JUNE · 1954

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electronics

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Automatic Astronomer Finds Stars Quickly

NEW "M" TYPE TOROIDS Maximum Q Minimum Size

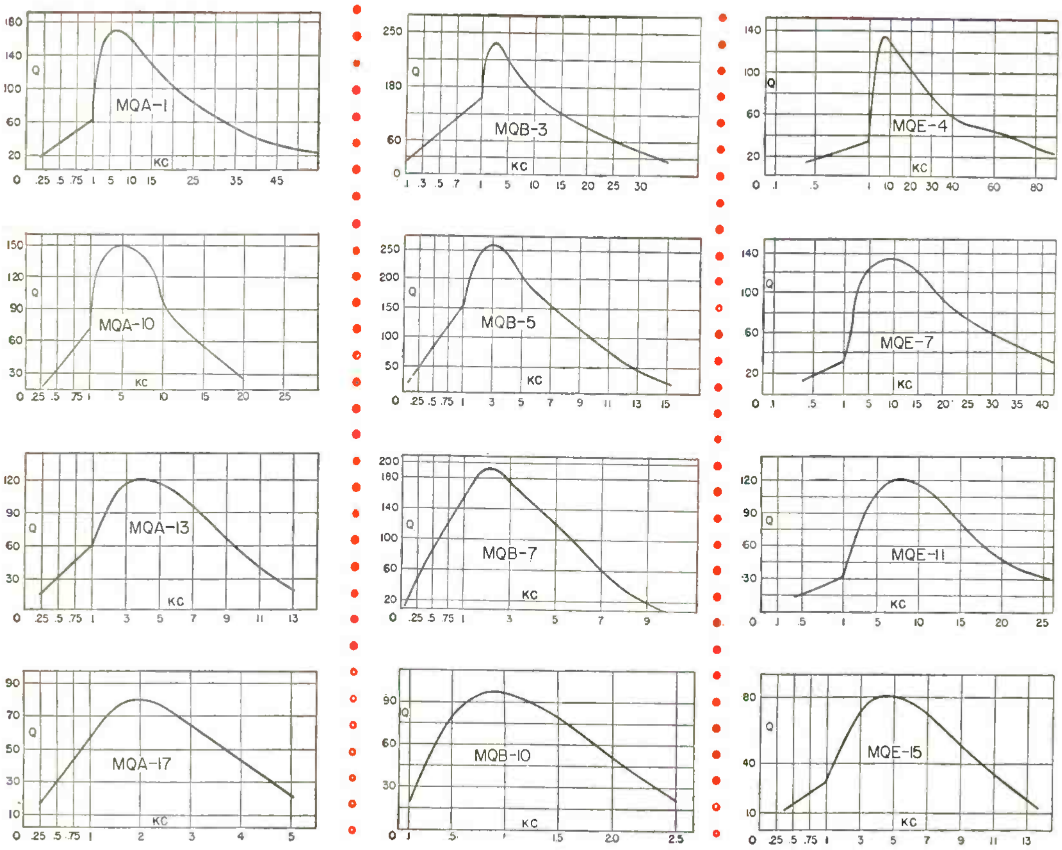
UTC Permalloy Dust Toroids have been the standard of the industry for over 15 years. The **MQ series** of coils provide the highest Q factor in their class (see curves below), with miniaturized dimensions. All units are **hermetically sealed** to MIL-T-27 Specifications.

The stability is excellent. For the MQE-7 the inductance change is less than 1% for voltages from .1 to 3 volts. The MQA-13 change is less than 1% for applied voltages from .1 to 20 volts. The MQB-5 change is less than 1% for applied voltages from .1 to 50 volts. DC is permissible through the coil (values listed below). Inductance is virtually independent of frequency temperature and vibration.

Hum pickup is extremely low due to the toroidal winding structure, with windings uniformly spread over the core. The case is of high permeability, affording additional shielding such that close spacing of units can be effected, the coupling attenuation being approximately 80 DB.

Other values of inductance than those listed are available on special order at the price of the next higher listed value.

TYPICAL Q CURVES



MQA TYPES

Type No.	Inductance		*DC Max.
MQA-1	7	mhy.	250
MQA-2	12	mhy.	200
MQA-3	20	mhy.	150
MQA-4	30	mhy.	125
MQA-5	50	mhy.	100
MQA-6	70	mhy.	80
MQA-7	120	mhy.	60
MQA-8	.2	hy.	50
MQA-9	.3	hy.	40
MQA-10	.5	hy.	30
MQA-11	.7	hy.	25
MQA-12	1	hy.	20
MQA-13	1.5	hy.	17
MQA-14	2.5	hy.	13
MQA-15	4	hy.	10
MQA-16	6	hy.	9
MQA-17	10	hy.	7
MQA-18	15	hy.	5
MQA-19	22	hy.	4

*This value of D.C. (MA) will drop the coil inductance 5%. Values of D.C. below this will show proportionately (linear) less inductance drop. For example, MQE-1 will drop ½% in L with 13.5 MA.

MQB TYPES

Type No.	Inductance		*DC Max.
MQB-1	10	mhy.	400
MQB-2	30	mhy.	250
MQB-3	70	mhy.	170
MQB-4	120	mhy.	120
MQB-5	.5	hy.	60
MQB-6	1	hy.	40
MQB-7	2	hy.	30
MQB-8	3.5	hy.	22
MQB-9	7.5	hy.	16
MQB-10	12	hy.	11
MQB-11	18	hy.	9
MQB-12	25	hy.	8

MQE TYPES

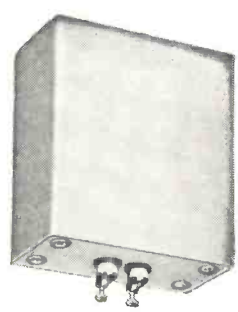
Type No.	Inductance		*DC Max.
MQE-1	7	mhy.	135
MQE-2	12	mhy.	100
MQE-3	20	mhy.	80
MQE-4	30	mhy.	65
MQE-5	50	mhy.	50
MQE-6	70	mhy.	40
MQE-7	100	mhy.	35
MQE-8	150	mhy.	30
MQE-9	.25	hy.	22
MQE-10	.4	hy.	17
MQE-11	.6	hy.	14
MQE-12	.9	hy.	12
MQE-13	1.5	hy.	9
MQE-14	2	hy.	8
MQE-15	2.8	hy.	7.2

MQE CASE

Length	1 1/16"
Width	½"
Height	1 7/32"
Unit Weight	1.5 oz.

MQA CASE

Length	1 9/32"
Width	1 1/16"
Height	1 23/32"
Unit Weight	4 oz.



MQB CASE

Length	2 9/16"
Width	1 13/16"
Height	2 13/16"
Unit Weight	14 oz.

United Transformer Co.

150 VARICK STREET NEW YORK 13, N. Y.

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

electronics

JUNE • 1954

A McGRAW - HILL PUBLICATION

AUTOMATIC ASTRONOMER FIND STARS QUICKLY—Computer-controlled machine built by Watson Scientific Computing Laboratory of Columbia University locates on photographic plate stars called for by IBM punched card (see p 158)

JUNE, 1954 ELECTRONICS Vol. 27, No. 6

Member ABC and ABP

Published monthly with an additional issue in June by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder. **Publication Office, 99-129 North Broadway, Albany 1, N. Y.**

Executive. Editorial and Advertising Offices: McGraw-Hill Building, 330 W. 42 St., New York 36, N. Y. Donald C. McGraw, President; Willard Chevalier, Executive Vice-President; Joseph A. Gerardi, Vice-President and Treasurer; John J. Cooke, Secretary; Paul Montgomery, Senior Vice-President, Publication Division; Ralph B. Smith, Vice-President and Editorial Director; Nelson Bond, Vice-President and Director of Advertising; J. E. Blackburn, Jr., Vice-President and Director of Circulation.

Subscriptions: Address correspondence to Electronics—Subscription Service, 99-129 N. Broadway, Albany 1, N. Y., or 330 W. 42nd St., New York 36, N. Y. Allow one month for change of address. Subscriptions are solicited only from persons engaged in theory, research, design, production, maintenance and use of electronic and industrial control components, parts and end products. Position and company connection must be indicated on subscription orders.

Single copies 75¢ for United States and possessions, and Canada; $1.50 for Latin America; $2.00 for all other foreign countries. Buyers' Guide $2.00. Subscription rates—United States and possessions, $6.00 a year; $9.00 for two years. Canada, $10.00 a year; $16.00 for two years. Other western hemisphere countries, $15.00 a year; $25.00 for two years. All other countries $20.00 a year; $30.00 for two years. Entered as second class matter August 29, 1936, at the Post Office at Albany, N. Y., under act of Mar. 3, 1879. Printed in U.S.A. BRANCH OFFICES: 520 North Michigan Avenue, Chicago 11, Ill.; 68 Post Street, San Francisco 4; McGraw-Hill House, London, E.C. 4; Washington, D. C. 4; Philadelphia 3; Cleveland 15; Detroit 26; St. Louis 8; Boston 16; 1321 Rhodes-Haverty Bldg., Atlanta 3, Ga.; 1111 Wilshire Blvd., Los Angeles 17; 738-9 Oliver Building, Pittsburgh 22. ELECTRONICS is indexed regularly in The Engineering Index.

HIGH CURRENT REGULATED DC SUPPLY

We have been repeatedly advised of the need for a laboratory power supply with current capacity of up to one-half ampere. During the design of the unit it appeared desirable that it should embody characteristics making it suitable for pulse work.

The result is our new Model 600B which we believe merits your attention by its reduced ripple, its internal impedance specifications, and its incorporation of type 5651 tubes to increase long-term stability of output voltage.

Look at these specifications

Output voltage	0-600 VDC
Output current	0-500 Ma
Regulation accuracy	±0.25% above 100 VDC ±0.5% below 100 VDC
Ripple (mV-RMS)	3 maximum
Bias supply	0-150 VDC
Maximum bias circuit impedance	50000 ohms
Internal impedance, maximum	2.0 ohms
Input range	105-125 VAC, 1ϕ; 50-60~
AC voltage unregulated	6.3 VAC, C.T., at 15 amperes

INTERNAL IMPEDANCE
The internal impedance of 2.0 ohms is determined by making measurements in accordance with I.R.E. specifications for the measurement of power supply internal impedance (cf. *The Proceedings of the I.R.E.*, January, 1951). However, this can be expressed in a slightly different manner. The 2.0 ohms impedance applies for frequencies above 20 cycles. Typical measurements indicate that at 10 kc impedance is 0.5 ohms in series with 18 microhenries, and at 20 kc it is 0.5 ohms in series with 8 microhenries.

RECOVERY TIME
Typical measurements indicate a recovery time of 1 millisecond when a load of ½ ampere is applied. It is approximately 0.5 milliseconds when load is decreased from full to no load, and is in the order of 0.2 milliseconds when load is decreased from full to 1/10 load.

REGULATION ACCURACY
The regulation accuracy applies where there is load change from zero to full at a fixed input voltage within the rating, or against an input change between 105 and 125 volts at a fixed load within rating. This accuracy applies down to 30 VDC. Below 10 volts the changes due to circuit instability are greater than those due to line or load conditions.

BIAS SUPPLY
The bias supply accuracy is ±0.5% at maximum output voltage and from 0-5 ma.

TUBE COMPLEMENT
OD3 (2), 5651 (1), 5R4 (3), 6L6 (7), 6BQ6 (1), 6SL7 (1), 5Y3 (1).

MECHANICAL SPECIFICATIONS
The instrument is 17" long, 10½" high, and 14⅞" deep. Net weight is 85 pounds. The unit is self-contained, but a panel is available; its dimensions are 19" long by 12¼" high.

PRICE
$395.00 f.o.b. Stamford, Conn.

Other B Supplies are available in the standard Sorensen line, as well as Nobatrons* (low-voltage, high-current regulated DC sources), AC regulators, frequency changers, and other power regulating equipment. Write for the new general catalog to Sorensen & Co., Inc., 375 Fairfield Ave., Stamford, Conn. In Europe, please correspond directly with Sorensen A.G., Gartenstrasse 26, Zurich 2, Switzerland.

SORENSEN

Sorensen & Company, Inc., 375 Fairfield Ave., Stamford, Conn.

*Reg. U. S. Pat. Off. by Sorensen & Co., Inc.

The scientific approach to vibration measurement

THE D-489

MUIRHEAD - PAMETRADA

WAVE ANALYSER

WITH the Muirhead-Pametrada Wave Analyser the localization of obscure vibrations can be carried out systematically. Designed specifically for such measurements, this instrument covers a range of 19-21,000 c/s with an accuracy of ±0.5%. Its high selectivity enables component frequencies close to one another to be measured; the flat top of the tuning characteristic can be varied to simplify measurements of fluctuating frequencies.

In almost every branch of engineering there is a use for this novel instrument.

FEATURES

- Wide frequency band — 19c/s to 21 kc/s in **9** over-lapping ranges
- Frequency accuracy ± 0.5% over entire range
- Response flat within ± 2db over entire range
- Flat-topped response curve — narrow or wide band-width selected at will
- Off-peak response proportional to percentage mis-tuning
- Output frequency is that of the selected component, and is available for oscilloscope viewing
- Octave discrimination better than 70db
- Mains operated from a separate stabilized supply unit

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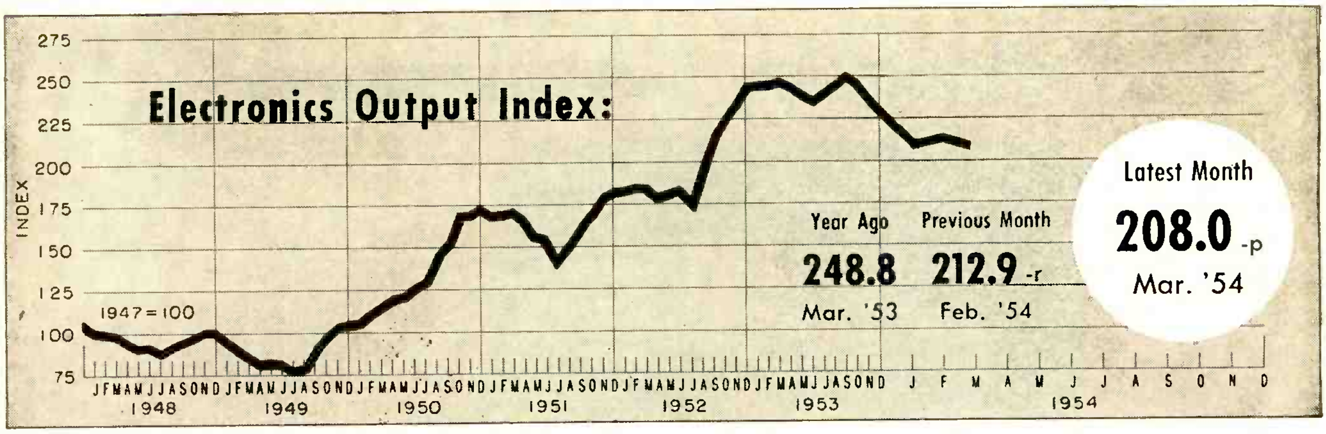


FIGURES OF THE MONTH

	Year Ago	Previous Month	Latest Month
RECEIVER PRODUCTION			
(Source: RETMA)	Mar. '53	Feb. '54	Mar. '54
Television sets	810,112	426,933	599,606
Home sets	442,101	233,063	244,110
Clock Radios	275,079	105,933	119,863
Portable sets	177,656	98,275	206,130
Auto sets	654,367	331,961	370,249
RECEIVER SALES			
(Source: RETMA)	Mar. '53	Feb. '54	Mar. '54
Television sets, units	603,704	536,017	512,861
Radio sets (except auto)	516,618	262,679	486,034
RECEIVING TUBE SALES			
(Source: RETMA)	Mar. '53	Feb. '54	Mar. '54
Receiv. tubes, total units	44,691,200	25,189,147	29,063,484
Receiv. tubes, value	$29,978,827	$18,319,819	$22,130,627
Pic. tubes, total units	974,154	645,715	759,468
Picture tubes, value	$23,772,801	$13,916,478	$15,904,687
SEMICONDUCTOR SALES			
(Source: RETMA)	Mar. '53	Feb. '54	Mar. '54
Germanium Diodes / Silicon Diodes	1,172,475	815,824	1,061,010

Quarterly Figures

INDUSTRIAL TUBE SALES	Year Ago	Previous Quarter	Latest Quarter
(Source: NEMA)	4th '52	3rd '53	4th '53
Vacuum (non-receiving)	$12,790,000	$9,434,082	$9,467,331
Gas or vapor	$3,480,000	$4,145,018	$4,854,222
Phototubes	$760,000	$510,686	$405,000
Magnetrons and velocity modulation tubes	$10,510,000	$9,822,600	$13,073,095
Gaps and T/R boxes	$2,090,000	$1,554,000	$1,707,730

	Year Ago	Previous Month	Latest Month
TV AUDIENCE			
(Source: Television Magazine)	May '53	Apr. '54	May '54
TV Homes—Total	......	......	29,565,759
BROADCAST STATIONS			
Source: (FCC)	Apr. '53	Mar. '54	Apr. '54
TV Stations on Air	179	385	387
TV Stns CPs—not on air	264	190	190
TV Stns—Applications	612	72	52
AM Stations on Air	2,430	2,539	2,563
AM Stns CPs—not on air	135	129	112
AM Stns—Applications	249	163	158
FM Stations on Air	600	555	552
FM Stns CPs—not on air	21	15	16
FM Stns—Applications	9	3	4
COMMUNICATION AUTHORIZATIONS			
Source: (FCC)	Mar. '53	Feb. '54	Mar. '54
Aeronautical	38,822	43,682	43,324
Marine	39,425	44,140	44,598
Police, fire, etc.	12,682	15,003	15,065
Industrial	16,232	20,280	20,599
Land Transportation	5,660	6,600	6,758
Amateur	112,666	117,427	118,750
Citizens Radio	1,980	5,550	5,612
Disaster	189	257	259
Experimental	415	532	544
Common carrier	1,094	1,490	1,534
EMPLOYMENT AND PAYROLLS			
(Source: Bur. Labor Statistics)	Feb. '53	Jan. '54	Feb. '54
Prod. workers, comm. equip.	418.1	352.6 -r	347.4
Av. wkly. earnings, comm.	$65.77	$65.96-r	$68.06
Av. wkly. earnings, radio	$63.92	$65.02-r	$67.03
Av. wkly. hours, comm.	40.6	38.8	39.8
Av. wkly. hours, radio	40.2	38.7 -r	39.9
STOCK PRICE AVERAGES			
(Source: Standard and Poor's)	Apr. '53	Mar. '54	Apr. '54
Radio—TV & Electronics	298.9	301.9	304.0
Radio Broadcasters	290.7	302.1	309.5

p—provisional; r—revised

FIGURES OF THE YEAR

TOTALS FOR THE FIRST QUARTER

	1953 Total	1953	1954	Percent Change
Television set production	7,214,787	2,259,943	1,447,110	—36.0
Radio set production	13,368,556	3,834,784	2,581,565	—32.6
Television set sales	6,375,279	1,780,899	1,780,795	——
Radio set sales (except auto)	7,064,485	1,438,866	1,059,336	—26.4
Receiving tube sales	437,091,555	122,058,756	76,385,978	—37.4
Cathode-ray tube sales	7,582,835	2,798,921	1,962,864	—29.9

INDUSTRY REPORT

electronics—June • 1954

DESIGNED for mass production and operation by anyone capable of using an existing business machine, this desk-size computer may prove . . .

Small Brain Can Do Big Jobs Fast

Electronic calculator the size of desk adds two twelve-digit numbers in 2/1,000 second

SUCCESS of computing techniques for business and automation depends upon continual evolution of useful, compact and inexpensive electronic brains. Giant computers needed to solve complex missile guidance, aerodynamic and basic research problems cost anywhere from millions to at least $500,000. Business needs more equipment intermediate between this and the desk-top calculator.

▶ **Desk-Size Machine**—One recent approach to fulfilling this need is suggested by Burroughs, long-time manufacturer of mechanical calculators. Their desk-size machine combines the electrochemical and electronic approach, using some 160 tubes and many germanium diodes. Not yet in production, but operating in prototype form, the machine is expected to sell for $30,000 in mass production. Initial computers will probably be handled on a rental basis to enable Burroughs to gain practical experience in this field.

▶ **Simple to Operate**—Data is introduced with a keyboard and answers are printed at 24 characters a second. A magnetic-drum memory stores information like tables of interest rates and logarithms. An operator trained for only an hour and forty minutes computed real estate tax assessments, rate of climb and path of a guided missile and determined power capacity of a hydroelectric system consisting of three dams in the initial demonstration at Detroit.

Diverging Trends Beset UHF Television

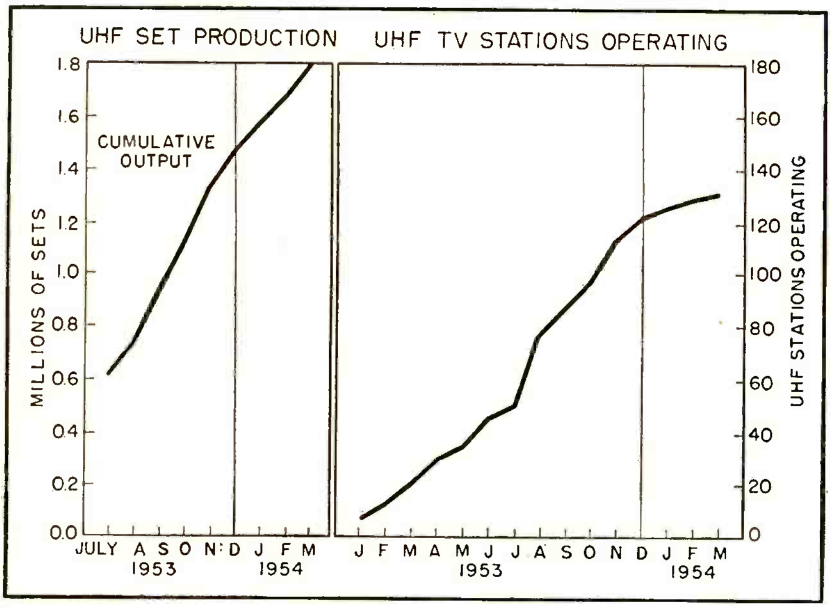
Receiver production is substantial but number of stations in operation levels off

THE INDUSTRY is keeping close watch on the uhf television picture. Another appraisal of uhf tv economics was scheduled for late in May by a subcommittee of the Senate Commerce Committee. Representatives of uhf stations, uhf associations and uhf set makers appear at the hearings.

▶ **Sets**—Factory production of sets with uhf tuning facilities is proceeding at a healthy rate. Since the beginning of 1953 over 1.8 million uhf sets have been produced representing 20 percent of total tv output. At the present production rate the percentage by the end of this year is expected to be substantially higher.

▶ **Stations**—The number of uhf stations in operation leveled off at the beginning of May. New uhf stations going on the air have taken up the slack of those who have gone off.

About 60 uhf applicants who were granted cp's have withdrawn applications. Two radio stations in New York City are among the latest to do so. One stated the rea-



son as being that economic problems involved in starting a uhf station in New York at present seemed insurmountable.

▶ **Manufacturers** — Experimental field tests of a system that utilizes a low-powered auxiliary transmitter to extend coverage of uhf tv stations to shadowed areas will be made by RCA in cooperation with WJTV in Jackson, Miss.

Six types of 12 kilowatt klystrons have been added by GE to its initial equipment and distributor sales lines. Since early 1953, GE has equipped 35 stations with the tubes.

Stations use klystrons under direct lease from GE but may now either lease the tubes or purchase them outright. The tubes have been added to the distributor sales line at a list price of $10,000 each. They operate in uhf band, and each type will provide 12 kilowatts of power output at synchronizing peak level with a power gain of 200 in broadband visual service.

Shadow-Mask Makers Profit With Color

SIZABLE new business developing as a result of color television is aperture-mask manufacturing. In pilot quantities, it is estimated that the price of a finished mask could run as high as $20 per unit. However, with mass production the cost could drop to $5 or lower as new techniques are developed.

▶ **How**—Many of the shadow-masks produced so far have been made in a two-step operation. The holes are etched first in a sheet of cupro nickel made of 70-percent copper and 30-percent nickel by a photo-etching subcontractor. It is then shipped to a precision-metal subcontractor for final finishing and shaping for either the curved or flat form.

Business for these sub-contractors has already been substantial. One photo-etching firm estimates that it produced nearly 8,000 masks in March of this year. In April, however, production dropped sharply as the industry switched to 19-inch color-tube production. However, mask suppliers say they can set up to produce 20,000 masks a month if demand calls for it.

Industry Scores Automation Progress

Methods are reviewed, costs are scrutinized and new advances described at symposium

EVALUATION of the problem of automatizing production lines was made at a symposium in San Francisco on automatic production of electronic equipment co-sponsored by the Stanford Research Institute and the U. S. Air Force.

▶ **Methods** — Stanfords Research's automatic factory research program, under sponsorship of the Air Force, was described. It proposes a line of single-purpose machines that could be installed one by one in a manual line to enable gradual conversion to automation in a small factory. The machines would assemble components of conventional construction but with standardized dimensions, in modular increments of 0.1 in., and would use some type of feedback control.

A similar approach to automation, Project Mini-Mach, is being made for the Navy under a Bureau of Ships contract by Melpar of Alexandria, Va.

It uses standard components in a punch-tape controlled assembly line, with a subassembly technique that is basically that of securing component boards together in a deck-like manner, mechanically supported by and spaced from adjacent decks by a special combination of male-female connectors. Wiring between components and between decks is entirely eliminated.

A modular coordinate system is used to locate the components; the location is coded digitally and recorded on a storage medium. A geometrical description of the entire equipment can be obtained by giving a set of component numbers which choose the component type and size, together with another set of numbers giving the location of the component.

It was explained that a high degree of component accessibility is achieved, since the wafers are detachable for inspection and repair.

(Continued on page 8)

For Improved and More Compact Circuits!

Sylvania's versatile new

POWER TRANSISTOR 2N68

Here's a simple, rugged unit which provides an efficient solution to numerous power requirements including: Servo systems, control applications, and compact radio receivers.

This versatile Sylvania development permits 1.5 watts dissipation with no external heat sink. Its power gain is better than 10 db. And, it may be mounted in any position, with lead wires soldered or clipped for socket mounting. For further details and technical data, write today to Dept. 4E-1606, Sylvania.

Electrical Ratings

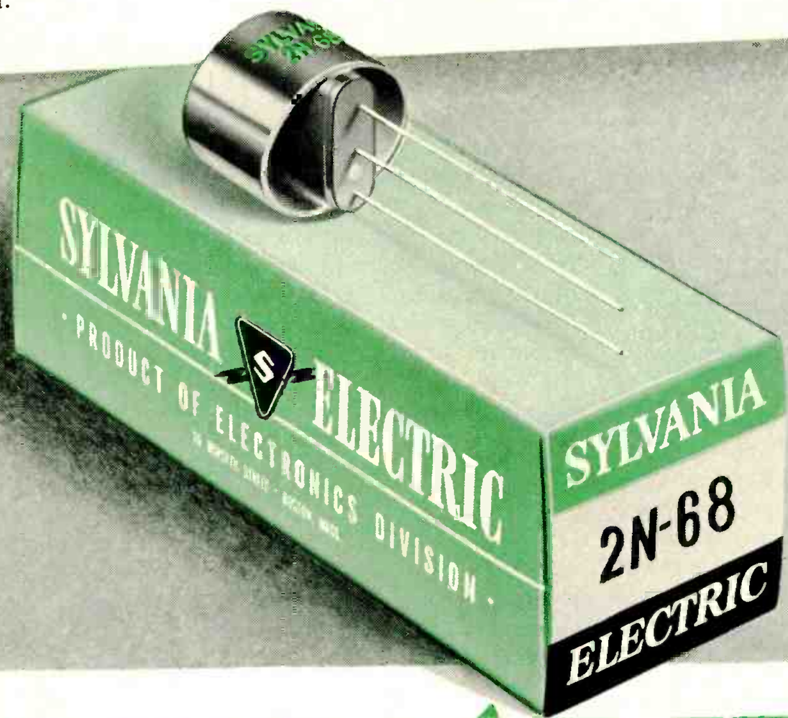
Collector to Base Voltage	—25 volts
Collector Current	—1.5 amps.
Dissipation in Free Air	1.5 watts

Typical Operating Conditions

Push-Pull Class B Amplifier . . . Grounded Grid or AC Grounded Collector Circuit.

Power Output	3 watts (MIN)
Collector Voltage	—12 volts
Load Resistance	24 ohms to each transistor.
Collector Current @ Zero Output	—5 ma
Collector Current @ 3 Watts Output	—320 ma
Collector Efficiency @ 3 Watts Output	75%
Power Gain	> 10 db
Frequency Response	> 10 KC

Another reason why it pays to specify Sylvania



SYLVANIA

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

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In insertion operations, a tool and anvil combine to effect mechanical fastening of the component to the wafer exclusive of soldering support, and fastening and soldering operations are combined or superimposed. All pertinent conductive surfaces are precoated with solder before entering the assembly machinery so that soldering is reduced to the controlled and precise application of heat by the anvil.

Melpar estimates the machines will produce a two-wafer assembly at a rate of two per minute and that it would be economical to produce as few as 100 of these units between changeovers.

▶ **Cost**—Attention was focused on the cost factor in automation. It was indicated that major costs in the electronic field were for components, and that automation efforts should be concentrated on standardizing and cutting costs of these.

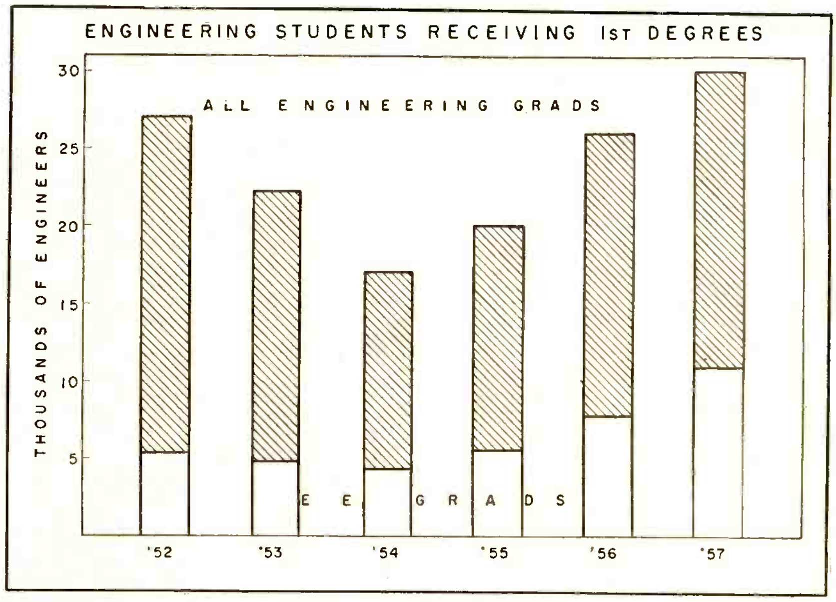
Cost of assembling typical electronic equipment, it was estimated, included only 10 to 20% for labor, so that little could be saved there. Automation in manufacture of components was described as a fertile field, however, since 60 to 80 percent of equipment assembly costs are for materials.

▶ **Advances** — Emerson reported that it is working with a conductive adhesive to replace hand soldering operations.

Sylvania Electric Products announced a new high-speed automatic technique for the manufacture of transformer coils. Under the process, the coils are made by rolling together wide sheets of metal foil and insulating paper. The roll is then sliced to form the windings of a transformer or a complete r-f coil.

Sylvania also announced the design of a receiving-tube mount structure adapted to automatic assembly.

The tube mount, developed under a Bureau of Ships contract, uses ceramic to replace mica and glass. The elements are stacked on two ceramic pins, separated by ceramic spacers held to thickness tolerances of 0.0005 inch.



SUPPLY of young engineering graduates hits low point, but . . .

Grads Find Gold Rush Over

Firms besiege top students; low men find little choice; some older engineers are out

ACCORDING TO ELECTRONICS, survey of nearly 80 percent of American engineering colleges and universities, a total of 4,400 students will receive first degree in electrical engineering this June. Of this number, 3,600 indicate that they will be available to accept industrial employment.

Ten percent of the total (440 men) will enter the armed forces by way of R.O.T.C. or regular commissioning while approximately 330 will remain in school for graduate studies.

▶ **Other Fields**—Although the electronics industry will draw largely from among electrical engineering graduates many mechanical, industrial and chemical engineers and engineering physicists are also sought. Total engineering graduates in all curricula this June will be 22,270.

Engineering educators report that interviewers on college campuses this spring are placing greater stress upon academic standing than at any time since the Korean war began back in 1950. Men in the top five percent of the class grade-wise can often choose from as many as six offers.

▶ **Salaries** — Average starting salary for engineers in all fields is $336 a month. This is up $10 over June 1953 figures. Top offer made by any of the 50 large companies reporting salary data is $438 while the low is $247. Salaries offered depend largely upon the graduates academic grades.

A potential surplus of engineering talent appears to be developing among some engineers in the 45-48 age bracket. Some observers attribute this to cutting of expenses by some firms. This trend presumably has done much towards firming up the demand for recent engineering graduates.

Broadcasters Pool Information at NARTB

TARGET DATE for completion of new broadcasting equipment has now become the annual convention of National Association of Radio and Television Broadcasters, held this year at Chicago, May 23-27. Collectors of data sheets at the exhibit

(Continued on page 10)

IT'S SPRAGUE FOR

Ceramic Capacitors

EVERY TYPE AND RATING FOR SMALL OR LARGE PRODUCTION RUNS!

Sprague can provide you with the best capacitors for your requirements. And when it comes to ceramic capacitors, large plants with adequate production and tooling facilities offer prompt delivery for small or large production runs.

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Some of Sprague's newest developments are shown at right. For future developments in ceramic capacitors, look to Sprague for the ultimate in performance, miniaturization, and reliability.

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Sprague, on request, will provide you with complete application engineering service for optimum results in the use of ceramic capacitors, and printed resistor-capacitor networks.

NEW!

'RING' CERAMIC CAPACITORS
to clean up chassis

Designed to fit around 7-pin miniature tube sockets, these capacitors may contain 2, 3, or 4 sections. They result in a neat physical layout while reducing space to a minimum. Positive positioning of the ultra short leads between the capacitor and socket terminals eliminates lead dress problems and, consequently, allows "hot" circuit designs. Voltage ratings from 100 to 500 d-c. Write for Engineering Bulletin 610.

NEW!

FLAT 'PAN' CERAMIC CAPACITORS
simplify circuit design

Mounted flat against a chassis with a screw or rivet, these miniature capacitors provide a highly secure mounting. 1 to 4 sections in the shallow pan are insulated and moisture-protected by a phenolic resin. Ideal for military electronics. These units have an unusually high self resonant frequency, and eliminate lead dress problems when mounted adjacent to a miniature tube socket. Available in ratings from 100 to 500 volts d-c. Write for Engineering Bulletin 611.

WIDELY-USED CERAMIC CAPACITORS
for electronics, radio, and TV

Shown at left are a few of the many other types of ceramic capacitors available from Sprague. These include:

- Buttons • Discs • Hi-Voltage Moldeds
- Precision Ceramic Trimmers • Plates
- Printed resistor-capacitor networks
- Hermetically sealed, metal cup and tubular precision capacitors

For complete details on any type of ceramic capacitor — it pays to ask Sprague. Write for catalog data on the types in which you are interested.

WORLD'S LARGEST CAPACITOR MANUFACTURER

SPRAGUE

Export for the Americas: Sprague Electric International Ltd., North Adams, Mass. CABLE: SPREXINT obtain the equivalent of an annual catalog of radio and television equipment.

▶ **Accent On Color**—Although broadcast businessmen traditionally discuss, on and off the record, the problems inherent in management of stations, their engineering associates concentrate upon technical aspects of station operation. This year, emphasis is on color tv. The engineering conference committee decided what engineers most needed to know and then sought out expert authors for about 25 technical papers. Resulting titles might well serve as a checkoff sheet for engineers hard-pressed to make the new medium work successfully.

Engineers from the two networks that have had most experience with live color will serve their colleagues by telling the essential trade secrets on staging, lighting, makeup, costumes and sets.

▶ **Improved Performance** — Axiomatic among tv engineers is the fact that monochrome performance must be well-nigh perfect before color can be successfully handled. Loss of quality or dead air have lost the broadcaster some revenue, making reliable operating procedures financially important.

Some of the technical papers reflect these philosophies by telling how to get the best possible performance from black-and-white, how to handle video recordings (backbone of small station programming) how to switch programs without a hitch and how best to perform preventive maintenance.

Authorized Mobile Transmitters Top 433,000

LATEST FCC figures show that 19,322 licensees for industrial, land transportation and public safety radio services are authorized to operate an average of better than 22 transmitters each, or a total of 433,627 transmitters— mobile or fixed. Not included are aeronautical, amateur, citizen, disaster and marine services in which an additional 200,000 licensees are permitted to operate about 600,000 transmitters.

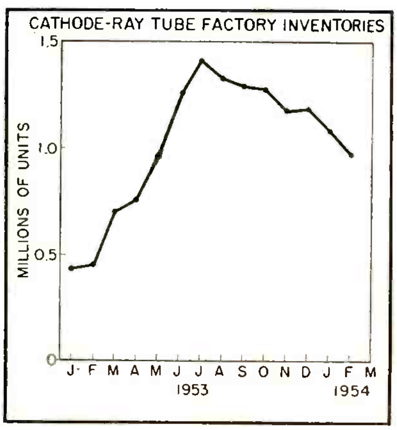
Authorizations shown in the table reflect a trend, but do not show actual stations on the air. The Commission recently voted to determine exactly how many of the authorized stations are now in service.

Class of Station	Number of Licensees	Fixed	Mobile	Total
Industrial Services				
Agriculture	1	9	......	9
Forest Products	277	634	7,260	7,894
Low Power Industrial	575	......	6,911	6,911
Motion Picture	12	13	334	347
Petroleum	505	4,110	19,898	24,008
Power	1,786	5,356	59,941	65,297
Radiolocation	40	56	94	150
Relay Press	38	28	691	719
Special Industrial	2,107	3,309	37,296	40,605
	5,341	13,515	132,425	145,940
Land Transportation Services				
Auto Emergency	293	253	2,782	3,035
Highway Truck	399	549	8,293	8,842
Intercity Bus	8	61	768	829
Railroad	138	942	12,597	13,539
Taxicab	5,357	4,156	90,397	94,553
Urban Transit	75	80	2,256	2,336
	6,270	6,041	117,093	123,134
Public Safety Services				
Fire	1,051	1,106	21,170	22,276
Forestry-Conservation	83	2,397	16,428	18,825
Highway Maintenance	34	727	9,122	9,849
Police	5,481	6,318	101,594	107,912
Special Emergency	1,060	1,079	4,308	5,387
State Guard	2	115	189	304
	7,711	11,742	152,811	164,553
Total	19,322	31,298	402,329	433,627

Manufacturers Adjust C-R Tube Inventory

Factory stocks are still higher than they were last year but are dropping fast

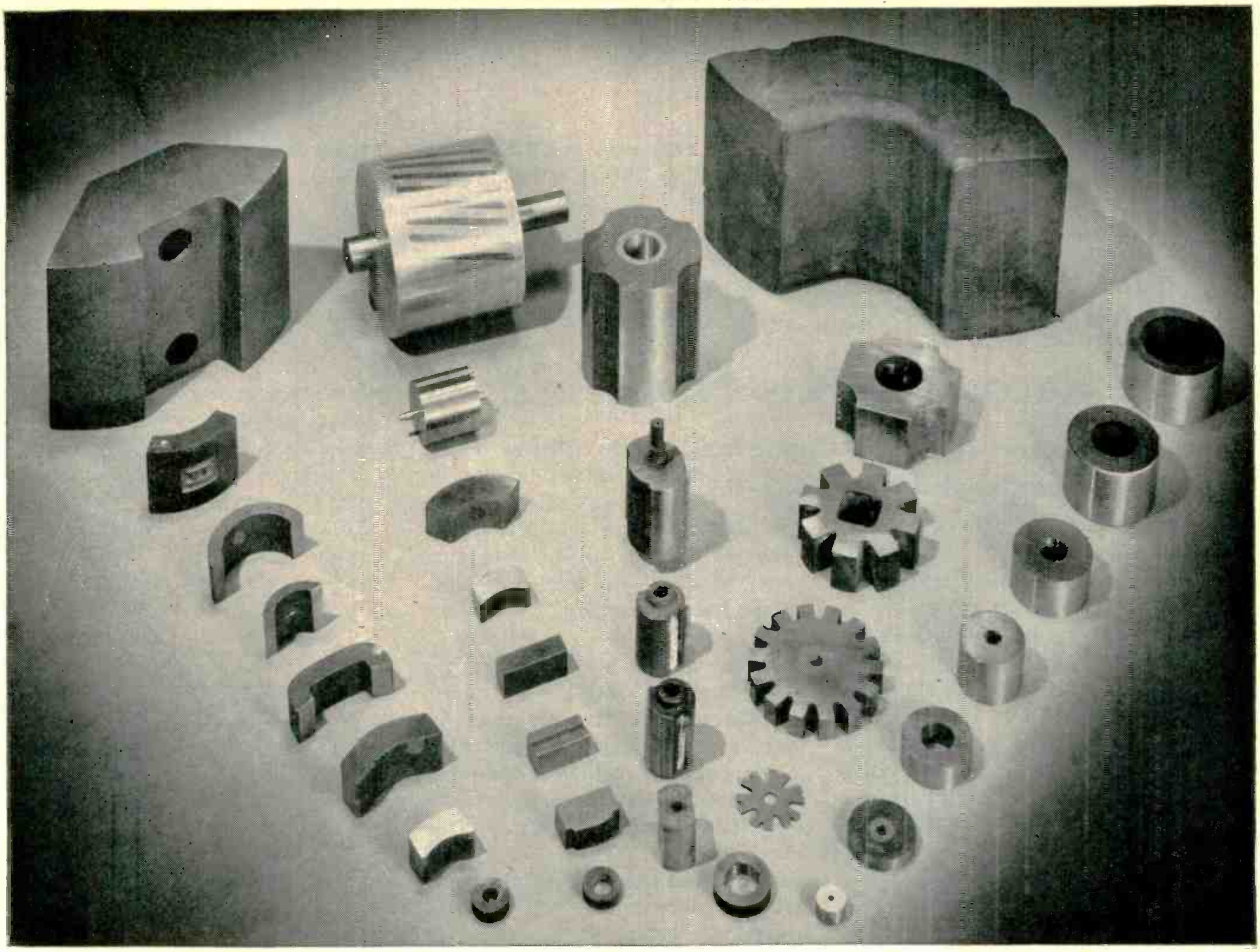
GOOD INDICATOR of the state of business in the tv tube industry is the number of tubes shelved in manufacturers' warehouses. For the past 10 months, c-r tube inventories have been over the million mark each month. However, from a high point of 1.4 million in July of last year, stocks have dropped 400,000.



▶ **Sales**—One measure of success of inventory management is the ratio of inventory to sales, with a lower ratio almost always being more desirable. Here are the ratio figures for the past 14 months: Jan. 44, Feb. 53, March 71, April 83, May 127, June 165, July 218, Aug. 150, Sept. 146, Oct. 132, Nov. 166, Dec. 180, Jan. 190, Feb. 149. They dropped nearly 25 percent in February but are still three times as high as they were in February, 1952.

▶ **Price**—As a result of large stocks price cutting and other symptoms of overstocked warehouses began

(Continued on page 12)



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

"MAGNETIC MATERIALS CATALOG"

Write for your copy

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

ADDRESS DEPT. E

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

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to appear this year. Some leading tube makers reduced prices on c-r tubes to unload excess stocks. This has shown up in some first quarter profit statements. One company, for example, reported net earnings of $450,304 for the first quarter of this year compared to $552,318 for the period in 1953. According to the company, disappointing results in the c-r tube division, which was adversely affected by an unfavorable price situation and instability in the tv industry was a cause.

Tape Recording Hits New Fields

Six major markets emerge; long-playing prerecorded tapes are making debut this year

ALTHOUGH the home entertainment market for magnetic recorders overshadowed all others with its gross sales of over $50 million last year, two other fields of application battled to a tie in dollar volume of sales last year. One was the long-familiar broadcast station market for high-fidelity tape equipment; the other, a relative newcomer, was the industrial instrumentation field.

Instrumentation recording is used for sound and vibration analysis, telemetering of guided missile performance data, seismic exploration and similar applications where many different channels of data must be recorded faithfully in a short interval for later playback through analyzing equipment. A tape master permits playback over and over again through different filters and equalizers so as to extract the maximum amounts of information from a recording.

▶ **Sales Reports** — Magnecorder sales for 1953 in this field were about $1 million, as contrasted to $1.4 million in studio equipment. Ampex sales of $1.2 million were divided equally between the two fields in 1953, with an additional $1.9 million of equipment going to the military for unspecified uses.

▶ **New Markets**—The three new markets showing promise this year are: (1) taped background music for business and industry; (2) taped music and tape players for home entertainment; (3) specialized tape equipment for office machines and computers.

Potential market for recorded background music systems using tape is estimated at about 430,000 outlets. Here tape is showing such distinct advantages that Muzak has announced plans for enfranchising firms to duplicate and distribute on tape its library of 7,000 selections.

Magnecord has finalized arrangements for distributing 8-hour reels of prerecorded magnetic tape especially programmed for factories, offices, restaurants, hotels and other commercial outlets, using over 4,000 selections from RCA Victor's Thesaurus library. The tapes will be leased to customers for use on a new tape transcriber that plays automatically either intermittently or continuously.

Magne-Tronics Inc., another recent entry into the taped industrial music field will lease tapes and players in 100 U. S. cities. Source of music here is the 3,000-selection transcription catalog of Capitol Records.

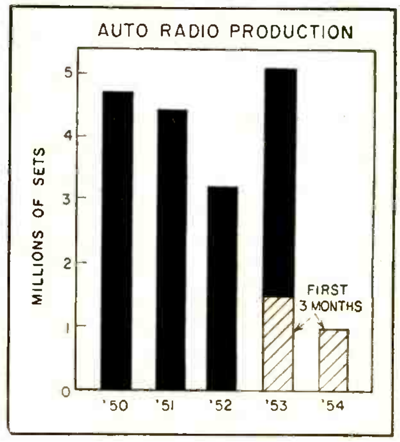
Audio-Video Tape Libraries, a pioneer in the music-on-tape field, has expanded its background music division and also set up a rental plan for 8-hour tapes.

▶ **Home Market**—At least eight firms are already making prerecorded tapes for home entertainment, and many record firms are actively working on limited tape libraries. The increased availability of taped music has in turn stimulated design and production of tape players. Advantages of players are lower cost and the impossibility of accidentally erasing a recorded tape.

▶ **Predictions**—Ampro Corp. estimates the market for all types of tape equipment to be 300,000 units for 1954, 540,000 for 1955, 600,000 for 1956 and 800,000 for 1957. Market saturation today is put at less than three-quarters of one percent.

Biggest unknown market is business itself, where advantages of storing records and data on tape for automatic access are a challenge to the entire tape industry. Recent announcement by Reeves Soundcraft of a Mylar-base high-fidelity tape that is practically unbreakable can accelerate work in the business field as well as in the other five markets.

Total number of licensees under Armour Research Foundation's basic patents is now 62, of which 14 are foreign concerns.



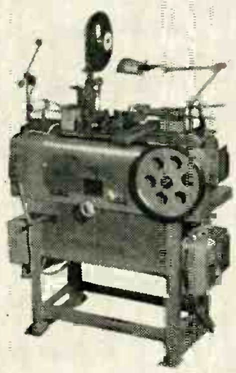
Auto Radio Output Slows Down

Production is off thirty percent in the first quarter as car market changes

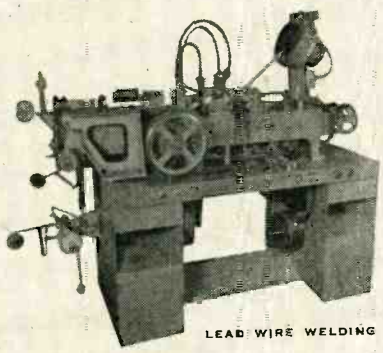
BUYERS MARKET that developed in the auto industry this year seems to be having its effect on the automobile radio business.

Nearly a half million less auto radios were produced in the first three months of this year compared to output in the same period in 1953. The drop is partially explained by the decline in auto production since the majority of auto sets are sold direct to car manufacturers and not through retail outlets. In the first two months of this year total passenger car out-

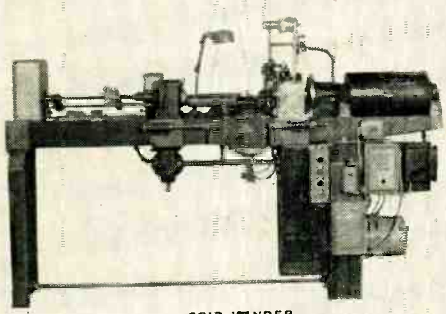
(Continued on page 14)



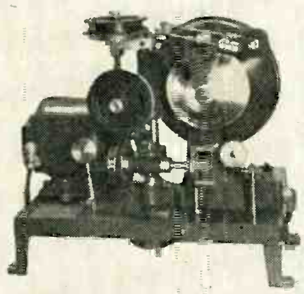
FILAMENT MAKING & TABBING MACHINE



LEAD WIRE WELDING MACHINE



GRID WINDER



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electronic industry wire products at high speeds with KAHLE MACHINERY

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up to 12,000
3-piece lead wires welded per hour for miniature receiving tubes!

up to 3,000
filaments per hour, depending on wire diameter!

up to 2,500
filament coils wound per hour for miniature lamps!

up to 1,200
RPM on Kahle Grid Winding Machine

Kahle is the largest producer of custom machinery for manufacturing electron tubes from the smallest to the largest size. If you have any difficulties to overcome in tube production . . . exhausting, sealing, stem making . . . write Kahle today and discover how this organization's engineering staff can assist you.

SPECIAL EXPERIMENTAL AND RESEARCH SERVICES OFFERED BY KAHLE INCLUDE:

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- Special tools for research
- Special models
- Small-lot manufacture of special items for research or development
- Regular industrial engineering at regular fee or contract rates
- Special tubes, lamps, etc. for research purposes including elements and parts
- Any special equipment for manufacture or research for tubes or lamps

Kahle ENGINEERING COMPANY
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put was five percent below that of last year and new car registrations were off 10 percent.

▶ **Autos**—Automobile manufacturers say that increased competition in the industry is not evoking stripdowns of cars that come factory-equipped with radios. They indicate that it is still the deluxe automobile with all the trimmings that is a large seller. In fact, they point out, the percentage of autos that come factory equipped with radios is pretty much as it was in 1953.

General Motors reports that in the first quarter of this year 94.3 percent of all Oldsmobiles produced were equipped with radios. In 1953 the percentage for the year was 92.2 percent. Accenting the trend to the deluxe auto, 15 percent of all radio-equipped Olds produced in the first quarter used the deluxe signal-seeking set.

The Pontiac division of GM reports a slight drop for the first quarter with 87-percent factory installed compared to the usual 89 percent. Buick also reports a slight drop to 92 percent of its output that is radio-equipped. It is presently installing 11 percent of new cars with the deluxe model.

▶ **What's New**—Last year saw the introduction of the signal-seeking car radio. Another move toward more automatic operation was made by Motorola this year with the introduction in its new line of auto radios of a feature called volumatic control. The control circuit uses a tube developed by the firm and Tung-Sol. Motorola plans to include the device in its entire line at no extra cost. It is reported that 18 percent of the firm's sales involve auto radio receivers.

Printing Trends to Tubes

RECENT DEVELOPMENTS in the printing industry indicate the growing importance of electronics in this field. In preproduction demonstration, the Mergenthaler Linotype Co. showed a two-unit punched-tape controlled photographic typesetter.

The typewriter unit uses a modified electric typewriter to provide a punched paper tape containing letter and spacing information. When the tape is run through the photographic unit, the punched information automatically sets shutters to uncover the proper letter on one of five glass negative plates. An electronically triggered flashlamp prints the letter by projection on a strip of photographic film. The typesetter can set type in sizes from 6 to 16 points using two sets of negatives.

In the demonstration model, mechanical computing and memory units were used for computing line width and keeping track of spacing information. These units may be replaced in whole or in part by electronic systems by the time full-scale production begins in the fall of 1955. An electronic accessory to the typesetter is a correction unit that slices out lines containing errors and replaces them with corrected lines butt-welded into place in the film strip.

▶ **Engraving**—Production of plastic halftone cuts by electronic engraving methods has been given added adaptability in a new engraving machine developed by the Fairchild Camera and Instrument Corp. In the present production model, the engraving is produced with exactly the same dimensions as the original photograph. The new unit can vary either or both dimensions of the engraving. Provided on a rental basis, the new engraver will cost from $300 to $600 per month.

Two-unit typesetter uses electric-typewriter keyboard to punch paper tape for controlling photographic unit at rear. Control panel at side of typewriter is for selecting style of type and word spacing

West Coast Electronics Spreads Out

Oregon joins California in extolling the industry's growth characteristics

CHAMBERS OF COMMERCE in both California and Oregon recently noted the rising importance of the electronics industry on the west coast.

The Los Angeles Chamber has formed an electronics committee to coordinate industry-wide action on component parts, scientific personnel, industry statistics and recognition and use of new equipment and techniques. According to the group, the electronics industry replaced the aviation industry in 1953 as the second largest in total capital investment in greater Los Angeles.

▶ **Dark Horse**—Portland, Oregon's Chamber of Commerce character-

(Continued on page 16)

ized the state's electronics business as a sleeper industry. It reports that the industry there has increased 25 percent since 1952 and that employment now totals 1,000 for the state. Sales made out of the state account for 90 percent of total volume.

In 1953, gross sales totalled $8.6 million and plant space stood at 200,000 sq ft for the 14 concerns that make electronic components and end products in the state. Ten years ago, the report states, only two of the 14 firms were in business. In 1949, seven companies then in business did $1.8 million in gross sales.

Currently, two companies in Oregon's electronics industry employ over 350 workers, two over 50 and five under 25 people. More than 100 engineers and technicians are employed by these firms.

▶ **WESCON**—Further indication of the continued growth is the gain made by the Western Electronic Show and Convention. In 1947, exhibitors in the show numbered 50. Last year 370 booths were taken and it is expected that the August show in Los Angeles will fill more than 465 booths. Attendance is expected to reach 20,000.

Company Combats Selenium Shortage

SUPPLY situation in selenium (ELECTRONICS, p. 8, May, 1954) has caused Sarkes Tarzian to request servicemen to turn in used rectifiers to its distributors. They, in turn, have been asked to send them to the company by truck, transportation collect, for credit at the rate of 2.5 cents for those rated at 65 to 150 ma and 5 cents each on rectifiers rated at 200 ma or more.

According to the company, cooperation is vitally needed to insure a continuous supply of replacement rectifiers. A reduction in production would lead to either rationing or the requirement that a replaced rectifier be supplied for each new one purchased.

Manufacturers Break Down Sales

SOME manufacturers in the electronics field have indicated the importance of their various types of products or lines of business in relation to total sales. Following are 1953 percentages of eight companies.

Company	Product or Business	Percent Of Total Sales
GE (Est) 1953 Sales, $3.1 billion	Affiliated & Foreign	20
	Apparatus	20
	Industrial Products & Lamps	20
	Appliance & Electronic	20
	Defense Products	20
IT&T 1953 Sales, $362.1 million	Sales From U. S. Manufacturing	43.8
	Sales From Manufacturing Abroad	56.2
Motorola	Television	45
	Communications Products	25
	Auto Radio	18
	Home And Portable Radio	12
RCA 1953 Sales, $853.0 million	RCA Victor, RCA Labs & RCA International	75.6
	NBC	20.6
	RCA Communications	2.1
	Radiomarine Corp.	2.2
	RCA Institutes	0.1
	Less Intercompany transactions	0.6
Texas Instruments 1953 Sales, $27.9 million	Engineering, Development & Manufacturing	60.4
	Geophysical Subsidiaries	32.3
	Supply Co. Subsidiaries	7.2
Varian Associates 1953 Sales, $5.1 million	Research, Development & Engineering Services	39
	Klystrons, electronic systems & Components	61
Western Electric (Est) 1953 Sales, $1.5 billion	Sales To Bell Telephone	67
	Defense Sales	4
	(82 percent electronic)	29
Westinghouse 1953 Sales, $1.6 billion	Apparatus & General Industrial	50
	Consumer	26
	Defense	24

▶ **Companies**—There is little basis for comparison between the various firm's listed in the table but trends for three companies are indicated.

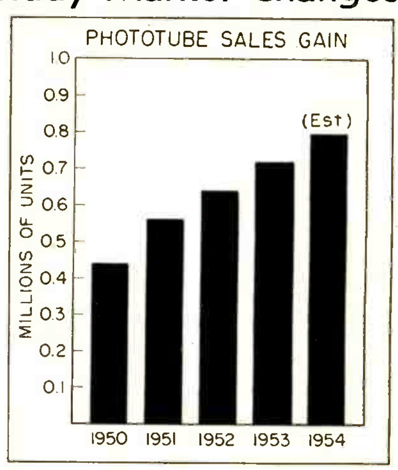
At a recent GE stockholders meeting, it was indicated that a few years ago it had set up the five product groups listed so that each would be roughly equivalent in size. It was stated that the four domestic groups, in general, had maintained the breakdown. In 1953, sales increased in all major product groups and leading increases were in electronics and appliances.

For RCA, shipments to the armed forces accounted for 19 percent of total sales in 1953 and 24 percent in the first quarter of this year. The products and services sold by RCA Victor, RCA Labs and RCA International totaled $645.1 million in 1953, an increase of 27 percent over 1952. As a result, the division's percentage of total sales jumped from 73.1 to 75.6 in 1953.

Although sales of NBC increased by 8 percent in 1953, its share of total sales dropped from 23.4 percent in 1952 to 20.6 percent last year. Its income was made up of 80 percent tv revenues and 20 percent radio. RCA Communications' share also dropped slightly in 1953 from 2.5 percent to 2.1. The Radiomarine Corp., however, increased its share from 1.7 to 2.2 percent. Its sales increased 57 percent from $11.8 million in 1952 to $18.6 million last year. RCA Institutes sales increased from $742,000 in 1952 to $960,000 in 1953 and thus maintained the 1952 percentage of total sales at 0.1 percent. RCA reported that tv has accounted for 50 percent of its total volume of business over the past seven years and reached 54 percent in 1953.

▶ **Changes**—Varying pattern in product groups was also evident from Westinghouse figures. Percentage of total sales accounted for by apparatus and general industrial products dropped from 53 percent 1952 to 50 percent in 1953. Consumer products percentage increased during the period from 23 to 26 percent. Defense sales continued to account for 24 percent.

Phototube Makers Study Market Changes



MANUFACTURERS of phototubes have enjoyed constantly rising sales since the end of World War II and ex-

(Continued on page 20)

NEW VARIACS

Standard VARIAC® continuously-adjustable transformers can be operated at line frequencies from 50 to 400 cycles. The new "M" Series are designed for use at frequencies between 350 and 1200 cycles.

Their design is entirely new. They are electrically the high-frequency equivalents of the popular Types V-2 and V-5 units, but are much smaller and lighter than the low-frequency models. At 400 cycles regulation obtained with the "M" units is considerably better than that of the 60-cycle "V"s when operated at 400 cycles. Design and operating features include:

★ Cast aluminum construction . . . lighter and even more rugged . . . will withstand vibration tests of 10 to 55 cycles, 1/32 inch total amplitude, 10 to 33 cycles, 1/16 total amplitude. MIL-T-945A. Shock test of 1200 ft.-lb.

★ Dynamically and statically balanced radiator

★ Excellent thermal conductivity between coil and base, and between base and panel . . . coils bear solidly through thin insulation against cast aluminum base which has annular panel bearing surface.

★ Two-ampere model M-2 has 400 turns of wire, giving adequate resolution for many computing and control operations.

★ Exclusive DURATRAK contact surface (a protective armor against oxides) provides extra factor of reliability under overload. Instantaneous overloads of ten times normal rating can be handled. Practically no maintenance required. Brush track shows no wear after one million cycles of brush operation

★ Unit Brush construction

★ Wiring diagram on terminal board

★ Ganged assemblies designed for minimum volume. Coils are mounted back-to-back on a single base for 2-gang assembly.

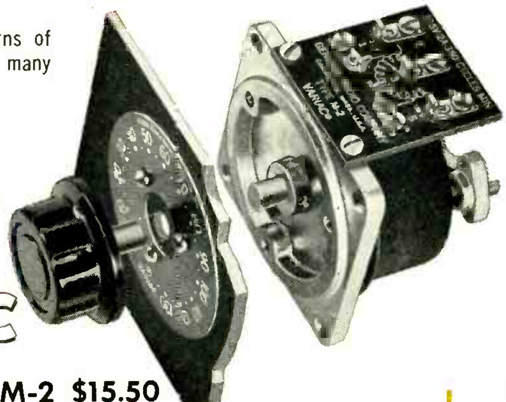
★ ALL VARIAC dials calibrated directly in output voltage at nominal line voltage

★ Four corner mounting holes for ganging and special mounting, in addition to three mounting holes identical with standard VARIACS

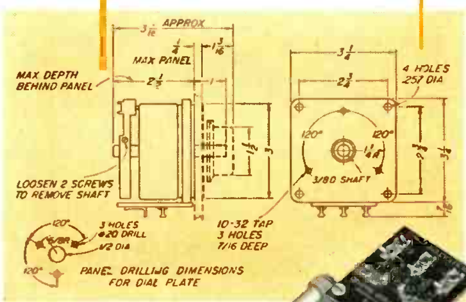
★ On special order, all units can be fungicide-treated to meet military requirements.

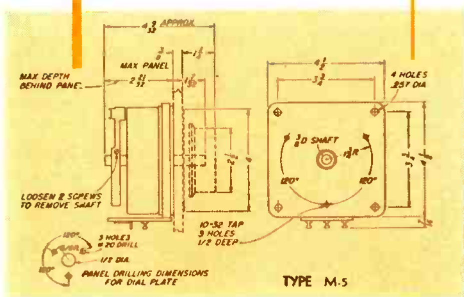
. . . for 350 to 1200 Cycles

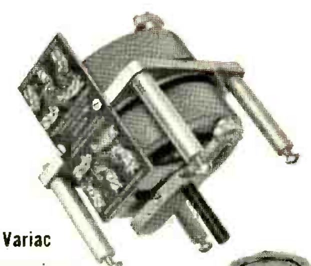
Variac®



	Type M-2 $15.50	Type M-5 $22.50
Line Frequency	350 to 1200 cps	350 to 1200 cps
Input Voltage:	115v	115v
Output Voltage:	0 to 135 or 0 to 115	0 to 135 or 0 to 115
Rated Output Current	2 amperes	5 amperes
Maximum Output Current (*for line-voltage connection only*)	3 amperes	7.5 amperes
No-Load Loss at 400 cpc	3 watts	6 watts
Number of Turns on Winding	402	293
D-C Resistance of Winding	6.6 ohms	1.3 ohms
Driving Torque	10–20 in.-oz.	15–30 in.-oz.
Net Weight, Lbs.	1-7/8	3-1/4





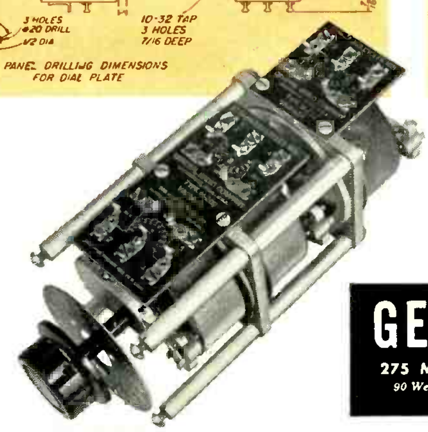


Type **M-5G2** Variac

Mounting Dimensions Same as Type M-5 Overall Depths Behind Panel are:
M-5G2: *5-1/32″* **M-5G3**: *7-27/32″*

TYPE M VARIAC ASSEMBLIES

Type	Description	Price
M-2G2	*2-Gang Type M-2*	$35.00
M-2G3	*3-Gang Type M-2*	52.50
M-5G2	*2-Gang Type M-5*	49.00
M-5G3	*3-Gang Type M-5*	73.50



Type **M-2G3** Variac

Mounting Dimensions Same as Type M-2 Overall Depths Behind Panel are:
M-2G2: *4-7/8″* **M-2G3**: *7-5/8″*

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Manufacturers of Electronic Apparatus for Science and Industry

GENERAL RADIO Company

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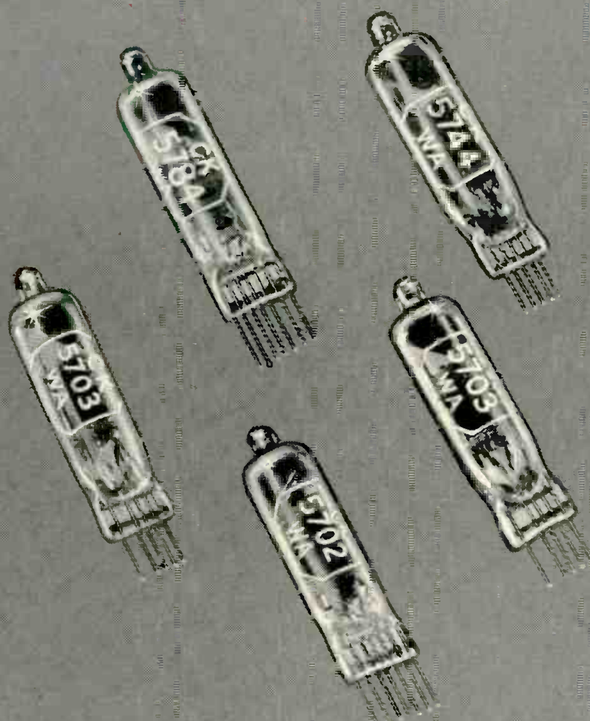
RAYTHEON

subminiature



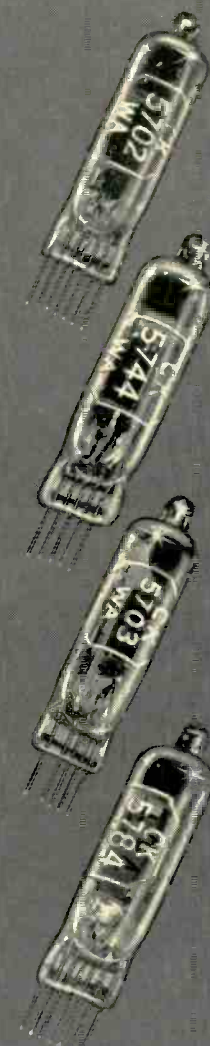
TEST
PLATE VOLTAGE MAXIMUM
PERMISSIBLE HEATER VOLTAGE RANGE
PLATE DISSIPATION
HIGH TEMPERATURE LIFE
1 HOUR STABILITY
100 HOUR SURVIVAL
HEATER CYCLING
MEDIAN CONTROLS

HERE ARE MORE REASONS WHY RAYTHEON SUBMINIATURE TUBES ARE SO RELIABLE:

- ★ Additional Life Test End Points
- ★ Larger Test Samples
- ★ Tighter AQL
- ★ Grouped AQL
- ★ Median and Range Control of Electrical Characteristics
- ★ 100% Microscopic Inspection — pioneered by Raytheon. Forty-seven microscopic tests on each tube
- ★ Narrower Tolerances
- ★ Lower Vibrational Noise Output from CK5702WA and CK5703WA

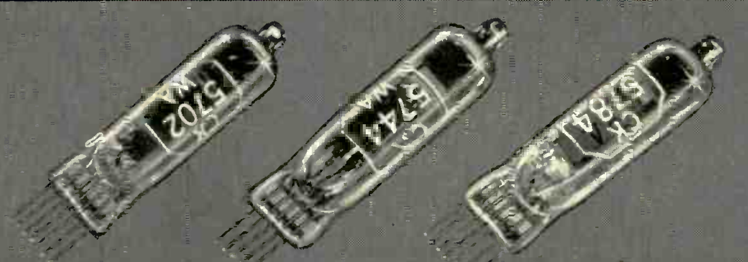
tubes have always been more RELIABLE–

CHARTED ARE SOME OF THE ACTUAL MIL SPECIFICATION REQUIREMENTS OF PARTICULAR INTEREST TO THE DESIGNER. MANY OF THESE WERE PIONEERED BY RAYTHEON. COMPARE THE RAYTHEON TUBE DATA WITH THAT OF THE NEAREST COMPETITIVE TYPE, SHOWN IN RED.



A FEW TYPICAL RAYTHEON SUBMINIATURE TUBES

	CK5702WA	CK5703WA	CK5744WA	CK5784WA
RAYTHEON COMPETITIVE TYPE	200v 165v	275v 165v	275v 165v	200v 165v
RAYTHEON COMPETITIVE TYPE	±10% ± 5%	±10% ± 5%	±10% ± 5%	±10% ± 5%
RAYTHEON COMPETITIVE TYPE	1.85w 1.1w	3.3w 3.3w	1.6w 0.55w	1.85w 1.1w
RAYTHEON COMPETITIVE TYPE	200°C 175°C	200°C 175°C	200°C 175°C	200°C 175°C
RAYTHEON COMPETITIVE TYPE	YES YES	YES NO	YES NO	YES NO
RAYTHEON COMPETITIVE TYPE	YES YES	YES NO	YES NO	YES NO
RAYTHEON COMPETITIVE TYPE	7.5v 7.0v	7.5v 7.0v	7.5v 7.0v	7.5v 7.0v
RAYTHEON COMPETITIVE TYPE	YES YES	YES NO	YES NO	YES NO



RAYTHEON

Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY

Receiving Tube Division — Home Office: 55 Chapel St., Newton 58, Mass.

For Application Information Call: Boston, Bigelow 4-7500 ● Chicago, NAtional 2-2770 ● New York, WHitehall 3-4980 ● Los Angeles, Richmond 7-4321

RAYTHEON *MAKES* ALL THESE:

RELIABLE SUBMINIATURE AND MINIATURE TUBES • SEMICONDUCTOR DIODES AND TRANSISTORS • NUCLEONIC TUBES • MICROWAVE TUBES • RECEIVING AND PICTURE TUBES pect the trend to continue in 1954. With the phototransistor now on the scene, phototube makers are taking another look at the business.

▶ **Volume**—As shown in the chart, sales of the units have risen at an annual rate of approximately 100,000 units in the past four years and if the rate holds for this year total unit sales will be brought up to 800,000 units.

The steady increase has occurred despite a sizable drop in sales to the government. Last year, only about 12,000 units were sold to the U. S. In 1952, such sales were 40,000, 85,000 in 1951 and 37,000 in 1950. However, sales to equipment manufacturers have evidently risen more than enough to take up the slack in government sales.

▶ **Transistors**—About four companies have phototransistors commercially available and others plan to make them. Already, units are being made for use in auto headlight dimmers. Their small size is seen as making the units more easily adaptable to many of the present applications of regular-size phototubes.

▶ **New Markets**—Multiplier phototubes used in nuclear instruments and other applications have been responsible for a substantial part of increased phototube business and manufacturers are increasing sales efforts on the product. Du Mont recently opened two new sales offices to specialize in multiplier phototube sales.

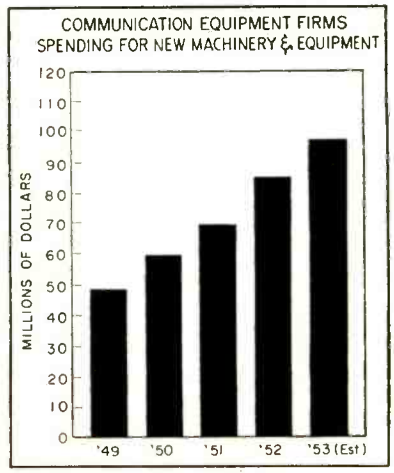
Companies are also bringing out new phototube types in response to market demands. Ten-stage multiplier phototubes have been introduced for use in the nuclear field and other new types have been made for use in headlight dimmer applications.

A new photocell that uses germanium linked to a button of indium is reported to be extra sensitive particularly to infrared radiation and so potentially useful in heat regulation. About ¼ inch in diameter and ⅜ inch long, the cell is reported to be more responsive to light than vacuum photocells a hundred times larger.

Firms Weigh Machinery Expense

New products mean additional investments in machinery and equipment for the industry

INVESTMENTS by electronic manufacturers in new machinery and equipment have steadily increased in the past few years. As shown in the chart, an estimated $97.5 million was spent for that purpose in 1953. In 1952, according to the Bureau of Census, a total of $85.5 million was spent representing 65 percent of total capital expenditures.



▶ **Why**—Constant stream of new products that move from the laboratory to mass production in the factory require, in most cases, a sizable investment by the industry. This is especially true for tube manufacturers. Bigger picture tubes, aluminizing, mass produced transistors and diodes and now color tv tubes have all necessitated large machinery expenditures.

However, not all new products require new equipment. Much tube machinery now used for black-and-white picture tube production, for example, is usable for color tube output. One reason why some color tubes may use metal envelopes is so that manufacturers can utilize metal envelope machinery that has been used for black-and-white tube output.

▶ **Business** — According to tube machinery makers, demand and inquiries for machinery used to manufacture transistors and diodes seems to be heaviest so far this year. Vacuum equipment manufacturers also report that demand is shaping up for color tube equipment and they expect substantially increased business this year as a result.

Some machinery firms catering to the electronics industry say that they note some hesitancy so far this year on the part of manufacturers to invest in the diode and transistor machinery field because of possible further product design changes that are in the wind. However machinery makers are not too concerned and expect their volume of business in 1954 will equal that of last year.

TV Antennas Invade Mass Sales Field

Better Business Bureau scores indoor performance claims after product tests

LATEST flurry to hit the tv antenna business industry is a new influx of competition from the indoor tv antenna field. Midget tv antennas are now on sale at dime stores at a retail price of a little over one dollar. Some of them purport to eliminate inside and some outside antennas.

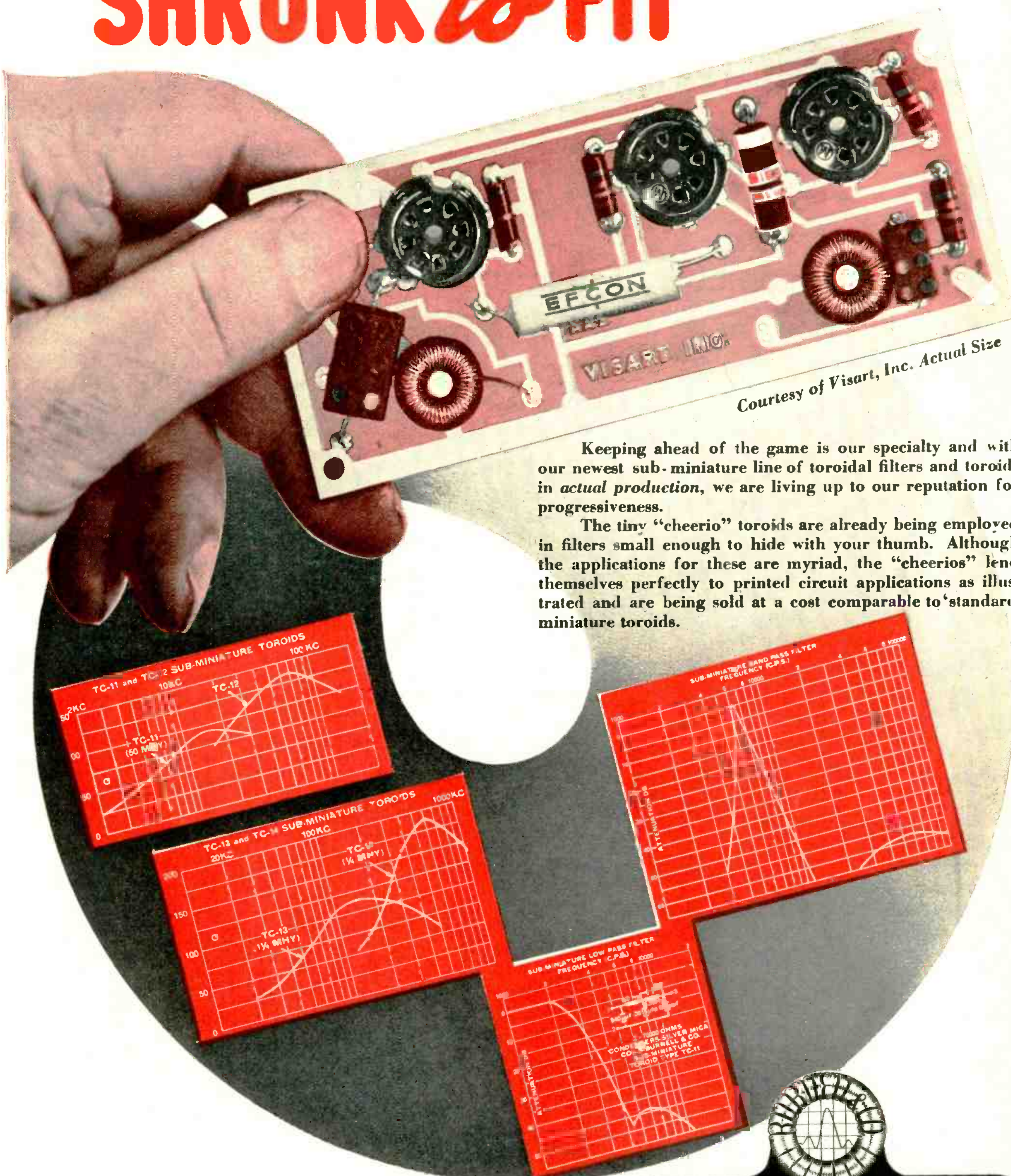
▶ **Claims**—According to the New York Better Business Bureau, some miniature indoor antennas have also been advertised as able to outperform all others and eliminate ghosts and snow. The Bureau made performance tests of some of them and found that they could not claim better reception on all channels.

It found that no present type of indoor antenna, including the miniature type, could legitimately make any claim of outperforming all others or of outperforming roof antennas, since performance varies with different channels and locations. It recommended that all

(Continued on page 22)

Burnell TOROIDS and FILTERS

"SHRUNK *to* FIT"



Courtesy of Visart, Inc. Actual Size

Keeping ahead of the game is our specialty and with our newest sub-miniature line of toroidal filters and toroids in *actual production*, we are living up to our reputation for progressiveness.

The tiny "cheerio" toroids are already being employed in filters small enough to hide with your thumb. Although the applications for these are myriad, the "cheerios" lend themselves perfectly to printed circuit applications as illustrated and are being sold at a cost comparable to 'standard' miniature toroids.

Write for new and enlarged 16 page catalog 102A

Exclusive Manufacturers of Communications Network Components

Burnell & Co., Inc.
YONKERS 2, NEW YORK
CABLE ADDRESS "BURNELL"

performance claims be limited to provable facts. Questionable claims were discontinued when the Bureau's findings were made known.

▶ **FTC**—The proposed FTC rules for the tv industry cover the antenna business.

As now proposed, they provide that it is an unfair trade practice to make the unqualified general representation that tv receiving sets equipped with built-in or indoor antennas will perform as satisfactorily as if they were equipped with outdoor antennas when such is not the fact. When the representation is true only in a limited number of locations or within a certain radius of tv stations, or only under specifically favorable conditions, or under other performance limitations, it is unfair trade practice under the rule to fail to make clear and plain disclosures of such limitations.

British Electronics Sets Records

Domestic and foreign sales of electronics products in 1953 reached new high

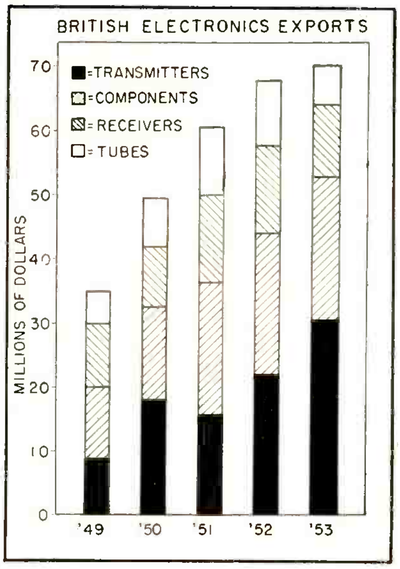
AN OUTSTANDING production job was done in 1953 by Britain's electronic industry.

Although the most marked increase was in the output of tv receivers, up 35 percent compared to 1952, from 785,000 to 1.1 million units, radio dropped from 1.4 million to 1.1 million sets.

▶ **Export**—Of the total British production in 1953 of radios and radio-phono combinations, approximately 75 percent was sold to the home market and 25 percent overseas. For tv all but about 7,000 sets were sold in the home market. The 7,000 exported set a record for the industry.

Overseas sales of electronic equipment represent about 25 percent of the total exports of British electrical goods. Of the total $71.9 million, transmitter and radio communication products group head the list, as in 1952, with exports worth nearly half the total. Components account for just over $22 million, radio and tv receivers $12.8 million, and tubes $6.1 million.

▶ **Where**—In 1953, India was the principal customer for British components, as it was in 1952, accounting for $1.8 million of the $22.1 million total. Australia followed with $1.6 million and the U.S. moved up to third place buying $1.4 million worth of components. Overseas sales of record changers and other phonograph parts reached $5.3 million and tape recorder exports neared the $1 million mark. Principal markets for these products were the U. S. and Australia followed by South Africa, Sweden, Belgium and New Zealand. The largest buyer of loudspeakers and microphones was Canada, followed by South Africa, Belgium, U. S., Netherlands, Australia and India.



▶ **Show**—A look at what the electronics industry has available product-wise this year was given at the British Radio Component Show held in London in April. The show emphasized tubes and parts designed to operate in the vhf bands because of the possible introduction of commercial tv in the near future and extension of BBC f-m sound broadcasting. It is reported that the initial commercial tv stations will operate around 200 mc and the f-m stations around 100 mc.

Microwave to Aid Wired TV

AFTER two-year delay, a community antenna outfit in Poplar Bluff, Mo. has been given permission to build the microwave relay system needed to extend service by picking up tv broadcasts from stations in Memphis, Tenn. With this grant, the first to any but the Bell System, community-type operators are scurrying to prepare applications for other microwave links.

▶ **Broad Horizon**—Formerly limited to whatever stations they could pick up on a hill and pipe down into town, the operators sometimes had several programs available, often only one and that one poor. With microwave links, they can now extend their pickup range by receiving the desired broadcast several mountains away and relaying to the local wired system.

Similar service, fed by Bell System relays to Casper, Wyoming and Reno, Nevada has already proved successful. The new non-Bell common carrier system will start with two relay points and provide one channel using a carrier frequency of 6,000 mc. Rates are set at $2,500 a month for each community system. Organizers of the new enterprise figure the original outlay will come to $143,000 for the particular system proposed.

Financial Roundup

PROFIT reports in the first quarter of 1954 for companies in the electronics field indicate that, despite sales declines in some cases, many manufacturers experienced increased net income.

According to the National City Bank of New York, the net income after taxes of 20 companies in the radio, tv and electrical equipment field totaled $83.8 million in the first three months of this year, a 35-percent increase over income in the first quarter of 1953 and a 4-percent increase over that of the fourth

(Continued on page 24)

INDUSTRIAL REMOTE CONTROL SYSTEMS CAN GREATLY REDUCE YOUR OPERATING COSTS

Hammarlund equipment centralizes control, ups man-hour output!

A careful review of operations within your plant may disclose the fact that a variety of functions are inefficiently handled manually . . . turning "off" and "on" valves, switches, or operating other controls at remote points. Perhaps the persons performing these functions do so only after receiving telephoned orders from a central dispatch point, and otherwise have little else to do.

Shift these men to more worthwhile activities. Their former duties can be handled direct from the central control point by use of highly-reliable Hammarlund remote control equipment. This all-electronic system requires only one telephone circuit (or microwave or radio circuit) to each remote point for complete control and metering of all your required operations.

Proven Performance

Refineries, pipelines, utilities, railroads and other industrial organizations who have need for centralized control of their wide-spread operations are finding that Hammarlund has a remote control system to fulfill their needs. These systems are now in operation by many progressing industries — a listing is available on request.

Two basic factors, carefully pre-determined for the equipment, were flexibility and versatility. Because it is designed on the building-block principle, using standard service-proven sections in the most efficient combinations, great flexibility has been achieved. For all practical purposes, each customer gets a custom engineered installation at a standard system cost.

Fill out and send the coupon below, or write immediately for detailed information on how you can cut your operating costs by using Hammarlund Remote Control and Signaling Equipment. If you send a brief description of your requirements, Hammarlund engineers will analyze them and suggest the most efficient system. No obligation, of course.

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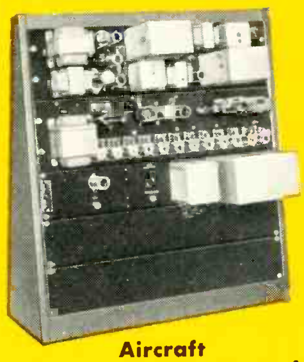
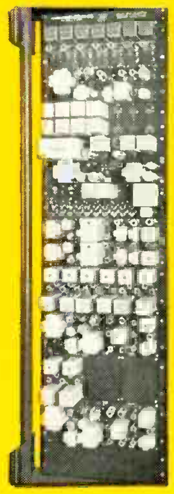


Aircraft Communications Control



Multi-Gate® Industrial Control

Duplex Signaling Unit

Alarm System

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quarter of last year.

A number of factors are seen as being responsible for the increases. Chief among them is the expiration of the excess profits tax at the end of 1953 which imposed taxes at the rate of 82 percent on income defined as "excess". Now corporate income is taxed at a rate of 52 percent.

Following are the profit reports of 19 companies in the electronics field. The notation 6m refers to first quarter and last quarter figures for the past years indicated. Companies reporting annual profits for 1953 compared to 1952 are listed separately.

Company	1954	1953
Air Associates 6m	$184,452	*$202,000
Burroughs 3m	2,315,995	2,525,081
Clevite 3m	941,115	932,785
GE 3m	48,029,000	33,849,000
W. L. Maxson 6m	659,412	412,960
RCA 3m	10,066,000	9,293,000
Servomechanisms 3m	180,137	......
Stewart Warner 3m.	801,469	1,076,344
Stromberg Carlson 3m	571,553	......
Sylvania 3m	2,121,487	2,773,243
Webster Chicago 3m	205,945	184,773
Zenith 3m	827,521	2,109,461

Company	1953	1952
Consolidated Eng.	$510,406	$501,511
Electronic Eng.	28,400	19,100
Radio Condenser	382,002	525,916
Servomechanisms	305,089	......
Standard Coil	2,972,481	2,861,290
Telecomputing	43,622	......
Trav-ler	412,000	291,000

* Loss.

▶ **Filings**—Electronic Associates of Long Branch, N. J., filed with SEC covering 7,500 shares of common stock (par $1) to be offered by subscription to stockholders of record in May at $18.50 per share on the basis of one new share for each 15 shares held. Proceeds are to be added to working capital.

I-T-E Circuit Breaker offered 100,000 shares of preferred stock, $50 par. Proceeds are to be added to general funds and will be available for general corporate purposes to reduce bank loans.

Wired Radio Extends A-M Broadcasting

Of 2,600 a-m radio stations in the United States, 800 operate during daylight hours only and of these, some 530 serve communities without other strong signals. Reason for closing at sundown is that sky-wave signals after dark reach out to great distances and would cause bad interference. There just aren't enough a-m frequencies to allow full-time operation for all.

▶ **Money Gimmick** — Since the night-time hours are the favored moments that bring in fattest revenue, day-only operators (who have organized into Daytime Broadcasters Association) have long hankered for a means of getting in on the bigger money. They now have a trick to do the job.

Curt Plummer, head of the FCC Broadcast Bureau, has held discussion with the association on connecting the transmitters to local power lines and feeding programs into receivers. While neither for nor against the scheme, the Commission is willing to let the broadcasters experiment for a year or so under controlled conditions, provided their signals don't escape from the wires.

▶ **Cleveland Project**—The idea is not new, having been tried abroad in Italy and elsewhere. It is also used, in modified form, by many a college campus system. Twenty-five years ago, it was tried in Cleveland by Wired Radio, Inc., but failed to pay because of its economic aspects. At that time, the plan was for the power company to furnish programs over its own lines, but the cost of suitable receivers proved too high.

Phonograph Makers Size Up 1954

Business was up last year compared to 1952 and is expected to remain there

According to most phonograph producers, sales in 1953 were up from 10 to 20 percent over 1952 totals.

Bureau of Census figures for 1953 place total turntable shipments of

(Continued on page 26)

Tubes Sell Tyrannosaurus

Using 125 high-gain audio amplifiers as portable receiving units, an audio-frequency broadcasting system, installed at the American Museum of Natural History in New York, gives visitors a conducted tour of exhibits. Record players feed descriptive talks to loops around five exhibition halls. An inductor in the input of the amplifier unit carried by the visitor picks up the a-f signal from the loops. Reaction of public will determine whether the system, installed by the Electro-sonic Corp., will be expanded to other sections of the museum

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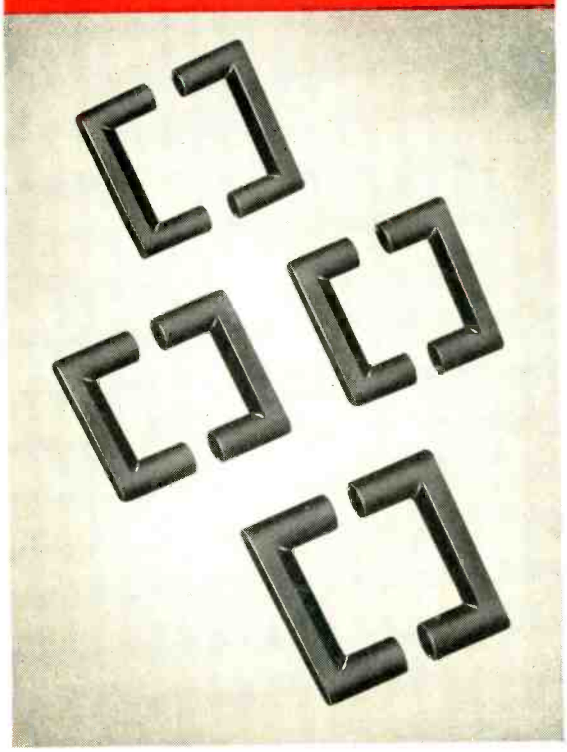
LINE OF SLOTTED ROUND LEG TV FLYBACK TRANSFORMER CORES

—drastically reduce TV power supply costs!



and here's why—

- CORES ARE LOWER PRICED
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General Ceramics research and engineering is geared to pace the industry with advanced designs, perfected to the highest possible degree, produced at absolute minimum cost. Introduction by General Ceramics of round leg transformer cores brings these objectives into sharp focus. Thoroughly engineered, field tested and proven, they have earned the immediate acceptance of leading TV manufacturers. Case histories prove the new cores make better TV flyback power supply units possible at substantially reduced cost. Why not request the facts today?

THESE STANDARD CORES ARE NOT JUST "PARTS"—EACH IS PRECISELY ENGINEERED FOR HIGH EFFICIENCY IN THE FOLLOWING APPLICATIONS:

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F465	17" ECONOMY MODELS
F492	21" ECONOMY MODELS
F410	21" THRU 27" MODELS
F456	COLOR SETS

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▶ **Breakdown**—Key to models involved is the Census breakdown of total shipments in 1953. Largest shipments were made of record player units. Over 1.6 million were produced. Accenting the hi-fi trend, 1.0 million of these units were for installation in combination and custom built sets. The remaining 625,000 were plug-in types complete with case for playing through radio and tv sets.

Radio-phonograph-tv combination models represented the smallest market for phonographs in 1953 when only 222,000 were shipped by the industry.

The mechanical or accoustical phonograph with spring or electric motors, was second largest in shipments in 1953 with 709,000 units.

Electronic phonographs, or those with tube amplifiers were the fourth largest shipments in 1953. Coin-operated juke boxes accounted for 61,000 of the total.

▶ **Future**—Phonograph manufacturers have felt the effect of the buyers market since last fall like most other manufacturers. As a result, price has been a factor not only for the end-product manufacturer but for component makers as well. The industry, as a result, has pressed for lower priced and improved components for its products. To meet this demand, GE recently conducted a survey to see if better tubes could not be designed and built for phonograph manufacturers at a price to meet their requirements. They found that specific tubes for phonographs would be out of step pricewise, at least for the present.

Credit

EXPLANATION and description of the cover photograph of the May 1954 issue of ELECTRONICS omitted mention of the Philco Corp., whose engineers developed the jet-etching technique for surface-barrier transistors and in whose laboratories the photograph was taken.

MEETINGS

JUNE 13–18: ASTM 57th Annual Meeting, Hotels Sherman and Morrison, Chicago, Ill.

JUNE 16–18: High Vacuum Symposium, Committee on Vacuum Techniques, Berkeley Carteret Hotel, Asbury Park, N. J.

JUNE 21–25: Summer and Pacific General Meeting, AIEE, Hotel Biltmore, Los Angeles.

JUNE 23–25: First Symposium on Global Communications, IRE, Washington, D. C.

JUNE 29–JULY 3: International Conference on Semiconductors, Netherlands Physical Society and UNESCO, Amsterdam, Netherlands.

JULY 6–9, 1954: International Conference on Electron Microscopy, Joint Commission on Electron Microscopy of International Council of Scientific Unions, London, England.

JULY 8–12: British IRE 1954 Convention, Christ Church, Oxford, England.

AUG. 24–SEPT. 4: National Radio Show of Great Britain, Earls Court, London, England.

AUG. 25–27: 1954 Western Electronic Show & Convention, Los Angeles, Calif.

SEPT. 1–16: Golden Jubilee Meeting of the International Electrotechnical Commission, University of Pennsylvania, Philadelphia, Pa.

SEPT. 13–24: 1954: First International Instrument Congress And Exposition, Commercial Museum and Convention Hall, Philadelphia, Pa.

SEPT. 16–18: Joint Electron Tube Engineering Council, General Conference, Chalfonte-Haddon Hall, Atlantic City, N. J.

SEPT. 1954: International Scientific Radio Union, Amsterdam, Netherlands.

SEPT. 30–OCT. 2, 1954: Second Annual International Sight and Sound Exposition, Palmer House Hotel, Chicago, Ill.

OCT. 4–6: National Electronics Conference, Hotel Sherman, Chicago.

OCT. 6–7: First Annual National Conference, IRE Professional Group on Nuclear Science, Sherman Hotel, Chicago, Ill.

OCT. 14–17: Sixth Annual Convention of the Audio Engineering Society, Audio Fair, Hotel New Yorker, New York.

OCT. 18–20: Radio Fall Meeting, Hotel Syracuse, Syracuse, N. Y.

NOV. 4–5: East Coast Conference on Airborne and Navigational Electronics, IRE, Sheraton-Belvedere Hotel, Baltimore, Md.

NOV. 10–11: Conference on Electronic Instrumentation and Nucleonics in Medicine, Morrison Hotel, Chicago, Ill.

NOV. 12–13: National Symposium on Quality Control Methods In Electronics, IRE and American Society for Quality Control, Hotel Statler, New York, N. Y.

NOV. 18–19: Sixth Annual Electronics Conference, Kansas City IRE, Hotel President, Kansas City, Mo.

Industry Shorts

▶ **Automobile** clubs have been assigned exclusive use of 452.55 and 457.55 mc and public garages 35.70 and 35.98 mc for mobile radio operation. In localities where both 450-mc frequencies have been assigned, clubs can be assigned the 35-mc channels.

▶ **Production** of radio and tv receivers in Germany reached 205,884 in January and 214,393 in February compared to a 1953 monthly average of 203,004.

▶ **Manufacturers'** cost for materials (glass envelope, screen and mask, electron gun) is estimated to be approximately $72 for the new 19-in. Du Mont color picture tube.

▶ **Educational** tv station will be established in Puerto Rico by the Department of Education with an appropriation of $600,000.

▶ **NIKE** missile and control systems have more than 1.5 million individual parts produced by several hundred contractors in more than 20 States.

▶ **Raydist** crews flew 30,000 miles to electronically survey the test range for Pacific bomb tests.

▶ **Television** sets in operation in Puerto Rico total over 8,000 and are expected to increase to over 50,000 by the end of 1954.

▶ **Radar** fire control systems produced by Hughes since 1945 total over 5,000.

STANDARD *flexlab* TEST PANELS & BENCHES

Current transformer test bench in the meter laboratory . . . one of the installations by Standard at Commonwealth Edison Co., Chicago, Ill.

. . . at COMMONWEALTH EDISON

Test benches and control and distribution panels.

Rotating and indicating standards test benches with test lead storage cabinets at each end.

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Test table with Wheatstone Bridge and Potentiometer.

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TAPE WOUND CORES

Are you ready for a revolutionary concept in the electrical and electronic industry—the Magnetics, Inc. "Performance-Guarantee" on Tape Wound Cores. Guaranteed to meet your specifications, *and sold at standard prices*; these Cores mean truly economical production of high permeability magnetic devices in your plant.

TABLE A

BASIC PHYSICAL CONSTANTS OF COMMON MAGNETIC MATERIALS

Trade Name	% Ni	% Fe	Other	Grain Structure	Satur. Flux Density Gausses	Resistivity Microhm-Cm	Curie Point °C	Dens. Grams per cc
Hy Mu 80	79	17	4 Mo	"random"	8,700	57	420	8.72
48 Alloy	48	52	....	"random"	16,000	45	500	8.3
Orthonol	50	50	....	oriented	15,500	45	500	8.25
Magnesil	..	97	3 Si	oriented	20,000	48	700	7.65

TABLE B

TRADE NAMES OF SIMILAR MATERIALS

Hy-Mu 80	48 Alloy	Orthonol	Magnesil
4-79 Permalloy	Carpenter 49	Orthonik	Armco Oriented T
Mo-Permalloy	Allegheny 4750	Permeron	Hypersil
Mu Metal*	Hypernik	Deltamax	Orthosil
		Hypernik V	Silectron

Typical of the unusual scope of the material contained in Catalog TWC-100 are Tables A and B, reproduced from Page 4 of "Performance-Guaranteed Tape Wound Cores."

GET THE COMPLETE STORY

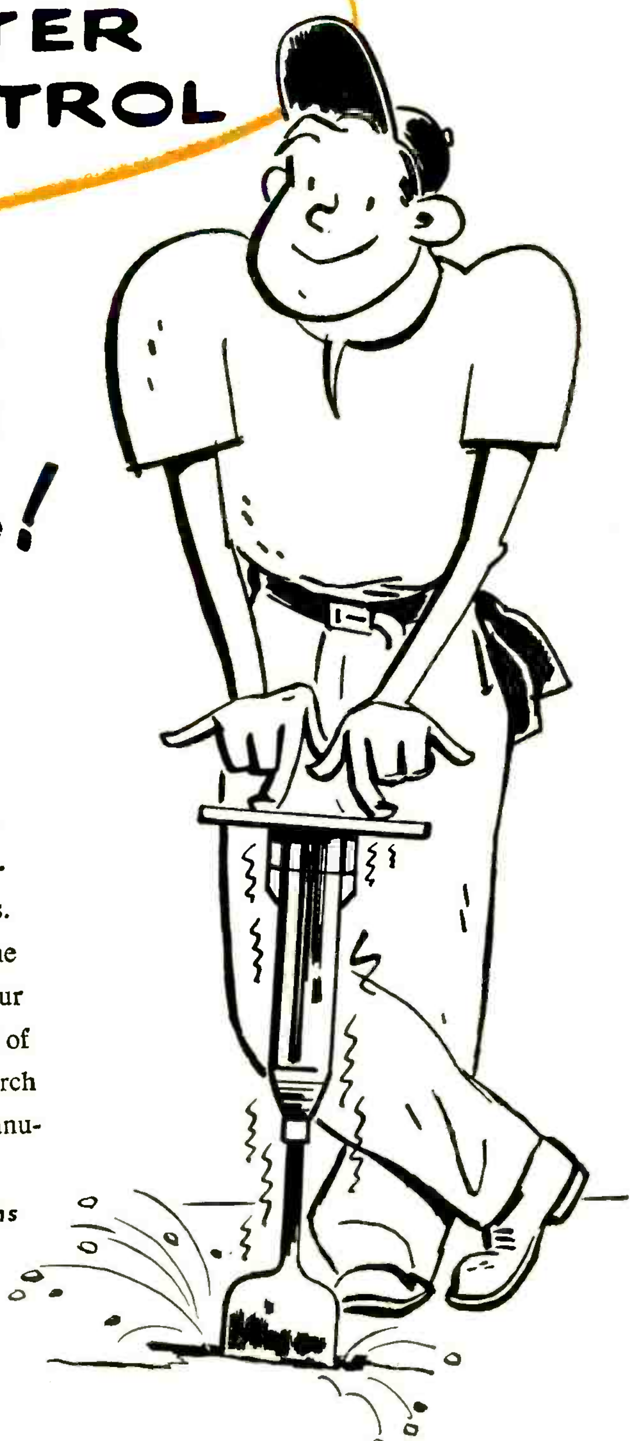
A wealth of new and unusual material on Tape Wound Cores is available to you in Catalog TWC-100, "Performance-Guaranteed Tape Wound Cores." Tables A and B of the catalog, reproduced on this page, present a striking illustration of material not to be found compiled together elsewhere.

Data and descriptive details on high permeability materials . . . factory core matching . . . free engineering design services . . . pages of characteristic graphs and tables . . . are yours for the asking. Simply write on your company letterhead.

MAGNETICS inc.

DEPT. E-7, BUTLER, PENNSYLVANIA

JUST A MATTER OF CONTROL



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. . . *anywhere!*

The difference between a good product and a better one is often just A Matter Of Control—control of vibration and shock which may be damaging your product. Pioneers in solving vibration problems for many industries, Lord Manufacturing Company is well qualified to assure you of better performance from your products through the use of Lord Vibration Control Mountings and Bonded-Rubber Parts. Our Engineers will be pleased to help you in the analysis of the vibration which may damage your product and in the selection of the correct method of control. Lord Engineering means Materials Research—Engineering Research—Product Design—Manufacturing Know-How for your application.

Over 27,000 designs and their variations from which to choose.

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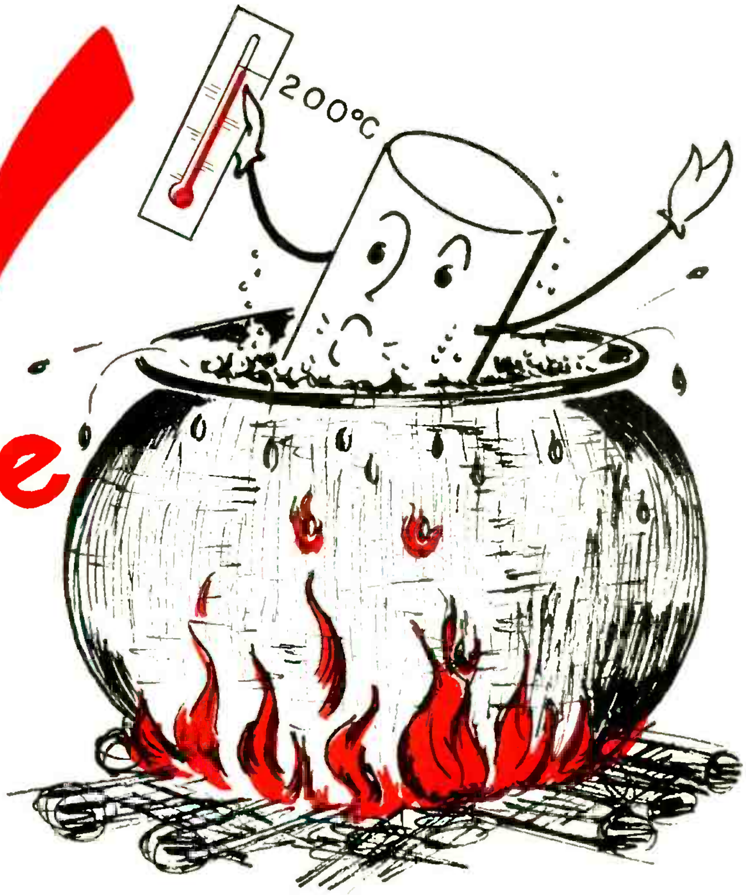

Airpax

proudly announces . . .

MODEL A-100

400 cycle 6 volt Chopper

• • • for continuous operation in a 200° c ambient

This remarkable Class H adaptation of our standard chopper is at no sacrifice to Airpax quality. In fact operating frequency range is enlarged to 360 to 440 cycles. Drive is 6.3 VAC, 1 watt. Residual noise less than 3 mv. peak to peak at one megohm. Phase lag is 65° between drive voltage and square wave output. Covers the full range of +200°C to −65°C. Will withstand 10g vibration. Contacts SPDT, rated 100 V, 2 ma., max.

DESIGNERS AIRPAX PRODUCTS COMPANY ENGINEERS

MIDDLE RIVER BALTIMORE 20, MD.

PRE-FLIGHT PRECAUTIONS

with GOODMANS PERMANENT MAGNET SHAKERS

The flight characteristics of a newly designed aeroplane are the subject of lengthy calculations before the first prototype is built. Whilst the mathematical calculations are themselves accurate, they are based, as in all design work, on several assumptions which have to be verified by a series of pre-flight tests.

One of these essential investigations is the Ground Resonance test, the purpose of which is to determine the various complex modes of vibration of the airframe structure. The frequency of the mode and the dynamic response at remote parts of the aircraft must be accurately determined. The information obtained together with the aerodynamic derivatives is used in predicting the critical 'flutter' speed of the aircraft. The illustration shows one of the two Goodmans Model 8/600 Shakers which were used to excite the Handley Page 'Victor' for this very important test.

For wide frequency range vibration testing and dynamic response investigations, Goodmans Shakers are an obvious choice. These units require no field excitation and provide a faithful reproduction of the input wave form. Industrial applications of controlled vibration are continually increasing; maybe it can serve you—in which case our unique experience is at your service.

Just another of the wide applications of Goodmans Shakers

The range includes models from the 8/600 shown, developing a force of ±300 lb., to the midget model, with a force of ±2 lb., for optical cell research and hairspring torque testing, etc.

MAIL THIS COUPON

TO GOODMANS INDUSTRIES LIMITED
AXIOM WORKS, WEMBLEY, MIDDX., ENGLAND

Please mail me your catalogue and technical data sheets in connection with your PERMANENT MAGNET Shakers.

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Cables: GOODAXIOM WEMBLEY, MIDDX.

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. . . through Chemistry

ELECTRICAL ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

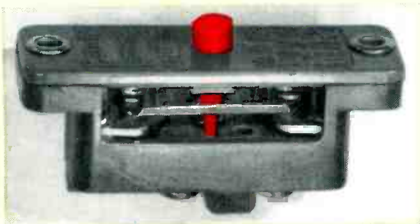
NO. 3 — 1954

Properties of Du Pont "Teflon" Make It Ideal Insulation for Electrical Equipment

Du Pont "Zytel" nylon gives improved switch performance

Snap switches for machine tools and basic contact mechanisms on industrial instruments often have buttons and stems molded of "Zytel" nylon. This engineering material is used to obtain more efficient production and better performance.

Du Pont "Zytel" is tough and resilient, and resists abrasion. It makes possible the maintenance of critical dimensions. This is particularly important in the manufacture of such parts as timing relays for resistance welding machines, which control the duration of current flow and electrode motion.



These switches feature one-piece buttons and stems of molded Du Pont "Zytel" nylon.

The lightness of weight and remarkable strength of "Zytel" in thin sections are important factors in such applications. Mass production by injection molding is economical. One molded part often replaces a complex assembly of many parts.

Perhaps "Zytel" nylon can help solve one of *your* design problems. For further information about this or any other Du Pont engineering resin material, clip and mail the coupon on the reverse side.

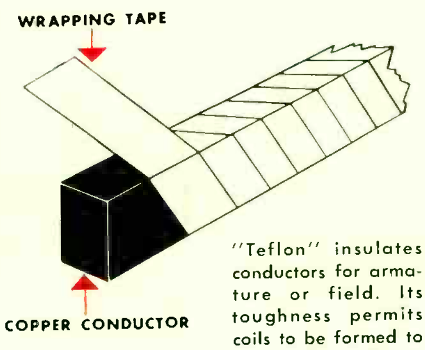
"Zytel" is the new trade-mark for Du Pont nylon resin.

Dielectric and thermal advantages of "Teflon" are unmatched by any other single material

Du Pont "Teflon" tetrafluoroethylene resin is used for insulation in power distribution equipment because of its unusual combination of properties. In tape form, as wire coating, or molded part, "Teflon" withstands hot-spot temperatures, to 500°F. It is not affected by weather or moisture (zero water absorption by ASTM test D570-42). "Teflon" has a power factor of less than .0005 for the tested range of 60 cycles to 10^8 cycles. A part molded of "Teflon", when exposed to an arc, leaves no carbonized path.

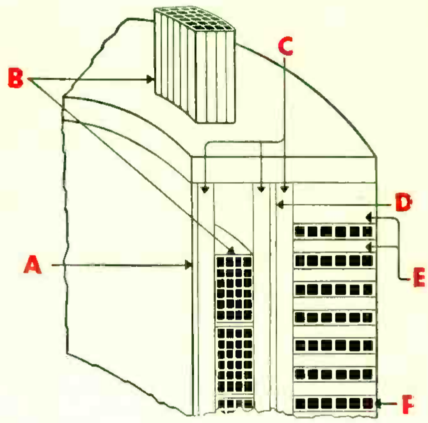
In addition, "Teflon" has high short-time dielectric strength—with values ranging from 1000 to 2000 volts per mil, depending on thickness. (Recommended working stresses: 50 to 100 volts per mil.) And it is inert to all chemicals normally found in industry.

"Teflon" is tough and flexible



"Teflon" insulates conductors for armature or field. Its toughness permits coils to be formed to shape *after* taping.

over a wide temperature range, from —450°F. to 500°F. "Teflon" can take a lot of abuse, both during assembly and in use. Parts will not crack if dropped. Cable insulation resists damage from vibration and bending. And tape of "Teflon" conforms easily to sharp corners and odd shapes.



Conductor and layer insulation of "Teflon" in power distribution coils: (A) core insulating barrier (laminate of "Teflon" and glass fiber); (B) low-voltage winding (glass fiber coated with "Teflon"); (C) axial spacers; (D) high-low insulating barrier (laminate of "Teflon" and glass fiber); (E) radial spacers; (F) high-voltage winding (glass fiber coated with "Teflon").

You will find "Teflon" performing with outstanding success . . . not only on power distribution equipment, but in these and other applications as well:

FOR MOTORS AND GENERATORS

The unusual advantages of "Teflon" become apparent when temperatures are too high or atmospheres are too corrosive for other dielectrics. Tape of "Teflon" is particularly suitable for armature or

(Continued, column 3, back side)

OVER

DU PONT

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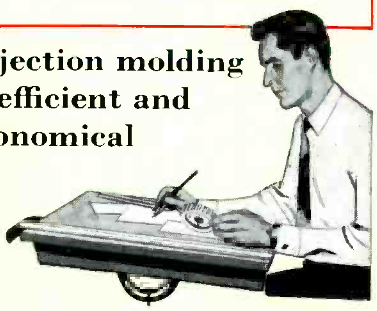
ELECTRICAL ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NO. 3 — 1954

POINTERS ON PROCESSING

Injection molding is efficient and economical



Injection molding, as a method of mass-producing parts made of Du Pont engineering resin materials, has been developed mainly within the past ten or fifteen years. And new improved techniques have accompanied that development.

Injection molding offers the advantages of high production rates, low unit cost, and usually does away with finishing operations. One important saving which has been effected by injection molding occurs when the molded piece replaces an assembly of two, three or more parts.

HIGH PRODUCTION RATE

Multi-cavity dies have been made which produce hundreds of identical pieces at a time. Molding time and cycle vary, of course, with the size of the part and its shape. The injection molding process is versatile, and is used to produce a wide variety of quality parts, rapidly and economically.

LOW UNIT COST

Another positive value of injection-molded parts is the low cost of fabrication per part. While the initial cost of the mold itself is high, a mass-production operation makes the cost per piece low. In addition, loss of molding material is generally low.

NO FINISHING OPERATIONS

With good molding techniques, pieces can be injection-molded to close tolerances. In many cases, molded pieces require no finishing operations. Thus, large savings in time and expense can often be realized.

SIMPLIFIED DESIGNS

The versatility of injection molding often permits design simplification. Du Pont "Zytel" nylon, for example, can be injection-molded into intricate shapes, as well as around metal inserts. Du Pont "Alathon" polyethylene resin and "Lucite" acrylic resin can also be successfully injection-molded into a variety of useful forms. For more information about Du Pont engineering resin materials and how they are being used in industry, clip the coupon.

Investigate Du Pont engineering materials in your product development programs

One of the family of these versatile engineering materials is often a key factor in product improvement or new product design.

The wide range of properties available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and "Zytel"* nylon resin are helping solve industrial design problems.

NEED MORE INFORMATION?

Clip the coupon for additional data on the properties and applications of these Du Pont engineering materials.

Du Pont "Teflon"

(continued from other side)

field conductor insulation, coil wrapping, slot lining, lead insulation, and coil separation.

FOR TRANSFORMERS

"Teflon" makes it possible for transformers to operate at hot-spot temperatures as high as 500°F. "Teflon" is used in transformers for conductor, layer, and ground insulation, and for coil separation. At the present time it is used commercially in electronic transformers and experimentally in distribution and power units.

FOR CAPACITORS

Where high ambient temperatures and minimum power loss are essential, "Teflon" gives outstanding service. It is used as the dielectric in many wrapped capacitors.

FOR ELECTRONICS EQUIPMENT

Under conditions of ultra-high frequencies, heavy moisture and concentrated heat, "Teflon" assures efficient operation. Here it takes the form of tape, molded component, or extruded insulation.

Can "Teflon" help you with your design problems? The properties discussed above show why no other single material can match it. And the coupon on the left will bring you whatever further information you need about "Teflon" or any of the other versatile engineering resin materials made by Du Pont.

E. I. DU PONT DE NEMOURS & CO. (INC.)
Polychemicals Department
Room 226, Du Pont Building, Wilmington 98, Delaware

Please send me more information on the Du Pont engineering materials checked: ☐ *"Zytel" nylon;* ☐ *"Alathon";* ☐ *"Teflon";* ☐ *"Lucite". I am interested in evaluating these materials for*

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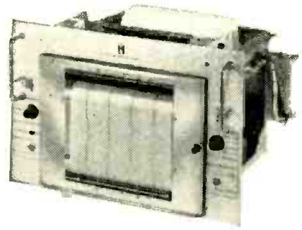
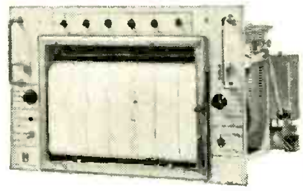
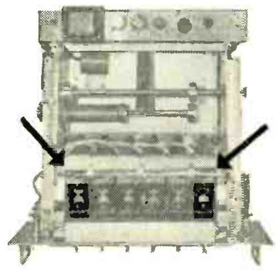


4 CHANNELS

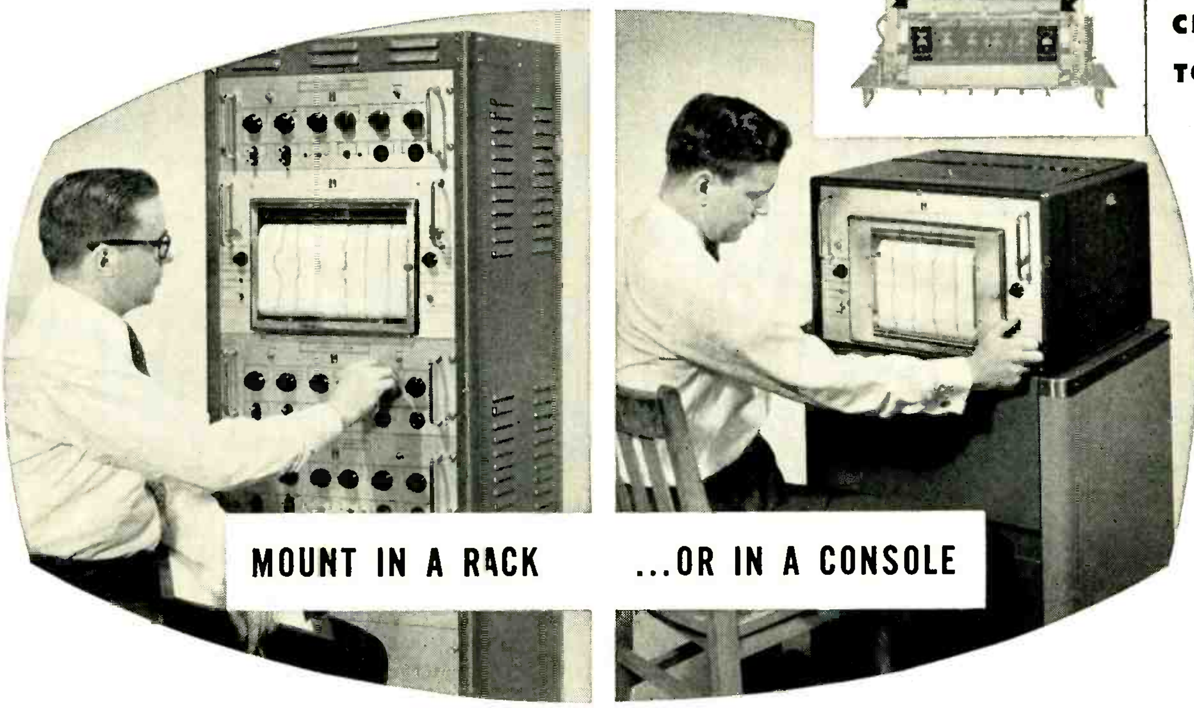


OR 6



OR EXPAND YOUR 4 CHANNELS TO 6

NEW
BRUSH OSCILLOGRAPHS



Standardized design of these new Brush multi-channel oscillographs permits greater flexibility in instrumentation. An identical chassis which can be installed in either a standard 19-inch rack or a console is used for both 4 and 6-channel units. The new electrically-controlled chart drive provides up to sixteen speeds for greater flexibility of speed and operation. The chart can be driven as slow as 1 cm/hour or as fast as 250 mm/sec.—the highest chart speed available on any standard oscillograph. The units can be equipped for local or remote control. Get all the facts—send the coupon today, or call your Brush representative. Brush Electronics Company, Cleveland 14, Ohio. In Canada: A. C. Wickman, Ltd., Toronto.

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formerly The Brush Development Co. Brush Electronics Company is an operating unit of Clevite Corporation.

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3405 Perkins Avenue, Cleveland 14, Ohio

Gentlemen:
☐ Please send bulletin on new oscillographs.
☐ Please have your representative call.

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Company ____________________

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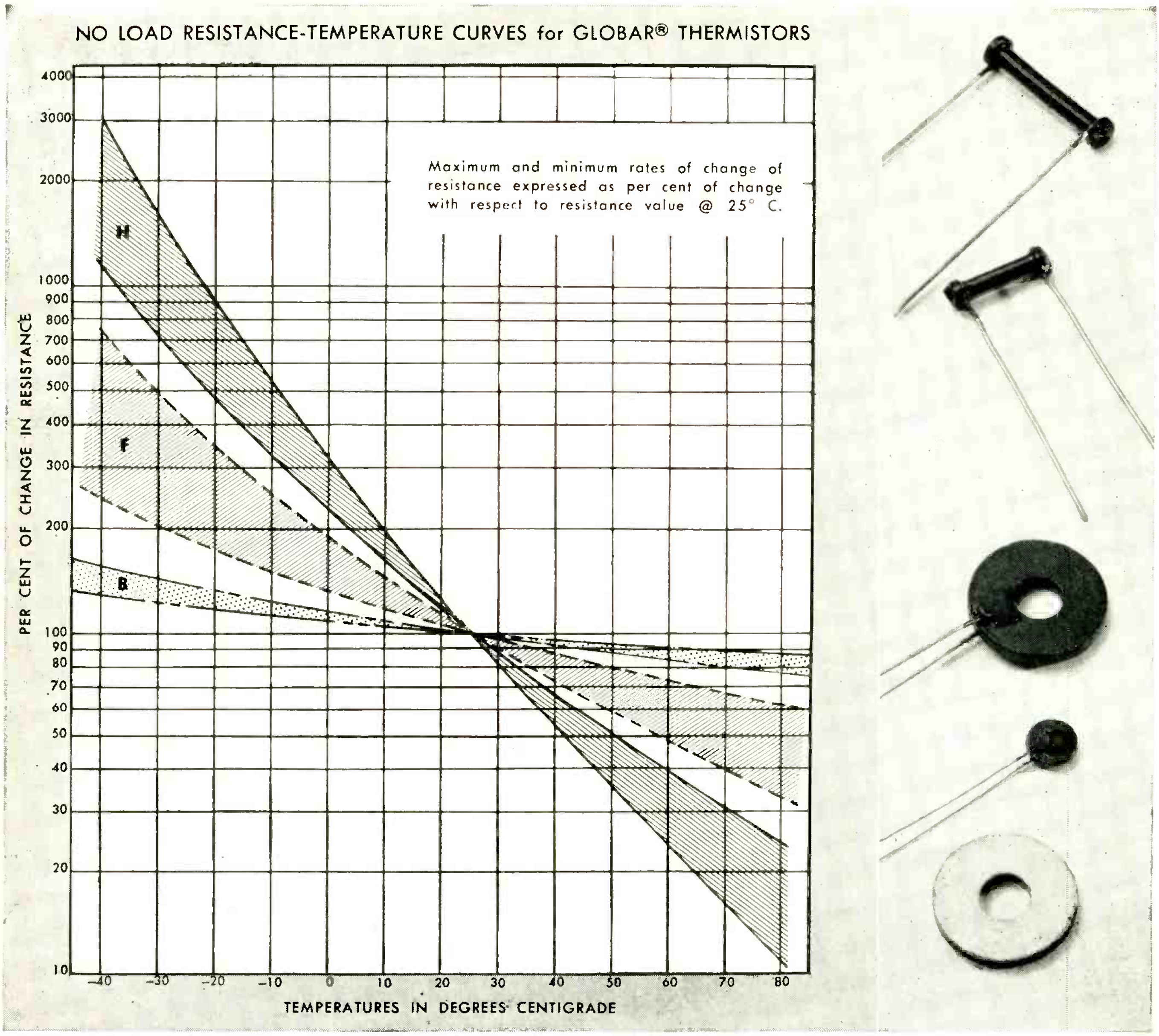


New GLOBAR® TYPE H THERMISTORS can help you solve many circuit problems

Where can *you* use resistors as sensitive to temperature changes as the new GLOBAR® Type H Thermistors shown on this chart? They offer many challenging possibilities in circuit design...can help you cut costs in the manufacture of radios, television sets, motors, relays, meters, temperature indicating devices, and many other products.

The introduction of the Type H Thermistor, which has a maximum negative temperature coefficient of 4.5%/°C at 25°C, supplementing the range previously obtainable with GLOBAR Types B and F, now provides you a working range from .33%/°C to 4.5%/°C at 25°C.

GLOBAR® Type H Thermistors are engineered to meet your exact requirements—in electrical properties as well as shapes and sizes.

TYPICAL APPLICATIONS for Type H Thermistors

- To provide time delays in relay, solenoid circuits.
- For temperature compensation in field coils.
- As protective resistors in series filament circuits of radio and television receivers.
- For temperature compensation in meters.
- To control remote temperature indicating devices.
- For temperature compensation in transistor circuitry.

WRITE FOR ENGINEERING BULLETIN ON THERMISTORS

Engineering Bulletin GR-3 gives detailed information on all three types of GLOBAR Thermistors—H, F and B. Write for your copy—and, if you have a circuit problem, send us the basic details. Our engineers will assist you, without obligation. Address: The Carborundum Company, Dept. E 87-47, Niagara Falls, N. Y.

GLOBAR® Ceramic Resistors

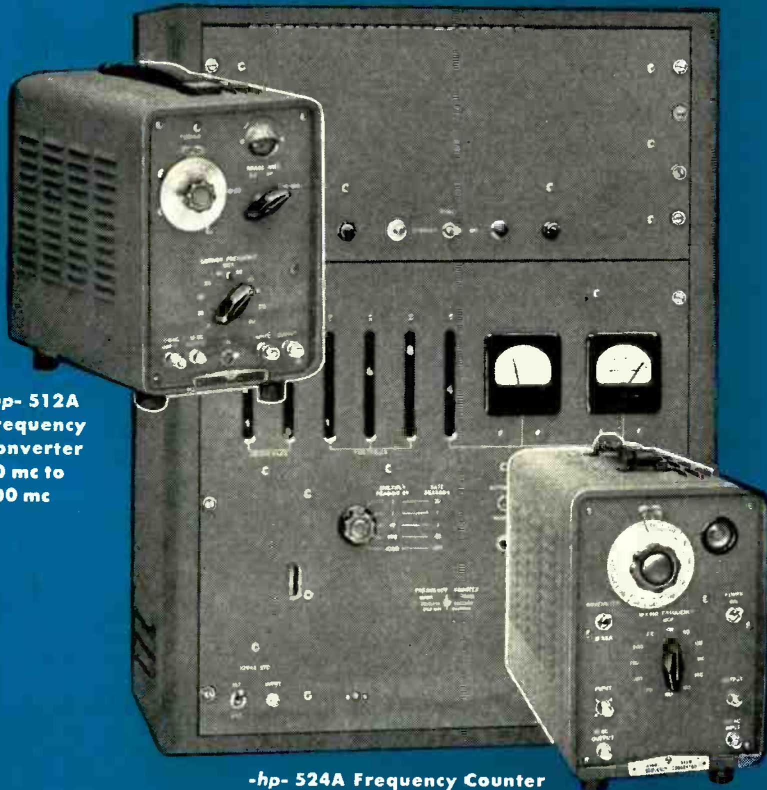
CONVENTIONAL • VOLTAGE SENSITIVE TEMPERATURE SENSITIVE

by CARBORUNDUM

REGISTERED TRADE MARK

87-47

New converters extend range of -*hp*- 524A Frequency Counter to 220 mc!



-*hp*- 512A Frequency Converter 10 mc to 100 mc

-*hp*- 512B Frequency Converter 100 mc to 220 mc

-*hp*- 524A Frequency Counter

- **Direct readings 10 cps to 220 mc**
- **Increases sensitivity**
- **No loss in accuracy**
- **Instant, automatic measurement**
- **Easily used by non-technical personnel**
- **Low cost; eliminates complex setups**

Now Hewlett-Packard offers two compact, economical Frequency Converters that greatly extend the range and usefulness of your -*hp*- 524A Frequency Counter—and MATERIALLY INCREASE SENSITIVITY WITHOUT LOSS IN ACCURACY.

The two Converters, -*hp*- 512A and 512B, increase Counter range from 10 to 100 mc and 100 to 220 mc, respectively. In combination with the Counter, they determine frequencies from 10 cps to 220 mc automatically, instantly, and in direct-reading form without interpolation or calculation. Complex setups and other equipment such as harmonic amplifiers, audio oscillators, multi-vibrators, search wave meters, transfer oscillators and oscilloscopes are completely eliminated. The -*hp*- Counter-Converter combination is readily used by non-technical personnel since operation consists merely of tuning the Converter to the unknown and selecting the measurement range.

Among the many measurements the Counter-Converter combination makes quickly and easily are crystal checking, oscillator calibration and stability, and broadcast FM and TV transmitter frequency. In addition, -*hp*- 524A Frequency Counter measures period of low-frequency phenomena by measuring the duration of a complete cycle in microseconds.

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

BRIEF SPECIFICATIONS

-*hp*- 512A Frequency Converter

Frequency Range: As Amplifier, 100 kc to 10 mc. As Converter, 10 mc to 100 mc.

Input Voltages: 100 kc to 10 mc, 0.1 v R.M.S. minimum; 10 mc to 100 mc, 0.01 R.M.S. minimum (on 50 ohm cable).

Standard Mixing Frequency: Multiplied from 100 kc output of 524A. (Accuracy 1/1,000,000 short term.)

Output Voltage: 2 v minimum (sufficient to operate -*hp*- 524A over entire range).

Connectors: Standard BNC type.

Power Source: 115/230 v, 50/60 cps, 60 watts.

Size: 7" x 10¾" x 14" deep. Weight 20 lbs. Rack mount available.

Accessories Furnished: Cables to interconnect with -*hp*- 524A.

Price: $350.00.

-*hp*- 512B Frequency Converter

Same as above except Frequency Range as Converter, 100 mc to 220 mc; and Input Voltage, 0.25 v R.M.S. minimum.

WRITE TODAY FOR COMPLETE DETAILS

HEWLETT-PACKARD COMPANY

Dept. A, 3032A Page Mill Road, Palo Alto, California, U.S.A.

Field representatives in all principal areas

INSTRUMENTS ***Complete Coverage***

Technology Instrument Corp., has pioneered in the development of PHASE MEASURING and STANDARDIZING EQUIPMENT and will continue its contributions in this critical and important field.

- for Measurement
- for Comparison
- for Calibration

These instruments have been designed for sustained, consistent performance. They are as simple and rapid in operation as possible. Full details are available upon request.

TYPE 320-AB PHASE METER

Phase Range: 0-360° without ambiguity
Frequency Range: 20 cycles to 100,000 cycles
Absolute Accuracy: 1% of full scale +3°
Incremental Accuracy: As close as meter scale can be read.
Meter Scales: 0-36°. 0-90°. 0-180°, 0-360°

TYPE 322-A PRECISION PHASE METER

Phase Range: 0-360° without ambiguity
Frequency Range: 20 cycles to 1 Mc
Absolute Accuracy: ±1° up to 20,000 cycles, slightly decreasing accuracy 20,000 cycles to 1 Mc.
Incremental Accuracy: ±0.1° up to 20 Kc.
Meter Scales: 0-360°. 0-30° (any 30° segment 0-360°)

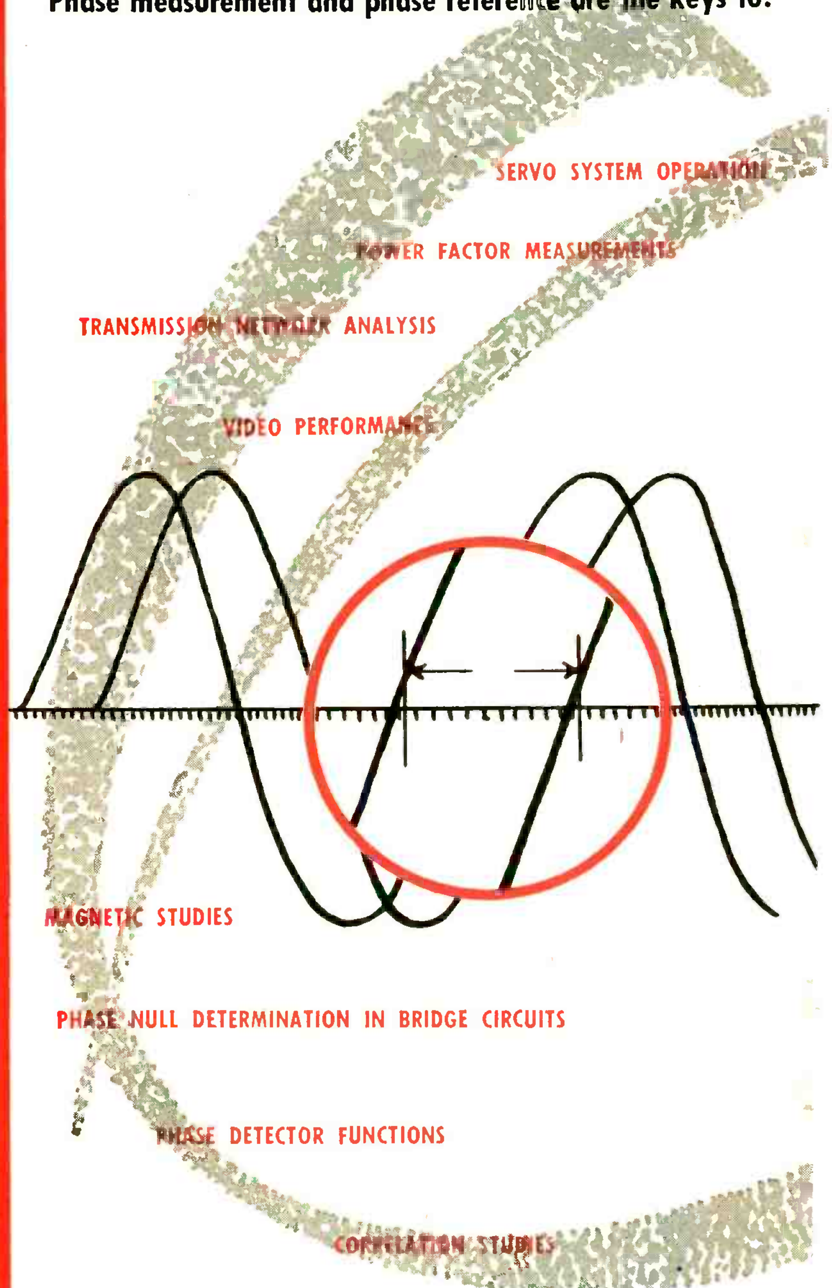
TYPE 324-A VIDEO PHASE METER

Phase Range: 0-360° without ambiguity
Frequency Range: 20,000 cycles to 4.5 Mc.
Absolute Accuracy: +4° over entire range
Incremental Accuracy: ±0.25 over entire range
Meter Scales: 0-360°. 0-90° (any 90° segment 0-360°)

AMPLIFIERS

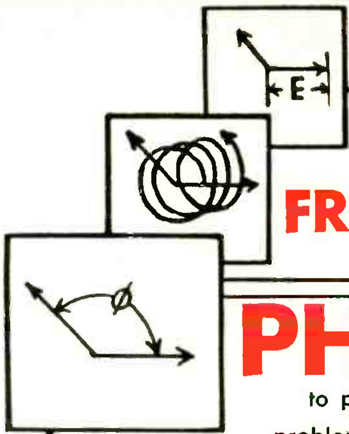
As adjuncts to the phase measuring and generating instruments described on these pages, an extensive line of amplifiers is available. These amplifiers have inherently low phase shift which is definitely known and which may be controlled to an accurately fixed value.

Phase measurement and phase reference are the keys to:



TECHNOLOGY

533 Main St., Acton, Mass. COlonial 3-7711



AMPLITUDE

FREQUENCY

For many years the industry has been well supplied with fine tools from many sources, for the measurement and control of amplitude and frequency. Well trodden paths of experimental procedure, based upon accurate instrumentation, have built up a tremendous body of know-how and familiarity with problems in this area of development.

PHASE

It has remained for Technology Instrument Corp., to provide superb tools designed exclusively for attack on less familiar problems in the field of PHASE MEASUREMENT. The advance in electronics technology has, more and more, exploited PHASE relationships and control. Familiarity and understanding of this field, together with techniques based upon *measurement* devices of *greater accuracy*, make available a Third Dimension in electronic mastery.

DATA TRANSMISSION SYSTEMS

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PRECISE ELECTRICAL CONTROL

INVESTIGATION OF FEEDBACK SYSTEMS

TYPE 704-A SECONDARY PHASE STANDARD
Range of Generated Phase Shift: 0-360° variable
Available for any one of the following standard frequencies: 60, 400, 1000, 20,000 cycles or
Available for any one specific frequency between 60 and 20,000 cycles
Absolute Accuracy of Phase Shift: Within 2°
Incremental Accuracy of Phase Shift Within 0.1°

TYPE 706-A ULTRASONIC PHASE STANDARD
Range of Generated Phase Shift: 0-360°, variable
Available in Standard Model for 82 Kc. or
Available in Special Models for any single frequency between 20,000 cycles and 200 kilocycles
Accuracy of Phase Shift: Within 0.1°

CONSULTATION ON PHASE PROBLEMS:
Technology Instrument Corp., as the leader in phase measurement techniques, will welcome the opportunity to assist in any problem in this field. A hand-picked engineering staff is ready at any time to consult with you on your phase problems. This staff has available the finest phase laboratory to be found and its services may be sought for any problem, large or small.

TYPE 7000-A PRIMARY PHASE STANDARD
Range of Generated Phase Shift: 0-360°, variable
Available for any single frequency between 60 cycles and 20,000 cycles
Absolute Accuracy of Phase Shift: At least 0.05°
multiples of 1° established to at least 0.02°

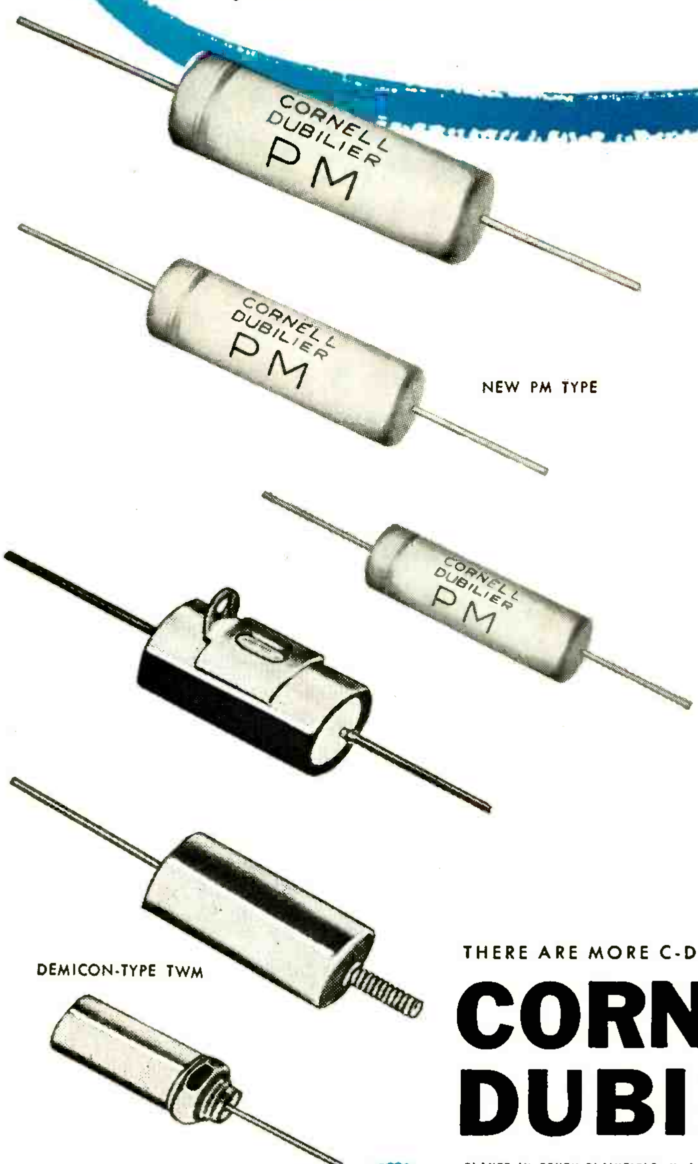
INSTRUMENT CORP.

West Coast Eng'r'g. Facility, 731 No. LaBrea Ave., Hollywood, Calif., WHitney 0108

THE GREATEST HIGH-TEMPERATURE CAPACITORS EVER DEVELOPED!

Consistently Dependable Cornell-Dubilier

molded and metal-case Mylar tubulars*



NEW PM TYPE

DEMICON-TYPE TWM

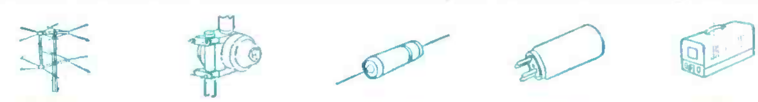
No voltage derating required from —55° C to +130° C!

Here are the greatest high-temperature capacitors ever developed—the product of Cornell-Dubilier's manufacturing know-how combined with DuPont's great new Mylar* Polyester film dielectric. Designed in the new Demicon-type *metal-cased* tubular and in the new PM series *molded* tubular styles. This new development results in a capacitor that remains exceptionally stable at temperatures up to 160° C. with no voltage derating required to 130° C. Within these temperature ranges, there is sure to be a capacitor to meet your exact needs. So why not send for individual operating characteristics data—today. Engineering samples sent on request. For your special design and application problems, use our Technical Advisory Service. No obligation, of course. Write to: *Industrial Division, Cornell-Dubilier Electric Corp., Dept. K-64 South Plainfield, New Jersey.*

THERE ARE MORE C-D CAPACITORS IN USE TODAY THAN ANY OTHER MAKE

CORNELL DUBILIER *Capacitors*

PLANTS IN SOUTH PLAINFIELD, N. J.; NEW BEDFORD, WORCESTER AND CAMBRIDGE, MASS.; PROVIDENCE AND HOPE VALLEY, R. I. INDIANAPOLIS, IND.; FUQUAY SPRINGS AND SANFORD, N. C.; AND SUBSIDIARY, THE RADIART CORPORATION, CLEVELAND, OHIO



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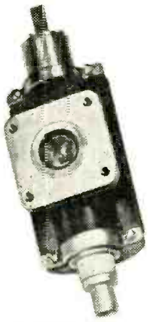
* DUPONT TRADE MARK

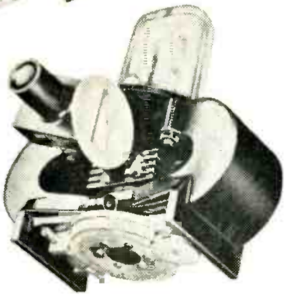
RAYTHEON MAGNETRONS AND KLYSTRONS MEET EVERY FREQUENCY AND POWER NEED

Two of these tubes just declassified

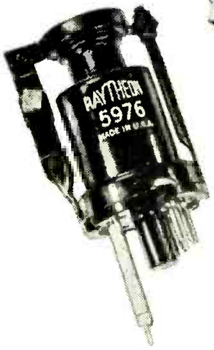


RK6230/QK299B — tunable pulse magnetron (8900-9400 Mc), 1 Kw average peak power

RK6410/QK338 — fixed frequency, pulse magnetron (2750-2860 Mc), 5 megawatt average peak power



RK2J51 — tunable pulse magnetron (8500-9600 Mc), 50 Kw average peak power

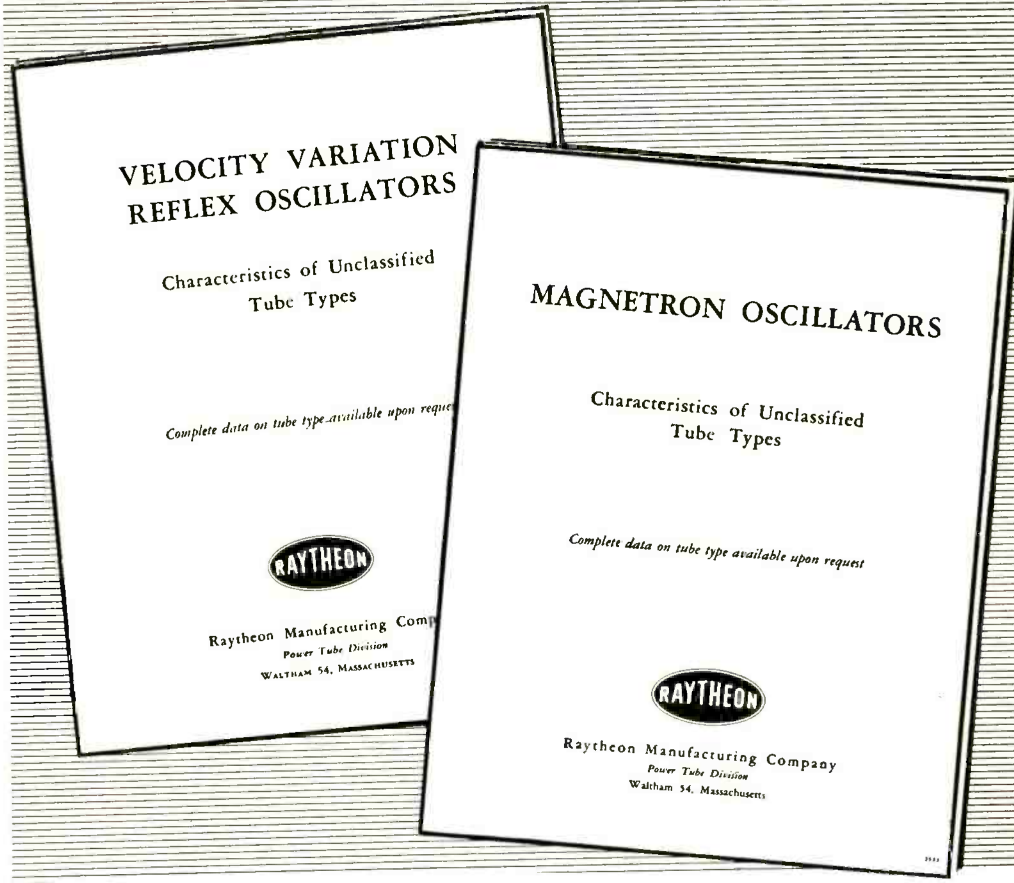


RK5976—mechanically tunable klystron (6250-7425 Mc), average power 100 milliwatts

RK6116 — thermally tuned ruggedized klystron (8500-9660 Mc), average power 25 milliwatts

RK5721—klystron tunable with external cavities from 3600 to 10,500 Mc. Average power 125 milliwatts in the 2¾ reflector mode (4290-8340 Mc)

Raytheon also manufactures transmitting tubes, storage tubes and square law tubes



Now Available —

CONSOLIDATED DATA BOOKLETS FOR RAYTHEON MAGNETRONS & KLYSTRONS

WRITE FOR YOUR COPIES TODAY

These valuable data booklets, which we will be glad to send you, list most principal unclassified types now manufactured — give maximum ratings, typical operating values, frequency ranges. Indispensable to every microwave engineer's file.

Raytheon is the world's largest producer of CW and pulse magnetrons, many tunable mechanically or electrically. A compact, efficient source of power, magnetrons are being used in an ever increasing number of applications.

Raytheon klystrons, which can be tuned mechanically or thermally, fit the widest range of requirements with tubes available from 550 to 60,000 Mc.

Please feel free to call on us for Application Engineering Service on your microwave problems. There is no cost or obligation.

WRITE TODAY for your data booklets. Please address Raytheon Manufacturing Co., Power Tube Sales — Section PL-02, Waltham 54, Mass., or telephone Waltham 5-5860, Ext. 2443.

RAYTHEON

Raytheon Manufacturing Company, Power Tube Division, Waltham 54, Mass.

RESISTORS...FOR EVERY NEED

Meets JAN-R-94 type RV3

1/2 watt 1-1/8″ diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94.

Meets JAN-R-94 type RV2

1/4 watt 15/16″ diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94.

Meets JAN-R-19 types RA25 and RA30

4 watt 1-17/32″ diameter variable wirewound resistor. Also available with other special military features not covered by JAN-R-19.

Meets JAN-R-19 type RA20

2 watt 1-17/64″ diameter variable wirewound resistor. Also available with other special military features not covered by JAN-R-19.

TYPE 35

TYPE 45

TYPE 25

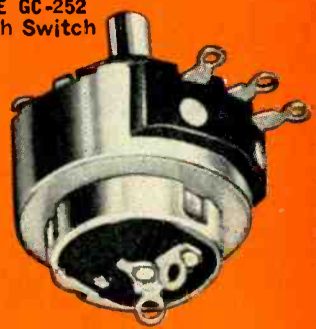
TYPE 252

TYPE GC-35
With Switch

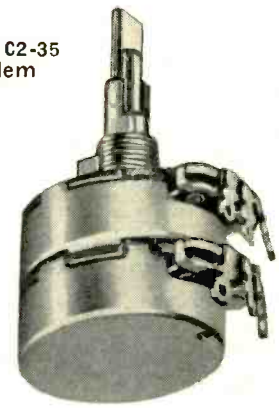
TYPE GC-45
With Switch

TYPE GC-25
With Switch

TYPE GC-252
With Switch



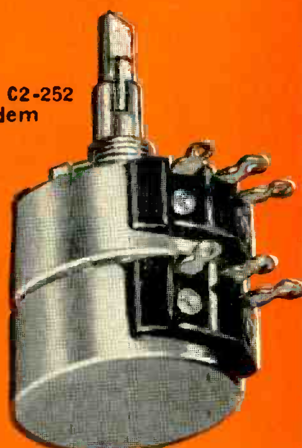
TYPE C2-35
Tandem

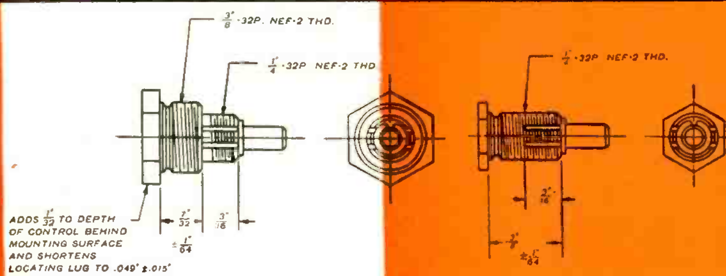


TYPE C2-45
Tandem

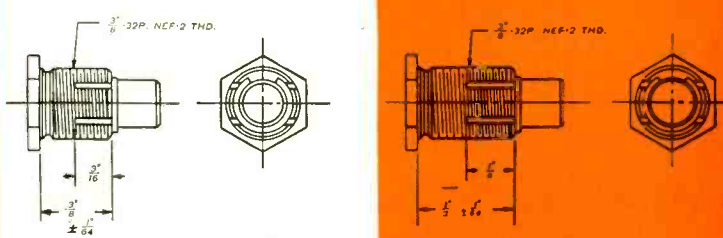
TYPE C2-25
Tandem

TYPE C2-252
Tandem



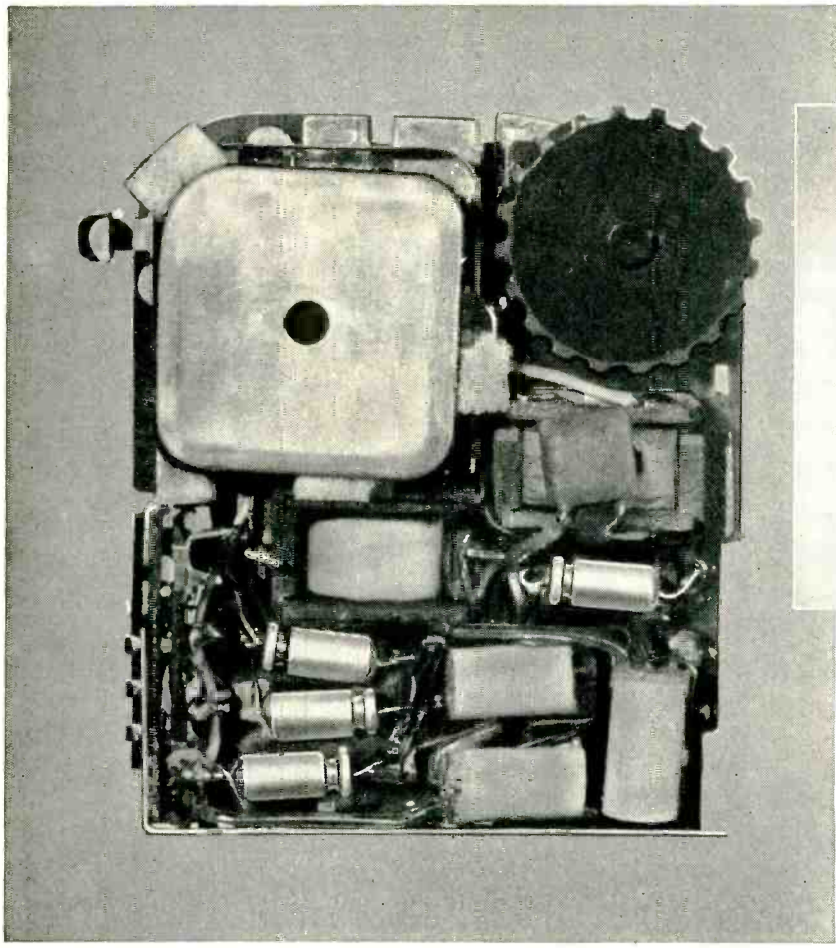


LOCKING BUSHINGS FOR TYPE 65 CONTROL.



LOCKING BUSHINGS FOR CONTROL TYPES 25, 252, 95, 35, 90, 45.

Specialists in Precision Mass Production of Variable Resistors • Founded 1896



Four G-E Micro-miniature Tantalytic capacitors easily fit into small space provided in this new all-transistor hearing aid. Man above adjusts volume control.

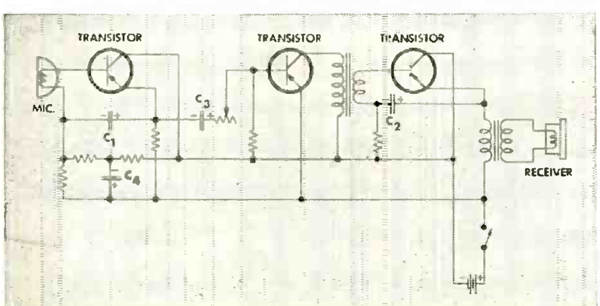
Other applications now being investigated:

WALKIE-TALKIES
WRIST RADIOS
PAGING SYSTEMS

How Tantalytic Capacitors Are Used In Miniaturized Hearing Aids

Four G-E Micro-miniature Tantalytic capacitors are used in this new all-transistor hearing aid. These high-capacitance, small-size units are necessary due to the low-impedance characteristics of transistors, as compared with the vacuum tubes formerly used. Ceramic and paper dielectric capacitors cannot supply sufficient capacitance in the small size desired, according to hearing aid design engineers.

Pictures, circuit diagram, application information courtesy Sonotone Corp.



Simplified schematic diagram of Sonotone all-transistor hearing aid, showing location of G-E Micro-miniature Tantalytic capacitors.

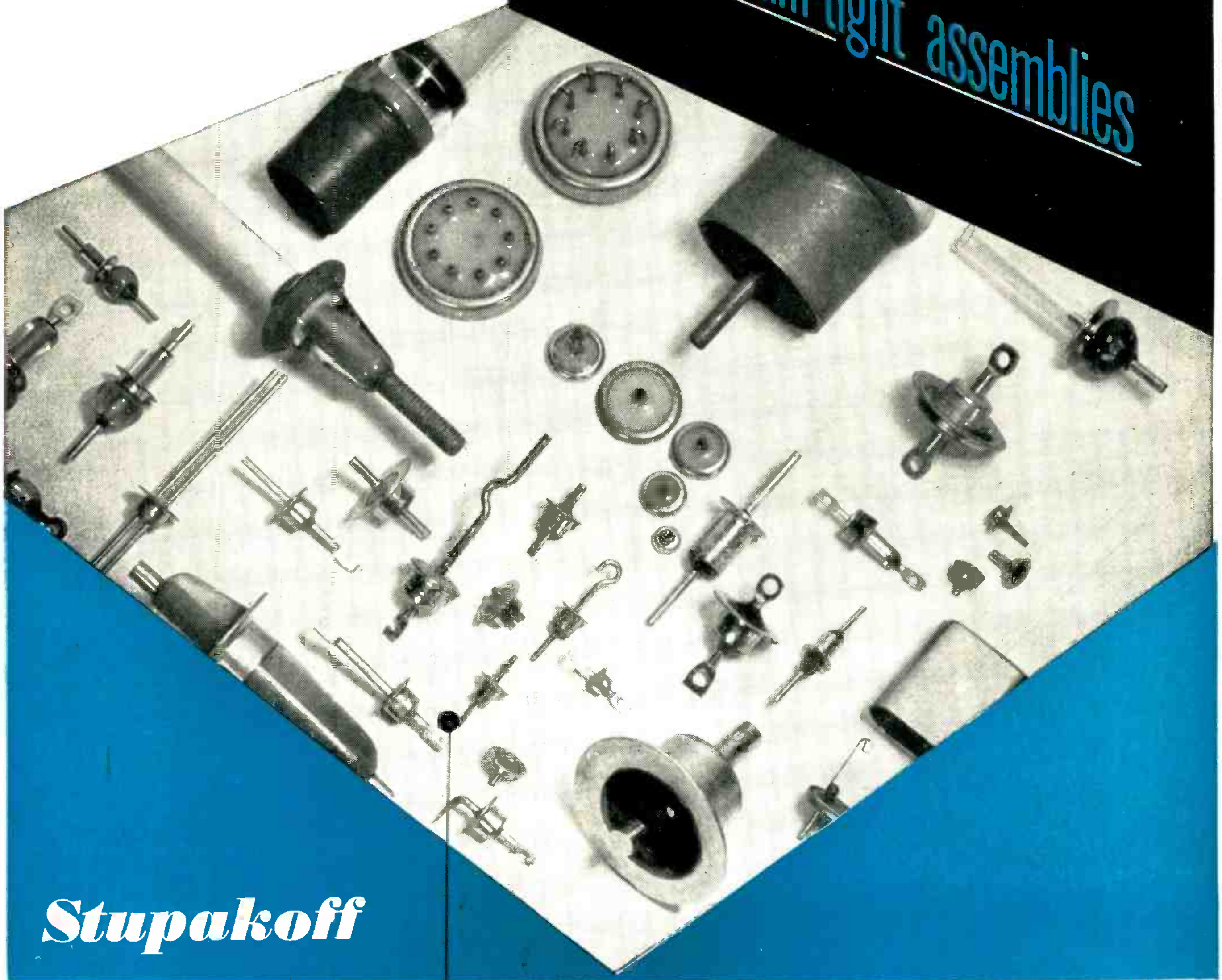
Operating at a battery voltage of 2.5 volts, this hearing aid uses two units rated at 2 microfarads each for by-pass, C_1 and C_2 (see diagram). They give a low-impedance signal path from the source to the input of the transistor. Two 1-microfarad units, C_3 and C_4, are used for coupling and filtering respectively, where their low leakage current of .18 microamperes/uf/volt at 25 deg. C is especially important.

G-E Micro-miniature Tantalytics can be obtained in ratings up to 20 volts, or, up to 8 uf in a $\frac{5}{16}$-in. long by $\frac{1}{8}$-in. dia. case size, higher capacitance in a $\frac{1}{2}$-in. long by $\frac{1}{8}$-in. dia. case size. Capacitance tolerance is -0% to $+100\%$.

For more information about G-E Micro-miniature Tantalytic capacitors, contact your G-E Apparatus Sales Office or write for bulletin GEA-6065 to General Electric Company, Section 442-15, Schenectady 5, New York.

GENERAL ELECTRIC

for durable and dependable vacuum-tight assemblies



Stupakoff

glass-to-metal seals

A complete range of sizes and designs of terminals, lead-ins and stand-offs for hermetic sealing is offered by Stupakoff. Made with Kovar metal, the ideal alloy for sealing to hard glass, Stupakoff Seals are durable and dependable. These are not mechanical compression seals, but are permanently fused by chemical interaction. They may be installed by conventional assembly techniques.

Write for a copy of the new Stupakoff Catalog 453, giving details of over a thousand sizes and styles of Stupakoff Seals.

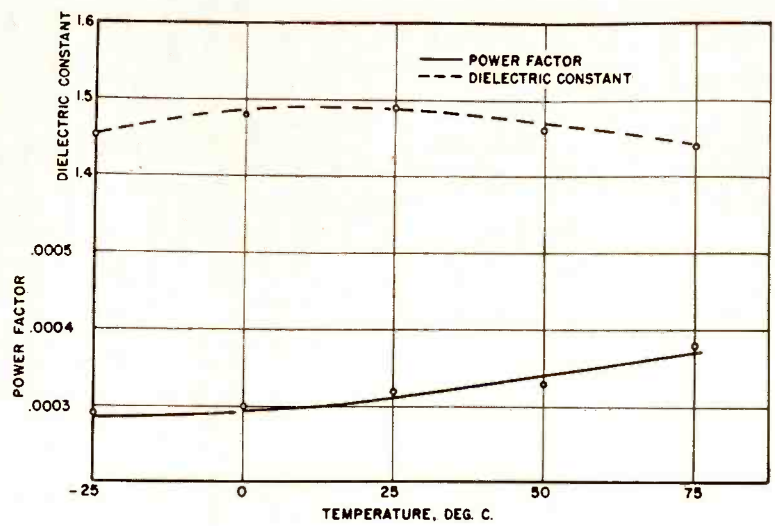
STUPAKOFF CERAMIC & MANUFACTURING COMPANY

LATROBE, PENNSYLVANIA

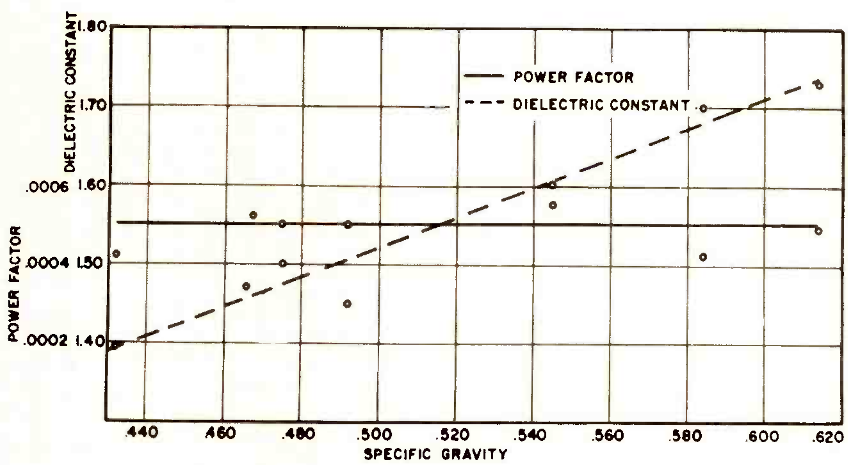
FACTS YOU SHOULD KNOW ABOUT

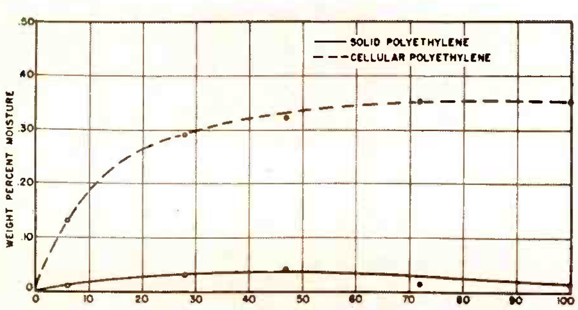
CELLULAR

Cellular polyethylene power factor and dielectric constant at 1 megacycle vs. temperature. The small effect of temperature change on these two properties indicates that the material will have minimal power losses when subjected to seasonal variations.

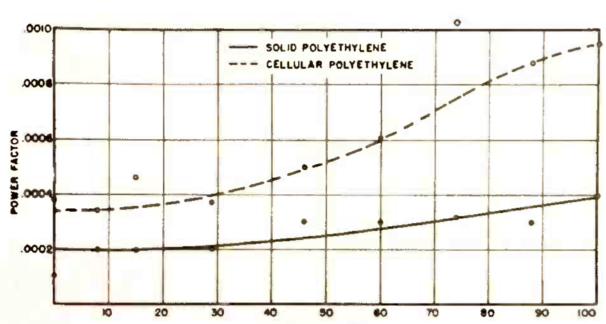


Plot of cellular polyethylene power factor and dielectric constant at 1 megacycle vs. specific gravity shows slight effect of density on power factor but great effect of density on the dielectric constant.





Moisture absorbed vs. days of immersion in tap water at 23 deg. C.



Power factor at 1 megacycle vs. days of immersion in tap water at 23 deg. C.

POLYETHYLENE

NEW BAKELITE MATERIAL FOR LOW-LOSS ELECTRICAL INSULATION

BAKELITE Polyethylene is already known as an outstanding material for electrical insulation. Now Bakelite Company has developed a polyethylene that can be foamed to a cellular form. It is marked by improved low-loss characteristics, and can be used wherever the tensile strength, elongation, and dielectric strength of solid BAKELITE Polyethylene are not of prime importance.

Production of BAKELITE Cellular Polyethylene can be carried out on standard extrusion equipment. Properly extruded, the new material will expand 100 per cent. Structurally, it consists of unconnected hollow cells, so that moisture absorption is of the same low order as solid polyethylene.

Cellular polyethylene is produced by combining polyethylene having a dielectric constant of 2.3 with a blowing agent that yields an inert gas having a dielectric constant of about 1.0. Its own constant lies between the two. Specific gravity is about half that of solid polyethylene. Power factor values are essentially the same. Since the dielectric constant is much lower, it is possible to make insulated conductors with a lower capacitance per foot than with the solid material.

An important application for this material is its use for covering UHF television lead-in wire. As shown in figure 4, there is little or no change in power factor and dielectric constant over a broad frequency range. This absence of irregularities means that power losses will be uniformly low.

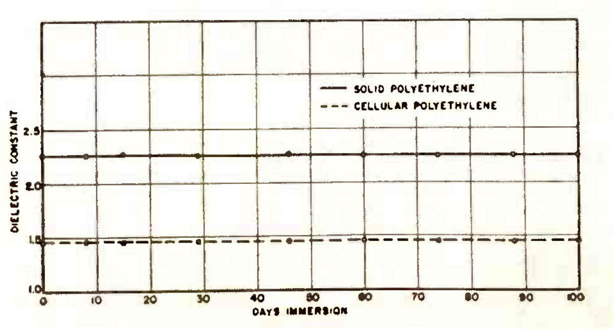
BAKELITE Cellular Polyethylene can be formulated for varying degrees of expansion. It has the chemical resistance of polyethylene, and withstands sea water, most acids, alkalies, and oxidizing agents.

For descriptive literature covering BAKELITE Cellular Polyethylene, write Dept. XM-79.

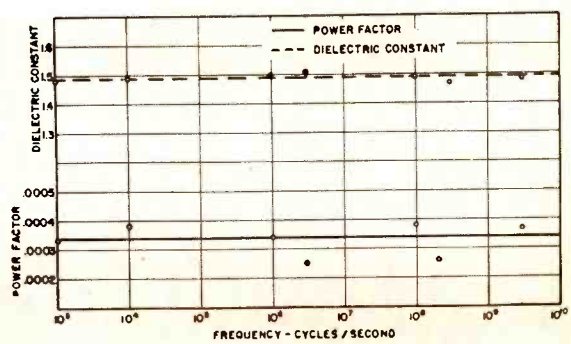
BAKELITE
TRADE-MARK
POLYETHYLENE

TRADE MARK

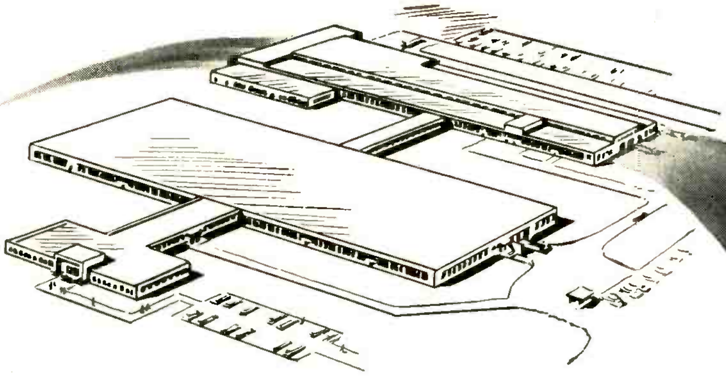
BAKELITE COMPANY
A Division of
Union Carbide and Carbon Corporation
UCC
30 East 42nd Street, New York 17, N. Y.
In Canada: Bakelite Company
Division of Union Carbide Canada Limited
Belleville, Ontario

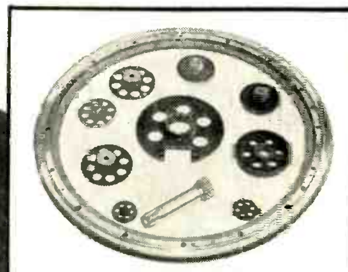


Dielectric constant at 1 megacycle vs. days of immersion in tap water at 23 deg. C.



Power factor and dielectric constant of cellular polyethylene vs. frequency.





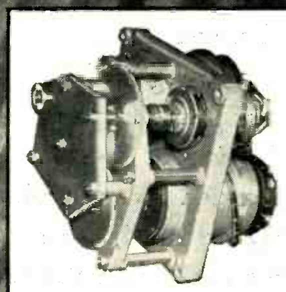
PRECISION GEARS

WHAT DAYSTROM HAS TO OFFER YOU . . .

UNDER ONE ROOF Daystrom Instrument can meet every one of your engineering and manufacturing needs—in their modern 350,000 sq. ft. plant, where a full range of up-to-date equipment is available for manufacturing from raw materials to finished assemblies and systems . . . for complete electro-mechanical and electronic parts and assembly in any quantity . . . for internal, external, surface and centerless grinding; low to high precision turning; jig boring and milling; welding, heat treatment and finishing; precision spur and helical gear shaping, hobbing and shaving; straight and spiral beveled gearing; test and inspection for entire range of gear production.

Daystrom's Research and Development Engineers have special skills in mathematics, radar circuitry, electronic computor design and instrumentations of a similar nature . . . Daystrom's Production Engineers are specialists in the mechanical, electronic and electromechanical fields . . . Daystrom's Manufacturing Engineers are experts in tool design, processing and tooling—with a new, complete toolroom for producing jigs, dies and fixtures.

Write today for our facilities report.



ANGULAR POSITION TRANSMITTER

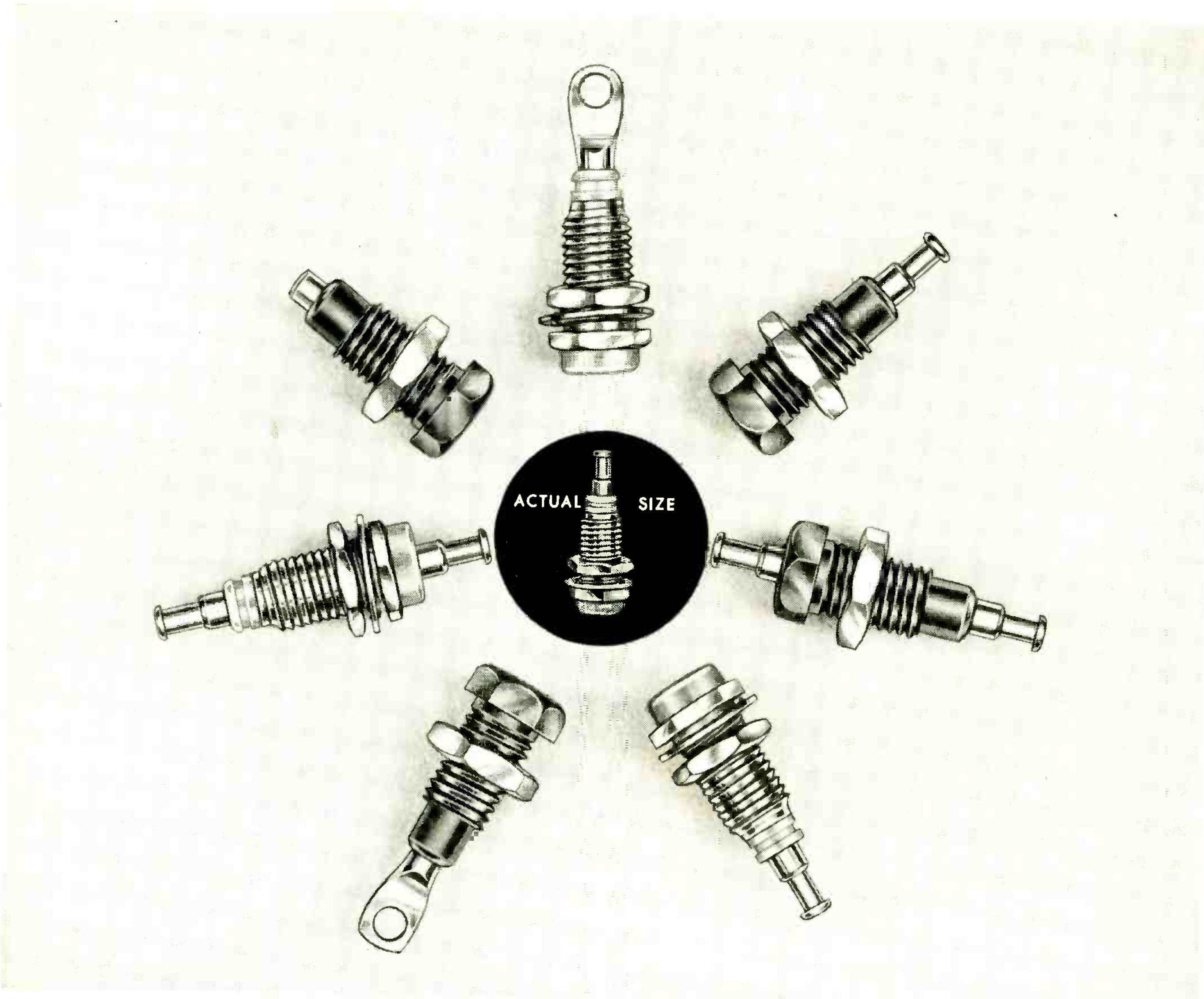
DIVISION OF DAYSTROM INCORPORATED

PRECISION VOLTAGE SUPPLY

DAYSTROM INSTRUMENT

ARCHBALD, PENNA.

Affiliates:
American Type Founders, Inc., Elizabeth, N.J.; Daystrom Furniture Div., Olean, N.Y.; Daystrom Electric Corp., Poughkeepsie, N.Y



Ucinite Test Jacks

In addition to Test Jacks with a brass, nickel-plated shell and nut with nylon insulator, Ucinite now offers a less expensive version with all-nylon threaded insulator for low capacity to panel and high voltage breakdown.

These Ucinite Test Jacks — designed for standard .080 phone tips — are available in a variety of colors . . . ideally suited to coded application. Silver-plated, heat treated beryllium copper contact is made in one piece with large terminal ends for easy soldering. The feed through type is provided with a one-piece brass terminal stud, tin-plated.

The specialized abilities and experience of Ucinite's own staff of design engineers are available for work on new and unusual problems. Volume production facilities ensure fulfillment of the largest requirements. For full information, call your nearest Ucinite or United-Carr representative or write directly to us.

ELECTRICAL ASSEMBLIES Ucinite RADIO AND AUTOMOTIVE

The UCINITE CO.

Newtonville 60, Mass.

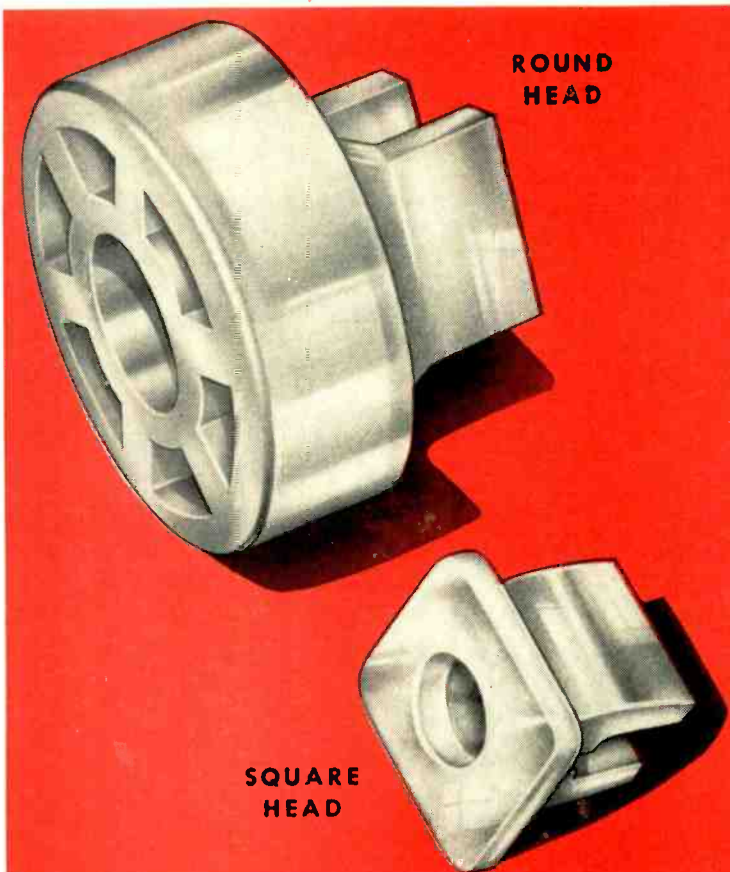
Division of United-Carr Fastener Corp.

Specialists in

ELECTRICAL ASSEMBLIES, RADIO AND AUTOMOTIVE

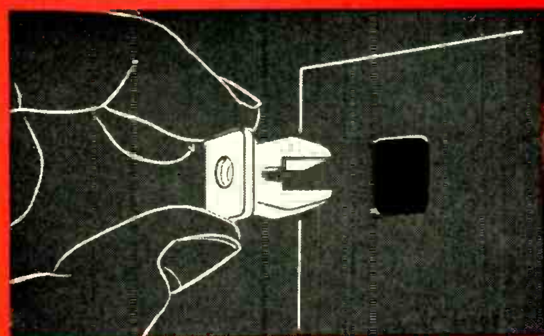
How many ways can you use

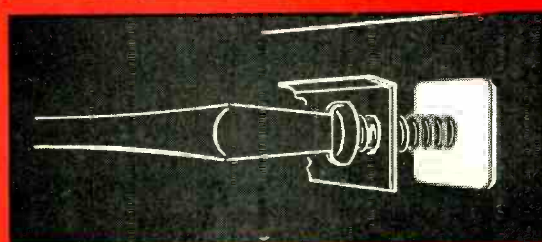
DOT PLASTIC snap in NUTS?



QUICK, EASY ASSEMBLY

Nut is pressed into square hole punched in sheet metal.





Ordinary sheet metal screw cuts its own threads as it is driven into the nut, expands fingers, locks nut and screw securely.

United-Carr's new self-locking, plastic nut is designed for blind application and can be used with all types of metal finishes without scratching or chipping the surface. Its plastic fingers provide rigid anchorage yet will not mar paint, polished metals or even porcelain.

Inexpensive sheet metal screws cut their own threads and expand the nut's fingers as they are driven, locking both nut and screw tightly in place. Screws can be removed and replaced several times without damage to the nut.

DOT plastic snap-in nuts are electrically non-conductive and provide a high degree of insulation against heat transfer. For all practical purposes, they also provide an effective vapor seal.

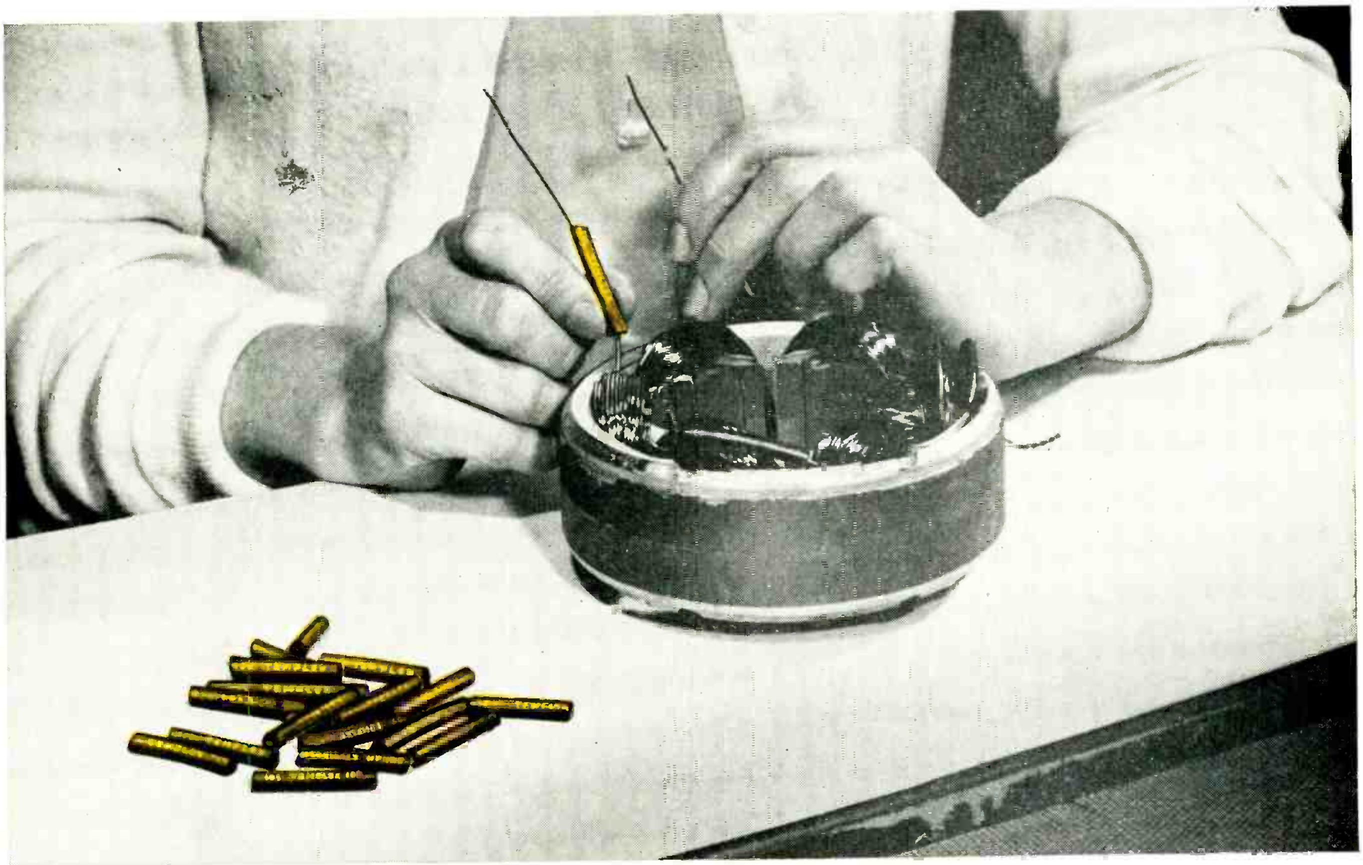
Available in several styles and sizes. Write for full information and samples or contact your nearest United-Carr representative.

UNITED-CARR FASTENER CORP.

CAMBRIDGE 42, MASSACHUSETTS

MAKERS OF DOT FASTENERS

"Retains Flexibility - Resists Abrasion"



says Redmond Company of TEMFLEX* 105 Tubing

In making the field connections for the unique TRI-FLUX shaded pole micromotors built by Redmond Company, Inc., Owosso, Mich., a $1\frac{1}{4}$" length of Irvington's Temflex 105 Tubing is slipped over the lead from one field coil, and the lead is twisted together with the connection from the next field coil. Twisted wires are then welded and bent back, and the Temflex tubing drawn over the welded joint. The entire field is then varnished and baked.

In addition to abrasion resistance and retained flexibility, "resistance to baking heat and high dielectric strength are other reasons for using this material," says Redmond about this flexible plastic tubing. Temflex 105 also carries Underwriters' Laboratories approval for continuous operation in air at 105° C. — and for 90° C. operation *in oil.*

Temflex 105 Tubing is produced by Irvington's Plastics Division in all standard colors, to fit all standard wire sizes. It's identified by the continuously printed name on the tubing surface — look for it when you buy high-temperature tubing. Send for literature and samples.

Look to
IRVINGTON
for Insulation Leadership

- INSULATING VARNISHES
- VARNISHED CAMBRIC
- VARNISHED PAPER
- VARNISHED WOVEN GLASS
- INSULATING TUBING
- CLASS "H" INSULATION

*T.M. Reg. U.S. Pat. Off.

IRVINGTON VARNISH & INSULATOR

DIVISION OF MINNESOTA MINING & MANUFACTURING COMPANY

11 ARGYLE TERRACE, IRVINGTON 11, N. J. • PLANTS: IRVINGTON, N. J.; MONROVIA, CALIF.; HAMILTON, ONTARIO, CANADA

SEVEN YEARS IN SERVICE

This Electronic Calculating Machine Is a Giant of Precision

✦ Mathematical robot with nearly 18,000 vacuum tubes does in hours what mechanical devices would require years to complete; built for war purposes, it has potentialities of interest to designers and engineers.

NOTHELFER 3 Phase Plate Rectifying Transformer 240/125 at 12½ KVA
125
All transformers designed for 40° rise.

. . . and the large transformers were all furnished by

NOTHELFER

THE Electronic Numeral Integrator and Computor shown above, designed and constructed in 1946 for the Ordnance Department, U. S. Army, at the Moore School of Electrical Engineering, University of Pennsylvania, is said to be the first all-electronic general purpose computor ever developed.

The design of the TRANSFORMERS among much other complex and expensive equipment, was limited by many unknown factors. However, this 3 Phase Plate Rectifying Transformer is representative of a typical installation by NOTHELFER, whose skill and experience has been instrumental in helping to solve many a difficult winding job.

NWL

NOTHELFER WINDING LABORATORIES

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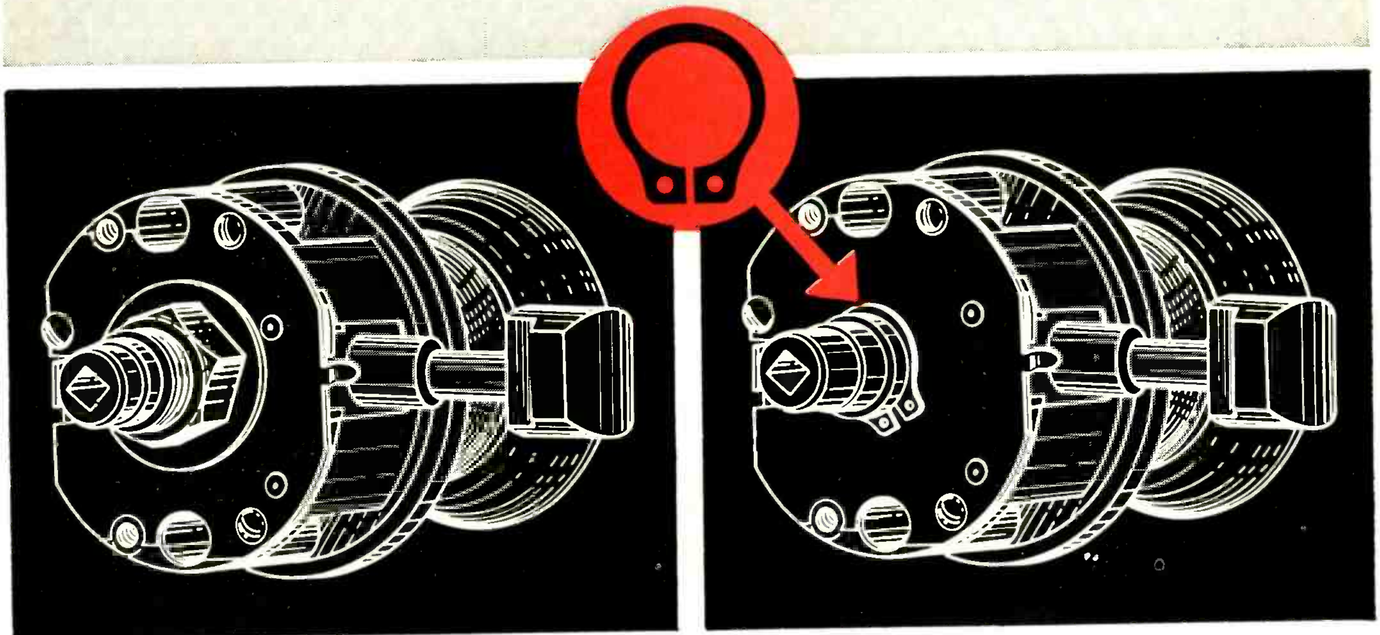
Waldes Truarc Ring Replaces Nut and Washer
...Cuts Costs $5.28 Per M...Speeds Assembly by 50%



OLD WAY. Main shaft required costly threading. Assembly was slowed by the double application of washer and nut and time-consuming tightening operation.

TRUARC WAY. Truarc Retaining Ring snaps quickly and simply over shaft. Lock assembly is secured in one fast operation. Virtually all play is eliminated from lock.

NEW DESIGN USING WALDES TRUARC RING PERMITTED THESE SAVINGS

OLD WAY

Cost of Nut	$10.00	*per thousand*
Cost of Washer	3.80	" "
Labor for Threading	2.00	" "
Assembly	3.00	" "
TOTAL	$18.80	

TRUARC WAY

Cost of Truarc Ring and Grooving Operation	$11.52	*per thousand*
Assembly	2.00	" "
TOTAL	$13.52	

J. Chesler and Sons, Inc., Brooklyn, N.Y., manufacturers of the pre-assembled "Reddi-Mount" cylindrical lockset, uses a single Waldes Truarc Retaining Ring instead of an old fashioned nut and washer to secure the entire assembly of their lock. This new, improved fastening method enables Chesler to eliminate costly threading . . . save money on material . . . speed assembly time by 50% and produce an improved, more durable product.

You, too, can save money with Truarc Rings. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better, more economical job. Waldes Truarc Rings are precision-engineered . . . quick and easy to assemble and disassemble.

Find out what Waldes Truarc Retaining Rings can do for you. Send your blueprints to Waldes Truarc engineers.

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

SEND FOR NEW CATALOG

E-066

Waldes Kohinoor, Inc., 47-16 Austel Pl., L. I. C. 1, N. Y.

Please send me the new Waldes Truarc Retaining Ring catalog.

(Please print)

Name..........

Title..........

Company..........

Business Address..........

City.......... *Zone*.......... *State*..........

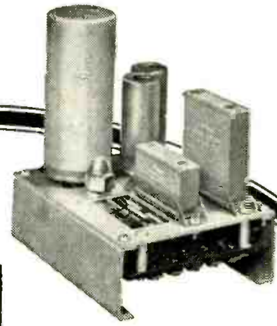
WALDES TRUARC REG. U. S. PAT. OFF. **RETAINING RINGS**

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

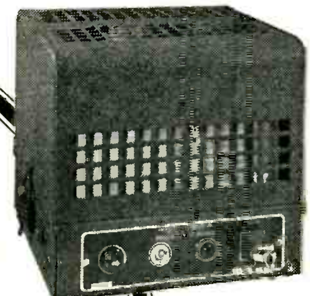
WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,382,947; 2,382,948; 2,416,852; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,420,941; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,509,081; AND OTHER PATENTS PENDING.

TYPE 2003
Same as Type 2007 (at right) except Tube 12AT7 and 5 pig-tail components are external.

TYPE 2007, BASIC UNIT
Contains shock-mounted fork, double triode and all circuitry. Output, 400 or 500 cycles. Accuracy ± 1 part in 50,000. Octal base container, 1½" x 4½". Weight, 10 oz. Power required, 75 to 200 V.-D.C. at 1 to 5 m.a. and 6.3 V. at 300 m.a. Designed for MIL equipment.



TYPE 2001-2, BASIC UNIT
Frequencies, 200 to 3000 cycles. Dividers and multipliers available for lower and higher frequencies. Output, 6 V.—JAN construction.



TYPE 2005, UTILITY
Provides 10 Watts at 110 V. Precision frequencies from 50 to 500 cycles. Input power, 50 to 500 cycles, 45 Watts.

TYPE 2121-A, LAB. STANDARD
Outputs, 60 cycles, 0-110 Volts, 10 watts; 120-240 cy. impulses. Input, 50-400 cycles, 45 Watts.

TYPE 2111A, POWER UNIT
50 Watt output. 0-110-220 V. at 60 cycles or any frequency 50 to 1000 cycles.

Precision FREQUENCIES

GUARANTEED ACCURACY
1 PART IN 100,000 (.001%)
except where otherwise noted

The basis of these frequency standards is an electronically actuated high-precision fork, temperature-compensated and hermetically sealed against barometric changes. The partial list of uses at the right not only suggests the broad range of applications but also proven dependability where there can be no compromise with accuracy. Please request details by Type No. Our engineers are available for advice or cooperation on related problems.

WIDELY USED IN SUCH FIELDS AS

Aviation, Navigation
Ordnance, Ballistics
High Speed Photography
Viscosity Measurement
Fluid Flow
Nuclear Physics, Telemetering
Chemical Reaction
Radiation Counting
Computers
Facsimile
Fire Control
School and Indl. Research Labs.
Accurate Speed Control

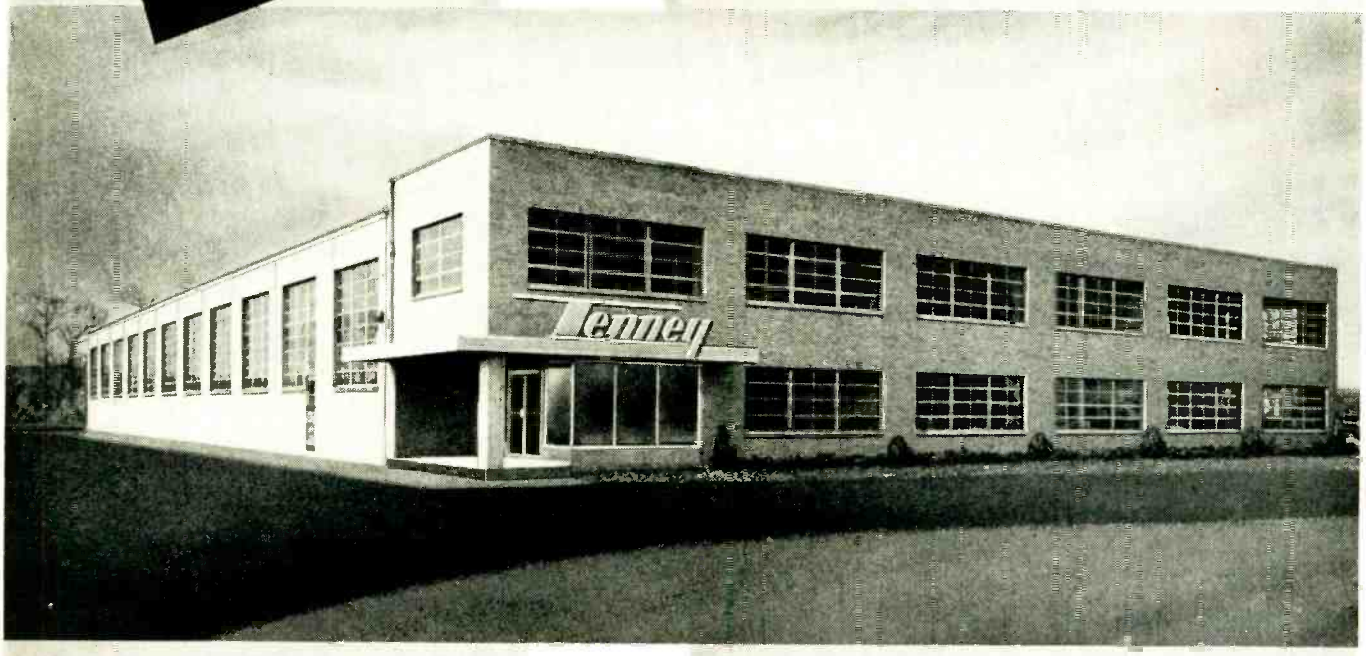
American Time Products, Inc.

580 Fifth Avenue ***New York 36, N. Y.***

OPERATING UNDER PATENTS OF WESTERN ELECTRIC COMPANY

For ENVIRONMENTAL TEST EQUIPMENT

see Tenney



From better facilities

including expanded engineering new, improved tooling and faster shipping, comes

a better product

a wide range of "standards" in altitude, temperature, humidity, sand and dust, explosion and walk-in chambers*

for you

our customers, whose names* include the largest firms in America, the U. S. Government, and Armed Services.

* Information on this equipment and a purchaser list will be sent on request.

Tenney ENGINEERING, INC.

1090 SPRINGFIELD ROAD, UNION, N. J.

Plants: Union, N. J. and Baltimore, Md.

Engineers and Manufacturers of Refrigeration and Environmental Equipment

3547

Now!

K11 ELECTRICAL CONTACTS (RIVETS)

K12 ELECTRICAL CONTACTS (BUTTONS)

General Plate

Electrical Contact Kits

for Laboratory and Development Use

A Wide Assortment of Sizes at Your Fingertips . . . Simplifies Design, Saves Time

These two General Plate Electrical Contact Kits are the answer to your contact requirements for development use.

Kit K11 contains a wide assortment of silver rivet contacts. Kit K12 has representative standard button contacts . . . silver facing on a base metal backing for projection welding. Also included are metal strips for fabrication of contact parts.

Dimensional working drawings are included so that you can duplicate the exact part on your own drawings.

These General Plate kits help you solve design problems by placing standard stock buttons and rivets at your fingertips. Once a design goes to production, there are no procurement delays . . . production quantities are available for immediate shipment from General Plate stock. Your contact inventories are minimized, "non-standards" are eliminated, delivery delays are avoided.

Available at a nominal cost . . . write for complete information and prices today.

You can profit by using General Plate Composite Metals!

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
36 FOREST STREET, ATTLEBORO, MASS.

ENTIRELY NEW

POWERSTAT

Variable Transformers

TYPE 136 AND 236

provide new higher ratings . . . smaller size . . . easier installation and servicing . . . smoother operation and longer life . . . greater overload characteristics.

POWERSTAT types 136 and 236 are all new . . . new design . . . new performance . . . new ratings. Incorporated into each unit are all the features essential for the ultimate in variable transformers.

Types 136 and 236 are offered for manually-operated and motor driven duty in 120, 240, 480 volt ratings. Here are the reasons they are superior:

- **Higher Ratings:** Type 136 is rated 120 volts, 50/60 cycles input; 0-120/140 volts, 20.0 amperes output.
- **Smaller Size:** "Pancake" coil design provides compactness for bench or panel mounting.
- **Easier Installation:** Three sets of mounting holes suit all needs. Binding post type terminals provide all connection methods.
- **Easier Service:** Simply remove plate block for access to brush assembly. Brush easily removed and replaced.
- **New Rhodium Plated Commutator:** The one best answer to smooth performance and long life. The contact surface remains forever free of oxides. Corrosion is reduced. Uniform contact drop maintained and greater overload characteristics allowed.

There is a complete standard line of POWERSTAT variable transformers type 136 and 236 to suit individual requirements. Write for Bulletin P354.

The SUPERIOR ELECTRIC COMPANY

Manufacturers of: Powerstat Variable Transformers • Stabiline Automatic Voltage Regulators • Voltbox A-C Power Supplies • Powerstat Light Dimming Equipment • Varicell D-C Power Supplies • Superior 5-Way Binding Posts

THE SUPERIOR ELECTRIC CO.
206 Clarke Ave., Bristol, Conn.

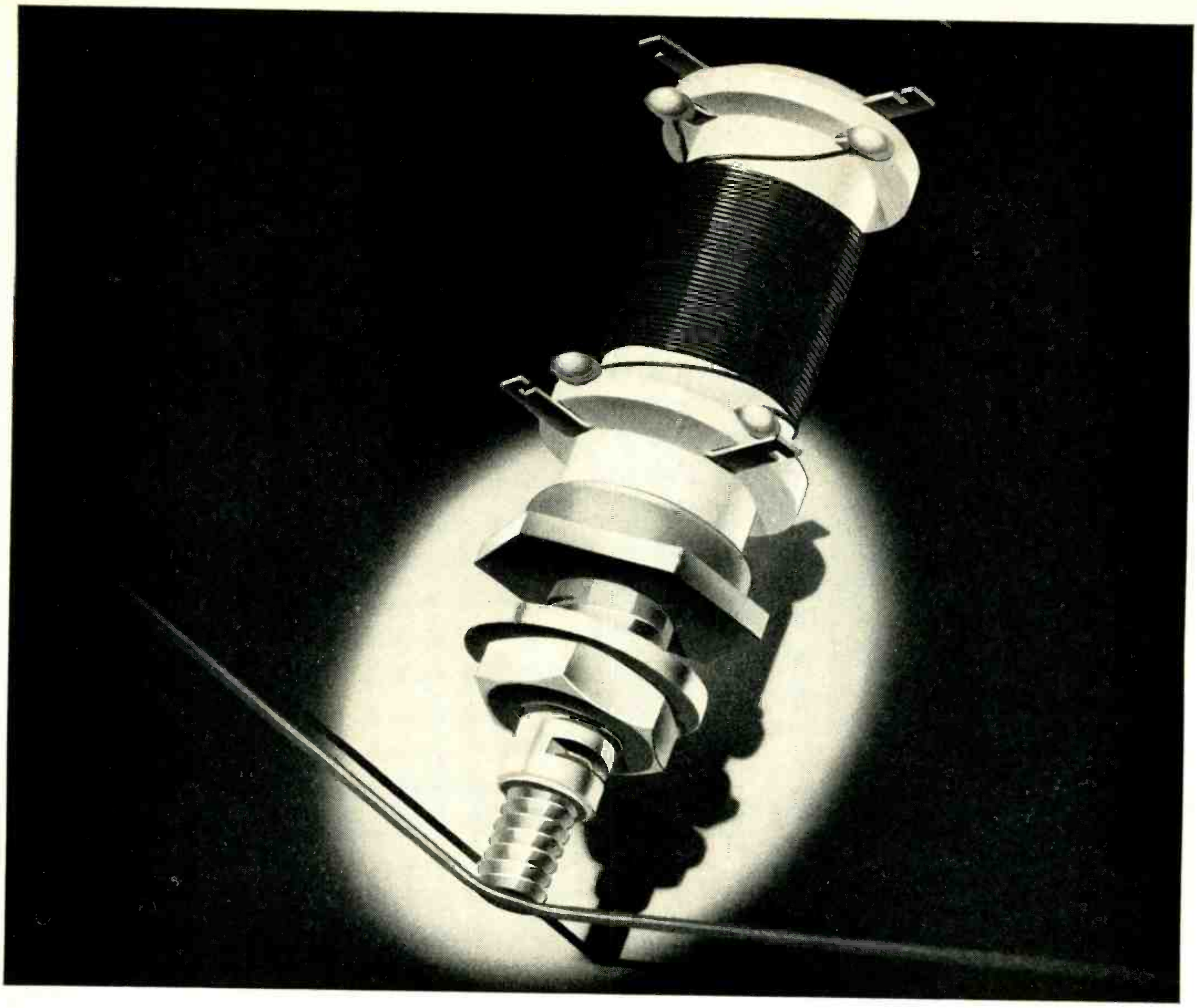
Please send Bulletin P354

Name. . . . .

Title. . . . .

Company. . . . .

Address. . . . .



Death-defying performance

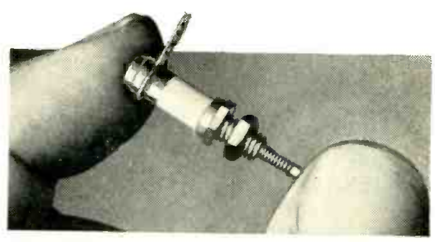
You can depend on C.T.C. coils to give a steady, star performance. They won't go dead despite threats of temperature, climate or vibration. And for very good reasons —

The mounting stud of every C.T.C. coil is fastened to the ceramic body in a special way that does away with weaknesses of ordinary coil fastenings. This special fastening makes C.T.C. coils vibration-proof. What's more, their tightness is preserved in hot, cold, dry or damp weather. All C.T.C. coils are precision-made, of course, to meet individual specifications — and to meet, or better, government specifications, as well. And continuous quality control is maintained.

As a result, you get a *guaranteed* electronic component — custom or standard — whose performance you can depend upon.

Precision-made C.T.C. components that benefit from C.T.C. high quality standards include terminals, terminal boards, capacitors, swagers, hardware, insulated terminals and coil forms. For all specifications and prices, write Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. West Coast manufacturers contact: E. V. Roberts, 5068 West Washington Blvd., Los Angeles 16 and 988 Market St., San Francisco, California.

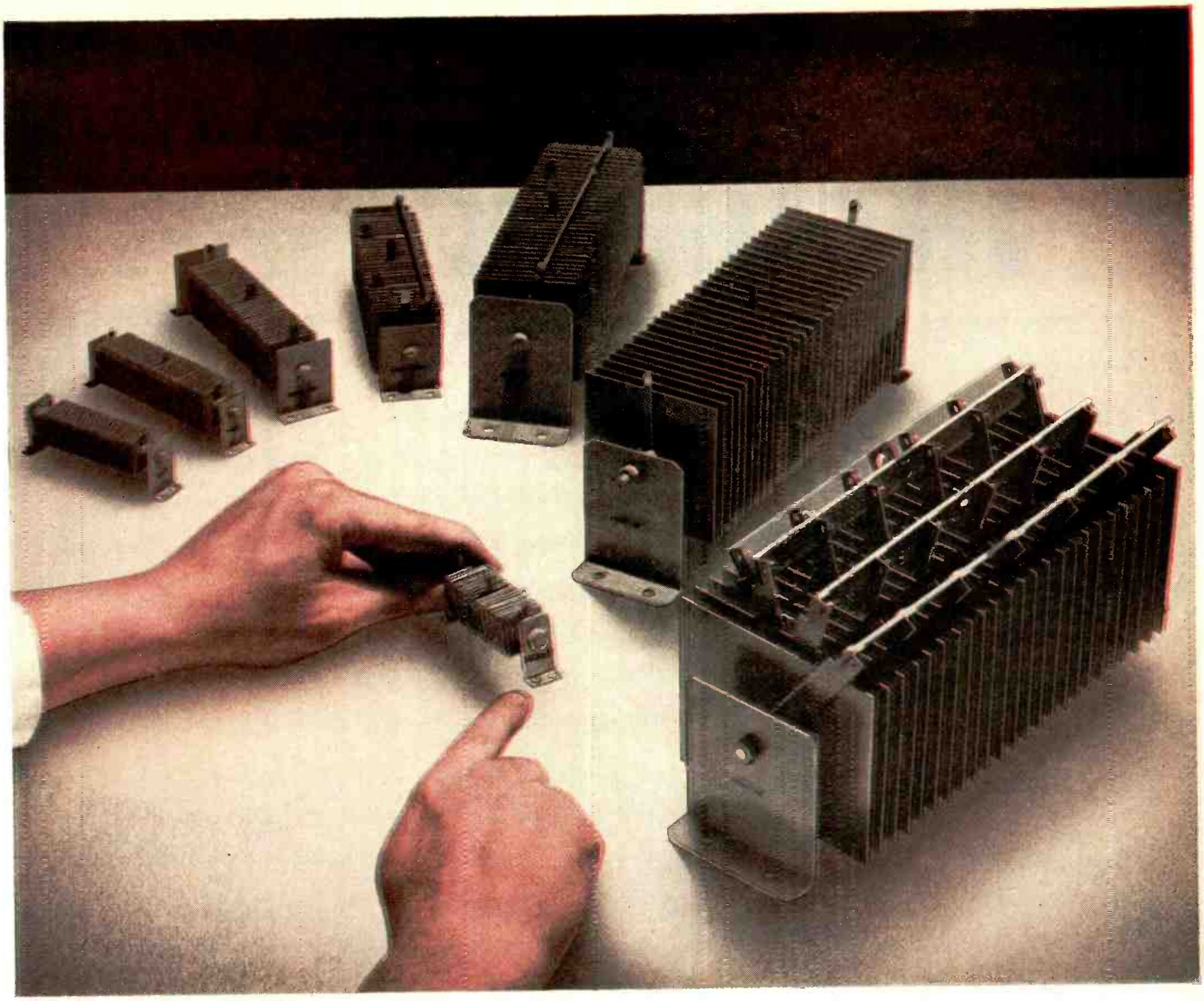
Slug Tuned Coil Data: Single layer or pie type windings to your specifications. Forms of quality paper base phenolic or grade L-5 silicone impregnated ceramic. Mounting studs are cadmium plated brass; ring type terminals are silver plated brass. All units include slugs and mounting hardware. One style (Type C) available with retaining collars of silicone fibreglas which permit 2 to 4 terminals. Windings can be coated with resin varnish, wax or lacquer.



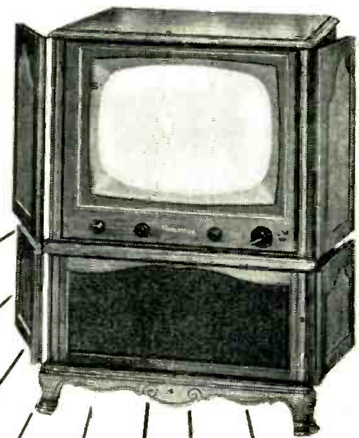
New CST-50 variable ceramic capacitor surpasses range of capacitors many times its size. Stands only 1³⁄₃₂" high when mounted, is less than ¼" in diameter and has an 8-32 thread mounting stud. A tunable element of unusual design practically eliminates losses due to air dielectric giving large minimum to maximum capacity range (1.5 to 12MMFD).

CAMBRIDGE THERMIONIC CORPORATION

makers of guaranteed electronic components, custom or standard



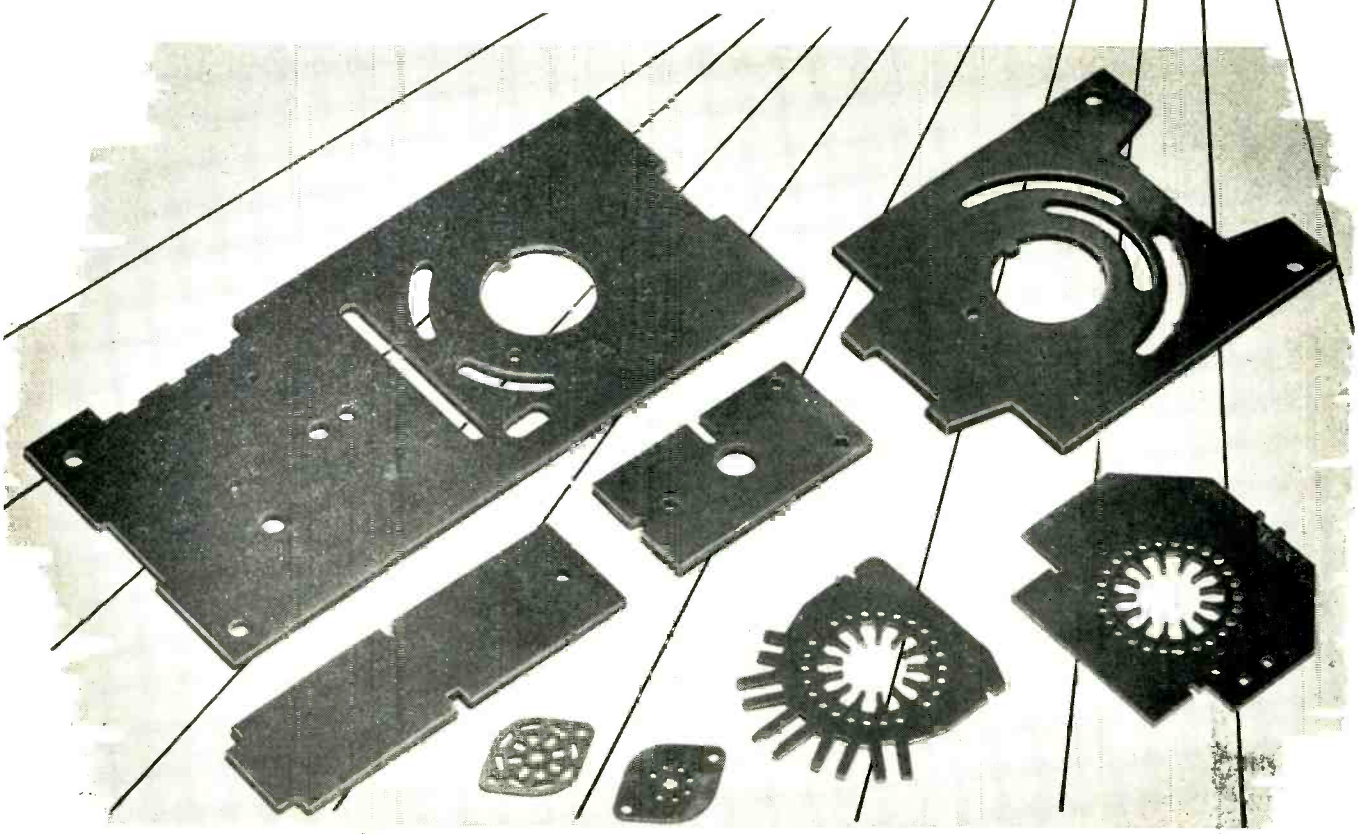
RCA VICTOR Television
CHOOSES
INSUROK®
T-725 INSULATING LAMINATE



The RCA Victor name is a symbol for the highest quality in electronic equipment. To meet their exacting standards, RCA Victor engineers selected INSUROK Grade T-725 phenolic laminate for their television receivers.

INSUROK T-725 provides RCA Victor with a unique combination of electrical properties. It is used in the R.F. tuners, to maintain insulation resistance under high temperatures and humidities . . . in the I.F. tube sockets, to minimize capacity changes with changes in humidity . . . and in the high-voltage compartment, to provide high dielectric strength and surface resistivity.

For the "tough spots" in your product, write or phone about T-725 and the many other grades of INSUROK laminated insulation.



Write Today for Booklet "LAMINATED INSUROK"

The RICHARDSON COMPANY

FOUNDED 1858—LOCKLAND, OHIO

2797-C Lake St., Melrose Park, Illinois (Chicago District)

SALES OFFICES: Cleveland • Detroit • Indianapolis • Lockland, Ohio
Los Angeles • Milwaukee • New Brunswick, (N. J.) • New York • Philadelphia
Rochester • San Francisco • St. Louis

G.E.'s NEW IMPROVED SWEEP TUBES GIVE HIGHER QUALITY AT SAME PRICE!

You can SEE the improvement over prototypes (left)

NEW 6BQ6-GA, 25BQ6-GA (Right)

G-E Design Service brings you . . . constantly . . . new, improved, more dependable receiving tubes at no increase in cost. The 6BQ6-GA and 25BQ6-GA are examples. These sweep tubes cut TV production costs by greatly reducing line rejects . . . also build customer acceptance for your sets, which will require fewer service call-backs.

Other improved G-E tubes are in development, and will be available soon. With the number of tubes per chassis to be at least doubled for Color, builders of sets justifiably are asking for tubes that will stand up—that won't slow TV production by poor performance or high failure rate, and won't make service costs prohibitive.

Better tubes at the same price is an extensive and continuing General Electric program. Get all the facts about these new, improved tubes for television from *Tube Department, General Electric Company, Schenectady 5, New York.*

OUTSTANDING PERFORMANCE! LONG LIFE!

"RUNNING HOT" shortened the life of many prototype 6BQ6-GT's and 25BQ6-GT's. G-E designers went to the heart of the problem, and gave the new tubes king-size bulbs that mean cooler operation under all normal conditions. Glass surface area is 89% increased!

Also—because of special mica design and new processing techniques—the 6BQ6-GA and 25BQ6-GA will handle higher pulse plate voltages than their predecessors. The peak rating now is 6,000 v instead of 5,500 v. Internal tube arcing has been reduced substantially.

A further improvement is use of a special high-melting-point solder for the plate cap-terminal. This prevents loosening of the terminal when tubes are removed for testing.

Basing layout is identical with prototypes. The new tubes are fully interchangeable with the old.

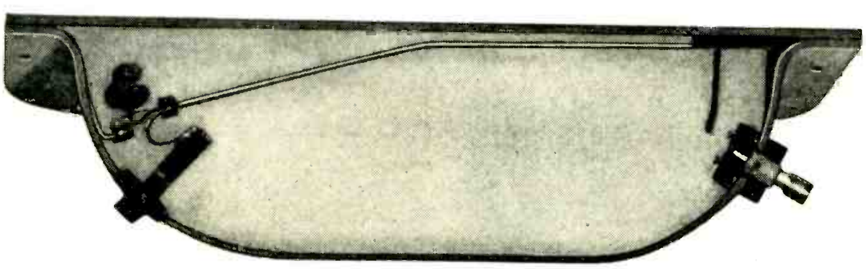
GENERAL ELECTRIC

162-1A3

NOPCO® LOCKFOAM

Seeking a material light enough yet strong enough to protect their Marker Beacon Antenna against terrific air pressure differentials, Electronics Research, Inc., encountered plenty of obstacles—until they found Nopco Lockfoam.

Today those obstacles are no more. Nopco Lockfoam does the job they needed done . . . offers the light weight and low dielectric constant they need, shields against vibration the delicate electrical apparatus within.

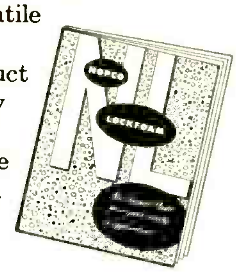


Illustrated is a half cross-section of the Type 140 Marker Beacon Aircraft Antenna made with poured Nopco Lockfoam by Electronics Research, Inc., Evansville, Ind. Before using Lockfoam, this manufacturer was unable to find an ideal reinforcing material which permitted airtight sealing without deformation of the antenna cavity. In its present construction, the difficulties both of deformation and of possible seal rupture are eliminated.

eliminates aircraft antenna deformation caused by air pressures

And from the standpoint of production, states Electronics Research, Nopco Lockfoam has consistent pour characteristics, and bonds strongly to the antenna cavity walls and cover.

Perhaps the rare combination of properties of this versatile foamed-in-place plastic can help with some product *you* have in mind. At any rate, you'll want the full story. Write today for the Nopco Lockfoam booklet.



Where Can YOU Best Use These Properties?

Near-perfect Radar Transmission

Ease of Fabrication
It's "poured-in-place"

Great Strength with Light Weight

Excellent Electrical Properties
6 lb/cu ft Lockfoam tested at 9.375 KMC
Dielectric Constant 1.05
Loss Tangent .0005

Good Thermal Insulation
"K" Factors
.018 at 8 lb/cu ft
to .025 at 11 lb/cu ft

Wide Range of Densities
From 2 to 35 lb/cu ft

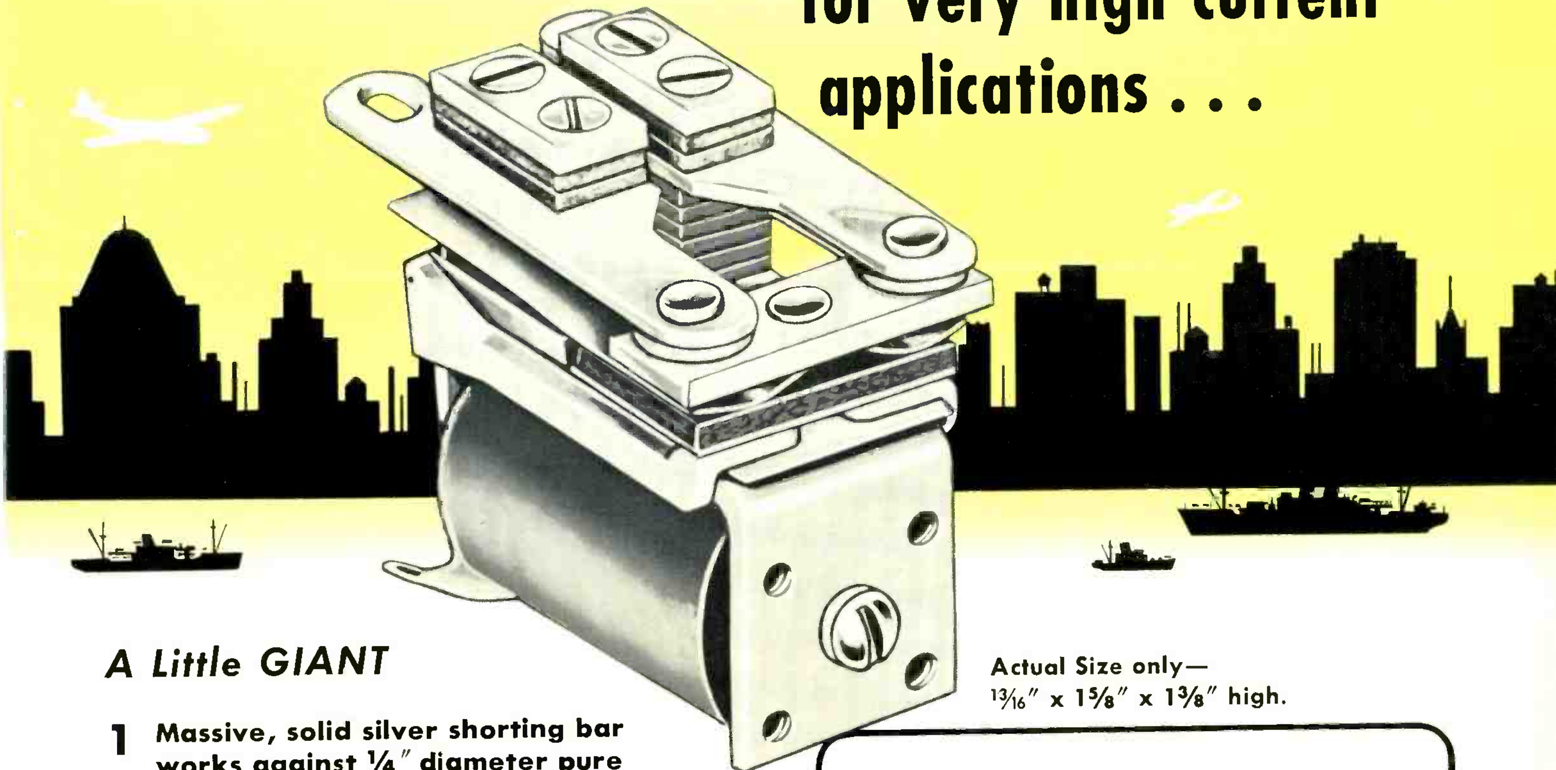
Great Versatility
50 different formulations available

Plastics Division
NOPCO CHEMICAL COMPANY
Harrison, New Jersey
Cedartown, Ga. • Los Angeles and Richmond, Calif.

NOPCO TRADEMARK EVOLVED THRU RESEARCH

NEW LOS ANGELES BRANCH. To aid West Coast manufacturers with complete field service on Nopco Lockfoam, our new office at 4858 Valley Blvd., Los Angeles 32, is now ready to serve you. Drop in and get acquainted, or write.

Potter & Brumfield's
MB3D miniature DC power contactor for very high current applications . . .



Actual Size only—
$\frac{13}{16}$″ x $1\frac{5}{8}$″ x $1\frac{3}{8}$″ high.

A Little GIANT

1 Massive, solid silver shorting bar works against $\frac{1}{4}$″ diameter pure silver contacts.

2 Heavy brass contact arms with large, tinned solder terminals.

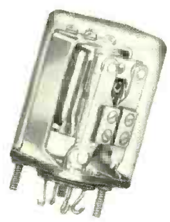
3 Sturdy over-travel spring made of nickel silver spring temper for maximum contact pressure, long life.

4 Magnetic structure utilizes high permeability relay steel for maximum efficiency.

5 Varnish impregnated coil for moisture protection.

Also Available Hermetically Sealed

"K" can enclosure—$1\frac{13}{32}$″ x $1\frac{5}{8}$″ x $2\frac{1}{8}$″ high. Glass compression type header; solder terminals rated 16 amperes. Mounting: three 6-32 studs on $\frac{15}{16}$″ x $1\frac{3}{16}$″ triangular centers.



Technical Specifications:

CONTACT ARRANGEMENT: 1 Form X (SPST-NO-DM)

CONTACTS: Pure silver, $\frac{1}{4}$″ diameter, rated *60 amperes, 28 volts DC, non-inductive load; 100,000 operations, minimum.

*(In dynamotor starting circuits contacts will carry a 150-ampere make surge of 0.3 second duration and will break a 15-ampere steady-state current more than 1,000 times. Contacts also meet tests requiring 250 makes and breaks at peak of surge current. These ratings apply to any contact voltage up to 28 DC nominal with conventional variations—32 volts maximum.)

PULL-IN: 75% or less of nominal coil voltage.

DROP-OUT: 50% or less of nominal coil voltage.

VIBRATION RESISTANCE: 10-500 cps, 10G minimum, three planes—energized and non-energized.

COIL VOLTAGES: 6, 12, 24, 110 DC.

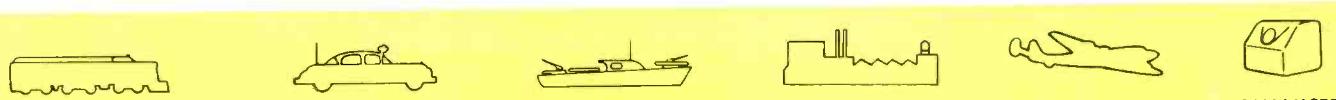
COIL RESISTANCES: 13.3, 62.3, 245, 3670 ohms.

BREAKDOWN VOLTAGE: 500 RMS, minimum.

MOUNTINGS: Four 3-48 holes on $\frac{3}{8}$″ centers; four 5-40 holes on $\frac{3}{8}$″ x $\frac{7}{16}$″ centers or four 4-40 internally threaded bosses $\frac{5}{32}$″ long on $\frac{3}{8}$″ x $\frac{7}{16}$″ centers.

(Stocked by your local Electronics Parts Distributor with one mounting . . . four 3-48 holes on $\frac{3}{8}$″ centers.)

APPLICATIONS: Ideally suited to dynamotor starting applications in mobile, aircraft or marine equipment. Also readily applicable to other high current, DC circuits. Its small size and light weight make the MB3D a natural for any high current circuit where space and weight are at a premium. Samples and quotations provided on request; specify winding, adjustment, termination and mounting. Write Potter & Brumfield, Princeton, Indiana. Sales offices in principal U.S. and Canadian cities.



Potter & Brumfield

offers you the benefits of

20 years' custom engineering

. . . with more than 100 Basic Relay Types!

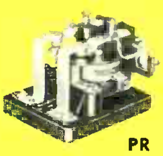
These basic relay types have been evolved from the design and production of more than 15,000 different custom relays. Used as they are or with slight modifications they will fit most any and all applications.

Thus you are assured of:

1. **Proven Design**—P & B standard relays have been field tested under all kinds of conditions, thereby giving long, trouble-free service.
2. **Lower Costs**—Because these relays are already tooled and manufactured in production quantities—a substantial cost saving is passed along to you!
3. **Fast Delivery**—Orders for standard relays can be filled from stock or with minimum delay.
4. **Available through Distributors**—Standard types available through P & B franchised Electronic Parts Distributors in all principal cities.

Potter & Brumfield engineers are available for consultation on special relay problems—design or application.

A FEW OF THE MANY P&B BASIC RELAY STRUCTURES


PR

POWER RELAYS Heavy (PR) and medium (MR) duty. For across the line power circuits, high current switching —SPST to 3PDT.


LB

PLATE CIRCUIT RELAYS—Actuate on few milliwatts. Fit many applications. LM series also available. From SPST to DPDT.


SS

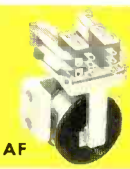
SUPER SENSITIVE RELAYS Operate on less than 10 MW. Dual coils, 10G vibration resistance. Wide versatility. One Form C-SPDT.


KR

LIGHT DUTY RELAYS Small, light weight, sturdy. Withstand high vibration and shock. From SPST to 3PDT.


AP

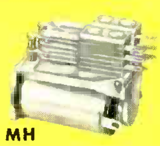
IMPULSE RELAYS Automatic stop prevents backlash. Precise, repetitive switching regardless of operating speed. DPDT or 4PDT.


AF

400 CYCLE AC RELAYS For aircraft or ground equipment. Withstand better than 10G shock. Heavy cast mounting foot. SPST to DPDT.


KL

MULTIPLE CONTACT RELAYS—Longer coil provides power sufficient to actuate additional contacts. For multiple switching—SPST to 4PDT.


MH

TELEPHONE RELAYS Meet practically all telephone relay requirements. Many contact combinations. MH, MT, LT and ST types also available.


SM

SUPER MIDGET RELAYS—Tiny and rugged —plug-in—SPDT. High degree of resistance to vibration and shock.


SU

MULTIPLE LEAF RELAYS For temperature, indicating or protective circuits. Heavy, tin-coated phosphor bronze contact springs. From SPST to 4PDT.


MS

MOTOR STARTING RELAYS Voltage controlled to insure throwout of starting winding when motor reaches rated speed. SPST-NC or SPST-NC-DB.


PW

SUBMINIATURE SENSITIVE RELAYS Standard 7 pin plug-in. Ruggedized for vibration and shock. Operating power 25MW. Contact load 2 amps.


LK

LATCHING RELAYS Compact—high utility switching. Coils operate on AC or DC. Voltage or current. From SP-ST to 4PDT.


SP

HEAVY-DUTY SHOCK-PROOF RELAYS Can be mounted in any position. Particularly resistant to vibration and shock. From SPST to DPDT.


MB

MINIATURE DC POWER CONTACTOR—Heavy duty contacts, rated 60 amperes, 28 V DC, non-inductive load. Rugged construction. Withstands high vibration and shock. SPST-NO-DM.

ALL P & B STANDARD RELAYS CAN BE SUPPLIED WITH DUST COVERS OR HERMETICALLY SEALED CANS WITH SOLDER OR PLUG-IN HEADERS

Write home office in Princeton or phone your local P & B Sales Office for new master catalog describing our wide line of basic relay structures, housings and enclosures. Samples, recommendations and quotations promptly furnished on special applications.

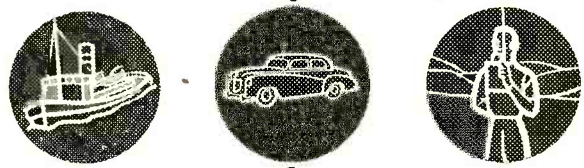
P & B Standard Relays available at your local Electronic Parts Distributor

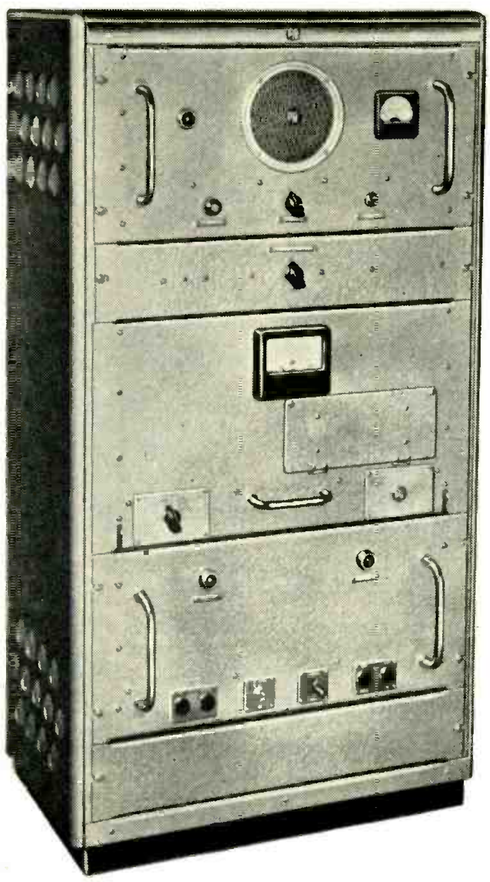
Potter & Brumfield

PRINCETON, INDIANA

EXPORT: 13 E. 40TH STREET, NEW YORK, NEW YORK
SALES OFFICES IN PRINCIPAL U. S. AND CANADIAN CITIES

50 Watt VHF FIXED STATION





The new Pye 50 watt V.H.F. FIXED STATION is of an advanced design employing the latest techniques. It is ideal for use in normal fixed and mobile schemes where high powered transmitters are required and may also be used for point-to-point radio-telephone links.

A further application is in the aeronautical band where the 50 watt transmitter, together with the standard Pye fixed receiver, provides one of the most efficient ground-to-air control stations at present available in the world.

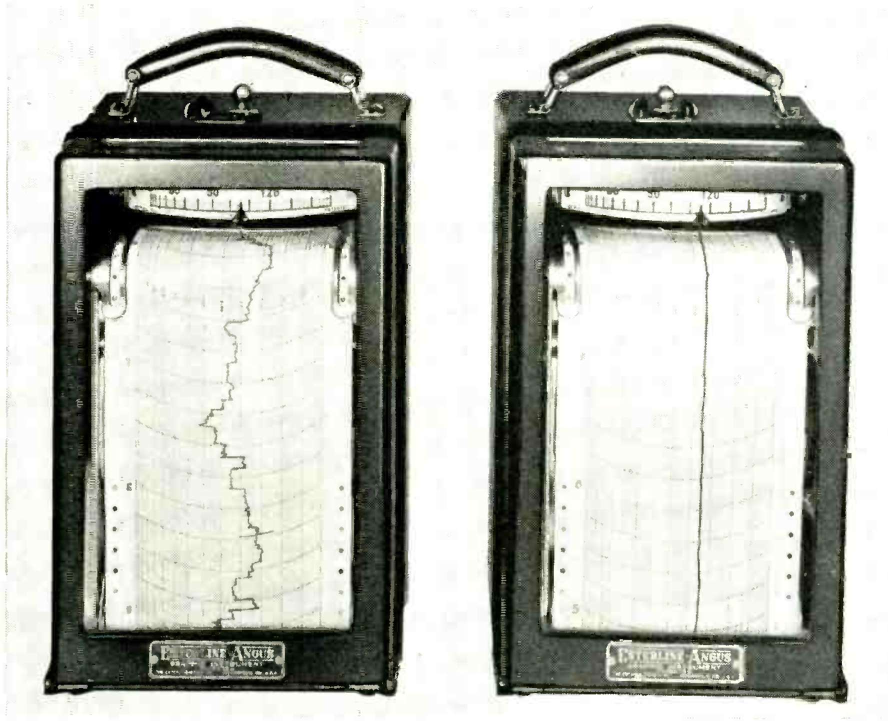
PYE Telecommunications

Pye (New Zealand), Ltd., P.O. Box 2839, Auckland C.1, New Zealand.	Pye Canada Ltd., Ajax, Ontario, Canada.	Pye-Electronic Pty. Ltd., 65 Park Street, Abbotsford, Melbourne, Victoria, Australia.	Pye Ireland, Ltd., Manor Works, Dundrum, Dublin, Eire	Pye Radio & Television (Pty.) Ltd., P.O. Box 10648, Johannesburg, South Africa.

PYE LIMITED • • CAMBRIDGE • • ENGLAND

E2

±1% stable voltage in face of 30% line variations

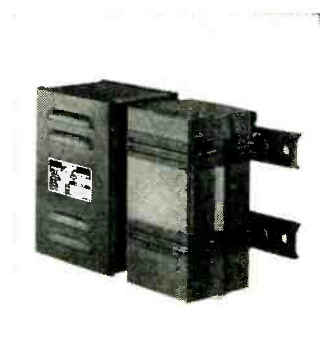


TYPICAL EXAMPLE OF SOLA VOLTAGE REGULATING ACTION. The recording on the left represents a fairly common condition of voltage fluctuation on a 115v line. The chart on the right was made at exactly the same time from the same line. The primary of the Sola regulator was fed the voltage charted on the left, the voltage charted on the right represents its secondary output, regulated to within ±1% of 115v.

Voltage-sensitive electrical and electronic equipment can not operate to performance specifications under conditions of voltage fluctuation. A source of constant voltage can be easily supplied with a Sola Constant Voltage Transformer . . . built-in as a component, or used externally as an accessory.

Among the chief advantages of Sola regulators are: dependable, automatic operation (static-magnetic regulation) . . . substantially instantaneous response (1.5 cycles or less) . . . no maintenance (no moving or expendable parts) . . . and immediate availability (40 stock units in a wide variety of ratings).

STANDARD TYPE CV
Twenty-nine units from 15va to 10kva in a common power line and filament voltage ratings . . . regulation ±1% or less with a total primary variation of 30% . . . for electronic and electrical equipment requiring close regulation.



HARMONIC-NEUTRALIZED TYPE CVH
Six units from 60va to 2kva . . . input range 95-125v, output 115v . . . all the features of the Standard Type CV plus a harmonic neutralizer circuit . . . ±1% regulated voltage with less than 3% harmonic distortion.

ADJUSTABLE, HARMONIC-NEUTRALIZED TYPE CVL
Two ac voltage supply units, 250va and 500va . . . input range 95-125v, output range adjustable from 0-130v . . . regulated ±1%, harmonic distortion less than 3% . . . for general lab work, testing and other applications.

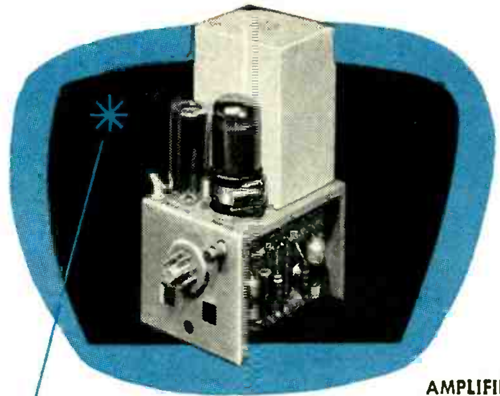
PLATE AND FILAMENT TYPE CVE
Three units in popular power supply ratings . . . a single, compact source of filament and plate supply voltages . . . regulated to within ±3% or less with line voltage variations of 100-130 volts . . . supplied with separate capacitor for chassis mounting.

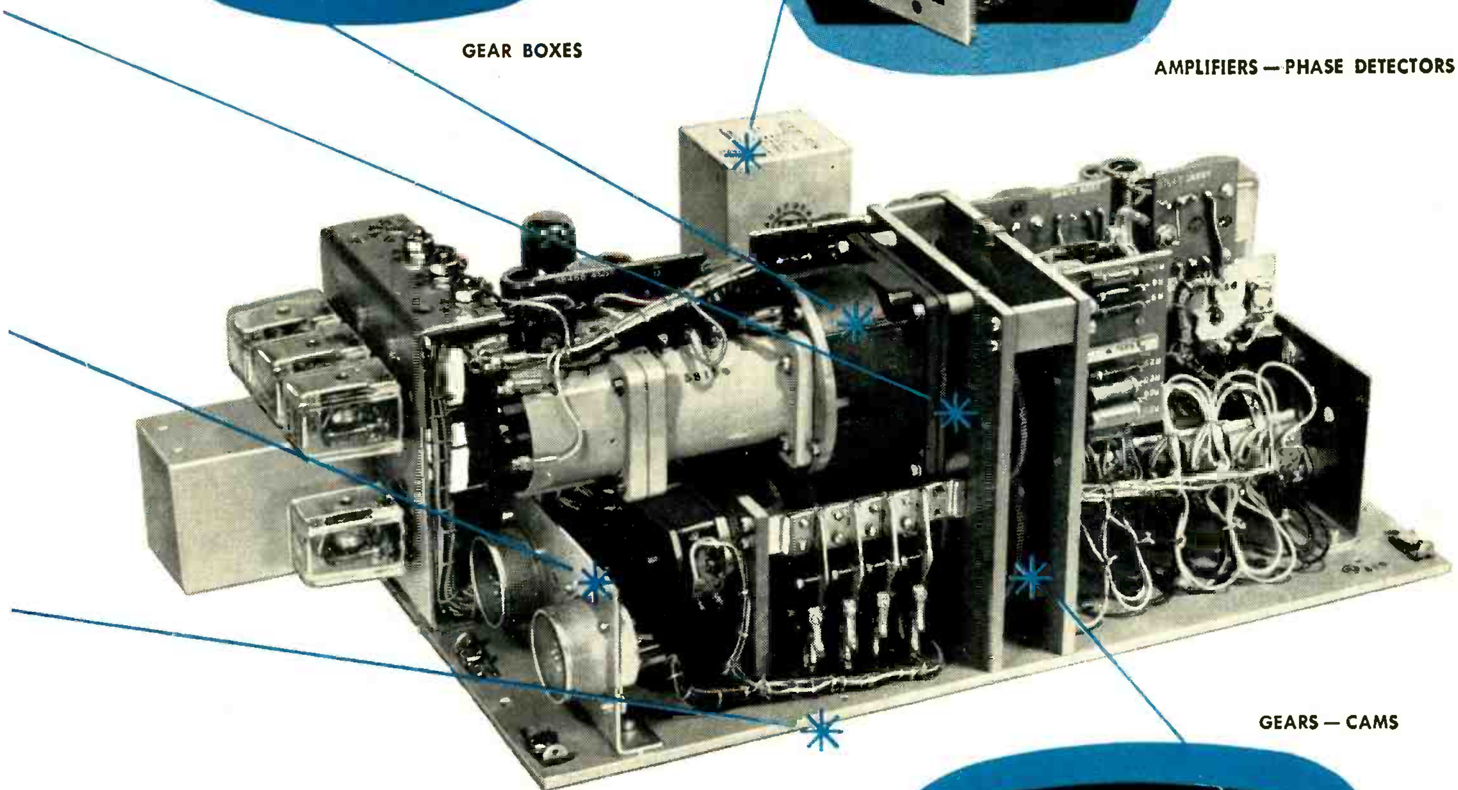
SOLA *Constant Voltage* TRANSFORMERS

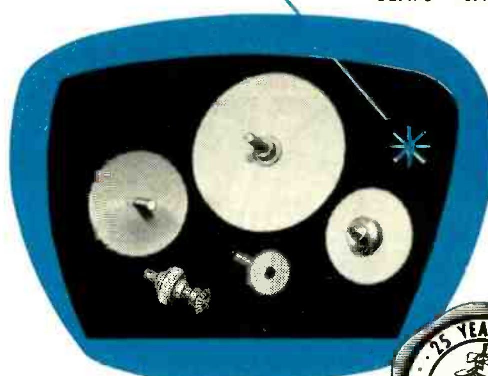
Write for a 28 page bulletin with complete electrical and mechanical specifications on these Sola units. Request BULLETIN 7F-CV-200.

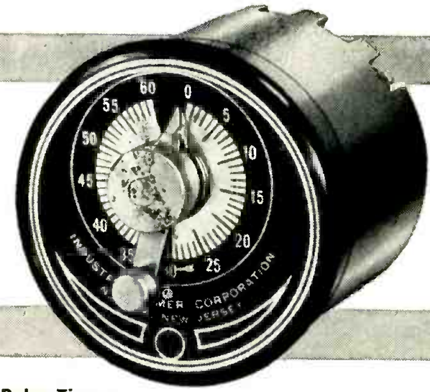
Transformers for: Constant Voltage • Fluorescent Lighting • Cold Cathode Lighting • Mercury Vapor Lighting • Plastic Signs
SOLA ELECTRIC CO., 4633 West 16th Street, Chicago 50, Illinois, Bishop 2-1414 • *BOSTON:* 272 Centre Street, Newton 58, Massachusetts
NEW YORK 35: 103 East 125th Street • *LOS ANGELES 26:* 2025 Sunset Boulevard • *PHILADELPHIA:* Commercial Trust Building
CLEVELAND 15: 1836 Euclid Avenue • *KANSAS CITY 2, MISSOURI:* 406 West 34th Street • *Representatives in Other Principal Cities*


GEAR BOXES


AMPLIFIERS — PHASE DETECTORS

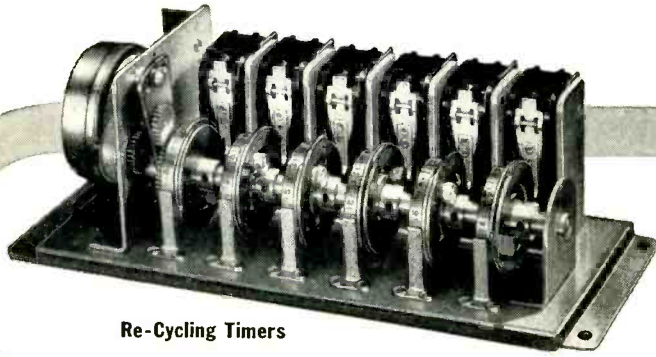



GEARS — CAMS

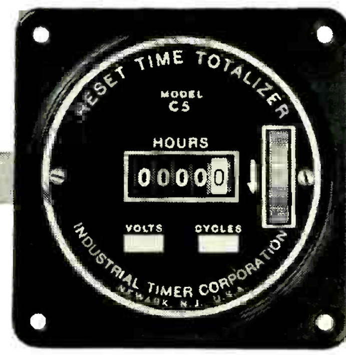


Time Delay Timers

Interval Timers



Re-Cycling Timers



Running Time Meters

MOST COMPLETE LINE OF INDUSTRIAL

TIMERS for automation

The individual requirements of each automation problem are best met by selecting timers designed to perform specific functions. Whatever your timing-control problem, Industrial Timer Corporation can meet it with one of its standard timers, a combination of its standard units, or by designing an entirely new timing element. Our Engineering Department not only originates new designs, but also develops modifications to meet our customers requirements.

We manufacture a complete line of timers in these 4 broad classifications:

TIME DELAY TIMERS • RE-CYCLING TIMERS
INTERVAL TIMERS • RUNNING TIME METERS

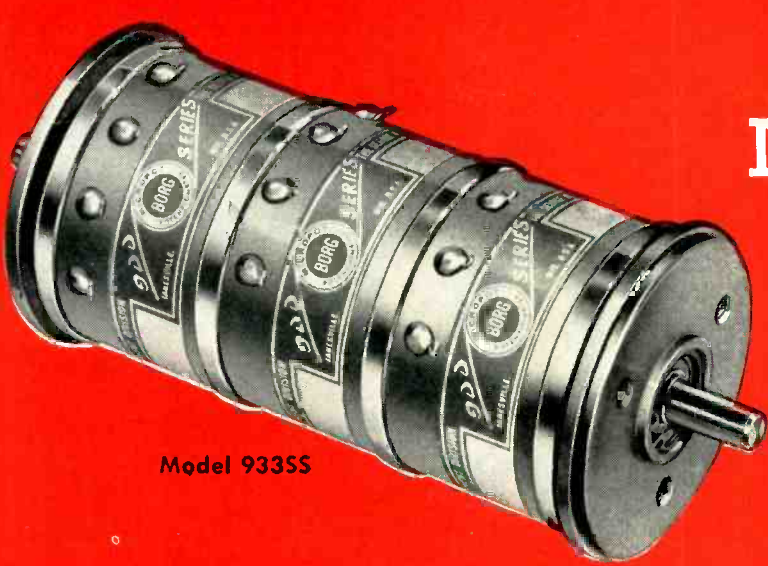
Our large stocks of 17 basic types from which we have developed over 660 combinations to date, enables us to make rapid deliveries in most cases . . . and excellent deliveries on special orders. Our automation timer specialists will be happy to discuss your automation timer requirements. Your inquiries will receive prompt attention.

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

INDUSTRIAL TIMER CORPORATION
131 OGDEN STREET, NEWARK 4, N. J.

BORG MICROPOTS



Model 933SS

the
NEW STANDARD
of precision
multi-turn
potentiometers

BORG 900 SERIES 3-TURN AND 10-TURN MICROPOTS

3-TURN MODELS 931-935 | 10-TURN MODELS 901-903

931S 932BB 933SK 935SS 901SK 902B 903BK 903S

Standard models of Borg 900 Series Micropots offer such flexibility that they meet special design needs. Borg has created a new standard for high-precision, multi-turn potentiometers.

Advantages of the Borg 900 Series include greater accuracy, finer resolution, lower torque, longer life, better performance under severe and excessive vibration, greater adaptability and versatility of application.

Standard models include: 10-turn precision Micropots in 1 to 3 gang models, 3-turn in 1 to 5 gang models, single or double shafts, servo or bushing mounts on either or both ends. Available to designers and engineers in any quantity.

SYNCHRONOUS AND INDUCTION BORG-MOTORS

1000 SERIES 2 POLE AND 4 POLE MODELS
With and Without Gear Trains

These Borg-Motors were designed specifically for instrumentation, control and timing devices. They are recommended for all applications where low torque, constant speed and long life are positive requirements.

For Complete Engineering Data

SERVO-CONTROL
Borg-Motors

Two phase, 115 volt, 400 cps induction type Borg-Motors for servo control applications. Approximate size 1½" diameter x 2" long with a locked rotor torque of 0.82 ounce-inch.

ATTACH TO YOUR LETTERHEAD

BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
JANESVILLE, WISCONSIN

NAME...

TITLE...

Please send complete information and engineering data on items checked.

- ☐ Precision Multi-Turn Potentiometers, 900 Series
- ☐ Borg Standard Potentiometer, 1100 Series
- ☐ Precision Multi-Turn Counting Dials
- ☐ Servo Control Motors
- ☐ Instrument Motors
- ☐ Frequency Standards
- ☐ Contract Manufacturing

BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
JANESVILLE, WISCONSIN

IT'S NEW...IT'S NEWS!

...this 360° Bearing Counter

Smaller and more compact than ever, this new 360° Bearing Counter gives users several *bonus* advantages: It can be either base-mounted, or face-mounted flush with a panel surface. It will run at 1500 rpm constant speed or 2500 rpm on intermittent service . . . and it comes equipped with Geneva Transfer.

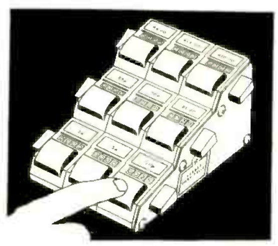
Added Evidence that —

Everyone Can Count on

VEEDER-ROOT

This is another Veeder-Root "first" . . . the latest of one of hundreds of standard and special Veeder-Root Counters for every mechanical and electrical application. What do *you* want to count? Write:

ANOTHER NEW VEEDER-ROOT "FIRST"
New *Vary-Tally* Multiple-Unit Reset Counter gives you quick finger-tip count of anything countable. Comes in any combination up to 6 banks high, and 12 units wide (minimum of 2 units wide). Write for news sheet and prices.

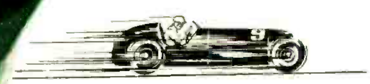


VEEDER-ROOT INCORPORATED • HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

"The Name that Counts"

Takes 22,000 sparks per minute at 140-mph . . . without electrical loss!



Top of Wells' new "Super Go" ignition coil, C-1850, is molded of Resinox 3700. This coil out-performed all others in racing car tests on Utah salt flats . . . losing no spark power at speeds up to 140-mph! Manufacturer claims this coil on passenger cars will give same heat and spark at 80-mph as at 40-mph, saving gas and giving same pickup at both high and low speeds.

RESINOX 3700

Wells Manufacturing Company of Fond du Lac, Wisconsin, needed an ignition coil top that combined tremendous arc and heat resistance with outstanding dimensional stability and toughness. After extensive tests, they selected Monsanto's thermosetting molding powder, Resinox 3700. Speed test results proved the wisdom of their choice!

Resinox 3700 is the ideal all-around material for magneto ignition, motor control and electronic circuits, and other electrical applications.

1. It combines high arc-resistance with excellent dimensional stability. Eliminates undesirable after-shrinkage.
2. It has relatively good impact resistance and outstanding moldability, including good transfer molding properties.
3. It offers superior heat resistance.

Perhaps Resinox 3700 is exactly what *you* need to solve an electrical equipment problem. Write today for full information!

Resinox: Reg. U. S. Pat. Off.

MONSANTO

SERVING INDUSTRY...WHICH SERVES MANKIND

MONSANTO CHEMICAL COMPANY, Plastics Division, Room 2502, Springfield 2, Mass.
Please send me complete information on Monsanto's new Resinox 3700 arc-resistant material.

Name & Title ______________________

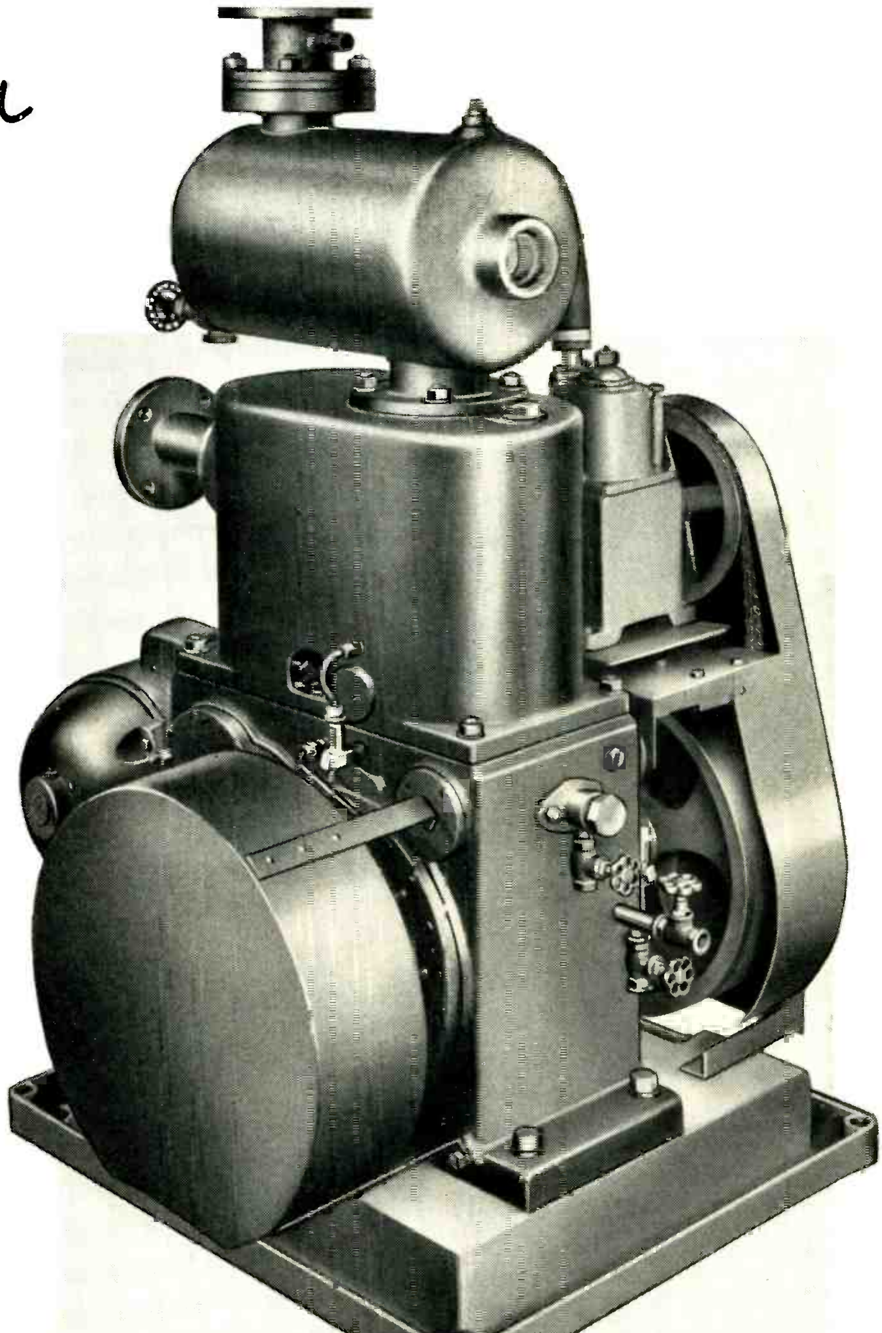
Company ______________________

Address ______________________

City, Zone, State ______________________

NRC Rotary Gas Ballast Pumps

Shave Minutes Off Pump-Down Time

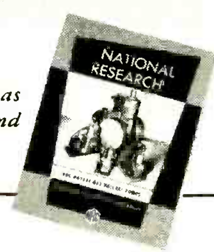


Experience proves NRC high vacuum Rotary Pumps pump down faster. Employing the revolutionary Gas Ballast principle, they're more efficient both mechanically and volumetrically especially at low pressures. They permit minimum blow back and leakage past the pumping members. Since vapors won't condense in this pump, fast pump down time is always maintained.

Dollars Off Your Pumping Costs

The efficiency of NRC Rotary Pumps makes for substantial savings. NRC's special inlet design screens out dust and foreign matter — protects pump parts from undue wear. Dynamic counter-balancing results in minimum vibration. Easier to service. More dependable to operate. Users report long life, low operating costs under the most adverse conditions.

Send today for new Bulletin explaining the Gas Ballast principle plus complete operating and construction data.

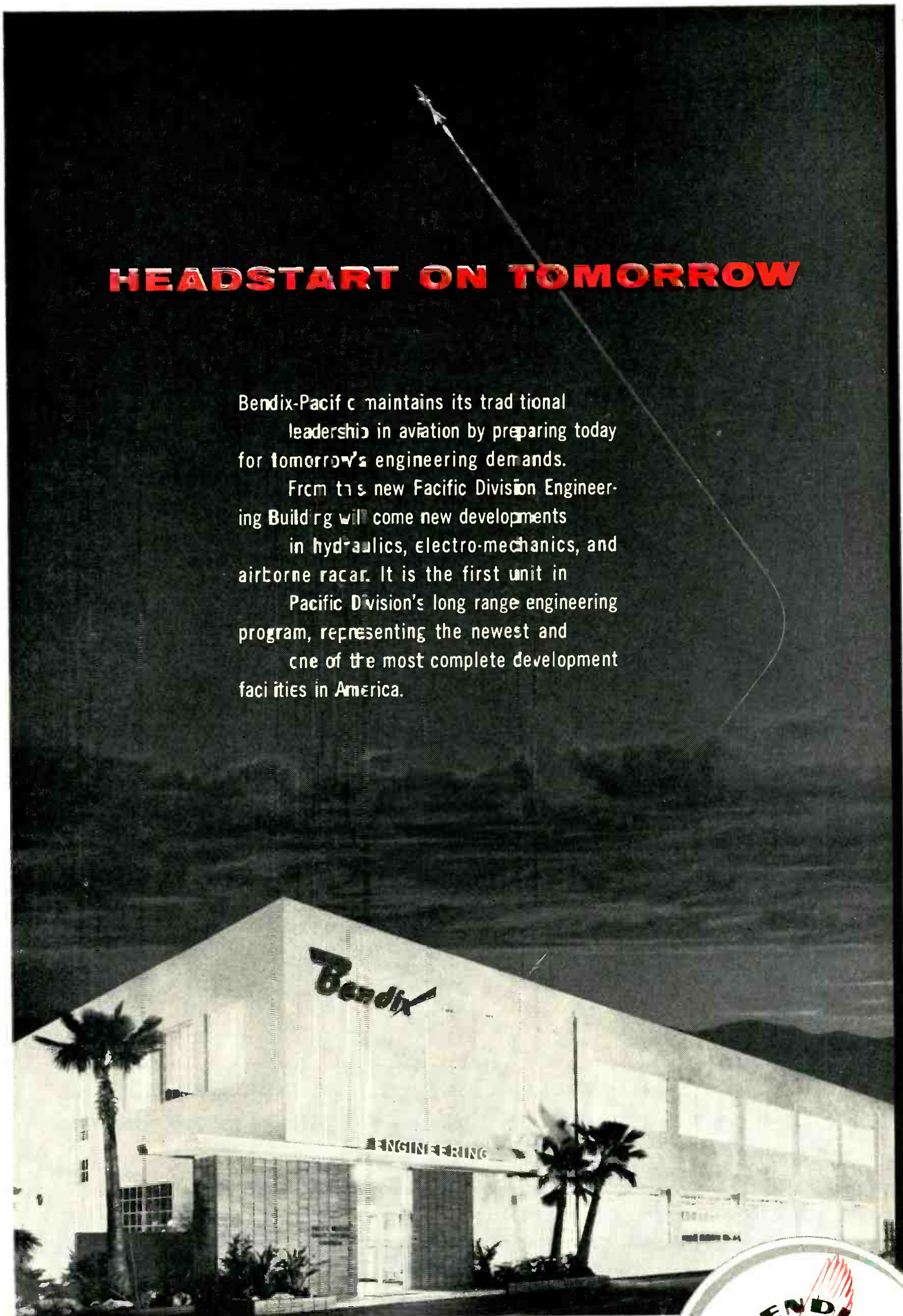


NRC

National Research Corporation

Equipment Sales Subsidiary: NARESCO EQUIPMENT CORPORATION
160 Charlemont St., Newton Highlands 61, Mass.
OFFICES: PALO ALTO, CALIF. • CHICAGO • CLEVELAND • NEW YORK CITY

HEADSTART ON TOMORROW



Bendix-Pacific maintains its traditional leadership in aviation by preparing today for tomorrow's engineering demands. From this new Pacific Division Engineering Building will come new developments in hydraulics, electro-mechanics, and airborne radar. It is the first unit in Pacific Division's long range engineering program, representing the newest and one of the most complete development facilities in America.

PACIFIC DIVISION • Bendix Aviation Corporation
11600 Sherman Way, North Hollywood, California

BENDIX PACIFIC

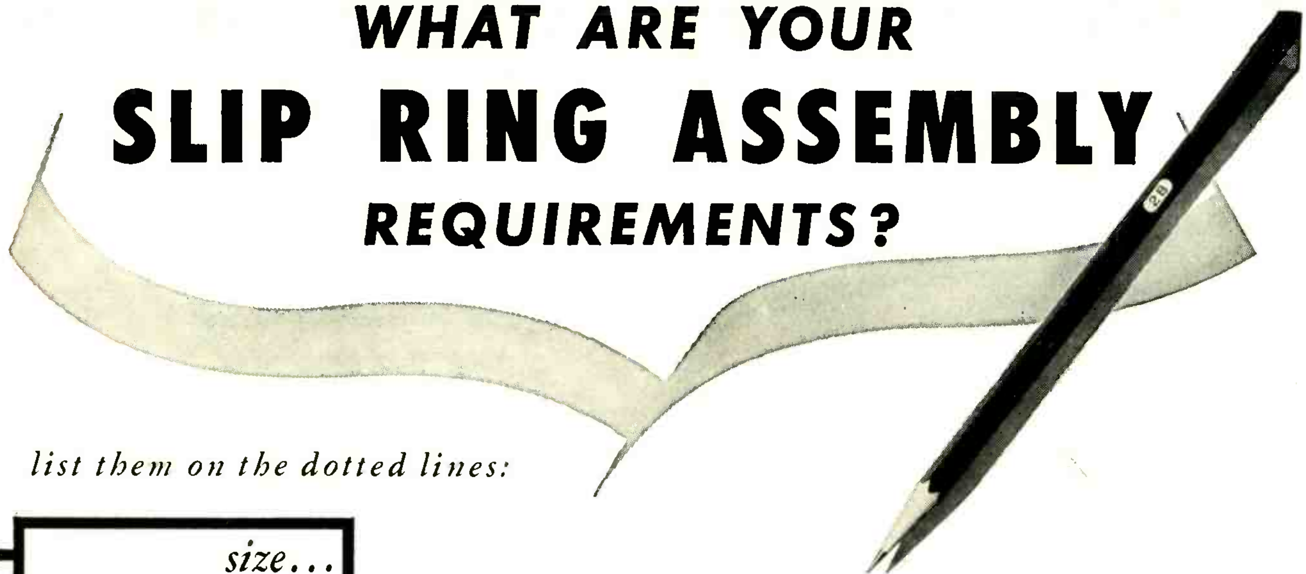
THE NAME Bendix AVIATION CORPORATION MILLIONS TRUST

East Coast Office: 475 5th Ave., N.Y. 17

Export Division: Bendix International 205 E. 42nd St., N.Y. 17

Canadian Distributors: Aviation Electric, Ltd., Montreal 9

WHAT ARE YOUR
SLIP RING ASSEMBLY
REQUIREMENTS?



list them on the dotted lines:

size... ______________________________________

____

Complete PMI Slip Ring Assemblies we have made range in size from .080″ diameter by .450″ long to 40″ diameter by 8′ high, weighing as much as 3100 lbs. We can make them smaller or larger — tailored to your exact requirements.

application... ______________________________________

____

PMI Slip Ring Assemblies surpass severe shock, vibration and water test conditions of MIL-E-2036A and MIL-T-17113 . . . provide trouble-free operation at 60,000 feet, resist fungus and corrosion.

electrical data... ______________________________________

____

PMI Slip Ring Assemblies have a Voltage Range from microvolts to more than 20,000 volts corona free; Current Range from microamps to more than 600 amps; number of circuits more than 500; typical Brush life 14 million linear feet; Frequency from DC to more than 60 mc.; Noise Level under all customer specifications has been met or bettered.

quantity... ______________________________________

____

Production on small Synchro Slip Ring Assemblies runs as high as 1000 per day. Ample manufacturing facilities make low-cost large runs possible.

mail this page TODAY *for immediate attention to your problem...*

NAME .... **POSITION** ....

COMPANY .... **ADDRESS** ....

If your requirements are in the specification stage or in production, PMI engineers will submit, at your request, a design layout or evaluate your present design layout for possible measures of economy or efficiency. Our diversified experience in designing and manufacturing Slip Ring Assemblies can save you time and money. Mail this page today.

PMI **P M INDUSTRIES, INC., - STAMFORD • CONN.**

DESIGN • DEVELOPMENT • PRODUCTION • ELECTRO-MECHANICAL ASSEMBLIES

WHY generate when you can convert?

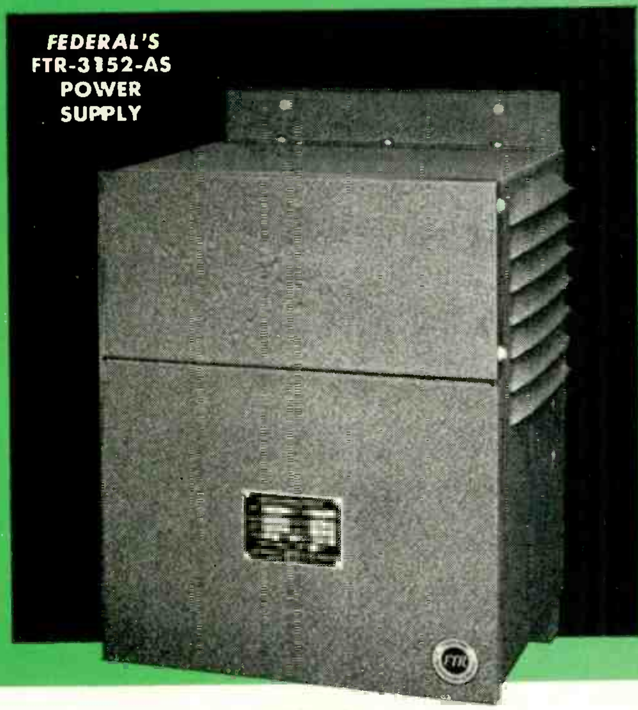
GET DC DIRECTLY FROM AC

Cut costs, maintenance and replacements with

Federal

SELENIUM RECTIFIER EQUIPMENTS

famous for steady, long-life industrial power supply



NO costly, bulky, moving equipment to buy . . . no expendable parts to replace frequently . . . virtually no maintenance!

No wonder Federal's compact, silent, rugged, ever-dependable selenium rectifiers are the economical and efficient way to get DC . . . for chucks, brakes, clutches, drums, pulleys, relays, circuit-breakers, motors and many other applications . . . for all DC needs of the machine tool industry.

Federal Equipments are ready to connect to your AC source . . . ready to deliver uninterrupted service. Powered by Federal's completely inert selenium rectifiers, their life is practically unlimited. All are conservatively rated . . . with a wide margin of safety to withstand momentary heavy overloads.

If the DC output you need is not listed in the table, Federal will gladly design and build to meet any specific requirements. Fill out and mail the attached coupon today!

RATINGS

CODE NUMBER	A-C INPUT			D-C OUTPUT	
	VOLTS	PHASE	CYCLES	VOLTS	AMPS.
FTR 3115-JS	115	1	50/60	115	1
FTR 3116-BS	115	1	50/60	115	5
FTR 3117-HS	115	1	50/60	115	10
FTR 3117-JS	230	1	50/60	115	10
FTR 3152-AS	220 or 440	3	50/60	115 230	4.4 2.2
FTR 3153-AS	220 or 440	3	50/60	115 230	6.6 3.3
FTR 3154-AS	220 or 440	3	50/60	115 230	8.8 4.4
FTR 3155-AS	220 or 440	3	50/60	115 230	13 6.5
FTR 3228-BS	220 or 440	3	50/60	115 230	26 13

MAIL COUPON TODAY for data on available FTR equipments, or any desired rating:

"America's first and largest manufacturer of selenium rectifiers"

Federal

Telephone and Radio Company

A Division of INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
Selenium-Intelin Department: 100 Kingsland Road, Clifton, N. J.
In Canada: Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., N.Y.

Federal Telephone and Radio Company
Selenium-Intelin Dept., Clifton, N. J. Dept. E-313

☐ Send complete data on FTR code numbers indicated below:

☐ Send preliminary data on the following rating:

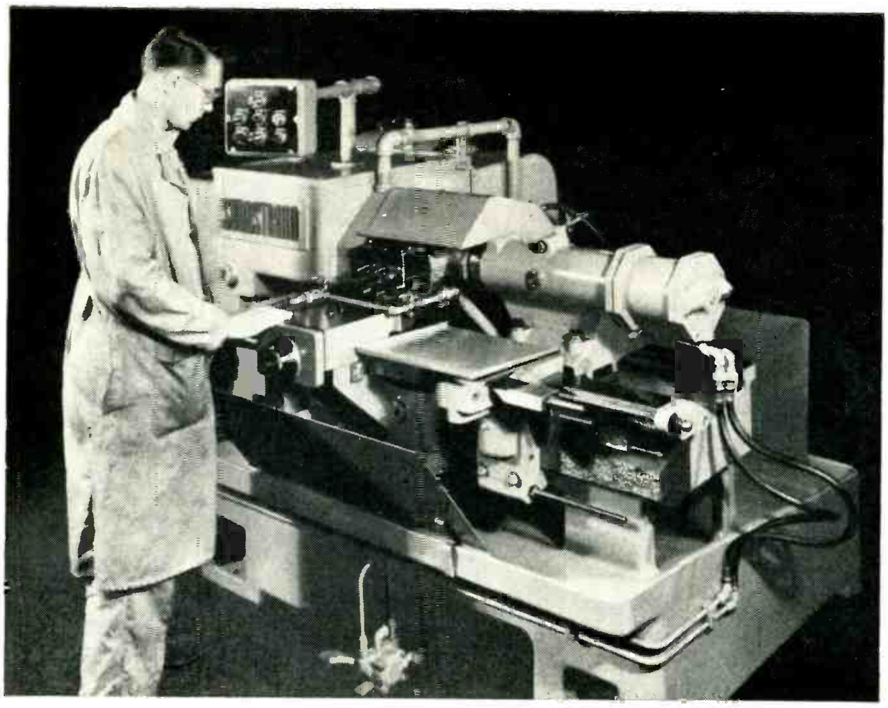
FTR. . . . .

FTR. . . . .

Company____________________

Address____________________

Signature____________________

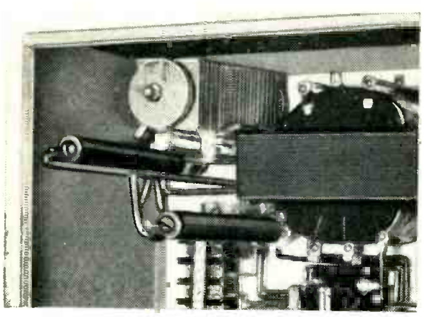


FASTER STARTING AND STOPPING HELPS THIS AUTOMATIC LATHE TO PRODUCE MORE

General Electric Selenium Rectifiers Help Make This Lathe More Productive

Speeding up starting and stopping operations has increased the productivity of many of today's finest machine tools. In the Sunstrand automatic lathe pictured above, an electric brake and clutch combination starts and stops the machine spindle. Another electric brake provides a fast stop when the tool carriage is advanced to the work, or backed off to the unloading position.

D-C POWER to operate the electric brakes and clutch on this lathe is supplied by General Electric selenium rectifiers shown in the smaller photograph. Their high quality (see C.E. Hamann's article at right) makes G-E selenium rectifiers ideal for almost all machine tool applications.



D-C POWER for the lathe's clutch and brakes comes from this selenium rectifier.

TOP PERFORMANCE of G-E selenium rectifiers is the result of a unique "evaporation" process and careful inspection and testing. Besides providing stacks with exceptionally low forward voltage drop and low reverse leakage, this process assures greater uniformity of these characteristics among different stacks. These qualities last in service. On test in the laboratory, and on-the-job in almost every field of application, G-E selenium rectifiers are demonstrating their extremely slow aging.

OTHER APPLICATIONS for G-E selenium rectifiers include supplying power to operate d-c relays in various control circuits and as components in electronic equipment. A complete range of ratings is available in either open stacks or various types of sealed cases to meet special operating conditions. Contact your nearest G-E Apparatus Sales Office for complete information, or write Section 461-33, General Electric Company, Schenectady 5, New York.

You can put your confidence in—

GENERAL ELECTRIC

METALLIC RECTIFIER FACTS FOR ENGINEERS

Quality

by C. E. Hamann

One of the most overworked terms used in the selenium rectifier industry is "high quality." Every manufacturer claims "high quality" for his product. Every user wants "high quality" in the selenium components he buys because the quality of the end device can be no higher than that of the components assembled into it.

There are many yardsticks for measuring the quality of a selenium stack. Electrical characteristics, for example: low forward drop and low reverse leakage. Often one is sacrificed in favor of the other.

LOW FORWARD DROP

LOW LEAKAGE

UNIFORMITY

STABILITY

RELIABILITY

Which "yardstick" measures quality?

Real quality insures that both the forward and the reverse characteristics are good.

Uniformity of characteristics is another yardstick. If the characteristics vary from stack to stack the performance of the end equipment will be questionable.

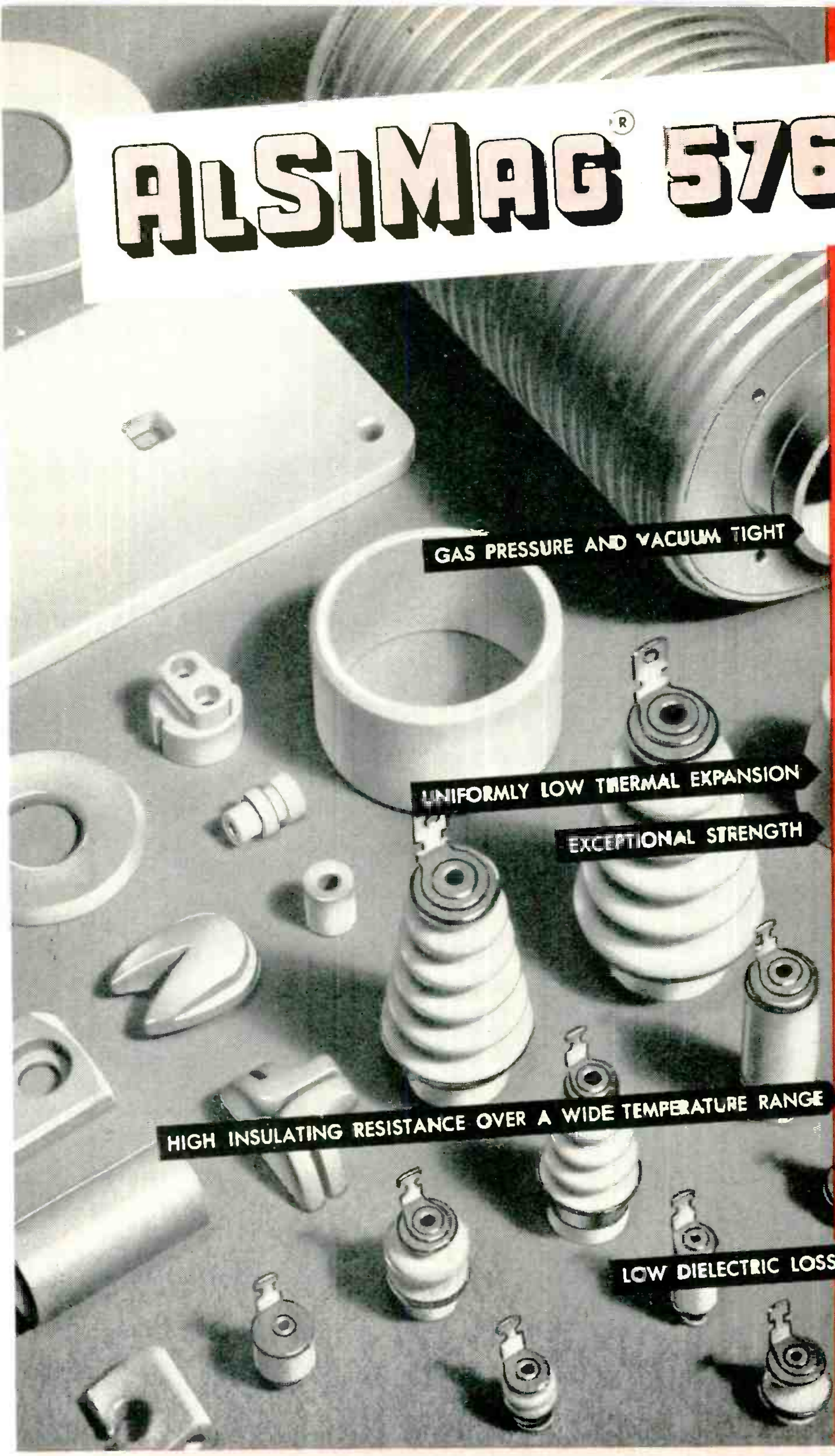
Stability is another important standard in determining quality. The initial characteristics must be good, but they must stay good and not deteriorate with time and use.

Reliability is still another measure of quality. No matter how liberal the manufacturers replacement policy, frequent failures in the field are costly to the equipment manufacturer, and annoying to the equipment user.

All of these yardsticks must be considered carefully in determining quality. To really earn the title of "high quality" a selenium stack must measure up to a high standard of performance by every one of these yardsticks.

C. E. Hamann

General Electric Company



AN ECONOMICAL HIGH STRENGTH ALUMINA CERAMIC

Meets L-5A Requirements of JAN-I-10 Specifications

Note These Advantageous Properties

PROPERTY		UNIT	ALSIMAG 576 L-5A
Water Absorption			Impervious
Specific Gravity			3.4
Density		Lbs. per cu. in.	.123
Standard Body Colors			White
Alternative Body Colors			Pink 513 (L-5A)
Safe Temperature at Continuous Heat		°C.	1 100
		°F.	2012
Hardness		Mohs' Scale	9
Thermal Expansion Linear Coefficient		Per °C. 25-700°C.	7.5×10^{-6}
Tensile Strength		Lbs. per sq. in.	20 000
Compressive Strength		Lbs. per sq. in.	140 000
Flexural Strength		Lbs. per sq. in.	40 000
Dielectric Strength (step 60 cycles) Test discs ¼" thick		Volts per mil	250
Volume Resistivity at Various Temperatures	25°C.	Ohms per centimeter cube	$>10^{14}$
	100°C.		2.0×10^{13}
	300°C.		5.0×10^{10}
	500°C.		1.0×10^{8}
	700°C.		3.0×10^{6}
	900°C.		4.0×10^{5}
Te Value		°C.	800
		°F.	1472
Dielectric Constant	60 Cycles		8.4
	1 M.C.		8.3
	10 MC.		8.2
	100 MC.		8.1
Power Factor	60 Cycles		.0013
	1 MC.		.0007
	10 MC.		.0007
	100 MC.		.0008
Loss Factor	60 Cycles		.011
	1 MC.		.006
	10 MC.		.006
	100 MC.		.006

QUICK DELIVERY IN ANY DESIRED QUANTITY. AlSiMag 576 parts can be made in the full range of sizes, designs and processes that are normally available in other AlSiMag ceramics.

53RD YEAR OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

A Subsidiary of Minnesota Mining and Manufacturing Company

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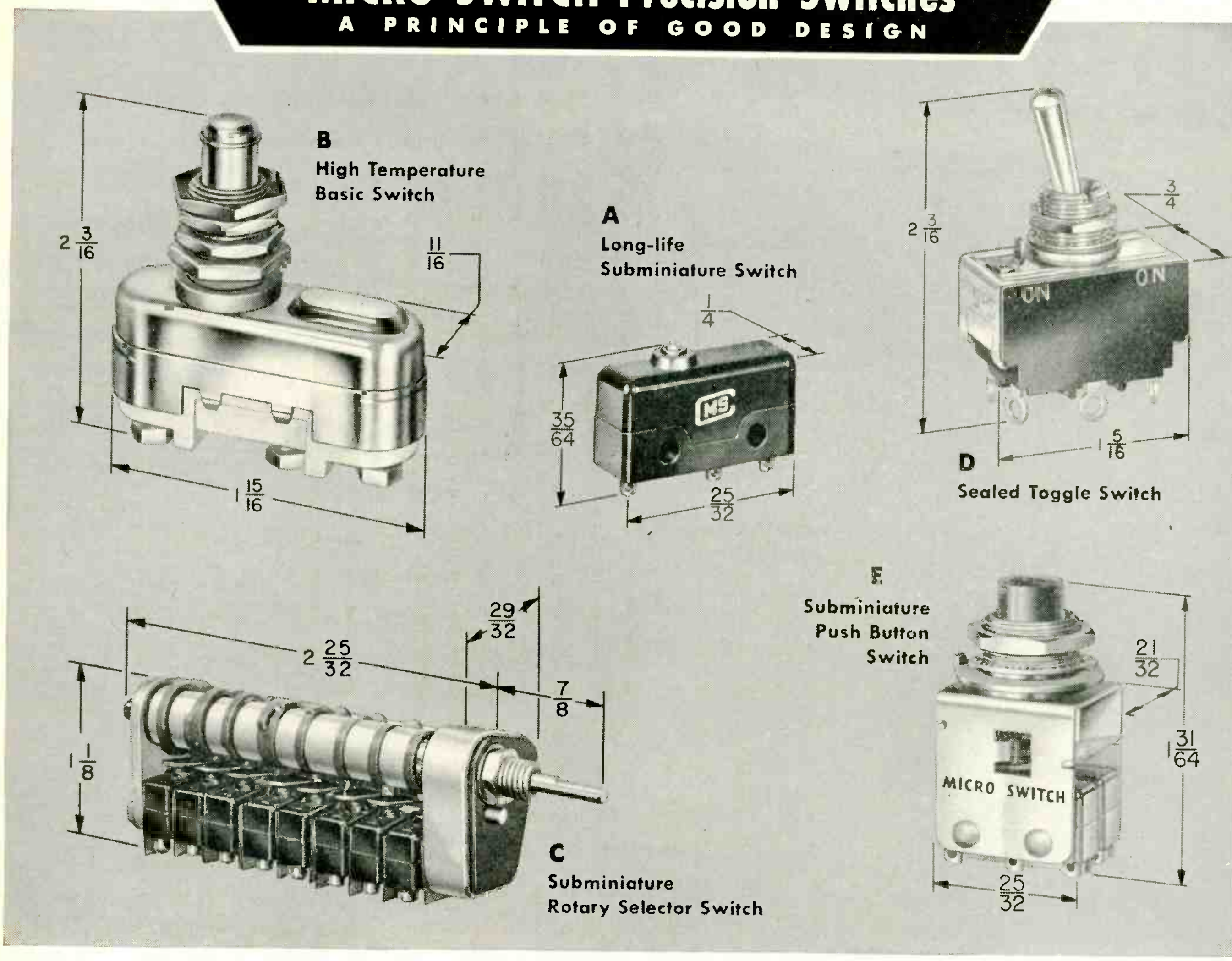
DIE PRESSED • EXTRUDED

MACHINED • METALLIZED

Bulletin 524, sent on request, shows standard metallized hermetic terminals of this material. Custom made items can be supplied promptly. Send blueprint.

MICRO SWITCH Precision Switches

A PRINCIPLE OF GOOD DESIGN



There are uses unlimited for these small MICRO SWITCH precision switches in electronic devices and instruments

A This subminiature switch is capable of operations in excess of 20 million. It is an improved type of the basic subminiature switch and is available with either solder post or turret type, wrap-around terminals.

B The high temperature basic switch will operate satisfactorily in a temperature range of from −50° to +1000°F. Originally designed for jet aircraft applications, it is equally useful for any application which requires a high-temperature switching component.

C The subminiature rotary selector switch uses from 2 to 8 single-pole, double-throw subminiature switches to control from 2 to 16 electrical circuits. It permits 2 to 8 switching positions with spring or manual return to neutral position.

D This sealed toggle switch is supplied with an external panel seal and an internal bushing seal below the bat handle. It has a bushing for panel mounting and may also be supplied with keying tab.

E The subminiature push button switch assembly is composed of two single-pole, double-throw subminiature switches. The plunger provides an unusually good snap make and break. Available with red or black plastic buttons and either solder post or turret-type, wrap-around terminals.

MICRO SWITCH *engineering service, fully experienced in every type of switch use, is available at 16 branch offices to consult with you on your switch application problem. A call to the branch office near you may save time and money. There is no obligation.*

MICRO SWITCH provides a complete line of extremely reliable, small-size, high-capacity, snap-action precision switches and mercury switches. Available in a wide variety of sizes, shapes, weights, actuators and electrical characteristics. For all types of electrical controls.

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

FREEPORT, ILLINOIS

DESIGN and PRODUCTION NEWS

FOR ELECTRICAL AND ELECTRONIC ENGINEERS

Published by TECHNICAL SERVICE, Chemical Manufacturing Division, The M. W. KELLOGG Company JUNE-JULY, 1954

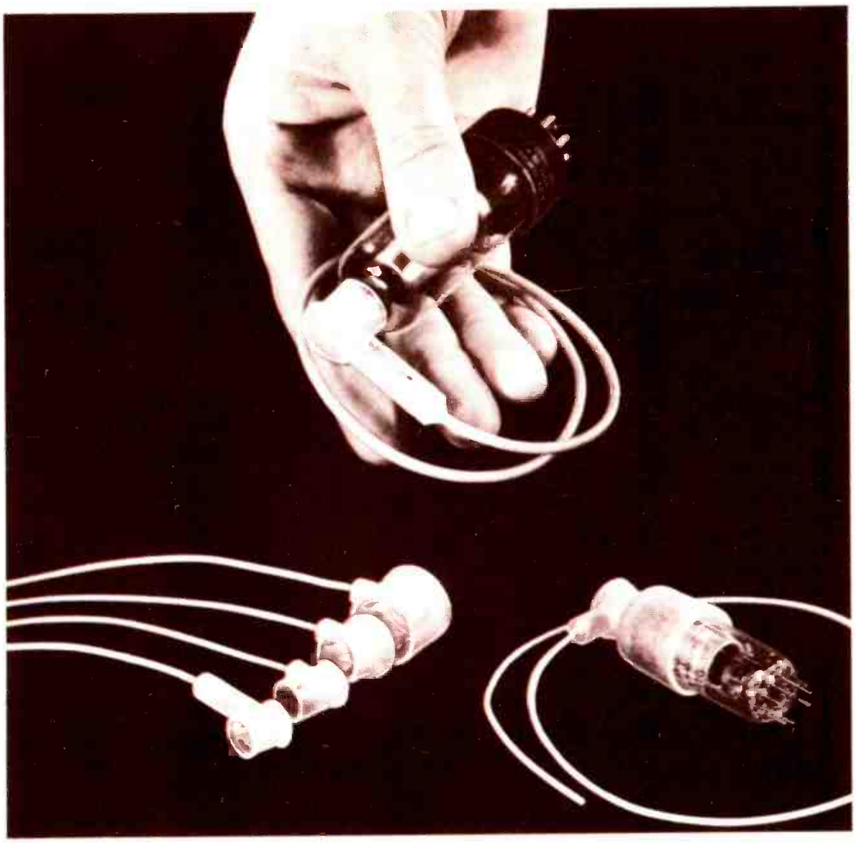
New Cap Connectors of KEL-F® Polymer Widen Tube Service Range... Cut Altitude, Moisture "Arc-Over"!

Exceptional moldability of KEL-F and special equipment permit the "insert" molding of grid cap leads and resistors into a one piece insulated jacket. Conventional wire holes are eliminated, preventing insulation "pull back". Zero moisture absorption of KEL-F polymer and the elimination of wire holes precludes moisture collection which formerly caused "arc over" under high humidity.

The high insulation resistance and dimensional stability of KEL-F polymer over a wide temperature range (minus 320°F to plus 390°F) permits use of these connectors in critical installations subjected to extremes of temperature.

Alden Products Company, Brockton, Mass., uses KEL-F trifluorochloroethylene and a special molding technique to produce an entire series of connectors. Variety includes top- or side-connected leads, with or without resistors.

For further information ask for Application Report E-124



NEW LOWER PRICES FOR "KEL-F" POLYMERS OPEN UP MANY NEW APPLICATIONS POSSIBILITIES!

This is the fourth important price reduction since the introduction of KEL-F polymer products in 1948. It cuts prices up to 25% in ton lots, and as much as 42% for small quantities nominally used for experimental work.

The reduction is made possible by the rapidly expanding acceptance of KEL-F polymers and the manufacturing economies achieved in Kellogg's new production facilities.

NEW PRICE SCHEDULE—Effective May 17, 1954

	High Density	Low Density	Plasticized
1-99 pounds	$10.00	$9.50	$11.00
100 - 1999 pounds	9.50	9.00	10.50
2000 pounds and over	9.00	8.50	10.00

F.O.B. Jersey City

(SEE REVERSE SIDE)

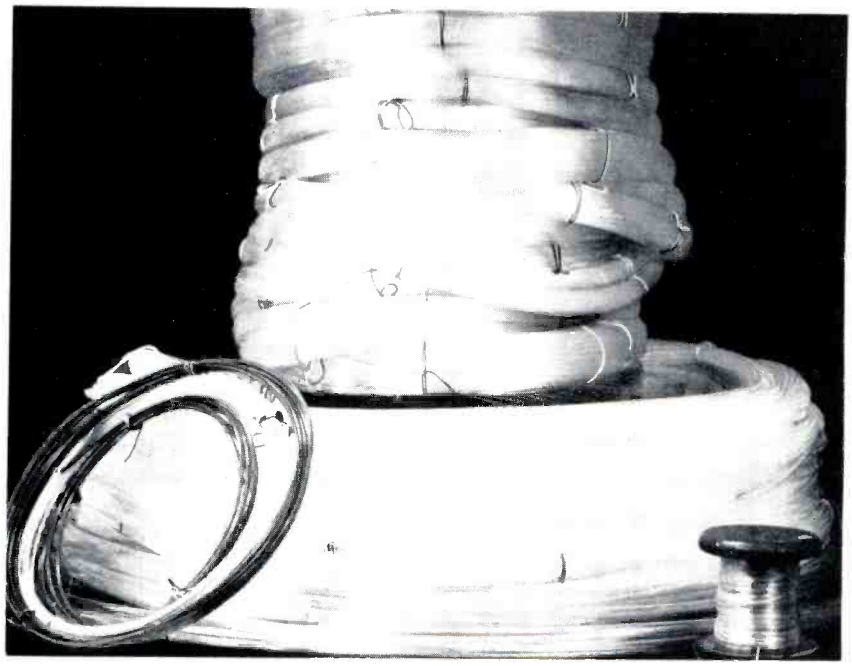
® *Registered trade-mark for The M. W. Kellogg Company's fluorocarbon Polymers.*

KEL-F
TRIFLUORO CHLORO ETHYLENE POLYMERS
KEL-F
MOLDING POWDERS
KEL-F
FLUORO CHLORO CARBON PLASTIC
KEL-F
DISPERSION COATINGS
KEL-F
TRIFLUORO CHLORO ETHYLENE POLYMERS
KEL-F
OILS WAXES GREASES

DESIGN and PRODUCTION NEWS

CONTINUED FROM PRECEDING PAGE

"Spaghetti", Flexible in Sub-sub-zero Temperature, Protects Against Oils, Chemicals and Moisture!



This smooth extruded "spaghetti" sleeving for aircraft wiring made of KEL-F polymer, is in a class by itself. Not only does it have a high dielectric strength of from 2500 to 5000 volts per mil, and excellent arc resistance, but it will stay pliable and resist cracking and splitting even after prolonged use at temperatures from minus 140° to 300° F. The unique physical and chemical properties of this fluoro-chloro-carbon plastic permits the lightweight but tough sleeving to remain unaffected under constant exposure to chemicals, oils, or aircraft fuels.

Resistoflex Corporation of Belleville, N. J., manufactures several grades of "spaghetti" and rigid sleeving, made from KEL-F polymers, under the name Fluoroflex "C"**.

** *Trade mark of Resistoflex Corporation*

For further information ask for Application Report E-105

Molders & Fabricators of the Month

Leading molders, extruders and fabricators specialize in the production of materials and parts made of "Kel-F" . . . each month this column will spotlight several of these companies with their principal services and products.

International Resistance Company

Philadelphia, Pa.

Extrusion, Compression, Transfer & Injection Molding
Terminals, Resistors, electronic components
Extruded Rod & Tube
Molded Rod, Tube & Sheet

Surprenant Manufacturing Company

Clinton, Mass.

Extrusion
Insulated Wire
Extruded Rod, Tube & Spaghetti
Tape, Strip & Monofilament

Tri Point Manufacturing & Developing Co.

Brooklyn, N. Y.

Machining

The United States Stoneware Company

Akron, Ohio

Corrosion Control
Dispersion Coating

Recent Significant KEL-F Polymer Developments . . .

"Lug" type pressure rupture discs now use extruded film not only to protect discs against corrosion damage, but as pressure and vacuum seals.

Wavemeter test probes (microwave control) use molded insulation for consistent performance in high humidity and under thermal cycling.

Heater coils and plates for severe chemical service are protected with "baked on" coatings of KEL-F polymer dispersions.

Indexed commutators for computors now consist of a molded plastic cylinder with intricate conductive inserts. High dielectric and non-carbonization of polymer improves performance.

Visit the KEL-F POLYMER EXHIBIT at the 6th Annual Plastics Show. June 7-10 • Cleveland, Ohio

For complete information regarding any item mentioned in DESIGN AND PRODUCTION NEWS, ask for detailed APPLICATION REPORTS, write

Technical Service
CHEMICAL MANUFACTURING DIVISION
THE M. W. KELLOGG COMPANY

P. O. Box 469, Jersey City 3, N. J.
or offices in Boston, Chicago, Dayton, Los Angeles and New York

KELLOGG — SUBSIDIARY OF PULLMAN INCORPORATED

KEL-F
TRIFLUORO CHLORO ETHYLENE POLYMERS
KEL-F
MOLDING POWDERS
KEL-F
FLUORO CHLORO CARBON PLASTIC
KEL-F
DISPERSION COATINGS
KEL-F
TRIFLUORO CHLORO ETHYLENE POLYMERS
KEL-F
OILS WAXES GREASES

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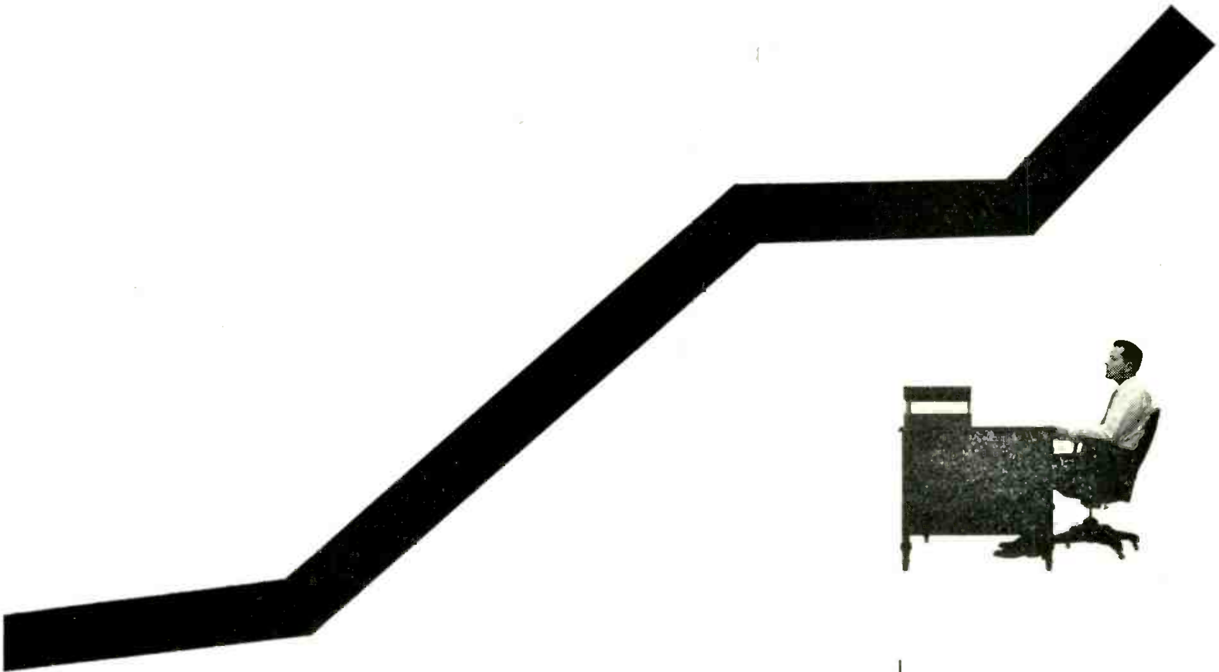
To **1954** *Engineers...*

Where will you be in 1964?



Will you have shifted from job to job, seeking the "right spot" and never finding it? Or will you have moved ahead steadily at one company, gaining recognition and promotion through achievement?

The answer to those questions depends on more than ability and ambition. It also depends on opportunity . . . opportunity to show what you can do . . . opportunity to make hard work and accomplishment pay off in promotion . . . the kind of opportunity you get at Lockheed, working on such diversified projects as huge luxury airliners, jet transports, nuclear energy, fighters, bombers, trainers, vertical rising aircraft and other classified activities.

There are other important yardsticks with which to measure a job: salary, extra employee benefits, living conditions. All standards that tell you *today's* job is a good one; all excellent at Lockheed.

But it is opportunity that makes a Lockheed job a position of the future – a position that in 1964 will enable you to look back on a record of achievement you earned *because you had the opportunity.*

Lockheed invites inquiries from Engineers who seek opportunity for achievement. Coupon below is for your convenience.

Lockheed has career openings for:

Electro-Mechanical Design Engineers
with a degree in Electrical Engineering and extensive experience in circuit analysis and design and electro-mechanical experience in servomechanisms and autopilots

Electrical Design Engineers
with a degree in Electrical Engineering and experience in aircraft circuit analysis and electrical design

Electrical Installation Design Engineers
with a degree in Mechanical or Electrical Engineering and experience in design of electrical equipment installation

Servomechanisms and Autopilot Research Engineers
with a degree in Electrical Engineering and experience in research and testing of servomechanisms and autopilots

Instrumentation Engineer
with a degree in Electrical Engineering and experience in instrumentation for flight testing

Thermodynamicists
with a degree in Aeronautical or Mechanical Engineering and extensive experience in aircraft thermodynamics

Lockheed

AIRCRAFT CORPORATION
BURBANK • CALIFORNIA

Mr. E. W. Des Lauriers, Dept. EE-6
Lockheed Aircraft Corporation
1708 Empire Avenue, Burbank, California

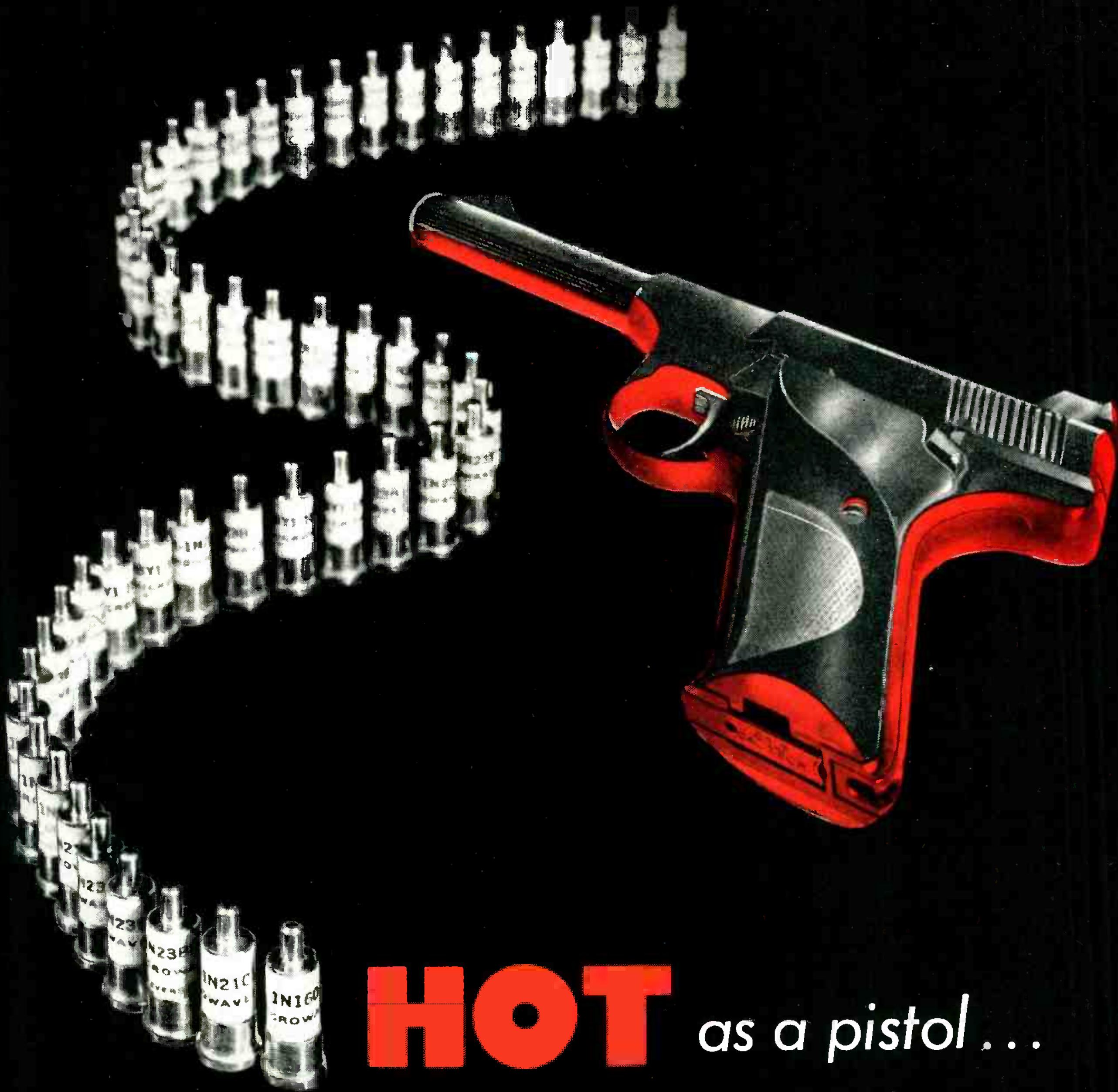
Dear Sir:
Please send me your Lockheed brochure describing life and work at Lockheed in Southern California.

Name

Field of engineering

Street Address

City and State



HOT *as a pistol . . .*

TYPE	CENTER FREQUENCY (mc)	MAX. CONVER. LOSS (db)	MAX. NOISE RATIO (times)	VSWR (max.)	IF IMPEDANCE (OHMS)
*IN21B	3060	6.5	2.0	–	200–800
*IN21C	3060	5.5	1.5	–	200–800
*IN150	6750	6.0	2.0	1.5	250–500
*IN160	6750	6.5	2.7	–	200–800
*IN23B	9375	6.5	2.7	–	200–800
*IN23C	9375	6.0	2.0	1.5	325–475
*IN149	9375	5.5	1.5	1.5	325–475
IN78	16000	7.5	2.5	–	325–625
IN26	23984	8.5	2.5	–	300–600
IN53	>30000	8.5	2.5	–	400–800
IN32	3295	Fig. Merit >85		Video Impedance: 4K–22K	

* Also available with reversed polarity

Designers and producers of microwave receivers are achieving lower noise figures over broader bandwidths plus longer life by specifying Microwave Associates, Inc., silicon diodes. High quality, low cost diodes are available for all microwave bands.

For super low noise performance, specify the 1N149 at X-band and the 1N21C at S-band. The new RF adjusted 1N32 outperforms the field for video use at S-band.

Write for catalog E54S, describing our complete silicon diode line, MICROWAVE ASSOCIATES, Inc., 22 Cummington Street, Boston 15, Mass. Telephone, COpley 7-4441.

μA MICROWAVE Associates INCORPORATED

Arthur Marquis
Design and Application Engineer

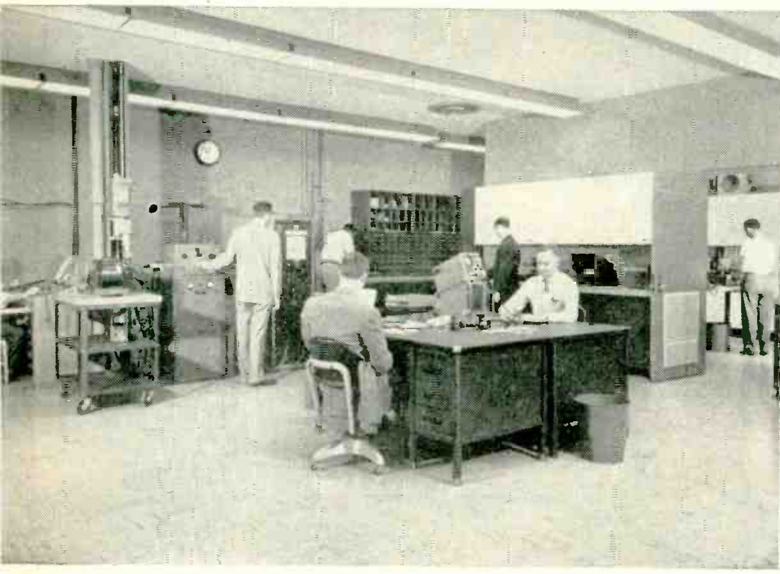
Arthur R. Kozlowski
Design and Application Engineer

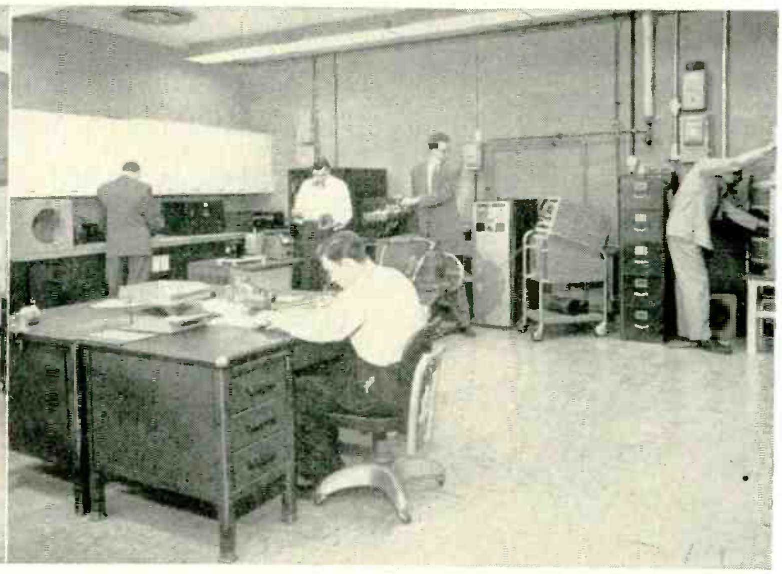
John H. Smedley
Design and Application Engineer

George D. Barcus
Design Engineer

Rollin J. Parker
Supervisor—Magnetic Products Design and Application

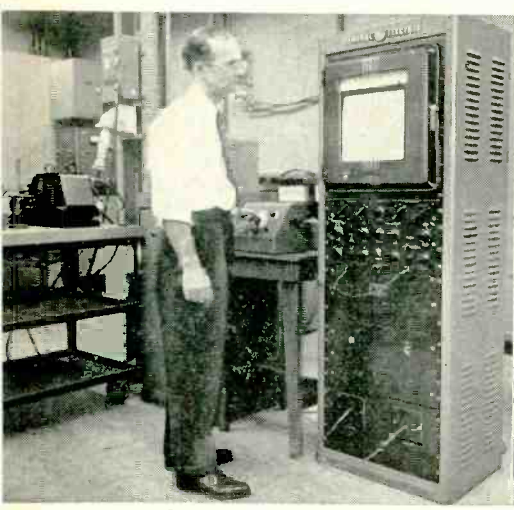
These Carboloy® permanent



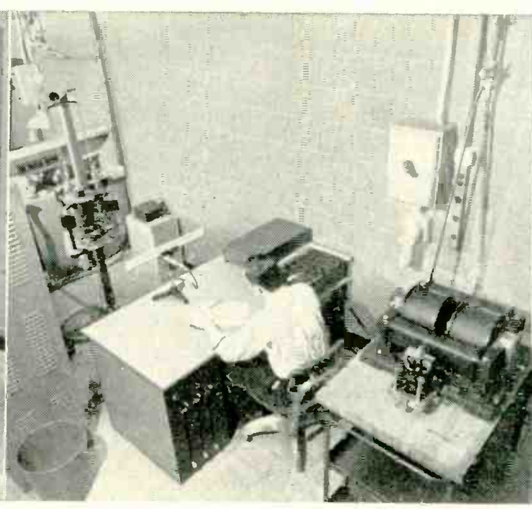


At the modern Carboloy magnet laboratory, in Detroit, trained engineers work with the finest equipment. Where necessary, special instruments are often designed by the engineers.

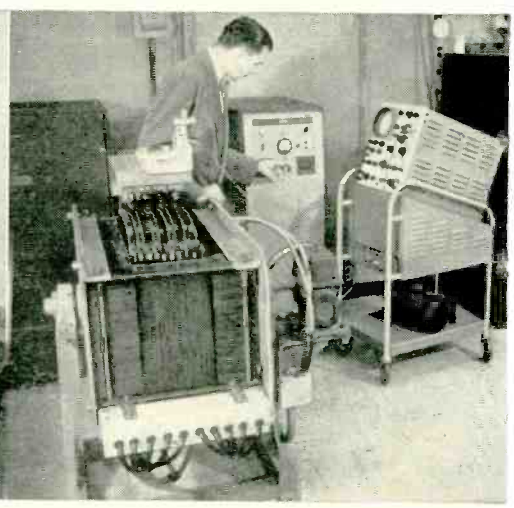
With such complete facilities, Carboloy magnet engineers can give you accurate information, quickly. And, they can thoroughly test their designs and the performance of the magnets in your products.



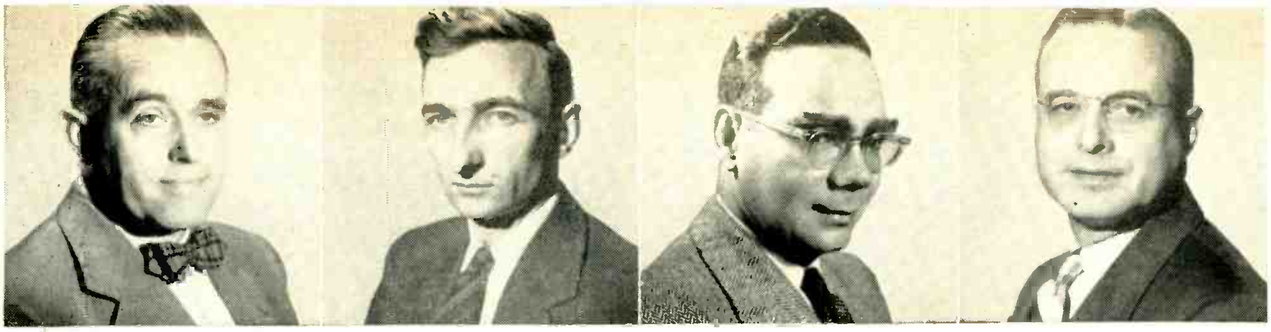
DC Recording Hysteresigraph. Simultaneously plots magnetic force and resulting magnetic induction. Produces complete hysteresis loops, not ordinary point-by-point readings.



High H-Permeameter. Provides point-by-point readings of magnetizing force and induction. Control table and Ballistic Galvanometer also used for general flux measurements.



Condenser Discharge Magnetizer. Produces very large current impulse for magnetizing magnet configurations that can best be accomplished with special field shapes.



Ernest E. George
Mgr.—Design and Application Engineering

Robert J. Studders
Supervisor—Magnetic Materials and Process Development

Edgar W. Engle
Mgr.—Product and Process Development Engineering

Edgar L. Hubbard
Sales Mgr.—Permanent Magnets

magnet engineers can help you improve products, cut costs

Experienced magnet engineers, using the latest test and development equipment, will provide complete engineering appraisal service

You can get valuable technical assistance, without obligation, on the design and application of permanent magnets, from Carboloy magnet engineers . . . men who are leaders in the field.

Only at the Carboloy Department can you obtain engineering appraisal service and sample magnets from separate laboratory facilities devoted exclusively to helping you determine the design and optimum size, shape and strength magnets to fit your particular application. Your product will be tested in the modern Carboloy magnet laboratories, on the latest test instruments, to assure the maximum operating efficiency of the magnets.

PROVED RESULTS

The assistance Carboloy engineers have given other designers and manufacturers has paid off time and again in lower production costs, improved product efficiency, simplified assemblies and reduced product size.

You can rely on their solutions because these engineers, many of whom worked on the original development of Alnico, are specially trained and experienced in all phases of permanent magnet design and application.

You can depend on Carboloy magnet sales engineers, too, for authoritative and intelligent answers to your questions. These men have intensive, special training in permanent magnets, supporting their engineering and technical backgrounds.

A COMPLETE SERVICE

Together with the engineers who are working on the development of new magnetic materials and on the improvement of existing Alnico grades, *these men make a complete permanent magnet team.* Their sole job is to help you utilize the tremendous potential of permanent magnets for new and improved products.

This team can start working for you, today. Just fill out the coupon and attach to it your company letterhead, and where possible, blueprints or sketches of the job. Or, if you prefer, the coupon will bring a call by your local Carboloy magnet sales engineer.

Three typical, successful appraisal projects:

INSTRUMENTS. Working with Thomas A. Edison, Inc., Carboloy engineers provided the magnet design that made possible a revolutionary fire detection relay. Use of the proper magnets simplified the design of the relay and reduced its size and weight.

CONTROLS. The development of the hysteresis brake was pioneered by Carboloy magnet engineers. Now widely used in the textile and wire rope industries, this brake eliminates friction, while maintaining the necessary constant tension.

TELEVISION. Carboloy magnet engineers collaborated with tube engineers on the design of a new magnetic internal focusing device. They designed the smaller, more efficient magnets that helped eliminate focusing dials and external assemblies.

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DEPARTMENT OF GENERAL ELECTRIC COMPANY

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☐ I would like magnet engineering assistance; I am enclosing necessary information and blueprints.

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SPLITTING HAIRS

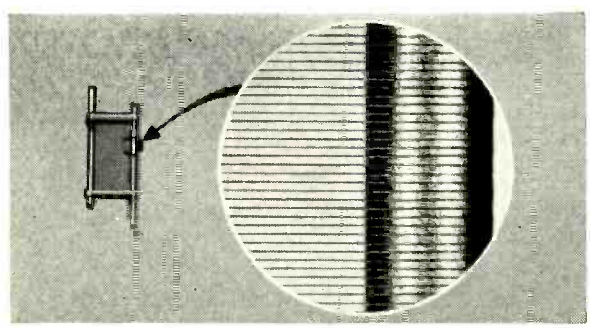
TO SPEED CALLS

This coaxial system electron tube amplifies more voices at the same time because of wider frequency band—made possible by bringing grid and cathode closer together.

To triple the voice-carrying capacity of coaxial cable, Bell Laboratories engineers had to create new amplifying tubes with the grid placed only two-thirds of a hair's breadth from the cathode. Furthermore, the grid wires had to be held rigidly in position; one-quarter of a hair's shifting would cut amplification in half.

Working with their Bell System manufacturing partners at Western Electric, the engineers developed precise optical means for measuring critical spacing insulators. On a rigid molybdenum grid frame they wound tungsten wire three ten-thousandths of an inch thick. To prevent the slightest movement they stretched the wire under more tension for its size than suspension bridge cables, then bonded it to the frame by a new process.

The resulting tube increases coaxial's capacity from 600 to 1800 simultaneous voices—another example of how Bell Telephone Laboratories research helps keep your telephone system growing at the lowest possible cost.



Grid is shown above left, actual size. Picture at right, enlarged 15 times, shows how wires are anchored by glass bond. They will not sag despite nearness of red-hot cathode.

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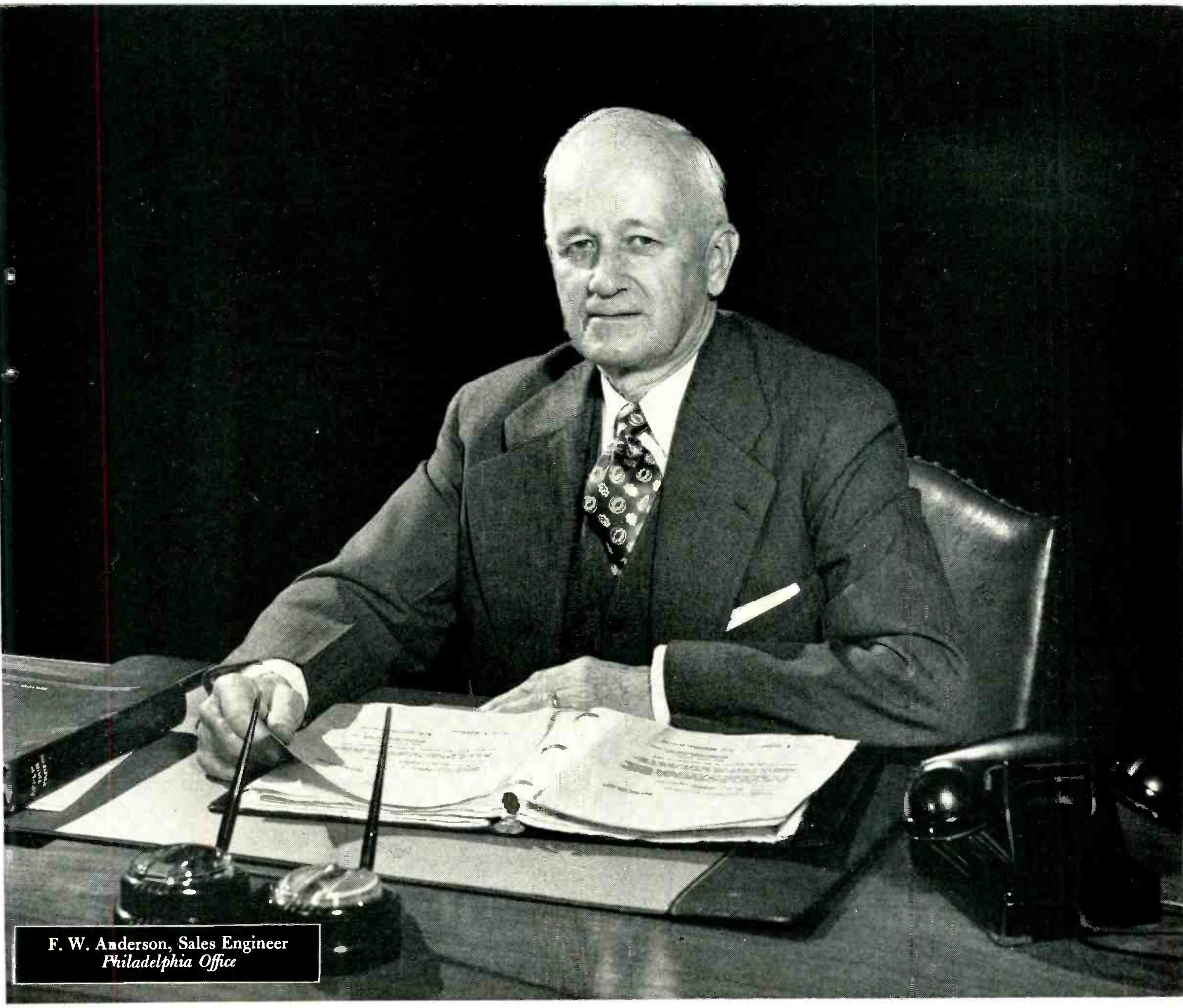
IMPROVING TELEPHONE SERVICE FOR AMERICA PROVIDES CAREERS
FOR CREATIVE MEN IN SCIENTIFIC AND TECHNICAL FIELDS



F. W. Anderson, Sales Engineer
Philadelphia Office

"Holtzer-Cabot Motors Ensure Satisfaction"

"My thirty years' experience in the motor business enables me to fully appreciate the truly outstanding application engineering that goes into every Holtzer-Cabot motor. I know, too, that Holtzer-Cabot motor dependability adds greatly to a product's performance and reputation.

"Here at Holtzer-Cabot, almost every order results from a sample motor which is designed to meet the customer's individual specifications. After intensive testing by our own engineers, the sample motor is submitted to the customer for his approval. In every case, our customers have ample opportunity of 'proving out' for themselves the advantages of Holtzer-Cabot special design.

"We at Holtzer-Cabot are confident of our ability to develop special motors that give peak performance and dependable service.

"We know that our motor specialists can solve practically any motor problem given to them and that our sales representatives are thoroughly qualified by training and experience.

"If *you* have a fractional horsepower motor problem, take advantage of Holtzer-Cabot's 78 years of experience in developing special motors and related electrical apparatus to highest quality standards. Our methods and facilities are yours to command.

"Write, wire or phone. Without obligation on your part, your problem will get expert — and prompt — attention."

NATIONAL PNEUMATIC CO., INC. AND **HOLTZER-CABOT** DIVISIONS

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Sales Service Representatives
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Designers and manufacturers of mechanical, pneumatic, hydraulic, electric and electronic equipment and systems

Quality Components
for the Radio-Electronics Industry
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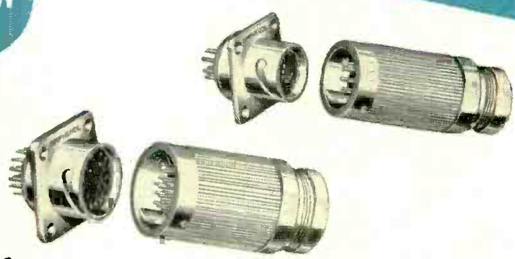
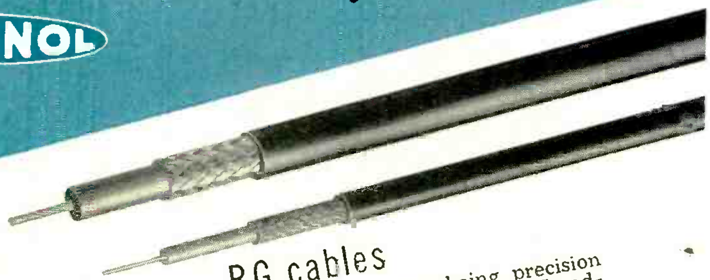
new



165 SERIES miniature connectors

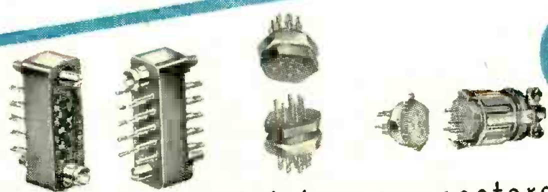
These new miniature AN-type connectors are obtainable in two connector sizes and six contact configurations. 165 series connectors, besides their very small size, are pressure-proof and completely waterproof.



RG cables

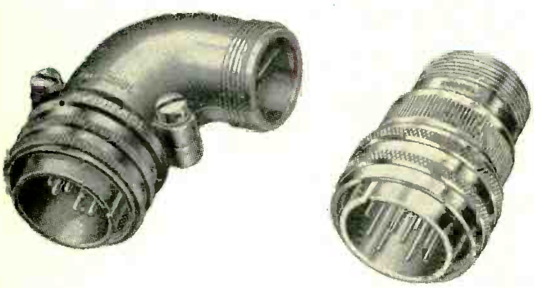
Ninety RG-/U coaxial cables are now being precision manufactured in AMPHENOL's up-to-date cable plant. In addition, AMPHENOL makes special cables, including aluminum jacketed ALJAK, *miniature*, *triaxial*, and *low-noise*.

new



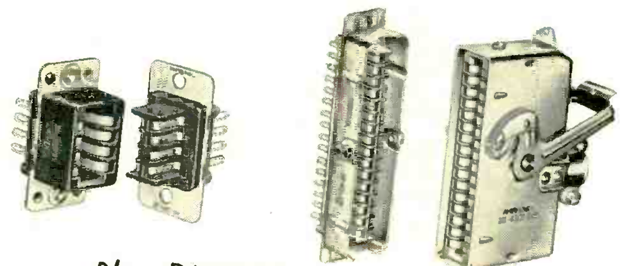
26 SERIES miniature connectors

Miniature connectors with 5, 7 or 9 contacts, rack & panel or hex nut sizes. Hood and clamp hardware available for hex nut connectors. Fine materials, electrical efficiency, makes the 26 series ideal in miniaturized application.



A N connectors

A complete selection of plugs, receptacles and fittings, a wide variety of insert contact arrangements. AMPHENOL AN connectors have many unique features, including gold-plated contacts and famous 1-501 blue dielectric material.



Blue RIBBON connectors

Famous AMPHENOL *blue* Ribbon connectors now available with pin or barrier polarization. Keyed shells and latch-lock cans are available for the barrier connectors. Both types have gold-plated contacts, AMPHENOL blue dielectric.

RF connectors

Made in strict accordance with government specifications, AMPHENOL RF connectors are the most efficient link between coaxial cables now available. Series include N, BN, HN, BNC, C, LC, Push-on, and splices, fittings and adapters.

new

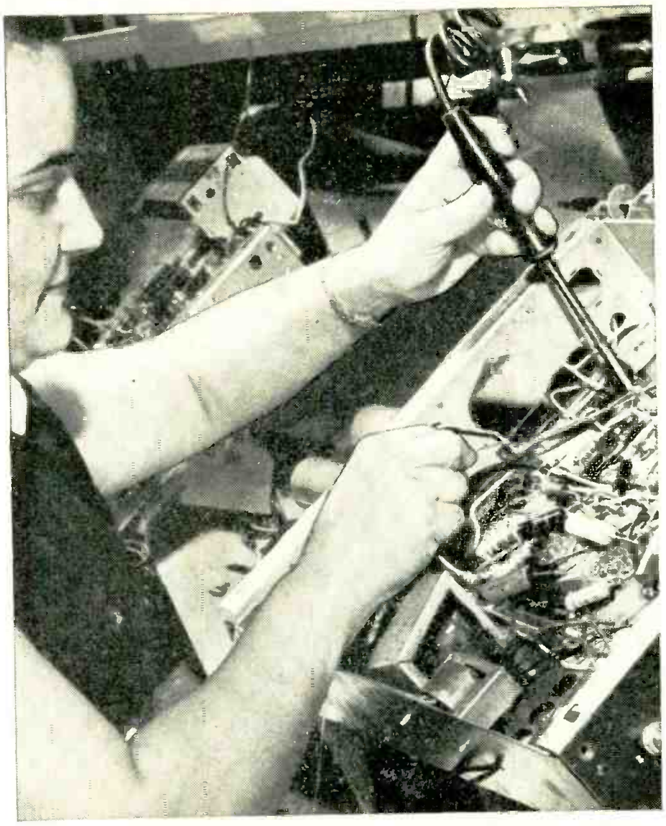
Qwik microphone connectors

Modern design makes the new QWIKs the most attractive, most efficient microphone connectors for every audio application. QWIKs are lightning-fast to use—plugs click-in to receptacles, disconnection is easily made with one hand.

AMPHENOL

AMERICAN PHENOLIC CORPORATION

chicago 50, illinois



LIGHT-AS-A-PENCIL G-E MIDGET reduces operator fatigue, has longer-lasting Ironclad tip. The Midget solders like a pencil dots an "i."

EXTRA-HEAVY-DUTY G-E IRON with long-life calorized copper tip is ideal for soldering heavy-gage cans and armature windings.

You get lower costs, faster soldering with the complete line of long-life G-E irons

Select a soldering iron from General Electric's complete line for easier, faster, cost-cutting soldering. You can choose from 24 different irons with ratings from 25 to 1250 watts.

Long-life G-E Ironclad Copper Tips last up to *ten times as long* as ordinary tips. Ironclad tips combine the durability of iron and excellent heat-transfer of copper.

For Soldering Small Connections, you'll want to try the G-E Midget iron with easily interchangeable $\frac{1}{4}$-in., $\frac{1}{8}$-in., and $\frac{3}{16}$-in. Ironclad tips. This $1\frac{3}{4}$-ounce, 25-watt iron reduces operator fatigue, makes pin-point connections. And because the Calrod* heater is *built right into the tip,* you get maximum heat transfer, amazing heat recovery for an iron of this size.

For Medium-sized Jobs, try G.E.'s sturdy Lightweight iron. This high-speed iron for continuous soldering takes plenty of hard use. Because the iron has a thin shank and interchangeable $\frac{1}{4}$-in. or $\frac{3}{16}$-in. Ironclad tips, you can solder tight joints without damaging small connections.

For the Bigger Soldering Jobs, General Electric has larger irons ranging from the 75-watt, $\frac{1}{2}$-in. tip unit to the heavy-duty 1250-watt, two-inch-copper-tipped model. With a G-E Calrod heater *cast into the heating head,* you get unusually quick heating and high efficiency.

Contact Your General Electric Sales Office or Distributor to solve your soldering problems. Start cutting costs *and* increasing production with long-life, high-speed irons from the complete General Electric line. And for more information mail the coupon at right.

*Reg. Trademark of the General Electric Co.

Sect. 720-126, General Electric Co.,
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Please send me Bulletin GEA-4519D, Industrial Soldering Irons.

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Company____________________

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City__________ **State**_______

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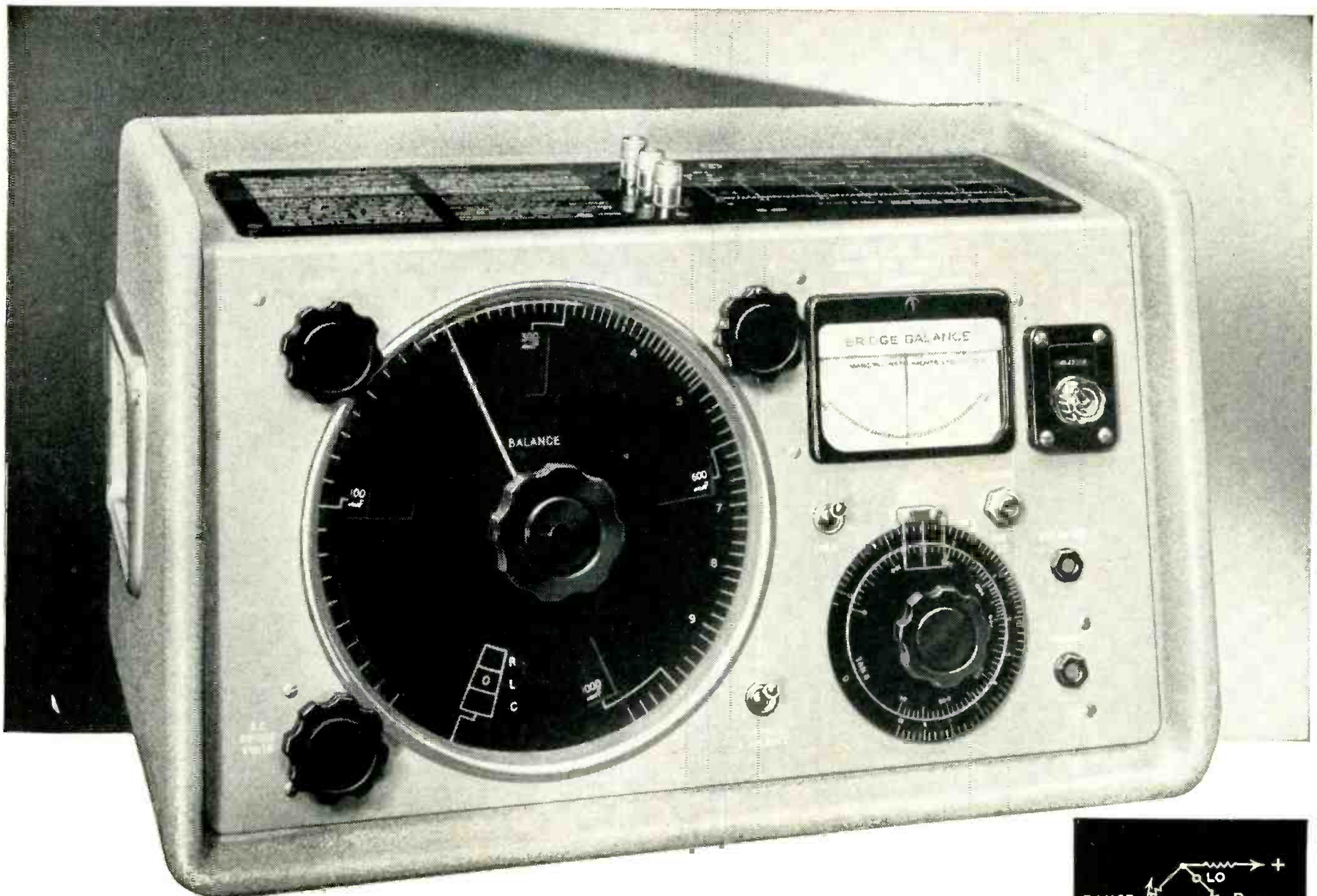
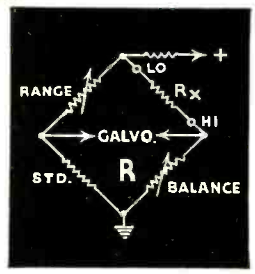
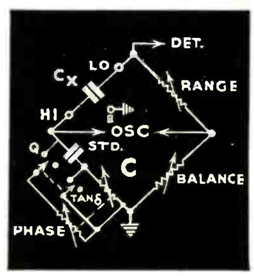




R, C AND L ACCURATELY MEASURED

RESISTANCE, CAPACITANCE, INDUCTANCE and power factor measured quickly and accurately on this self-contained and robust instrument. Its industrial-designed appearance fits well in modern surroundings and partners its outstanding electrical performance.

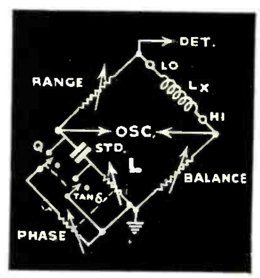


UNIVERSAL BRIDGE TYPE TF 868

Resistance from 0.1 Ω to 10 MΩ, Capacitance from 1 μμF to 100 μF, and Inductance from 1 μH to 100H.

Single direct reading L.C.R. dial—no multiplying factors involved.

Continuously variable bridge voltage and automatic detector sensitivity control.



Full data and prices of any of the items listed below will be mailed immediately on request:

UNIVERSAL BRIDGE TF 868 · FM DEVIATION METER TF 934
FM/AM SIGNAL GENERATOR TF 995 · STANDARD SIGNAL GENERATOR TF 867
ALSO
VACUUM TUBE VOLTMETERS · FREQUENCY STANDARDS · OUTPUT METERS
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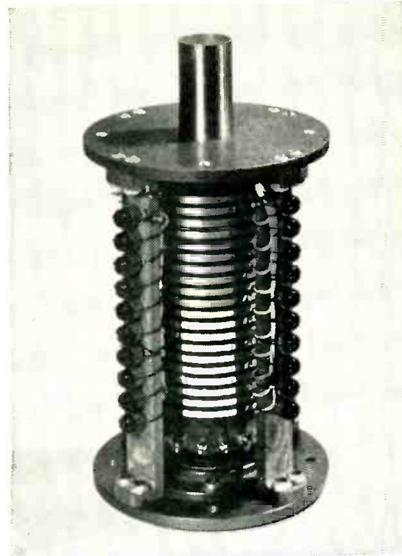
TC39

ideas in the making!

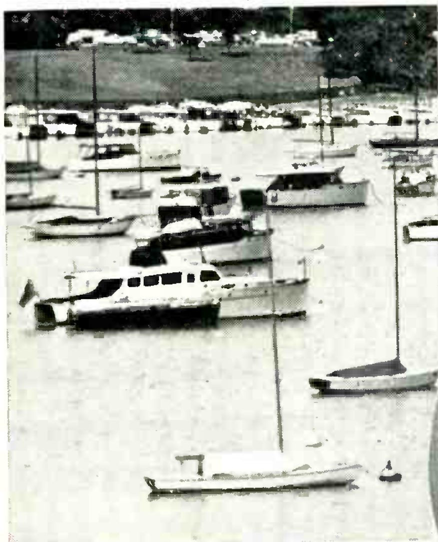
ARALDITE® Epoxy Resins developed by Ciba Research are simplifying manufacturing methods, improving product efficiency and opening new fields of product development. The formulator and the end product producer will want to know more about them. We at Ciba want to help you further your development.

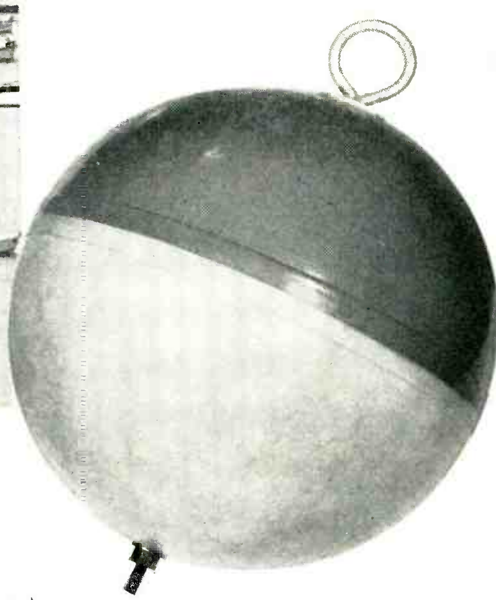


SLIP RING ASSEMBLY

The exceptional casting properties of ARALDITE Resins are demonstrated in this unit designed to operate with strain gauges or radar equipment. ARALDITE Epoxy Resins provide high dielectric strength, arc and humidity resistance which permit a current capacity of 5 amperes per ring.

(Courtesy Airflyte Electronics)





ARALDITE IMPREGNATED MOORING BUOY IS STRONG . . . LIGHT . . . WEATHER-PROOF AND SINK-PROOF

(Courtesy United Pattern Company)

One-seventh the weight of a steel buoy of comparable size including the unicellular filling beneath the surface skin, this newest idea in modern maritime equipment eliminates hull-scuffing damage and is functionally superior in every other way. Since color is "built-in" with salt-water corrosion resistant laminate, it stays bright and new looking, thereby minimizing maintenance. All these advantages suggest a wide range of new and improved product development in which ARALDITE Resins may prove the answer for you.

600 VOLT TRANSFORMER TYPE TWM

This example of ARALDITE Resin encapsulating insulation shows how completely it may be applied to encompass coils in housing in an application where rugged use can be expected for the entire life of the unit. *(Courtesy Allis-Chalmers)*

SEND THIS COUPON . . . or write us on your company letterhead . . . for complete technical data on the physical properties and recommended procedures for the successful use of Araldite Resins for your fabricating needs.

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ARALDITE Epoxies

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E-2

Starting here it's mostly nickel and chromium...

127 operations later, it's

Nichrome*

There are several excellent nickel-chrome combinations on the market. But there is only one Nichrome*.

What is it that makes this alloy the universal standard by which engineers judge the properties of heat and corrosion resistance? There is always at least one extra ingredient added to the nickel and chrome. That is . . . the supreme mastery of the Driver-Harris specialists, gained in their 55 years of melting and drawing experience. This hard-won skill of theirs is reflected in improved heating and quenching techniques . . . in specially developed deoxidizing anneals . . . in expert and precise control of every technical process of the entire manufacturing cycle. Sometimes, indeed, there are as many as 127 distinct operations between melting crucible and the finished wire, strip, or rod.

In recognition of its unique properties, the United States Patent Office in August, 1908, granted solely and exclusively to us the trademark NICHROME. There is only one Nichrome, and it is produced by Driver-Harris.

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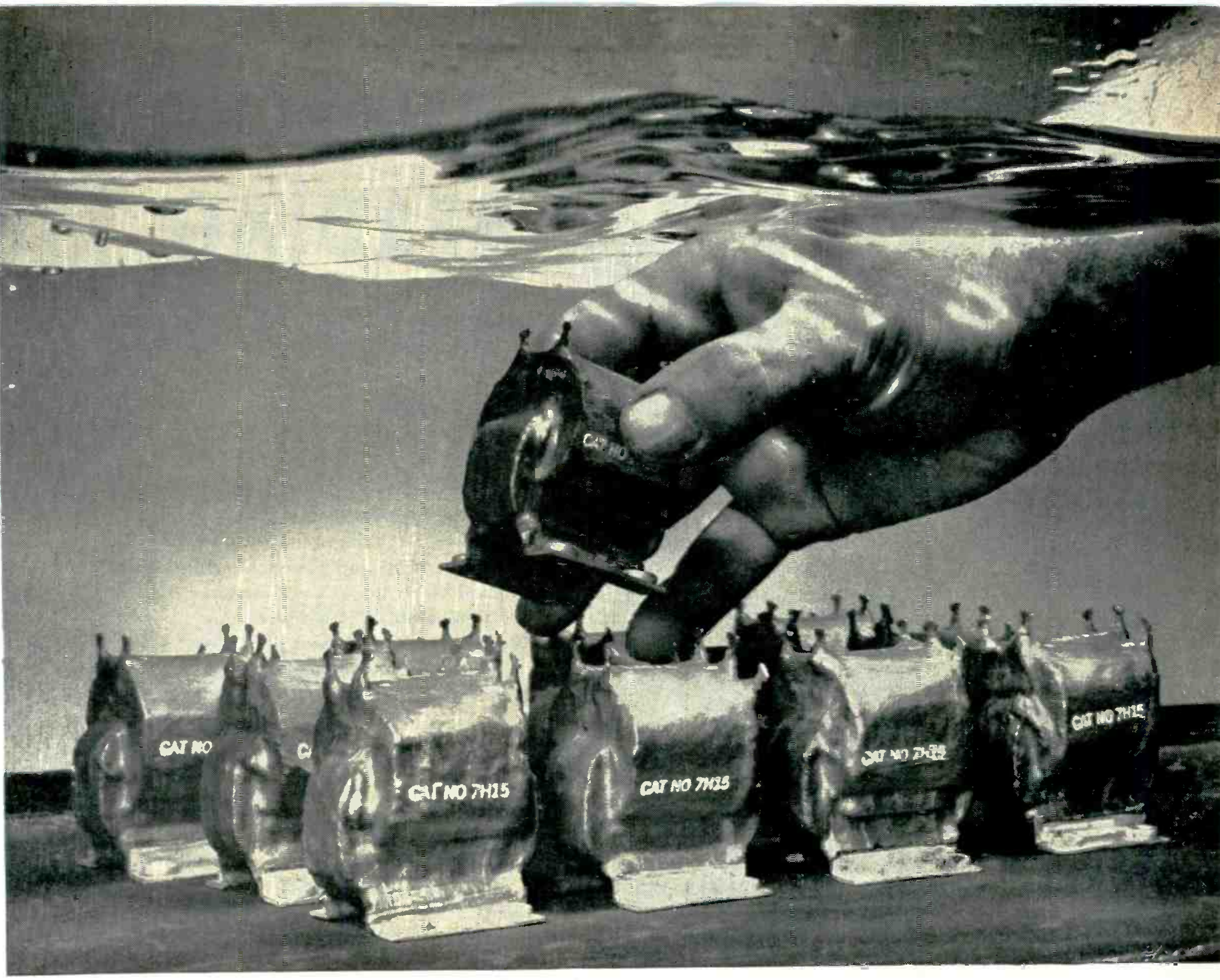


Westinghouse Fosterite® Transformers must pass this 4-hour underwater test

If you're looking for a small, open-type transformer, fully protected against moisture, check the line of Westinghouse Fosterite impregnated transformers. This four-hour underwater test proves the point:

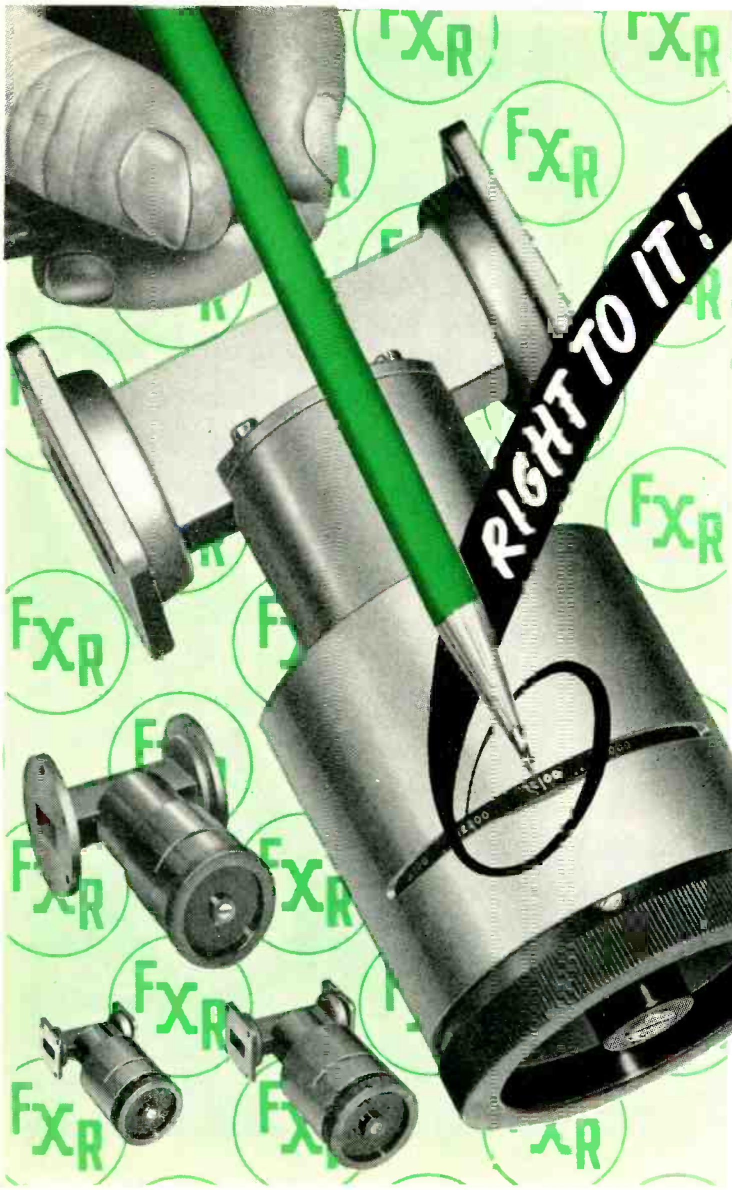
All Fosterite-treated transformers are completely submerged in hot water at 60° Centigrade for two hours, after which they are "thermal-shocked" in cold tap water, and soaked there for an additional two hours. An electrical test is then applied, in which each transformer must show an insulation resistance reading of at least 2000 megohms. Fosterite has to be good!

This is just one of many severe tests to which Westinghouse specialty transformers are subjected. They assure you of quality that will meet your requirements exactly . . . quality that stands up under extreme conditions.

Fosterite impregnated and coated transformers can be made available to meet your most stringent specifications. In addition to moisture protection, Fosterite makes drastic weight reductions possible . . . as much as 30 to 50%, when compared to enclosed types.

Call your Westinghouse representative for further information, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-70678

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



DIRECT READING Frequency Meters

DESIGNED for easier, more accurate readings . . .

Tried and true—the FXR Type 410A Direct Reading Frequency Meters give you bull's-eye accuracy, right to the exact reading spot. No more jiggling of many dials, no more complicated calculations. Human error factor is eliminated. These dependable FXR units provide the most convenient means available for determining oscillator frequency in the microwave region.

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- FULL WAVEGUIDE FREQUENCY RANGE
- DIRECT READING
- HIGH Q
- NOMINAL 30% ABSORPTION DIP
- BACKLASH-FREE OPERATION

TYPE	FREQUENCY RANGE
C410A	5.85 to 8.20 KMC/S
W410A	7.05 to 10.00 KMC/S
X410A	8.20 to 12.40 KMC/S

DELIVERY FROM STOCK • PRICE $125 EACH*

Write today for new catalog of complete line of FXR Precision Microwave Test Equipment

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*Data and prices subject to change without notice.

FINANCIAL AID TO HIGHER EDUCATION

Our Colleges and Universities Face Grave Financial Problems

For the past decade the nation's colleges and universities have been caught in a destructive financial squeeze. It is particularly destructive for the independent, privately endowed institutions. Unless extraordinary measures are taken to relieve this squeeze, it promises to become progressively worse. To let it do that is to court a national disaster.

This is the first of two editorials devoted to the financial plight of our colleges and universities. This first editorial deals with the character of the problem, present and potential. The second will indicate some things that need to be done about it, and particularly what American business might do.

Enrollment Soars, Income Lags

In broad outline, the financial problem that afflicts our colleges and universities is simple. The demand for their services has increased rapidly, and promises to keep on increasing even more rapidly. At the same time, their financial capacity to provide these services has lagged behind, primarily because of price inflation.

Between 1940 and 1950, college and university enrollment increased from approximately 1⅓ million to 2⅓ million—about 75 per cent. Over the same period, the educational income of these institutions, measured in terms of its actual purchasing power, increased only about 64 per cent. Thus, at the end of the decade, our colleges and universities as a group had, on the average, about 6 per cent less to spend per student than they had at the beginning. Meanwhile, the rapid advance of science and technology had made a good college or university course a much more expensive operation than it was in 1940. Since 1950, the latest date for which comprehensive figures are available, the financial squeeze on our colleges and universities has intensified, largely because of another wave of price inflation touched off by the Korean War.

Among the colleges and universities, the independent, privately endowed institutions are particularly hard pressed. In terms of actual purchasing power, the independent liberal arts colleges are now spending at least 20 per cent less per student than they spent in 1940. Public institutions of higher learning, supported out of tax revenues, have managed to increase slightly their expenditure per student. Otherwise, the financial squeeze on higher education as a whole would be even more severe.

Why Independent Colleges Are Hit Hardest

The principal reason why the independent colleges and universities are so hard up is the shrinkage in their income from endowments. These endowments, created in other days by gifts of generous benefactors to help pay the expenses of higher education, have been hit hard from two directions. During the war and postwar years, the tax collector took so large a part of the incomes and estates of wealthy people that this source of endowments has been greatly reduced. Over the same period price inflation cut in half the purchasing power of the income derived from existing endowments. In 1940 income from endowments provided 26 per cent of the total income of the independent colleges and universities. By 1950 it provided only 14 per cent. The figure is still lower today.

The financial plight of the independent colleges and universities is directly reflected in the salary status of their teaching staffs. In mid-1952 a national survey showed that, after adjustment for the increased cost of living, the salaries of those holding full professorial rank in these institutions were 12 per cent lower than they were in 1941-42. Junior teachers, with the rank of instructor, fared somewhat better. In terms of actual purchasing power, their salaries declined only 2 per cent over the 12-year period, largely because there is more direct competition for their services from industry. Over the same period, the real wages of industrial workers increased 55 per cent.

Time Will Not Provide a Cure

The plight of the colleges and universities, which is shared in some degree by all parts of our educational system, is not one that can be left to time for a cure. On the contrary, the financial problems of our institutions of higher learning will be intensified in the years ahead by the pressure of rapidly increasing enrollments. Present prospects indicate that during the next decade college and university enrollment will increase by about one-third, or from 2⅓ million to over 3 million. The problem of increased enrollments will become particularly acute toward the end of this decade when the babies born during the great surge of population in World War II are ready to enter college.

Such an increase in population as that now in prospect can be a tremendous asset to the nation. It is still a truth, even though it is worn a bit thin by frequent repetition at commencement exercises, that a nation has no resource more valuable than the education of its people. And the better the education, the more valuable the asset.

But to realize this, our colleges and universities must have the financial strength to handle the increased enrollments that face them in the years ahead. This means that we must relieve our independent colleges and universities, in particular, from the financial squeeze in which they are now caught and make them full partners in the economic well-being of the nation. Some of the means by which American business might help achieve this will be discussed in a second editorial.

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments that are of particular concern to the business and professional community served by our industrial and technical publications.

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Donald C McGraw

PRESIDENT

McGRAW-HILL PUBLISHING COMPANY, INC.

Outstanding Value

PRESTO SR-11 STUDIO CONSOLE TAPE RECORDER

For the first time . . . a precision Presto tape recorder complete with amplifier in studio console cabinet for less than $1000. Here are the facts about this amazing value:

- Three triple shielded magnetic heads
- Frequency response: 50 to 15,000 cps. (15"/sec.
- 55 db signal to noise ratio (at 2% distortion)
- Flutter: less than .15% (15"/sec.)
- Push button function switches
- Will accommodate reels up to 10½"

The R-11* Mechanism Here is the smooth operating, sleekly designed tape transport unit that drew engineers acclaim when it was introduced last year. Embodies the exclusive Presto capstan drive unit where pressure pulley and solenoid are mounted on a single sub-assembly for easy maintenance. Capstan and motor are interconnected by a belt. Two torque motors, each including its own brake system (external contracting type) assure smooth, positive action without the usual hazard of tape breakage. If tape does break, an automatic safety switch instantly stops the mechanism.

The Amplifier Actually there are two separate chassis for amplification. One contains the recording and reproducing channels. The second is the power supply located at the base of the console. This arrangement reduces noise and keeps operating temperature down.

The Console Cabinet Presto's designers have given particular attention to accessibility of every part of the SR-11. The top panel swings upward on a sturdy hinge to expose the underside of the tape mechanism, while the amplifier opens from the front and turns over on gimbals for access to tubes.

Ask your Presto distributor to order your SR-11 today. You'll never match it in value or performance.

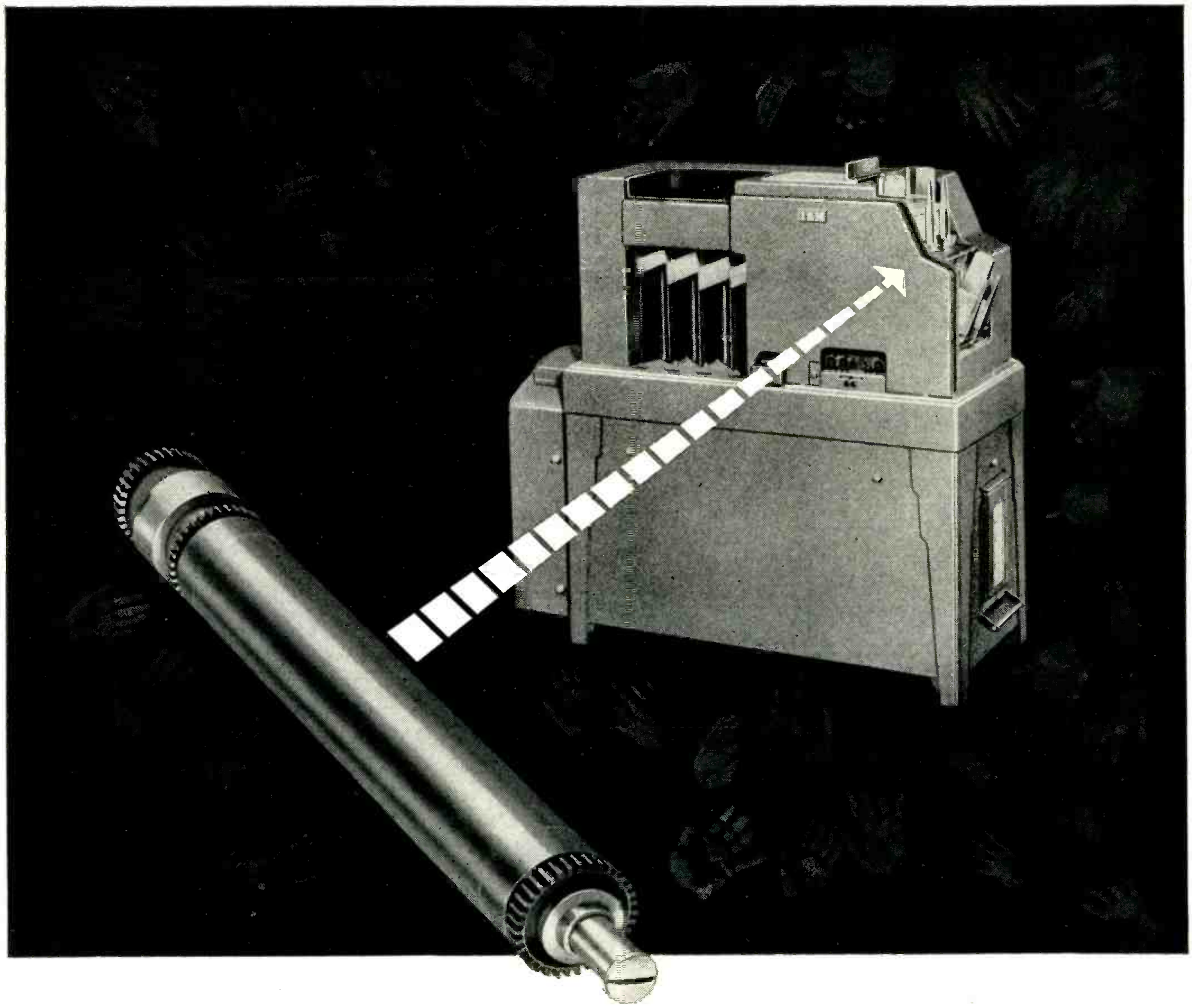
*formerly RC-11

PRESTO RECORDING CORPORATION

PARAMUS, NEW JERSEY

Export Division: 25 Warren Street, New York 7, N. Y.
Canadian Division: Walter P. Downs, Dominion Square Bldg., Montreal

WORLD'S LARGEST MANUFACTURER OF PRECISION RECORDING EQUIPMENT AND DISCS



Out of IBM's Collator pops a tubing idea for you!

This is IBM's Collator—a mechanical super-accountant that shuffles, selects, matches and merges punched cards at the rate of four per second!

Heart of this electronic gee-whizzer is an extraordinary kind of tubing—a contact roll over which the cards must pass. Eighty miniature, hard steel brushes finger each card as it skims by—penetrate it through pre-punched holes, touch the contact roll and close the electronic circuit—flipping the card into the right slot.

Collator contact rolls must have good wear resistance to stand this high-speed workout. And they must resist corrosion and be good electrical conductors. So IBM employs Superior WELDRAWN* Beryllium Copper and low carbon steel composite tubing for Collator contact rolls. This tubing meets IBM's tight specifications for wear resistance, peak hardness and conductivity. Superior supplies the composite tube in 1⅛″ O.D. with .049″ wall.

When tubing troubles put the hex on your plans, call on Superior.

We have years of experience, the modern test and development facilities, and more than 55 analyses in many metals to unravel your problem. Write for a copy of our new Technical Bulletin #7-2 on Seamless and WELDRAWN* Beryllium Copper Tubing. Superior Tube Company, 2500 Germantown Ave., Norristown, Pa.

Round and shaped tubing available in Carbon, Alloy and Stainless Steels; Nickel and Nickel Alloys; Beryllium Copper; Titanium; Zirconium

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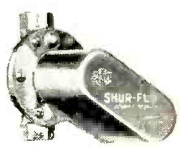
ELECTROFLO VALVE

A solenoid valve for water or air. Provides *AUTOMATIC* control on fluid lines.

MESURFLO CONTROL

Flow Volume Control. *AUTOMATIC.* Maintains one set rate of flow regardless of variable inlet pressures.

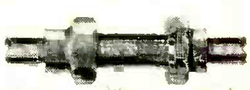


SHUR-FLO AUTOMATIC INTERLOCK

Flow switch. *AUTOMATIC.* Protects equipment against an inadequate rate of flow.

ELECTROMITE VALVE

Small solenoid valve for low flow rates. *AUTOMATIC.* Available with flow volume control.



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HAYS controls give *AUTOMATIC* control for water and air!

HAYS flow controls are *ACCURATE, RELIABLE* and *AUTOMATIC.*

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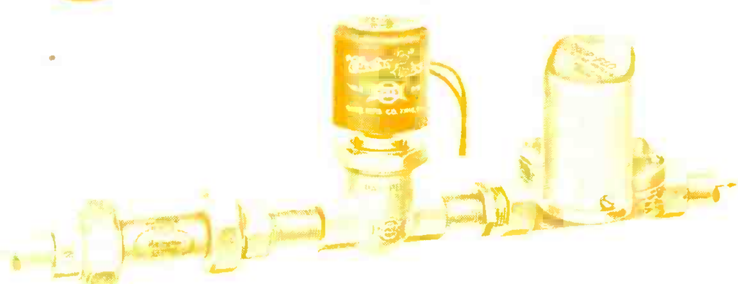

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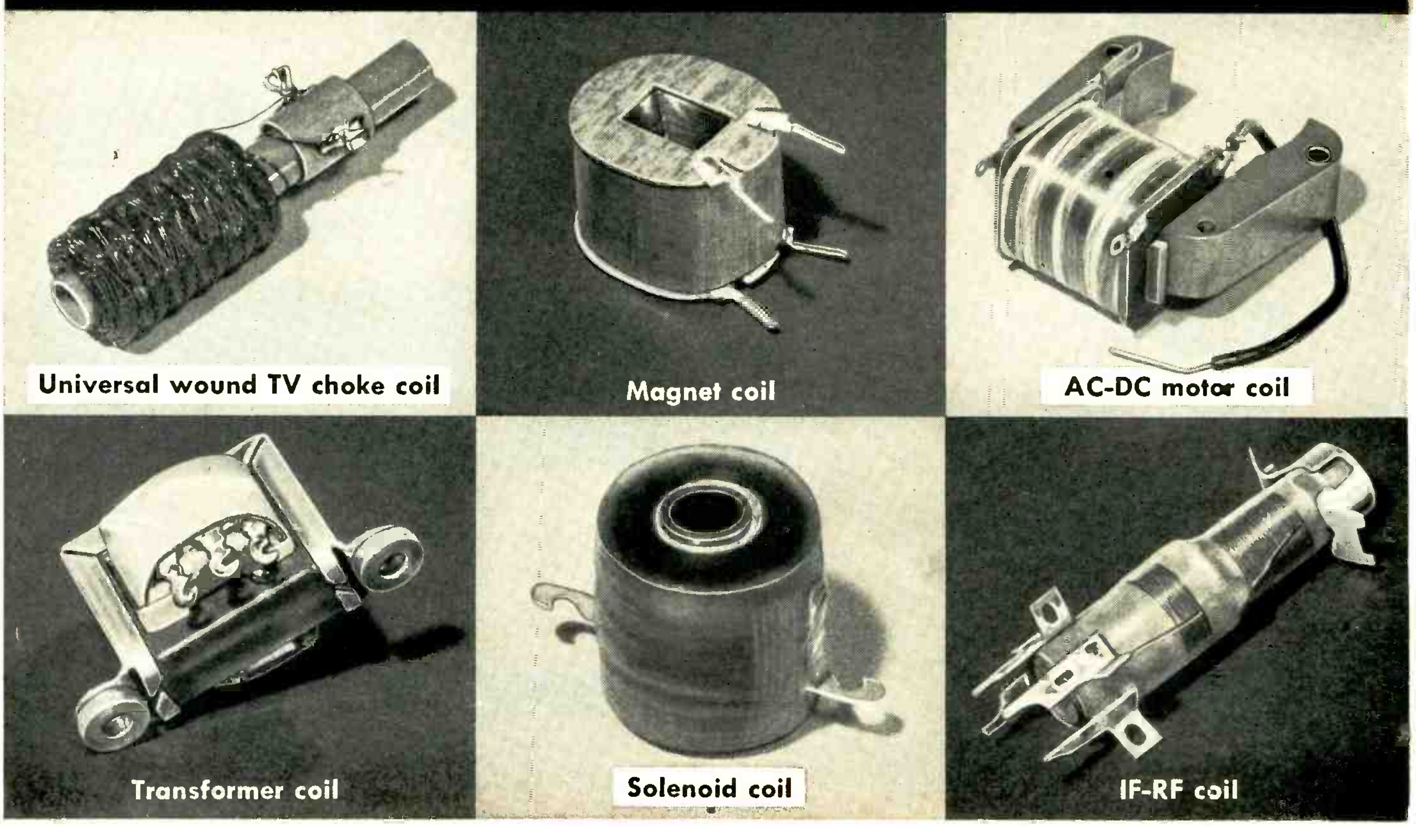

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Magnet coil

AC-DC motor coil

Transformer coil

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New Sodereze represents a spectacular advance in ready-to-solder magnet wire. It's a new and typical Phelps Dodge development designed to keep pace with industry's growing need for wires that handle easily, save time, reduce overall costs and satisfy a variety of different operating conditions. The versatility and outstanding properties of New Sodereze not only permit its use wherever solderable wire has been *proved* practical and dependable but suggest its application in unlimited other electronic and electrical fields to replace conventional wires.

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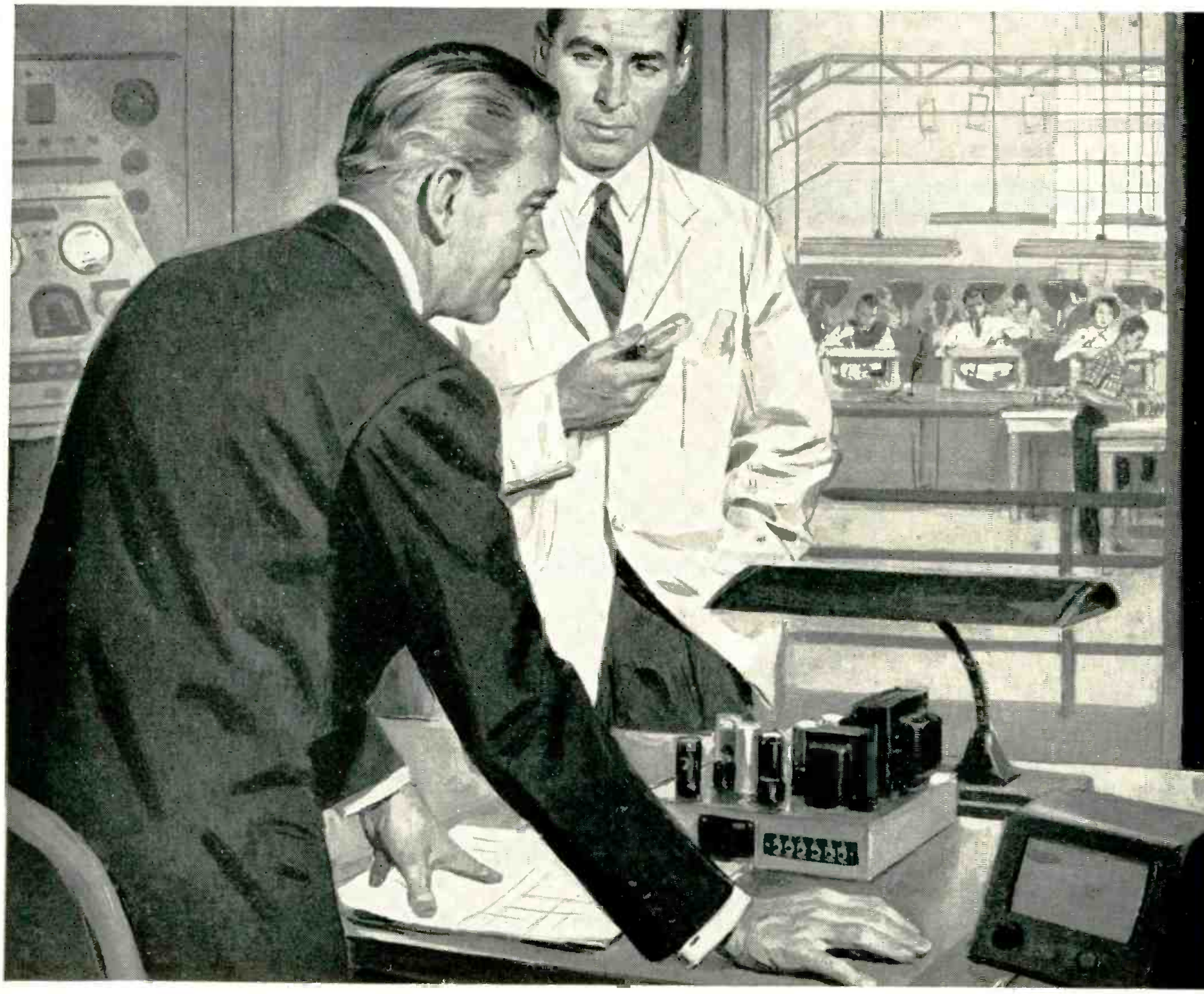
CORPORATION

INCA MANUFACTURING DIVISION

FORT WAYNE, INDIANA

WHEN MISSING PARTS HOLD UP ASSEMBLY LINES...



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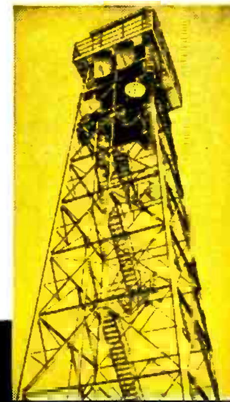
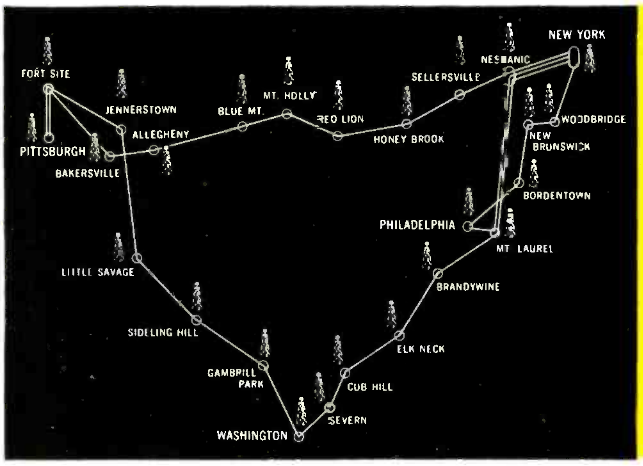
IN ITS 21 TOWER MICROWAVE SYSTEM

Western Union uses Sperry Klystrons



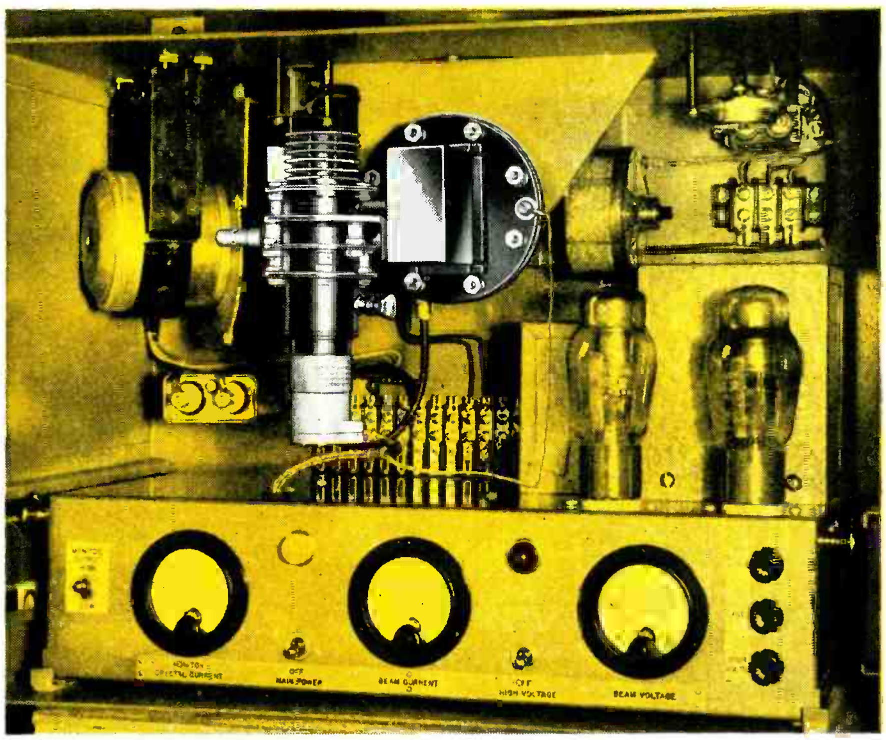


"Dependability has been excellent," writes H. P. Corwith, Vice President, Development and Research. "Average tube life has been more than 15 months, and some tubes have been in continuous service for almost 3 years."

■ Installed in 1948, the Western Union microwave system between New York, Philadelphia, Washington and Pittsburgh, consists of 21 towers, varying in height from 60 to 120 feet, and spaced up to 55 miles apart. The system handles hundreds of telegraph circuits—including important government and leased private wire systems as well as circuits for regular message traffic.

■ Through the use of Sperry SAC-41 Klystrons providing power output of 10 watts, Western Union has effectively reduced circuit outages due to fading, and provided dependable service under all conditions. Furthermore, as Mr. Corwith points out above, the average life of Sperry SAC-41 Klystrons has been 15 months—and some tubes have served continuously for almost 3 years.

■ Since 1938, when Sperry sponsored the development of the Klystron, this Company has extended its application to tubes for low, medium and high power applications—and in a frequency range from 750 to 40,000 megacycles. The research, development and specialized production facilities of Sperry in Klystrons — and in accompanying Microline* equipment—are at your disposal to help in solving your problem.



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

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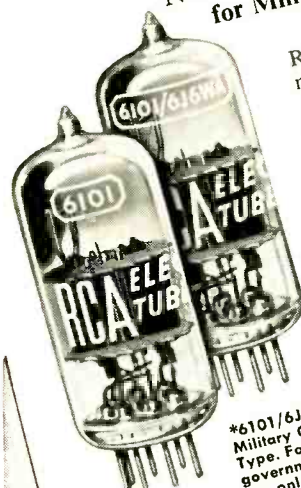
RCA **DESIGNER'S NEWS**

—from the RCA Tube Division

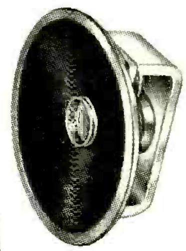
New "Premium" Miniature Twin Triodes for Military and Industrial Applications



*6101/6J6WA Military Control Type. For government end use only.

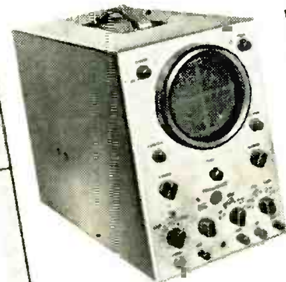
RCA-6101 and 6101/6J6WA* are medium-mu triodes designed principally for use as class A amplifiers and control tubes in mobile and aircraft equipment where uniformity of characteristics and dependable performance under shock and vibration are essential requirements. The tube can withstand an impact acceleration of 500 G max. and vibrational acceleration of 2.5 G max. Developed from the type 6J6, these "premium" types incorporate many structural improvements, and undergo stringent production controls and rigorous tests during and after manufacture.

New "Mighty Midget" Speaker for "Pocket-Personal" Radios



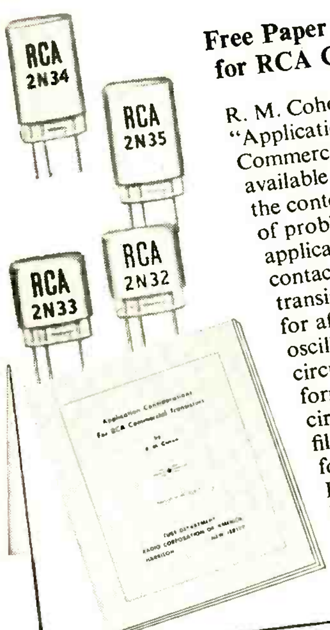
Contoured for economy of space, this new RCA-222S1 PM speaker features a 2½-in. cone and measures only 2¾ in. in diameter by 1¼ in. in depth. The weight is only 4.6 ounces, including a 1.0-ounce Alnico V magnet for high efficiency. Frequency range is 300-3500 cps and the voice-coil impedance is 12 ohms. Life-tested at 250 milliwatts, the speaker is designed for long trouble-free service in applications where space is at a premium.

New Dual-Band Oscilloscope for Color and Black-and-White TV



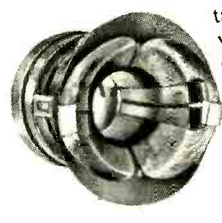
The new WO-78A 5-inch Oscilloscope permits accurate voltage measurements of TV signals throughout the video range in both color and black-and-white receivers. In the wide-band position, the WO-78A has a response flat within −1 db, from 3 cps to 4.5 Mc, with sensitivity of 0.1 volt peak-to-peak per inch (0.035 volt rms per inch). In the narrow-band position, sensitivity is 0.01 volt peak-to-peak per inch. Phase characteristics are excellent throughout entire frequency range.

Free Paper on Application Considerations for RCA Commercial Transistors



R. M. Cohen's popular technical paper entitled "Application Considerations for RCA Commercial Transistors" is now available on request. Included in the contents are: descriptions of problems involved in the application of RCA point-contact and junction type transistors and typical circuits for af and rf amplifiers, rf oscillators, and "flip-flop" circuits—as well as performance data for these circuits. For your free copy fill out coupon—or write for Reprint ST-817 to RCA, Commercial Engineering, Harrison, N.J.

New 90° Deflecting Yoke for Full Screen Focus



The new RCA-220D1 yoke is designed for rectangular-type 90° kinescopes operating at ultor voltages up to 18 kv. A ferrite core and precision-shaped cosine-type windings, treated with anti-corona silicone resin, provide high efficiency and good side and corner resolution. Molded insulation is employed to withstand the high peak voltage between the horizontal and vertical coils. The 220D1 is designed for use with the RCA-238T1 and RCA-239T1 horizontal-output and high voltage transformers.

RCA Tube Division
Commercial Engineering, Section F-46, Harrison, N. J.
Please send me technical data on:

- ☐ RCA-6101
- ☐ Transistor Reprint ST-817
- ☐ RCA-222S1 "Mighty Midget" Speaker
- ☐ RCA-220D1 Yoke
- ☐ WO-78A Oscilloscope

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VOLTAGE REGULATED POWER SUPPLIES

VOLTS	CURRENT	REGU-LATION	RIPPLE	6.3 V.† AC. CT.	MODEL
0-1500	0-200 Ma.	0.5%	20 Mv.		1520
0-1200	0-20 Ma.	0.1%	10 Mv.	10 Amp.	1220
0-1000	0-500 Ma.	0.5%	20 Mv.		1350
200-1000	0-500 Ma.	0.5%	20 Mv.		1250
0-1000	0-50 Ma.	0.1%	10 Mv.	10 Amp.	1020
0-600	0-3 Amp.	0.5%	10 Mv.		780
0-600	0-2.25 Amp.	0.5%	10 Mv.		770
0-600	0-1.5 Amp.	0.5%	10 Mv.		760
0-600	0-750 Ma.	0.5%	10 Mv.		750
0-600 0-150 Bias	0-300 Ma. 0-5 Ma.	0.5% *	10 Mv. 5 Mv.	10 Amp.	615
0-600	0-300 Ma.	0.5%	10 Mv.	10 Amp.	500R
#1 0-600 #2 0-600	0-200 Ma. 0-200 Ma.	0.5% 0.5%	5 Mv. 5 Mv.	10 Amp. 10 Amp.	800
0-600 0-150 Bias	0-200 Ma. 0-5 Ma.	0.5% *	5 Mv. 5 Mv.	10 Amp.	815
#1 200-500 #2 200-500	0-200 Ma. 0-200 Ma.	0.5% 0.5%	5 Mv. 5 Mv.	6 Amp. 6 Amp.	510
200-500	0-200 Ma.	0.5%	5 Mv.	6 Amp.	245
0-400 0-400 0-150 Bias	0-150 Ma. 0-150 Ma. 0-5 Ma.	0.5% 0.5% *	5 Mv. 5 Mv. 5 Mv.	10 Amp. 10 Amp.	2400
0-400 0-150	0-150 Ma. 0-5 Ma.	0.5% *	5 Mv. 5 Mv.	10 Amp.	400
0-400	0-150 Ma.	0.5%	5 Mv.	10 Amp.	141
100-400	0-150 Ma.	0.01%	1 Mv.	10 Amp.	2000
0-350	0-3 Amp.	0.5%	10 Mv.		730
0-350	0-2.25 Amp.	0.5%	10 Mv.		720
0-350	0-1.5 Amp.	0.5%	10 Mv.		710
0-350	0-750 Ma.	0.5%	10 Mv.		700
100-325 0-150 Bias	0-150 Ma. 0-5 Ma.	0.5% *	5 Mv. 5 Mv.	10 Amp.	131
0-300 0-150 Bias	0-150 Ma. 0-5 Ma.	0.5% *	5 Mv. 5 Mv.	5 Amp.	315
0-150	0-50 Ma.	0.5%	5 Mv.		150
3-30	0-30 Amp.	0.5%	0.1%		3030
1-13	0-10 Amp.	0.5%	10 Mv.		3200

MODEL 750

MODEL	VOLTS	CURRENT	REGULATION	RIPPLE
750	0-600	0-750 Ma.	0.5%	10 Mv.
760	0-600	0-1.5 Amp.	0.5%	10 Mv.
770	0-600	0-2.25 Amp.	0.5%	10 Mv.
780	0-600	0-3 Amp.	0.5%	10 Mv.

DC POWER SUPPLY SPECIFICATIONS

KEPCO Voltage Regulated Power Supplies are conservatively rated. The regulation specified for each unit is available under all line and load conditions within the range of the instrument.

REGULATION: As shown in table for both line fluctuations from 105-125 volts and load variations from minimum to maximum current.

***REGULATION FOR BIAS SUPPLIES:** 10 millivolts for line 105-125 volts. ½% for load at 150 volts.

†All AC Voltages are unregulated.

WORKMANSHIP

Workmanship is of a quality with the highest existing production standards and best instrument electronic practices consistent with the intended use of the item as a continuous duty voltage regulated power supply. Oil filled paper condensers and resistor-board construction are included in the design.

FOR NEW POWER SUPPLY CATALOG — WRITE DEPT. No. 789

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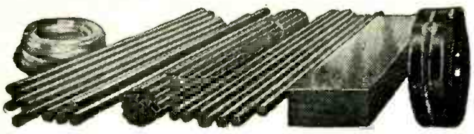


BRIDGEPORT BRASS COMPANY

COPPER ALLOY BULLETIN

Bridgeport Brass Co. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

Bridgeport Technical Handbook

To Help Our Customers on Metal Problems

Mass production of tiny but precise metal parts for electronic equipment calls for exacting specifications in brass and copper mill products. The Bridgeport "Technical Handbook" is designed as a ready-reference for product engineers and those responsible for purchasing and fabricating copper and copper-base alloys.

Bridgeport Brass Company recognizes the importance of supplying metal of uniform high-quality for automatic operations. Close cooperation between the fabricator and our technical service department will quickly help with materials to answer performance requirements, cut wasted time and prevent excessive spoilage.

Simplifies Alloy Selection

The Bridgeport "Technical Handbook" is divided into logical, easily read sections covering both general information and specific engineering data.

The first section discusses the numerous coppers and copper-base alloys, their compositions, physical and mechanical properties and their uses. It covers in non-technical language such subjects as the copper-zinc alloy system; the effects of additional elements such as lead, tin, aluminum, silicon, manganese, iron, nickel and arsenic on coppers; and the effects of annealing on physical properties. Temper or degree of hardness for sheet, rod, wire and tubing is explained. The causes and prevention of stress corrosion, cracking and hot breaks are discussed.

In addition, the "Technical Handbook" contains information on the importance of the microstructure of rolled and annealed brasses, graphically illustrated by micrographs and curves.

Mill Product Shapes

The following three sections are devoted to mill products—strip and sheet, rod and wire, and tubing. They are further broken down into groups such as Brass and Copper Strip for Drawing, Spinning and Stamping; Rods for Screw Machine Operation; Wire and Rod for Cold Heading; Rods for Hot Forging; Tubing for Fabrication; and many others.

Each classification lists not only the alloys and their applications, but gives a table of Composition, Mechanical Properties, Physical Constants, Fabrication Properties, as well as the latest specification numbers. By referring to these tables, the purchasing agent and the design engineer can see at a glance the alloys available and their comparative properties. This simplifies alloy selection, saves time and effort.

Hints on Metalworking

The handbook contains a brief but authoritative outline of procedures for working copper-base alloys. There are many diagrams and tables relating to machining, the tools to be used and recommended coolants. Data on Milling, reaming, chasing and sawing are given in concise tabular form with suggested procedures for the different alloys discussed. There are also full sections on drawing and drawing lubricants, annealing, cold heading, soldering, cleaning and dip coloring.

Useful Appendix

To complete the Handbook, almost thirty pages of informative tables are included as an Appendix. These tables cover equivalent weights, temperature conversions, metal melting points, length measurement conversions, and weights of flat products, circles, rod, round wire and copper tubes.

How to Get Your Copy

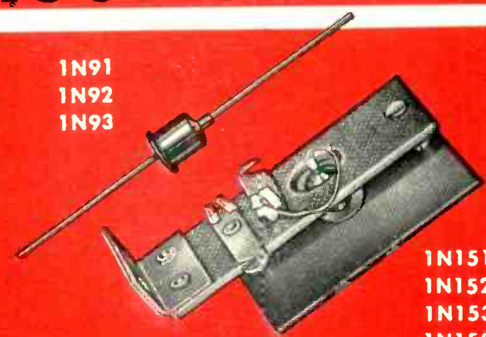
The Bridgeport "Technical Handbook" is a reliable guide to many problems and situations met by purchasing agents, design engineers and production superintendents in every-day work with copper-base alloys. Your copy will be quickly mailed upon request on company letterhead. And if you are confronted with metal problems not completely answered in the Handbook, do not hesitate to contact our nearest branch office for assistance as well as for your metal requirements. (1593)

FIVE SEVERE TESTS PROVE EXTENDED LIFE . . . HIGH QUALITY OF G-E GERMANIUM RECTIFIERS FEATURING *NEW* ALL-WELD SEAM CONSTRUCTION

ABSOLUTE MAXIMUM RATINGS—T-55°C—RESISTIVE LOAD

DIFFUSED JUNCTION RECTIFIER	1N91	1N92	1N93	1N151	1N152	1N153	1N158
RMS INPUT VOLTAGE (Volts)	–	–	–	35	70	105	130
PEAK INVERSE VOLTAGE* (Volts)	100	200	300	100	200	300	380
PEAK FORWARD CURRENT (Amps.)	0.47	0.31	0.25	1.57	1.57	1.57	1.57
D.C. OUTPUT CURRENT* (Ma.)	150	100	75	500	500	500	500
D.C. OUTPUT CURRENT—CAPACITIVE LOAD (Ma.)	–	–	–	350	350	350	350
D.C. SURGE CURRENT (Amps.)	25	25	25	25	25	25	25
FULL LOAD VOLTAGE DROP (volts peak)	0.5	0.5	0.5	0.7	0.7	0.7	1.4
LEAKAGE CURRENT (Ma., @ rated P.I.V.)	2.7	1.9	1.2	2.4	1.9	1.2	0.8
CONTINUOUS REVERSE WORKING VOLTAGE (Volts D.C.)	30	65	100	30	65	100	185
OPERATING FREQUENCY (KC)	50	50	50	50	50	50	50
STORAGE TEMPERATURE (°C)	85	85	85	85	85	85	85

*Typical absolute maximum ratings.



ORDER IN QUANTITY FOR IMMEDIATE DELIVERY

HERE are just five of many severe criteria G.E. insists be met before a diffused junction rectifier is shipped:

1. Life of every day's production is evaluated by sample lot operation at full current, full voltage, and at elevated temperatures under stringent on-off cycle conditions. Acceptance is made only after compliance with 10,000 hour standards.

2. 100% testing of specified characteristics.

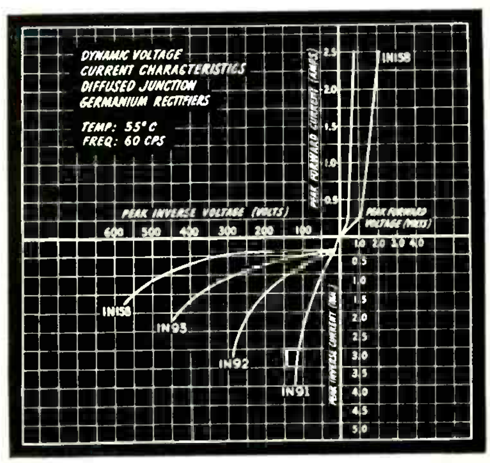
3. Full load aging of *all* units.

4. Absolute hermetic seal is checked on *all* units.

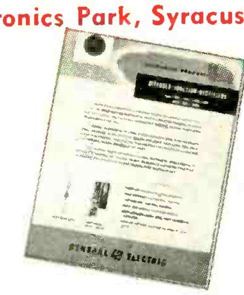
5. A 1% quality control level is imposed on *each* shipment.

Your rectifier applications demand nothing less than these standards. Specify General Electric and receive a custom shipment of quality germanium products.

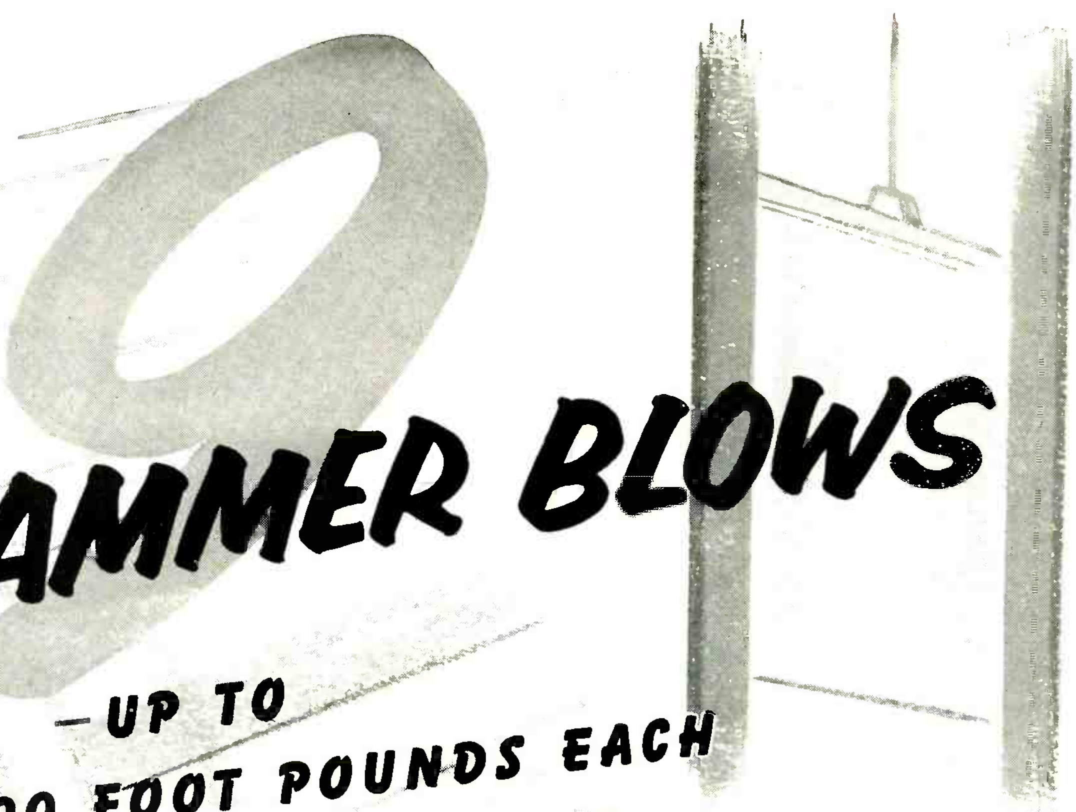
- HERMETICALLY SEALED.
- VERY LOW LOSSES.
- MINIATURE SIZE made possible by low internal losses.
- DESIGNED to meet all military humidity tests and shock and vibration requirements.
- MULTIPLE ARRANGEMENTS for full wave or bridge circuits.



Send for complete G-E Diffused Junction Rectifier Information: General Electric Co., Sec. X464, Electronics Park, Syracuse, N. Y.



GENERAL ELECTRIC



9 HAMMER BLOWS

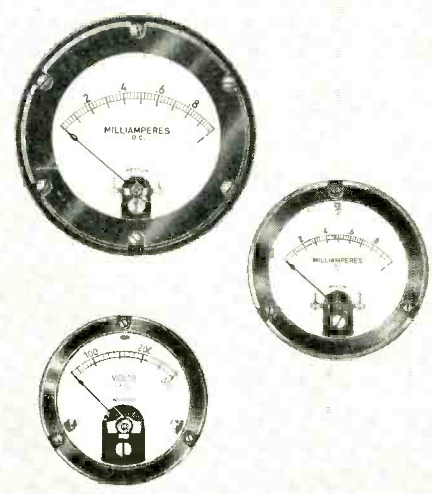
—UP TO 2,000 FOOT POUNDS EACH

WESTON RUGGEDIZED INSTRUMENTS ARE AVAILABLE FOR A-C AND D-C IN 2½", 3½", 4½" SIZES.

yet WESTON

RUGGEDIZED INSTRUMENTS

remain operable and accurate!



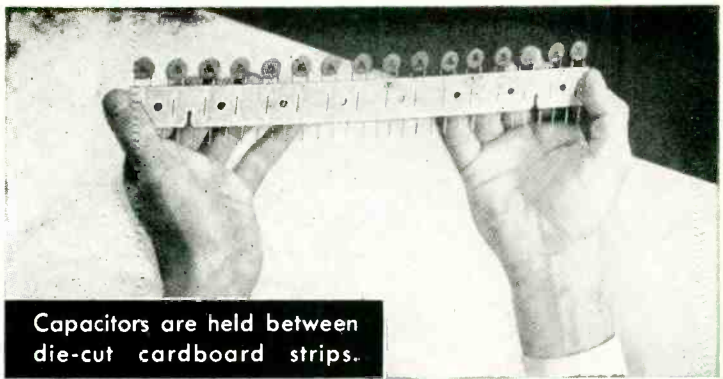
There's no guesswork about *ruggedizing* instruments at WESTON. Duplicates of *all* the approved equipment for testing — including the High Shock Hammers . . . the Vibrating and Tumbling equipment . . . the Temperature, and Moisture Cycling cabinets — all are here in the WESTON test department continually *proving* the soundness of WESTON's ruggedized design. Thus you can *be sure* each instrument not only meets the specifications for ruggedized instruments, but will also *prove* its superior ruggedness in service. WESTON Ruggedized instruments now are available for A-C and D-C requirements in 2½", 3½" and 4½" sizes. Bulletin giving complete information sent on request. WESTON Electrical Instrument Corporation, 614 Frelinghuysen Ave., Newark 5, N. J. 6917

WESTON *Instruments*

For Automatic Assembly plus Easy Inventory and Storage

TRADE **ERIE** MARK

Pallet-Pak



Capacitors are held between die-cut cardboard strips.

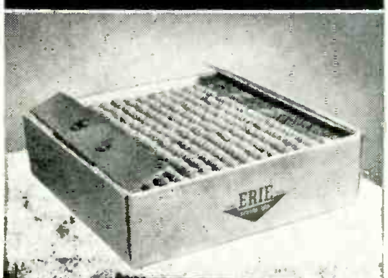
NEW PACKAGING METHOD FOR DISC CERAMICONS®

Pallet-Pak, ERIE's exclusive new packaging method for Disc Ceramicons, answers the need for mechanically pre-aligned capacitors that can be fed into automatic assembly machinery. Hand assembly is also improved because of the ease of handling and the physical uniformity of the capacitor.

ERIE is constantly searching for new ways to assist manufacturers in reducing production costs. Pallet-Pak is a development by ERIE Industrial Engineers with this purpose in mind.

The many other advantages of Pallet-Pak are noted at right. Write for our Pallet-Pak Bulletin with complete illustrations and advantages of this new packaging method that is currently available on a portion of ERIE Disc Ceramicon production.

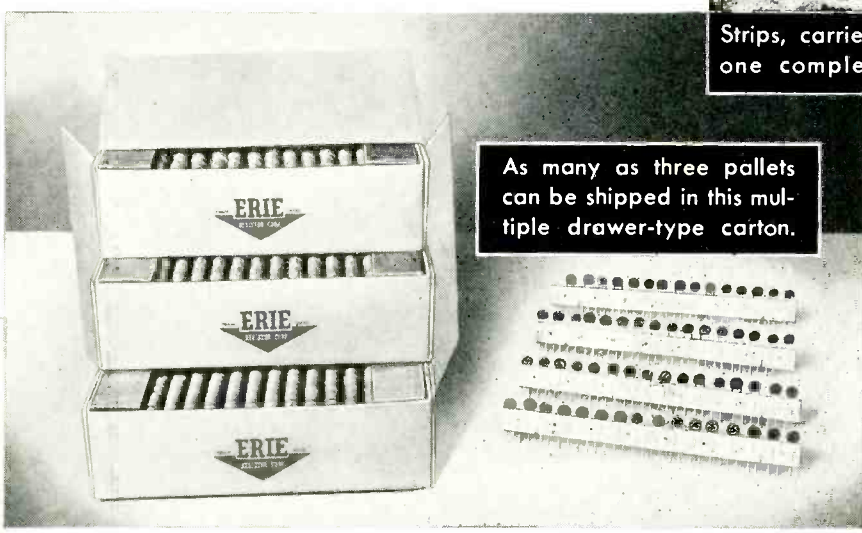
Strips are placed in carrier insert which fits in pallet.



Strips, carrier, and pallet form one complete shipping unit.

ADVANTAGES FOR INVENTORY AND STORAGE

- Known number in strip makes inventory control easier.
- Count empty strips—multiply by number for usage control.
- Markings all face one direction for easy identification.
- Drawer type disposable pallet for storage and shipping.



As many as three pallets can be shipped in this multiple drawer-type carton.

ADVANTAGES FOR YOUR PRODUCTION

- Straight lead wires—no tangling—units easily removed by pulling from strip.
- Uniform lead length.
- Carrier insert acts as tote-tray for easy handling.
- Index holes in strip 1½" center to center for use in lead forming and cutting equipment.
- Index holes are above carrier sides—rods can be inserted through holes and entire lot lifted easily in one operation.
- Assurance of uniform quality, resulting from continuous production flow.

TRADE **ERIE** MARK
RESISTOR CORP.

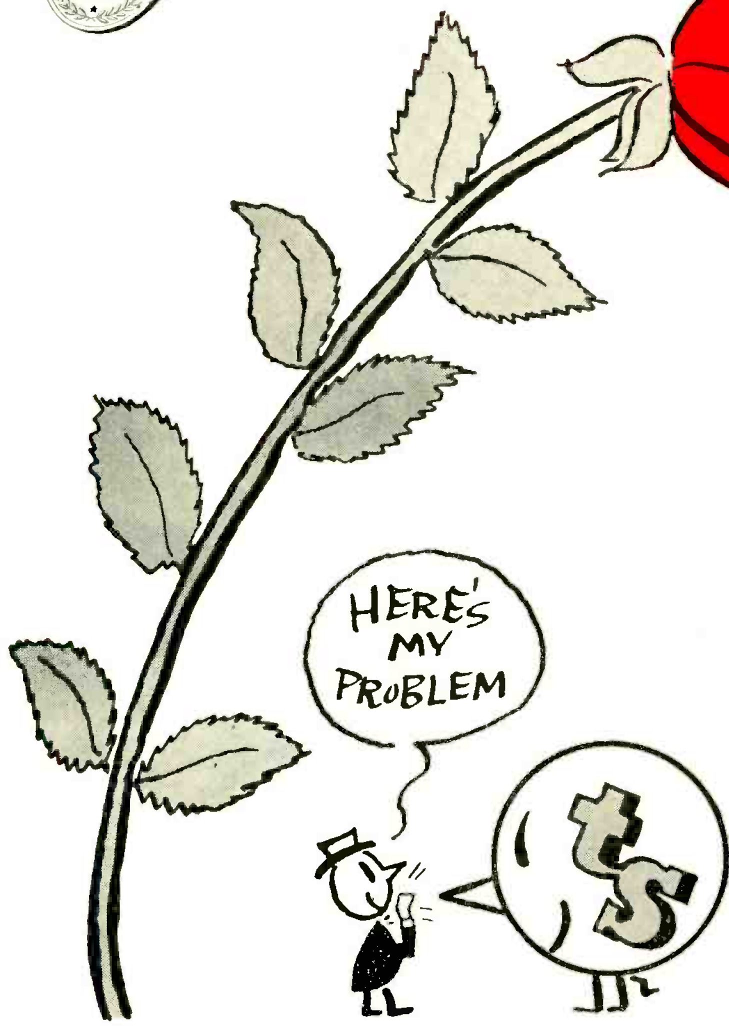
ERIE RESISTOR CORPORATION . . . ELECTRONICS DIVISION

Main Offices and Factories: **ERIE, PA.**

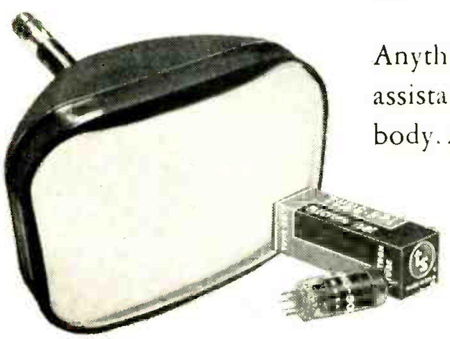
Sales Offices: Cliffside, N. J. • Camden, N. J. • Chicago, Ill. • Detroit, Mich.
Cincinnati, Ohio • Fort Wayne, Ind. • Los Angeles, Calif. • Toronto, Ontario

Manufacturing Subsidiaries:
HOLLY SPRINGS, MISSISSIPPI • LONDON, ENGLAND • TRENTON, ONTARIO

TUNG-SOL 50 YEARS ACHIEVEMENT 1904 1954



strictly "under the rose"



Anything you tell Tung-Sol is absolutely *sub-rosa*. Our engineering assistance to you is completely confidential. Never a peep to anybody. And we make only tubes—no sets—no equipment—just tubes.

TUNG-SOL ELECTRIC INC., Newark 4, N. J.

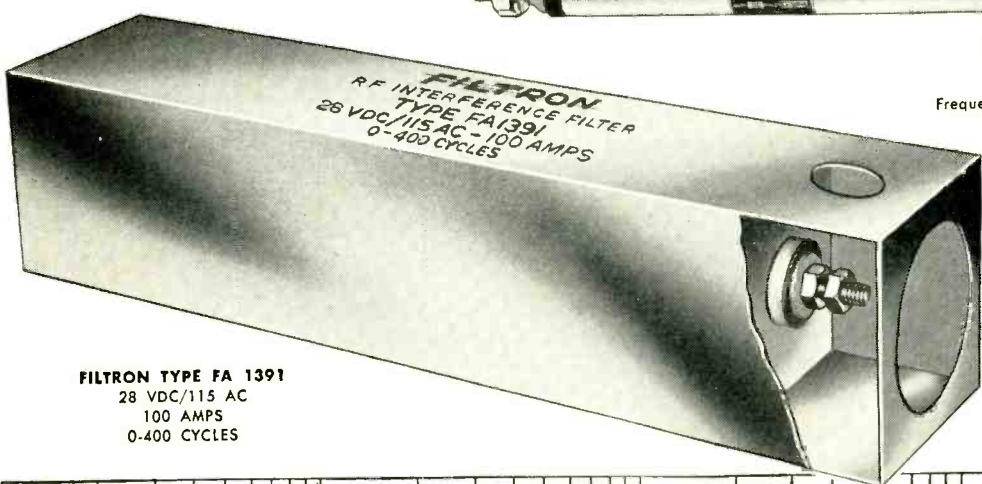
Sales Offices: Atlanta, Chicago, Columbus, Culver City (Los Angeles), Dallas, Denver, Detroit, Newark, Seattle

TUNG-SOL MAKES All-Glass Sealed Beam Lamps, Miniature Lamps, Signal Flashers, Picture Tubes, Radio, TV and Special Purpose Electron Tubes and Semiconductor Products.

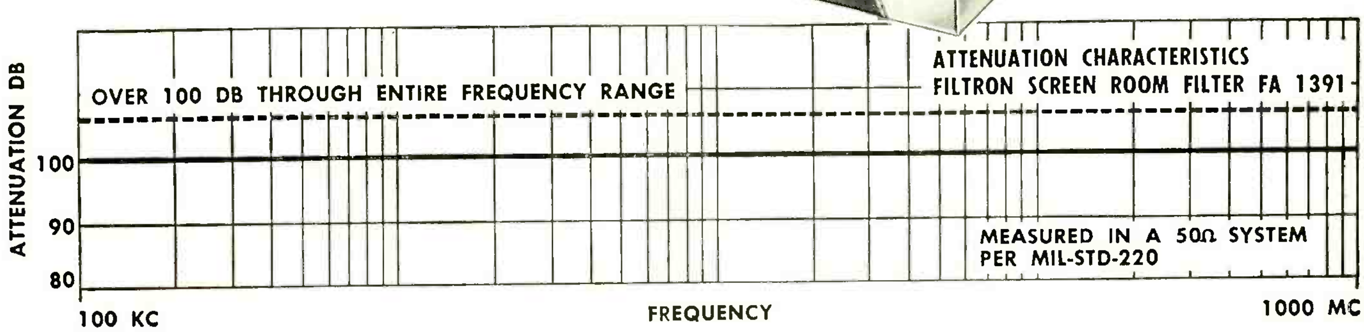
HIGH ATTENUATION
CONTINUOUS DUTY
HERMETICALLY SEALED

FILTRON SCREEN ROOM FILTERS

FILTRON TYPE FA 736
500 VAC/DC
100 AMPS
Frequency Range 1000 to 15,000 MC



FILTRON TYPE FA 1391
28 VDC/115 AC
100 AMPS
0-400 CYCLES



Screen room manufacturers specify and install FILTRON Screen Room Filters as standard equipment.

FILTRON Screen Room Filters are used in the majority of industrial, government and military screen rooms, to meet the requirements of specification MIL-S-4957, and wherever critical RF measurements are required.

FILTRON has over 30 types of Screen Room Filters available, ranging from 1 Amp to 1000 Amps, 28 VDC to 500 Volt AC/DC, 0 to 1000 cycles. Complete technical information available.

FILTRON RF Interference Filters are also specified in the latest types of Radar, Radio Transmitters, Receivers, Motor Generator Sets, Inverters, Aircraft, Electronic Systems, and numerous other "restricted" equipments.

When you have an RF Interference Filter problem, consult FILTRON — the most dependable name in RF Interference Filters.

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Massey Associates, Inc., Narbeth, Pa., Washington, D. C.
Holliday-Hathaway, Sales Offices at: Cambridge, Mass., Canaan, Conn., New York, N. Y., Great Neck, N. Y., Rochester, N. Y., Binghamton, N. Y., Wood-Ridge, N. J.

An inquiry on your company letterhead will receive prompt attention.

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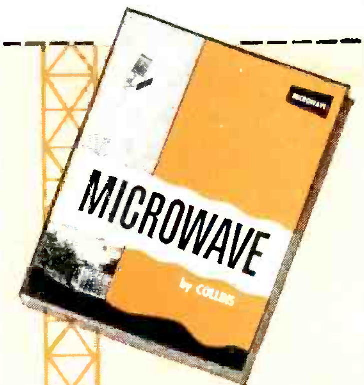

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and find out why Collins Microwave will serve you best.

You'll want all the facts in this informative booklet, but this is the story in a nutshell. Collins can do your communications and remote control jobs better because they're *specialists* in radio-electronic design and manufacture. Collins' extensive experience and success in the aviation, broadcast and amateur radio fields supply the required background and facilities to deliver microwave systems that represent the ultimate in dependability. If your plans include the use of Microwave, be sure you get assured performance and quality. Why not mail the coupon now.

COLLINS RADIO COMPANY **Cedar Rapids, Iowa**

11 W. 42nd St., NEW YORK 36 1930 Hi-Line Dr., DALLAS 2 2700 W. Olive Ave., BURBANK

Collins Radio Company of Canada, Ltd., 74 Sparks Street, OTTAWA, ONTARIO

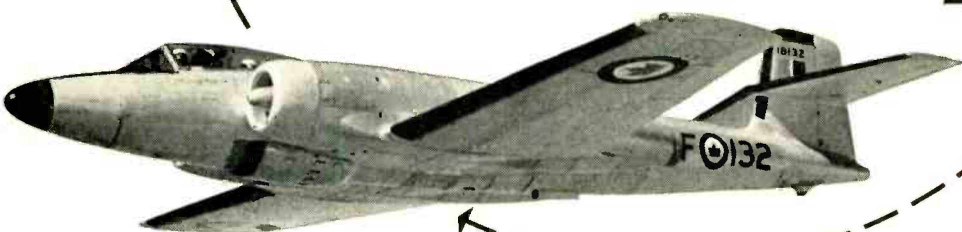
COLLINS

J. F. Mandrow (left) and T. W. Connolly prepare a problem in dynamic analysis of an interceptor fire control system for solution on analog computing equipment.

B. D. McVey (foreground) and E. Foxman examine operation of interceptor fire control system with equipment simulating in-flight performance of target, fire control system, and interceptor.

PLANNING PERFORMANCE

In the development of advanced radar fire control systems for all-weather military aircraft, system design objectives are determined by systems engineering and analysis. To implement these objectives the next step is the detailed analysis, design, and evaluation of the individual subsystems and units.



The Avro Canada CF-100 of the RCAF is one of the all-weather interceptors equipped with Hughes radar fire control system.

At Hughes special simulation equipment is used to synthesize aircraft and system performance. The simulator provides a means for examining system performance under laboratory-controlled conditions. In the case of airborne systems such study would otherwise require hundreds of hours of expensive flight testing to achieve comparable results.

Three important aspects of this work are:

Determination of effects on over-all dynamic stability of items such as dynamic range of amplifiers, filtering included to reduce effects of noise, aerodynamic response characteristics of the aircraft, and characteristics of computers.

Evaluation of existing systems, subsystems, or units to determine degree of modification necessary in order to meet new installation or performance requirements.

Assessment of completed systems under simulated operation to establish performance before start of production. Simulator studies are correlated with actual flight tests, helping to predict in-flight performance with reduced flight testing.

SYSTEMS ENGINEERS—CIRCUIT ENGINEERS

Further advancements in the field of radar fire control are creating new positions on our Staff for engineers experienced in the fields of systems engineering and circuit design, or for those interested in entering these areas.

Scientific and Engineering Staff

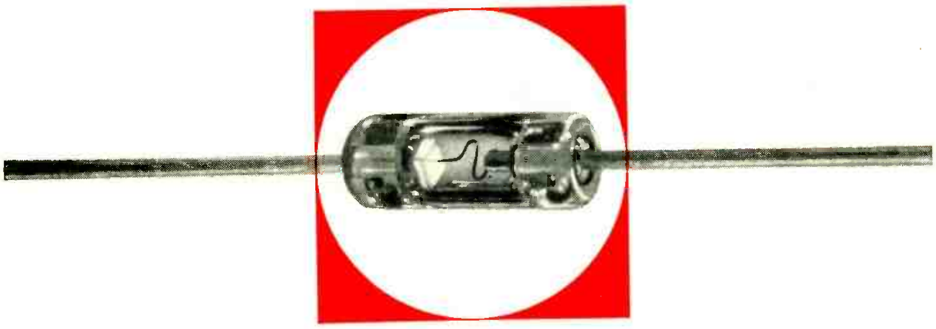
HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

Culver City, Los Angeles County, California

Assurance is required that relocation of the applicant will not cause disruption of an urgent military project.

Hughes *Fusion-Sealed* Germanium Diodes



ACTUAL DIMENSIONS
DIODE BODY:
0.265 by 0.130 inches (maximum)

SHUNT CAPACITANCE:
0.5 μμf (maximum)

AMBIENT OPERATING
TEMPERATURE RANGE:
−78°C to +90°C

Hughes Point-Contact Germanium Diodes are fusion-sealed in a one-piece, gas-tight glass envelope . . . impervious to moisture, fumes or other external contaminating agents. The flexible dumet leads are especially suitable for spot-welding; or they can be iron- or dip-soldered as close as ¼ inch to the diode body—without special precautions.

The germanium crystal is permanently bonded to one lead, the cat whisker is welded to the other, and the point of the cat whisker is welded to the crystal. Hughes diodes are highly resistant to shock and vibration. *Positive* mechanical stability is achieved without risking contamination from fluxes, waxes or impregnants. And—*each diode is thoroughly tested* to ensure the stability of its electrical and physical characteristics. All this means: sturdy, highly reliable diodes.

TYPES—The Hughes line of diodes comprises standard RETMA, JAN, and many special types. Special types are produced according to customer specifications and are tested at high or low temperatures . . . for specific recovery time . . . for matching in pairs or quads.

ELECTRICAL SPECIFICATIONS AT 25° C *unless otherwise indicated*

DESCRIPTION	RETMA or Hughes Type	Clip-In Hughes Type	Peak Inverse Voltage† (volts)	Absolute Maximum Inverse Working Voltage (volts)	Minimum Forward Current @ +1V (mA)	Maximum Inverse Current @ −50V (mA)	Maximum Inverse Current Other (mA)	Other Characteristics
HIGH PEAK	1N55B	HD 2052	190	150	5.0		0.500 @ 150V	
	1N68A	HD 2053	130	100	3.0		0.625 @ 100V	
1 MEG TYPES	1N67A	HD 2054	100	80	4.0	0.050	0.005 @ 5V	
	1N99	HD 2055	100	80	10.0	0.050	0.005 @ 5V	
	1N100	HD 2056	100	80	20.0	0.050	0.005 @ 5V	
500K TYPES	1N89	HD 2057	100	80	3.5	0.100	0.008 @ 5V	
	1N97	HD 2058	100	80	10.0	0.100	0.008 @ 5V	
	1N98	HD 2059	100	80	20.0	0.100	0.008 @ 5V	
	1N116	HD 2060	75	60	5.0	0.100		
	1N117	HD 2061	75	60	10.0	0.100		
	1N118	HD 2062	75	60	20.0	0.100		
GENERAL PURPOSE	1N90	HD 2063	75	60	5.0	0.500		
	1N95	HD 2064	75	60	10.0	0.500		
	1N96	HD 2065	75	60	20.0	0.500		
JAN TYPES	1N126*		75	60	5.0	0.850	0.050 @ 10V	Non-JAN equivalent, HD2070; clip-in, HD2066
	1N127**		125	100	3.0	0.300	0.025 @ 10V	Non-JAN equivalent, HD2071; clip-in, HD2067
	1N128***		50	40	3.0		0.010 @ 10V	Non-JAN equivalent, HD2072; clip-in, HD2068
COMPUTER TYPES	1N191	HD 2077		§	5.0	400K Ω min. between −10 and −50V @ 55°C§		Back resistance recovers to 50K Ω and 400K Ω (200K Ω for 1N192) in 0.5 μsec and 3.5 μsec max., respectively.‡
	1N192	HD 2078		§	5.0	200K Ω min. between −10 and −50V @ 55°C§		
	HD2013				50 @ 1V & 1 @ 0.35V		0.120 @ −3V	0.2 μsec recovery time.°
	HD2014				50 @ 1V & 1 @ 0.35V		0.60 @ −6V	0.2 μsec recovery time.°
UHF	HD2016A	UHF MIXER DIODE						
MISCELLANEOUS	HD2051		125	100	4.0	0.050		1N63 equivalent.

†That voltage at which dynamic resistance is zero when back voltage rises linearly at 90v/sec.
‡Back Recovery Time is measured with a forward pulse of 30mA, followed by a reverse pulse of 35 volts. Loop resistance of test circuit 2500 Ω max.
°Recovery time is that point at which the diode voltage reaches −1V after the initiation of a 6V back pulse through 20K Ω from an initial 3 mA forward bias. Total shunt capacitance is 20 μμf.
§Tested at 55°C. Test voltage is a continuous 60 cps sine wave. Peak Reverse Voltage across the diode is 70V. Peak Forward Voltage not less than +2V or Peak Forward Current not less than 20 mA, whichever occurs first.
**Formerly 1N69A.* ***Formerly 1N70A.* ****Formerly 1N81A.*

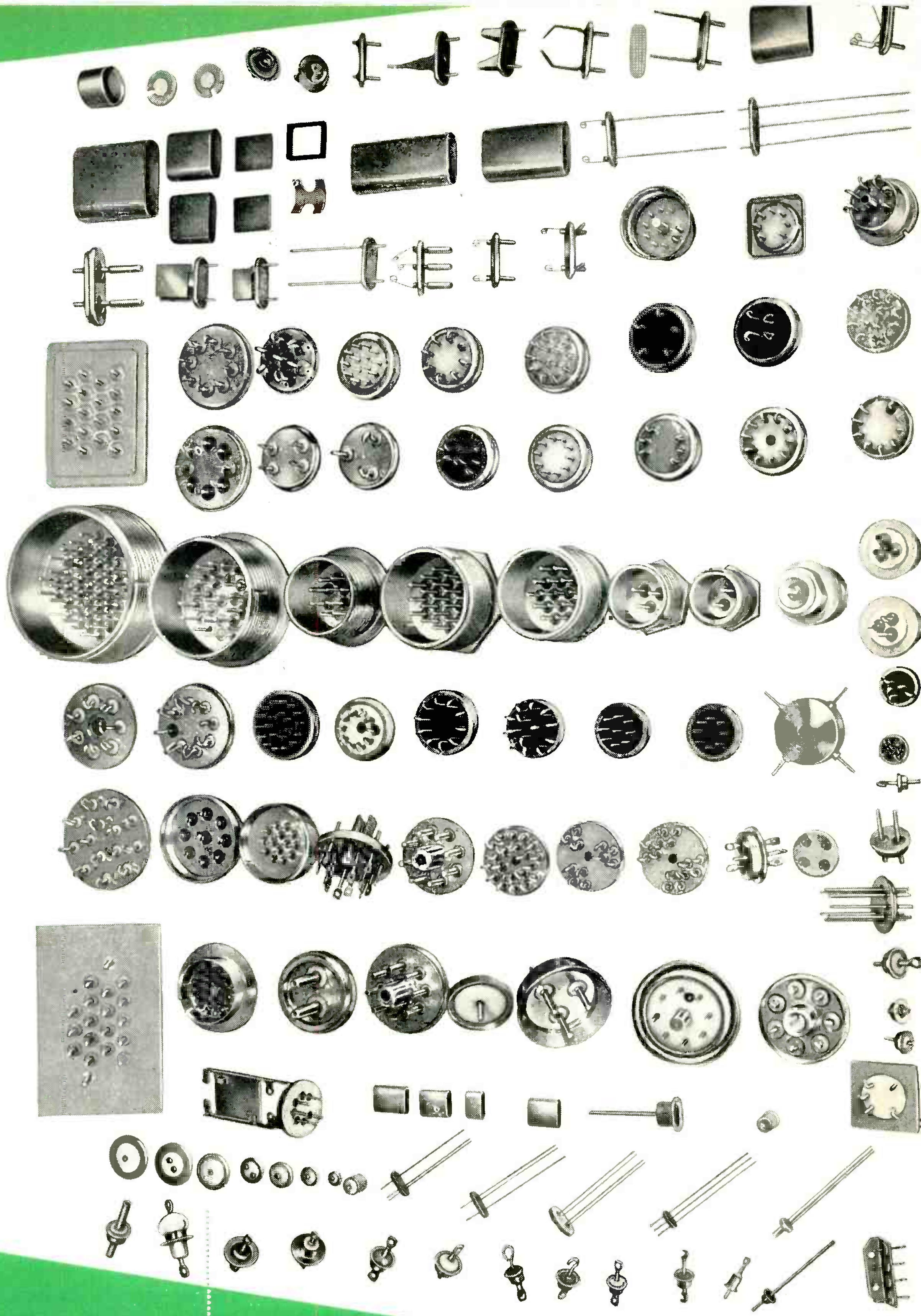
Descriptive Bulletin SP2A is available on request.

Hughes

SEMICONDUCTOR SALES DEPARTMENT

Aircraft Company, Culver City, Calif.

New York Chicago



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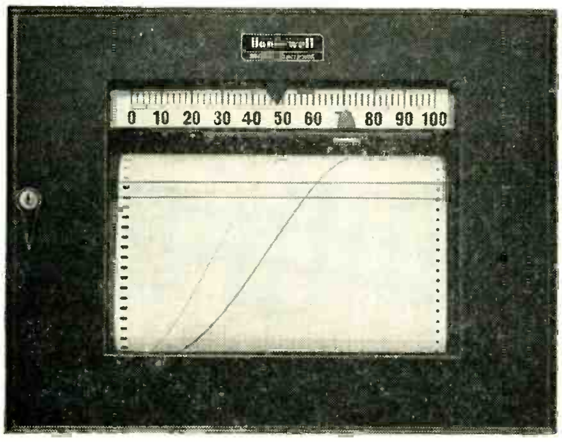
L. L. Constantin & Co.

Glass-to-Metal VACUUM Seals
Manufacturing Engineers
Rt. 46, Lodi, N. J.

KOVAR and COMPRESSION HEADERS • AN CONNECTORS • TRANSISTOR MOUNTS • SINGLE TERMINALS • END SEALS • CRYSTAL BASES • MINIATURIZATION

Automatically plots two variables as a function of a third---



the ElectroniK Duplex Function Plotter

NEWEST of the many modifications of the *ElectroniK* recorder, especially designed for research work, is the Duplex Function Plotter. A two-pen version of the now famous Function Plotter, this instrument has three independent measuring systems; one for each of the horizontally moving pens, and one coupled to the vertically moving chart. The instrument is thus able to draw two simultaneous, continuous curves representing the relationship $x, x' = f(y)$.

In the testing of missiles, engines, nuclear reactions and numerous other studies, the Duplex Function Plotter further helps to accelerate the pace of research. It provides better data by giving scientists a continuous plot of related functions on a single chart, without need for replotting from two separate records. It helps to lift even more of the burden of routine transcribing and data-taking from the shoulders of trained men . . . and frees them for more complete utilization of their skills.

Input to either pen or to the y-axis can be practically any variable that can be converted to a d-c signal. All three inputs can be of different calibrations.

Your local Honeywell sales engineer will welcome the opportunity to discuss your specific applications for this time-saving instrument. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

● **REFERENCE DATA:** Write for new Data Sheet No. 10.0-17, "*ElectroniK* Duplex Function Plotter."

H HONEYWELL

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

MICROWAVE SIGNAL GENERATORS

Complete coverage of the range 950-10,800 mcs/sec.

with Polarad single dial operation

Four new Microwave Signal Generators covering the range 950-10,800 mcs/sec. All with famous **Polarad single dial operation.** Each provides the maximum working range possible in one compact signal generator. And, additional Polarad Signal Generators are available to cover 12.8 to 39.7 kmc.

These features on all MSG units assure fast and simple operation: direct reading, single dial frequency control that tracks reflector voltages automatically . . . direct reading attenuator dial . . . conveniently placed controls, in logical sequence . . . high visibility on the face of each instrument.

Polarad Signal Generators are built to the same high standards required for military equipment. They are practical for the factory assembly line—engineered ventilation assures continuous and stable operation of all instrument functions. Components are readily accessible for easy maintenance. And laboratory accuracy is guaranteed under the most rigorous operating conditions.

Write directly to Polarad or your nearest Polarad representative for details.

	MSG-1	MSG-2	MSG-3	MSG-4*
Frequency Range	950-2400 MCS/sec.	2150-4600 MCS/sec.	4450-8000 MCS/sec.	6950-10,800 MCS/sec.
	(Frequency set by means of a single directly calibrated control)			
Frequency Accuracy	±1%	±1%	±1%	±1%
Power Output	1 MW	1 MW	.2 MW	.2 MW
Attenuator Range	120 db	120 db	120 db	120 db
Attenuator Accuracy	±2 db	±2 db	±2 db	±2 db
Output Impedance	50 ohms	50 ohms	50 ohms	50 ohms
Input Power	115V±10% 60 cps	115V±10% 60 cps	115V±10% 50-1000 cps	115V±10% 50-1000 cps
Internal Pulse Modulation:				
Pulse Width	0.5 to 10 microseconds			
Delay	3 to 300 microseconds			
Rate	40 to 4000 pulses per second			
Synchronization	Internal or external, sine wave or pulse			
Internal FM:				
Type	Linear sawtooth			
Rate	40 to 4000 cps			
Synchronization	Internal or external, sine wave or pulse			
Frequency Deviation	±2.5 MCS	±2.5 MCS	±6 MCS	±6 MCS
External Pulse Modulation:				
Polarity	Positive or Negative			
Rate	40 to 4000 pulses per second			
Pulse width	0.5 to 2500 microseconds			
Pulse separation	(For multiple pulses) 1 to 2500 microseconds			
Output Synchronizing Pulses:				
Polarity	Positive, delayed & undelayed			
Rate	40 to 4000 pps			
Voltage	Greater than 25 volts			
Rise time	Less than 1 microsecond			
Size / Approx. weight	17" long x 13¼" high x 15½" deep | 60 lbs.		17" long x 15" high x 19½" deep | 100 lbs.	

*Also available—MSG 4A: 6,950—11,500 MCS/sec.

"THE FINEST SIGNAL GENERATORS OF THEIR KIND" **Polarad** ELECTRONICS CORPORATION 100 METROPOLITAN AVENUE, BROOKLYN 11, NEW YORK

REPRESENTATIVES Albuquerque • Arnprior, Canada • Atlanta • Boston • Chicago • Cleveland • Fort Worth • Kansas City • Los Angeles • New York • Philadelphia • San Francisco • Seattle • St. Paul • Syracuse • Washington, D. C.

ESTIMATORS SAY . . .

"We ALWAYS Specify *Heldor*

BUSHINGS

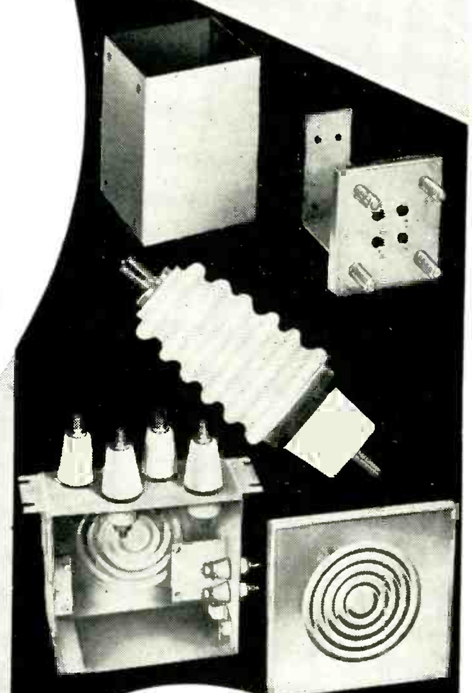
hermetic-seal, compression type

CANS and COVERS

built to meet MIL-T-27 & Commercial Specifications

ASSEMBLY SERVICE

from assembly of bushings in covers to actual hermetic sealing of your component.



. . . because, when we 'quote' on a job, we must be sure of LOW material- and assembly-costs plus consistent top quality."

More and more estimators in the electronic and nuclear fields are experiencing the outstanding advantages of basing their costs on the selection of components from Heldor's line of hundreds of standard and non-standard Cans, Covers and hermetic-seal Bushings . . . (now, lower in cost than ever* because of improved production facilities). These men are also specifying Heldor's Assembly Service because it further reduces costs, speeds delivery and meets rigid inspection standards.

Be Wise! *Economize* . . . the Heldor way! Send specifications or prints of your requirements for a quotation that will tell its own QUALITY with ECONOMY story! *Do it NOW!*

Write for your copy of New Price List!

NEW!

Heldor LOCK-IN, HERMETIC-SEAL TERMINAL

Meets MIL-T-27 Twist Test. Improved Electrical Characteristics. WRITE FOR DATA!

HELDOR MANUFACTURING CORPORATION

HELDOR BUSHING & TERMINAL CO., INC.

238 Lewis Street • Paterson, N. J.

Midwestern Branch: 3821 Montrose Ave., Chicago 18, Ill.

Is Our Face Red!

Most people have had the experience of moving from one place to another. Most people, therefore, will appreciate our predicament . . . that at such a time, efficient methods of production as well as delivery schedules bog down badly.

That is exactly what has happened to us . . . *and is our face red!* Yes, moving our entire operation to Manchester, N. H. during the past few months has inadvertently caused many disappointments and delays. Our expanding operations were so hampered by our previous space limitations that we've subjected you to uncertain promises and regretable let-downs. *For this, we apologize deeply.*

Out of all the havoc, however, comes good news! Now, swinging into full production in our great new plant, we will soon be ready to give you the kind of products we can be proud of — the kind of service you deserve!

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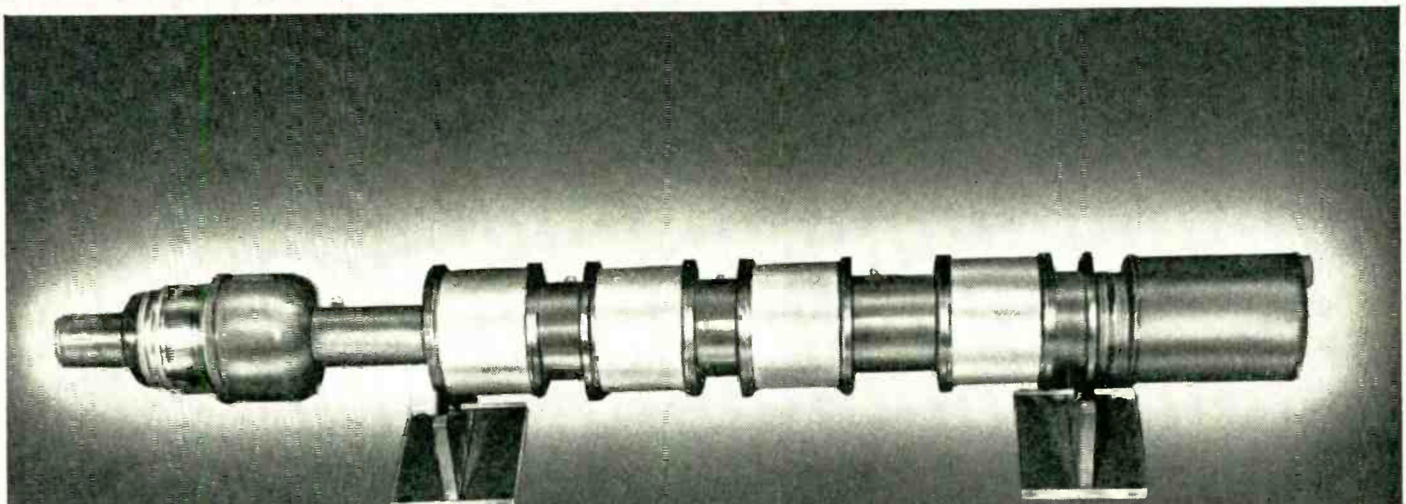
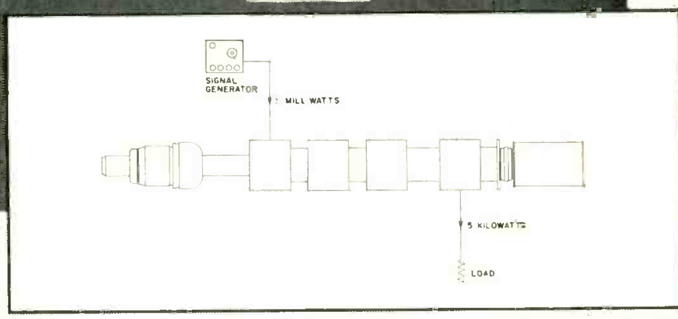
- **5kw power output at 650mc**





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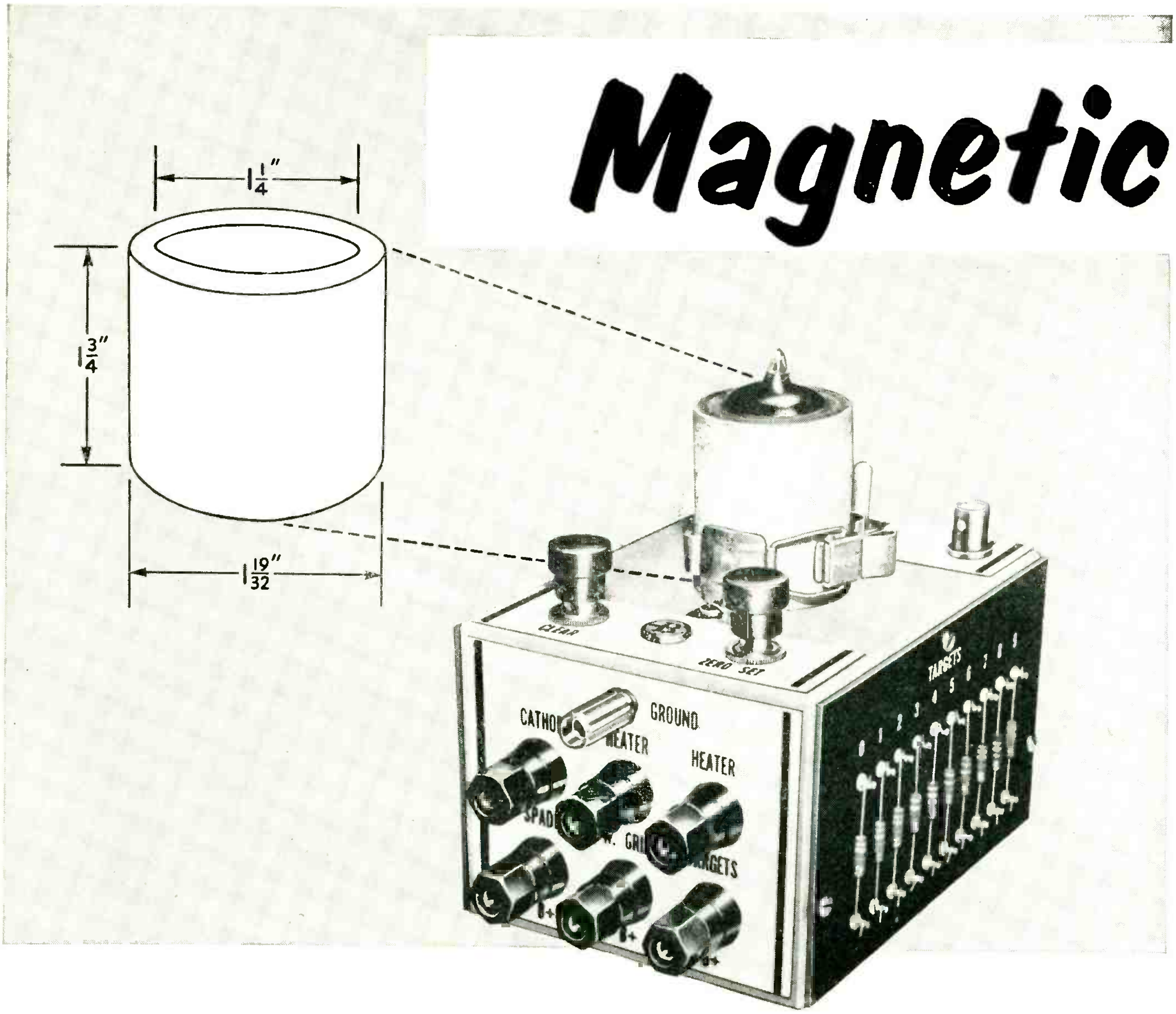
Magnetic



New Burroughs beam switching tube uses Thomas & Skinner permanent magnet

One of the principal problems in designing the new Burroughs Beam Switching Tube—recently announced by Burroughs Electronic Instruments Division—was a means of providing an electron beam, which could be formed, switched, and modulated in any one of 10 discrete automatically locked positions—consecutively or at random.

The solution was a combination of magnetic and electric fields. . . and to obtain a cylindrical permanent magnet to surround the tube, Burroughs called in Thomas & Skinner engineers. The result was a permanent magnet of the exact-type material needed—and with the specific magnetic characteristics required for successful operation, including maximum energy product, coercive force, residual induction, and other required characteristics.

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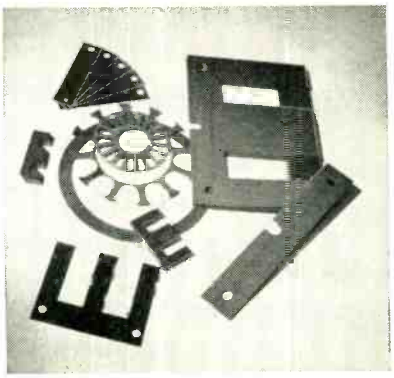

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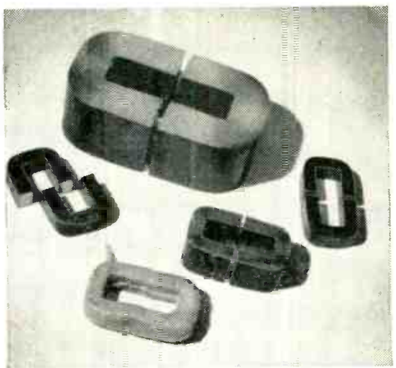

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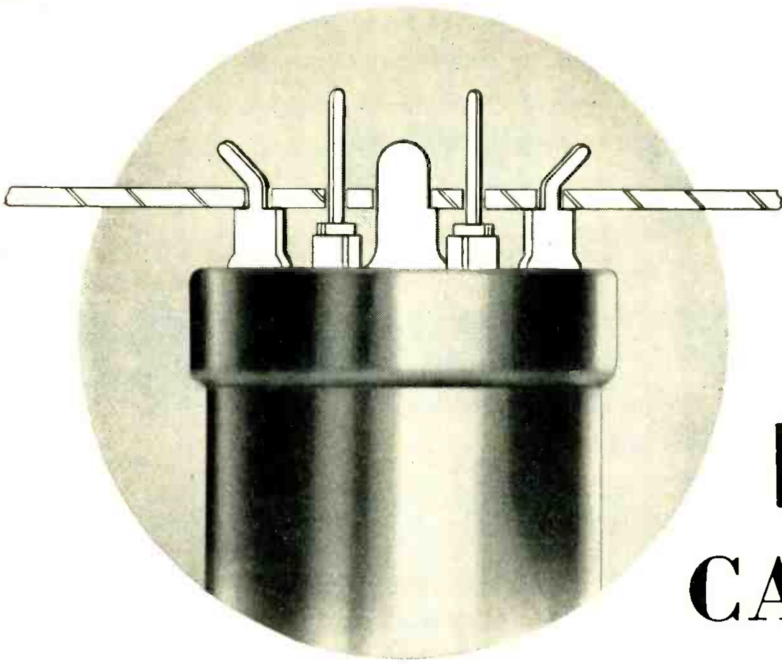

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CROSS TALK

► **NEW ENGLAND** . . . A field trip to the northeast strengthens our belief that this section of the country will continue to exert a major influence upon the design, production and use of electronic equipment despite spectacular gains by other areas.

New England has a number of advantages that cannot be discounted. Its people possess the will to work. They have a high degree of technical skill. Ingenuity is almost the watchword of the Yankee; it flourishes in the shade of fine educational institutions with excellent facilities for research.

While in Boston we had the opportunity of hearing half-a-dozen suppliers of materials and services not in our field speculate, industry by industry, concerning their future markets. In every case electronics was mentioned near the top of the list. We are, it seems, an important industry not only because of what we sell but also because of what we buy, and nowhere is this more evident than in the land of the Pilgrim Fathers.

► **WEIGHT** . . . Sat through a night-spot show with a disc-jockey friend who runs a WCOP remote. This served the double purpose of providing relaxation during a week on the road and keeping our hand in on broadcasting techniques. Noted that operator used a spool of solder over the turntable spindle to stop record slip. A novel use for the stuff, in our experience.

► **WRITING** . . . The cost of engineering comes up in many conversations with management people these days, perhaps because less of it is financed by the government than a year or so ago.

Several men with whom we have recently explored this subject think the increasing cost is due in large measure to duplication of effort from plant to plant. This reminds us that three separate pieces of printed matter having a direct bearing on this point arrived in the mail this week:

An abstract of a speech says engineering progresses in direct proportion to the number of good published papers. A government experiment station advises that it is starting a course in technical writing for its personnel. And a manufacturer sends us a long letter outlining the opportunities in industry for engineers who can write.

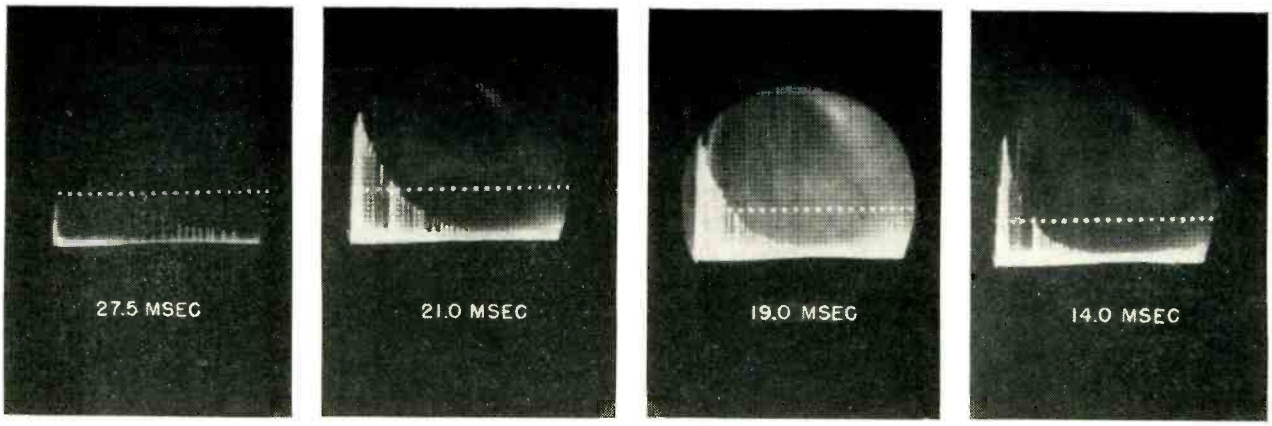
The ultimate importance of technical writing, it seems to us, is simply that by the interchange of information today's work can begin where yesterday's ended—one need not do again today what was well done yesterday.

► **ROLLING STONES** . . . Widespread pirating of engineers who are up on color television receiver design is reported. Manufacturers are letting no grass grow under their feet in preparing for the new market.

This reminds us that the business of job jumping is not as lucrative in the long run as it was just a few short years ago. Most companies have upped their pay scales, improved working conditions and provided other benefits calculated to hold technical help in a time of shortage. Opportunities for advancement exist in almost every firm in our fast-moving business. Normal obstacles to advancement probably have to be hurdled in the plant across the street too, even though this may not be evident to an outsider. The grass over there is not necessarily greener.

► **HUMAN** . . . On a recent technical program was a paper entitled *The Monte Carlo Method as a Natural Mode of Expression* . . .

We've always suspected that there was a little bit of a gamble in even the most precise branches of engineering.



Relaxation times of molecules in oil samples give clue to SAE viscosity

Field Pulses Produce

Pulse transmitter supplies r-f magnetic field for nuclear resonance spectrometer. Study of resulting spin echoes provides additional information about chemical and physical properties of material. Measuring viscosity of lubricating oil is one example

By LEONARD MALLING
Varian Associates
Palo Alto, Calif.

CERTAIN ADVANTAGES of pulse techniques for exciting nuclear resonance become evident when comparisons are made with c-w nuclear resonance systems. The pulse method does not require a homogeneous polarizing field. The received echo signal is obtained when the transmitter is cut off, greatly reducing the effect of the transmitter field at the receiver coil and simplifying probe design. It is in fact possible to use one coil for both transmitter and receiver. However there are advantages in reduction of transient effects in the receiver to be gained by separation of transmitting and receiving circuits. Another advantage of pulsing is that the pulsed signal is readily demodulated and amplified at video frequency and auxiliary sweep fields for producing modulation are not required.

Equipment

Pulse equipment for producing spin echoes is similar to equipment used in radar or television. Differences occur mainly in equipment for producing the pulses. Figure 1 is a block diagram of a typical spin echo system designed for proton excitation of liquid chemical samples. A convenient polarizing field and frequency for proton observation is 7,060 gauss and 30 mc, which will satisfy the requirements of the nuclear equation discussed in a previous article.[1] Radio-frequency equipment for proton investigation may be designed for fixed frequency operation and the required nuclear flexibility obtained by varying the polarizing field. Since pulse operation requires wide bandwidths, tuning or searching for signals is relatively simple with magnetic field control.

The sample in its probe is inserted between the pole faces of an electromagnet. The probe uses a simplified cross-coil arrangement similar to that used in the spectrometer[1]; however, since the coils have preset tuning, low-impedance coaxial cables may be used to connect the probe to the electronic apparatus, as shown in the schematic diagram.

Transmitter

Radio-frequency pulses are applied to the probe from a 30-mc transmitter that provides the field for initiating nuclear resonance. The signals generated in the receiver coil are amplified in a 30-mc receiver that has sufficient r-f and video gain to permit observation on an oscilloscope.

A low-frequency function generator supplies continuous pulses to a nuclear timer, which has a flexible control arrangement that provides pulses of the desired characteristics to drive the pulse modulator in the transmitter. The timer ensures also that echo signals are readily observable by supplying suitable con-

USE OF SPIN-ECHO INFORMATION

Main use for equipment of the type described in this article is in measuring certain physical properties of chemicals. Some idea of the applications of spin-echo equipment may be gained from the photographic recordings at the left. These show the experimental results obtained from standard automobile oil samples having different viscosities—from left to right: SAE 10, 20, 30 and 40. The dots on the photos are 5-millisecond time calibration markers.

The physical property measured is the relaxation time, which is a property associated with the motion of molecules in oil samples. The slowly decaying vertical lines are photographic recordings of the change in echo amplitude with change in initiating pulse spacing. As pulse spacing is increased, echo amplitude slowly decreases. With higher viscosities, the decay time is much shorter.

Spin-echo equipment may presently be regarded as a highly specialized tool for the nuclear physicist or chemist. However, as knowledge is gained concerning uses to which nuclear resonance may be put, increasing application of this relatively new phenomenon may be expected—including possible uses in solving purely electronic problems such as memory storage

Nuclear Spin Echoes

trol voltage to the oscilloscope for synchronization and other purposes.

One of the main requirements for the r-f transmitter is that it be capable of producing the required field intensity in the sample enclosed by the transmitting coils. The field intensity should also be continuously controllable to meet the field required depending on the length of the pulse. The field requirement is of the order of 10 gauss and may be readily compared to that for magnetic scanning of television tubes. For nuclear work, however, a sinusoidal r-f field is used.

One effect of the r-f field pulse on nuclei that have already become orientated by the steady d-c polarizing field is to tilt their magnetic moment vectors from the original direction to some new position. The amplitude of the echo is dependent on the amount of tilt produced by the excitation pulses. The tilt is a function of both pulse width and r-f magnetic field

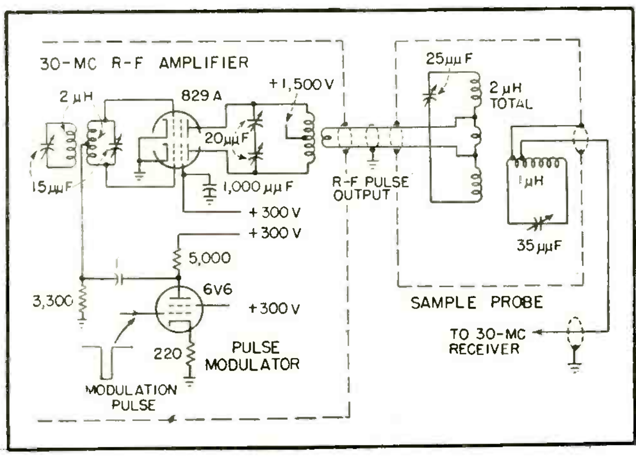
$$\theta = \gamma H_1 t_\omega$$

where θ is the angle of tilt of the magnetic moment vectors of the nuclei; γ, a nuclear constant; H_1, the magnitude of the r-f field; and t_ω, the pulse width.

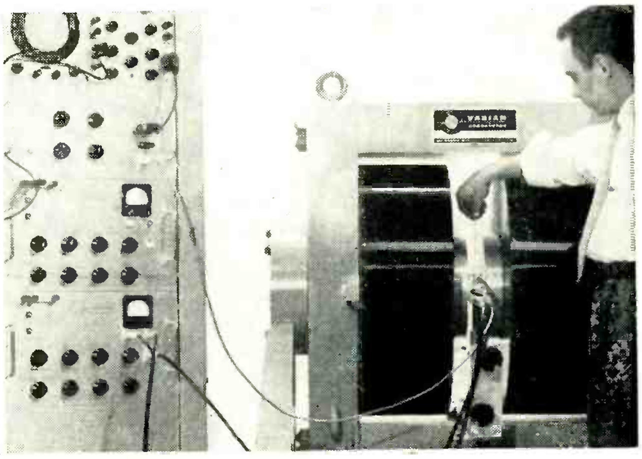
For spin echo equipment, for proton excitation the tilt required may be of the order of 90 degrees. This requires an r-f field of several gauss for a pulse width of the order of 30 microseconds. The r-f field intensity may be provided by an 829A operating as shown in the schematic. Since one of the major requirements of the transmitter is to provide maximum r-f current in the probe coils, a high Q would appear to be desirable. However, pulse fidelity limits coil Q and sets requirements on output tube operation similar to those for television transmitter output systems.

Receiver Considerations

While one of the primary objectives of spin echo equipment is to produce readily observable echoes, it is sometimes desirable to observe the decay signals that occur immediately after the pulse. A typical presentation of the decay signals may be as shown in Fig. 2. The applied pulses are shown as lines representing relatively narrow



Schematic diagram of probe and transmitter output stages



Inserting sample into spectrometer probe pulses compared to the pulse spacing T. The free decay signals follow immediately after the pulse application and the echo builds up to a maximum after time interval T.

With the simple cross-coil system used on spin echo probes, where no extreme precautions are taken to reduce transmitter pickup at the receiver coil terminals, the transmitter voltage at the receiver coil may be many thousand times greater than the desired signal. Although the free decay signal occurs after the transmitter pulse, the receiver must be capable of presenting the desired information without objectionable transients caused by transmitter pulse overload.

Other receiver considerations such as gain, bandwidth and low signal-to-noise input circuits follow practices now well established in the literature of wide-band amplifier systems.

For a fixed tuned system such as is used here, the signal is brought into resonance by adjusting the magnetic polarizing field to satisfy the resonance equation. The echo signal so obtained may then be maximized by adjustment of the various electronic parameters to suit conditions of the experiment. These parameters include pulse spacing, pulse width and transmitter power.

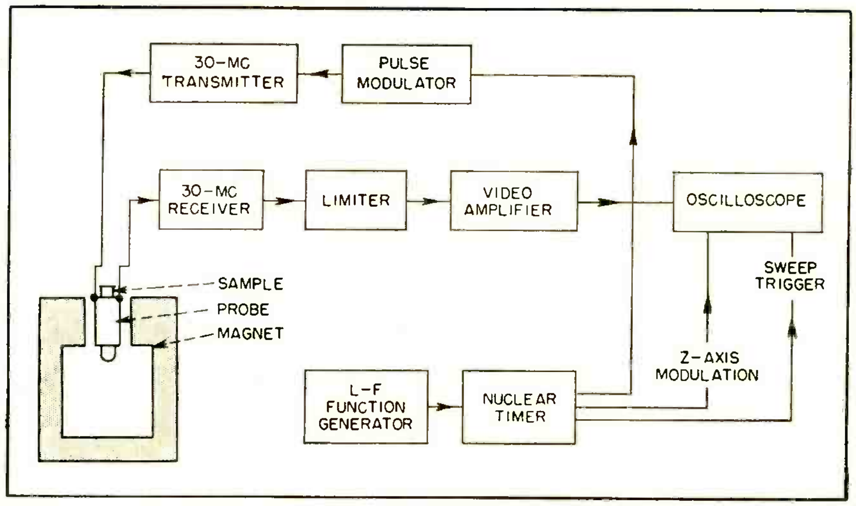


FIG. 1—Pulse operated equipment for studying nuclear spin echoes

Timer

The nuclear timer for spin echo differs from timers used for radar or television in that extremely slow repetition rates are required due to the long free decay times associated with nuclear resonance of the proton. The repetition rate may vary from 10 to 0.01 cps. However, for convenience of adjustment and ease of observation it is also desirable to have repetition rates as high as 100 cps. As stated above, two r-f field pulses are required to obtain a spin echo and the pulse spacing may be as short as a few milliseconds or as long as several seconds corresponding to frequencies of from 1,000 to 0.1 cps. The pulse width may be required to vary from 10 to 100 microseconds. In addition, for some nuclear tests a third pulse should be available that may be placed at any desired spacing from the initiating pulse pair.

One of the best ways of securing flexible control and accurate timing in pulse systems is to use a generator of continuous waves or pulses as a driving source. This is the system employed in the spin echo nuclear timer. The block diagram, Fig. 1, shows a low-frequency function generator driving the nuclear timer. The function generator has a continuous range of 0.1 to 1,200 cps, corresponding to a pulse pair spacing of one millisecond to 10 seconds.

The system is such that the initiating pulse pair spacing is determined by the frequency of the function generator and all other timing sequences are multiples of the pulse pair spacing. Tuning to maximize the spin echo signal is then readily accomplished by rotating the freqency control dial of the function generator and the time interval between pulses will be known at all times within the accuracy of calibration of the function generator. For some tests the pulse spacing may be quite short—a few milliseconds—whereas the repetition rate may be of the order of once every few seconds.

One way of looking at the nuclear

SPIN ECHOES AND NUCLEAR RESONANCE

The nuclear resonance spectrometer has proved a useful tool for qualitative and quantitative analysis of materials.[1] Study of spin echoes from the nucleus may provide additional important information.

In nuclear resonance spectrometry, a continuous r-f field is applied to a sample immersed in a strong d-c magnetic field. The magnetic moments associated with the nuclei within the sample can be made to precess, producing a small signal that may be amplified and displayed on a recorder. The physical requirements for resonance to occur are $\omega = \delta H_0$—where $\omega = 2\pi f$ (with f the signal frequency), δ is a nuclear constant, different for each isotope and H_0 is the strength of the polarizing field.

If an r-f pulse is applied rather than a c-w signal, not only does precession occur during the pulse but a steadily decaying signal also persists after the pulse.[2] This is because energy stored in the orientation of magnetic moments of nuclei during the pulse is dissipated relatively slowly through molecular collisions. This free decay time may be in the order of tenths of a second even though the r-f pulse is only in the order of several microseconds.

If two successive field pulses are applied, then by constructive interference of nuclear-magnetic-resonance signals an echo may be produced after the application of both pulses. This is the spin echo.[3, 4]

If, before application of the first pulse, the nuclear magnetic moments are oriented in a particular direction by the polarizing field, the first pulse tilts the axis of the nuclei in a new direction. After a period that may be long compared to the pulse width a second pulse is applied and a further shift in orientation produced. The nuclear resonance echo signal is obtained at a time interval equal to the spacing between applied r-f pulses.

In some experiments a third pulse is added to produce further sets of spin echoes. This provides additional information regarding properties of the nuclear spin system

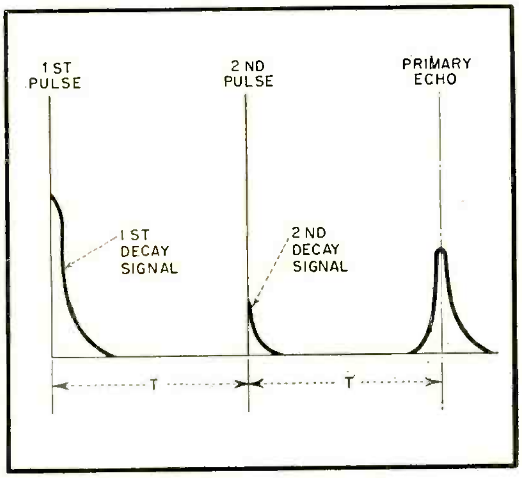


FIG. 2—Free decay signals and echo

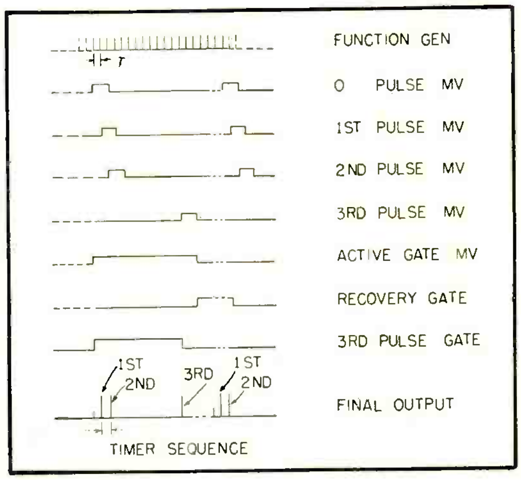


FIG. 3—Relation of pulses and gates

timer is to regard the output as representing a special form of counting, the sequence being, say 1, 2; 101, 102; 201, 202; 201, 302; 401, 402; etc. The 1, 2 count would be the first paired pulse and the interval between 1 and 101 would be the time interval representing the repetition rate, which would be an integral multiple of the spacing between pulses 1 and 2, in this case chosen at 100. This long time interval actually corresponds to the spin recovery rate of the spinning nuclei, or the time required for the spin assembly to return to an equilibrium position in the polarizing field after the application of the r-f pulses. In practice it has been found convenient for oscilloscope synchronization to precede the pulse pair by a synchronizing pulse that does not appear as a r-f pulse. Thus, if in addition a third field pulse is added the counting sequence might be: 0, 1, 2, 21; 100, 101, 102, 121; 200, 201, 202, 221; 300, 301, 302, 321; etc.

Operation

Figure 3 shows the pulse and gate sequences, starting with the continuous pulses delivered by the function generator to the nuclear timer and finishing with the final pulse arrangement at the output. Figure 4 is a simplified block diagram showing the key operation performed by the timer.

Referring to Fig. 4, continuous pulses from the function generator are applied to the control grids of three flip-flop multivibrators V_1, V_2 and V_3. Tube V_1 is normally on and V_2 and V_3 are normally off. A pulse from the function generator will pass directly through V_1 to the output and will simultaneously trip V_1 to cutoff position. As V_1 trips, it trips V_2 through a delay network so that V_2 now passes the next pulse from the input to the output circuit. After the pulse, V_2 drops back to cutoff position and simultaneously readies V_3 for a pulse. After the three pulses have passed, all three flip-flops are in cutoff position so that no further pulses can pass. A reset gate initiated by the first pulse then resets the multivibrators after the desired reset time interval.

Referring once more to Fig. 3, the zero, first and second pulse multivibrators comprise V_1, V_2 and V_3 in the block diagram, Fig. 4. The reset gate comprises two gates: the active gate, which covers the pulse field application and the reception of the echo; and the recovery gate, which covers the period during which the nuclei return to equilibrium. When a third field pulse is required, an extra multivibrator is cut into the pulse selection circuits and is operated by an adjustable gate that is also initiated by the zero pulse.

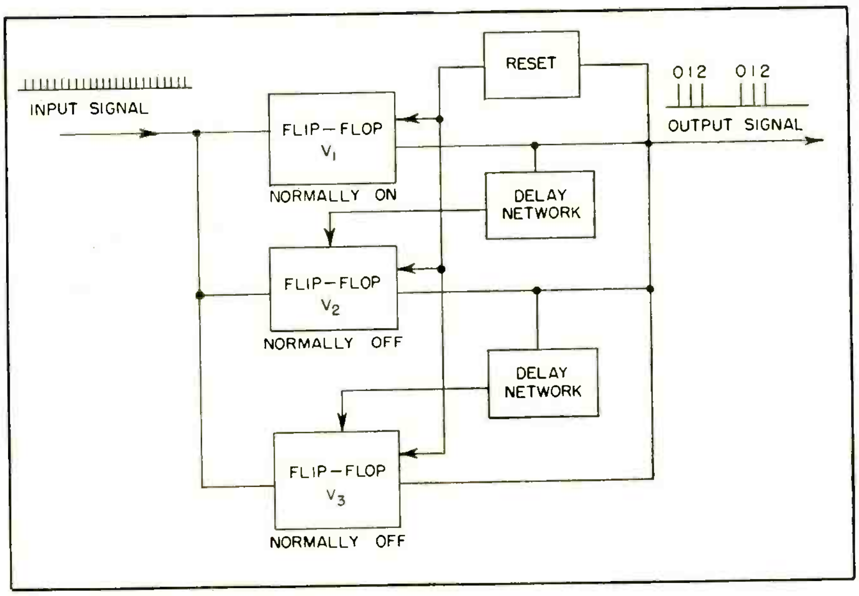


FIG. 4—Obtaining isolated periodic pulse trains from continuous pulse input

Acknowledgments are due the engineers, physicists and technicians associated with this project.

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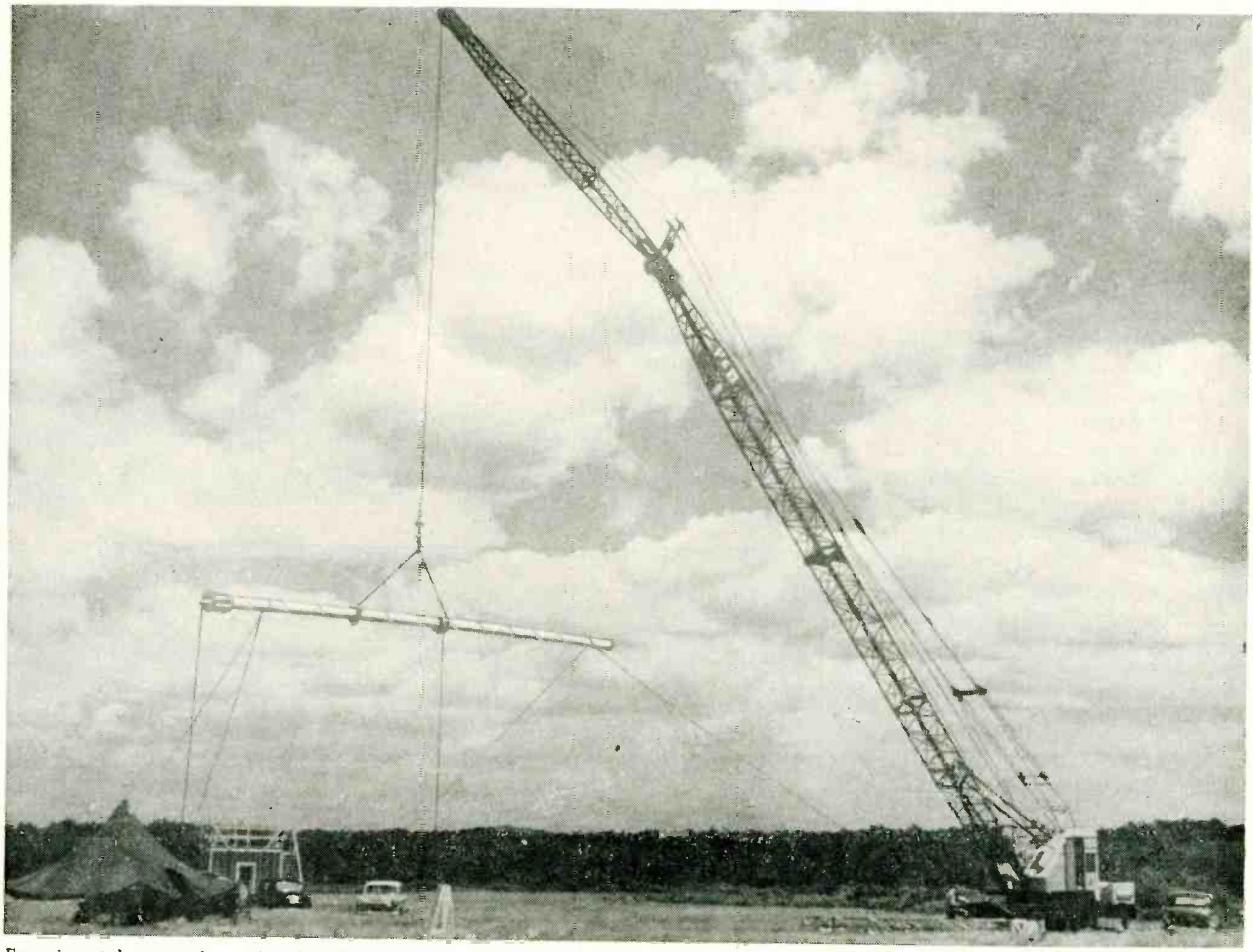
(4) E. L. Hahn, Free Nuclear Induction, *Physics Today*, 6, Nov. 1953.
(5) See reference 2.

Cosecant Antenna Aids

By JOHN E. MARTIN and JOHN RUZE

The Gabriel Laboratories
Needham Heights, Mass.



Experimental pattern is verified (see Fig. 10) by suspending antenna and rotating in azimuth while it is illuminated by distant source

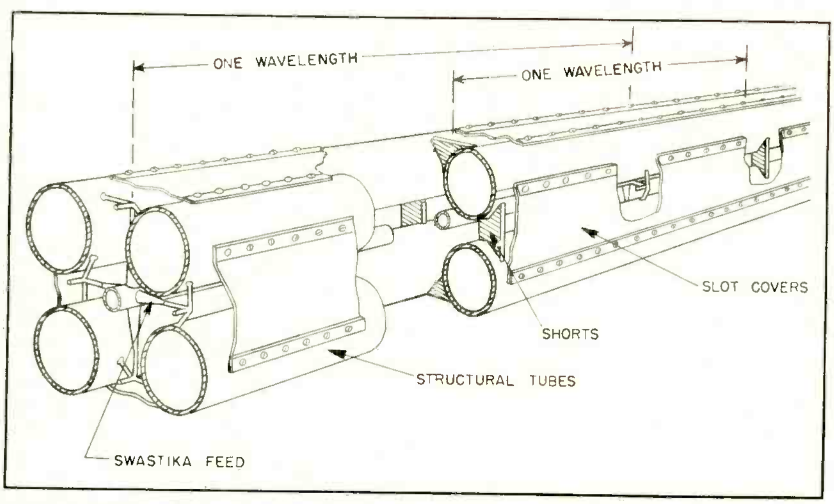


FIG. 1—Sectional view of structural-tube antenna shows shorting members and swastika feeds displaced by a half wavelength

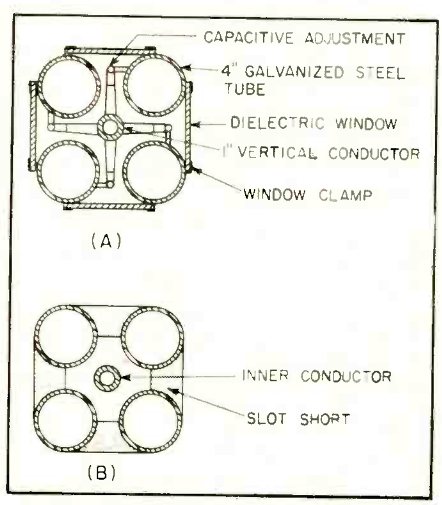


FIG. 2—Cross-section of structure near swastika feed (A) and short (B)

UHF-TV Coverage

Slot-type radiator employs four structural tubes and center conductor to approximate coaxial lines. Advance adjustment permits welding and hot galvanizing. Odd nulls are compensated by unequal power division between top and bottom, while second null is filled by reversing one ring of slots

DESIGN of antennas for uhf television broadcasting presents problems in some ways more stringent than for vhf broadcasting. At uhf, lower transmitter power is available and higher transmission line losses are incurred at both the transmitter and receiver installations. The signal-to-noise ratio of uhf receivers, in general, is less than that obtainable with vhf receivers.

Sharper shadow regions exist at higher-frequency transmission. Furthermore, it is doubtful if larger-aperture receiving antennas actually effect greater gain since they may often be installed in a highly distorted and rapidly varying field. Consequently, for uhf picture quality comparable to vhf standards, greater effective signal strength is required.

Design Problems

Increased signal strength from higher-gain transmitting antennas, obtained with a number of stacked elements, necessarily implies a narrower vertical beamwidth. If the technique of branch-feeding is used, a complex harness greatly increases the cost of manufacture. Alternatively, the simplification afforded by end-feeding makes it more difficult to realize the low vswr required for good picture quality.

Narrower vertical beamwidths also cause the first and second antenna nulls to advance well into the service area, thereby creating circular regions of low field strength. This situation is particularly disconcerting when the antenna is located in a large metropolitan area where deep valleys of low signal intensity are flanked by regions of high field strength. The ideal radiation pattern is a shaped vertical pattern proportional to the cosecant of the depression angle. Such a pattern would lay down a constant field regardless of range.

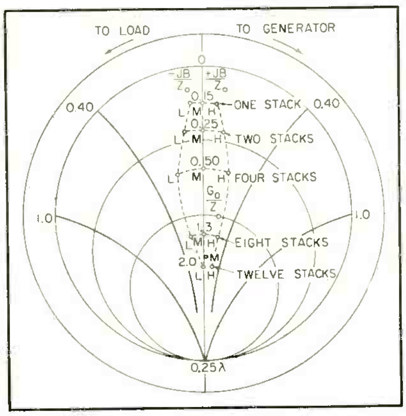


FIG. 3—Optimum bandwidth for twelve stacks is confirmed by plotting

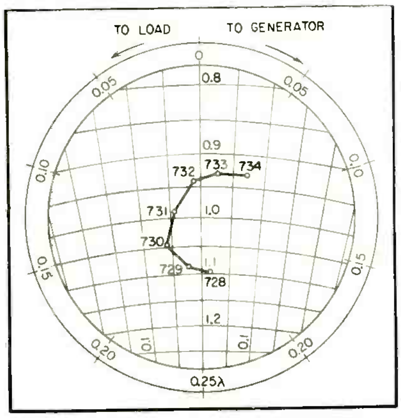


FIG. 4—Admittance curve of the complete antenna

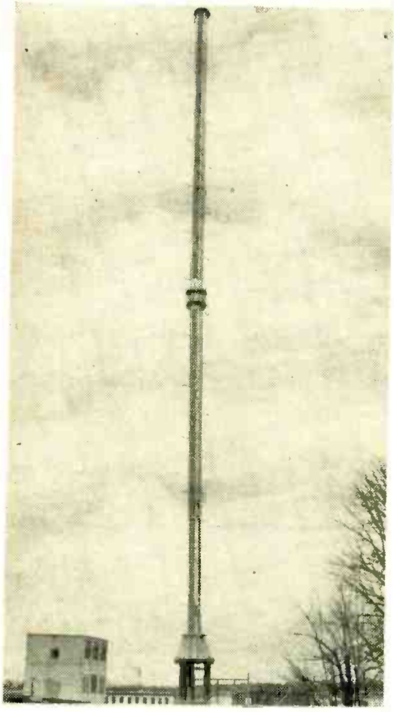
Chief problems confronting the antenna designer are: limited bandwidth owing to the larger number of elements and the increased effect of transmission-line discontinuities, irregular coverage resulting from presence of antenna nulls in the primary service area, higher manufacturing costs owing to the increased number of elements and need for a simplified mechanical design affording minimum maintenance and maximum reliability.

These problems have been effectively resolved in a newly developed cosecant uhf antenna that is the subject of this article.

Slot Array

The antenna comprises a vertical array of slot radiators propagating horizontally polarized waves. The slots are formed by the spaces between four vertical tubes of structural steel with four-inch outer diameter and wall thickness of a quarter inch. The tubes are arranged in a square with tube centers five inches apart. The tubes are shorted at intervals by welded steel members, forming a series of rings of resonant slots spaced one wavelength between centers and approximately a wavelength long.

The arrangement shown in Fig. 1 results in a radiating system integral with the supporting structure. The slot apertures are sealed by low-loss plastic covers that envelop a major portion of the external surface of the antenna. The covers are dyed international



Twenty-four wavelength aperture of uhf-tv antenna is accomplished with no external appendages, thereby minimizing ice formation

orange to obviate maintenance painting of the antenna.

The complete antenna comprises two electrically identical sections of twelve slots each, forming a 24-wavelength aperture.

R-F Feed

The two 12-wavelength sections are center-fed by a standard 3⅛-in. coaxial line that runs up one of the 4-in. vertical tubes. The individual slots of each section are tapped across the transmission line formed by the inner conductor and the four structural tubes and extending the length of each section. A cross-section of this arrangement is shown in Fig. 2.

A five-wire line is thus formed with the four structural elements acting as the ground; that is, they are equivalent to the outer conductor of a coaxial system. Each ring of slots is energized in phase by the so-called swastika branch-feed arrangement shown in Fig. 1.

The center conductor is rigidly supported by the solid swastikas every wavelength and by the quarter-wave short after the last slot. With the exception of the gas seal at the input, no insulators are used in the antenna proper.

End feeding of an array of many elements is possible only for relatively small bandwidths because the input admittance and the vertical pattern vary considerably with changes in frequency. To obtain the exacting match over the 6-mc channel required for good picture quality, it is necessary to optimize the various antenna parameters for maximum bandwidth.

The antenna can be represented by a vertical transmission line loaded at one-wavelength intervals by equal normalized admittances γ_s that can be assumed constant over the narrow frequency spread. For a small frequency variation, analysis indicates that the input admittance γ_{IN} is given by

$$\gamma_{IN} = n\gamma_s + j2\pi\frac{\Delta f}{f} \times \left[(n-1) - \gamma_s^2 \sum_{k=1}^{n-1} k^2 \right] + \text{higher order terms} \qquad (1)$$

where n is the number of radiators.

At the midfrequency Δf is zero and the input admittance becomes matched to the feeder of characteristic admittance γ_o when

$$n\,\gamma_s = \gamma_o \qquad (2)$$

The use of this value of γ_s yields a variation of the input admittance with frequency principally owing to the imaginary term. For example, a 1-percent frequency variation results in a mismatch of approximately 1.3.

On the other hand, making

$$\gamma_s = \left[\frac{n-1}{\sum_{k=1}^{n-1} k^2} \right]^{1/2} \qquad (3)$$

produces an input admittance constant for small percentage variation in frequency and equal to

$$\gamma_N = n\left[\frac{n-1}{\sum_{k=1}^{n-1} k^2} \right]^{1/2} \qquad (4)$$

As an example, for a bandwidth of ±1 percent the input vswr does not exceed 1.05 and is due to the higher order terms. Under this optimum bandwidth condition, the bandwidth can be shown proportional to the square of the number of slots.

This optimum bandwidth condition can be regarded as minimizing the stored energy in the system and the vswr on the vertical feeder is minimum near the center of the array. In the case where $\gamma_s = \gamma_o/n$, unity vswr occurs at the antenna input and the vswr increases in steps toward the end of the array.

An experimental verification of the optimum bandwidth condition, is illustrated in Fig. 3, where the input admittance variation for one,

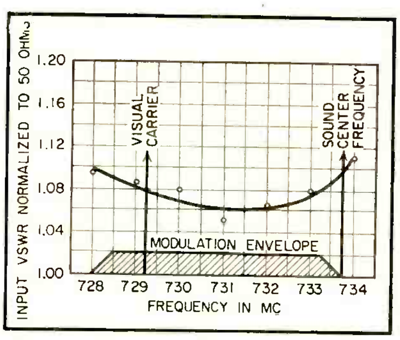


FIG. 5—Input vswr curve plotted against frequency

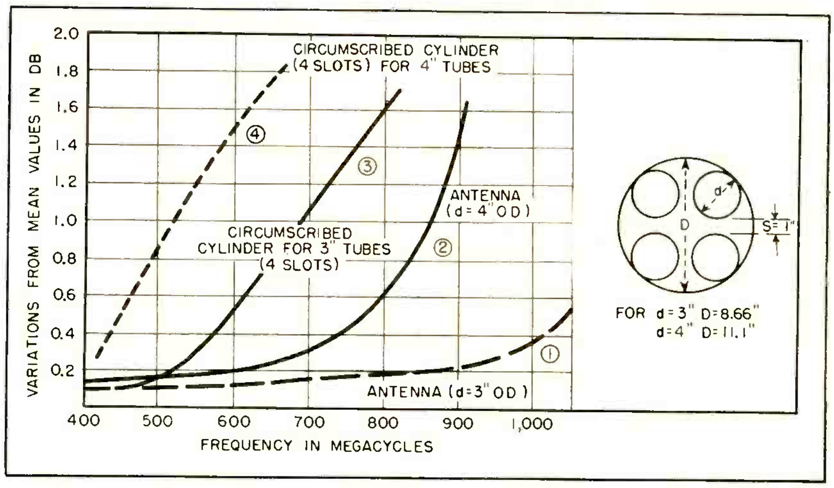


FIG. 6—Measured variations from mean field strength of horizontal radiation

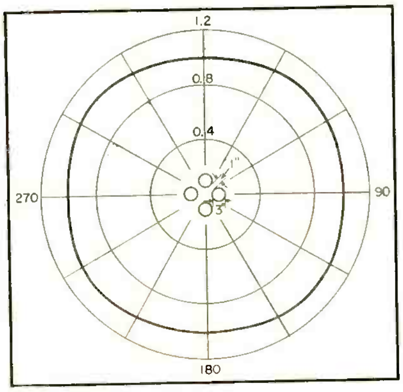


FIG. 7—Horizontal pattern measured at 650 mc

two, four, eight and twelve-element arrays from an optimized twelve-element array is plotted. The measured variations are a maximum for half the array, decreasing to a minimum for the complete array. A simple quarter-wave transformer is used to match the admittance to the input feeder. The final admittance and vswr for the complete antenna consisting of two center-fed sections are shown in Fig. 4 and 5.

To apply the optimum bandwidth condition, it is necessary to adjust the slot admittance to be real and of the magnitude required by Eq. 3. This value is obtained by adjusting the point of contact on the slot and the length of the tuning susceptance. Correct adjustment of the tuning susceptance is determined on a special test section for each channel, permitting the actual antenna to be constructed with no variable adjustments. The entire antenna becomes a welded unit that is hot-dip galvanized after adjustment and welding.

Horizontal Pattern

The horizontal patterns of this structure did not exhibit the theoretical circularity expected of an approximate cylinder having four in-phase slots. To illustrate this point the measured and calculated variations from circularity are plotted in Fig. 6. Curves 1 and 2 are plots of measured variation from circularity; curves 3 and 4 are plots of calculated variation based on maximum cross-sectional diameters.

The striking conclusion is that the actual pattern deviation is considerably less than that computed on the basis of a cylinder circumscribing the vertical tubes. Moreover, the equivalent cylinder giving the same circularity as the tube configuration is smaller than the circle joining the tube centers, a circumference on which no radiating current exists.

Circular Pattern

Maximum radiation intensity occurs opposite each slot in a typical measured pattern (Fig. 7). The improved circularity has no special significane apart from the practicability of using fewer slots to obtain a given circularity with a fixed cross-sectional dimension.

The vertical pattern of a uniform in-phase aperture of 24 wavelengths is given by

$$\frac{\sin(24\,\pi \sin\theta)}{(24\,\pi \sin\theta)}$$

which is plotted in Fig. 8. This function has zero values at arcsin $n/24$, for integer values of n which bracket the subsidiary maxima. The locus of the maximum values follows the cosecant pattern. The power gain of such an antenna is 27.5, after allowing for a 0.3-db copper loss. Figure 9 indicates the coverage diagram to be expected on the basis of the FCC (50, 50) curves when the antenna is mounted on a 500-foot tower. Note the regions of low signal strength caused by the antenna nulls. This antenna should be satisfactory in installations where the service area does not include the region immediately adjacent to the transmitter.

In many installations it is desirable to fill in the antenna nulls. The first, third, fifth and successive odd nulls can be filled by unequal power division between the top and

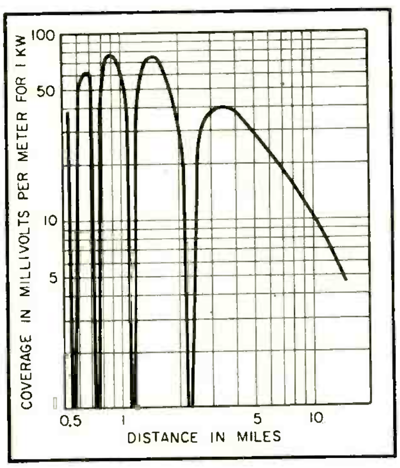


FIG. 9—Predicted coverage of antenna with gain of 27.5

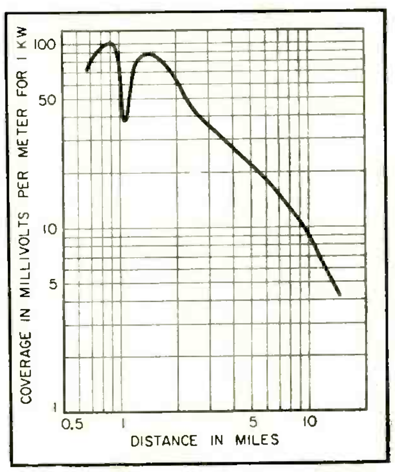


FIG. 11—Predicted coverage of fill-in pattern and gain of 24

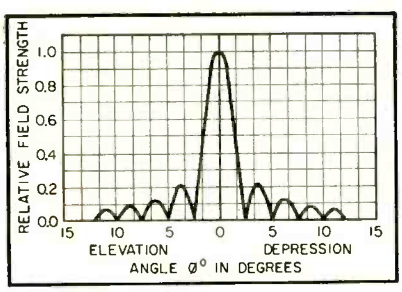


FIG. 8—Vertical pattern of in-phase aperture

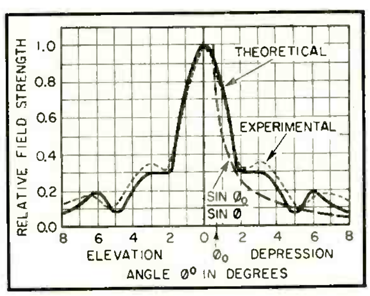


FIG. 10—Vertical pattern with null fill-in

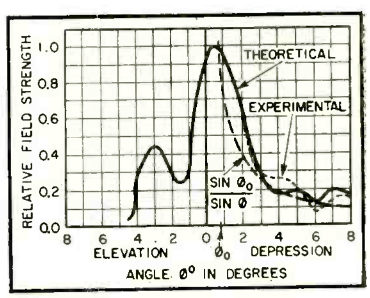


FIG. 12—Vertical pattern with null fill-in and beam tilt

bottom sections. The radiation pattern then becomes

$$\frac{\sin (12 \pi \sin \theta)}{(12 \pi \sin \theta)} \times [\cos (12 \pi \sin \theta) + jb \sin (12 \pi \sin \theta)]$$

where b is related to the power division by power ratio $= [(1 + b)/(1 - b)]^2$.

The second null still remains unfilled. To fill the second null, one of the rings of slots is reversed in phase. The slot chosen is one that contributes quadrature field in the immediate vicinity of the second null. The resulting pattern is shown in Fig. 10 and the predicted coverage diagram in Fig. 11. The antenna gain is correspondingly reduced to 24.

The antenna beam can also be depressed by advancing the phase of the top section. Figures 12 and 13 indicate the pattern and the expected coverage diagram with a phase advance of 60 deg. The peak gain is now reduced to 19.

Pattern Verification

The measurement of the vertical pattern of a horizontal omnidirectional antenna is beset with many difficulties. The antennas for the lower uhf channels are over 50 feet long and weigh approximately 3,000 pounds. The antenna must be properly supported and rotated, using a pattern range in excess of 2,500 feet. It is necessary that the area surrounding the antenna under test be reasonably clear to avoid reflections. Supporting structure reflections are particularly troublesome.

The main body of the pattern can be recorded quite accurately; however, some doubt exists about the data in the null regions. Patterns were taken on several antennas supported four feet above a heavy steel mount by a wooden structure. The data did indicate adequate null fill-in, but the variation of the null structure with a small percentage change of frequency indicated that some field distortion was present.

To obtain a better evaluation of the true free-space pattern, the arrangement shown in the photograph was used. Here the antenna, elevated by a large crane, was connected to a 36-to-1 selsyn arrangement for angular information. As the crane and the recording equipment were located on the antenna axis, in which direction the antenna does not receive radiation, it was felt that the free-space condition was simulated as closely as possible.

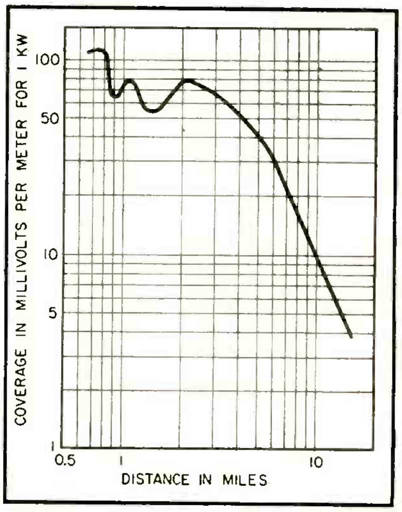


FIG. 13—Predicted coverage with null fill-in and beam tilt. Gain is 19

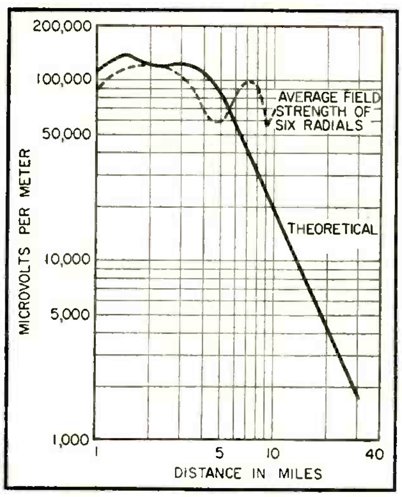


FIG. 14—Observed field strength versus distance for WNOK-TV

The entire test was performed on an abandoned air field, so that reflections from the rear were also minimized. The pattern so obtained is compared with the theoretical in Fig. 10.

Mechanical Design

The antenna is a self-supporting cantilever designed for general tower mounting. The structural rigidity is based on a maximum deflection of less than 0.5 deg at the radiation center for a wind velocity of 100 mph assuming a pressure of 35 psf. An advantage of the structural configuration is that there are no weakening cutaways or fragile appendages. The absence of insulators and connectors enables welding and galvanizing the antenna as a complete unit, a process that eliminates practically all subsequent deterioration and failure in service.

Weatherproofing

The antenna is weatherized using strips of dielectric material caulked and clamped over the slots on the tangent planes of the tubes. A specially treated polyethylene or Fiberglas board is suitable. The antenna is allowed to breathe through holes drilled through the base plate, which also serve to drain away moisture during excessive condensation. The gas seal at the antenna input seals off the tower feeder from the antenna.

Elimination of all external appendages and the large ratio of dielectric-to-metal on external surfaces hinder ice formation. Furthermore, each slot layer is essentially a low-Q system with a low slot impedance yielding a low slot voltage. This minimizes the adverse effect of ice layers of high dielectric constant, $\epsilon = 4$. As a result, deicing is seldom required in the majority of applications.

Experimental Survey

To obtain an experimental verification of the predicted coverage diagram and especially to demonstrate the effectiveness of the null fill-in feature, a field-strength survey was conducted on television station WNOK, Columbia, South Carolina. This station operates on channel 67 (790 mc) with a 5-kw transmitter. The survey was conducted by the Allen B. DuMont Laboratories with the consulting firm of Kear and Kennedy participating. Figure 14 indicates the average measured field strength of six radials in comparison to the predicted curve.

This final antenna is based on a design originally developed by H. J. Rowland, formerly of these Laboratories. The development was under the general supervision of L. J. Chu.

Color-Bar Generator Produces I-Q Signals

Signals for alignment of Q and I demodulators obtained from color-bar generator by control of blue-green and blue-red overlap. Simple set-up makes method useful for laboratory alignment work

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GENERATORS producing red, green, blue and green bars for color tv work can be adjusted to provide I and Q bars for alignment of decoders for these signals. Normally, such a generator is set up to display green, yellow, red, magenta, blue, cyan and green in the most saturated condition possible. Where Q and I bars are needed, it is possible to produce them by proper adjustment of the color-bar overlaps.

The process can be explained by reviewing the equations for Q and I

$$Q = -0.52\,G + 0.21\,R + 0.31\,B \quad (1)$$

$$I = -0.28\,G + 0.60\,R - 0.32\,B \quad (2)$$

In the red-blue overlap, $G = 0$, so

$$I = 0.60\,R - 0.32\,B \quad (3)$$

which can be reduced to zero by making $R = (0.32/0.60)\,B = 0.52\,B$. This means the magenta overlap can be adjusted to be a bar with $I = 0$, which is a Q bar, by making the red-bar amplitude about ½ the blue-bar amplitude.

Similarly, in the blue-green overlap, $R = 0$, so

$$Q = -0.52\,G + 0.31\,B \quad (4)$$

which can be reduced to zero by making $G = (0.31/0.52)\,B = 0.60\,B$. Consequently the cyan overlap can be adjusted to be a bar with $Q = 0$, which is an I bar.

Equations 1 and 2 show that the actual bars produced with these adjustments are $+Q$ and $-I$. This does not hamper their usefulness.

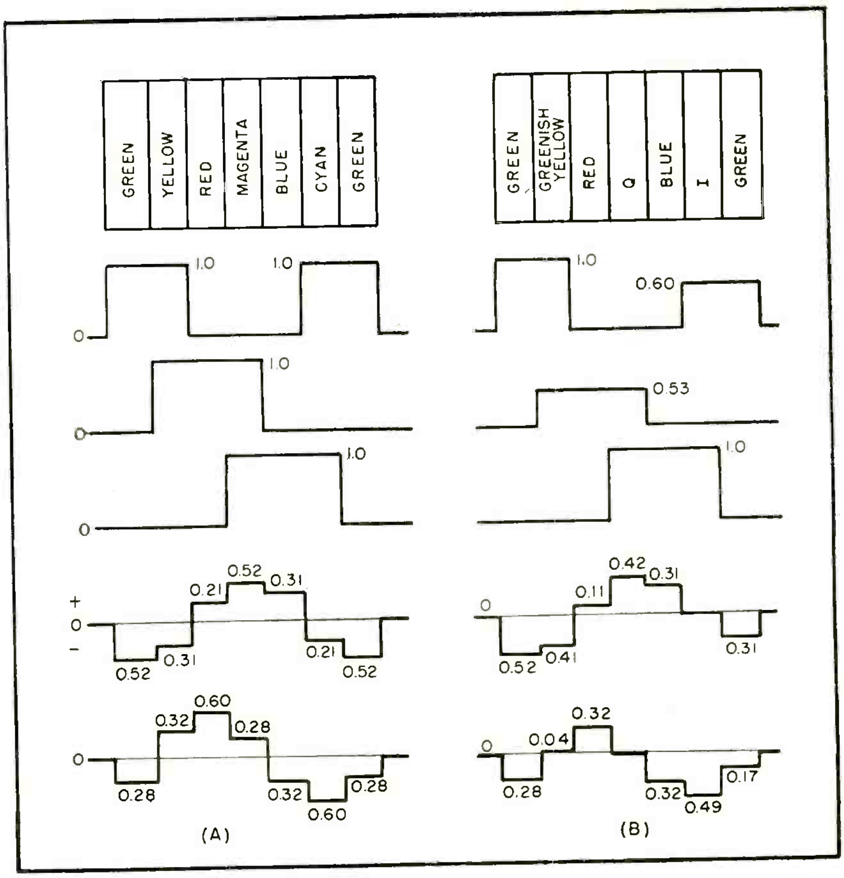

FIG. 1—Generator waveforms for normal display (A) and for I-Q display (B)

In practice the generator is set up for the normal overlapped display of green, yellow, red, magenta, blue, cyan and green. Waveforms at various points in the equipment will appear as in Fig. 1A. Then, observing the Q signal at the matrix adder (or at any other available point) the second green-bar amplitude is reduced until the blue-green overlap shows up as zero amplitude Q. This adjusts the $-I$ bar in the cyan overlap.

Next, observing the I signal in the matrix adder, the red-bar amplitude is reduced until the blue-red overlap shows zero amplitude. This completes the adjustment of the Q bar. The waveforms with this arrangement are shown in Fig. 1B.

Inspection of Eq. 1 and 2 will show that a similar procedure could have been carried out using the red-green overlap, but the method presented has proved more practical.

* Work done while with Warwick Mfg. Corp.

Temperature-Stabilized

Design equations and nomograph for determining variation of operating point of junction-transistor amplifiers with temperature provide information for using circuit parameters to stabilize operation. All equation data can be easily measured or calculated

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SEMICONDUCTOR devices are much more sensitive to variations in ambient temperature than electron tubes. In the case of the point-contact transistor, the most temperature sensitive parameters are r_c, the collector resistance, and α, the current gain.[1,2]

Variations of I_{co} and r_c with temperature can cause marked limitations in the operation of junction-transistor amplifiers. (I_{co} is the saturation collector current which flows when the emitter circuit is open.) Due to increase in I_{co}, a perfectly stable amplifier at room temperature can shift in quiescent operating point to collector-current saturation if precautions in temperature stabilization are not observed.

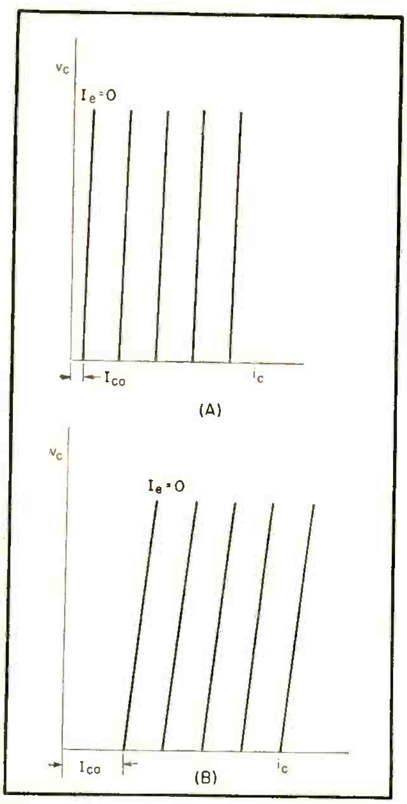


FIG. 1—Typical transistor characteristics at room temperature (A) and at higher temperature (B)

With variations in I_{co} alone, stabilization can be achieved by controlling the ratio of equivalent-emitter to equivalent-base series resistance in the bias network.[3]

The treatment which follows will examine the question of temperature stabilization in the general case, including the possibility of changes in r_c. No assumption is made as to the linearity of these changes with temperature. A relatively simple relationship can be derived to show the effect of variations in r_c and I_{co} on the quiescent collector current of any junction-transistor amplifier.

For convenience, all analyses are carried out in terms of the *pnp* junction transistor. However, the final results apply to the *npn* type as well.

Temperature Effects

Figure 1A shows the collector characteristics of a typical *pnp* junction transistor at room temperature and Fig. 1B shows the collector characteristics of the same transistor at an elevated temperature.

Two effects can be observed as a result of the rise in ambient temperature: a pronounced shift of the characteristics in the direction of increased collector current caused by an increase in I_{co} and a small tilt or decrease in slope of the characteristics caused by a decrease in r_c.

The temperature coefficient of I_{co} is different for the various transistor types currently available. In addition, it varies among transistors of the same type. However, as better control is exercised over manufacturing processes, more exact information should become available.

For the *npn* grown-junction transistor I_{co} is of the order of 10 percent per deg C.[1]

Analysis

In the analysis which follows, R is used for parameters external to the transistor and r for internal equivalent-T parameter[4]. The I_{co} value and its primes refer to quantities described in Fig. 2. All other V's and I's refer to values at the operating point. Lower case v's and i's are instantaneous values. It is assumed that:

(1) Emitter-base voltage is zero for all values of forward emitter current greater than zero. This voltage will generally be 0.1 volt or less.[5]

(2) Base resistance is negligible compared to collector resistance.

(3) Collector resistance is constant over the entire operating range of currents and voltages. It

Transistor Amplifiers

is, however, a function of temperature.

(4) Current gain, α, is independent of temperature.

Equivalent Circuit

The d-c equivalent circuit of a *pnp* junction-transistor amplifier is shown in Fig. 3. The biasing network can be reduced to this equivalent circuit by application of Thevenin's theorem.

The loop equations for this network are

$$i_e (R_e + R_b) - i_c (R_b) = E_e + E_b \qquad (1)$$

$$-i_e (R_b) + i_c (R_b + R_c) = E_c - E_b - v_c \qquad (2)$$

From Eq. 1,

$$i_e = \frac{E_e + E_b}{R_e + R_b} + \frac{R_b}{R_e + R_b} i_c \qquad (3)$$

Solving Eq. 1 and 2 for v_c,

$$v_c = E_{cc} - i_c R' \qquad (4)$$

where

$$E_{cc} = E_c + E_e \frac{R_b}{R_e + R_b} - E_b \frac{R_e}{R_e + R_b} \qquad (4A)$$

$$\text{and } R' = R_c + \frac{R_e R_b}{R_e + R_b} \qquad (4B)$$

Figure 2 shows the load line represented by Eq. 4 superimposed on a typical set of collector characteristics. At the operating point *OP*

$$I_c = \alpha I_e + I''_{co} + I_{co} \qquad (5)$$

$$\text{where } I''_{co} = \frac{V_c}{r_c} \qquad (5A)$$

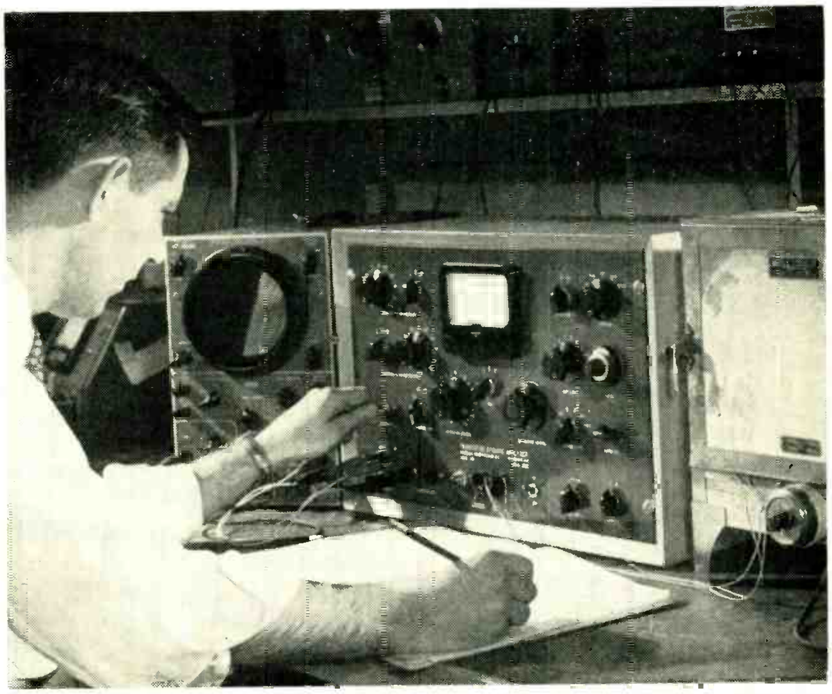
Combining Eq. 3, 4 and 5 and solving for I_c

$$I_c = \frac{\dfrac{\alpha (E_e + E_b)}{R_e + R_b} + \dfrac{E_{cc}}{r_c} + I_{co}}{1 - \dfrac{\alpha R_b}{R_e + R_b} + \dfrac{R'}{r_c}} \qquad (6)$$

Taking the natural logarithm of each side of Eq. 6

$$\ln I_c = \ln \left(\frac{1}{1 - \dfrac{\alpha R_b}{R_e + R_b} + \dfrac{R'}{r_c}} \right) + \ln \left(\alpha \frac{E_e + E_b}{R_e + R_b} + \frac{E_{cc}}{r_c} + I_{co} \right)$$

Differentiating and collecting terms,



Characteristic variations with temperature are measured with analyzer. Transistor is in oven at right

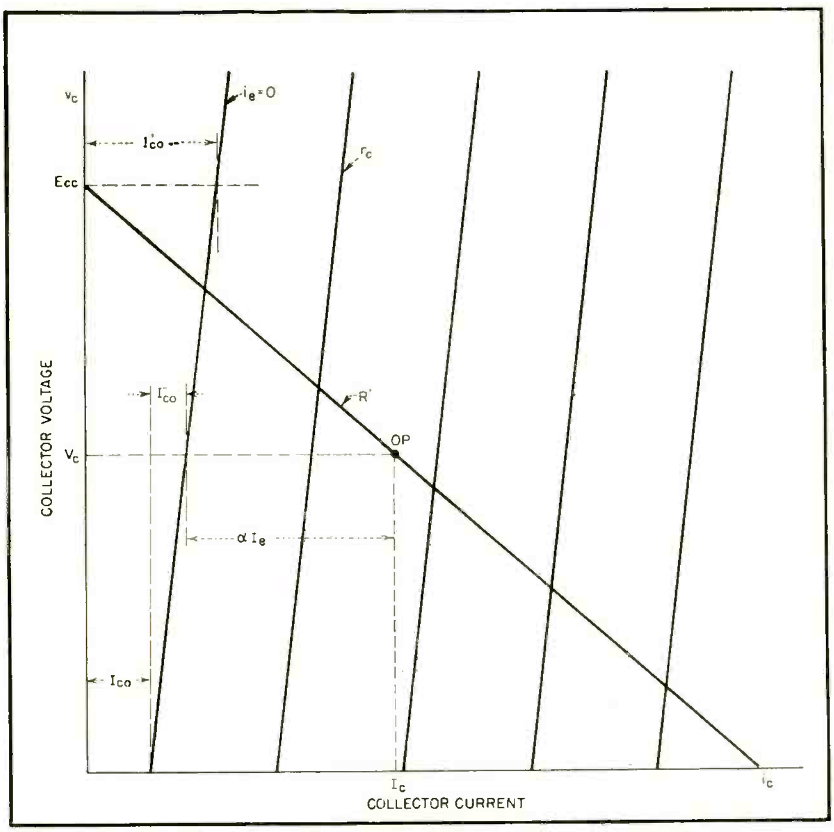


FIG. 2—Graphical definition of terms used in stabilization calculations

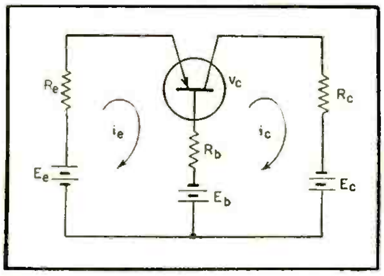


FIG. 3—Direct-current equivalent circuit for *pnp* junction transistor

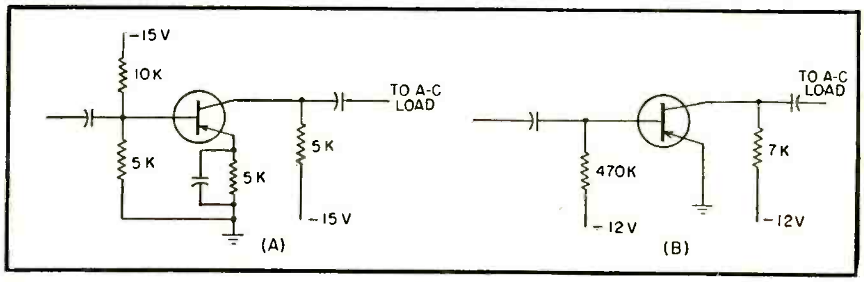


FIG. 4—Stabilized grounded emitter amplifier (A) and unstabilized amplifier (B) used in examples

where the temperature-dependent variables are r_c and I_{co}, and using $d(\ln v) = dv/v$,

$$\frac{dI_c}{I_c} = \left[\frac{I_{co}}{\alpha\dfrac{E_e + E_b}{R_e + R_b} + \dfrac{E_{cc}}{r_c} + I_{co}}\right]\frac{dI_{co}}{I_{co}} + \left[\frac{R'}{R' + r_c\left(1 - \dfrac{\alpha R_b}{R_e + R_b}\right)} - \frac{E_{cc}/r_c}{\alpha\dfrac{E_e + E_b}{R_e + R_b} + \dfrac{E_{cc}}{r_c} + I_{co}}\right]\frac{dr_c}{r_c} \quad (7)$$

After further simplification, using Eq. 4 and 6,

$$\frac{dI_c}{I_c} = \left[\frac{I_{co}}{\alpha I_{eo} + I'_{co}}\right]\frac{dI_{co}}{I_{co}} + \left[\frac{I''_{co}}{\alpha I_{eo} + I'_{co}}\right]\frac{dr_c}{r_c} \quad (8)$$

where

$$I_{eo} = \frac{E_e + E_b}{R_e + R_b} \quad (8A)$$

$$I'_{co} = I_{co} + \frac{E_{cc}}{r_c} \quad (8B)$$

$$I''_{co} = \frac{V_c}{r_c} \quad (8C)$$

$$\frac{dI_{co}}{I_{co}} = \text{fractional increase in } I_{co} \quad (8D)$$

$$\frac{dI_c}{I_c} = \text{fractional increase in } I_c \quad (8E)$$

$$\frac{dr_c}{r_c} = \text{fractional decrease in } r_c \quad (8F)$$

Equation 8 relates the change in collector quiescent operating current to the change in r_c and I_{co} which caused it. Each term in Eq. 8 has a simple physical significance. Terms I_{co}, I'_{co} and I''_{co} appear graphically in Fig. 2.

The most important term in Eq. 8 is αI_{eo}, which must be large for good stabilization. The term I_{eo} also has a simple physical significance: it is the emitter current which flows if the collector circuit is opened. Since I_{eo} is generally greater than I''_{co}, the form of this equation suggests that a junction-transistor amplifier will be stabilized against temperature variations if the emitter current which flows with the collector circuit open is large compared to I_{co}.

This criterion can generally be applied by inspection. For example, Fig. 4 illustrates two grounded-emitter amplifiers. If the a-c load impedance is small compared to 5,000 ohms, then each amplifier will have about the same input impedance, output impedance and power gain. However, the amplifier of Fig. 4A is stabilized and that of 4B is not.

Circuit Analysis

Consider figure 4A. By Thevenin's theorem, the d-c base circuit is equivalent to a 5-volt battery in series with 3,300 ohms. Current I_{eo} is therefore 5 volts divided by 3,300 ohms plus the 5,000 ohms in series with the emitter, or 0.603 ma. This is large compared to I_{co}, which will be of the order of magnitude of 0.02 ma. The stabilization will therefore be good. In Fig. 4B, I_{eo} is 12 volts divided by 470,000 ohms or 0.025 ma, which is comparable to I_{co}. The stabilization will be poor.

Examples

To illustrate a complete sample calculation, the amplifiers of Fig. 4 will be examined in more detail. Assume that the transistor is a *pnp* type having collector characteristics as shown in Fig. 5. For this transistor $\alpha = 0.95$, $r_c = 1$ megohm and $I_{co} = 20$ microamperes.

To assist in making calculations, the nomograph of Fig. 6 is used. Rewriting Eq. 8 in slightly different form

$$\frac{dI_c}{I_c} = \Delta\frac{dI_{co}}{I_{co}} + \Delta'\frac{dr_c}{r_c} \quad (9)$$

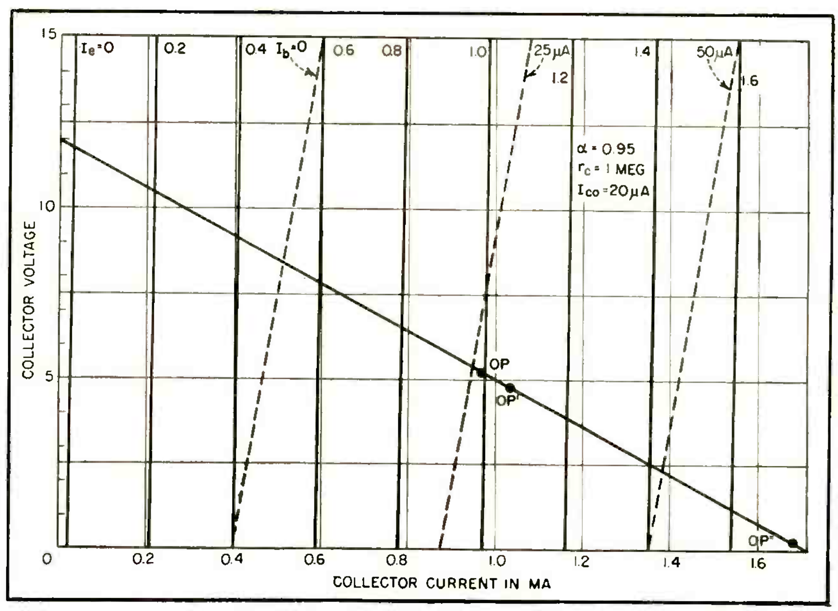


FIG. 5—Collector characteristics for *pnp* transistor example described in text

where $\Delta = \dfrac{I_{co}}{\alpha I_{eo} + I_{co}'}$

$$\Delta' = \frac{I''_{co}}{\alpha I_{eo} + I'_{co}}$$

Equation 9 can now be solved graphically by use of the nomograph in Fig. 6.

Stabilized Amplifier

Considering the amplifier of Fig. 4A, the necessary quantities will be computed for use in stabilization Eq. 9.

E_{cc} = 12 volts (Eq. 4A)
R' = 7,000 ohms (Eq. 4B)
I_c = 0.963 ma (Eq. 6)
V_c = 5.3 volts (Eq. 4)
I_{co}' = 0.032 ma (Eq. 8B)

therefore

$\alpha I_{eo}/I'_{co} = 17.8$, $I_{co}/I'_{co} = 0.625$, $I''_{co}/I'_{co} = 0.166$

Entering the nomograph with these values

$\Delta = 0.034$
$\Delta' = 0.009$

and so

$$\frac{dI_c}{I_c} = 0.034\,\frac{dI_{co}}{I_{co}} + 0.009\,\frac{dr_c}{r_c}$$

To calculate dI_c/I_c assume typical values for dI_{co}/I_{co} and dr_c/r_c. If dI_{co}/I_{co} is 10 parts in 100 per deg C, then for a temperature rise of 20 deg C, $dI_{co}/I_{co} = 2$.

If it is further assumed that $dr_c/r_c = 0.5$

then $\dfrac{dI_c}{I_c} = 0.034(2) + 0.009(0.5) = 0.0725$

so that I_c increases 7.3 percent for a 200-percent increase in I_{co}, and a 50-percent decrease in r_c. Considerable stabilization is seen to have been achieved. The operating point *OP* moves to $1.073 \times 0.963 = 1.03$ ma which is represented by *OP'* in Fig. 5.

Considering the amplifier circuit shown in Fig. 4B:

I_{eo} = 0.025 ma
E_{cc} = 12 volts
R' = 7,000 ohms
I_c = 0.98 ma
V_c = 5.1 volts

The d-c load line and quiescent operating point for this calculation are the same as in the previous example.

For this amplifier:

$\alpha I_{eo}/I'_{co} = 0.743$, $I_{co}/I'_{co} = 0.625$, $I''_{co}/I'_{co} = 0.159$

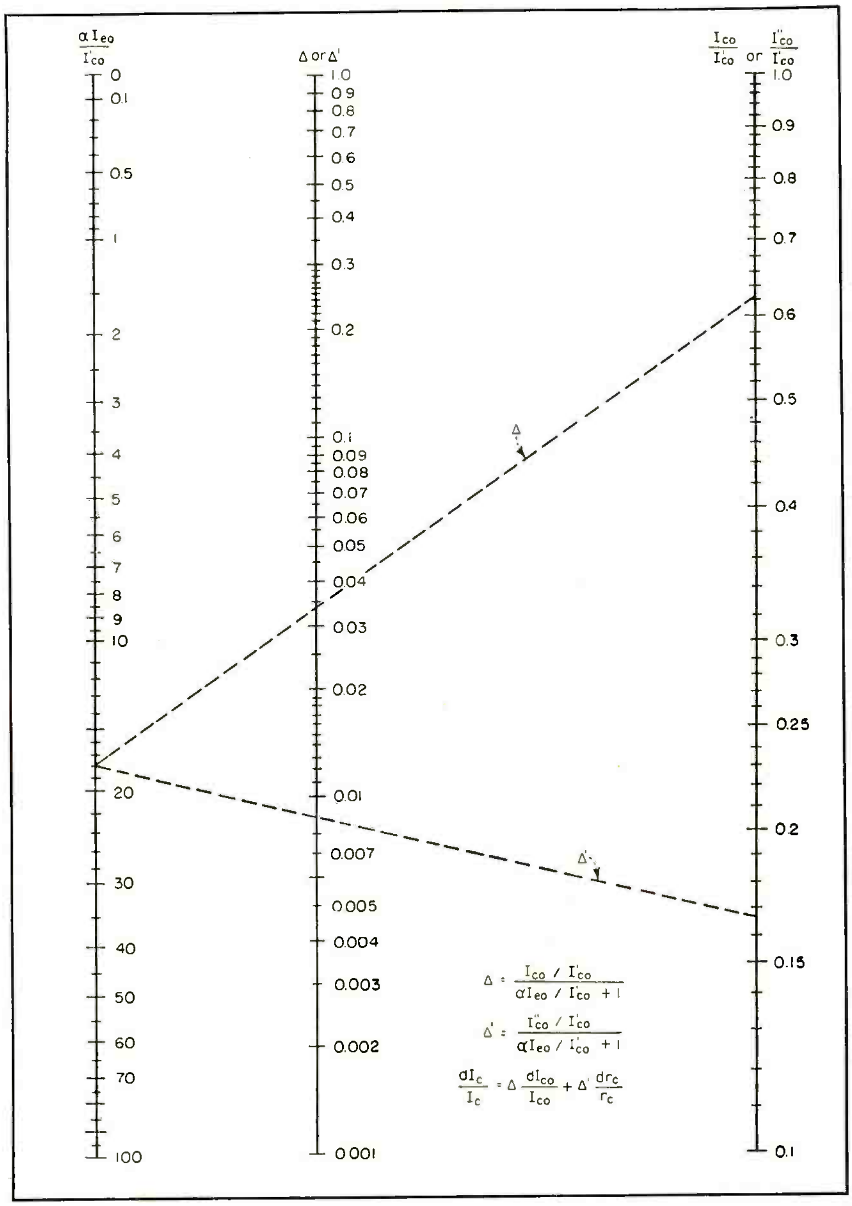


FIG. 6—Nomograph supplies operating point data for variation in temperature of junction transistors

Again entering the nomograph,

$\Delta = 0.35$
$\Delta' = 0.09$

so that

$$\frac{dI_c}{I_c} = 0.35(2) + 0.09(0.5) = 0.745$$

In this case, I_c increases 75 percent for the same increase in I_{co} and r_c as in the previous example. The operating point has moved to $1.745 \times 0.98 = 1.68$ ma, represented by *OP''* in Fig. 5, which is close to collector saturation.

The method described will supply both quantitative and qualitative information concerning the bias-circuit behavior of junction-transistor amplifiers at elevated temperatures. The technique is easily applied since all quantities in the stabilization formula can be simply measured or calculated in a given design.

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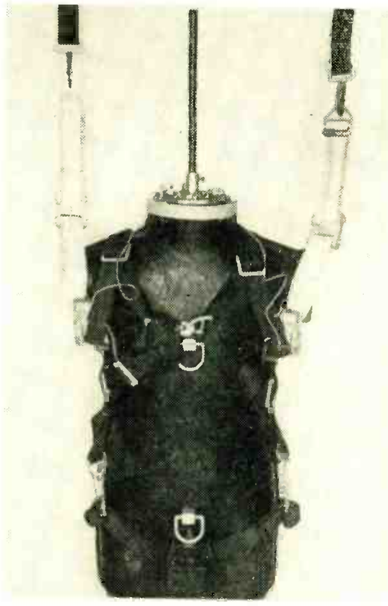

FIG. 1—Test dummy with harness and telemetering equipment installed

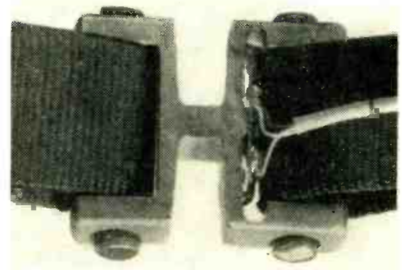

FIG. 2—Tensiometer buckle for sensing tension in harness risers

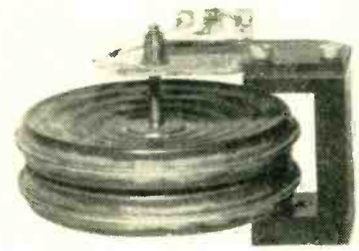

FIG. 3—Aneroid transducer

Parachute-Borne

EXPERIMENTAL TESTS on parachutes associated with modern high-speed aircraft has resulted in the development of a system for sensing, transmitting and remotely recording parachute data. Seven information channels are provided, permitting simultaneous study of the influence of a number of variables on parachute behavior.

In a typical test procedure, the live jumper is replaced by the rubber and steel torso-shaped dummy, illustrated in Fig. 1, which is weighted to simulate a jumper with his equipment. The dummy is built around a hollow well five inches in diameter in which the electronic equipment is carried. The dummy's head is replaced with the transmitting antenna. The harness, with strain gages inserted into the desired member, is fastened around the dummy in the normal manner.

Information Desired

In the sudden inflation of a parachute, various load-carrying members of the harness and shroud lines are subjected to rapidly applied tensile forces. Knowledge of their maximum values is needed and the duration of the forces is also of significance. Therefore complete time-function plots of the forces at several points in the rigging is the preferred form of output data from the instrumentation system. Altitude information with sufficient accuracy to determine rate of descent is also essential.

Design

The instrumentation system consists of: (1) a series of tensiometer buckles of graduated ranges; (2) altimeters for low and high altitude use; (3) parachute-carried telemetering units for coding and transmitting the data from these pickup instruments to the ground; (4) a ground station assembly for decoding and photographing the telemetered signals; (5) a film reader for producing time graphs of the measured quantities.

The seven information channels have an accuracy of approximately 10 percent. Each channel is sampled 100 times per second. Output information from the overall system is displayed in the form of simultaneous time plots of the seven selected variables on continuous graph paper. The method of modulation employed for conveying the intelligence is pam/f-m.

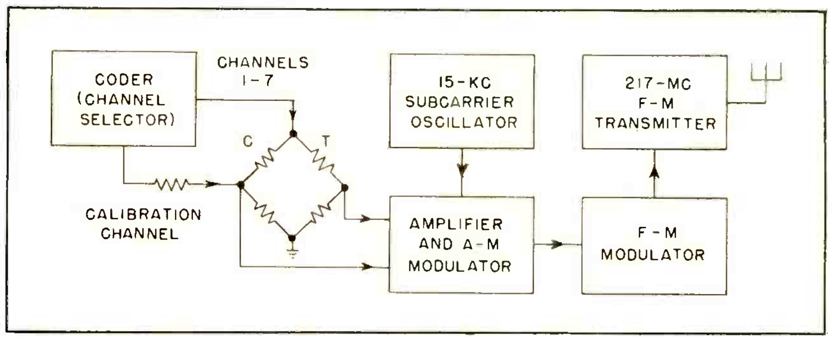

FIG. 4—Block diagram of parachute-borne unit of telemetering system

Transducers

The transducer elements provide for measuring harness tension in ranges of 500, 3,000, 5,000, and 10,000 pounds full scale and altitude in ranges of 20,000 and 40,000 feet. Since the transducers all operate with resistance-wire strain gages, many of the commercially available pressure and acceleration transducers may also be used with the telemetering system.

The construction of a typical tensiometer buckle for sensing harness forces is shown in Fig. 2. The H-shaped structure is inserted into loops sewn in the webbing and held in place by removable pins. When force is applied to the webbing, the upright members of the H act as cantilever beams. Resistance-wire strain gages are cemented to one elongated and one compressed surface of the cantilever beams, so that strain in the beam surfaces results in proportional resistance changes. Due to the elastic limits of the steel of which the buckle is made,

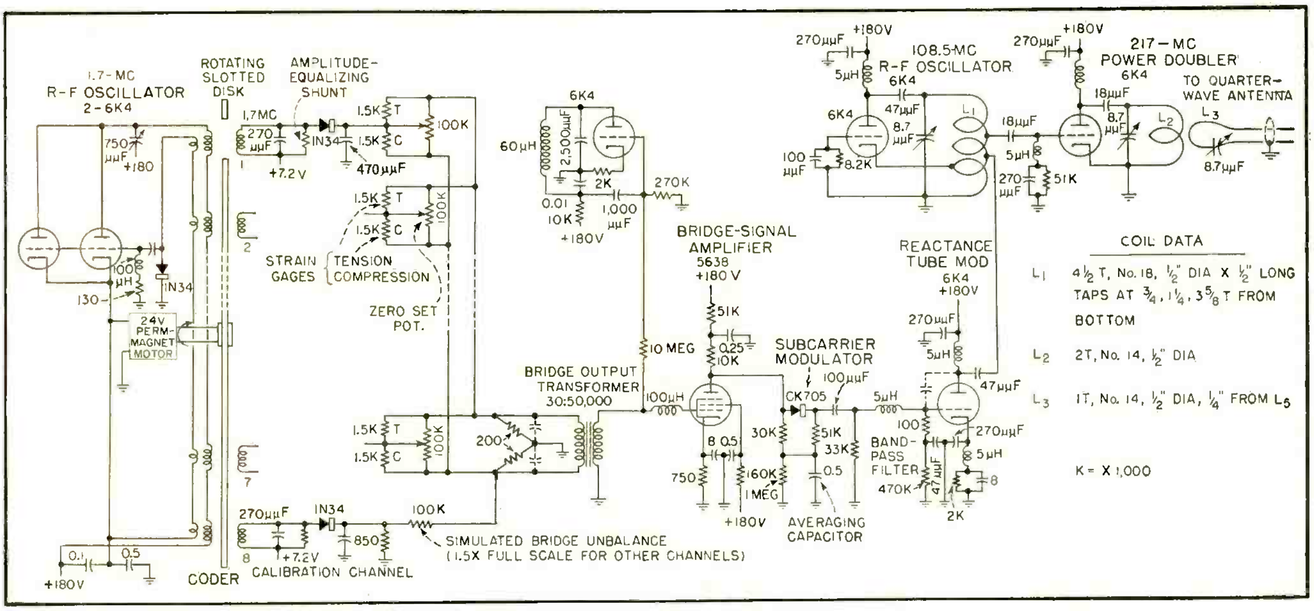

FIG. 5—Circuit diagram of parachute-borne unit. Motor is operated by rectified output of 1.7-megacycle oscillator

Telemetering System

Low-cost, semi-expendable unit transmits data from experimental parachutes during actual descent despite tumbling and shock. System provides seven information channels, each sampled 100 times per second, over an operating range of 2 to 10 miles

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the amount of available resistance change is limited to approximately 0.5 percent. Since the gage resistance is 1,500 ohms, the source of signal is a resistance change proportional to harness tension, whose maximum usable range is ±7.5 ohms.

Response of this type of buckle possesses a slight degree of nonlinearity and hysteresis whose total is within 5 percent of linearity.

A typical altimeter for the airborne units is illustrated in Fig. 3. Its operation is based upon the expansion of an evacuated bellows at lowered atmospheric pressure. A thin cantilever beam, to which strain gages are attached, is deflected by the bellows motion changing the resistance as a function of altitude.

The bellows is of the radiosonde type in which a nearly linear relationship between altitude and motion is provided. As in the case of the tensiometer buckles, the response approximates a linear relation with sufficient accuracy for practical purposes.

Airborne Equipment

A block diagram of the airborne equipment is shown in Fig. 4, and a circuit diagram, in Fig. 5. The starting point is the coder, which generates a series of time-sequential pulses at eight circuit points with a repetition rate of 100 pps at each point. Duration of the pulses is slightly less than one-eighth of the 1/100-second period of the complete scan, or about one millisec. Each of the eight outputs feeds one of the strain-gage bridges, as shown in Fig 5.

The low or inactive side of the bridge is common to all of the transducer elements. Since only one bridge receives an exciting pulse at any instant, there is no over-

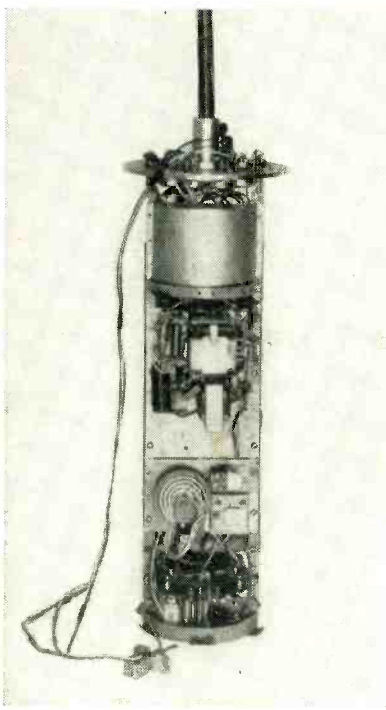


FIG. 6—Parachute-borne unit construction; tensiometer is shown at bottom

lapping or confusion of signals. The bridge output is a repeated series of eight pulses whose amplitudes are proportional to the unbalance of the strain gages on each of the transducers in turn. To assign actual magnitudes to the observed pulses, channel eight is derived from a fixed bridge unbalanced by an amount equivalent to 1.5 times a normal full-scale signal. Then the ratio of channel to calibration signal is indicative of transducer unbalance. Since this ratio is extracted by the output-reading apparatus, system-gain variations do not produce erroneous readings.

The bridge-unbalance signals are raised in level by an amplifier stage and fed to a modulator for conversion to amplitude-modulation of the 15-kc (nominal) subcarrier. The pam subcarrier is then passed to a reactance-tube modulator for applying f-m to the 217-mc transmitter for transmission to the ground station. The transmitting antenna can be seen in Fig. 1.

The entire airborne unit is powered by a self-contained battery pack with capacity for about one hour of continuous operation.

Coder

The coder, visible at the bottom of the airborne unit in Fig. 6, acts as an inductive commutator to activate each of the eight channels in turn. The essential features of the coder are a r-f oscillator at about 1.7 mc, a permanent-magnet motor which rotates a slotted copper disk at approximately 6,000 rpm, eight pickup coils arranged in a circle and tuned to 1.7 mc and diode rectifiers. As the disk revolves, the oscillator is coupled periodically to each of the eight coils, inducing a voltage pulse in each which is rectified and filtered. The pulse amplitudes are adjusted to 10 volts ±3 percent across an 850-ohm load by shunting resistors on the pickup coils. In this manner the problems associated with high-speed sliding contacts are avoided.

The motor, instead of being operated on the A-battery supply, is actuated by rectified r-f power supplied by the 1.7-mc oscillator. A better balance of life of A and B batteries is secured by placing the load of the motor, even with its only moderately efficient r-f source of supply, on the B battery. Parallel 6K4's generate the required power for feeding both the motor and the transducers.

Modulation

The subcarrier modulation is achieved by adding the amplified bridge-unbalance signals and the 15-kc subcarrier, then passing the sum through a threshold diode and filter circuit. Thus the subcarrier is allowed to come through whenever a bridge-unbalance signal is present, and in an amount proportional to the unbalance signal. The relative levels are set so that the resultant minimum or zero-signal output at 15 kc is approximately one-quarter the maximum produced by the calibration signal. Full-scale signals from the various transducers therefore amount to 50-percent modulation change in the subcarrier amplitude.

The transmitter and its f-m modulator are conventional in design. The power oscillator, operating at approximately 108.5 mc, feeds a power doubler tuned to 217 mc whose output into a resistive load is nominally 0.75 watt. In the modulator portion the necessary quadrature phase shift from plate to grid is provided by the grid-to-plate capacitance and a low resistance in the r-f grid return path.

Ground Station

The ground station panel is shown in Fig. 7. The receiver has a bandwidth of 300 kc, video response to 20 mc and includes afc on the local oscillator. As contrasted with f-m/f-m systems, there is no stringent requirement for discriminator linearity. The receiver output is identical to the amplitude-modulated 15-kc subcarrier appearing at the amplifier-modulator output in the airborne unit.

This signal is fed to demodulator and filter circuits which convert the waveform back to the duplicate of the transducer bridge unbalance signals. Equalization to correct for amplifier response, particularly the low-frequency deficiency due to the bridge transformer, is included in this portion of the circuit. The demodulated bridge-unbalance signals are then fed to the camera unit whose function is to record these signals transversely on 16-mm film continuously moving at 10 ips. Provision is made for intermittent film motion to reduce film consumption during the long period of drop after parachute inflation.

The bridge-unbalance signals are also applied to the monitoring crt on the front panel of the ground station for observation of received signals. A low-frequency saw-tooth wave is added to the crt deflection to provide timing indications at

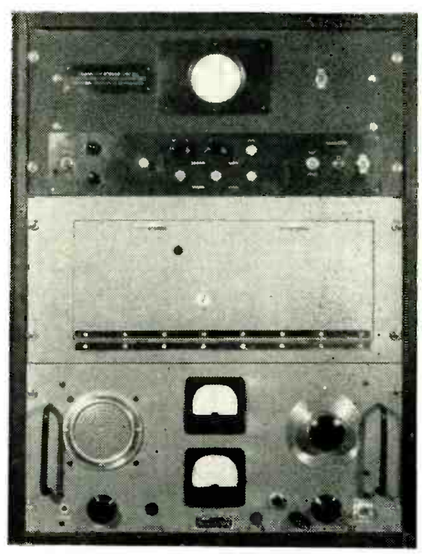


FIG 7—Front panel of ground station equipment. Decoder is at top, camera in center and receiver at the bottom

one-second intervals and for shifting the pattern on the tube screen for longer screen life.

Film Reader

The output of the ground station is a film record of the transducer-unbalance signals, recorded sequentially as each of the eight circuits is pulsed in turn. Before this form of record can be interpreted, it is desirable that it be converted to side-by-side graphs of the individual functions. Such is the purpose of the film reader shown in Fig. 8.

By the time the bridge-unbalance signals have been passed through the entire system the pulses are rounded off somewhat at the base-line corners and have acquired some overshoot. Furthermore, because the pulses are unidirectional, they possess an average value proportional to their amplitudes. This average value cannot be passed by the system and so the occurrence of any one pulse shifts the base line for the immediately succeeding pulses. Clamping at this point is inadvisable because of the loss of small signals. As a result, the magnitude of tension in a given harness section in indicated by the excursion of the peak from the average of the base line at the beginning and end of the individual pulses. Necessary averaging of base lines and subtraction from the peak is performed in the film reader.

The operator turns knobs in the film reader connected to current-summing potentiometers until pointer lines coincide with the peaks and bases of the pulses. Seventeen potentiometers are provided so that one whole scan of all eight channels may be covered. The operator then adjusts a master gain control until the amplitude of the calibration signal comes to the reference value. Therefore the outputs at the seven other summation points are voltages indicative of the ratios of signal-to-calibration line which corresponds, for example, to zero tension in the buckles or to zero altitude for the altimeter. Time is indicated by scaling off the intervals between the occurrence of the one-second base-line shifts on the film. Actual amplitudes in terms of force are then assigned by reference to the known scale factor for the buckles employed in the drop. Altitude is determined by marking the altitude of the aircraft beside the corresponding altitude signal.

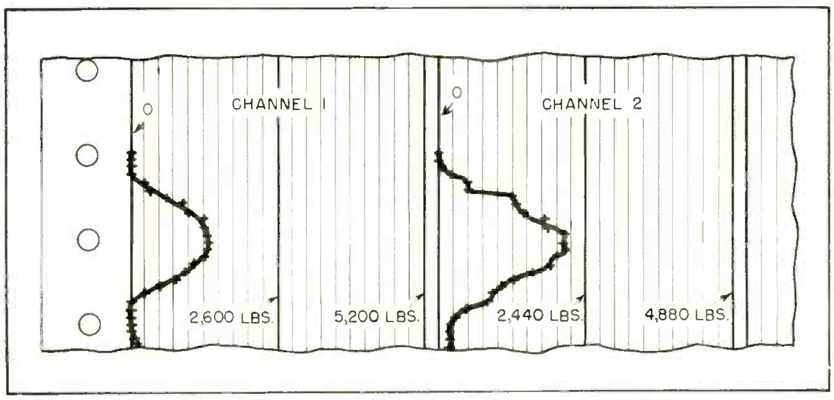


FIG. 9—Sample record showing two channels of system. Curves represent forces on two risers visible in Fig. 1

amplitudes. When the record button is pushed the strip-chart recorder plots all of the seven information channels and stops for the next frame. This procedure is then repeated until all information of interests has been covered.

Test Evaluation

The resultant record consists of seven parallel graphs. Each of the channels starts from its own base

Time-function plots of the forces on two shoulder straps are shown in Fig. 9. The results shown are for a test produced by dropping the dummy from a scafford, with ropes to provide the decelerating forces. Such a test setup can easily create a given maximum deceleration, however, the dummy does not reach the high velocity encountered before inflation, hence for given peak deceleration the duration of the peak forces is relatively short. The rate of rise however is simulated closely enough to provide an indication of behavior under actual conditions.

In the graph, the rapid rise of the harness forces may be seen. After the peaks, the force remains at a lower level, then finally drops to zero as the dummy effectively bounces on the ropes.

On the basis of experience in actual service the useful range of the equipment is between 2 and 10 miles, depending upon terrain, altitude and relative orientation of transmitting and receiving antennas.

The authors acknowledge the assistance of Paul Selgin, C. Stansbury, F. H. Bayhi, B. K. Hawes, M. L. Kuder and others.

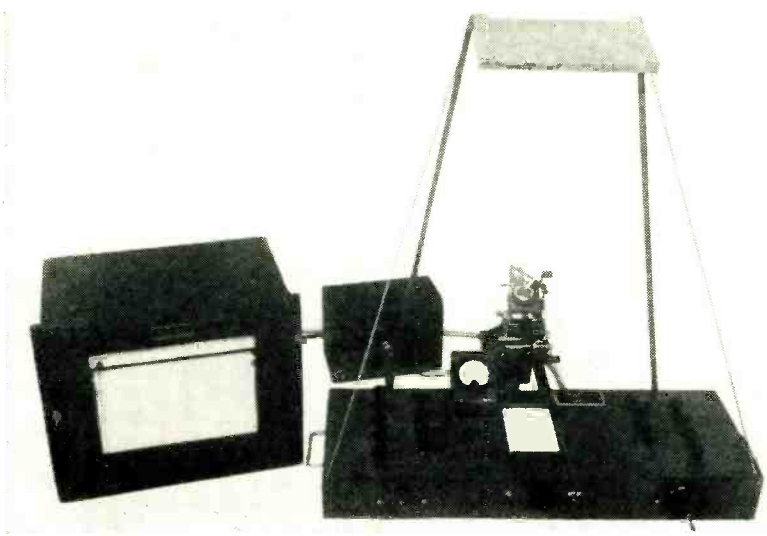
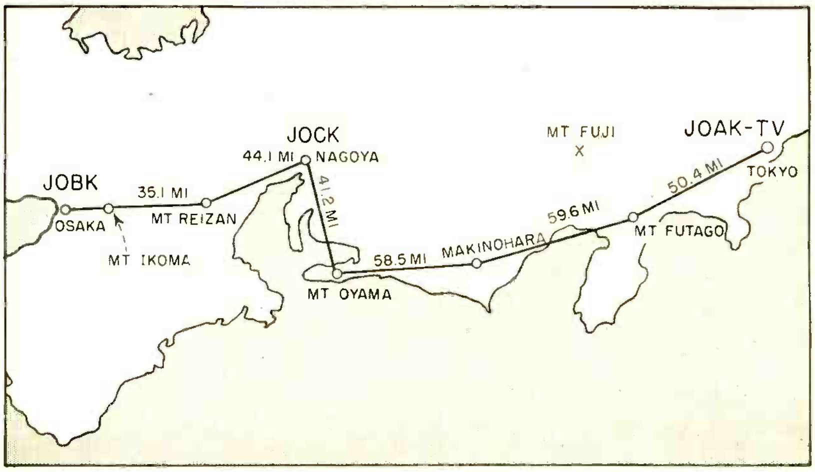


FIG. 8—Film reader converts sequential record on film to seven channels on chart



HIGH-GAIN paraboloidal antennas beam microwave signals over 288-mile mountainous path to provide a . . .

Microwave Relay

Seven-station relay operating in 4,000-mc band links three television outlets of Japanese Broadcasting Company. Traveling-wave tubes used in three-stage microwave amplifier provide three-watt output for hops up to 60 miles between repeaters

MICROWAVE techniques provide network television in Japan. A 4,000-mc tv relay feeds stations in Tokyo, Nagoya and Osaka. The system comprises five repeaters and two terminals. Transmission in either direction is possible by switching waveguide connections.

The relay is 288 miles in length and includes single hops of nearly 60 miles. The terrain is mountainous and as the map shows the system includes two overwater hops.

Propagation difficulties include high free-space attenuation and deep fades. To provide the necessary gain each repeater incorporates a three-stage traveling-wave amplifier that furnishes about a three-watt output. High-gain paraboloidal antennas 13.1 feet in diameter also are used. These antennas provide 40-db gain. To avoid overshoot the repeaters utilize a double-heterodyne system and alternate transmitting and receiving frequencies between 4,000 and 4,045 mc.

Table I—Television Relay System Gain Requirements

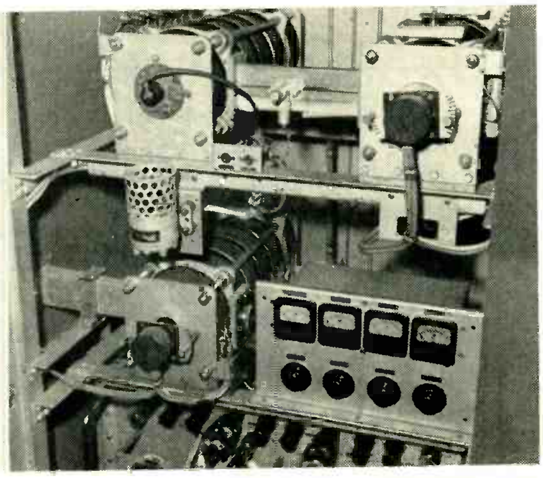
Losses	
Waveguide loss at transmitter	1.0 db
Waveguide loss at receiver	1.0 db
Free-space attenuation (60 miles)	144.8 db
Fading	23.0 db
Total	169.8 db
Gains	
Transmitting antenna gain	40.0 db
Receiving antenna gain	40.0 db
Amplifier output—3 watts	34.8 dbm
Total	114.8 dbm
Min. receiving power under worst fading conditions —55 dbm	

System Requirements

Table I gives the gain requirements for a typical relay link with signal-to-noise ratios expressed in decibels. Table II lists the r-f signal-to-noise ratios of each relay section for both no-fading condi-

Table II—System Performance—R-F S/N for Relay Sections, Video S/N at Terminals

Relay Sections	Distance (miles)	R-F S/N per Section (no fading)	R-F S/N per Section (max fading)	Video S/N at Terminal (no fading)	Video S/N at Terminal (max fading)
Tokyo–Mt. Futago	50.4	55.5 db	34.5 db	....	....
Mt. Futago–Makinohara	59.6	53.5	32.5	....	....
Makinohara–Mt. Oyama	58.5	53.5	32.5	....	....
Mt. Oyama–Nagoya (term.)	41.2	60.5	39.5	56.8 db	35.8 db
Nagoya–Mt. Reisan	44.1	60.5	39.5	....	....
Mt. Reisan–Mt. Ikoma (term.)	35.1	62.0	41.0	56.3	35.3



Received picture (left) on monitor illustrates transmission quality. Three-stage traveling-wave amplifier (right provides high gain

for Japanese Television

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tions and conditions of maximum fading.

The signal-to-noise ratios given for the video signal at Nagoya and Osaka take into account the fact that here the r-f signal is demodulated and retransmitted over vhf broadcasting transmitters. The f-m improvement factor R is added to the r-f signal-to-noise ratio. This factor is given by

$$R = 3 \ (B_{i-f} \ D^2)/2B_v^3$$

where D is the maximum frequency deviation of f-m, B_{i-f} is the bandwidth of the i-f amplifier and B_v is the bandwidth of the video amplifier.

The tables show that even under the worst expected fading conditions, a signal-to-noise ratio of at least 35 db would be obtained at both terminal stations, Nagoya and Mt. Ikoma (Osaka).

Terminal Equipment

The arrangement of the f-m terminal equipment is shown in Fig 1. The video input is superposed on the repeller voltage of a klystron to achieve direct frequency modulation. The 3-watt output is obtained in two stages of amplification utilizing traveling-wave tubes.

Frequency modulation by the video signal necessitates stabilization of the klystron oscillator frequency at the peaks of the synchronizing signal.

Thus, on the peaks of the synchronizing signal, a portion of the klystron output is fed back for automatic frequency control. The signal is taken from one arm of a T-junction through a standing-wave microwave frequency discriminator. A switching circuit utilizing a radar-type t-r tube is inserted in the feedback arm of the T-junction. The t-r tube is made to discharge only when afc output is desired—on the peaks of the horizontal synchronizing signal.

However, if the tube was made to discharge on the peak of every horizontal sync pulse, its life would be unduely shortened. A switching pulse generator is used to count down the horizontal sync pulses and pulse the t-r tube only during every tenth sync pulse.

The schematic diagram, Fig. 2, shows the automatic frequency control circuit including the 10:1 switching pulse generator. The loop gain of the complete afc circuit can be made about 50.

Repeater

As shown in Fig. 3, the television relay repeater operates on the double heterodyne principle. Approximate power levels at various stages are indicated.

The particular repeater shown receives on 4,000 mc and transmits on 4,045 mc. Two local oscillators, three crystal mixers and a 6AK5 i-f mixer perform the conversion.

The input signal received from the paraboloidal antenna is fed into the first crystal mixing circuit through the waveguide. After passing through the input 4,000-mc band-pass filter, it is mixed with a locally generated 3,930-mc signal and converted to the first i-f—70 mc—after which it is amplified by an i-f preamplifier of low noise

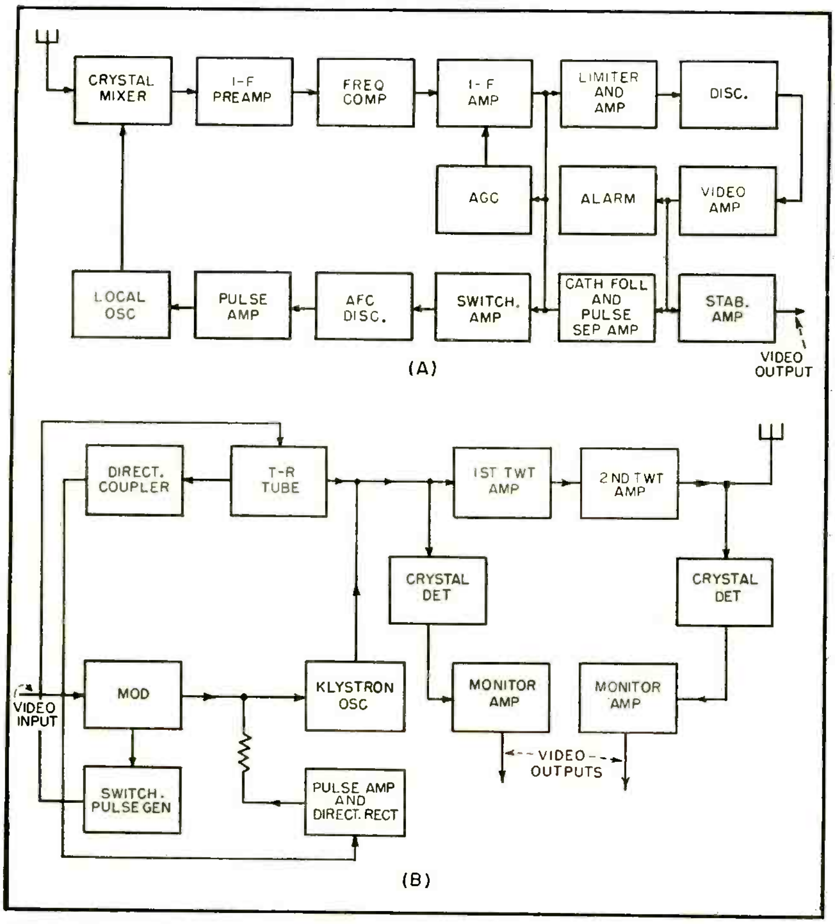


FIG. 1—Terminal station equipment comprises separate microwave receiver (A) and transmitter (B)

figure. This output is then fed into the delay equalizer through a 75-ohm coaxial cable after which it is further amplified by the 70-mc main i-f amplifier. This output and the crystal-controlled second local-oscillator signal (45 mc) are mixed and the second intermediate frequency, 115 mc, is applied to the second i-f amplifier. After it is further amplified by passing through the limiter circuit, the signal is fed into the third crystal mixer where it beats with the 3,930-mc klystron local oscillator output. The desired microwave output is obtained through the 4,045-mc band-pass filter.

The signal is amplified to the required 3-watt output by a three-stage traveling-wave amplifier and radiated from the transmitting antenna.

Table III—Characteristics of Traveling-Wave Tubes Type 7811 and 7812

Performance Data	Type 7811 Voltage amplifier	Type 7811 Driver	Type 7812 Power amplifier
Heater voltage	6.3 v a-c/d-c	6.3 v a-c/d-c	6.3 v a-c/d-c
1st-anode voltage	1,500 v d-c	1,500 v d-c	2,280 v d-c
2nd-anode voltage	1,500 v d-c	1,500 v d-c	2,280 v d-c
Grid voltage	zero	zero	−60 v d-c
1st-anode current	0.5 ma	0.5 ma	3 ma
2nd-anode current	2.7 ma	2.7 ma	30 ma
Input power	0.5 mw	3.5 mw	200 mw
Gain	23 db	20 db	13 db
Output power		350 mw	3.8 w
Frequency	4,000 mc	4,000 mc	4,000 mc
Magnetic field	400 gauss	400 gauss	400 gauss

Facilities for afc, agc and monitoring are also installed.

Crystal Mixer

For the first mixer, a broadband balanced crystal converter is used. The noise figure of the i-f preamplifier is adjusted to a minimum of 11.8 db.

Since the relay repeater is equipped with resonant circuits in each stage of the i-f amplifier, it is necessary to equalize the delay time.

Delay time distortion is two milliseconds at one stage of the M-coupled amplifier of the i-f strip and nine milliseconds at the three-stage stagger-tuned amplifier. To equalize the delay distortion of the repeater, a delay-equalizer circuit is inserted in two stages. The circuit impedance is 150 ohms and buffer amplifiers are placed both at the input and at the output.

Main I-F

The first and second i-f amplifiers are composed of triple-stagger-tuned circuits to achieve their respective bandwidth requirements. Since grid current flows in the limiter circuits and some of the amplifier stages double-tuned, M-coupled circuits are used.

AFC

Since the frequency variation of the klystron oscillator in the repeater has no direct effect on the output frequency, frequency control need be good enough only to make the resulting i-f signals fit into the amplifier passband.

For an f-m signal modulated by a composite video signal, only the frequency at the peaks of the synchronizing pulses is fixed. Thus it is necessary to hold the klystron frequency constant at these sync pulse peaks. The synchronizing pulse is obtained from the monitor output of the repeater. This signal is impressed on the screen grid of a 6AK5 gate tube to pass the second i-f signal for just the duration of the synchronizing pulse. The gate tube output is impressed on the afc frequency discriminator whose output becomes zero when the frequency is lower by 5 mc than the

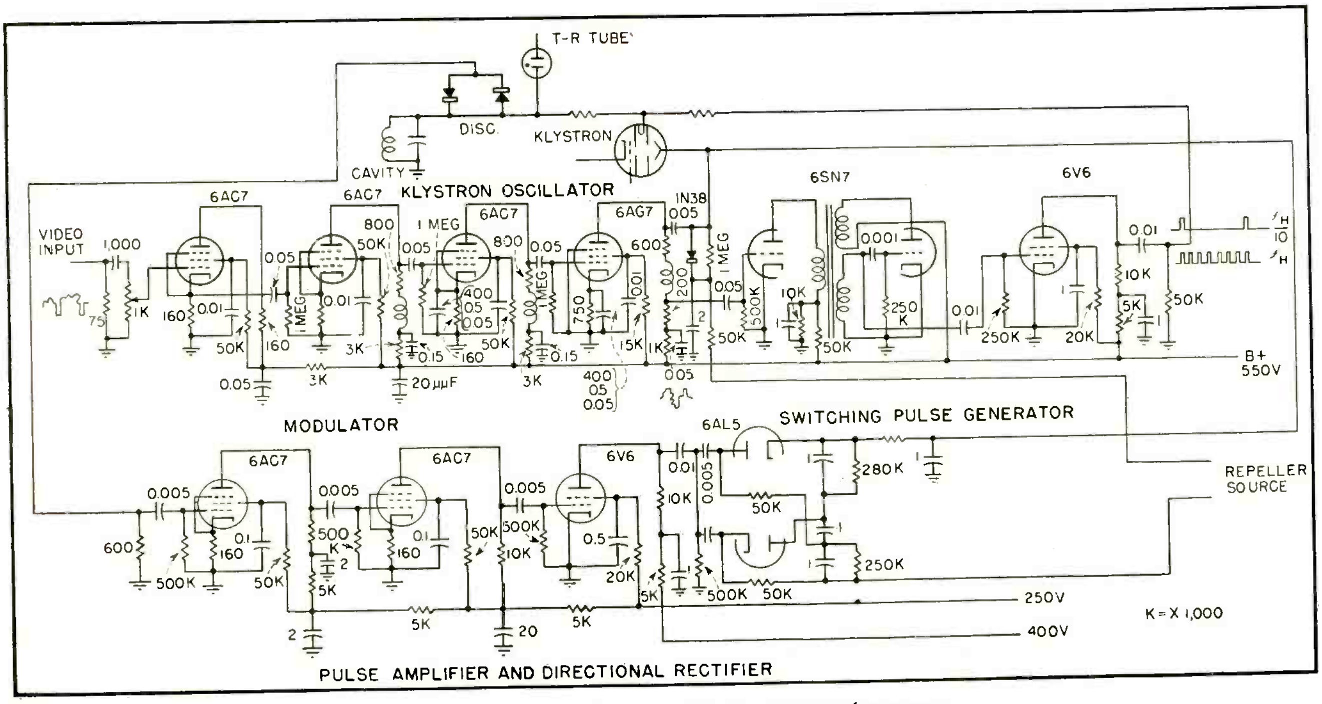


FIG. 2—Automatic frequency control system for terminal station establishes operating frequency

center frequency of the second i-f amplifier. The pulse output is then amplified, rectified and added to the repeller voltage of the klystron oscillator to control its frequency.

The limiter current is used for automatic gain control. This signal is superposed through a d-c amplifier as grid bias on a set of triple-stagger-tuned i-f stages.

To make sure the repeater is operating properly, the picture is monitored. The monitor input is taken from the second i-f amplifier. In addition, a cavity-type microwave frequency discriminator and video amplifier are installed in the final traveling-wave amplifier stage for monitoring the output signal.

Modulator

As in the first crystal converter, a balanced-type transmitter modulator is used in the repeater output. The second i-f and the klystron local-oscillator output are mixed and passed through a high-frequency filter to obtain the required microwave output frequency. Maximum output level is approximately 1 mw.

TWT Amplifier

The three-stage traveling-wave-tube amplifier provides a gain of 50 to 60 db and an output of 3

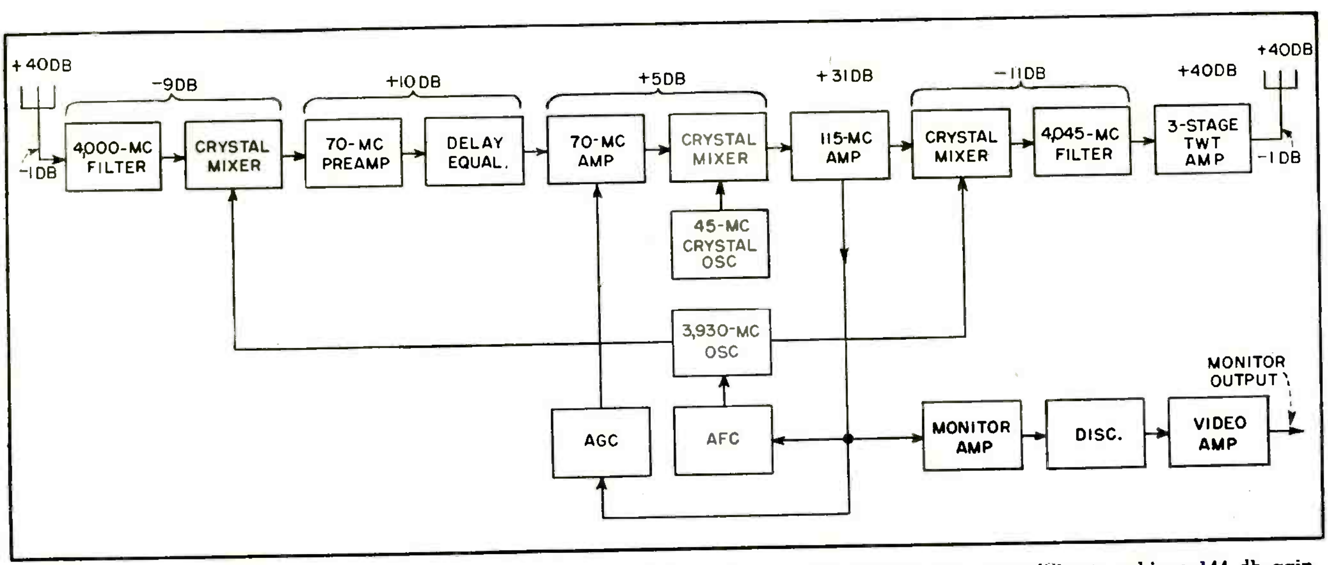


FIG. 3—Relay repeater utilizes high-gain receiving and transmitting antennas and three-stage twt amplifier to achieve 144 db gain

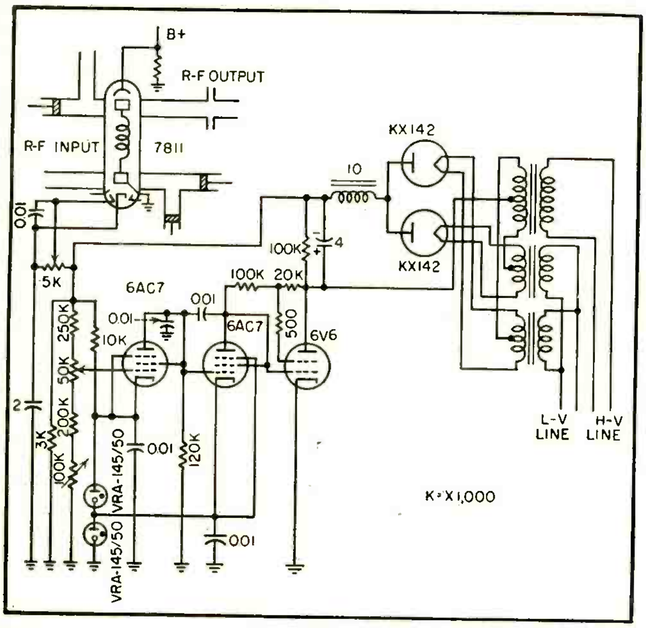


FIG. 4—Regulated high-voltage d-c supply for twt amplifier

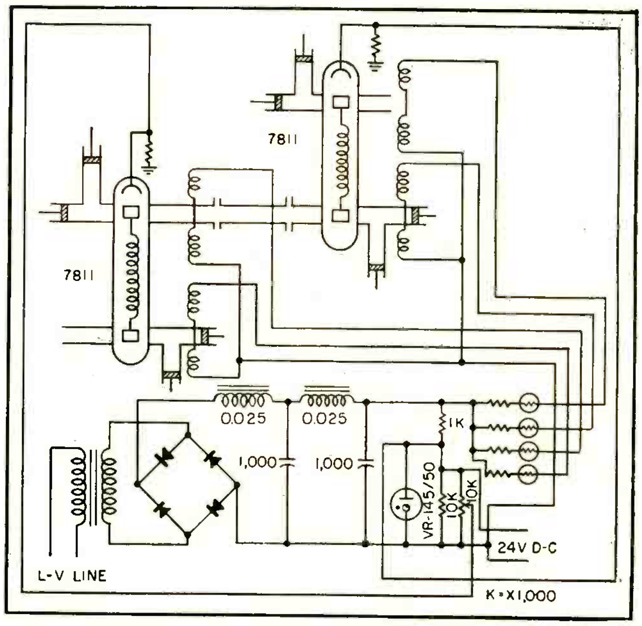


FIG. 5—Current regulator for twt focus coils

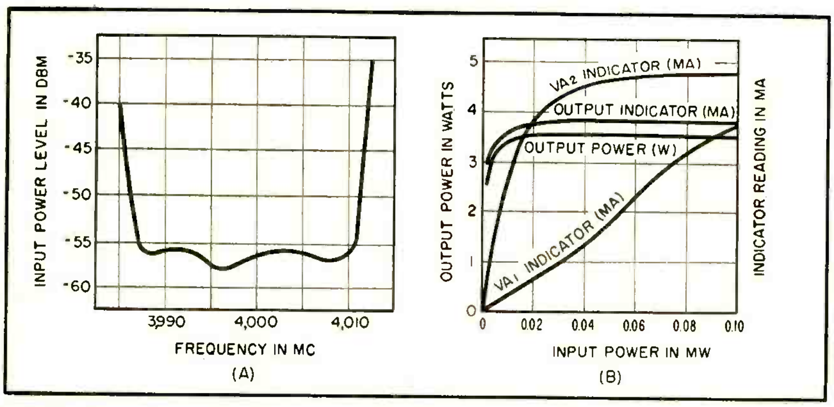


FIG. 6—Overall response of repeater (A) and characteristics of twt amplifiers (B)

watts. Thus, the output level of the third mixer can be small.

The traveling-wave amplifiers have ideal wide-band characteristics, but since the gain and output power are sensitive to voltage variation, the d-c high voltage is held constant by the regulator circuit shown in Fig. 4. Current for the electromagnetic coil is held constant by the circuit shown in Fig. 5. Overall frequency characteristics of the relay repeater including the three-stage traveling-wave amplifier is shown in Fig. 6A.

The characteristics of the twt amplifier are shown in Fig. 6B. The horizontal axis indicates input power in milliwatts and the V_1 output power level indication is proportional to the output power level of the first-stage twt voltage amplifier. Since this output increases in proportion to the input power, the first stage operates as a linear amplifier The V_2 indication is proportional to the output power level of the second-stage twt amplifier. The second stage begins to saturate around 0.04 mw of first-stage input power level, and the third stage output power indicator shows saturation around 0.01 mw of the first-stage input level. Thus a perfect limiter characteristic is displayed.

The vswr of the standard input waveguide is below 1.5 over the 200-mc range of the amplifier. The same can be said of the output side. Thus frequency response of the amplifier can be kept within 3 db over the band.

Antennas

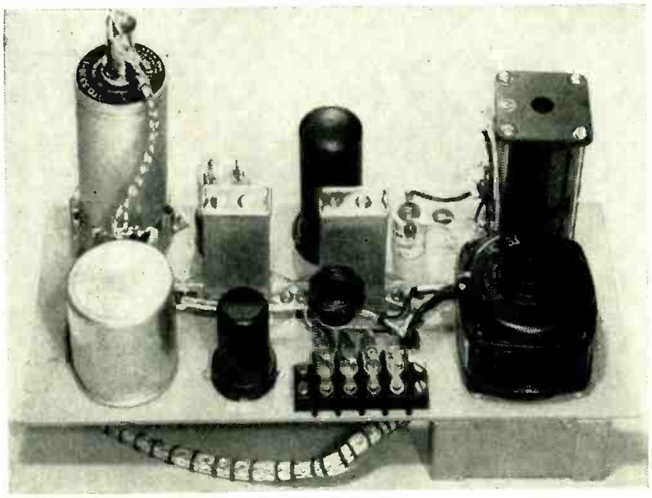
High-gain paraboloidal antennas are used. The waveguide feeding the antenna terminates in a horn and a Styrofoam piece is pasted over the open end for waterproofing. Antenna gain is about 42 db. The horizontal half-power beamwidth is 1.34 deg and the vertical: 1.44 deg.

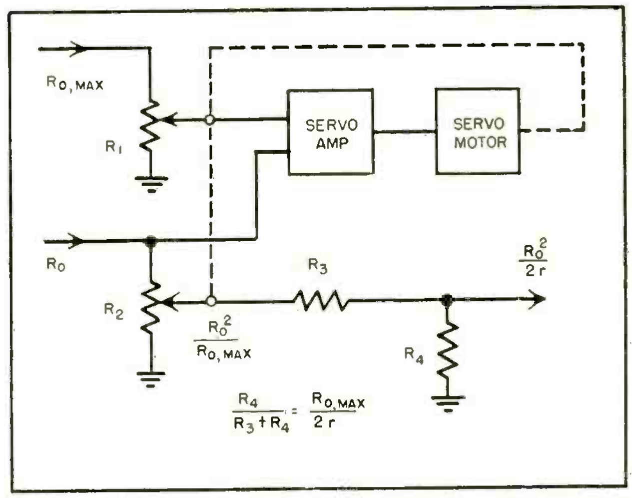
The waveguide is of a standard type and its attenuation is less than 0.1 decibel per meter.

A microwave repeater system of more recent design utilizes all traveling-wave amplifiers and has given satisfactory results.

The input r-f amplifier is a type 7810 low-noise traveling-wave tube. Following the input band-pass filter are two type 7811 twt voltage amplifiers. The signal is then shifted 45 mc and passed to a three-stage voltage amplifier using type 7811 traveling-wave tubes. Output power amplifier is a type 7812.

The authors acknowledge the aid of Yoshitoshi Tanabe, chief of NHK technical research laboratory, Kazuo Murase, chief of the facility department, Mr. Iwao Honjo, director of Matsuda Research Laboratory and Naonobu Shimomura, chief engineer of Tokyo Shibaura Electric Company. Appreciation is also due the engineers of NHK technical research laboratory and the facility department of Matsuda Research Laboratory and Komukai Works of Tokyo Shibaura Electric Company for adjusting and testing the equipment.





Altitude correction computer (left) uses chopper-type 60-cps servo amplifier with two-phase servo motor to drive two 10-turn helical potentiometers (right)

Altitude Corrector for Tracking Radars

Simple analog computer introduces earth's curvature correction to target-altitude data obtained from tracking radars. Correction permits plotting data from widely separated radars on master board and furnishes accurate information to interceptors

By W. R. McQUISTON

Point Mugu Division
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CONVERTING altitude data as determined from a radar to altitude above sea level can be accomplished by a simple analog computer. Conversion is necessary when data from radars separated by as much as 50 miles are displayed on a master plotting board or when data from ground radars are supplied to interceptor aircraft. At 100 miles uncorrected radar altitude data would be in error—about 6,600 feet low.

Radar altitude data is normally available as height above a plane tangent to the earth at the radar. Due to the earth's curvature, altitude data from two separated radars are not compatible.

Using assumptions that do not decrease the desired accuracy of 0.01 percent, altitude above mean sea level becomes $H_c = H_o + (R_o^2/2r)$ where H_o is altitude observed by the radar, R_o, horizontal range to target and r, radius of the earth.

The analog computer that calculates the term $R_o^2/2r$ is shown in the drawing.

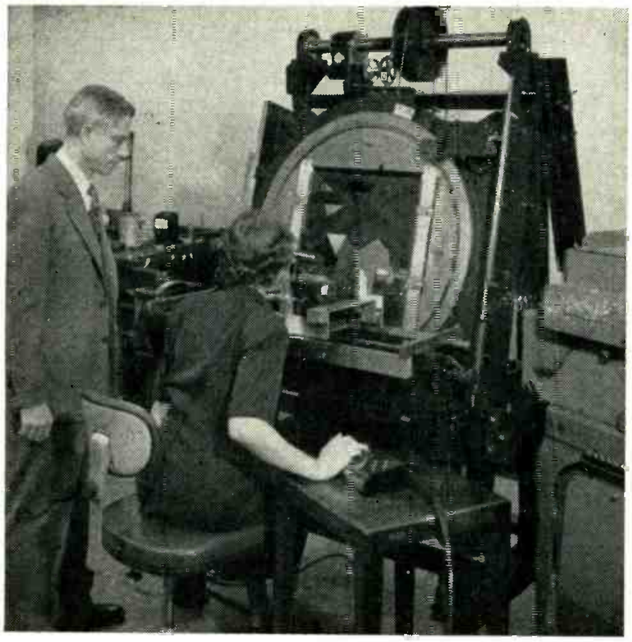
Direct-current voltages proportional to R_o and $R_{o,max}$ are available from the radar computer. The inputs to the 60-cps chopper-type servo amplifier are R_o and a d-c voltage from R_1. Any difference between the two inputs is converted to 60-cps amplified and used to drive a two-phase servo motor that drives R_1 and R_2 by a gear train until the two inputs are equalized.

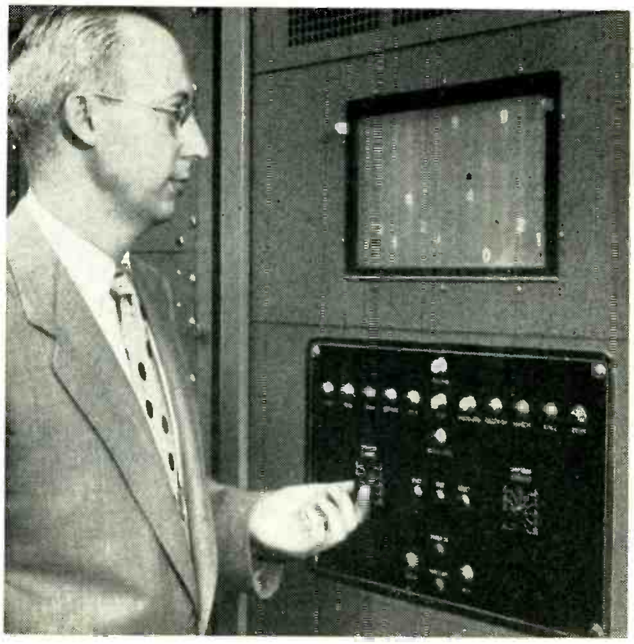
When the wiper of R_1 is accurately positioned to match R_o, its physical position on the potentiometer is proportional to $R_o/R_{o,max}$. Since R_2 is mechanically linked to R_1, R_2 is also positioned in the same ratio and the voltage output of R_2 is $(R_o/R_{o,max})\ R_o$ or $R_o^2/R_{o,max}$. Potentiometers R_1 and R_2 are ganged 10-turn Helipots.

Voltage divider R_3 R_4 is made proportional to $R_{o,max}/2r$, a constant. The output of R_2 is applied to this divider giving $(R_o^2/R_{o,max}) \cdot (R_{o,max}/2r)$ or $R_o^2/2r$, the desired altitude correction.

The observed altitude H_o and the altitude correction are summed in the radar computer to provide the corrected altitude H_c.

The computer can be used also to solve equations involving division of a squared variable by a constant.





THE FRONT COVER

Automatic astronomer consists of massive measuring engine containing 17-inch-square glass photographic plate made with telescope, punched-card input-output equipment (at right of engine) and two computer and control racks

Sequence control rack, with visual indicator panel that shows, left to right, the star number (1214 here), the X-coordinate of its position on the plate (219.4 mm) and the Y-coordinate (092.1 mm), corresponding to data punched on IBM card

Automatic Measurement

Computer-controlled photoelectric measuring head locates star images one by one on glass photographic plate, measures their coordinates with accuracy better than 1 micron and records results automatically on punched cards for comparison with old data

SINCE THE TIME of Hipparchus, 2,000 years ago, the astronomer has systematically measured the positions of celestial bodies in the sky with the utmost accuracy and recorded them for future study and comparison. The positions of the fixed stars, as distinguished from the planets, or wanderers, are recorded in star catalogs. Positions from early catalogs can be compared with those from later ones for a study of the tiny motions that are gradually unfolding the structure and history of the stellar systems.

Photographic Technique

Methods of measurement have been steadily improved. Today a ten-minute exposure on a photographic plate permits the astronomer to measure as many stars as he could formerly in long hours at the telescope. This ease of collecting data at the telescope aggravated the associated phases of the star catalog program—years of painstaking measurements, stacks of computations and months of proofreading.

The unique automatic methods described here for doing the computing, printing and proofreading have developed to the point where the outstanding remaining drudgery is that of locating the star image on the plate, measuring its position and recording the results.

To the naked eye the images of stars on a photographic plate appear as tiny black dots on clear glass. Magnification shows that each is composed of a group of isolated silver grains distributed over a roughly circular or elliptic area. For the purposes of the star catalog, it is necessary to measure the coordinates of these star images relative to each other. From these rectangular coordinates can be computed the celestial coordinates of right ascension and declination of each star.

Description of Engine

In the past, a human operator measured the locations of the star images with a measuring engine. Typical of these engines is the one built in 1927 by Heber D. Curtis, made available to Watson Laboratory for modification in the current project. Supported at three points by an angle-iron framework is a massive cast-iron bed that supports

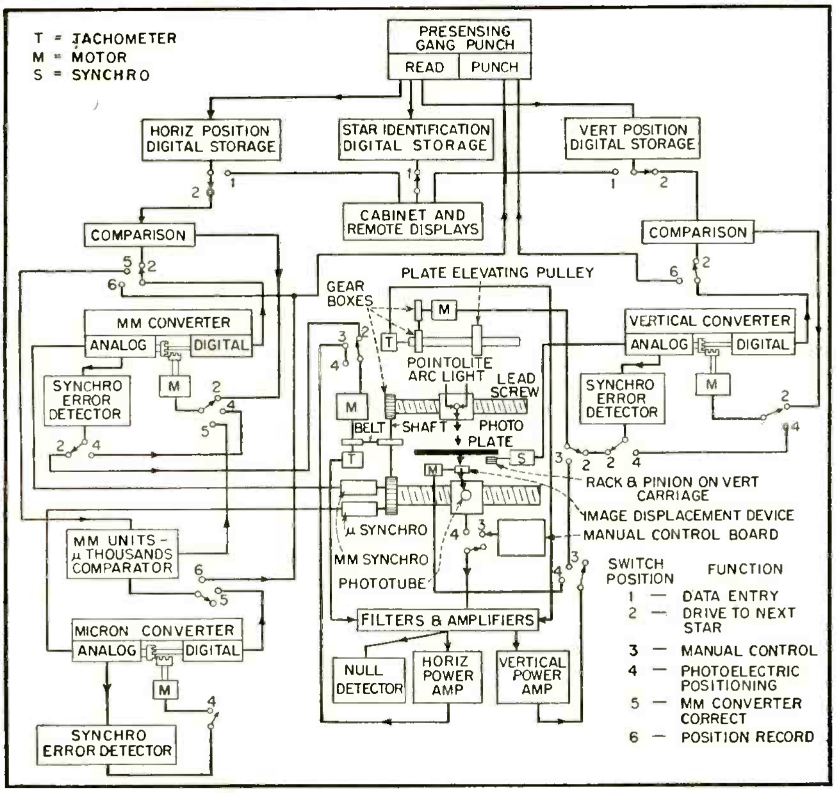


FIG. 1—Simplified block diagram of complete star-measuring system

# of Star Positions

By JOHN LENTZ and RICHARD BENNETT

Watson Scientific Computing Laboratory of International Business Machines Corp. Columbia University, New York, N. Y.

the ways upon which a plate holder moves in the vertical direction. Other ways on the bed provide running surfaces for a horizontal carriage.

A $2\frac{7}{8}$ inch diameter lead screw with 1-mm pitch drives the horizontal carriage by means of a nut affixed thereto by a system of gimbals. The nut is a bronze cylinder with approximately 50 radial wooden plugs providing contact with the screw. At one end of the lead screw is an index head whose circumference is divided into 1,000 equal divisions by ruled index lines. The index head furnishes information as to the angular position of the lead screw and hence, when backlash is removed, information as to the linear displacement of the horizontal carriage. One division on the head corresponds to 0.001 mm or one micron on the plate.

Requirements for Automatic Measurement

The process of measurement of a given coordinate of a given star image may be divided into three phases. First, out of all the stars whose images are shown on the plate under consideration, the image of the desired star must be found. Approximate plate coordinates can be obtained from earlier star catalogs; these are sufficiently precise to locate unambiguously the desired star. Second, the horizontal carriage of the measuring engine must be moved to a position accurately representative of the coordinate of the star being measured. Finally, the precise new coordinate value of the star must be recorded.

To make the process of star measurement fully automatic, it was necessary to provide mechanisms and control equipment capable of accomplishing the three phases of the operation automatically in the proper sequence.

To adapt the original measuring engine for an automatic system, a photoelectric scanning device was substituted for the visual microscope. An auxiliary screw and carriage were installed to carry a source of illumination in alignment with the optical scanner for illumination of the photographic plate.

Electrical driving motor assemblies were provided for the horizontal and vertical motions. An auxiliary carriage on ball-bearing wheels on an auxiliary set of horizontal ways was added to remove part of the weight of the microscope carriage from the precision ways.

The original horizontal and vertical scales and graduated head on the lead screw were supplemented by synchro position transmitters.

The engine was enclosed in a case with thermostatic temperature control. A projection system was installed for visual inspection of the field of view of the optical scanner from outside the case.

Three cabinets contain electrical and electronic control and sequencing units. A standard IBM machine for reading and punching cards, called a presensing gang punch, feeds the old star catalog coordinates into the system. Included in the cabinets are analog-digital converters that handle the output from synchro position transmitters on the engine. Since the cards are read while in motion, digital storage is provided so that the data may be compared with the digital output of the converters.

How the Machine Operates

The complete system is shown in Fig. 1. A deck of cards containing the approximate coordinates of the stars to be measured on a given plate, one card per star in order of increasing x, is inserted in the hopper of the gang punch. The cards are fed into the punch one by one, in response to signals from the sequence unit. Numbers in the form of holes punched in the card are read by sensing brushes making electrical contacts through the holes and this information in the form of electrical impulses is transmitted to digital storage. After the approximate coordinates are read, the card passes to the punching station where it comes to rest temporarily while the measurement of the star position is made.

The coordinates that have been read from the card into digital storage are compared with the outputs of analog-digital converters. The comparison device emits a directional error indication that is applied to the drive motors of the converters, causing them to drive until the converters agree with the storage relays. At this point, the appearance of an error signal in the synchro link between the drive shafts of the measuring engine and the converters causes relays to operate to drive the carriages of the engine to positions that agree with the converters. The star image should now be in the field of the viewing screen.

The machine pauses in its sequence to allow the operator to inspect visually the star image and to move it by push-button control to the center of the screen and within the field of the rotating scanner.

After control has been returned to the sequence mechanism, the error signal derived from the optical scanning head causes the horizontal drive motor and the vertical correction motor to position the carriages so that the optical axis of the scanner will pass through the center of gravity of the star image. The synchro link between shafts and converters furnishes error signals to drive the converters to new positions corresponding to the precisely measured coordinate of the star image.

Finally, the sequence mechanism causes the new coordinate in the converters to be transmitted to the punch and punched in the appropriate columns of the card that is waiting at the punching station. As the first card is punched, the second card is read and the whole cycle is repeated until the last card of the deck has been read and punched. Save for the stop for inspection just before final positioning, the complete process of measurement of star position is carried out automatically.

The basic sequence control units and analog-digital converters were developed originally by A. H. Dickinson and associates for use in IBM automatic measuring and recording machines installed in wind tunnels during World War II. Subsequently, B. E. Tobin and associates made certain improvements and modifications that were used in the present machine.

The digits from the punched card are stored in stepping switches from which a comparison is made with the analog-digital converters for their positioning. The electrical output from the digital storage and the converters represents the ten digits, 0 to 9, by voltages at 5-volt intervals from 5 to 50. During the stage of setting the converter to the number in digital storage, a comparison unit interprets these voltages, sensing first the highest-order position, then the next lower in succession, and directs the converter motor to drive the converter in the proper direction to bring the two units into agreement.

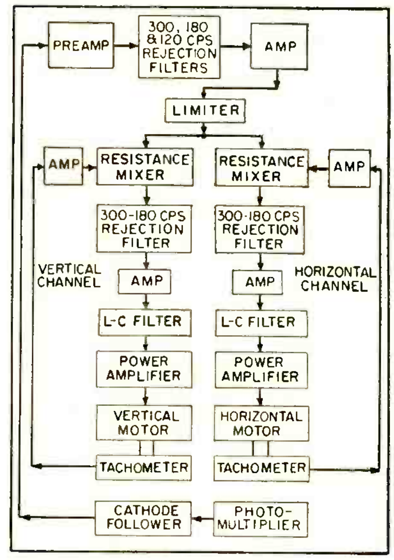


FIG. 4—Photoelectric servo system

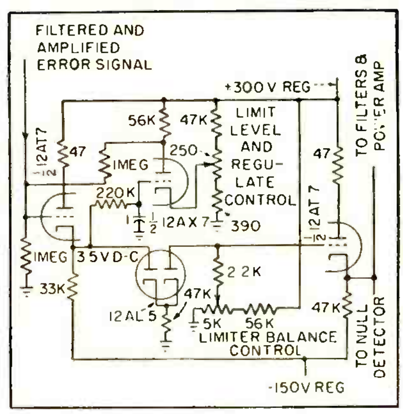


FIG. 5—Series diode limiter with level and balance controls

The analog-digital converter consists of two parts. The digital part operates similarly to a Veeder counter, with four 10-position commutators replacing the number dials and driven by a universal motor whose direction of rotation is controllable. The analog part consists of two synchros, coarse and fine, geared to and driven in syn-

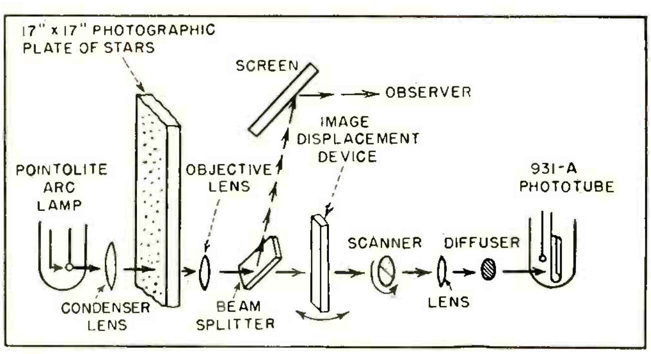


FIG. 2—Optical system employed to locate center of gravity of star image on photographic plate

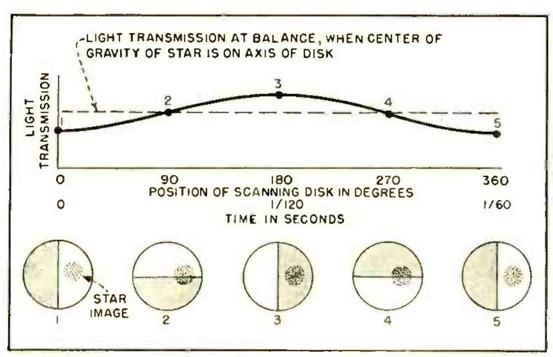
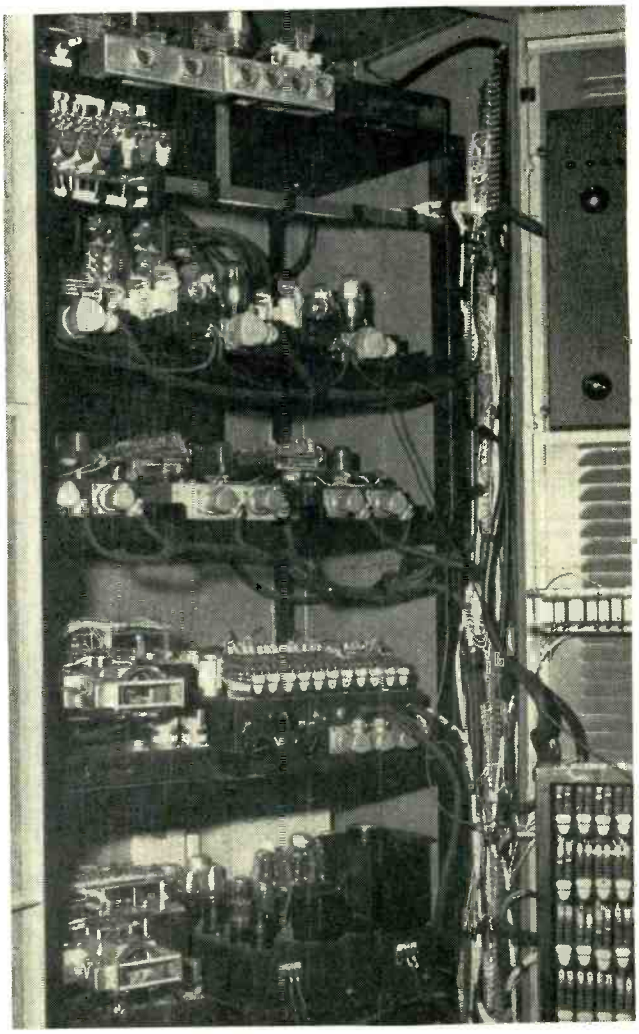
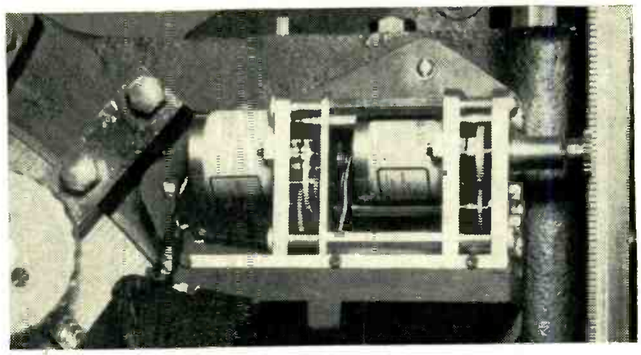


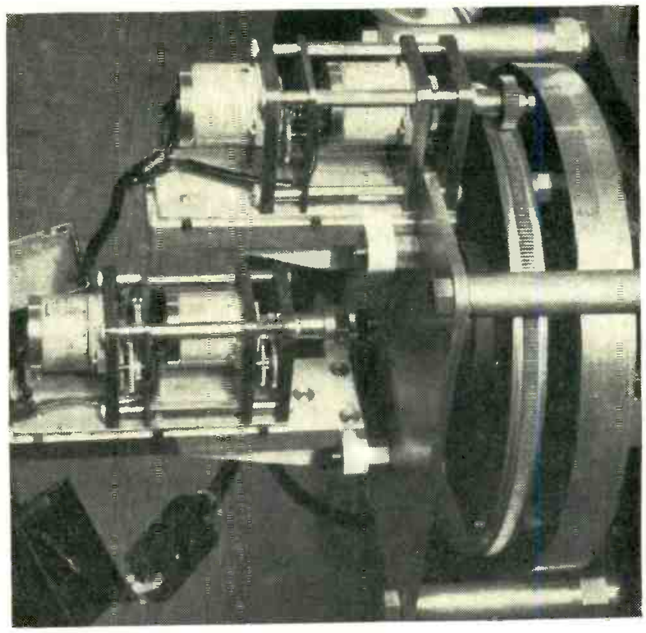
FIG. 3—Operation of scanning disk in relation to magnified opaque image of star



Rear view of sequence control unit



Vertical position-transmitting synchros



Horizontal position-transmitting synchros

chronism with the digital part and electrically connected to two synchros on the engine. When the converter is made to agree with the number in digital storage, a synchro link indicates an error that is used to drive the engine to agree with the converter.

Analog-Digital Converters

Although four-digit numbers (to tenths of a millimeter) are used in the initial vertical and horizontal positioning of the engine, it is necessary to punch out a seven-digit reading of the screw position (to 0.2 μ). The additional three digits are furnished from an auxiliary four-digit or micron converter linked to a pair of synchros connected to the lead screw and so geared as to repeat for every revolution of the screw. The highest-order position of the micron converter corresponds to the lowest-order position of the horizontal converter, but it is exact where the other may be off by two-tenths of a millimeter.

The necessity for a forced agreement in the overlapping position is shown in the following example. Assume that the horizontal or millimeter converter is positioned at 247.9 mm and the micron converter at 0.0015. The 9 and 0 are in the same decimal position, but 0 is the correct digit. It is not sufficient merely to punch out the 0, since in this case the 9 must be corrected to read 0 to force a carry into the next column and give the correct reading of 248.0015. The correcting device is so designed that, regardless of whether the lowest-order position of the millimeter counter is to be increased or decreased, the change is made in the shortest direction.

Optical System

The optical system of the measuring engine is shown in Fig. 2. Behind the plate is a carriage driven by an auxiliary screw, which is of the same pitch as the lead screw and rotates synchronously with it. Upon this carriage are mounted the light source, an Edison Pointolite lamp and a lens system that forms a real image of the incandescent sphere of the lamp upon the photographic plate. A substantially uniform illumination of the plate is thereby furnished in the immediate vicinity of the image of the star whose position is being measured. Light from this area is collected by the objective lens and brought to a focus to form a real image of the star, magnified about 20 times, on a rotating scanning disk. On its way from the objective lens to the scanner, the light passes through a thin-film beam splitter, which diverts part of the light to the external viewing screen and through an image displacement device.

The rotating scanning device contains a thin disk through which a semicircular hole is cut. The assembly rotates at 3,600 rpm about an axis perpendicular to the plane of the disk and passing through the center of the diametral edge of the hole. As the disk rotates under the magnified image of the star, the amount of light transmitted through the shutter varies periodically with the fundamental frequency of 60 cps, as shown in Fig. 3. Fourier analysis of this periodic variation of light shows that the amplitude and phase of the fundamental component are measures of the radial and angular coordinates of the center of gravity of the star image with respect to the axis of rotation and an arbitrary angular reference axis.

To obtain an electrical signal suitable for use as an error signal in a servo follow-up system, the light transmitted through the rotating scanner is picked up by a phototube. If the light were to go directly through the scanner to the phototube, the illuminated spot on the cathode of the phototube would move around as the scanner rotated, and variations in sensitivity of different areas on the cathode would give rise to a spurious signal superimposed on the desired error signal. With a lens and diffusing plate in front of the phototube, light is imaged from a point just ahead of the condenser lens on the diffuser and a stationary spot of light is obtained on the cathode. This minimizes any signal due solely to the action of the scanner itself.

Error Signal

The output of the phototube is passed through filtering and limiting units, which deliver to the motors a 60-cps electrical signal, as shown in Fig. 4 and 5. For small amplitudes the amplitude of the signal is proportional to the radial distance of the shutter from the axis of rotation to the center of gravity of the star image. For large amplitudes the amplitude of the signal is constant and independent of the radial error. The phase is at all times proportional to the angular coordinate of the star image.

The error signal, after being limited, is supplied as input to each of two mixer amplifier channels that terminate in hard-tube power amplifiers supplying power for the horizontal and vertical drive motors of the engine.

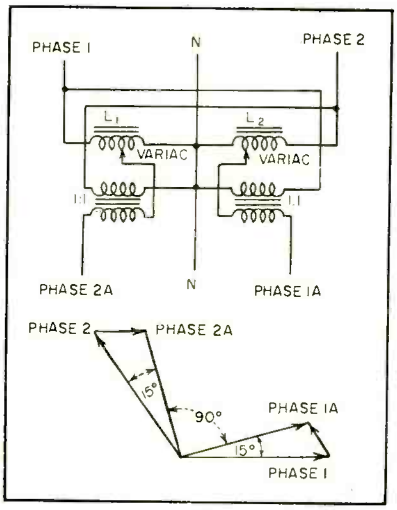


FIG. 6—Variable-phase motor exciter

In the horizontal channel the error signal is mixed with a voltage derived from an induction tachometer driven by the horizontal drive motor. This tachometer is mounted on a pivoted bearing in such a manner that the rubber-tired friction wheel on its shaft does not make contact with the driving wheel on the motor shaft. However, by energizing the coil of an actuating solenoid, the tachometer assembly can be tilted so that the rubber wheel on the tachometer shaft comes in contact with the driving wheel and thus causes the armature of the tachometer to rotate. For high-speed slewing of horizontal carriage, the system operates without tachometer feedback. During final approach in positioning star image, the system is stabilized by the feedback from tachometer.

Drive Motors

The outputs of the horizontal and vertical power amplifiers are each applied to one winding of the respective drive motors. These motors are two-phase induction motors whose second windings are excited from independent phaseable sources of 60-cycle voltage. The torque developed by such a motor is proportional to the sine of the electrical phase angle between the voltages applied to the two excited windings.

Assume the error voltage to be resolved into two components, one in phase with the error voltage that would be produced by a purely horizontal error in image position and the second in phase with the error voltage that would be produced by a purely vertical error in image position. It is possible to phase the exciting voltages applied to the second windings of the motors so that the horizontal motor will ignore signals produced by a vertical error in each position, but will develop torque tending to drive the lead screw in such direction as to reduce the horizontal component of error of image position. Conversely, the vertical correction motor can be made to drive in such direction as to reduce vertical errors, but it will ignore horizontal errors.

Since the vertical and horizontal components of the driving signal are 90 deg apart, the exciting voltages for the drive motors must be 90 deg apart. However, to correct for amplifier phase shifts and scanner synchronization, the exciter voltages must be made adjustable in phase. The circuit for the variable phase exciter is shown in Fig. 6. Two legs of the three-phase power lines are added to each other by means of variable inductors and 1-to-1 isolation transformers. From L_1 a portion of phase 1 is added in the isolation transformer to all of phase 2, to give phase 2*A*. The same operation performed in the other half of the circuit produces phase 1A.

Image Displacement Device

Originally it was planned to center the star image on the axis of the scanner by using the two motions of the original measuring engine. The effect of static friction in the vertical motion made it impossible to position the vertical carriage with sufficient accuracy, however. Although no attempt is made to measure accurately in the vertical direction, proper functioning of the follow-up system requires a precise setting in both coordinates, because the same amplifier channel carries both the horizontal and the vertical error signal.

The image displacement device makes it possible to reduce the vertical error signal to zero. A piece of plane parallel glass mounted in the optical path can be rotated about an axis parallel to the horizontal ways by a correction motor, which is powered by the signal formerly directed to the vertical drive motor. As this glass sheet rotates, it causes the star image on the scanning shutter to move slightly ($\pm 40\mu$) in the vertical direction and gives a fine control of vertical image position. The device is used solely to achieve a null at the final balance point; during the initial rough positioning in response to the approximate coordinates read from the card and in response to pushbutton control, the drive motor operates the original vertical motion of the engine.

The effect of static friction when driving the heavy plate holder under manual or pushbutton control was minimized by attaching a mechanical vibrator to the vertical carriage and buzzing whenever a vertical direction button is depressed.

Friction and Lubrication

Sliding friction between the accurate ways and the horizontal carriage was increased when the simple microscope was replaced by a unit containing a periscope, motors, damper, projection screen, cathode follower and a photomultiplier tube. To support the additional weight of 20 pounds, a ball-bearing wheeled carriage was mounted on a set of ways aligned with the precision ways and the two carriages coupled by means of a system of lift rods, self-aligning pivots and counterweights.

Lubrication of the measuring engine is another serious problem. Any lubricant will form a wedge under the horizontal carriage when the carriage has been driven an appreciable distance. The wedge of oil fim tends to tilt the optical system, thereby causing errors in measurement. To distribute the oil film in the vicinity of the final setting point, the horizontal servo of the engine is allowed to run undamped so that it hunts back and forth ($\pm 50\mu$) for five oscillations. On the fifth count the tachometer is clutched in, signaling the final approach to the star center. Figure 7 shows the simple circuit used to generate counter impulses.

When signals of forward drive phase are applied to the network, the total voltage across the terminals will be 230 volts, which provides sufficient current to pick up the impulsing relay. A reverse drive signal presents an in-phase input to the circuit; no voltage appears across the terminals and the relay drops. Forward and reverse signals continue until enough impulses are delivered to the counter for it to cause the operation of the tachometer clutch.

Figure 8 shows the circuit used to advance the sequence control unit when a null point has been reached. The output from a 60-cycle pass filter is rectified and used to bias a thyratron. When a null is reached, no bias is obtained and the thyratron picks up its plate relay. The R-C network in the 2D21 plate supply prevents firing of the tube before bias is developed.

As in any system that uses a 60-cycle carrier, residual hum presented a serious problem. To minimize its effects, each chassis was grounded to a common cabinet point. As a further aid to hum reduction, opposing signals, variable in amplitude and phase, are injected into the system at selected points.

Discussion of Results

The first measurements by the machine in its present form were made on a plate whose star positions had been measured at Yale

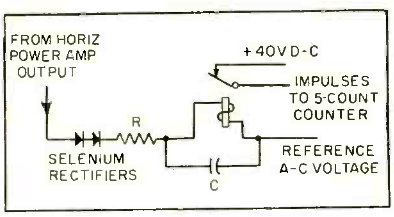


FIG. 7—Counter impulse generator for control of horizontal tachometer clutch

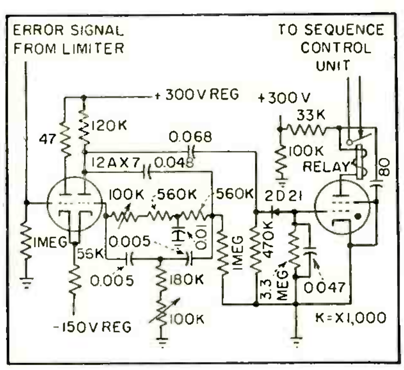


FIG. 2—Photoelectric null detector

for the zone catalog. The 450 star images on the plate were measured automatically on each of three successive days without a change of position of the plate in the engine. After the plate was rotated 180 deg, it was measured on three succssive days in the reversed position. Differences in the raw measures of individual stars from the direct runs ($D_2 - D_1$ and $D_3 - D_2$) and from the reverse runs ($R_3 - R_2$) show remarkable consistency. Allowing for a change in zero point of one micron or less from one day to the next, the largest residual **is** 1.5μ and there are only five **as** large as 1μ. The average difference from one residual to the next is about 0.4μ, or the probable error of a setting is 0.2μ.

The automatic engine will measure in one working day as many stars as a good observer can measure visually in a week (the observer can measure for only a few hours a day). The weight of an automatic measurement is about four times that of a visual one. Moreover, the precision of the photoelectric setting itself is still higher, the overall accuracy in the present case being limited by the engine rather than the setting.

In the entire process of producing a new star catalog, the only attention given to the individual star is the glance at the image on the screen and the moving of it to the edge of the scanner field. The automatic process includes moving the plate to the precomputed position, measuring, recording, mathematical reductions, statistical analysis and publication. The astronomer plans the program, takes the plates, examines questions that arise from the statistical analysis and discusses interesting results exhibited on the machine records.

The hand adjustment is made because the aperture of the scanner needed for high precision is smaller than the error in the approximate coordinates. An auxiliary device could be used for this adjustment if desired.

The automatic cycle of measurement and control described here is applicable in any circumstances where various control functions are based on the results of measurement and calculations.

Color Demodulators for

By E. G. CLARK and C. H. PHILLIPS

Philco Corporation
Philadelphia, Pennsylvania

DEVELOPMENT is underway on several types of color-carrier demodulation circuits based upon tubes other than the widely used 6AS6. Diode, pentode and beam-deflection systems have recently been described.[1,2,8] This article covers demodulation circuits based upon heptodes, including a special split-anode version, and dual triodes.

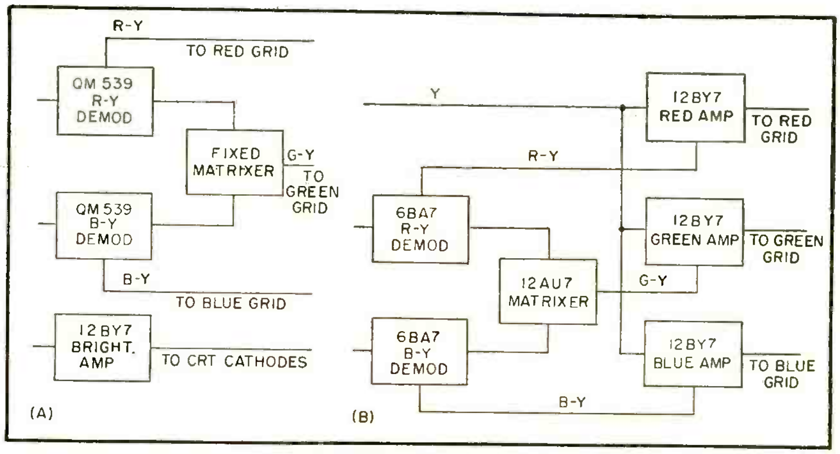


FIG. 1—Block diagram shows essential parts of high-level color demodulator (A) and low-level demodulator (B)

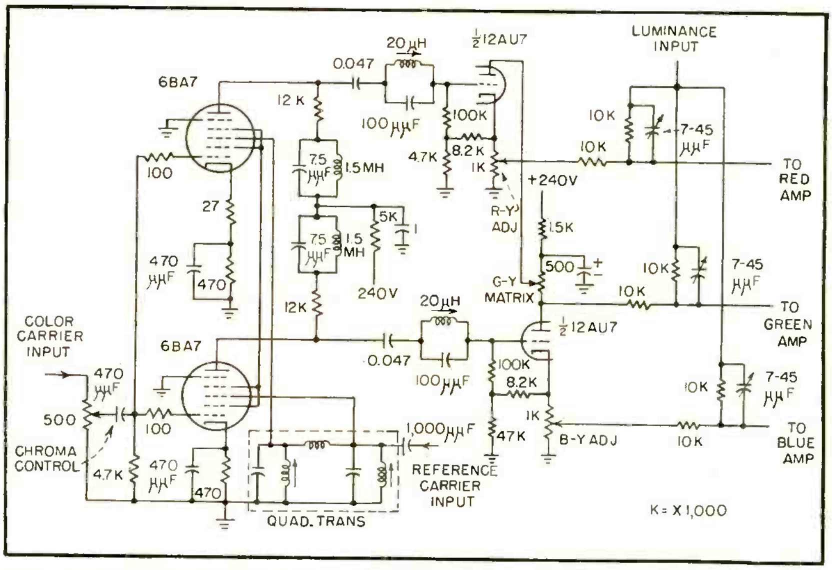


FIG. 3—Complete decoder circuit of receiver used in NTSC color tests. Type 6BA7 heptode demodulators are used

High-Level Demodulation

The 6AS6 is restricted to use as a low-level demodulator and is expensive by receiving-tube standards. Improvement in demodulation circuit design can therefore be realized either by reducing cost of the demodulator tube or by increasing its signal-handling capacity to permit high-level demodulation.

For high-level demodulation to offer any economic advantage, it should allow elimination of the following stages of amplification and permit direct drive of the cathode-ray tube. Addition of the chrominance and luminance signals in the three guns of the tricolor crt is implicit in direct drive schemes.[3,4] While the potential simplifications of such a system are apparent in Fig. 1A, practical difficulties arising from crt variations make it almost impossible to realize. The circuit shown in Fig. 1B is the basic circuit environment of the color demodulators to be described.

Heptode Demodulators

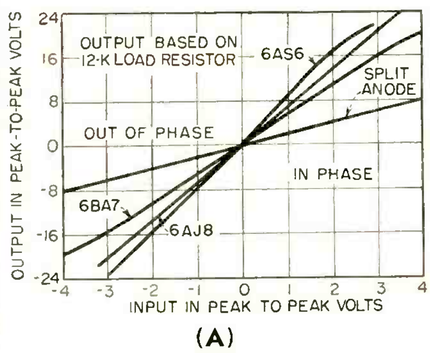
The suppressor-gated pentode is suited to color demodulator service because it has two grids for injection of color carrier and reference carrier respectively. The 6AS6, in particular, has sharp-cutoff grids, high conversion gain, small interelectrode capacitances and acceptable linearity. The 6BA7 provides characteristics similar to those of the 6AS6 but at approximately one-quarter the cost.

A comparison of the relative linearities, gains and output levels of the 6BA7 and 6AJ8 heptodes with the 6AS6 is furnished by Fig. 2A. The superior linearity and symmetry of the 6BA7 is demonstrated by the curves. The lower conversion gain of the 6BA7 is not a disadvantage since it is not of sufficient magnitude to reduce seriously the gain reserve of the single color-carrier amplifier that precedes it.

The interaction problem produced both by capacitance and conductance coupling is of the same magnitude for the 6BA7, 6AS6 and split-anode heptode. Figure 2B lists in-

Television Receivers

Heptode and cascode-connected color demodulating circuits achieve economies over circuits using suppressor-gated pentodes. Split-anode heptode provides single tube demodulation. Cascode-connected circuits use dual triodes and pentode-triode combinations



Interelectrode Capacitances in $\mu\mu F$

Tube Type	6BA7	6BE6	6AS6	split anode
G_1-K	6.7	5.5	4.0	5.5
G_3-K	9.5	7.0	3.4	4.0
G_1-G_3	0.1	0.15	0.15	0.08
P-K	8.3	13.0	3.0	6.2
G_3-P	0.19	0.25	0.70	0.15
G_1-P	0.05	0.05	0.02	0.05

(B)

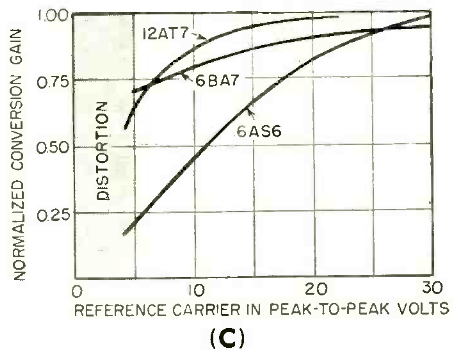


FIG. 2—Properties of some tubes used in color demodulators: conversion gain characteristics (A), interelectrode capacitances (B) and effect of reference carrier input (C)

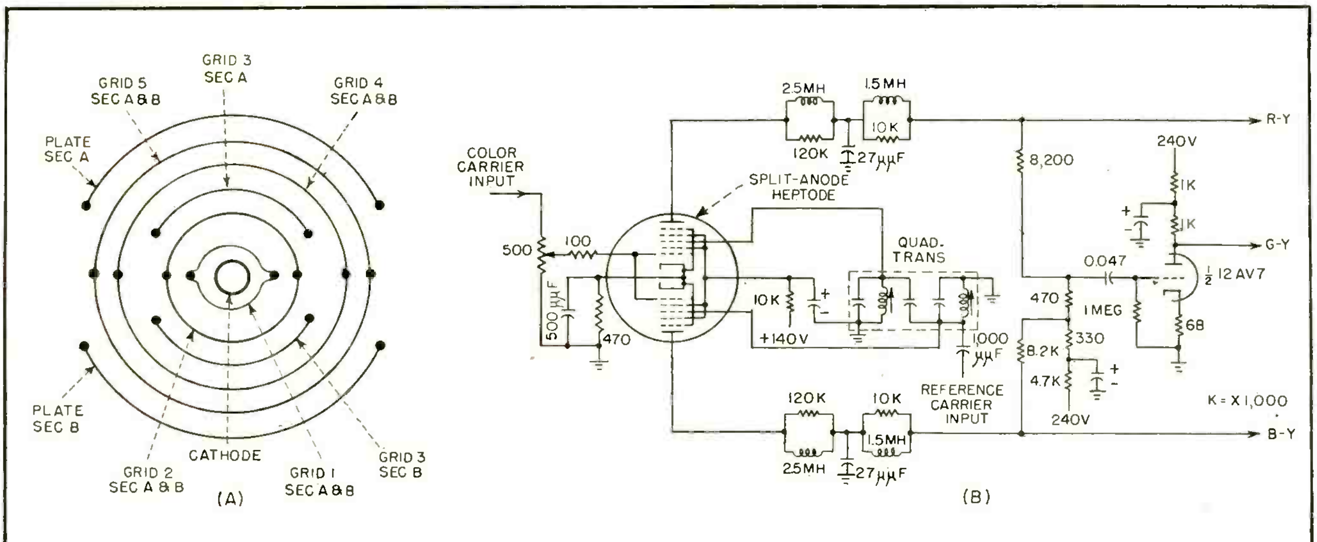


FIG. 4—Plan view of split-anode heptode (A) and demodulator circuit employing it (B)

COLOR TELEVISION RECEIVER ARTICLES

- Compatible Color TV Receiver, Jan. 1953.
- NTSC Color TV Standards for Engineers, Dec. 1953.
- Synchronization in Color TV, May 1953.
- TV Color Detectors Use Pulsed Envelope Method, March 1954.
- Beam-Deflection Tube Simplifies Color Decoders, May 1954.

terelectrode capacitances.

Heptodes were originally designed with a variable-pitch third grid for avc applications. The resulting remote cutoff presents a slight disadvantage for demodulator applications since it requires a higher amplitude of reference carrier to reach gain saturation. The effect on gain of varying reference-carrier amplitude is illustrated

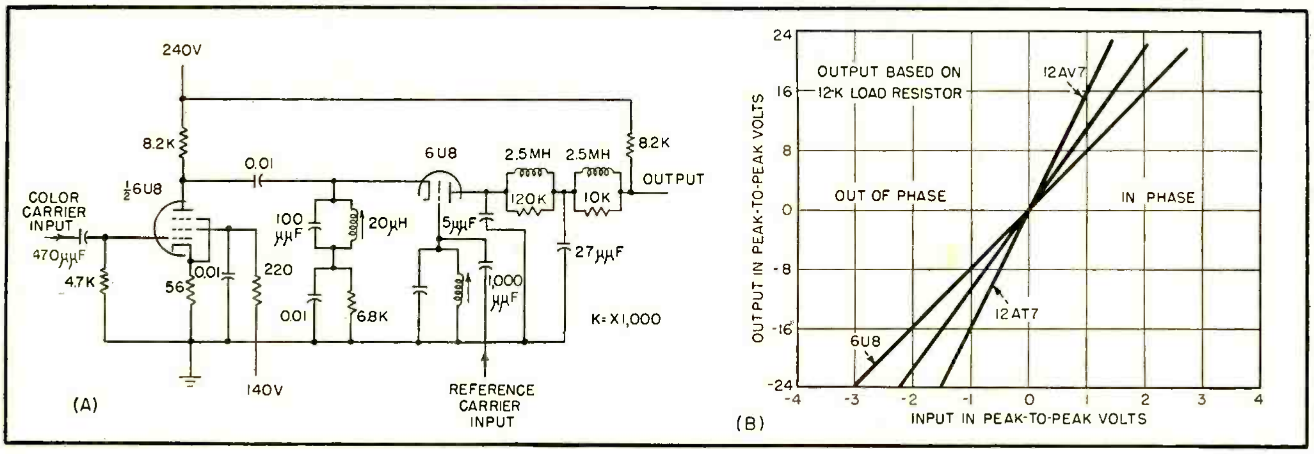


FIG. 5—Cascode-connected demodulator (A) and conversion gain characteristics of some tubes useful in this circuit (B)

in Fig. 2C for various types of tubes. A complete color decoder circuit using type 6BA7 heptode demodulators is shown in Fig. 3.

Simplification of receiver circuits results when two quadrature demodulators are combined in one envelope. Figure 4A illustrates the electrode arrangement for producing dual demodulation in a single nine-pin miniature tube. This tube has been constructed experimentally by splitting the third grid and anode of a conventional heptode and providing them with separate pin connections. Figure 4B illustrates a typical circuit employing the split-anode heptode and a triode G—Y matrixer.

Cascode Demodulators

The advantages of dual control grid demodulators over simple diode or triode demodulators include superior isolation of input signals, immunity to reference carrier amplitude variations or higher conversion gain depending on the form of the particular circuit. A circuit based on dual triode multiplication[5] can be arranged to provide the advantages of dual control grid operation. Such a circuit, shown in Fig. 5A, has been called a cascode demodulator.

As the curves of Fig. 5B show, the cascode demodulator is characterized by high conversion gain with excellent linearity.

By operating the two sections in parallel across the B supply, sufficiently high peak currents are obtainable to provide true high-level demodulation should it become practial. Series a-c operation provides the effect of current feedback with its accompanying linearity.

The price paid for the increased efficiency produced by dispensing with the screen grid is higher coupling capacitance between signal injection grids. If a low-impedance drive is not available for the color-carrier, or if neutralization is not feasible, a pentode-triode combination such as the 6U8 can be utilized to minimize coupling of reference carrier into the color-carrier.

One of the advantages of the cascode demodulator is its flexibility. A wide range of characteristics can be obtained through choice and combinations of tube types. The 12AT7 dual triode has a sharp cutoff that reduces the amplitude of reference carrier required to reach saturation.

In one special application,[6] it was desired to time gate a demodulator at the horizontal sync frequency without having the gating pulse appear in the video load of the demodulator. This would be impossible with a heptode, but with a cascode demodulator a frequency-selective intrastage coupling network provided the required rejection without affecting the demodulated output.

Measurements

Demodulator characteristics are usually plotted from data collected by point-by-point measurements. Test equipment required includes a phase splitter and switching arrangement for obtaining the in-phase and out-of-phase signals. The technique used here provides a visual display of output symmetry at any given input, expedites gain measurements and removes the need for a phase splitter.

If the color-carrier grid is supplied with a short duty cycle burst of the test frequency, preferably 3.6 mc, and the reference-carrier grid is supplied with a c-w signal of the same frequency, then the burst envelope can be recovered across a suitable output load resistor.

The amplitude is a function of the relative phase of the two input signals, reaching opposite polarity peaks at zero and 180 degrees.

It is necessary only to produce a difference in frequency between the two inputs so that the switching takes place as the signals precess at this frequency. The positive and negative peaks can conveniently be measured with an oscilloscope synchronized at the burst repetition frequency, which should be substantially higher than the difference frequency. Symmetry of output appears directly as positive and negative peaks relative to the base line. Gain is measured in the conventional manner.

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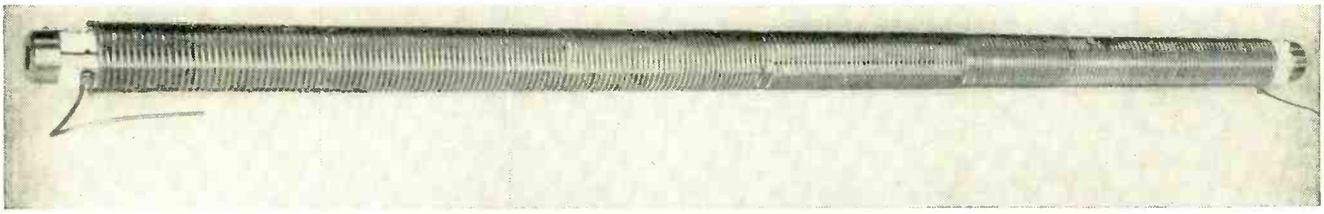
(5) Chance, et al., "Waveforms," p 670, MIT Rad Lab Series, McGraw-Hill Book Co., Inc., New York, 1949.

(6) E. G. Clark, A Self-Balancing Phase Detector for Color Reference Oscillator APC System, paper at IRE Conv, New York, March 1954.



Detail view of delay-line dummy load with outer tube removed showing stainless-steel wire wound on ceramic coil form

Delay-Line Dummy Load Has High Power Rating

Stainless-steel helix wound on coaxial ceramic form functions as dummy load for rhombics or for testing and tuning transmitters. Experimental model rated at 40 kw provides 600-ohm balanced input with swr less than 1.1 over range from 3 to 30 mc

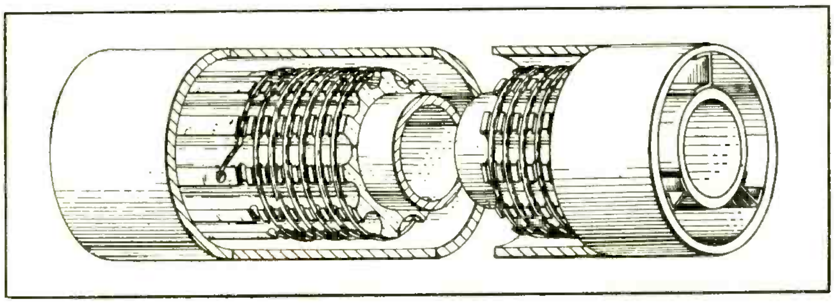


FIG. 1 —Construction of delay-line dummy load showing stainless-steel helix

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DUMMY LOADS or artificial antennas of high-power capability are needed, for example, as accessories to rhombic antennas. Rhombic antennas must be terminated at the front end in a balanced nonreactive and frequency-independent load of proper resistance to give optimum performance. In transmitting rhombics, the dissipation is often quite high, as in long-range communication at frequencies from about 3 to 30 mc where transmitter power up to several hundred kw is employed. Presently, open-wire dissipation lines of stainless steel are used as such a load. These dissipation lines have limitations.

A dummy load of high power rating is also needed in transmitter testing, particularly transmitters for long-range communication. Requirements are very similar to those for rhombic terminations. The delay line, Fig. 1, is superior as a load of high power rating as compared to other types of loads.

An inner metal tubing supports a coaxial ceramic form of cylindrical shape having on its outside a thread of uniform pitch. Wire made of a material of high resistivity is wound on this form. An outer metal tubing shields the entire helix. This tubing is in electrical contact with the inner tube through brackets at both ends. A stream of air through the gap between the wire and the outer tubing and through the inner tubing serves for cooling. The wire ends are brought out to the side through openings in the outer tubing covered with an insulator.

This configuration differs from others described in recent literature[1] in that it employs an inner metal tubing in addition to an outer tubing.[2] This inner tubing has greater rigidity and better control over electrical properties.

Basically, this device is a uniform transmission line, inductance, capacitance and resistance being uni-

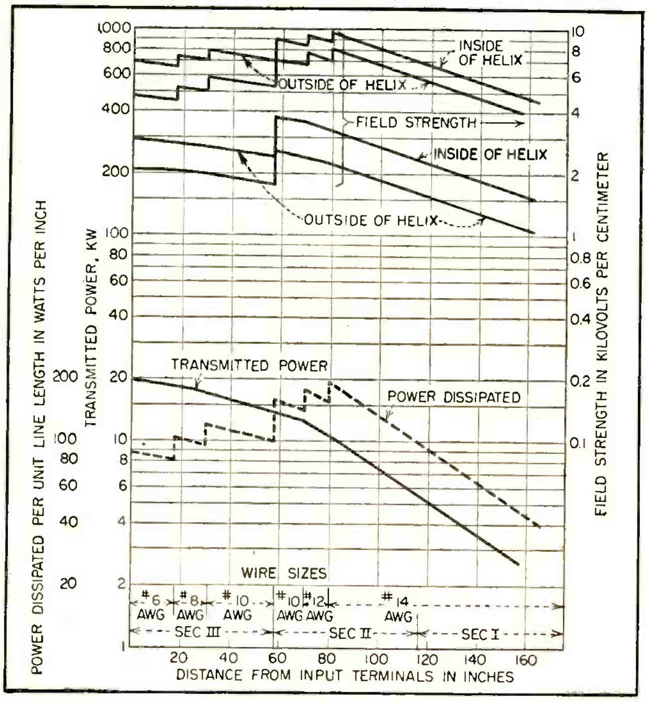

FIG. 2—Operational values at 3 mc with upper two curves computed for single turn and lower two substituting helix

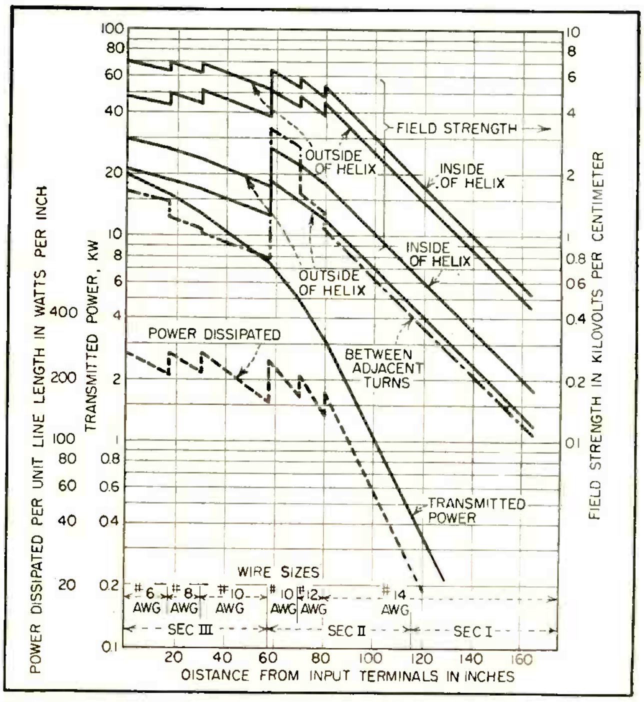

FIG. 3—Operational values of experimental dummy load taken at a frequency of 27 mc show practical frequency limit

formly distributed rather than lumped, and its electrical length is not small compared to the wavelength. More specifically, the device is a delay line because the propagation velocity is greatly reduced compared to that of free space due to the relatively large inductance and capacitance per unit length.

The impedance between one end of the wire and the tubing is nonreactive and frequency independent if the other end is terminated in a matching resistor. Most important, the input impedance is practically independent of wire resistance. If the termination does not match the characteristic impedance, or is a short or open circuit, the input impedance circles in the complex impedance plane with increasing frequency around an average impedance equal to the characteristic impedance of the line. The deviations from the average decrease with the increase in attenuation of the line. If the attenuation is greater than 13.3 db, the swr near the input is smaller than 1.1 and the deviations of the input impedance from the average are smaller than ±10 percent, regardless of the termination. It is, therefore, a matter of providing enough attenuation to keep the fluctuations of the input impedance below any specified value.

Wire Size

High breakdown-voltage and large cooling surface are essential in achieving high power-handling capability. This indicates the use of wire sizes greater than a certain minimum diameter, depending upon the power to be handled. On the other hand, the r-f resistance per unit length should be relatively high in order to keep the line as short as possible.

The material which has the highest r-f resistance for a given wire size, consistent with high oxidation-resistance, is stainless steel. Stainless steel not only has fairly high resistivity, about 33 times that of copper, but also has relatively high permeability. Recently tests of No. 410 stainless steel yielded an initial relative permeability of about 50. In the frequency region where skin effect is predominant the resistance is proportional to the geometric mean of resistivity and permeability. Accordingly, stainless steel wire has a resistance 39 times that of copper wire.

The high oxidation-resistance of stainless steel permits continuous operation at temperatures of 1,000 deg F. and more, making cooling by air sufficient. The relatively high temperature coefficient of the resistivity is not detrimental in this particular application because the wire resistance does not affect the input impedance of a terminated line. The same is true for the change of permeability with field strength, which is not small. Stainless steel, although a poor material for ordinary resistors, is an excellent material for use in this delay line.

Assuming the delay line is terminated at one end in a matching resistor and r-f power is fed into the other end, the transmitted power then decreases exponentially with line length. The power dissipated per unit length also decreases exponentially with the distance from the input, if all the dimensions of the line remain constant. This means that the dissipation capabilities of the line are not fully utilized over its entire length.

Fortunately, the ends of two stainless steel wires of different sizes can be butt-welded easily, and the characteristic impedance is affected little by a change in wire diameter if all the other dimensions including the pitch are kept the same. Better utilization of the dissipation capability can be made by tapering the wire from large to small sizes towards the output.

The helix winding starts with No. 6 AWG wire. After about 20 inches of axial length the wire size is changed to No. 8 which is maintained for about 15 inches.

Wire size is again reduced to No. 10 and maintained for the rest of the length of this unit. Total length is 5 feet. The characteristic impedance of this model is 300 ohms, and propagation velocity is 2.7 percent of the velocity in free space.

Considering the operating temperature of the wire, it is important to keep the dissipation per unit length below the value corresponding to the permissible temperature. The unit dissipation and transmitted power of the experimental model are presented in Fig. 2. At each joint of different wire sizes the unit dissipation rises an increasing amount and falls off in between. Overall, it maintains a fairly constant level, except near the output end, where the wire size is kept constant.

Wire sizes smaller than No. 14 were considered undesirable from the mechanical point of view. It was for this reason that the pitch of the helix was increased from 4 turns per inch to 8 turns per inch in going from section III to section II. This permitted the use of larger wire in section II although higher attenuation per unit length is required than in section III. The diameters of the helix and the tubing had to be changed simultaneously to obtain the same characteristic impedance as in III.

Section I is identical with II, except for the wire size. Propagation velocity of section I and II is only 1.4 percent of the velocity in free space.

One difficulty in the design of this dummy load arises from the fact that wire resistance is proportional to the square root of the frequency. The effect of a change in frequency is shown in Fig. 3. The change of attenuation with frequency puts practical limits to the frequency range that can be covered with one particular delay line. It is possible to reduce this effect by coating the wire with a metal of lower resistivity.

The design of any dummy load for high power would not be complete without considering the field strength in the dielectric in view of possible voltage breakdown. In this unit the field strength does not come near the breakdown field strength of air, although it is relatively high at certain points.

Figure 4 shows a graph of the measured input impedance as a function of frequency. The values indicated by a dotted line were measured first, indicating the existence of a lumped capacitance at both ends. Such a lumped capacitance can be explained by a decrease in unit inductance and an increase in unit capacitance near the ends of the helix. It was possible to compensate for this end effect by cutting slots in the inner tubing near the terminals and connecting small solenoid coils in series with the line at both ends.

Values measured after these changes were made are shown by solid line. The variation of the input resistance with frequency is within ±10 percent and input reactance is smaller than ±10 percent of the average resistance. Resistance seems to decrease with increasing frequency. This effect is due to points of phase reversal of the current along the line approaching each other with increasing frequency, resulting in a decrease of the average unit inductance[3].

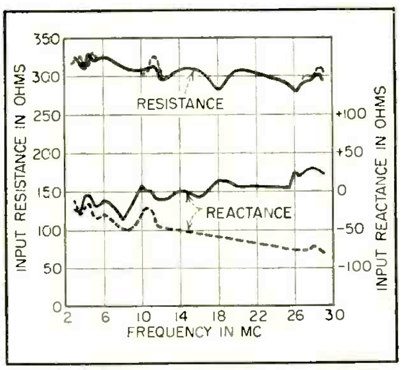

FIG. 4—Curves plotted with and without equalizing coils, terminated into a 307-ohm resistor

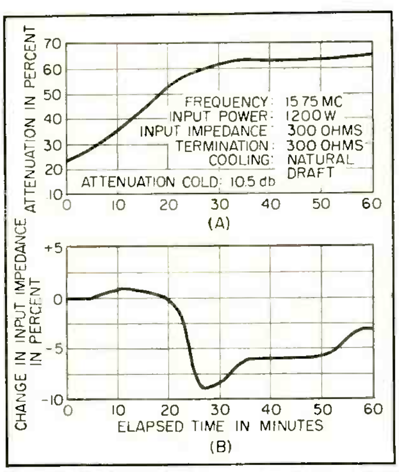

FIG. 5—Effect of input power on input impedance and attenuation

The graph in Fig. 5 *A* shows attenuation plotted against elapsed time after a certain constant power is applied. The attenuation is normalized on the attenuation in the cold state, that is, measured with very low power and at room temperature.

The curve starts with an attenuation 23 percent higher than in the cold state. This can be interpreted as caused by an increase in permeability of the stainless steel wire with current and, as a result, an increase in resistance of the wire with current. The increase of attenuation with time is due to the increase of resistance with temperature. Both effects have the desirable result of limiting the power dissipated in the terminating resistor, or permitting the omission of this resistor.

The graph of Fig. 5 *B* shows the effect of temperature on the input impedance referred to cold state. At the end of the test it had reached 1,000 deg F. Measurements with the complete dummy load showed changes smaller than 5 percent. The reason for this is that most of the dielectric in the line, particularly in section III, is air, the dielectric constant of which changes very little with temperature.

This dummy load combines the merit of a dissipation line, in that its input impedance is not affected by changes in input power or temperature, with the compactness of a lumped resistor.

Thanks are due R. E. Lacy and H. F. Meyer of the Signal Corps Engineering Laboratories, for their valuable assistance as well as T. Torretti, D. Lieberman and other personnel of these laboratories.

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Improved Demodulator

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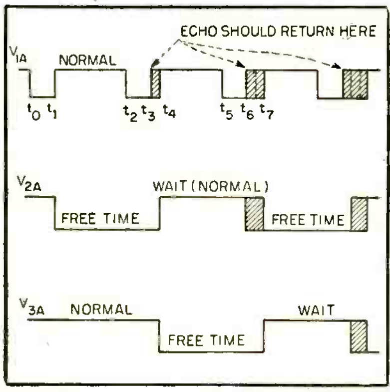

FIG. 1—Waveforms on plates of tubes V_{1A}, V_{2A}, and V_{3A}

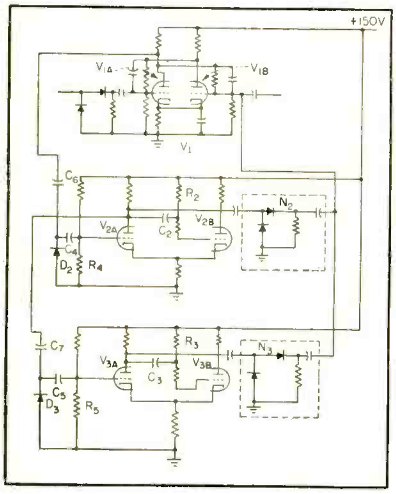

FIG. 2—Simplified schematic of demodulator using Eccles-Jordan trigger circuit

A SIMPLE DEMODULATOR such as a rectangular wave generator and R-C integrator combination which provides a d-c voltage proportional to range can produce either large instantaneous or average errors in range determination if loss of echo occurs. Among other things loss of echo can be caused by temperature stratification, inhomogeneous transmission medium, foreign bodies in the transmission path, secondary absorbers and reflectors.

Demodulator

To realize the simplicity and advantages of a square-wave integration type demodulator, and also minimize errors due to loss of echo, the delta demodulator has been developed.

Delta demodulation indicates that each time an echo is absent a given known increment of range will be added to the range indication of the previous repetition frame.

If a true echo is received the demodulator action is nonexistent. However, if an echo is subsequently lost the demodulator will sense this loss and cause the square-wave pulse generator, consisting of an Eccles-Jordan trigger circuit, to generate a square wave of width equal to the width of the preceding square wave plus the incremental increase, delta. The time interval, delta, should be as small as possible to introduce the minimum amount of error in any frame. The lower limit on delta is set by the rate at which the target position is varying. Delta cannot be made less than the maximum change in echo transit time corresponding to the maximum change in range of the target during one repetition frame.

Assume that the transmission velocity in the medium is v ft/sec and the maximum rate of change of target range during the interval t sec is r ft/sec, where t is the repetition interval. The minimum value for delta is then tr/v sec.

Percentage-wise this error will be a maximum at the shortest range of interest, but this is not as serious as it might initially appear. For example, assume that every fifth echo is absent. Range is essentially constant and at its minimum value over the interval of interest, and delta is made equal to 10 percent of the pulse width corresponding to minimum range. If the square wave is integrated to produce an average range value the average error due to the loss of echo sequence is only 2 percent. Without the demodulator and under the same conditions the error would be 20 percent.

In practice it is possible to establish the value of delta at approximately ±2 percent thereby obtaining a still greater improvement in accuracy. Secondly, and most important, the probability of echo loss at short ranges is negligible. Only when the target is located at a great range do such factors as scattering, absorption and secondary reflections introduce a sizeable amount of echo loss.

Demodulator Operation

Figure 1 shows the waveforms present during a cycle of the demodulator circuit shown in Fig. 2. At time t_o the same trigger that initiates the transmitted pulse, is fed to the grid of V_{1A}. This positive pulse causes the V_{1A} to conduct and a negative step appears at its plate. This step is passed through C_6 and shorted to ground by D_2 having no effect on V_2. At time t_1 the detected positive echo is fed into V_{1B}, the tube changes state producing a positive step. This step passes through C_6, is differentiated by C_4 and R_4 and applied to the grid of V_{2A}. This action changes the state of V_2 where it remains for a free period determined by the discharge characteristics of C_2 and R_2.

At t_4, the end of this free period, the tube returns to its normal state with a positive step at the plate of V_{2A}. Meanwhile, at t_2, another pulse has gone out, and V_1 has changed state with a negative step.

for Radar Ranging

Range errors due to echo loss caused by scattering, absorption and secondary reflections are reduced by pulse demodulator incorporating square-wave generator to fill in lost pulses. Error in correction can be held to less than two percent

This step is again prevented by D_2 from reaching V_2. The echo from this second pulse, at t_3, would change the state of V_1 back.

If the echo were lost, at t_4, V_2 returns to its normal waiting state with a positive step on the plate of V_{2A}. This step is differentiated through network N_2, and applied to the grid of V_{1B}, returning V_1 to its normal state, indicating a depth delta greater than the depth shown by the previous frame.

At t_4 the positive step from V_2 is also applied through C_7 to the differentiating network C_5 R_5 and thence to the grid of V_{3A} changing the state of V_3. This tube remains changed for a free period determined by the discharge characteristics of C_3 R_3. This period is set equal to the free period of V_2. At t_7, the end of this free period, V_3 returns to its normal state producing a positive step. This step is differentiated through N_3 and applied to V_{1B}. If an echo has been received, the grid of V_{1B} will already have been driven positive and the positive pulse at t_7 will have no effect. If, however, no echo has been received V_1 will be returned to its normal state again indicating a depth delta greater than the depth shown by the previous frame.

This action of V_2 and V_3 alternately supplying simulated echoes will continue as long as no true echoes are received. The purpose of the two networks N_2 and N_3 is to prevent the positive step at t_1, t_3/t_4, t_6/t_7, from driving V_2 or V_3 positive at the same time this step on the grids of V_2 or V_3 is trying to drive the plates negative. These networks also prevent negative steps from V_2 or V_3 from driving the grid of V_{1B} negative again at t_4, t_7, in the event a true echo has already driven the grid positive. If true echoes are not received the error delta is cumulative. The indicated range is the last true range plus $n \times$ delta, where n is the number of echoes lost.

Simplifying Assumptions

Because it is impossible to predict all the loss of echo sequences and target position variations that can occur, it is difficult to analyze the demodulator behavior under all situations. However, if certain simplifying assumptions are made it is possible to derive relationships useful in determining the best circuit operating criteria.

If repetition rate is fast or target position changes slowly, the range can be considered essentially constant and the following generalized statements are possible:

With constant range no matter how many consecutive echoes are lost, up to the limit defined under Eq. 1 following, upon the receipt of either one or two successive echo pulses the system will reestablish its in-step operation. Only one echo need be received to pull in step if an odd number of successive echoes have been lost, whereas two successive echoes are required to pull the system in step if an even number of consecutive echoes have been lost.

If the range is constant then no matter how many consecutive echoes are lost, up to the limit defined under Eq. 1, the system will always reestablish its in-step operation if a like number of successive echoes are received.

If loss of echo sequence is not successive the following relationships hold:

If an even number of echoes are initially lost and only one echo received, followed by another sequence of echo loss, sum the total number of echoes lost and subtract the number of echoes received. If this number x is odd then the subsequent receipt of one echo will establish the in-step operation. If the number x is even then the subsequent receipt of two consecutive echoes will establish the in-step operation.

If an odd number of echoes are lost in any sequence followed by the receipt of one echo in-step operation is reestablished.

If range is constant, the maximum number of successive echoes which may be lost before malfunction occurs is stated by the following limit

$$(T - t)\left[1 - \frac{\Delta\,(M + 2)}{(T - t)}\right] > 0 \qquad (1)$$

Where:

T = repetition period
t = pulse width corresponding to the fixed range
Δ = incremental time due to demodulator
N = number of successive echoes lost
$M = f(N)$, tabulated below

$M = 0$	$N = 0, 1$
$M = 2$	$N = 2, 3$
$M = 4$	$N = 4, 5$

If Δ bears a relative prime relationship to the quantity $(T - t)$, the system will automatically reestablish it's in-step operation even if the limit defined by Eq. 1 is exceeded. This reestablishment will take place after a time corresponding to the total time during which the loss of echo occurred.

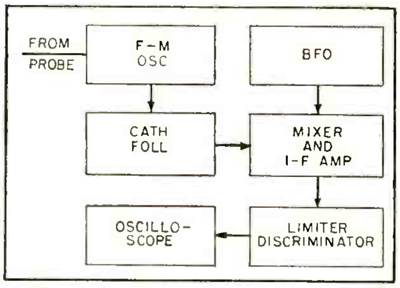

FIG. 1—Frequency deviations of f-m oscillator are controlled by metal-rod probe that is capacitively coupled to face of transducer under examination

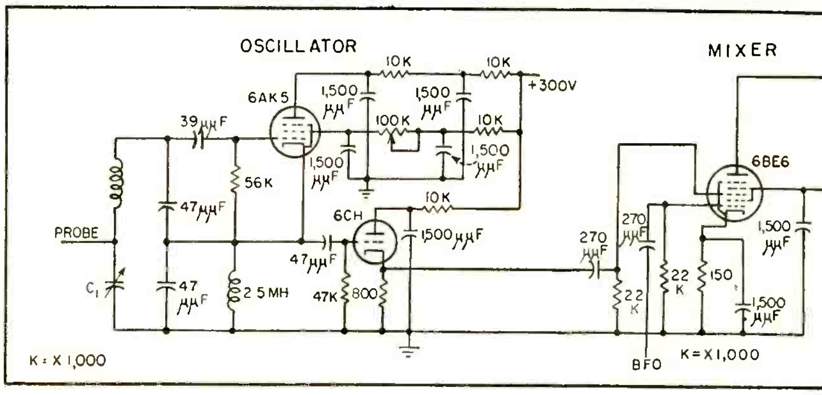

FIG. 3—Circuit of f-m microdisplacement meter uses two-stage stagger-tuned i-f amplifier.

Noncontacting Gage

Frequency-modulation system for point-by-point study of vibrating transducer surfaces. Used in air or liquid medium, the capacitance-coupled probe is capable of responding to displacements of one microinch at vibration rates up to 500 kc

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PHYSICAL characteristics of a vibrating transducer can be measured by incorporating the transducer face into an oscillator design so that dynamic displacements of the transducer are translated into a corresponding frequency deviation. The frequency-modulation system described in this article translates these deviations into an amplitude-varying signal that is more easily examined.

The equipment is capable of responding to one-microinch displacement using a 1/16-inch diameter probe. The discriminator is capable of detecting a 100-cycle deviation from center frequency at a modulation rate as high as 500 kc, and provides an output signal capable of being measured with an oscilloscope. This last requirement facilitates relative phase measurements of transducer vibrations.

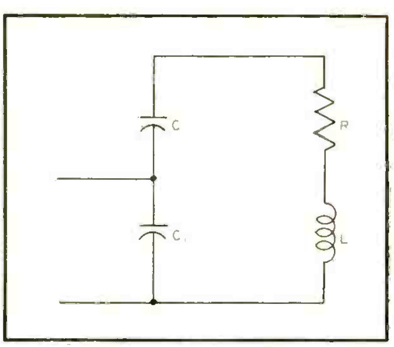


FIG. 2—Equivalent circuit of crystal-controlled oscillator tank circuit

A block diagram of the system is shown in Fig. 1. The probe, a metal rod capacitively coupled to the transducer under examination, is in parallel with the oscillator tank tuning capacitance. The f-m oscillator consists of a stable variable-frequency Clapp-type oscillator whose output is coupled to a mixer stage where the frequency spectrum is translated to an intermediate frequency for amplification and detection. The difference frequency from the mixer is then coupled through an i-f amplifier to the limiter-discriminator stage.

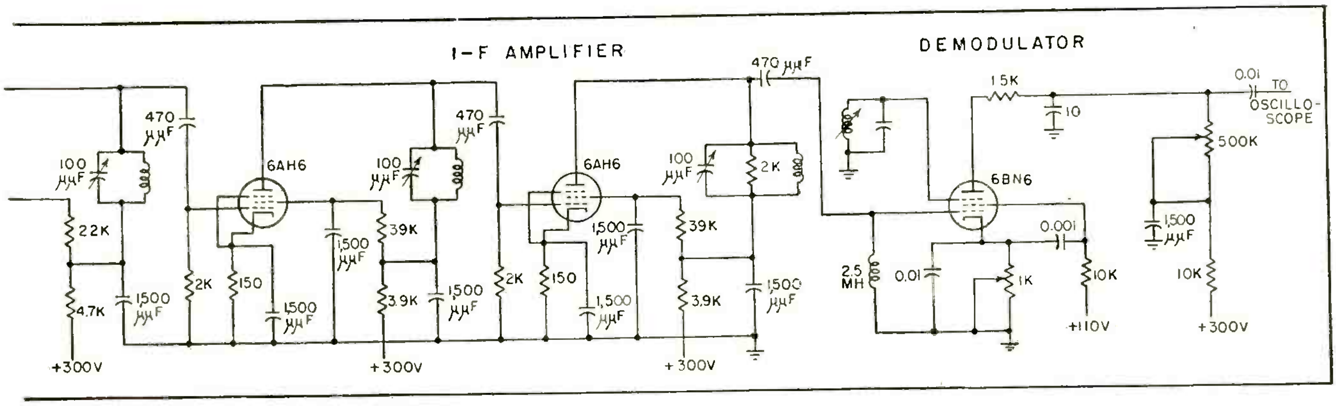
Operation of the probe and transducer in a viscous fluid will increase sensitivity of the equipment since the dielectric constant, K, of most fluids is greater than that of air. For a given transducer deflection, the absolute frequency deviation of the displacement meter will be K times that in air.

The absolute displacement can be found from the relation $f = 1/2\pi (LC_T)^{\frac{1}{2}}$ where C_T is tuning capacitance plus probe capacitance. The capacitance of the probe is $K\varepsilon_o A/D$, where A is area of plate and D the distance between plates. Differentiating f and C_{probe} implicitly the relation $dD = 2D^2 C_T \, df/f_o \, KA \, \varepsilon_o$ is obtained.

Since df, D, C_T, and f_o can be measured within a few percent, substitution in these relations will give absolute displacement reading.

Probe

Sensitivity of this equipment can also be enhanced by increasing the effective area of the probe. However, the probe's ability to respond to transducer vibrations in any one



Output is a-m signal for oscilloscope presentation of small area vibrations of transducer surface

for Microdisplacements

segment will be reduced. Some compromise between sensitivity and area response must be made. A maximum probe diameter of 1/16 inch was finally decided on. A smaller diameter probe could be used if the vibration amplitude of the transducer were sufficient to produce reliable detection in the discriminator.

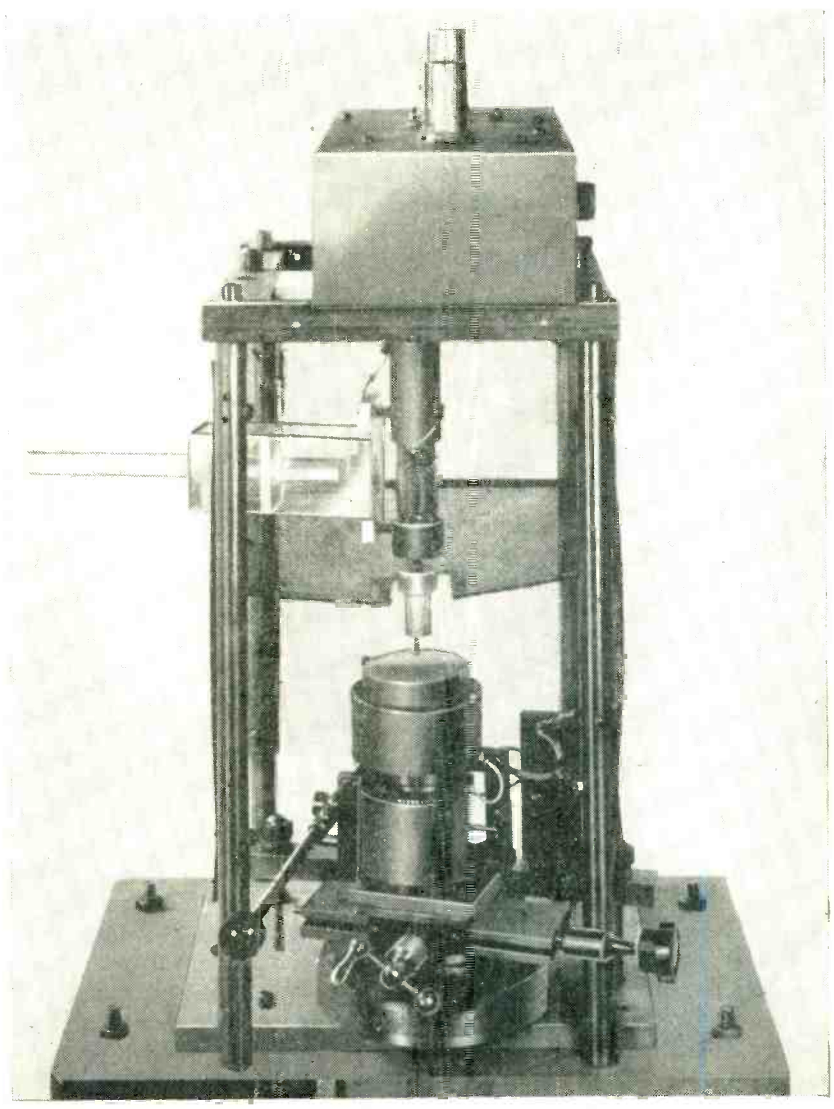
A $\frac{1}{16}$-inch probe has an effective area of 0.003 sq in. With a spacing of 0.003 inch between probe and transducer face, the effective probe capacitance in air is 0.229 $\mu\mu$f. This is approximately 3 percent of the total tank tuning capacitance.

For a peak deviation of one microinch over the entire surface under investigation the change in tuning capacitance is $dC = 0.765 \times 10^{-4} \mu\mu$f. Assuming a center frequency of 25 mc and substituting in the relation $df = f\ dC/2C$, where C is assumed to be 8 $\mu\mu$f, then $df =$ 119 cycles.

The center frequency of the oscillator should be high with respect to the highest modulation frequency to realize a high-Q oscillator tank circuit. A ratio of 50-to-1 between the center frequency of the oscillator and the maximum modulation frequency has been found to be sufficient.

Oscillator Circuit

As the electrical stability of the oscillator is largely dependent on



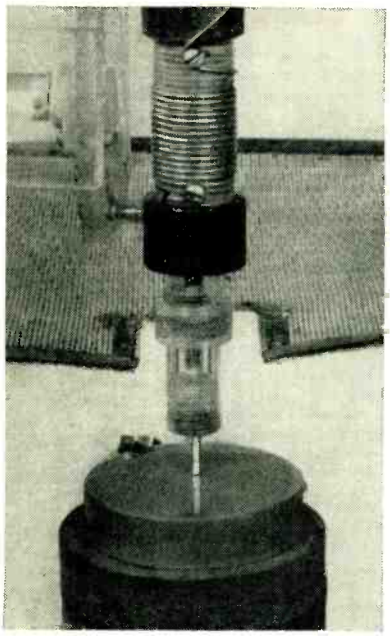
Probe and f-m oscillator are mounted above transducer under examination. Transducer mounting permits accurate placement of transducer under probe the effective Q of the tank circuits, the L-C ratio should be as low as possible. To secure a maximum frequency deviation, however, C should be as small as possible. A maximum tank tuning capacitance of 4 to 8 μμf was used as a compromise between a very sensitive discriminator and an excessively unstable oscillator.

Consider the simplified equivalent electrical network of a vibrating quartz-crystal oscillator tank circuit shown in Fig. 2. The important feature of this circuit is that the ratio of C/C_1 is always minute so that the coupling between the crystal resonator and the external circuit is quite small.

The Clapp oscillator[1] circuit provides the isolation necessary for high stability. The probe used for measuring surface displacements is in parallel with the oscillator tuning circuit. The upper side of the transducer under examination is grounded to form the other capacitor plate.

Stray capacitance is negligible in comparison to the relatively intense field existing between the probe and transducer. No efforts were made to shield the probe either mechanically or electrically.

In the complete circuit, shown in Fig. 3, the output of the f-m oscillator is heterodyned to 10.7 mc by a mixer stage and beat-frequency oscillator. The difference output is coupled to a two-stage stagger-tuned i-f amplifier. Since frequency deviations are quite small, the f-m signal can be treated as an equivalent a-m signal. Thus, the maximum bandwidth of the i-f amplifier should be at least one mc. The stagger-tuned arrangement of broadband amplifiers provides the required bandwidth with a gain sufficient to provide 3-volts output for a one-volt oscillator signal coupled with a 0.1-volt beat-frequency oscillator signal.



Probe and oscillator coil assembly. Strap on surface of transducer grounds upper face

Discriminator

A 6BN6 gated-beam tube is used as a discriminator capable of detecting high modulation rates. There are neither R-C time-constant networks to distort the input or output wave nor tuned circuits, barring the quadrature grid circuits, to adjust.

Due to the step-function control action of the limiter and quadrature grids, each grid can independently control the total plate current. The quadrature grid is so arranged that a resonant parallel tank circuit connected to this grid will develop an alternating voltage that lags the limiter-grid voltage by 90 deg. The Q of this quadrature tank must be reasonably high. If the frequency of the input voltage should deviate instantaneously from center frequency, the phase relationship of the limiter and quadrature grids are such that the average plate current will vary in direct relation to the phase difference.

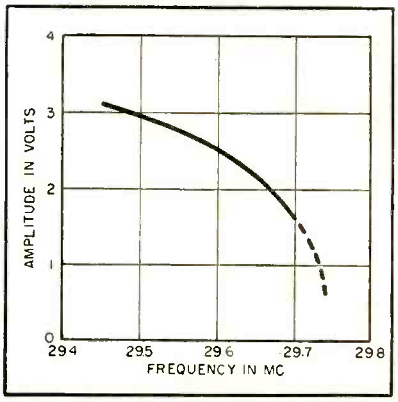


FIG. 4—Plot of amplitude against frequency for displacement meter used as a static measuring instrument

Limiter grid input is 3.0 volts; E_{acc}, 110 volts; and E_{bb}, 300 volts. Frequency-modulation deviation is 20 kc and amplitude-modulation 30 percent. Amplitude-modulation suppression factor is 28 db and output is 0.12 volt per kc. The system provides a linear output for a frequency-deviation range from 1 to 20 kc. Modulation rates of 300 kc have been reproduced faithfully and there are indications that the equipment will respond at 500 kc.

Test Results

With a power amplifier used as the transducer driving source, signals were observed at the resonant frequencies of 30, 57, 167 and in a region of 200 to 300 kc. At 167 kc, the magnitude of displacement L was calculated to be about 4 microinches. Signal level was about 20 db above noise level. The transducer was a ½ in. thick, 2¼ in. diameter disk of barium titanate.

A trial measurement in distilled water provided a reproducible output signal using an earphone as the transducer. Stray modulation of the transducer probe was excessive, however. Careful shielding of components should eliminate this effect.

All readings were secured by decreasing the spacing between the probe and the transducer face until a sizeable output voltage was obtained. A signal generator was set to zero beat with the center frequency of the oscillator. To obtain a relative measurement from one section of the transducer face to another, the transducer was displaced horizontally and probe spacing rechecked by securing a zero beat in the signal generator. In this manner f_o and D were held constant within the factor of stability of the oscillator.

This instrument will also operate satisfactorily as a static measurement device. The graph in Fig. 4 was taken by varying C_1 to simulate a variation in spacing between the probe and transducer being measured. The d-c voltage was measured by a vacuum-tube voltmeter connected across the 56-K grid resistor in the oscillator circuit. The curve approaches that of a parabola, making it possible to calibrate a meter directly in displacement versus output voltage.

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Transistor Flip-Flop Uses Two Frequencies

Bistable circuit operation is provided by a transistor oscillator with two stable output frequencies. Successive input pulses cause oscillator to shift between frequencies. Scheme avoids undesirable heating effects of current cutoff circuits

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TRANSISTOR OSCILLATORS capable of stable operation at either of two frequencies represent a new type of binary computer element.

The two circuits to be described differ from the Eccles-Jordan bistable circuit in that selection between states is according to frequency difference rather than difference in d-c level. Because operation is at a more nearly constant energy level, many undesirable transient heating effects of current on-off transistor circuits are avoided.

Application of successive trigger pulses will alternately change the oscillator frequency from one stable value to the other. Pulses suitable for driving similar units may be derived by passing the oscillator output through a frequency discriminator and differentiating network. Alternatively, the oscillator may be adjusted to give highly unequal amplitudes in the two states. The amplitude difference may then be detected and converted into a suitable driving pulse for a following unit.

Description

Two transistor bistable oscillators exhibiting high performance characteristics are shown in Fig. 1. In each case the primary requirement of the oscillator is that it possess two stable operating frequencies. This may be achieved by employing as the resonant circuit any of the four coupled oscillatory circuits shown in Fig. 2.

In the oscillator of Fig. 1A, two stable frequencies, 425 and 500 kc, are possible because of the coupled action between the resonant circuit comprising L_3 and C_3 and that represented by L_2, C_1, C_2 and C_4. This configuration was derived from the circuit in Fig. 2D according to an inverse transformation associated with transistor-electron triode duality. The transistor, a GE type G11, secures its d-c current bias by R_1 and L_1. The d-c power source is of the constant-current type and generates approximately 1.8 ma at collector voltages less than 10. Triggering is by positive pulses derived from a low-impedance source and applied through the crystal diode

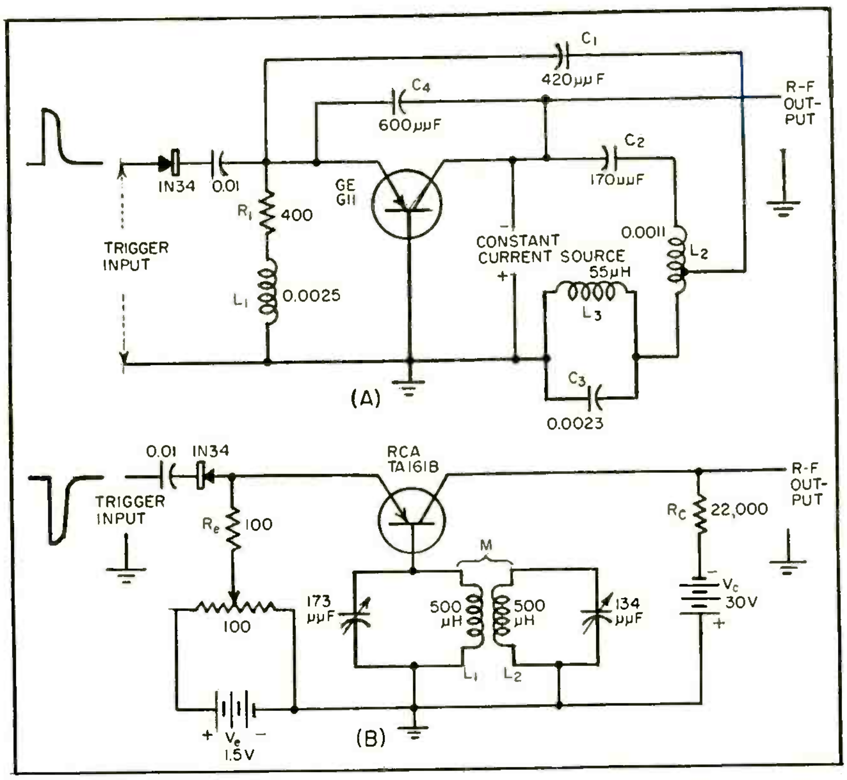

FIG. 1—Two forms of the transistor bistable oscillator. Circuit *B* utilizes negative resistance transistor

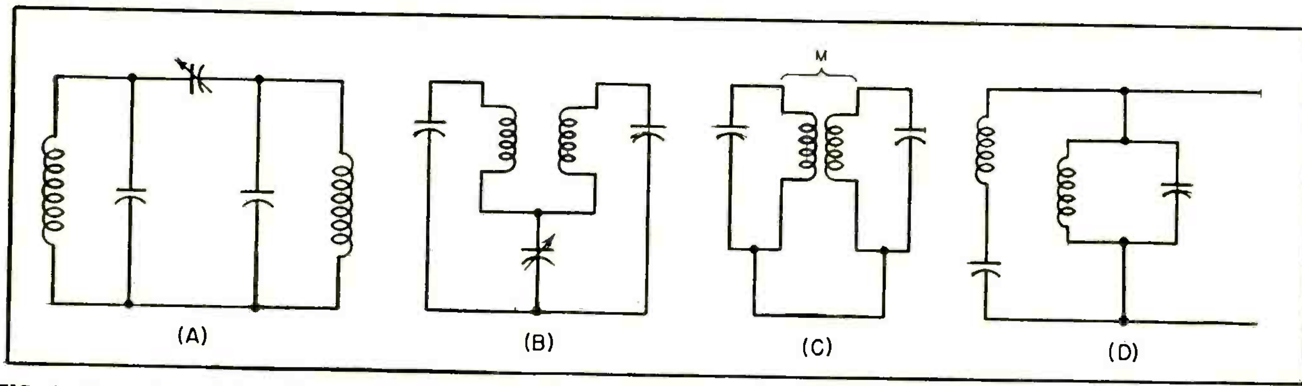

FIG. 2—Several coupled oscillatory circuits suitable for use in bistable oscillators

and capacitor to the emitter. The output may be taken from the collector. The transistor should have low internal base resistance and be capable of operating at low collector voltages.

Operation

Successful operation has been obtained with this circuit for pulse input rates from zero to 5 kc, the highest attempted. Unreliability was not encountered at slow pulse rates such as one every 20 minutes as is often the case in a conventional transistor on-off bistable circuit. This particular circuit was adjusted to given a 2-to-1 ratio between r-f voltage amplitudes for the two states. Tolerances of ± 5 percent appear to be satisfactory for all components and voltages.

The oscillator shown in Fig. 1B is simpler in form although somewhat more critical in operation than the one in Fig. 1A. Here two-frequency operation is attained through a parallel resonant circuit mutually coupled to a similar secondary, as indicated in Fig. 2C. Reliable triggering from one stable frequency to the other may be achieved by applying successive pulses of negative polarity to the emitter circuit. The output may be taken across the 22,000-ohm resistor.

Since external feedback is not employed, this circuit depends on transistors having large internal base resistances. Operation has been achieved with several RCA type TA 161B transistors and only minor circuit adjustments. The stable operating frequencies for the circuit constants chosen are approximately 500 and 550 kc. The operation is reliable for pulse input frequencies from zero to 250 pps. No attempt has been made to extend the pulse frequency range.

For either of the two circuits in Fig. 1 the oscillator is an electrically coupled circuit externally driven in a sinusoidal manner. The transistor is the driving source and is capable of driving at either of the two stable frequencies of resonance. The transistor is restricted to supplying voltage of limited amplitude and it is this feature that makes it possible to produce the desired shift in frequency with the pulsing networks.

Assume the oscillator is operating at one of the two stable frequencies. Application of the triggering pulse on the emitter temporarily overrides the finite amplitude of the transistor voltage and allows the coupled circuit to go into free oscillation. During this time both stable frequencies coexist and there is a rapid exchange of energy between the coupled circuits. If the time duration of the trigger pulse is of such length that the desired frequency predominates when the transistor regains control of the coupled circuit, the frequency change will have been accomplished as desired. Successive trigger pulses then will alternately shift the oscillator frequency from one stable value to the other.

Design Considerations

The design of a bistable oscillator entails designing an L-C circuit having two frequencies of resonance and combining this circuit with other components to form an oscillator. The circuit of Fig. 1A was designed for an electron triode then transformed to a transistor-circuit according to the duality relation between electron triodes and transistors. The circuit of Fig. 1B was designed directly for use with transistors.

Figure 3 shows the configuration of the electron-tube oscillator that is transformed according to the duality relations into the circuit of Fig. 1A. The tuned circuits, comprising L_3 and C_3 and L_1, L_2 and C_2 are each designed to resonate separately at the same frequency. That two distinct frequencies of resonance are present when the two circuits are directly coupled may be shown analytically by an investigation of the impedance of each circuit. Significantly the resulting requirements for existence of two distinct frequencies of resonance are

$$R_p^2 > \omega_0^2 L_3 (L_1 + L_2) \quad (1)$$

$$\left\{[\pi^2 (L_1+L_2)^2/R_p^2] - [(L_1+L_2(4f_0^2L_3)] + (1/f_0^2)]\right\} f^2 - (2/f_0) f + 1 = 0 \quad (2)$$

where R_p is the effective parallel resistance in ohms of the L_1 L_2 C_2 circuit; $\omega_o = 2\pi f_o$, the angular frequency of resonance in radians per second of either tuned circuit alone; and L_1, L_2 and L_3 are inductances in henrys.

Specific numerical calculations are best facilitated by trial and error. Reasonable values of L_1, L_2 and L_3 are chosen. Then, for a particular frequency f_o a minimum

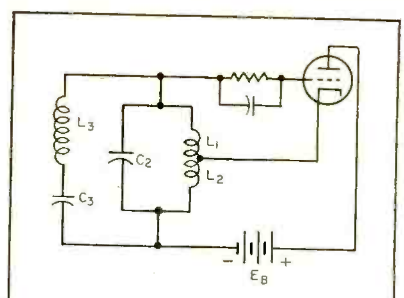

FIG. 3—Basic electron-tube bistable oscillator

value for R_p is determined from Eq. 1 and the two resonant frequencies f_1 and f_2 determined as roots of Eq. 2. Knowing f_o and the values of inductances for each circuit it is possible to determine values for C_2 and C_3 such that each circuit is independently resonant to the same frequency f_o.

Having determined the particular requirements for the tuned circuits, the design of the oscillator in Fig. 3 may be completed in the conventional manner. The resulting circuit is then transformed into the transistor bistable oscillator of Fig. 1A.

In designing the circuit of Fig. 1B the inductively coupled L-C circuits are considered first. The analysis leading to conditions under which these coupled circuits exhibit two frequencies of resonance is complex since it is necessary to solve the differential equations describing circuit operation both for no external driving source and for an external sinusoidal driving emf such as operation with a transistor. It is found from the study of forced oscillations that the coefficient of coupling τ between L_1 and L_2, where

$$\tau = M/(L_1L_2)^{1/2} \quad (3)$$

must lie between certain fixed limits if two resonant frequencies are to exist. Specifically the treatment of forced oscillations yields the requirement that

$$\tau > (R_2/\omega_0 L_2) \quad (4)$$

where R_2 is the effective resistance of the secondary circuit and $\omega_o = 2\pi f_o$ is the angular frequency of resonance in radians per second of either tuned circuit alone.

Analytical study of these circuits under conditions of free oscillation places an upper limit on the value of τ. Since the resulting equations are complex, the value of τ must be considerably less than unity if the two resonant frequencies are to be reasonably close to each other.

For actual design of the coupled circuit, a suitable operating frequency is chosen. Both the primary and secondary must then be separately resonant at the frequency ω_o. Inductance L_2 is chosen such that its Q will satisfy Eq. 4 for a value of coupling coefficient τ that is reasonably achieved and not too near unity. The remaining constants of the coupled circuits are chosen such that resonance occurs for each circuit alone at frequency ω_o. The values of the two stable frequencies may be predicted by the results of the analysis for the case of free oscillations or may be determined experimentally. Adjustment of the coupling may then be required to obtain the desired operating characteristics.

The coupled circuit when combined with a suitable transistor circuit results in the oscillator of Fig. 1B. A negative-resistance transistor can be utilized as an oscillator by introducing a parallel L-C circuit in the base lead since the base-circuit regeneration inherent in negative-resistance transistors can overcome the losses of the tuned circuit.

Exact design of such a circuit would entail a study of the negative-resistance base characteristics. Such a study would determine the magnitude of the regenerative effect and the d-c bias conditions under which it is present. However, it is generally sufficient to employ a high-Q tank circuit and adjust the bias conditions until the desired operation is achieved. Careful design will be justified when transistor characteristics become more uniform between units.

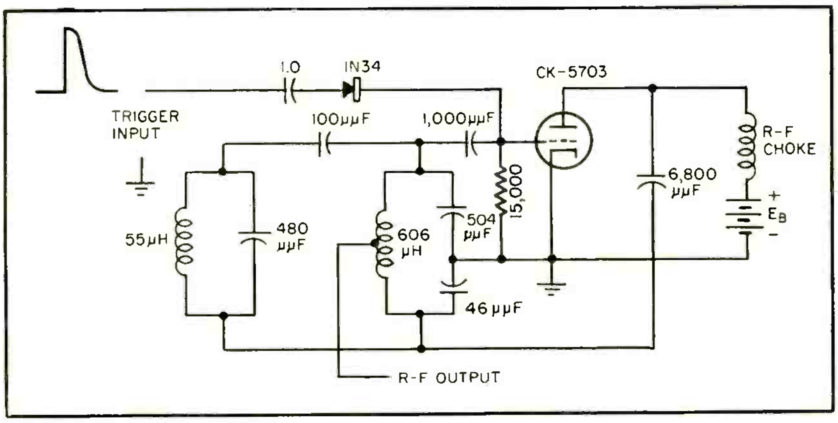

FIG. 4—Bistable oscillator using CK-5703 electron triode

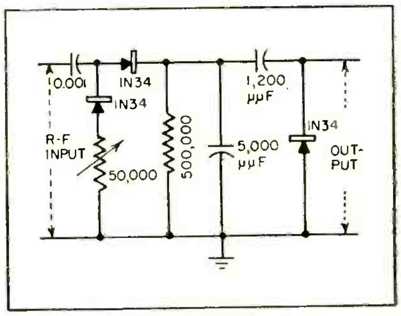

FIG. 5—Counter coupling network

Both R_e and R_c tend to reduce the regenerative action and hence the amplitude of oscillation, but they also serve as current limiting or protective components. The effect on regeneration of adding R_e is much more pronounced than for adding R_c. Resistance R_c serves as a load across which an output can be taken while R_e acts as a resistance across which the trigger pulse may be applied.

Bistable oscillators need not be restricted to the use of transistors as active elements. Electron triodes will serve just as well. The circuit of Fig. 4 represents one form of bistable oscillator using a CK-5703 triode. Two such circuits each driving a coupling network of the type shown in Fig. 5, have, when operated in tandem, performed reliably as a two-stage binary counter giving one pulse out for every four pulses impressed on the first input.

The author thanks J. E. Maynard of the physical research unit for suggesting this application of double-resonant coupled circuits and for his helpful suggestions during the investigation; also T. Ross for his assistance in the experimental work.

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Electronic Shake Table

Highly discontinuous motions having step, ramp, square or triangular wave shapes for testing accelerometers are produced by using three feedback paths from shake table to amplifier which drives moving coil. Inputs include mask-type photoelectric generator

GENERATION of precise mechanical motions is required in testing for microphonics in electron tubes, exciting vibrational modes in propellers or turbine blades, testing air-frames and in dynamic calibration of seismometers, accelerometers and pickups.

Testing these instruments with sinusoidal motions is not too difficult. In studying the response of accelerometers and seismometers, however it is desirable also to have arbitrary transient or discontinuous motions of such wave shapes as steps, ramps and repetitive square and triangular waves.

A transducer system which reproduces discontinuous motions with acceptable fidelity is shown in Fig. 1. The main electromechanical transducer executes the desired vertical motions. The accelerometers on test are clamped to its moving platform. A power amplifier energizes the force coil with varying currents in the image of the desired waveforms. This actuates the main transducer platform. A low-frequency electronic oscillator supplies cissoidal oscillations; a simple type of wave shaper provides square and triangular waves from the oscillator output.

An arbitrary wave generator of the photoelectric type utilizes a mask cut to the desired mathematical function. The mask intercepts a light beam focused on a phototube to produce electromotive forces of the desired waveform. These are used to drive the power amplifier.

Three feedback circuits are incorporated, one producing a voltage proportional to the moving platform displacement, the second to its velocity and the third to its acceleration.

A dual-beam cathode-ray oscilloscope provides a display of the platform motions and the electric output of the accelerometer or other device on test.

System Equations

The physical operation of the feedback system in the transducer is portrayed by Fig. 2. The input to the power amplifier μ_o includes not only the arbitrary transient signal voltage $e(t)$, but also voltages proportional to the platform displacement x, to its first derivative and to the second derivative of the platform motion. This arrangement can produce faithful mechanical motions x in the image of the electric signal $e(t)$. The following definitions are used in analysis of the feedback system

$e(t)$ = applied transient electric signal input

x, dx/dt, d^2x/dt^2 = transducer platform output displacement (vertical), velocity and acceleration

μ_o = power amplifier gain

β_1, β_2, β_3 = respective feedback loop amplifier net voltage gains (positive or negative)

T_o = transfer function of main force transducer converting voltage to mechanical displacement: $e_o = T_o x$

T_1 = transference of photoelectric displacement transducer converting platform displacement to voltage: $e_1 = T_1 x$

T_2 = transference of velocity feedback transducer converting platform velocity to voltage: $e_2 = T_2 (dx/dt)$

T_3 = similar device converting the platform acceleration to corresponding voltage: $e_3 = T_3 (d^2x/dt^2)$

m = total mass of suspended platform, including mass of accelerometer on test

d = residual velocity damping, due to motion of conducting metal in stray magnetic fields, air damping etc.

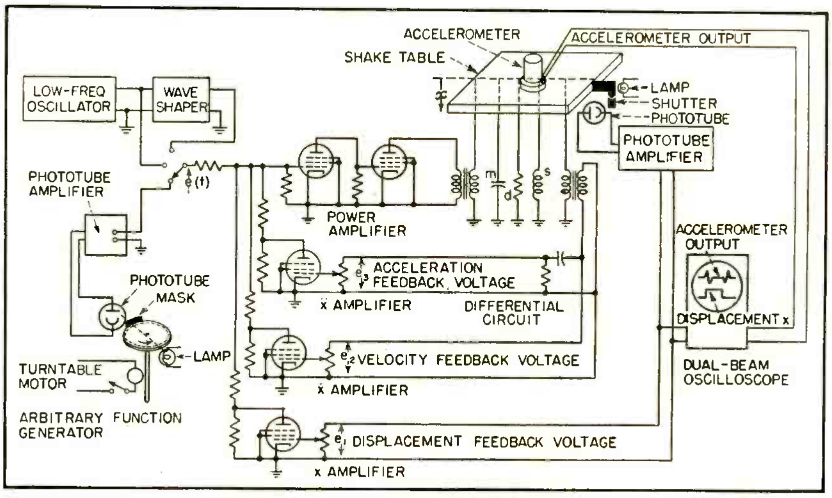

FIG. 1—Power amplifier driving shake table has choice of three input voltage sources. Three feedback paths link table to input of amplifier; two are from an extra coil mounted on the table and the third is from a photoelectric system actuated by a vane mounted on the table

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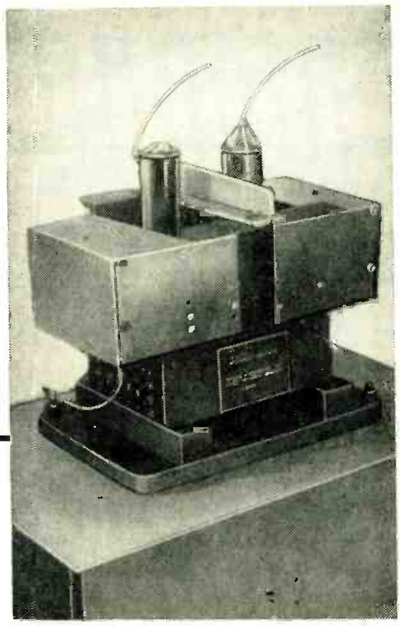

Construction of shake table, showing method of bolting to heavy concrete base as required for faithful generation of wave shapes having steep fronts

s = equivalent stiffness of springs suspending moving platform

The transfer function of the main force transducer is

$$e_o = T_o x = h\left(m\frac{d^2x}{dt^2} + d\frac{dx}{dt} + sx\right) \quad (1)$$

where h is a constant depending upon the electromagnetic parameters of the force coil. The resistance and inductance of the force coil windings are neglected here for simplicity.

Summing the voltages at the input e_{in} of the power amplifier in Fig. 2 gives

$$e_{in} = e(t) + \beta_1 e_1 + \beta_2 e_2 + \beta_3 e_3 \quad (2)$$

Multiplying Eq. 2 by μ_o gives the power amplifier output voltage e_o

$$e_o = \mu_o e_{in} = \mu_o e(t) + \mu_o\beta_1 e_1 + \mu_o\beta_2 e_2 + \mu_o\beta_3 e_3 \quad (3)$$

Use of Eq. 1 and the appropriate transferred mechanical variables for the feedback voltages yields

$$h\left(m\frac{d^2x}{dt^2} + d\frac{dx}{dt} + sx\right) = \mu_o e(t) + \mu_o\beta_1 T_1 x + \mu_o\beta_2 T_2\frac{dx}{dt} + \mu_o\beta_3 T_3\frac{d^2x}{dt^2} \quad (4)$$

Combining terms yields

$$(hm - \mu_o\beta_3 T_3)\frac{d^2x}{dt^2} + (hd - \mu_o\beta_2 T_2)\frac{dx}{dt} + (hs - \mu_o\beta_1 T_1)x = \mu_o e(t) \quad (5)$$

The coefficients of each term of the left hand side of this linear differential equation consists of the algebraic difference of two factors —a constant parameter (such as hm) fixed by an electromechanical magnitude and an adjustable factor (such as $\mu_o\beta_3 T_3$) depending upon a feedback voltage gain. Thus, by a mere change of polarity and gain settings of the feedback voltage amplifiers, the order of the differential equation can be changed at will, since specified coefficients can be made vanishingly small or very large.

Modes

By appropriate feedback loop gain settings it is possible to make the coefficients of d^2x/dt^2 and dx/dt in Eq. 5 vanish, and the sign of $\mu_o\beta_1 T_1$ positive. Thus, solving for the displacement

$$x = \frac{\mu_o}{hs + \mu_o\beta_1 T_1}e(t) \quad (6)$$

That is, the transducer platform displacement x is in the image of the applied signal $e(t)$, no matter what wave shape the function $e(t)$ may have. This is called the displacement mode of operation of the transducer system.

It is possible to adjust the feedback loop gain settings such that

$$\frac{dx}{dt} = \frac{\mu_o}{hd + \mu_o\beta_2 T_2}e(t) \quad (7)$$

In this event, the transducer platform velocity dx/dt is a replica of the applied electric signal $e(t)$, no matter what the function $e(t)$ may be. This is the velocity mode of operation of the transducer system.

Limitations

Exact accomplishment of Eq. 5 for a physical system is difficult, if not impossible. Parasitic parameters, such as the driving coil resistance and inductance, are not specifically included in the analysis but are nevertheless present; also, amplifier gains and mechanical network parameters are not constants. The analysis is only an approximation to the physics, but is a useful idealization nevertheless.

Stability of the system is always an important consideration. By improper adjustments of the gain polarities and magnitudes, it is quite easy to obtain an unstable system. For example, by making the coefficient of the velocity term dx/dt slightly negative, electromechanical oscillations immediately result. This is not usually desirable, especially if the oscillations are not quickly stopped, as they may damage the pickup on test. However, adjustment of the system to a regenerative state is sometimes useful in sinusoidal calibrations.

Finally, the linear voltage range of electronic amplifiers is limited.

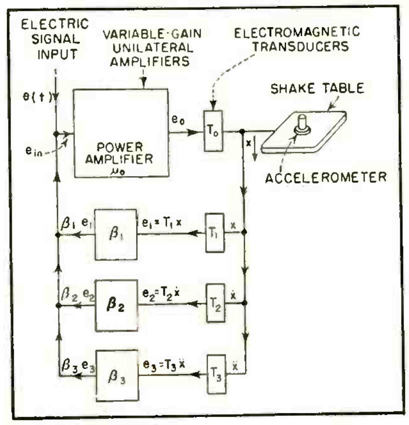

FIG. 2—Feedback representation of electromechanical transducer system

Thus, the maximum available displacement output of the transducer is also limited, although adequate for the precise testing of many electromechanical devices and for fundamental researches.

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Aircraft Receiver for VOR-

Complete navigation and communications equipment, including transmitter on same chassis, provides cro presentation of omnirange signal and c-r indicator for instrument landing system right-left signals. High sensitivity and in-flight calibration are featured

THE OMNIRANGE navigation system for aircraft operates in the frequency range between 112 and 118 mc. There are four separate modulations on the carrier. A 1,000-cycle tone, identifying the station in Morse code, modulates the carrier 10 percent. Voice modulation for weather and communication with aircraft modulates the carrier 30 percent. Third, there is a 30-cycle modulation of 30 percent. Fourth is 9.96-kilocycle modulation of 30 percent. Thus, the carrier may be modulated up to 100 percent.

The navigational features are carried in the 30-cps and 9.96-kc signals. The 30-cps modulation is such that if a receiver north of the station compares the phase of the 30 cps received with that of a similar receiver east of the station, there will be 90 degrees phase difference.

With a receiver south of the station, there will be 180 degrees phase difference and west of the station, the difference will be 270 degrees.

Thus, if there were some way of knowing the phase north of the station without being there, it would be possible to tell the direction of any receiver relative to the transmitter. This reference information is carried in the 9.96-kc modulation by frequency-modulating it at 30 cps in such phase that the 30-cps amplitude modulation will be in phase for a receiver north of the station. Thus, a receiver designed for this type of signal can tell its bearing from the transmitter.

Omnirange Receiver

Figure 1 shows the functions that an omnirange receiver must perform. The tuner and i-f amplifier are conventional. The i-f amplifier is followed by a conventional detector whose output consists of four modulating signals. The 30-cps and 9.96-kc signals are the two required for omnirange operation.

The 30-cps signal is used directly, but the 9.96-kc signal goes into a discriminator to recover its 30-cps frequency modulation. The 30-cps signal from the discriminator is known as the reference-phase signal since its phase is independent of the relative position of receiver and transmitter. The 30-cps signal directly from the detector is known as the variable-phase signal since its phase varies with the position of the receiver relative to the transmitter.

There are two types of phase meters in general use. The first consists of a phase detector giving zero output for 0-degree phase angle and either positive or negative output if the phase is other than 0 degree. The actual polarity depends upon the sign (positive or negative) of the phase difference. Since such a phase detector will also give a null at 180 degrees, a second phase detector giving nulls at 90 and 270 degrees must also be used to resolve the ambiguity.

A continuously variable calibrated phase shifter is then placed in either the variable or reference-signal channel. The reading of the phase shifter when the first phase detector gives a null thus shows the phase difference between the incoming signals except for a 180-degree ambiguity that is resolved by the second phase detector.

A simpler method is to make a circular deflection on an oscilloscope tube from either the variable or reference-phase signal and then use the other signal to make a sharp pulse that marks a spot on the circular trace. This method has the advantage of being direct reading and does not require the adjustment of a variable phase shifter. There is, likewise, no 180-degree ambiguity to be resolved.

New Design

In designing a receiver for maximum sensitivity, the limit is set by thermal noise at the input. It is important to plan the receiver front end for as good a signal-to-noise ratio as possible. Improvement also results from making the receiver with as narrow a bandwidth as possible, since noise power is proportional to bandwidth. Narrowing the bandwidth seems to offer more room for improvement than any other change because receivers have not so far exploited this possibility.

In a typical commercial receiver, a Wien-bridge type filter is the narrowest element therein; this

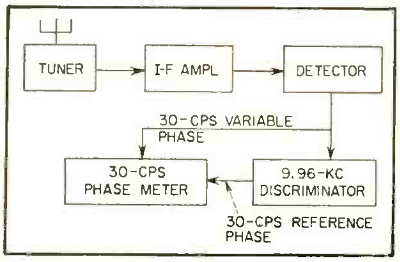

FIG. 1—Principle of phase meter for VOR direction indication

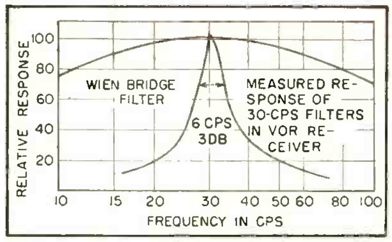

FIG. 2—Comparison of broad Wien-bridge null and measured response of narrow-band filters

ILS and Communications

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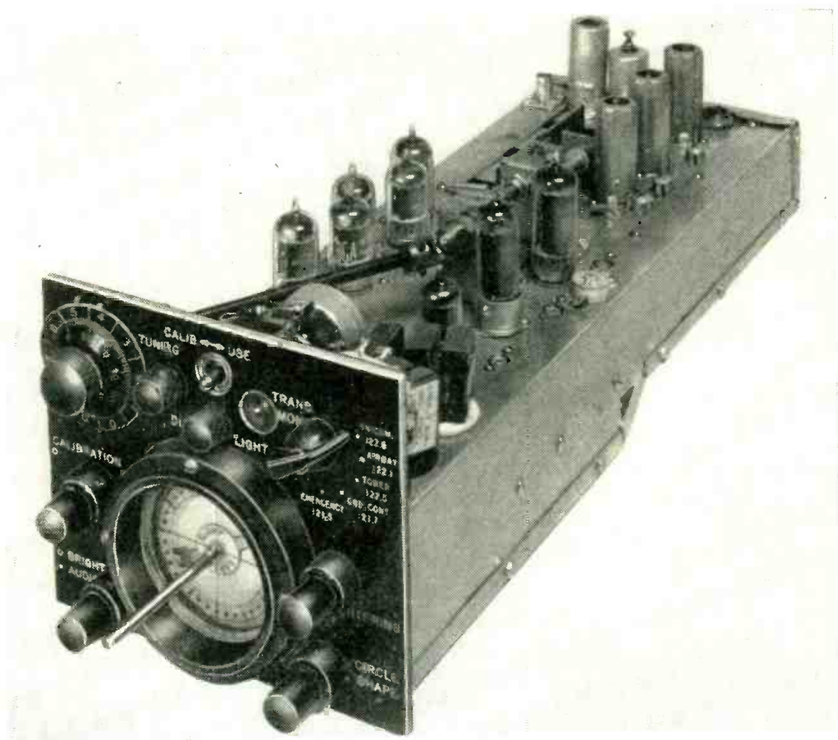
filter commonly has a bandwidth of about 120 cycles at the 3-db points. In the receiver to be described here, a bandwidth of about 6 cycles is used and thus a voltage sensitivity is obtained that is 4 to 5 times better than current commercial sets. Figure 2 compares the band-pass characteristics of these receivers.

A disadvantage of this narrow bandwidth is that it introduces the possibility of phase shift and resultant error. If the tuning of the narrow-band filter should drift slightly, the phase of the 30-cps signal would be shifted a relatively large amount. Since the whole omnirange system is based upon phase measurement, the possibility of such phase shifts cannot be tolerated unless there is some means of checking the filters. Such a method is described by reference to Fig. 3, a block diagram of the developmental receiver.

All the circuits to obtain the 30-cps variable and reference signals are straightforward. In order to measure the phase between the two 30-cps signals, one makes a circular sweep on a cathode-ray tube and a narrow pulse from the second blanks out a portion of the circular sweep. In operation, this gives a presentation whereby the omni station being received is at the center of the circle and the receiver is in the direction of a blanked spot. Tube orientation and circuits are so adjusted that the 12 o'clock position is magnetic north.

Since it is known that the two 30-cps signals will be in phase when the receiver is north of the station, it is possible to feed one of the 30-cps signals into both channels of the phase meter for check purposes. Under these conditions the phase meter should read north. Figure 3 shows the calibration switch that facilitates adjustment of all circuits likely to shift the 30-cps.



Control chassis shows omnirange presentation, receiving and transmitting adjustments

A 1-percent change in the tuning of one of the phase-meter filters will produce approximately five degrees of error. Also, the circuit that makes a narrow pulse from the reference 30-cps signal may be subject to variations in the phase relation between the pulse and the original sine wave. These errors can all be compensated by throwing the switch to CALIBRATE and adjusting the phase of one channel to give a north reading. The switch is thrown to NORMAL for navigation.

Many omnirange receivers employ a left-right meter instead of the circular sweep described here. Such a calibration switch may be employed to advantage with the meter presentation and narrow-band filters may be used to increase the usable sensitivity.

The 30-cps tuned amplifiers are selective-feedback types to avoid using inductances that are heavy, bulky and costly at these low frequencies. The amplifiers consist of two R-C coupled stages, with all the output being fed back to the first stage by means of a cathode-coupled third stage and in such phase as to be degenerative.

This large amount of feedback reduces the gain of the amplifier to only a little more than unity. A parallel-T R-C filter tuned to reject 30 cps is placed in the feedback path to reduce the feedback at 30 cps to nearly zero. Thus, the amplifier will have nearly full gain at 30 cps and the gain will fall off sharply at both higher and lower frequencies. The result obtained is

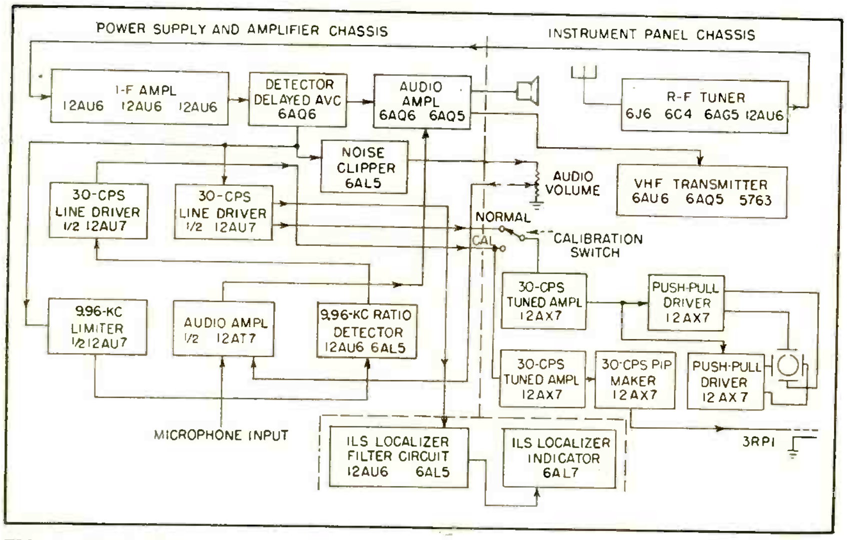


FIG. 3—Block diagram of aircraft equipment shows power chassis (left) that can be stowed anywhere and control equipment (right) mounted near pilot

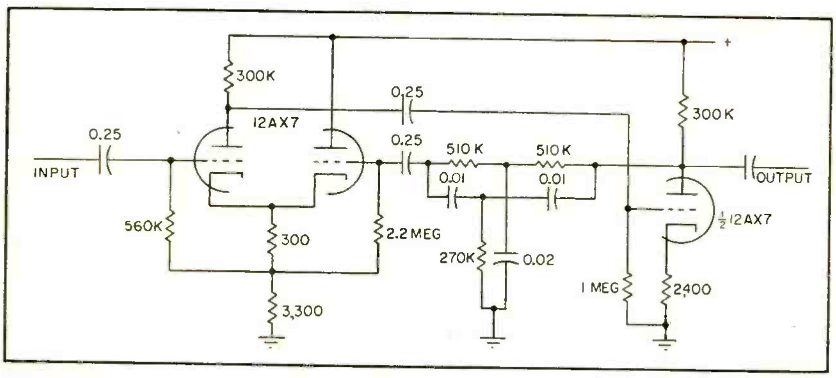


FIG. 4—Tuned amplifier is sharply peaked at 30 cps

Equipment mounted on dashboard of plane

shown in Fig. 2; the circuit is given in Fig. 4, indicating its simplicity.

In the construction of a receiver using these principles a standard f-m tuner and i-f strip manufactured by Collins Audio Products were converted. The original equipment used powdered iron slugs for tuning over the 88-to-108 mc band. Replacing the iron slugs with brass slugs changed the range to 108 to 126 mc. Although the tuner as supplied by the manufacturer is wired for 6-volt filaments, changing one wire modifies it for 12 volts with no changes in tubes. A little extra gain can be obtained from the r-f amplifier by decreasing bias. The only changes made in the i-f strip were removal of limiter and discriminator stages. The tubes were replaced by equivalent 12-volt filament types.

The circuit of the complete receiver is shown in Fig. 5. Circuits on the right are contained in a chassis designed for the instrument panel and include operating controls. The circuits at the left of the diagram are in a second chassis that may be mounted anywhere, since it has no controls.

Tuning the receiver is accomplished both mechanically and electrically. The mechanical system uses a ten-turn dual dial to actuate the brass slugs of the tuner. Since there is some backlash in the mechanical system, electrical tuning with no backlash is also incorporated. The electrical tuning consists of a neon glow tube connected across the oscillator tube in a circuit allowing direct current through the neon tube to be varied by means of a variable resistor on the front panel.

The neon tube acts as a variable capacitor with the capacitance proportional to direct current through the tube. With the circuit shown, approximately 1-megacycle variation in oscillator frequency is obtained. There are two advantages to this type of fine tuning. The variable resistor has no backlash so the fine tuning of the receiver is easier. This is especially true since the mechanical linkage is long and does have a little backlash.

Second, when contacting a station that is not transmitting continuously, the receiver may be tuned approximately by means of the mechanical linkage and then varied around this frequency with the fine tuning while listening for a reply. Since the fine-tuning range is limited, there is no danger of getting far from the desired frequency even when the dial is not watched.

The i-f strip is conventional. Automatic volume-control voltage is applied to all stages except the last, since this stage operates at a relatively high level and might distort the signal at high bias levels. The detector is biased to provide delayed avc and thus hold the output level nearly constant over wide changes of input level. Output of the detector goes to three places—an audio volume control, an amplifier to amplify and limit the 9.96-kc signal and an amplifier to select the 30-cps variable-phase signal. The 9.96-kc signal goes to a ratio detector circuit for recovery of the 30-cps reference-phase signal.

Wien-bridge coupling circuits are used for the 30-cps signal because of the relatively small capacitors that can be used without introducing phase shift. One of the Wien-bridge coupling circuits incorporates a variable resistor to provide a small amount of phase shift for calibration purposes. The variable-phase 30-cps signal is filtered in a tuned amplifier and then divided into two phases—one phase advanced 90 degrees with respect to the other phase. Each phase goes to a push-pull driver stage for the deflection plates of the cathode-ray tube. A circular sweep is thus produced from the variable-phase omnisignal.

Marker Phase

The reference-phase 30-cps signal goes to a second tuned amplifier and after filtering to a circuit that converts the sine wave to a narrow pulse. Ideally, this circuit should always produce a narrow pulse from the same portion of the sine wave even though the sine-wave amplitude changes. This is not difficult when a transformer is used, since it has low d-c resistance compared to its 30-cps impedance. Such transformers are bulky and expensive, so the simple circuit of Fig. 6 was devised.

The circuit makes a square wave from the sine wave; it then differentiates the square wave to form positive and negative pulses. Finally, the positive pulses are clipped, leaving one negative pulse per cycle. The pulse obtained by this method is about seven degrees wide. It is important not to build up bias on the grid of the triode as a result of clipping action taking place there.

If bias did build up, it would be proportional to amplitude and this would result in phase shift of the pulse with respect to the sine wave as a function of sine-wave amplitude. Diode D_1 prevents grid current on the positive half of the sine wave; however, the diode must have a finite back resistance for proper clipping. Either a crystal diode or a vacuum diode shunted by approximately 300,000 ohms is used. Thus, the resistance to ground looking into the cathode of D_1 varies depending on whether the voltage is above or below ground. This can be compensated by putting a second diode D_2 in series with grid resistor R.

Figure 6 shows the expression for the resistance for voltages above and below ground on the assumption that the back resistance of the two diodes is equal. Solving for R shows that R equal to 0.6 of the diode back resistance will result in zero bias being built up on coupling capacitor C. Since the effective back resistance of the diode is not known, the correct value of R is experimentally determined by applying 30-cps sine waves to the pulse-shaping circuit and simultaneously to the horizontal plates of an oscilloscope. The output pulse is applied to the vertical-deflection plates. Changing the amplitude of the input to the pulse maker will cause the pulse on the oscilloscope to move sideways if R is not right. The value of R can be adjusted until the pulse does not move as a function of input amplitude.

Diode Balance

Two precautions obviate the possibility of errors resulting from changing back resistance of the

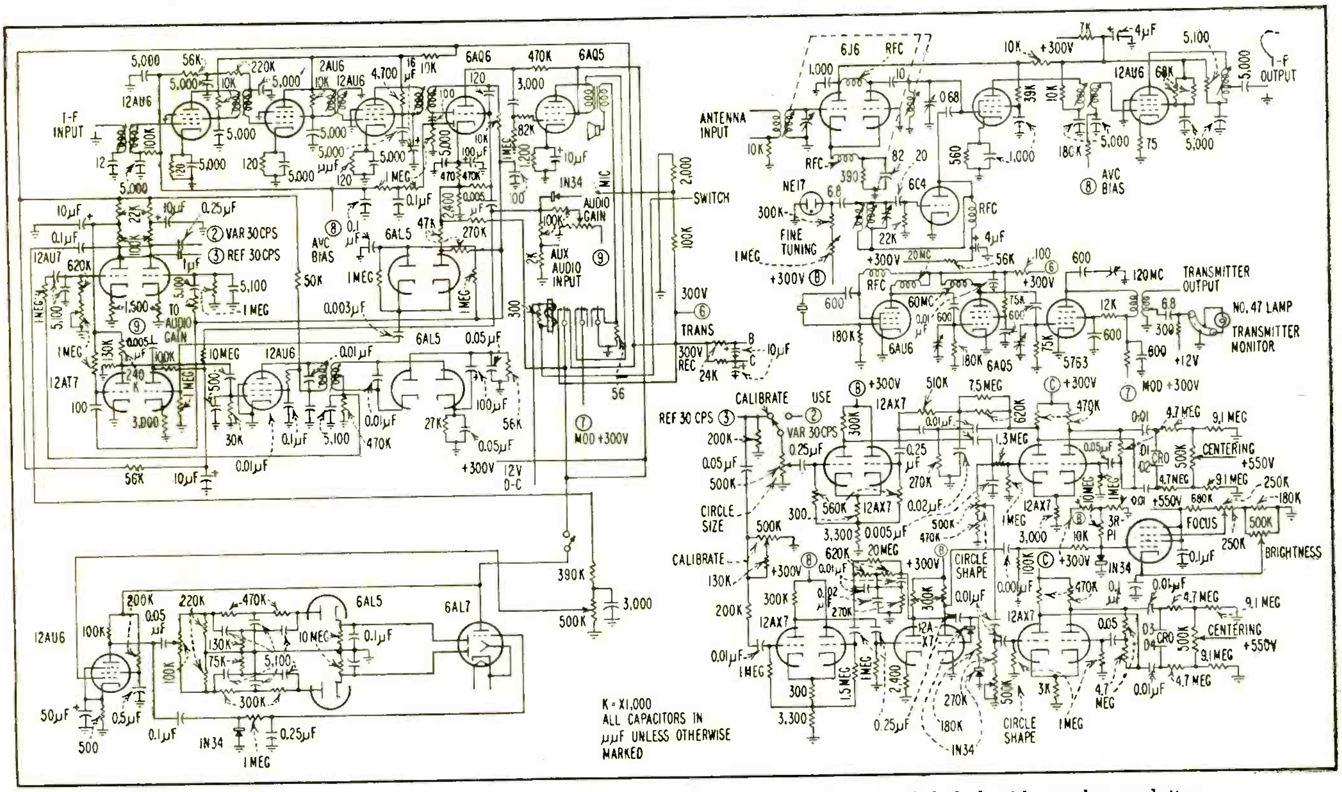


FIG. 5—Complete circuit diagram with vibrator power supply omitted. Interconnections are labeled with number or letter

diodes. The reference-phase signal is put into the pulse maker, since the reference signal derives from the frequency-modulated 9.96-kc signal that went through a limiter and ratio detector. The resulting 30-cps signal is not subject to wide amplitude variations. Second, the pulse-making circuit receives the same signal in both the normal use and calibration positions of the calibration switch. If the pulse maker should introduce phase errors on signals of different strengths, the calibration switch will not only detect the error but also allow in-flight compensation of the circuit.

One criticism of the oscilloscope-type phase meter compared to the course-selector dial and left-right meter is the difficulty involved in figuring which way to turn to get back on course. This problem is easily solved by having some sort of adjustable index on the face of the oscilloscope, as shown in the photograph of the instrument panel chassis. The procedure follows.

If it is desired to fly away from station, the arrowhead is set to the bearing of the radial from the station to be flown. The heading of the plane is that shown at the arrowhead with allowance for the wind. If it is desired to fly towards the station, the tail of the arrow is set to the bearing of the radial from the station to be flown. The heading of the plane is again that shown at the arrowhead with allowance for wind. When flying away from the station, the blanked spot will appear at the arrowhead, and when flying towards the station, at the tail of the arrow.

As shown in the photograph, one side of the arrow may be marked left and the other side right. If the blanked spot on the circle moves to the side of the arrow marked left, the course should be altered to the left in order to get back on the desired course; likewise, if the blanked spot moves to the side marked right, the course should be altered to the right. These corrections apply whether the blanked spot is at the head or tail of the arrow. In practice this device has been found completely satisfactory.

The oscilloscope presentation instead of the left-right meter type insures virtually fail-safe operation. If the oscilloscope shows a centered circle with a pip that goes to north when calibrating, the 30-cps filters and phase meter are completely checked. The avc circuit is the only other part of the circuit that could produce appreciable 30-cps phase shift; if the avc voltage is not filtered sufficiently, it will grid modulate the i-f amplifier to produce 30-cps phase shift. Even this possible trouble can be made virtually impossible by putting paralleled bypass capacitors on the avc lead.

Since the power supply and modulator are already available, a vhf transmitter is included in the design. The transmitter is crystal-controlled and operates on the eighteenth harmonic of the crystal.

All the controls for operation have been grouped on the front panel without too much difficulty; however, experience has shown that some of the controls are rarely used and probably do not need to be so readily available. Two adjustments labeled CIRCLE SHAPE are not required on the front panel. With sufficient magnetic shielding of the cathode-ray tube, the two centering controls can be left off the front panel.

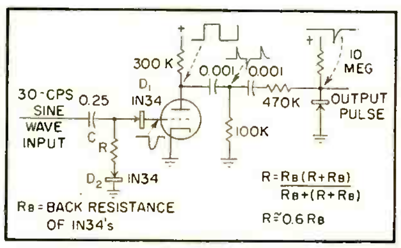


FIG. 6—Pip-making circuit uses matched diodes to prevent phase shift with amplitude

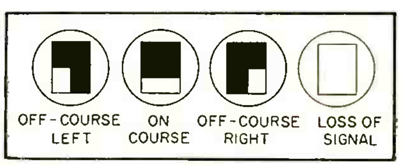


FIG. 7—Patterns of indicator tube for ILS localizer conditions

ILS Adapter

Most omnirange receivers include circuits to receive the instrument landing system localizer signal since the carrier frequency is adjacent to the omnirange band. The localizer signal consists of a carrier with two modulations, 90 and 150 cycles. When the receiver is on course, the two modulations are of equal amplitude; off course on one side the 90-cps signal is larger; off course on the other side the 150-cps signal is larger. In omnirange receivers using left-right meters the same meter can be used for indicating the relative output of detectors tuned to each frequency.

An omnirange receiver using an oscilloscope has no left-right meter available for the ILS localizer. Addition of a meter to an instrument panel is troublesome both for lack of space and because of magnetic effects. In place of a meter a 6AL7 tube may be used. This tube indicates the balance of two voltages and tells which voltage is greater.

Since the 6AL7 uses deflection plates, its input impedance is very high—much higher than that of a meter. With a high-impedance null indicator the filters that separate the 90 and 150-cps signals can be high impedance and thus require less driving power. However, the real advantage of using high-impedance filters is that they require only resistors and capacitors. Expense and bulk of inductors for these low frequencies can be thus avoided. The sharpest R-C filter is a parallel-T rejection type, which is used here. The 90-cps signal is selected by using a 150-cps parallel-T rejection filter and 150-cps signal by 90-cps rejection.

The two signals are rectified by two peak detectors and the resultant voltages applied to the 6AL7 deflection plates. To make the system fail-safe, a third rectifier turns the beam on when a signal is received. If the signal fails, the beam is biased off and no indication is given. The circuit for this 6AL7 indicator is shown on the complete schematic diagram. The type of indication for on-course and off-course is shown in Fig. 7.

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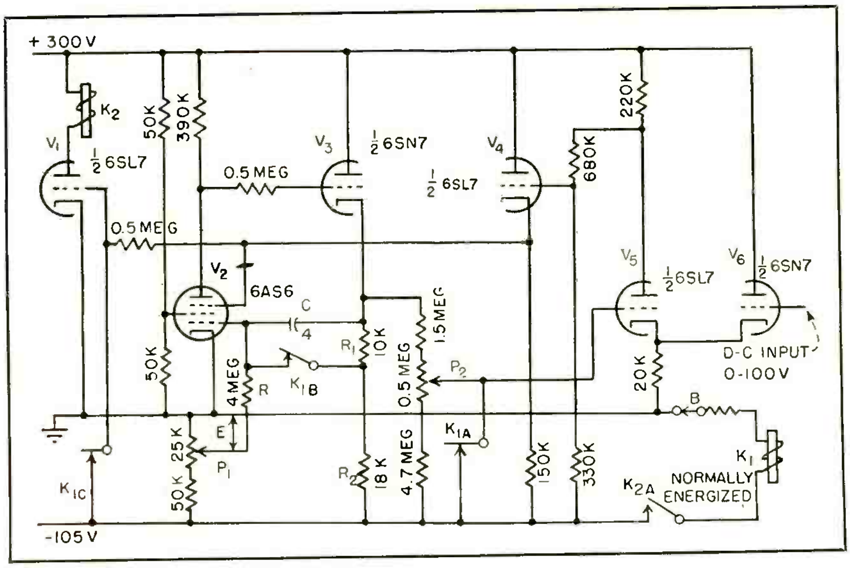

Circuit of the voltage-responsive timer uses two relays and three tube envelopes

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Long-Period Timer

Miller-integrator sawtooth is compared with input d-c to generate voltage-dependent periods from 0 to 50 seconds with accuracy better than ±0.25 second. Delays of minutes are possible with device that combines magnetic relays and vacuum tubes

A TRANSDUCER circuit has been designed to convert d-c output of a computer servosystem into a time period starting at any wanted instant. The variable d-c input is between 0 and 100 v, the wanted time period to be linear from 0 to 50 seconds. The accuracy is better than ±0.25 sec or 0.5 percent of the maximum period if a well-regulated power supply is used. The circuit is practically independent of tube characteristics. Longer time periods can easily be obtained.

A Miller integrator produces a linear sawtooth voltage. Comparison of the slow sawtooth voltage with the input d-c voltage in a triode comparator generates the timing pulse by regenerative switching of the suppressor grid of the Miller integrator pentode. The maximum timing period depends on the R-C constants of the Miller circuit, switching speed being independent of the sawtooth slope, as the feedback circuit is completely d-c coupled. The timing capacitance is the only capacitor in the circuit.

In its quiescent condition K_1 is energized and contacts K_{1A}, K_{1B} and K_{1C} are closed. Tube V_5 is biased to cutoff through contacts K_{1A} and its plate voltage is high. The grid of cathode follower V_4 is connected to a voltage divider from the plate of V_5. The cathode voltage of V_4 is approximately +1 v to the suppressor grid of pentode V_2.

The control grid of V_2 is connected through contacts K_{1B} to a tap on the load resistance R_1 and R_2 of cathode follower V_3. By means of the d-c coupled negative feedback between V_2 and V_3 plate voltage of V_2 is stabilized at about +50 v. Relay tube V_1 is biased to cutoff through contacts K_{1C}.

To start the timing sequence, pushbutton B is pressed, opening the coil circuit of relay K_1. With contacts K_{1A}, K_{1B} and K_{1C} open, relay tube V_1 conducts, closing timing relay K_2. Contacts K_{2A} open, so that K_1 remains open after pushbutton B is released. Tubes V_2 and V_3 now operate as a Miller integrator, the plate of V_2 and the cathode of V_3 rising linearly from +50 v towards the supply voltage, the slope depending on R, C and the voltage E.

The sawtooth voltage continues to rise until the grid of comparator tube V_5 rises above cutoff voltage produced at the cathode of V_6 and determined by input d-c-voltage on its grid. At that instant V_5 starts to conduct. Because its plate is coupled through V_4 to the suppressor of V_2, falling plate voltage of V_5 reduces the plate current of V_2 and thus increases the slope of its plate-voltage rise, this change being fed back again to V_5. The switching action is regenerative and fast.

The negative voltage step at the suppressor grid of V_2 also cuts off relay tube V_1 and timing relay K_2 opens. Contacts K_{2A} close relay K_1. The circuit returns to its quiescent condition as soon as C is discharged through R_1. Time T required for the circuit to reach a steady state after closing K_1 is $3R_1C$. In this case, T is 0.12 second.

The slope of the Miller integrator sawtooth voltage and therefore the maximum wanted timing period depend on the choice of components R and C. The exact time is set at 100 v d-c input by adjustment of E on potentiometer P_1. The minimum time period is adjusted at 0 v input by P_2 in such a way that the switching back occurs immediately after pressing the pushbutton.

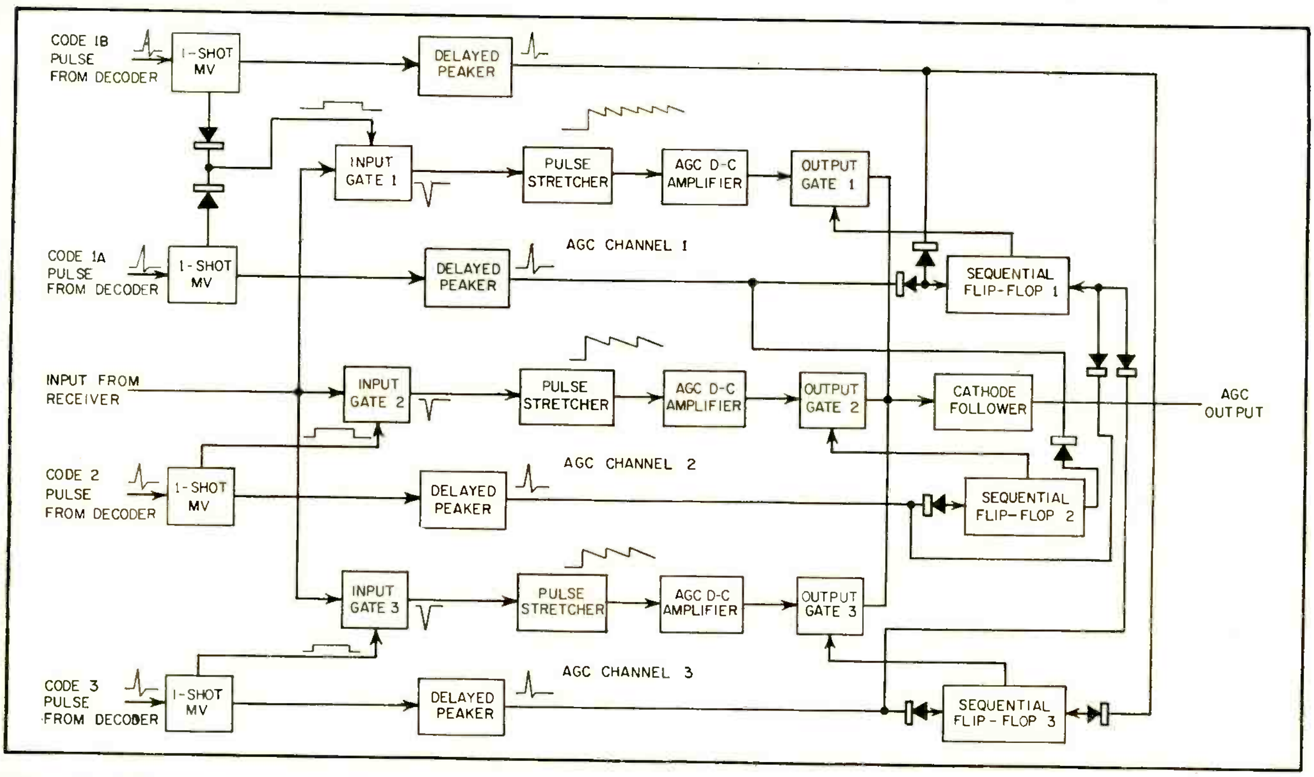

FIG. 1—Block diagram showing stages of three separate agc sections. The input gates are normally off. Control pulses from the decoder activate the multivibrators, which turn on their associated gates

Sequentially Gated

Special agc system equalizes amplitudes of signals from two or more co-channel pulse transmitters differing up to 50 db in intensity. System is applicable in loran, shoran, telemetering and guided missile control receivers

OBJECTIVE of the automatic gain control system to be described is to supply control voltages to a receiver to hold its output constant within ±1 db while receiving pulsed signals alternatively from two or more transmitters—all operating on the same frequency and varying as much as 50 db in signal intensity. The transmitted pulses have a 0.1-microsecond rise time and a duration of approximately 0.5 microsecond.

Since the leading edge of each pulse must be preserved and the rise time is exceedingly short, an instantaneous automatic-gain-control circuit is unsatisfactory. In this sequentially gated control, the input and outputs of three agc channels are gated on or off in a specific cyclic sequence.

The main pulses sent out by the three transmitters are preceded by identifying code pulses. The transmitters operate in a one-two-one-three sequence. Pulses are received in the same order. This gives a synchronous cycle to the received signals. The decoded signal tells which transmitter is sending and which transmitter will send next. This information is used to control input and output gating and a separate automatic-gain-control channel is established for each transmitter.

Pulse Coding

Transmitter 1 has two distinct codes which are transmitted alternately; transmitters 2 and 3 have the same code. Transmitter 1 transmits code A if transmitter 2 is to follow and code B if transmitter 3 is to follow. For simplicity, coding pulses will be referred to as code 1A and 1B for transmitter 1, code 2 for transmitter 2 and code 3 for transmitter 3.

All incoming transmitted pulses

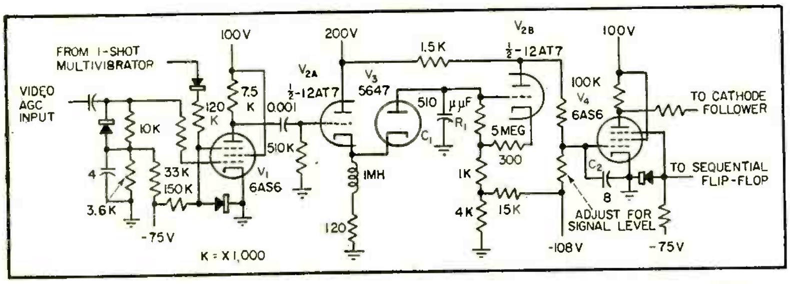

FIG. 2—Typical agc section showing input gate, pulse stretcher, d-c amplifier and output gate. This section is identical to all agc sections in the unit

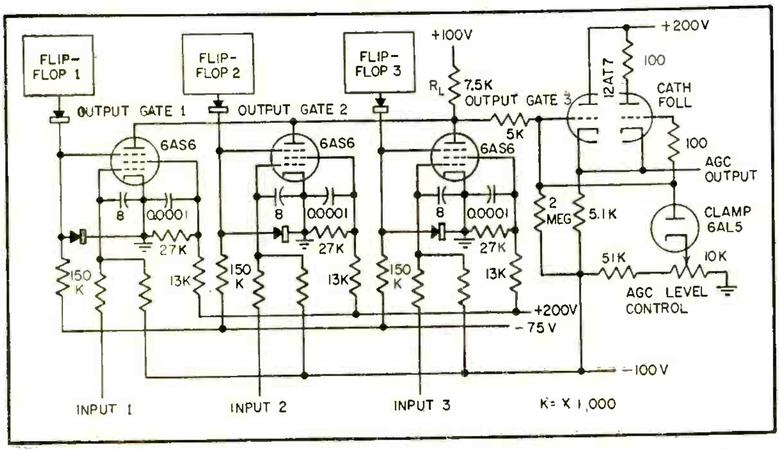

FIG. 3—Output gating circuit including output gates of three agc sections

Table I—Gating Sequence for Automatic Gain Control

Transmitter	Code	Input gate	Output gate
1	1*A* 1*A* delayed	open 1 close 1	open 2 close 1
2	2 2 delayed	open 2 close 2	open 1 close 2
1	1*B* 1*B* delayed	open 1 close 1	open 3 close 1
3	3 3 delayed	open 3 close 3	open 2 close 3

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Automatic Gain Control

from the detector of the receiver are fed to the video amplifier and then directly to the agc unit. These same video signals are received simultaneously by a decoder.

The main transmitted pulses are preceded by coding pulses identifying the originating transmitters. The agc system is controlled by the coding pulses and the main pulse in each case is used to control receiver gain.

AGC Operation

Figure 1 is a block diagram of the composite agc system. When a signal consisting of coding and main pulses is received, it is fed to the three gates in the agc unit. These circuits are normally off until the proper control pulse from the decoder is fed to a one-shot multivibrator whose output opens the appropriate gate to pass the main pulse. If the incoming signal is from transmitter 1, the decoder will furnish a code 1A pulse which is fed to a one-shot multivibrator whose time constant is 12 microseconds. The output of this multivibrator is impressed on the suppressor of input gate tube 1. Since the coding pulse arrives approximately 10 microseconds before the main pulse, there is time for the code 1A pulse to trigger the gating multivibrator before the main pulse arrives. The gate closes at the end of the 12-microsecond multivibrator pulse.

The main pulse is amplified in the first gate tube and fed through a pulse-stretching circuit that lengthens it from 0.5 microsecond to approximately 15 milliseconds. The output of the pulse stretcher is fed through the d-c amplifier and output gate to the cathode follower which feeds the i-f amplifier.

When the one-shot multivibrator shuts off input gate 1, its output is also fed to a delay-peaker network which emits a pulse 12 microseconds after the code 1A control pulse. This code 1A delayed pulse is fed to flip-flop 1 which in turn deactivates output gate 1.

The code 1A delay pulse also feeds flip-flop 2 turning on output gate 2. The voltage stored in the pulse stretcher from previously received pulses is now applied to the cathode follower. This furnishes the proper agc voltage to the i-f amplifier, anticipating the proper agc level for the next set of pulses to be received from transmitter 2 because of the sequential operation of the transmitters.

When the next group of pulses

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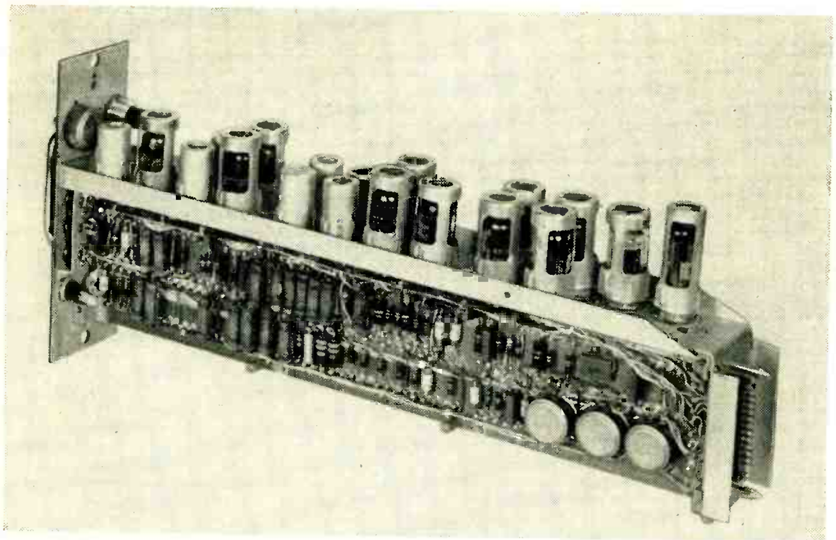


Complete agc circuit assembled on plug-in type chassis

is received from transmitter 2, the decoder decodes the pulses and furnishes the code 2 control pulse. This pulse is fed to its one-shot multivibrator whose time constant is also 12 microseconds. The output from this multivibrator is fed to input gate 2 and holds it open 12 microseconds allowing the main pulse from transmitter 2 to pass before it closes. This pulse is also lengthened to 15 milliseconds, amplified and stored. The one-shot multivibrator triggered by the code 2 control pulse also feeds a peaker network. The output of this peaker emits a code 2 delay pulse which feeds flip-flop 2 turning off output gate 2.

The code 2 delay pulse also triggers flip-flop 1 turning on output gate 1. This allows the voltage stored in circuit 1 to be fed to the cathode follower and the receiver i-f strip. The receiver now has proper bias applied to the i-f strip awaiting the pulses from transmitter 1. The next group of pulses received and decoded are from transmitter 1. As this is the alternative output of transmitter 1, the decoder furnishes a code 1B control pulse. This pulse is fed to the one-shot multivibrator. The output of the multivibrator is delivered to input gate 1 which allows the main pulse from transmitter 1 to pass. This pulse is lengthened and amplified. The one-shot multivibrator also feeds a peaker. This peaker network emits the code 1B delay pulse to flip-flop 1 which shuts off output gate 1. The delayed pulse is also fed to flip-flop 3 to turn on output gate 3 allowing the voltage stored in agc channel 3 to pass to the cathode follower and the i-f strip of the receiver. The agc level is now correct for receiving pulses from transmitter 3.

When the signal is received from transmitter 3, the output of the receiver activates the decoder generating a code 3 pulse which is fed to its one-shot multivibrator which also has a time constant of 12 microseconds. This multivibrator output is connected to input gate 3 so the main pulse from transmitter 3 can pass, be lengthened and amplified. The output one-shot multivibrator associated with the code 3 pulse also feeds its peaker. This peaker network emits its code 3 delay pulse to flip-flop 3 for turning off output gate 3. Simultaneously the code 3 delayed pulse operates flip-flop 1 which turns on output gate 1 allowing voltage to pass to the cathode follower and the i-f strip of the receiver.

Operational Details

The entire operation represents one sequential agc cycle. Output gates 1, 2 and 3 are flip-flop controlled and remain off or on until triggered. This sequential operation is shown in Table I.

The period for each set of transmitter pulses is approximately 2,000 microseconds for transmitter 1 and 4,000 microseconds for transmitters 2 and 3. Because the pulse stretcher lengthens each pulse to approximately 15 milliseconds, there is sufficient amplitude information from about 8 pulses for transmitter channel 1 and 4 pulses for transmitter channels 2 and 3 for setting the levels in each of the agc circuits at any time. Since the transmission repetition rate is approximately 500 per second for transmitter 1 and approximately 250 per second for transmitters 2 and 3, a 15-millisecond pulse-stretching network is necessary for setting average levels and storing sufficient agc voltage to be applied to the receiver i-f strip the next time a transmission is received.

A typical agc section is shown in Fig. 2. Tube V_1 is the input gate. When the 12-microsecond squarewave from the one-shot multivibrator is applied to the suppressor of this tube, the pulse is clamped to approximately zero potential allowing the tube to conduct. During this period, however, the main pulse arrives at the control grid, is amplified and coupled to cathode follower V_{2A} to drive pulse stretching network V_3, C_1 and R_1.

The suppressor of V_4 is controlled by one of the three sequential flip-flops. Capacitor C_2 smoothes out the pulse peaks on the agc voltage. The plate of this stage is direct-coupled to the grid of the cathode follower whose cathode is tied directly to the agc bias line in the receiver i-f strip. Direct-current output gating between the three separate agc channels is obtained by connecting the plates of output gates 1, 2 and 3 as shown in Fig. 3. Since only one gate operates at one time, the plates of the three output gates are tied to a common load resistor. The voltage developed at the grid of the cathode follower stage is due to only one of the agc channels. When one output gate is turned off, another gate tube is simultaneously turned on thus assuring correct bias on the receiver i-f strip at all times. A common-cathode resistor network in the three sequential flip-flops assures that only one output gate can be on at one time.

Frequency Meter Uses Digital Counters

Direct readings of frequencies from 0 to 42 mc are obtained using counter techniques. Simple operating procedure enables unskilled personnel to make highly precise measurements. Instrument incorporates self-checking feature

By A. F. BOFF

Berkeley Division
Beckman Instruments, Inc.
Richmond, California

TECHNIQUES of digital counting and heterodyning are combined in a frequency meter that is as simple to operate as basic counters and has a frequency range of 42 mc. In contrast to heterodyne systems alone, there is no ambiguity, no searching or adjustment, no possibility of falsely identifying harmonics and a measurement is completed in a few seconds.

Figure 1 is a block diagram of the frequency meter. Fundamental and harmonic frequencies of the crystal oscillator are applied to the harmonic amplifier. Reference harmonics are selected in 1-mc steps over a frequency range of 2 to 41 mc and beat against the input signal in the mixer stage to obtain a beat frequency less than 1.2 mc. The unbalanced mixer circuit is followed by a low-pass filter which has its cutoff frequency below that of the input signal and also below the lowest harmonic. When a beat frequency below 1.2 mc is produced, the SET LEVEL meter will be deflected. This signal is then applied through the gate circuit to the counter which displays the answer.

Operation

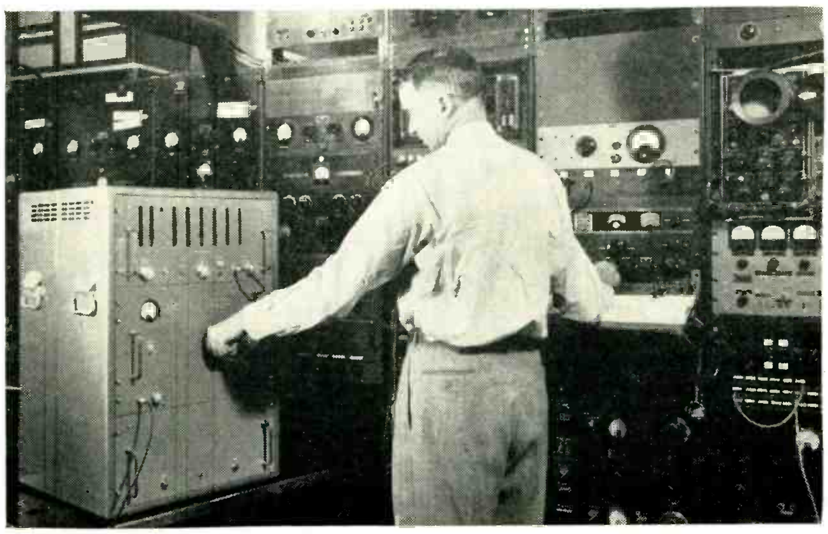
To make a measurement, the selector switch is turned in the direction of increasing frequency (clockwise) until a position is reached where the SET LEVEL meter is deflected. The full answer is then displayed on the eight banks of decade lights. There are two adjacent positions of the selector switch which will produce a beat frequency below 1.2 mc with consequent deflection of the meter. One position uses a reference frequency lower than the signal and the other a higher reference frequency. The lower reading is in all cases correct.

Circuit Design

The circuits of the counter and time-base sections of the instrument are conventional.

The circuit diagram of the heterodyne section is shown in Fig. 2. Crystal controlled oscillator V_1 is a triode amplifier with two separate feedback paths. The series network containing thermistor R_2 provides loop gain and automatic amplitude control. Resistor R_3 provides a negative feedback path to prohibit oscillation except when the grid resistor is shunted by the series resonance of the crystal and its trimmer capacitor C_2. This circuit is extremely stable due to its relative immunity to changes in tube characteristics and has the added advantage of allowing the trimmer capacitor to have one side at ground potential thereby avoiding the effect of hand capacitance during standardization of crystal frequency.

Capacitor C_2 is a piston type con-



Frequency meter in use at RCA communications center, Bolinas, California to measure frequency of transmitters

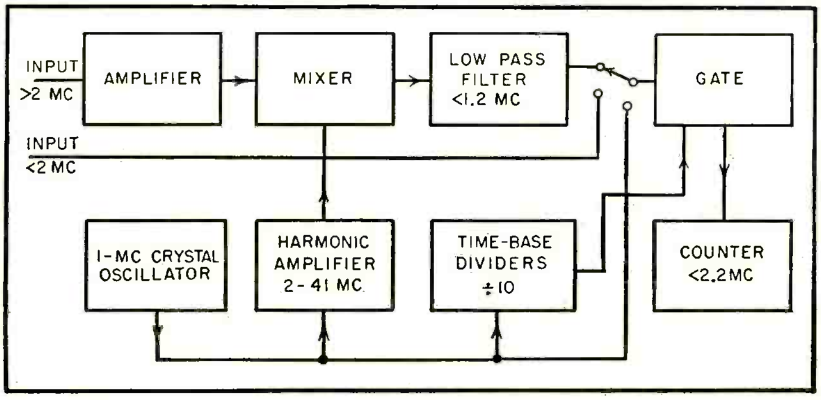


FIG. 1—How heterodyne and counter techniques are combined

structed of invar and quartz. It has very little dielectric loss and a nominally zero temperature coefficient of capacitance.

Cathode follower V_2 provides a convenient take-off point for synchronizing the time base dividers in the counter section.

The output from the oscillator is amplified by V_3 and applied at high level to the grid of V_4. A large bias is built up on C_3 by the grid current of V_4 and consequently V_4 passes plate current during only a small part of each cycle of the oscillator waveform.

The current pulse causes a damped oscillation in L_1 at a frequency in the region of 10 mc. Since the process is concerned only with producing a pulse of proper shape and polarity, the exact frequency is of no consequence. The first positive going cycle of this waveform is larger than all subsequent cycles until the next 1-mc impulse is received.

Negative bias is built up on C_4 by grid current in V_5 causing this tube to be completely cut off except during the peaks of the largest positive cycles of its input waveform. The input to V_5 is a fast, narrow pulse at a repetition rate of 1 mc precisely controlled by the crystal oscillator. Such a waveform contains harmonics of 1 mc at practically costant amplitude to an order dependent upon the width and rise time of the pulse.

Harmonic Selector

The tuned circuit comprised of L_2 and its associated capacitors selects individual harmonics from 2 to 41 mc. The response of this circuit to harmonics adjacent to that selected is so small that the input circuits reach a limiting condition before sufficient energy at a false frequency can be forced through to the meter circuit. Inductance L_2 is tuned by capacitors mounted on the turret switch and maintains a Q in the neighborhood of 400 over the complete range 2 to 41 mc. This value of Q is obtained by high quality capacitors, low loss dielectric material for the switch and a physically large inductor. Plate damping by V_5 is negligible since the tube conducts for only a very short interval of time.

Response

At the most critical frequency—41 mc—the response to 42 mc is more than 26 db down. Since the input amplifier is designed to limit at about 15 db above normal signal level, it is virtually impossible to obtain false answers due to this cause, even allowing substantial detuning of the selective circuit. Excessive variation in sensitivity over the range is corrected by signal input amplifier V_6. Stray capacitances shunting the resistance plate load cause a rapid decline of amplification at high frequencies.

The resonant selector circuit is loosely coupled to mixer V_7. In typical heptode mixers, the signal grid has a characteristic which is considerably more linear than the injection electrode. The customary positions of signal and reference frequencies with respect to the injection electrodes are reversed to minimize demodulation of 1-mc sidebands inevitably present in the reference frequencies.

The three-section filter following the mixer tube is a conventional M-derived, constant-K type having nominal cutoff at 1.2 mc and infinite attenuation at 2 mc. Stray capaci-

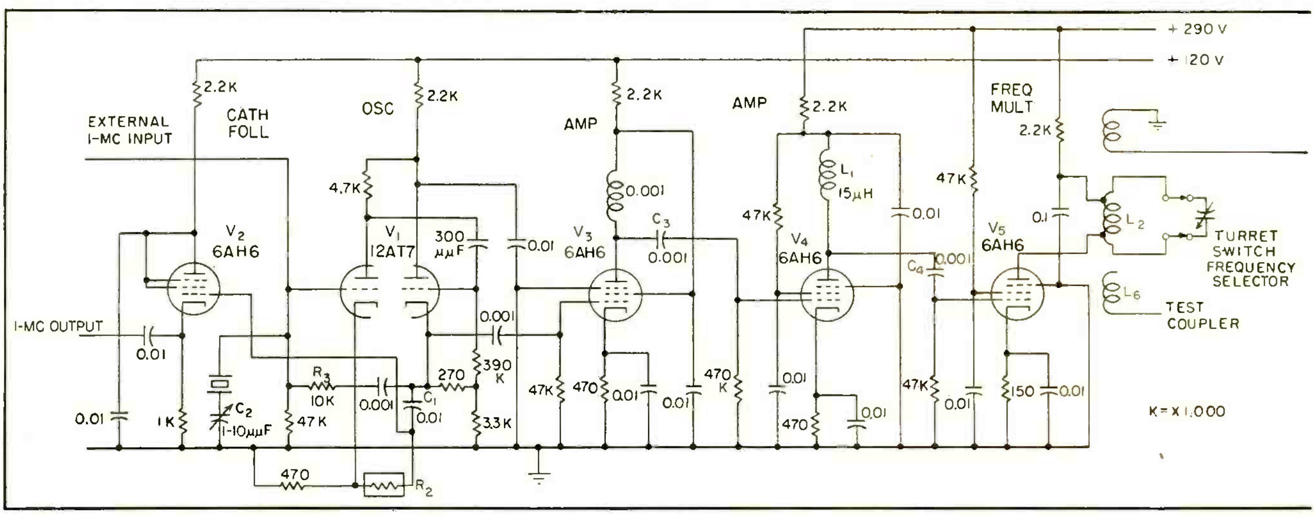


FIG. 2—Schematic diagram of heterodyne section of frequency meter. Mixer output is applied through gate to counting unit for display.

tances across L_3, L_4 and L_5 are effective as additional elements normal in an M-derived design. Pentode V_8 is a low-impedance output stage connected by coaxial cable to the counter section of the instrument. Further amplification to drive the meter circut is provided by V_9 and V_{10}.

Coil L_6 is a pickup probe brought to a socket on the front panel. A small amount of energy at all harmonic reference frequencies is available here. By coupling to a radio receiver, a beat note may be obtained with a standard WWV transmission and the frequency of the crystal oscillator adjusted to zero beat using trimmer C_2 which is accessible on the front panel.

Counters

A decimal counter unit with neon light indication is illustrated in Fig. 3. Several of these units are used in cascade to form the counter illustrated in the block diagram. Every pulse which passes through the gate circuit to the counter is precisely registered. For frequency measurement, the gate must be opened for a precisely known time interval. This time interval is obtained by dividing the output from a crystal controlled oscillator operating at 1 mc. Additional circuits must be provided to allow time for adequate display of the total reading and resetting to zero.

Accuracy

There are three separate contributions to error in the measurement of frequency by this method. All counting instruments which measure the number of impulses in a finite time introduce an irreducible error of ± 1 count, dependent upon the instant the gate opens in relation to the phase of the signal. Also, a small amount of jitter is produced in the processes of division in the time base. Finally, the frequency of the crystal oscillator is not exactly correct.

In this instrument, the error due to jitter is less than 0.1 μsec and is not therefore significant in the measurement of beat frequencies of the order of 1 mc. The crystal is housed in a thermostatically controlled oven and it has been found practicable to obtain short-term stability of 1 part in 10^7. Regular comparison with a standard is necessary to maintain this accuracy.

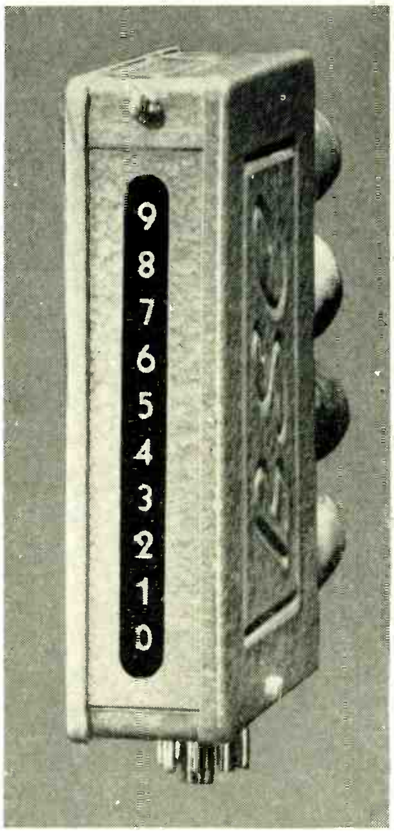


FIG. 3—Direct-reading decimal counter

Overall accuracy at all frequencies from 0 to 42 mc is ± 1 part in 10^7 ± 1 cps.

Calibration

The circuit complexity makes self-checking indispensable. A simple but thorough method is readily available. When the input selector switch shown in Fig. 2 is thrown to the TEST position, consistent correct readings can be obtained only if all the decimal counter units are functioning correctly, the time base dividers are dividing in the proper ratio and in a stable fashion and the gate and control circuits are operating correctly. Absolute accuracy of the crystal oscillator is the only factor not checked by this test.

The author is indebted to his associates at Berkeley Division for design of sections of this instrument and for assistance during its development.

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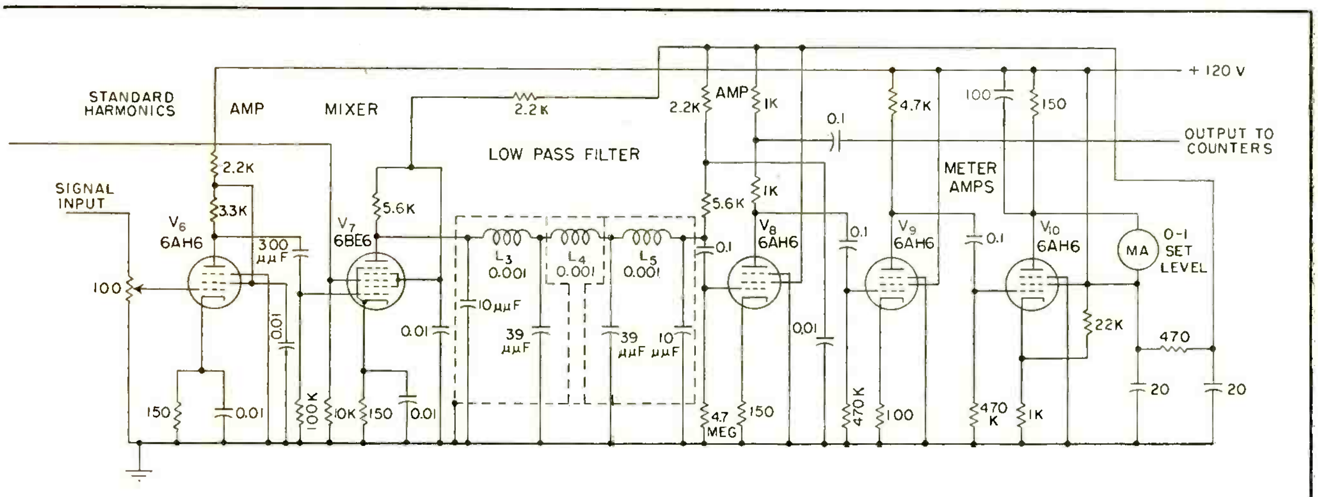

Crystal oscillator output is applied to time-base dividers

TV Lighting Calculator

Chart permits graphical determination of illumination on photosensitive surface of camera pickup tube when scene brightness and lens aperture are given. May also be used to find required scene brightness if other factors are known

By JOSEPH SODARO

Los Angeles, Calif.

ILLUMINATION INTENSITY on the photosensitive surface of a tv camera pickup tube is given by $E = \pi BT \cos^4\theta / 4f^2$ where E is in foot-candles, B is scene brightness in candles per square foot, T the lens transmission coefficient, f the lens aperture and θ the angle between the direction of the light and the optical axis of the system.[1] For practical use this formula is simplified by assuming 15 degrees as an average value of θ and 0.75 as an average value of T.[2] The calculator is based upon the equation after simplification for average values.

Use

Camera pickup tube illumination is determined from this nomograph by selecting scene brightness in candles per square foot on the B scale and the lens aperture on the f scale. Join these points with a straight line. At the intersection of this line with the E scale read camera pickup tube illumination. This value can be multiplied by the pickup tube photosensitive surface area in square feet to obtain lumens.

As an example, determine the camera illumination for a scene brightness of 10 candles per square foot for an $f/3$ lens. From 10 on B draw a straight line to 3 on f. Read 0.55 foot-candles at the point where this line crosses the E scale.

To determine required scene illumination, enter the nomograph on the E scale with the required camera pickup tube illumination in foot-candles and on the f scale with the aperture stop value. A straight line through these points extended to the B scale will indicate the necessary scene brightness.

The nomograph is not applicable directly to close-up work in which the pickup tube image is greater than one-tenth the actual size of the object. For these cases, divide the value obtained on the E scale by $(m + 1)^2$ in which m is the magnification ratio.

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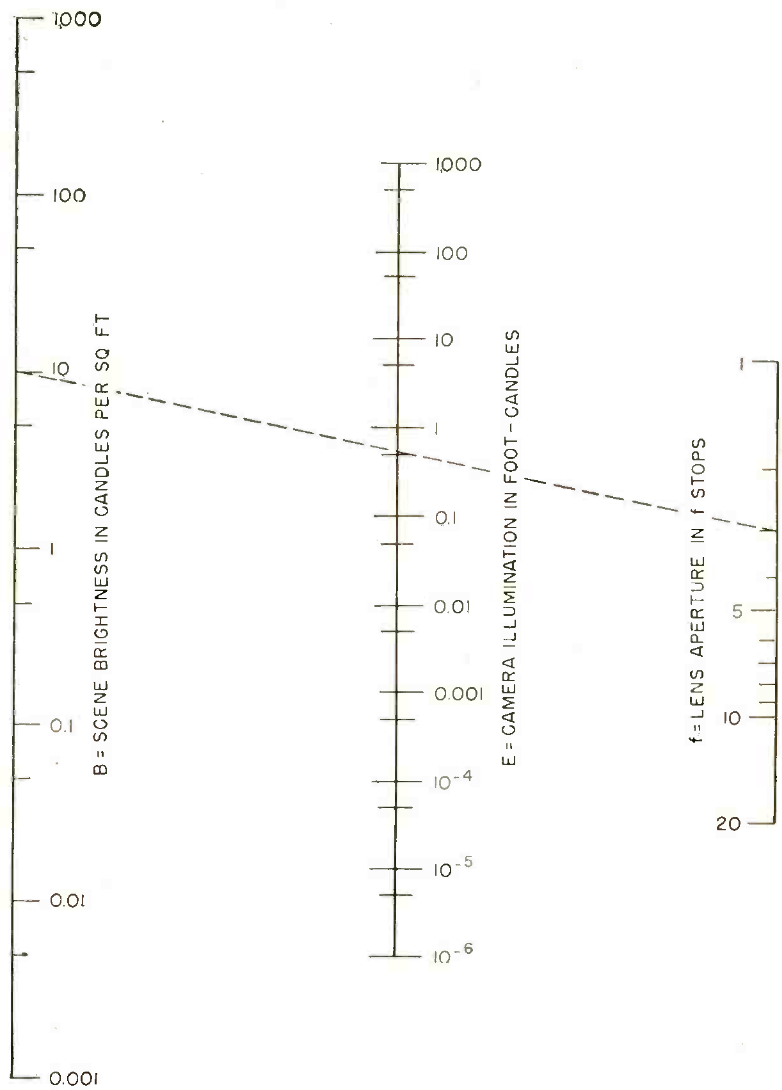

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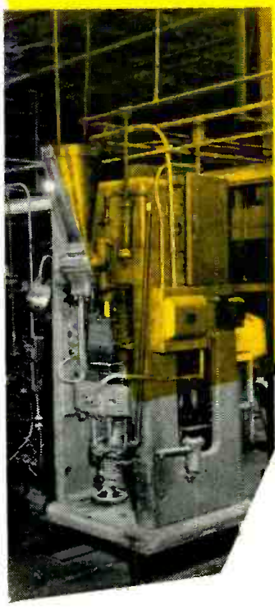

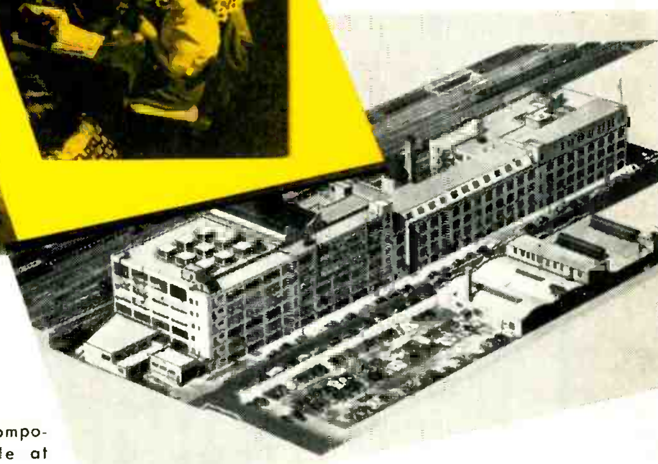

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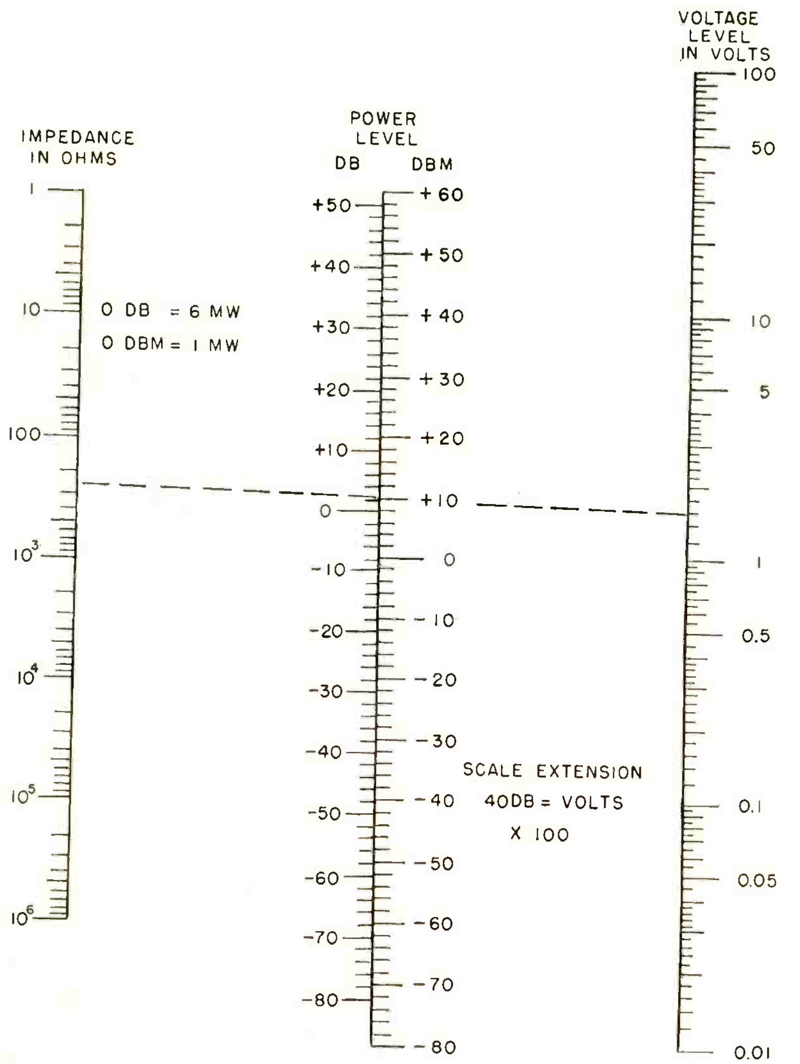
Power Level Nomograph

By THEODORE HALABI
Atlantic Transformer Co.
Groton, Conn.

Conversion chart gives voltage and power levels for db or dbm across any normal value of impedance from one to one million ohms. Scale extension covers any level not directly intersecting on graph



POWER LEVELS are commonly expressed in db or dbm instead of directly in watts. With a given level of +20 db across an impedance of 600 ohms, it is relatively simple to calculate the corresponding voltage level. Since +20 db is a gain of 20 db of power over a reference of 0 db or 6 milliwatts, $P = 0.006 \times$ antilog $20/10 = 0.6$ watt. Then using Power $= E^2/R$, $E = \sqrt{0.6 \times 600} = 19$ volts. The same computation can be made whenever the power is given in multiples of 10 db, such as −50 dbm or +40 db, utilizing the fact that the log of multiples of 10 is an integer.

However, when the power level is some number indivisible evenly by 10 such as −75 dbm, the input level of a high-gain amplifier, or +35 db, the output of an audio amplifier, it is necessary to find the voltage across an impedance by looking up the antilog of the power level, a decimal number.

To use the nomograph, draw a straight line from the impedance at left through the power level and read volts directly at the right. For example, a 250-ohm audio line is transmitting +10 dbm of power from which 1.58 volts is read off the graph.

The scale extension value, 40 db, allows calculation of any level not intersecting directly on the nomograph. For instance, a 5,000-ohm plate load impedance at a +42 db level intersects off the graph. However, read 6.9 volts at +2 db (42–40). The multiplying factor for 40 db is 100 and therefore, the level is $6.9 \times 100 = 690$ volts.

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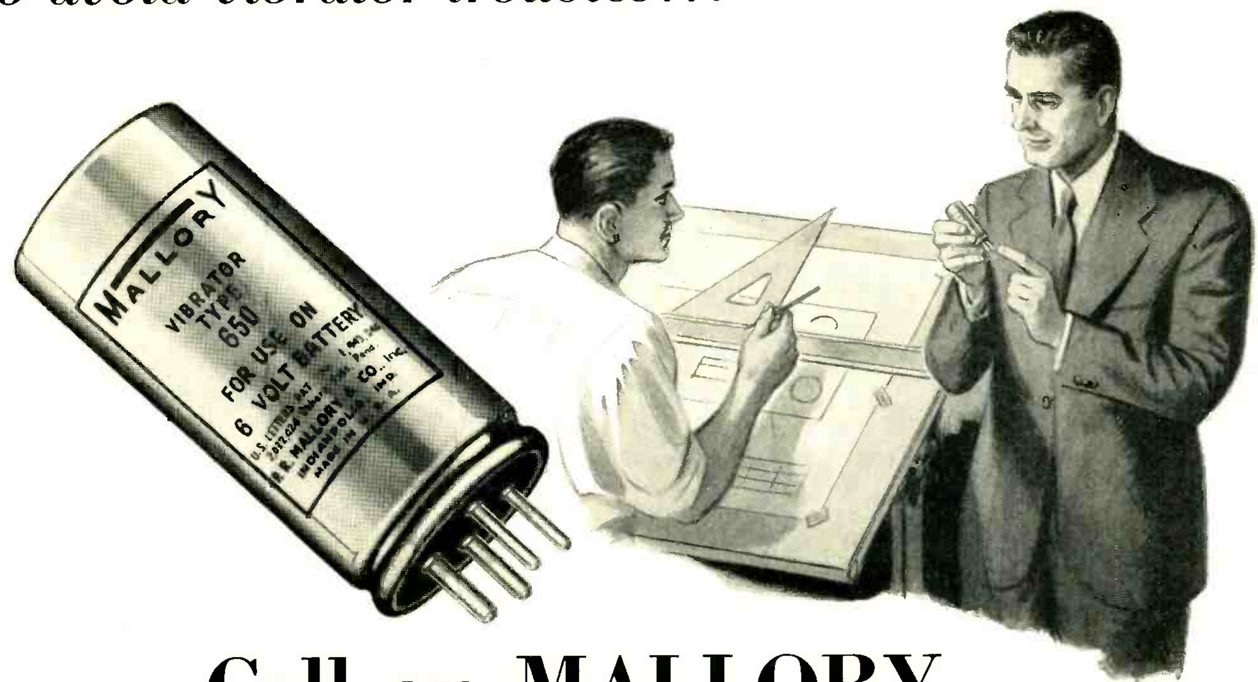

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ELECTRONS AT WORK

Edited by ALEXANDER A. McKENZIE

OTHER DEPARTMENTS

featured in this issue

Mobile f-m transmitter powered by sun's rays falling on developmental silicon solar battery has possible range of several miles

Sun Powers Telephone

LOW-POWER demands of transistorized telephone equipment (ELECTRONICS, p 192, May 1954) and development of *p-n* junctions in silicon have made feasible a practical solar battery.

The battery illustrated comprises a number of silicon strips each measuring about a half inch by two inches, which when connected together, produce power from sunlight at a rate of 50 watts per square yard of surface.

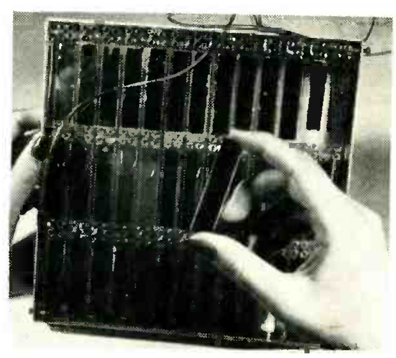
Heart of the development is a technique, useful in the manufacture of transistor devices, of introducing controlled amount of impurity beneath the surface of extremely pure silicon. Introduced at a precise rate under carefully controlled conditions, the impurities reach a depth of less than one ten-thousandth of an inch.

Wires, through which useful current may flow, are connected to the surface layer and to the body of the silicon. In full sunlight, current flows at a rate of 24 milliamperes per square centimeter at a voltage of approximately half a volt. In practice, the silicon strips, which can stand much higher temperatures than comparable germanium devices, are encapsulated in a clear high-resistance plastic.

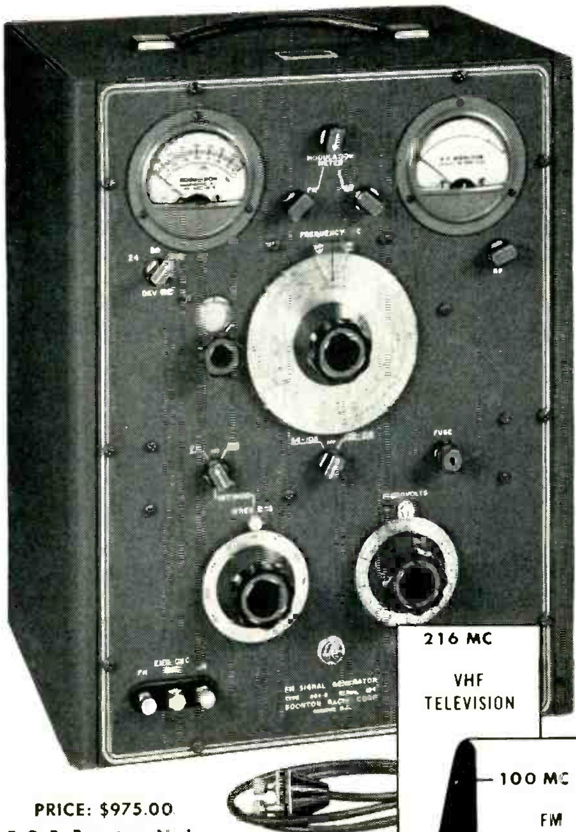
Bell Labs scientists estimate that this type of energy conversion unit, operating on the light rather than the heat of the sun, can never convert more than 22 percent of total incident solar energy. They believe that it may be possible to attain practical efficiencies as high as 10 percent. The present solar battery has an efficiency of 6 percent, which is many times that of comparable devices, such as thermocouples and photocells.

Although many interesting experiments can be performed with the solar batteries constructed in the laboratory, using either sunlight or artificial illumination, they are not yet in a stage of development for high-power applications.

First practical employment of the sun for telephone service may be with transistor equipment now undergoing field tests near Americus, Ga. Prime source of power must be storage batteries, as is true generally in telephone plant. By determining the probable incidence of sunshine a solar battery of



Solar battery is made up of special silicon strips like that held in hand. Units are encapsulated in clear plastic



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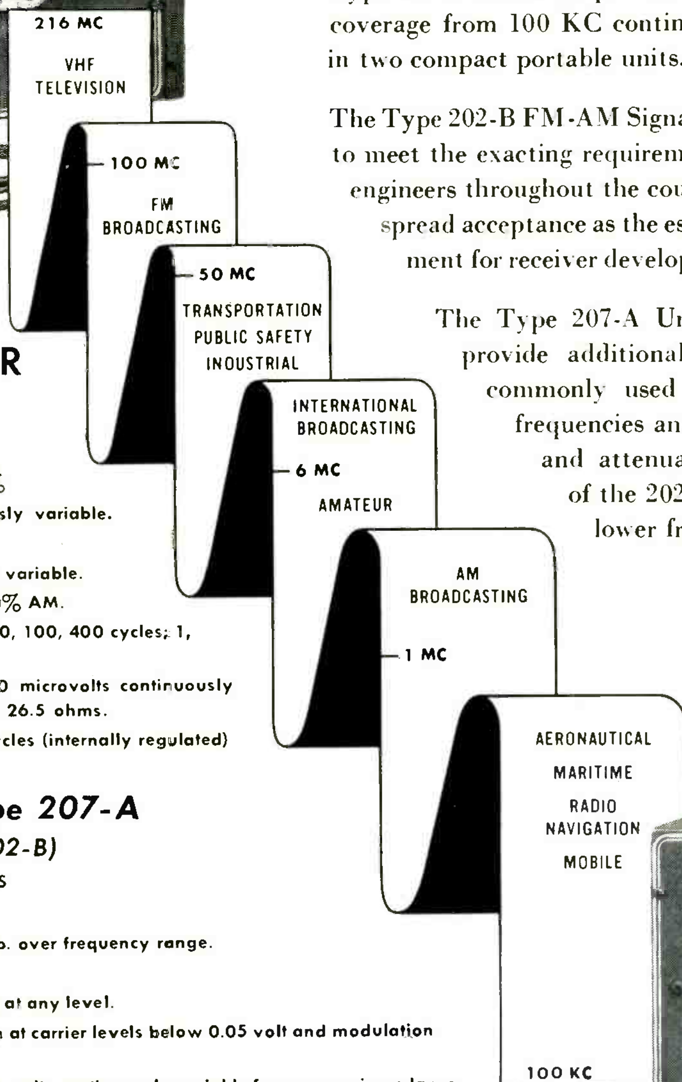

FM-AM SIGNAL GENERATOR
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FREQUENCY RANGE: 54—216 MC ± 0.5%
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FM DISTORTION: Less than 2% at 75 KC.
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AM DISTORTION: Approximately 5% at 50% AM.
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R. F. OUTPUT VOLTAGE: 0.1 to 200,000 microvolts continuously variable from source impedance of 26.5 ohms.
POWER SUPPLY: 105—125 volts, 50/60 cycles (internally regulated)

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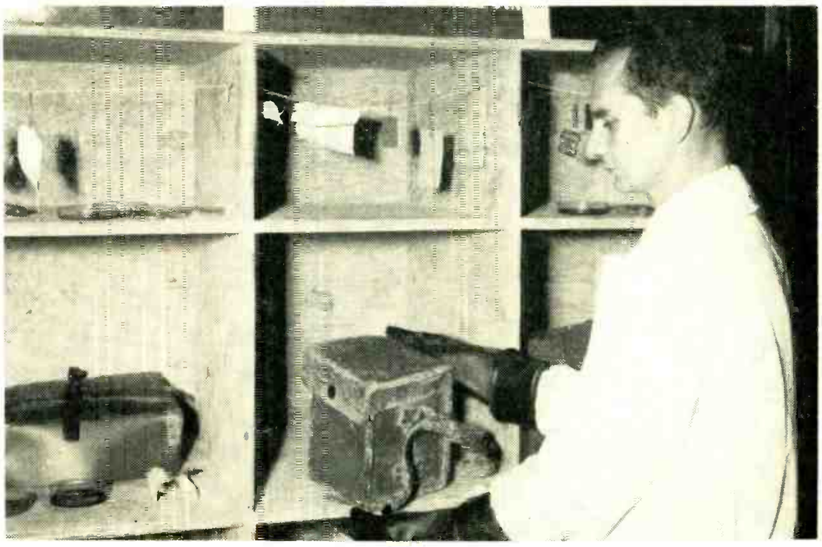
Bell Labs research team, G. L. Pearson (physicist), D. M. Chapin (engineer) and C. S. Fuller (chemist) who invented the solar battery check samples for photoelectric efficiency

sufficient size may be installed to keep the storage battery charged. This solar battery would probably have from three to five times the energy of one required for service under continuous illumination.

At a recent demonstration, the solar battery was used to power a portable transistor f-m transmitter and turn the motor to run a toy Ferris wheel.



Two-week exposure in tropic test chamber at Signal Corps Engineering Labs, For Monmouth, N. J. has left untreated leather case covered with fungus. Specifications for manufactured equipment now reflect experience of tests.

Fungi Attack Army Equipment

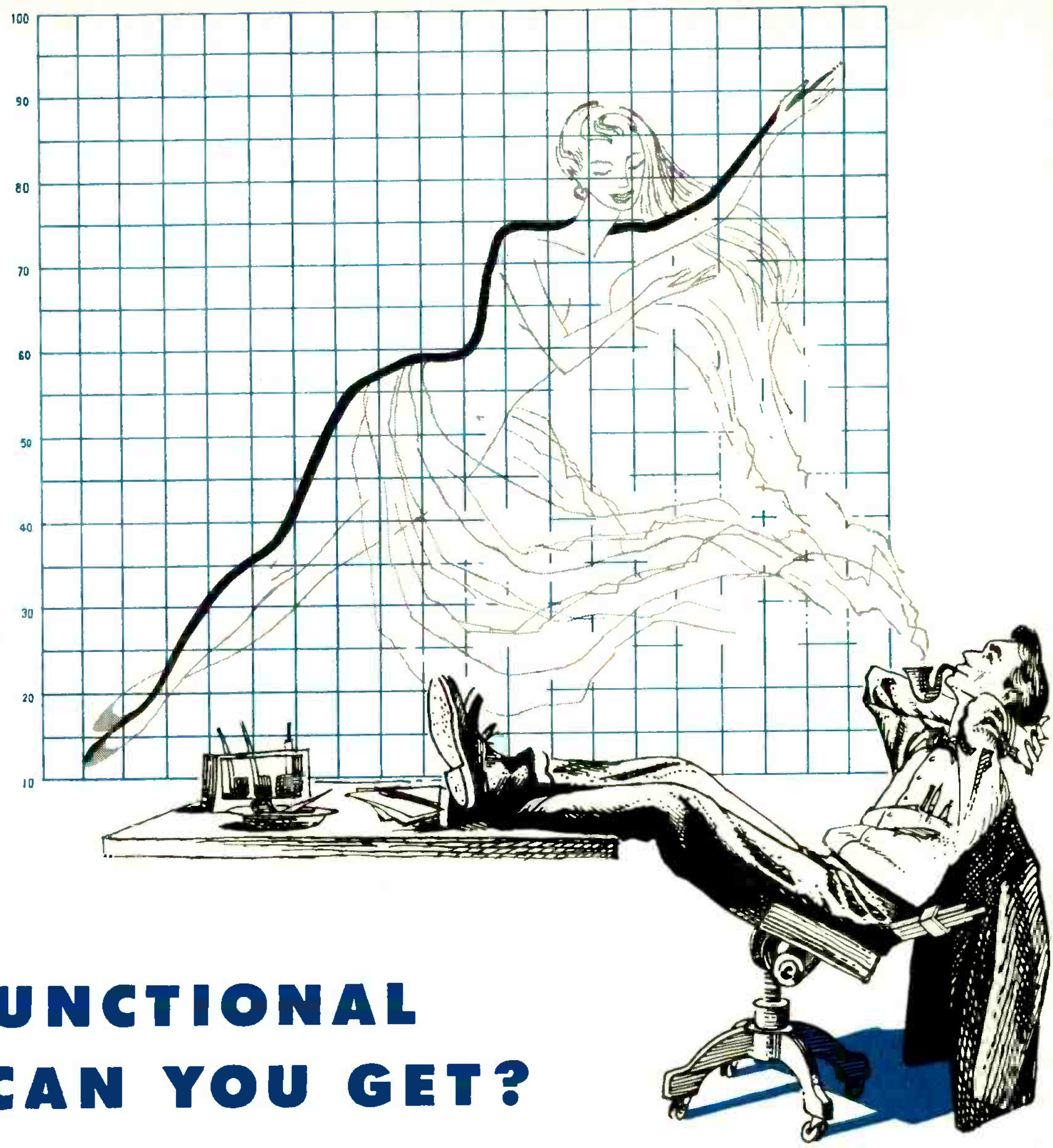
DAMAGE by fungus to electronic equipment and carrying cases has been reduced to a fraction of that suffered during the war. Tests in the mycological laboratory at Fort Monmouth under precision control of temperature and humidity are likely to reduce the deleterious effects of fungi still further.

Conditions in the South Pacific area gave similar results.

A test room ten feet long and

Electronic Store Dick

California market owner has installed three small television cameras (like that near ceiling at right) to scan 22,000 square feet of floor area. Shoplifters can be detected by viewing displays on three receiver screens (at left). Each camera is suspended four feet below ceiling and can be completely rotated or turned downwards at 45 degrees. Controls are located at the receivers



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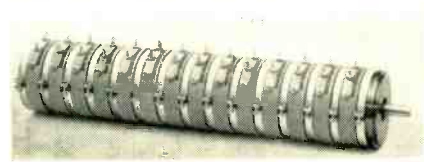

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five feet wide can be operated at a temperature of 82 F and relative humidity of 95 percent. In this muggy climate, harmful fungi flourish.

The Signal Corps is interested in the general type of fungus known as saphrophytic, which utilizes dead organic material such as cellulose, leaf mold, dead insect bodies and other matter as nutrient. Other food sources include untreated leather (used in pole climbers' safety belts and field telephone cases). Web carrying straps and cotton-braid wire and cable insulation are also vulnerable.

While fungi are unable to obtain nutrition from glass or metals, they often spread from adjoining nutrient surfaces and accelerate corrosion. The acids produced by fungus mycelium and alkaline products of metabolism have been known to etch glass.

Some of the plastics have a high natural immunity to fungus damage that make them attractive for the design of new equipment. After the effectiveness of fungicidal varnishes or sprays and antifungus impregnations has been tested, equipment specifications for Signal Corps materials are included in contracts.

Radio Controls Traffic Signals

AUTOMATIC CONTROL of traffic lights by emergency vehicles has been accomplished with a device called NATECS, developed by North American Aviation, Inc. at Downey, Calif.

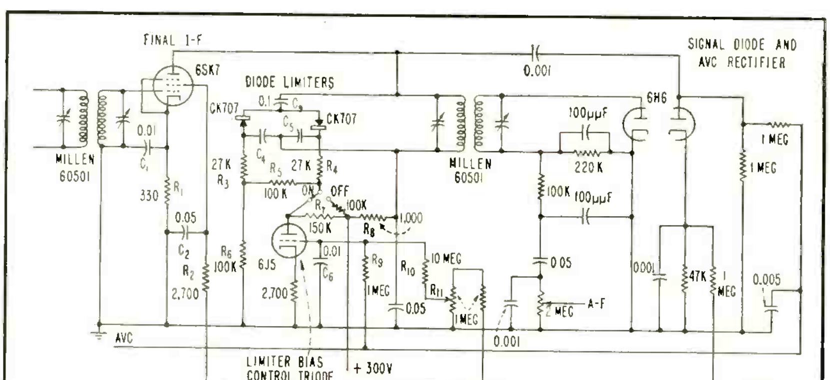
In the experimental system, a small radio transmitter mounted on the emergency vehicle activates receivers connected to traffic light controls. The warning signal causes all lights a quarter of a mile ahead to turn red for fifteen seconds. After the emergency, regular timing is re-established.

A somewhat similar device developed by the Aetco Co. of Downey has an added feature. When another fast-moving emergency vehicle is approaching, a red dashboard light flashes. This automatic feature is included to prevent accidents that might be caused when two emergency vehicles, each with the same frequency siren, approach an intersection at right angles.

Still in the developmental stages, these equipments are not available.

Bias Control for I-F Limiters

By NATHANIEL BISHOP
Time, Inc.
Springdale, Conn.



Noise limiter circuit uses crystal diodes taking advantage of low forward resistance to improve limiting action

ADVANTAGES of limiting impulse noise in the i-f system of an a-m receiver has been pointed out (ELECTRONICS, p 164, June 1953). Further development work has resulted in a new circuit that provides for better limiting action and less distortion on all grades of a-m signals. Restriction of the choice of limiters to vacuum-tube diodes has been eliminated since the comparatively low back resistance of conventional crystal diodes is not a factor in the design. Advantage is taken of the comparatively low forward resistance provided by crystal diodes to give improved limiter performance.

The diagram illustrates the application of the circuit to the last stage of a 5-mc i-f strip in a mobile vhf receiver. Three stages of i-f are used with delayed avc applied only to the first two stages. The bandwidth of the i-f strip is approximately 40 kc for effective noise

limiting and ease of tuning in mobile operation.

The values shown, while successfully used in one receiver, are subject to modification depending upon the design of the particular receiver. As in all types of receivers employing limiters, the gain must be high up to the point of limiting or effective limiting will not be possible when receiving weak signals.

Limiter bias in the original circuit depended upon the rectified voltage developed by the limiters themselves, which in turn tended to follow the peak of the applied voltage at a syllabic rate. Signals with poor positive-modulation characteristics failed to provide sufficient limiter bias to prevent serious loss of intelligibility. In this circuit, however, limiter bias does not depend upon rectification of the limiters but is derived from an independent source under control of the avc system.

Limiter Bias

Bias for the two crystal limiters is derived from the B+ supply by the series combination of R_7, R_5 and R_6. Resistor R_7 also serves as the plate load resistor of the triode control tube. Variable negative bias applied to the grid of the control tube, therefore, will control the limiter bias. This variable negative bias is obtained from the avc circuit and is fed to the grid of the control tube through a low-pass filter consisting of R_9 and C_6. To allow application of the full range of avc voltage to the grid of the control tube and at the same time provide for optimum bias in the absence of a signal, a small positive voltage is applied to the grid to buck down the avc voltage appearing at this grid in the absence of a signal.

This adjustment is provided for by the potentiometer R_{11}, the arm of which is connected to the control grid through the 10-megohm resistor R_{10}. This is usually adjusted in the absence of a signal or impulse noise and the adjustment is gaged by a slight diminution in receiver noise in the output of the receiver indicating that limiting is taking place on receiver noise peaks. When a signal is applied to the receiver, the bias on the control tube

swings negative, thereby increasing the limiter bias as it appears across R_5. Resistors R_3 and R_4 isolate intermediate frequencies from the control system.

The time constant of response of the bias-control system to changes in avc voltage is established partially by the low-pass filter R_9 and C_6 in the grid circuit of the control tube, but to a greater degree by the time constant of the limiter-bias circuit consisting of the two miniature 1-μf capacitors C_4 and C_5 in series in combination with the resistors R_3, R_4 and R_5.

The necessity for limiter-bias control results from the fact that few if any receivers have essentially flat avc. If such were the case, limiter bias could be fixed. The addition of amplified control of the limiter bias makes provision for the fact that the voltage appearing at the limiter terminals is not independent of signal strength over the wide ranges of input encountered in mobile service.

Since the bias conditions may be established for limiting at any desired percentage of modulation, the system becomes independent of the modulation characteristics of the incoming signal insofar as limiter operation is concerned. In addition, a continuous series of high-amplitude pulses can increase the bias on the limiter only to the point where the control tube is cut off. Hence, excessive limiter bias in the presence of such interference is minimized.

Construction

Care must be exercised in placement and shielding of the limiter components, in particular C_3, C_4, C_5, the crystal diodes and R_3 and R_4 to prevent feedback in the i-f system. Excessive coupling between the primary and secondary of the last i-f transformer may prevent adequate limiting owing to a reduction in the primary impedance by the loading of the signal diode circuit. A slight detuning of the secondary of the last i-f transformer will suffice to handle this situation if a tightly coupled i-f transformer is used, without noticeably impairing the overall frequency characteristic of the i-f strip. A better solution is

to reduce the coupling between primary and secondary to prevent excessive reduction of the primary impedance.

Field experience with this noise limiting system has proved satisfactory under all conditions of mobile operation. Its performance on weak signals in the presence of heavy ignition noise is excellent owing to the fact that the avc system is protected from excessive noise peaks, thereby preserving maximum receiver sensitivity in the presence of high-level impulse noise. The distortion produced by this type of controlled i-f limiter appears to be insignificant in terms of maintaining excellent speech intelligibility.

Single Tube Square-Wave Generator

By Sergio Bernstein and William J. Spaven

Government Division
Fada Radio and Electric Co., Inc.
Belleville, N. J.

A relatively simple, one-tube clipper circuit has been designed which is capable of developing square waves by properly shaping a sinusoidal input waveform.

Basically the circuit consists of a

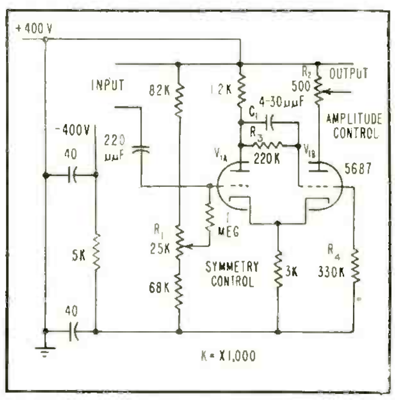


FIG. 1—Generator uses Schmitt trigger circuit to produce square waves from sine-wave input

high-speed, cathode-coupled bistable multivibrator known as the Schmitt trigger circuit.

In Fig. 1, the grid of the first triode V_{1A} is connected to a d-c voltage source which can be varied in amplitude. When this voltage is

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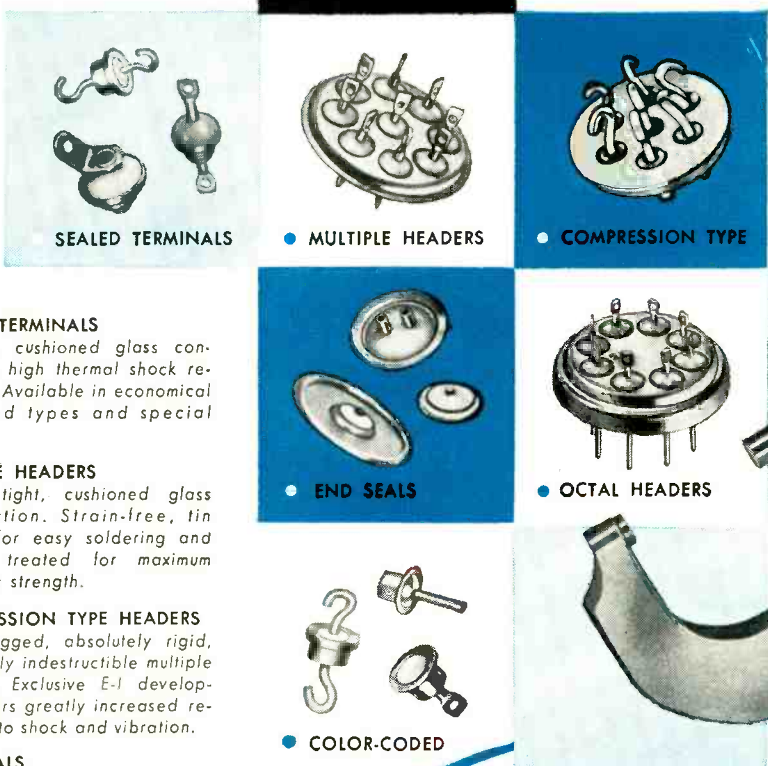

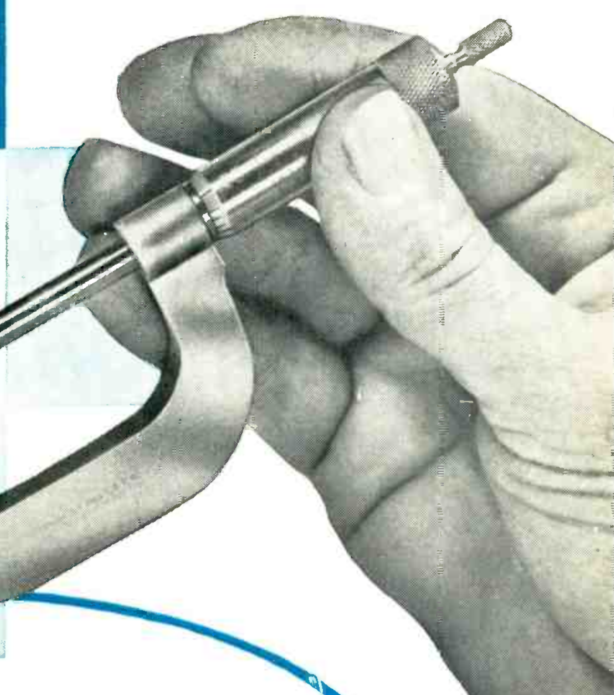

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zero V_{1A} is nonconducting. The plate voltage is direct-coupled through a frequency compensated voltage divider, R_3, R_4 and C_1, to the grid of the second triode causing V_{1B} to conduct. When the grid voltage of V_{1A} approaches a voltage equal to the cathode potential minus the grid bias, V_{1A} starts to conduct. At a slightly higher voltage, a critical point is reached and regeneration takes place causing a sudden transfer of current from V_{1B} to V_{1A}. In this second state, V_{1A} is conducting and V_{1B} is cut off.

As the grid voltage is reduced no change in state will occur until the input voltage approaches a second critical potential. A regenerative condition again results, and the circuit returns to its previous stable state with V_{1A} cut off and V_{1B} conducting.

Rectangular Wave

By introducing a varying waveform at the grid of V_{1A} it is possible to develop a rectangular waveform at the plate of V_{1B}. The signal to be clipped is coupled to the grid through a large blocking capacitor. Any waveform may be used at the input to provide a rectangular waveform of constant amplitude at the output.

With the parameters indicated, a waveform having a peak-to-peak amplitude of approximately 5 volts is required to trigger the circuit. The input impedance is 1 megohm. Maximum output waveform amplitude is approximately 20 volts peak-to-peak. The output impedance varies from zero to 500 ohms depending on the setting of the amplitude control. A negative power supply is used so that no output coupling capacitor is required. This feature is necessary if long pulses with perfectly flat tops are to be obtained. The measured rise time between 10 and 90 percent amplitude points of the output waveshapes is 0.25 microsecond. It is important that the 3,000-ohm cathode resistor be noninductive. If a wire-wound resistor is used, the rise time of the output waveform will be greater than specified.

Two controls are included in the design. Symmetry control R_1, var-

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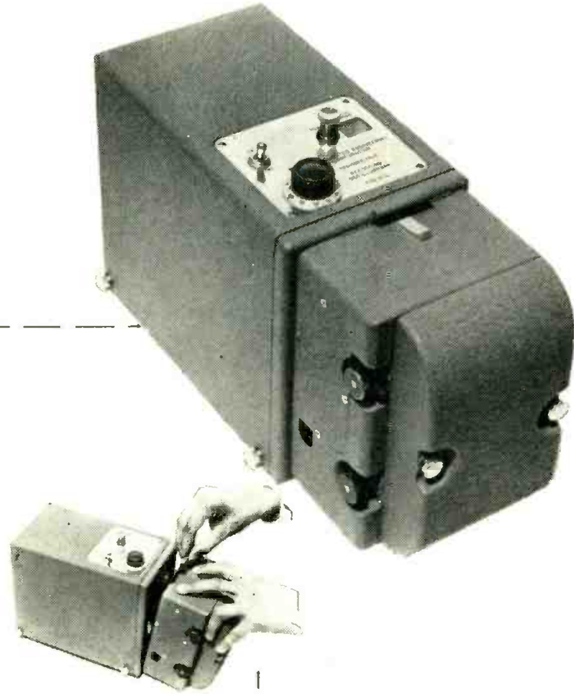
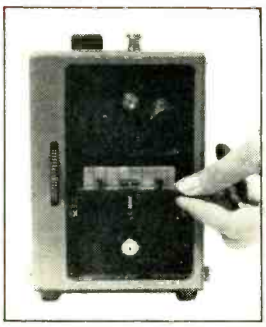


The Consolidated 5-117 Recording Oscillograph features a detachable magazine which accommodates 100 foot rolls of recording paper 70 millimeters wide. An integral footage indicator shows the remaining or unexposed record length. The record is positively driven through change gears, and any one of six speeds from ¾ inch to 24 inches per second may quickly be selected. The CEC Type 5-117 Recording Oscillograph gives you precision dynamic data recording for the price of a pen-type recording oscillograph.



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Record material	70 mm wide photographic record paper or film.
Record magazine	Daylight loading, 100 foot capacity.
Record speeds	6 steps from ¾" to 24" per second.
Time indication	½ inch lines photographed along edge of record at 1/10th and 1/100th second intervals.
Record identification	5 digit number automatically advanced and photographed at start of each run.
Controls	Recording Switch, Galvanometer Illuminator Rheostat, Power On-Off Switch.
Viewing screen	Calibrated ground glass screen for initial spot setting and observation of galvanometer traces.
Connectors	Individual locking-type connector for each galvanometer input.
Power requirement	115 volt, 60 cycle ac, 90 watts maximum.
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ies the d-c bias applied to the grid of V_{1A}. When a sine wave is applied to the input grid, it is possible to obtain an assymmetrical output waveform, the duty cycle of which may be varied from 20 to 80 percent.

The amplitude control, R_2, varies the amplitude of the output waveform from 0 to 20 volts peak-to-peak. The device is capable of developing square waves varying in frequency from 20 to 200,000 cycles.

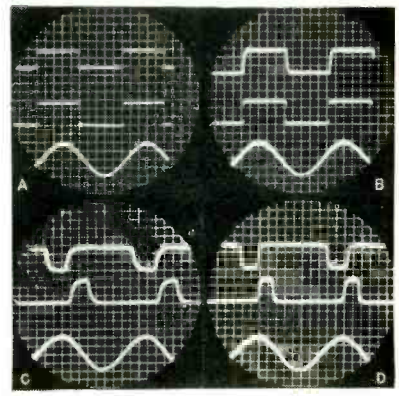

FIG. 2—Output waveforms obtained using a 20 cps input (A), 10 kc input (B), 200 kc input (C) and 200 kc with capacitive loading (D)

Figure 2 shows the output waveforms obtained with sine-wave input signals. Effect of capacitive loading is also shown. Pulses as short as 1 microsecond can be obtained with a repetition rate of 200 kc.

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Elmore and Sands, "Electronics", p 99, McGraw-Hill Book Co., Inc., N. Y., 1949.

Signal Detector for High Noise Levels

By Scott L. Shive
Signal Corps Engineering Laboratories
Fort Monmouth, N. J.

A DEVICE useful for detecting a small sine-wave signal of known frequency masked by random electrical noise of relatively high amplitude consists essentially of a gating

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circuit which alternately presents high and low impedance for equal periods of time to the source. When the frequency of the switching coincides exactly with the frequency and phase of the signal, the signal voltage is rectified and appears as a d-c component, with an average value proportional to signal level. It may be detected by placing a d-c ammeter in the line carrying the signal-plus-noise currents.

Although the rms value of the total noise-voltage spectrum may be many times greater than the rms value of the signal, noise voltage components existing at any frequency other than exactly that of the switching frequency will produce no net average direct current. The frequencies to which the d-c meter will respond determine the bandwidth of noise voltages above and below the switching frequency which may produce meter oscillation.

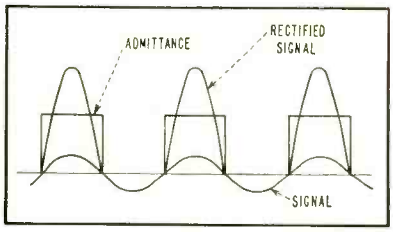

FIG. 1—Rectified signal resulting from combination of a-c signal with square admittance wave of detector circuit

For example, if the meter responds to frequencies from zero to 5 cycles per second, then noise voltages in a frequency band 5 cycles on either side of the switching frequency may produce oscillatory meter response. However, the meter may be damped to any desired degree and made to respond to no frequency greater than a small fraction of one cycle per second. In this sense the circuit may be considered to be an extremely selective detector circuit, or a filter circuit with extremely narrow band response whose center frequency may be varied over any desired range by changing the switching frequency, and whose bandwidth of response may be controlled to any desired degree by regulating the meter damping.

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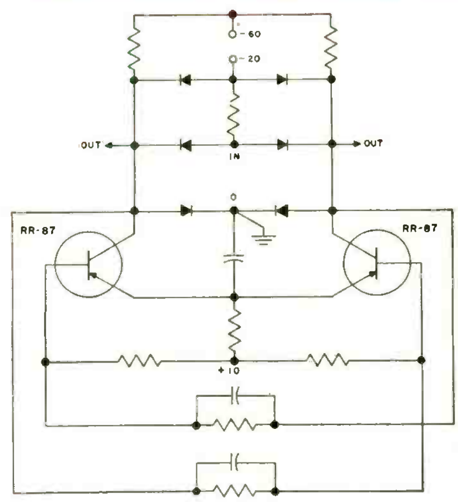

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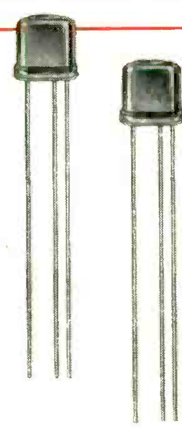

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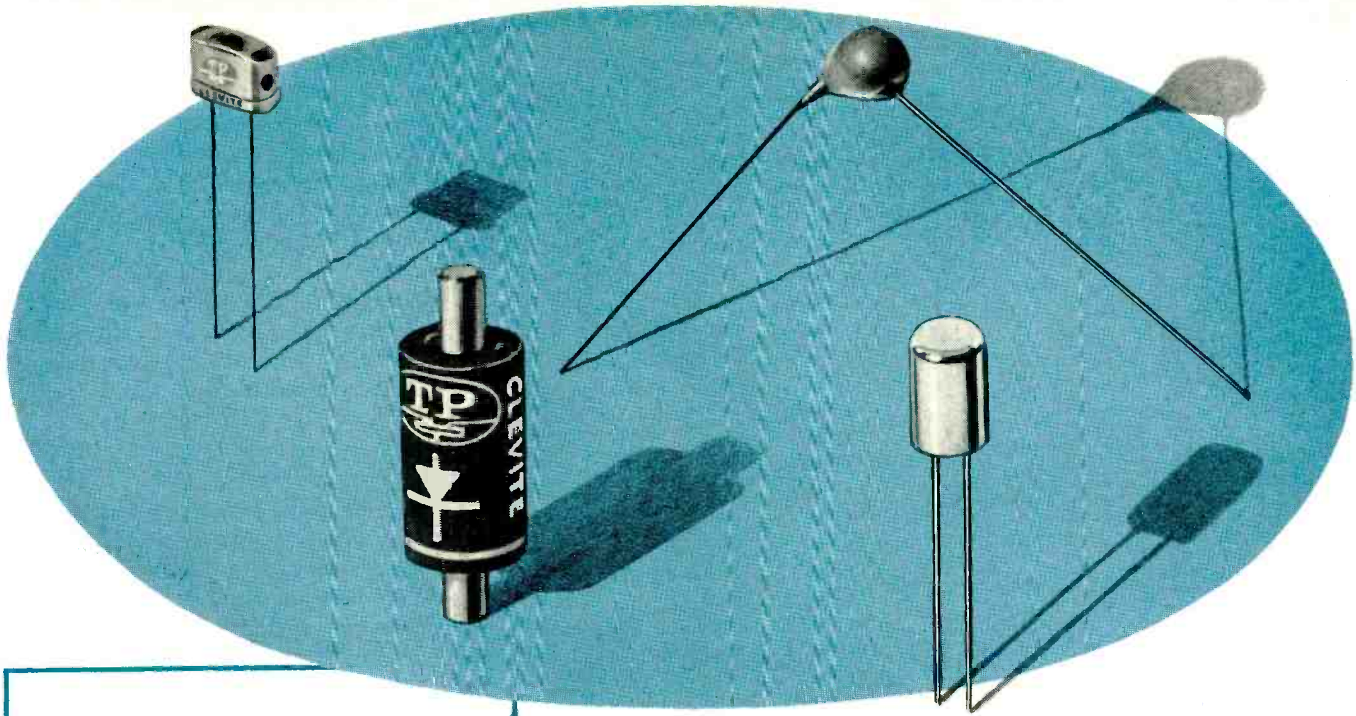
single frequency detection consists of the mechanically driven commutator. Driven at a speed equal to one-half that of the signal to be detected, the commutator presents an open circuit for one quarter revolution and no current flows through the ammeter. For the next quarter revolution the commutator presents a short circuit and current flows through the ammeter limited only by the source impedance. Since current can flow only for alternate half cycles of the signal, half-wave rectification of the signal occurs and is evidenced by a net average d-c reading on the ammeter proportional to signal voltage amplitude.

The signal voltage to be detected is a sine wave alternating at the switching frequency, and the resulting current is equal to the product of the sinusoidal signal voltage wave and the zero-based square admittance wave as shown in Fig. 1.

D-C Components

A d-c term, equal to the value of the rectified signal voltage, results only from the product of the signal voltage and the fundamental of the admittance wave, because the product of two sine functions contains a constant, or d-c term, only when the frequencies are identical. However, because of the harmonic content of the admittance wave, small d-c currents may result from the products of the harmonics of the admittance wave with components of the noise voltage existing at those same frequencies. Such d-c currents, however, will be extremely small because any single frequency component of a random noise voltage is theoretically infinitely small, but low frequency voltages within the response band of the d-c meter will be produced by the combined sum of noise-voltage components within that narrow frequency band around each of the specific harmonic frequencies of the admittance wave. These low-frequency voltages will produce random fluctuations of the d-c ammeter. The products of higher harmonics of the admittance wave and noise voltages of those higher frequencies will give rise to progressively lower amplitudes of fluctuation voltages, however, because the amplitude of



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1N54	1N70	1N110	4E
1N54A	1N72	1N111	4F
1N55	1N75	1N112	4G
1N55A	1N81	1N113	4H
1N55B	1N86	1N114	4I
1N56	1N87	1N115	4J
1N56A	1N88	1N116	4K
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TRANSISTORS • DIODES • SEMI-CONDUCTOR MEASURING EQUIPMENT any of the square wave harmonics is inversely proportional to the order of the harmonic. Fluctuation voltages due to all harmonics of the admittance wave except fundamental may be eliminated by a low-pass filter in the ammeter circuit cutting out all noise-voltage frequencies above the signal frequency. The harmonics could also be eliminated if the admittance-time function were a perfect sinusoid instead of a square wave.

If only the sine-wave signal voltage and the square pulsed admittance wave with base on the zero axis are considered, the damped ammeter which reads the average of the product of these two functions could be taken to indicate one point on the cross correlation curve of the sine wave and the square wave of this specific type. If the signal frequency shifts phase slowly and continuously with respect to the switching frequency, the ammeter reading relative to the phase represents a plot of the cross correlation function.

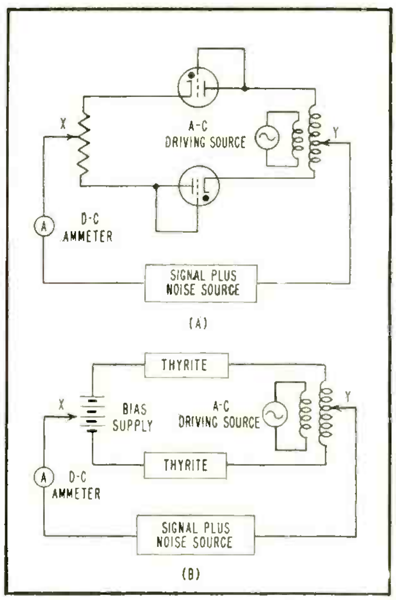

FIG. 2—Detector circuit using thyratrons (A) and thyrite resistors with bias source (B)

The magnitude of the average d-c current for a given a-c signal voltage and given maximum circuit admittance is greater for a square wave admittance-versus-time function than for any other wave shape.

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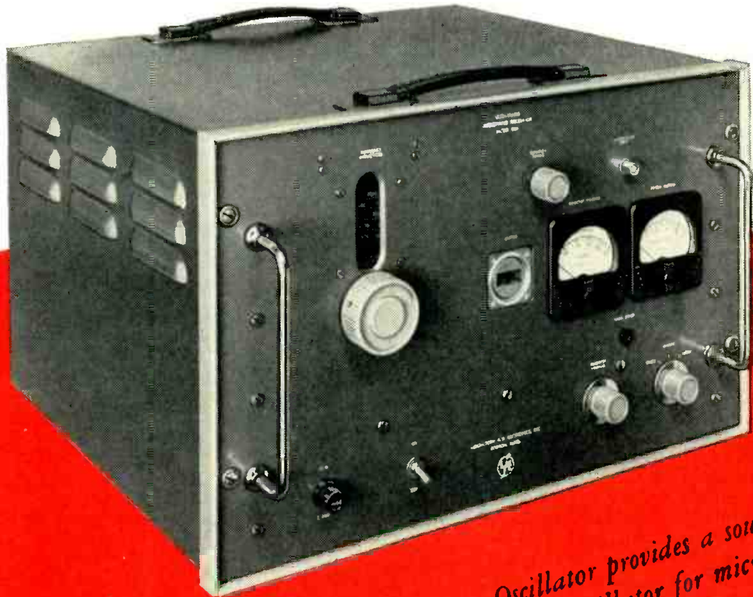

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Dial Calibration
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Frequency Stability
Short Term Deviation – less than one part in 10^8
Long Term Drift – negligible after complete warm-up

Modulation
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Power Output
80 – 100 milliwatts
Output flange – UG 40/U

Power Consumption
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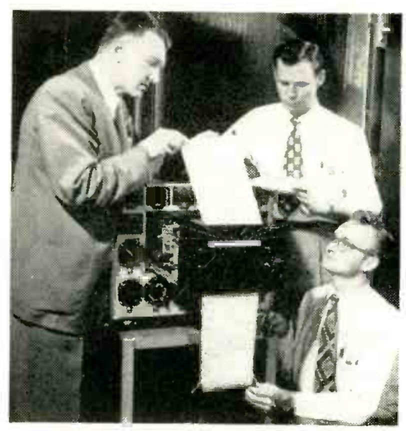
PRECISION ELECTRONIC EQUIPMENT • OSCILLOSCOPES • MAGNETOMETERS • COMPUTERS • SOLID DELAY LINES square wave, admittance-versus-time characteristic, is shown in Fig. 2A. The a-c driving signal applied to the primary of the transformer builds up potential between plate and cathode in the two thyratrons in series with the transformer secondary. When the potential is in the forward direction they ionize and become conducting at a relatively low voltage and remain so for virtually the duration of that half cycle. When the potential across the tubes changes from the forward to the reverse direction, the tubes extinguish and remain so for the duration of that half cycle. During this process, the admittance of the circuit, as seen between points X and Y, is zero during the half cycle that the tubes are extinguished and relatively high during the half cycle that the tubes are conducting. The grids of the thyratrons, instead of being tied to the plates as shown, may be separately driven by a timed pulse to insure simultaneous ionization of both tubes.

The thyratrons in this circuit may be replaced by any rectifier elements including vacuum tubes or solid-state devices connected in



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471-1000	1200-K	5/8"	±20%	GMV
1001-2700	HI K	9/16"		GMV
2701-5000	HI K	3/4"		GMV
5001-10000	HI K	3/4"		GMV
	3-KV			
220-500	1200-K	5/8"	±20%	GMV
501-1000	1200-K	5/8"	±20%	GMV
1001-5000	HI K	3/4"		GMV
	4-KV			
181-680	1200-K	3/4"	±20%	GMV
681-1000	HI K	5/8"		GMV
	5-KV			
131-330	1200-K	7/8"	±20%	GMV
331-1000	HI K	7/8"		GMV
	6-KV			
101-220	1200-K	3/4"	±20%	GMV
221-470	1200-K	7/8"	±20%	GMV
221-1000	HI K	7/8"		GMV
471-1000	HI K	7/8"		GMV

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69-82	N-750	5/8"	5-10-20%	GMV
83-130	N-750	5/8"	5-10-20%	GMV
131-200	N-1500	5/8"	5-10-20%	GMV
201-250	N-1500	3/4"	5-10-20%	GMV
251-330	N-1500	7/8"	5-10-20%	GMV
	3-KV			
5-15	N-750	5/16"	5-10-20%	GMV
16-20	N-750	1/2"	5-10-20%	GMV
21-56	N-1500	5/8"	5-10-20%	GMV
57-180	N-1500	5/8"	5-10-20%	GMV
181-240	N-1500	3/4"	5-10-20%	GMV
241-330	N-1500	7/8"	5-10-20%	GMV
	4-KV			
5-68	N-1500	7/8"	5-10-20%	GMV
69-180	N-1500	7/8"	5-10-20%	GMV
	5-KV			
5-30	N-1500	5/8"	5-10-20%	GMV
31-60	N-1500	3/4"	5-10-20%	GMV
61-130	N-1500	7/8"	5-10-20%	GMV
	6-KV			
5-20	N-1500	3/4"	-10-20%	GMV
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series such that they are both in the same direction relative to the driving voltage and both have approximately similar impedance-voltage characteristics.

Virtually any device with a nonlinear impedance-voltage characteristic, not necessarily a rectifying device, might be used by the introduction of a d-c bias voltage source. A circuit utilizing nonlinear elements, such as thyrite, with symmetrical forward and reverse impedance characteristics, is illustrated in Fig. 2B. In this circuit, the battery furnishes a constant bias voltage across the thyrite elements, and the a-c driving voltage superimposed upon this bias, raises and lowers the unidirectional potential such that the impedance of the elements is alternately lower and higher. The admittance of the circuit alternates and selective rectification of the signal voltage will result.

VHF Transistor Oscillators

By H. E. Hollmann
U. S. Naval Air Missiles Test Center Point Mugu, Calif.

The dual of a conventional vacuum tube is the positive-grid or retarding-field tube at an aperiodic condition of operation[1]. The conventional tube is based on an electrostatic control of its space charge around the grid and the positive grid tube exhibits a control of the current distribution and has a current gain $\alpha_o = -1$.

The positive-grid tube is a perfect example for an ideal transistor that, with semiconductors, can only be approached to a degree. The analogy between transistors and retarding-field tubes is so complete that the latter can be measured and investigated in transistor testers[2]. The ideal form, however, results in the fact that the positive-grid tube is characterized only by a single parameter, input impedance, instead of a multiplicity of transistor parameters.

Only under peculiar conditions of operation can the alpha be less or

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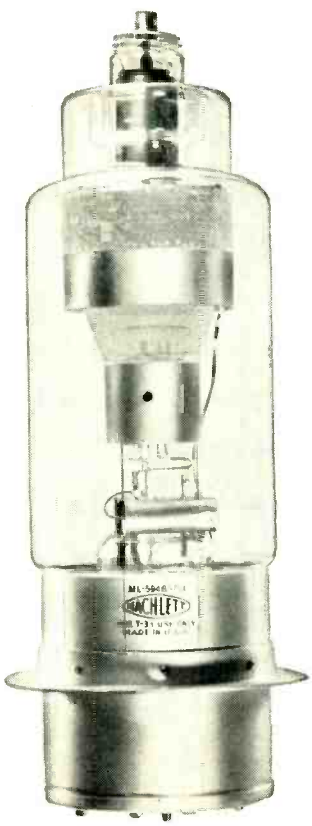

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Typical Operation

	ML-5949/1907	ML-5948/1754	
Plate voltage, forward, epy	25	25	KV max.
Plate voltage, inverse	5	5	KV max.
Peak current, ib	500	1000	amps max.
Pulse repetition rate, prr	450	360	pps
Pulse duration (nominal)	2.0	2.5	usec
epy × prr × ib*	6.25×10^9	9.0×10^9	

* epy × prr × ib is the product of maximum forward plate voltage by pulse repetition rate by maximum pulse current. The maximum limit is determined to hold average tube dissipation to a reasonable maximum value.

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Hydrogen thyratrons as high speed shunting switches are described in Cathode Press, Vol. 11, No. 1, 1954. Write for a copy.

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greater than one, namely if electron oscillations or secondary emission occurs. On the other hand, an imperfect retarding-field tube, such as a pentode with imperfect saturation, simulates junction transistors and requires some additional parameters.

Retarding Field

With this analogy in mind, almost all transistor circuits can be simulated with aperiodic retarding-field tubes as in the Hartley oscillator[3], and the transistor audion[4].

Retarding-field tubes exhibit a peculiar phenomenon that is not possible in present transistors, namely the electron-oscillations around the grid. Their frequency is determined by the Barkhausen

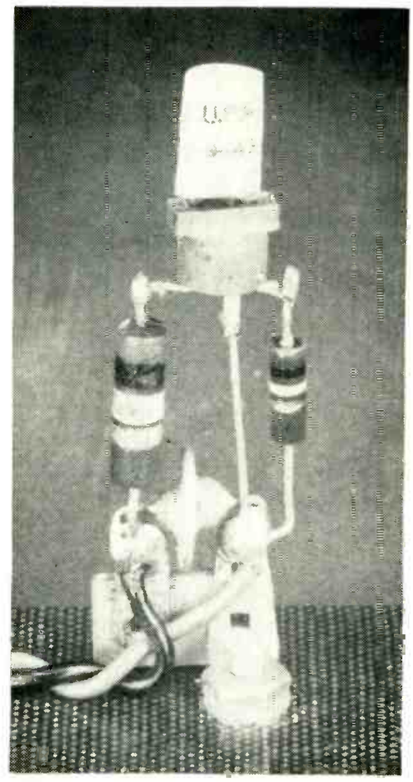

FIG. 1—Simple circuit uses internal oscillations of transistor to reach very-high frequencies

relation $\lambda^2 V_g = K$ or $f_o^2/I_c = K$, where V_g denotes the positive-grid potential. Extending the analogy into the transit-time region where the transit time of the charge carriers determines the performance of the tubes as well as of transistors, it can be seen that a type of internal transistor oscillations is to

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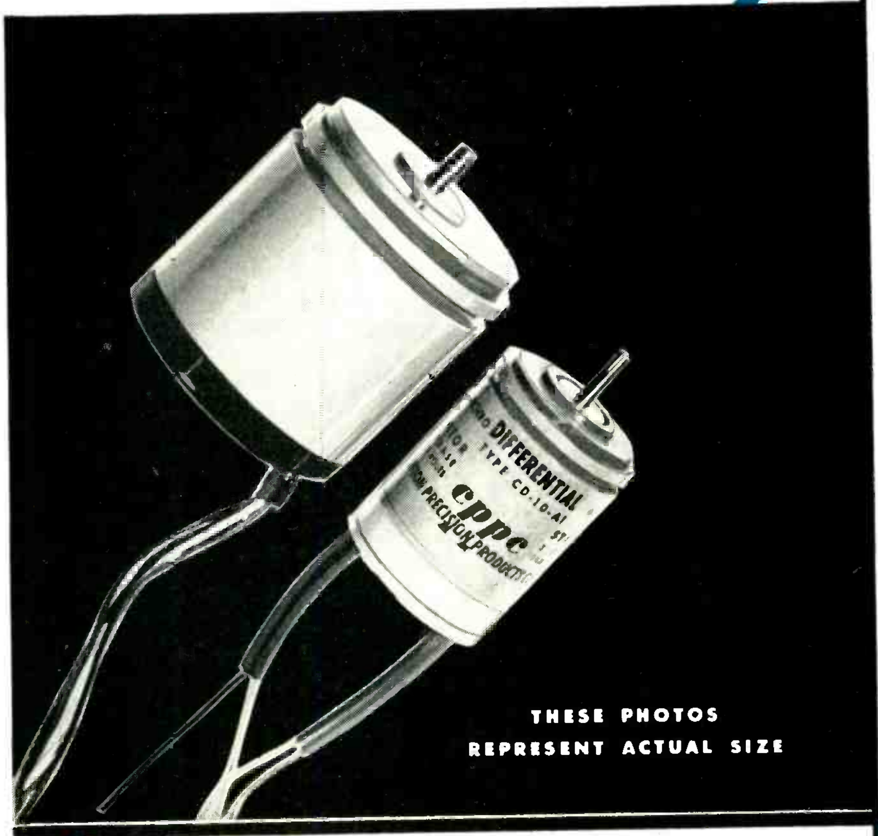

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1944	20′	5 oz.	$35.00
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Coming	5′	5 oz.	?
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be expected even if they are based on a different mechanism.

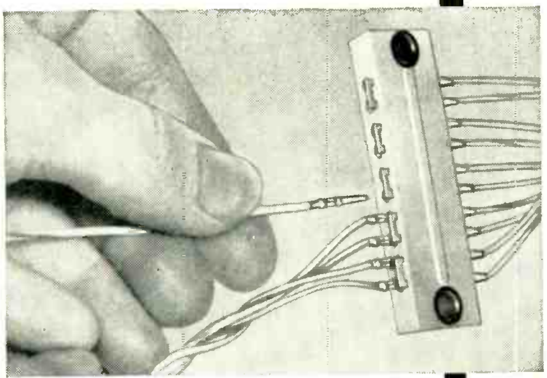
A significant difference between the retarding-field oscillator and self-oscillating transistors must be pointed out. Whereas the electrons themselves represent the resonator of a positive-grid tube, transistors incorporate a resonator in the form of an induced inductance resonating with the cold transistor capacitances.

To explain the origin of the induced inductance, consider the Miller effect. In a vacuum triode, grid voltage and plate voltage are in phase-opposition so that the displacement current passing the grid-plate capacitance is superimposed upon the displacement current charging the grid capacitance.

FIG. 2—Cavity resonator transistor oscillator operates at frequencies as high as 350 mc

The result is an effective input capacitance proportional to voltage amplification. In transistors, the opposite phenomenon takes place. Input and output voltages of a grounded-base connection are in phase so that the emitter sees the collector capacitance with a negative sign or in the form of an inductance. This may be attributed to a dual Miller effect and, in connection with the cold capacitances, forms a series-resonant circuit. At the same time, the transistor may exhibit such a large α_o that the resistive component of the input impedance becomes negative so that self-excitation of the internal tank circuit takes place.

Figure 1 shows an extremely



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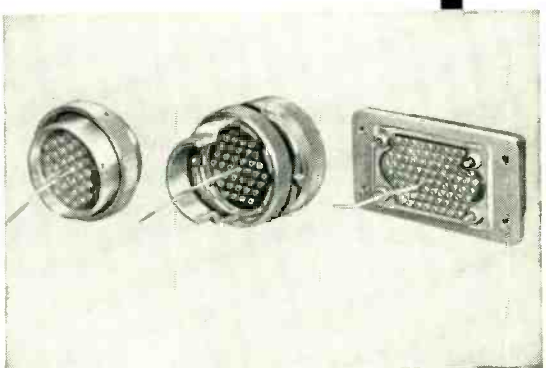

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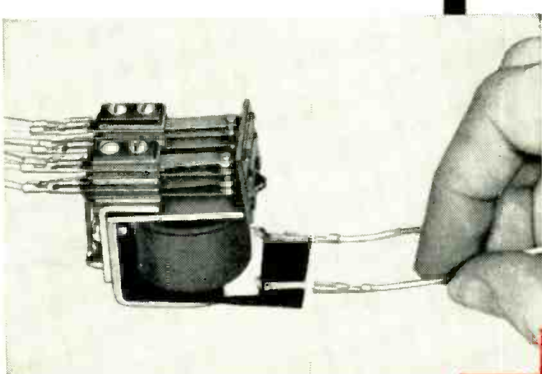

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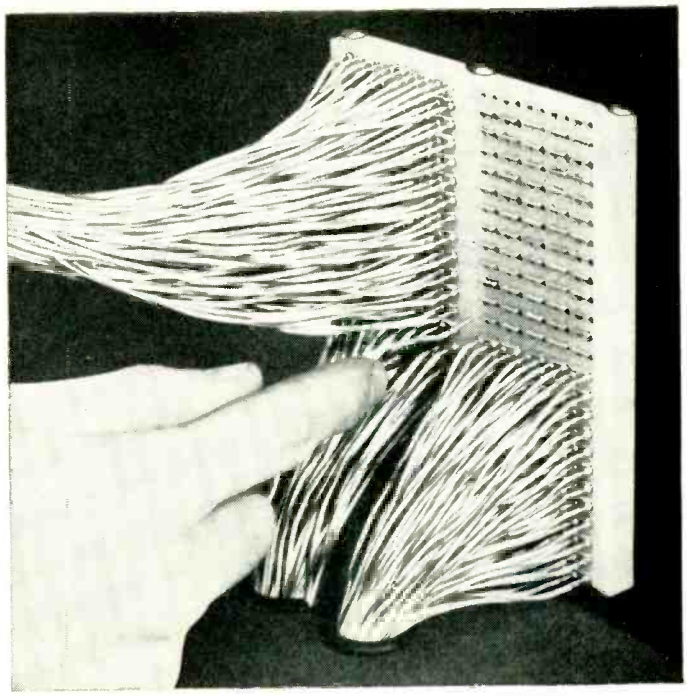

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simple transistor transmitter producing the described internal oscillations. The transistor is supported by two precision resistors of 10,000 ohms in the emitter and collector circuit which stabilize the supply currents and secure proper operating conditions. The internal oscillations have sufficient power to permit their frequency to be measured with a grid-dip meter.

Since the induced inductance depends on transistor parameters, frequency f_o varies with the operating point and in particular with the collector current. The relationship between f_o and I_c follows the formula $f_o^2/I_c = K$, which is the dual of the Barkhausen relation in that the collector current replaces the grid voltage.

With r-f transistors combining a large α_o with a high cutoff frequency, oscillations as high as 75 mc have been measured. Much higher frequencies, however, may be expected if the transistors are pulsed. Harmonics run as high as 600 mc and are utilized to drive a cavity resonator.

Figure 2 shows a vhf transistor oscillator whose cavity reaches as high as 350 mc. Frequency modulation is produced by superimposing a minute modulating current upon the supply or bias value. For example, in the 100 mc range, the output voltage of a record player with a piezoelectric pickup has been found to produce a 100 percent modulation with good fidelity.

REFERENCES

(1) H. E. Hollmann, Vacuum Tube Analogy of Transistors, ELECTRONICS, p 156, July 1952.

(2) H. E. Hollmann, Transistors in Terms of Vacuum Tubes, *Tele-Tech*, p 74, May 1953.

(3) H. E. Hollmann, Transistor Oscillators, *Tele-Tech*, p 82, Oct. 1953.

Measuring TV Sound Modulation

BY ROBERT F. WOLFSKILL

Commercial Radio Monitoring Co. Kansas City, Mo.

FREQUENCY SWING or deviation of a television sound transmitter can be measured with portable equipment. Required are a good quality


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audio oscillator and a communications-type receiver, with S meter, capable of tuning 4.5 mc.

Basis of the technique is the fact that, depending upon frequency and amplitude of modulation, the varying carrier amplitude of a frequency-modulation transmitter often goes through zero. The particular application is possible because a 4.5-mc signal is generated by the difference in frequency between the picture and sound carriers of a standard television transmission.

In practice, with both picture and sound carriers present, there is a strong 4.5-mc signal in the vicinity of the transmitter. Frequency swing is checked by modulating the sound transmitter with a specified tone until at a given amplitude the power in the center-frequency carrier is all dissipated in the sidebands. The magnitude of the frequency-modulated center-frequency carrier will theoretically reach zero when the peak frequency swing is 2.40, 5.52 and 8.65 times the audio frequency used to modulate the f-m transmitter.

Receiver Placement

The receiver should be located in the transmitter room near the modulation monitor. The antenna on the receiver need be only a short wire five to ten feet long. Receiver and antenna should be kept away from the transmitters proper to avoid picking up signals from lower-power multiplier stages. The modulation should be removed from both the picture and sound transmitters so the 4.5-mc signal will be at maximum amplitude and as sharp as possible.

The receiver is tuned to the center of the frequency where the S meter will be at maximum reading. Adjust the r-f gain control or antenna length until the reading is about 9 to 10 db over S 9. With either the picture or sound carrier turned off the S meter reading with no 4.5 mc signal should be near zero or not more than S 2 or S 3.

The frequency of the audio oscillator is set to 5.2 kc with the output control of the oscillator at minimum. Slowly increase the output of the oscillator until a minimum

reading is obtained on the S meter. At this point the aural transmitter is being modulated 50 percent or about 12.5-kc swing. This first null will appear when the amplitude of the audio-tone frequency modulates the transmitter to a frequency swing equal to 2.4 times the frequency of the audio tone being used, in this case 5.2 kc. Since 25 kc swing on the aural transmitter equals 100 percent modulation, 12.48 kc will equal 50 percent modulation.

After rechecking the tuning of the receiver to make sure it is still peaked on the 4.5 mc signal, set the frequency of the audio oscillator to 4.55 kc. Increase the output of the audio oscillator until the S meter reaches a null and increases to a maximum as the output of the audio oscillator is increased. Continue to increase the output of the audio oscillator until the S meter indicates a second null. Slowly increase and decrease the output of the audio oscillator until the S meter is at a minimum reading on the second null.

Full Modulation

At this point the aural transmitter will be modulated 100 percent. In this case where the second null is being used, the factor to determine frequency swing in kc is 5.52 times the frequency of the tone being used. Since the frequency of the tone in this case was 4.55 kc and the factor is 5.52, the frequency swing is 4.55 times 5.52 or 25.2 kc. Since 25 kc swing equals 100 percent modulation, the modulation monitor should read 100 percent under these conditions.

Another test that can be used to determine 100 percent modulation is to modulate the sound transmitter with a 10.4-kc tone. With this higher-frequency tone, the 100 percent modulation condition will be reached on the first null. However when using higher audio frequencies, there may be some error in the reading of the modulation monitor owing to error in the pre-emphasis and de-emphasis pads in the transmitter and monitor. If the output of the audio oscillator can be kept constant, the 100 percent modulation reading can be determined and then the frequency of

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the audio oscillator can be lowered to 1 kc watching the monitor to see if the modulation-percentage reading changes. This will give an indication of how flat the combination of the pre-emphasis in the transmitter and de-emphasis in the monitor is. To make this test the output of the audio oscillator must be flat over the frequency range.

There are some other factors that must be considered in making measurements where no modulation monitor is available and the 50-percent and 100-percent readings are to be established on a vu meter. The pre-emphasis should be removed at the transmitter. If this is not possible, it will be necessary to take into consideration the amount of pre-emphasis at the frequency of the tone being used. Referring to the standard pre-emphasis curve for a time constant of 75 microseconds will give specified increases in db over the curve referred to 1 kc.

For example, if the 100-percent modulation condition is obtained by using a tone of 4.55 kc on the second null, it would be necessary to increase the input to the transmitter about 6.5 db to obtain 100-percent modulation at an audio input of 1 kc.

Third Null

If oscillator tone is about 2.89 kc the sound transmitter can be modulated until the third null is obtained on the S meter. This would give a reference point on the vu meter for 100-percent modulation, since a tone of 2.89 kc times a factor of 8.65 (third null) equals 25-kc swing. Referring to the standard pre-emphasis curve will show that it would take about 3 db more signal from the audio oscillator to modulate the aural transmitter 25 kc (100 percent) with a 1-kc tone than it takes with a 2.89 kc tone.

While additional nulls will be obtained as the audio oscillator output is increased, the nulls become less predominant and it is harder accurately to determine and count on the S meter. Also the receiver must be very selective to prevent the selection of first and second-order sidebands that occur at about factors of 3.0 and 5.0 times the modulation-

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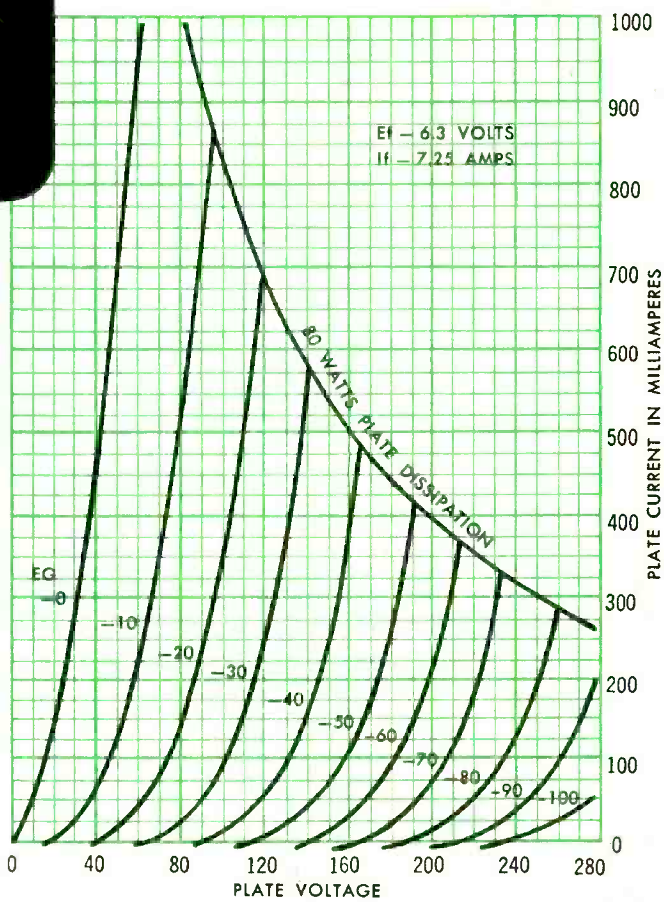

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tone frequency. When using low modulating frequencies, these might be counted along with the first and second nulls unless the receiver is extremely selective.

Similarly, with low modulating frequencies the first and second nulls occur with such a low level of audio signal that it is difficult to control the increase in output of the audio oscillator slowly enough not to miss either or both the first two nulls. If the fourth or fifth nulls are used, the factors are about 11.8 and 15.0 respectively. For 100-percent modulation (25-kc swing) using the fourth null, the tone should be about 2.12 kc. For the fifth null the tone should be about 1.66 kc. Another disadvantage of using the lower audio frequencies is that the accuracy of the audio tone used must be greater to determine the kilocycle swing accurately, owing to the higher multiplying factor.

Pre-emphasis

If the station has a modulation monitor or if the pre-emphasis circuit is removed from the transmitter (where the monitor is not available) it is not necessary to consider the above. The modulation monitor contains a de-emphasis circuit that will cancel the effect of the pre-emphasis circuit in the transmitter.

In making these measurements it is important that the picture and sound carriers be unmodulated so that a clean sharp signal will be received at 4.5 mc with both carriers on. The picture carrier can be operated at reduced power if that is necessary to use the transmitter unmodulated. The sound carrier should have as little residual modulation as it is possible to have.

The receiver should be selective enough to reject carriers in the order of 5 kc either side of 4.5 mc to the extent that they will not read on the S meter. With the 4.5-mc carrier off, the noise level at the receiving location should not read over S 2 or S 3 at the most. With the 4.5-mc carrier on, the r-f gain and antenna pick-up should be adjusted so the meter reading is about S 9 or 10 db over S 9.

Several readings of the modulation percentage can be taken and the average of all the readings can

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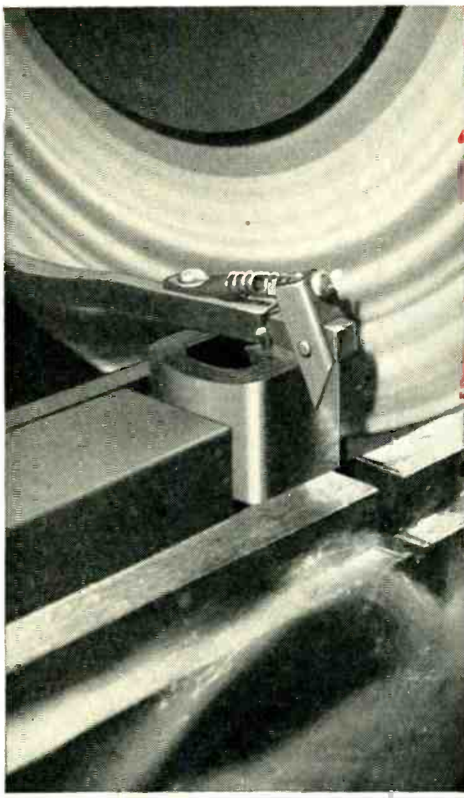

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Increasing Validity of Shock Tests

By Charles E. Crede
Chief Engineer
Barry Corporation
Watertown, Mass.

LIKELIHOOD of damage to equipment increases as the maximum stress in structural members increases. A typical equipment may be considered to consist of many structures each with its characteristic natural frequency. The equipment may be simulated by a device known as a multifrequency reed gage.

Such a gage is made up of a chassis, a number of reeds of different natural frequencies and means to indicate the maximum deflection of each reed during shock. If the deflections of identical reeds are compared for different conditions of shock, the relative severity of the respective shocks may be estimated by comparing the deflections of identical reeds.

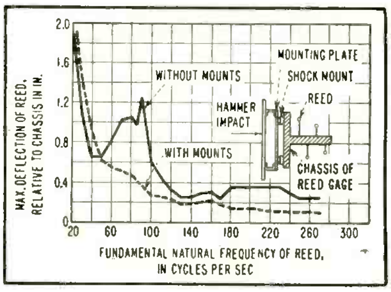

FIG. 1—Data from multifrequency reed gage using five foot hammer drop on high impact shock testing machine for lightweight equipment

Shock tests were made on a high impact shock testing machine first with a reed gage attached rigidly to the mounting plate of the testing machine and then with the gage attached to the mounting plate by shock mounts. By varying the natural frequency of the reeds the effect of this shock upon structures of different natural frequencies was determined.

Figure 1 shows the maximum deflection of the reeds and Fig. 2 shows the maximum acceleration of

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the same reeds, calculated from their maximum deflections, both expressed as a function of the fundamental natural frequency of the reed.

The amplitudes of the curves indicate the relative severity of the shock experienced by the equipment. The solid curves are generally somewhat above the level of the dotted curves indicating the extent of the protection that is afforded by the mounts. The difference between the two curves is relatively modest and it is possible that this difference could be compensated by designing the equipment to have greated strength. If no other considerations were involved, it would be difficult to justify the use of shock mounts except for use on equipment of marginal strength.

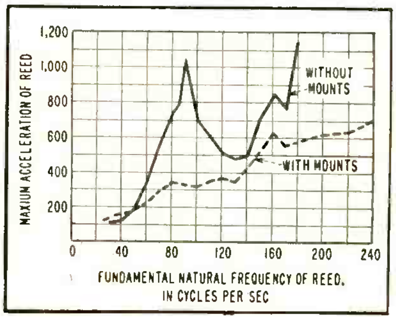

FIG. 2—Response spectra showing large excursions of maximum acceleration characteristic

However, the relatively high peaks in the solid curves at a frequency of approximately 90 cps are significant. These peaks occur because the mounting plate of the shock testing machine had a natural frequency of 90 cps and the reed whose natural frequency is 90 cps experienced a large amplitude as a result of resonance between reed and mounting plate. The curves representing tests with mounts show little evidence of the peak at 90 cps. The mountings thus function as vibration isolators to isolate the transient vibration of the plate resulting from the hammer impact of the shock machine.

The mounting plate of the shock testing machine may be considered simulating one particular type of mounting for the equipment. When the equipment is installed in a vessel, it will probably be mounted

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The 6BQ6GT is a good tube. (Heck, CBS-Hytron originated it.) But, it was designed for 10- and 12-inch TV sets. Today it carries the load in 21-inch sets. Furthermore, it must combat the accumulated dissipation caused by: 1. Line-voltage variations. 2. Faulty receiver adjustments. 3. Shifting values of components due to age and overload. Result: The 6BQ6GT is often operated above maximum ratings.

Obviously, a brand-new design . . . not just an improved 6BQ6GT . . . was needed. The husky CBS-Hytron 6CU6 (See Mechanical Features) is the answer: a premium-performance tube *at no extra cost.* CTS-Rated, it offers generous safety margins for plate dissipation . . . high-voltage insulation . . . and high-line protection. Note also the bar graph showing much larger plate and envelope areas of CBS-Hytron 6CU6.

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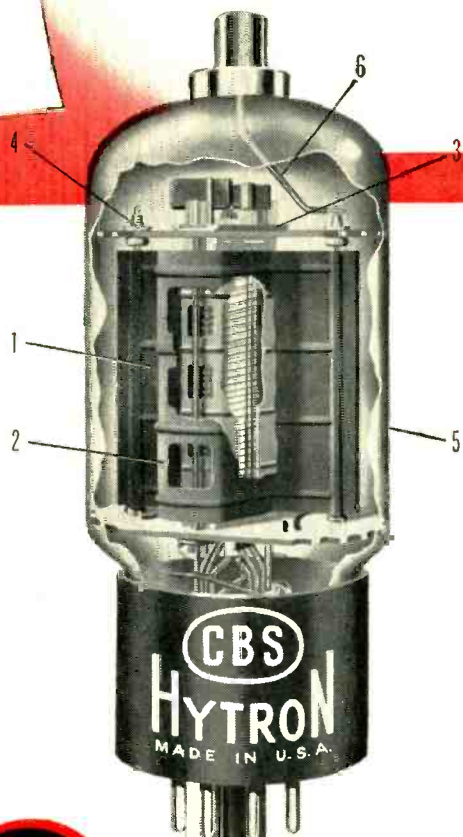

MECHANICAL FEATURES OF 6CU6

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4. Anti-arc mica eyelets.
5. T-12 transmitting-type bulb.
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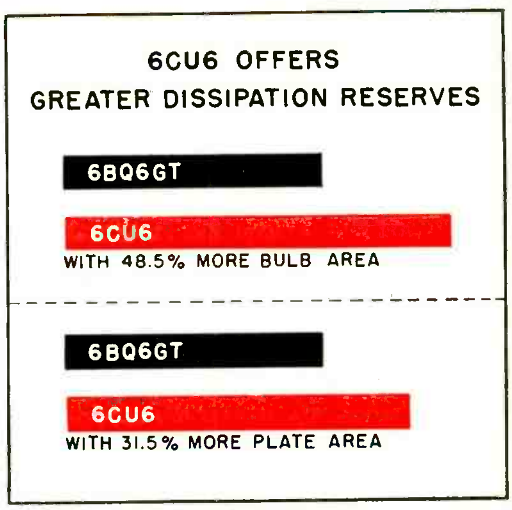

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RECEIVING • TRANSMITTING • SPECIAL-PURPOSE • TV PICTURE TUBES • CRYSTAL DIODES AND TRANSISTORS on a bracket whose natural frequency is different from the natural frequency of the mounting plate on the shock testing machine. The resonance will then occur at a different frequency. A structure of the equipment that did not experience such resonance during the shock test may experience resonant conditions when installed within the vessel.

The shock test without shock mounts thus tends to become invalid, because it fails to predict the failure that may occur as a result of resonance between the structures of equipment and the mounting brackets.

The use of shock mounts almost completely eliminates the effect of these resonances and creates a condition in which the natural frequency of the mounting brackets is unimportant. The natural frequencies of mounting brackets are difficult to predict. In many installations no effort is made to control such natural frequencies.

Tester for Transistor Selection

By NOAH H. KRAMER
*Engineering Laboratory
International Business Machine Corp.
Endicott, N. Y.*

ULTIMATE TEST of a transistor is its behavior in an actual circuit, but it is usually beneficial to have some tests to ascertain if the transistor meets minimum requirements. These requirements must be intelligently chosen to select proper transistors for specific applications.

The tester described here is designed to check two characteristics of a junction transistor that are significant in amplifier applications. They are, I_{co}, the collector current with zero emitter current and $I_{co}/(1 - \alpha)$, the collector current with zero base current. Provision is made to test either *pnp* or *npn* transistors.

The first test measures the saturation current of the collector-base diode I_{co}. On a small signal basis, the I_{co} is indicative of the magnitude of the collector resistance r_c of the equivalent circuit. This current is temperature sensitive and in the usual operating ranges, will double

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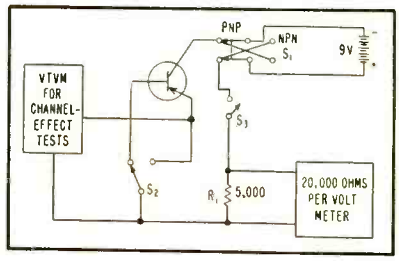
To avoid the use of a sensitive microammeter, currents are measured by the voltage drop across a 5,000-ohm resistor, R_1, as shown in Fig. 1.



Transistor tester measures saturation current of collector-base-circuit and short-circuit gain

The second test determines the short-circuit gain of the transistor. With zero base current, the collector and emitter current will stabilize at the value $I_c = I_{co}/(1 - \alpha)$. Such a circuit, with no d-c path in the base, is extremely sensitive to temperature change and therefore is seldom recommended. However, the measurement obtained representing 5,000 $I_{co}/(1 - \alpha)$ volts is used to determine the short-circuit current gain of the transistor, $1/(1 - \alpha)$, in the following manner.

The result of the first test (5,000 I_{co} volts) is divided into the result of the second test [5,000 $I_{co}/(1 - \alpha)$ volts] obtaining $1/(1 - \alpha)$. This result is independent of the actual value of the 5,000-ohm resistor.

The low resistance of R_1 was chosen so that a 20,000 ohm-per-volt meter could be used for measurements without degrading the accuracy more than twenty percent. A ten microampere I_{co} would then develop a reading of about fifty millivolts.

Provision is made to choose the proper battery polarity by double-pole double-throw switch S_1.

To test for I_{co}, voltage is applied to the collector and the circuit is completed through R_1 to the base. The emitter is left unconnected.

When it is desired to test for $I_{co}/(1 - \alpha)$, the base is left open and the circuit is completed through the emitter. Single-pole double-throw switch S_2 completes the circuit to either the base or the emitter.

To avoid the possibility of

transients owing to plugging the transistor into a circuit with an applied voltage, the momentary normally open switch S_3 is installed. This switch applies voltage to the transistor only when measurements are required.

A third test, pertinent to *npn* grown-junction transistors, can be made with a modification of this equipment. This test is for the so-called channel effect. In this test, a vacuum-tube voltmeter must be used to read the emitter voltage when the S_2 switch is positioned for the I_{co} test. For transistors without the channel effect, the reading will be in millivolts. However, most of the present grown-junction transistors will show a voltage that increases with time. This measurement reaches a few volts in a matter of minutes. The cause of this phenomena is attributed to impurities that create a channel across the very thin base layer of the transistor.

Table I—Typical Data Obtained from Transistor Tester

Transistor (*pnp*)	$5{,}000 I_{co}$ in volts	$\frac{5{,}000 I_{co}}{1-\alpha}$ in volts	$\frac{1}{1-\alpha}$
1	0.038	1.6	42
2	0.038	2.5	66
3	0.08	3.1	39
4	0.04	1.8	45
5	0.02	1.0	50
6	0.04	1.5	37
7	0.03	2.1	70
8	0.04	2.5	62
9	0.05	3.1	62
10	0.06	2.8	47

Typical data concerning the actions of different transistors is presented in Table I. This data could be used, for example, to choose transistors 8 and 9 for push-pull circuits because of their equal gains. Transistor 3 might be rejected for some circuits because its I_{co} is high ($5{,}000\ I_{co} = 0.08$ volt, $I_{co} = 16$ microamperes) and would cause excessive currents as temperature was increased. On the other hand, the low I_{co} of transistor 5 could make it desirable in an application involving extreme ranges of temperature.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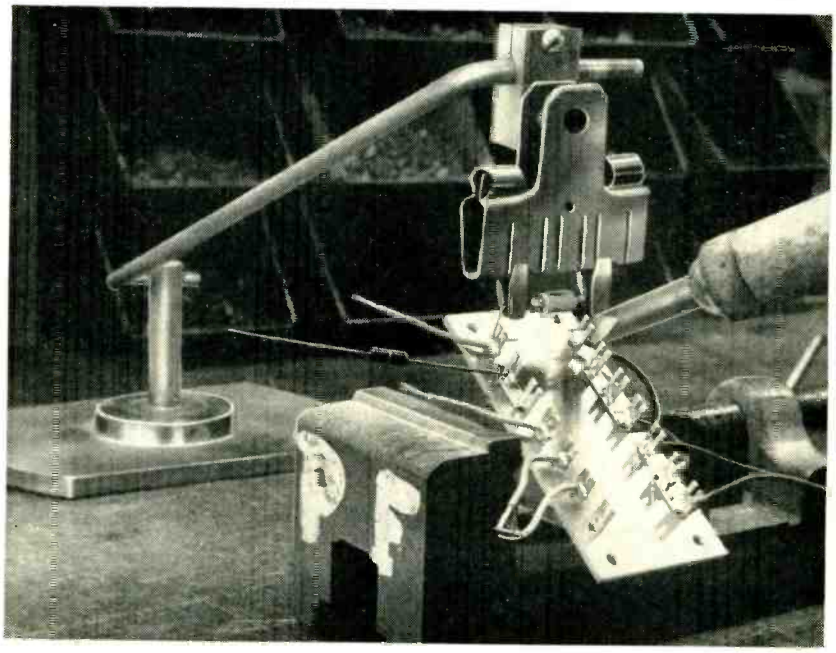
Production Techniques

Edited by JOHN MARKUS

OTHER DEPARTMENTS featured in this issue

Soldering Crystal Diodes

SOLDERING CRYSTALS to a resistor board is a critical job because the heat of the soldering iron can damage the delicate construction of the crystal. A crystal soldering jig devised by Hewlett-Packard, Palo Alto, Calif., solved the problem. It holds the crystal in place for soldering to the resistor board and at the same time dissipates the heat of the soldering operation so it will not harm the crystal.

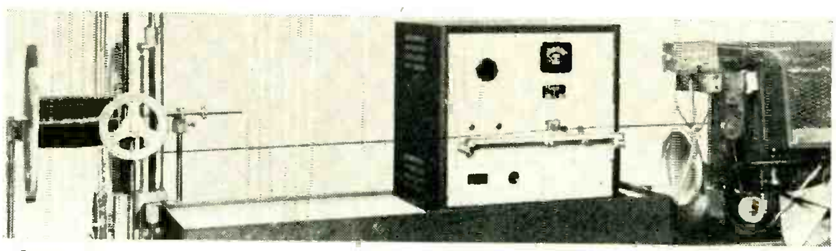


Copper jaws soldered to spring clamps hold crystal in position on terminal board and conduct soldering iron heat away from crystal. Arm on heavy metal plate holds clamp in position

Induction Heater Bonds Wire Strands Before Cutting and Stripping

A TUBE-OPERATED high-frequency induction heater used in conjunction with an Artos automatic wire cutting and stripping machine at Federal Telephone and Radio Corp. serves to bond together the individual tinned strands in the regions to be stripped. This eliminates the necessity of tin-dipping the ends after cutting and stripping.

The heater is located between the reel of insulated wire and the Artos machine, so that the cutting machine mechanism draws the wire through the work coil of the heater. The heating cycle is synchronized with the stroke of the wire cutter so that heating and bonding occurs only in regions where subsequent cutting and stripping operations occur. Manufacturer of the heater is Lepel High Frequency Labora-



Setup for automatic bonding, stripping and cutting of stranded insulated wire

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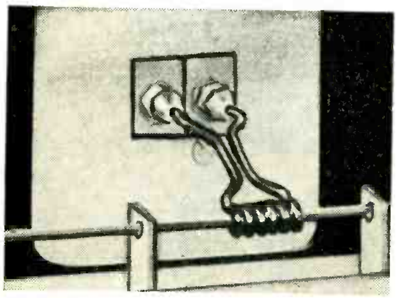

Method of guiding insulated stranded wire through work coil of heater

Motorized Neck Sparker for Picture Tubes

REMOVAL of sharp points from surface areas inside the necks of picture tubes, which might cause difficulty in later high-voltage field installations, is accomplished at General Electric's picture-tube plant at Electronics Park, Syracuse, N. Y., by an automatic sparking process. The metal arm and spring assembly, mounted on top of the high-voltage insulator, is rotated in a horizontal plane while being alternately raised and lowered by an electric motor and gear box over the bench. This mechanical movement gives complete coverage in the tube neck and base while a high-frequency generator provides the necessary power for the sparking operation.

Pushing start button of timer to initiate automatic sparking during final processing of picture tubes

Conveyor Belt Speeds Induction Brazing

Conveyor belt carries transformer headers though induction heating coil from left to right for soldering of terminal seals. Finished parts drop off into tote box at right. Right hand of operator is on knob which raises or lowers conveyor-belt for centering parts in work coil

SOLDERING and brazing of small transformer parts is speeded up greatly by a belt conveyor attached to an induction heater at Triad Transformer Co., Venice, Calif. The endless asbestos-covered canvas belt moves parts through heating coils at easily controlled speeds (regulated by a Powerstat on top of the heater). A simple hand control positions the belt up or down as required for various sizes of parts.

In soldering hermetic seals to transformer lids, the operator simply places the terminals in the lids and drops a preformed ring of soft solder around each terminal. When the lid has passed the coil, soldering is complete.

Original setup time for an operation is fairly lengthy, requiring experimentation with speed of belt, height of belt and power through the work coil. A log of settings for each operation reduces subsequent setup time to a minimum. For operations of 25 or more parts, economy is great. A four-minute hand operation takes 12 seconds per assembly on the conveyor. Use of preformed rings of solder eliminates waste solder and permits use of a non-skilled operator. The conveyor was added to a standard Salesmaster Corp. electronic heater.

Lever-Operated Press Installs Tiny C Washers

A SIMPLE hand-operated tool installs and locks $\frac{3}{16}$-inch C washers in shaft grooves with one movement of the operating lever. Automatic feed is incorporated, similar to that of a stapling machine, so that the operator does not have to touch the washers during assembly. An additional feature is a lever-operated die for removing C washers easily from faulty components. The tool was developed in the television plant of E. K. Cole Ltd., Southend-on-Sea, England.

The C washers are first placed on a loading mandrel by hand. When

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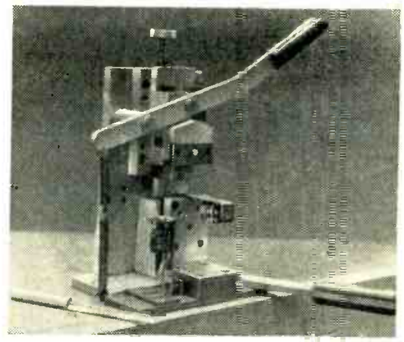
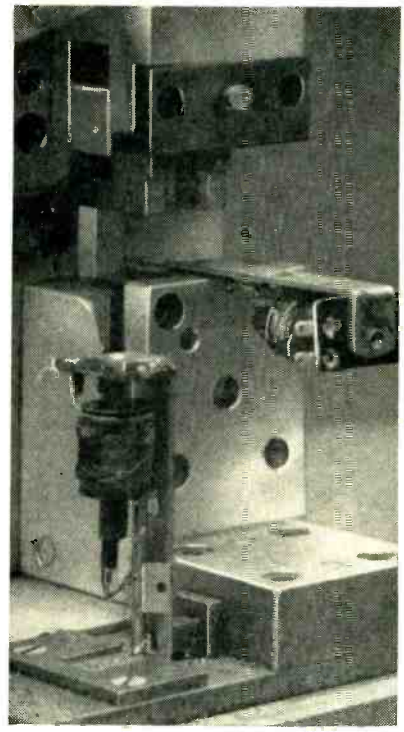


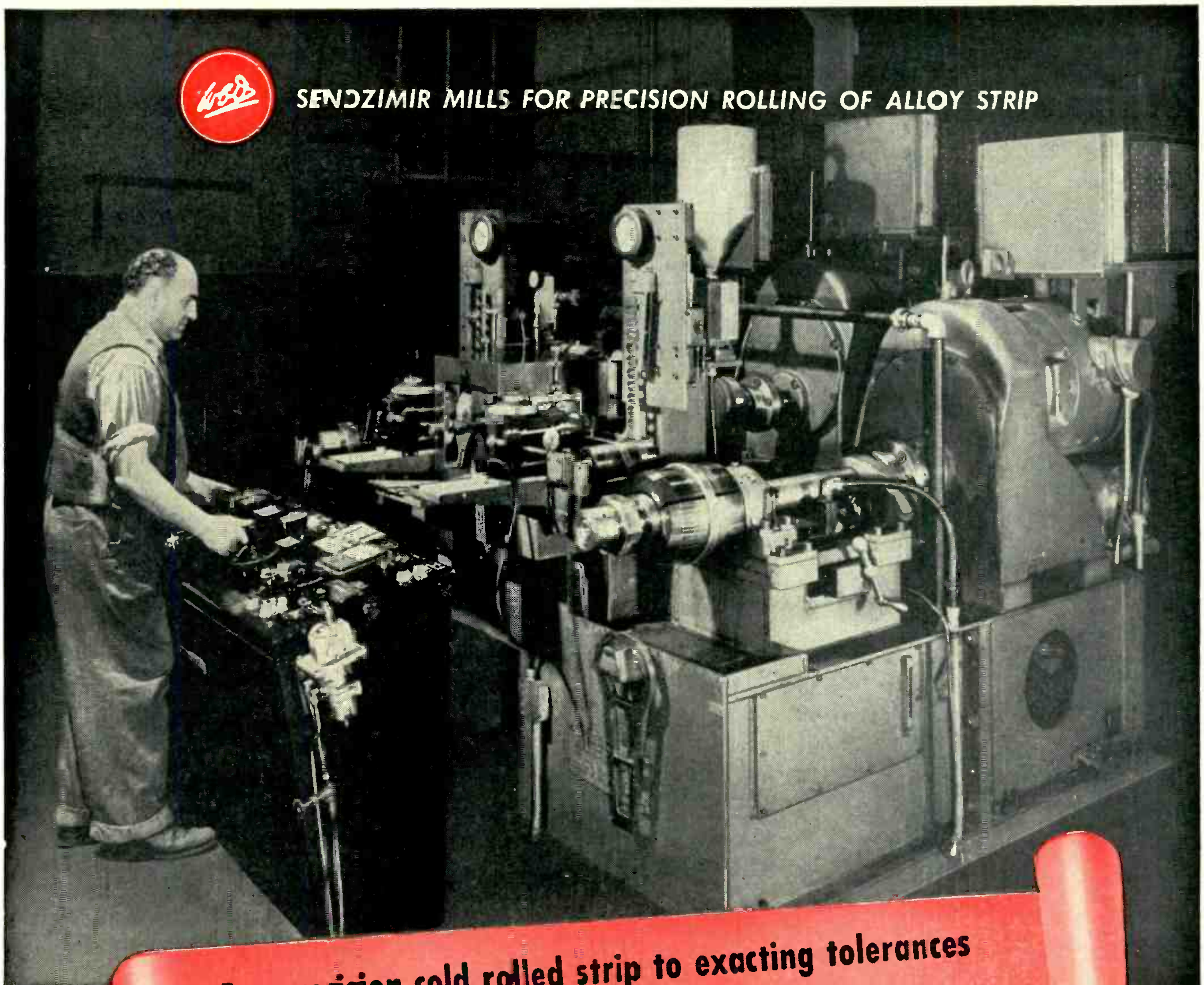
Combination fixture for installing and removing C washers from rotating spindles of adjustable television coils. Loading mandrel is on bench at left



Details of C washer fixture

the mandrel is loaded, its end is held against the back of the magazine on the fixture, so that the washers slide off the end of the blade into the magazine. A feed saddle behind the washers in the magazine forces them toward the front under spring pressure, much as in an ordinary paper-stapling machine, so that the foremost washer is pushed into a pocket in the ram blade.

The rotating spindle of the component is positioned in a recess on the anvil of the fixture and the top hand lever is pulled down. This causes the ram blade to descend and force its C washer into the groove of the spindle. Immediately under the spindle is a die for closing the



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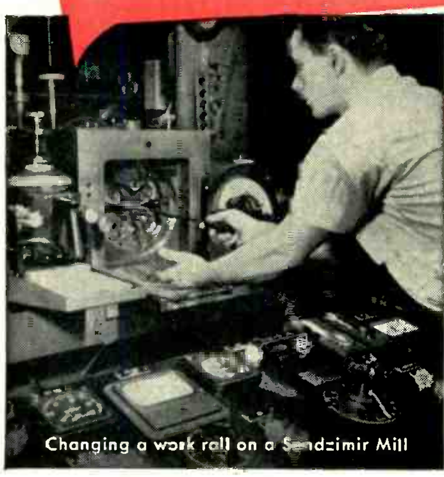
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ends of the washer as the ram forces it down. The spring-loaded hand lever then returns to its original position and the magazine feeds another C washer into the ram in readiness for the next assembly.

When manufacturing faults in components necessitate dismantling of the spindles, the spindle is inserted in a vertical hole in the base of the fixture. The other hand lever is then operated, forcing a blade against the C washer to spread it open and push it out of the groove. Here the operator must position the open end of the washer correctly before inserting the spindle in the hole.

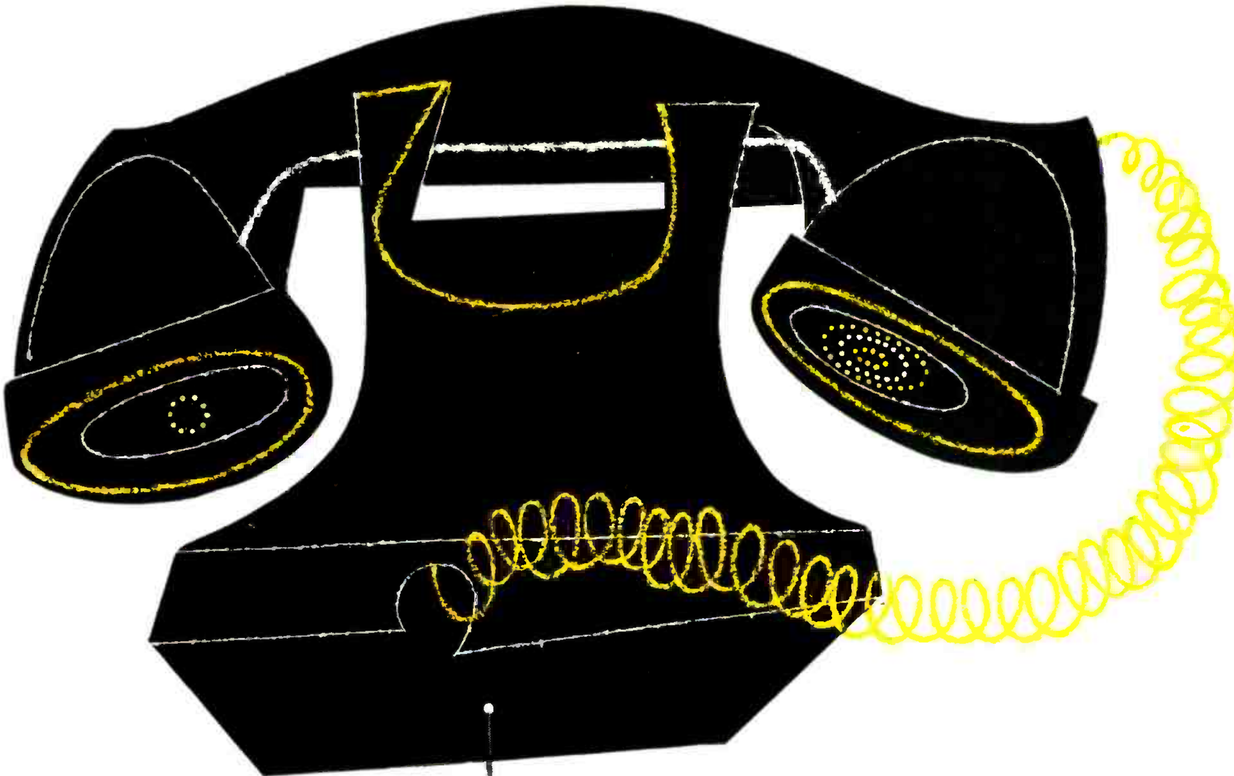
Graphite-Spraying Machines for Anodes

BOTH rotary turntable and inline conveyor machines are used in Tung-Sol's Bloomfield, N. J. plant to move anodes through the beam of a spray gun and then through a baking oven. The spray solution is graphite in a suspension of butyl acetate with some nitrocellulose binder. Baking evaporates the butyl acetate, leaving a hard carbonizing coating that serves to suppress secondary emission.

Both setups provide for rotation of the anodes during spraying, so that all sides receive an even coating. Operating speed is high enough to permit running the gun continuously. Over the spray area is a sheet-metal hood connected to a pipe stack that draws out fumes.

The smaller machine, with a six-head rotary turntable, is used for small anodes that can be dried in a relatively short distance of travel; the oven here occupies an arc of

Rotary turntable setup for carbonizing small anodes of tubes



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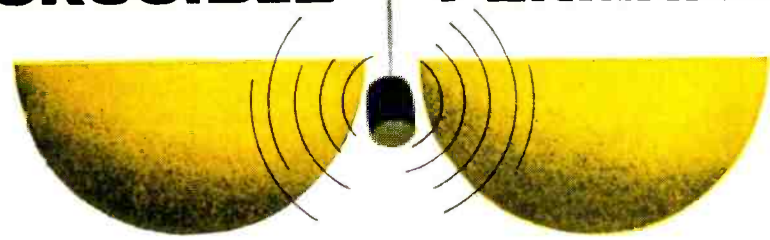

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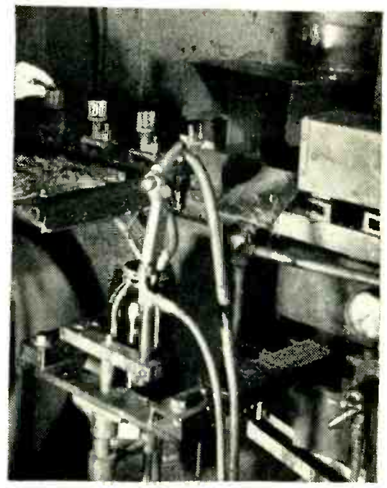


Inline conveyor and spray setup for carbonizing large anodes. Bake oven is at right

about 90 degrees along the turntable.

The inline conveyor employs anode holders bolted to a chain conveyor running horizontally. After passing through the spray area, the anodes move through a long baking oven and fall off into a bin when the conveyor chain goes over the end sprocket wheel to return underneath. Rotation during spraying is achieved by mounting each head on a shaft having a gear that meshes with a stationary rack running the length of the spray area.

Painting Picture Tubes with Knuckle-Joint Brushes

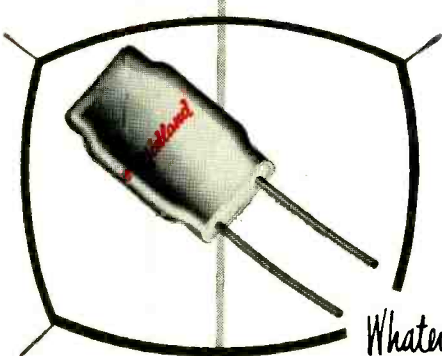
APPLICATION of a conductive coating to the inner surfaces of rectangular glass picture tubes is expedited through use of specially designed paint brushes in the General Electric tube plant at Elec-

Operator demonstrates how squeezing of finger lever makes brush bend

Midland

leads again...this time in

far in Advance in the development of Frequency Control Crystals and Circuits for COLOR TELEVISION, Midland is prepared NOW to supply you in quantity with Color TV Crystals to your exact specifications... and to counsel on all matters concerned with this subject.



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When it has to be exactly right, contact

Midland **MANUFACTURING COMPANY, INC.**
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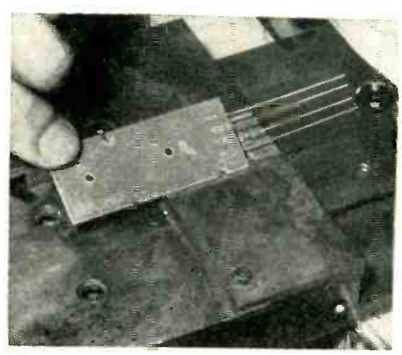
WORLD'S LARGEST PRODUCER OF QUARTZ CRYSTALS tronics Park, Syracuse, N. Y. For maximum efficiency, different lengths of brushes are used for different areas to be painted. A knuckle joint in the handle permits the brush unit to be straightened for insertion in the long, small-diameter neck. When the brush is inside the tube, the operator operates the joint by a lever, and the brush bends to cover the necessary area while the bulb is rotated by the motor-driven vacuum chuck.

Lead-Staking Machine for Printed I-F Transformers

UP TO FOUR separate wire leads are simultaneously applied to the terminals of an etched coil strip by a special lead forming and staking machine used by one manufacturer of printed-circuit components.

Wire for the leads is pulled out from reels mounted at the rear of

Loading sheet on machine in preparation for attachment of leads through rectangular slots at right on copper-clad plastic strip



Removing the etched coil strip after applying four leads simultaneously to the coil terminals

Mr. Milton Kaufman, President of Aquatogs, Inc., tells how:

He makes sales go up in a downpour

"Women, weather and fashion are fickle," says Milton Kaufman. "Put 'em together and you have our business—all-weather garments.

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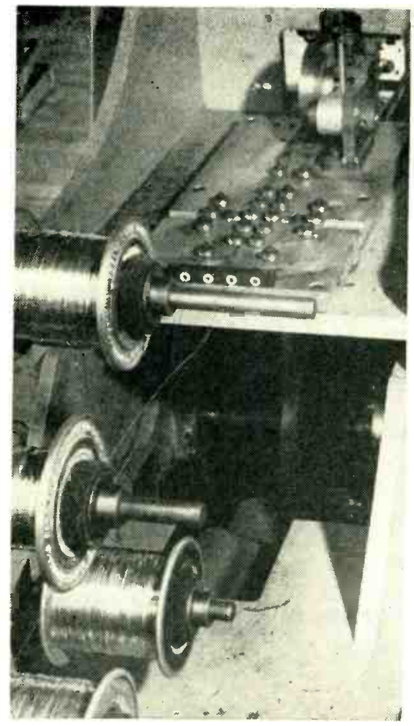


Rear of lead forming and staking machine, showing friction-drag mountings for the wire reels. Each wire runs around five straightening rollers mounted on steel bed plate

the machine and each wire is run through a series of five straightening rollers. The wires then go through four grooves in a large steel drive drum, to emerge at the front of the machine. Here small metal fingers push each lead wire up through its slot in the etched strip which has previously been placed in position by the operator.

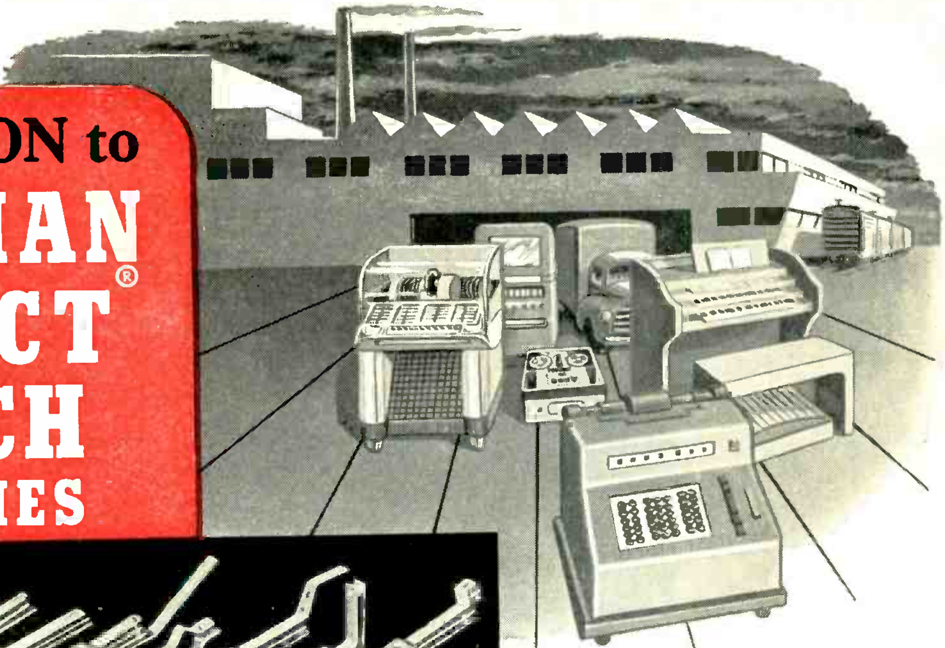
Next, head hammers come down from above and flatten the loops so as to lock the leads in the slots. Simultaneously, a rotating knife cuts the leads to length to complete the operation.

New wire feeds foward while the operator unloads the finished piece and places a new one in position. This technique is used for at least six different types of 40-mc i-f transformers, coils and traps employing photo-etching as a production process.

Machining Printed Circuits

A NEW METHOD of producing copper-foil printed circuits, announced by Erie Resistor Corp., involves embossing the foil in laminated Bakelite sheets in such a way that the switch is ON to

GUARDIAN® CONTACT SWITCH ASSEMBLIES



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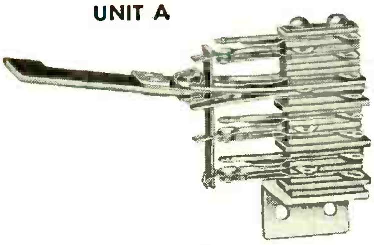
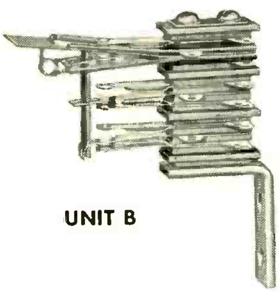
- PHYSIO-THERAPY
- GUN-FIRING
- ROCKET-FIRING

UNIT A



SNAP-ACTION REVERSING SWITCHES



UNIT B

You're looking at performance and low cost that have never been so efficiently combined when you study these new Guardian Contact Switches. Use them independently or in combination with Guardian Relays, Steppers, Solenoids, or special controls and you will soon discover these Guardian Contact Switches make no compromise with quality and performance despite their reasonable price. They are quickly available in a vast variety of contact combinations and in all popular materials from Guardian's enormous stocks of standard and special blades, lug adaptors, insulating separators and bushings ready for immediate assembly. Fine silver, silver alloy, platinum-ruthenium and Fasloy #7 contacts with blade materials of all types are available.

GUARDIAN SNAP-ACTION REVERSING SWITCHES

Unit "A" controls reversing of 10 amp., 115 v., non-inductive loads in automatic equipment. 4 P.D.T. contacts are of Fasloy #7. Life tests up to 5,000,000 operations. Unit "B" has automatic return with 3 P.D.T. combination. Both units U. L. approved.

GUARDIAN ENGINEERS' KIT

Indispensable to those who design, build or test electrical controls. Kit contains a generous supply of standard Guardian contacts for various blade dimensions and includes all parts necessary for complete switch assemblies. Order yours today.

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It illustrates contacts, contact blades, lug adaptors and insulating separators. Yours for the asking . . . no cost . . . write today.

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1625-G W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY the depressed portions represent the wiring desired. This embossing operation is performed during the Bakelite curing process. The unwanted part of the copper foil is then removed mechanically. Advantages are expected to be in economy of production and in elimination of chemicals in contact with the insulating material during manufacture.

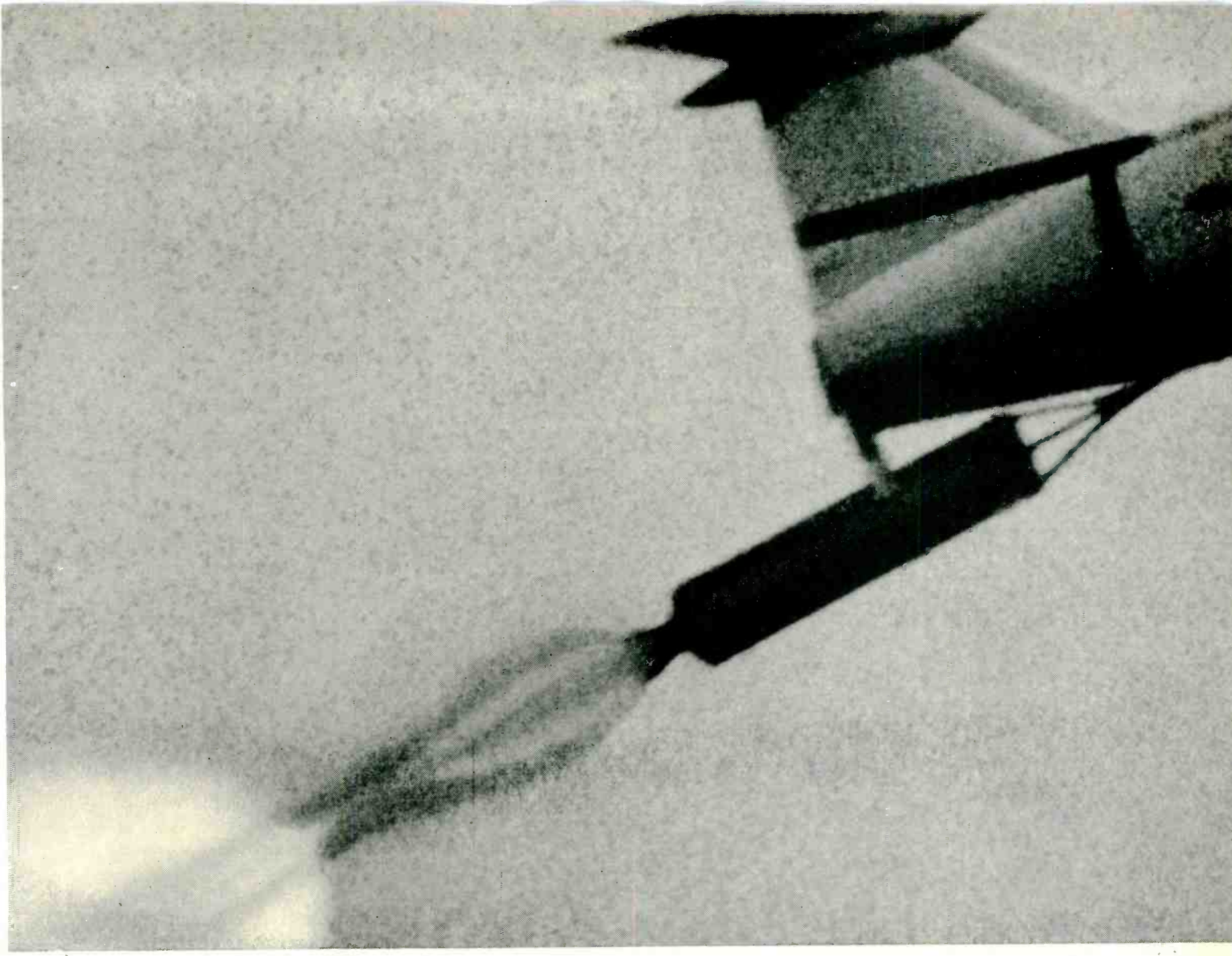
Aluminizing TV Tubes

A REFLECTIVE aluminum coating is applied to the inner surface of a picture tube to reflect the light which otherwise would be absorbed

Picture tube aluminizing area, showing individual vacuum buggies

by the black interior. In producing aluminized tubes at the G-E tube plant at Electronics Park, Syracuse, N. Y., the aluminum coating is applied in three different ways. For black-and-white tubes, one method involves use of individual aluminizing buggies and the other a 24-head rotary machine called a merry-go-round. For color tubes a three-at-a-time stationary bell-jar setup is used.

Each buggy contains a vacuum pumping system, a vacuum connection to the tube being processed and a suitable means for melting the aluminum strip within the tube while it is under vacuum. The aluminum first is melted and then vaporized, after which it condenses on the inner surface of the tube. Automatically controlled, the aluminizing equipment goes through a cycle which includes exhausting the air in the tube to produce the vacuum, preheating the aluminum slug, flashing the aluminum and then re-



moment in history

You are looking at 1/1000 of a second in the history of aviation. It occurred at a fraction past 4:31 p.m. on January 20, 1949.

This was the Zero moment which marked the official launching of the first successful pilotless bomber to be approved by the U.S. Air Force—the Martin B-61 Matador.

The picture is historic for a very significant reason: it records the tradition-shattering payoff of an entirely new development in the aircraft industry, known as Martin Systems Engineering. This is a science and a method of developing spaceborne systems as total solutions of Operations problems.

The Martin Matador is far more than the thing you glimpse here. Behind it is an integrated network of facilities designed to give this important new weapon simplicity of operation and extreme mobility. These components add up to the total solution of one of the most formidable security problems of our time.

They also add up to one of today's most important developments: the full story of Martin Systems Engineering.

You will hear more about Martin!

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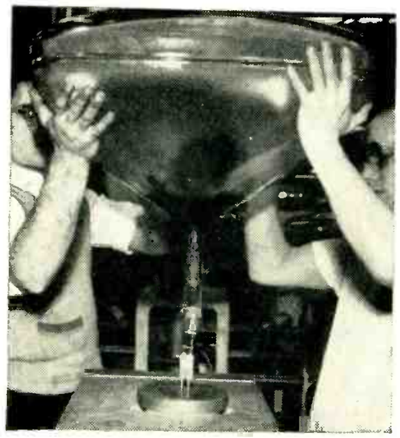


Lowering 27-inch rectangular picture tube into aluminizer

turning the tube to atmospheric pressure. The equipment is manually loaded and unloaded. Canvas safety curtains normally cover tubes during aluminizing.

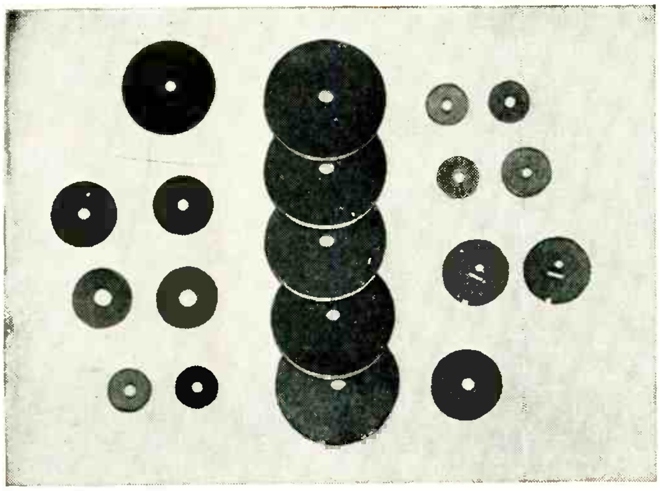
Two men are required to lower a 27-inch all-glass picture tube bulb into position on the aluminizing equipment. At the top of the aluminizing unit is the vaporizing shield, and just below is the filament holding the aluminum slug. The dark inside conductive coating does not cover the entire surface area of the bulb, as in non-aluminized tubes, since the aluminum coating will serve as a return path for the screen excitation currents.

Aluminizing Merry-Go-Round

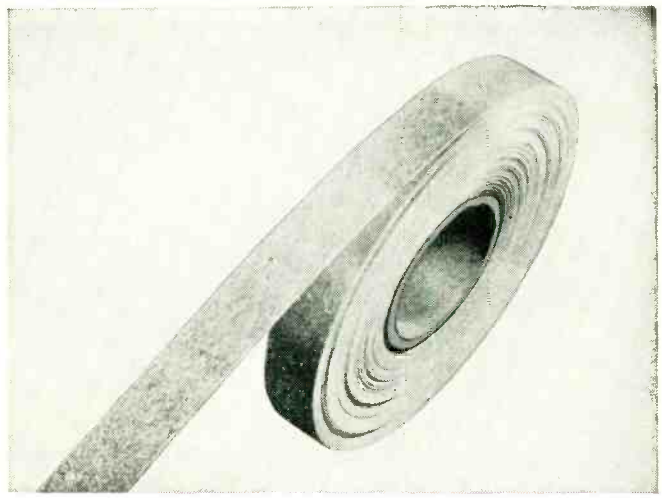
The automatic 24-head rotary aluminizing machine was made by the Equipment Development Works, General Electric Company, Schenectady, N. Y. It consists of 24 complete self-contained aluminizing buggies mounted on a continuously revolving turntable. Each buggy

Rotary aluminizing machine

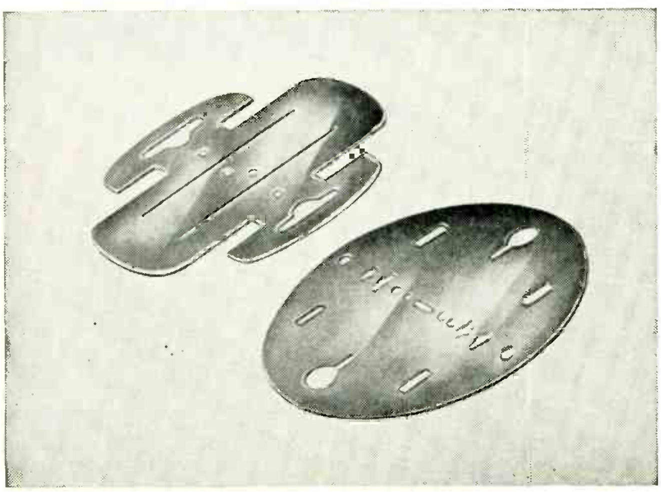
Do you have any of these problems?



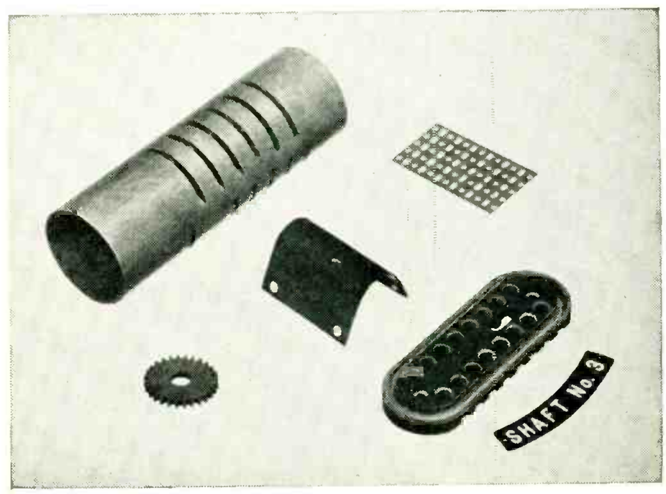
1. Need a combination of gasket sealing and mechanical and electrical properties? Various grades of LAMICOID® — laminated plastic made with organic and inorganic binders — are combined with natural or synthetic rubber to obtain the excellent insulating and mechanical properties of LAMICOID and the sealing properties of rubber.



2. Need a mica tape that can be run on taping machines at high speed? ISOMICA* tapes are made from long rolls of thin continuous mica sheet . . . are more uniform in mechanical and dielectric strength . . . have no high spots or voids. For electrical insulation of class B or class H motors, generators and transformers.



3. Need accurately punched mica stampings for filament, grid and plate supports? MICO produces mica stampings to extremely fine tolerances. Whenever you need precision-fabricated mica parts of the highest quality, call on MICO. We have 60 years of experience in this field.



4. Need special mechanical and electrical properties for brackets, terminal blocks, access panels, etc.? LAMICOID® is half as heavy as aluminum and, weight for weight, stronger than steel. Offers high impact strength, high dielectric strength, excellent abrasion and moisture resistance.

Whatever electrical insulating materials you need, MICO makes them best. We manufacture all standard types and many special materials, and fabricate parts to your specifications. Send us your blueprints or problems today.

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LAMICOID ® (Laminated Plastic) • MICANITE ® (Built-up Mica) • EMPIRE ® (Varnished Fabrics and Paper) • FABRICATED MICA • ISOMICA* contains a roughing and fine vacuum pump, power supply, electrodes for flashing the aluminum slugs, and a fixture for supporting and sealing the bulb in position during the process.

At the start of a new cycle, the operator loads a filament and aluminum charge assembly into the filament holder and places the bulb in position in its fixture atop the buggy. The vacuum seal is obtained

Tri-cornered bell jar for aluminizing three phosphor plates at a time for 15-inch round color television picture tubes

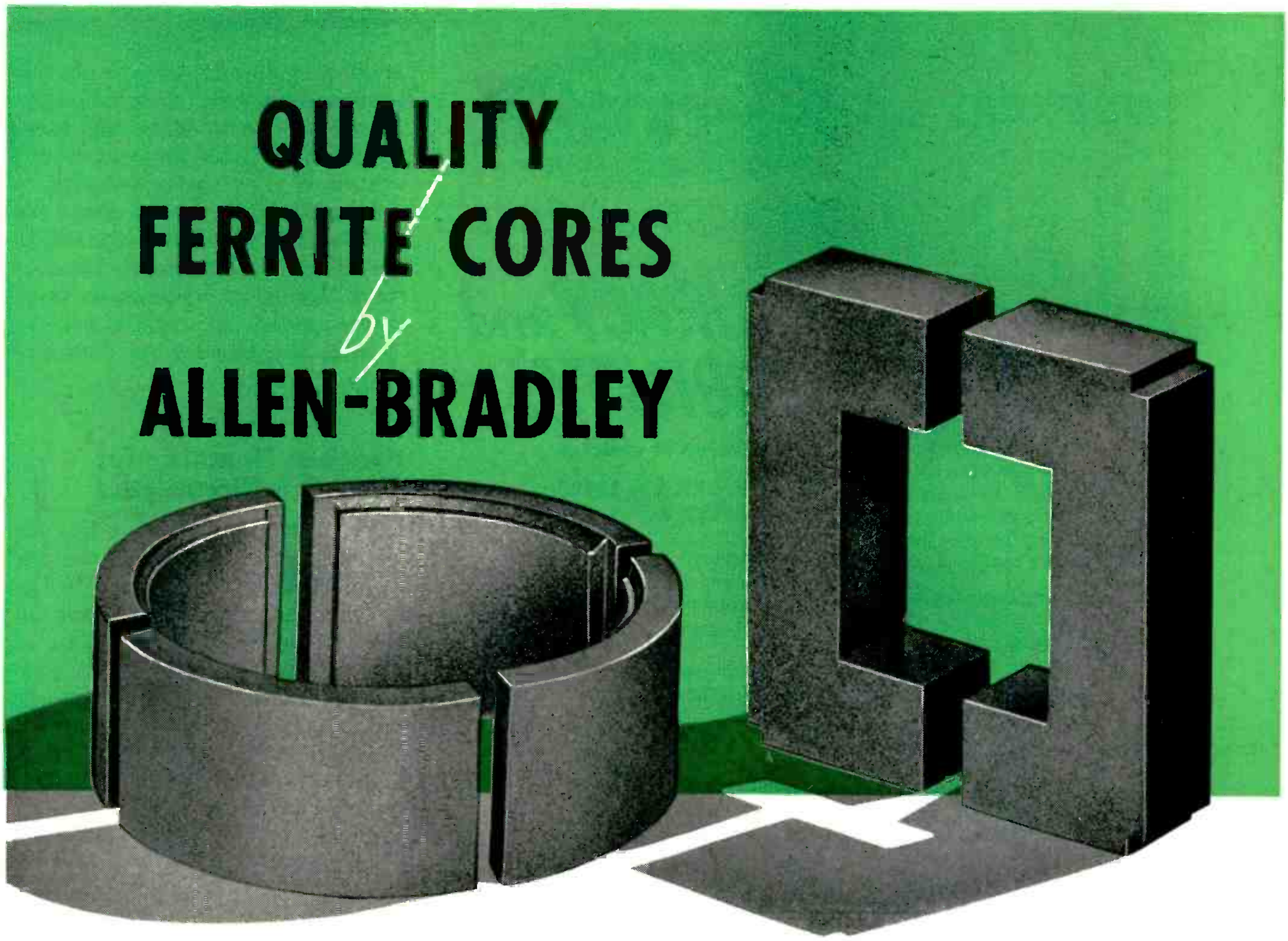
by use of a large rubber seat in the fixture, which makes contact with the bulb funnel just above the yoke reference line. The self-contained vacuum system then starts to work, first roughing out the bulb with the mechanical pump and finally pulling a high vacuum by means of a large oil diffusion pump. Power is applied to the pumps at the proper time by means of a commutator located in the center of the machine.

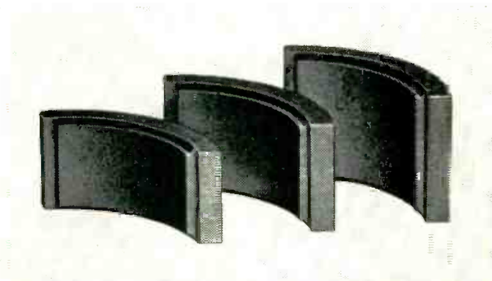
When the bulb reaches the proper vacuum condition, voltage is applied to the filament assembly, thereby melting and vaporizing the aluminum charge. This vaporized aluminum condenses on the inner surface of the bulb, producing the desired mirror-like effect. Safety drapes around the machine are used to minimize the hazard from any glass breakage during processing. The equipment is capable of aluminizing bulbs at a rate of over 100 per hour.

Color Tube Setup

Only the phosphor plate is aluminized in a color picture tube. Aluminizing is essential in even a

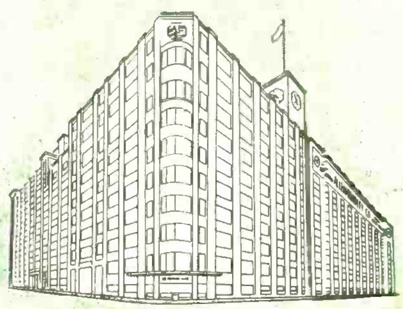
QUALITY FERRITE CORES *by* ALLEN-BRADLEY





Deflection Yoke Cores in Six Widths

Allen-Bradley yoke cores are all made with an inside radius of 1.027 inches and in six widths as follows: — 0.960 in., 1.125 in., 1.188 in., 1.225 in., 1.250 in., and 1.437 in. Samples for qualification tests can be furnished on request.



The modern Allen-Bradley main plant in Milwaukee, Wisconsin.

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The production of Allen-Bradley QUALITY ferrite parts is held to the same close manufacturing standards as all other Allen-Bradley radio and television components . . . such as Bradleyunits, Bradleyometers, and Allen-Bradley ceramic capacitors . . . long recognized as TOP QUALITY. Television equipment manufacturers already consider Allen-Bradley as a desirable source of ferrite cores.

These ferrite cores are now listed in ten part numbers for the U cores and in nine part numbers for the quarter ring cores.

Write for blueprints or samples, today.

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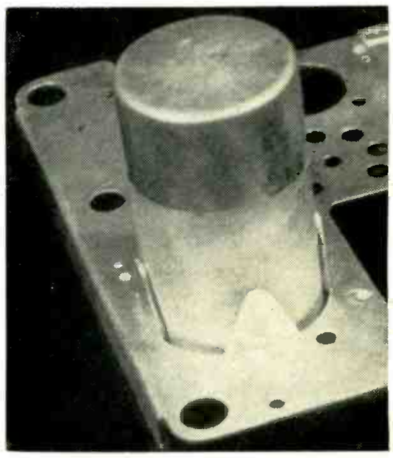
small color picture tube, to provide a conductive layer that maintains a uniform potential on the phosphor screen. This prevents deterioration of color purity and also increases the light output from the screen. The aluminizing station at the GE color picture tube development laboratory aluminizes three screens at once in a special bell jar, to coat the rear of the phosphor screens.

Punched Mounting for Metal-Can Electrolytics

BY FORMING the mounting lips for an electrolytic capacitor from the metal that would normally be punched out of the chassis hole for the component, mounting time is reduced from 1.3 minutes to only 0.18 minute and mounting cost is reduced approximately 2 cents in the television receiver plant of E. K. Cole Ltd., Southend-on-Sea, England.

Punching of the mounting tabs is included in the first punching operation on the chassis. Upward



New capacitor mounting method, requiring no additional parts. Capacitor is inserted from underneath

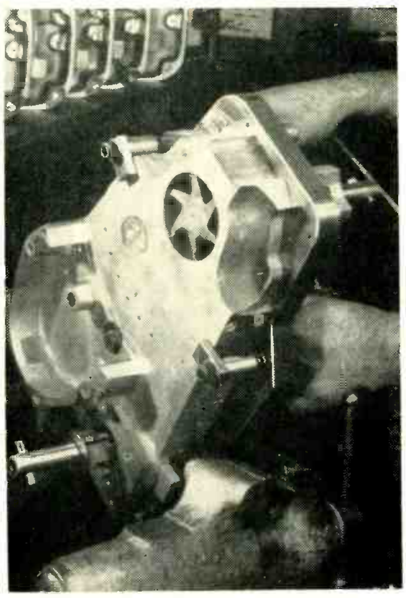
Conventional mounting method formerly used, involving seven additional parts

forming of the tabs is combined with the second piercing tool if it is the spring stripper type, or in the chassis bending tool, and thus no additional punching operations are involved for producing the mounting.

The new method holds the capacitor in place securely by friction alone, as the mounting tabs are bent slightly inward during forming.

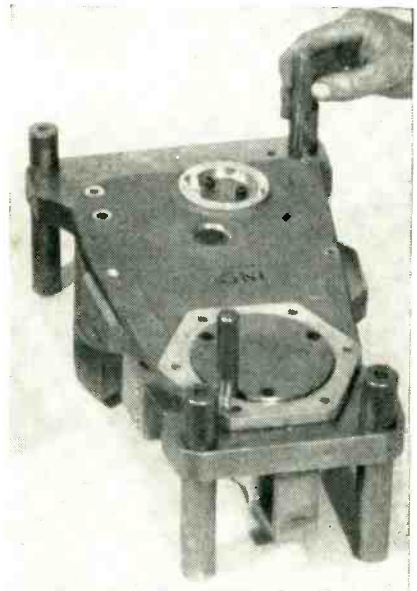
Reaming Fixtures for Radar Antenna Units

PRODUCTION bottlenecks on airborne radar antenna units have been eased at Dalmo Victor Co., San Carlos, Calif. largely through development and use of precision hand-operated reaming fixtures. These reduced the previous time-consuming operation on jig boring machines by nearly 75 percent, at only 10 percent of the former cost. Improved accuracy is another benefit, permitting complete interchangeability of parts with near-zero dimensional limits. Formerly the components making up the housing for the azimuth drive gear had to be preassembled and aligned with specially ground plug gages,



Using master hand reaming fixture on azimuth drive gear housing. Fixture is clamped in vise on bench, a casting is placed on the fixture and anchored with mounting tabs, and each reamer in turn is then turned in by hand to complete the final finishing of four holes, one of which is counter-bored and faced along with hand drilling and reaming of mating parts.

Mechanite castings are used as a supporting foundation for the fixture assembly. The castings are rough-machined, stress-relieved and ground true for face location of parts to be reamed. Bores for reamer journal guides and locators



Alignment-checking fixtures for azimuth drive gear housing proves out correct location of bores and dowel pin holes and determines face squareness. Any casting distortion will show up here

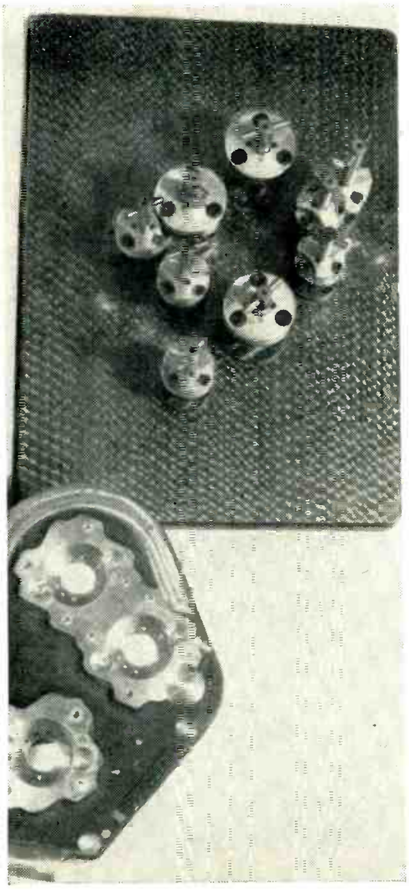
are held within very close dimensional limits on a jig borer. Where production drawings allow plus or minus 0.0005 inch jig boring tolerances on the fixtures are held to practically zero limits.

Journal guides and caps, reamer bodies and shanks are fabricated of high-carbon steel, rough-machined, normalized and carburized. Guides and caps are ground, honed or lapped on all critical surfaces, maintaining extreme concentricity and face squareness.

Tungsten carbide inserts are brazed to reamer flutes and the entire unit ground on centers to near-zero concentricity and to the nominal diameter of the production part to be made.

All critical dimensions are checked with precision gage blocks and special gaging equipment. An additional check is made by using a jig borer to inspect the fixture and the first part run.

Several types of these master



Example of reaming fixture for gear housing cover

reaming fixtures are currently in use, including those producing individual finished surfaces on external and internal diameters, face and shoulder dimensions, or a combination of these operations.

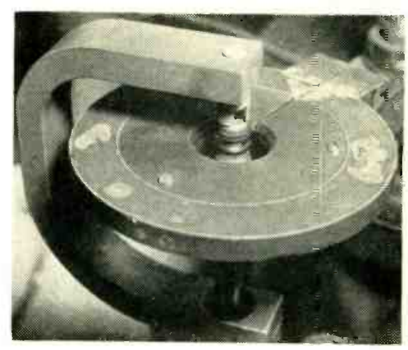
Besides providing precise alignment and interchangeability of parts, the fixtures eliminate match markings formerly used, hold scrap parts to a minimum and greatly reduce bench inspection time.

Induction Sealing of Magnetron Pulse Plug

FUSING of the metal pulse plug assembly to the glass envelope section of a type 4J52 high-power X-band search radar magnetron is achieved with a single-turn work coil during production of this tube in the Hicksville, N. Y. plant of Amperex Electronic Corp.

The water-cooled work coil is connected to a Ther-Monic r-f heating transformer having a single-turn secondary. The ring-shaped work coil has a rectangular cross-section, made by brazing together two washer-shaped pieces and two bands of copper. A solid inner ring fitting tightly inside the work coil adapts its large size to a specific smaller heating job. This solid center section is cooled by conduction from the hollow water-cooled outer ring. A single saw cut breaks

Rotating knurled sleeve to move pulse plug up and down during sealing to glass section of magnetron by induction heating



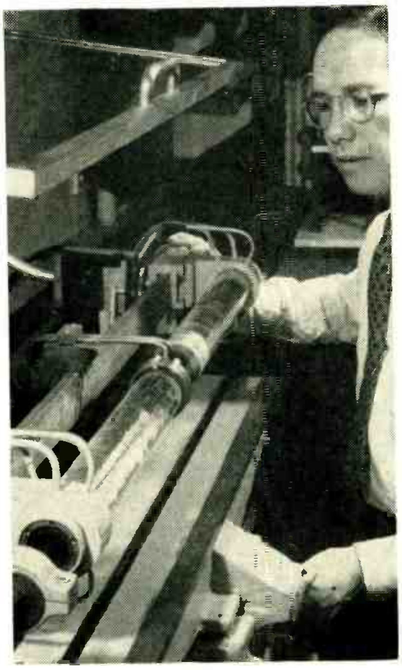
Construction of single-turn work coil, and details of pulse plug support

up the rings for connection to the transformer.

The operator first raises the C-shaped support bracket and inserts the pulse plug in the upper end of the bracket. She then places the mating glass section on the rod which comes up through the lower end of the bracket, and adjusts a knurled sleeve to adjust the joint up or down into the plane of the work coil. A touch of the start button then turns on the r-f generator for an interval controlled by a preset timer. During heating, the operator can move the plug and the glass up and down independently to work the molten glass as required for obtaining a vacuum-tight metal-to-glass seal. This is done by manipulating the concentric supports, as shown in the photo.

Zone-Melting Setup for Refining Germanium

A NEW zone-melting method for refining germanium and other materials to practically perfect purity—99.99999999 percent pure—has been developed by W. G. Pfann at



Zone-melting setup for refining germanium

Bell Telephone Laboratories.

The new process is based on the fact that impurities are not equally soluble in the solid and liquid states of a substance; usually, impurities are more soluble in the liquid. To take advantage of this, a narrow molten zone is moved slowly along an ingot of relatively impure material to sweep the impurities to one end of the ingot.

This is accomplished by passing the ingot through a circular induction heater which, in the case of germanium, brings it to the molten state at a temperature of about 1,760 F. As the ingot is passed slowly through the heater, the molten zone tends to hold the impurities while the ingot solidifies into a purer state on the other side of the heater.

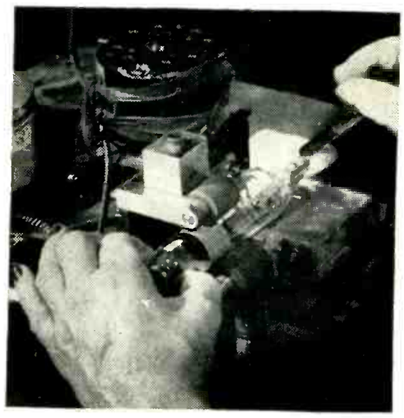
In actual practice, a series of such circular heaters is used and each molten zone extracts its share of impurities from that left by the preceding zone. At the end of the run, substantially all the impurities have been swept to one end of the ingot. Here they are trapped when the tip of the ingot passes out of the heater and solidifies. This section, loaded with the impurities swept into it from the entire ingot, may then be cut off.

The zone-melting technique, adapted to the requirements of production operation, is now used to make the ultra-pure germanium required in the manufacture of transistors by Western Electric Co.

Painting Insides of 1B3 High-Voltage Tubes

Two different motorized setups are used to apply a band of insulating paint on the inside of glass envelopes for type 1B3 high-voltage tubes, in the Bloomfield, N. J. plant of Tung-Sol Electric Inc. The paint serves to break up the leakage path from the top to the bottom of the tube on the inside surface of the glass envelope. This path is provided by a barium oxide deposit resulting from getter flash. Painting material used is green in color, applied in a smooth thin layer.

The first setup uses one motor to rotate the glass envelope of the tube and another to drive a paint-

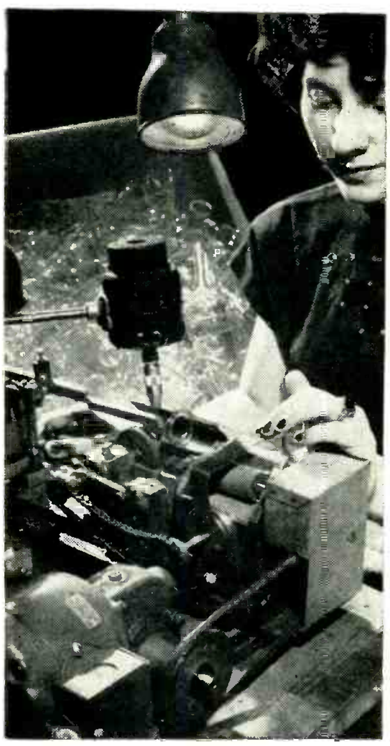


Setup using manually operated brush

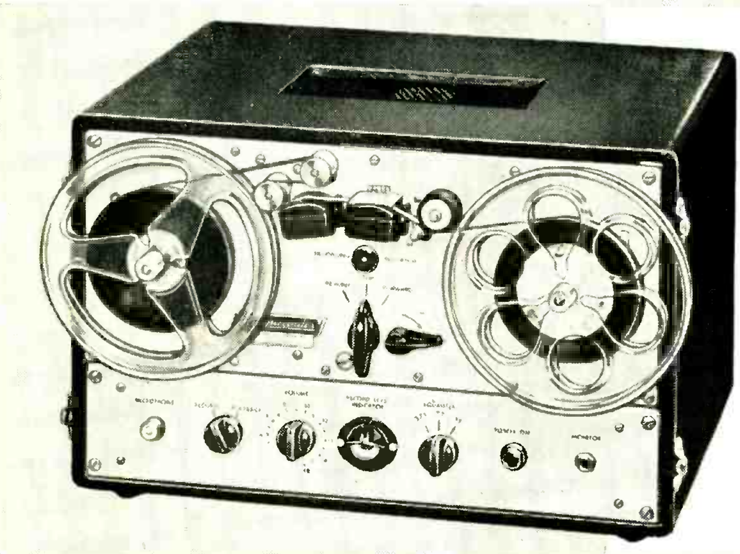
mixing paddle and a wheel that runs in the paint and automatically applies the paint to the brush. Both motors operate through gear reduction systems.

The tube envelope rotates between three rubber rollers, one of which is driven by friction with a steel shaft on the gear system of the first electric motor. The upper rubber roller is mounted on a hinged and weighted arm that can be flipped up out of the way for unloading and loading tubes. A stop is provided for the top cap of the tube and the driven-rubber roller is skewed just enough to keep the tube pressing against the stop.

When an envelope has been loaded, the operator moves in a spring-mounted brush by bringing up a slide with her right hand. This slides the brush over the rotating paint wheel, making it pick up the required amount of paint. The slide is moved inward to a stop, bringing the brush in position. The operator then depresses the spring blade of the brush to apply the band of paint. The brush clears the en-



Setup using cam-operated brush for applying paint automatically in desired band inside envelope when operator moves in brush slide with right hand. Left hand is pressing down spring metal strip that holds envelope against its drive rollers



velope when there is no pressure on the blade, to permit insertion and removal of the brush without causing streaks.

A newer and more automatic setup which gives higher production rates has a cam arrangement for lowering and raising the brush automatically as the slide is moved in and out. Here both paddle and paint wheels are driven by the main drive motor through a sprocket and chain linkage, and a separate electric mixing motor with stirrer paddle is mounted overhead in the paint box to give additional mixing. Only two rubber rollers are used; the operator presses down a piece of spring steel over the top of the rotating envelope to keep it in position during the painting operation. This strip springs up out of the way automatically when released, permitting quicker removal and reloading of envelopes.

Installing Shock Mounts

FITTING RUBBER SHOCK MOUNTS into the chassis of electronic apparatus is usually an awkward hand operation. Hewlett-Packard, Palo Alto, Calif., uses a collet-type screw holder for quick and simple insertion of the shock mounts used for supporting a tube socket plate on a chassis.

The three mounts are first in-

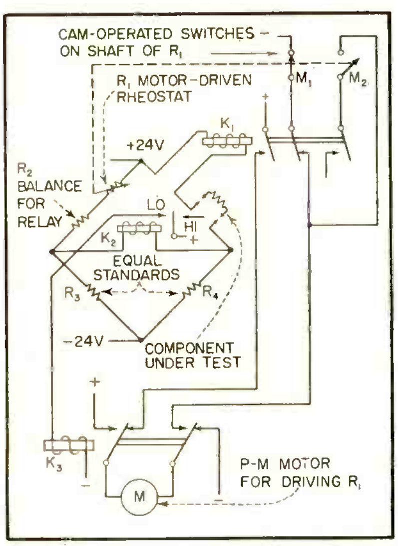
Collet-type tool in position for pulling shock mount through chassis hole for socket plate held in hand serted one by one in the socket plate with the aid of the tool. The plate is then held in position against the bottom of the chassis and the tool is inserted through each mounting hole in turn from the top of the chassis to grip each mount and pull its other end through the chassis hole.

Self-Balancing Bridge Checks Parts Automatically

By DESMOND E. S. ISLE
Isle of Wight, England

A MOTORIZED Wheatstone Bridge, connected in the conventional manner but provided with fully automatic indication and control features, speeds testing and sorting of resistors in a British electronic plant. The unit is arranged to give an almost immediate output reading after connecting the component to be tested. Insofar as no controls are used by the operator, the possibility of maloperation is zeroed. No vacuum tubes are needed.

Values of bridge components vary with the resistance range of the products under test, hence no values are given. At balance $R_1 = R_x$ if the preset R_2 is adjusted to equal the resistance of relay K_1. Rheostat R_1 is rotated by a permanent-magnet motor M at a speed of about 10 rpm during operation of the unit. This type of motor is



Circuit of bridge for production-testing all types of resistors used to reduce overshoot time, as well as for its good acceleration qualities.

Relay Operation

Across the balance points of the bridge is connected a sensitive side-stable relay K_2, which moves its armature to the LO or HI contact depending on the direction of the out-of-balance current in its coils. As motor M drives R_1 from its high value to its low value, the armature of K_2 will change over to LO shortly after balance is passed. In doing so, relay K_3 is operated.

During the period of search, relay K_1 is operated by the current passing through the component under test, and the motor for R_1 is driven through the contacts of K_1 and the normal-position contacts of K_3. At the operation of relays K_2 and K_3, the motor is halted as there is no path to minus for the motor while all three relays are pulled in. The value of the component is now read off a scale whose calibration is staggered slightly in advance of the value of R_1 to account for overshoot.

On removing the component, relay K_1 releases, causing the motor to continue driving R_1 and the indicator pointer. Rotation continues to an unmarked portion of the scale where a cam on the indicator shaft operates the mechanical contacts M_1 and M_2. In opening, M_1 stops the unit in the ready position. Relay K_3 is still held operated by relay K_2, although the test component has been removed.

On application of another test component in position, relay K_1 re-operates and completes the motor circuit through cam contact M_2 which is now closed. Driving once more on to the useful arc of R_1, relay K_2 changes over and ensures release of K_3. Control of the equipment now rests again with the finding of a balance condition. Thus, the complete sequence is repeated automatically.

If the test component is of higher value than can be normally indicated, relay K_2 will not pull over to HI, and due to the opening of the mechanical contact M_2, an obvious fault condition will be shown up.

Similarly, if the test component

is shorted, relay K_2 will not pull in to LO, and the unit will continue to run for as long as the offending component is connected.

Mechanical Construction

The motor-driven resistor R_1 is driven via a 600-to-1 reduction gear box, with the indicating pointer moving at the same speed as the resistor wiper arm. About 70 percent of the indicator scale is calibrated, the remainder of the rotation being used for interlock purposes. When batching components having a particular tolerance, a colored Plexiglas arc of the required size is used to cover the permissible area of indication for the particular end values. Other similar aids may be devised locally.

Relay K_2 is a telegraph relay operating at about 2 ma, while K_1 and K_3 are standard K-3000 Inter-Services relays. Total size of the unit complete with rectifier-transformer assembly is about a 10-inch cube.

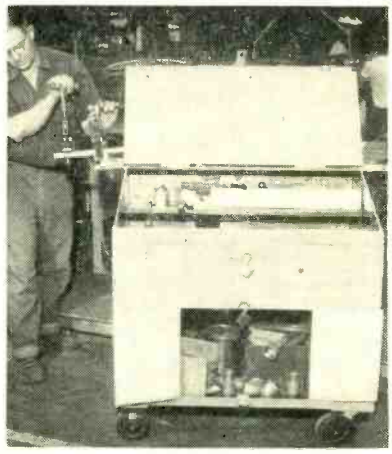
Performance

With regard to maintenance while in use, dust, particularly of the silica-base variety, is the main offender. Therefore, if ventilation is necessary, louvers should be carefully placed. Trouble from other sources is rare, as the majority of relays are given an adjustment-free life expectation of 10^7 operations. The mechanical contacts should be constructed to give a small measure of self-cleaning action, by using about $\frac{1}{16}$ inch overtravel on the lifting cams.

The positive action of the equipment commends itself readily to use in quantity. Total cost of manufacture is about $45. Production of a quantity would be assisted by the provision of a common d-c power supply serving all units in parallel.

Maintenance Tool Dolly

PORTABLE maintenance dollies for on-the-spot repairs, alteration and installation work cut travel time to the maintenance shop in General Electric's picture-tube plant at Electronics Park, Syracuse, N. Y. The dollies are used by plumbers,



Plumber's maintenance dolly in picture tube plant

electricians and machine maintenance personnel.

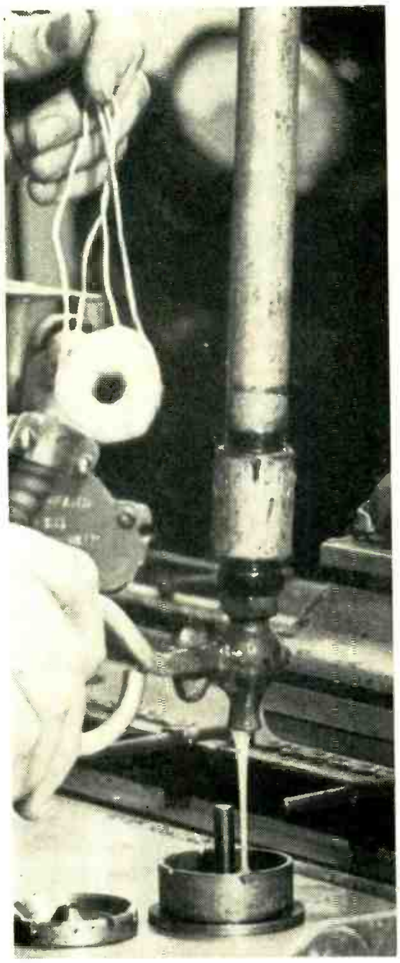
The plumber's dolly includes pipe fittings, hand tools, plumbing compounds and other commonly used items. Mounted on top is a pipe vise. When a new shift begins, each maintenance man moves his dolly to the assigned area in the plant to be ready for rapid service.

Applying Dolflex Coating to Toroidal Coils

PLASTIC coating of toroidal coils was speeded and quality of work improved greatly when Lenkurt Electric Co. of San Carlos, Calif. designed a special conveyor for the operation. In early experiments without the conveyor and without automatic heating, two production workers were able to coat only 125 toroids a day and the rejects averaged 20 percent. Using the conveyor system, the same two workers now can produce at least 250 coated coils a day and the rejection rate is less than ½ percent.

The plastic material, Dolflex, is thermosetting, providing a fungus-resistant and fire resistant coating that is satisfactory electrically. It needs high and even heat to cure properly, and it must be handled rapidly before curing because it begins setting within a few seconds after touching a preheated object. Since the coating on toroids is only 0.015 to 0.020 inch thick, it must be perfect if it is to seal properly.

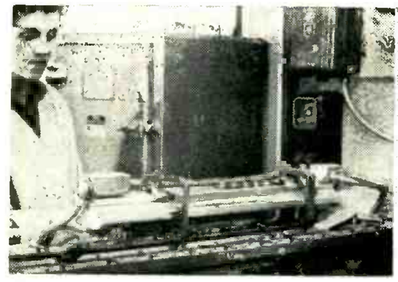
The oval-shaped conveyor de-



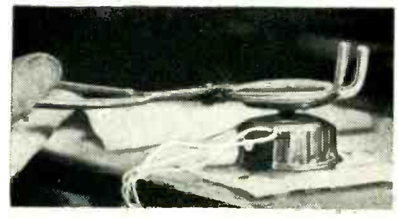
As first step in plastic coating, operator removes preheated mold from conveyor and preheated toroid from oven. Toroid is dipped in plastic and permitted to drain while mold is filled with plastic to the three-quarter mark

signed for the coating operation has a circumference of 10 feet and moves at a speed of three inches a minute. One section of the conveyor has a radiant heater above it that preheats metal molds and their lids to 275 F. Toroids are preheated in an oven at the same temperature at least 2 hours to drive out most of the air and moisture in them.

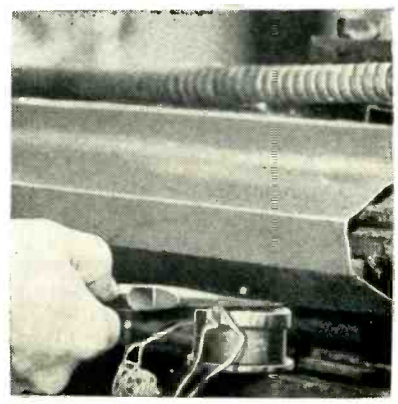
At the start of the operation a hot toroid is removed from the oven, dipped into the liquid plastic at room temperature, then removed and allowed to drain for a few seconds. While this is draining, a hot mold and lid are removed from the conveyor and sprayed with mold release. The operator then opens a faucet and permits the plastic to enter the hot mold to the three-fourths full mark. The toroid—on



Conveyor used in plastic coating operation for small toroids



Preheated lid is partially filled with plastic and then pressed quickly in place on mold. Excess air and coating material are squeezed out as lid is pressed down firmly. Toroid leads extend through notches in wall of mold



Placing mold in conveyor for heating 10 minutes at 310 F with radiant heaters above and below conveyor

which the coating has already begun to set—is immersed in the filled mold and pushed down with the fingers.

Wires or leads are threaded through notches in the wall of the mold. The hot lid is then picked up with tongs, partially filled with the plastic and quickly put into position on the mold. It is pressed down firmly to squeeze out excess material and any air trapped in the mold. The excess solidifies immediately and can be peeled off the outside of the mold easily.

The entire operation described above must be done quickly—in 12 to 15 seconds—to prevent imperfections forming in the plastic before it is cured.

The operator places the mold containing the toroid and coating on the conveyor where, for the next 10 minutes, it is cured by being heated to 310 F with radiant heaters both above and below the conveyor. A voltage regulator on the radiant heaters prevents spoilage resulting from voltage variations. A 30-second repeat interval timer is used to control on-off time for the radiant heaters.

After going through the 10-minute heating area (30 inches on the conveyor), the mold passes through a cool 30-inch area for another 10 minutes. It is then removed by a second operator who takes the mold apart, ejects the coil, trims it as needed and inspects it. The mold, now empty, is placed back on the conveyor and will pass through the preheat area before again reaching the first operator and being re-used.

Plastic-Top Assembly Bench

A SPECIALLY DESIGNED assembly bench is used at Helipot Corp., South Pasadena, California, for assembly of precision potentiometers. The design was carefully planned as a result of time and

Bench setup having recesses for parts pans. Assembly jig is fastened to bench

motion studies, and is custom built in the firm's own carpentry shop. The laminated sheet plastic top is glued to plywood, and holes are then drilled or cut to accomodate the small metal pans used for holding the small parts used in assembly operations. The gleaming plastic top contributes to cleanliness in producing precision components.

NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

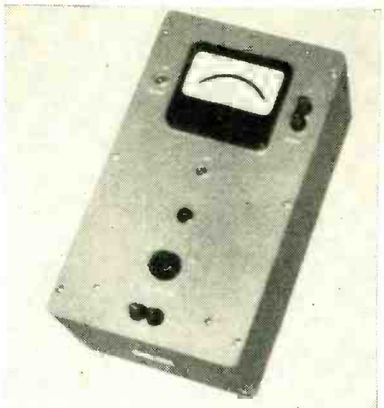
50 New Products and 65 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

OTHER DEPARTMENTS featured in this issue:

MILLIVOLTMETER

useful in transistor studies

INDUSTRIAL CONTROL CO., Wyandanch, L. I., N. Y. The 213-A is a d-c millivoltmeter with high sensitivity, stable zero and direct polarity indication. It features full scale deflection of 1.00 mv d-c, a zero center movement with plus or minus deflection, and internal noise and drift kept below 10 μv d-c. In addition, a d-c amplifier channel is made available with a maximum gain of 1,000, low output resistance, and stable zero and gain. No warmup time is necessary other than tube



heating. Operation is from the 117 v, 60 cps line. No damage results from heavy input overloads. The 213-A is especially useful in semiconductor and transistor studies, circuit design, microwave and radiation work, transducer calibration, bridge measurements and as a low-level amplifier driving c-r and mechanical oscillographs, pen recorders and alarm relays.

COLOR CAMERA

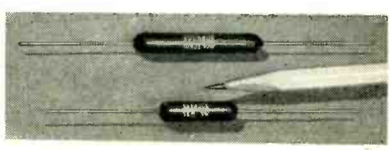
televises films and slides

RADIO CORP. OF AMERICA, Camden, N. J., has announced the 3-V camera for televising color motion picture film and slides. It employs three Vidicon pickup tubes and a light-splitting optical system of dichroic mirrors. With the 3-V, many broadcasters can use present black-and-white film and slide projectors with only minor modification. Equally important, they can use a single 3-V camera to select up to three picture sources and shift from one to another simply and instantaneously. The new camera will be used with a special 3-V optical multiplexer. Into this unit may be fed the output of two motion picture projectors—either 16 mm or 35 mm —and a dual-disk, single-lens, 2 × 2 slide projector. Controls on the mutliplexer will permit instantaneous shifting of the camera pickup among these sources. The dichroic mirror system divides the color image into three parts. It does this by light-splitting lenses which reflect light of a given primary color while transmitting light of the other primary colors. Each of the three resulting images is fed to a corresponding Vidicon tube, which then generates a signal representing only that part of the image.

POWER RESISTORS

in 5 and 10 watt sizes

SPRAGUE ELECTRIC CO., 35 Marshall St., North Adams, Mass. Two miniaturized self-mounting wire-wound power Blue Jacket resistors for use in tv and industrial electronic production where space is a factor have been announced. These axial-lead vitreous-enamel units, types 27E



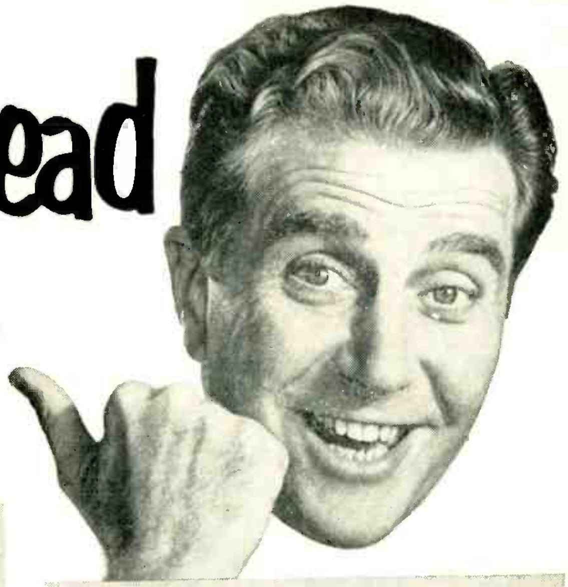
and 28E, are designed specifically for applications where reliability is a must, and are ideal for point-to-point wiring, terminal board mounting, and processed wiring boards, fitting ideally in dip-soldered subassemblies.

TINY CONNECTORS

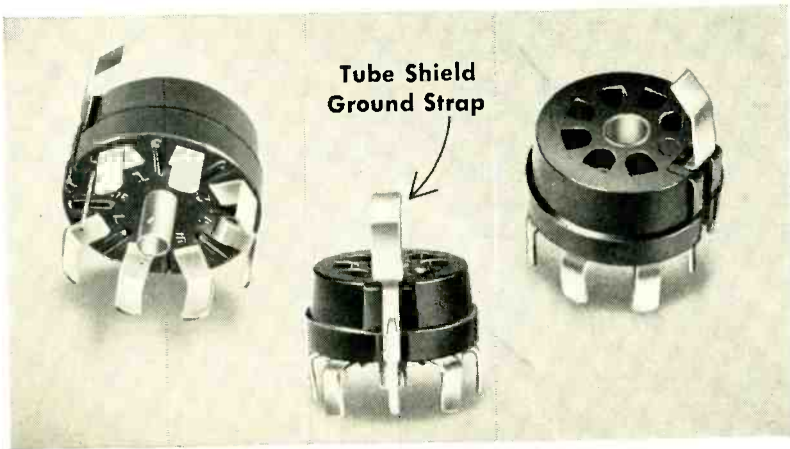
feature reduced weight

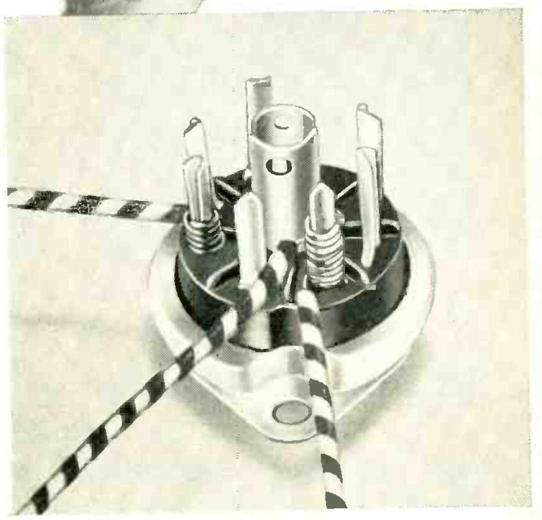
AMERICAN PHENOLIC CORP., Chicago 50, Ill. A reduction of weight

Big Savings Ahead



2 New SYLVANIA SOCKETS save Assembly Time . . . Cut Costs . . . Improve Performance!





1. **New Sylvania 7-pin Miniature Printed-circuit Sockets.** Contacts and center shield are shaped so that sockets can be stacked one upon another for automatic feeding and assembly. Small slots are used on the circuit board to receive the contacts, resulting in stronger chassis construction. Only one socket assembly need be stocked since terminals can be interconnected by printing the circuit on the chassis board rather than using a metallic connector on the socket itself.

Insulator is molded of general-purpose or low-loss phenolic. Contacts are brass or phosphor bronze, plated to suit your specification. Supplied with or without center shield. Now available in 7-pin construction with 9-pin miniature and other types to follow. Tube Shield Ground Strap can also be furnished.

2. **New Sylvania Solderless-type Sockets** for wire-wrapped connections are now being made in all 7 and 9-pin miniature sizes. Contacts are shaped to provide reliable connections with the use of present wire-wrapping tools.

See the full story of Sylvania's Fabricating Services in Sweet's Catalog—Product Design File. Look for $\frac{1b}{Sy}$

For full information *concerning these or other Sylvania parts, or special quality components engineered to your own specifications, write to Dept. 4A-1606, Sylvania today.*

SYLVANIA

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

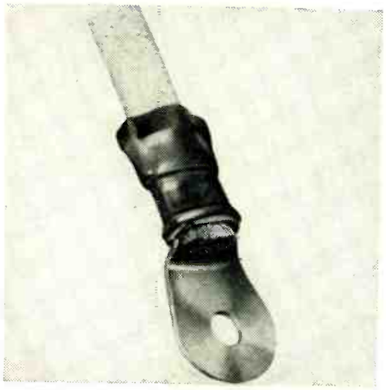
In Canada: Sylvania Electric (Canada) Ltd., University Tower Building, St. Catherine Street, Montreal, P. Q.

LIGHTING · RADIO · ELECTRONICS · TELEVISION

is a feature of the new 165 series of miniature AN connectors. These miniatures are used extensively in modern aircraft and guided missiles. The new connectors are available in two sizes, six configurations—with 5, 9, 11, 12, 14 or 24 gold plated contacts. They are pressurized but not hermetically sealed and will far exceed the government-required 50-hour salt-spray test. Female connectors feature a sandwich-type construction for the inner seal with the containing cartridge spun over, thus being sealed at the factory with no chance of leakage. The outer seal is accomplished with a silicone O ring. Other features include a hard-coat finish anodically formed on the aluminum shell; the blue 1-501 dielectric; and interchangeable inserts (contact sizes No. 20 and No. 16).

INSULATED TERMINAL

for heavy-duty wire use

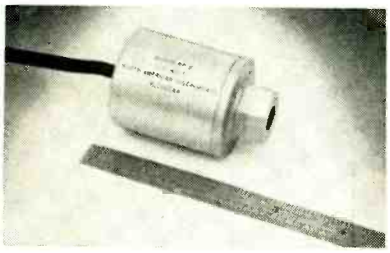


AIRCRAFT-MARINE PRODUCTS, INC., 2100 Paxton St., Harrisburg, Pa., has developed the Ampli-Bond insulated terminal for users of heavy-duty wire. It gives a positive and complete bond of the insulation to the terminal sleeve, insures uniform insulation thickness under confined crimping pressures, and therefore transmits the pressure evenly to the center of the crimp area. Insulation is designed to extend minimum distance beyond terminal barrel, provides maximum permanent support and allows the use of large-size wire in restricted areas. Completely separate metallic ring grips wire insulation, prevents exposure of conductor during sharp bends and cable fatigue caused by excessive flexing and vibration. This nonconducting ring forms a barrier to foreign objects coming in contact with current-carrying members. A tough vinyl insulation is used that will withstand a minimum of 6,000 v, which is four times the military specification for insulated terminals.

PRESSURE TRANSDUCER

for high-range use

NORTH AMERICAN INSTRUMENTS, INC., 2420 N. Lake Ave., Altadena, Calif. Model GP-8 high-range pressure transducer has ranges extending from 200 to 5,000 psi gage and all are rated at 100-percent safe overload. The instrument is suitable for both static and dynamic measurements. Dynamic response is more than sufficient for most measurements involving transient

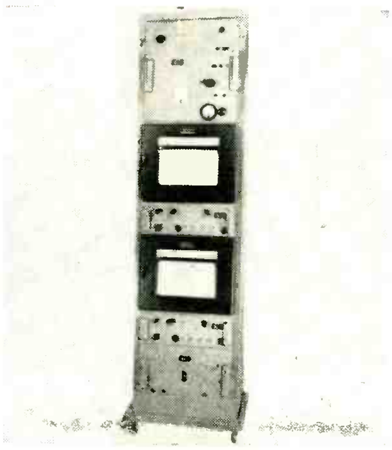


pressure phenomena. The natural frequency runs from 2,000 cps to 10,000 cps. The unit has been designed with particular emphasis on resistance to mechanical vibration and shock excitation. Electrical characteristics of the model GP-8 are the same as those of the company's other transducers. Any excitation frequency from 60 to 50,000 cps may be used, the maximum input voltage at 3,000 cps being 30 v. Full scale output is 40 mv per v input in bridge circuit operation. Rated accuracy including linearity is 1 percent full scale or better.

WAVE ANALYZER

for vibration analysis

THE DAVIES LABORATORIES, INC., 4705 Queensbury Road, Riverdale, Md. Completely automatic reduction of vibration, seismic, power line transient, noise, shock and the like can be made on the heterodyne type, series 901 automatic wave analyzer. The analysis is a Fourier analysis—amplitude vs frequency. Covering the frequency range of 3 to 2,000 cps, it has the following features: variable bandwidth ½ to 45 cps, analysis down to 3 cps, amplitude accuracy ±5 percent of reading on logarithmic scale, frequency accuracy ½ percent of reading, input voltage range 60 db and input impedance 2½ megohms. Analysis is recorded and up to 14 inputs are handled and selected completely automatically, including if desired the simultaneous analysis of from two up to the total number of inputs. The analyzer consists of 6 basic units, which are available individually as well as in an as-



FAMOUS KINGS IN HISTORY

RICHARD I—affectionately surnamed "the Lion-Hearted" — was King of England from 1189 until his death in battle ten years later. In the first year of his reign he started on the Third Crusade. A major figure in English romance, Richard Coeur de Lion is a symbol of chivalry and famous for many deeds of valor.

FAMOUS KINGS CONNECTORS

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In this scientific age, Connectors by Kings are a symbol of the most modern progress in engineering ingenuity and precision manufacture. Electronics engineers everywhere accord them a valued recognition earned by years of research and product development. For the finest "Solid Contact" Connectors make Kings your prime source.

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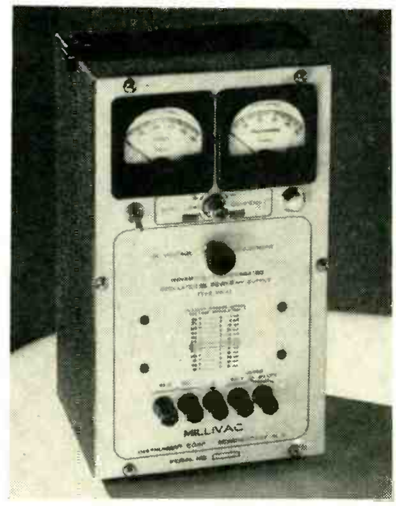
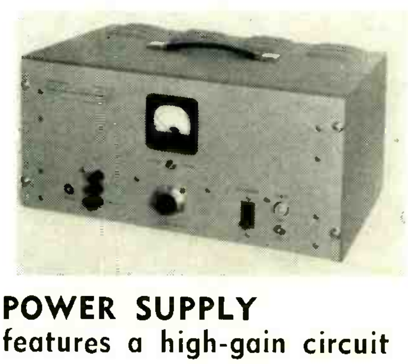
sembly-input switching panel, oscillator-controller, modulator-filter, recorder, power supplies and rack.



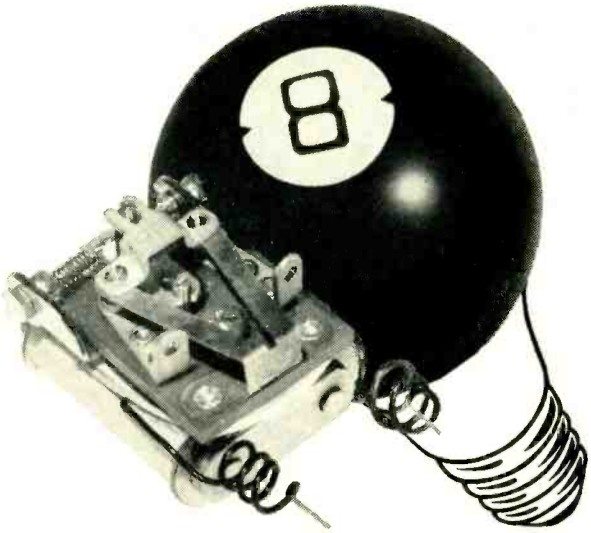
D-C POWER SUPPLIES have unusual stability

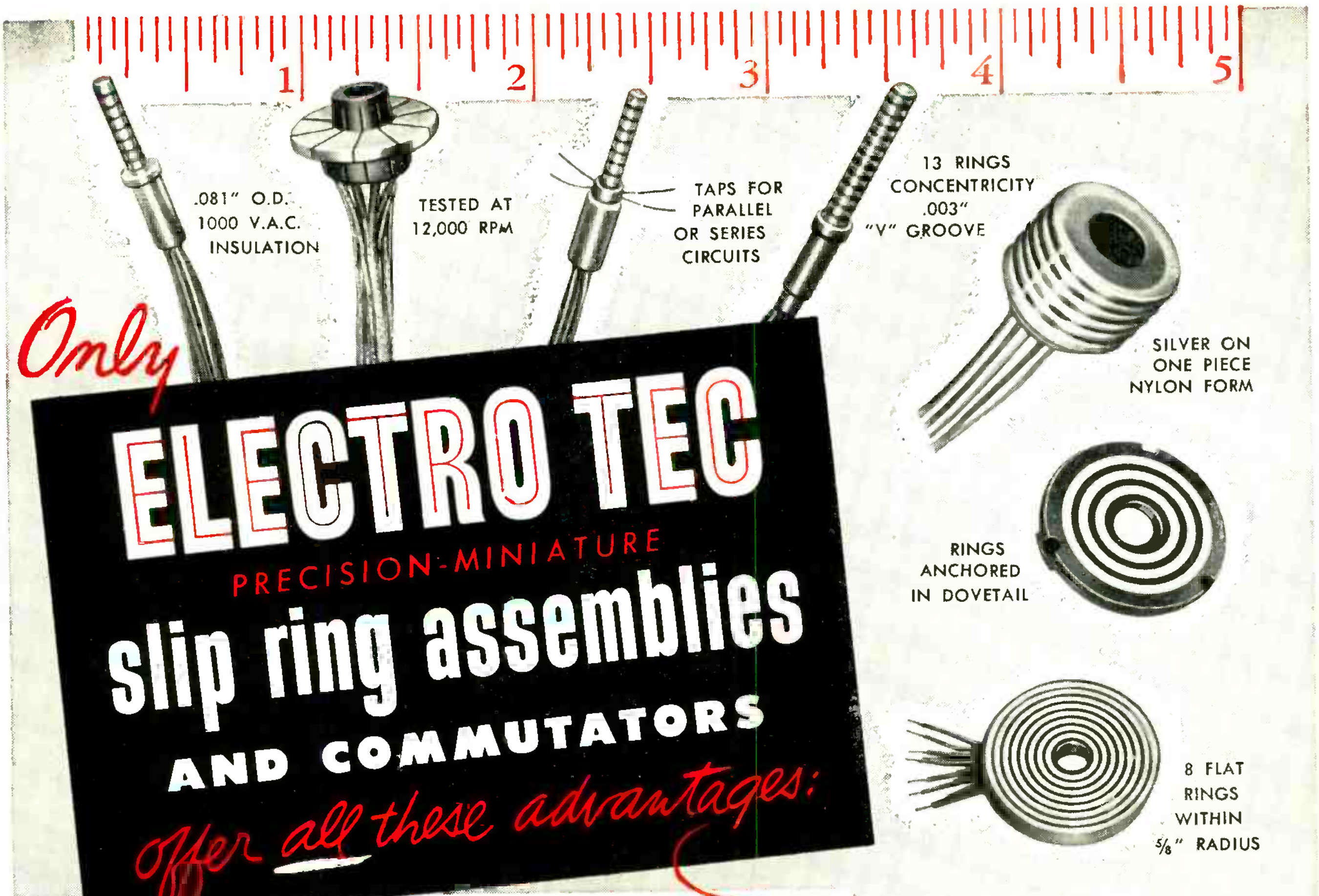
MILLIVAC INSTRUMENT CORP., 444 Second St., Schenectady 6, N. Y., has developed a series of RP supplies to meet the demand for regulated d-c power supplies that have high stability at a reasonable cost. They are dynamically compensated to provide zero or slightly negative internal impedance to compensate for voltage drops in lines between the power supply and the consumer. These new small supplies range in voltage from 250 to 400 v and in current from 50 ma to 100 ma.



POWER SUPPLY features a high-gain circuit

CONSOLIDATED ENGINEERING CORP., 300 N. Sierra Madre Villa, Pasadena 8, Calif. Zero to 15 v d-c at a maximum of 1 ampere is the output furnished by the type 3-132 power supply. Designed for the excitation of multiple strain gages and other resistance type transducers, it may be used as a second-





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slip ring assemblies AND COMMUTATORS

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Electro Tec units are the product of an exclusive manufacturing technique that results in accuracy unattainable by conventional fabricating methods. In this process a plastic is moulded around the wire leads. Accurate machining reduces this blank to the proper shape, complete with grooves. Hard silver is deposited into the grooves by electroplating to produce the required rings. Final machining insures concentricity and dimensional accuracy. The result is one-piece, unitized construction with conducting rings of 60 to 70 Brinell hardness.

Diameters of these assemblies range from .045" to 24" cylindrical or flat. Cross-sections may range from .005" to .060" or more. Rings are polished to a jewel-like finish and can be held to 4 micro-inches or better. Even the smallest sizes withstand a 1000 V.A.C. breakdown test. Most types easily withstand rotational speeds up to 12000 rpm.

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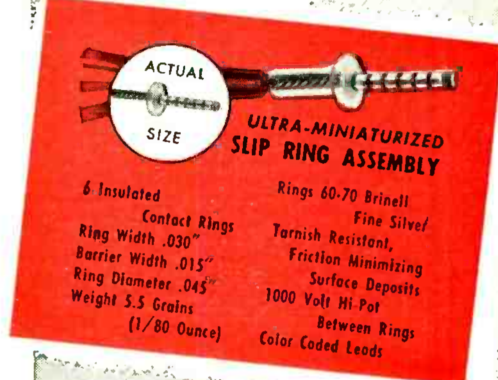
The uniformly superior performance of Electro Tec slip ring and commutator assemblies in thousands of industrial and governmental applications has resulted in wide adoption of these component units by most leading manufacturers of precision instruments and equipment. Although these products provide improved performance and extra dependability, prices are strictly competitive. Write today for fully illustrated literature.



*PATENTS PENDING

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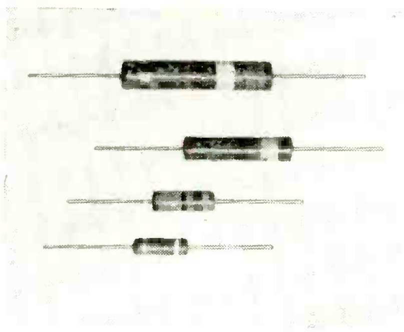
PRODUCTS OF PRECISION CRAFTSMANSHIP BY A NEW AND REVOLUTIONARY PROCESS

ary reference voltage source in many other research, production, calibration and measurement applications. It is also a convenient voltage supply for sensitive filaments in d-c amplifiers. Continuously adjustable over the 0 to 15-v range, output voltage is indicated on a front-panel meter and may be varied with a 10-turn voltage-setting control. Output impedance is less than 0.1 ohm; output drift, less than 5 mv per hour; and ripple, less than 1 mv peak-to-peak. A 10-v change or transient in a 105 to 125-v a-c line voltage causes less than 10-mv change in the output; a 0 to 1-ampere change in load causes less than 20-mv change. The unit's outstanding performance results from its high-gain circuit, a portion of which continually compares the output against a stable internal reference voltage to insure absolute regulation.

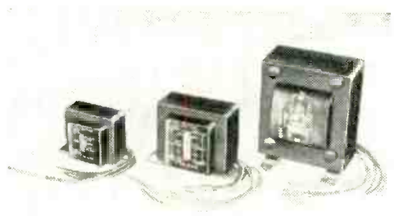
S-S FILTER
for amateur receivers

BURNELL & Co., 45 Warburton Ave., Yonkers 2, N. Y. Type S-15000 single-sideband filter for amateur receivers utilizes a toroid coil instead of the costly crystal filters formerly required. The S-1500 ssb filter features compact size and ease of installation. Fixed-tuned and hermetically sealed, it requires no adjustment, is rugged and trouble-free. It may be installed in any existing amateur receiver now in use, and is also suitable for incorporation into new designs by set manufacturers. It utilizes 50 kc as a 2nd i-f and provides a narrow-band, sharp cutoff response which insures maximum intelligibility and maximum signal intensity. Descriptive information, including schematic and response curve, is available in a single-sheet bulletin.



INSULATED CHOKES
for many applications

INTERNATIONAL RESISTANCE CO., 401 North Broad St., Philadelphia 8, Pa., has available a line of chokes in four sizes, all protectively insulated against high humidity in molded plastic housings. Identified as types CL1/2, CLA, CL1 and CL2, they offer a wide range of size and characteristic combinations, and permit accurate specification to individual space and electrical requirements. The chokes offer numerous circuit applications, such as: filament chokes, plate loads, wave traps, parasitic suppressors, line terminating impedances, cathode chokes, antenna chokes and grid chokes.

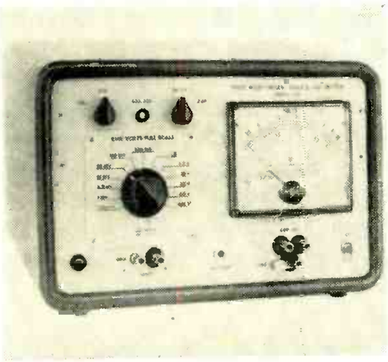


TRANSFORMERS
are plastic-molded

TELECTRO INDUSTRIES CORP., 35-18 37th St., Long Island City 1, N. Y., announces the introduction of Telectrans, the new custom plastic-molded transformers and reactors for the electronic industry. Through the use of a novel method of plastic encapsulation, Telectrans improve upon the conventional hermetically sealed transformer and the use of hermetically sealed solder terminals. Telectrans are manufactured with sealed, flexible leads that can be supplied to any length and with any type of termination. These transformers and reactors have been approved by the Signal Corps Engineering Laboratories and meet the requirements of MIL-T-27, grade 1, class A. Using special techniques, custom designed transformers and reactors for all types of audio, power and low-frequency r-f applications, can be supplied at savings in size, weight and cost.

DIGITAL COMPUTER
with magnetic-drum memory

CONSOLIDATED ENGINEERING CORP., 300 N. Sierra Madre Villa, Pasadena 8, Calif. Model 203 general purpose digital computer is not limited to any specific field of activity but is adaptable to almost any problem reducible to numerical terms. The numerical notation used is an easily understood, binary-coded decimal system in which four binary digits form each decimal digit. The four binary digits are operated upon in parallel, while each successive decimal digit is handled serially. Progress of a problem can be quickly checked, for contents of all internal registers are displayed as arrays of neon lights which can be directly read as decimal digits. A magnetic drum rotating at 3,600 rpm, along with the associated reading-writing heads and electronic circuits, serves as the computer's memory. Capacity of 4,080 words of 10 decimal digits each plus the speed at which the computer can extract the words from the memory gives the overall system an appreciable speed advantage. All additions, subtractions, logical shifts and transfers are performed at an average rate of 500 per second, while multiplications are accomplished at 120 per second and divisions at 85 per second. Complete description is given in bulletin 3100.



VOLTMETER
measures true rms values

BALLANTINE LABORATORIES, INC., Boonton, N. J. Model 320 Voltmeter of the ultrasensitive type measures true rms values of highly complex waveforms in addition to sinusoidal waves. It operates over a range of 100 μv to 320 v and in a band of 5 cps to 500 kc. Accuracy is better than 3 percent between 15 cps and 150 kc for any reading regardless of scale position. Other features include 10-megohm input impedance, provision for simultaneously observing the voltage reading and monitoring the amplified signal with phones or cro, and a built-in calibrator unit for correcting the effects of advanced aging of tubes. Accessories are available for extending voltage range to 20 μv and 10 kv and for measuring rms currents from 0.1 μa to 10 amperes.

CALIBRATOR
has iron vane type meter

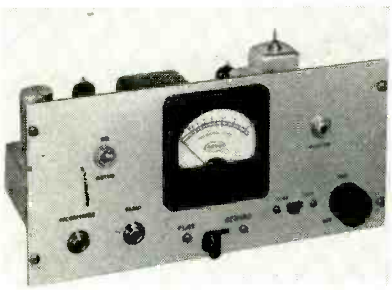
NORTHEAST ELECTRONICS CORP., Municipal Airport Building, Concord, N. H. Model 3 calibrator is designed to facilitate calibration of vtvm's and oscilloscopes in the low voltage ranges. It provides a calibrated a-c output voltage from 0.50 mv to 7.50 v with an rms accuracy of 1.5 percent or better over the frequency range of 25 cps to 1,000 cps. A 60-cps variable voltage supply is contained in the instruments; other frequencies can be applied to the external terminals. It uses a meter with an iron-vane movement to insure permanent calibration. The calibrator is available for standard relay rack mounting or for portable use. It is 5¼ in. high, 4 in. deep and weighs 7 lb.

PLATED FINE WIRE
for the electronic industry

NORTH AMERICAN RESEARCH LABORATORIES, INC., 275 Lexington Ave., Kenilworth, N. J., announce their own high quality product of gold, silver and platinum and other plated wire, available now directly to the user. The wire is shipped on new throw-away type plastic spools. A 2-page brochure discusses the company's services and such products as continuous wire plating, strip plating and plating of small parts such as electrical connectors, contacts and Tinkertoy components.

POWER BRIDGE
covers 10-1,000 mc range

ELECTRO-METRIC INSTRUMENT CO., 241 Center St., New York 13, N. Y., has available a vhf-uhf power bridge that covers a frequency range of 10 to 1,000 mc. It can measure power levels from 2 μw to 30 mw in 6 ranges—0.1 mw through 30 mw, full scale. A self-balancing circuit is used, requiring a minimum of manual operation. Input impedance is 300 ohms balanced and vswr is better than 1.3 in the range specified. Total error is less than 5 percent. The extensive range of applications includes speedy and accurate gain measurements on tuners and converters, transmission measurements of active and passive networks, and calibration of signal generating equipment. Recorder connections are made available. Continuous recording should prove of interest to transmitter engineers and in propagation studies.



TAPE PREAMPLIFIER
has 50-12,000 cps response

PENTRON CORP., 221 E. Cullerton, Chicago 16, Ill. Model HFP-1 high-fidelity tape preamplifier offers frequency response of 50 to 12,000 cps ±3 db, with an absolute minimum of distortion. Used with the company's intermatching 9T-3M tape transport mechanism, the preamplifier provides an inexpensive tape recording and playback system. The HFP-1 controls are: an illuminated v-u recording meter, gain control and power switch, record-play switch and compensation switch.

PULSE TRANSFORMERS
useful in computer systems

MAGNETICS RESEARCH CO., 142 King St., Chappaqua, N. Y. The MDT series of transformers are designed for use in driving magnetic drum or magnetic tape recording heads or for any application requiring moderatly high power pulses. They have two primary windings and one secondary and are characterized by fast rise and fall times and relatively long allowable on time. Available in primary (each winding) to secondary turns ratios of 1 to 2, 1 to 1, 2 to 1, 3 to 1, 4 to 1, 5 to 1 and 6 to 1, these units will match any recording head to any driving tube. Typical figures for the MDT-1 (1 to 1 ratio) being driven by a pair of type 5881 tubes and driving a Raytheon magnetic drum recording head are: record current, 200 ma; peak voltage across record head, 200 v; maximum pulse width for less than 20-percent peak current falloff, 6 μsec; and current overshoot, less than 5 percent with critical damping.

BEAM POWER TUBE for uhf color tv use

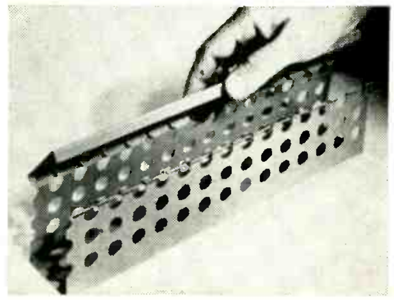
RADIO CORP. OF AMERICA, Harrison, N. J. Type 6448 beam power tube, developed for uhf tv broadcasting, is capable of 12,000 w of power output at 900 mc. The tube measures only 7¾ in. in height and 11⅜ in. in diameter, and features a novel built-in canal system for water-cooling. In color or black-and-white tv service, the 6448 can deliver a synchronizing-level power output of 15,000 w at 500 mc. As a c-w amplifier in class C telegraphy, the tube can generate useful power output of 14,000 w at 400 mc or 11,000 w at 900 mc. Construction of the water-cooled tube described minimizes circuitry, reduces tuning requirements, results in rugged, simple mechanical arrangements, and makes possible small overall cavity size. Only one set of cavities is required to tune the entire uhf tv frequency band.

PLUG-IN NETWORKS for impedance matching

THE DAVEN CO., 191 Central Ave., Newark, N. J., has available the 690 series of plug-in attenuation networks. The plug-in feature permits input and output impedance to be changed to any value by substituting plug-in pads of the particular impedance desired. The networks are intended for use in general laboratory and production testing; are extremely rugged, flexible and reliable. They are available in either T or balanced H circuits. A range of 110 db in 1-db steps can be obtained on the 2-dial series, or a range of 111 db in 0.1-db steps on the 3-dial series. A special card-type, noninductive winding is used, giving a frequency range of from 0 to 50 kc. Resistor units are calibrated to ±1.0-percent accuracy and operate at a ±20-db (0.6 w) maximum input level. To insure low contact resistance and uniform contact pressure, knee-action switch rotors are used. Silver alloy rotors, slip-rings and contacts insure finest performance.

SOLDER POTS with controlled heating

VULCAN ELECTRIC CO., Danvers 10, Mass., has available a line of thermostatically controlled rectangular solder pots, designed specifically for tinning printed circuits or dipping small chassis assemblies. Shallow cast iron crucibles are designed with wide lips and come in any inside dimensions from 6 in. × 12 in. to 12 in. × 12 in., with depths of from 1 in. to 4 in. Replaceable electric heating elements are clamped to the under surfaces of crucible castings and are well insulated from the sheet metal casing. Both pot and thermostat are mounted on the same heavy metal base.



WIRING DUCT eliminates lacing

TAYLOR ELECTRIC INC., 15460 Dale, Detroit 23, Mich. To hold, protect, and distribute a harness, this newly designed duct has important time-and-labor-saving advantages. Made from a thermoplastic material, its chemical and physical properties are similar to those of machine tool wire insulation. Cover snaps on and off. Clips, inserted at regular intervals, hold wires firmly and eliminate costly lacing or harness in wiring and maintenance. It will not support combustion, and will not warp under damp or moist conditions. It is available in lengths up to 45 in., and is easily cut into sections with a knife.

FREQUENCY CHANGER makes ideal bench supply

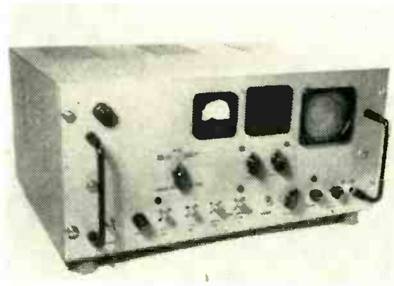
BLISS SCIENTIFIC INSTRUMENTS, 107 Elmwood Ave., Ithaca, N. Y., is introducing a line of electronic frequency changers of which the Multicycle model 281 is typical. Operating from the 115-v, 60-cycle line, the unit delivers 115 v, 400 cycles constant duty. Voltage regulation is ± 2.5 percent, and waveform distortion is practically negligible from zero to full load. It makes an ideal all-around 400-cycle bench supply for use with servomechanisms, magnetic amplifiers, testing airborne equipment and the like. Model 281 is available in a wide range of frequencies. Frequency may be readily changed at any time through simple internal adjustments.

S-W AMPLIFIER
has vswr range to 100

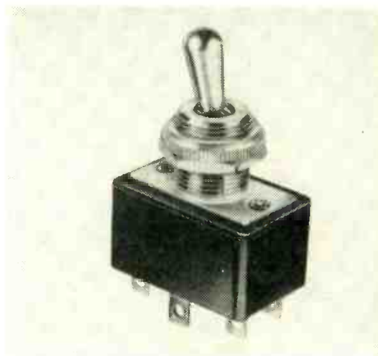
F-R MACHINE WORKS, INC., 44-14 Astoria Blvd., Long Island City 3, N. Y. The FXR type B810A standing wave amplifier is designed to provide full utilization of the latest precision slotted sections and probes when measuring the impedance or vswr in a coaxial or waveguide transmission line. Some features are: (1) noise level less than 0.03 μv; (2) variable, metered bolometer bias, 3.5 to 9 ma constant current; (3) automatic bolometer protective circuit; and (4) narrow and wide-band operation.

WWV MONITOR
for local standards

MATAWAN ELECTRONICS CO., INC., 236 Creek Road, Keansburg, N. J., has available a new WWV receiver, model ME-117. It compares a local standard to the WWV 5-mc standard. After demodulation, the 5-mc carrier is doubled to 10 mc and displayed on a 2-in. crt as a circular pattern. A 10-mc multiple of the local standard modulates the inten-



sity of this pattern. Speed and sense of rotation of the pattern indicate the amount and direction of the deviation from the WWV standard. The receiver will accommodate any local standard frequency in the range from 50 kc to 10 mc equal to a subharmonic of 10 mc, 2 mc or 400 kc. A second channel receives the audio modulation and time signals of the WWV standard.

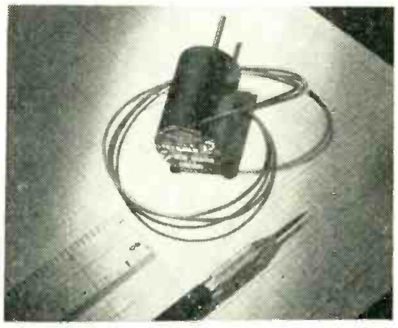


TOGGLE SWITCH
rated at 3,000 v flash test

BRITISH ELECTRONIC SALES CO., 23–03 45th Road, Long Island City 1, N. Y. Type T622 is the latest addition to a broad line of electronic instrument switches using unusually heavy plated beryllium wiping contacts in a unique design. This dpdt quick-make-and-break toggle switch features very small overall size with relatively high current handling ability of 6 amperes on a-c or d-c. It is rated at 3,000 v flash tests, and uses standard U. S. threads. Handle style is made to customer's sample or specification.

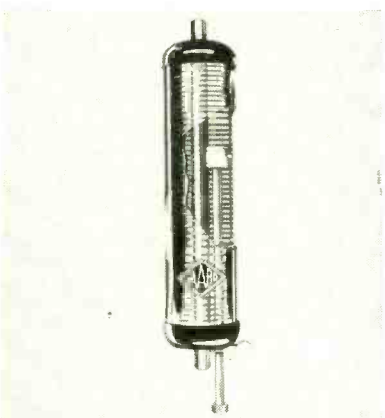
CRYSTAL DETECTOR
with detachable crystal

F. W. SICKLES DIVISION, General Instrument Corp., Chicopee, Mass. Type 17036 is a miniature 45.75-mc picture i-f crystal detector with filter assembly and detachable, snap-in crystal and shielding cover to reduce radiation. The unit is $\frac{3}{4}$ in. sq × 2 in. high. It contains either single or double tuned transformer and crystal, tweet network and silvered mica capacitors.



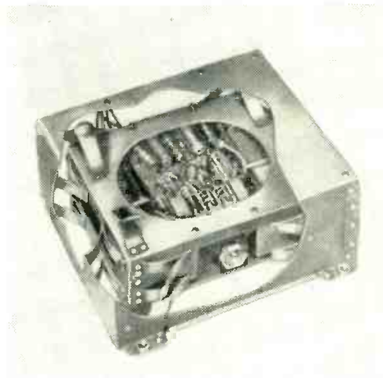
TINY P-M MOTOR rated at 1/400 h-p.

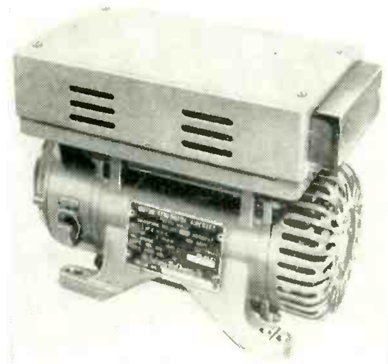
DALMOTOR CO., 1375 Clay St., Santa Clara, Calif. Type PM-47 miniature permanent-magnet motor, rated at 1/400 horsepower with operating rotor speed of 10,500 rpm, is suggested for application to small fans, blowers and other similar light-weight-load applications. Designed for continuous duty, it draws 0.18 ampere at 27 v d-c, and has a total weight of 5 oz. Dimensions are $1\frac{13}{16}$ in. long × $1\frac{1}{8}$ in. diameter and the $\frac{1}{8}$-in. diameter shaft has an extension length of $1\frac{1}{16}$ in. Other lengths and special arrangements can be provided where required.



VARIABLE COIL for mobile use

VAARO ELECTRONIC ENGINEERING CO., Box 5035, Long Beach, Calif., has announced a new variable single-unit mobile coil for use in the 75, 40, 20, 15, 11 and 10-meter band range. It incorporates a slider that can be moved up or down until the transmitter loading is obtained, and then the slider remains exactly in place through a shaft lock feature. The single-unit coil is built in two models: model V-102 for rigs developing from 0 to 250-w input, and the model V-103 for rigs developing from 0 to 500-w input. Outstanding features and information on construction details are given in bulletin VC-1.





INVERTER
has shock-mounted control

THE LELAND ELECTRIC CO., Division of American Machine & Foundry Co., Dayton 1, Ohio. A new 1,500 v-a inverter for operation up to 50,000-ft altitude is in production.

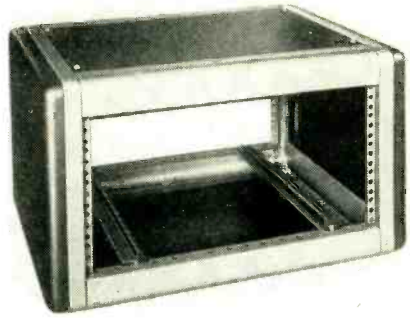
It features light weight (40-lb) and compactness ($13\frac{1}{2}$ in. long × $7\frac{1}{8}$ in. wide × $9\frac{1}{4}$ in. high). The electronic voltage and frequency control package utilizes a new concept of vibration and shock isolation consisting of stainless steel folded springs mounted on the six faces of the regulator chassis and slide on graphitized phenolic sheet fastened to the inner surfaces of the outside package. Adequate isolation of the regulator is accomplished while the complete inverter is subjected to vibration (to 10 g) from 0 to 500 cps.

D-C POWER SUPPLIES use no vacuum tubes

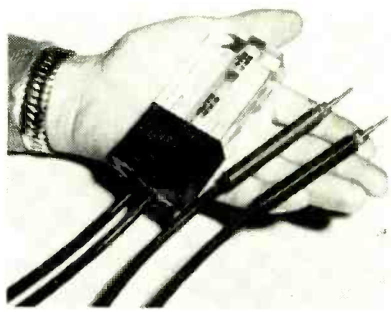
MAGNETIC RESEARCH CORP., 318 Kansas St., El Segundo, Calif. Utilizing no vacuum tubes or moving parts, the Stablvolt type A line of power supplies is designed for ruggedness, reliability and years of maintenance-free operation. It features dual magnetic regulation which effectively isolates line voltage transients from the d-c output voltage. The response to a-c line variations of 95 to 135 v is practically instantaneous with dynamic line regulation better than 0.2 percent. The transient free feature permits an all magnetically regulated power supply to be used as a transient free d-c power source in the field of d-c measurement and instrumentation for strain gages, comparators, potentiometers, tungsten lights and recording lamps. Standard sizes are available in 6, 12 and 28 v at current ratings up to 100 amperes. From no-load to full-load, regulation is better than ±1 percent, and response to extreme conditions of loading is faster than 0.2 second. Ripple is less than 0.5 percent, rms.

INSTRUMENT CABINET permits handy maintenance

ELGIN METALFORMERS CORP., 906 N. Liberty St., Elgin, Ill., has introduced an instrument cabinet designed for maintenance and production assembly men. Top, bottom, back and both end panels are

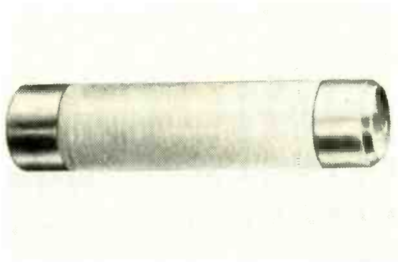


quickly removed with only a screwdriver, allowing complete accessibility to the interior. It is constructed throughout of smooth, premium-quality cold-rolled steel, fabricated with electronically controlled welds. The cabinets can be stacked vertically or horizontally, locked together in minutes with Tinnerman Speed Nuts and a screwdriver. They can accommodate chassis with 8¾ in. × 19 in. front panel, 15 in. depth. Chassis guide supports are adjustable to chassis of any width up to 17 in.



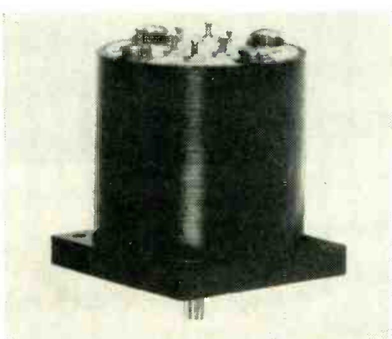
VOLTAGE TESTER
is rugged and light

CRAFT LABORATORIES, 214 E. Broad St., Westfield, N. J., has available the model AP1 voltage tester, for testing circuits from 90 to 600 v. By substituting an electronic means for a mechanical one, the voltages can be separated by large, easily distinguished marks. The operating section is transparent, so that it can be seen from any angle; a low voltage lighting only the bottom part, the higher voltages causing the light to climb up the tube, giving the voltage indication the way a thermometer shows temperature. It will give an accurate voltage indication on all frequencies from d-c to 400 cycles on the same scale, and indicate polarity on d-c. In addition, it has the standard features of the mechanical types such as 30-in. leads made of 10,000-v wire, and a place to bury the prod tips for the protection of the one carrying it.



BOLOMETER
is of the hot wire type

NARDA—NASSAU RESEARCH & DEVELOPMENT ASSOCIATES, INC., 66 Main St., Mineola, N. Y. The N-821B bolometer for detection of microwave and ultrahigh frequencies is of the hot wire type, requiring a bias current of 8.75 ma to obtain the operating resistance of 200 ohms. The detection is square law for power levels within any 40-db interval. Burnout power is over 15 mw, and sensitivity is 4.5 ohms per mw. The bolometer is made by a new process that permits the use of a continuous plastic sleeve enclosing the hot wire, resulting in a higher tensile strength than previously available.

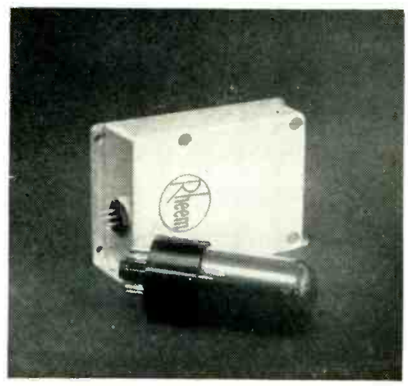


SERVO MOTOR
is two-speed unit

RAYTHEON MFG. CO., 148 California St., Newton 58, Mass. This motor was designed for a servo unit which required two-speed operation of its components. The two speeds are obtained by pole changing which is accomplished by simple connection changes. Speeds of 11,000 and 5,500 rpm are available with a 400-cycle motor. The stalled torque is 0.13 oz in. with the high-speed connection and 0.35 oz in. with the low-speed connection. This motor eliminates the need for gear ratio changing devices in applications when two-speed operation is essential. For complete technical information, write for bulletin DL-Y-15.

POTTING COMPOUNDS
with many applications

Isocyanate Products, Inc., P. O. Box 1681, Wilmington, Del. IPI-Isofoam is a new foamed-in-place, polyisocyanate expansible resin, which is self-cured to produce a low density product with a multiplicity of applications. The strength and electrical properties of the compound can be effectively utilized as a core material for radomes in aircraft and guided missiles. These same properties can also be used to provide space saving through potting of radio and other electronic circuits.

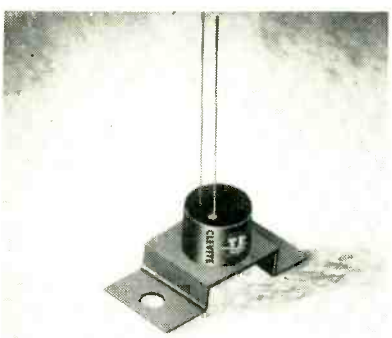


AUDIO AMPLIFIER
for instrumentation

Rheem Mfg. Co., 9236 East Hall Road, Downey, Calif. This subminiature, wide-band audio amplifier is designed for a wide variety of applications in the instrumentation field. Its circuitry, which includes the use of overall feedback, together with minor feedback loops, results in very stable operational characteristics. The major feedback loop is independent in the input and output circuits. The amplifier is a versatile unit capable of furnishing gains of 30,100, 300 or 1,000. It has an input impedance of 2 or 100 megohms and either a 6 or 24-v filament supply may be utilized. The unit may be subjected to extreme shock and vibration and still maintains constant output.

DELAY LINES
designed for color tv

OSSIAN MFG. CO., Box 151A, Ossian, Ind., has added the designs illustrated to its stock delay lines. These distributed constant lines are available with impedances of 3,300, 2,700, 2,000, 1,500 and 1,100 ohms. The rise time for a 1-μsec delay is 0.1 μsec for the 3,300-ohm type. The lines are designed primarily for color tv.

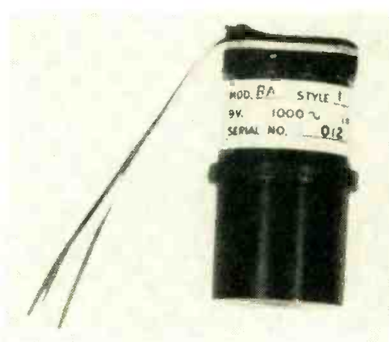


TRANSISTOR
is experimental type

TRANSISTOR PRODUCTS, INC., Snow & Union St., Boston 35, Mass., has available an experimental high-power transistor, type X78. It is a *pnp* diffused junction transistor, useful principally when used in matched pairs in class-B audio amplifier applications. Subminiature matching transformers have been made available for use in such a circuit. Although the unit is derated when operated at temperatures above 80 F, it has still found widespread usefulness in the laboratory. Minimum power gain is 10 db at room temperature when used in the recommended circuit.

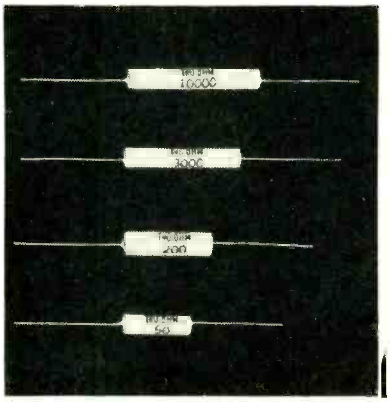
R-F PROBE
with dual tuning control

F-R Machine Works, Inc., 44-14 Astoria Blvd., Long Island City 3, N. Y. High sensitivity and convenient, broadband tuning are achieved in the FXR type B200A broadband probe. The dual tuning control provides optimum matching from the probe pickup to the easily replaceable crystal or bolometer detector. An adaptor is provided for the type 821 barreters. A BNC output connector permits easy connection to a standing-wave amplifier. The probe is tunable over the frequency range of 1 to 12.4 kmc.



TINY GYRO
and miniature accelerometer

Raytheon Mfg. Co., 148 California St., Newton 58, Mass. The miniature gyro will indicate angular rates from 0.05 deg per sec to 120 deg per sec. An accelerometer in an identical package measures accelerations from 0.01 g to 25 g. These instruments are approximately 2 in. long and 1 in. in diameter, and meet very high standards for reliability under shock and vibration. A variety of models of both devices is available having different performance characteristics, and for operation from power supplies of frequencies of either 400 or 1,000 cycles. For complete details write for bulletin DL-Y-21 on the gyro or DL-Y-20 on the accelerometer.

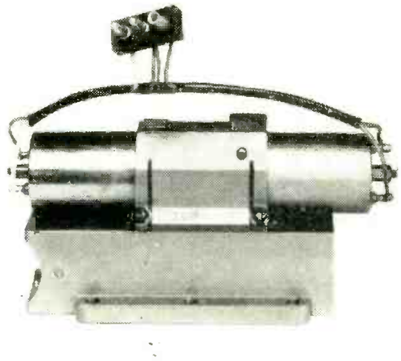


RESISTORS
of the axial lead type

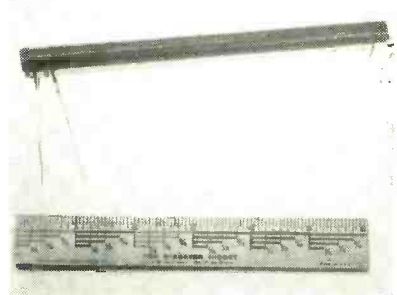
TRU-OHM PRODUCTS, DIVISION OF MODEL ENG. & MFG., INC., 2800 N. Milwaukee Ave., Chicago 18, Ill., has available axial-lead resistors wound on fiber glass cord in a continuous length. The cord is cut to required length and then the leads are securely clamped to each end. The core is then coated with silicone cement and inserted in a ceramic tube which affords maximum mechanical protection and high dielectric strength. The ends of the resistors are then sealed with silicone cement, which precludes any possibility of moisture coming in contact with the resistance element. Axial-lead resistors are supplied in standard watt ratings of 5, 7 and 10 w and to maximum resistance values of 1,000 ohms, 5,000 ohms and 7,500 ohms respectively.

HYDRAULIC VALVE
features low phase shift

RAYTHEON MFG. CO., 148 California St., Newton 58, Mass. This high-performance hydraulic valve has a phase shift of only 2 deg per cps. It has two stages—a pilot and a

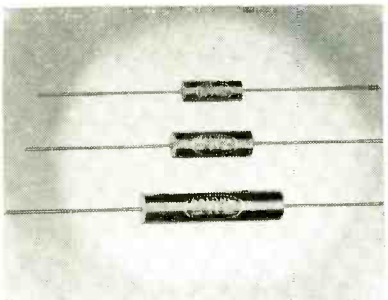


control stage—which results in a valve that can produce up to 5 hp at a hydraulic pressure of 3,000 psi from very small electrical signals. The control sleeve is removable and can be obtained with various size ports for individual requirements. Freedom from the effects of Bernoulli forces at high flow rate is made possible by the inherent design of this valve. For complete details, write for bulletin DL-Y-17.



DELAY LINES with variety of mountings

TECHNITROL ENGINEERING CO., 2751 N. Fourth St., Philadelphia 33, Pa. Very compact delay lines can be obtained in a tubular shape or a package, with a wide choice of mountings. The delay can be varied from 0.01 to 1.6 μsec. Characteristic impedance can be had from 400 to 2,500 ohms. There is a wide frequency response. For instance in a line with 0.5-μsec delay at 1,200-ohms impedance, the frequency response is 3 db down at 5 mc, 6 db down at 8 mc and 10 db down at 10 mc. Continuously wound delay lines provide minimum pulse distortion and are extremely stable with temperature variations. All lines are covered and impregnated to protect the winding from moisture and mechanical damage.

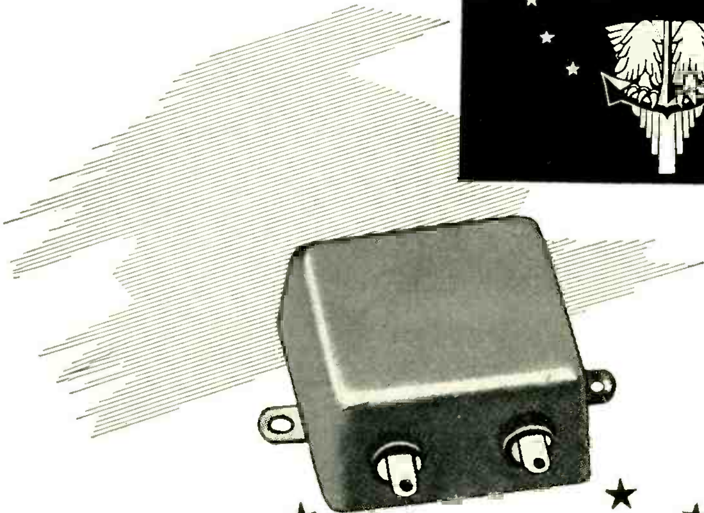


POWER RESISTORS
are tiny, ruggedized type

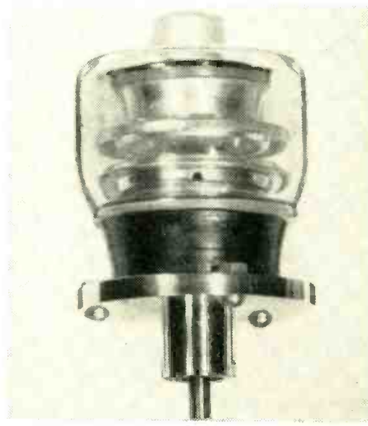
DALE PRODUCTS, INC., Columbus, Neb., has announced production of a new Dalohm ruggedized miniature power resistor designed to withstand the utmost in shock conditions. Type RSE resistors are available in 2, 5 and 10-w sizes. They are sealed in a special silicone coating and housed in black metal tubing. They are impervious to moisture; have complete welded construction from terminal to terminal; and have a temperature coefficient of 0.00002 per deg C. Ranges are from 0.05 ohm to 55,000 ohms. Tolerances of 0.05, 0.1, 0.25, 1.0 and 3.0 percent are available.

POTENTIOMETER
is sine-cosine type

FAIRCHILD CAMERA & INSTRUMENT CORP., 225 Park Ave., Hicksville, N. Y. Type 753 is a 3-in. continuous sine-cosine potentiometer utilizing two wipers spaced 90 deg apart to furnish full function sine-cosine outputs. It is also available as a straight sine function with a single wiper. It is 1¼ in. long from the front of the servo flange to the



rear of the cup. Type 753 is easily ganged up to 6 cps. Standard resistance value is 20,000 ohms per quadrant. Standard linearity tolerance of ±0.5 percent of the peak-to-peak output is offered. Torque of shaft per cup section is 1.5 oz in. for single wiper and 2.0 oz in. for dual wiper at 25 C. All terminals are gold plated for reduced contact resistance, low corrosion factor and faster soldering.

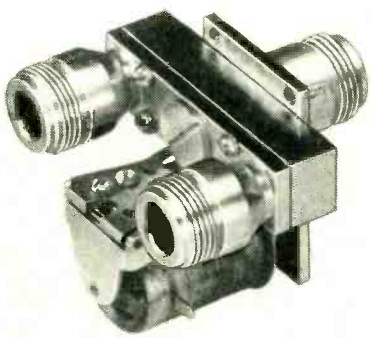


CAPACITOR
for use in amateur field

JENNINGS RADIO MFG. CORP., P. O. Box 1278, San Jose 8, Calif., has introduced a new vacuum variable capacitor designed for service in the amateur field. Type VAC has a capacitance range of 4 to 40 $\mu\mu$f with a nonlinear variation that makes tuning easier at the low capacitance end. Its rating of 42 amperes rms at 10 kv peak (and 22 mc) also makes it highly useful as a neutralizing capacitor in commercial applications. The voltage rating of 10 kv peak is determined at maximum capacitance and increases rapidly as the plates are separated at lower capacitances. The unit is 5 in. long and $2\frac{5}{8}$ in. in diameter, with a $\frac{1}{4}$-in. diameter tuning shaft.

I-F TRANSFORMERS
are small, bifilar type

LABORATORY FOR ELECTRONICS, INC., 75 Pitts St., Boston 14, Mass. is introducing a line of new, small bifilar type i-f transformers. They are wound on special ceramic forms and are given a thorough vacuum impregnation with silicone varnish to increase moisture resistance. The units are adjustable in that they are slug tuned. Small fixed-tuned and slug-tuned solenoids and peaking coils are also available. Another new product is a line of custom-built pulse transformers of both the small interstage type and the high-power output type. These transformers can be supplied in cases per customers' specifications or in the small sizes that can be made up as encapsulated units.



COAXIAL SWITCH
has low vswr

DANBURY-KNUDSEN, INC., P. O. Box 170, Danbury, Conn. Type CR25N, with type N connectors, is one of a new series of coaxial switches recently introduced. This 2-position coaxial switch has a maximum vswr of 1.25 and a minimum crosstalk figure of 42 db at frequencies up to 3,000 mc. Electrical performance at lower frequencies is considerably better. Minimum expected life is 1,000,000 operations. It can be supplied for remote operation with a-c or d-c operating coils for any standard voltage and is available with a control knob for manual operation.

Literature

Microphones and Acoustic Devices. Shure Brothers, Inc., 225 W. Huron St., Chicago 10, Ill. The revised general catalog No. 44B contains illustrations and data on Shure microphones for all applications; microphone accessories; magnetic tape and wire recording heads (with replacement chart); crystal and ceramic pickup cartridges (with replacement chart); and crystal phonograph pickups and needles.

Crystal Units. Reeves-Hoffman Corp., Cherry and North Sts., Carlisle, Pa. A 4-page bulletin describes the company's most used crystal units which range in frequency from 16 kc to 100 mc, and include the new RH-7BTV designed specifically for use in color tv. Comprehensive data pertaining to dimensions, frequency range and corresponding military specifications are given.

Contact Materials. P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis 6, Ind., has published a 59-page catalog devoted to electrical contacts and contact assemblies. It contains detailed specifications of the company's contact materials; numerous photographs and descriptions of manufacturing facilities and processes; and sketches, line drawings, charts and tables. An outstanding feature is a contact material selector guide, containing descriptions, applications and advantages of each material.

Toroidal Coils. Torwico Electronics, Inc., 961 Frelinghuysen Ave., Newark 5, N. J. A 4-page bulletin entitled "Toroids by Torwico" describes the fine wire winding technique range to No. 46 gage as used in the 18,000 turns on 20-henry chokes. Other coils and finished components that can be furnished from stock or on a contract order basis are illustrated and details given. They include miniature magnetic amplifier coils, high temperature coils, high-Q chokes, large coils, miniature chokes, oscillator coils and low-pass filters.

Oscilloscope Handbook. The Hickok Electrical Instrument Co., 10527 Dupont Ave., Cleveland 8, Ohio, has released a 24-page handbook on cathode-ray oscilloscopes. It contains explanation and illustration of the basic characteristics of the oscilloscope, how it works and tips on its more general uses. It also lists technical features and performance specifications of models ranging from 3-in. portable scopes up to large technician bench models and includes the highly accurate industrial-electronic laboratory types.

Coil Winding Machines. Geo. Stevens Mfg. Co., Inc., Pulaski Rd. at Peterson, Chicago 30, Ill., has just issued the 46-page catalog No. 54. It illustrates and completely describes machines for winding practically every kind of coil, including toroidal, transformer, bobbin, repeater, solenoid, resistor, armature, variable pitch, space wound, lattice-wound universal and field coils. A variety of accessories are also pictured and described. One page is devoted to winding formulas.

Microwave Equipment. Bogart Mfg. Corp., 315 Seigel St., Brooklyn 6, N. Y. A 4 page folder illustrates and describes five types of microwave equipment. Information is given on the S-band rotary joint, a waveguide to coaxial to waveguide structure employing doorknob transitions; the type 130 magnetron coupler; type 466 reaction frequency meter; type 834 duplexer; and type 535 shielded tube mount.

Magnetic Amplifiers. Magnetic Amplifiers, Inc., 632 Tinton Ave., New York 55, N. Y. A 6-page folder illustrates push-pull magnetic amplifiers, adjustable magnetic servo amplifiers, saturable transformers, demodulators, magnetic voltage regulators and variable speed drives. Included are tabular technical data on 60-cps magnetic amplifiers, 400-cps magnetic amplifiers and magnetic amplifier position servo systems.

Power Transistor. Minneapolis-Honeywell Regulator Co., 2753 Fourth Ave. South, Minneapolis 8, Minn. A 4-page data sheet gives preliminary specifications on the 2N57 power transistor. It includes general information, maximum ratings, information on total transistor dissipation, maximum power output, typical operating conditions and typical values. Also available is a single sheet (RD-53-002) showing characteristic curves.

Potentiometers and Rheostats. P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis 6, Ind., has available a catalog devoted exclusively to carbon and wire-wound potentiometers and rheostats. It tells the equipment design engineer how to specify control requirements to facilitate quotation and sample preparation and to assure production without delay. The catalog consists of 19 pages containing electrical and mechanical characteristics of available designs in the forms of description, line drawings with dimensions, and large clear photographs. Also illustrated are numerous charts and graphs as well as available hardware. The catalog also contains descriptions and values of potentiometers which can be manufactured in compliance with military specification JAN-R-19.

Portable Insulation Tester. Milwaukee Electronics Corp., 5231 N. Hopkins St., Milwaukee 9, Wisc. A single-sheet catalog bulletin covers the model ME-5KV portable high-potential a-c insulation tester. Included are operational information, technical specifications and descriptive data on the unit's 11 built-in features.

Transfer Volt-Ammeter. Charles Engelhard, Inc., 850 Passaic Ave., East Newark, N. J., has published a 4-page folder dealing with the new Hermach-Engelhard transfer volt-ammeter, a precision a-c multirange instrument with an accuracy of 0.05 percent through a frequency range from 20 to 20,000 cps. The folder describes and illustrates the unit, outlining its features. One page is devoted to information on how to use the unit.

Insulated Chokes. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa. Bulletin H-1 gives comprehensive data on new sizes and extended ranges, construction, insulation, humidity, aging, applications and color coding for a line of insulated chokes. The 4-page catalog contains detailed charts and graphs.

Seals Catalog. Minnesota Rubber and Gasket Co., 3630 Wooddale Ave., Minneapolis 16, Minn., has published a new 16-page brochure documenting in detail the production and application of rubber O-ring seals. Included are sections on end products, O-ring sizes, dash numbers and variable tolerances, dimensional data for installation of standard size O-rings, cross-sectional drawings of correct and incorrect installations and methods of utilizing O-ring sealing properties.

Mounting Systems. Robinson Aviation, Inc., Teterboro, N. J. Advanced design features of all-metal mounting systems are described and illustrated in a new 4-page bulletin, No. 800. The special types of all-metal (Met-L-Flex) mountings described have been developed after extensive research and laboratory work, collaboration with missile designers and service experience. The bulletin offers the answer to many exacting and unusual problems of mounting electronic equipment in guided missiles, rockets and jet aircraft. It includes engineering data and specific examples of various types of mounts and mounting systems.

Electric Actuators. AiResearch Mfg. Co., Los Angeles 45, Calif. A 64-page catalog of electric actuators is now available. The descriptive booklet outlines the applications and specifications of 20 basic types of linear and rotary actuators, power units, jacks, gear boxes and ammunition boosters. The company manufactures some 300 different models in these fields. Illustrated with photographs, charts and engineering drawings, the booklet is designed to help potential users choose the model that will best suit their needs.

Tube Sockets. Remler Co. Ltd., 2101 Bryant St., San Francisco 10, Calif. A one-sheet bulletin illustrates and describes medium base

4-pin and octal tube sockets. Specifications and dimensional drawings are given for these heavy duty industrial type components that are designed for rugged service and applications subject to vibration and shock.

Trimmers. Arco Electronics Inc., 103 Lafayette St., New York 13, N. Y. A 1-page bulletin announces two new Elmenco trimmers—the type 40 (miniature) and type 42 (midget). Sizes and guaranteed ranges are given.

Low Inertia Servo Motor. Infra Electronic Corp., 553 Eagle Rock Ave., Roseland, N. J. A recent bulletin deals with the type M100 low inertia servo motor. It lists motor characteristics, and contains a performance data curve and a schematic diagram showing fixed phase and control phase. A dimensional drawing is also included.

Power Supplies. Kepco Laboratories, 131-38 Sanford Ave., Flushing 55, N. Y., has available a folder illustrating and describing 20 models of voltage regulated power supplies. Tabular material lists output, volts, current, regulation and ripple for each.

Thermal Time Delay Relay. Elly Electronics Corp., P.O. Box 395, Fair Lawn, N. J., has issued a bulletin illustrating and describing its positive snap-action spdt thermal time delay relay that features small size, light weight, low heater current and low operating temperature. Technical specifications and ordering information are given.

High-Vacuum Pumps. Consolidated Vacuum Corp., 735 Ridge Rd., W., Rochester 3, N. Y. Data sheet 6-55 contains complete physical dimensions, operating data and performance curves for each of the type MCF high-vacuum oil diffusion pumps. The smallest of the eight fractionating metal pumps in the series described has a 2-in. diameter and a peak speed of 60 liters per sec; the largest has a 32-in. diameter and a peak speed of 19,000 liters per sec. The pumps discussed will produce an ultimate pressure of 5×10^{-7} mm Hg at 25 deg C.

Electronic Typer. Shepard Laboratories, 480 Morris Ave., Summit, N. J. A 4-page bulletin deals with the model 134 high-speed typer, an electronically operated printing device, capable of producing hard copy from the output of an electronic computer or magnetic tape. The machine described is adaptable to a wide variety of applications, such as data handling, inventory control or the production of subscriber labels. Illustrations, specifications and dimensional drawings are included.

Data Processing Equipment. International Business Machines Corp., 590 Madison Ave., New York 22, N. Y. The significant principles and components of electronic data processing equipment are described in "Light On The Future", an illustrated booklet now available. After a brief comparison of the construction and applications of analog and digital computers, the booklet explains the organization of digital computers and describes briefly the functions of the input, storage, arithemic, control and output components. A glossary is included.

Time Delay Generator. Rutherford Electronics Co., 3707 S. Robertson Blvd., Culver City, Calif. A single-sheet catalog bulletin illustrates, describes, outlines special features and the many uses of the model A-5 time delay generator, a precision electronic device for the generation of accurate and variable time intervals. Complete technical specifications are given.

Color Broadcast Equipment. Radio Corp. of America, Camden, N. J., recently released a catalog of standard color broadcast equipment. It contains detailed descriptions and specifications covering all essential items of color networking and test equipment. Included are RCA's color stabilizing amplifier, color monitor, color signal analyzer, linearity checker, color monitor analyzer, burst controlled oscillator, color frequency standard, burst flag generator, color bar generator and colorplexer. The catalog is accompanied by a complete price list.

Power Oscillator. Industrial Test Equipment Co., 55 E. 11th St., New York 3, N. Y. A single-sheet bulletin illustrates and describes the model 1040 power oscillator, a compact precision oscillator providing 3-w output. Included in the bulletin are applications, features and complete technical specifications.

Precision Potentiometers. The Gamewell Co., Newton Upper Falls 64, Mass., has issued an 8-page folder on its precision potentiometers which are electromechanical devices containing a resistance element that is contacted by a movable slider. Included are illustrated descriptions and specifications on the RL-270 series linear potentiometers and the RL-14MS and RL-11C nonlinear group. Also given are data on toroidal (sometimes referred to as type RL-257) linear potentiometers. The company's materials and methods are described. Ordering and pricing information are given.

Galvanometers. Edin Co., Inc., 207 Main St., Worcester 8, Mass. Descriptive bulletin B-1 outlines in considerable detail the characteristics and features of a line of ink-writing galvanometers for research and industrial instrumentation. Response curves and complete specifications for eight models are given.

Evaluating Shielding Enclosures. The Ace Engineering and Machine Co., 3644 N. Lawrence St., Philadelphia 40, Pa., has announced publication of an engineering study entitled "Evaluating Shielded Enclosures." It devotes considerable space to such things as: attenuation vs insertion loss; how each is measured and what they mean in terms of actual performance; screen rooms vs solid sheet enclosures, and where each should be used in terms of both physical and electrical considerations. Filters and filter performance, structural factors, contacting of components, air inlets—all are covered at length and in a highly objective manner.

Thermistors. Carboloy Dept. of General Electric Co., Detroit 32, Mich. A new manual that enables a user to understand easily what thermistors are, how they are applied, what functions they perform and what benefits industry derives from them in detecting and compensating temperatures, and providing time delay or surge control in electrical equipment, is announced. The 52-page publication includes considerable new information on thermistors, tests supplied by an independent laboratory, characteristic curves for a thermistor carrying current in thermal equilibrium with the ambient, and for one where the time delay function is of primary interest. Illustrations are keyed so a user can tell at a glance which style or type thermistor is best adapted to his application.

Precision Resistors. The Daven Co., 191 Central Ave., Newark, N. J. A 32-page catalog is intended as a guide to basic data on precision wire-wound resistors for the application and design engineer. The catalog is divided into sections starting with broad general data on all of the company's precision wire-wound resistors and continuing into complete detailed specifications of each type. Where applicable, latest government specifications are cross-referenced.

Electronic Temperature Control. Fielden Instrument Division, Robertshaw-Fulton Controls Co., 2920 N. Fourth St., Philadelphia 33, Pa. A bulletin on the new electronic temperature control, series 97, is now available. The control discussed is applicable in production processes for electric, steam and hot water heaters; baths of all kinds; ovens, kilns and dryers; plastic extrusion presses and a number of other uses. The series 97 described is available for wide ranges in temperature and operates on the principle of the change of resistance of a wire-wound sensing element with changes in temperature. The company will recommend and supply a complete range of control elements for use with the unit.

Power Plants. Kupfrian Mfg. Co., 395 State St., Binghamton, N. Y. Bulletin 5464 illustrates and outlines chief features of the model MGA-600 portable 600-w power plant. The unit described could have applications for transmitters, p-a systems, civil defense and other possibilities. Complete specications are included.

Tubular Paper Capacitors. The Gudeman Co., 340 W. Huron St., Chicago 10, Ill. Catalog X-100 contains engineering data, electrical characteristic curves, available mounting styles and tabular material giving technical specifications for a wide line of miniature tubular paper capacitors. Ordering information is included.

H-V Half-Wave Vacuum Rectifier. CBS-Hytron, Danvers, Mass. Bulletin E-225 is devoted to the type 3A3 high-voltage half-wave vacuum rectifier for color television. Mechanical and electrical data, a basing diagram, maximum ratings and an average plate characteristics curve are included.

Microwave Balanced Mixers. Airtron, Inc., 1103 W. Elizabeth Ave., Linden, N. J. A 6-page technical bulletin on the relatively new art of microwave balanced mixer design has been published. Technical bulletin T-2600 provides much of the basic theoretical and design information needed by the radar or commercial microwave relay engineer in choosing the proper waveguide mixer for his particular application. Each mixer is individually described as to construction, operating characteristics and applications.

Information Storage System. Logistics Research, Inc., 141 S. Pacific Ave., Redondo Beach, Calif. A revolutionary method of electronic information storage that provides users with an open door to complete automation is described in detail in a 4-page illustrated pamphlet. The pamphlet describes technical functions of the Magnetic Library System, and outlines its practical application in such varied operations as accounting, production and inventory control, and preparation of detailed reports. The system described consists of an electronic digital computer and a memory wheel working in conjunction with commonly-used office machines.

Flexible Shafts and Couplings. Kupfrian Mfg. Co., 395 State St., Binghamton, N. Y. Catalog 5495 covers a wide line of light duty flexible shafts and couplings. Included are typical applications, technical descriptions and dimensional drawings. A section is devoted to special assemblies dealing with a variety of shaft fittings, casings, casing ferrules and casing nuts.

Relays. Advance Electric and Relay Co., 2435 North Naomi St., Burbank, Calif. A recent 6-page brochure lists 48 of the company's relays designed for a wide variety of applications. The relays shown are grouped in accordance with their primary function, such as: antenna, coaxial, delay, power and telephone types. Complete technical specifications and ordering information are given.

X-Y Plotter. Librascope, Inc., 1607 Flower St., Glendale, Calif., has available a 6-page folder illustrating and describing the X-Y plotter and recorder, a compact, desk-size unit designed for plotting two independent variables from either analog or digital inputs. Included are data on the even-flow ink supply, floating gear train and full-visibility plotting surface. The folder also gives information on the mechanical, power amplifier and removable input sections. Accessory converters are illustrated and described.

Microwave Communication Equipment. Collins Radio Co., Cedar Rapids Iowa. A 12-page booklet illustrates and describes a line of microwave communication equipment that can be used in conjunction with existing wire lines or other facilities to provide communication circuits suitable for telephone, teletype, telemetering, supervisory control, facsimile and video transmission. Included are microwave and multiplex block diagrams together with illustrations of various units and typical racks. A diagram shows a typical microwave station listing no-standby and with-standby r-f and multiplex equipment.

Test and Measuring Equipment. The Clough-Brengle Co., 6014 Broadway, Chicago 40, Ill. Complete specifications and data on a line of test equipment are presented in catalog No. 54-A. Listed are the model 603 i-f sweep generator; models 179A and 405 beat frequency oscillators; models 182-A and 282-A audiomatic generators; model 217H transmission measuring set; models 299A and 552 r-f signal generators; model 712 capacity-resistance-inductance bridge; and model 411 extended range audio oscillator. The 12-page publication with price list included is available on request.

High-Power Rotary Joint. Microwave Development Laboratories Inc., 220 Grove St., Waltham 54, Mass. Bulletin RJ-1 illustrates and describes model B172, a high-power rotary joint. Operational characteristics and specifications are given.

Solenoid Catalog. West Coast Electrical Mfg. Corp., 233 W. 116th Place, Los Angeles, Calif., has available a new a-c solenoid catalog. It presents easy-to-read solenoid design information, engineering drawings, solenoid performance charts, work and temperature curves. This information is necessary to assist the engineer in selecting the right solenoid for his application.

Regulated Power Equipment. Sorenson & Co., Inc., 375 Fairfield Ave., Stamford, Conn., manufacturers of electronic a-c voltage regulators, regulated d-c sources and B-supplies, electronic frequency changers, inverters, magnetic-amplifiers d-c sources and related equipment, now have available a new general catalog including their entire standard line of instruments. The catalog provides abundant general information on the operating principles of the company's instruments and complete specific data on each instrument, including pictures, general descriptions, electrical and mechanical specifications. Request catalog No. 254.

Resistors. Atlas Resistor Co., 24 E. Coulter St., Philadelphia 44, Pa., has published a 4-page folder illustrating and describing a line of fixed (pack wound) and adjustable resistors. Complete technical data includes wattage, size, mountings and range in ohms.

Precision Noninductive Resistors. K-F Development Co., 2634 Spring St., Redwood City, Calif. A new leaflet describes a series of 9 resistor types providing standard values over the range of 0.1 ohm to 1 megohm in values exact to 1 percent, 0.5 percent or 0.1 percent accuracies. The series is illustrated, identified by type number, and tabulated in a compilation of data which includes wattage, diameter, length and net prices. Ordering information as well as data on alloys of wire used for standard and special resistors are also included.

Transformers and Reactors. Thordarson-Meissner, Seventh and Bellmont, Mt. Carmel, Ill. Now available is catalog 400-L covering the company's line of transformers and reactors. It features a new, complete television replacement section, new output transformer chart and complete cross reference.

Automatic Controls. J. B. Rea Co., 1723 Cloverfield Blvd., Santa Monica, Calif. A new 16-page brochure covers the company's products and automatic control engineering services. Some of the products discussed in the brochure are a hovering control for rotary wing aircraft, an automatic cruise control system, a digital strain gage recording system, an automatic control for cold blankets and a digital autopilot for fighter aircraft.

Insulators. Fluorocarbon Products, Inc., a division of the U. S. Gasket Co., Camden 1, N. J., has issued a 12-page catalog on a complete line of Teflon insulated Chemelec stand-off and feed-through insulators—designed for low-loss, high-frequency service, unaffected by a wide range in ambient temperatures, pressures, altitudes, humidity and mechanical shock and vibration. Two series of miniature and subminiature stand-off insulators are illustrated and described: (1) with stud, screw or rivet mounting hardware and (2) compression mounting type. Four series of feed-through insulators are shown: (1) hermetic solder-seal type, (2) moisture and oil-proof gasket type, (3) miniature threaded metal body type and (4) miniature and subminiature compression mounting type. Ask for bulletin No. EC-1153.

Slide Wire Rheostats. Herman H. Sticht Co., Inc., 27 Park Place, New York, N. Y., has issued bulletin No. 551 which shows their complete line of Standco slide wire rheostats with graduated percentage scale. Of particular interest are the new type double rheostats shown on page 3 which are suitable for series or parallel connection and are designed to cover a particularly long range in resistance, and have a large amount of current capacity. Also shown are fixed resistors-potentiometers with one or more adjustable bands. The graduated percentage scale attached to all rheostats discussed has a feature which enables the user to calculate approximate resistances very quickly and to vary the resistances and current intelligently.

Magnetic Recording Head Replacement. Shure Bros., 225 W. Huron St., Chicago 10, Ill., have issued a magnetic recording head replacement chart. This chart lists the exact Shure replacement for the tape head used in the manufacturer's original equipment. Illustrations of the types of recording heads, recording head dimensions, technical data, and a numerical listing of Shure type heads, may be found on the reverse side of the chart.

Communication Tape Monitor System. Magnecord Inc., 225 W. Ohio St., Chicago 10, Ill., has available a folder dealing with its communication tape monitor system for the automatic and continuous recording of radio and phone intercommunication. The system described permits simultaneous and continuous recording of 4 individual intelligence signals on standard ¼-in. tape. Illustrated descriptions are given for: (1) a multichannel recording tape transports system; (2) a multichannel reproduce transport; (3) a mobile storage table; (4) a portable bias-record indicating meter; and (5) a portable erase unit.

Selenium Rectifiers. Radio Receptor Co., 251 W. 19th St., New York 11, N. Y., has issued bulletin No. 177, a comprehensive 24-page catalog describing Seletron selenium rectifiers—both radio and industrial types. Fully illustrated with voltage curves, circuitry, tabular matter and product applications, it devotes considerable space to an expanded tabulation of power rectifiers up to 260 v input and 30 amperes. Among the rectifiers discussed are those special ones for magnetic amplifier application, hermetically sealed and high temperature types, as well as embedded stacks.

Waveform Simulator. The Newton Co., 55 Elm St., Manchester, Conn., has available a folder discussing the Synthescope, an instrument which will reproduce waveforms on an oscilloscope from patterns that have been drawn manually. The instrument described is comprised of 3 basic components: waveform generator, intermediate electronic circuitry and oscilloscope. Applications of the unit are included.

Frequency Meter. Colortone Electronics, Inc., 238 William St., New York, N. Y. A single-page bulletin deals with the model TS-175A/U frequency meter. It illustrates the unit and outlines its frequency range, calibration accuracy, stability, environmental conditions passed and applications.

Meter Calibrator. Kalbfell Laboratories Inc., 1090 Morena Blvd., San Diego 10, Calif., has available a mailing piece that illustrates and describes its meter calibrator, a compact unit that produces an absolutely calibrated d-c voltage, independent of input line voltage and output load variations. Specifications and applications are included.

Electrometer Voltage Dividers. Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio. A loose-leaf perforated catalog sheet illustrates and describes the models 2006 and 2007 voltage dividers that clip onto electrometers to extend their voltage ranges. Typical applications of the units discussed include measuring voltages on c-r tubes, photomultiplier tubes, tv picture tubes, x-ray and radiation equipment, leakage of high-voltage insulators, and testing the voltage breakdown of cables. Specifications are given.

Stacked Retaining Rings. Industrial Retaining Ring Co., 8 W. Sidney Ave., Mt. Vernon, N. Y. A 4-page folder illustrates and describes the company's method for cutting costs and speeding assembly with its stacked open-type retaining rings. The booklet shows how these retaining rings work to eliminate waste motions, nonproductive time and ring loss. A free offer is included.

Disk Thermostats. Stevens Mfg. Co., Inc., 69 South Walnut St., Mansfield, Ohio. Bulletin F-2009 describes the line of type M bimetal disk thermostats for appliances, electronic devices and apparatus. Hermetically sealed and semienclosed styles are covered. Punched for insertion in standard three-ring binders, the bulletin describes the operating principle and illustrates it with a schematic diagram. Ratings, typical performance curve, dimensions, construction, and various available terminal arrangements and mounting provisions are shown in diagrams, tabular data and photographs.

Toggle Switches. Micro Switch, a division of Minneapolis-Honeywell Regulator Co., Freeport, Ill. Catalog No. 73a covers 19 precision snap-action toggle assemblies and over 90 AN and JAN approved designs, including assemblies that will control anywhere from 1 to 24 separate electrical circuits. The catalog has complete dimensions, operating characteristics, electrical ratings and contact arrangements on each switch, as well as an illustration of one representative switch from each group or family of switches. There is also general information on each family of switches to aid in selecting just the right switch for any specific application. The toggle switches described are designed for aircraft, mobile, marine, railway and other low-voltage d-c applications.

Subminiature Blower. Sanders Associates, Inc., Nashua, N. H. A tiny folder discusses subminiature blower featuring a motor and blower complete in a 1-in. cube. Weight of the unit described is 1 oz.; input—400 cps, 2 phase 4 w; and output—3 cu ft of air per minute. Dimensional data, characteristics and environmental conditions for the Minicube are included.

Power Supplies. Allied Engineering Division, Allied International, Inc., Connecticut & Richards Aves., South Norwalk, Conn. An 8-page brochure contains technical information on five of the company's power supplies. Clear illustrations and specifications are provided for each model. A detachable sheet is included for filling in specifications of special design.

Portable Analog Computer. Dynamic Analysis, Inc., Box 2188 South Annex, Van Nuys, Calif. An illustration and outstanding features of the Dyalyzer are given in a single-page mailing piece. The unit described is a new low-cost, portable analog computer for analysis, synthesis and simulation of dynamic systems.

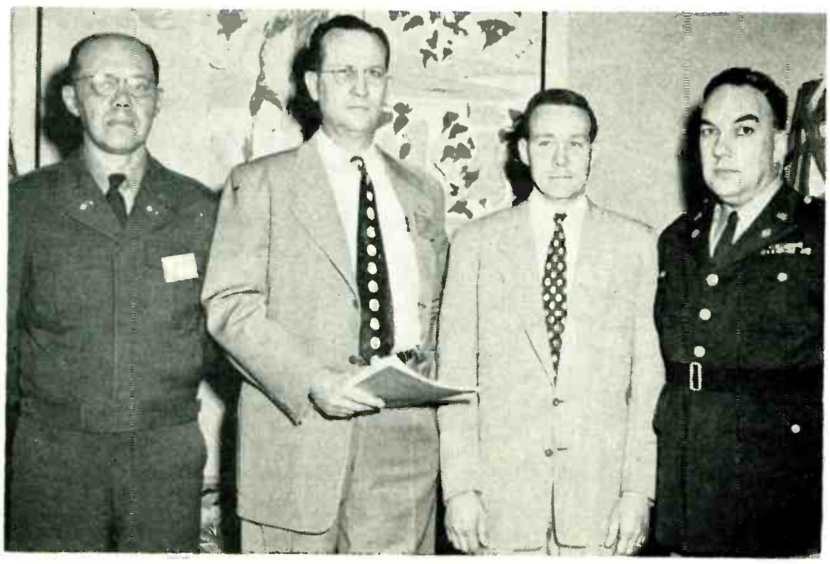
PLANTS AND PEOPLE

Edited by WILLIAM G. ARNOLD

New plant expansions are announced by manufacturers . . . Associations plan conventions, shows and meetings . . . Engineers are named to new positions . . .

OTHER DEPARTMENTS featured in this issue:

Frequency Symposium Fetes Engineers



AMONG THE ENGINEERS attending the eighth annual Frequency Control Symposium at the Berkeley-Carteret Hotel in Asbury Park, N. J. were, from left to right, Col. F. F. Uhrhane, Commanding, Signal Corps Engineering Laboratories; W. L. Doxey, chief, Frequency Control Branch, Squire Signal Laboratory, Fort Monmount, N. J.; J. L. Greber, RCA and Lt. Col. J. V. Fill, director, Squire Signal Lab.

RETMA Plans 30th Anniversary Celebration

THE RADIO-ELECTRONICS-TELEVISION MANUFACTURERS ASSOCIATION attained its 30th birthday in April. Celebration of the event will be deferred until the Association's annual convention June 15-17 in Chicago.

The trade association for the radio-tv and electronics industry was founded in April, 1924, in Chicago, by a small group of component manufacturers who foresaw some of the potentialities of the new industry and the need for cooperative action to guide it.

H. H. Frost was elected the Association's first president.

Besides Frost, the first board of directors of RMA consisted of A. J. Carter, A. A. Howard, Frank Reichmann, Philip Lenz, Jr., J. McWilliams Stone and E. N. Rauland, the latter three of whom are still active in the industry.

The Association was known as the Radio Manufacturers Association until 1950 when it became the Radio-Television Manufacturers Association. In 1953 "Electronics" was added to the name in recognition of the expanding scope of both the Association and the industry it represents.

The first major reorganization of the Association occurred in 1933 with the establishment of four major divisions. These were the Set, Tube, Parts and Amplifier & Sound Equipment Divisions. The Transmitter Division, now known as the Technical Products Division, was formed in 1942.

As the industry has grown and more services have become necessary, the Association has established statistical, government relations and international departments.

The latest reorganization took place in 1953 with the formation of the two committees of the Board of Directors—the Radio-Television Industry Committee and the Electronics Industry Committee.

Sixteen industry leaders have served as president of the Association between 1924 and 1954. In 1951 the Association for the first time employed a paid president, Glen McDaniel, and elected an industry executive as chairman of the board of directors. Robert C. Sprague became the first board chairman and holds the same office today.

Leslie F. Muter, of Chicago, holds the record of having held office in RETMA longer than any other industry representative. In addition to serving four terms as president,

10 RECORD FEATURES

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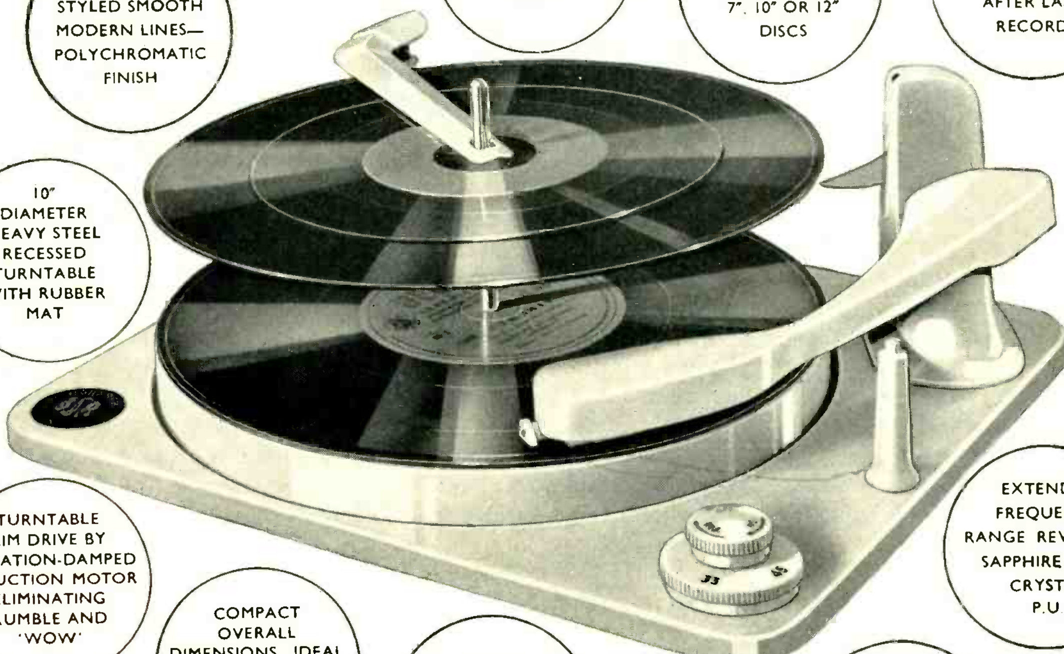

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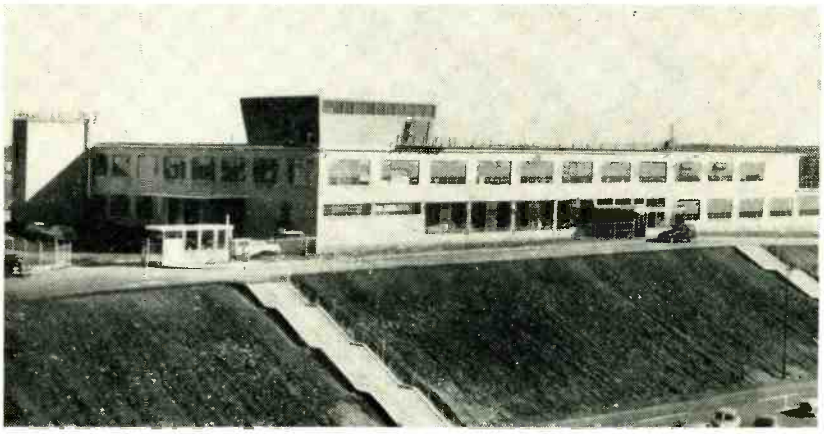
he has been treasurer for 18 years, a position he still holds.

Forty-six manufacturers organized RMA in 1924. Today the Association's membership exceeds 370. Of the charter members, all but a few have disappeared as corporate entities either through mergers, dissolutions or for other reasons.

Raytheon Opens Electronics Lab, Appoints Personnel



A NEW TWO-MILLION DOLLAR electronics laboratory was opened near Hanscom Air Force Base in Bedford, Mass.

The U. S. Navy began construction of the building late in 1952, when it was planned that Raytheon would use the structure as a Navy research and development center. It has 100,000 sq ft of floor space on two floors, and will house approximately 700 workers. There are 21 specially designed bays for operating and testing radar equipment.

The personnel of the new laboratory comprise an establishment which has been engaged in missile and radar work since 1944.

David D. Coffin, manager of Raytheon's missile and radar division, has been named an assistant vice-president of the firm.

He manages the group of more than 700 employees based in the new laboratory building; a large manufacturing plant in South Lowell and the Raytheon plant at the Naval Air Missile Test Center, Point Mugu, Calif.

He joined Raytheon in 1934, where he has served as design and supervisory engineer for the transformer division, chief engineer of the commercial division, and in other positions of increasing responsibility in the engineering operations of the company.

Sidney A. Standing has been appointed manager of Raytheon's cathode ray tube division.

In 1941, Standing was employed by North American Phillips, subsequently becoming manager of its electronic tube division in Dobbs Ferry, N. Y. He later went to Tung-Sol where he set up and managed the cathode ray tube division. From that position he has rejoined Raytheon specifically to direct the engineering, manufacturing, and quality control of black-and-white, color, and industrial cathode ray tubes.

Wescon Hosts Set For 1954 Convention

THE WESTERN ELECTRONIC Show & Convention (Wescon) is getting set to receive the thousands of engineers who will attend the show in August.

The event takes place in Los Angeles' Pan-Pacific Auditorium and the Ambassador Hotel on August 25, 26, and 27 and more than 465 booths will be occupied—nearly 100 more than last year. And overall attendance is expected to approach 20,000.

Hosts for this year's Wescon will be the Los Angeles Section of the IRE, and the Los Angeles Council of WCEMA. With a membership of only 830 in 1946, the Angeles Section of IRE today is composed of more than 2,880 engineers. It is second only to the New York Section in number of members.

Ellis F. King

E. P. Gertsch

Chairman of the section is Ellis F. King, of the University of California at Los Angeles; vice-chairman is Bruce S. Angwin of GE; secretary is Walter E. Peterson of Northrop Aircraft and treasurer is Charles E. Rutherford of Rutherford Electronics.

Chairman of the Los Angeles Council of WCEMA is E. P. Gertsch of Gertsch Products; vice-chairman is R. G. Leitner of Packard-Bell and secretary-treasurer is

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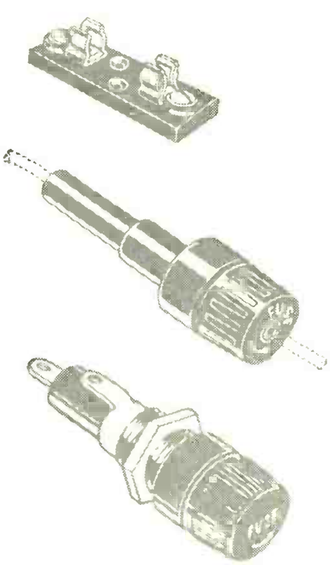

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Gramer Yardbrough of American Microphone. Its present membership includes more than 110 electronic firms in Southern California.

Volkert Launches Apprenticeship Program

JOHN VOLKERT METAL Stampings has allotted part of its newly-constructed plant in Queens Village, N. Y., to the exclusive use of tool-and-die-maker apprentices.

Working under a veteran tool and die maker, employed as a full-time instructor, the apprentices get constant instruction from him and, in addition, specialized instruction from other Volkert craftsmen.

"We recognize that high-precision tooling skills are in great demand in our mass-production economy," Jack Kleinoder, general manager, said, "and we've stepped up our apprenticeship program. We have been training apprentices on a small scale since our company was founded in 1934, but we now hope to have about a dozen or more at all times. Six are already taking the course." Kleinoder is chairman of the apprenticeship committee of the National Tool & Die Manufacturers Association.

The program, covering four years for each apprentice, has the approval of both the New York State Apprenticeship Council and of the National Tool & Die Manufacturers Association. It is planned that graduates of the course will be eligible for credits toward an engineering degree at Pratt Institute.

Francis Beck, a veteran of almost 50 years as a tool and die maker, has been appointed Volkert's supervisor of apprentice training. Working under Beck, apprentices will get training in their own shop for three years. In the fourth year, they will spend most of their time in the Volkert toolroom under actual working conditions.

Related classroom instruction, supervised by Professor Bergin of Pratt and approved by the Board of Education of the City of New York, is being given to the apprentices in the Volkert plant two evenings a week.

All applicants, who must be at least high school or trade school graduates, must pass aptitude, qualification and physical examinations. Apprentices sign an agreement under which they are hired for a 90-day probationary period.

NBS Members Receive Commerce Award

SIX MEMBERS of the staff of the National Bureau of Standards have received the Department of Commerce Gold Medal Award for Exceptional Service. The awards were made for "outstanding contributions, as a member of a group, in the field of production technology for electronics with important implications for the electronics industry and for national defense". The men receiving the award were: J. G. Reid, Jr.; Robert L. Henry; Benjamin L. Davis; Charles C. Rayburn; James G. Black, Jr. and Harold S. Horiuchi.

These six men were the primary scientists responsible for the development of an automatic method for mechanical production of electronics and for the design and construction of machinery to mass produce electronic components on a pilot plant scale. This program was formerly known as "Project Tinkertoy".

J. Gilman Reid, Jr., joined the staff of NBS in 1937. In 1941 he became a project engineer at the Bureau working on the design and development of electrical and electronic control equipment for uranium isotope separation. In 1943 Reid joined the program for development of radio proximity fuzes and from 1944 he directed a major project in this field. Following this work he served as chief engineer for the Electronic Instrumentation Laboratory. From 1950 to 1953 he was chief of the NBS Electronics Division.

Henry joined NBS in 1946 and worked in the field of printed electronic circuits, conducting research on materials and technique associated with special electronic production processes. After conception of the Modular Design of Electronics system, he was chosen to lead "Project Tinkertoy" in its development into a method for the Mechanical Production of Electronics. Henry was technical and administrative director of the project and was also responsible for coordinating the efforts of the private contractors involved. He received the Fleming Award as an outstanding young man in the Federal Government.

Benjamin L. Davis was basically responsible for the general development of organic materials and the processes for their use in the mechanized production of electronics. He was especially responsible for development of the tape resistor and a protective coating for the tape resistor. He came to the NBS in 1937 after serving with the Department of Agriculture and the Office of Technical Services of the Department of Commerce.

Charles C. Rayburn came to NBS in 1951. Previously he designed and constructed an apparatus which he used to detect the presence of short-lived nuclear isomers. He also had worked for GE.

While in the Air Force he specialized in communications and engineering.

James G. Black, Jr., came to the Electronics Division of the National Bureau of Standards in 1952. He was previously assistant professor in industrial arts at Morehead State College.

Harold S. Horiuchi came to the National Bureau of Standards in 1948. He has been closely connected with the miniaturization program of electronic equipment employing printed circuit techniques.

All of these men except Dr. Davis

are now connected with ACF Electronics of Alexandria, Virginia.

Clary Multiplier Names Oldenburg

KENNETH F. OLDENBURG has been appointed supervisor of the electronic laboratory of Clary Multiplier in a move to effect closer coordination between development work on new products and electronic manufacturing operations.

Oldenburg joined Clary as an engineering designer for the company's business machines in 1947 and for the past two years has been a supervisor in charge of the development of new electro-mechanical equipment, including input keyboard machines and automatic readout printers. He was previously with Ohmite in research. In his new position he will head research and development on all the company's electronic data handling products in addition to the input and readout machines.

Milton Scozzafava will take over Oldenburg's specialized projects in the office equipment division and will continue his own work as engineering supervisor for Clary adding machines and cash registers.

Slyvania Establishes Guided Missile Lab

SYLVANIA established a new laboratory that will analyze and evaluate the scientific and engineering problems associated with guided missiles. The facility, known as the Missile Systems Laboratory, is located in Queens County, N. Y.

Howard L. Richardson, vice-president in charge of engineering operations, said the activity's first project is a long-range advanced study of missile problems for the Army Ordnance Corps.

Scientists at the laboratory, according to Richardson, will stress the "systems" approach to missile problems.

The value of a missile must be judged on the basis of how well it accomplishes some useful military purposes, he said. In addition to the design of the missile itself, scientists must determine how a target is to be located and identified, how and when the missile is to be fired, how many missiles are required to accomplish a certain purpose, where the missiles are needed, and how many men are required to keep a military missile activity in a state of readiness. The work of the missile group will embrace this entire system of missile development, Richardson added.

Oliver G. Haywood, Jr., has been appointed manager of the Missile Systems Laboratory. Before his present assignment, Dr. Haywood was manager of engineering planning. A former colonel in the U. S. Air Force, he was at one time head of the Air Force Office of Scientific Research in Baltimore, Md.

Members of Dr. Haywood's staff will include Frank S. Manov, manager of the systems analysis department, who formerly was chief of the operations analysis directorate of the Allied Air Force in Central Europe; Maurice E. Bell, manager of the laboratory's plans department, who until recently was scientific director of the U. S. Office of Naval Research in London, England; and Ernest Schlieben, manager of the electronics department, formerly with the Navy at Sands Point, N. Y.

Link Aviation Plans Affiliation

THE AFFILIATION of Link Aviation with General Precision Equipment Corp. has been planned.

The operation of Link will continue under its present management and expansion of operations in Binghamton is expected.

Reeves Soundcraft Receives Award

THIS IS THE MAGNA-STRIPER machine developed by Reeves Soundcraft. The firm recently received an award from the Academy of Motion Picture Arts and Sciences "for developing the process of applying stripes of magnetic oxide to film for sound recording and reproduction." Ernest W. Franck, chief engineer of Soundcraft for development and research, is pictured checking a reel of film that has just been striped at Soundcraft's Springdale, Conn., plant.

Bogue Electric Opens New Plant

OVER ONE THOUSAND visitors attended the new plant opening of Bogue Electric Manufacturing Company in Paterson, N. J.

Principal speaker was Vice Admiral John E. Gingrich, Chief of the Office of Naval Material and former commander of the largest task force operating in Korean waters.

Other speakers included Governor Robert E. Meyner; Brigadier General William T. Hudnell, Office of the Deputy Chief of Staff, Materiel, U. S. Air Force; Major General Francis H. Lanahan, Deputy Assistant Chief of Staff, G-4, U. S. Army; Ora W. Young, Regional Administrator, Civil Aeronautics Administration; Edward J. MacEwan, Executive Vice-President, Paterson Chamber of Commerce; Mayor Lester F. Titus of Paterson, and Edward P. Schinman, President of Bogue.

The new plant will increase present Bogue plant facilities by approximately thirty percent, and is part of an extensive program of continuing diversification.

California County Sets Communications

LOS ANGELES COUNTY'S Board of Supervisors has voted to establish a separate department of communications to be headed by an electronics engineer. Among the factors that led the board to coordinate all communications activities in one administrative unit are the largest telephone switchboard operated by any local governmental unit in the country; six departments with radio communications systems; traffic problems indicating a need for radar speed timers and electronic traffic controls and electronics needs for Civil Defense.

Westinghouse Names Two To New Posts

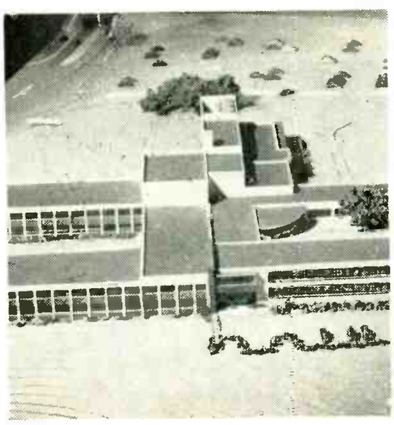
FRANKLIN P. HINMAN has been named acting manager of manufacturing for the Westinghouse electronic tube division in Elmira, N. Y. and Harry F. Pully has been appointed to the newly-created position of acting manager of the Division's Elmira plant.

Hinman, who replaces John M. Smith, assumes his new position after serving as product manager of power tube manufacturing for the past year. He joined Westinghouse at the electronic tube division in September 1951 as a general foreman. Later he became superintendent of maintenance and installation of equipment.

Hinman came with Westinghouse from the Lancaster, Pa., plant of RCA where he held various manufacturing and engineering positions from 1942 to 1951.

Pully assumes his new managerial duties after serving as product manager of cathode-ray tube manufacturing. He joined the tube division in September 1951 as a general foreman. In December 1951, he was made a division staff supervisor and later was appointed superintendent of cathode-ray tube manufacturing.

Prior to joining Westinghouse, Pully held various supervisory positions in the Lancaster, Pa., plant of RCA.



Burroughs Moves Into New Research Center

THE 22-MILE move from downtown Philadelphia to its new research center in Paoli, Pa., was completed by Burroughs Corp.

The Research Center with 105,000 sq ft of space is concerned primarily with research and development work in electronics, electro-mechanics and magnetics. In addition to building two "giant brain" electronic computers, the laboratory has developed specialized tubes, pulse control equipment, magnetics components and a number of electronic applications in punched paper tape for improving and speeding the performance of business machines.

More than half of the personnel now working in the new Paoli building are electrical engineers, physicists, mathematicians, mechanical engineers and technicians; the balance are administrative and office personnel.

Du Mont Appoints Three Engineers

Leonard A. Bayer, Rudolf Leopold and Joseph A. Hatchwell have been appointed to new posts at Du Mont Laboratories.

Bayer has been appointed to the new position of manager of the product engineering department of the Communication Products Division.

Bayer, whose 18 years of engineering experience includes 12 years in the television and radio fields, will translate blueprint plans and working models into products ready for mass assembly.

Leonard A. Bayer

Since joining Du Mont in 1946, Bayer's activities have included work on government radar projects, commercial television equipment, and industrial color television systems.

Rudolf Leopold was appointed manager of the newly formed specifications and records department of the Communications Products Division. He will be in charge of drawing up final plans and specifications for the firm's line of television broadcast transmitters, studio equipment and mobile communication products.

Leopold, who joined Du Mont in

1945, has handled designs for new electronic equipment including a 3-D television camera for the Atomic Energy Commission and Du Mont's image orthicon camera.

Joseph A. Hatchwell, Mid-Atlantic regional sales manager for the television receiver division, has been promoted to director of service.

Hatchwell's new responsibilities include the administration, supervision, and direction of the technical activities of the division's Service Department on a national basis. Prior to joining Du Mont in 1952, he served with RCA from 1946 to 1952. He was one of the staff that initiated that company's tv service organization. Earlier, he served as RCA's foreign technical manager on government contracts with headquarters in Tokyo, and was also a technical advisor to the Armed Forces in Korea.

GE Breaks Ground For New Controls Plant

CONSTRUCTION has started on a new GE plant in Waynesboro, Va. which will manufacture electronic controls for industrial and aviation use.

The new factory is being built "in anticipation of projected heavy demands for such equipment as electronic drives, adjustable speed drives, speed regulators, aircraft and regulating equipment, and similar devices."

Expected to be in full operation some time next year, it will employ about 550 people. Facilities on the 70-acre site will include a large manufacturing area, warehouse, laboratory, personnel facilities, and offices.

Collins Names Five Executives

ORGANIZATIONAL CHANGES at Collins Radio Company have been announced by Arthur A. Collins, president.

R. S. Gates was named executive vice-president; L. E. Bessemer, vice-president, manufacturing; R. T. Cox, vice-president, research & development; J. G. Flynn, Jr., vice-president, sales, and M. W. Burrell, second vice-president.

Other officers of the company are L. M. Craft, vice-president; W. J. Barkley, senior vice-president; S. J. Storm, secretary-treasurer; L. E. Wiles, controller, and L. M. Schoon, assistant treasurer.

NBC Begins Color Studio Construction

CONSTRUCTION OF THE NATIONAL Broadcasting Company's first West Coast color television studio was started in Burbank, Calif.

Programs from the new studio, part of NBC's Television Center, will go on the air in January, 1955. The color studio, to be known as Studio 2, will be built exclusively for colorcasting. It will be 90 by 140 ft. in area and 42 ft. high.

In addition to the studio proper, there will be an adjoining dressing room section and a technical building.

The technical building will house three rehearsal rooms and a storage room for equipment. On the second floor will be a film projection room, video control room and central control.

ASC Cable Appoints New Process Engineer

JAMES M. CAMPBELL, JR., was appointed process engineer for the ASC Cable division of Radio Apparatus. The firm specializes in wire harnesses and cable assemblies used in electronics apparatus.

Prior to joining the ASC staff,

MAGNETIC-AMPLIFIER CIRCUITS

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PROBABILITY AND INFORMATION THEORY WITH APPLICATIONS TO RADAR

Just Published!

Shows in easy stages how the theory of probability applies to electronics, communication, and particularly radar. Using basic mathematics, it discusses the theory of probability distribution, mathematical description of waveforms, Shannon's information theory, applications of inverse probability to problems of signal and noise, etc. By P. M. Woodward, Telecomm. Research Establishment, Malvern, England. 128 pp., $4.50

TELEVISION BROADCASTING

Practical manual for radio engineers, operations personnel, and others interested in the technical aspects of television broadcasting. Covers in detail the equipment, facilities, and techniques involved in the running of a television studio—topics such as lighting, staging, television recording, and color television equipment. Gives a valuable insight into the whole field without the use of complex mathematics. By Howard A. Chinn, Columbia Broadcasting System. 688 pp., 346 illus., $10.00

ELECTRONICS FOR COMMUNICATION ENGINEERS

Saves research time and effort on electronic problems in communications. Its 252 articles from *Electronics* contain a wealth of design equations, charts, nomographs, tables, etc. Covers amplifiers — antennas — audio — cathode-ray tubes — components — electronic music — filters — measurements — microwaves — oscillators — power supplies — propagation — pulses — receivers — transmission lines — transmitters. Edited by John Markus and Vin Zeluff, Assoc. Editors, *Electronics*. 624 pp., hundreds of illus., $10.00

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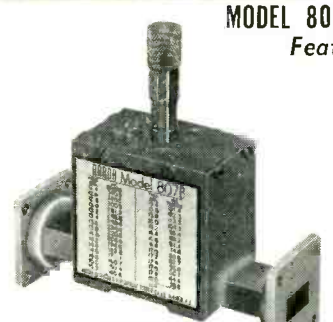

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Campbell was in the service and repair department of P. R. Mallory Co. of Indianapolis.

Pentron Names Chief Engineer

JAY T. NICHOLS has been appointed Chief Engineer of Pentron Corp. His present projects with Pentron include the development of magnetic recorders for both the commercial market and the government services.

Previous to joining Pentron, he served on the staff of the Armour Research Foundation in the development and use of instrumentation. He was in charge of various programs studying effects and causes of shock and vibration phenomena both in the laboratory and in the field. He also participated in the development of automatic weapons and in tests of atomic weapons at Eniwetok and in Nevada.

Before joining Armour Research, Nichols was manufacturing engineer with Western Electric Co. in the production of central office equipment.

Boyers Heads New National Division

JOHN S. BOYERS joined the National Company as chief engineer of the magnetic memory devices division.

Until recently, Boyers was vice-president of Magnecord which he helped organize in 1946. Since that time, he had held various positions from chief engineer to president.

Prior to Magnecord, he had been associated with Armour Research Foundation, Chicago, in the development of magnetic recording systems. During the war, he was with the U.S. Navy Underwater Sound Laboratory at New London, Conn., and the Radiation Laboratory at MIT.

Forst Receives Canadian GE Award

For the Fifth consecutive year, Canadian GE presented its engineering award "to stimulate interest in technical development contributing to the betterment, in any way, of Canadian Broadcasting; and to increase recognition of the value and essential function of radio broadcasting and television technical personnel."

Bill Forst, left, & Don Schofield

The award was conferred upon William Forst of radio station CKOM, Saskatoon, "in recognition of his pioneering efforts in the field of unattended operation of broadcast transmitters." It was presented by Don Schofield of Canadian GE.

Brooklyn Polytechnic To Buy New Building

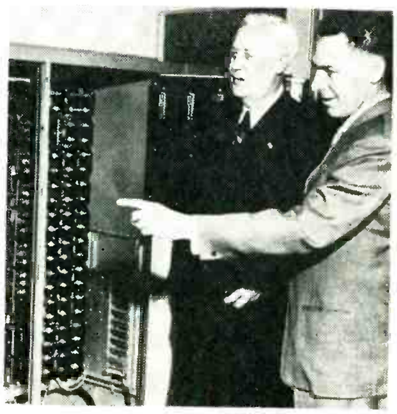
The Polytechnic Institute of Brooklyn contracted to purchase for $2,000,000 the eight-story, block-long plant building of American Safety Razor in downtown Brooklyn.

The building fronts on Brooklyn's

$80,000,000 Civic Center and is opposite the site of the proposed Supreme Court Building soon to be erected.

Harry S. Rogers, president of the century-old Institute, declared that acquisition of the building will enable Polytechnic to bring its widely dispersed facilities together in one suitable modern structure.

He said it cannot be determined at this time when the Institute will move into the new quarters. The date depends upon a number of factors, particularly the success of efforts to raise the required funds.



Swedish Industrialist Backs New Computer

AXEL L. WENNER-GREN, left, Swedish industrialist and philanthropist, inspected ALWAC, the new low cost general purpose electronic digital computer developed with his financial backing by Logistics Research of Redondo Beach, Calif. Glenn E. Hagen, LRI's physicist-president, is at the right.

Slutz Appointed To NBS Post

RALPH J. SLUTZ has been appointed assistant chief of the central radio propagation laboratory of the National Bureau of Standards. Dr. Slutz was formerly a consultant to NBS in the fields of electronic computers and mathematics.

From 1949 to 1953 Dr. Slutz was assistant chief of the NBS electronic computers laboratory.

In his new position, he will assist in the direction of the research pro-

gram of the Central Radio Propagation Laboratory, which serves as the primary agency of the government for radio wave propagation research and for the centralization and coordination of information in this field.

Dr. Slutz was a design engineer at the Institute for Advanced Study from 1946 to 1948, doing research on input-output mechanisms and high-speed electronic digital arithmetic circuits. From 1942 to 1945 he was a member of Division 2 of the Office of Scientific Research and Development, investigating the effects of bomb and projectile explosion and impact, and in 1937 and 1938 he was with the Bell Telephone Laboratories.

Philco Names Skinner TV Vice President

JAMES M. SKINNER, JR., was appointed vice-president of the television division of Philco.

For the past two years, he has been vice-president in charge of distribution for the firm.

Skinner will help coordinate all activities of the television division including product planning, manufacturing, engineering, advertising, sales promotion and sales.

Kelly Honored By Research Institute

MERVIN J. KELLY, president of Bell Telephone Laboratories, received the Industrial Research Institute's 1954 Medal at the Institute's annual meeting.

The medal was presented to Dr. Kelly "for distinguished leadership in industrial research, joining the mind of the scientist and the hand of the technologist to serve the security and well being of mankind, and for outstanding personal contributions to national security."

Air Force Opens Research Center

THE NEW LABORATORIES of the Air Force Cambridge Research Center were opened at Bedford, Mass.

The five million dollar research and development buildings were recently accepted by the Air Force and will be the site of important work involving the air defense of the nation.

The Air Force Cambridge Research Center is one of eleven installations that are engaged in the vital mission of keeping the United States Air Force the most modern and powerful in the world through the development of new and improved weapons, weapons systems, and guided missiles.

The Center is charged with administrative and logistical support of Lincoln Laboratories as well as the conduct of long-range projects in electronics and geophysics.

A number of laboratories, libraries, machine shops and supporting administrative offices already have moved into the new Center buildings.

MB Manufacturing Acquired by Textron

TEXTRON ACQUIRED its third non-textile business, the MB Manufacturing Co. of New Haven, Conn. A few months ago, the firm purchased the entire stock of Dalmo Victor of San Carlos. In 1953, Burkhart Manufacturing was acquired.

MB specializes in engineering and producing vibration equipment for military and civilian planes and ships, guided missiles and other defense and civilian items.

These non-textile operations have been acquired by Textron as a part of its program to protect stockholders against the severe fluctuations in the textile industry.

It was pointed out that if Dalmo Victor Company, Burkhart Manufacturing Company, and the MB Manufacturing Company continue at their past earning rates, they are expected to produce combined earnings before taxes of approximately $6,000,000 in 1954.

Clarostat Mid-West Plant in Full Swing

NOW ENTERING its third year of operation, the Mid-West plant of Clarostat Mfg. is reported to be in full production. Supplementing the output of the main plant in Dover, the Mid-West plant now produces power resistors, power rheostats, metal-clad strip resistors, carbon and wire-wound controls, and aircraft controls.

The Mid-West plant maintains a complete inventory of distributor items.

Superior Tube Names Richard

C. D. RICHARD, JR. was appointed supervisor of the electronic laboratory of Superior Tube. The laboratory is responsible for the development and control of materials and products for the radio and television industry. He joined Superior in 1946.

Smith Appointed Control President

STANLEY J. SMITH is the president of Control Laboratories, a new company recently formed by Avien. He was formerly director of engineering and development at Simmonds Aerocessories. He is an inventor in the aircraft instrument field and particularly in the field of fuel quantity gages, in which he is credited with a number of key patents.

Fubini Appointed Harvard Lecturer

EUGENE G. FUBINI has been named a Gordon McKay Visiting Lecturer on applied science at Harvard University and will be in residence for

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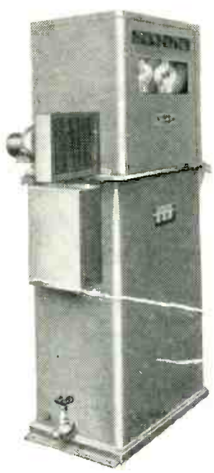

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the first half of the academic year 1954-55.

From 1938 to 1943 Dr. Fubini was acting engineer for the design and installation of vhf links for CBS. During the war he was a research associate at the Radio Research Laboratory of Harvard and became technical observer in countermeasure work with the Air Force in charge of operational analysis, radar countermeasures section of the Eighth Air Force in England. From 1945 to date he has been with Airborne Instruments, Mineola, L. I., N. Y. In 1947 he was appointed supervising engineer of the special devices section.

He has recently specialized in the development of microwave strip lines which make use of printed circuit techniques and which transmit power at microwave frequencies with low loss. Present plans call for Dr. Fubini's giving two courses, one concerned with the practical aspects of noise in electrical circuits, the other dealing with special topics in microwave antennas and circuits.

Jensen Opens New Loudspeaker Plant

JENSEN MANUFACTURING acquired a new plant in Guttenberg, Iowa, that will concentrate on a standardized line of speakers, in six-inch sizes and smaller, for volume industrial customers.

The space made available in the Jensen Chicago plant by the move has been devoted to expanded production of hi-fi speakers.

The new plant encompasses 25,000 sq ft of space on a 15-acre plot.

Four Engineers Receive Commerce Award Medal

SAUL R. GILFORD, Peter B. Haas, Arthur W. Holt and Robert K-F Scal of the National Bureau of Standards have received the Department of Commerce Silver Medal for Meritorious Service.

Saul R. Gilford received the award for "very valuable contributions to electronic instrumentation in the field of biophysics".

He joined the staff of NBS in 1948 and since that time has developed a number of instruments for use in the medical field. Among these are a physiological monitor, developed in cooperation with Dr. H. P. Broida of NBS, which can give immediate warning of unfavorable changes in a patient undergoing an operation.

Peter H. Haas received the Medal for "outstanding contributions in the field of magnetic measurements and standards at radio frequencies".

He joined the staff of NBS in 1949 and is presently a member of the high frequency standards laboratory of NBS. In his work he has developed standards for measuring commercial magnetic materials, and a precise and accurate secondary standard developed by him has been adopted by an instrument manufacturer, making the standard available commercially.

Arthur W. Holt received the award for "a major contribution of unusual value to science and technology in the original design and construction of a new high-speed memory for electronic data processing machines".

Holt joined the staff of NBS in 1949 to carry out research on the Bureau's first high-speed automatic electronic computer, SEAC. He has made several contributions to the improvement of that machine and has taken part in the development of a second computer, DYSEAC.

Robert K-F Scal received the Medal for "an outstanding contribution to electronic engineering in the development of a miniaturized airborne radar".

Since 1947, Scal has been associated with the Electronics Division of the Bureau, where he has been engaged in development of new techniques, materials and components for electronic miniaturization.

Radio Plant Planned for Iran

ESTABLISHMENT OF a Swedish factory in Iran for manufacturing radio equipment is being planned. Production is expected to start before the end of 1954.

It is reported that the factory is

expected to produce 3,000 to 4,000 receiving sets per month. Manufacture will be on a license basis with AGA, a Swedish firm, with component parts delivered from Sweden. The plant will be staffed with Swedish engineers and will draw on the Iranian labor force.

The market for radios in Iran is said to be good because of the large portion of the population who cannot read.

Bruce Coffin Elected Victoreen Chairman

BRUCE A. COFFIN, formerly vice-president and a director of CBS, has been elected chairman of the board of directors of Victoreen Instrument of Cleveland, Ohio.

The company also appointed E. W. Glasenapp as general manager of its resistor department. He was previously associated with Service Equipment and was instrumental in organizing Wilcor Products.

New Capacitor Firm Organized

CONDENSER MANUFACTURERS was recently formed in Nashville, Tenn., for the manufacture of electrolytic capacitors of the etched foil type.

The company is in production at its 10,000 sq ft factory.

Personnel of the new firm include:

Hampton Lackey, president, who was formerly half-owner and president of Industrial Products of Nashville.

Howard W. Gates, vice-president & chief engineer, was formerly con-

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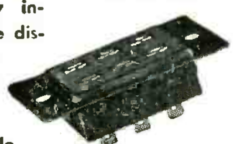

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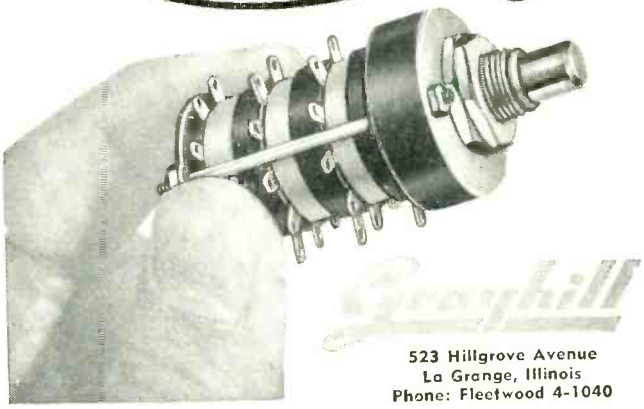

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APPLICATION-DESIGNED RESISTORS FOR ELECTRONICS AND INSTRUMENTATION nected with Western Electric, Bell Labs and U.S. Signal Corps. He also owned and operated Lectrex, electrolytic capacitor manufacturers for the hearing aid trade.

J. C. Carlin, director of research, also held that position with Tennessee Products & Chemical Corp. and was general manager of engineering of Warwick Mfg. Corp.

Armour Research Names Lerner

IRWIN S. LERNER has been promoted to supervisor of the computer systems section in the electrical engineering department at Armour Research Foundation of Illinois Institute of Technology, Chicago.

He formerly held the post of electrical engineer in the department and has been with the Foundation since 1951.

Lerner's section is concerned with design, development, and construction of special and general purpose digital and analog computer equipment.

From 1948 to 1951, he was with the geophysics exploration research department of Continental Oil.

Levinthal Forms Electronics Firm

ELLIOTT C. LEVINTHAL, former chief engineer at Century Electronics, Los Angeles, has established his own company—Levinthal Electronic Products, in Redwood City, Calif. The new firm will develop, produce and merchandise electronic medical instruments, microwave devices and other electronic equipment.

The company has two medical instruments on the market. Both were developed by Albert J. Morris, vice-president of the firm.

Before joining Century Electronics, Levinthal was research director and member of the board of Varian Associates, Palo Auto; research associate at Stanford University and project engineer at Sperry Gyroscope.

Daven Promotes J. P. Smith

J. P. SMITH, JR., formerly chief engineer of the Daven Co., has been promoted to director of engineering for the company.

Radio City Products Expands Plant

RADIO CITY PRODUCTS has awarded a contract and construction has already started on a new and additional building at Easton, Pa. It will add about 5,000 sq ft to the present 28,000 sq ft now occupied.

The new building will be used for shipping and warehousing. The company recently moved its engineering and development labs to Easton.

Leeds & Northrup Plans New Plant

LEEDS & NORTHRUP plans to construct an instrument plant on a 129-acre tract adjacent to North Wales, Pa.

Estimated cost of the 250,000

sq ft building, additional equipment, utilities and landscaping is in excess of $4 million.

Present schedules call for construction to start in the early Fall, with occupancy in latter 1955. Approximately 1,300 of the firm's 3,100 employees will be at the new location.

The building will provide facilities for the manufacture of Micromax and Speedomax recorders and controllers, panels and cubicles for load frequency control, as well as space for supporting units engaged in engineering, industrial engineering, order control, inspection, receiving, warehousing and shipping.

Gudeman Expands

THE GUDEMAN CO. announced the opening of additional facilities in the Los Angeles area for the manufacturer of pulse transformers and delay lines.

Fairchild Recording Forms New Division

A NEW MOTION PICTURE sound division has been established by Fairchild Recording of Whitestone, Long Island to manufacture Perspecta Stereophonic Sound Integrators for theaters. The new unit is a 'compatible' theatre sound system that produces three-speaker stereophonic sound from a single optical sound track.

Ray Crews, vice-president of Fairchild and formerly supervisor of sound recording under Loren L. Ryder at Paramount, will direct this new division. Crews was manager of a Westrex subsidiary installing and servicing theatre equipment for many years.

Marconi Promotes Top Engineers

WITH THE RETIREMENT OF G. M. WRIGHT, engineer-in-chief of Marconi Wireless, B. N. MacLarty takes over that position. His deputy will be R. J. Kemp, formerly chief of research.

E. Eastwood, deputy chief of re-

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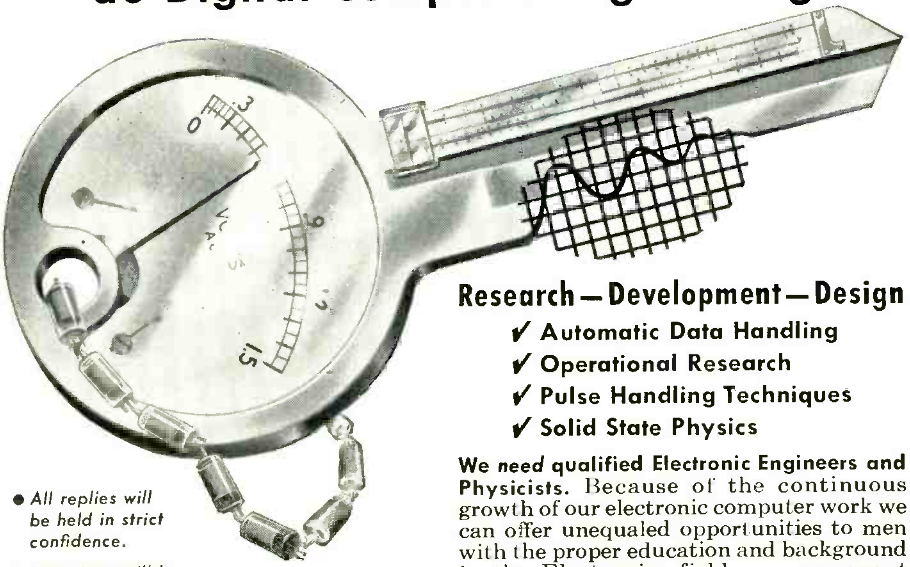

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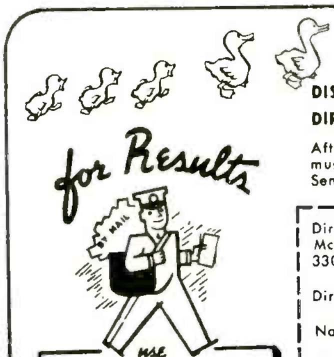

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search, replaces Kemp as chief at the company's research establishment at Great Baddow, England.

New French Tube Company Planned

A GROUP OF FOUR French companies producing electronic and cathode ray tubes plan to form a new company to handle the entire production of the group. The new concern will be called Compagnie Industrielle Francaise des Tubes Electroniques and will have an initial capital of 300 million francs. Founders are Cie des Lampes Mazda, Cie Claude-Paz et Silva, Lampes Fotos and Lampes Visseaux.

Co-operation between the plants of the four companies is expected to result in increased French production of electronics and cathode-ray tubes, which totalled 14 million in 1953.

Zenith Plastics Consolidates Facilities

ZENITH PLASTICS CO. of Gardena, Calif. has consolidated all its aircraft engineering and fabrication facilities into a new division, to be known as Zenith Aircraft.

The company is producing plastic fuselage assemblies for Lockheed P2V5 Neptune bombers and a series of radar housings for the Navy WV-2 and Air Force RC 121C Constellation.

Telectro Industries Names Grossner

NATHAN GROSSNER has been appointed chief engineer and sales engineer for Telectro's transformer division.

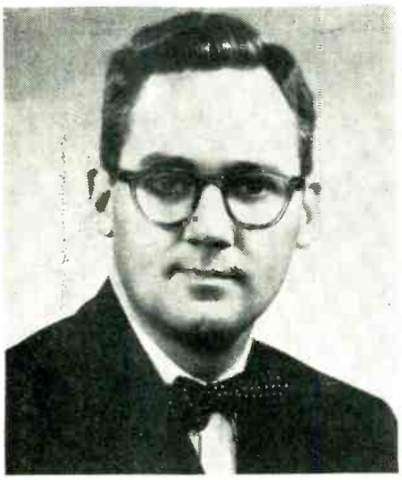
He has been associated with a number of transformer manufacturers over the last seven years.

Vulcanized Fibre Plans Research Laboratory

NATIONAL VULCANIZED FIBRE has announced plans for a modern research laboratory to enlarge the facilities of the company's research and development section.

The laboratory will be housed in

what is currently a large stone warehouse at Yorklyn, Del., near Wilmington. Formerly used for storage of raw materials employed in the manufacture of Vulcanized Fibre, the building will be completely renovated at an estimated cost of nearly a quarter of a million dollars. It will embrace 20,000 sq ft of floor space.



Blackstone Named U. S. Consultant

HENRY BLACKSTONE, president of the Servo Corporation of America, has been appointed a member of the National Council of Consultants of the Small Business Administration.

Blackstone, who founded Servo in 1945, has invented and developed electronic components for national defense. He is now serving as a national director of the Young Presidents Organization and advisor to its committee to encourage new business.

Thompson Products Elects Engineers

DEAN E. WOOLDRIDGE AND SIMON RAMO were elected to the board of directors of Thompson Products.

Both men resigned top management jobs with Hughes Aircraft last year and, with financial backing provided by Thompson Products, organized the Ramo-Wooldridge Corporation to specialize in new advanced system developments involving the general field of guided missiles, radar, computers, electronic controls and automatic intelligence devices.

Webster-Chicago Elects Owen

NORMAN C. OWEN was elected president of Webster-Chicago. He was vice-president in charge of sales.

E. J. Moritz, general manager of the laminations division, was elected vice-president in charge of manufacturing. Other officers who were re-elected are Walter P. Altenburg, vice-president and general counsel; G. W. Wallin, vice-president in charge of engineering; C. B. Dale, vice-president in charge of research; Herman Biechele, secretary and Edward R. Johnson, treasurer.

Trav-Ler Expands TV Set Plant

TRAV-LER RADIO CORPORATION will be in production in a new 70,000 sq ft modern addition to its plants in Orleans, Ind., to handle an anticipated twenty-five percent increase in billing for the current year over 1953, according to Joe Friedman, president.

The new plant, specially equipped to handle production of television and high fidelity products will occupy a 3½ acre section adjoining the present plants in Orleans and has been specifically designed for continuous production line operation. The addition will give Trav-

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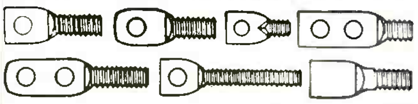

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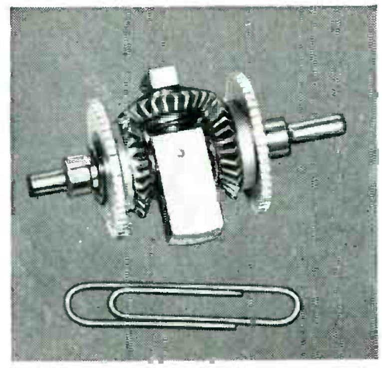

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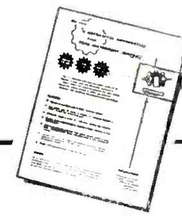

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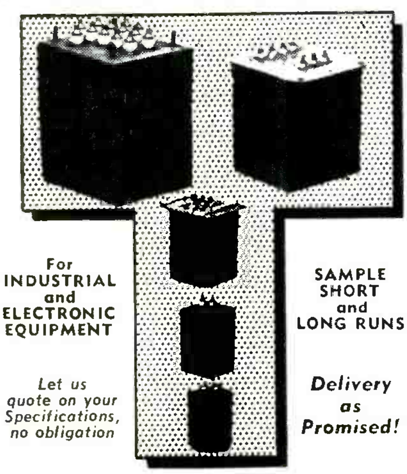

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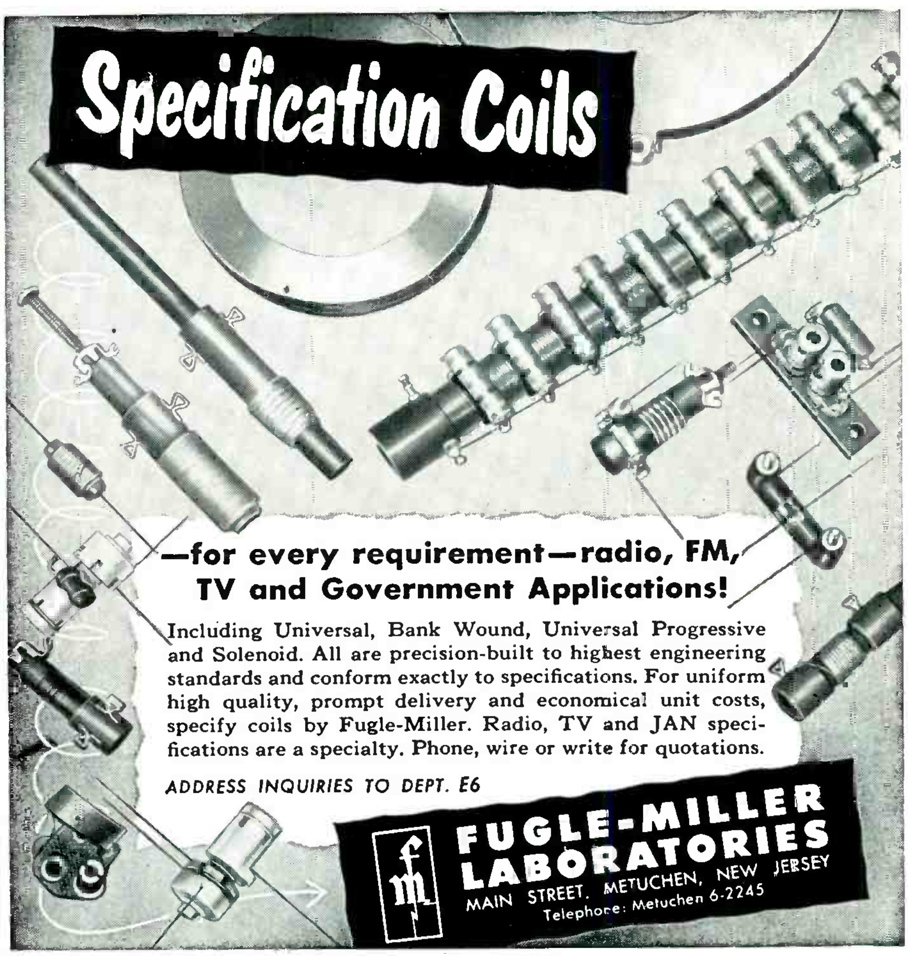

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Ler a total of 210,000 sq ft of production space in Orleans.

Veeder-Root Names Burton

ALLAN L. BURTON has joined Veeder-Root to carry out market research and electronic development work with the company.

Burton comes to Veeder-Root from RCA where he specialized in new product administration. He previously had been associated with the American Optical in research and new business activities, and had been manager of industrial sales for Tracerlab.

During World War II he was associated with the Underwater Sound Laboratories at Harvard University where he worked on the development of underwater weapons.

Navy Needs Engineers

ENGINEERS, TECHNOLOGISTS, physicists, physiologists and metallurgists are needed by the U. S. Navy. The Naval Air Material Center, located in the U. S. Naval Base at the extreme south end of Broad Street in Philadelphia, Pa., has vacancies in the above positions for qualified eligibles. These vacancies are at grade GS-5 to GS-12 level with salary ranging from $3,410 to $7,040 per annum.

The Naval Air Material Center (the Air Center is divided into three major branches—the Naval Aircraft Factory, the Naval Air Experimental Station and the Naval Auxiliary Air Station) is engaged in research (applied), development, manufacture, modification, test evaluation and overhaul of aircraft, aircraft components and aeronautical materials, including launching and arresting devices.

Interested persons should file an application for Federal Employment, Standard Form 57, with the Industrial Relations Department, Naval Air Material Center, Naval Base, Philadelphia 12, Pa. Applications may be obtained from the Industrial Relations Department, Naval Air Material Center, or any first or second class post office or from any Civil Service Regional Office.

Schulman Named By CBS-Columbia

HAROLD J. SCHULMAN has been named director of service for CBS-Columbia.

In the newly established post, he will have supervision of all CBS-Columbia service and field engineering activities.

Schulman resigned as director of service for Du Mont Laboratories, a position he held for more than three years, to accept his new post. Prior to his Du Mont affiliation, he was for three years service manager for Admiral distributors of New York City.

Schulman is chairman of the service committee of RETMA.

Bennett Named General Cable Chairman

IRVING T. BENNETT was elected chairman of the board of General Cable Corporation. He will continue also as the company's chief executive officer, a position he has held since August, 1953. As chairman, he suceeds D. R. G. Palmer who is retiring after 35 years with the firm.

Mr. Bennett came to General Cable Corporation in April, 1953 as a director and chairman of the executive committee. Previously, he had been vice president and general manufacturing manager as well as a director of Revere Copper and Brass Incorporated which he joined as sales promotion manager in 1929. From 1944 to December, 1952, he had been vice president in charge of the Baltimore and Aluminum Divisions of Revere.

RETMA Membership Increases

THE FOLLOWING companies were admitted to membership in RETMA: Central Sales & Manufacturing Co., Denville, N. J.;

Electronic Tube Corp., Philadelphia, Pa.; International Rectifier Corp., El Segundo, Calif.; Jackson Electronics & Television, Inc., Chicago, Ill.; Klipsch & Associates, Hope, Ark.; Magnex Corp., Jamaica, N. Y.; McCoy Electronics Co., Mt. Holly Springs, Pa.; Onondaga Pottery Co., Syracuse, N. Y.; Orradio Industries, Inc., Opelika, Ala.; Rectifier Corp. of Puerto Rico, Fajardo, P. R.; Reiner Electroncis Co., Inc., New York, N. Y.; The Tetrad Co., Yonkers, N. Y.; Waters Conley Co., Rochester, Minn.

Raytheon Expands Marine Radar School

RAYTHEON'S radar training school for instructing ship's officers in the operation of marine radar and other electronic aids to navigation has been expanded. The action came with the closing of the Maritime Administration's Radar and Loran School in New York.

A three-day course in Waltham, Mass. will be offered without cost to merchant mariners. The curriculum will include operating instructions for the firm's marine equipment. Instructions in making minor repairs and adjustments will also be given.

The company also announced that Captain John N. Boland, USN (ret.), has been appointed manager of its office in Washington, D. C. He became associated with Raytheon in 1951. From 1945 to 1948 Capt. Boland was in charge of the fire control radar research and development section of the Navy's Bureau of Ordnance.

New York Central Names Auerbach

THE NEW YORK CENTRAL RAILROAD announced the appointment of Al Auerbach as electronics engineer succeeding the late George M. Brown.

In addition to teaching tv and electronics, Auerbach has been associated with Emerson, Radio Receptor and most recently with Fada Radio as a tv engineer.

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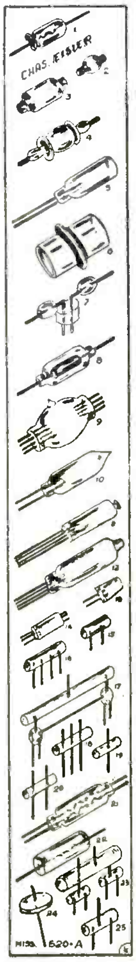

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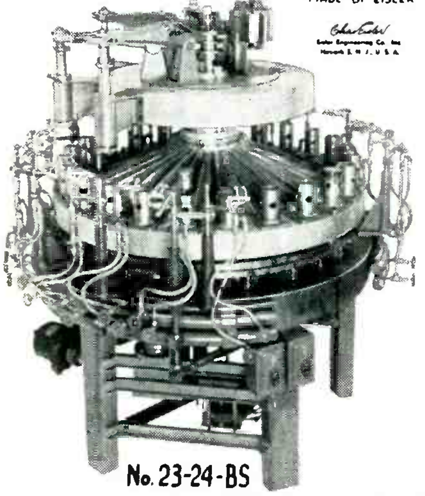

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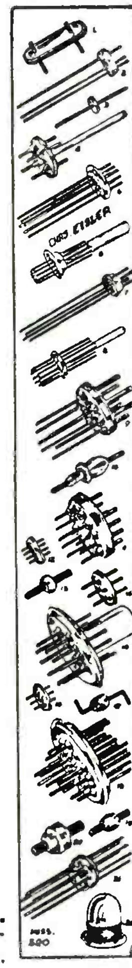

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140ST-32	150VDC	140VDC	1.5MA

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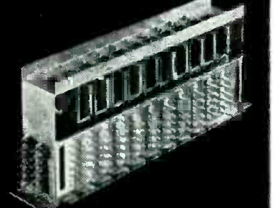

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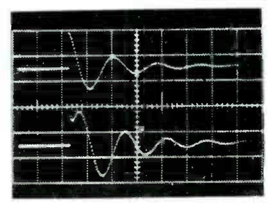

SINGLE-SWEEP PRESENTATION
Response of two networks excited by a single pulse shows free-running operation of the Dual-Trace Unit in a one-shot application. A single 200-μsec/cm sweep is used for this display.

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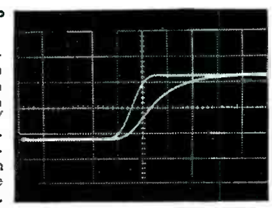
Output of an RC network superimposed on the input pulse. Both waveforms appear on alternate 0.04 μsec/cm sweeps, accurately measuring the rise-time deterioration caused by passage through the network.



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10 KV Accelerating Potential—Brighter display at low repetition rates.

Flexible Sweep Delay—1 μsec to 0.1 sec, jitter-free, incremental accuracy within 0.2% of full scale.

Type 535 Oscilloscope—$1300 plus price of desired plug-in units.

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Type 53C Specifications

Two Identical Amplifier Channels
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Risetime—0.04 μsec.
Sensitivity—0.05 v/cm to 20 v/cm calibrated, continuously variable to 50 v/cm.

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Free-running rate—100 kc, approximately.

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NEW BOOKS

The Electronic Musical Instrument Manual

BY ALAN DOUGLAS, *Senior Scientific Officer, British Iron and Steel Research Association. Pitman,* 221 *pages, 2nd Ed.,* 1954, $6.00.

THIS is not primarily for the beginner. While it is not a mathematical book, when equations are needed they are given and explained. The first two chapters on "Sound" and "Music and Noise" are reviews of fundamentals rather than being elementary in treatment. However, any electronic engineer would feel completely at home, and an average high school student of physics would understand just about all of it.

There are seven chapters, 187 figures, 3 appendices, 57 references and a 5-page index. One appendix indicates the twelve half-tone musical notations for vibrations from 16.353 to 16.744.032 vibrations per second (excessive digits, no doubt). Two of the chapters are enlarged from the first edition: "IV. The Production And Mixing Of Electrical Oscillations" (68 pages) and "VII. Experimental Methods" which in 18 pages indicates three broad fields for future experiment and improvement.

In Chapter "VI. Commercial Electronic Instruments" (65 pages, 54 figures) the author has done a fine job of integration. Each of thirteen instruments has been allotted adequate space. Since this is not a book on what organ to buy, there is perhaps no reason to indicate preference of one organ over another. In this chapter, the illustrations were chosen to show "differences between two basic schools of thought. . . (a) should the originally-generated waveform contain all the required harmonics, subsequent analysis or control being effected by removing unwanted harmonics and modifying others: or (b) should pure sine waves be independently generated for each required fundamental and harmonic frequency, and control or synthesis achieved by adding numbers of these pure waves of varying frequencies and amplitudes?"

The figures are uniformly excellent. In two cases, folded inset pages of adequate size are used: "Part circuit of the Novachord" and "Complete circuit of the Solovox". The latter gives all circuit constants, though these are lacking in the former. In addition the "Hammond mixing circuit" occupies a two-page spread. All waveforms are clear line drawings. The publisher is to be congratulated on his courage and enterprise in reproducing these figures. The paper is good quality, and no misprints were found.

Some confusion may exist for readers not familiar with British terms. Two important examples occur repeatedly; our unwieldy micromicrofarad is the picofarad or pF, and h.t. is plate voltage. There should be no trouble in identifying a high magnification valve as a high-mu tube, and screening is, of course, shielding. Gas tubes, like 884, are shown cross-hatched, instead of by the familiar dot. L. F. Oscillator is an a-f oscillator, speech coil is voice coil, but what is sorbo rubber (page 113) and a paxolin strip (page 204)?

In general it isn't too hard to think of our own tube equivalent when a circuit is shown, as it usually is. Some of the tubes (valves) are international, but to open the book at random, on pages 50-51 four circuits of one-tube oscillator circuits show: 6A8G, AC/SG and L 63, EF50, 7A8. The first and last are readily identified, but the others are not likely to be familiar.

There will be no argument to the author's discourse on distortion, but immediately following, he says that a practical amplifier range is "30 to 10,000 cycles/sec., which will still allow a substantial precentage of signals of higher frequencies being heard". (argument!)

A couple of minor faults: (page 106) output transformers "should not have taps"; the secondary winding must be matched to the load. He should know that sectionalized secondaries can be paralleled or otherwise connected. On page 11 a slight recasting of the definition of the decibel would be desirable.

Some examples of the author's style and knowledge: (page 26) "the form of vibration in a piano is very interesting. There is no other instrument quite like it, and it cannot be exactly similated by electrical means. The principal reason for this is the very strong characteristic starting tone which is almost of a transient nature, having a very steep wave front containing many frequencies"; (page 43) "Beat tones do, in fact, contribute much more to music than is generally realized. For example, the ear detects a fundamental tone in the lower tones of a violin. The real fundamental is very weak, because it lies below the fundamental resonance of the violin body, and any sound output lower in pitch then the resonance is very small. Adjacent, strong upper harmonics produce the beat tones which sounds to the ear like the actual fundamental or pitch tone of the sound being produced"; . . . (page 35) "The square wave is exceedingly useful in musical synthesis, as all "hollow" sounding tones consist principally of odd harmonics; . . . (page 37) "it might be said that the successful imitation of orchestral tones demand both square and sawtooth wave forms, as well as sine waves".

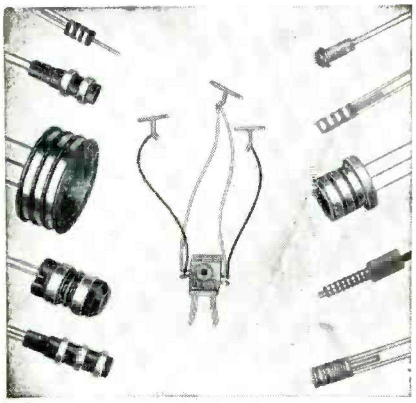
The reviewer would like to see added a glossary listing British and American terms, also a list of similar tubes and valves mentioned in the text.

If music is your vocation or avocation, and you know something about electronics, you will get a great deal from this book. It is well worth careful reading. It is also valuable as an authoritative reference.—RICHARD C. HITCHCOCK, *Syntron Company, Homer City, Penna.*

Industrial Electronics

BY R. KRETZMANN. *Philips' Technical Library, Eindhoven, Holland,* 236 *pages*, 1954, $5.50.

THIS book adds to the expanding series of Philips' Technical and Scientific Publications, of which there are already a considerable number in the field of radio and electronics. The author is German and the translator of the present book is a Londoner. The translation of a technical text is difficult, in



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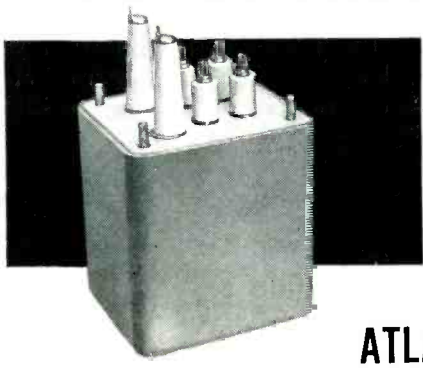

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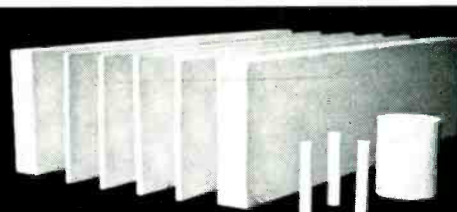

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This new technique just worked out for Color TV can give you connectors and cables for solving many problems involving high voltage and corona suppression.

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As illustrated in this Alden 220FTSC Color TV Tube Connector, the new technique permits a jacket of high voltage insulation to be integrally molded around each high voltage contact and lead, while the low voltage leads take the resilient "figure 8" clips in the regular isolated pockets providing air space leakage.

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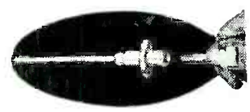

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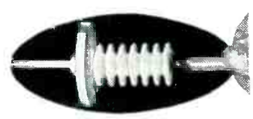

8111FP/M
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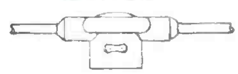

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general, and in a relatively new science such as electronics it is even more difficult. Therefore, unfamiliar phrases are bound to occur and minor errors as well as none-too-clear explanations inevitably creep into the text. Thus, it is not too well suited for use in this country as practically all of the tubes and equipment referred to are naturally those made or sold by the Philips Company. This lack of familiarity with our techniques is indicated by the book's sub-title "Introduction to Modern Industrial Electronical Practice." There are a number of other terminologies that are a little strange to us, such as enneode, senditron, zero point anode arrangement and pulsation welding.

The book is divided into two parts. The first, comprising about one-third of the text, is devoted to the tube types used in the industrial field and their basic circuits. Part II is devoted to circuit details and applications. Diagrams are used extensively but in only a few cases are the numerical values of components given. Its greatest value in this country is undoubtedly to engineers interested in the line of industrial tubes and equipment built and sold by the Philips Company. For instance, the Senditron tube for welding control is apparently a commercial product of the Philips Company, but it is quite different in its principle of operation than anything available in the U. S. A. Thus, it might well be interesting reading to those competing in foreign countries, particularly South and Central America, with the able engineers and export representatives of this highly successful firm.—W. C. WHITE, *General Electric Research Laboratory.*

Microwave Spectroscopy

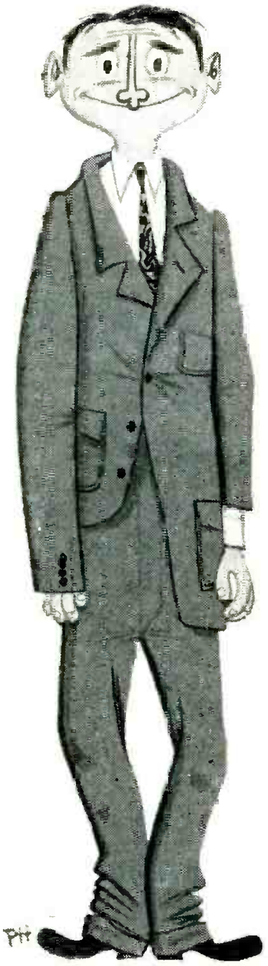
BY M. W. P. STRANDBERG. *John Wiley and Sons, Inc., (Methuen's Monographs on Physical Subjects), New York*, 1954, 140 *pages*, $2.50.

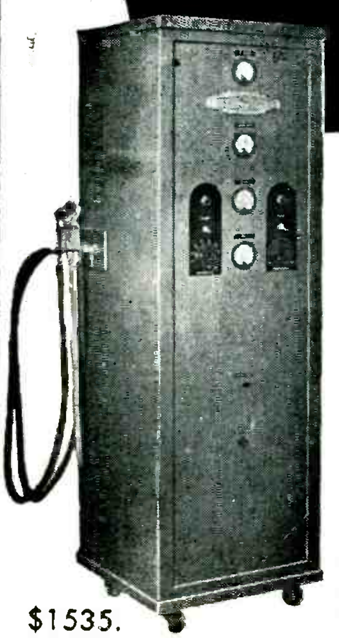
THIS IS THE SECOND book on the subject that has come out within the last year. (The first, by Walter Gordy et al and having the same title, was reviewed in ELECTRONICS last October.) The present volume is a much less ambitious monograph, being restricted to the microwave spectroscopy of rotating molecules.

Like most of the books in the Methuen series, Dr. Strandberg's contribution comprises a concise, rather advanced treatment of the subject. The book is intended either as a fundamental text for someone interested in specializing in the field or, as the author puts it, as "a second course in quantum theory whose framework consists of the many problems which may be precisely illustrated experimentally by microwave spectroscopic methods."

The subject of microwave spectroscopy dates back no further than the end of World War II. The good start which American scientists obtained in the field was due largely to a poor guess on the part of the radar designers toward the end of the war. In their efforts to produce a narrow searchlight radar beam which could be handled by antennas of convenient size and yield more detailed information, the designers went from wavelengths of 10 cm to 3 cm, and finally 1.25 cm. To their amazement they found that contrary to all expectations the range of the 1.25-cm radar was limited to a few miles. This limitation was due to the absorption of microwaves in water vapor in the atmosphere at that frequency. Many of the radars were discarded, and the surplus equipment thus created became a ready source of apparatus suitable for microwave instrumentation at research centers all over the United States.

Perhaps the most outstanding of these centers today are at Columbia and Duke University, MIT and the National Bureau of Standards. (The abovementioned book by Gordy was the contribution of the Duke group.) Dr. Strandberg (an MIT professor) is a physicist, a fact which is evident from his approach to the subject. The book presupposes a knowledge not only of matrix methods, but of quantum mechanics as well. The larger part of the text is devoted to the physics of the subject, with experimental considerations remaining unmentioned until Chapter 10. However, this chapter, as well as the following chapters (on sources of radia-





tion, sample cells, detectors and electronic apparatus), are in themselves very complete, though they could have been profitably supplemented by a more voluminous bibliography.

Studies of the electronic hyperfine structure and paramagnetic materials are not treated in the present volume, but within the limitations that the author set himself, he has produced an excellent contribution to this expanding new field.—CHARLES SUSSKIND, *Stanford University, Stanford, Calif.*

Television Receiver Design—Flywheel Synchronization of Sawtooth Generators

BY P. A. NEETESON. *Philips' Technical Library. Elsevier Press, New York and Houston,* 1953, 156 *pages,* $4.50.

THIS is the second of the excellent series of monographs on television receiver circuits produced by Philips engineers, of which the first (on i-f stages, by A. G. W. Uitjens) was reviewed in these pages in the August, 1953 issue. The first part of the book sets the stage by a detailed treatment of the circuit to be synchronized, that is, the sawtooth-wave generator. Capacitive and inductive sawtooth circuits are treated from the theoretical and practical standpoints. A separate chapter is devoted to tubes specially developed for such circuits.

Then follow three chapters, the meat of the book, on the general principles of synchronization, the particular forms of storage-stabilized (flywheel) sync circuits, and the automatic-phase-control circuits. The latter chapters are models of compact presentation and clarity, well worthy of the close scrutiny of the experienced designer as well as the tyro. The former class of reader well knows that the control of second order effects in stabilized sync circuits requires knowledge of many terms in the equations. These are all faithfully set down, with liberal use of the operational symbolism (further developed in two Appendices). The book is very well illustrated with explicit circuits and their significant waveforms, as well as tabular presentations of fre-

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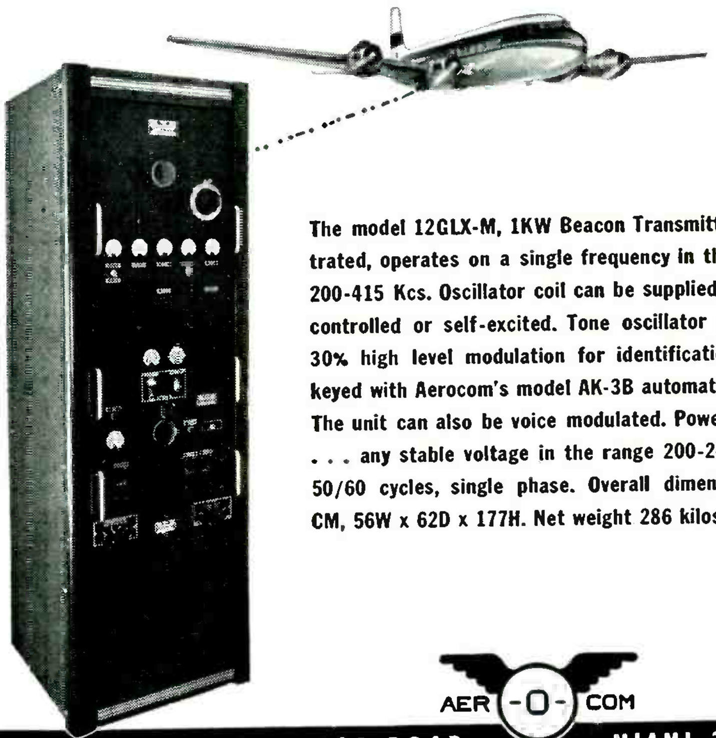

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quencies, voltages and circuit constants.

This book clearly illustrates the value of the specialized monograph. It takes careful study, but it rewards the effort well.—DONALD G. FINK, *Philco Corp., Philadelphia, Pa.*

THUMBNAIL REVIEWS

Dielectric Constants and Electric Dipole Moments of Substances in the Gaseous State. NBS Circular 537. By Arthur A. Maryott and Floyd Buckley. U. S. Government Printing Office, Washington 25, D. C., 29 pages, 1953, 20¢. A tabulation of data for approximately 350 substances in the vapor state derived from consideration of microwave, radio-frequency and optical data.

Reference Data for Orienting Quartz Plates by X-ray Diffraction. NBS Circular 543. By Catherine Barclay and Leland T. Sogn. U. S. Government Printing Office, Washington 25, D. C., 7 pages, 1953, 15¢. Considerable information useful to the technician in checking crystal orientation.

Electrodeposition Research, Proceedings of the NBS Semicentennial Symposium, December 4–6, 1951, NBS Circular 529, Government Printing Office, Washington, D. C; 129 pages, 1953, $1.50. Cross section of research currently being conducted in electrodeposition by industrial, university and government laboratories in Europe and the United States.

Tables of Normal Probability Functions, NBS Applied Mathematics Series 23. (Supersedes MT14), 344 pages, 1953, $2.75, Government Printing Office, Washington, D. C. Tables of two functions to fifteen decimal places and tables of two functions to seven places, useful to a wide variety of statistical applications.

Stability Theory of Differential Equations. By Richard Bellman. McGraw-Hill Book Co., New York, N. Y., 166 pages, 1953, $5.50. A theoretical book for the mathematician.

Protection against Betatron-Synchrotron Radiations up to 100 Million Electron Volts. NBS Handbook 55, 52 pages, 1954, $0.25, Government Printing Office, Washington, 25, D. C. Protection requirements for operating personnel, hospital patients, and the public against the potential hazards of accelerators. The hazards resulting from the various radiations produced by the sources are included, as well as those due to certain associated effects, such as noise, electricity and ozone protection. Recommendations are also given on a consistent system of units and of measurement procedures that can be applied to radiations with energies above 5 Mev.

Selenium Rectifier Handbook. Sarkes Tarzian, Inc., Bloomington, Ind., 72 pages, 1954, $1.00. Manufacturing processes, characteristics, how-to-use, guide for replacements in radio and tv chassis, with many circuits and much practical matter.

Tables of Lagrangian Coefficients for Sexagesimal Interpolation. NBS Applied Mathematics Series 25, 157 pages, 1954, $2.00. Tables for interpolation when the arguments are expressed in sexagesimal measure, such as degrees (or hours), minutes and seconds. Useful in many branches of engineering.

Tables of 10^x. NBS Applied Mathematics Series 27, 543 pages, 1953, $3.50, U. S. Government Printing Office, Washington 25, D. C. Antilogarithms to the base 10, or 10^x, in the form of two tables, a readily interpolable table for 10 decimal accuracy and a basic radix table for 15-figure accuracy. Used in conjunction with logarithmic tables in any extensive computations involving logarithms and antilogarithms, these tables will save considerably more labor than will logarithmic tables used alone. The only similar table is J. Dodson's **"Antilogarithmic Canon,"** published over 200 years ago.

Crystal Handbook. James Knights Co., Sandwich, Illinois, 36 pages, 1953, $1.00. Handy reference of crystal and oscillator theory for the design engineer using crystals, outlining important factors that should be considered in equipment design if maximum crystal performance is to be realized. A bibliography is included.

Circular and Hyperbolic Sines for Radian Arguments. NBS Applied Mathematical Series 36, 407 pages, 1953, $3.00. U. S. Government Printing Office, Washington 25, D. C. Tables of sin x, cos x, sinh x and cosh x, $x = 0(0.0001)$ 1.9999, 9D; sinh x and cosh x, $x = 0(0.1)$ 10, 9D; a conversion table of degrees, minutes, seconds $\leftrightarrow$ radians and a table of multiples of $\pi/2$.

Les Filtres a Cristaux Piezoelectriques. By D. Indjoudjian and P. Andrieux. Gautheir-Villars, 55 Quai des Grands-Augustins, Paris, France, 177 pages, 1953, 3,300 francs or $10.00. A treatise on crystal filters, in French.

Magnetic Fields of Cylindrical Coils and Annular Coils. By Chester Snow. NBS Applied Mathematics Series 38, 30 pages, 1953, U. S. Government Printing Office, Washington 25, D. C., 25 cents. Axial and radial components of the magnetic field at any point in space of a cylindrical or an annular coil carrying an electric current, expressed in terms of complete elliptic integrals or of Legendre functions which involve ratios of the significant dimensions of the coils. Applications range from laying-out of large current-limiting reactors in electric power stations to design of coils for studying paramagnetic resonance in atomic nuclei.

BACKTALK

Audio Feedback

DEAR SIRS:

REGARDING the article "Multiple Feedback Audio Amplifier," (ELECTRONICS, p148, Nov. 1953) we have received a number of technical inquiries. . . .

In his letter in the Jan. 1954 issue, W. B. Bernard indicates he has obtained excellent results using tetrode tubes with 20 db of feedback, and expresses concern with respect to the critical nature of balance, etc in a 36-db feedback amplifier of this type.

The potential difficulties he mentions were carefully considered in the development of the amplifier, but proved to be of no real consequence. On the contrary, the design combines the efficiency and high power output of tetrodes with exceptionally low distortion and complete stability under all load conditions.

Mr. Bernard considers triodes and pentodes comparable in producing distortion. This is surprising . . . since it is commonly accepted that higher-order distortion is greater in pentodes (see Langford-Smith, "Radiotron Designer's Handbook," 5th Ed. p546), so that pentodes require more feedback to equal the distortion performance of triodes. Since advanced triode amplifiers (Williamson) generally use 20 db of feedback, it was considered essential to use a good deal more in a tetrode design to achieve substantially negligible distortion. As mentioned in the article, the design employs 36 db of feedback split into three loops to achieve low and high frequency stability.

Mr. Bernard doubts that the local feedback introduced into the output stage by the 480K resistors is effective around the output stage. It is true that the effect of the output stage feedback is to reduce the interstage impedance, and that the voltage gain of the output stage from grid to plate is not altered. However, the reduction of interstage impedance is simply the mechanism through which feedback operates.

For example, a doubling of gain in one 6L6 will cut the interstage

impedance in half, thus halving the gain of the 6AU6 and keeping the output constant. The local feedback, therefore, is actually effective in stabilizing the gain of the output stage, and reducing its distortion.

Mr. Bernard is concerned with the rather large plate current excursions required of the 6AU6's in driving the 6L6's. The current swing required in the 6AU6 is only 0.88 ma peak at full power (0.20 ma due to the 15-v swing across the 100K plate load of the 6AU6 and the 330K grid leak of the 6L6, plus 0.68 ma due to the 325-v swing across the 480K feedback resistor). This leaves a comfortable margin in the 1.5-ma plate current of the 6AU6.

The low voltage swing required of the 6AU6 (15 v) is very favorable for low-distortion production . . . the distortion product is virtually pure second harmonic which is cancelled by the push-pull connection and by opposite second-harmonic distortion in the output stage. This low voltage swing is one of the advantages of pentode drivers. Triode drivers applied to a multiple-feedback amplifier would have to supply about 75-v peak swing.

Mr. Bernard expresses concern regarding the accurate balancing required using push-pull feedback, referring to a previous article and correspondence in ELECTRONICS covering an amplifier which employed 40 db of push-pull feedback. In the reference article, the authors reported that unbalance had no audible effect on their circuit, in spite of 40 db of push-pull feedback.

The multiple-feedback amplifier uses only 24 db of push-pull feedback, and is so little sensitive to unbalanced tubes that one 6AU6 can be replaced by a 6CB6, or one 6L6 by a 6V6, with only negligible effect on power output and distortion. The reasons include the feedback loops themselves, which stabilize the gains of each half of the push-pull system, and the individual cathode resistors of the 6AU6's. The latter result in a considerable stabilization of transconductance—because of plate current stabilization in the first place, and local signal-frequency feedback in the second.

Consider the balance problem as

one of operating two low-impedance generators in parallel. The generators are then halves of the push-pull system, which are closely coupled by the output transformer. The output impedance at each 6L6 plate, due to push-pull feedback, is 300 ohms. While this figure is fairly low, and calls for reasonably correct setting of the signal balance control (1,000-ohm cathode pot of 6AU6), it is no lower than that of a 6AS7G output stage without feedback, which would certainly not be considered impractical because of considerations of balance.

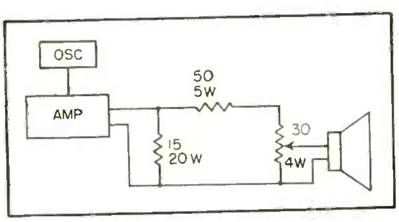
To answer other inquiries regarding the published amplifier circuit we add the following information:

Full output is obtained with about 0.9 v rms input.

The 7,500 and 25,000-ohm resistors in the output stage are of 5-watt rating. The 270-ohm cathode resistors are 2 watts and one-watt resistors are recommended for all other cases.

We use our LS-63 output transformer, connected 10,000 ohms plate-to-plate. The power supply uses our R-105 transformer and R-20 choke. The input capacitor should be 600-volt rating.

The 1,000-ohm pot in the 6AU6 cathode is a signal balance control. It can be set either for minimum second-harmonic distortion if a distortion meter is available, or for maximum output at clipping level if only a scope is available. If neither can be had, a method suggested by Arthur Hansen can be used. The amplifier is loaded with its rated impedance, as shown in the accompanying diagram, and a small portion of the output is fed to a loudspeaker. The amplifier can then be run at full power, with the output at a comfortable level. The signal balance control can be set for minimum distortion by ear. If no oscillator is available, a 60-cps signal is adequate.



The twin-T at the input is an optional rumble filter. It results in a 3-db loss at 45 cps and a null at 9 cps, and is a desirable addition when a record changer is used.

The 3.3-μμf capacitor shown in the phase inverter depends upon the wiring capacitance, and in some cases can be omitted. If a small trimmer is used, it should be set for maximum clipping-level power at 5 kc.

The 8-μf capacitors in the push-pull feedback loops are 450-v tubular electrolytics.

JOSEPH DIAMOND
United Transformer Company
New York, N. Y.

Source Impedance

DEAR MR. ONDER:

I READ with interest your article "Audio Amplifier Matches Voice-Coil Impedance", p 176, February issue of ELECTRONICS. As a physicist, it occurred to me that the value of source impedance you gave for your amplifier (400 ohms) was not in keeping with elementary bridge theory. That is, for a resistive bridge with four equal legs the source impedance is equal to one of the legs. I built your circuit using four different tube types keeping all parameters constant. This entailed changing the voltage amplifier ladder so as to keep equal grid-cathode excitation on all tubes.

The source impedances shown by the four tube types were plotted on log paper and, rather surprisingly, fitted a line with the equation

$$R_i = 50 \sqrt[3]{R_p}$$

How this could be predicted from theoretical considerations, I have not yet determined.

If we are to assume that the equation is true for all values of R_p and then enter the equation with R_i = 16 ohms, we obtain the ridiculous plate resistance of 0.033 ohm. Thus it seems impractical to reduce the source impedance by paralleling tubes. Feedback was used to reduce the source impedance but reductions of only about 50 percent seemed practical.

Do you know any other method by which the circuit can be modified in order to reduce the source impedance? I think that some method can be devised by which low-im-

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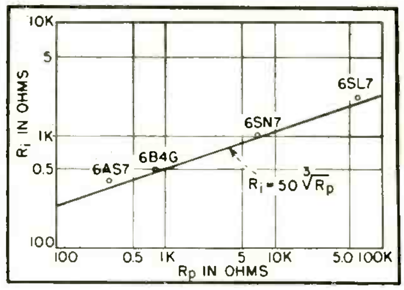
pedance devices can be used with the circuit and still have appreciable power output and acceptable efficiency.

WILLIAM E. BLUMBERG
Chemical Corps Biological Laboratories
Frederick, Maryland

DEAR MR. BLUMBERG:

THANK YOU for your letter . . . forwarded to me by ELECTRONICS magazine.

You state that the source impedance of 400 ohms is not in keeping with elementary bridge theory and yet in your next sentence you mention the fact that for a resistive bridge with four equal legs the source impedance is equal to one of the legs. The figure of 400 is correct; and is the plate resistance of a single 6AS7 triode unit under those operating conditions. Please also note that the load impedance and not the source impedance is mentioned in the article and on Fig. 6A.



Source impedance versus plate resistance for bridge-type amplifier

As far as power transfer is concerned, I do not know of any method whereby the generator impedance can be reduced. Therefore your equation and your curve are a mystery to me and I can not see how the 7K plate resistance of a 6SN7 triode unit can be reduced to 940 ohms as you show it.

In my experiments with this particular tube it was necessary to use a load resistance of 7,000 ohms for maximum power with or without feedback. With the 9-watt amplifier, a loudspeaker of 400 ohms is required, whereas the 18-watt unit calls for 200 ohms for maximum power transfer. These are in agreement with basic theory.

I trust that this information will clear any misunderstanding.

KERIM ONDER
Circuit Research Laboratory
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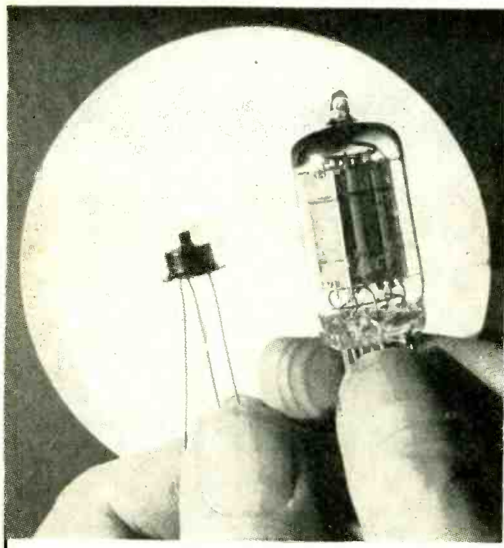

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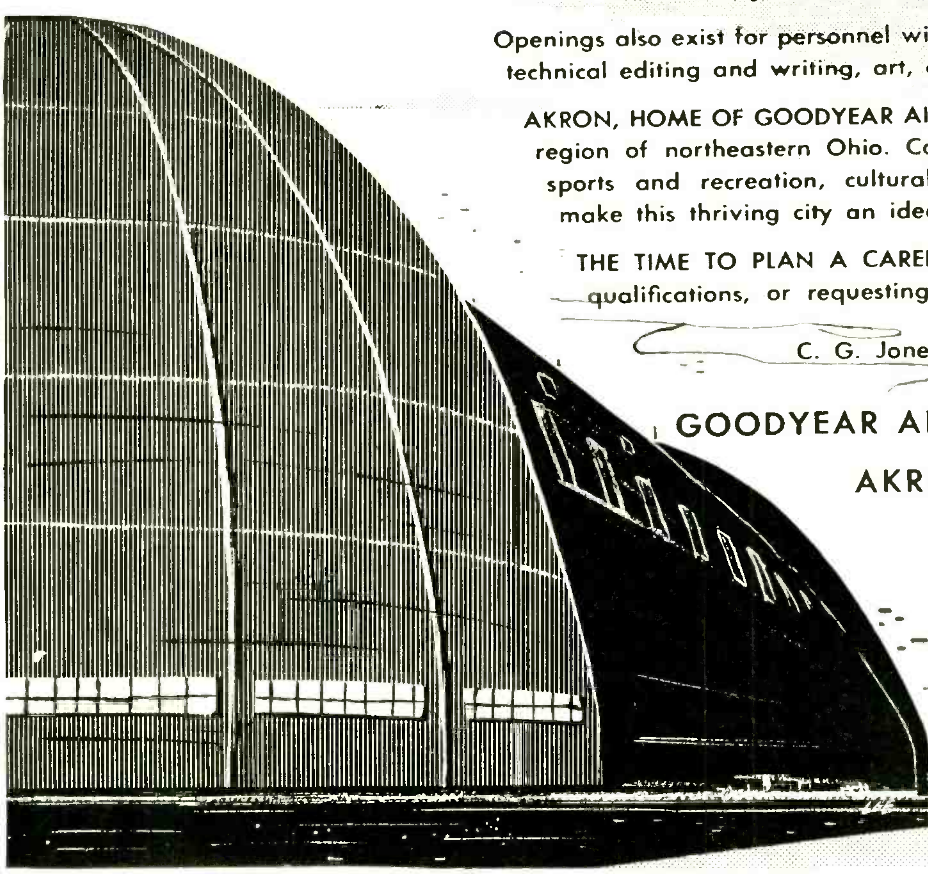

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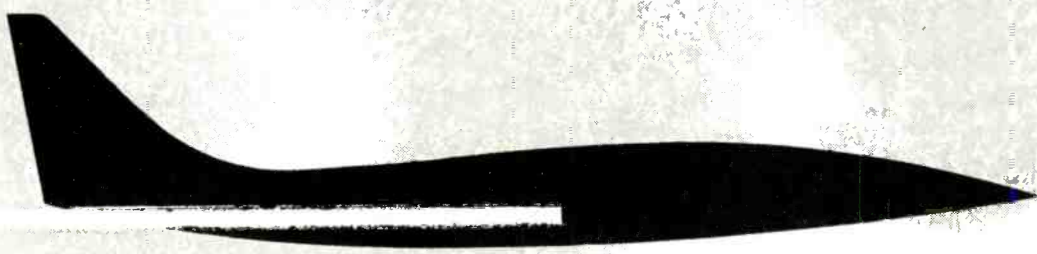

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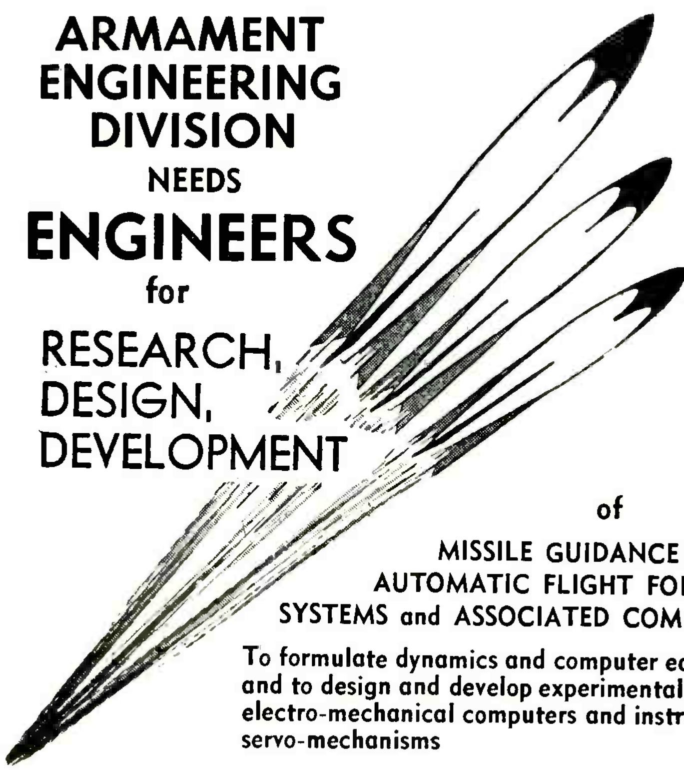

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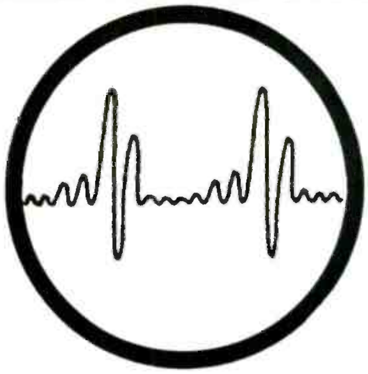

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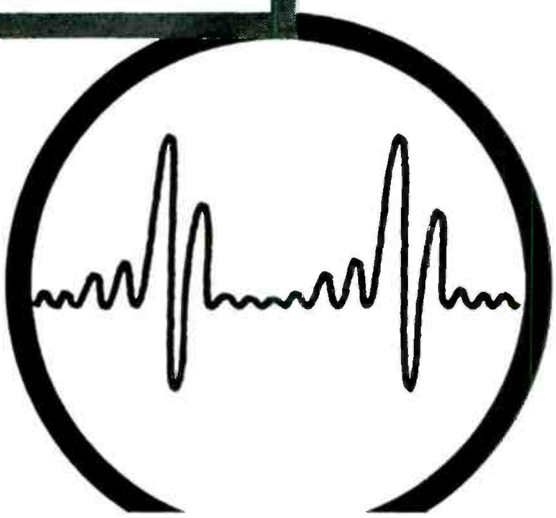

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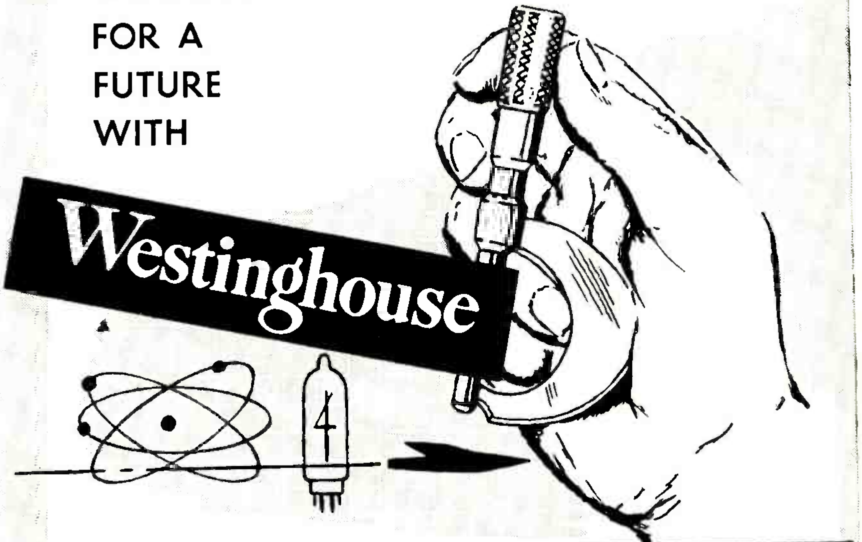

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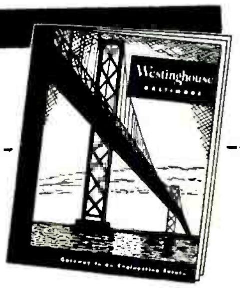

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Employment Supervisor, Dept. JE - 1
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HIGH CYCLE GENERATOR
Dual Voltage

115 volts AC; KW 1.5; PF 1.0, Single Phase, Cycles 800; DC; Volts 28.5; watts 500; r.p.m. 2666; mfgd. by D. W. Onan & Sons; frame No. 19533B $99.50

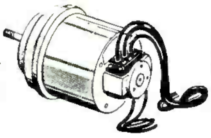
SINE-COSINE GENERATORS
(Resolvers)

Diehl Type FJE-43-9 (Single Phase Rotor). Two stator windings 90° apart, provides two output sequel to the sine and cosine of the angular rotor displacement. Input voltage 115 volts, 400 cycle .... $30.00 ea.
Diehl Type FPE-43-1 same as FJE-43-9 except it supplies maximum stator voltage of 220 volts with 115 volts applied to rotor .... $25.00 ea.

VOLTAGE GENERATORS (RATE)

ALNICO MIDGET D.C. VOLTAGE GENERATOR Type B-35-D $17.50
ALNICO MIDGET D.C. VOLTAGE GENERATOR Type B-44-D $17.50
A.C. GENERATOR: 67 V., 20 Cyc., 2-Phase, .015 Amps. Type PM-1, 1200 R.P.M. $15.00

SYNCHRONOUS SELSYNS



110 volt, 60 cycle, brass cased, approx. 4" dia. x 6" long. Mfg. by Diehl and Bendix.

Quantities Available.

REPEATERS .... $20.00 ea.
TRANSMITTERS .... $20.00 ea.

AUTOSYN MOTOR TYPE 1

115 VAC; 60 cycle; 1-phase; DR. #4279 Foot mounted; Mfg. Bendix Aviation Corp. .... $15.00 ea.

SYNCHROS

General Electric MOD. 2J15M1; 115-57.5 Volts 400 Cycle .... $22.50 ea.
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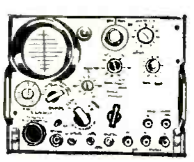
1F Special Repeater (115V-400 Cy.) .... $15.00 ea.
2J1F 3 Generator (115-400 cyc.) .... $10.00 ea.
5CT Control Transformer: 90-50 Volt; 60 Cy. .. $45.00
5F Motor (115/90 Volt—60 cyc.) $45.00
5SDG Differential Generator (90-94 volts — 400 cyc.) .... $30.00 ea.
TRANSMITTER, BENDIX C-78248: 115 Volt, 60 Cycle .... $25.00 ea.
Differential—C-78249: 115 V., 60 Cy. $5.00
REPEATER, BENDIX C-78410: 115 Volt, 60 Cycle .... $37.50 ea.
REPEATER, AC synchronous 115 V., 60 cycle, C-78863 .... $15.00 ea.
REPEATER, DIEHL MFG. No. FJE 22-2; 115 Volt; 400 Cy., Secondary 90 V $27.50
5G GENERATOR (115/90) 60 cycles $45.00
7G Synchro Generator (115/90 volts; 60 cycle) .. $75.00
6G Synchro Generator (115/90 volt; 60 cycle) .. $60.00
6DG Synchro Differential Generator (90/90 volt; 60 cycle) $50.00
2J5F1 Selsyn Control Transformer: 105-55 Volts; 60 Cycle $22.50
2JD5HA1 Selsyn Generator: 115-105 Volts; 60 cycle $50.00
2J1F1 GENERATOR: 115—57.5 Volt; 400 cycle. $12.50 ea.
2J1H1 DIFFERENTIAL GENERATOR: 57.5—57.5 Volt; 400 cycle .... $12.50 ea.
2J1G1 CONTROL TRANSFORMER: 57.5—57.5 Volt; 400 cycle .... $7.50 ea.
2J5H1 SELSYN GENERATOR: Mfg. G. E., 115-105 Volts, 60 Cycle $27.50

PANORAMIC ADAPTER
Model AN/APA-10



Provides four types of presentation . . . (a) Panoramic (b) Aural (c) Oscillographic (d) Oscilloscopic. Designed for use with AN/ARR-7, AN/ARR-5, AN/APR-4, SCR-587 or other equipment with I.F. of 455 kc., 5.2 mc or 30 mc. Includes 21 tubes with 3" scope tube.
PRICE $99.50

INVERTERS

10563 LELAND ELECTRIC
Output: 115 VAC; 400 cycle; 3-phase, 115 VA; 75 PF. **Input:** 28.5 VDC; 12 amp $59.50

PIONEER 12117
OUTPUT: 26 volts; 400 cycles; 6 volt amperes, 1-Phase. **INPUT:** 24 VDC; 1 amp .... $25.00 ea.

ALTERNATOR, CARTER
Mfg. Carter Motor Co.; OUTPUT: 7 VAC; 9.7 amp.; 650 cycles, and 295 VDC. 200 amps. INPUT: 26.5 VDC; 10.5 amps; 6500 rpm .... $49.50 ea.

PE 218 LELAND ELECTRIC
Output: 115 VAC; Single Phase; PF 90; 380/500 cycle; 1500 VA. **INPUT:** 25-28 VDC; 92 amps; 8000 RPM; Exc. Volts, 27.5
BRAND NEW .... $39.95 ea.

PE 109 LELAND ELECTRIC
Output: 115 VAC, 400 cyc; single phase; 1.53 amp; 8000 RPM. **Input:** 13.5 VDC; 29 amp $65.00

MG 153 HOLTZER-CABOT
Input: 24 V. DC. 52 amps. **Output:** 115 volts — 400 cycles, 3-phase, 750 VA. and 26 Volt — 400 cycle, 250 VA. Voltage and frequency regulated ..... $95.00 ea.

PIONEER 12130-3-B
Output: 125.5 VAC; 1.5 amps. 400 cycle single phase, 141 VA. **Input:** 20-30 VDC, 18-12 amps. Voltage and frequency regulated $75.00

12116-2-A PIONEER
Output: 115 VAC; 400 cyc.; single phase; 45 amp. **Input:** 24 VDC 5 amp $65.00

10285 LELAND ELECTRIC
Output: 115 Volts AC, 750 V.A., 3 phase, 400 cycle, .90 PF. and 26 volts, 50 amps, single phase, 400 cycle, .40 PF. **Input:** 27.5 VDC, 60 amps, cont. duty, 6000 RPM. Voltage and Frequency regulated $95.00

10486 LELAND ELECTRIC
Output: 115 VAC; 400 Cycle; 3-phase; 175 VA; .80 PF. **Input:** 27.5 DC; 12.5 amp; Cont. Duty. $90.00 ea.

PIONEER 10042-1-A
DC INPUT 14 Volts; **OUTPUT:** 115 Volts; 400 Cycle 1-Phase; 50 Watt $75.00

94-32270-A LELAND ELECTRIC
Output: 115 Volts; 190 VA; Single Phase; 400 Cycle; .90 PF. and 26 Volts; 60 VA; 400 Cycle, .40 PF. **Input:** 27.5 Volts DC 18 amps cont. duty, voltage and freq. regulated $95.00

PIONEER 12147-1
OUTPUT: 115 VAC 400 cycle; Single phase. **INPUT:** 24-30 VDC; 8 amps $79.50

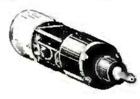
MG 149F HOLTZER CABOT
OUTPUT: 26 VAC @ 250 VA; 115V @ 500VA; Single Phase; 400 cycle. **INPUT:** 24 VDC @ 36 amps. $49.50

EICOR CLASS "A" NO. 1-3012/08-7
OUTPUT: 125 VAC; 400 cycle; single phase; 100 VA. **INPUT:** 24-30 VDC; 11 amps; Duty int. Voltage and Frequency Regulated $99.50

HAZELTINE PULSE GENERATOR
MODEL 1017

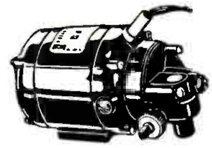
Electrical Characteristics: Pulse Freq: initiating and sliding pulse-external. Pulse Width: initiating and sliding pulses, 10 microseconds. Pulse Amplitude: initiating and sliding pulses, plus 150 volts. Sliding Pulse Delay: variable over full trace length. Sweep Duration: 50, 200, and 1000 microseconds. TUBES: 16-6SJ7; 3-6AG7; 3-6L6; 2-6J5 gt; 2-6SN7 gt; 1-5U4 G; 1-6SK7; 1-6Y6G; 1-991; 1-9002. Power input: 110-125 volts, 60 cyc. single phase; batteries none. Dimensions: 13½" x 20½" x 23". Weight 85 lbs.
PRICE $79.50

ALNICO FIELD MOTORS



(Approx. size overall . . . 3¾" x 1¼" diameter)
DELCO TYPE #5069600: 27.5 volts DC; 250 RPM $15.00
DELCO #5069230: 27.5 VDC; 145 rpm $15.00
PM Motors Delco Type #5069371: 27.5 volts; DC Alnico Field; 10,000 R.P.M.; dimensions 1" x 1" x 2" long; shaft extension ½" diameter 0.125" $8.00

BODINE GEAR HEAD MOTORS



10.1 Gear Ratio: Motor operates: 24 VDC, 2 Amps, 1/50th H.P., 5000 RPM.
NEW $9.95

400 CYCLE MOTORS

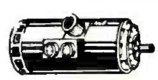
EASTERN AIR DEVICES #133 Synchronous Motor 115 Volt; 400 cycle $17.50
PIONEER: TYPE CK5 2 Phase; 400 cycles $25.00 ea.
EASTERN AIR DEVICES TYPE J49A: 115 V; 0.1A; 7000 r.p.m. Single phase 400 cycle .... $17.50 ea.
AIRESEARCH: 115V; 400 CPS; Single phase 6500 RPM; 1.4 amp; Torque 4.6 in. oz.; HP. .03. $10.00 ea.
EASTERN AIR DEVICES TYPE JM6B: 200 VAC; 1 amp; 3 phase; 400 cycles, 6000 RPM .. $12.50 ea.
EASTERN AIR DEVICES, TYPE J31B: 115 V. 400 1200 Cycle. Single Phase .... $12.50 ea.
AIRESEARCH: AC induction, 200 V; 3 Phase, 400 Cycle, 2 H.P.; 11,000 RPM; 8 amps ..... $79.50 ea.
AIRESEARCH: AC Induction, 200 V; 3 Phase, 400 Cycle, 12 H.P. 6500 RPM; 1.5 amps $25.00
Electric Motor: PNT—1400—A1—1A Serial No. 207, 208 V., 400 Cycles, 3 Phase Kearfott Co., Inc. $17.50 ea.

SERVO MOTOR 10047-2-A; 2 Phase; 400 Cycle, with 40-1 Reduction Gear $17.50

SMALL DC MOTORS

GENERAL ELECTRIC #5BA10AJ18 . . . 27 VDC; RPM 110; 1 oz. FT $12.50
DELCO #5069625 . . . 27 VDC; 120 RPM; Governor controlled $22.50
EMERSON 175: 12 Volt DC; 1/6th HP; 10 amp; 3800 RPM; Approx. size: 2½" x 5" .... $9.95 ea.
DELCO #5068750: 27 VDC; 160 RPM; built-in reduction gears .... $12.50 ea.
J. OSTER: series reversible motor 1/50th H.P.; 10,000 RPM; 27½ VDC; 2 amps; **SPERRY #806069:** approx. size 1⅝" x 3½" .... $7.00 ea.
General Electric Type 5AB10AJ37: 27 volts, DC; 5 amps. 8 oz. inches torque; 250 RPM, shunt wound; 4 leads; reversible $12.50
General Electric. Mod. 5BA10FJ33: 12 oz. inches torque. 12 DC 56 RPM. 1.02 amp .... $15.00 ea.
General Electric Type 5BA10AJ52C: 27 volts DC; 5 amps. 8 oz. inches torque; 145 RPM; shunt wound; 4 leads; reversible $12.50
GENERAL ELECTRIC DC MOTOR Mod. 5BA10AJ-64. 160 r.p.m.; 65 amp; 12-oz.-in. torque 27V DC. $12.50
2¼ H.P. MOTOR—Mfg. LEECE-NEVILLE Co; Type 1454-MO; 24VDC; 4000 RPM; 100 amp $35.00

115 VOLT GENERATORS



Brand new Eclipse generators; 115 VAC; 9.4 amp; 1000 watts; single phase; 800 cycles. 2400-4200 rpm. DC output is 30 volts at 25 amp. Unit has spline drive shaft and is self-excited. $29.95

BLOWER

Eastern Air Devices, Type J31B: 115 volt; 400-1200 Cycle; single phase; variable frequency; continuous duty; L. & R. #2 blower; approx. 22 cu. ft./min. $15.00

BLOWER: Mfg. John Oster; Type C2A-1B; 27 VDC; 63 amps; 1/100 H.P.; 7000 RPM; Series Wound ...... $9.95 ea.

BLOWER ASSEMBLY
115 Volt, 400 Cycle, Westinghouse Type FL. 17CFM, complete with capacitor. New .... $9.95 ea.

TEST EQUIPMENT

TS 13/AP	$650.00
TS 35/UP	495.00
TS 45/APM	195.00
TS 51/APG	95.00
TS 59	69.50
TS 61/AP	69.50
TS 76/APM	79.50
TS 80/U	14.95
I-96-A	195.00
TS 251	650.00
LZ Signal Generator	149.00

Immediate Delivery
ALL EQUIPMENT FULLY GUARANTEED
All prices net FOB Pasadena, Calif.

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INVERTERS

Onan MG-215H. Navy type PU/13. Input 115/230, 60 cy., 1 Ph. Output: 115, 480 cy., 1 Ph., 1.2Kw and 26 V DC at 4 amps. New....$295.00

Onan MG-0-75. Navy type PU/11 Input 115/230, 60 cy., 1 Ph., Output: 115, 480 cy., 1 Ph., 5.3 amps. and 26 VDC @ 3.8 Amps. New....$225.00

Leland Elec. Co. PE206A. Input: 28DC at 38 Amps. Output, 80V, 800 cy., 1 Ph., 485W. New....$22.50

PE218H. Input: 28DC. Output: 115, 400 cy., 1 Ph., 1.5KVA. New....$32.50

G.E. 5AS131551IA. Input: 28DC. Output: 115, 400 cy., 1 Ph., 1.5 KVA. Regulated. New....$89.50

Elcor. 32VDC to 110AC. 60 cy., 1 Ph. at 2.4 Amps. New....$39.50

DYNAMOTORS

Navy type CAJO-211444. Input: 105 to 130VDC. Output: either 26VDC at 20 amps. or 13VDC at 40 amps. Radio filtered and complete with line switch. New....$89.50

Type PE94CM. For SCR-522. Brand new in overseas cases. Has wide band input and output filters....$19.50

AMPLIDYNES

5AM21JJ7. Input 27 VDC @ 15 A. Output 60 VDC @ 2.5A 4600 RPM. New....$34.50

5AM31NJ9A. Input 27 VDC @ 44 A. Output 60 VDC @ 8.8 A., 7500 RPM. New....$23.50

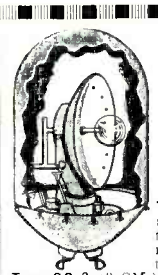
5AM31NJ18A. Input 27 VDC @ 44 A. Output 60 VDC @ 8.8 A., 8300 RPM. New....$12.50

SMALL DC MOTORS

G.E. 5BA50LJ2A. Armature 60VDC at 8.3 Amps. Field 27.5VDC at 2.3A RPM 4000. H.P. 0.5. New....$27.50

Oster E-7-5. 27.5DC. 1/20 HP, 3600 RPM Shunt Wound. New....$9.50

Dumore Co. type ELBG. 24 VDC, 40-1 gear ratio. For type B-4 Intervalometer. New....$3.75



RADAR ANTENNAS

TYPE SO-13 ILLUSTRATED

Type SO-1 (10CM) assembly with 24" reflector, waveguide nozzle and drive motor. New....$279.50

Type SO-3 (3 CM.) Surface Search type with reflector and drive motor, but less plumbing. New in original cases....$99.50

Type SO-13. (10CM.) Complete assembly with 24" dish, dipole, drive motor and gearing. New....$89.50

RADAR SETS

MODEL SQ. Portable radar set, 10CM. Operates on 90-130 volt. 60 cy., 1 Ph. "A", "B", and "PPI" presentation. Complete with tech manual and full set of operating spare parts. Used but in good condition....$749.50

MODEL ASG-1 Radar unit consisting of transmitter and converter assembly CPR-43ABC, Antenna Assembly CRP-ACZ, Mouting Base CPR-10ABE, etc. New in original case....$279.50

SCR-545A RADAR

Removed from trailer. Includes: Azimuth and Elevation Control Units; 214A and 154A Indicators; Input and Output Servo Amplifiers; Three BC-1035A Scopes; Power Panel and RA-65A Power Supply; Range Cont. Unit; Range Converter; Search Rec. and Cont. Unit; Search Trans; Track Rec. and Control Unit; Track Trans; Range Unit; Auto. Controller; no Antenna included. In good condition. A terrific value at $1375.00

Only one set available.

REPAIR PARTS For BC 348

MODELS H, K, L, R, ONLY

Main Tuning Capacitor	$ 4.50
1st I-F Transformer Assembly	2.00
2nd I-F Transformer Assembly	2.00
3rd I-F Transformer Assembly	2.00
4th I-F Transformer Assembly	2.00
Crystal Filter Assembly	6.50
C. W. Oscillator Assembly	2.00
915 kc Crystal mounted	2.75
Antenna Unit Assembly	12.50
R. F. Unit Assembly	12.50
Resistor: Volume Control	2.75
Knob for Main Tuning Condenser	.50
Band #1 Coils—per set of 6	3.60
Band #2 Coils—per set of 4	2.00
Band #3 Coils—per set of 4	2.00
Band #4 Coils—per set of 4	2.00
Band #5 Coils—per set of 4	2.00
Band #6 Coils—per set of 4	2.00

G. E. SERVO AMPLIFIERS

Used in B29 planes for Central Station Fire Control Systems B2, B3 and B4. Used to drive Amplidyne 5AM31NJ9A and Control Motor 5BA50LJ2A listed in 1st column. New less tubes....$29.50

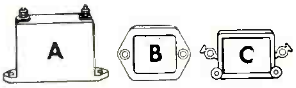
9 CONDUCTOR CABLE

Army spec. CO-215 Weatherproof 9 Cond. No. 20 AWG stranded tinned copper, plastic ins., color coded, double vinyl jackets with tinned copper braid between. Dia. 9/16" made by G.E. Available 1000, 1500, 2000 ft. reels....Price $.15 ft.

SCR-522 EQUIPMENT

Complete BC-624C receivers and BC-625AM Transmitters including mounting racks, plugs, connectors, dynamotor. Brand new equipment with instruction manuals. Write for full details.

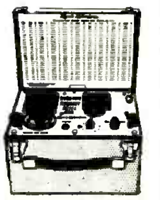
BARGAINS IN TRANSMITTING MICA CAPACITORS



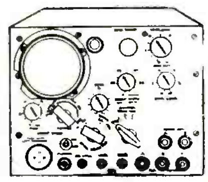
MFD	DCWV	Style	Price
.00003	2000	A	$ .29
.00003	3000	A	.39
.00005	3000	A	.39
.00009	3000	A	.39
.0001	3000	A	.39
.0002	3000	A	.39
.00035	2500	B	.29
.00036	5000	A	1.79
.000375	5000	A	1.79
.0004	2500	B	.29
.0004	3000	A	.39
.0005	3000	A	.39
.00056	5000	A	1.79
.0006	2500	A	.39
.0007	3000	A	.39
.00075	2500	A	.39
.00075	5000	A	1.79
.0008	5000	A	1.79
.001	4500	A	1.79
.002	500	C	.19
.002	3500	A	1.29
.003	2000	A	.29
.003	3000	A	.39
.005	1200	C	.29
.005	2000	A	.39
.006	1200	C	.19
.006	2500	A	.39
.01	600	C	.19
.01	1200	C	.29
.015	1500	A	2.49
.02	600	C	.19
.025	1250	A	1.10
.025	2500	A	1.79
.12	500	A	2.49

High voltage Transmitting types. Thousands in stock. Wide selection of sizes, types and ratings. All new and made by top manufacturers.

FREQUENCY METER 375 to 725 MCS



Model TS-127/U is a compact, self-contained, battery powered, precision (± 1 Mc) frequency meter which provides quick, accurate readings. Requires a standard 1.5V "A" and 45V "B" battery. Has 0-5 Min. time switch. Contains sturdily constructed HI-"Q" resonator with average "Q" of 3000 working directly into detector tube. Uses 957, 1S6 and 3S4 Tubes. Complete new with inst. book, probe and spare kit of tubes. Less batteries.... **$47.50**



PANADAPTER and SCOPE AN/APA-10

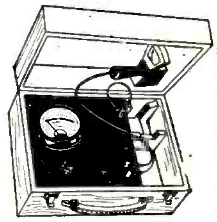
A combined Panoramic Adapter and Oscilloscope. Has 3 coax input connectors for feeding in from receivers having I.F. of 455kc., 5.2 mc or 30mc. Designed also to be used as regular oscilloscope for testing other equipment. Has both vertical and horizontal push-pull amplifier inputs, etc. Complete with 21 tubes including 3" CR scope tube.

For operation on 115V. 400 Cy. Price....$99.50
For operation on 115V. 60 Cy. Price....$145.00

SPECIAL OFFER!

AN/APA-10 TECH, MANUAL. 80 pages. Postpaid in U.S.A....$1.0

FLUXMETER



Used to calibrate field strength of magnets from 500 to 4000 gauss and indicate polarity. Probe has gap of 1¼". Beautifully built in hardwood case with hinged cover. Instructions for operation on under side of cover. Size 12¾ x 9 x 6 in. Ideal for lab and school use. New. An exceptional value at.... **$24.50**

400 CY. BLOWERS

Westinghouse Type FL. 115V, 400 cy., 6,700 RPM. Airflow 17C.F.M. New $3.95

SYNCHROS

Ford Inst. Co. Synchro Differential Generator. Mod. 3 Type 5SDG. 90/90V. 400 cy., Ord. Dr. 173020. New....$6.50

Armor. Synchro Differential Generator. Type 6DG. New....$29.50

Hobart Mfg. Co. Synchro Dif. Generator Type X1X 115V, 60 Cy. New $4.95

5F, 5G, 5CT Also in Stock

D.C. SELSYN MOTOR

Step by step type for use with potentiometer in D.C. Selsyn Control Systems. **Bendix**—Type CAL 14810 (MK1 Mod 0). 70 Volts DC input....$4.95

MOTOR GENERATORS

2 KKVA O'Keefe and Merritt. 115DC to 120AC, 50 cy., 1 Ph., Export Crated. New....$125.00

MOTOR GENERATOR. TYPE CGU-2 Unit of U. S. Navy TCK-7 Transmitter Motor: 2 H.P. 230V. D.C., 10 amps. Generator: 1800V. D.C., 0.4 A, 500V. D.C., 0.35A, 115V. D.C., 1.5A, 12 V. D.C., 2A. 3480 R.P.M. Self excited. Brand new including spare armature. $95.00

ALLIS-CHALMERS 230DC to 115AC. 60 cy., 1 Ph., 1.25 KVA....$149.50

FREQUENCY STANDARD

Complete self contained, dual 100/1000 kc crystal, multivibrator and harmonic amplifier. Calibrates with WWV and provides 1000, 100, and 10 kc check points from 100 to 45,000 kc. 115V. 60 cycles. New with instructions. **$23.95**

Radar Repeater Adapters NAVY TYPE CBM-50AFO

A repeater unit for video signals and trigger pulses designed to work in connection with standard Navy radar equipments wherein provision is made for operation of remote P.P.I. sets. This adapter provides four video and trigger pulse lines for operating one or more remote P.P.I. control installations. 115 Volts, 60 cycles A.C. Dimensions are 31½ x 21 x 15 in....New $97.50

HIGH POT TRANSFORMER

Westingohuse. Pri: 115, 60 cy. Sec: 15,-000V C.T., @ .030A, C.T. ungrounded. Excellent for high-potting tests. Size OA 12H x 8½W x 9¼D. Weight 67 lbs. Fully enclosed steel case. Price....$29.50

30-10,000 CYCLE MODULATION TRANSF.

For RCA, Type 250-K Broadcast Transmitter (MI-7242) P to P Primary Imp. 15,000 ohms. Secondary Load 5,030 ohms. Size 11¼x9½x13". Wt. 143 lbs. New....$49.50

60 CYCLE TRANSFORMERS

G. E. Step-Down. 6KVA. Pri: 230/460. Sec: 115/125, 60 cy. Size: 20" x 11" x 9½". Weight 225 lbs. Navy grey finish, integral junction box and mounting brackets....$69.50

Plate Trans. Raytheon. U-5815. Pri: 440/220, 60 cy. 3 phase. Sec: each phase 1310V @ 0.67A test 6000V....$59.50

Plate Trans. Pri: 115V., 60 cy., 1 Ph. Sec: 1470V. C.T. @ 1.2A tested at 5500V. RMS. Raytheon. Size 12¼ x 10 x 10 in. Shipping wt: 150 lbs. New. Price....$27.50

ALTITUDE INDICATOR

Type ID-14A/APN-1. Brand New in original cartons. Special....$2.95

SPECIALS

ATTENUATOR. Daven Type T-800 Circuit: TEE. Imp. 50,000., 0.5 D.B. per step. New....$2.75

CRT Shields for 3" Tube....$2.75

FIRE DETECTOR. Designed for use on aircraft, tanks, armored vehicles. Heating of outside casing as by fire causes inside snap blade switch to close. Good Experimenters item....3 for $1.00

JACK BOX. BC-1366M. Band New $.65

JACK PLUG ASSEMBLY. 787Q. New. 10 for $1.00

PARABOLOIDS. 17½" dia. spun magnesium, 4" deep, 1½ x 1⅝" opening at apex. Per pair....$12.50

SAWTOOTH POTENTIOMETER. Continuous winding, 2 rotating and 2 take-off brushes. GE251X95....$2.75

SOLENOID. 24V DC, 2 lb. pull, ¾" stroke. New....$1.45

SWEEP GENERATOR CAPACITOR. 5/10 mfd., split stator coax type. Hi-speed ball bearings....$1.95

SOUND POWERED CHEST SETS

U. S. Instrument Co. No. A-260 Combination headset and chest microphone. Brand new, including 20 ft. of rubber covered cable and plug....$17.50 each

FIELD TELEPHONES. RM29A Complete with carrying cases and TS-13 handsets. New in original cartons $17.50

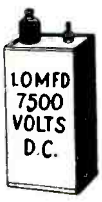
HEADSET ADAPTER. MC-385C Matches hi to lo imp., for HS-33 or 38 phones. New in original cartons....$1.65

TRANSMITTER CAPSULE for TS-13 handset. New in original cartons....$1.75

COMMANDO POLE JACKS. A weatherproof jack and terminal box. Used with EE8 phones in the field. New....$.95

HIGH VOLTAGE OIL CAPACITORS

Mfd.	Volts	Price
.001	50 KV	$22.50
.01	5 KV	2.50
.02	8 KV	4.50
.02	20 KV	9.75
.025	50 KV	34.50
.025-.025	50 KV	34.50
.1	3 KV	1.75
.1-.1	4.5 KV	3.50
.135	7.5 KV	6.95
.2	50 KV	47.50
.25	15 KV	17.50
.25	20 KV	19.50
.25	50 KV	67.50
1.	7.5 KV	6.95
1.	15 KV	47.50
2.	5.5 KV	9.50
2.	6 KV	12.50



SPECIAL **$6.95**

METER SPECIALS

G.E. Type DO-50, 3" Sq. Scale reads 0-3 D.C. Basic Mov. 10 MA. F.S.V.=3. New....Price $2.45

G.E. Type DO-50, 3" Sq. Scale reads 0-3/0.9 V. D.C. Basic Mov. 10 MA. F.S.V.=3. New....Price $2.45

G.E. Type DO-50, 3" Sq. Scale reads 0-80 Amps. D.C. and F.S.V.=.050. New....Price $2.45

G.E. Type DO-50, 3" Sq. Scale reads 0-100 Amps. D.C. and F.S.V.=.050. New....Price....$2.45

TERMS: Rated Concerns Net 30, FOB Bronxville, New York. All Merchandise Guaranteed. Prices Subject to Change.

PHONE: BRONXVILLE 2-0044

ELECTRONICRAFT INC.

Cable Address: Electraft, N.Y.

27 MILBURN ST. BRONXVILLE 8, N. Y.

COMMUNICATIONS EQUIPMENT CO.

MICROWAVE COMPONENTS

10 CM.—RG48/U Waveguide

10 CM ECHO BOX: Tunable from 3200-3333 Mc. For checking out radar transmitters, for spectrum analysis, etc. Complete with pickup antenna and coupling devices. $27.50

10 CM ANTENNA ASSEMBLY: 3000-3300 Mc. Parabolic Dish, 29 inch Diam. Fed from dipole **Rotation:** 360 Deg. Azimuth at speeds of 20 and 10 RPM. **Tilt:** 20 deg. above and below horizontal. Motor-Driven by 2-28V motors, 4.5 A Total Drain. Azimuth info. is fed to selsyn mechanism, and elevation data is obtained from Azimuth potentiometer. Net Weight 65 lbs. $78.50

POWER SPLITTER for use with type 726 or any 10 CM Shepherd Klystron. Energy is fed from Klystron antenna through dual pick-up system to 2 type "N" connectors ....$22.50 EACH

DIRECTIONAL COUPLER. Broadband type "N" output. Coupling, 20 db, with std flanges, Navy CABV47A-AN-2 ....$37.50

LHTR, LIGHTHOUSE ASSEMBLY. Parts of RT39 APG 5 & APG 15, Receiver and Trans. Cavities w/assoc. Tr. Cavity and Type N CPLG, To Recvr. Uses 2C40, 2C43, 1B27, Tunable APX 2400-2700 MCS. Silver Plated $32.50

BEACON LIGHTHOUSE cavity p/o UPN-2 Beacon 10 cm. Mfg. Bernard Rice, each $32.50

MAGNETRON TO WAVEGUIDE Coupler with 721-A Duplexer Cavity, gold plated $45.00

721A TR BOX complete with tube and tuning plungers $12.50

McNALLY KLYSTRON CAVITIES for 707B or 2K28 ....$4.00

WAVEGUIDE to ⅞" Rigid Coax "Doorknor" Adapter Choke Flange Silver Plated Broad Band $32.50

AS14A AP-10 CM Pick up Dipole with "N" Cables $4.50

HOLMDELL-TO-TYPE "N" Male Adapters. W. E. #D167284 ....$2.75

I.F. AMP. STRIP: 30 MC, 30 d.b. gain, 4 MC Bandwidth, uses 6AC7's—less tubes $24.00

BEACON ANTENNA. AS31/APN-7 in Lucite Ball, Type "N" feed $22.50

ANTENNA. AT49A/APR: Broadband Conical, 300-3300 MC Type "N" Feed $12.50

"E" PLANE BENDS, 90 deg. less flanges $7.50

3 CM.—RG 52/U Waveguide

FLEX. WAVEGUIDE SECTION, 1 ft. long. With UG-40/UG-39 flanges. Attenuation is less than 0.1 db. at 9375 mc, and VSWR is less than 1.02. Rubber covered $7.50

3 CM ANTENNA ASSEMBLY: Uses 17" paraboloid dish, operating from 24 vdc motor. Beam pattern: 5 deg. in both Azimuth and elevation. Sector Scan: over 160 deg. at 35 scans per minute Elevation Scan: over 2 deg. Tilt: over 24 deg. $85.00

Cross-Guide Directional Coupler, UG-40 output flange. Main Guide is 6" Long, with 90 Deg. "E" Plane bend at one end, and is fitted with Std. UG 39/UG 40 flanges. Coupling figure: 20 db Nominal $22.50

HORN FEED, Mounted at end of 1' run. Designed to be used with dish reflector $15.00

VSWR Measuring Section. Consisting of 6" straight section, with 2 pick-up, Type "N" Output Jacks, mounted ½ Wave apart $8.50

RG52/U waveguide in 5' lengths, fitted with UG 39 flanges to UG40 cover ....per length $7.50

Rotating-joints supplied either with or without deck mounting. With UG40 flanges ....each, $17.50

Bulkhead Feed-thru Assembly $15.00

Pressure Gauge Section with 15 lb. gauge $10.00

Directional Coupler, UG-40/U Take off 20db $17.50

TR-ATR Duplexer section for above $8.50

Rotary joint choke to choke with deck mounting $17.50

90 degree elbows. "E" plane 2½" radius $12.50

Microwave Receiver, 3 CM. Sensitivity: 10-13μ Watts. Complete with L.O. and AFC Mixer and Waveguide Input Circuits, 6 I.F. Stages give approximately 120 DV gain at a bandwidth of 1.7 MC. Video Bandwidth: 2 MC. Uses latest type AFC circuit. Complete with all tubes, including 723A/B Local Oscillator $175.00

ADAPTER, waveguide to type "N", UG 81/U. p/o TS 12, TS-13, Etc $14.50

ADAPTER, UG-163/U round cover to special btl. Flange for TS-45, etc ....$2.50 ea.

3CM Motor-Driven Echo Box

Cavity Q is 30,000. Tuning range 80 mc Motor operates from 24 VDC Type, "N" INPUT $32.50

K Band—½" x ¼" W.G.

Right Angle Bend E or H Plane, specify combination of couplings desired $12.00

45° Bend E or H Plane, choke to cover $12.00

Mitered Elbow, cover to cover $4.00

TR-ATR-Section. Choke to cover $4.00

Flexible Section 1" choke to choke $5.00

"S" Curve Choke to cover $4.50

Adapter, round to square cover $5.00

Feedback to Parabola Horn with pressurized window for APS-34 ....$27.50

MAGNETRONS

Type	Freq. Range (MC)	Peak Power Out (KW)	Duty Ratio	Price
2J21A	3345–9405	50		$8.75
2J22	3267–3333	265		7.50
2J26	2992–3019	275	.002	7.49
2J27	2965–2992	275	.002	19.95
2J29	2914–2939	275	.002	44.95
2J31	2820–2860	285	.002	24.50
2J32	2780–2820	285	.002	28.50
2J38*	3249–3263	5		16.50
2J39*	3267–3333	8.7		24.50
2J48	9310–9320	50	.001	24.50
2J49	9000–9160	50	.001	59.50
2J56*	9215–9275	50	.001	132.50
2J61†	3000–3100	35	.002	34.50
2J62†	2914–3010	35	.002	34.50
3J31	24–27KMC	50	.001	85.00
4J34	2740–2780	900		125.00
4J42†	670–730	30	.003	169.50
5J23	1044–1056	475	.001	49.00
700B	690–700	40	.002	22.50
700D	710–720	40	.002	39.75
706EY	3038–3069	200	.001	32.50
706CY	2976–3007	200	.001	32.50
725-A	9345–9405	50	.001	Write
730-A	9345–9405	50	.001	24.50
4J38	3550–3600	750	.001	169.45

*—Packaged with magnet.
†—Tunable over indicated range.

KLYSTRONS

723A	$12.50	2K25/723A/B	$27.50
723A/B	19.50	417-A	17.50

70 WATT MAGNETRONS

These tubes provide a simple, rugged, inexpensive source of C.W. energy. An inexpensive power supply is all that's required.

CHARACTERISTICS:

Heater: 6.3 V, 3.8 A.	Power out: 70 W. Cw
Anode V. 1250 V.	Anode current: 125 ma.
Pk. Input: 200 Watts	Av. input: 100 W

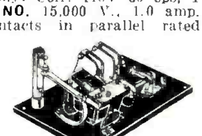
Each tube is packaged with an integral magnet, and is tunable over the range shown below.

TYPE	RANGE (MC.)	TYPE	RANGE (MC.)
QK 60	2840-3005	QK 61	2975-3170
QK 62	3135-3330		

Price $85 ea.

15 KV CONTACTOR

Rugged contactor assembly: Coil: 115V 60 cps, 1 phase Contacts: **SPST NO.** 15,000 V., 1.0 amp. plus- **2-SPST NO** contacts in parallel rated 100 amp per contact. Contactor has 2 auxiliary contact assy's. For operating accessory pilot equipment Equipped with flash barriers. Size 19" x 14" x Overall



$37.50

VARISTORS

D-167208	$1.35	D-171812	$1.63
D-171858	$1.42	D-172155	$1.50
D-168687	$1.35	D-167176	$1.25

THERMISTORS

D-164699 Bead Type DCR: 1525-2550 Ohms @ 75 Deg. F. Coefficient: 2% Per. Deg. Fahr. Max. Current 25 MA AC/DC $2.50

D-167332 Bead Type. DCR is 1525-2550 Ohms. Rated 25 MA at .825-1.175 VDC $1.35

D-167613 Disk Type DCR: 355 Ohms @ 75 Deg. F.P.M. 2.5%. 1 Watt $1.35

D-166228 Disk Type 7120 Ohms @ 60°F. 4220 Ohms @ 80°F. 2590 Ohms @ 100°F., 1640 Ohms @ 120°F $1.35

—IN STOCK—

AIA	APS-4	APT-4	SJ-1
APA-9	APS-6	MKIV	TAJ
APA-10	ASD	MKX	TBK
APN-3	ASH	RC145	TBL
APN-7	BG	RC148	SCR520*
APN-9*	DAS†	SO-1	SCR521
APS-2	DBS†	SO-8	SCR518
APS-3	APT-2	SG-1	

* COMPONENTS. † LORAN EQUIPMENT

—TEST SETS—

TS-10	TS-12	TS-159
TS-36	TS-56	TS-268
TS-47	TS-34	TS-270

JAN WAVEGUIDE FLANGES

UG 39/U	$1.10	UG 51/U	$1.65
UG 40/U	$1.25	UG 52/U	$3.40
UG 40A/U	$1.65	UG 52A/U	$3.40

MICROWAVE ANTENNAS

AT49/APR—Broadband Conical. 300-3300 MC. Type N Feed $8.95

AS-31/APN-7: 10cm Polyrod in Lucite Ball. Type N Fitting Coax Feed $22.50

Relay System Parabolic reflectors approx. range 2000 to 6000 Mc. Dimensions 4½" x 3'. New $100.00

Dipole for above $12.00

Cone Antenna. AS 125 APR. 1000-3200 mc. Stub supported with type "N" connector $14.50

AS14A/AP. 10 CM pick up dipole assy, complete w/length of coax and "N" connectors $4.50

AS46A/APG-4 Yagi Antenna, 5 element array $22.50

30" Parabolic Reflector Spun Aluminum dish $4.85

APS-34 Pillbox Antenna, waveguide input: 24,000-27,000 MC $22.50

SCR 584, Dishes Perforated, Metal Construction $185.00

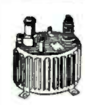
PULSE TRANSFORMERS

Westinghouse 4P37: Primary: 50 ohms imp, 750 v. Sec. 15 kv, 1000 ohms imp. Bifilar filament trans. built in, delivers 12.6 v at 2.5 amp. (pri. 115 v. 400 cy.) $37.50

RAYTHEON WX 4298E: Primary 4KV., 1.0 USEC. SEC: 16KV-16 AMP DUTY RATIO: .001 400 CYCLE FIL. TRANS. "BUILT-IN" $42.50

WECO: KS 9948: Primary 700 ohms: Sec. 50 ohms. Plate Voltage: 18 KV, Part of APQ-13 ....$12.50

GE #K-2449A



Primary: 9.33 KV, 50 ohms Imp.
Secondary: 28 KV, 450 ohms.
Pulse length: 1.0/5 usec @ 635/120 PPS. Pk Power Out: 1,740 KW
Bifilar: 1.5 amps (as shown) ..$62.50

GE #K2748-A. 0.5 usec @ 2000 Pps. Pk. Pwr. out is 32 KW impedance 40:100 ohm output. Pri. volts 2.3 KV Pk. Sec. volts 11.5 KV Pk. Bifilar rated at 1.3 Amp. Fitted with magnetron well $39.50

K-2745 Primary: 3.1/2.8 KV, 50 ohms Z. Secondary: 14/12.6 KV 1025 ohms Z. Pulse Length: 0.25/1.0 usec @ 600/600 PPS. Pk. Power 200/150 KW. Bifilar: 1.3 Amp. Has "built-in" magnetron well $42.50

K-2461-A. Primary: 3.1/2.6 KV—50 ohms (line). Secondary 14/11.5 KV—1000 ohms Z. Pulse Length: 1 usec @ 600 PPS. Pk. Power Out: 200/130 KW. Bifilar: 1.3 Amp. Fitted with magnetron well $39.75

UTAH X-151T-1: Dual Transformer. 2 Wdgs. per section 1:1 Ratio per sec 13 MH inductance 30 ohms DCR $7.50

UTAH X-150T-1: Two sections, 3 Wdgs. per section. 1:1:1 Ratio. 3 MH. 6 ohms DCR per Wdg $7.50

68G711: Ratio: 4:1 Pri: 200V, Sec. 53V, 1.0 usec Pulse @ 2000 PPS, 0.016 KVA $4.50

TR1049 Ratio 2:1 Pri. 220 MH, 50 Ohms. sec. 0.75 H. DCR 100 Ohms $6.75

K-904695-501: Ratio 1:1, Pri. Imp. 40 Ohm, Sec. Imp. 40 Ohms. Passes pulse 0.6 usec with 0.05 usec rise $8.95

Ray UX 7896—Pulse Output Pri, 5v sec. 41v $7.50

Ray UX 8442—Pulse inversion—40v + 40v $7.50

PHILCO 352-7250, 352-7251, 352-7287

RAYTHEON: UX8693, UX5986 ....$5 ea.

W.E.: D-166310, D-166638, KS9800, KS9948.

UTAH #9262, with Cracked Beads, but will operate at full rated capacity $5.00

UX 8693 (SCS #2Z9627-54): 3 Wdgs. 32 turns #18 wire. DCR is: 362/.372/.4 ohms. Total voltage 2500 vdc $5.00

D-166173: Input: 50 ohms Z. Output: 900 ohms 3 Wdgs. Freq. range 10 kc-2mc. P/0 AN/APQ*-13 ....$12.50

K-2450: Pulse-inversion auto-transformer: primary 13 kv, 4 usec. Output: 14 kv @ 100 kw peak $34.50

PULSE NETWORKS

15A—1-400-50: 15 KV, "A" CKT. 1 microsec. 400 PPS. 50 ohms imp $37.50

G.E. #3E (3-84-810) (8-2.24-405) 50P4T; 3KV "E" CKT Dual Unit: Unit 1, 3 sections, 0.84 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. 67 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

7-5E3-3-200-67P, 7.5 KV, "E" Circuit, 3 microsec. 200 PPS. ohms imp. 3 sections $12.50

H-616, Sprague 10KV. 2.2 usec., 375 PPS. 50 ohms imp. Philco #358-2755 ....$27.50

H-615, Sprague 10KV: 0.85 usec., 750 PPS. 50 ohms. imp. Philco #358-2754 ....$27.50

#754: 10KV, 0.85 usec., 750 PPS. 50 ohms imp ..$27.50

KS8865 CHARGING CHOKE: 115-150 H @ .02A, 32—40H @ .08A, 30,700V Corona Test. 21KV Test $37.50

G.E. 25E5-1-350-50 P2T, "E" CKT. 1 Microsec. Pulse @ 350 PPS, 50 OHMS Impedance $69.50

G.E. 6E3-.5-2000 50 P2T: 6 KV., "E" Circuit 0.5 usec /2000 PPS/50 ohms/2 sections $7.50

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: 1-71B, 1-89-B, 3-'72's, 1-'73. New ....Less Cover—$135

ASD Modulator Units, mfd. by Sperry. Hard tube pulser delivers Pk. pulse of 144 kw. Similar to Mod 3 unit. Brand new, less tubes $85.00

Airborne RF head, model AIA, delivers 50 Kw peak output at 9000 mc, at .001 duty. Complete with pulser unit and all tubes. Used, excell $185.00

MAIL ORDERS PROMPTLY FILLED. ALL PRICES F.O.B. NEW YORK CITY. 25% DEPOSIT WITH ORDER. BALANCE C.O.D. RATED CONCERNS SEND P. O.

131 Liberty St., New York 7, N. Y. Dept E-6 Chas. Rosen Phone: Digby 9-4124

POWER TRANSFORMERS

COMB. TRANSFORMERS 115V/50-60 CPS INPUT

CT-479 7000V/.018A (2 X Ind. V. Test) 2.5V 5A/17.800 V. Test $37.50
CT-138 520-0-520V/500MA, 6.3V/3A, 6.3V/17A, 2 X 5V/3A 14.75
CT-013 450-0-450V @ 200MA, 10V/1.5A, 2.5V 3.5A 5V/3A 6.95
CT-341 1050V/10MA—625V @ 5MA, 26V @ 4.5A 2x2.5V/3A, 6.3V @ 3A 9.95
CT-403 350VCT .026 A 5V/3A 2.75
CT-931 585VCT .086 A 5V/3A, 6.3V/6A .. 4.25
CT-442 525VCT 75 MA 5V/2A, 1CT/2A, 50V/200 MA ... 3.85

FILAMENT TRANSFORMERS 115V/50-60 CPS INPUT

Item	Rating	Each
FT-140	5VCT @ 10A 25KV Test	$22.50
FT-157	4V/16A, 2.5V/2.75A	2.95
FT-101	6V/.25A	.79
FT-924	5.25A/21A, 2x7.75V/6.5A	14.95
FT-824	2x26V/2.5A, 16V/1A, 7.2V/7A, 6.4V/10A 6.4V/2A	8.95
FT-463	6.3VCT/1A, 5VCT/3A, 5VCT/3A	5.49
FT-55-2	7.2V/21.5A, 6.5V/6.85A, 5V/6A, 5V/3A	8.95
FT-38A	6.3/2.5A, 2x2.5V/7A	2.79
FT-650	2.5V/10A-3KV TEST LO-CAP	7.50

PLATE TRANSFORMERS, 115V/60 CY INPUT

PT 175 550-0-550VAC (400VDC) @ 150MA .. $6.30
PT 157 660-0-660 VAC (500VDC) or 550-0-550 VAC (400VDC) at 250 MADC 8.70
PT 158 1080-0-1080V (1000VDC) at 125MA Plus 500-0-500VAC (400VDC) at 150MADC Simult. Ratings 10.80
PT 159 900-0-900 VAC (750VDC) or 800-0-800 VAC (600VDC) at 225 MADC .. 10.35
PT 167 1400-0-1400 VAC (300MADC) or 1175-0-1175 VAC (1000VDC) at 300MADC 25.50
PT 168 2100-0-2100 VAC (1750VDC) or 1800-0-1800 VAC (1500VDC) at 300 MADC 33.00
PT 371 210-0-210V at 2.12 Amp 9.45
PT 133 3140/1570V, 2.36 KVA $105.00
PT 801 22,000V/234 MA., 5.35 KVA, "Lo-Cap" Donut $135.00
PT 521 7500V/.06A, Half-Wave $85.00
PT 579 3100-0-3100V/2KVA, 15KV.INS. C. T. Grounded (case) $135.00

GE #M-7470689 Input: 115 V, 60 Cycle, Single Phase
1 WDG 3700 V Tapped at 710V
1 WDG 1700V Primary Rated .0377KVA
Lo-Cap Donut Construction **$24.75**

FILTER CHOKES

Stock	Description	Price
CH-187	Swing, 4-16H, 150MA, 210 ohms, 3KV Test	$3.90
CH-189	Swing, 4-16H, 250MA, 125 ohms, 3KV Test	6.60
CH-190	Swing, 3-14H, 300MA, 80 ohms, 3KV Test	6.90
CH-CEC117:	9-60H/.05-400MA, 10KV Test	14.95
CH-366	20H/.3A	6.95
CH-322	.35H/350MA—10 Ohms DCR	2.75
CH-141	Dual 7H/75 MA, 11H/60 MA	4.69
CH-119	8.5H/125 MA	2.79
CH-69-1	Dual 120H/17 MA	2.35
CH-8-35	2/.5H/380 MA/25 Ohms	1.79
CH-776	1.28H/130 MA/75 ohms	2.25
CH-344	1.5H/145MA/1200V Test	2.35
CH-43A	10HY/15MA—850 ohms DCR	1.75
CH-366	20H/300MA	6.95
CH-999	15HY/15MA—400 ohms DCR	1.95
CH-445	0.5 HY/200 MA, 32.2 OHMS, 3000 V.T.	1.39
CH-914	12 HY-250 MA SCS 3C1987-14	3.69
CH-533	13.5H, 1.0 AMP DC, 13.5 KV INS	29.95

DYNAMOTORS

TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT AMPS	Price
DM 416	14	6.2	330	.170	$6.75
DM33A	28	7	540	.250	3.95
BD AR 93	28	3.25	375	.150	7.50
23350	27	1.75	285	.075	3.95
B-19 Pack	12	9.4	275	.110	8.95
			500	.050	
DA-3A*	28	10	300	.260	6.95
			150	.010	
			14.5	5.	
PE 73 CM	28	19	.1000	.350	22.50
BD 69‡	14	2.8	220	.08	12.95
D-402†	13.5	12.2	300	.200	
			8.8VAC		12.50
SP 175	18	3.2	450	.06	4.49
DM 25†	12	2.3	250	.0	6.95

‡ Less Filter. * Replacement for PE 94.
† Used, Excellent.
PE 94-C, Brand New 6.95

INVERTERS

800-1B Input 24 vdc, 62 A. Output: 115 V, 800 cy. 7A, 1 phase. Used, excellent $18.75
PE-218H: Input: 25/28 vdc, 92 amp. Output: 115V. 350/500 cy 1500 Volt-ampere. NEW $37.50
PE-286: Input: 28 vdc, 36 amps. Output: 80 v 800 cy, 500 volt-amps. Dim: 13" x 5½ x 10½" New $22.50
NAVY COR-211095: Input 22-30 VDC/75-60A. OUTPUT: 115V/400 CY. 1 KVA/8.7A. RPM: 4800 with coupling provision for Spark Gap. Brand New. Original packing $150.00
ALTERNATOR: Belt-Driven, Output 80V/600 Watts/1200 CPS $49.50

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TS-35A/AP—(LATE MODEL) X-BAND SIGNAL GENERATOR AND POWER METER—Input 115/1/50-1200 CPS. Generates and measures RF power. Produces (CW or pulsed, int. or ext. synchronized) signal of known frequency and power. Generates FM signal for trouble shooting radar.
NEW—$475.00

SN—RADAR—10 cm—Compact, light and portable, ranges of 5 and 20 miles. Uses 5CPI scope. Operation is from 115 volts, 60 cycle, but we can supply converter for dc operation. **$850.00 ea**

ANTENNA ASSEMBLY—10 cm Radar—Reflector is a lightweight parabolic cylinder, Ass'y has both manual and motor drive. Ideal unit for labs, classroom demonstration, small craft, etc. **$99.50 ea**

MAG—10 cm. remarkable link radar, portable, operated from 6 volt battery, uses folding antenna and tripod. A pair at **$1,750.00**

APS-3—3 cm—Airborne radar for search and homing, 5-in. scope. 10 brand new sets at **$750.00 ea**

APQ-13—Very late model airborne radar set, complete and new. One only at **$2,950.00**

SCR-545—Complete radar set, less vehicle, antenna and power plant, pretty fair condition, sold as-is at **$1,375.00**

MOTOR GENERATORS CONVERTERS • INVERTERS DYNAMOTORS

We Have One of the Largest Stocks of Electrical Conversion Equipment in the East, including All Types of Rotating Machinery and a Variety of DC and AC Magnetic Starters and Controllers from 100 Watts to 100 Kilowatts

MOTOR GENERATOR, in 115 vac, out 220-250 vdc, @ ½ KVA **$65.00**
ESCO ROTARY CONVERTERS — Mounted in Steel Drip-Proof Boxes—Type R-1-41. Filtered **Input** 110 volts, 2.5 amps, 3600 rpm. **Output** 110/1/60 @ 1.8 amps, 200 watts **$45.00**
ESCO MOTOR GENERATORS—Dual unit (a) **Input** 32 v dc @ 8 amp. **Output** 110/1/60 @ 1.5 amps, 165 va 150w, 1800 rpm. (b) **Input** 32 volts dc @ 16 amps. **Output** 260 volts, 1500 cycles @ 4 amps. Rating 1.05 kva, 3.000 rpm. Filtered. These two units are mtd. together on bed plate, complete with control panel containing switch & 0-50 v dc meter. **$32.50** ea. part.
MOTOR - GENERATOR - ALTERNATOR—Mfgr.—Quality Electric Co. Ltd. **Input** 115/1/60 ac @ 22.5 amps, 1800 rpm. **Outputs:** #1.500/1000 v dc, 0.25/0.3 amp., 0.125/0.3 kw #2 150 v dc, 0.667 amp., 0.1 kw. #3. 115 v ac 0.87 amp., 3000 cycles. 0.1 kva. PF-1. **$245.00**

ESCO CONVERTER—Input 110 volts dc. **output** 110 volts ac @ 1.2 amps. Brand new. **$35.00**

ALLIS CHALMERS CONVERTER 110 volts dc to 110 volts ac @ 1.25 kva output .. **$165.00**
PINCOR ROTARY CONVERTER — **Input** 110 volts dc. **Output** 220/1/60, 0.300 kva: .90 pf; 3000 rpm; cont. duty; 40°C. Filtered for Radio use **$60.00**

CONTINENTAL MOTOR - GENERATOR — 350 watts. Type CC-21991—Wt. 148 lbs. **Input** 115 volts dc @ 5.7 amps, 0.625 hp. **Output** 115 volts ac, 1 ph., 60 cycles @ 3.04 amps, 1800 rpm, 0.85 pf, 40°C temp. rise, sep, excited. Filtered **$95.00**

WESTINGHOUSE ELECTRIC GENERATOR — 10 KVA—AC. **Output** 115/1/60 @ 108.5 amps; .80 pf; 50°C; cont. duty 1800 fpm, sep. excited, 125 dc. DC generator **Output** 125 volts dc @ 8 amps. This generator is mounted on bed plate with room for motor mounting. It can be driven by any mechanically coupled motor, dc or ac or other drive **$459.00**

MOTOR GENERATOR 800-1D — **Input** 24-28 volts dc, **Output** 115 v, 800 cycles at 10.5 amps. Small and compact **$29.50**
M-209—Holtzer-Cabot—Filtered. **Input** 115/1/60. **Output** 115 volts, 3ϕ, 233 cycles; at 0.4 amps and **24 volts dc** at 6.5 amps. 3500 rpm. **$125.00**

MG-149—Holtzer-Cabot Inverter **$49.50**
2J1F1 SELSYN—115-57.5v. 400 cycles **$4.45**
SF, SG—SYNCHRO—115 v, 60 cycles **$39.50**

POWER UNIT TYPE 23 — Rotary transformer, filtered. **Input** 24 vdc. **Output** 6.3 volts at 2 amps and 200 volts at 30 ma **$19.50**
And, of course, PE-73, PE-94, PE-98, BM-25, -28, -32, -33, etc.

SA-2-RADAR. Used for air traffic control, tracking and search, both land-based and ship-borne. 5 microsec. pulse., PPI indication, operates at 200mcs, peak power of 150 KW. Input 110/120 volts a.c. 4 complete installations in stock.

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200 Sets MN-28
200 Sets SCR-269
200 Sets SCR-284
30 Sets TCS
200 Sets BD-71, 72 Switchboards
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Your choice of frequencies!
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FT-243 HOLDER

Lots of 10 or more. Each 69c
Lots of 5 or more. Each 79c
Individually, Each 99c

1015	2135	2480	2630	2775	2940	3085	3230	6073	6405	7140	7590	7860	8066
1110	2140	2485	2635	2780	2945	3090	3235	6075	6406	7150	7600	7870	8070
1129	2145	2490	2640	2785	2950	3095	3240	6100	6425	7173	7610	7800	8073
1150	2155	2495	2645	2790	2955	3100	3290	6106	6440	7175	7620	7890	8075
1195	2165	2505	2650	2795	2960	3105	3300	6125	6450	7200	7630	7891.7	8083
1525	2175	2510	2655	2815	2965	3110	3310	6140	6473	7206	7640	7900	8100
1900	2180	2515	2660	2825	2970	3115	3320	6142	6475	7225	7650	7910	8108
1915	2195	2520	2665	2830	2975	3120	3340	6150	6500	7240	7660	7920	8110
1930	2300	2525		2835	2980	3125	3410	6173	6506	7273	7666.7	7930	8116
1940	2305	2530	2675	2840	2985	3130	3420	6175	6525	7275	7670	7940	8125
1950	2320	2535	2680	2845	2990	3135	3455	6185	6540	7300	7680	7950	8130
1965	2350	2545	2685	2850	2995	3140	3465	6200	6550	7306	7690	7960	8133
1977	2355	2550	2690	2855		3145	3510	6206	6573	7325	7700	7970	8140
1980	2360	2557	2695	2860	3005	3150	3525	6225	6575	7340	7710	7980	8141
1985	2365	2560	2700	2865	3010	3155	3550	6235	6600	7350	7720	7990	8150
2010	2370	2565	2705	2870	3015	3160	3655	6240	6606	7375	7730	8000	8160
2015	2375	2570	2710	2875	3020	3165	3700	6250	6625	7400	7740	8006	8163.4
2017	2390	2575	2715	2880	3025	3170	3825	6273	6640	7406	7750	8008	8166
2020	2415	2580	2720	2885	3030	3175	3885	6275	6650	7425	7760	8010	8170
2025	2430	2585	2725	2890	3035	3180	3940	6300	7000	7440	7770	8016	8173
2035	2435	2590	2730	2895	3040	3185	3955	6306	7006	7500	7780	8020	8180
2040	2440	2595	2735	2900	3045	3190	3980	6315	7025	7510	7783.3	8025	8183
	2442	2600	2740	2905	3050	3195	3990	6325	7040	7520	7790	8030	8190
2060	2450	2603	2745	2910	3055	3200	6000	6335	7050	7530	7800	8033	8191
2065	2455	2605	2750	2915	3060	3202	6006	6340	7073	7540	7810	8040	8200
2090	2460	2610	2755	2920	3065	3205	6025	6350	7075	7550	7820	8041	8206
2105	2465	2615	2760	2925	3070	3210	6040	6362	7100	7560	7830	8050	8208
2125	2470	2620	2765	2930	3075	3220	6042	6373	7106	7570	7840	8058	8220
2130	2475	2625	2770	2935	3080	3225	6050	6375	7125	7580	7850	8060	8225

FT-243 HOLDER

Lots of 10 or more. Each 34c
Lots of 5 or more. Each 39c
Individually. Each 49c

4035	4300	4635	4930	5295	5645	5782.5	5906.7	6275	6706.6	6906.6	7625	7975	8475
4045	4330	4680	4950	5300	5660	5800	5907.5	6300	6725	6925	7673.3	8240	8500
4080	4340	4695	4980	5305	5675	5806.7	5925	6306	6740	6940	7675	8250	8525
4095	4395	4710	4995	5327.5	5687.5	5820	5940	6325	6750	6950	7706.6	8273	8550
4110	4397.5	4735	5030	5335	5700	5825	5950	6340	6773.3	6973.3	7725	8275	8575
4135	4445	4780	5035	5385	5706.7	5840	5955	6350	6775	6975	7773.3	8300	8600
4165	4450	4785	5090	5397.5	5725	5850	5973.3	6373.3	6800	7450	7775	8306	8625
4175	4490	4815	5127.5	5435	5730	5852.5	5975	6375	6806.6	7473.3	7806.6	8325	8650
4190	4495	4820	5165	5437.5	5740	5860	5995	6400	6825	7475	7825	8340	8675
4215	4535	4840	5180	5485	5750	5873.5	6206.6	6406.6	6840	7506.6	7873.3	8350	8690
4220	4540	4845	5205	5500	5760	5875	6225	6425	6850	7525	7875	8375	
4255	4580	4852.5	5235	5545	5773.3	5880	6240	6673.3	6873.3	7573.3	7906.6	8400	
4280	4510	4880	5245	5582.5	5775	5892.5	6250	6675	6875	7575	7925	8425	
4295	4620	4900	5285	5587.5	5780	5900	6273.5	6700	6900	7506.6	7973.3	8450	

DC-34 & DC-35 CRYSTALS
Your Choice. Ea. only 99c

			2220	2390	2586	2776	3023	3317	3610	3770	3935	4085	4255
			2235	2395	2587	2807	3027.5	3365	3630	3775	3940	4090	4275
			2240	2415	2605	2816	3055	3385	3650	3790	3950	4095	4280
			2255	2422	2625	2831	3077.5	3390	3655	3792.5	3960	4097.5	4305
			2258	2435		2851	3095	3395	3665	3807.5	3965	4115	4310
1690	1890	2000	2275	2446	2643	2853	3117	3412.5	3680	3825	3985	4130	4325
1705	1910	2105	2280	2466	2665	2894	3149	3422.5	3695	3830	3995	4135	4335
1720	1930	2106	2295	2467	.....	2895	3155	3462	3700	3850	4012.5	4150	4345
1738	1950	2131	2300	2478	2685	2899	3161	3480		3855	4015	4155	4350
1746	1970		2315	2491	2710	2925	3190	3485		3870	4020	4175	4370
1770	1990	2155	2326	2500	2711	2926	3201	3500		3885	4030	4177.5	4380
1790	2010		2335	2510	2725	2960	3270	3520		3890	4035	4192.5	4397.5
1810	2030	2175	2340	2415	2732	2971	3279	3540		3895	4050	4210	4415
1830	2050	2195	2355	2527	2745	2980	3280	3550	3750	3905	4055	4215	4435
1850	2075	2202	2360	2540	2764	3000	3297	3575	3760	3920	4065	4235	4440
1870	2082	2215	2375	2559	2775	3010	3311	3580	3765	3925	4080	4240	

FT-171 HOLDER

Lots of 10 or more, Each .... .79¢
Lots of 5 or more. Each .... .89¢
Individually. Each .... .99¢

			2123	2280	2415	2582	3010	3422.5	3660	3812.5	3980	4245	5225
			2125	2282.5	2435	2630	3010.5	3500	3667.5	3825	3995	4255	5492.5
			2131	2290	2442.5	2665	3175	3510	3682.5	3870	4012.5	4280	6000
			2145	2300	2467	2725	3202.5	3520	3695	3880	4037.5	4310	6210
			2150	2305	2470	2780	3205.5	3550	3700	3945	4050	4345	7165
			2155	2320	2500	2835	3215	3562	3712.5	3950	4080	4350	7950
1151.8	1940	2045	2191	2340	2532.5	2911	3237.5	3569	3760	3955	4097.5	4360	8000
1562.5	2010	2065	2220	2360	2545	2940	3250	3570	3790	3966.5	4110	4400	9200
1738	2030	2082	2258	2390	2550	2967	3322.5	3580	3807.5	3970	4112	4735	9590
1746	2040	2105	2260	2405	2557	2990	3400	3637.5	3810	3975	4177.5	5200	

DISCOUNTS FOR QUANTITY PURCHASES

WE INVITE INQUIRIES FROM FOREIGN BUYERS, AIRLINES, MILITARY AND EXPORT PURCHASERS, MANUFACTURERS, JOBBERS, WHOLESALE AND VOLUME DEALERS.

NOTE! All items subject to prior sale and change of price without notice. MINIMUM ORDER: $2.50. All orders MUST be accompanied by check, cash or M.O. WITH PAYMENT IN FULL. No C.O.D. CALIFORNIA BUYERS add sales tax. INCLUDE APPROXIMATELY 5c PER CRYSTAL FOR POSTAGE. **DEALERS & JOBBERS: WRITE FOR SPECIAL QUANTITY DISCOUNTS.** All buyers invited to write for FREE crystal catalogue giving complete list of frequencies.

COMPLETE SETS

Individually tested and *Guaranteed* to operate!

SCR-508 — Channels 0–79. FT-241 HOLDERS. Fundamental crystal frequency range: 370.370 to 516.667 KC. Set of 80 crystals $25.00

SCR-509 & SCR-510 — Channels 0–79. FT-243 HOLDERS. Fundamental crystal frequency range: 5706.7 to 8340 KC. Set of 80 crystals $32.00

SCR-608 — Channels 270–389. FT-241 HOLDERS. Fundamental crystal frequency range: 375.000 to 540.277 KC. Set of 120 crystals $48.00

TRC-1 — Channels 700–999. In 2 types of holders: TRANSMITTER Crystals in FT-241 HOLDER. Fundamental crystal frequency range: 729.167 to 1040.625 KC.
RECEIVER Crystals in FT-243 HOLDER. Fundamental crystal frequency range: 7500 to 8750 KC
MATCHED PAIR (1 transmitter crystal and 1 receiver crystal) $1.50
SET OF 300 TRANSMITTER CRYSTALS $300.00

SCR-609 & SCR-610 — Channels 270–389. FT-243 HOLDERS. Fundamental crystal frequency range: 5675–8650 KC. Set of 120 crystals $48.00

FUNDAMENTAL OUTPUT FREQUENCIES

4035	4280	4495	4710	4930	5205	5397.5	5587.5	5780	5950
4080	4330	4540	4780	4980	5245	5437.5	5645	5820	5995
4165	4397.5	4580	4840	5030	5285	5500	5687.5	5860	
4240	4445	4635	4880	5127.5	5327.5	5545	5730	5907.5	

SCR-536 — Matched pairs of Transmitter-Receiver crystals in FT-243 HOLDERS. Receiver crystal is 455 KC. higher than the frequency of Transmitter crystal.

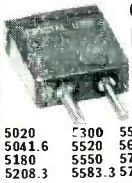
YOUR CHOICE OF ANY MATCHED PAIR. PER PAIR $1.00

NOTE: For individual crystals, see frequencies and prices in the chart on the left.

MISCELLANEOUS & SHIP BAND FREQUENCIES

81.95	KC. Octal tube type (Used in SCR-581 & SPM-1)	$3.99
200	KC. in FT-241 holder	1.99
200	KC. Type DC-15 in octal tube base type holder	1.99
327.8	KC. No. D-168342 (used in TS-102/AP)	9.95
500	KC. in FT-241 holder	1.99
1000	KC. in FT-241 holder	2.49
1000	KC. Type DC-9, in octal tube base type holder	3.45
2000	KC. in FT-243 holder	1.99
2142	KC. in DC-34 holder	2.99
2174	KC. in DC-34 holder	2.99
2182	KC. in FT-243 holder	2.99
2500	KC. in FT-243 holder	1.99
2632	KC. in FT-243 holder	2.99
2637	KC. in FT-243 holder	2.99
2638	KC. in DC-34 holder	2.99
2638	KC. in FT-243 holder	$2.99
2670	KC. in FT-243 holder	2.99
2647	KC. in FT-443 holder	2.99
2670	KC. in DC-34 holder	2.99
2738	KC. in type 1-C holder	2.99
2738	KC. in FT-243 holder	2.99
2738	KC. in MC-7 holder	2.99
3000	KC. in FT-243 holder	1.99
3088	KC. in FT-243 holder	2.99
3093	KC. in Ft-243 holder	2.99
3098	KC. in FT-243 holder	2.99
3103	KC. in FT-243 holder	2.99
3188	KC. in FT-243 holder	2.99
3193	KC. in FT-243 holder	2.99
3198	KC. in FT-243 holder	2.99
3203	KC. in FT-243 holder	2.99
5000	KC. in FT-243 holder	1.99
10.000	KC. Type SR-5 Bliley, in CR-1 holder	1.99

CR-1A HOLDERS



Lots of 10 or more .... .69¢
Lots of 5 or more .... .74¢
Individually. Each .... .79¢

			5980	6670	7120	7460	7930	8032	8116	8172.2	8272.5	8340	8423
			6181	6700	7130	7470	7960	8050	8126	8176	8284	8351	8428
			6350	6740	7160	7550	7980	8060	8128	8193.2	8290	8357	8430
			6380	6750	7180	7570	8007	8080	8132.3	8194.2	8397.1	8373	8438.7
			6450	6890	7230	7590	8010	8090	8137	8200	8308	8374	8475
5020	5300	5590	6510	7010	7350	7670	8013	8092	8140	8205	8317	8380	8502.8
5041.6	5520	5677.7	6530	7020	7360	7730	8018	8103.7	8142.8	8216.2	8320	8392	8528.5
5180	5550	5700	6550	7040	7400	7790	8020	8110	8146.1	8220	8328	8400	8554.2
5208.3	5583.3	5722.2	6650	7080	7440	7810	8025	8115	8152	8260	8335	8404	8580
													8590

AR7-W
1500 to 3400 KC
Ea. $2.99

FT 164
201 to 4300 KC.
Ea. $3.99

FT-241 or CR-4
300 freqs. from 729.167 to 1040.625 KC. in steps of every 1.041 KC.
Ea. 99c

COLLINS TYPE 1-C
1335 to 4467.5 KC.
Ea. $1.99

RCA MI-8412 A or B
2618 to 5805 KC.
Ea. $1.99

RCA MODEL AVA 10J
169 to 6510 KC.
Ea. $1.99

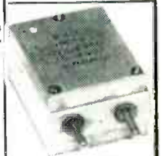
BLILEY TYPE MC-7 or BSD
163.94 to 8730 KC.
Ea. $1.99

AVA-53
2035 to 6910 KC.
Ea. $2.45

MX9-E
Freqs. & Prices on request.

AA9-A PIEZO ELECTRIC
1388 to 8730 KC.
Ea. $1.99

AR-4W or FT-249
1398 to 4765 KC.
Ea. $1.99



BSD-180G
956.875 to 1300 KC.
Ea. $1.99

TEST EQUIPMENT

Measurement Corp. Test Set		IE-19A	TS-7/ASQ
TS-428 (XM-2) PCM		TS-14/AP	TS-102A/AP
TS-35A/AP	TS-481U	W.E. 17B	W.E. 19C (SPC)

U. S. CRYSTALS, INC.,

Dept. E.
805 S. UNION AVE.,
LOS ANGELES 17, CALIF.

AVAILABLE FROM STOCK

THE TS-250 ALTIMETER TEST SET

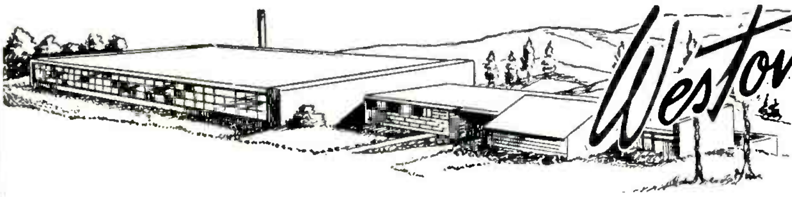
Complete with Accessories and Instructions

This set is designed to provide an accurate signal source for calibrating all ranges of AYB, AYD, AN/ARN-1 or AN/APN-1 Radio Altimeters. The TS-250 may also be used for measuring over-all loop sensitivity.

As compared with standard delay line type of calibrators, the 250 is better because of greater accuracy and because it provides a means of calibrating both the high and low altitude ranges. Provision for alignment of the counter circuits is also included. Operating from a 24-29 VDC source, the TS-250 is the logical instrument for all Airline maintenance personnel. The calibration accuracy of the TS-250 is within 1%, while the attenuator accuracy is within 3 db.

Housed in an attractive St. James grey enameled splash proof case, the weight of which, complete, is 20 lbs., the over-all dimensions are 12 x 12 x 15.

The net price of this instrument F.O.B. Harvard, Massachusetts, complete as per illustration, $660.00.



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FG81A—2^{49} . . . 705A—75¢ . . . 1616—59¢
8013A—1^{95} . . . 9004—20¢

All new, standard brand tubes. JAN specifications. Original manufacturers' boxes.

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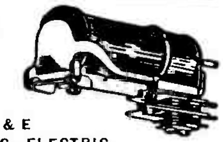
TELEPHONE RELAYS



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CLARE TYPE C STANDARD SIZE SENSITIVE TELEPHONE RELAYS

	Coil	Contracts	Will Close at	Price
1)	6500 ohms	1C	4 MA	$2.50 ea.
2)	6500 ohms	1B-1C	3.5 MA	2.75 ea.
3)	6500 ohms	2A	4 MA	3.00 ea.
4)	6500 ohms	2A-1B	4 MA	3.00 ea.
5)	6500 ohms	5A	5 MA	3.25 ea.
6)	6500 ohms	5A-2D	5 MA	3.50 ea.

CLARE TYPE G HALF SIZE SENSITIVE TELEPHONE RELAYS

	Coil	Contacts	Will Close at	Price
1)	6500 ohms	2A	5 MA	$2.50 ea.
2)	5800 ohms	3A	4 MA	2.50 ea.
3)	5800 ohms	2B-1C	5 MA	2.50 ea.
4)	4850 ohms	1C	4 MA	2.50 ea.
4)	3600 ohms	1C	6 MA	2.00 ea.
5)	4850 ohms	1A	5 MA	2.00 ea.
6)	3300 ohms	(None)	ACTUATOR	1.50 ea.
7)	3300 ohms	1A	Micro-Switch	2.50 ea.

All above Relays may be used for continuous duty operation on 110V. D.C.

OTHER TYPE C TEL. RELAYS

1)	1300 ohms	2A-1B	24 or 48V	$2.75 ea.
2)	1300 ohms	1B	24 or 48V	2.25 ea.
3)	2500 ohms	1A	24-48V	2.25 ea.
4)	400 ohms	5A1C	24V	2.75 ea.
5)	400 ohms	5B1C	24V	2.75 ea.

OTHER TYPE G TELEPHONE RELAYS

1)	1300 ohms	1A-1C	24 or 48V	$2.50 ea.
2)	400 ohms	1A	24V	1.65 ea.
3)	500 ohms	1D	24V	1.65 ea.
4)	200 ohms	1A	24V	1.50 ea.

CONTACT SYMBOLS
A=Norm. Open B=Norm. Closed C=S.P.D.T.
D=Make Before Break

CLARE TYPE A Tel. Relay. Coil—110 Volts A.C. 60 cy. Contacts—3PDT (3 form C) Price—$3.50 ea.
Signal Wheelock Relays #KS9665 Coil—2,000 ohms Contacts-1A, 1B, 1C Oper. at 9 Ma Price—$2.75 ea.
GM #13017 **Relays.** 24 volts 150 ohm. Contacts-3PDT 10 Amp. ....Price—$2.00 ea.
MINIATURE TEL. RELAY. 300 ohm. 24 volt SPDT ....$1.65 ea.
FIVE Prong CR-2791 G.E. Plug In Relays.
1) C-103C25 2200 ohms SPDT 4.5 MA....$4.00 ea.
2) C-104B28 700 ohms SPDT 6 MA.......$3.00 ea.

Bulletin #700 **Allen Bradley Contactors** 110V AC 60 cy. D.P.S.T. N.O. 25 Amps...........$7.50 ea.

ALLIED BJ6D36 MINIATURE RELAYS
1) 24V. 260 ohms DPDT $1.25 ea.
2) 24V. 100 ohms DPST NO 1.00 ea.

Clare SK-5032 (Herm. Sealed) Plug-In Relays. Coil —30 ohms 6 volts Contacts—DPDT. Price $4.00 ea.

SIGMA TYPE 5F SENSITIVE RELAYS. Has two 70 ohm coils. Contacts—SPDT....Price—$3.00 ea.

Leach Relays Type 1025-SN-BF. Coil—24V. 425 ohms. Contacts—D.P.S.T. Norm. closed. Rated at 10 Amps ....Price—$1.25 ea.

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6V6G
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LOTS OF 100 OR MORE

OA2	.85	3A4	.55	F127A	17.50	837	.95
OA3	.85	3A5	.79	HF200	13.50	845	12.50
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OB3	.85	3B26	2.75	211/VT4C	.75	865	.95
OC3	.85	3B28	3.75	RX233A	3.25	866A	1.25
OD3	.85	3C24	1.00	250TH	19.00	872A GE	2.75
1B24	6.75	3C33	8.75	304TL	6.95	878	1.25
1B29	2.40	3E29	11.50	307A	2.25	918	2.00
1B32/532	1.00	4C22/HF100	10.50	313C	2.85	919	2.00
1N21B	1.65	4D22	17.50	316A	.85	921	1.40
1N23B	2.40	4E27	13.50	394A	2.50	923	1.75
1N26	7.75	4J52	150.00	GL434A	10.75	931A	3.95
1N34	.64	5R4GY	1.45	446A	1.00	954	.25
1N43	1.35	C6J	6.50	450TH	44.00	955	.35
1N81	1.35	6AS6	1.75	506AX	1.10	956	.35
1P23	2.50	6C21	18.00	507AX	1.00	957	.35
1P36	3.95	10Y	.45	702A	1.75	CK1005	.45
1P40	1.50	FG17	4.00	703A	2.50	CK1006	1.95
2C39	12.50	28D7	.95	704A	.85	1608	.95
2C39A	15.00	FG32	8.95	705A	1.50	2050	1.20
2C40	7.75	RK60/1641	1.95	707A	4.95	2051 RCA	.85
2C42	7.50	QK60	60.50	715A	2.95	5591 WE	5.75
2C43	14.50	QK61	60.50	715C	15.85	5635	9.75
2C46	7.50	FG98	17.50	717A	.85	5636	5.75
2C52	3.50	FG105	25.00	723A	9.95	5642	1.00
2D21	.75	F123A	6.95	801A	.35	5651	1.95
2J33	20.00			807	1.45	5654	1.65
2J34	17.75			813	8.50	5670	3.25
2J39	12.50			814	2.50	5676	1.15
2J54	47.50			815	4.25	5725	4.10
2J62	17.50			816	1.40	5726	1.50
2K22	17.50			829	6.65	5749	1.90
2K23	15.50			829B	9.95	6080	3.50
2K28	25.00			832	7.25	6097	1.50
2K33A	65.00			832A	7.50	7193	.45
2K54	65.00						
2K55	65.00						
2X2/879	.45						

8012A	1.95
8013A	3.50
8025	4.50
9001	.85
9002	.80
9003	1.25
9004	.25
9005	1.95
9006	.25

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2AP1	6.95
3AP1	4.95
3AP1A	6.95
3BP1	3.50
3DP1	2.75
3GP1	2.75
3JP1	9.75
5BP1	3.50
5BP1A	8.00
5HP1	4.25
5HP4	4.25
7BP7	4.25
9GP7	4.25

Write for other types.

Diodes****

1N21	1.35
1N21B	1.55
1N23A	2.25
1N23B	2.50
1N26	7.75
1N34	.64
1N43	1.50
1N81	1.35

Receiving Tubes

1A7GT	.60
1C5GT	.45
1E7G	.85
1L4	.45
1Q5GT	.60
1S5	.60
1T4	.45
3B7	.33
3D6	.33
3Q4	.60
3S4	.60
5T4	.99
6A8	.65
6AC7	.75
6AG7	.95
6AK5	.75
6AL5	.49
6B8	.55
6H6	.40
6J6	.65
6K7	.42
6L7	.75
12A6	.45

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ART-13/type T-47A $200.00
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BC-348 unmodified $65.00
ARC1 Radio $200.00
BC-312 Receiver $60.00
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CFD-B 4-channel pilot regulated telephone repeaters.
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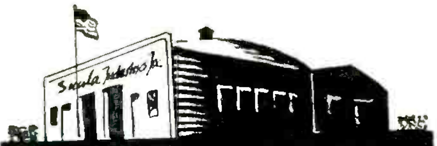

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REMOTE CONTROL UNITS, RM-29
ANTENNA EQUIPMENT, RC-173
DYNAMOTORS, DY-12
DYNAMOTORS, DM-32A
DYNAMOTORS, DM-36
DYNAMOTORS, PE-86

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RADAR—INDUSTRIAL—ELECTRONIC

OA2	.85	2J50	20.00	6AR6	2.50	715B	4.00	5763	1.50
OA3	.95	2J51	215.00	6AS6	1.75	722A	1.50	5814	1.85
OB2	.75	2J54	50.00	6AS7G	3.45	723AB	18.00	5840	4.50
OC3	.80	2J61	22.00	C6J	6.75	728AY, BY, CY DY, EY, FY	Price upon Request	6099	1.00
OD3	.80	2J62	25.00	6J4	4.60	800	1.50	6110	11.25
1B24	6.75	2K22	15.00	9LP7	2.95	805	3.00	8011	.80
1B26	1.70	2K23	11.25	15R	.45	829B	11.00	8013A	3.00
1B27	9.75	2K25	23.50	FG17	5.00	830B	2.00	8020	1.25
1B42	7.00	2K28	25.00	FG27A	7.40	832A	7.50	8025	3.75
1B63A	40.00	2K29	22.50	28D7	1.25	837	1.00	XTAL DIODS	
1P21	27.50	2K33A	90.00	35T	3.00	838	2.50	1N21A	1.50
1P23	2.55	2K34	120.00	5G105	18.00	865	.95	1N21B	2.00
1P28	8.50	2K55A	75.00	FG172	25.00	866A	1.25	1N22	1.20
1P40	1.50	3B24	4.00	215A	5.00	872A	3.00	1N23A	1.85
1Z2	1.90	3B24W	7.50	249C	4.50	884	1.50	1N23B	2.00
2AP1	8.50	3B25	3.40	274B	2.00	885	1.50	1N25	4.95
2B22	1.75	3B26	2.75	316A	.80	921	1.75	1N26	8.50
2C33	2.00	3B28	4.50	394A	2.50	1612	1.50	1N27	1.50
2C39A	17.50	3CP1	1.75	GL434A	11.75	1620	5.00	1N34	.60
2C40	4.90	3C23	6.50	GL446A	.95	1636	1.50	1N34A	.85
2C43	14.50	3C24/24G	.90	GL464A	7.00	2050	1.40	1N35	1.60
2C44	.95	3C45	11.50	471A	2.50	5557	5.00	1N38A	1.25
2C51	3.65	3DP1	2.25	505AX	1.75	5636	5.50	1N41	8.90
2C53	11.65	3E29	9.50	KU627	16.50	5642	1.00	1N42	16.90
2D21	.95	3FP7	1.75	700A	9.50	5645	7.50	1N43	1.70
2J21	3.75	4B22	5.00	700B	9.50	5646	7.50	1N45	1.40
2J21A	3.75	4B25	7.75	700C	9.50	5651	2.50	1N46	.65
2J22	5.00	4B32	10.50	700D	9.50	5654	1.65	1N47	3.95
2J26	6.75	4C35	19.00	701A	4.50	5670	3.50	1N48	.45
2J27	21.00	4J32	175.00	702A	1.50	5686	3.00	1N51	.40
2J31	20.00	4J36	130.00	703A	2.50	5687	2.95	1N54	.75
2J32	35.00	ELC5B	2.75	704A	.85	5702	2.95	1N54A	.95
2J33	37.50	5BP1	2.80	705A	1.00	5703	1.90	1N58A	1.10
2J34	25.00	5C22	37.50	706B	15.00	5718	5.00	1N60	.55
2J37	12.00	5D21	11.50	706C	15.00	5719	5.00	1N64	.65
2J38	17.00	5J29	9.00	707A	4.75	5750	2.00	1N69	.90
2J39	35.00	5J33	11.95	707B	9.00			1N70	.80
2J40	29.00	5R4GY	1.25	708A	3.50			1N72	.85
2J48	46.50	(JAN)6AK5	.85	709A	1.75				
2J49	60.00	6AK5W	1.35	713A	.85				

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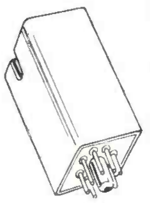
ALPINE ELECTRONICS
"The Peak in Tube Deals"

P. O. Box 979
Grand Central Station
New York 17, N. Y.

Sigma SENSITIVE Relays



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COIL: 5000 ohms; polarized; max. current 0.9 ma. (either polarity)
CONTACTS: SPDT; 2 amp., 28V DC or 110V AC; silver cont.; fast acting

COIL: 16,000 ohms; max. pick up 0.9 ma.; min. drop out 0.1 ma.
CONTACTS: SPDT & SPST (1A1C); 1 amp., 28V DC or 110V AC; silver cont.; fast acting

3^{75} Either type

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TUBE—ZP-623 (893)
20 KW Plate Dis. to 5mc.
UNUSED & TESTED $150^{00}

ARC-3 TRANS.-REC.
10 Channel Certified $580^{00}

C-H SPDT SWITCH
Sgle Hole Mtg. w/hdwe; Bat Hdle. 15 A—125V;
JAN-S-32, ST42D
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JUNE, 1954

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SEARCHLIGHT SECTION
(Classified Advertising)
H. E. Hilty, Mgr.

NEW YORK'S RADIO TUBE EXCHANGE

TYPE	PRICE
OA2	$1.00
OA3	1.10
OB2	.99
OB3	1.10
OC3	.96
OD3	.89
C1B	2.95
1B21	1.50
1B22	1.50
1B23	6.95
1B24	12.00
1B26	1.75
1B27	12.50
1B32	2.95
1B38	35.00
1B50	23.00
1B51	7.50
1B56	35.00
1B60	35.00
1N21	1.25
1N21A	1.75
1N21B	2.75
1N21C	19.50
1N22	1.00
1N23	1.95
1N23A	2.75
1N23B	2.75
1N23C	7.50
1N25	4.50
1N26	6.75
1N27	3.50
1N34A	.79
1N43	2.25
2B4	1.25
2B22	1.75
2C34	.15
2C40	9.00
2C42	12.00
2C43	14.50
2C44	.60
2C46	7.50
2E22	2.25
2J21A	12.00
2J22	9.00
2J26	15.00
2J27	15.00

TYPE	PRICE
2J31	24.00
2J32	29.00
2J33	32.00
2J34	36.00
2J36	90.00
2J38	8.95
2J39	8.95
2J40	29.00
2J42	135.00
2J49	60.00
2J50	55.00
2J55	150.00
2J56	110.00
2J61	35.00
2J62	35.00
2K22	15.00
2K23	15.00
2K25	27.50
2K26	68.00
2K28	35.00
2K29	35.00
2K33A	75.00
2K39	140.00
2K41	135.00
2K45	80.00
2K50	275.00
2K51	125.00
2K55	125.00
2K56	72.00
3AP1A	10.00
3BP1	7.20
3B24	4.50
3B25	5.50
3B26	5.00
3B28	8.00
EL3C	5.50
3C22	99.00

TYPE	PRICE
3C24	1.50
3C31	2.95
3DP1	7.50
3DP1A	10.00
3DP1A-52	10.00
3EP1	5.00
3E29	15.50
3FP7	5.00
3HP7	5.00
4A21	2.75
3GP1	5.00
4B26	5.40
4C27	22.50
4C28	35.00
4E27	16.00
4J25	150.00
4J26	150.00
4J27	150.00
4J28	150.00
4J29	150.00
5J30	150.00
4J31	150.00
4J32	150.00
4J33	150.00
4J34	100.00
4J35	150.00
4J36	150.00
4J37	150.00
4J38	150.00
4J39	150.00
4J40	150.00
4J41	150.00
4J42	190.00
4J51	190.00
4J52	225.00
4J53	225.00
C5B	250.00

TYPE	PRICE
5BP1	3.95
5BP2A	12.00
5BP4	3.95
5CP1	7.50
5CP7	6.95
5CP7A	14.00
5D21	18.00
5FP7	1.95
5JP1	27.50
5JP2	19.50
5JP4	27.50
5J23	45.00
C6A	11.00
C6J	7.50
7BP7	5.00
7DP1	9.00
12AP4	50.00
12DP7	24.00
LM15	225.00
15E	1.75
15R	.75
NE16	.59
20-4	.75
KY21A	8.25
RX21	8.00
HK24G	1.50
25T	2.95
45 Special	.35
RK39	2.75
HF50	1.75
VT52	.35
HK54	4.50
RK72	1.00
RK73	1.00
FG95	19.95
100TH	7.95
FG105	20.00

TYPE	PRICE
122A	1.75
203A	7.50
211	.95
217C	12.00
242C	10.00
244A	9.50
249C	4.25
250TH	19.95
250TL	12.00
274B	2.75
304TH	1000.
304TL	10.00
307A	3.50
310A	4.50
310B	4.95
311A	6.50
312A	3.50
323A	15.00
327A	3.75
328A	6.75
350A	10.00
350B	5.95
352A	3.00
HK351C	15.00
357A	15.00
368AS	4.95
371B	1.50
385A	4.50
388A	1.80
393A	7.50
394A	3.95
MX408U	.50
417A	15.00
434A	15.00
446A	1.95
446B	3.95
450TL	45.00

TYPE	PRICE
450TH	52.50
464A	7.50
471A	1.25
527	18.00
WL530	23.00
WL531	22.50
WL532	1.75
WL533	15.00
HK654	35.00
700A/D	10.00
701A	4.50
703A	3.95
704A	1.95
705A	21.75
706AY/FY	5.00
707A	9.75
707B	15.00
714AY	18.00
715A	4.50
715B	9.00
715C	22.50
717A	1.50
718AY/EY	30.00
719A	22.50
720AY/GY	150.00
721A	3.50
722A	3.50
723A/B	18.00
724A	1.95
724B	2.25
725A	9.00
726A	18.00
726B	45.00
726C	45.00
728AY/GY	15.00
730A	22.50
750TL	99.00

TYPE	PRICE
801A	.90
802	2.95
803	5.95
805	4.95
807	1.50
808	1.95
809	2.95
810	10.50
811A	3.75
812A	3.95
813	13.75
814	3.75
815	6.25
816	1.45
829	11.00
829A	12.00
829B	15.00
830B	2.00
832A	9.95
833A	45.00
834	7.50
836	3.95
837	2.75
838	5.95
849	35.00
860	3.50
861	25.00
866A	1.50
869B	67.50
869BX	50.00
872A	3.50
878	1.50
879	.50
880	250.00
884	1.50
885	1.59
914A	75.00

TYPE	PRICE
931A	5.00
954	.35
955	.50
956	.75
957	.25
958A	.60
959	2.25
E114A	.25
1280	.95
1500T	135.00
HK1554	75.00
1603	5.00
1612	1.50
1613	1.25
1616	1.25
1619	.45
1622	1.50
1624	1.75
1625	.35
1626	.25
1851	1.80
2000T	150.00
2050	1.80
2051	1.00
Various 5000 and 6000 series of new production	
8012	2.00
8012A	2.50
8013	3.00
8013A	3.50
8019	1.75
8020	1.80
8025	3.75
PD8365	96.00
9001	1.25
9002	.90
9003	1.25
9004	.35
9005	2.75
9006	.25

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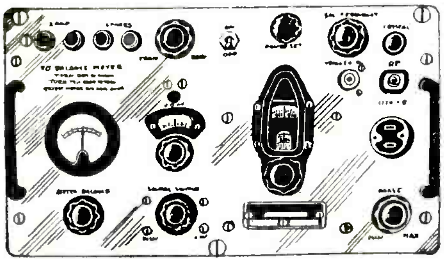

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5,000 V. Power Supply

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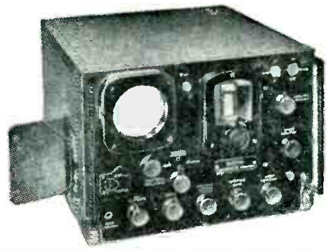

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Hard-to-get X-Band SIGNAL GENERATOR Now Available

Test Set TS 147 UP is a portable Microwave Signal Generator designed for testing and adjusting beacon equipment and radar systems which operate within the frequency range of 8500 MC to 9600 MC.

NEW MICROWAVE TEST EQUIPMENT TS148/UP SPECTRUM ANALYZER

Field type X Band Spectrum Analyzer, Band 8430-9580 Megacycles.

Will Check Frequency and Operation of various X Band equipment such as Radar Magnetrons, Klystrons, TR Boxes. It will also measure pulse width, c-w spectrum width and Q or resonant cavities. Will also check frequency of signal generators in the X band. Can also be used as frequency modulated Signal Generator etc. Available new complete with all accessories, in carrying case.

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TS13/AP X Band Signal Generator
TS14/AP Signal Generator
TS33/AP X Band Power and Frequency Meter
TS34/AP Western Electric Synchroscope
T35/AP X Band Signal Generator
TS36/AP X Band Power Meter
1-96A Signal Generator
TS45 X Band Signal Generator
TS47/APR 40-400 MC Signal Generator
TS69/AP Frequency Meter 400-1000MC
TS100 Scope
TS102A/AP Range Calibrator
TS108 Power Lead
TS110/AP S Band Echo Box
TS125/AP S Band Power Meter
TS126/AP Synchroscope
TS147 X Band Signal Generator
TS270 S Band Echo Box
TS174/AP Signal Generator
TS175/AP Signal Generator
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TS239A-TS239C Synchroscope
TF890/1 X Band Spectrum Analyzer
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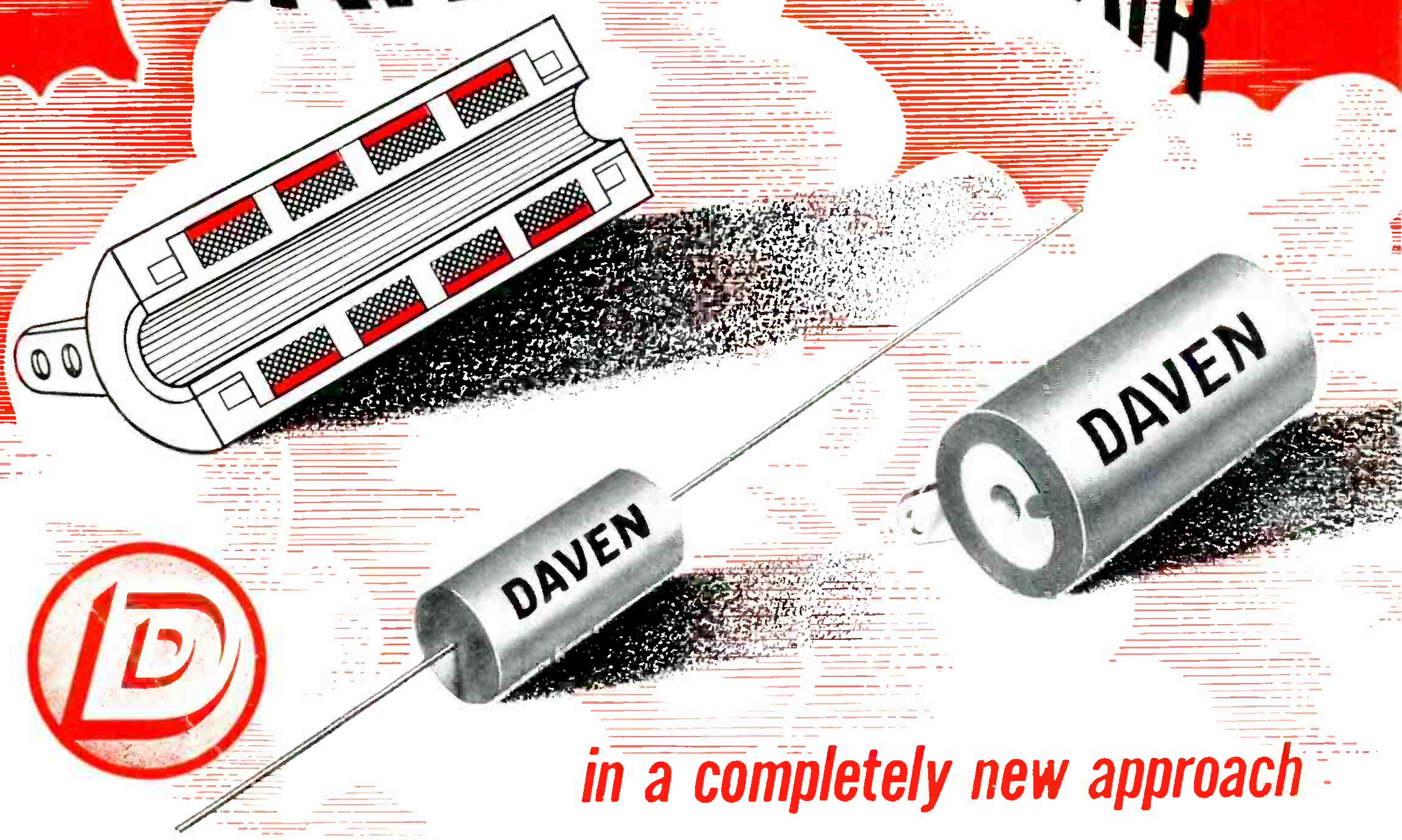
DAVEN TURNS TO AIR



in a completely new approach

to the production of Encapsulated Seald-Ohm Wire Wound Resistors

***Only* DAVEN** turns to air to keep the molding material absolutely separated from the resistance wire in its new line of Super Davohm Encapsulated Seald-Ohm Resistors. The wire is maintained in a slot filled with dry air . . . no external pressures are applied to it. These air pockets, between the wire and the plastic coating, guarantee absolute stability . . . eliminate shorted turns.

***Only* DAVEN** matches the temperature coefficient of expansion of the molding compound with the ceramic bobbin, the resistance wire and the metal terminals. This removes the possibility of cracks or strains on the wire during cycling.

Because of the special construction used, Daven can furnish Encapsulated Wire Wound Resistors with temperature coefficients below ±20 P.PM/°C. when required, and with accuracies to ±.05%.

These exclusive Daven precision, wire wound resistors are completely hermetically sealed . . . yet are no larger than standard lug-type resistors.

In addition, these units are made in accordance with MIL-R-93A specifications, and are substantially more rugged than conventional resistors. They will withstand the JAN-R-93, characteristic A, salt-water immersion test, and, in addition, temperature cycling from −65°C. to +125°C. The strong molding material will resist pressures equivalent to 75,000 ft. altitude, and will not cold flow at temperatures up to 150°C.

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RCA-6BC4

high gain, low noise RF amplifier

RCA-6BC4
UHF Medium-Mu Triode
(actual size)

Here's an excellent combination of important tube characteristics for UHF tuner designs. The new RCA-6BC4, for rf amplifier service, provides high gain combined with low noise factor . . . thanks to its high transconductance of 10,000 micromhos at relatively low plate current.

You also get the advantages of low lead inductance, low lead resistance, and low interelectrode capacitances . . . plus good isolation of input and load circuits. In addition, silver-plated base pins are used to reduce UHF skin-effect losses.

A well-tried companion for top UHF performance is the RCA-6AF4 for local oscillator service. This tube features *good* frequency stability as well as low lead inductance, low rf lead resistance, and low interelectrode capacitances.

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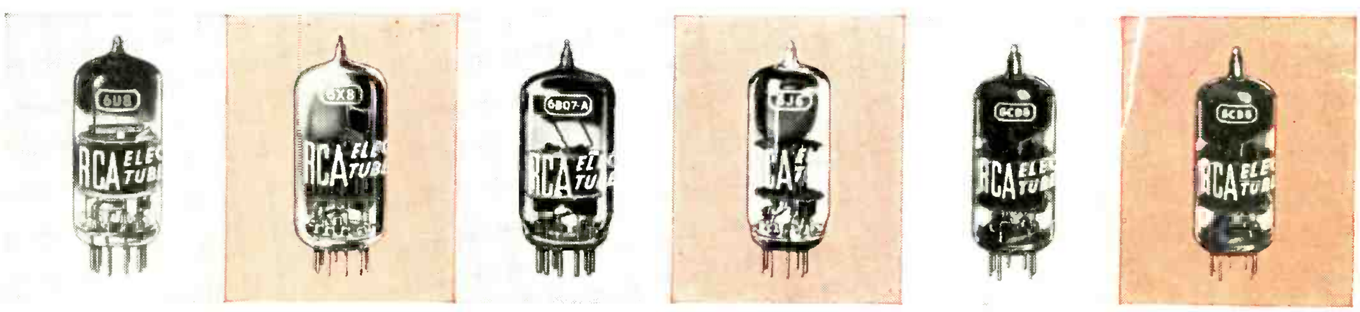
(CENTRAL) Whitehall 4-2900
589 E. Illinois Street
Chicago 11, Illinois

(WEST) Madison 9-3671
420 S. San Pedro Street
Los Angeles 13, California

RCA-6AF4 for local UHF oscillator service

RCA TUBES FOR VHF TUNERS



RCA-6U8	RCA-6X8	RCA-6BQ7-A	RCA-6J6	RCA-6BC5	RCA-6CB6
Triode-Pentode Converter	Triode-Pentode Converter	Medium-Mu Twin Triode	Medium-Mu Twin Triode	Sharp-Cutoff Pentode	Sharp-Cutoff Pentode

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