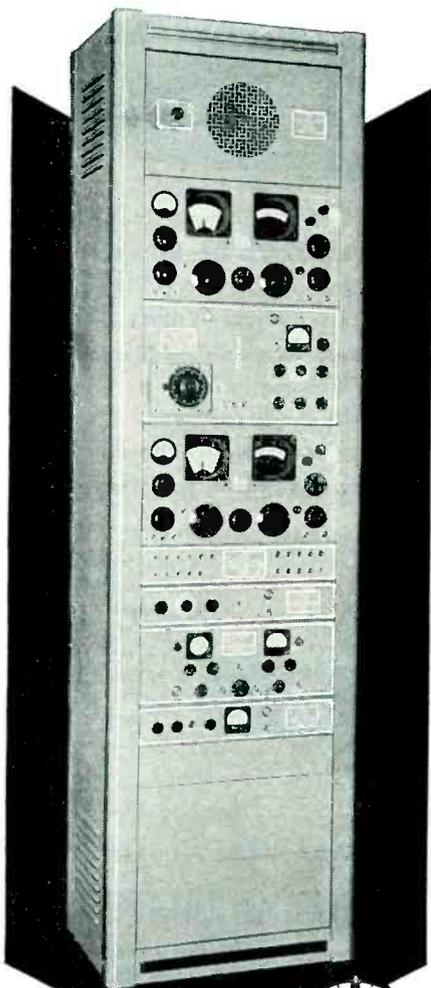


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NORTHERN RADIO Co., inc.
143 West 22nd Street, New York 11, N. Y.
Pace-Setters in Quality Communication Equipment

BACKTALK

(continued)

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.

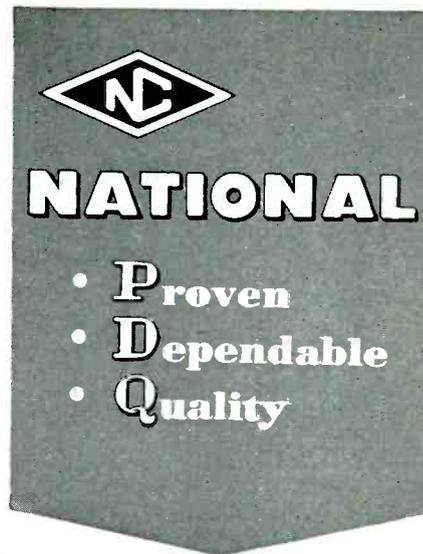
Cross Correlation

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.

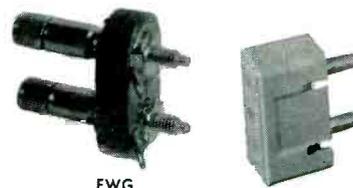
This technique is the detection of a signal in a phase detector followed by a low-pass or long-time-constant filter to average the output of the detector. This technique is used in many types of radar; in the omni-directional beacons; in c-w range-measuring equipment and in other equipment where a phase-coherent 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



FWH

FWJ



FWG

FWF

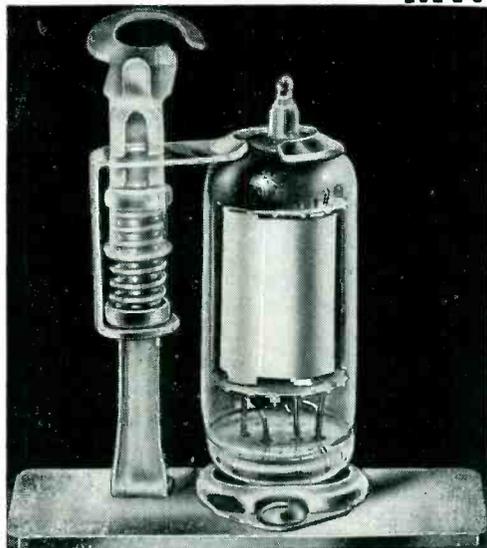
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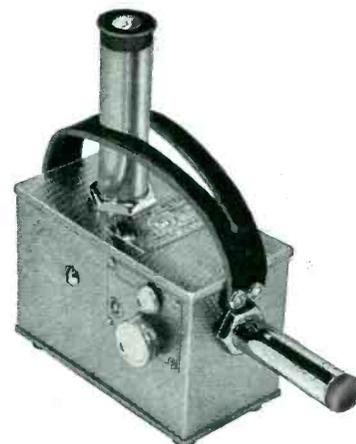
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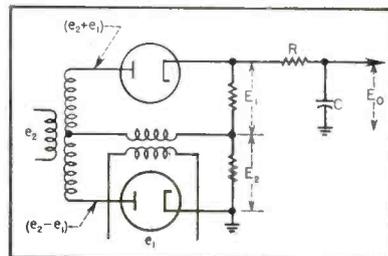
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BACKTALK

(continued)

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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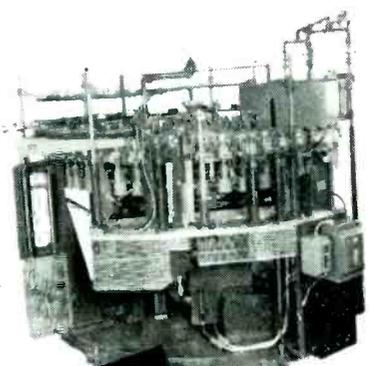
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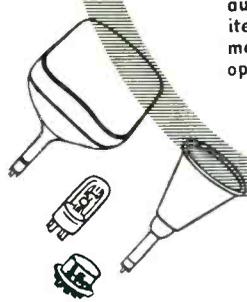


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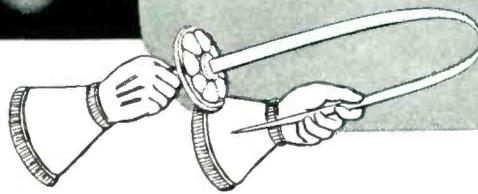
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BACKTALK

(continued)

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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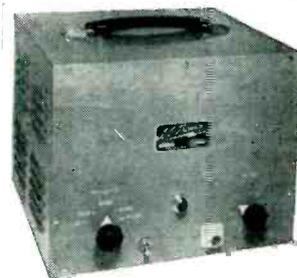
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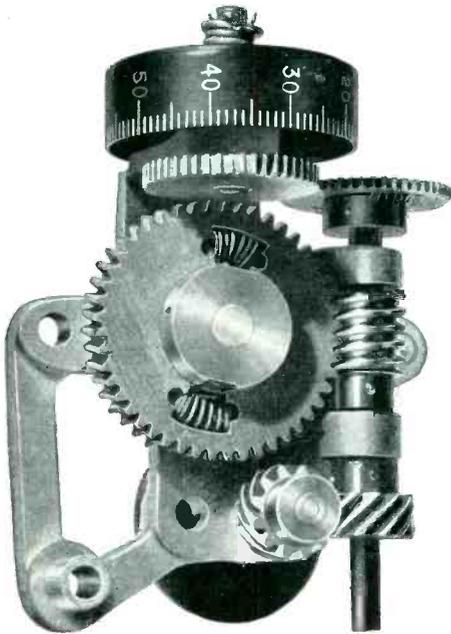
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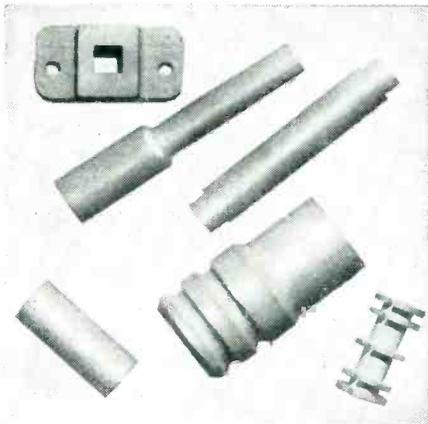
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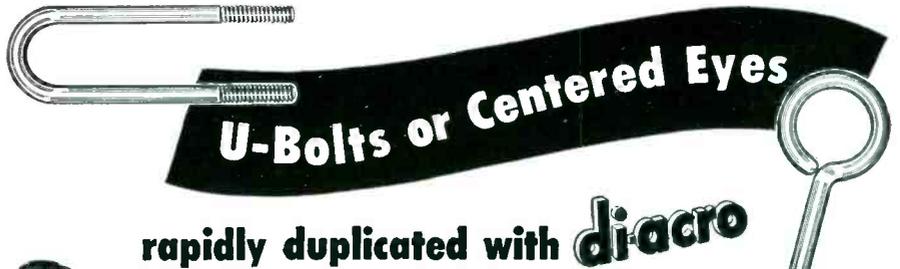


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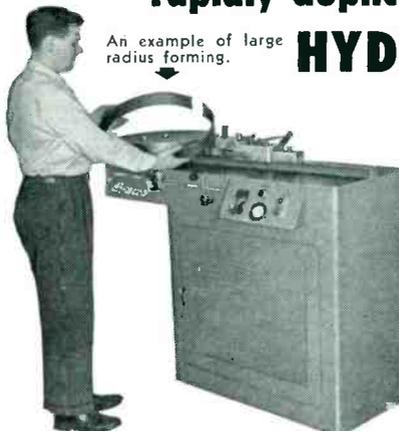
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several years so far—broadcast of the same programme, at about 90 mc, on f-m and a-m from the same site. By this means we are able to test the relative merits of the two methods. I have attended a number of tests and know of a great number more, and 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 than 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.

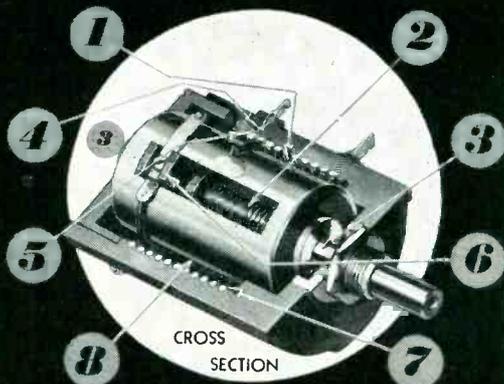
It is extremely rare for hold controls to be adjusted in modern British receivers, and most manufacturers tuck them out of the way so that they will not be accidentally touched.

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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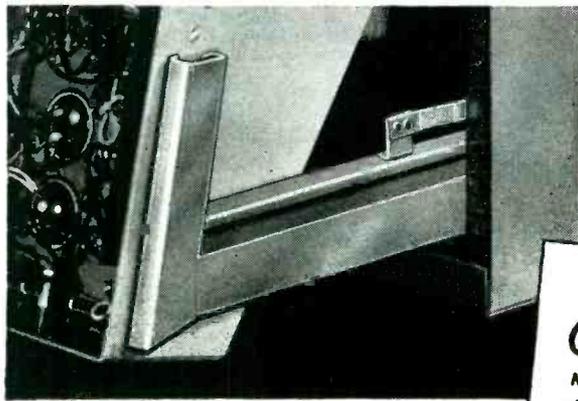
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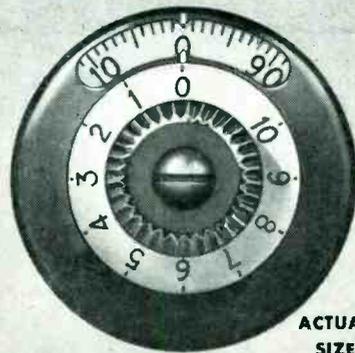
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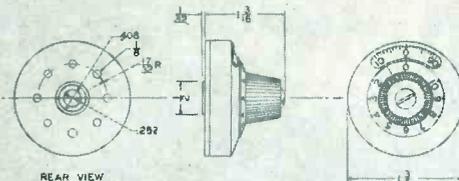
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BACKTALK

(continued)

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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).

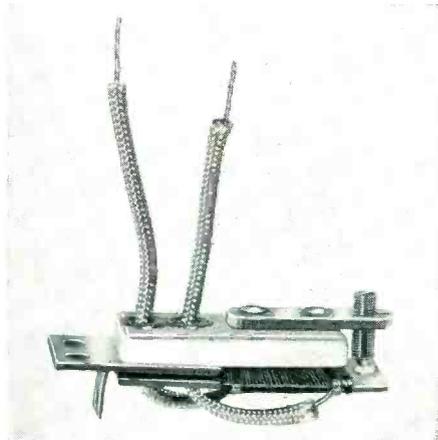
Figure 1B, which is a sketch of anode current, should appear directly above that of initial inverse voltage to show their time relation.

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 thyatron 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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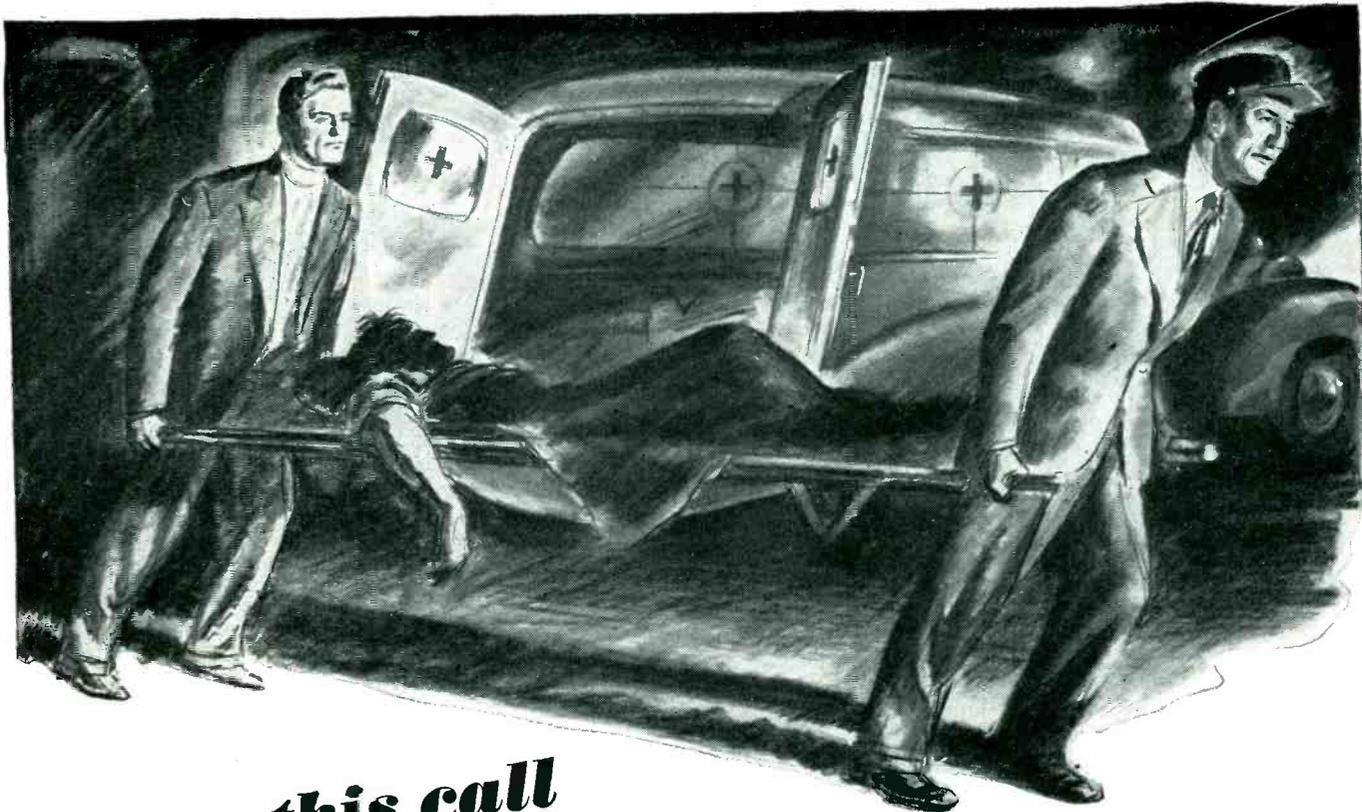
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accompanying diagram".

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
The W. L. Maxson Corp.
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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-grid-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.

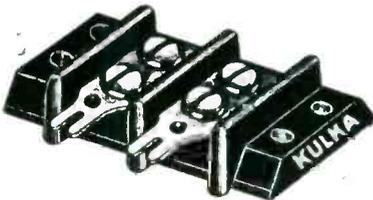
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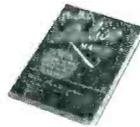
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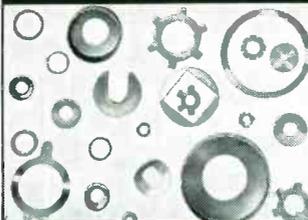
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LARGE MID-WEST Manufacturer has positions open for electrical and electronics engineers and technicians. Applicants are requested to submit data concerning their education and experience together with photograph. P-9060, Electronics.

DRAFTSMAN, DESIGNER, wanted by hard-hitting, fast growing small organization, located in western Michigan, engaged in the manufacture of electronic and sound equipment. This position provides a chance to get in on the ground floor with good starting pay and the best possible opportunities for advancement. P-8995, Electronics.

ELECTRONIC AND Mechanical Engineers, with imagination and plenty of inventive ability, wanted by hard-hitting, fast growing small organization, located in western Michigan, engaged in the manufacture of electronic and sound equipment. This position provides a chance to get in on the ground floor with good starting pay and the best possible opportunities for advancement. P-8996, Electronics.

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SALARIED PERSONNEL, \$3,000-\$25,000. This confidential service, established 1927, is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jira Thayer Jennings, Dept. L, 241 Orange St., New Haven, Conn.

POSITION WANTED

TECHNICAL SUPERVISING editor wants position out of Los Angeles Smog area. Direct experience in organizing depts. and producing illustrated parts catalogs to latest specs Aircraft and Electronic Eng. background. Reply to 7614 South Western Ave., Los Angeles 47, Calif.

SELLING OPPORTUNITY WANTED

CALIF. REG. Electrical Engr., 32, married, desires position as manufacturer's representative in Palo Alto-San Francisco area. Excel. electronic background in diverse fields; viz., television, radar, electro-medical eqpt., communications, etc. Interested in new development or something off beaten track. Aggressive and capable of making good contacts. RA-9054, Electronics.

PATENTS

Consult: Z. H. Polachek,
Reg. Patent Attorney, 1234 Broadway, New York 1, N. Y.

Wanted—Representative FOR SELLING RESISTORS EASTERN TERRITORY

CONTACT:
MONSON SALES COMPANY
919 North Michigan Ave. Chicago, Ill.

WANTED ENGINEERS

With power and transmitting tube design experience. State draft status and experience.

Write Direct To:

TAYLOR TUBES, INC.
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PROJECT ENGINEERS

Five years or more of experience in charge of design and development of radio and communication equipment. Must be a graduate of a credited Engineering School. Well equipped laboratory in modern radio and television plant, with excellent opportunities for advancement.

Send resume of qualifications to Mr. S. F. Cascio, Personnel Director of the Hallcrafters Company

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SENIOR DEVELOPMENT: extensive experience pulse circuitry, computers, nuclear instruments. Requires leadership qualities, initiative, ingenuity.

DESIGN (Production): Experience in above fields with demonstrated ability in design for economical small lot production.

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ELECTRONICS ENGINEERS—At all salary and experience levels.

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BASE SALARIES FOR ALL POSITIONS LISTED ABOVE ARE SUPPLEMENTED BY UP TO 30% FOR REGULARLY SCHEDULED 48 HOUR WEEK.

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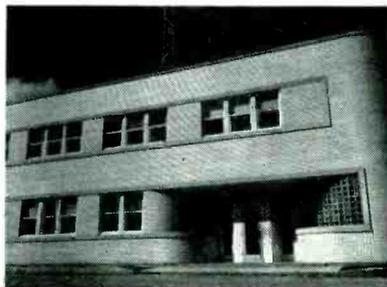
You may apply at once by letter to Mr. John F. Byrne, Associate Director of Research, and be sure of prompt, courteous consideration. Please state your qualifications, references, and salary requirements in your first letter.

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COMMUNICATIONS AND ELECTRONICS DIVISION

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CARRIER AND CONTROL

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WORLD LEADERS IN FM 2-WAY MOBILE RADIO

ATOMIC ENERGY INSTALLATION NEEDS ELECTRONICS ENGINEERS

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TEST EQUIPMENT RELATING TO THE ABOVE

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These are PERMANENT POSITIONS with Sandia Corporation in Albuquerque, New Mexico. Sandia Laboratory is operated by Sandia Corporation, a subsidiary of Western Electric Company, under contract with the ATOMIC ENERGY COMMISSION. This laboratory offers good working conditions and liberal employee benefits, including paid vacations, sick leave, and a retirement plan.

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Research and Development Engineers and Physicists with educational background in mechanical, electrical or electronic engineering, physics or engineering physics for openings in plant and laboratory instrumentation, physical measurements, geophysics, and industrial electronics. Prefer persons with two to four years experience in experimental research design and development of instruments, intricate mechanisms, electronic apparatus, optical equipment, servo-mechanisms or allied fields. Positions are of immediate and permanent importance to our operations.

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Research and Development Department
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Secondary Emission, Converters,
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We invite interested personnel with ex-
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The Employment Department

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Positions are now available in our organization for qualified physicists and engineers with backgrounds in circuit analysis, microwaves, servomechanisms, analog computers, etc. Openings exist at several levels with salaries dependent on education, ability, and experience.

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Electronic and Electrical, Mechanical, and Chemical Engineers for research, design, and development work on rockets, rocket components, and guided missiles.

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For Overseas Assignments

Technical Qualifications:

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2. Navy veterans ETM 1/c or higher.
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4. Willing to go overseas for 1 year.

Base pay, bonus, living allowance, vacation add up to \$7,000.00 per year. Permanent connection with company possible.

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Must have at least one year's experience.

For work on airborne radar, shipborne radar, radio communications eqpt., microwave relay, or micro-wave communications.

Good pay, excellent working conditions; advancement on individual merit; location Baltimore.

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MANAGER, TECHNICAL EMPLOYMENT
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Long-term electronic Research, Development and Production projects assuring permanent employment at excellent salaries immediately available at Laboratory that has steadily expanded since its founding in 1942.

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*Scientific or engineering
degree, and extensive technical
experience required.*

Write:

Manager, Engineering Personnel

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Immediately

Minimum Requirements are:

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- Electronic equipment

This organization can offer excellent prospects for security and personal advancement due to our continued growth. Our location is in the New York metropolitan area.

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National Union Research Division

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At least three (3) years post-college experience in development, DC amplifier, digital computers, pulse and servo designer. Established Company, New York City.

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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 222 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, 6A67 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
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8500—9600 Mc Bench Test Plumbing
1" x 1 1/2" 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, 1.6 low power load, adapters, etc. TS 12/Unit 2. \$385
AN/AP5-15A "X" Band compl. RF head and mod. incl. 725-A mag and magnet, two 723A/B klystrons (local osc. & beam) 1B24, TR, rcvr ampl. duplexer, HV supply blower, pulser xfmtr. Peak Pwr Out: 45 KW apx. input: 115, 400 cy. Modulator pulse duration 5-2 microsec., apx. 13KV. PK. Pulse, with all tubes incl. 115B, 829B, BK7 73, two 723's. Complete pkg. \$575
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.

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3 CM SECTOR SCANNING ANTENNA, 18" dish, cutler feed dipole, 24 vdc drive motor. \$75
APS-3 RADAR, new and complete, using 723A magnetron. \$95
TS 36 X BAND POWER METER 1 1/2" 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, \$500 to 9400 Mcs., with calibration. Microm. adjust head. Reaction type. \$85.00
90 DEGREE ELBOWS, E or H plane, 2 1/2" 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 lb. \$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, T6-40/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 dial. 0.5w. Mnt. w/ctrl 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. 55c
SQ. FLANGES, Flat Brass ea. 55c

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 & 2 1/2" radius, 90 deg. bend. \$4.50
TWIST 90 deg. 5" choke to cover w/press nipple. \$6.50
WAVEGUIDE SECTIONS, 12" ft. long silver plated with choke flange. \$5.75
ROTARY JOINT choke to choke with deck mounting. \$17.50
3 CM. MITRED ELBOW plane unplated. \$12.00
1 1/2" x 3/8" 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.
B1 DIR-COUPLER WG output calibrated —25 db nominal. \$17.50
Coated. \$14.50

MITRED ELBOW H Plane UG51-UG52. \$12.00
6" ST. SECT. choke to choke \$22.50
APQ 13 Constant Z Rotat Jnt. \$22.50
CG 98B/APQ 13 12" Flex. Sect. 1 1/4" x 5/8" OD. \$10.00

WAVE GD. RUN 1 1/4" 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, solid brass.
X BAND WAVE GD. 1 1/4" x 5/8" O.D. 1/16" wall aluminum. Per ft. 75c
SLUG TUNER ATTENUATOR W.E. guide. Gold Plated. \$6.50

WAVEGUIDE
 1/2" x 1/4" ID. \$1.00 per foot
 1/2" x 3/8" OD. \$1.50 per foot
 5/8" x 1/4" OD. \$1.65 per foot
 5/8" x 1/4" OD Aluminum. .75 per foot
 1 1/2" x 3" OD. \$3.00 per foot
 2 1/2" x 2" OD. \$3.50 per foot
 1" x 1/2" OD Flexible. \$4.00 per foot
 7/8" rigid coax 1/4" 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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1000 KC crystal BT cut. \$3.95
 3" scope shield. 1.29
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 ATC 100 mfd air trimmer screwdriver shaft. .29
 Centralab 850 S 50MMF 5KV BUTLON COND. .39
 500 watt 12.5 ohm power rheostat. 3.49



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 3 mfd 4000v oil condenser. 3.95
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TUBES!! BRAND NEW! STANDARD BRANDS! NO SECONDS! COMPARE! TUBES!!

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0C3/VR105 1.49	3C30 2.95	212E 49.50	811 2.95	8014 0.92	68T7GT
0D3/VR150 1.29	3C31 C1B 1.19	212E 49.50	812 2.95	8020 1.29	0A4
1B22 3.45	3C45 12.75	217C 8.95	812H 8.95	8025 5.95	01A
1B23 12.50	3CP1 S1 2.25	327A 5C27 5.95	813 6.90	9001 1.49	1A4P
1B24 2.75	3C46 2.40	340C 3.95	814 3.95	9002 1.49	1A5GT
1B27 3.95	3DP1 4.95	250R 12.95	815 8.15	9003 1.49	1A6
1B29 24.50	3DP1A 6.95	250TH 21.50	816 1.19	9004 2.35	1A7GT
1B32 2.75	3E29 2.95	250YL 21.50	817 2.95	9005 2.35	1A8
1B36 24.96	3E29 2.95	274A 5.50	828 12.75	9008 9.29	1A8/5
1B38 32.50	3E29 2.95	274B 2.65	829 12.95	9011 9.95	1B4
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1N21A Xtal 2.25	3GP1 4.75	294A 5.75	832 3.95	9013 1.49	1B7GT
1N21B Xtal 3.25	3HP7 1.42	303B 3.95	833A 3.95	9014 1.49	1C3GT
1N23 Xtal 2.25	4-125A 26.95	304TH 27.50	836A 3.95	9015 1.49	1C6
1N23A Xtal 3.25	4-250A 29.95	304TL 29.95	836A 3.95	9016 1.49	1C7G
1N23B Xtal 3.25	4-250A 29.95	307A/RK75 5.95	837 1.49	9017 1.49	1C8GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	838 2.95	9018 1.49	1D7G
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	841 4.95	9019 1.49	1D8GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	843 4.95	9020 1.49	1E7G
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	849 29.50	9021 1.49	1E7G
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9022 1.49	1F4
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9023 1.49	1G4GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9024 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9025 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9026 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9027 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9028 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9029 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9030 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9031 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9032 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9033 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9034 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9035 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9036 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9037 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9038 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9039 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9040 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9041 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9042 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9043 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9044 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9045 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9046 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9047 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9048 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9049 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9050 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9051 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9052 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9053 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9054 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9055 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9056 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9057 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9058 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9059 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9060 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9061 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9062 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9063 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9064 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9065 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9066 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9067 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9068 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9069 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9070 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9071 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9072 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9073 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9074 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9075 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9076 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9077 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9078 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9079 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9080 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9081 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9082 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9083 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9084 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9085 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9086 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9087 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9088 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9089 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9090 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9091 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9092 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9093 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9094 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9095 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9096 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9097 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9098 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9099 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9100 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9101 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9102 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9103 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9104 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9105 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9106 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9107 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9108 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9109 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9110 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9111 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9112 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9113 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9114 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9115 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9116 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9117 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9118 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9119 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50	9120 1.49	1G6GT
1N23B Xtal 3.25	4-250A 29.95	310A 8.95	851 69.50</		

Reliance Specials

WIRE WOUND PRECISION RESISTORS 2% OR BETTER

1/4 Watt—30c				
2	10.84	13.52	62.54	301.8
2.5	11.4	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

1/2 Watt—30c				
.250	13.15	260	4,000	8,000
.334	46	270	4,300	8,500
.502	52	273.3	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—35c				
.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—45c				
100,000	128,000	158,000	270,000	500,000
105,000	130,000	200,000	295,000	520,000
120,000	132,000	260,000	320,000	522,000
			348,000	600,000
				700,000

1 Megohm, 1 Watt, 1%—65c; 5%—45c				
	2,000	4,385	5,000	6,000

CAPACITORS

POSTAGE STAMP MICAS

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

.82 MMF to .001 MFD	5c
.0011 MFD to .002 MFD	7c
.0026 MFD to .0082 MFD	12c
.01 MFD	22c

SILVER MICAS

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	.008
23	68	180	360	510		.0033
24	68	200	370	625	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	760	.0024	.006
	115		466		.0028	.0082

Price Schedule

10MMF to .001625MFD	10c
.0022MFD to .0028MFD	20c
.0028MFD to .0082MFD	50c

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	3	1,000	80	
.03	16,000	22.95	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 mfd		
2	5,000	4.50	4,000		
2	4,000	3.95	V.D.C.		
2	3,000	3.15	G.E.		
.25	3,000	1.10	SPECIAL		
8	2,000	3.95	\$3.95		
4	2,000	3.65			
2	2,000	2.50			
.5	2,000	1.25			

FILAMENT TRANSFORMERS

Pri., 115V., 60 Cyo.—Secondary: { 8 V. @ 35 A.	\$6.50
{ 12 V. @ 18 A.	
{ 24 V. @ 9 A.	

PULSE TRANSFORMERS

D161310, 50 K ω to 4 Mc, 1/4" dia. x 1 1/2" 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, V.E. Freq. resp. 10KC to 2 MC..	\$9.80
800 KVA, G.E. #2731, 28,000 Volt peak output;	
Bifilar: one microsecond pulse width....	\$37.50

Wrapped—BALL BEARINGS—New

Mfg	ID	OD	Width	Price
Fafnir 33K	3/16"	1/2"	5/32"	\$0.25
MRC 295R	63/64"	2 3/64"	19/32"	1.10
N.D. 5202C13M	1 1/2"	1 3/8"	1/8"	1.00
Fafnir 7308W	1 37/64"	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" 30c

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 8-32 x 3/4
ALL SIZES \$1.50 per 100

VERNIER DIAL OR DRUM (From BC-221)

DIAL—2 1/2" dia. 0-100 in 360°. Black with silver marks. Has thumbblock. DRUM—0-50 in 180°. Black with silver marks. either, 85c
--

BLOWER & MOTOR

Blower #1 1/2, motor 27 1/2 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
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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!!

RG-6/U	76	150	RG-35/U	71	Price per Ohms 1,000 ft
RG-7/U*	97.5	65	RG-37/U	55	\$450
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-44/U	58	55
RG-24/U	125	240	RG-55/U	53.5	65
RG-25/U	48	575	RG-67/U*	96	100
RG-26/U	48	75	RG-68/U*	53.5	60
RG-27/U	48	290	RG-69/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		
30c	45c	40c	9c		
M-359	PL-259	SO-239	83-1H		
83-IAP	83-ISP	83-IR			
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
83-18P	.45	UG-22/U	1.10	UG-187/U	2.00
83-18PN	.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	1.33
83-22R	.48	UG-33/U	14.80	UG-206/U	.63
83-168	.15	UG-34/U	16.00	UG-256/U	1.22
83-185	.15	UG-58/U	.63	UG-264/U	1.74
UG-7/AP	2.14	UG-85/U	.88	UG-281/U	.60
UG-12/U	.63				

CERAMICONS

2 MMF	30 MMF	500 VOLT CERAMIC CONDENSERS
5.6	35	MMF MMF MMF MMF
12	45	2 18 56 150
15	62	3.44 22 62 180
18	82	4.7 27 88 200
20	110	12 30 82 220
	150	13 33 91 270
	200	15 40 100 300
		16 47 140 1000

\$6.50 per hundred \$5.00 per hundred

SOUND POWERED HANDSET

Includes 6 fr. 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 * 2 1/2 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, 6800 \$50.00
W. E. Delay Line #D165997. 1 1/2 micro-second delay, 4700 \$7.50

400 CYCLE INVERTER

Leland Electric Co. #10800, IN, 25-28 V.D.C. 92 A. 8,000 RPM. OUT, 115 V., 400 cpy. 1 phase, 1,500 V.A., 90 PF \$12.50
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TIMING MOTOR 8 RPM

115V., 60 cpy., E. Inghram Co. \$1.79
45 V., 60 cpy., E. Inghram 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.

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. \$8.9c

UNIVERSAL JOINT
3/16" hole x 3/8" O.D.
1 1/8" long
Steel or Aluminum
50c

2J1G1 SELSYNS
BRAND NEW
400 Cycle
Can be used on 60 cycle
\$1.90

DIFFERENTIAL
115 V., 60 Cyc.
#C78249
3 3/8" dia. x 5 1/4" 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. \$3.50 pair

JONES BARRIER STRIPS

Type	Price	Type	Price	Type	Price
2-140Y	\$0.13	4-141W	.30	9-141W	.64
2-140 1/2 W	.19	5-141	.26	9-141Y	.64
6-140	.40	5-141 1/2 W	.37	17-141Y	1.17
10-140 1/2 W	.53	7-141	.36	3-142	.17
2-141	.13	7-141 1/2 W	.49	2-150	.39
3-141 1/2 W	.24	8-141 1/2 W	.58	3-150	.54
3-141 W	.24			4-150	.70

DELAY NETWORK—ALL 1400

T 113—Approx. 1.2 micro sec. delay.....	} 85c each
T 114—Approx. 2.2 micro. sec. delay.....	
T 115—Similar to T 114 with tap brought out	

CHOKES

80 Henry 80 ma.....	\$1.29
6 Henry 80 ma.....	79

3AG FUSES

AMP	Per 100	AMP	Per 100	AMP
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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
2K28	32.50	2K55	135.00	723A/B	14.95
2K29	29.95	417A	10.65	726A	8.50
		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 12 1/2"D.....\$125.00

VOLTAGE DIVIDER

G.E. Cat. 8248886G-I and 9001934G-I 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

IN21	\$1.19	IN23	\$1.49	IN34	\$.79
IN21A	1.69	IN23A	2.55	IN45	.94
IN21B	3.25	IN23B	5.25	IN52	1.05
IN22	1.09	IN27	1.79	IN63	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)......95
 AN-65A (P/O SCR-521)......95
 AN-66A (P/O SCR-521).....1.15
 A1A-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 3/4 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-24	UG-37	UG-102	UG-175	UG-236
UG-12	UG-23	UG-37	UG-103	UG-176	UG-234
UG-18	UG-27	UG-38	UG-104	UG-181A	UG-255
UG-19	UG-37A	UG-83	UG-106	UG-185	UG-284
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 permanently 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
100	SS 10K	50K	SS
200	SS 10K	100K	5/16"
500	1/8" 15K	100K	7/16"
650	1/8" 15K	100K	7/16"
1K	SS 20K	100K	SS
5K	1/8" 25K	150K	1/8"
5K	SS 25K	500K	SS
6500	SS 30K	1 1/2"	1 MEG SS

Dual "JJ" Potentiometers.....\$1.60 each
 Triple "JJ" Potentiometers.....\$1.95 each
 100K/100K/100K—20K/150K/15K—
 All shaft lengths beyond bushing—SS (screw slot)

METERS

3 MA DC 2 1/2" R—Simpson black scale.....	\$3.35
50 μA DC SS 100 Ω SS 250 Ω SS 330 Ω SS.....	4.30
1 ma. DC Fan type—1/2" scale (rem. from equip).....	3.95
500 ma. DC 2 1/2" R—General Electric.....	2.95
2 amp. RF 2 1/2" S—Simpson.....	3.15
5 amp. AC 4 1/2" R—JBT.....	4.11
50 VAC 3 1/2" R—General Electric.....	2.95
10 amp. RF 3 1/2" R—Simpson.....	4.95
50 amp AC 3 1/2" 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 INPUT - 40
 DC VOLTS OUT - 14.5 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 1/2 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.....\$49.50
 - 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.....\$69.00
 - 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-1159 Frequency Meter 160-220 MC.....\$39.95
 - CWI-60AAG Range Calibrator for ASB, ASE, ASV and ASVC Radars.....\$32.95
 - 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 1228—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 6V DC to 110 VAC 60 cy 75W.....19.95
- ID-6/APN-4 Indicator.....4.50
- R-7/APS-2 Receiver.....49.50
- R-7B/APS-15 Receiver.....49.50
- SCR-522 Transceiver.....36.95
- RT-7/APN-1 Transceiver—less tubes.....6.95
- FL-2 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.....\$75.00
- 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).....22.66
- 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-827	W. E. D-16310
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 impd. 3 sections.....\$4.30
- 7.5 E3-3-200-67P. 7.5 KV. "E" Circuit 3 microsec. 200 PPS. 67 ohms impd. 3 sections.....\$6.75
- 7.5 E4-16-60-67P 7.5 KV. "E" Circuit 4 sections. 16 microsec. 60 PPS. 67 ohms impd.....\$8.25
- 15 E4-91-400-50P. 15KV "E" circuit .91 microsec. 400 PPS. 50 ohms impd. 4 sections.....\$12.00
- 15A-1-100-50P. 15KV. "A" Circuit, 1 microsec. 400 PPS. 50 ohms impd.....\$37.50
- 15 E7-2-200-50P. 15KV "E" Circuit, 2 microsec. 200 PPS. 50 ohms impd... 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

ELECTRONIC RESEARCH LABORATORIES
 1021-A CALLOWHILL ST. PHILA. 23, PA.
 Telephones - MARKET 7-6590 and 6591

SEARCHLIGHT SECTION

CRYSTALS Low Frequency

FT-241. A holder 1/2" pin spacings, 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	426	473	506	538	448
374	428	474	507	539	449
375	427	475	508	539	451
376	429	476	509	539	453
377	430	477	511	539	454
379	431	479	512	539	455
380	433	480	513	539	456
381	434	481	514	539	457
383	435	483	515	539	463
384	436	484	516	539	465
385	437	485	518	540	468
386	438	486	519	540	469
387	440	487	520	540	501
388	441	488	522	540	538
412	442	490	523	540	540
413	443	491	525	540	each
414	444	492	526	540	each
415	444	493	527	540	each
416	448	494	527	540	each
418	459	495	530	541	each
419	461	496	531	541	each
420	462	497	533	541	each
422	469	503	534	541	each
423	470	504	536	541	each

\$1.49

69¢

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	2	6.3/2A, 6.3/6A	6.95
CT-43A	230VCT	.077	2.5VCT/6A, 6.3VCT/12A	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	6.3/1A, 6.3/1.8 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	.040	6.3/1A, 2.5VCT/7A	3.25
CT-91A	720V	.100	5V/3A, 6.3/3.5	3.25
CT-328	15V	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	.062MA	2.5V/2.1A, 2.5V/1.75A	4.95
CT-137	350VCT	.026MA	5V/3A, 6.3/3.5	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	13V/1.11A	.79
FT-367	5VCT/3A, 58VCT/40A	1.95
FT-346	5VCT/13.5, 5VCT/16.75, 5VCT/6.75	5.95
FT-731	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/1.1A	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/6A, 6.3VCT/1A	1.79
FT-101	6V/2.5A	1.10
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	\$ 4.69
PT-31A	2x300V/5MA	.79
PT-46A	4080VCT N.L. 3% to 18" Hx6" Wx7" L 20 lbs.	29.95
PT-033	4150V/400MA 11x19" Wx9" D 70 lbs.	49.95
PT-75-2	3780/3446/3112VCT/77MA	4.25
PT-28-1	4600VCT/0.77	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 71x7" Wx 8 1/4" H	10.95
PT-31A	2x300V/5MA	.79
PT-976	120VCT/10MA	.79
PT-47-1	62V/3.5A	2.95
PT-12A	280VCT/1.2A	2.95
PT-997	78V/.00754KVA	1.49

SPECIAL TYPES

Item	Pri	Output	Price
STP-946	210/220/230	2.5V/4A 3 1/2"Hx2 1/2"x2 1/2"D	\$1.29
STP-05A	115/230	6.3V/7.5 7 1/2"Hx7 1/2"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, 5 1/2x5 1/2	5.25
STF-619	110/220	2.5V/600, 7x5 1/2x5	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, 103/48x57/30 lbs.	27.95
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	2x2.5/6.5, 6.3V/4 ?	3.25
	115/180/230	Few	

PL TRANSFORMER

STP-405	220/440	117/79V, 13.05A	\$17.95
STP-96	220/440	136VCT/3.5A	10.95
STP-945	210/20/30	110VCT/300 5 1/2x4 1/2	5.95
STP-444	230/460	230/105/115/12515 lbs. 5 1/2x6 1/2	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	95NLS-50V/FL 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.	2.95
STC-607	220V	70VCT/75MA, 40VCT/100, 15/10/15V/100MA	3.95
STC-612	230V	400V/30, 100/30, 2x5V/2.5W/2-866 Socket	3.95
STC-622	230V	250V/100, 2x5V/2-9-2-4 Png. Sockets	4.25

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, 4-820-B, 3-72's, 1-73. New	\$110.00
APQ-13 PULSE MODULATOR. Pulse Width .5 to 1.1 Micro Sec. Rep. rate 624 to 1348 Pps. Pk. pwr. out 35 KW Energy 0.018 Joules.	\$49.00
TPS-3 PULSE MODULATOR. Pk. power 50 amp. 24 KW (1200 KW pk); pulse rate 200 PPS. 1.5 microsec. pulse line impedance 50 ohms. Circuit—series charging version of DC Resonance type. Uses two 705-A's as rectifiers. 115 v. 400 cycle input. New	\$49.50
APS-10 MODULATOR DECK. Comp. less tubes	\$75.00

MODULATOR UNIT BC 1203-B

Provides 200-4,000 PPS Sweeptime: 100 to 2,500 microsec. in 4 steps, fixed mod. pulse, suppression pulse, salivating modulating voltage, marker pulse, sweep voltages, calibrating voltages, fl voltages. Operates 115 vac, 50-60 cy. Provides various types of voltage pulse outputs for the modulation of a single generator such as General Radio #894B or #804C used in depot bench testing of SCR 695, SCR 595, and SCR 535. New. \$395.00
 BC 750A Pulse modulator. \$18.50
 APS-10 Low voltage power supply less tubes. \$18.50
 725A magnetron pulse transformers. \$18.50 ea.

PULSE NETWORKS

15A—1-400-50: 15 KV. "A" CKT, 1 microsec 400 PPS, 50 ohms imp.	\$42.50
G.E. #E2-5-2000-50P2T, 6KV "E" circuit, 3 sections 5 microsecond, 2000 PPS, 50 ohms impedance.	\$6.50
G.E. #E3 (3-84-810) 8-2-24-405 50P4T: 3KV "E" CKT Dual Unit: Unit 1, 3 Sections, 84 Microsec, 810 PPS, 50 ohms imp.; Unit 2, 8 Sections, 2.24 microsec, 405 PPS, 50 ohms imp.	\$6.50
7.5E3-1-200-67P, 7.5 KV. "E" Circuit, 1 microsec 200 PPS, 61 ohms impedance, 3 sections.	\$7.50
7.5E4-16-60-67P, 7.5 KV. "E" circuit 4 sections 16 microsec, 60 PPS, 67 ohms impedance.	\$15.00
7.5E33-20-60P, 7.5 KV. "E" Circuit, 3 microsec 200 PPS, 67 ohms imp. 3 sections	\$12.50

PULSE TRANSFORMERS

G.E.K.-2745	\$39.50
G.E.K.-2744-A: 11.5 KV High Voltage, 3.2 KV Low Voltage @ 200 KW oper. (270 KW max.) 1 microsec. or 1/2 microsec. @ 600 PPS.	\$39.50
W.E. #166173 Hi-Volt input trans. W.E. impedance ratio 50 ohms to 900 ohms. Prev. range: 10 kg to 2 mc. 2 sect. parallel conn. potted in oil.	\$36.00
W.E. KS 9600 input transformer. Winding ratio between terminals 3-5 and 1-2 is 1:1:1, and between terminals 6-7 and 1-2 is 2:1. Frequency range: 30-520 c.p.s. Permalloy core.	\$27.50
G.E. #D16927 Hi Volt Input Pulser Trans.	\$27.50
G.E. #2459A. Will receive 15KV, 4 micro-second pulse on pri. secondary delivers 14KV. Peak power out 100KW G. E.	\$34.50
G.E. #K2748A. Pulse Input, line to magnetron	\$36.00
Pulse 131-AWP J-421435	\$6.00
Pulse 134-RWP 2P J-440895	\$2.25
RAY-WX-298SF	\$39.50
G.E.—K6824730	\$50.00
G.E.—K9216945	\$50.00
#766489—9332	—
A 7766490	—
UX-7350—JX7300	\$6.95
#352-7181	—

DYNA-MOTORS

AT SURPLUS PRICES



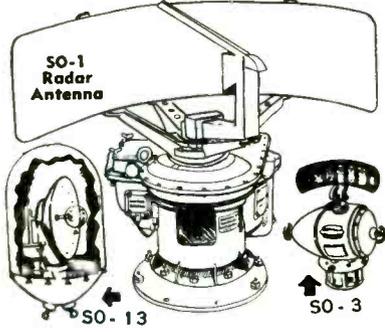
Type	Input Volts	Output Volts	Radio Amps.	Set
PE88	28	1.25	250	.060 RC 36
DM416	14	6.2	330	.170 RU 19
DY-2/ARR-2	28	1.1	250	.060 ARC-5
DM36	28	1.4	220	.080 SCR 608
DM25	28	1.2	250	.060 BC 367
	28	1.25	275	.070 BC 348
	28	7	540	.250 BC 466
DM33A	28	14	515	.110 SCR 506
DM42	14	46	1030	.050 1
			2/8	
PE101C	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	12,075	3/110
B-19pack	12	9/4	275	.110 Mark II
			500	.050
			300	.060 SCR 522
DA-3A	28	10	150	.010
			4/5	.5
5053	28	1.4	250	.060 APN-1
PE73CM	28	19	1000	.350 BC375
DM21A	14	3.3	235	.090 BC 312
CW21AAX	13	12.6	400	.135
	26	6.3	800	.020
			1	.5
BD 77KM	14	40	1000	.500 BC 191
PE94	28	10	300	.200 SCR
			150	.010 522
			14.5	.5
PE 86	DM 32A	DY 22	ARC 3	DAG 33A

400 CYCLE TRANSFORMERS

115 V 400 CYCLE INPUT

Item	Rating	Price Each
6.3V/1.8A P/O APG2		\$1.49
6.4V/2.5, 400VCT/35Ma, 6.4/150a		3.95
6.4V/7.5, 6.4/3.8, 6.4/2.5A		3.49
780V/27/4.7, 6.3/2.9, 1.25/2a		2.49
6.4V/3a, 6.4V/2.5a		1.95
6.3V/9.1A, 6.3VCT/6.5a, 2 x 2.5/3.5a		2.49
5V/2a, 6.3V/2a, 5V/2a, 6.3/5a		2.99
5V/15A, 5000V Ims		3.95
6.3/2.7, 6.3/66, 6.3VCT/21A		5.95
760V, 6.3V, 6.3V, 5V, 320V, 6.3V/20A		
592V/118MA, 6.3/8.1a, 5V/2 W.E.		2.95
6.3V/9.1, 6.3VCT/.65a, 2 x 2.5V/3.5A		2.95
6VCT .00006 KVA		.98
6.4V/8a, 6.4V/1a		1.49
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
400VCT/35MA, 6.4/2.5, 6.4/15a		3.25
600VCT/36MA		1.49
2.5V/1.75, 5V/3A, 6.5V/6.5, 6.5/2a.		
For SCR729a		
640V/600MA, 2.5V/1.75a P/O APS/15B		3.95
360VCT/20A, 1500V/1MA, 2.5V, 6.3/2.5, 6.3V/.6a, P/O 729A		2.95
2 x 2.5V/5A, 2.5V/10A, P/O APT 4		3.95
2 x 2.5V/2.5a, 6.3V/2.25a, 1200V Tap 1000V/75V		4.95
P/O AN/APS-15		2.95
742.5V/50MA, 709V, 47MA, 671V/45MA		
600VCT/36MA, 2 3/4 x 2 1/4 x 3 1/4		3.95
1150-1160, 2 3/4 x 2 1/4 x 3 1/4		3.25
640VCT/250MA, 6.3V, 9, 6.3V/.6, 5V/6A		12.50
6.3V/9.1a, 2.5V/3.5a, 6.3VCT/65a, 2.5V/3.5a		3.50
9800V or 3600V/32MA		7.50
592VCT/120MA, 6.3V/8a, 5V/2A		

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. 400/2800 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-887E. 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). Elestat shlded. Wt. 2.3 lbs. New \$2.95
 Plates. Thordarson #T40889. 1650 VA. Pri: 105-120V. 500 cy. I PEL. 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 .003A. Fil. Wdgs. 6.4V4A/2.5V1.75A/6.4V.6A. Elestat shlded. Wt. 1.4 lbs. New \$2.75
 FILAMENT. 400/2400 cps. WECO KS9553. Pri: 115V. Sec: 8.2V1.25A/6.35V1.5A Elestat shlded. Wt. 0.5 lbs. New \$1.95
 PLATE & FIL. 400/2800 cy. Pri: 0/80/115V. Sec #1=120VDC at 1.5MA, Sec #2=400VDC at 130MA. Fil. Secs: 6.4V4.3A/6.35V0.8A. (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: 8.3V22A/6.3V2.4A/6.3V2.25A/6.3V0.6A 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 \$69.50
 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. 1 1/2" Dia. x 1 1/2" 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, L56 and 854 Tubes. Complete, new with inst. book, probe and spare kit of tubes. Less batteries. Write for descriptive circular. \$69.50

PARABOLOIDS

Spun Magnesium dishes 17 1/2" dia. 4" deep. Mounting brackets for elevation and azimuth control on rear. 1 1/2" x 1 1/2" 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. 1/2 of 1% Reg. Wt. 20 lbs. 6 1/2" H x 8 1/4" L x 4 1/2" 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 2-8SN7GT and 4-6VE6GT tubes. Supplied less tubes. New \$22.50



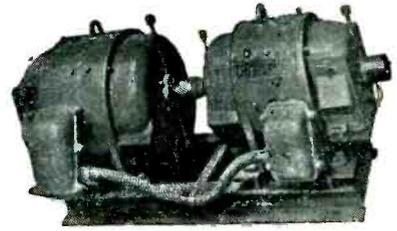
**LINEAR SAWTOOTH POTENTIOMETER
W.E. KS-15138**

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. \$285.00

2 KVA MG SET. O'Keefe and Merritt. 115V DC to 120V AC. 60 cy. 1 Ph. 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. Elicor. 32V DC to 110V AC. 60 cy. 1 Ph. 2.04 Amps. New \$24.50
 Also available for 64 volts input. Same price.

DYNAMOTOR. Elicor. 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 5AM21J37. 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 5AM31N118A. Input: 27 volts 44 Amps. 8300 RPM. Output: 60V DC at 8.8 amps. 530 Watts. New \$22.50

INVERTER—G. E. Model 5D-21N33A. Input: 24V. DC. Output: 115V. 400 cy, 485 Va. New \$49.50

INVERTER—Leland Elec. Co. Model PE206A. Input: 26V. 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 50L2A 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

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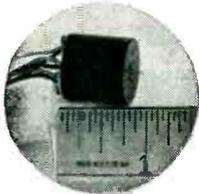
SYNCHROS • AMPLIFIERS • ALNICO MOTORS • SHUNT MOTORS • BLOWERS • RATE GENERATORS • SUB-FRACTIONAL HORSEPOWER AC MOTORS • SELSYN
 AUTOMATIC PILOT COMPONENTS • DC MOTORS • SINE-COSINE GENERATORS • U. S. NAVY SYNCHROS • AUTOSYNS • SERVO MOTORS • DYNAMOTORS

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zero dial adjustment. Stock #SA-268. Price \$14.50 each.

INDICATOR

Miniature indicator. 24 v. d-c operation with G.E. Position Transmitter or with Ohmite 360° type potentiometer. Has iron plug for

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 3622B—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. 1/2 rpm. 29 v. d-c. 100 ma.
Delco 5069625—120 rpm. Gov. cont. 27 v.
General Electric 5BA50L366—1/2 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—1/2 hp. 27 v. 3600 rpm.
Arma Latitude Motor — 8413-30 (Step motor)
Elenco B-64—1/165 hp. 3100 rpm. 27 v. f. 30 v. armature. (Thyatron control)
John Oster—A-21E-12R—Split field series reversible. 28 v. 0.4 amps. 2 watts output.
General Electric 5P56HC18 — 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, 351, 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, 2J5F3, 2J5R1, 2J5R1, etc.
Army Ordnance Selsyns IV, V, X, 11, V11, XV, XV11, XXI, etc.
400 Cycle Selsyns Kollsman 775-01, 1F (special. W. E. KS-5950-LO-2).
Aircraft Amplidynes General Electric 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, 5AS131J11A, 5D21NJ3A, etc.

C-1 AUTOPILOT COMPONENTS

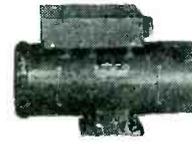
A-5 AUTOPILOT GYROS

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-218E Inverters 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 \$49.60 each.



Pioneer 12150-4-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



Elenco Type B-64. 1/165 hp at 3100 rpm. Field volts 27.5 Max. armature voltage 80. Ideal for thyatron 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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TELECHRON SYNCHRONOUS MOTOR, Type B3, 110 V., 60 Cy., 4 W., 2 RPM. PRICE \$5.00 EA.
TELECHRON SYNCHRONOUS MOTOR, Type BC, 110 V., 60 Cy., 6 W., 60 RPM. PRICE \$4.00 EA.
EASTERN AIR DEVICES, Type J33, Synchro-nous, 115 V., 400 Cy., 3 ϕ , 8000 RPM. PRICE \$15.00 EA.

**HAYDON TIMING MOTORS
110 V., 60 CY.**

TYPE 1600, 2.2 W., 4/5 RPM. PRICE \$3.00 EA.
TYPE 1600, 2.2 W., 1/240 RPM. PRICE \$3.00 EA.
TYPE 1600, 2.3 W., 1 RPM. PRICE \$3.00 EA.
TYPE 1600, 2.2 W., 1-1/5 RPM. PRICE \$3.00 EA.
TYPE 1600, 3.5 W., 1 RPM. With shift unit automatic engaging and disengaging shaft. PRICE \$3.75 EA.
TYPE 1600, 2.2 W., 1/60 RPM. PRICE \$3.00 EA.

SERVO MOTORS

CK1, PIONEER, 2 ϕ , 400 Cy. PRICE \$10.00 EA.
CK2, PIONEER, 2 ϕ , 400 Cy. PRICE \$14.00 EA.
CK2, PIONEER, 2 ϕ , 400 Cy., with 40:1 reduction gear. PRICE \$15.50 EA.
10047-2-A, PIONEER, 2 ϕ , 400 Cy., with 40:1 reduction gear. PRICE \$10.00 EA.
MINNEAPOLIS HONEYWELL Type B, Part No. G303AY, 115 V., 400 Cy., 2 ϕ , built-in reduction gear, 50 lbs. in torque. PRICE \$10.00 EA.
MINNEAPOLIS HONEYWELL Amplifier Type G403, 115 V., 400 Cy., Used with above motor. PRICE \$10.00 EA, WITH TUBES

**REMOTE INDICATING
COMPASSES
26 V., 400 CY.**

PIONEER TYPE AN5730-2 Indicator and AN5730-3 Transmitter. PRICE \$40.00 PER SET
KOLLSMAN TYPE 680K-03 Indicator and 679-01 Transmitter. PRICE \$15.00 PER SET

D C MOTORS

DELCO TYPE 5069625 Constant Speed, 27 V. D.C., 120 RPM. PRICE \$10.00 EA.
JOHN OSTER TYPE C-28P-1, 27 V., 0.7 Amp., 7,000 RPM, 1/100 H. P. PRICE \$5.00 EA.
JAEGER WATCH CO. TYPE 44K-2 Contactor Motor, 3 to 4.5 V. Makes one contact per second. PRICE \$2.50 EA.
GENERAL ELECTRIC TYPE 5BA10AJ52C, 27 V., 0.65 Amp., 14 oz. in torque, 145 RPM. PRICE \$6.50 EA.
GENERAL ELECTRIC TYPE 5BA10AJ37, 27 V., 0.5 amps., 8 oz. in. torque, 250 RPM. PRICE \$6.50 EA.
GENERAL ELECTRIC TYPE 5BA10J18D, 27 V., 0.7 Amps., 110 RPM, 1 oz. ft. torque. PRICE \$6.50 EA.
BARBER-COLMAN CONTROL MOTOR, Type AYLC 5091, 27 V., 0.7 Amps., 1 RPM. Contains 2 adj. limit switches. 500 in. lbs. torque. PRICE \$6.50 EA.
WHITE RODGERS ELECTRIC CO., Type 6905 No. 3, 12 V., 1.3 Amps., 1/2 RPM, torque 75 in. lbs. PRICE \$10.50 EA.

RECTIFIER POWER SUPPLY

GENERAL ELECTRIC TYPE 6RC146. Input 230 V., 60 Cy., 3 ϕ , adjustable input taps. Output 130 Amps., at 28 V. D.C. Continuous duty. Size 46" high, 28" wide and 17.5" deep. PRICE \$225.00 EA.

INVERTERS

WINCHARGER CORP. PU-16/AP, MG750. Input 24 V. D.C., 60 Amps. Output 115 V., 400 Cy., 1 ϕ , 6.5 Amps. PRICE \$75.00 EA.
HOLTZER CABOT TYPE 149 H, Input 24 V. D.C. at 44 Amps., Output 26 V. at 250 V.A., 400 Cy., and 115 V., 400 Cy., at 500 V.A., 1 ϕ . PRICE \$55.00 EA.
HOLTZER CABOT TYPE 149F, Input 24 V. D.C. at 36 Amps., Output 26 V. at 250 V.A., 400 Cy., and 115 V., 400 Cy., at 500 V.A., 1 ϕ . PRICE \$55.00 EA.
PIONEER TYPE 12117. Input 12 V. D.C., Output 26 V., 400 Cy. at 6 V.A. PRICE \$30.00 EA.
PIONEER TYPE 12117. Input 24 V. D.C., Output 26 V., 400 Cy. at 6 V.A. PRICE \$25.00 EA.
PIONEER TYPE 12116-2-A. Input 24 V. D.C. at 5 Amps. Output 115 V., 400 Cy., 1 ϕ at 45 watts. PRICE \$100.00 EA.
GENERAL ELECTRIC TYPE 5D21NJ3A. Input 24 V. D.C. at 35 Amps. Output 115 V., 400 Cy., 485 V.A., 1 ϕ . PRICE \$25.00 EA.
LELAND PE 218. Input 24 V. D.C. at 90 Amps. Output 115 V., 400 Cy., 1 ϕ at 1.5 K.V.A. PRICE \$47.50 EA.

PIONEER AUTOSYNS

TYPE AY1, 26 V., 400 Cy. PRICE \$8.50 EA.
TYPE AY5, 26 V., 400 Cy. PRICE \$8.50 EA.
TYPE AY14G, 26 V., 400 Cy. PRICE \$15.00 EA.
TYPE AY14D, 26 V., 400 Cy. PRICE \$15.00 EA.
TYPE AY54D, 26 V., 400 Cy. PRICE \$10.00 EA.
TYPE AY131D Precision Autosyn. PRICE \$35.00 EA.

**PIONEER AUTOSYN POSITION
INDICATORS & TRANSMITTERS**

TYPE 5907-17. Dial graduated 0 to 360°, 26 V., 400 Cy. PRICE \$25.00 EA.
TYPE 6007-39. Dual Dial graduated 0 to 360°, 26 V., 400 Cy. PRICE \$40.00 EA.
TYPE 4550-2-A Transmitter, 26 V., 400 Cy., 2:1 gear ratio. PRICE \$20.00 EA.

VOLTAGE REGULATORS

LELAND ELECTRIC CO. TYPE B, Carbon Pile type. Input 21 to 30 V. D.C. Regulated output 18.25 at 5 amps. PRICE \$6.50 EA.
WESTERN ELECTRIC TRANSTAT VOLTAGE REGULATOR Spec. No. V-122855, Load K.V.A. 0.5. Input 115 V., 400 Cy. Output adjustable from 92 to 115 V. PRICE \$10.50 EA.

**RATE OR TACHOMETER
GENERATORS**

EASTERN AIR DEVICES J36A, .02 V. D.C. per RPM. Max. speed 5000 RPM. PRICE \$12.50 EA.
ELECTRIC INDICATOR CO. TYPE B68 Rotation Indicator, 110 V., 60 Cy., 1 ϕ . PRICE \$14.00 EA.
ELECTRIC INDICATOR CO. TYPE PM-1-M. Same as Type B35, 2 V. D.C. per 100 RPM. Max. speed 5000 RPM. PRICE \$14.00 EA.
GENERAL ELECTRIC TACHOMETER GENERATOR TYPE AN5531-1. Variable frequency, 3 ϕ output. PRICE \$20.00 EA.
GENERAL ELECTRIC TACHOMETER GENERATOR TYPE AN5531-2. Variable frequency, 3 ϕ output. PRICE \$25.00 EA.

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GREAT NECK
N. Y.

SYNCHROS

1F SPECIAL REPEATER, 115 V., 400 Cy. PRICE \$15.00 EA.
2J1F3 GENERATOR, 115 V., 400 Cy. PRICE \$5.50 EA.
2J1G1 CONTROL TRANSFORMER, 57.5/57.5 V., 400 Cy. PRICE \$3.50 EA.
2J1F1 GENERATOR, 115 V., 400 Cy. PRICE \$4.00 EA.
5SDG DIFFERENTIAL GENERATOR, 90/90 V., 400 Cy. PRICE \$20.00 EA.
5G GENERATOR, 115 V., 60 Cy. PRICE \$50.00 EA.
W. E. KS-5950-L2 Size 5G, 115 V., 400 Cy. PRICE \$10.00 EA.

D C ALNICO FIELD MOTORS

DIEHL TYPE S.S. FD6-23, 27 V., 10,000 RPM. PRICE \$6.50 EA.
DELCO TYPE 5069466, 27 V., 10,000 RPM. PRICE \$15.00 EA.
DELCO TYPE 5069370, 27 V., 10,000 RPM. PRICE \$15.00 EA.
DELCO TYPE 5072400, 27 V., 10,000 RPM. PRICE \$10.00 EA.

BLOWER ASSEMBLIES

JOHN OSTER TYPE MX215/APG, 28 V. D.C., 7,000 RPM, 1/100 H.P. PRICE \$8.50 EA.
WESTINGHOUSE TYPE FL, 115 V., 400 Cy., 6,700 RPM, Airflow 17 C.F.M. PRICE \$7.50 EA.
DELCO TYPE 5068571 Motor and Blower Assembly, P.M. Motor, 27 V., 10,000 RPM. PRICE \$15.00 EA.

**GENERAL ELECTRIC
D C SELSYNS**

8TJ9-PAB, TRANSMITTER, 24 V. PRICE \$4.00 EA.
8DJ11-PCY, INDICATOR, 24 V. Dial marked -10° to +65°. PRICE \$6.00 EA.
8DJ11-PCY, INDICATOR, 24 V. Dial marked 0 to 360°. PRICE \$7.50 EA.

MISCELLANEOUS

SPERRY A5 AMPLIFIER RACK, Part No. 644890. PRICE \$20.00 EA.
SPERRY A5 CONTROL UNIT, Part No. 644836. PRICE \$7.50 EA.
SPERRY A5 AZIMUTH FOLLOW-UP AMPLIFIER, Part No. 656030, with tubes. PRICE \$5.50 EA.
SPERRY A5 DIRECTIONAL GYRO, Part No. 656029, 115 V., 400 Cy., 3 ϕ . PRICE \$25.00 EA.
PIONEER TYPE 12800-1 GYRO SERVO UNIT, 115 V., 400 Cy., 3 ϕ . PRICE \$20.00 EA.
ALLEN CALCULATOR TYPE C1 TURN & BANK INDICATOR, Part No. 21500 28 V. D.C. PRICE \$15.00 EA.
TYPE C1 AUTO-PILOT FORMATION STICK, Part No. G1080A3. PRICE \$15.00 EA.
PIONEER GYRO FLUX GATE AMPLIFIER Type 12076-1-A, 115 V., 400 Cy. PRICE \$40.00 EA.

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53	AN3100-85-1P	M	38	-32-7P	M	32	-16S-4S	B
10	-85-1S	M	62	-32-15P	M	450	-16S-5P	B
15	-10SL-3P	B	34	AN3106-85-1P	M	65	-16S-5S	M
81	-12S-3S	B	61	-85-1P	B	152	-16-11S	M
650	-12-5P	B	12	-85-1S	M	137	-16-11S	B
2098	-12-5S	B	116	-85-1S	B	2947	-18-4P	B
586	-14S-1S	B	809	-10S-2P	M	12	-18-4S	B
69	-14S4P	B	275	-10S-2P	B	147	-18-4S	M
141	-14S-6P	M	177	-10S-2S	B	1437	-18-5P	B
73	-14S-6S	M	50	-10S-2S	M	11	-18-5S	B
65	-14S-7S	B	466	-10S-2S	B	404	-18-6S	B
96	-14S-7S	B	500	-10SL-3S	B	233	-18-9P	B
328	-16S-4S	B	2737	-10SL4S	B	97	-18-11S	M
41	-18-4S	B	248	-12S3S	B	35	-18-20P	M
99	-18-8S	B	373	-12S-4P	B	38	-22-14S	B
448	-18-12S	B	351	-12S-4P	M	556	-22-19P	B
314	-18-12S	B	13	-12-4S	B	30	-24-2S	B
28	-18-15S	B	22	-12S-4S	B	19	-24-9S	B
70	-18-22P	M	250	-12S-4S	M	15	-24-10P	M
50	-20-21S	M	191	-12-5S	B	25	-24-10S	M
92	-22-2S	M	10	-14S-4P	M	42	-28-1S	M
698	-22-5S	B	68	-14S-7S	B	26	-28-2P	M
16	-22-14P	M	138	-16-2S	B	235	-28-12S	B
32	-22-21P	M	12	-16S-4P	B	106	-28-16P	B
15	-24-2S	M	62	-16S-4S	B	169	-28-17S	M
14	-24-5P	M	200	-16S4P	M	20	-32-1S	M
65	-24-5P	M	45	-16-13S	M	24	-32-6P	M
37	-32-6P	B	200	-18-1S	B	70	-32-7S	M
45	-32-7P	B	269	-18-5P	B	54	-32-13S	M
98	-PR32-7P	M	32	-18-5S	M	40	-32-13P	M
314	-32-7S	M	4711	-18-6S	B	152	-32-14S	M
281	-32-14P	B	278	-18-10S	M	30	-36-6P	B
132	-32-14S	B	20	-20-5P	B			
26	-36-7P	M	828	-20-12S	B			
358	-36-19P	B	12	-20-23S	M			
77	AN3102-85-1P	M	49	-20-25S	M			
440	-10S-2S	B	56	-20-27S	B			
828	-10S-2S	M	20	-22-3P	B			
31	-10S-8S	M	12	-22-5P	M			
577	-12S-3P	M	510	-22-19P	B			
70	-12S-3S	B	72	-22-27S	B			
172	-12S-3S	M	14	-24-2P	B			
34	-16S-1P	B	78	-24-3P	B			
330	-16S-5P	B	38	-28-12P	M			
32	-16S-8S	M	22	-32-7P	B			
10	-16-11S	B	173	-32-7S	B			
734	-16-13P	B	155	-32-14S	B			
1428	-18-4S	B	43	-32-16S	M			
1607	-18-5S	B	25	-36-10S	M			
38	-18-12S	M	68	-44-1P	B			
25	-18-22P	M	146	AN3108-85-1S	B			
1122	-20-3P	B	324	-85-1S	M			
17	-20-5P	B	1013	-10S-2S	M			
16	-20-14P	M	815	-10S-2S	B			
207	-22-1S	B	36	-12S-3S	B			
227	-22-5S	B	72	-12-5P	B			
349	AN3102-24-1S	M	13	-12-5S	M			
82	-PR28-7P	M	102	-14S-2P	M			
20	-28-11P	B	1062	-14S-2S	B			
34	-28-11S	B	12	-14S-7S	M			
70	-32-1P	B	14	-14S-7S	M			
154	-32-1S	B	438	-14S-10P	B			
66	-32-6P	M	411	-16S-1S	B			
20	-32-6S	M	1759	-16S-4P	B			
				-16S-4P	M			

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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HOLTZER-CABOT MG149F. Input: 24 VDC, 36 amp. Output: 28 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 28 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 150 volts, 1 lb weight, 100 lbs. Price.....\$425.00

OUR OWN SPECIAL 400 CYCLE MG SET. Made in our own shop employing 7 1/2 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 3/8 Motor.....\$645.00

ONAN 400 CYCLE MG SET. Motor: 7 1/2 H.P. operative at 220/440 V, 3/8, 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 BF852/RF854 Input: 220 Volts, 3 Ph. 60 cy. 3800 RPM. Output: 250 Volts, 20 Amp. single ph. 180 Cys. 5000 V.A. 5000 Watts. Brand New. Compact ball bearing units for operation of III-cycle equipment. SPECIAL PRICE.....\$160.00

ONAN 800 CYCLE MG UNIT. Employing 5 H.P. Motor operative at 220/440 Volts, 3/8, 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.....\$229.00

GENERAL ELECTRIC MG SET. 4 Bearing unit directly coupled consisting of Motor of 5 H.P. operative at 220/440 V. 3/8, 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. 300 CPS, 500 VA. Price.....\$19.00

KINGSTON-CONLEY MG SETS. Motor: 15 H.P. 220/440 V. 3/8, 60 Cy. on which there is range 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. 20 Cycles. All three components in a single compact housing. Price.....\$200.00

800 CYCLE UNIT. Operate at 440 V. 3/8, 60 cy. directly connected to self-exc. 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.....\$98.88

RLX DUAL GENERATORS. Flange mounted. Output: 500 Watts, 1300-2600 Cycles, also 12-14 VDC 750 Watts. Price.....\$25.51

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, 3/8, 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, 3/8, 820 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. Specially excited at 110 VDC. Price.....\$4.00
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. 145 cyc. 220 Watts, 1.8 amperes. 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. 3/8, 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. Employ 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: 375 VDC, .25 Amp. also 55 VAC. .91 Amp. 1/8, 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. 300 Cye, 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 1/8, 400 CPS. 1500 V.A. With filter system built-in. Price.....\$29.51

HOLTZER-CABOT 500 CYCLE MG SET. Motor: 110 VDC. GENERATOR: 5 KVA, 230 VAC, 1/8, 500 Cye. 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 built like new. (1) 220/440-3-60; Sec: 30 K.W. 306 Volts, 2 Ph. 500 Cye. .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 Amperes, 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. 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/A. Input: 28 VDC, 160 Amperes. 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 100 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 cy. 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; 30% 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 cye. 1 amp. output: 115 Volts, D.C. 3.25 amp. 3450 RPM.....\$88.00

Model 5AM49AB3; Input: 440 Volts, 3 ph. 60 cye. 1 amp. Output: 250 Volts, D. C. 1.5 amp. 375 watts. \$99.00

Model 5AM73AB58; Input: 110/220 Volts, single phase, 60 cye. 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, 1/8, 60 cye. 9 amp. Output: 375 K.W. 250 VDC, 1.5 amp.....\$86.00

Model 5AM65FB2A; Input: 115 VAC, 3/8, 60 cye. 5 amp. Output: 500 watts, 250 Volts, 2 Amp.....\$144.00

Model 5AM73AB62; Input: 115/230 VAC 6.2/3.1 Amp. 60 cye. 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, 1 1/2 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. 1/8, 60 Cye. 480 V.A. Brand New.....\$120.00

JANETTE ROTARY CONVERTERS

110 V.A. 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. 120/160/140 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., .8 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 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.

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WILLIAM I. HORLICK COMPANY

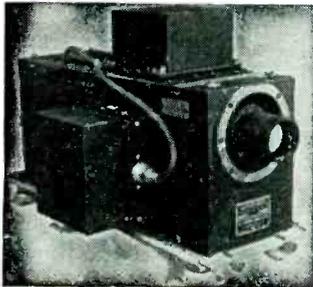
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DUMONT 224-A OSCILLOSCOPE

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-108/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 YDC OR AC.

WE WANT THIS EQUIPMENT:

BC-348	ART-13
BC-611	ARC-1
RTA-1B	ARC-3
BC-1000	R5A/ARN7

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LOS ANGELES 13, CALIF.

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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 $\frac{1}{2}$ " x 1" waveguide. Sand load TS 108\$35.00

HI POWER X BAND TEST LOAD, dissipates 350 watts of average power for $\frac{5}{8}$ " x $1\frac{1}{4}$ " 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 $1\frac{1}{2}$ " 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 $1\frac{1}{2}$ " 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 $\frac{1}{2}$ " 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.

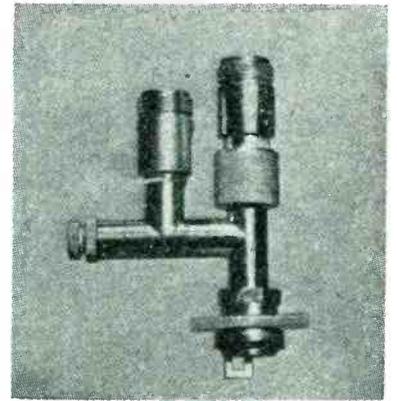
AMPLIFIER STRIP AM-SSA/SPR-2 contains I.F. amplifier, detector, video amplifier, pulse stretcher and audio amplifier and Rectifier Power Unit PP-155A/SPR-2 bandwidth 10 mc, center frequency 30 mc, sensitivity 50 microvolts for 10 milliwatts output. Power supply 80/115 V ac, 60-2600 cps 1.3 amps. Send 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, $\frac{1}{2}$ "x1" waveguide.....\$40.00
Fixed triple tuned $\frac{5}{8}$ "x $1\frac{1}{4}$ " waveguide \$50.00

Frequency Meter, 8500-9600, variable, absorption type for either $\frac{1}{2}$ "x1" or $\frac{5}{8}$ "x $1\frac{1}{4}$ " waveguide, with calibration, ± 4 MC, precision ground thread...\$150.00

X Band Crystal Mount, $\frac{1}{2}$ "x1" waveguide \$25.00

X Band Attenuator, double van type, VSWR less than 1.4 8500-9600 MC 0-30 db, calibrated for $1\frac{1}{4}$ "x $\frac{5}{8}$ " waveguide \$80.00

$\frac{1}{2}$ "x1" to $\frac{5}{8}$ "x $1\frac{1}{4}$ " adapter, UG80/U \$5.00

TS-203/AP CALIBRATED SELSYN..\$10.00

GENERAL RADIO PRECISION WAVE-METER 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 Milliammeter 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

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Red Bank 6-0404

Red Bank, N. J.

BRAND NEW U. S. GOV'T. SURPLUS GUARANTEED

POWER RHEOSTATS



Ohms watt ea.	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
2 100	3.51 300	50 1.49
2 225	4.95 300	100 3.29
3 300	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 25	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	100 1.49
6 75	2.95 500	100 3.29
7 25	1.24 500	150 3.51
8 50	1.49 585	150 9.95
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	4.95 1250	25 1.10
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 1.10
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	25 2.34
125 500	9.13 7500	100 3.98
150 50	2.10 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.

OIL CONDENSERS



Mfd.	Volts	Avail.
.1	3-6-20K	
.25	2-3-3-4-5K	
.5	600-1-1-3K	
1	600-1-1-2-5-9K	
2	400-600-1-1-1-2-3-4K	
4	600-700-1-1K	
6	400-600-1-1-2K	
8	600	
10	600-21K	
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

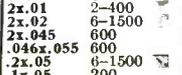
BATHTUBS



Mfd.	Volts	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	
4	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	
1x.1	4-600	
2x.16	600	
2x.2	600	
2x.25	4-600	
3x.5	500	
2x.5	4-600	
1x.05	500	
1x.1	300	
1x.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	
.018x.03x.045x.08x.12/600		

Also available CHAN-NEL Types. Special Prices on request.

SHOCKMOUNTS



100P-1	1 lb.	.15
100P-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

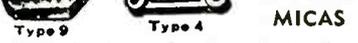
ohms	ohms	ohms	ohms	ohms
50*	2500*	100K*	500-500†	130 K-130K*
65*†	4000†	100K†	600-600†	150 K-150K†
200†	5000†	125 K†	1500-1500†	250 K-250K†
300†	10K*	200 K*	2000-2000*	350K-5K†
400†	15K*	250 K*	2000-50K*	350K-25K†
500†	20K*	250 K*	1200-24K†	300K-300K*
600†	25K*	500K*	20K-200†	350K-350K*
750†	30K*	1meg*	25K-10K†	800K-75K*
1000*	50K*	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†

† screwdriver slotted shaft.
‡ Knob type shaft.

TRANSMITTING MICAS



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	4	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	83-15PN
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	83-1	
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	

Jones Connectors Jones BARRIER STRIPS

P-101-1/4	.25
P-101-3/8 MOD	.30
S-302-AB	.13
S-304-CCT	.25
P-306-AB	.16
P-306-CCT-L	.33
P-306-FHT	.24
S-308-AB	.21
P-312-AB	.24
P-312-CCT-L	.42
P-315-FHT	.40
P-315-EB	.40
P-315-CE	.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-100R-SB	.53
P-2412-SB	.61
S-2412-CE	.87
S-502-DB	.87
P-508-CE	2.55
P-510-CE	3.04
P-512-CE	3.52
S-512-CE	3.95
2-140-Y	.13
6-140-Y	.33
10-140-3/4W	.53
10-240	.38
13-140	.48
18-240	.66
4-141-W	.30
4-141-3/4W	.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

REAL VALUES!

TUBE SPECIALS

1625	\$.39	807	1.89
1626	.39	813	0.95
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
AP8 13 UHF Antenna, Pair		.98
FL 8 Filter		2.95
1-97 Blas 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 slung 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 182 indicator.		2.45
(Both \$82F & Tr ns. 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	TS-251 Less Xtal

CONDENSERS

1 mfd 6000 VDC. OIL FILLED	Each \$1.98
.00025 mfd. 25000 VDC OIL FILLED	2.95
50 mfd—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 50atts. 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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- 40 VOLTS. WESTINGHOUSE NA-33, 2 1/2" 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, 2 1/2" Round flush metal case @ \$6.00

A. C. AMMETERS

- 100 MILLIAMPERES. WESTON 476, 3 1/2" Round flush bakelite case 400 cycles @ \$6.50
- 150 MILLIAMPERES. GENERAL ELECTRIC AO-22, 3 1/2" Round flush bakelite case @ \$4.95
- 500 MILLIAMPERES. WESTON 476, 3 1/2" Round flush bakelite case, 400 cycles @ \$7.50
- 50 AMPS. WESTINGHOUSE NA-35, 3 1/2" Round flush bakelite case, 25 to 500 cycles @ \$5.50
- 60/120 AMPS. DUAL RANGE. BURLINGTON 32xC, 3 1/2" Round flush bakelite, 5 Amp movement, external current transformer @ \$7.50
- 75 AMPS. BURLINGTON # 32xC, 3 1/2" Round flush bakelite case @ \$4.95

RADIO FREQUENCY AMMETERS

- 120 MILLIAMPS. SIMPSON 125, 3 1/2" Round flush bake, arbitrary linear sc. calib. 0-10 with caption output units, ext. thermocouple @ \$7.50
- 1 AMP. GENERAL ELECTRIC DO-44, 3 1/2" Round flush bakelite @ \$11.00
- 1.5 AMP. GENERAL ELECTRIC DW-52, 2 1/2" 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, 3 1/2" Round flush bakelite case @ \$8.50
- 2.5 AMPS. McCLINTOCK MD3001, 3 1/2" Round flush bakelite case, Signal Corps IS-111 @ \$4.50
- 3 AMPS. WESTON 425, 3 1/2" Round flush bakelite case, with external thermocouple @ \$9.50
- 3 AMPS. WEST. NT-35, 3 1/2" Round flush bakelite case, (JAN type MR35W0031FAA) @ \$6.00
- 8 AMPS. WEST. RT-35, 3" Square flush bakelite @ \$7.50
- 10 AMPS. WESTON 425, 3 1/2" Round flush bakelite case @ \$8.50

MICROAMMETERS

- 100 MICROAMPERES. WESTON 643, 4 1/2" Round flush bakelite case (red line at 90) @ \$21.00
- 500 MICROAMPERES. G. E. DO-41, 3 1/2" Round fl. bake, sc. calib. 0-20 Kilovolts D.C. approx. 250 ohms resistance @ \$5.95

D. C. MILLIAMMETERS

- 1 MILLIAMP. WEST. NX-33, 3 1/2" Round flush bakelite, black scale, calib. 140 v., 500 MA @ \$3.00
- 1 MILLIAMP. WESTINGHOUSE NX-35, 3 1/2" Round fl. bake. (JAN type MR35W001DCMA) approx. 53.7 ohms resistance @ \$7.50
- 5-0-5 MILLIAMPS. WEST. ELEC. D-185647, 3 1/2" Round fl. bakelite concentric style movement, approx. 160° deflection sc. calib. 50-0-50 @ \$4.00
- 15 MA., SIMPSON 26, 3 1/2" Round flush bakelite case (JAN type MR25W015DCMA) @ \$6.00
- 50 MA., G. E. DO-41, 4 1/2" Round fl. bake @ \$4.95
- 150 MA., G. E. DO-53, 3" Square fl. bake @ \$5.50
- 200 MA., MARION, 3 1/2" Round flush bake Knife Edge pointer @ \$4.00
- 200 MA., G. E. DO-41, 3 1/2" 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, 3 1/2" Round flush bakelite (JAN type MR35W-800DCMA) @ \$5.50

USN CY49598 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 9989. 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.
7 1/2" 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, detector and oscillator. With a few modifications this unit makes an ideal P.M. Receiver. Each set complete with circuit diagram and the 14 following tubes: 1-6SN7 Cathode Follower; 1-6J6 second Detector; 2-6SH7 1st and 2nd I.F. Amp; 1-6SB7 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 Rect.; 1-6E5 Tuning Indicator. Complete in a metal cabinet 10" high 16 1/2" wide and 15" deep @ \$34.50

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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 3 1/2" meter transformers, relays, circuit breakers too numerous to list. Complete in metal cabinet 17 1/2" x 18 1/2" x 18" with circuit diagram @ \$29.50

GASOLINE HEATER—MOTOROLA

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 primarily 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 9 1/2" high x 9 1/2" wide. Complete with technical manual and parts list. Made by Galvin (Motorola) Mfg. Co. YOUR COST ONLY \$22.50

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- 300 VOLTS. SUN 2AU346, 2 1/2" Round flush bake., 1000 ohms per Volt. @ \$6.00

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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			

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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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SCR-522 Transmitter-Receiver Sets — Complete with PE-94 dynamotor, BC-602 Control Box, BC-631 rack box, AN-104A Antenna, plugs, racks, and mounts. New accessories. EXCELLENT \$ 75.00

APR4 Receiver with TN-17—New—Write for prices.

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RA-10 Bendix Compass Receiver. LIKE NEW 24.50
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Clean Bulk and Boxed—We have thousands of tubes—Send us your requirements.

Crystal and Coil Sets for Handy-Talkie—3885, 4280, 4840, 5327.5, 5487.5, 5000 KC. 2 crystals and 2 coils per set. SET 1.95
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Matching Transformer for IIS-30. NEW .40

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Transformer—High voltage, General Electric No. 6949101, Single phase Plate 15.550 volts—5.2KVA. Input 115 volts 5/60 cycles. Filament 5 volts—0.65KVA. Input 100 volts 50/60 cycles. EXCEL. CONDITION 59.50
Variac—General Radio Type 50A, 115V. 60 cycles—5KVA. EXC. COND. 95.00

Selsyn Transmitter—Pioneer Inst.—AY 14 excellent for indicator EXCELLENT 3.50
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Onan Motor Generator Set MG G-1 Generates 115V. AC 5.3 amps, 26 D.C. 100 watts, 480 cycles 3.8 amps. Motor 115-230V. 60 cycles. Single phase, 2450 RPM 10.5 amps. NEW 170.00
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NEW 6.95

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1. mfd. 6000 WVDC. 5.95
We have hundreds of new oil and high voltage mica capacitors. Send us your requirements.

PE-73 Dynamo Power Supply for BC-375 1000V. D.C. Output. EXCELLENT 5.95
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Delco Motor—27 volts 2-4 amps—3600 RPM Constant Speed. Model A-7155 Governor Type Shunt. NEW 5.95

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PLQ-171, PL-172, PLQ-60, PLQ-63, PL-147, PL-148, PL-151, PL-152, PL-153, PL-154, PL-156, PLQ-103. Plugs for ARC-1, ARC-3, ARC-5, BC-375, SCR-522, BC-348, GP-6, GP-7, LM Frequency Meters and many others.

BC-1060 Oscillograph — Same as Dumont #224. LIKE NEW 175.00
TS-224 Dumont Oscillograph. GOOD USED 170.00
Megger—50 megs. 500 volts. EXCELLENT 75.00
Insulation Tester—Superior Model 6101, 200 McOhms. Complete. NEW 49.00
I-100A Test Set for ARN-7 and 269 Compass. LIKE NEW 595.00
IE-19A Test Set for SCR-522—Complete with manual, original factory packing. NEW 325.00
LM Frequency Meter with calibration books, crystal, tubes. EXCELLENT 79.50
BC-221 Frequency Meters, Complete with calibration books, crystal, tubes. EXCELLENT 7950
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BC-906 Frequency Meter. EXCELLENT 17.50

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Engine Cylinder Thermometer Tester—Wheelco Inst. Co. Iron-Constantan, Copper Constantan, Chromel-Alumel 0-1400°C. EXCELLENT 69.50
TS-24A/ARR2 Test Oscillator. EXCELLENT 29.50

We will buy new or clean used ARC-1, ARC-3, ART-13, BC-348 original condition or converted to 115V. AC. BC-342, BC-312, Test Equipment, etc. All letters will be answered promptly. Please list equipment, condition, and lowest price.

TERMS: Prices f.o.b. Pasadena, Cal. 25% on all C.O.D. orders. Californians add 3% Sales Tax.

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OA2	3.00	3A5	1.25	242C	10.00	717A	1.75	869B	29.50
OA3	1.50	3B24	5.50	249C	4.95	718A/EY	48.50	872A	3.95
OA4G	1.35	EL3C	5.95	250T	19.95	720A/B/C/D	95.00	878	1.95
OB2	3.00	3C22	72.00	304TH	15.00	721A	2.95	884	1.95
OC3	1.75	3C23	10.95	304TL	14.50	722A	3.95	885	1.75
OD3	1.50	3C24	2.50	307A	4.95	723A/B	18.95	889R	199.50
CIA	4.95	3C45	12.95	310A	7.95	724A	2.95	913	12.95
CIB	6.95	3DP1 A	7.95	312A	3.95	724B	3.95	914	75.00
1B21A	2.75	3E29	15.50	312A	19.95	725A	9.95	931A	8.95
1B22	3.95	5N4	5.50	323A	3.95	726A	6.95	954	.25
1B23	9.95	4A1	4.95	327A	3.95	726B	36.00	955	.55
1B24	17.95	4C27	15.00	350A	7.95	726C	69.00	956	.69
1B26	2.95	4J25	199.00	350B	27.50	728AY	27.00	957	.19
1B27	17.95	4J26	199.00	357A	1.95	800	1.00	959	.69
1B32	4.10	4J30	395.00	371B	4.95	801A	1.00	975A	17.95
1B38	33.00	4J31	99.00	385A	2.95	802	3.60	991	.45
1B42	9.95	4J32	99.00	388A	8.95	805	2.95	1280	1.95
1B56	49.95	4J33	99.00	393A	8.95	805	1.69	1613	1.08
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1N21	1.35	4J38	89.00	417A	6.95	809	2.45	1619	.89
1N21A	1.75	4J39	99.00	446A	1.95	810	11.00	1620	5.95
1N22	1.75	4J41	99.00	446B	45.00	813	7.95	1622	2.75
1N23	2.00	4J52	350.00	450TH	45.00	815	5.95	1624	2.00
1N23A	3.75	4J62	99.00	464A	9.95	829	9.95	1825	4.45
1N23B	7.00	CS8	2.95	464B	2.75	829A	11.95	2051	1.80
1N27	5.00	5BPA	4.95	471A	25.00	829B	14.95	8012	4.25
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1S21	6.95	5CP7A	15.00	701A	7.50	832A	9.95	8013A	5.95
2B22	4.95	5I21	22.50	703A	3.95	834	7.95	8020	3.50
2B26	3.75	5I23	45.00	705A	2.95	836	4.95	8025	6.95
2C34	35	5I29	19.95	706A	48.50	837	2.95	9001	1.75
2C40	27.00	5JP1	37.50	706CY	48.50	838	9.00	9002	1.50
2C43	27.00	5JP2	17.50	707A	17.95	845	5.95	9003	1.75
2C44	27.00	5JP4	19.00	714AY	27.00	849	32.50	9004	.75
2C51	5.95	5LP1	18.95	715A	5.95	851	49.50	9005	1.90
2D21	1.75	6C21	39.50	715B	7.95	860	4.95	9006	.35
2E22	3.75	6CA	3.95	715C	12.95	861	39.50		
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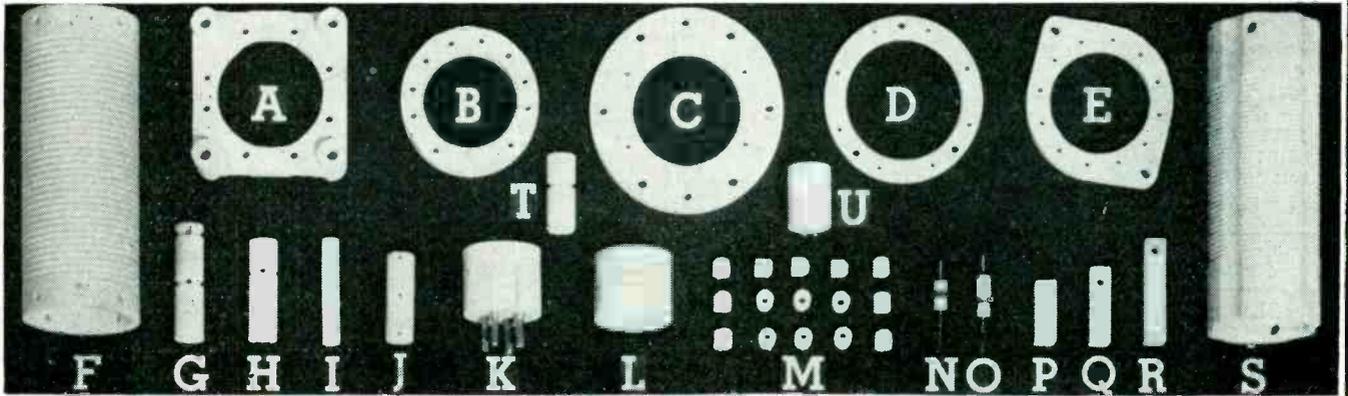
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 - Q - SQUARE INSULATED SPACERS 3/8" X 1 1/4" THREADED ONE END - .02
 - R - SQUARE INSULATED SPACERS 3/8" X 1 3/4" THREADED ONE END - .02

S - THREADED COIL FORMS	Dia.	No. of Ribs	Winding Length	Overall Length
YOUR CHOICE 10¢ EACH	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"

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T - ROUND INSULATED SPACERS 1/2" X 1 1/4" THREADED BOTH ENDS - .02
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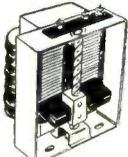
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10SL-3P	16S-4P	18-12S	20-14P	22-10S	24-2S	28-6P	32-20P
10SL-4S	16S-5S	18-12P	20-15S	22-10P	24-2P	28-7S	36-1S
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12S-3S	16S-6S	18-13P	20-16P	22-11P	24-4S	28-8P	36-7S
12S-3P	16S-6P	18-16S	20-17P	22-12S	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
14S-1S	16S-8P	18-22S	20-20S	22-14S	24-9S	28-12S	36-10P
14S-1P	16-9S	18-22P	20-21P	22-14P	24-9P	28-12P	36-11P
14S-2S	16-10S	18-30S	20-22S	22-15S	24-10S	28-15S	36-15S
14S-2P	16-10P	18-30P	20-22P	22-15P	24-10P	28-15P	36-15P
14S-3S	16-11S	18-31S	20-23S	22-16S	24-11S	28-16S	36-19S
14-3S	16-11P	18-31P	20-23P	22-16P	24-11P	28-17S	40-1S
14S-4S	16-12S	20-1P	20-24P	22-17P	24-14S	28-18S	40-2P
14S-4P	16-12P	20-2S	20-24S	22-18S	24-14P	28-18P	40-2S
14S-5S	18-1S	20-2P	20-26P	22-18P	24-15S	28-19S	40-11S
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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
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14S-10P	18-5P	20-7S	22-3S	22-26S	24-28S	32-7P	
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14S-11P	18-6P	20-8S	22-4P	22-27S	28-2P	32-8P	
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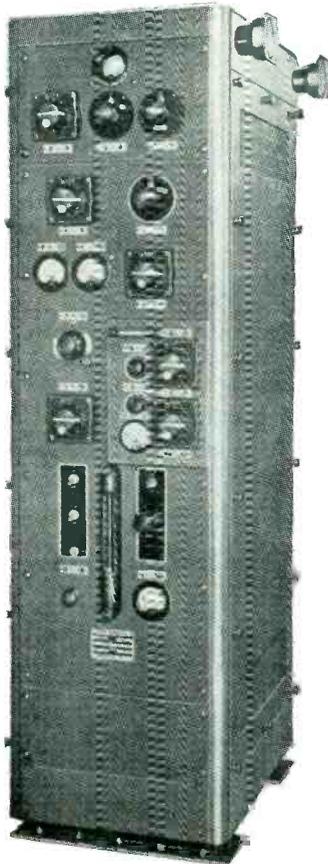
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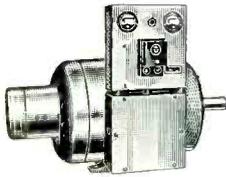
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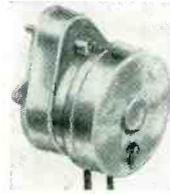


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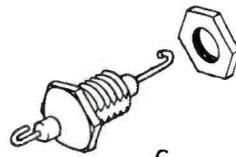
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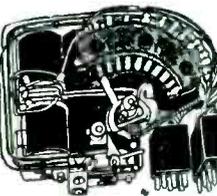
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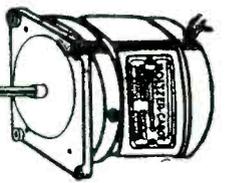
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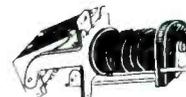
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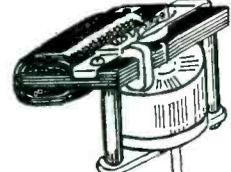
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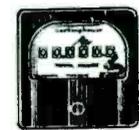
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IB46	3.69	2J55	139.00	6AU5GT	2.65	6U7G	2.25	12SH7	.89	49	.98	393A	4.98	954	.25	3DP1-S2	8.85	Msd New Base		CK553DX	1.98	PM7	.49	
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IB56	40.95	2J62	49.98	6AV6	1.50	6V6GT	2.45	12SK7	1.07	50	1.95	X400	14.98	956	.39	3FP7A	14.98	Neon Bulbs		CK556DX	1.98	PM7	.49	
IB59	12.95	2K25	6A6W	2.65	6V7G	1.18	12SN7GT	2.20	50A5	1.35	WL414	63.95	957	.69	3GP1	4.89	NE15/991	.40	CK557DX	1.98	PM7	.49		
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IF6	.98	3B5	.98	6BE6	1.40	6Z5Y5G	.98	14E6	1.10	58	1.10	58	1.10	58	1.10	5FP7	1.85	12A1A	2.00	CK570DX	1.98	PM7	.49	
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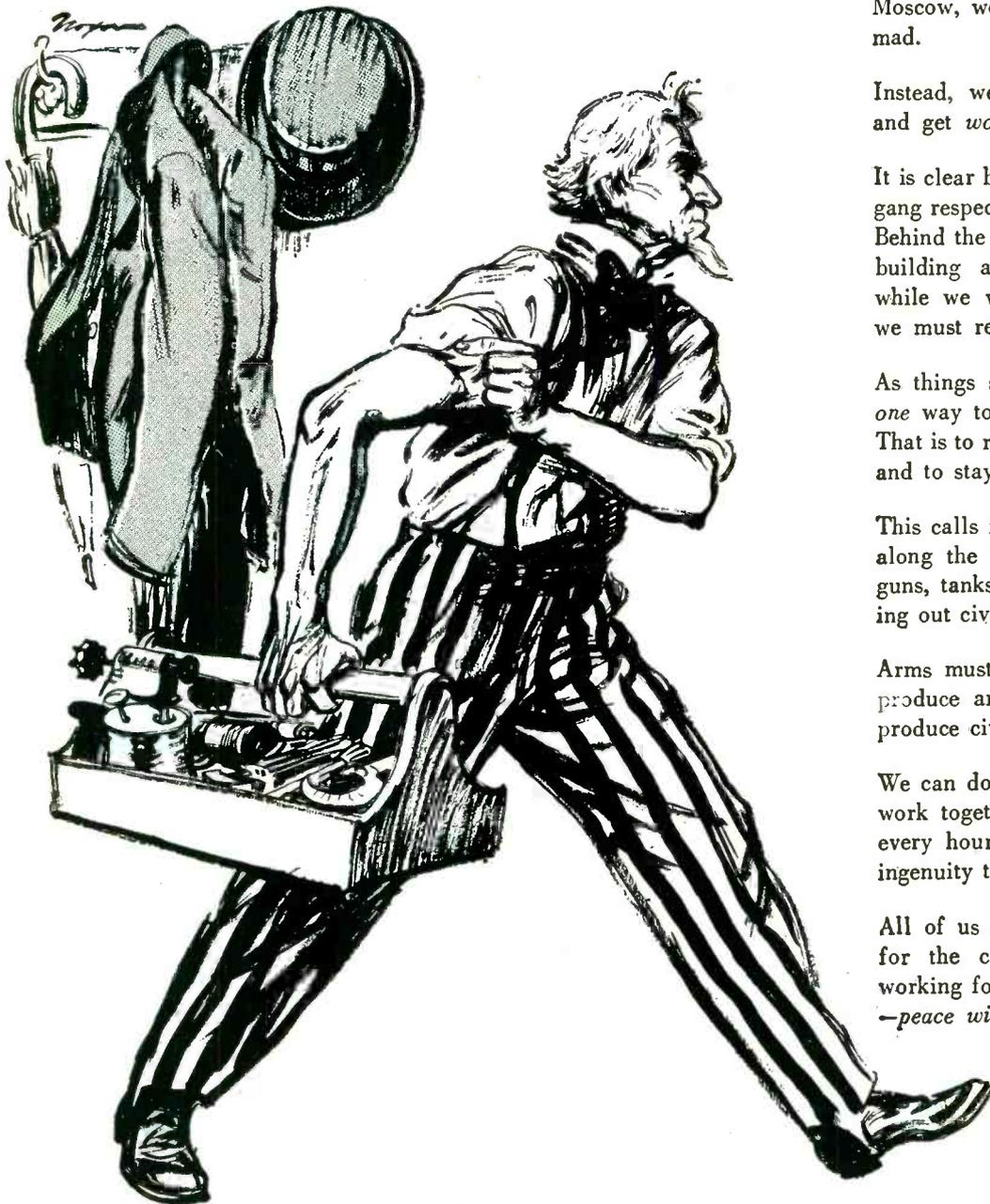
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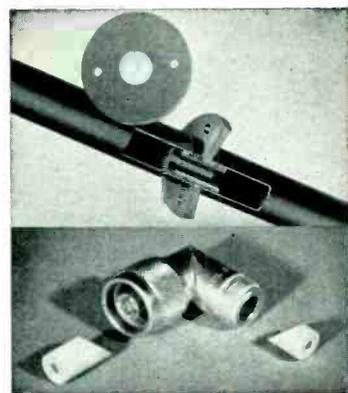
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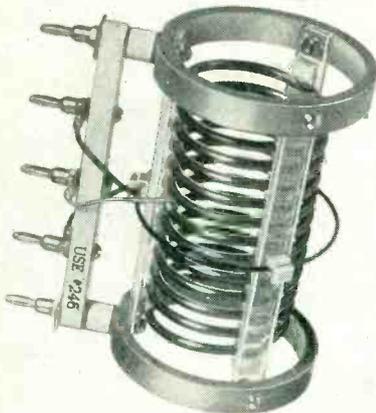
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AIR COOLING PRINCIPLE

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**

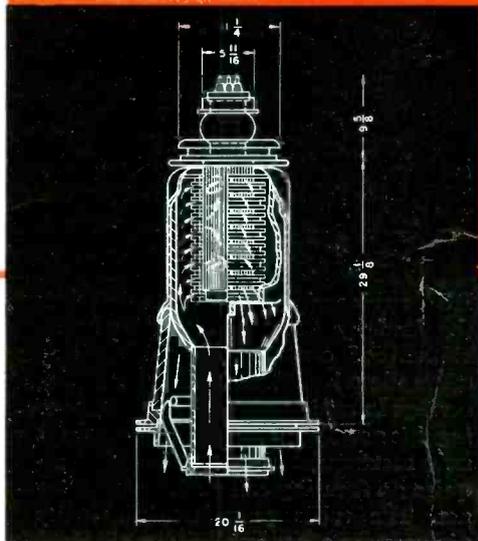
Power outputs up to **108 kw.**

Maximum plate dissipation **45 kw.**



*Patented Dec. 5, 1950—No. 2,532,858

Also available as water cooled Type AX9906/6077. Data sheets for either or both types will be supplied on request.



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.

*Re-tube with **AMPEREX***



AMPEREX ELECTRONIC CORP.

25 WASHINGTON STREET, BROOKLYN 1, N. Y.

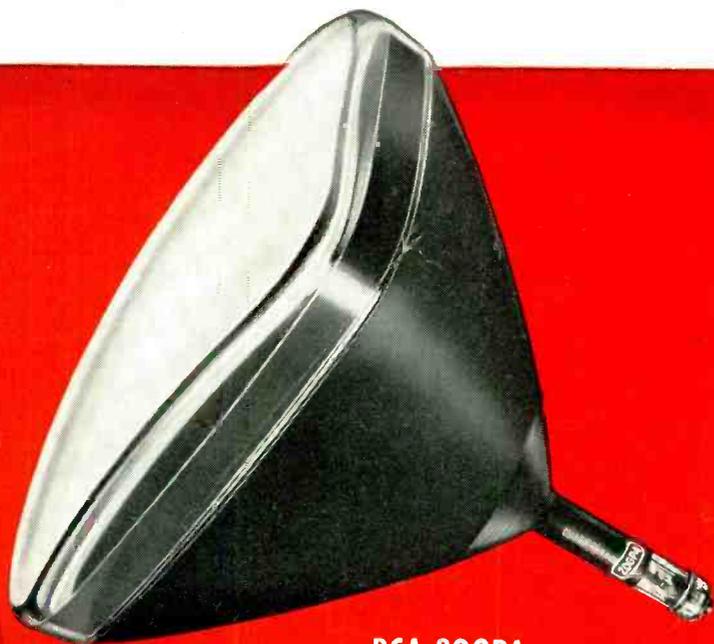
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Another **RCA FIRST!**

Electrostatic Focusing



RCA-17GP4



RCA-20GP4



RCA-14GP4

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 magnet-

ically 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.