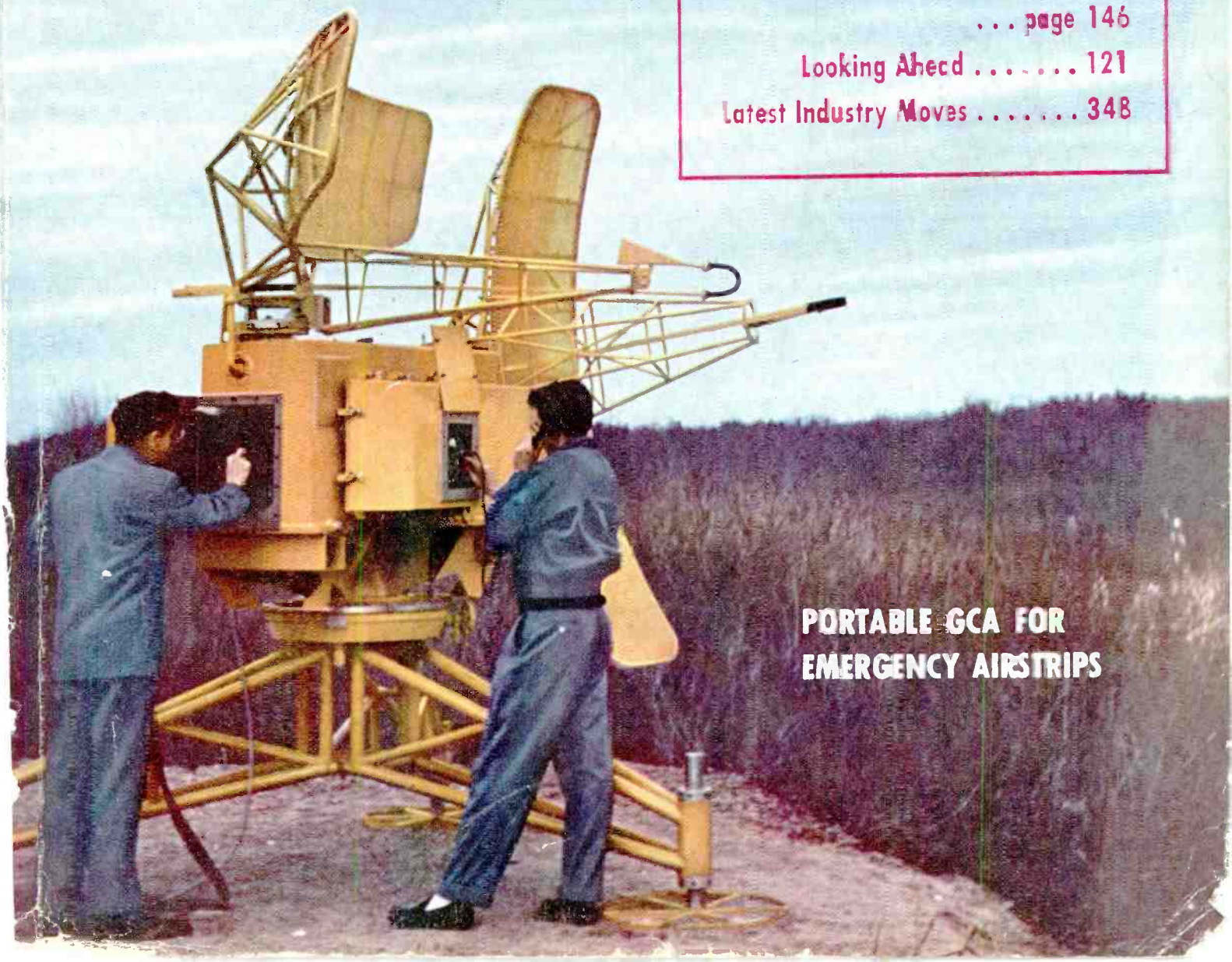
OCTOBER · 1955
PRICE 75 CENTS

electronics

A McGRAW-HILL PUBLICATION

10/5

MULTIPLEXING F-M TRANSMITTERS



PORTABLE GCA FOR EMERGENCY AIRSTRIPS

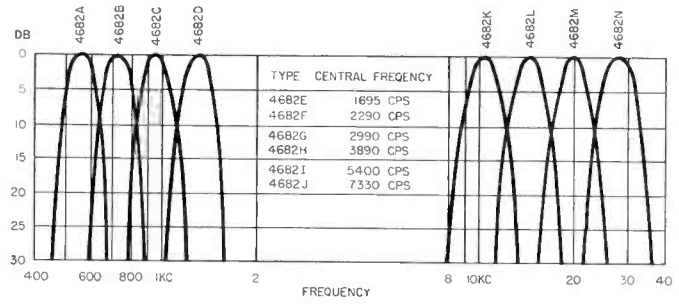
OUR MILLIONTH FILTER SHIPPED THIS YEAR...

FILTERS

FOR EVERY APPLICATION

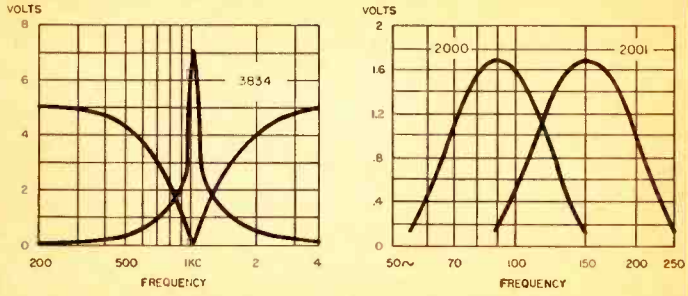
TELEMETERING FILTERS

UTC manufactures a wide variety of band pass filters for multi-channel telemetering. Illustrated are a group of filters supplied for 400 cycle to 40 KC service. Miniaturized units have been made for many applications. For example a group of 4 cubic inch units which provide 50 channels between 4 KC and 100 KC.



Dimensions:
(4682A) 1½ x 2 x 4″

Dimensions:
(3834) 1¼ x 1¾ x 2-3/16″.
(2000, 1) 1¼ x 1¾ x 1⅝″.



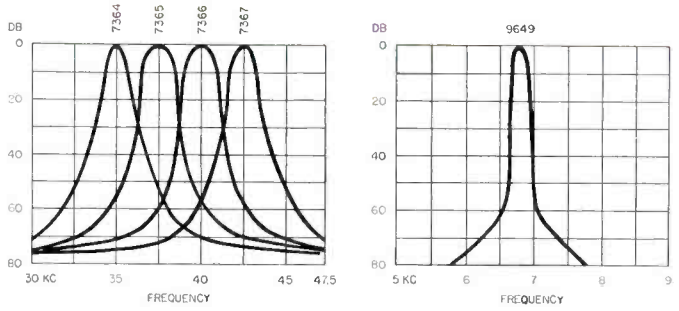
AIRCRAFT FILTERS

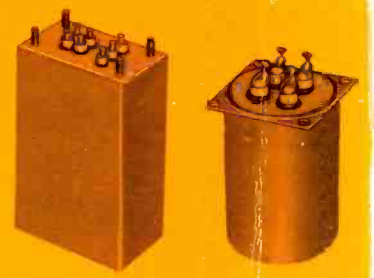
UTC has produced the bulk of filters used in aircraft equipment for over a decade. The curve at the left is that of a miniaturized (1020 cycles) range filter providing high attenuation between voice and range frequencies.

Curves at the right are that of our miniaturized 90 and 150 cycle filters for glide path systems.

CARRIER FILTERS

A wide variety of carrier filters are available for specific applications. This type of tone channel filter can be supplied in a varied range of band widths and attenuations. The curves shown are typical units.

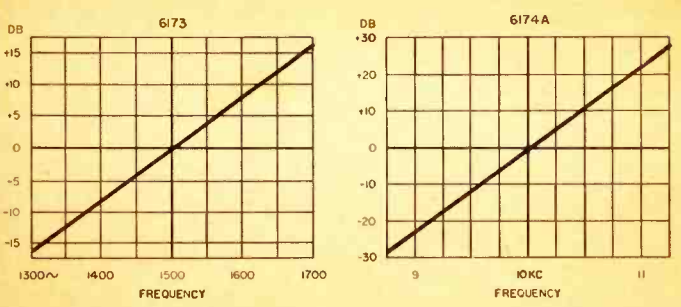




Dimensions:
(7364 series) 1⅝ x 1⅝ x 2¼″.
(9649) 1½ x 2 x 4″.

DISCRIMINATORS

These high Q discriminators provide exceptional amplification and linearity. Typical characteristics available are illustrated by the low and higher frequency curves shown.



Dimensions:
(6173) 1-1/16 x 1⅜ x 3″.
(6174A) 1 x 1¼ x 2¼″.

For full data on stock UTC transformers, reactors, filters, and high Q coils, write for Catalog A.

UNITED TRANSFORMER CO.

150 Varick Street, New York 13, N. Y. EXPORT DIVISION: 13 E. 40th St., New York 16, N. Y. CABLES: "

electronics

A McGRAW-HILL PUBLICATION

OCTOBER • 1955

PORTABLE GCA FOR EMERGENCY AIRSTRIPS—Precision approach radar system made by Laboratory for Electronics, Boston, weighs only 2,100 lb including monitor equipment. Intended for small military and commercial airports, it can be set up in six hours by two-man crew (see p 154) . . COVER

CONTINUED ON NEXT PAGE

contents

continued

SHOP

MONEY-MAKING F-M—When FCC recently authorized multiplexed paid programs for f-m broadcast stations, the editors began thinking of potential writers for articles on the subject. It took no cudgeling of brains to come up with the name of an expert and competent author for an initial basic article.

Johnny Bose was Major Armstrong's right-hand man at the Marcellus Hartley laboratories from the time he graduated with honors from Columbia University in 1935. Armstrong gave him great credit for work on the double-channel phase-shift modulator. Bose carried out development of a highly successful multiplex system under Armstrong's direction — the last big project before the Major's death.

An old friend of John's, associate editor MacKenzie went to see him.

We think the resultant article spells out for the engineer in simple and concrete terms what has been done and what excellent results can be obtained with multiplexed f-m. It's on page 146 of this issue.

MUSICAL EDITORS — The high fidelity bug has hit nearly every staff member at some time or another. Most of us have operating equipment, some homemade from circuits published in ELECTRONICS. Output power ranges up to 30 watts.

The bass-reflex type of baffle arrangement is popular with the staff. Partly for a gag, one editor built one of these with quarter-inch-thick wood, now needs strain gages to

electronics

OCTOBER, 1955 Vol. 28, No. 10

Member ABC and ABP

TALK

in and out displacement accurately. Another has eflex enclosures. One is he volume of the other. the small one.

staff have two or more ers or sets. To receive a ain recent program, broadcast on a-m only, one editor belatedly discovered that he had only f-m in bedroom, living room, dining room and kitchen. His wife had relegated all a-m receivers to basement storage. He heard the broadcast, but out in the driveway, in his car, in the rain.

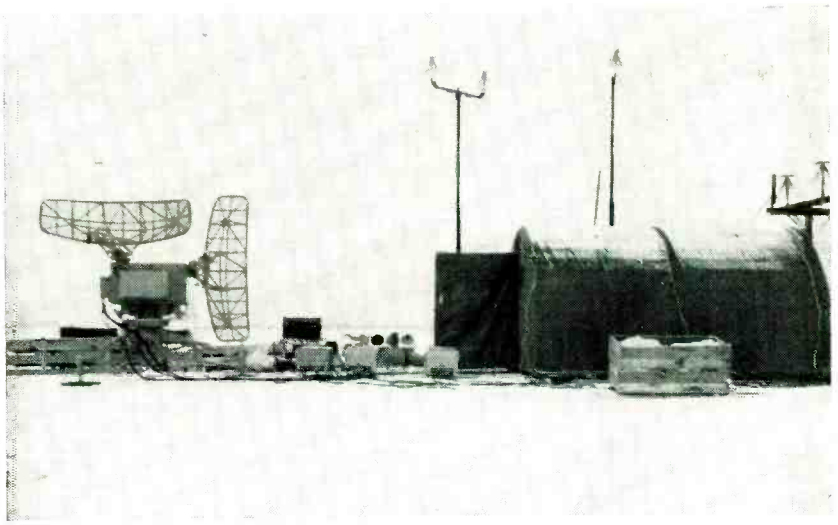
Record-playing equipment averages more than one per editor because of the three speeds available. Half the staff can handle all three.

One editor proudly informs us that he can play two and four-minute cylinders, on one of his museum pieces.

Another museum piece is a camera-size German player, a 78, circa 1900, with folding turntable. Volume control is achieved by adjusting slots in the front of a small horn.

STORY BEHIND HEADLINE— Much of the material used in the article in our July Industry Report on the growth of electronics in France was furnished by McGraw-Hill World News Service.

While editing the item, assistant editor Arnold decided to add statistics on the number of radio and television sets in use in recent years in that country. He soon found that this took some doing.



OUR COVER shows one view of a portable gca and the photo above shows the same equipment undergoing tests in Alaska at 42 below zero. The record-breaking heat wave in New York this summer made us wish we could witness such tests

He contacted the New York office of the French Embassy, United Nations, Voice of America, the French Broadcasting System, DuMont International and RCA Frequency Labs.

He got the data. We call him Bill Arnvoy now.

COMING NEXT MONTH – First published details of the machines and mechanisms in the Signal Corps-GE system for assembling components on wiring boards automatically under control of punched cards will appear in ELECTRONICS next month. Four operators load components, etched wiring boards and a stack of punched cards, and take out finished, dip-soldered and fully tested boards.

Intended for job-lot production of small quantities of complex military electronic equipment, the system assembles 20 boards at a time. There is only one insertion head; the boards circulate under this in ring-around-the-rosie fashion, pausing a moment for the head to jab in a component.

When each board has received the first component, the punched cards call for a new component magazine and servo the head to a new position for the second trip around. With this system, there are no training problems when designs are changed frequently, because the production know-how is stored in the stacks of punched cards.

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Single copies 75¢ for United States and possessions, and Canada; $1.50 for Latin America; $2.00 for all other foreign countries. Buyers' Guide $3.00. 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 and the Philippines, $15.00 a year; $25 for two years. All other countries $20.00 a year; $30.00 for two years. Three-year rates, accepted on renewals only, are double the one-year rate. 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.

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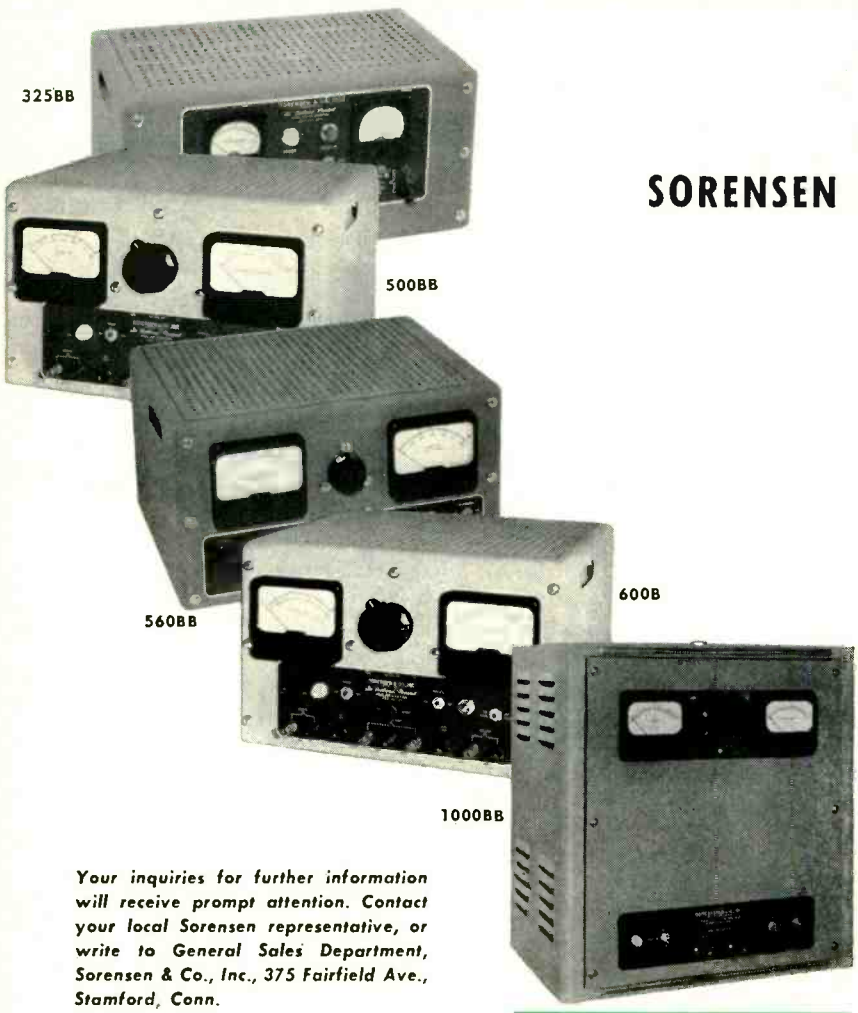
SORENSEN B-NOBATRONS*

PERFORMANCE • DEPENDABILITY • PRICE



SORENSEN B-NOBATRONS (B Power Supplies) were designed specifically to provide an economical answer for a very wide range of technical requirements.

Look them over. Five catalog models, available from stock, give you choice of outputs from 0-325, 0-500, 0-600, and 0-1000 VDC, accurately regulated. High grade engineering, high grade materials, and Sorensen's unequaled know-how in designing and manufacturing regulated power equipment combine to assure you top performance, dependability, and fair price.

**Reg. U.S. Pat. Off.*

DC POWER SUPPLY SPECIFICATIONS

Model	325BB	560BB	500BB	600B	1000BB
AC input range (50-60 cps, 1Ø)	105-125	105-125	105-125	105-125	105-125
Output range (VDC)	0-325	0-500	0-500	0-600	200-1000
Output current (Ma)	0-125	0-200	0-300	0-500	0-500
Regulation accuracy	±0.5%	±0.5%	±0.5%	±0.25%	±0.5%
Ripple (MV-RMS)	5 max.	5 max.	5 max.	3 max.	20 max.
Bias supply (VDC at 0.5Ma)	0-150	0-150	0-150	0-150	— —
Internal impedance (max.)	2 ohms	2 ohms	2 ohms	2 ohms	2 ohms
AC voltage (C.T., unreg.)	6.3 at 10 amp.	6.3 at 10 amp.	6.3 at 10 amp.	6.3 at 15 amp.	— —
Max. bias circuit impedance	25000 ohms	25000 ohms	25000 ohms	50000 ohms	

Your inquiries for further information will receive prompt attention. Contact your local Sorensen representative, or write to General Sales Department, Sorensen & Co., Inc., 375 Fairfield Ave., Stamford, Conn.

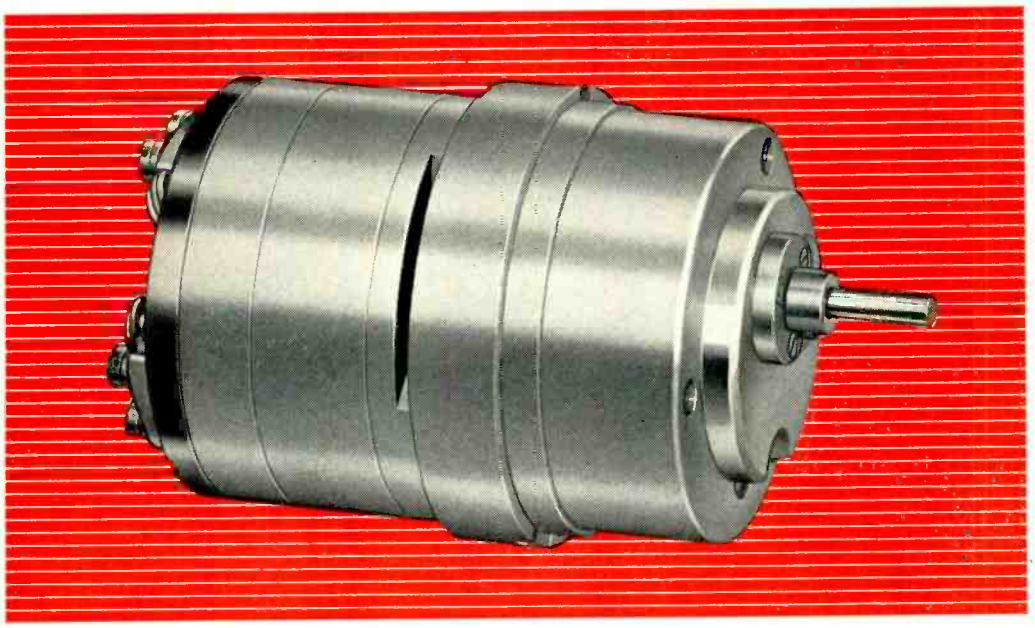
CONTROLLED POWER FOR RESEARCH AND INDUSTRY

SORENSEN

Want more information? Use post card on last page.

A HIGH FREQUENCY HYSTERESIS MOTOR

—WITH BUILT-IN GEAR BOX



The practical uses of a hysteresis motor designed for high frequency operation have hitherto been restricted by the high rotor speed of this type of motor. The Muirhead D-565-G Hysteresis Motor employs an integral gearbox so that although the rotor speed is 10,000 rev/min when operating from a 1000 c/s supply, the output spindle speed is only 720 rev/min — a convenient speed for many applications.

The motor may be supplied from a single-phase push-pull amplifier using a phase splitting capacitor in the output. The tuning may be adjusted to vary the relationship between the pull-in and the pull-out torque.

★ ★ ★

Power supply	50V, 0·4A at 1000 c/s	Output spindle speed	720 rev/min
Maximum pull-out torque	Not less than 9 oz in (650 gm cm)	Full load efficiency	30%
Maximum pull-in torque	Not less than 2·5 oz in (180 gm cm)	Weight	1¼ lb (0·6 kg)

MUIRHEAD

PRECISION ELECTRICAL INSTRUMENTS

WRITE UNDER YOUR BUSINESS LETTERHEAD FOR PUBLICATION 7717

MUIRHEAD & CO. LIMITED · BECKENHAM · KENT · ENGLAND

143

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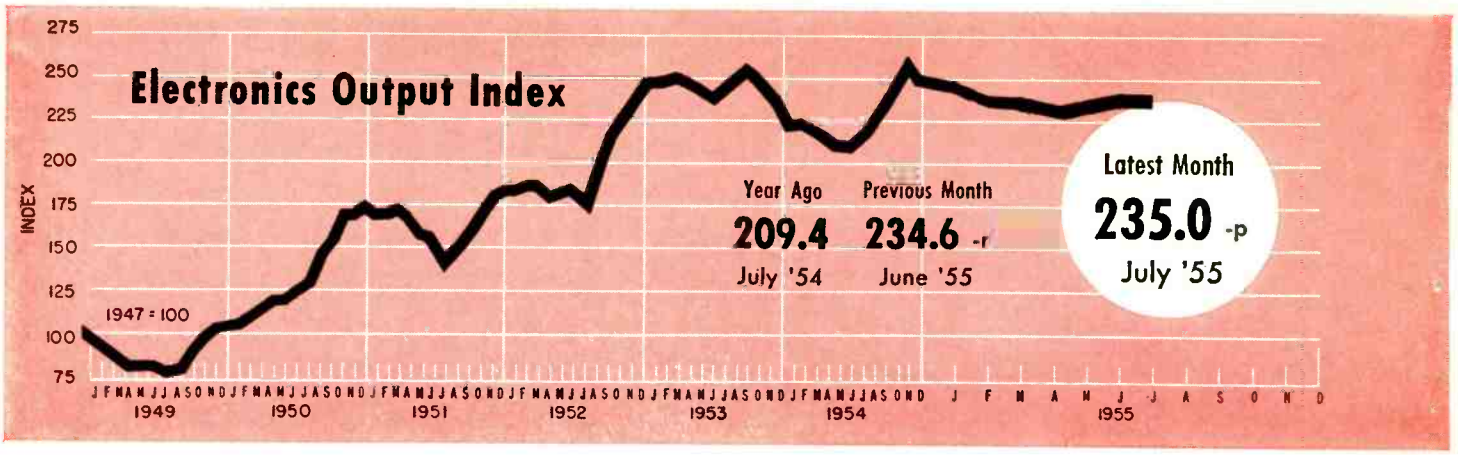


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Latest Month	Previous Month	Year Ago
	July '55	June '55	July '54
Television sets, total	344,295	589,973	306,985
With UHF	63,466	59,892	57,838
Color sets	nr	nr	nr
Radio sets, total	718,489	1,204,935	438,061
With F-M	2,385	9,106	8,622
Home sets	141,119	181,930	150,002
Clock radios	93,517	182,605	57,100
Portable sets	79,410	255,833	39,447
Auto sets	404,443	584,567	191,512

RECEIVER SALES

(Source: RETMA)	July '55	June '55	July '54
Television sets, units	381,567	429,357	368,634
Radio sets (except auto)	303,965	421,387	411,197

RECEIVING TUBE SALES

(Source: RETMA)	July '55	June '55	July '54
Receiv. tubes, total units	28,340,000	40,819,961	24,146,012
Receiv. tubes, value	$21,167,000	$31,254,324	$18,082,753
Picture tubes, total units	515,793	706,890	514,346
Picture tubes, value	$9,498,169	$13,244,499	$10,102,903

SEMICONDUCTOR SALES

	May '55	Apr. '55	May '54
Germanium diodes, units Silicon diodes, units	1,493,211	1,419,245	1,001,905

INDUSTRIAL TUBE SALES

	Quarterly Figures		
(Source: NEMA)	Latest Quarter	Previous Quarter	Year Ago
	1st '55	4th '54	1st '54
Vacuum (non-receiving)	$8,784,478	$9,338,181	$8,971,335
Gas or vapor	$3,747,490	$3,498,123	$4,589,239
Phototubes	nr	nr	nr
Magnetrons and velocity modulation tubes	$14,229,442	$15,249,651	$16,135,274
Gaps and T/R boxes	$1,434,683	$1,788,780	$1,517,426

TV SETS INSTALLED

(Source: NBC Research Dept.)	Latest Month	Previous Month	Year Ago
	July '55	June '55	July '54
Total sets	36,477,000	36,100,000	30,717,000

BROADCAST STATIONS

(Source: FCC)	July '55	June '55	July '54
TV stations on air	461	458	409
TV stations CPs—not on air	123	124	169
TV stations—new requests	17	16	16
A-M stations on air	2,748	2,732	2,592
A-M stations CPs—not on air	125	108	121
A-M stations—new requests	201	222	167
F-M stations on air	538	540	559
F-M stations CPs—not on air	17	12	12
F-M stations—new requests	4	6	5

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	July '55	June '55	July '54
Aeronautical	44,435	43,855	40,708
Marine	51,528	50,714	46,621
Police, fire, etc.	18,593	18,415	15,926
Industrial	25,189	24,845	21,867
Land transportation	7,792	7,668	6,925
Amateur	137,682	139,993	120,409
Citizens radio	12,801	12,334	8,093
Disaster	317	317	305
Experimental	639	625	592
Common carrier	1,964	1,950	1,661

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	June '55	May '55	June '54
Prod. workers, comm. equip.	355,300-p	350,000-r	329,300
Av. wkly. earnings, comm.	$71.38-p	$70.98-r	$68.51
Av. wkly. earnings, radio	$68.68-p	$68.85-r	$67.32
Av. wkly. hours, comm.	40.1 -p	40.1	39.6
Av. wkly. hours, radio	39.7 -p	39.8 -r	39.6

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	Aug. '55	July '55	Aug. '54
Radio-tv & electronics	462.1	484.8	354.8
Radio broadcasters	533.9	560.4	381.3

p—provisional; r—revised
nr—not reported

FIGURES OF THE YEAR

	TOTALS FOR FIRST SEVEN MONTHS 1955	1954	Percent Change	1954 Total
Television set production	4,173,088	3,152,132	+32.4	7,346,715
Radio set production	7,777,378	5,324,620	+46.1	10,400,530
Television set sales	3,584,562	3,174,394	+12.9	7,317,034
Radio set sales (except auto)	2,732,983	2,822,090	— 3.2	6,430,743
Receiving tube sales	254,842,000	189,856,000	+34.2	385,089,458
Cathode-ray tube sales	5,429,817	4,471,584	+21.4	9,913,504

INDUSTRY REPORT

More Setmakers Move Into Color TV

Color may bloom in spring. Industry byword now is "wait and see"

REMAINING months of 1955 will see limited production of color television sets as manufacturers feel the water. First production will be slanted toward supplying dealers with demonstration models and getting sets into bars and hotel lobbies.

Should customer interest warrant, spring will see setmakers tooling up in earnest and a strong pitch at the upper middle income group readied for fall 1956.

► **Immediate Plans**—RCA avowedly is out to take first place in color. For the most part other manufacturers are content to let RCA run with the ball at least initially.

There are three kinds of setmakers when it comes to color: those with no set at all, 15 or 20 who are buying RCA chassis and installing them in cabinets and those who are cautiously making short production runs on sets of their own.

► **Industry Activity**—Here's what a few set manufacturers are saying and doing about color tv for the balance of 1955:

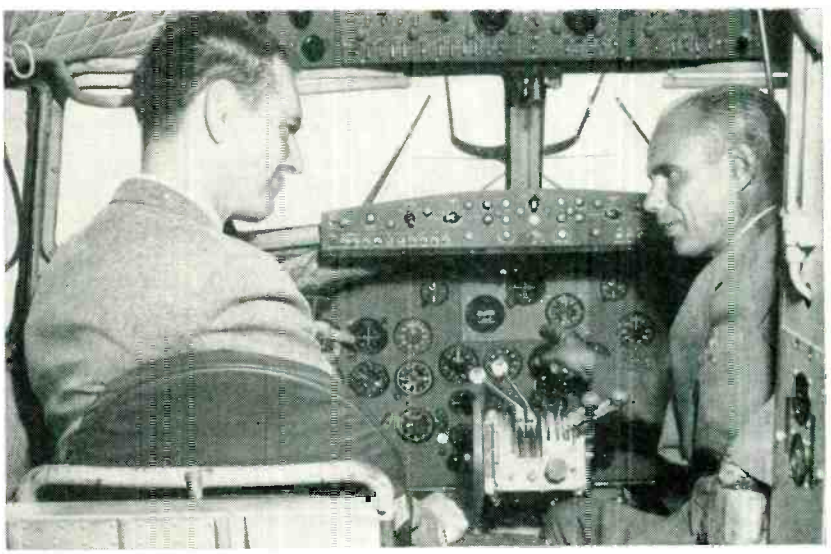
Admiral plans limited production. Du Mont will make limited quantities of a set to retail at $949. Emerson plans progressively increasing production of a 28-tube 21-in. console selling for $894.

Motorola will produce to meet distributor needs. Its 19-in. model will sell for $695. Olympic plans a pilot run in November to supply dealers. Magnavox and Sentinal will also offer color sets.

Philco will make color sets in limited quantities for delivery to distributors Oct. 1. Models will sell for $795 and $89. Raytheon will have a 21-in. set; table model $795, console $895. Zenith is planning color set production. Development at Zenith has been directed toward decoding circuits using the 6AR8.

CBS-Columbia has no production line at present; will sell the 205C2 console for $795 from stock. Westinghouse will sell 15 and 19-in. sets from stock. Plans are to put out 28-tube sets—perhaps in spring.

GE, Bendix, Crosley and Sylvania have no immediate set production plans but Sylvania is coming out with an RCA-type chassis.



New navigation aid called . . .

Tacan Comes Out From Wraps

SUBJECT of controversy as replacement for VOR-DME system sponsored by CAA, Tacan (for tactical air navigation) has importance in its own right as development sponsored by U. S. Navy and Air Force.

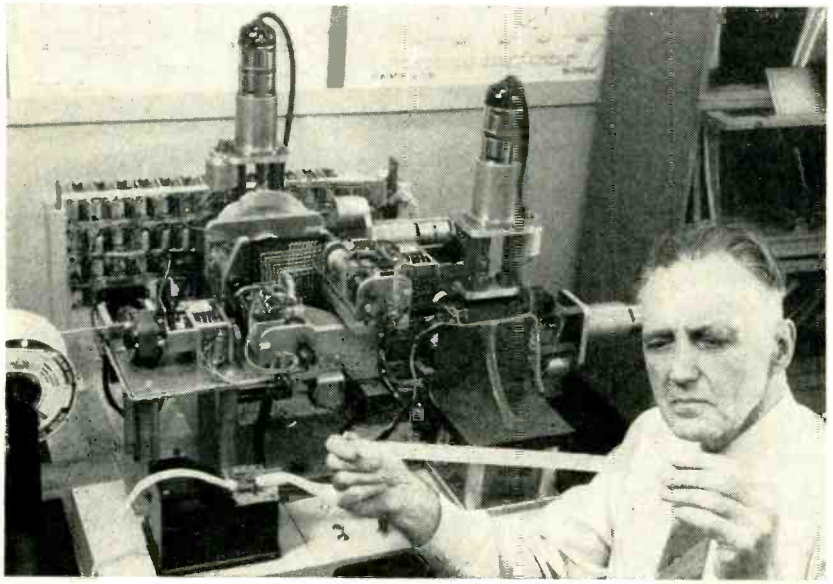
Declassification of system elements was implemented by Federal Telecommunication Laboratories, division of IT&T, who have started demonstrations for government, financial and press groups.

► **Direct Reading**—Visual indica-

tions of direction and distance to the ground station are displayed in the pilot's cockpit. Bearing accuracy is within a degree either way and distance is accurate to within about 600 feet. Technical details are given on page 174.

Big advantage of Tacan is relative freedom from siting errors caused by nearby obstructions that reflect a portion of the radio wave upon which determination depends. This feature is particularly helpful on aircraft carriers.

Plans are nearing completion for manufacture of a nonmilitary receiver indicator to sell for about $2,000.



PUNCHED paper tape gives the instructions and . . .

Automatic Machine Wires Chassis

Another approach to mechanized wiring uses no solder, wraps wire connections

AN EXPERIMENTAL machine that automatically wires electrical apparatus by following instructions from a punched tape has been developed by Bell Telephone Laboratories. A series of relays translates the taped information into electrical signals which control the machine.

► **Winder**—The M-4, as the machine is called, wires a chassis using solderless wrapped connections. This method, applied by hand-controlled tools, is now used for production work by Western Electric. Connections are made by automatically winding six tight turns of solid-conductor wire around a rectangular terminal. An airtight, corrosion-resistant contact results between the wire and terminal at numerous points.

Bell Laboratories tests indicate that such connections could be expected to provide a satisfactory connection for at least the usual life expectancy of the apparatus.

► **How It Works**—The experimental machine uses two rotating spindles. One spindle pulls the wire from a large spool to a connecting terminal. At the same time the wire is cut to the correct length at the second spindle.

The spindles strip some insulation from each end of the wire and whip the bare wire ends around the terminals. This produces a pressure of about 15,000 pounds per square inch at each contacting area. The spindles then pick up the supply wire from the spool and move to the next electrical connection and repeat the operation according to punched tape instructions.

Research Radio Stations Increase

Rise in experimental station authorizations mirrors development growth

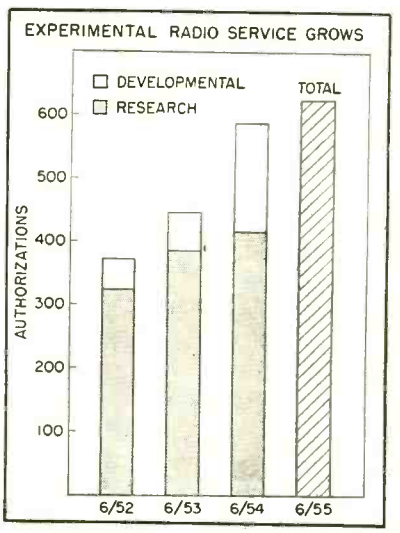
DURING the past three years the number of stations authorized by the FCC in the experimental radio services has increased nearly 70 percent. In 1952 there were 369 experimental authorizations. In June, the total stood at 625.

► **Types**—There are two classes of experimental stations (see chart). Approximately 60 percent of the authorizations are of the research type. However, the number in the development class, has increased by more than 260 percent since 1952.

According to FCC, research stations are for fundamental or general research, or the development, testing or calibration of equipment not relating to an existing service.

Developmental stations are for the development of equipment, engineering data or techniques for an existing or proposed service.

► **Research**—Greatest use of research stations is for contract and export development work. This includes developing equipment or techniques under contract with federal agencies and the development of equipment for use abroad.



(Continued on page 10)

NEW VLI (VERY LOW IMPEDANCE) DIODE

up to 300 ma at 1 volt with excellent stability and fast recovery time

V.L.I. DIODE CHARACTERISTICS @ 25° C

	Forward Current @ + IV	Reverse Current Microamps Max.					Max. Reverse Working Voltage	Max. Average Anode Current
	ma min.	-10V	-30V	-50V	-100V	-150V	Voltage	ma
1N447	25	20	60				30	60
1N448	25		30		100		100	60
1N449	50	10	30				30	60
1N450	50		30		100		100	60
1N451	50					150	150	60
1N452	100		30				30	80
1N453	100		30		100		100	80
1N454	200			50			50	100
1N455	300		30				30	100

The new Sylvania V.L.I. Diode is a significant development for electronic equipment designers with applications for high current carrying diodes. For the first time, you can expect high forward conductance combined with stable, drift-free performance, and fast recovery time.

The new Very Low Impedance diode is the result of recent technological advances in the diode field by Sylvania research engineers. It's the ideal diode for demanding computer applications in clipper, clamper, and logical circuits. In fact, it's the only diode wherever you want high forward conductance with high back resistance—high current carrying capacity with fast recovery time—and high rectification efficiency. The V.L.I. diode is designed into the Sylvania sealed-in-glass package and is 100% inspected for a positive, protective seal.

There's a full line of V.L.I. Diodes in a range of current-carrying capacity. Write for complete information or samples. Address Dept. K20R.

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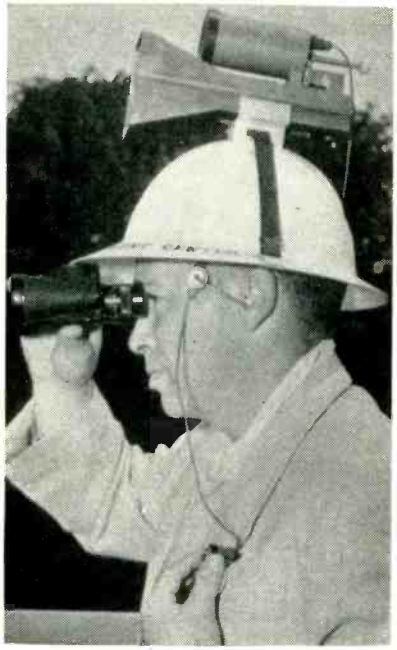


GROUND observers get all-weather eye when . . .

Radar Helmet Helps Aircraft Spotters

Microwave receiver uses transistors to reduce weight and power drain

TWENTY-ounce radar receiver mounted on helmets designed for the Air Force's civilian Ground Observer Corps by the ARDC center at Rome, N. Y., will tighten U.S. air defenses. With the receiver, part-time aircraft spotters can pick up a plane's search, navigation or fire-control radar.

► **How It Works**—The microwave horn antenna picks up the signal which is passed through a crystal detector. Transistors on a printed circuit board provide a pulse amplifier. A coaxial choke with filtering action delivers a sharp pulse to the amplifier.

Signals from the amplifier are fed directly to the light-weight headphones.

► **Weight and Power**—A four-ounce battery pack supplies the required power. The set's low power drain makes possible operation for a week under normal conditions.

Dwindling Selenium Conserved

As supplies drop sharply BDSA requests rectifier makers to reclaim scrap

PRODUCTION of selenium in the U. S. has again suffered a severe cutback due mainly to work stoppages in the copper industry. The electronics industry, which consumes 45 percent of the metal, is feeling the effects. A survey made by the Business and Defense Services Administration indicates that there is less than a month's supply of high-purity selenium.

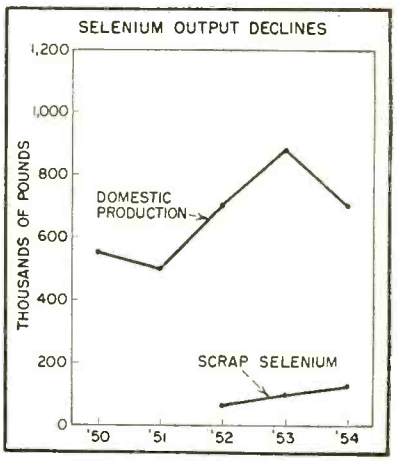
A few selenium rectifier makers have shut down because of lack of the metal. Supplies are considerably lower now than they were last year when selenium shortages appeared. Then the amount of elemental selenium held by primary producers amounted to a two-month supply because work stoppages in the copper industry had not been as prolonged.

► **Action**—BDSA has asked rectifier makers to make every effort to recover all discarded selenium rectifiers. It suggests that distribution outlets return discarded rectifiers. According to BDSA, such a program should result in an annual reclamation of approximately 20 percent of the total amount of high-purity selenium used.

Rectifier manufacturers are getting behind the program. Sarkes Tarzian and IT&T's. Federal Telephone & Radio Co. have announced reclamation drives and other companies are planning to do so.

Last year some 125,000 pounds of the metal were recovered compared to 98,000 pounds a year earlier. Sarkes Tarzian is allowing 10 cents merchandise credit on each replaced rectifier returned regardless of size or make. Last year the company offered 2.5 cents credit for rectifiers rated at 65 to 150 ma and 5 cents for those rated at 200 ma or more.

► **Imports**—Reduced production of



selenium in the U. S. has led to increased imports. In 1954, 195,000 pounds were imported compared to 100,000 pounds in 1953 and 123,000 pounds in 1952.

Canada is the main foreign source, accounting for about 90 percent of total imports. Japan, Sweden, West Germany and Belgium are other sources.

Electronics Builds Up In Chemical Plants

More chemical plants are using electronic instruments to foster increased production

EXTENT to which electronics is entering the chemical industry was indicated at a symposium on electronics and automatic production held in San Francisco. It was estimated by V. F. Hanson of du Pont that whereas ten years ago the investment in instruments was about one or two percent of a complete chemical plant, it has risen to 7 to 10 percent on plants built during the past four or five years.

This growth was seen continuing as long as total plant investment and operating costs can be reduced by use of smaller process equipment. This in turn is made possible by faster and more accurate control.

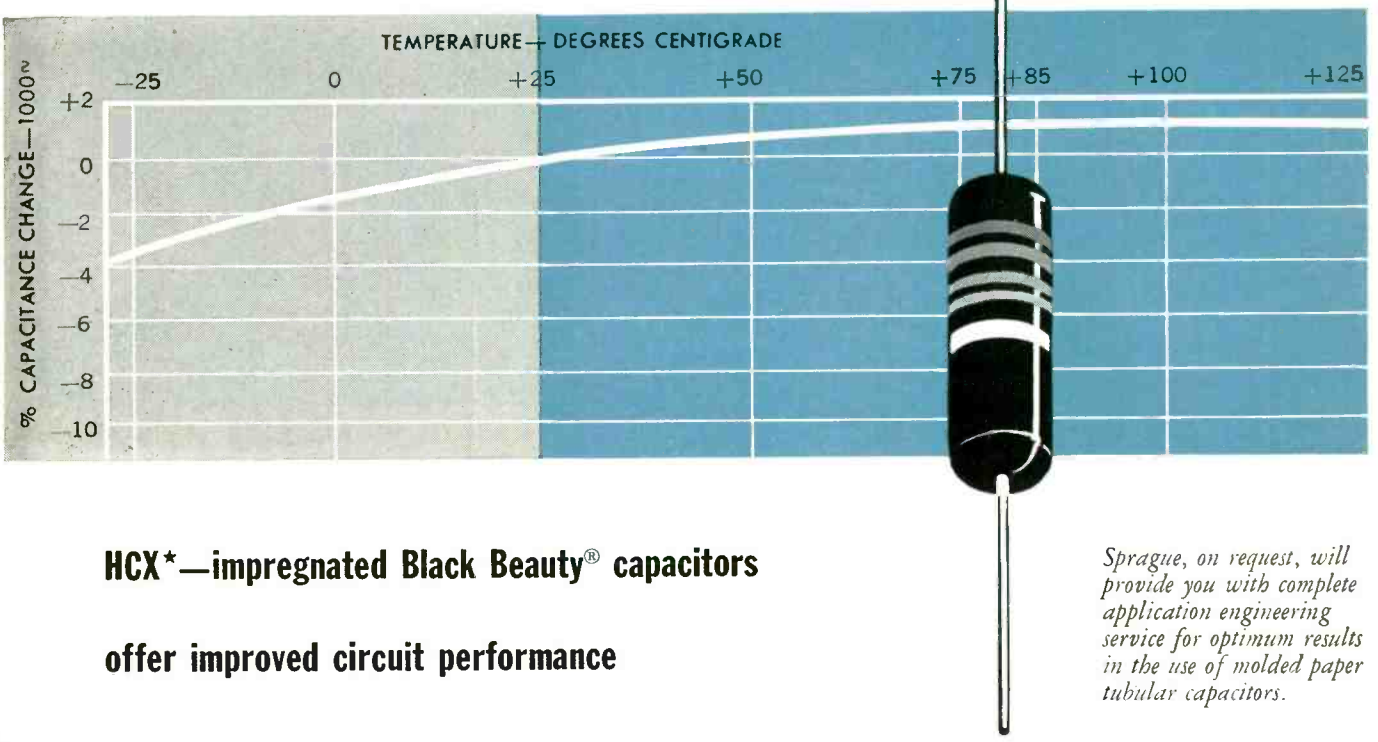
► **Gear**—The chemical industry is pioneering many of the special elec-

(Continued on page 12)

new!

a solid-dielectric molded paper tubular capacitor

with flat capacitance-temperature characteristics



HCX*—impregnated Black Beauty® capacitors

offer improved circuit performance

Sprague, on request, will provide you with complete application engineering service for optimum results in the use of molded paper tubular capacitors.

SPRAGUE'S NEW TYPE 109P CAPACITORS use a unique new impregnant identified by the trademark HCX. Developed in the Sprague research laboratories in the search for a better material than the polyesters customarily used for impregnating solid dielectric paper tubulars, HCX is a hydrocarbon which polymerizes after the rolled section has been vacuum impregnated. Its salient electrical characteristic of insulation resistance, power factor, and capacitance change with temperature are superior to those of the ordinary polyester units on the market today.

Type 109P Black Beauty Telecaps are molded in non-flammable phenolic and are mechanically rugged. They make an ideal capacitor for all TV and auto radio operations and are well suited for automation assembly by machine since the lead concentricity is closely fixed and there is no outer wax dip to jam inserting heads or magazines.

Complete performance data covering the wide range of sizes and ratings are in Engineering Bulletin 223, available on letterhead request to the Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

★ Trademark

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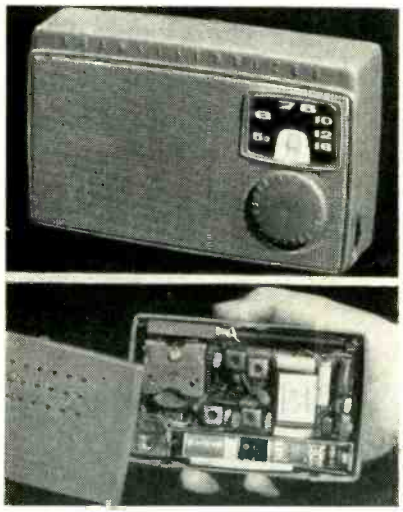
tronic instruments needed to give instanteous answers about the operating conditions of processes. It is developing its own staffs of qualified instrument mechanics, instrument engineers and research and development physicists.

As a result, in many cases, chemical companies have licensed instrument firms to make developments available to industry as a whole. This has come about because instrument manufacturers have not been expected to develop equipment to do special jobs because of high development costs, limitation of the market and a lack of knowledge of the problems that require quick solutions in a plant.

► **Needs**—Substantial gains in process equipment design along with improvements in product quality were seen possible providing instruments could be developed to measure continuously more process variables. These would include chemical composition, color, molecular weight and viscosity of flowing streams.

Instruments are needed also to measure weight per unit length of yarns and filaments, thickness measurements of moving webs of films and fabric and molecular orientation in fibers and films.

Japanese Portable Uses Five Transistors



SONY set delivers 10-mw to 2.5-in. speaker. Sensitivity is 1-2 mv/m. Uses agc and second-detector diodes. Sold in Japan since August

BATTERY-powered base station using Du Mont radiophone goes to work in Delaware River valley as . . .

Radio Aids Flood-Stricken East

Amateurs, commercial users and regular disaster groups employ radio equipment

MOBILE radio again proved its emergency value when devastating floods swept through the river valleys of the North-East in August. Police, National Guard, Red Cross and Civil Defense units used the equipment extensively. Amateurs put their equipment into service and one station in the Hartford, Connecticut area handled an estimated 800 messages during the disaster.

► **On the Spot**—The first amateurs to participate in flood relief work were mostly those enrolled in the civil defense organizations. Short range radio equipment, most of it mobile or portable, was put into service in hard-hit communities in Connecticut, Pennsylvania, and other disaster areas.

To replace telephone service disrupted by overflowing rivers, amateurs were stationed with equipment at fire houses, police stations, hospitals, dispatch points for rescue boats and helicopters and other strategic spots.

Others carried officials on damage-inspection tours, did patrol duty and served in other ways. Some manned longer-range radio gear at city or CD headquarters for contact with other communities.

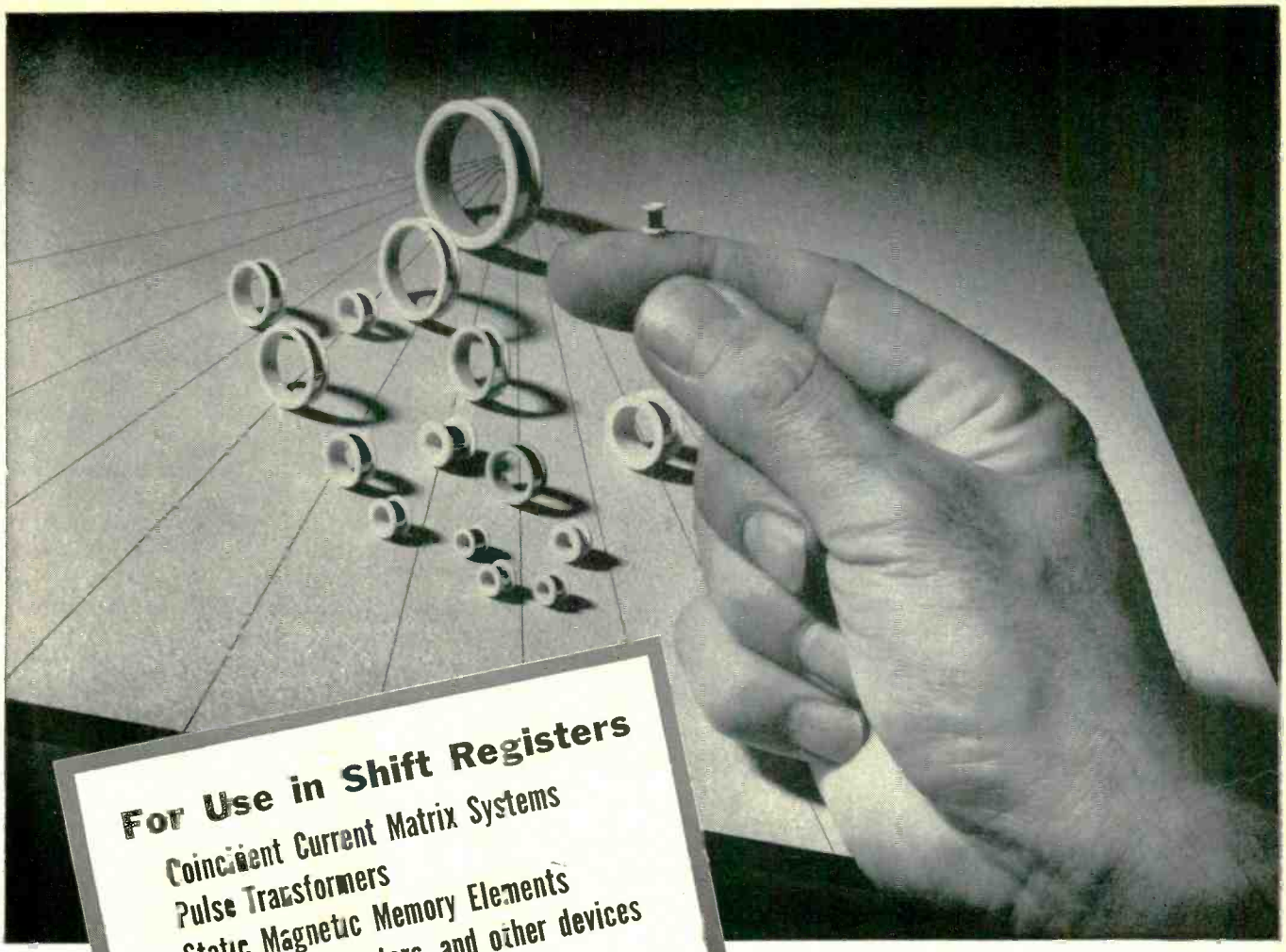
► **Relay Service**—Amateurs outside the heaviest-hit areas relayed messages for the Red Cross, state health and highway departments, the press services, Civil Defense and other authorities.

Amateurs were credited with an important part in the rescue of 300 youngsters on Pennington Island, in the Delaware River. Surveying the situation from the river bank, an amateur radioed from his car to state CD officials that helicopters would be needed. The last several children evacuated were in waist-deep water.

► **Town**—Commercial users of two-way radio pressed their equipment into service and communications firms in or near the flooded areas offered their equipment for use during the disaster. One company, Arnolt Communications Service of Metuchen, N. J., sent its emergency base station and four mobile units into the Delaware River valley area to aid flood victims.

The base station was set up at

(Continued on page 14)



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"TAPE-WOUND BOBBIN CORES FOR COMPUTER APPLICATIONS"

Includes essential data on applications and properties, fabrication and testing of Arnold Bobbin Cores; lists standard sizes, etc.

ADDRESS DEPT. E-510

These cores, fabricated by winding ultra-thin tape of high-permeability magnetic materials on ceramic bobbin cores, possess ideal qualities for use in electronic computer assemblies as memory cells.

Specifically, their desirable properties include quite rectangular hysteresis loops, relatively low coercive values and high saturation densities; plus temperature stability and the ability to shift in a few microseconds from negative remanence to positive saturation, and vice versa, under conditions of pulse excitation.

Arnold Bobbin Cores are available in a wide range of sizes, tape thicknesses, widths and number of wraps to suit the ultimate use of the core. Magnetic materials usually employed are Deltamax, Square Permalloy and Supermalloy, in standard thicknesses of .001", .0005", .00025" and .000125". Special advantages derive from Arnold's position as a fully-integrated producer of wound cores, able to maintain precise control over every production operation . . . melting, rolling, winding, testing, etc.

● *Let us supply your requirements for bobbin cores or any other magnetic materials.*

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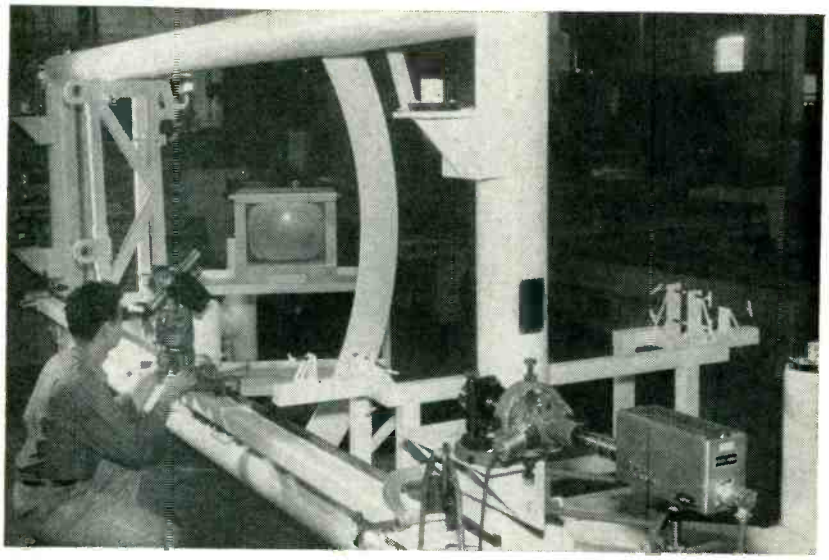
Carpentersville, a town of 400 persons, where rescue work had been proceeding slowly.

The four mobile units roamed a 15-mile area along the river, providing communications.



ITV, aimed at eyepiece of a jig transit of Douglas Aircraft, facilitates adjustment of aircraft assembly jigs as . . .

More Industries Put ITV To Work

Applications are increasing rapidly as tv manufacturers and customers push its use

STEPPED-UP use of closed-circuit industrial television equipment has been evident this year in many widely varied fields of business and industry. This has been largely due to the growing number of companies that are now making, promoting and selling the equipment. There are now 27 firms in the field.

New applications of equipment have not necessarily meant increased sales for all of the manufacturers because some of the uses have been on an experimental basis. However, sales in the field are up and total sales volume for 1955 has been variously estimated at from $3 million to $6 million.

► **Use**—Range of applications that have been made of closed-circuit tv show in the following list:

Dental and medical school instruction
Chemistry class instruction
Controlling linoleum mix
Guiding cranes and steam shovels
Railroad car classification
Auto and train tunnel viewing
Cueing sound effects in stage plays
Disseminating plane and train departure information
Interoffice and interplant two-way communication
Guarding plant entrances
Verifying signatures at banks and stores
Taking hotel reservations
Scheduling passenger and freight elevators
Baby sitting at supermarkets
Lining up aircraft assembly jigs
Reading water gages
Checking burner flames and smoke stacks
Remote medical diagnosis
Monitoring cigarette paper manufacturing
Aiding on-the-job training
Watching toll booth collections
Watching gambling tables
Watching for forest fires
Remote viewing of meetings and conventions
Interhospital consultation
Displaying merchandise in stores
Finding space in parking lots
Viewing fishery equipment underwater
Checking freight car numbers
Catching thieves in action
Viewing police lineups
Displaying meats in freezer to customers
Riding guided missiles
Watching atomic reactions
Defusing, unloading bombs
Underwater salvage
Guarding prisoners in jail
Displaying odds at race track
Viewing hot steel rolling mill operations
Providing entertainment on moving train
Remote viewing aboard ship
Viewing molten steel pouring
Allowing mass viewing of one microscope
Making motion pictures
Underwater viewing of river beds for dam sites
Monitoring furnace operations
Underwater inspection of docks and wharves
Studying oyster beds
Checking sugar cane conveyors
Observing plane landings in bad weather
Viewing military exercises

► **Future**—As can be seen from the list of actual installations, the possible uses for industrial tv are virtually limitless, bridled only by its initial cost and upkeep versus savings to be made by its use.

Copper Prices Soar As Supplies Drop

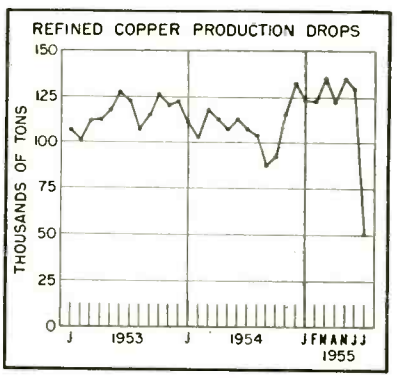
Strikes and floods combine to bring worst crisis in the industry's history

PRODUCTION of refined copper dropped from 131,431 tons in June to 51,182 tons in July and indications are that the decline is continuing. Demand has increased and copper prices have climbed steadily from 30 cents a pound in May to a current price of 43 cents a pound.

Some electronics manufacturers have already felt increasing prices or tightness of supply. Electrolytic sheet copper for printed circuits has gone up about 7 cents a pound in the past month and one type is now selling for about 80 cents a pound in 1,000-pound lots.

American Brass, supplier of electrolytic sheet copper, had no flood damage to its electrolytic sheet plant located in New Jersey. Revere Copper & Brass, which now supplies rolled printed circuit copper, also had no flood damage. But work stoppages and shutdowns in the copper industry earlier this summer combined with the effects of the flood on other segments of the industry have kept the entire copper supply picture critical.

► **Plea**—At the end of August, in a meeting of the Business and Defense Services Administration and the Primary Copper Producers Industry Advisory Committee, it was estimated domestic copper production would return to normal by the end of September. However,



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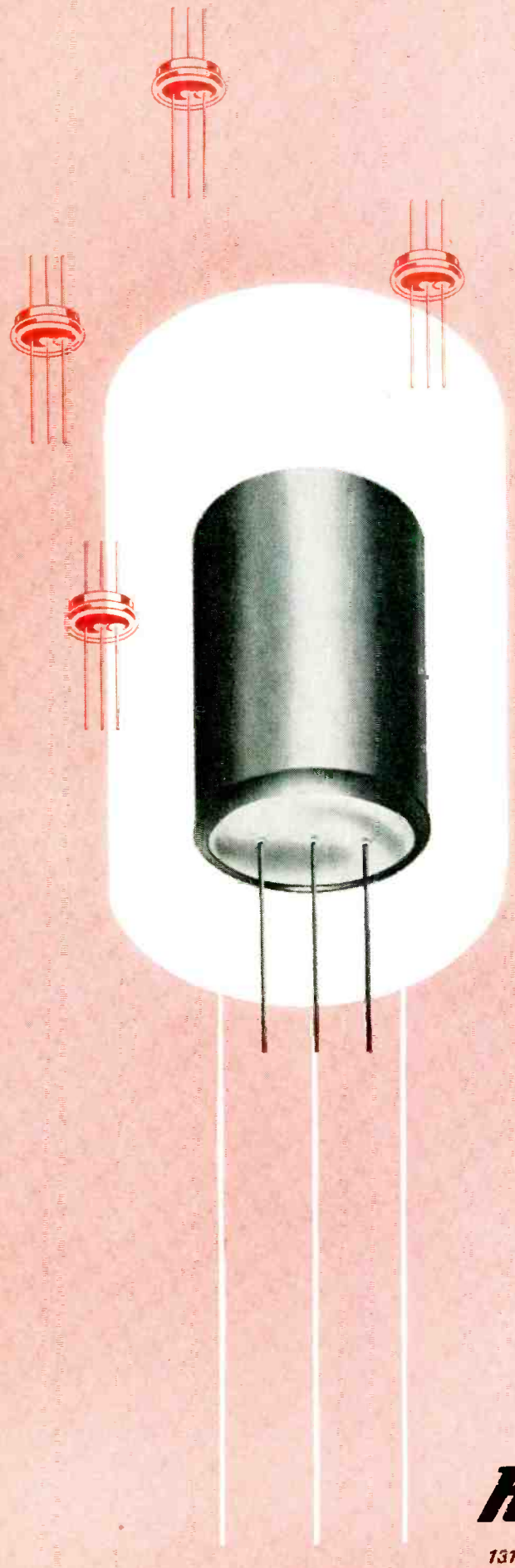

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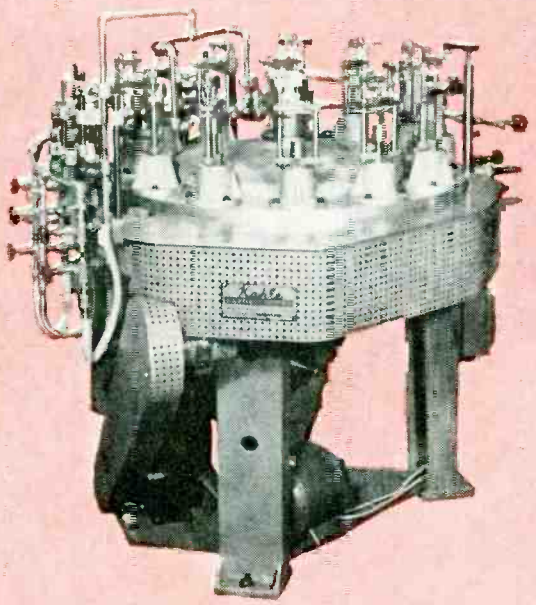
DIODES, TUBES AND
TUBE COMPONENTS...
faster,
more economically.



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on September 6, President Eisenhower was asked to call a special session of Congress if necessary to bring relief to the copper and brass industry now confronted with "the worst crisis in the industry's history".

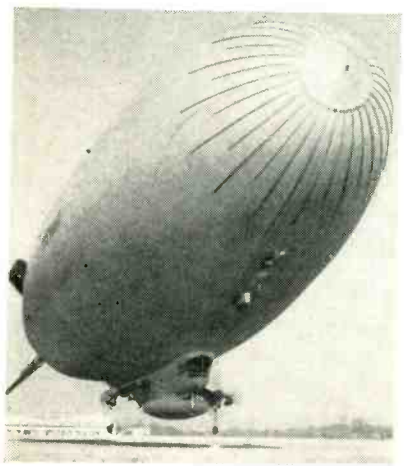
The request was made by the Copper and Brass Warehouse Association speaking also for the Copper and Brass Research Association and the wire and cable section of NEMA. The group asked for release of 100,000 tons of copper from the nation's stockpile.

According to the association, a nationwide survey indicated that brass and copper inventories have been reduced almost to the vanishing point. Distributors and warehouses across the country reported an average of one to three weeks supply on hand.

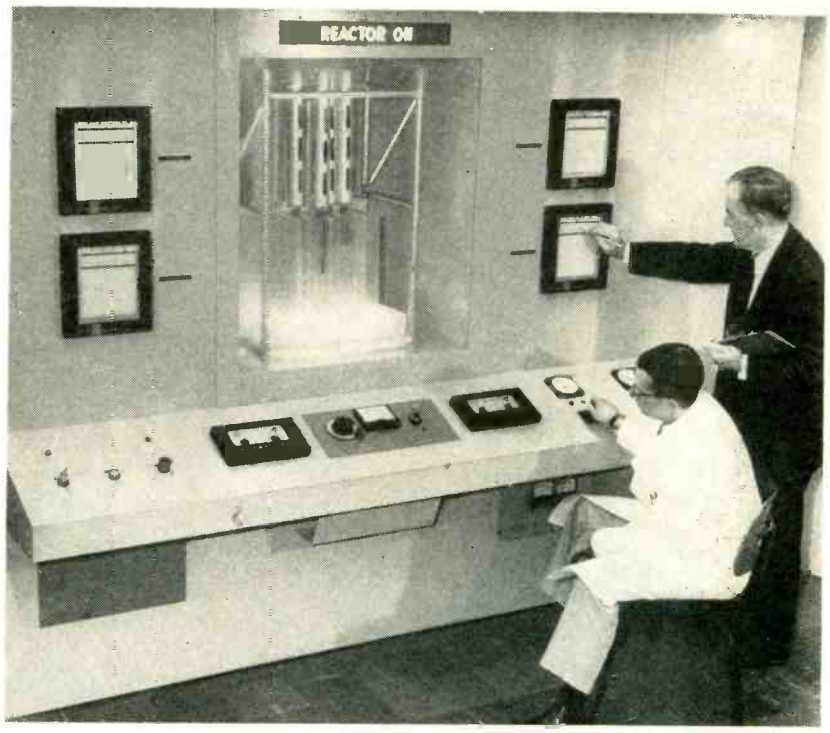
Normally reserve stocks in warehouses are sufficient to meet demands for two to three months. The survey also showed that 30,000 small manufacturing plants would have to shut down by the end of September unless deliveries returned nearer to normal.

The government has diverted a total of over 45,000 tons of copper from its stockpile for use by civilian industry this year.

Radar Network Link Takes To The Air



Mushroom-shaped radome beneath the cabin of this Navy picket blimp houses the antenna of high-power search radar, type AN/APS-20E, new airborne link in the radar network guarding North America



CONTROL rods move upwards and a ghostly blue light sweeps up the core when . . .

Mock Reactor Trains Engineers

Panel board, plastic core and analog computers provide operating experience

A TOTAL of 250 reactor engineers will complete training this year but by 1965 the atomic-energy industry may require 15,000. One answer may be the nuclear reactor simulator recently demonstrated by Leeds and Northrup.

Patterned after the Geneva swimming-pool reactor, the reactor model is made of plastic. The full-sized control panel is complete with instruments and controls. Rods in the reactor model move up and down in response to the controls.

► **Analog Computers** — Operating conditions are simulated by the equipment's analog computer. Incorporated in the control panel, it solves continuously the differential equations describing the kinetic operation of the reactor.

The mock-up reactor costs from $11,000 to $17,000 as against $350,000 for a real swimming-pool reactor. Simulators can be built for other types of reactors.

Flooded Industries Bounce Back

Defense contracts will aid recovery of electronic-component manufacturers

DAMAGE to electronics-manufacturing industry by recent floods will be partly alleviated by action of the Signal Corps. It is placing 100 to 150 contracts, at an estimated dollar value of $750,000, in the disaster areas.

Every procurement with the exception of mobilization base items, purchases under $1,000 and urgently required delivery items will be negotiated solely in the officially declared areas whenever a qualified source is known to exist in those areas. In procuring the urgently needed items, qualified firms in the disaster areas will be given an opportunity to compete

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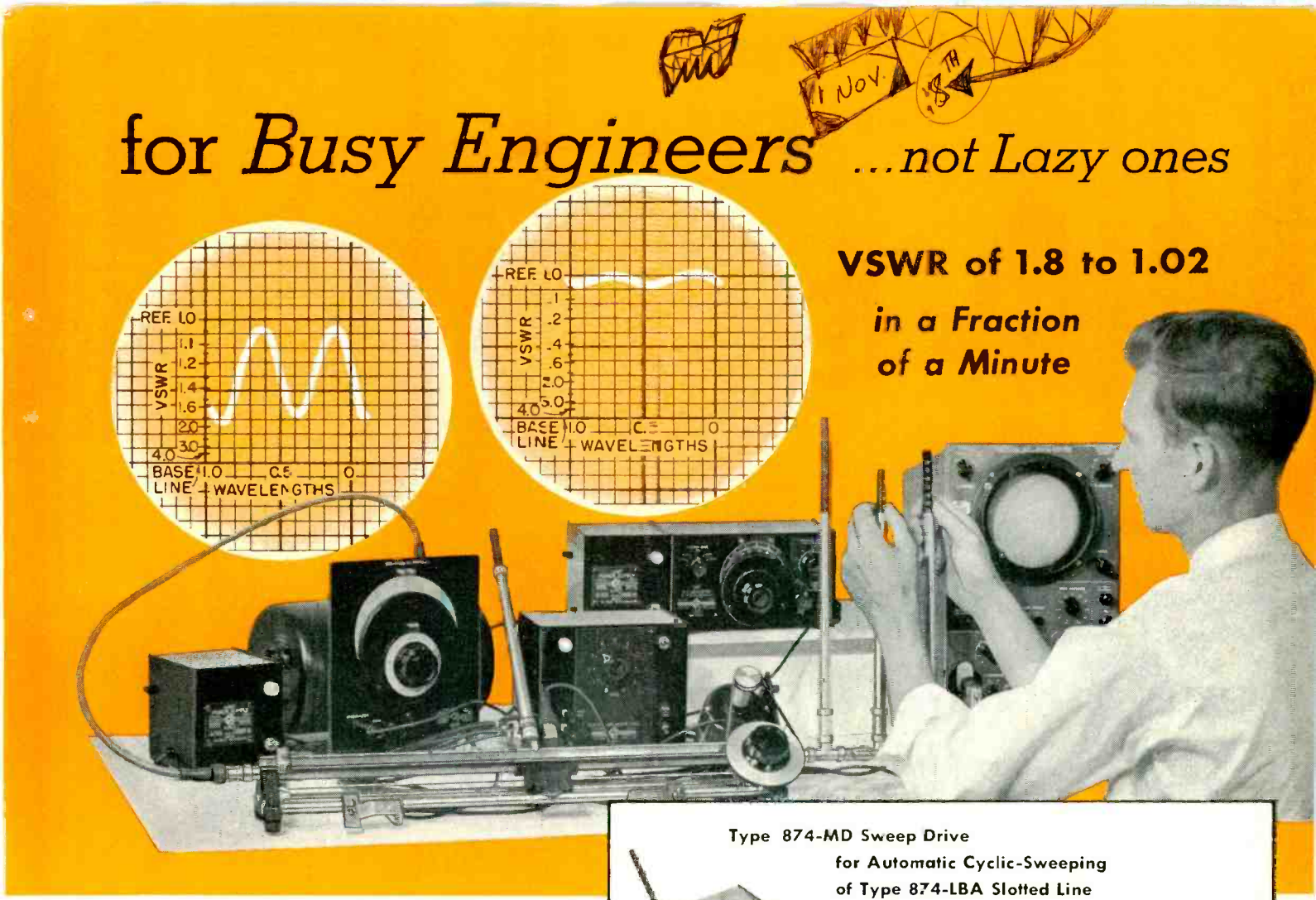
for *Busy Engineers* ...not Lazy ones



VSWR of 1.8 to 1.02

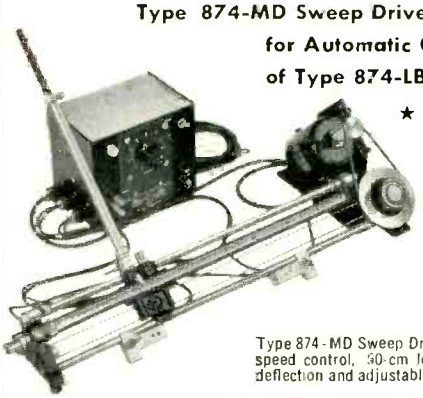
in a Fraction of a Minute

Anyone who has adjusted a three-stub matching network for minimum VSWR at microwave frequencies knows this is a time-consuming trial and error operation.

With the new G-R Type 874-MD Sweep Drive providing automatic sweep for the Type 874-LBA Slotted Line, this adjustment can be accomplished in 45 seconds. Without automatic sweep, the job could take as long as 15 minutes; two dozen or more stub adjustments and slotted-line hand-driven operations might be required before the matched condition is accomplished. This relatively simple application is an excellent example of the benefits which can be derived through an Automatic Sweep for the precision Type 874-LBA Slotted Line.

Wherever load adjustments or settings of any kind must be made in production or laboratory . . . to minimize VSWR, create a matched condition or to arrive at some desired impedance . . . the Sweep Drive can save hours of valuable engineering time. While the Slotted-Line probe carriage is automatically driven back and forth along the Line, the load adjustment or change is made slowly but *continuously*, as one notes the consequent change in VSWR pattern on the CRO face (or meter dial). The instantaneous indication of VSWR for each immediate setting provides the feedback link, via the operator's eye, which permits him to quickly "ease" the adjustable element in the load into the optimum position. There are no trial and error operations. The correct condition is arrived at the first time.

Type 874-MD Sweep Drive
for Automatic Cyclic-Sweeping
of Type 874-LBA Slotted Line



★ SWEEP SPEED — continuously adjustable from one full sweep (46 cm) in more than 10 seconds, to one full sweep in less than one second.

★ SWEEP RANGE — continuously adjustable from 1 cm to 46 cm.

★ CRO HORIZONTAL DEFLECTION SIGNAL — voltage divider with sliding contact on probe carriage provides d-c output.

Type 874-MD Sweep Drive . . . includes motor and drive mechanism, speed control, 50-cm long precision-wound potentiometer for CRO deflection and adjustable travel stops.....$220.00

Type 874-LBA Slotted Line . . . with Adjustable Stub for tuning crystal rectifier . . $231.00

The uses for this new tool in research and development laboratories are many. With an oscilloscope, this equipment not only gives an accurate visual presentation of the standing-wave over a very wide range of frequencies, but also presents the phase of the reflection coefficient. Impedance is *directly measured* from information on the scope face. For production "Go, No-Go" testing, the scope face can be crayon-marked for maximum acceptable VSWR — the answer appears as rapidly as the terminations, coaxial switches, connectors or other elements are connected to the Slotted Line.

The combination of the G-R Slotted Line with Automatic Sweep provided by the Type 874-MD Sweep Drive can save valuable engineering man-hours each day, at a time when engineers are in short supply. *Keep in mind, this equipment is designed for busy engineers — not lazy ones.*

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NEWER SMALLER TRANSISTORS

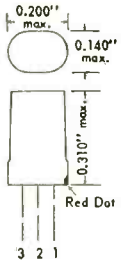
Transistor shown actual size

HERE'S PROOF!

Size of Raytheon 2N130 Series compared with other makes

Type	Volume* cu. in.
Transistor made by "A"	0.0546
Transistor made by "B"	0.0318
Transistor made by "C"	0.0242
Raytheon's New Transistors	0.0087

*The volume is that of the smallest rectangular parallelepiped which will contain the transistor.



RAYTHEON

Here they are! The new Raytheon Transistors that are only *one quarter to one third the former size*. They permit *real* miniaturization of equipment. Hermetically sealed; completely stabilized and interchangeable.

Hundreds of thousands of these new, small Raytheon Transistors have set new standards of performance in hearing aid service for more than a year. They are equally available for all other applications.

Look at the characteristics charted below including 2N133 with maximum noise factor of 10db. They are based on over two and a half years of mass production of transistors for commercial applications.

No other producer of transistors even approaches Raytheon's experience in manufacture and quality control or Raytheon's knowledge gained through large scale usage in everyday operation.

Type	Collector			Emitter	Base	Base Current Ampl. Factor	Max. Noise Factor db	Alpha Freq. Cutoff mc.	Max. Junction Temp. °C	Temp. Rise °C/mW
	Volts	Meg. ohms	Cutoff μA	mA	ohms					
2N130	−6	2.0	6	−1.0	350	22	25	0.6	85	0.77
2N131	−6	2.0	6	−1.0	700	45	22	0.8	85	0.77
2N132	−6	2.0	6	−1.0	1500	90	20	1.2	85	0.77
2N133	−1.5	1.0	6	−0.5	700	45	10	0.8	85	0.77

RAYTHEON TRANSISTORS

more in use than all other makes combined

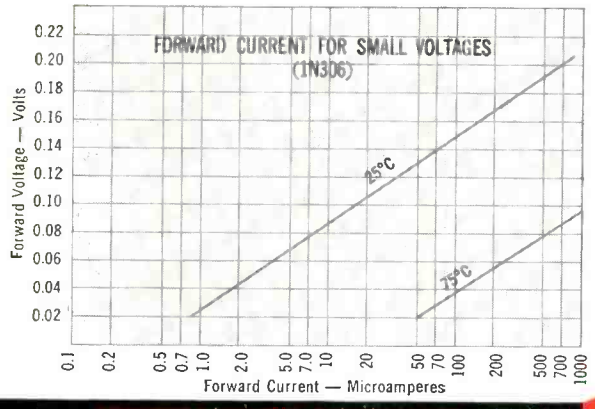
for predictable UNIFORMITY and STABILITY

specify RAYTHEON Gold Bonded Germanium DIODES

You'll find these small, rugged, hermetically sealed Raytheon Germanium Diodes ideal for Computers, Magnetic Amplifiers, Power Supplies, Detectors, Meter Protection or countless other applications where extremely low forward resistance and high reverse resistance characteristics are important. Here are some of the advantages you get when you specify Raytheon

1N305, 1N306 and 1N307 DIODES:

- **High forward current at low voltage**
- **Low saturation current**
- **Operable to 90°C with high uniformity and stability**
- **Mechanical ruggedness**
- **Small size**



	Forward Volts for 100 mA	DC mA. (max.)	Peak Inverse Volts	Reverse μA at −10V
1N305	0.8	125	60	2
1N306	0.8	150	15	2
1N307	1.0	50	125	5

Temperature rating −55°C to +90°C (Above ratings at 25°C)

MULTIPLE DIODE ASSEMBLIES

Raytheon can supply both germanium and silicon diodes, electrically matched, if required, in assemblies to meet your needs. For quotation, send your specifications to the nearest Raytheon office.

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Visit RAYTHEON Booths 73-4-5 at the National Electronics Conference, Chicago

with past and present suppliers.

Hardest-hit of several regions was that of Naugatuck River valley of Connecticut. Here, however, several electronic-component manufacturers of those affected are back to almost full production.

► **Typical Cases**—Haydon Manufacturing Co. of Torrington had losses totaling approximately $13,000. Their production of timers was interrupted primarily by lack of power.

Technicraft Lab. of Thomaston, Conn. had 6½ feet of water rushing through its plant at 45 mph. The water took with it most of the company's inventory and damaged equipment resulting in $150,000 loss. Except for some delays in deliveries, the company sees no loss of business. Production and facilities are expected to return to normal by October 1.

Inventory loss was experienced by Dano Electric Co. of Winsted, Conn. Most of the firm's equipment was at a level higher than the maximum reached by the flood waters. Inventory lost consisted of semifinished materials for production of coil windings and transformers. Full-scale production is expected before October 1.

Most damage was incurred by the American Brass Co. with six divisions in plants in Waterbury, Torrington and Ansonia. A producer of brass, copper and other metal rods and sheets, the company sustained a $15,000,000 loss, principally in fabricating machinery and buildings. Loss of inventory was relatively small.

Factory Inventories Set New Highs

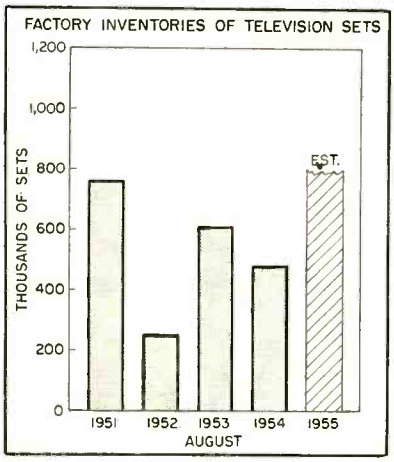
Manufacturers' warehouses bulged. Production and sales continue at a high rate

FACTORY inventories of tv receivers during the second and third quarters of this year have been the highest in history.

Between 700,000 and 800,000 sets were stacked in factory warehouses in August, equaling the record high stocks of 1951. In June and July, factory inventories approached one million units, by far the largest stocks ever held.

Inventories at distributor and dealer levels were also high, bringing total stocks in the industry to over 2.4 million sets, approximately one-third higher than in 1954. But dealer inventory was not as high as in 1954. At the end of June, retail outlets held 742,000 sets compared to 878,000 in June of 1954.

► **Makeup**—According to Standard & Poor's, at the end of June, 1954, high-priced console sets constituted 46 percent of total tv unit inventories and table models accounted for 52 percent. At mid-1955, these percentages had changed to 40 percent and 58 percent respectively.



► **Effect**—Television set manufacturers do not seem overly concerned about the current inventory situation. The summer months are traditionally the periods of high factory inventories.

After new line introductions have been made, shipments to distributors start and stocks dwindle rapidly. This year, factory inventories dropped approximately 200,000 units by September as distribution pipelines were filled.

Retail sales continued at a record pace. During the first seven months of this year, retail outlets sold 3.6 million tv sets and established a record for the period.

Computer Firms Report Gains

Smaller companies reveal several new installations and product developments

SALES of small, medium and special-purpose computers contribute significantly to the electronic digital computer business.

ElectroData discloses that 13 of their Datatron medium-sized computers are in use. Another machine will be installed this month for Babcock and Wilcox in New York.

► **Other Machines**—Two special-purpose machines are being installed at Convair-San Diego to solve differential equations in aircraft and missile dynamics. They will check solutions from analog computers. The machines are CRC-105's built by Computer Research division of National Cash Register.

Monrobot V is being checked out at the Corp of Engineers' Research and Development Labs, Fort Belvoir, Va. The 1,500-lb, 5-kw machine is designed for loading into a mobile laboratory. It will be used in preparing military maps. The machine is a product of the Monrobot Laboratory, Morris Plains, N. J.

► **Reservations**—Braniff Airways will install Teleregister Corp. equipment to keep track of reservations on all flights 31 days in advance. The equipment will be tied in with a 12,000-teleprinter network linking 58 U. S. cities and Latin American points.

Another Teleregister system will be installed by the New York Central to store information regarding up to 600,000 accomodations. Magnetic storage drums at New York, Chicago and Cleveland will serve 48 locations in 36 cities.

► **New Developments**—The Burroughs' character recognizer which reads serial numbers on 120 checks a minute is completing field tests at First National City Bank of New

(Continued on page 22)

NO SHOCK MOUNT EVER HAD IT SO TOUGH

That's why *ALL-ANGL* Barry mounts are used in MARTIN's *MATADOR*

Under the cumulative shocks of rocket-boosted zero-length take-off, jet-fighter flight maneuvering, and on-target dive that cracks the sound barrier, the nation's first operational pilotless bomber relies on ALL-ANGL Barrymount® isolators to protect critical electronic control gear.

Equally effective in every flight attitude, ALL-ANGL mounts permit bulkhead mounting that saves vital space in this deadly weapon. And their proved performance makes Barry mounts Martin's choice for the Matador

Let us show you how Barry's new ALL-ANGL isolators can lick *your* tough mounting problems. Data sheet M-9 gives mechanical and dynamic specifications. For specific recommendations, call your nearest Barry Sales Representative.

PHOTOGRAPH COURTESY THE MARTIN COMPANY

BARRY CONTROLS
INCORPORATED

707 PLEASANT ST., WATERTOWN, MASS.

York. The machine did work 10 times as fast as by manual means while reducing errors 90 percent.

Under development is an automatic bank bookkeeping system, a joint venture by Burroughs, Todd and Addressograph-Multigraph. Coded information in the form of invisible fluorescent dots is placed on a check as a by-product of other operations. Thus coded, the check can be used as input to data processing systems. Varying sized checks can be handled.

▶ **Fast Printing**—Installation of the Burroughs 900-line-a-minute printer will be this month in the New York area. The machine will combine multiple printing and card-punching operations from one pass of cards through the machine.

Burroughs has also under development an electrographic recording process in which characters are printed at the rate of 5,000 a second when coated paper carrying a pinpoint pattern of electrostatic charges is passed through a dry ink bath.

Several orders are reported for the E101, a $32,500-computer with input-output mechanism based on a standard type bookkeeping machine.

U.S. Contract Awards Emphasize Radar

Radar buying accounts for seven of ten big contracts let in August

GOVERNMENT contract awards amounting to one million dollars or more were let to seven firms during August. Total value of the ten contracts involved was $34,585,429.

Seven contracts amounting to $26,725,218 were for radar sets and related equipment. Three contracts for radio equipment totaled $7,860,211.

▶ **Contractors** — Two contracts were awarded to General Electric. Value amounted to $16,497,930. The contracts were for electronic countermeasures transmitters and for ground-based search radar.

RCA received contracts worth $4,512,051 for two models of radar equipment one of which was an airborne navigational radar.

▶ **More Radar**—Two contracts for airborne search radar and for radar parts went to Motorola. Value was $3,672,500.

Western Electric received a $2,042,737 contract for shipborne gun-directing radar equipment.

▶ **Radio Equipment**—Magnavox received a $3,096,619 contract for airborne navigational equipment. A $3,587,418 contract went to Crosley for ground-based radio communications equipment.

Kearfoot was awarded a contract for $1,176,174 worth of loop assemblies, indicators and other electronic parts.

Gas-Tube Shift Noted

Rectifier and control types have lost volume but hydrogen thyratrons have gained rapidly

SIGNIFICANT changes have been taking place in the gas-tube business in the past few years. Total sales for all types of gas-filled tubes have grown as have other electronics products.

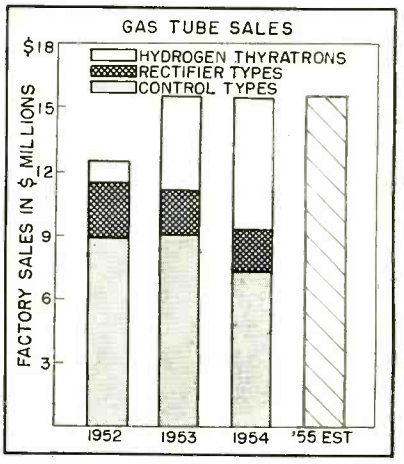
Total sales rose from $10.6 million in 1951 to $15.5 million last year. Some producers see 1955 sales continuing on the upgrade.

The makeup of these rising sales has changed considerably in the past three years. Hydrogen thyratron sales have risen from about $900,000 in 1952 to $6.2 million last year. Hydrogen thyratrons, primarily used as radar pulsers, are classified separately from control tubes by the industry.

▶ **Units**—Annual sales of rectifier and control types of gas or vapor tubes have both dropped more than $1 million since 1952. Rectifier types dropped from 455,000 units in 1952 to 293,000 in 1954 while control types declined from 1.5 million to 1.1 million during the period. Unit volume of hydrogen thyratrons climbed from 21,000 units to 64,000.

▶ **Gas**—Of the five rare gases of the atmosphere: argon, neon, xenon, helium and krypton, the first three find greatest use in electronics.

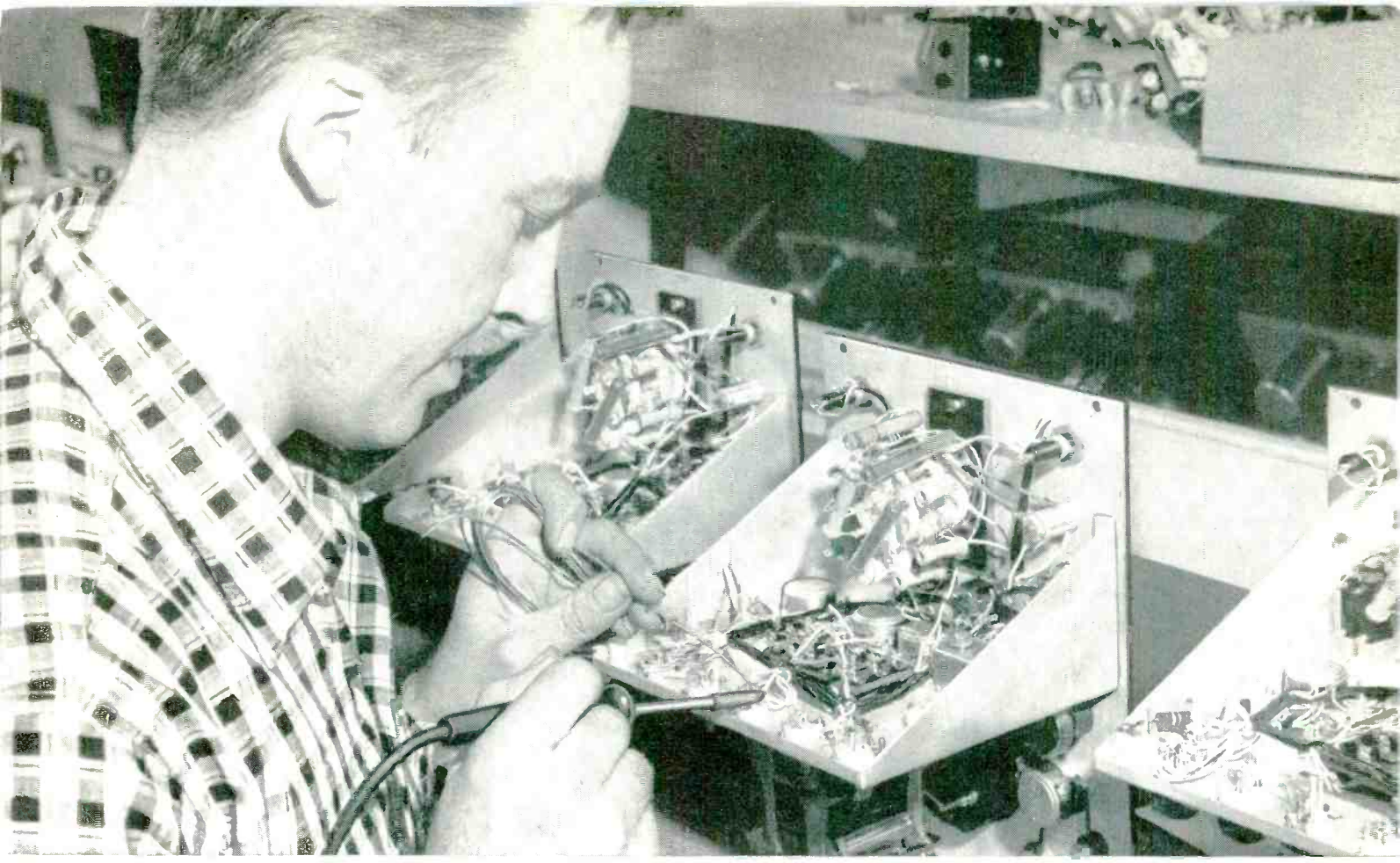
Argon is used in a number of electronic devices and as a fill gas for incandescent lamps. It is a major factor in the automatic electric welding industry. Neon, with other rare gases, is used in voltage regulator tubes, Geiger-Muller tubes, glow lamps and other electronic devices. Xenon is used in thyratrons and in high-speed photographic lamps.



▶ **Up**—According to the Department of Commerce use of argon by the electronics and electric-lamp industries rose from 8.8 million cubic feet in 1951 to 12.2 million cubic feet in 1953. Last year annual consumption reached a high of 13 million cubic feet. With prices of the purified grade of argon varying from 9 to 12 cents per cubic foot, this represented a dollar volume of some $1.3 million.

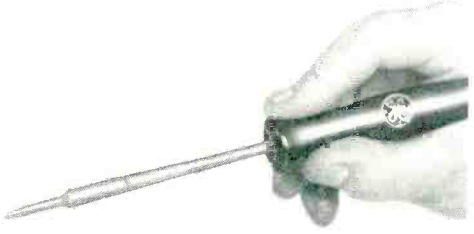
Nine companies produce argon in 14 plants across the U. S. Their combined capacity amounts to about 450 million cubic feet of refined argon per year. By the end of 1956 12 companies will be operating 21 plants with a capacity of 550 million cubic feet.

(Continued on page 24)

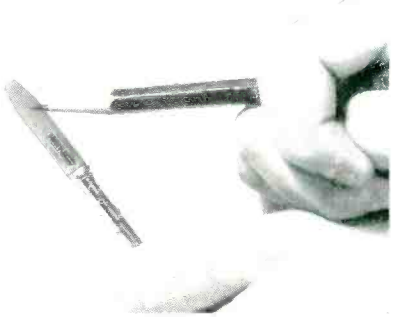


"BEST IRON WE'VE HAD in the plant," says William Fish, a production supervisor of General Radio, Cambridge, Mass. This company has switched to G-E Midget irons for soldering *both* delicate and heavy joints in their Type 1862-B Megohmmeters—jobs which formerly required *both* a heavy and a light iron. G-E Midget iron's light weight also helps reduce fatigue.

50 G-E Midget irons do work of 100 former irons at General Radio Co., boost production 25%



HANDLES LIKE A PENCIL—Weighing less than a package of cigarettes, the General Electric Midget soldering iron speeds production by reducing operator fatigue.



RAPID HEAT TRANSFER is achieved through a famous Calrod* heater located in the ironclad-copper tip. Result—the G-E Midget iron's heat efficiency is 90%.

*Reg. trademark of the General Electric Company

THREE-IN-ONE IRON with $\frac{1}{8}$", $\frac{1}{4}$", $\frac{3}{16}$" tip sizes gives you greater versatility to meet your soldering requirements. Tips can be changed in only 5 seconds.

For more information write for GED-2263, G-E Midget Soldering Iron, Section 724-3, General Electric Co., Schenectady 5, N. Y.

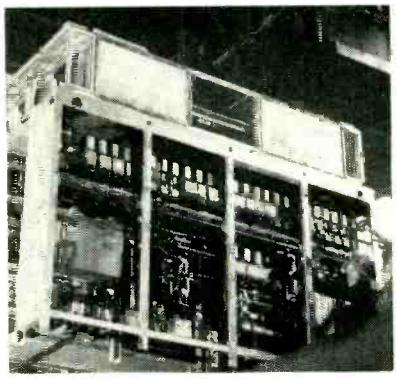
GENERAL ELECTRIC

More Locomotives Use Rectifiers

Ignitrons permit operating mass-produced d-c motors from railroad's a-c lines

TWELVE 3,300-hp rectifier locomotives now on order with GE will haul Virginian Railway trains over the 134-mile mountainous road from Roanoke to Mullins, W. Va. A pantograph trolley will collect 11,000-v, 25-cps, single-phase a-c from overhead lines. In each locomotive, 12 type GL6504 ignitrons will convert the a-c to low-voltage d-c.

The locomotives may thus be equipped with the mass-produced d-c traction motors developed originally for diesel-electric service. The ignitrons used weigh approximately 100 lbs each and measure 8 in. in diameter.



Preassembled control units speed locomotive erection

► **New Haven**—In March, GE delivered the first of 10 rectifier locomotives to the New York, New Haven and Hartford Railroad. The New Haven locomotives can operate from both 11,000-v a-c and 600-v d-c power.

Medical Television Makes Progress

Contract awarded to RCA for three color tv systems to be used in hospital activities

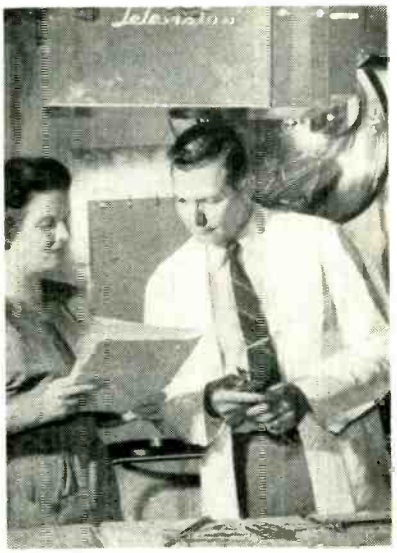
COMPATIBLE color tv installation is underway at the Walter Reed Army Medical Center for use in medical research, teaching and consultation.

The installation will provide three color television systems for use by the Armed Forces Institute of Pathology, the Walter Reed Army Hospital, and the Army Medical Service Graduate School.

► **Amount**—Contract for the color television system was awarded RCA on the basis of a low bid of $425,800. Installation is scheduled for completion early next year. The system will be operated by the Army Signal Corps.

Ultimately, it will be expanded to connect other governmental hospitals and military medical installations into a network for exchange of information and services.

► **Setup**—The three separate and complete color television studios can be operated independently, or joined as a network. Each will be equipped for closed-circuit operation and for direct transmission to commercial networks.



New tv camera developed by RCA for medical use

Thirty RCA Victor 21-inch color television receivers will be used.

The pictures transmitted by each studio can be confined to certain receivers or can be fed to a central control for distribution over an antenna system to all 30 receivers. Provisions are made for relay of signals from any studio to a projector in a central auditorium for large-screen pictures.

The antenna system provides three channels, one for each studio.

Computer Controls Cut Machining Costs

Machine tool manufacturers offer programming systems on wide range of tools

ELECTRONICS portion of the estimated $2-billion that manufacturers will spend in the next 18 months for new machine tools will be the largest ever and is expected to grow with the trend to more automatic production.

A survey by *American Machinist* comparing 1947 and 1955 machine tools indicates that the use of electrical and electronic equipment has increased by about two-thirds in the eight-year period.

► **Automobiles**—In the auto industry, where all major manufacturers are building or operating highly automatic engine building lines, the amount spent for electronic equipment has doubled. In the recently completed $22-million Packard engine plant, the entire operation is under the control of 14 separate electronic systems.

► **Computers**—Complete machining operations under control of analog or digital computers are now being supplied for lathes, boring machines, grinders, millers, punch presses and gear shapers. These units receive their instructions from punch cards, tape (both magnetic and punched paper) or from dial settings made by an operator.

► **Costs**—Although addition of computer control adds a sizable amount to the price tag on a machine tool, the saving in machining time can make up for it. In one

(Continued on page 26)

Performance is TOPS!

When you buy communications receivers, you buy performance above all else. And, performance is what you get when you buy the *NEW* PRO-310. It's the receiver designed with performance in mind. And, the PRO-310 outperforms all other receivers in its class. Here's why –

- **Took 3 years engineering and design time to develop, including 1½ years to iron out the 'bugs'.**
- **Hammarlund has the receiver know-how gained by making thousands of sets for gov't. service.**
- **These features:**
  Frequency readings to 1 part in 5000
  Continuously calibrated bandspread *over the entire range*
  Exceptional stability
  High Image Rejection—*on all 6 bands*
  Sectionalized construction
  Etched and plated circuits in the RF section
  Many others

Check on the *NEW* PRO-310—it's made to order for your "tough-spot" service. Write for specs and other details to The Hammarlund Manufacturing Co., Inc., 460 West 34th Street, New York 1, N. Y. Ask for Bulletin E-10.

The "Heart" of the Pro-310

Newly developed front-end with three tuned circuits but only one RF tube amplifier provides remarkable selectivity and ultra-high signal-to-noise-ratio.

HAMMARLUND
Since 1910

New PRO-310

Want more information? Use post card on last page.

instance, machining time on jet engine parts was reduced from 56 hours to less than four minutes.

Financial Roundup

More first half profit reports show the industry's healthy business volume

ALTHOUGH net profits in the first six months of this year for individual companies in the electronics field have shown wide variation, they have left no doubt as to the overall well-being of the industry. This can be seen in the following profit reports of 11 firms in the field for the fiscal periods indicated:

Company	1955 Net Profit	1954
Barry Controls 6m	$180,515	$168,926
Clary Corp. 6m	179,632	(loss) 40,638
Coleman Eng. 12m	52,290	30,687
CBS 6m	6,327,672	5,177,449
Eastman Kodak 6m	36,365,989	28,134,192
T. A. Edison 6m	571,378	459,603
Lear 6m	876,366	1,397,558
National Cash Reg. 6m	6,263,683	5,627,065
Texas Inst. 6m	696,010	591,596
Topp Industries 12m	130,274	71,885
United-Carr 6m	1,963,686	1,068,754

► **Securities**—Philco sold $15 million of 25-year 3.5-percent sinking fund notes to John Hancock Mutual Life Insurance. Proceeds will be added to working capital and will be used to finance expanded business volume planned in the advanced electronic and appliance fields.

El-Tronics offered 100,000 shares of common stock, par 5 cents, at $2.75 per share. Net proceeds are to be used to increase working capital and reduce accounts payable.

Tel-Instrument Electronics offered 199,999 shares of common stock, par 10 cents, at 1.50 per share. Net proceeds are to be used to purchase stock or assets of Roebrink, Labscope and Therica Equipment; for a research program and for acquisition of inventory and working capital.

Precision Radiation Instruments offered 225,000 shares of common stock, par 50 cents, at $5 per share. Proceeds will be used for acquisition of property, equipment and for working capital.

FUTURE MEETINGS

OCT. 3-5: National Electronics Conference, Hotel Sherman, Chicago, Ill.

OCT. 3-7: AIEE Fall General Meeting, Morrison Hotel, Chicago, Ill.

OCT. 3-7: 78th Convention of SMPTE, Lake Placid Club, Essex County, New York.

OCT. 10-12: AMA Conference on Automatic Production, Hotel Roosevelt, New York, N. Y.

OCT. 12-15: 1955 Convention of the Audio Engineering Society concurrent with the Audio Fair, Hotel New Yorker, New York, N. Y.

OCT. 17-19: RETMA Radio Fall Meeting, Hotel Syracuse, Syracuse, N. Y.

OCT. 20-22: Eighth Annual Gaseous Electronics Conference, GE Research Lab., The Knolls, Schenectady, N. Y.

OCT. 24-25: First Annual Technical Meeting, IRE Professional Group On Electron Devices, Shoreham Hotel, Washington, D. C.

OCT. 25-27: International Conference on Electronic Digital Computers and Information Processing, Darmstadt, Germany.

OCT. 26-28: Fourth Annual Conference, Atomic Energy In Industry, NICB, Waldorf-Astoria Hotel, New York, N. Y.

OCT. 28-29: 1955 Symposium of Philadelphia ISA, Penn Sherwood Hotel, Philadelphia, Pa.

OCT. 31-NOV. 1: 1955 East Coast Conference on Aeronautical and Navigational Electronics, IRE, Lord Baltimore Hotel, Baltimore, Md.

OCT. 31-NOV. 1: International conference on scientific basis of applied solar energy, University of Arizona, Tucson.

NOV. 1-5: World Symposium On Applied Solar Energy sponsored by AASE, Stanford Research Institute and University of Arizona, Phoenix, Ariz.

NOV. 3-4: Eighth Annual Electronics Conference, Kansas City IRE, Town House, Kansas City, Kan.

NOV. 7-9: IRE, AIEE, ACM Eastern Joint Computer Conference, Hotel Statler, Boston, Mass.

NOV. 14-15: IRE symposium on Communication by Scatter Techniques, Lisner Hall of George Washington University, Washington, D. C.

NOV. 14-16: IRE, AIEE, ISA Electrical Technology in Biology & Medicine, Shoreham Hotel, Washington, D. C.

NOV. 15-17: Second International Automation Exposition, Navy Pier, Chicago, Ill.

NOV. 21-22: IRE Aeronautical Communications symposium, Hotel Utica, Utica, N. Y.

NOV. 28-30: IRE Instrument Conference & Exhibit, Hotel Biltmore, Atlanta, Georgia.

DEC. 12-16: Nuclear Engineering and Science Congress, coordinated by Engineers Joint Council, Cleveland, Ohio.

Industry Shorts

► **Mini-Resistron** tube that is 90 mm long and 15 mm in diameter is used in a hand-size miniature tv camera introduced by Grundig at the German Radio Exhibition.

► **Conduction**-type radiation counter small enough for use in the body of a living animal or person has been designed and developed by Battelle Institute for the Army Chemical Corps.

► **Total** power supplied in the U. S. from the annual production of batteries is approximately 2 million watts, according to E. G. Linder of RCA.

► **More** than one tv antenna is used in about 75 percent of tv set installations in Caracas, Venezuela, according to Channel Master.

► **Special** Industrial Radio Service liberalized by FCC now includes building construction, mining, oil, gas and ice deliveries.

KAY

Wide Band Sweeps for Aligning Radar IF Amplifiers

KAY *Radaligner*

SPECIFICATIONS

Sweep: Regular sawtooth, adjustable around or synchronized with 60 cps power line.

Frequency Range: Center frequencies may be selected at any two points in the 15 to 80 mc band.

	Wide Band	Narrow Band
Sweep Width: Center Frequency below 30 mcs:	±5 mcs	±0.5 mcs
Center Frequency above 30 mcs:	±10 mcs	±1.5 mcs

Amplitude Modulation While Sweeping: Less than 0.05 db/mc.

RF Output Voltage: 250 millivolts into 70 ohms.

RF Output Control: Switched attenuators: 20 db, 10 db and 3 db. Continuous attenuator: approximately 6 db.

Markers: Fixed: Eight, narrow pulse-type, crystal-controlled markers, positioned at customer's option. Available singly or in any combination through individual switches.
Variable: Frequency continuously variable throughout selected sweep ranges. Frequency calibration accurate to within 0.5%.

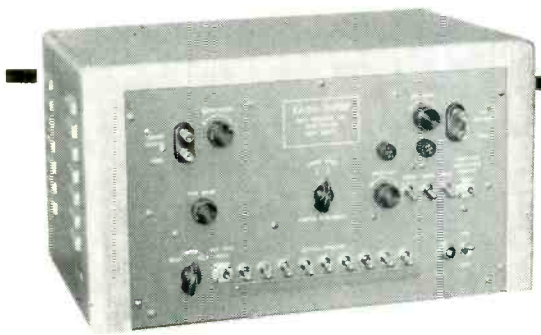
Marker Output Voltage: Positive pulse, approximately 10 volts peak.

Marker Output Control: Continuously variable, zero to maximum.

Power Requirements: 105 to 125 volts, 50-60 cps, approx. 110 watts.

Price: $795.00 (rack-mounted), f.o.b. plant. Cabinet $35.00 extra.

The Radaligner is a two-band sweeping oscillator designed to be used with a standard oscilloscope to determine frequency response of circuits from 10 to 170 mc. For frequency identifcation, the Radaligner includes eight narrow, customer-specified, crystal-controlled markers and a single variable marker covering both sweeping oscillator ranges. Center frequencies of sweep ranges also set to customer's requirements.



KAY *Rada-Sweep*

SPECIFICATIONS

Center Frequencies: 30 and 60 megacycles. Others may be added to special order.

Sweep Width: Wide—20 mcs or Narrow—3 mcs selected by a panel switch.

Sweep: All electronic, linear sawtooth. Sweep signal is brought out to terminals for connection to oscilloscope horizontal amplifier. Sweep repetition rate is adjustable around and may be synchronized to the cps line.

Markers: Up to 9 crystal positioned pulse type marks fed directly to scope vertical amplifier. Four supplied standard at 25, 35, 55 and 65 mcs. Others located as specified by purchaser. The standard marks may be replaced with others as specified. Individual on-off control of each mark.

Amplitude Modulation While Sweeping: Less than .05 db/mc.

RF Output Voltage: 250 millivolts across 70 ohms.

RF Output Control: Switched Attenuator: 20 db, 20 db, 10 db. Continuous Attenuator: covers approximately 5:1 ratio.

Marker Output Voltage: Positive pulse, approx. 10 V peak.

Marker Output Control: Continuously variable, 0 to maximum.

Power Supply: 105 to 125 volts, 50 to 60 cps. Power input approximately 100 watts. Circuit electronically regulated.

Price: $395.00 f.o.b. plant with standard marks. Any standard mark may be replaced with a special frequency—$10.00 each. Additional marks at $20.00 each.

A combined sweeping oscillator and crystal marker generator, the Rada-Sweep is designed especially for rapid alignment of radar IF amplifiers. Used with an oscilloscope, it will display response curves of IF amplifiers and mark up to nine frequencies to allow precise adjustment of response.

For complete information write:

KAY ELECTRIC COMPANY

DEPT. E-10 14 MAPLE AVENUE PINE BROOK, N. J.

TWO channels for ONE
with NORTHERN RADIO . . .

NEW! TWINPLEX COMMUNICATION UNITS

• provide 2 channels of FS communication with existing single channel transmitter and receiving facilities—with performance comparable to the existing single channel system

This Twinplex communication system makes possible a 2-channel radio circuit whereby 2 non-synchronous or synchronous telegraph transmissions modulate a single radio carrier wave by causing the carrier to assume one of four specific frequencies with 400 cps separations.

The transmitting equipment consists of the Twinplex Combiner Type 177 Model 1 and an RF Frequency Shift Keyer such as the Northern Radio Type 105 Model 4. The Combiner converts the four possible conditions of two telegraph signals (M1-M2, M1-S2, S1-M2, S1-S2) respectively into one of four voltages related in a 0-1-2-3 manner. The Combiner output voltage modulates the FS Keyer.

The receiving equipment consists of the Twinplex Converter Type 178 Model 1 and a single or diversity receiver such as the Northern Radio Type 110 Dual Diversity Receiving System. The Converter demodulates and separates the four audio tones from the radio receiver(s) into two channels each carrying the originally transmitted intelligence. The Twinplex Converter replaces the standard FS Converter for this purpose.

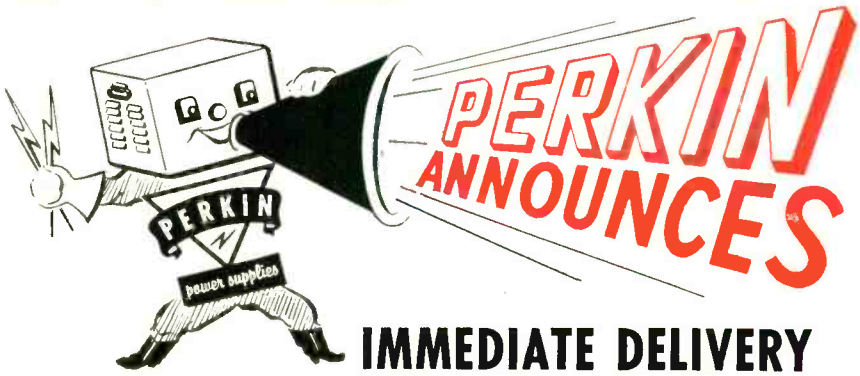
The two telegraph channels provide the same operational flexibility as that of two separate single channel FS systems. One can, for example, simultaneously use channel #1 on 60 wpm teletype and channel #2 on high-speed Morse or Time Division Multiplex. It further permits the reception of channel #1 signals on all standard FS converters (tunable to 400 cps shift) without need for a Twinplex Converter: this is valuable for "Forked Circuit Operation" where the intelligence of channel #1 is intended for pick-up by other receiving stations which are not equipped for Twinplex Reception in addition to the main receiving stations which are so equipped. Reception of channel #2 (or of both channels) requires the receiving end to be equipped with a Twinplex Converter.

Write for complete information.

- Frequency Shift Keyers
- Master Oscillators
- Diversity Receivers
- Frequency Shift Converters
- Multi-Channel Tone Systems
- Tone Keyers
- Demodulators
- Monitors
- Radio Multiplex Systems
- Tone Filters
- Line Amplifiers
- Twinplex Equipment

NORTHERN RADIO COMPANY, inc.
147 WEST 22nd ST., NEW YORK 11, NEW YORK
Pace-Setters in Quality Communication Equipment

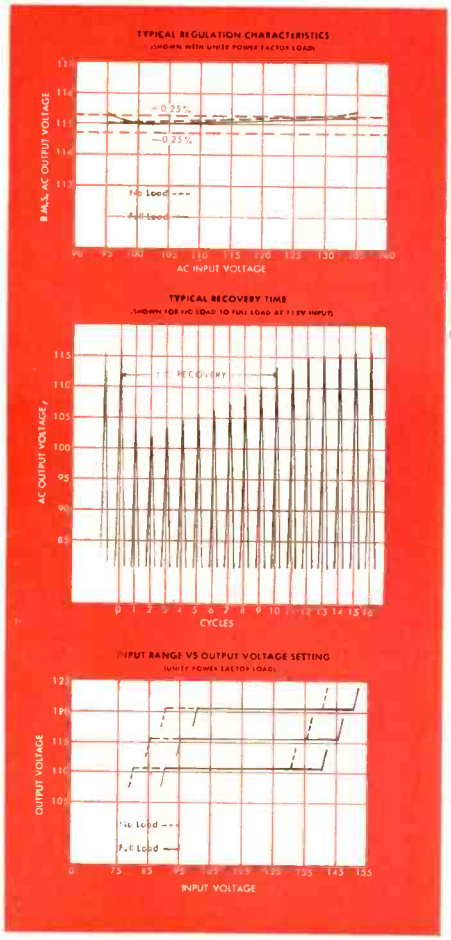
IN CANADA: Northern Radio Mfg. Co., Ltd., 1950 Bank St., Billings Bridge, Ottawa, Ontario.



IMMEDIATE DELIVERY on a NEW TUBELESS!

MAGNETIC AMPLIFIER

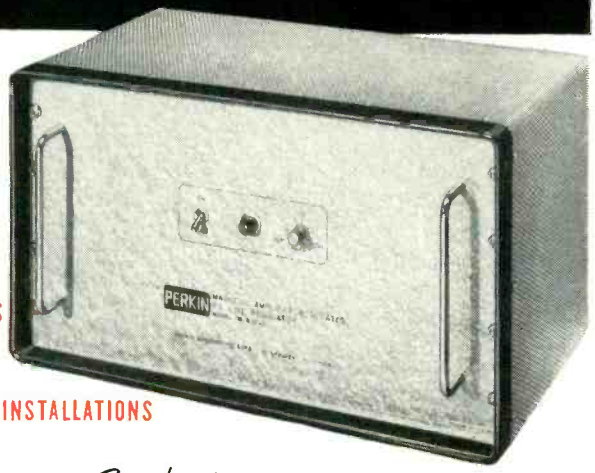
AC LINE VOLTAGE REGULATOR



MODEL MLR - 1000

1 KVA

- ☆ NO TUBES TO REPLACE
- ☆ NO MOVING PARTS
- ☆ NO VIBRATING CONTACTS
- ☆ REGULATES RMS VALUE
- ☆ IDEAL FOR UNATTENDED INSTALLATIONS



Specifications...

- Input Voltage Range: 95 to 135 volts
- Output Voltage: Nominal 115 volts. can be adjusted from 110 to 120 volts.
- Output Current: 8.5 amperes
- Regulation Accuracy: ±0.25% for any combination of line or load
- Frequency Range: 60 cycles ±10%
- Wave Form Distortion: 3% maximum
- Power Factor Range: 0.5 lagging to 0.9 leading
- Response Time: 0.2 sec.
- Maximum Load: 1.0 KVA
- Ambient Temperature Range: Up to 45° C.
- Dimensions: 19½" wide x 11" high x 11½" deep (cabinet)
  19" wide x 10½" high x 11½" deep (rack panel)
- Mounting: Cabinet or 19" Rack Panel
- Finish: Gray Hammertone
- Weight: 85 lbs.

PERKIN power supplies

Write for Bulletin MLR 1000

For PROMPT REPLY, wire the factory collect or phone our nearest sales office.

New York City:	HUnter 2-7784
Philadelphia:	NOrristown 5-2600
Chicago:	DIversey 8-6885
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Denver:	MAin 3-0343
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Syracuse:	2-1167
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Seattle:	MOhawk 4895
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PERKIN ENGINEERING CORP.

345 KANSAS ST, EL SEGUNDO, CALIF. PHONE: OREGON 8-7215

B-H VINYL-SIL 8000 FIBERGLAS SLEEVING

unequalled

moisture resistance

BH Vinyl-Sil 8000 has no capillary attraction to water. The heat-treated Fiberglas braid supporting the stabilized vinyl coating is pre-treated with a silicone sizing for water repellency — keeps it as dry as the Sahara at high noon.

In product assembly, proper varnish impregnation is difficult with a sleeving containing moisture. During operation, entrapped moisture will impair the insulation resistance of the sleeving. The presence of moisture will produce corrosive effects when coating breakdown is brought about by excessive overheating. But not when your products are protected by BH Vinyl-Sil 8000 — it has unequalled moisture resistance.

And, there are these additional features . . . *minimum* guaranteed dielectric breakdown of 8000 volts; high resistance to heat-aging, flow, oils, chemicals, abrasion and cut-thru; excellent low temperature flexibility.

All this positive protection is available at a cost no greater than that for less modern sleevings. Then, add this saving: BH Vinyl-Sil 8000 can be used for many varied insulation applications — helps keep sleeving inventories low.

There's only one way to know what BH Vinyl-Sil 8000 can do for you — try it. Send for a sample — split it and dip the end in an inkwell. You'll see that there is no capillary attraction to moisture — then make the same test with your present sleeving. Samples and data are yours for the asking — write today.

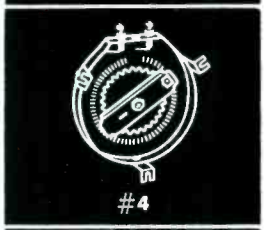
BENTLEY, HARRIS MANUFACTURING CO. **1310 Barclay St.**
CONSHOHOCKEN, PA. Telephone: Conshohocken 6-0634

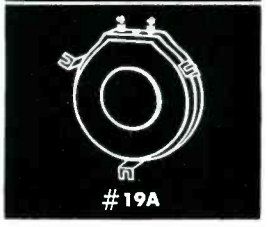
BENTLEY, HARRIS *Fiberglas** **SLEEVINGS**

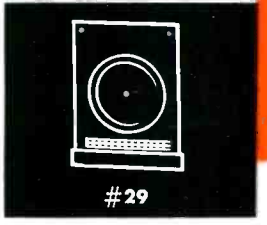
*BH Non-Fraying Fiberglas Sleevings are made by an exclusive Bentley, Harris process (U.S. Pat. Nos. 2393530; 2647296 and 2647288). "Fiberglas" is Reg. TM of Owens-Corning Fiberglas Corp.

Ward Leonard's Vitrohm...

the rheostat that wears many hats







Why do motor and generator builders prefer – and specify – Ward Leonard Vitrohm rheostats?

It's because the tremendous variety of standard accessories we build enables our rheostats to fit exact job requirements.

Standard Ward Leonard Vitrohm rheostats ranging from 120 to 3200 sigma watts (per plate) are available for mounting front or back of panel – in single or multi deck and in combinations of small and large plates – with single or concentric drive – and for manual or motor operation.

You get this exceptional versatility along with Ward Leonard's famous Vitrohm construction – steel plate foundation and large rectangular brass contacts embedded in vitreous enamel. Adds up to more rheostat for your money – when you shop at Ward Leonard.

For information on Vitrohm rheostats, send for fully illustrated, data-packed catalog #60. Write Ward Leonard Electric Company, 350 South Street, Mount Vernon, N.Y.

5.3

#3 Rear view 8" rheostat with standard contacts
#4 Rear view 8" rheostat with multistep contacts
#10 2 deck rheostat for back of board; single handwheel
#12 2 deck rheostat for front of board; concentric handwheel
#19A Rheostat with enclosing cover
#19B Rheostat with cover and conduit fitting
#21 Rheostat with adjustable stop
#24 3 terminal rheostat for potentiometer connection
#27 Special panel for extruder and capstan take-up
#29 Special motor operator for variable speed drive

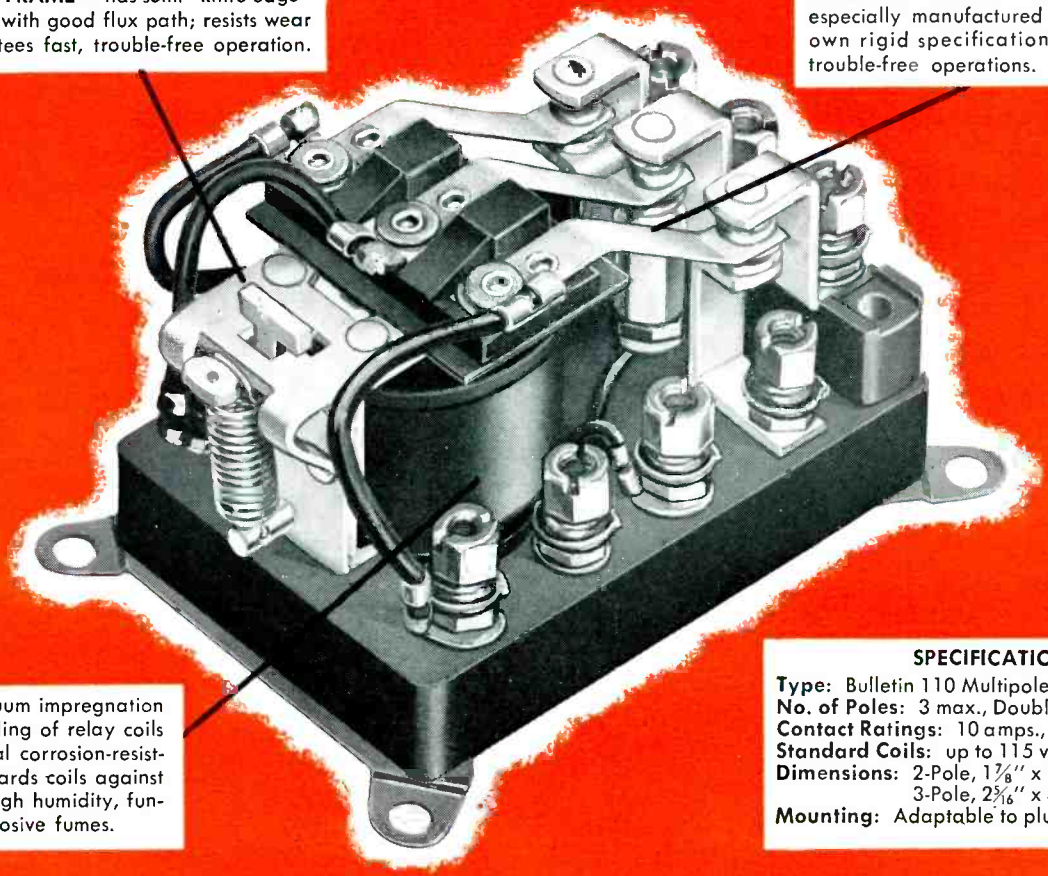
WARD LEONARD ELECTRIC COMPANY
MOUNT VERNON, NEW YORK

RHEOSTATS | RESISTORS | RELAYS | MOTOR CONTROLS | DIMMERS | CHROMASTER

Result-Engineered Controls Since 1892

ARMATURE-FRAME — has semi "knife-edge" construction with good flux path; resists wear and guarantees fast, trouble-free operation.

CONTACT FINGERS — alloy leaf-spring type especially manufactured to Ward Leonard's own rigid specifications gives millions of trouble-free operations.



COIL — vacuum impregnation and end sealing of relay coils plus a special corrosion-resistant finish guards coils against salt spray, high humidity, fungus and corrosive fumes.

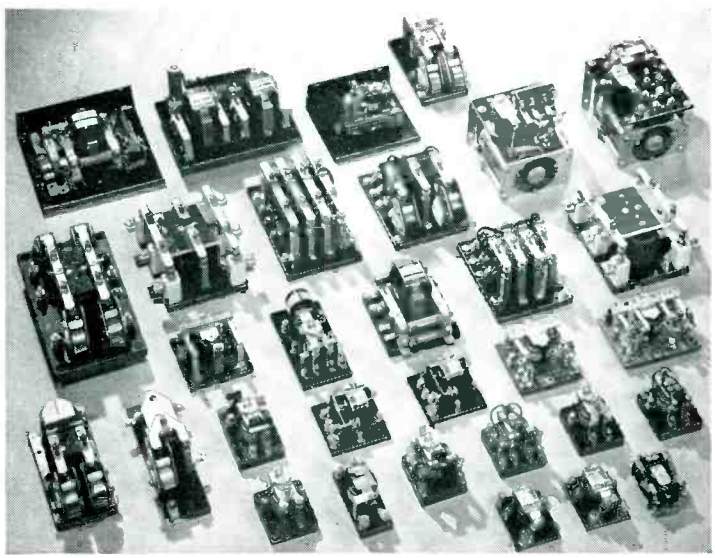
SPECIFICATIONS

Type: Bulletin 110 Multipole Midget
No. of Poles: 3 max., Double Throw
Contact Ratings: 10 amps., 115 volts, A.C. max.
Standard Coils: up to 115 volts, A.C. or D.C.
Dimensions: 2-Pole, 1⅞" x 3" x 1⅞" high
3-Pole, 2⅝" x 3⅝" x 1⅞" high
Mounting: Adaptable to plug-in mounting

Here's why you get long life from Ward Leonard relays

• When applied properly and given normal care, Bulletin 110 relays, shown above, have a life expectancy of several million operations. Such exceptionally long life, typical of Ward Leonard's relay line, is made possible by: 1. Good mechanical design. 2. Quality-controlled manufacturing methods and materials. 3. Ample "safety-factor" electrically and mechanically.

Whether your product is a complex electronic instrument or a simple household gadget, our engineers will be glad to help you select the dependable electrical controls you need. Write Ward Leonard Electric Co., 350 South St., Mount Vernon, New York.



SHOWN AT RIGHT are typical Ward Leonard relays designed to meet your specific requirements in dimensions, methods of mounting, circuit connections, contact materials, coils and other features.

WARD LEONARD ELECTRIC COMPANY
MOUNT VERNON, NEW YORK

RHEOSTATS | RESISTORS | RELAYS | MOTOR CONTROLS | DIMMERS | CHROMASTER

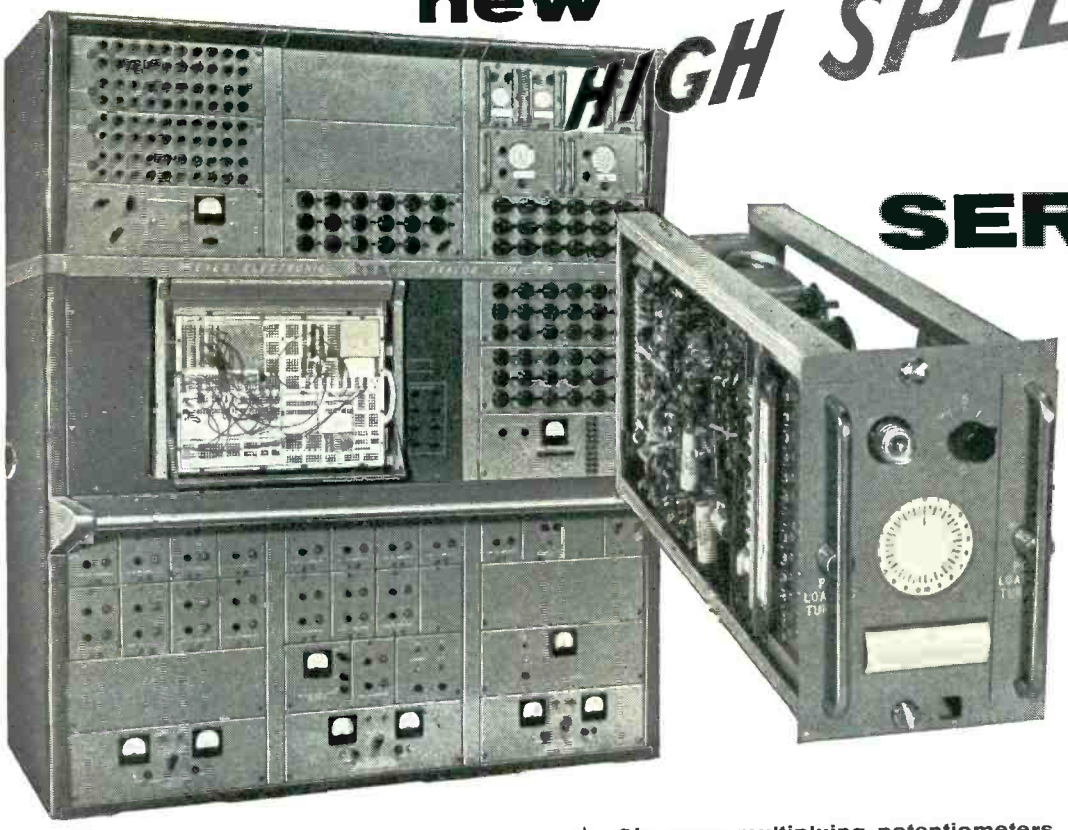
Result-Engineered Controls Since 1892

another outstanding feature . . REEVES

REAC 400

ANALOG COMPUTER

new HIGH SPEED SERVOS



- Bandwidth over 50 cps.
- Velocity 1500 v/sec.
- Plug-in turrets for function generation

New **BUILDING-BLOCK CONSTRUCTION**

Permits assembly of computer elements in any desired combination to do particular job or expand existing installation

New **CONVENIENT PATCHBAY**

Available in units of 1632, 3264 or 4896 holes for maximum flexibility. Patchboard changes possible during operation.

New **POWERFUL AMPLIFIERS**

Noise less than 3 mv rms **in cabinet.** Phase shift 0.075° @ 100 cps. **in cabinet.** Bandwidth over 10 KC **in cabinet.**

New **HIGH SPEED RESOLVERS**

Vastly improved dynamic performance . . . 35-cycle bandwidth.

★ **Six gang multiplying potentiometers.** Accuracy equivalent to 0.1% linearity potentiometers (over-all multiplying accuracy 0.2% *including mechanical non-linearities).* Two gangs tapped for function generation.

★ **Two front panel plug-in turrets** for padding or feeding voltages into the tapped pots for function generation. Turrets may be stored for future use.

★ **High Speed** — Velocity 1500 v/sec.

★ **Long Life** — Carbon film potentiometer gives exceptionally long life even at high velocities.

★ **Superior Frequency Response:**
Maximum amplitude rise 1.4 @ 40 cps.
Bandwidth over 50 cps.
Dynamic error less than 0.5% of input @ 2 cps.!
Phase shift less than 0.3° @ 3 cps.!

★ **Exceptional low speed performance too** — Typical tracking error less than 0.05 volts maximum for ramp input as low as 0.01 v/sec.

Reeves INSTRUMENT CORPORATION

REEVES INSTRUMENT CORPORATION

A Subsidiary of Dynamics Corporation of America

201 East 91st St., New York 28, N. Y.

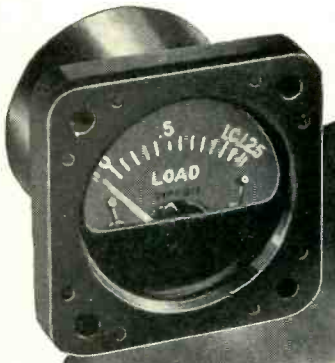
REAC Analog Computers

Precision Floated GYROS

Precision RESOLVERS and PHASE SHIFTERS

SERVO MECHANICAL PARTS

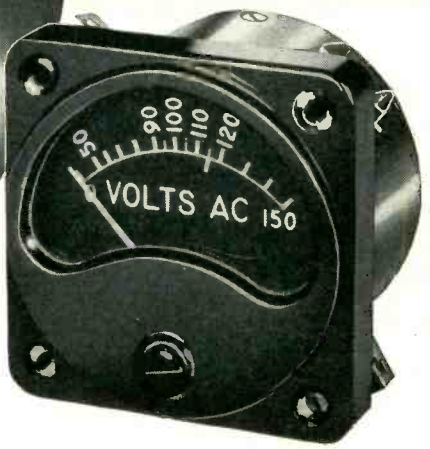
5RV55



AIRCRAFT LOAD METER
Range: 50 MV, Arbitrary scale in LOAD. Used in conjunction with external shunt to measure load on DC aircraft systems.

The SKY'S the Limit!

AIRCRAFT VOLTMETER
Range: 150 VAC
Supplied in 400 cycle, 350-1000 cycle, 800-1400 cycle frequencies.



DUAL VOLT-AMMETER
Ranges: 15-33 volts—0-150, 0-300, 0-450 amperes. This meter is produced exclusively by Roller-Smith.

IN AVIATION THERE'S NO INSTRUMENT PROBLEM TOO GREAT FOR ROLLER-SMITH

Aviation today relies on Roller-Smith to supply high quality precision aircraft instruments. Drawing on a background of nearly fifty years of engineering and manufacturing experience, Roller-Smith instrument-makers are able to offer a complete line of instruments, designed to meet exacting specifications.

If you have a specific problem in instrument research or development, take advantage of Roller-Smith's years of experience and know-how . . . consult our engineering staff for the answer.

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Instrument Division
CORPORATION
1825 WEST MARKET STREET BETHLEHEM, PENNSYLVANIA
Precision Products Since 1908

w! Use your 4B Electronic Counter

to 12 KMC!

Your -*hp*- 524B is the world's premier electronic counter—standard of the industry. Today, the usefulness of this outstanding instrument is extended—vastly—by one simple new instrument from the Hewlett-Packard laboratory.

NOW YOU CAN HAVE...

FREQUENCY MEASUR[illegible]ENT
0 TO 12 KMC!

*You need just these two basic instruments**

-*hp*- 524B ELECTRONIC COUNTER

NEW -*hp*- 540A TRANSFER OSCILLATOR

With the perfection of the versatile -*hp*- 540A Transfer Oscillator, Hewlett-Packard has made possible—for the first time—convenient high accuracy frequency measurements far into the microwave region.

Measurements can now be made with electronic counter accuracy to 12 KMC—with a new system composed of the 524B counter, the new 540A, and the 524B's appropriate plug-in Frequency Converter, -*hp*- 525B.

The heart of the system is the precision -*hp*- 524B Electronic Counter—in terms of capability, accuracy, convenience and quality, the world's premier counter and standard of the electronic industry. Together with its unique plug-in frequency converters, video amplifiers and time interval units, this versatile instrument will measure frequency from 10 cps to 220 MC, interval from 1 μsec to 100 days and period from 0 cps to 10 KC.

The development of the new -*hp*- 540A Transfer Oscillator permits the 524B, together with its converter, to measure

*Oscillosynchroscope required for pulsed measurements. External detector (-*hp*- 440A) required for measurements above 5 KMC.

SPECIFICATIONS

-*hp*- 540A Transfer Oscillator

GENERAL

Frequency Range: 10 MC to 5,000 MC. (10 MC to 12,000 MC or higher with external detector such as -*hp*- 440A.)
Input Signal: CW, FM, AM or pulse.
Input Signal Level: 50 MV to 5 v peak across 50 ohms.
Accuracy: CW: Approx. 1/1,000,000 or better.

OSCILLATOR

Fundamental Frequency Range: 100 MC to 220 MC.
Harmonic Frequency Range: Above 12,000 MC.
Stability: Less than 0.002% change per minute after 30 minute warmup.
Dial: Six inch dia., calibrated in 1 MC increments. Accuracy: ±½%.
Output: Approx. 2 v into 50 ohms.

ATTENUATOR

Range: Approximately 20 db to 80 db.
Input Impedance: 50 ohms, SWR: 1.5 max. at 1 KMC; 3 max. at 5 KMC.

AMPLIFIER

Gain: Variable, 40 db max.
Bandwidth: Variable. High Frequency: 3 db point adjustable 1 KC to 2 MC. Low Frequency: 3 db point switched from 100 cycles to below 10 KC. Adjustable to above 400 KC.

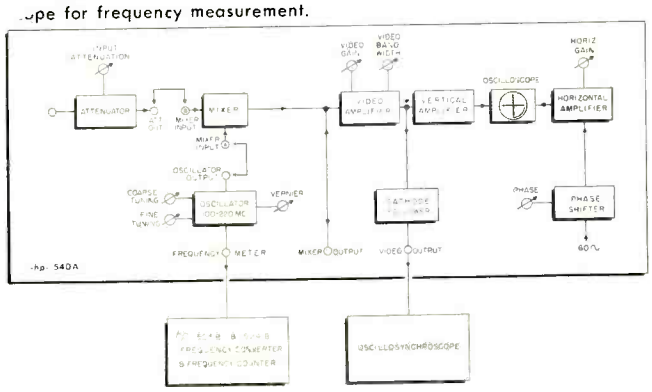
Today, more than ever, hp stands for

Measure pulsed, FM, CW, AM or noisy signals with electronic counter accuracy!

ith precision hitherto associated se instruments now make possible etermination of frequency in CW ermine center frequency and devi- ing appreciable FM or noise. With ey make highly accurate measure- in pulsed signals.

s a stable, 100 to 220 MC oscillator 12 KMC for comparison with the son device is a diode mixer, ampli- oscilloscope. (See Figure 1)

Block diagram, -*hp*- 540A with 524B, 525B and oscillosynchroscope for frequency measurement.



In operation (assuming approximate frequency of signal to be measured is known), the -*hp*- 540A oscillator is tuned until one of its harmonics zero beats with the unknown. The multiplying factor is noted. The transfer oscillator frequency is measured directly on the 524B counter. This 524B reading, times the multiplying factor, gives the frequency of the unknown.

When the frequency to be measured is totally unknown, a convenient method employing two or more harmonics can be used to calculate the multiplying factor.

In measuring carrier frequency of pulsed power, an external oscillosynchroscope is used to display the detected pulse. Zero beat appears as horizontal lines across the pulse when the oscillator is tuned to an exact sub-multiple.‡

In working with noisy or AM signals, the -*hp*- 540A delivers a CW signal to the counter while the comparison circuits are narrowed so that accurate indication of zero beat may be obtained.‡

In signals with appreciable FM, the 540A's built-in oscilloscope presents a characteristic pattern delineating upper and lower frequency deviation limits. If FM deviation is uniform, center frequency will also be determined. When used with the new -*hp*- 500B Frequency Meter, the 540A will permit indication of exact FM deviation.‡

ACCURACY

Accuracy of the system is approximately 1/1,000,000 or better on clean CW signals. On pulsed signals, the accuracy of measurement depends on the frequency of the carrier and the length of the pulse. Typical accuracy is approximately 2/1,000,000. On signals where high amounts of noise or intense AM is present, the transfer oscillator system often provides the only means of making accurate measurement. The accuracy of the system in general is better than 10 times that of the best microwave wavemeters.

UNIQUE QUALITY FEATURES

Each of the circuit elements of the 540A Transfer Oscillator (see Figure 1) may be used separately by shifting patch cords on the instrument panel. Tuning controls are triple; including a coarse and fine mechanical control and an electric vernier. Vernier range is approximately ±125 parts per million. The instrument's video amplifier has both gain and bandwidth control. Horizonal input to the oscilloscope is 60 cps, with phase control. Input attenuation is variable from 20 to 80 db to adjust signal for optimum mixing level.

‡For complete discussion of microwave measuring with transfer oscillator and electronic counter, write to -*hp*- for -*hp*- Journal, Vol. 6, No. 12.

Output: 1 volt peak max. into 1,000 ohms.

OSCILLOSCOPE (SELF-CONTAINED)

Frequency Range: 100 cps to 200 KC.
Vertical Deflection Sensitivity: 1 volt per inch.
Horizontal Sweep: Internal, power supply frequency with phase control, or external (connection at rear).

MISCELLANEOUS

Connectors: Input, type N; all others type BNC.
Size: Cabinet Mount: 20¾" wide, 12½" high, 14¾" deep. Rack Mount: 19" wide, 10½" high, 12¾" deep.
Power Supply: 115/230 v ±10%, 50/60 cps, app. 75 watts.

Auxiliary Equipment: -*hp*- 524B Electronic Counter, $2150.00
-*hp*- 525B Frequency Converter, $250.00
-*hp*- 440A Detector Mount, $85.00

Price: -*hp*- 540A Transfer Oscillator, $615.00.

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

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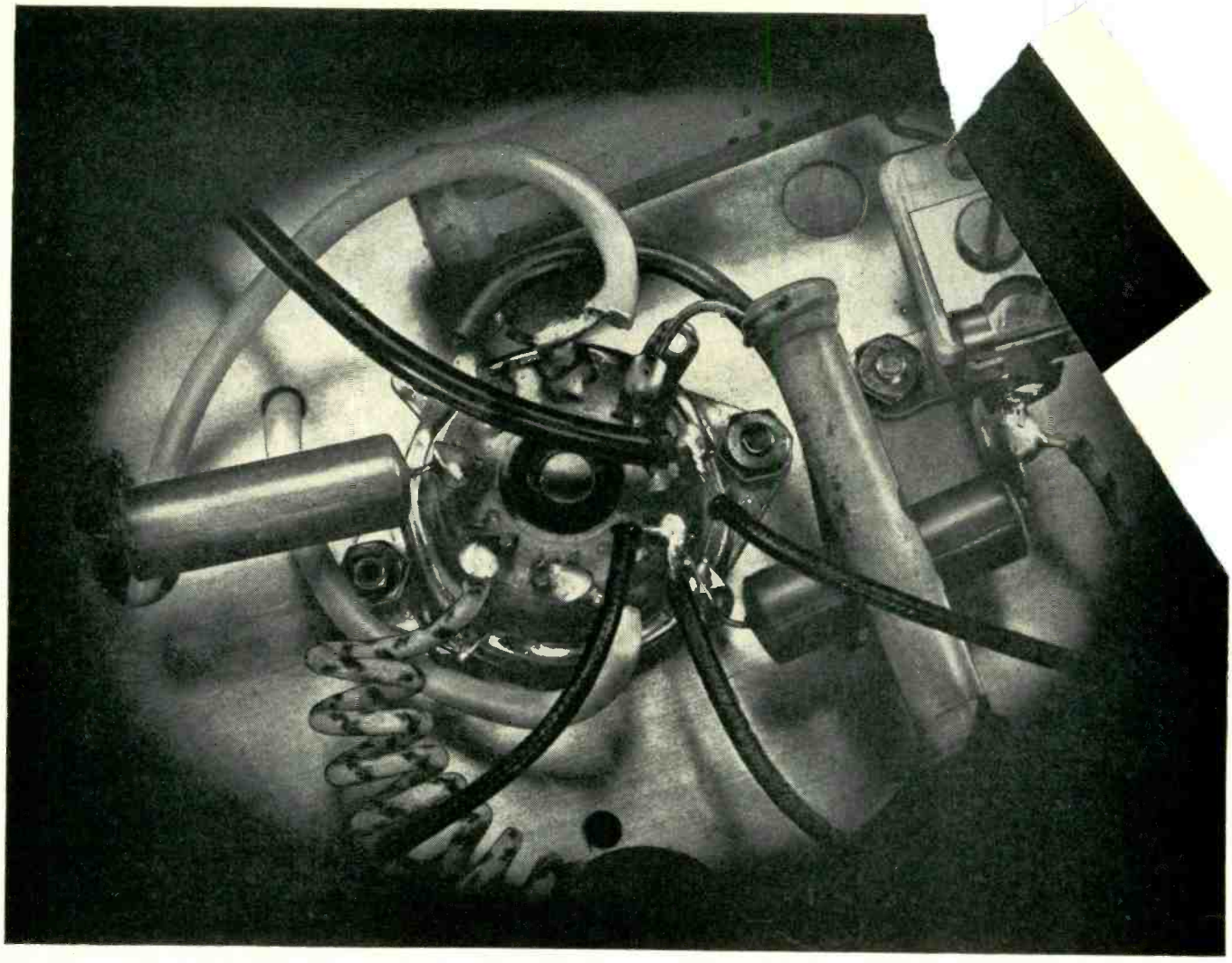


Vacuum-melted alloys give superior electrical properties...

HERE ARE SOME EXAMPLES . . .

Vacuum-melted cathode nickel alloys, iron and metal-glass-seal alloys are held to extremely close standards of purity, composition and uniformity. Secondary emissions and outgassing are minimized – shelf life increased – for vacuum tubes of many kinds.

Vacuum-melted copper shows marked increase in purity, soundness and conductivity.

Soft magnetic alloys achieve improved permeability, both initial and saturation – with stronger directional properties.

The reason lies in the process itself. Undesirable interstitial elements such as oxygen, nitrogen and carbon are literally sucked from the molten metal by the high vacuum that's used. The result is high-purity, gas-free alloys of closely controllable composition . . . alloys that may far outperform conventional air-melted metals.

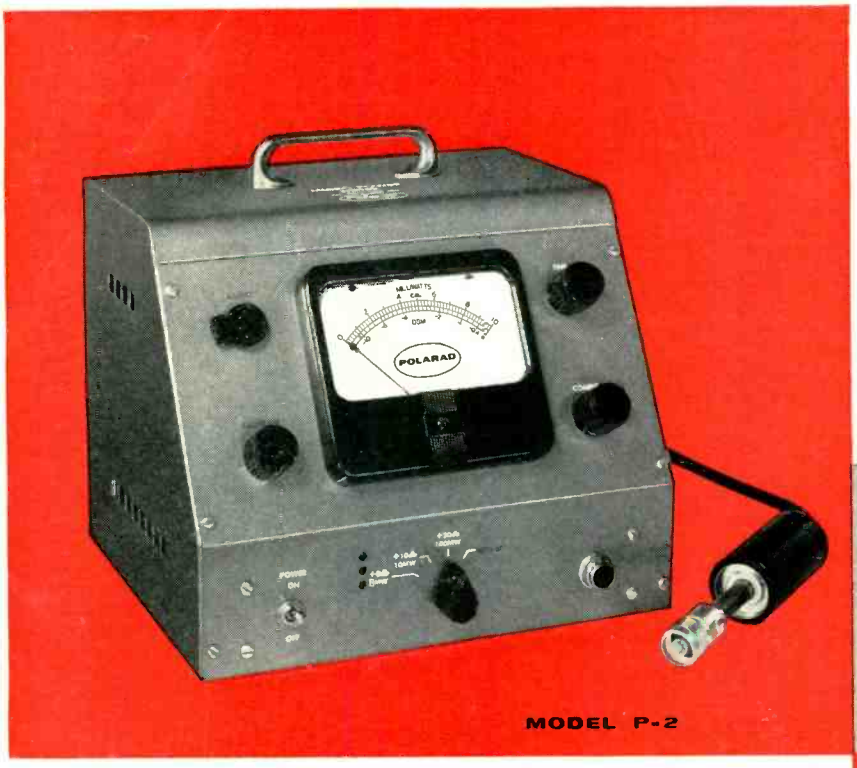
Vacuum Metals Corporation, with its newly expanded facilities, can now deliver a wide range of vacuum-melted alloys for electrical and electronic uses. But can these superior materials improve *your* products? Let our engineers help you decide. Write us, giving full details of the application in which you are interested, *Vacuum Metals Corporation, P.O. Box 977, Syracuse 1, N.Y.*

VMC

VACUUM METALS CORPORATION

Jointly owned by Crucible Steel Company of America and National Research Corporation

NEW—
MICRO POWER METER
DC to 11,000 mc



MODEL P-2

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

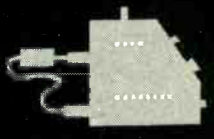
Direct Reading Scale

Reads from DC to 11,000 mc with three power ranges: Full scale readings: 1 mw (0 dbm), 10 mw (+10 dbm), and 100 mw (+20 dbm)

Single Broadband Probe

Used for entire frequency range DC to 11,000 mc. Can withstand 150 percent overload without damage or burnout.

Self Calibrating



DC calibrating circuit provided to recalibrate or check meter operation without additional external equipment.

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

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

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

SPECIFICATIONS

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

Price: $360

AVAILABLE ON EQUIPMENT LEASE PLAN

FIELD MAINTENANCE SERVICE AVAILABLE THROUGHOUT THE COUNTRY

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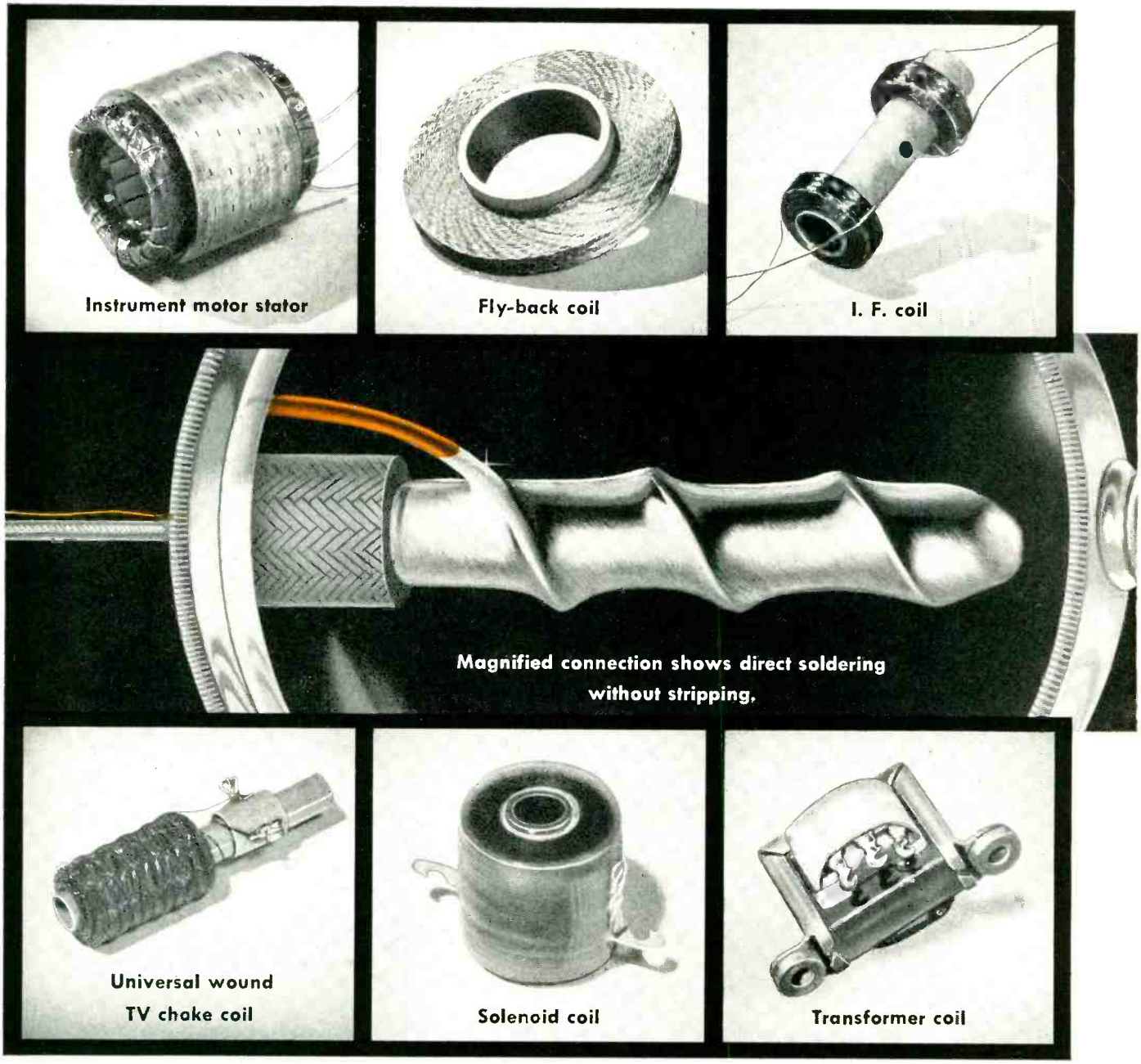
NOW PHELPS DODGE SODEREZE*

SUITABLE FOR ALL



First for Lasting Quality—from Mine to Market!

*Reg. U. S. Pat. Off.

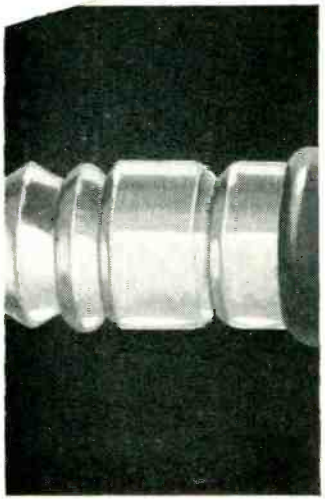
GIVES H GH "Q"...

CLAS "A" APPLICATIONS!

materials assure high "Q".

essential properties equal or superior existing film wires.

sitive uniform soldering. No stripping cleaning necessary.



Phelps Dodge Sodereze represents a new advance in ready-to-solder magnet wire. It's a typical Phelps Dodge development designed to keep pace with industry's growing need for wires that handle easily, reduce over-all cost and satisfy a variety of operating conditions.

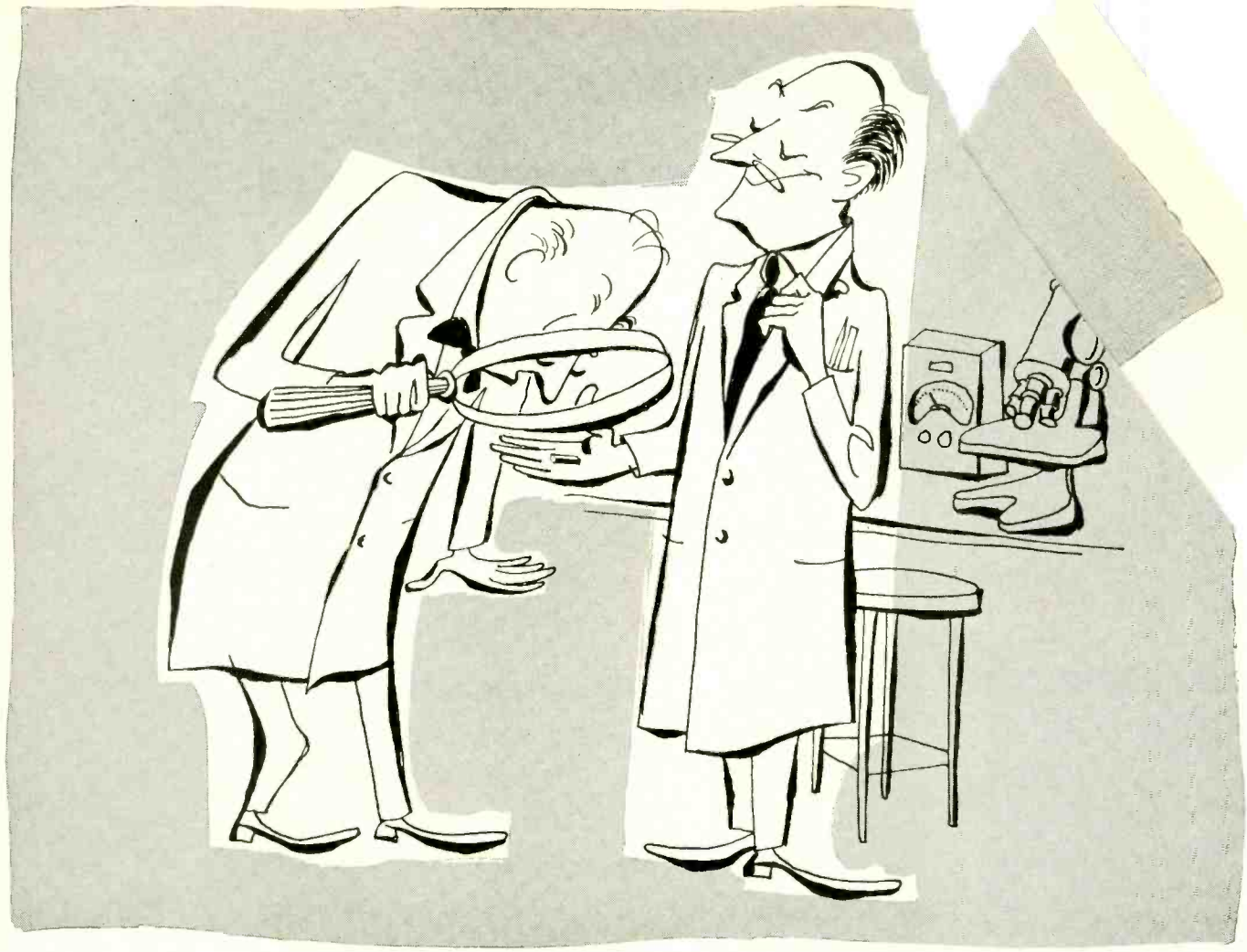
Phelps Dodge Sodereze offers a unique combination of improved chemical and mechanical properties with the advantage of high "Q". The versatility of Phelps Dodge Sodereze not only permits its use wherever solderable wires have been proven practical but suggests new applications, particularly in the finer sizes, to replace conventional wires.

Any time magnet wire is your problem, consult Phelps Dodge for the quickest, easiest answer!

PHELPS DODGE COPPER PRODUCTS CORPORATION

INCA MANUFACTURING DIVISION

FORT WAYNE, INDIANA



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

Write for your copy "MAGNETIC MATERIALS"

This 32-page book contains valuable data on all Allegheny Ludlum magnetic materials, silicon steels and special electrical alloys. Illustrated in full color, includes essential information on properties, characteristics, applications, etc. Your copy gladly sent free on request.

ADDRESS DEPT. E-70

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

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

In addition to Permendur, we offer a range of high-permeability alloys, oriented silicon steels and other electrical alloys that is unmatched in its completeness. Our services also include the most modern facilities for lamination fabrication and heat treatment.

Let us supply your requirements. *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.*

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Allegheny Ludlum

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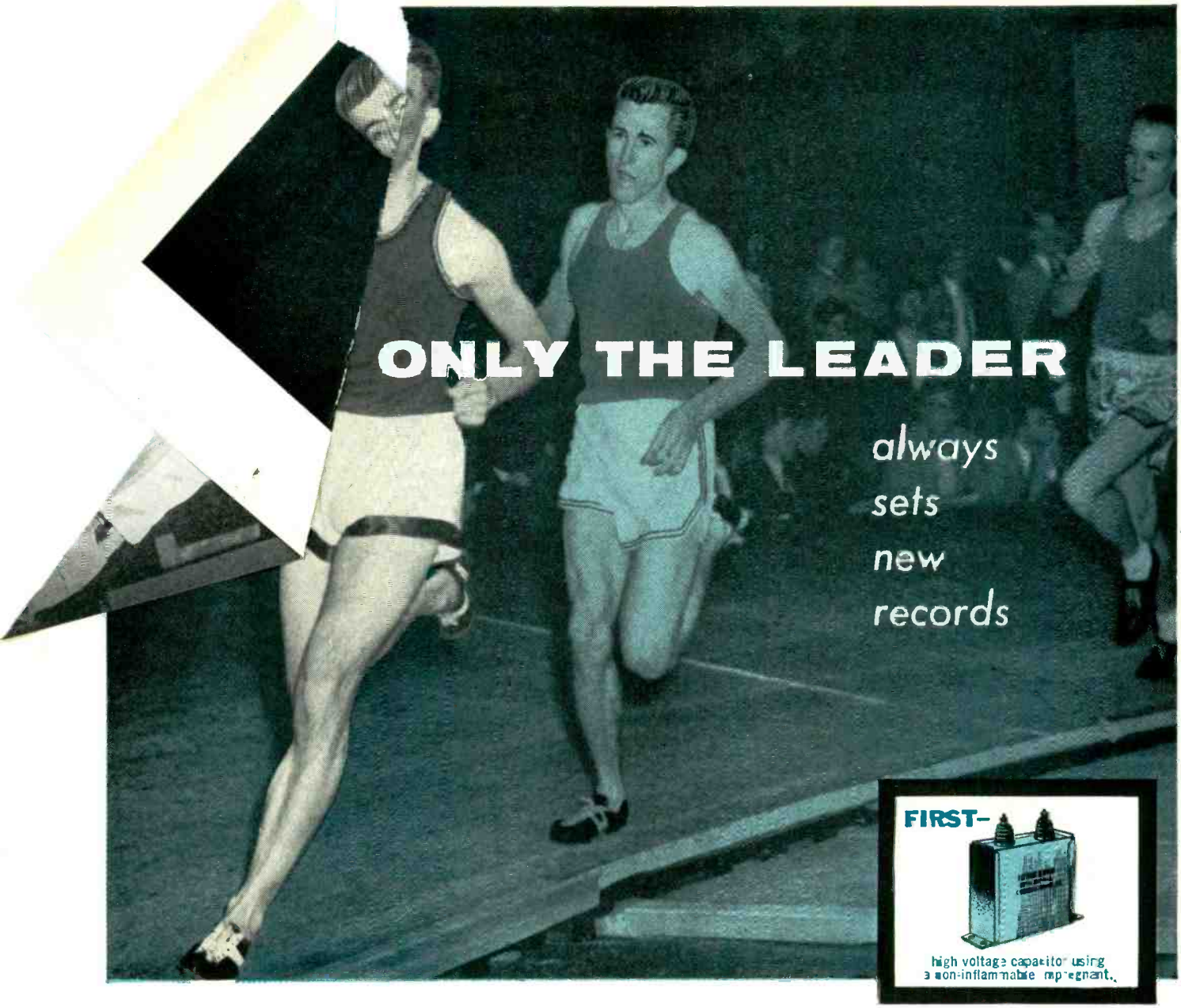
STEELS FOR THE ELECTRONIC AGE

Want more information? Use post card on last page.



Setting the first 4-minute mile record or making the first miniaturized capacitors are feats that only leaders can accomplish. Cornell-Dubilier's miniaturized capacitor is only one of hundreds of new capacitor developments that we have contributed in our record-making history.

FIRST–

high voltage capacitor using a non-inflammable impregnant.

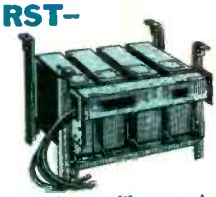
FIRST–

high voltage paper capacitor oil impregnated and filled.

C·D...45 YEARS OF FAMOUS FIRSTS

Typical of these "famous firsts" are the three examples shown here ... *proof* that whatever your capacitor requirements may be, your needs can be filled by C-D. Write to Cornell-Dubilier Electric Corp., Dept.K-105, South Plainfield, N. J.

FIRST–



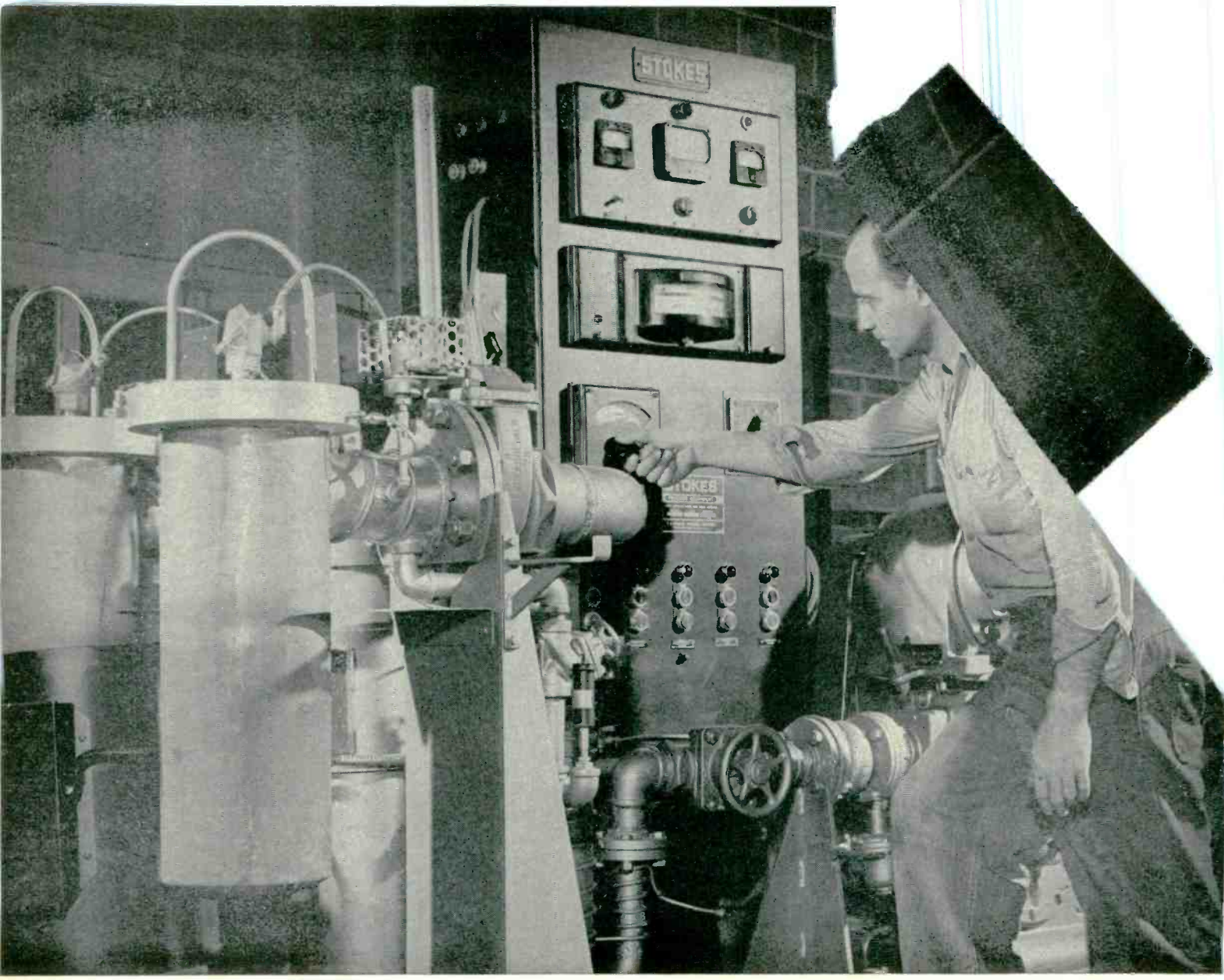
box-type, ceiling-mounting, power capacitors.

CONSISTENTLY DEPENDABLE

CORNELL-DUBILIER CAPACITORS

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

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

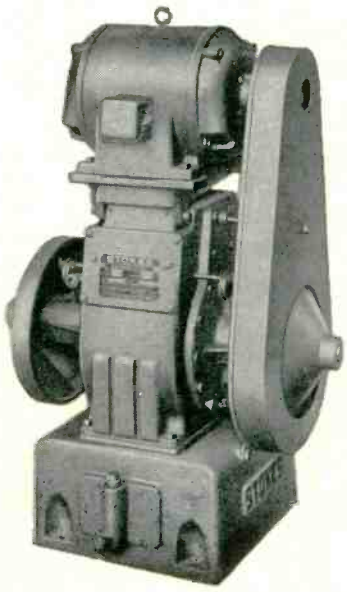


Operator checks pyrometer control of a standard Stokes dual-retort high-vacuum furnace.

THE COMPLETE LINE OF STOKES

Stokes manufactures a complete line of vacuum pumping equipment. This includes mechanical vacuum pumps, diffusion and booster pumps, vacuum valves and gages, and complete vacuum instrumentation. In engineered high vacuum equipment, Stokes builds vacuum metallizers, vacuum furnaces and other vacuum processing equipment.

Stokes has for many years been active in vacuum research. Vacuum experience among our engineers covers the range from laboratory equipment to some of the largest vacuum equipment in service. This experience is available to help solve your vacuum problems.



STOKES MECHANICAL VACUUM PUMPS

For vacuum processing systems and for maintaining low forepressures in high-vacuum systems, the Stokes Microvac pump provides efficient, economical operation. Designed with fully automatic lubrication and a long-lasting exhaust valve assembly, every Microvac pump is assured of smooth, trouble-free operation. Six sizes give capacities from 15 to 500 cfm. Send for catalog listed at right.

Production vacuum furnaces now available for the Electronics Industry

You can now buy specially designed Stokes vacuum furnaces for all phases of heat treating and outgassing. They are compact . . . give maximum capacity for minimum floor area. Sequence-operated grouped controls permit even unskilled personnel to handle furnace operations.

The basic problems of vacuum design and engineering have been a Stokes specialty for many years. Stokes vacuum furnaces for commercial production have proved their efficiency and earned the respect of manufacturers in numerous fields of technology. Stokes is the leading supplier of vacuum furnaces for industry.

The new Stokes Ring-Jet pumps described below are incorporated in Stokes vacuum systems to assure pumping cycles of maximum speed.

Stokes vacuum furnaces of numerous basic types are made in sizes and with modifications to fit users' requirements.

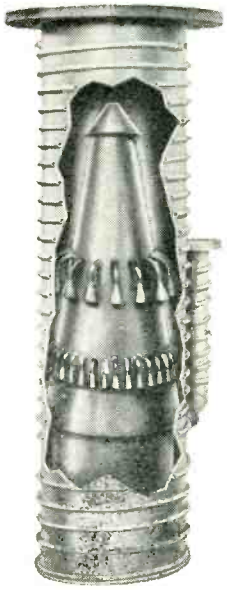
If you are interested in heat treating, degassing or melting of metals, you'll want to know more about Stokes high-vacuum furnaces. Write for your free copy of Stokes Catalog No. 790, "High-Vacuum Furnaces".

F. J. Stokes Machine Company
5503 Tabor Road
Philadelphia 20, Pa.

SEND FOR TECHNICAL LITERATURE:

- Microvac Pumps—Catalog 750
- Diffusion and Booster Pump Specification sheets and performance curves
- The Story of the Ring-Jet Pump
- Complete Vacuum Processing Systems—Catalog 730
- How to Care for Your Vacuum Pump—Booklet 755
- Vacuum Impregnation — Catalog 760
- Vacuum Drying—Catalog 720
- Vacuum Furnaces — Catalog 790
- Vacuum Metallizing — Catalog 780
- Vacuum Calculator Slide Rule

VACUUM EQUIPMENT



STOKES RING-JET DIFFUSION AND BOOSTER PUMPS

The new Stokes Ring-Jet Pumps embody a new concept of the diffusion principle. Size for size, they have pumping speeds of 10% to more than 100% above any other diffusion pump for a given heat input. Ring-Jet Diffusion Pumps are available in sizes of 4, 6, 10, 14 and 16 inches; Booster Pumps in sizes of 4, 6, 10 and 16 inches. Send for information listed.

STOKES VACUUM VALVES

To control vacuum safely and surely, Stokes vacuum valves are available in 4, 6, 10 and 16-inch standard flange sizes.

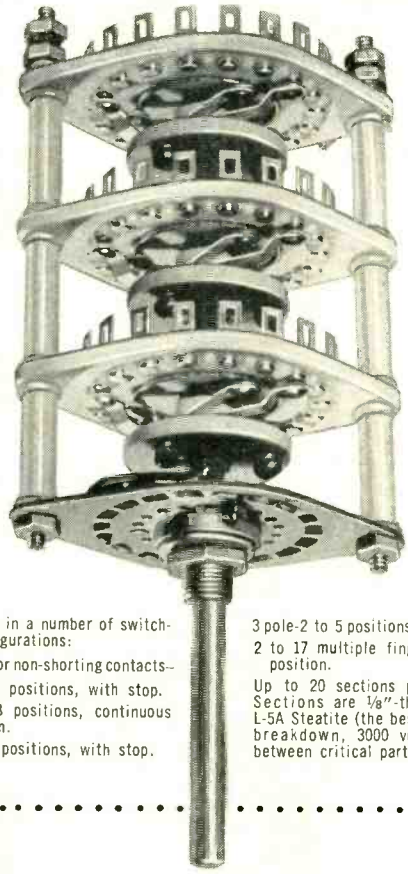
STOKES-McLEOD VACUUM GAGES

For measuring vacuums from fractions of a micron up to 50 mm, Stokes-McLeod gages are the standard of reference. Four sizes available.

STOKES

OFFICES IN PRINCIPAL CITIES, REPRESENTATIVES THROUGHOUT THE WORLD

Pin-point accuracy for medium high-power applications



Centralab Series PA-230 Rotary Power Switch

7½ amps.-110 v.a.c.—meets the requirements of transmitter, industrial control and balancing, laboratory testing, power-supply converter, and many other special applications

Low frequency loss — Wiping contact assures long life. You get low-loss operation at high frequencies and high voltages.

Excellent accuracy—Each contact and clip is aligned by hand. Contact pressure is individually adjusted. Exclusive, floating, square-shaft construction prevents any "play" in rotation.

Positive, non-stall rotation — Special index insures minimum of 25,000 cycles of operation. Distinctive Centralab design permits operating with ball-bearing ease.

Write today for Technical Bulletin EP-74 that gives complete engineering data.

Available in a number of switching configurations:

Shorting or non-shorting contacts—

1 pole-17 positions, with stop.

1 pole-18 positions, continuous rotation.

2 pole-8 positions, with stop.

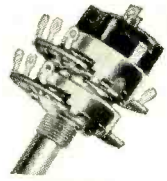
3 pole-2 to 5 positions, with stop.

2 to 17 multiple fingers at any position.

Up to 20 sections per switch. Sections are ⅛"-thick, Grade L-5A Steatite (the best). Voltage breakdown, 3000 volts R.M.S. between critical parts.

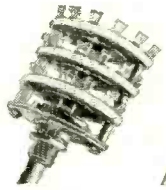
More proof that if it's a job for electronic components, it's a job for Centralab

Centralab's advanced engineering continues to create the prototypes of the components industry

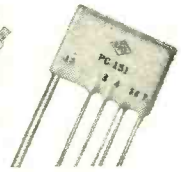


CONTROLS

CERAMIC CAPACITORS



SWITCHES



PACKAGED ELECTRONIC CIRCUITS

STEATITE INSULATORS

†Nothing to buy. Employees of Centralab and their advertising agency not eligible. Duplicate prizes awarded in case of tie. Entries become the property of Centralab —none can be returned.

P-5510

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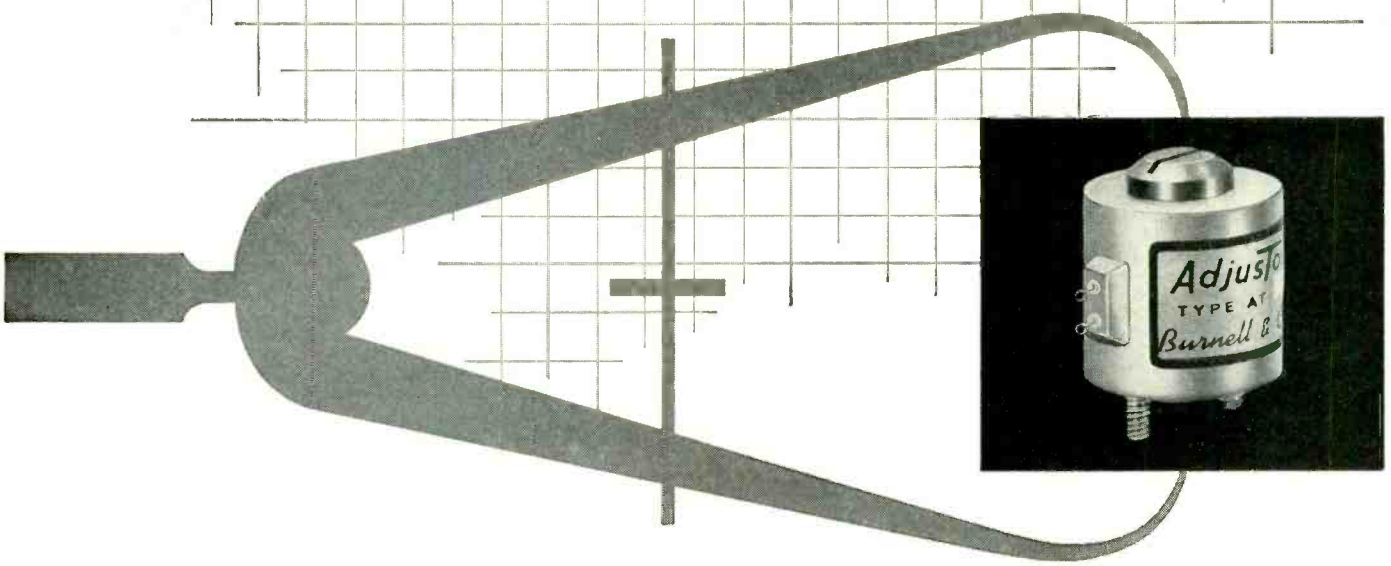

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- eliminates critical close tolerance capacitors
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Write for Adjusteroid Technical Brochure C

LET BURNELL ENGINEERS SHOW HOW USE OF ADJUSTOROIDS REDUCES EQUIPMENT COSTS

Many types of Adjustoroids and Rotoroids now available from stock.

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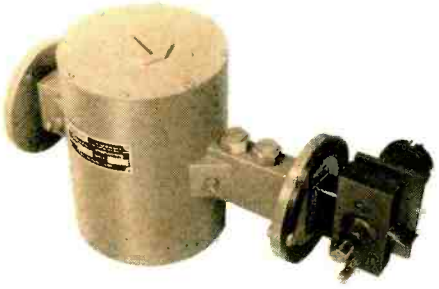
SOMETHING NEW FROM VARIAN...

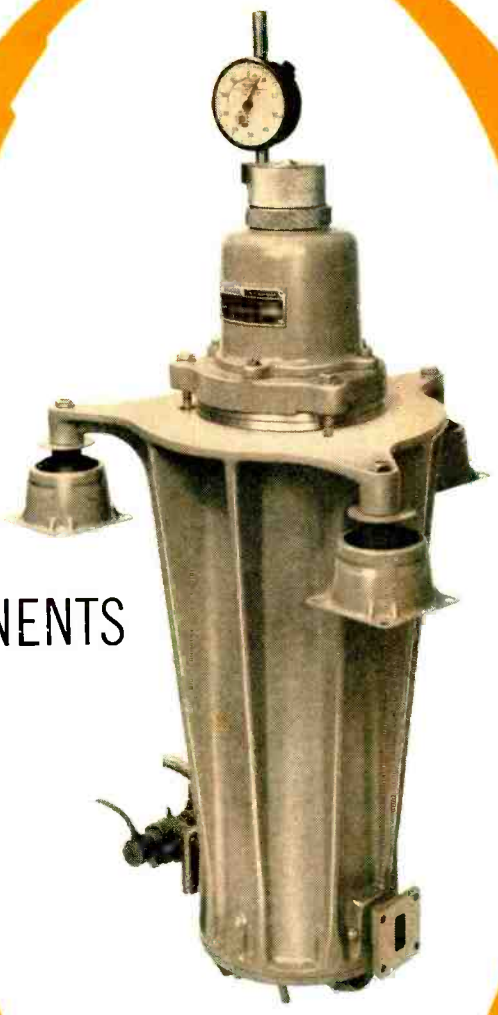
HIGH STABILITY

WITHOUT ELECTRONIC COMPONENTS

VA-1281
Stalo Cavity
with VA-201 klystron



VA-1282
Stalo Cavity
with X-26 klystron



VA-1280
Stalo Cavity
with VA-201 klystron

Now—with Varian's new line of high Q Cavities, frequency stabilized local oscillators (Stalos) utilizing direct cavity stabilization are commercially practical. Varian Stalo Cavities provide a very high degree of short time frequency stability. Stabilization is completely independent of the frequency of oscillator fluctuations and external disturbances . . . an inherent advantage over electronic stabilization systems utilizing the feedback principle. Elimination of all electronic components except the klystron oscillator also affords greater reliability and longer life.

The ratio of the oscillator modulation sensitivity to the modulation sensitivity of the stabilized oscillator defines the stabilization factor of the cavity. Varian Stalo Cavities are available in three models—VA-1280, 1281 and 1282—offer stabilization factors from 15 to 160 . . . cover a wide range of important applications, including stabilization of signal sources in high power klystron transmitters . . . airborne uses in conjunction with receiver local oscillators . . . laboratory testing. When used with Varian's new highly stable reflex klystron oscillators, stability comparable to that of many crystal controlled oscillators can be obtained.

COMPLETE TECHNICAL DATA and specifications are now available.

Your inquiry is cordially invited.

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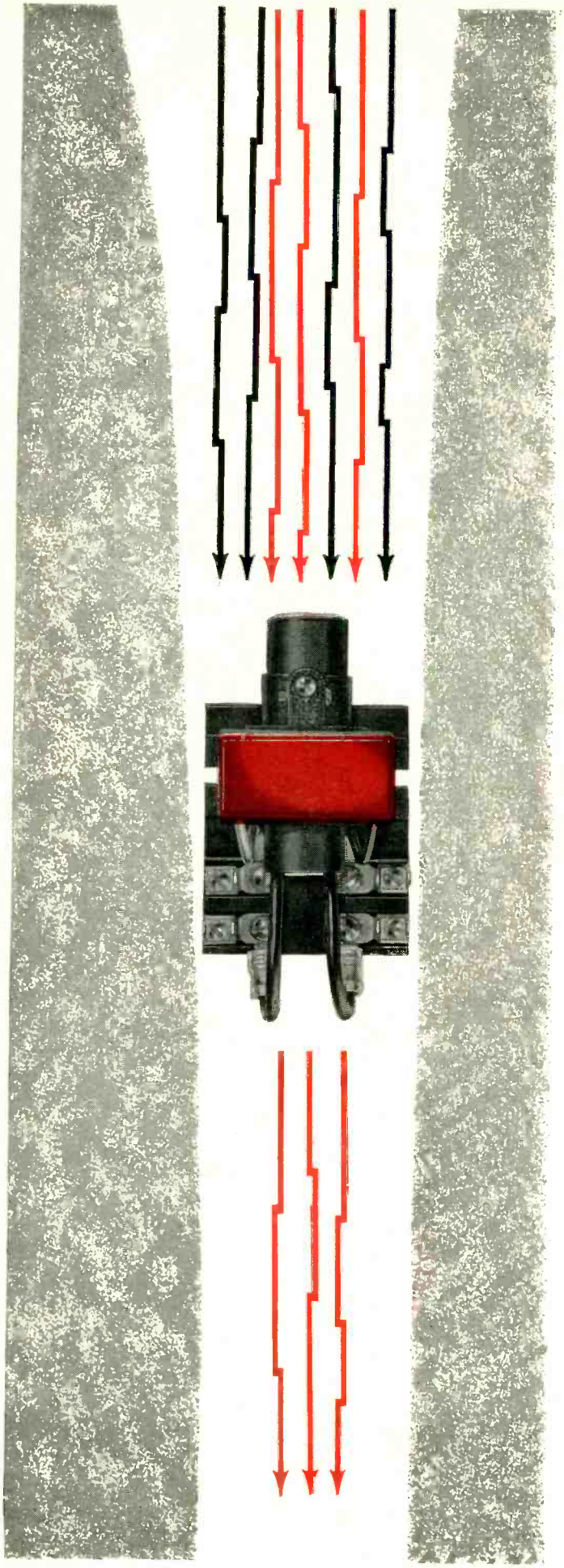


to protect equipment against overloads

use Adlake mercury relays

The new Adlake Mighty Midget relay, like *all* Adlake relays, requires no maintenance whatever . . . is quiet and chatterless . . . free from explosion hazard. Dust, dirt, moisture and temperature changes can't affect its operation. Mercury-to-mercury contact gives ideal snap action, with no burning, pitting or sticking.

Write for catalog and information.

The Adams & Westlake Company
Established 1857 • Elkhart, Indiana • New York • Chicago

Adlake 98th year

the original and largest manufacturers of mercury plunger-type relays

New Leesona No. 108 Coil Winders (foreground) in the plant of Ram Electronics, Inc., Irvington, N. Y., where Leesona Winders have become "standard equipment." These were added as best winders for producing short runs of stick-wound coils of varying specifications. (Inset) Ram has built an excellent reputation for winding quality coils and transformers used in radio and TV equipment.

RAM standardizes on Leesona coil winders...adds No. 108 machines

These winders help maintain highest quality standards . . . with good production performance

Ram Electronics, Inc. (Irvington, N. Y.) earned its fine reputation by adhering to unusually high quality standards.

This reputation, of course, is one they intend to keep. So in adding to coil winding facilities they picked Leesona No. 108 Coil Winders, standardizing on Leesona equipment which has served them so well in the past. To quote Mr. Del Vecchio, plant manager:

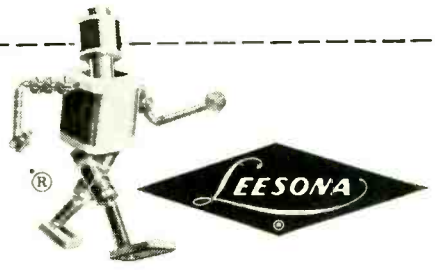
"We have come to count on Leesona Coil Winders to assure the high quality coils we insist upon for our products. That's why any additions to our present installation will be Leesona winders."

The Leesona No. 108 Hand Feed Coil Winder was designed specifically for complete accuracy, great flexibility and top production at low operating cost.

Investigate

how Leesona No. 108 Coil Winders can perform with great efficiency in your plant. The coupon will bring you complete details, together with other helpful coil winding information. Why not check and mail it today?

23B-5-6



FOR WINDING COILS
IN QUANTITY...
ACCURATELY...USE
LEESONA WINDING MACHINES

UNIVERSAL WINDING COMPANY

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Please send me

- ☐ Bulletin on the Leesona No. 108 Hand-Feed Coil Winder.
- ☐ Condensed catalog of Leesona Winders.
- ☐ Bulletin on the new Leesona *Pay-As-You-Profit Plans* for purchasing or leasing modern coil winding machinery.

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MARCONI SIGNAL GENERATOR

TYPE TF 995A/1

For both r.f. and i.f. testing with c.w., f.m., a.m., or simultaneous f.m. and a.m.

The MARCONI Signal Generator Type TF 995A/1 is a compact, transportable, a.c. operated instrument. It covers from 1.5 to 220 megacycles in five bands and there are facilities for crystal standardization from 13.5 megacycles upwards; its open-circuit output level is variable, in 1-db steps, from a minimum of 0.1 microvolt to a maximum of 100 millivolts at 52 ohms and 200 millivolts at 75 ohms. The output may be continuous wave, frequency modulated, amplitude modulated, or simultaneously both frequency and amplitude modulated. The modulation, obtained either from an internal 1000-cps oscillator or from an external source, is variable to maximum frequency deviations ranging from 25 to 600 kc for f.m., and to depths up to 50% for a.m.

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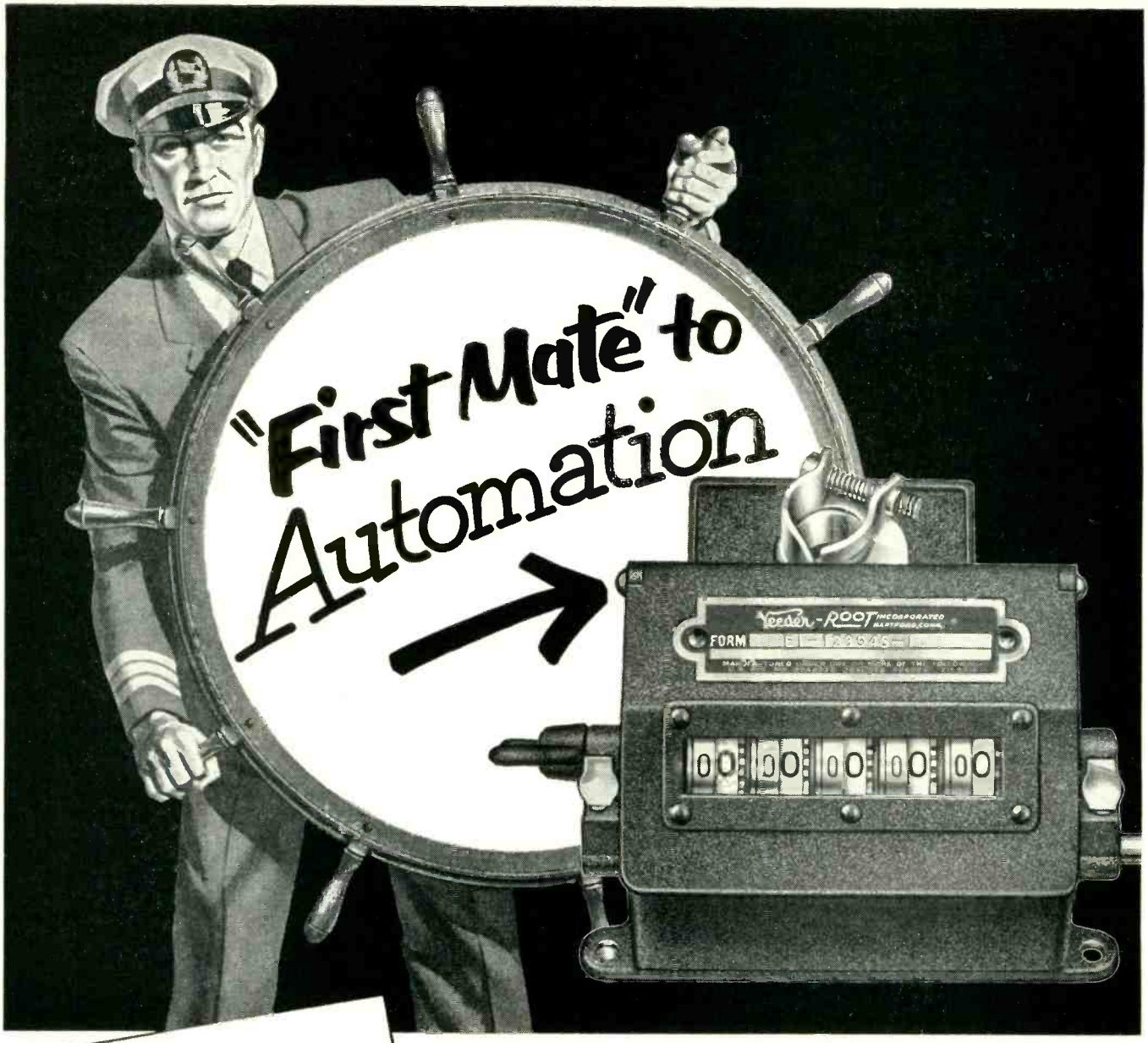

Added Evidence that . . .

Everyone Can Count on VEEDER-ROOT

In figuring out new systems of automatic electrical control, Veeder-Root *Count*rol can supply vital connecting links. For instance, this Predetermining Counter can be hooked into such a system to light a light, ring a bell, or actuate a mechanism to stop a machine or process *at any pre-set point.* And there are many other Veeder-Root Counters that can serve as "countponents" in almost any way desired. Or special counters can be designed for specific applications. Engineers in any industry, now engaged in working out automatic control systems, can count on Veeder-Root engineers to work with them on any problem where reliable facts-in-figures are needed.

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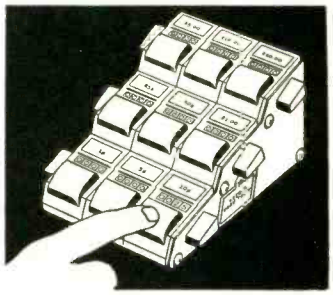
"The Name That Counts"



New *Vary-Tally* Multiple-Unit Reset Counter comes in any combination up to 6 banks high, and 12 units wide Write for news sheet and prices.

DU PONT

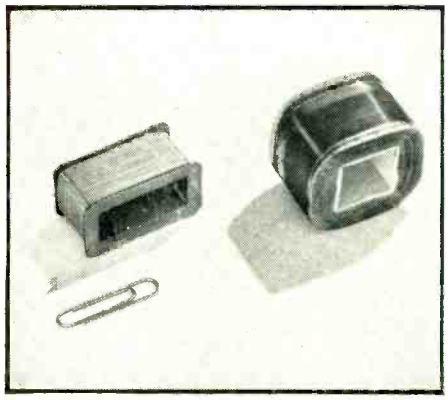
Better Things for Better Living
. . . through Chemistry

ELECTRONIC DESIGN NEWS

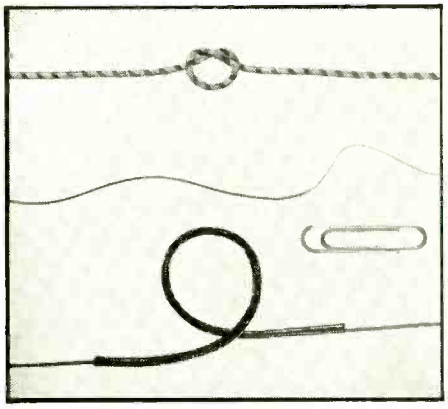
PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NO. 4 — 1955

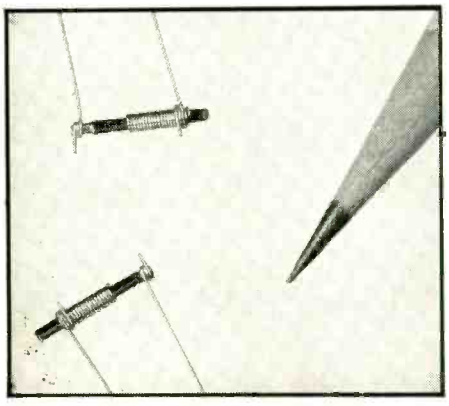
Miniaturized Components Utilize Unique Insulating Properties of TEFLON®



The paper clip indicates the small size of these coils. The insulation of "Teflon" is one important reason why they can be miniaturized.



Here are shown (top) a striped, wrapped lead wire and (bottom) two samples of miniaturized flexible sleevings—all insulated with "Teflon."



These small capacitors use "Teflon" as the dielectric. Their degree of miniaturization is shown by comparison with end of lead pencil.

Working temperature range of Du Pont "Teflon": —450°F. to +500°F.

Miniaturization of electronic components is possible with a unique engineering material: Du Pont "Teflon" tetrafluoroethylene resin.

"Teflon" has a low loss factor, low dielectric constant, and high volume resistivity. It is nonflammable, and unaffected by moisture. "Teflon" is the only insulating material available today that is inert to every commercially used solvent and chemical, excepting only molten alkali metals and fluorine at high temperatures and pressures.

Use of "Teflon" helps cut production costs, too. In soldering operations, the iron will not burn or melt insulation of "Teflon." This important fact can save time, labor, and materials.

The three photographs on this page show some current uses for insulation of "Teflon." The wire is manufactured by Hitemp Wires, Inc., Mineola, New York. Other typical applications by Hitemp which utilize Du Pont "Teflon" are listed below.

The six products listed, insulated with "Teflon" and used in a wide variety of applications, illustrate the application of this material in current electronic designs:

MAGNET WIRE. Such wire, coated with "Teflon," is widely used on high-temperature components for aircraft and guided missiles: transformers, relays and various types of motors.

HOOKUP WIRE AND LEAD WIRE. Insulation of "Teflon" on hookup and lead wire proves advantageous on transformers, motors, and harness assemblies for high-temperature applications. The chemical resistance of "Teflon" is particularly valuable in gyros and other hermetically sealed components.

COAXIAL CABLE. Used as the dielectric medium of coaxial cable, "Teflon" permits the design of miniature constructions which are the equivalent of coaxial cables using much thicker insulation of other materials.

TUBING. Insulation of "Teflon" provides excellent protection for tubing used as bus wire and jumpers.

RESISTANCE WIRE. Insulation of "Teflon" on small resistance wire facilitates miniaturization of heating equipment.

FIBER-GLASS PRODUCTS. Insulation of "Teflon" is being applied currently to such fiber-glass products as lacing, tape and sewing thread. "Teflon" provides excellent temperature resistance, and withstands cutting action of glass fibers.

NEED MORE INFORMATION?

CLIP THE COUPON . . .

If you would like further information about the properties and uses of "Teflon" as an electronic design material, fill out and mail the coupon.

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department
Room 2210, Du Pont Building, Wilmington 98, Delaware
In Canada: Du Pont Company of Canada Limited,
P. O. Box 660, Montreal, Quebec

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

NAME_____

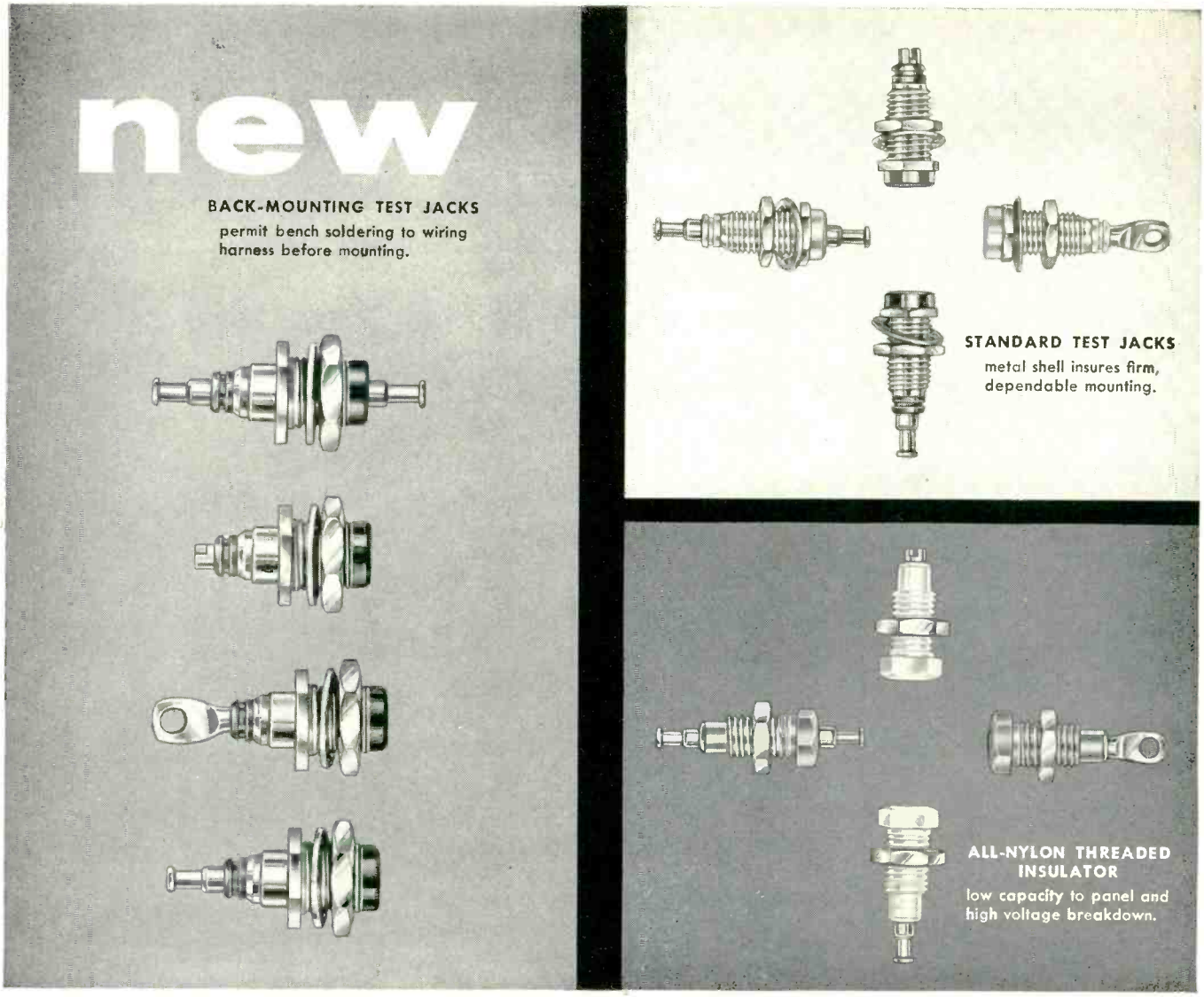
POSITION_____

COMPANY_____

STREET_____

CITY_____ STATE_____

TYPE OF BUSINESS_____



Test Jacks by Ucinite

The introduction of Ucinite's back-mounting jacks makes available for the first time a *complete* line of *high quality* test jacks suitable for use in equipment where long life and dependability are essential.

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.

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Division of United-Carr Fastener Corp.

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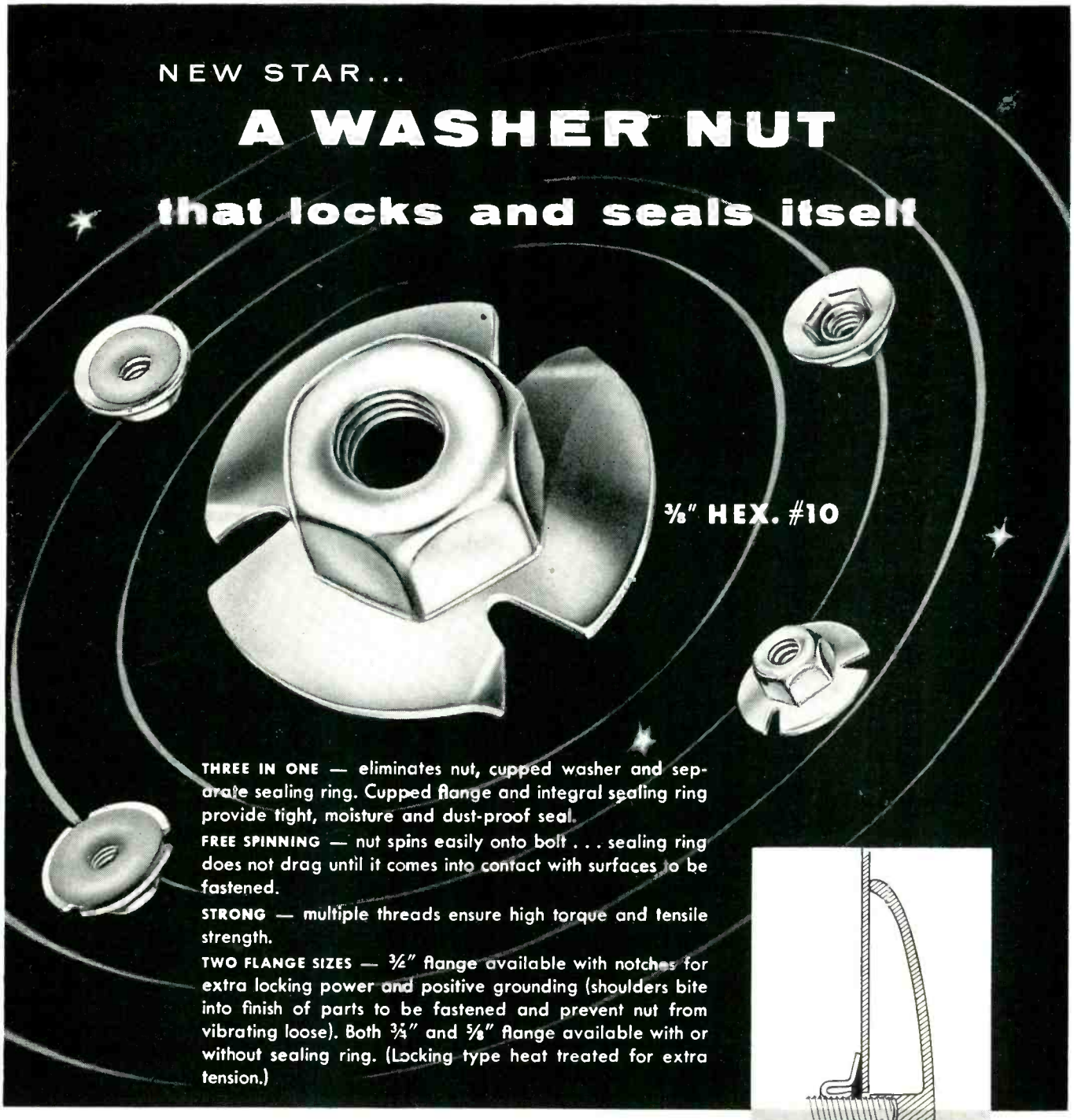
NEW STAR...

A WASHER NUT

that locks and seals itself



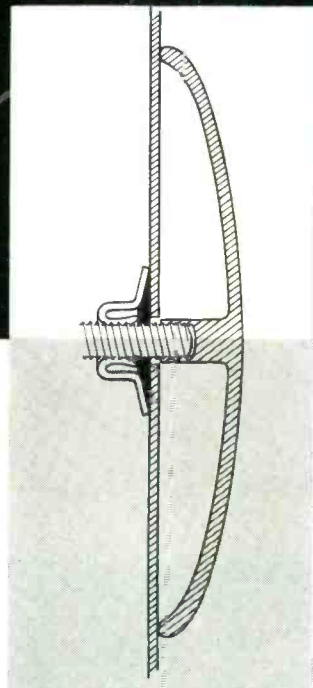
⅜" HEX. #10

THREE IN ONE — eliminates nut, cupped washer and separate sealing ring. Cupped flange and integral sealing ring provide tight, moisture and dust-proof seal.

FREE SPINNING — nut spins easily onto bolt . . . sealing ring does not drag until it comes into contact with surfaces to be fastened.

STRONG — multiple threads ensure high torque and tensile strength.

TWO FLANGE SIZES — ½" flange available with notches for extra locking power and positive grounding (shoulders bite into finish of parts to be fastened and prevent nut from vibrating loose). Both ¾" and ⅝" flange available with or without sealing ring. (Locking type heat treated for extra tension.)



Note how cupped base of nut allows tapped portion of cast or molded part to project through sheet metal mounting structure in typical application.

For further information on WASHER NUTS or any other problems involving special fasteners or self-fastening devices, contact your nearest United-Carr representative or write us direct.

UNITED-CARR

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Seeking to overcome the deficiencies in many of today's standard electronic devices, engineers at Airborne Instruments Laboratory created the devices shown here. Though developed for use at AIL, their adaptability for many applications has resulted in a wide demand by manufacturers and users of electronic equipment. Thus, production and sales have become important areas of operations at Airborne.

TYPE 124A WIDE RANGE POWER OSCILLATOR

Frequency Range: 200-2500 mc (in three ranges, 200-300, 300-900 and 900-2500 mc).

Power Output: 300 mc: 8 watts, 600 mc: 20 watts, 1500 mc: 10 watts, 2500 mc: 2.5 watts.

Output Impedance: 50 ohms

$ 2285.

TYPE 40 INTEGRATING AMPLIFIER

The type 40 INTEGRATING AMPLIFIER is a four-tube electronic integrator for use as a component of specialized electronic analogue computers.

The characteristics of the unit especially adapt it for such difficult applications as:

Integration of video or other pulse signals of low duty factor;

long term memory of information derived by intermittent sampling of data.

$ 500.

TYPE 30 PRECISION 30 MC ATTENUATOR

Accuracy: ± 0.2 db at any frequency from 25 to 35 Mc. Counter-type indicator reads attenuation above minimum insertion loss in tenths of a decibel.

Range of Attenuation: 80 db

Input Impedance: 50 ohms (BNC connector)

Output Impedance: 50 ohms (BNC connector)

Minimum insertion loss: 25.0 db (at 30 Mc)

$ 395.

TYPE 373 RECTANGULAR COORDINATE RECORDING SYSTEM

PEN POSITION SYSTEM

Range: 80 db of recorded voltage

Pen Speed: full scale deflection (10 inches) in 1/4 second.

Accuracy: static error less than ± 0.25 db dynamic error less than ± 0.4 db at maximum pen speed of 40 inches per second.

Input: audio frequency voltage of fixed frequency in the range 500 to 2000 cps. 2 microvolts minimum input from 200 ohm source. Selective amplifier bandwidth 35 cps.

CHART POSITION SYSTEM

20-1/4, 121-1/2, and 729 inches per revolution of device under test. Maximum chart speed 10 inches per second. Reversible chart drive.

$ 8,500.

TYPE 390A MICROWAVE CRYSTAL TEST SET

Accepts ceramic cartridge and coaxial types of both normal and reversed polarities.

Remote test jack permits testing crystals without removing them from receiver.

Portable

Self-contained

$ 97.

All prices F.O.B., Mineola, N. Y. Subject to change without notice.

TYPE 116R POLAR PATTERN RECORDING SYSTEM

Pen Positioning System

Input:
Audio-frequency voltage of fixed frequency between 500 and 2000 cps. Amplifier bandwidth 35 cps. Maximum sensitivity 100 microvolts for full scale deflection.

Pen Speed:
15 inches per second.

Accuracy:
Overall system static accuracy ±1% of full scale.

Turntable Positioning System

Input:
1:1 and/or 36:1 synchro signals, 115 volts 60 cps, size 5.

Accuracy:
± Maximum error degree. 0.2° at 6 R.P.M.

$ 7500.

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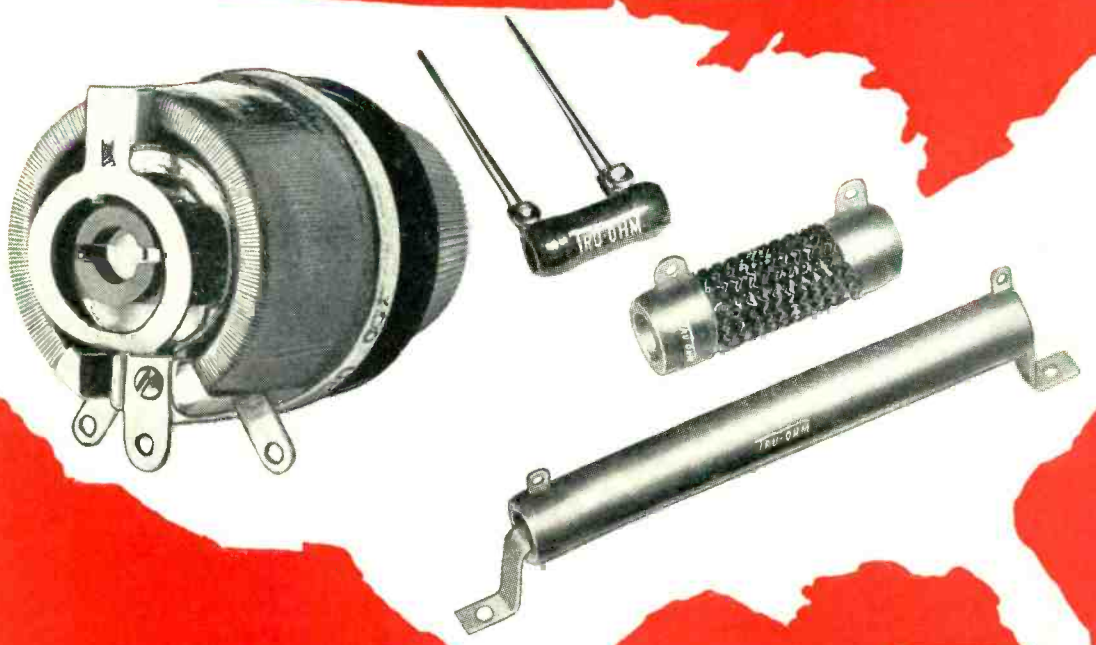
AMERICA'S NO. 1 LINES



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The finest power rheostats . . . UL approved rheostats . . . 25 watt . . . 50 watt . . . 75 watt . . . 100 watt . . . 150 watt. We maintain a large stock for ready shipment or can design a rheostat with many special features for your particulor need. Our rheostats are interchangeable. Prompt engineering service is available.

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Because we are the world's largest producers of wire-wound resistors, we have the production facilities to GUARANTEE best delivery and finest quality . . . from stock or to your specifications.

We invite your inquiry on RHEOSTATS and RESISTORS . . . Have you seen our latest catalog?

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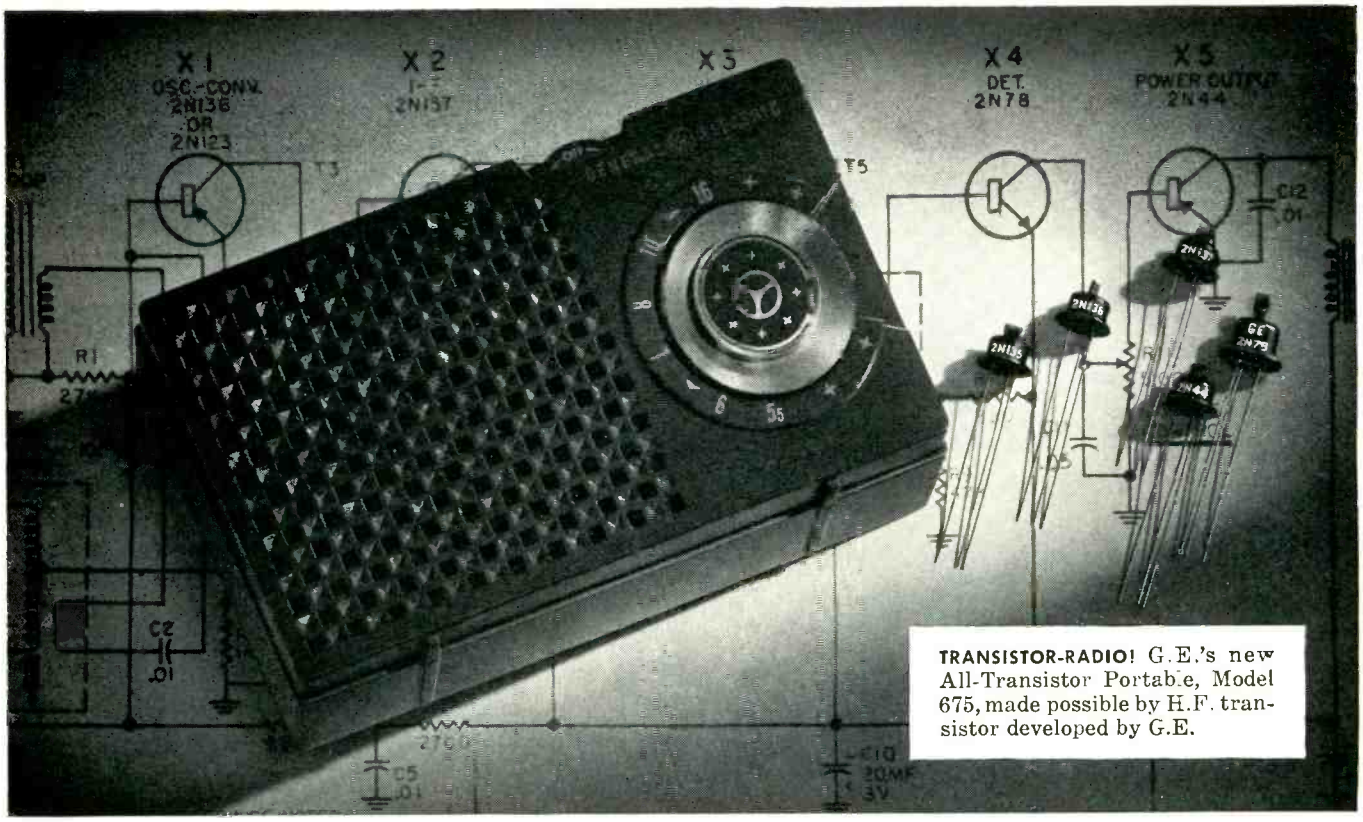
Division of Model Engineering & Mfg., Inc.

General Sales Office: 2800 N. Milwaukee Ave., Chicago 18, Ill.

Factory: Huntington, Indiana

"Largest producers of wire-wound resistors in the U. S. A."

MANUFACTURERS: Power Rheostats, Fixed Resistors, Adjustable Resistors, "Ecqnohm" Resistors, "Tru-rib" Resistors



TRANSISTOR-RADIO! G.E.'s new All-Transistor Portable, Model 675, made possible by H.F. transistor developed by G.E.

NOW—A FULL LINE OF G-E H.F. TRANSISTORS FOR ALL RADIO APPLICATIONS

New G-E H.F. PNP Transistors, 2N135, 2N136, 2N137, Complement the G-E 2N78 NPN

THIS new line of G-E High Frequency PNP Transistors offers immediate benefits to electronics manufacturers for use in RF and IF amplifier circuits. The new High Frequency designs, now in full production, were created specifically for use in radio circuits. The line provides minimum alpha cut-offs of 3 MC, 5 MC and 7 MC—coupled with a 5 ua maximum collector cut-off current. The result: all the high-gain and high-power advantages of other General Electric transistors, *plus* operating ranges extending from 3 to 15 MC depending on the transistor selected.

NOW IN COMMERCIAL RADIO CIRCUITS

In the circuit above, the 2N136 is used as a converter—its 5 MC minimum alpha cut-off assures stable oscillator performance and high conversion gain. The 2N137—with 7 MC minimum alpha cut-off—provides 33 db gain at 455 KC. The high frequency 2N135 offers a higher collector voltage rating for the second IF where it is needed. The 2N78 NPN transistor—originally designed for computer and RF circuitry—proved ideal as a power detector and audio amplifier to drive a 2N44 power output transistor with direct coupling.

PRODUCTION QUANTITIES AVAILABLE

General Electric's new high frequency line is in mass production now. Detailed characteristics and specifications of the G-E 2N135, 2N136, and 2N137 transistors may be obtained upon request. Your G-E Semiconductor specialist and our factory application engineers have the answers to your transistor radio circuit questions. Call them in, or write: *General Electric Co., Semiconductor Products, Section X4105, Electronics Park, Syracuse, N. Y.*

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GENERAL ELECTRIC

For Generation of Pulse Voltages –

CHATHAM
MODEL 5C22
HYDROGEN THYRATRON

A three electrode zero bias thyratron with peak power handling capacity to 2.6 megawatts

ELECTRICAL DATA

	MIN.	BOGEY	MAX.	
HEATER VOLTAGE	5.8	6.3	6.8	Volts
HEATER CURRENT @6.3V	9.6	10.6	11.6	Amps
CATHODE HEATING TIME	300			Sec.
ANODE VOLTAGE DROP, PEAK	100	150	200	Volts

For detailed characteristic data request sheet DSW-104-1

MAXIMUM RATINGS—Absolute Values

Maximum Peak Anode Voltage	
Inverse	16 Kilovolts
Forward	16 Kilovolts
Minimum Peak Anode Voltage	
Inverse	800 Volts
Forward	4500 Volts
Maximum Cathode Current	
Peak	325 Amperes
Average	200 Milliamperes
Averaging Time	1 Cycle
Minimum D.C. Anode Voltage	4500 Volts
Maximum Operating Frequency (Note 1)	1000 cps
Minimum Peak Trigger Voltage	200 Volts
Maximum Peak Trigger Voltage	600 Volts
Maximum Heating Factor (Note 2)	3.2×10^9
Maximum Current Rate of Rise	1500 Amps/μs.
Maximum Anode Delay Time	1 μs.
Maximum Time Jitter	0.02 μs.
Ambient Temperature	+90 to –50°C

NOTE 1: This is not necessarily the upper operating frequency limit but represents the highest repetition rate for present life test requirements.
NOTE: 2. Heating factor is the product (epy x prr x ib).

CHATHAM TYPE VC-1257
Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of pulse power up to 33 megawatts.

CHATHAM TYPE 5948/1754
Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of peak pulse power up to 12.5 megawatts.

CHATHAM TYPE 5949/1907
Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of peak pulse power up to 6.25 megawatts.

CHATHAM TYPE VC-1258
Zero bias miniature hydrogen thyratron for the generation of peak pulse power up to 10 KW. Also available with a 28 v heater and in a super ruggedized type for extreme vibration.

Chatham Hydrogen Thyratrons are the product of many years of concentrated experience in this specialized field. Embodying the most advanced developments in the art, the tubes illustrated offer uniformly high performance when employed in the generation of pulse voltages in the order of microseconds. For complete data and specifications on Chatham Hydrogen Thyratrons, call, write or wire today – no obligation.

Chatham Electronics
DIVISION OF GERA CORPORATION – LIVINGSTON, NEW JERSEY

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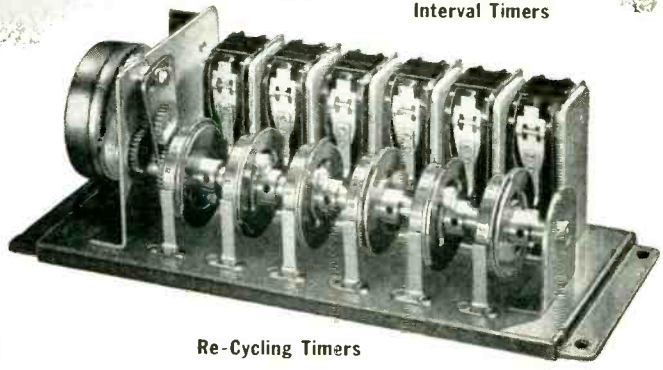
Interval Timers



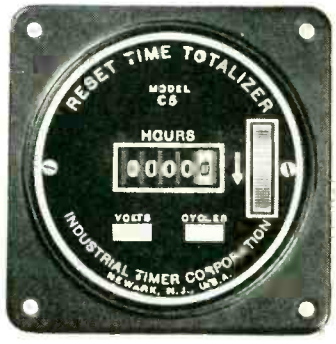
Re-Cycling Timers

To meet the widely different requirements of our customers, we work with 17 basic types, from which we have so far developed 721 combinations. 19 years of successfully "timing" these customers has equipped us with a breadth of practical experience that you can draw on. The timers we manufacture comprise a complete line in 4 broad classifications.

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

That's why you can depend on us to meet your needs. If we can't do it with one of the 721 combinations already developed, we'll have our engineers get on it at once and develop the combination that's right for you.

Our deliveries are extra good because we maintain large stocks of our 17 basic types, and even if your order is very "special" you'll be more than satisfied with our service. Send us your specifications; you'll get a prompt reply.



Running Time Meters

Timers that Control the Pulse Beat of Industry

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THIS IS HELIAX®...

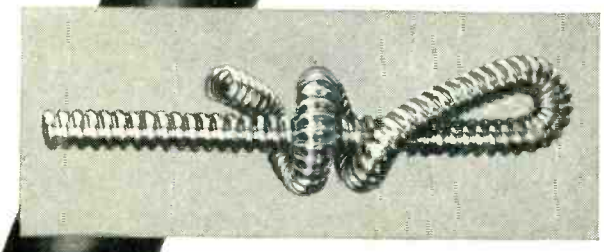
The truly FLEXIBLE Air dielectric cable

This latest ANDREW cable, introduced just 18 months ago, has received phenomenal industry acceptance. This is easy to understand, when you consider that HELIAX offers electrical performance equal to that of the finest copper cables, yet is far lower in price and much easier to install.

HELIAX has its own complete series of connectors, matching the superior electrical performance of the cable. These fittings are pressurized and weatherproofed, and attach easily without special tools.

For a maximum of convenience in the field, HELIAX is normally supplied in complete assemblies, with end fittings factory attached. Available in 7/8" and 1 5/8" sizes. Continuous lengths to 3,000 feet.

Write now for complete engineering data and a sample of this remarkable cable.



The secret of HELIAX lies in its corrugated outer conductor. As demonstrated at the left, this by itself can be bent on its own diameter without breaking, kinking or going out of round. These qualities give HELIAX its unusual flexibility, strength and ease of handling.

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Varo

DIRECT READING
FREQUENCY METER
FOR AIRBORNE AND GROUND
POWER EQUIPMENT

When an electrical system requires a reliable Direct Reading Frequency Meter — check VARO. This ruggedly built Frequency Dial Meter and Control Box is accurate to ± 0.2%.

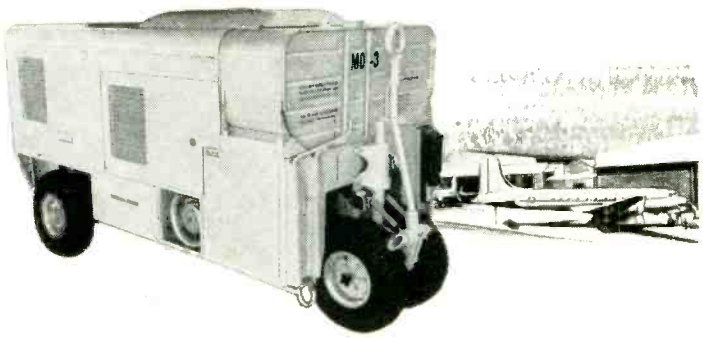
It meets all military environmental specifications and no temperature correction is required. A precision tuning fork is used as the reference standard and the signal to the indicator can be used simultaneously for chart recordings where permanent record is desired. The 400 cycle calibration on the meter face is offset from null position to cause actual indicator movement for more positive calibration.

Compact and light in weight, the VARO Frequency Meter is ideally suited for either airborne or ground power equipment.

Other VARO Products made for Military Aircraft Fire Control and Navigational Systems.

Frequency Standards	Electronic Inverters
Frequency Changers	Regulated Supplies
Voltage Regulators	Speed Controls

Voltage and Frequency Sensitive Relays



The MD-3 Ground Power Equipment designed and manufactured by Beech Aircraft Corp. is used by the Air Force to check out aircraft in pre-flight test. The VARO Frequency Meter is utilized as part of the system to provide accurate and reliable measurement of 400 cycle electrical systems.

SPECIFICATIONS

INPUT: 110 to 120 Volts AC
350 to 450 cycles (Meter not damaged at 200 cps.)
28 Volts DC at 1 ampere

OUTPUT: Meter scale calibrated at 1 cps. intervals between 395 and 405. Pointer indicates high or low over the range of 350 to 450.

PHYSICAL DESCRIPTION

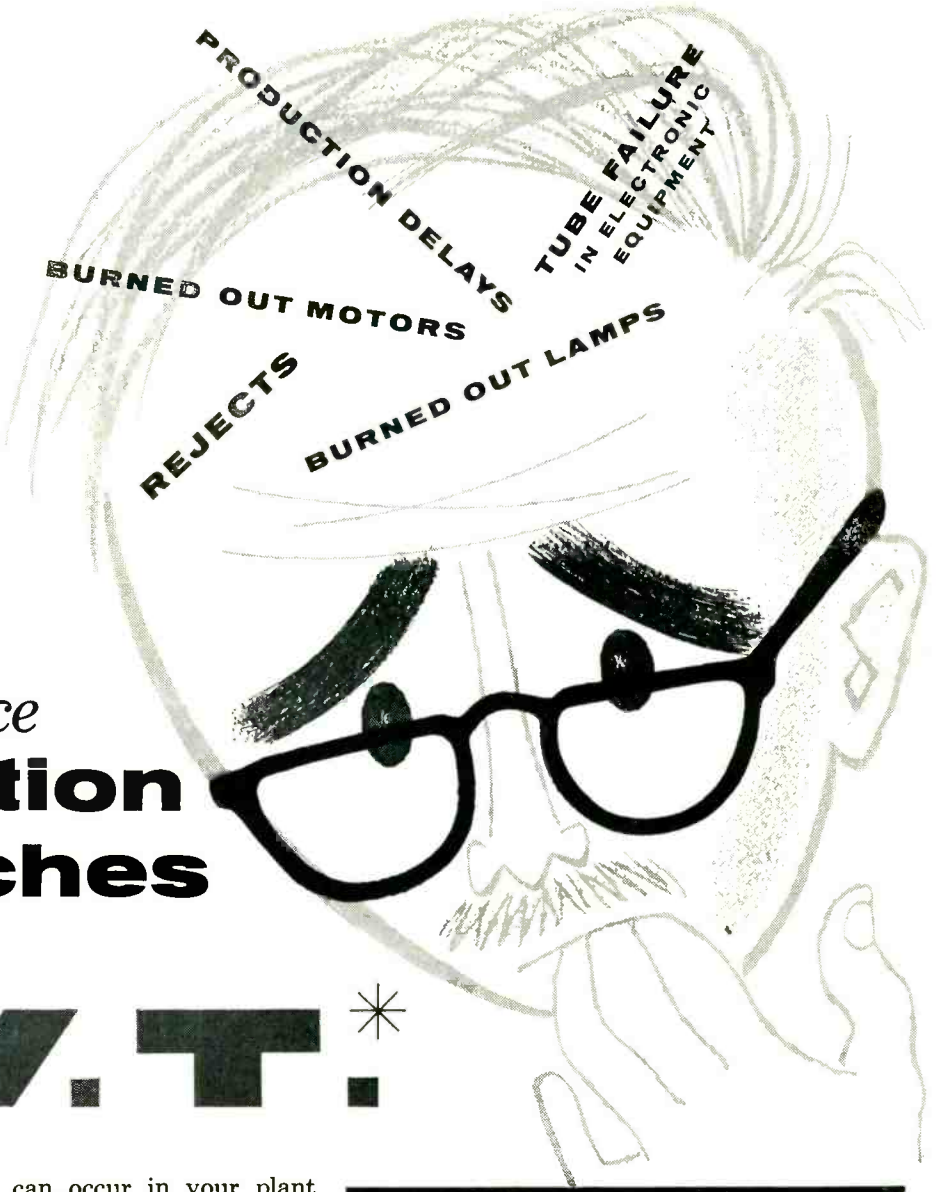
CONTROL SECTION		INDICATOR SECTION
Height:	4 inches	Standard meter case per MIL-M-10304 for sealed ruggedized instrument. Body dimensions 2.800" max. diameter and 1.405" depth. Weight: 14 oz.
Width:	2½ inches	
Depth:	7 inches	
Weight:	2 lbs., 14 oz.	

VARO

For further information please write:

MANUFACTURING CO., INC.
2201 WALNUT STREET, GARLAND, TEXAS

Representatives: Box 553, Far Hills Branch, Dayton, Ohio, Pacific Scientific Co., 1430 Grande Vista Ave., Los Angeles 23, California

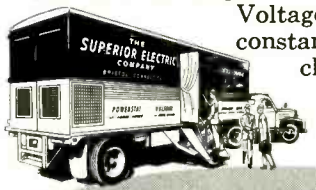


How to Reduce **Production Headaches** *Caused by* **V.V.T.***

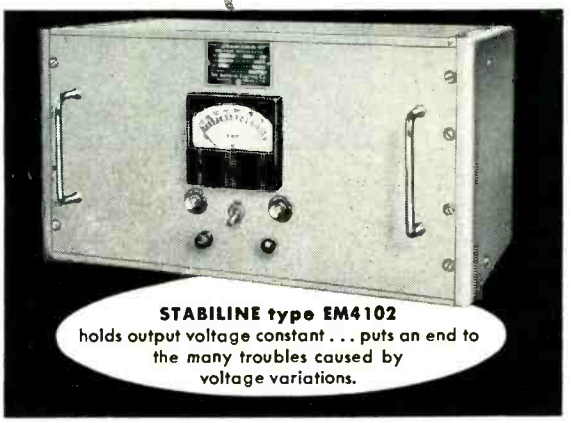
***Varying Voltage Troubles** can occur in your plant every time the voltage varies to electrically-operated equipment — *and that can be happening many times a day!*

V.V.T. can be the cause of unexplained production delays, rejects, defective units, burned out lamps or motors, tube failures in electronic equipment. A single department can be "dogged" by V.V.T. — or your entire production line.

The cure is simple and effective: a STABILINE Automatic Voltage Regulator that will hold voltage constant regardless of line voltage or load changes. Ask your local electric distributor or write direct for full information.



See Superior Electric's Mobile Display when it visits your area.



STABILINE type EM4102
holds output voltage constant . . . puts an end to the many troubles caused by voltage variations.

THE SUPERIOR ELECTRIC COMPANY
BRISTOL, CONNECTICUT

SALES OFFICES: The Superior Electric Company

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THE SUPERIOR ELECTRIC COMPANY
210 Reynolds Avenue, Bristol, Conn.

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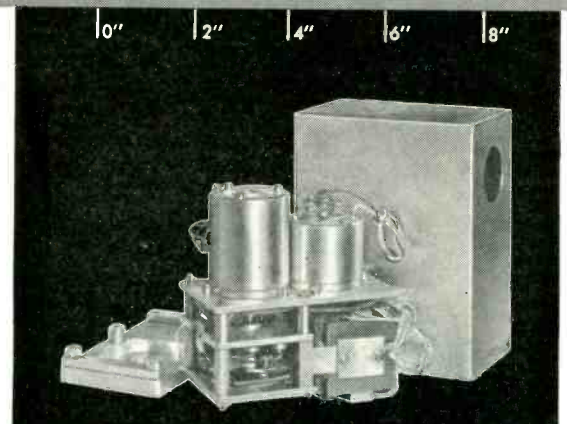
built to do just one servo control job . . .

perfectly



An incremental synchro positioner before wiring to header and hermetic sealing. The synchro rotor is stepped in one or fifteen degree increments clockwise or counterclockwise depending upon which of four coils is momentarily energized by a d-c pulse. The synchro can be rotated any number of degrees or revolutions. The cylindrical member resets the synchro to electrical zero if a pulse is applied to the "reset" circuit.

Like all Transicoil servo assemblies, this incremental positioner "does the job right" because it was designed for a single application . . . by a company whose major function is to provide complete servo assemblies precisely engineered and manufactured to solve individual servo control problems.

Of course, if you merely want servo *components*, you'll find Transicoil's control motors, motor-gear train combinations, motor-gear train-generator combinations, and servo amplifiers built to the highest order of precision and accuracy. But it is in the "package" engineering of unique assemblies that Transicoil's experience and creative imagination offer the greatest value. And in most cases, these assemblies cost no more than the individual components would purchased separately.

That's why it pays to check your servo problems out with Transicoil first. Write outlining your problem, and ask for Transicoil's new gear-motor bulletin. You'll find it a mighty handy availability guide in designing for tight production schedules.

Transicoil

CORPORATION

Worcester • Montgomery County • Pennsylvania

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PERMASEAL®

PRECISION, WIREWOUND RESISTORS FOR 85° AND 125° AMBIENTS

You can choose from 46 standard designs in tab and axial lead styles to meet requirements for all types of military and industrial electronic apparatus and instruments.

This complete line of Permaseal Resistors is designed for applications which require highly accurate resistance values in small physical size at 85°C. and 125°C. operating temperatures.

Protected by a special Sprague-developed plastic embedding material, Permaseal Resistors provide maximum resistance to high humidity (they meet severe humidity requirements of MIL-R-93A and proposed MIL-R-9444 USAF).

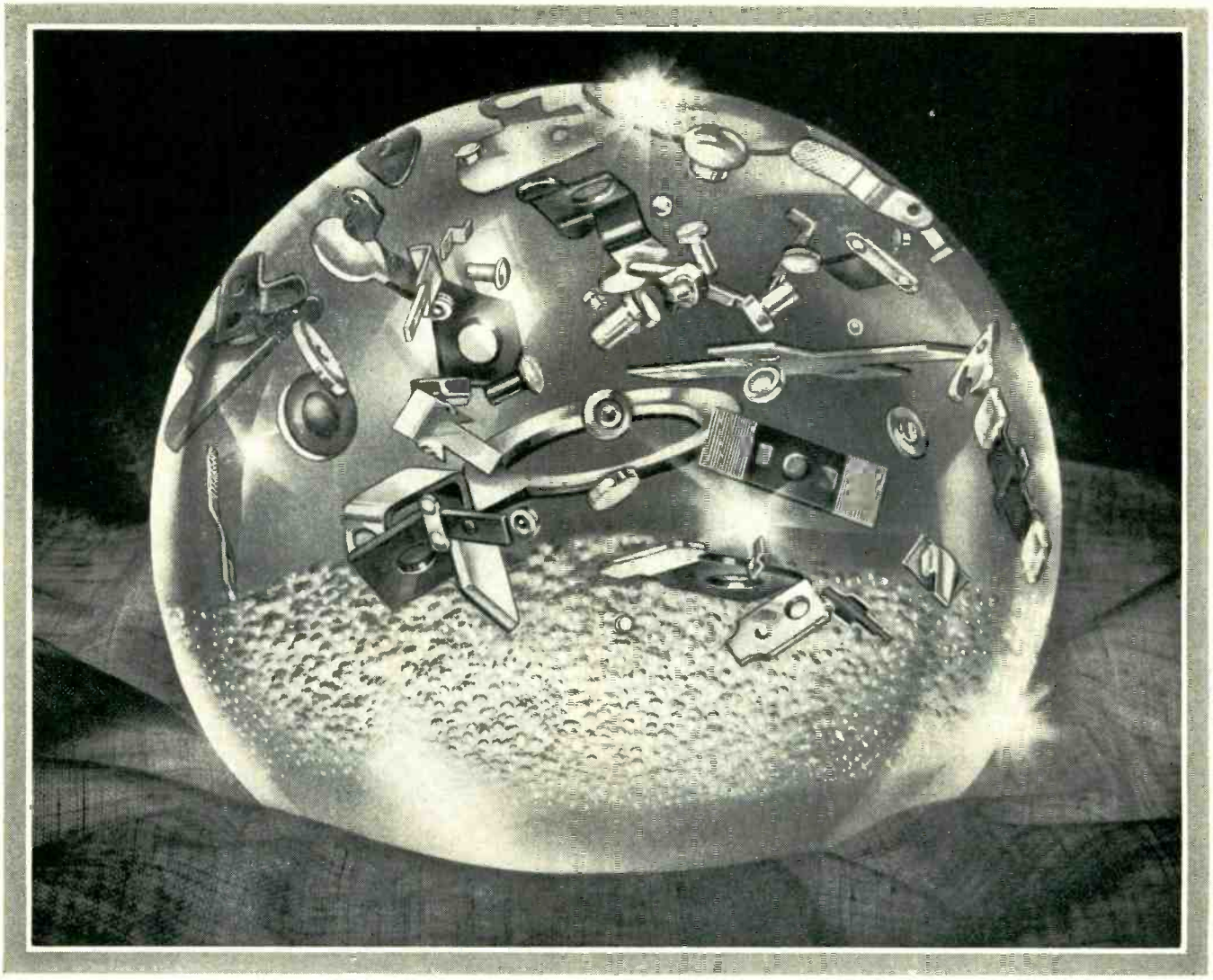
The winding forms, resistance wire, and embedding material are matched and integrated to assure long term stability at rated wattage over the operating temperature range.

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

SPRAGUE

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

SPRAGUE ELECTRIC COMPANY • 35 MARSHALL ST. • NORTH ADAMS, MASS.



Use GENERAL PLATE Composite Contacts to cut costs,

Brighten Your Product's Future

increase production, and provide reliable performance

General Plate's "know how" in the production of Composite Contact Materials can indeed brighten your products' future. By having General Plate fabricate your complete contact assemblies, you will save money, time, and trouble . . . eliminate needless equipment cost and problems of scrap disposal . . . and have at your disposal contacts and contact assemblies made to exact specifications shipped to you ready for installation when you want them.

Or, you may prefer to fabricate your own assemblies. General Plate Composite Contact Materials — available in overlay, edgelay, top-lay and inlay strips — make it possible for you to produce complete contact assemblies to close tolerances by simple blanking and forming operations.

In either case, comparison of the final costs of properly designed Composite Contact Assemblies fabricated from General Plate Composite Contact Materials against costs of similar assemblies produced by older methods of brazing, welding, staking, or spinning will reveal the resultant economies and fabricating ease available to you.

Write for complete information and catalog PR700 which describes General Plate Composite Contacts and other General Plate Composite Metals.

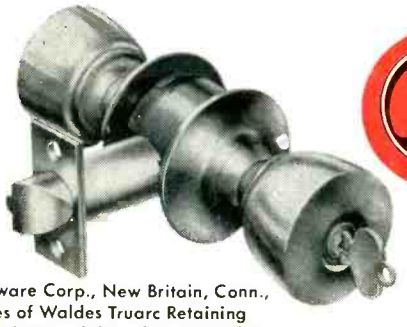
METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
310 FOREST STREET, ATTLEBORO, MASS.

GENERAL PLATE ELECTRICAL CONTACT KITS FOR LABORATORY AND DEVELOPMENT USE

Kit K11 contains a wide assortment of silver rivet contacts; Kit K12 has representative standard button contacts. Also included are composite metal strips for fabrication of contact posts. These kits are available at nominal cost.

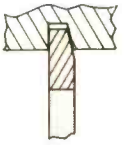
You can profit by using General Plate Composite Metals!

Waldes Truarc Retaining Rings Eliminate Machining— Provide Stronger Assembly, Greater Accuracy



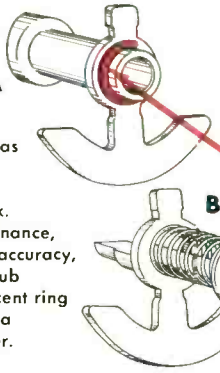
The American Hardware Corp., New Britain, Conn., uses 4 different types of Waldes Truarc Retaining Rings in the original design of these famous Corbin and Russwin Heavy Duty Cylindrical Locks. Truarc rings improve product performance, eliminate rejects, and cut labor costs.

Knob Sub Assembly



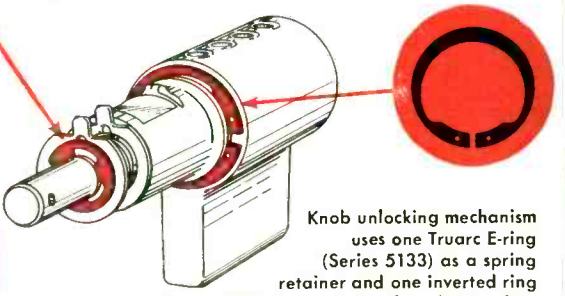
Truarc Beveled Ring (Series 5002) couples the knob to the knob shank. It eliminates two tapped holes and two screws, provides stronger assembly and greater accuracy. Beveled ring takes up end play rigidly.

Spindle Sub Assembly



Spindle sub assembly "A" has two Waldes Truarc crescent rings (Series 5103) used as locating flanges for rollback. This saves labor and maintenance, improves performance and accuracy, eliminates rejects. Spindle sub assembly "B" uses one crescent ring as a spring retainer and as a locating shoulder for washer.

Cylinder Sub Assembly



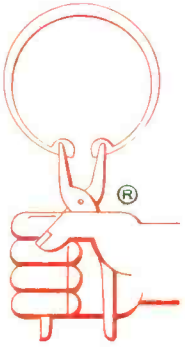
Knob unlocking mechanism uses one Truarc E-ring (Series 5133) as a spring retainer and one inverted ring (Series 5108) for retaining the cylinder plug. Rings are re-usable in the event of disassembly for maintenance. Rejects are eliminated.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product...to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types...as many as 97 different sizes within a type...5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U.S.A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today...let our Truarc engineers help you solve design, assembly and production problems...without obligation.

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



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WALDES
TRUARC®
RETAINING RINGS

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)

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E107

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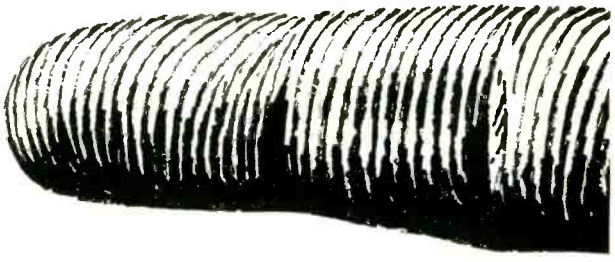
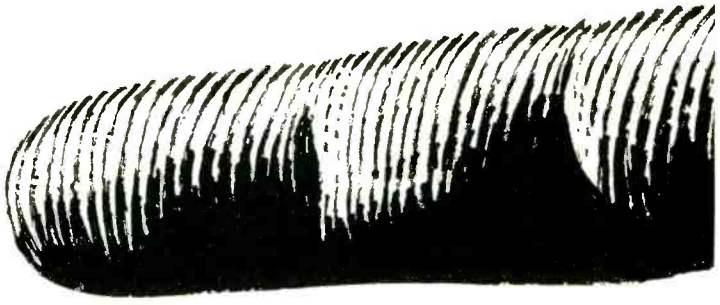
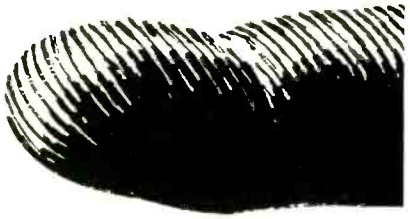
America's most experienced airfreight service assures you of expert handling, prompt forwarding and dependable on-time deliveries





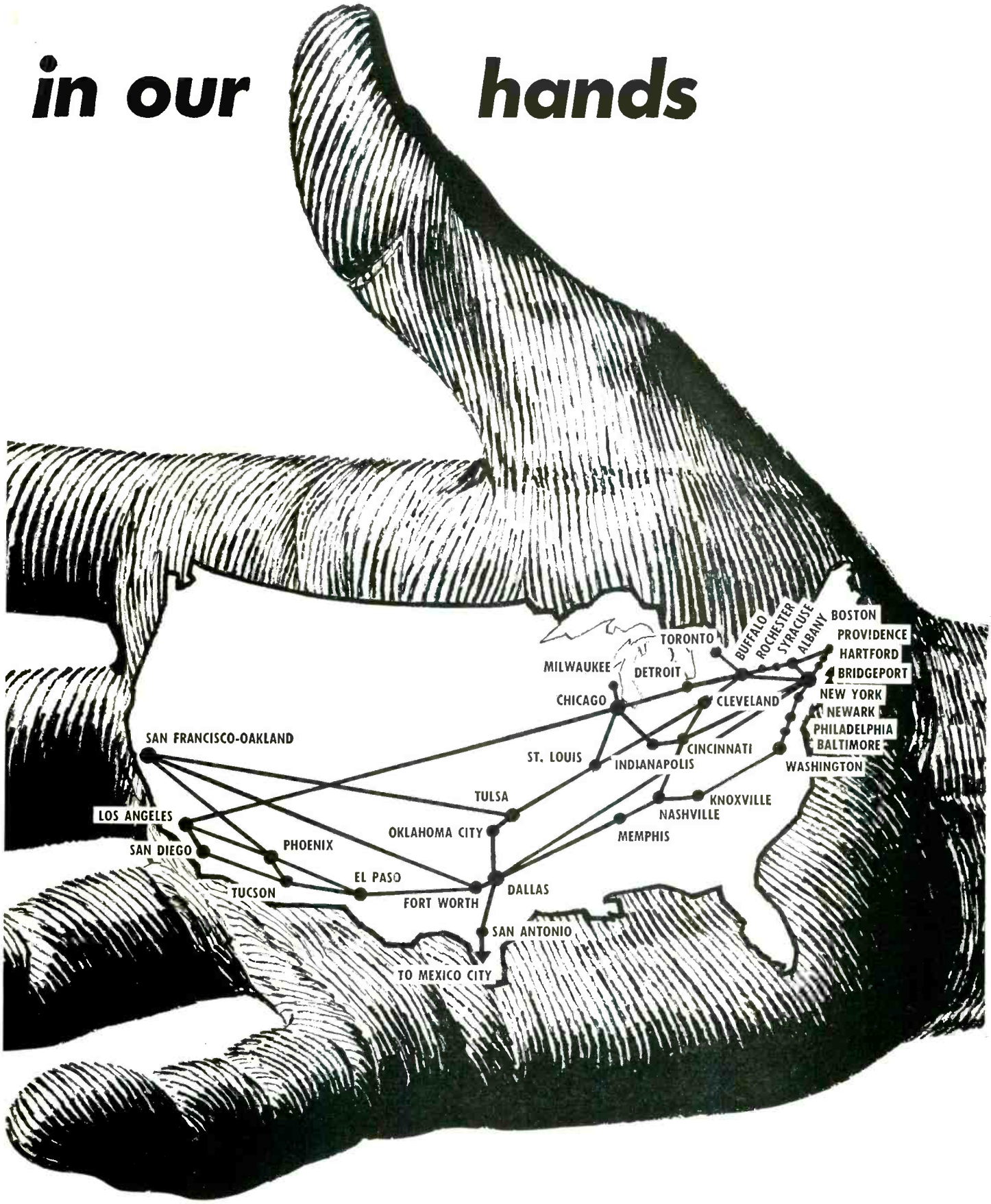


First with scheduled airfreight, American Airlines today has the largest personnel force, the most modern handling equipment. Add this edge in experience and facilities to American's superiority in coverage and capacity and you'll readily see why American Airlines is better qualified *than any other carrier* when it comes to solving shipping problems and cutting distribution costs. American Airlines, Inc., Cargo Sales Division, 100 Park Avenue, New York 17, New York.

AMERICAN AIRLINES INC

America's Leading Airline

in our hands



ACCURATE FREQUENCIES

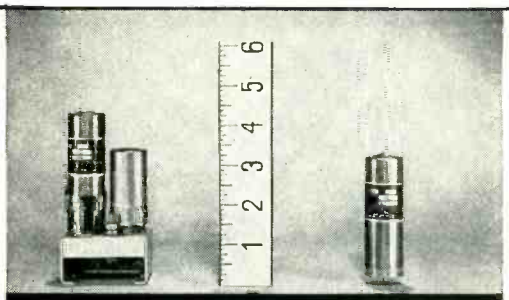
LOW WEIGHT
SMALL SIZE
ECONOMICAL

HIGH RELIABILITY
HIGH PRECISION
HIGH QUALITY

FREQUENCY STANDARD
240 to 800 Cycles

Type 50 C
± .02% at — 65° to 85°C

Type R 50 C
± .002% at 15° to 35°C



PRECISION FORK UNIT
240 to 800 Cycles

Type 50
± .02% at — 65° to 85°C

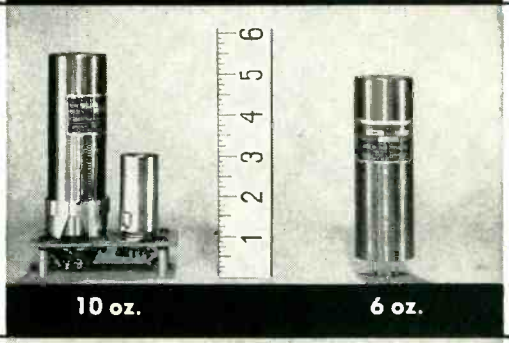
Type R 50
± .002% at 15° to 35°C

FREQUENCY STANDARD
200 to 4000 Cycles

Type 2003 C
± .02% at — 65° to 85°C

Type R 2003 C
± .002% at 15° to 35°C

Type W 2003 C
± .005% at — 65° to 85°C



PRECISION FORK UNIT
200 to 4000 Cycles

Type 2003
± .02% at — 65° to 85°C

Type R 2003
± .002% at 15° to 35°C

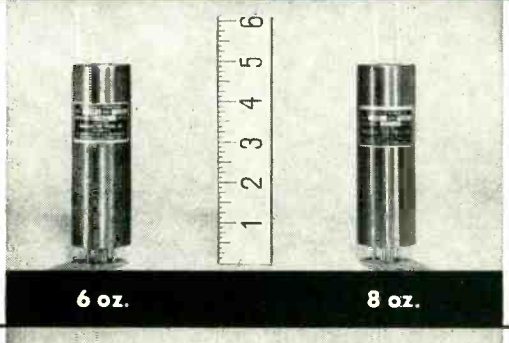
Type W 2003
± .005% at — 65° to 85°C

FREQUENCY STANDARD
200 to 2000 Cycles
Sub-miniature Tube

Type 2007
± .02% at — 65° to 85°C

Type R 2007
± .002% at 15° to 35°C

Type W 2007
± .005% at — 65° to 85°C



FREQUENCY STANDARD
240 to 1000 Cycles
Transistorized

Type 2007 T
± .02% at — 65° to 85°C

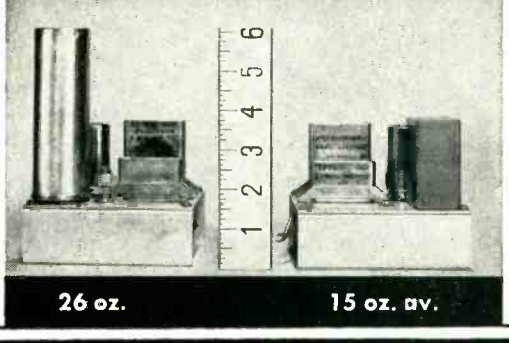
Type R 2007 T
± .002% at 15° to 35°C

Type W 2007 T
± .005% at — 65° to 85°C

FREQUENCY STANDARD
200 to 3000 Cycles

Type 2001-2
± .001% at 20° to 30°C

WHEN REQUESTING
INFORMATION
PLEASE SPECIFY
TYPE NUMBER



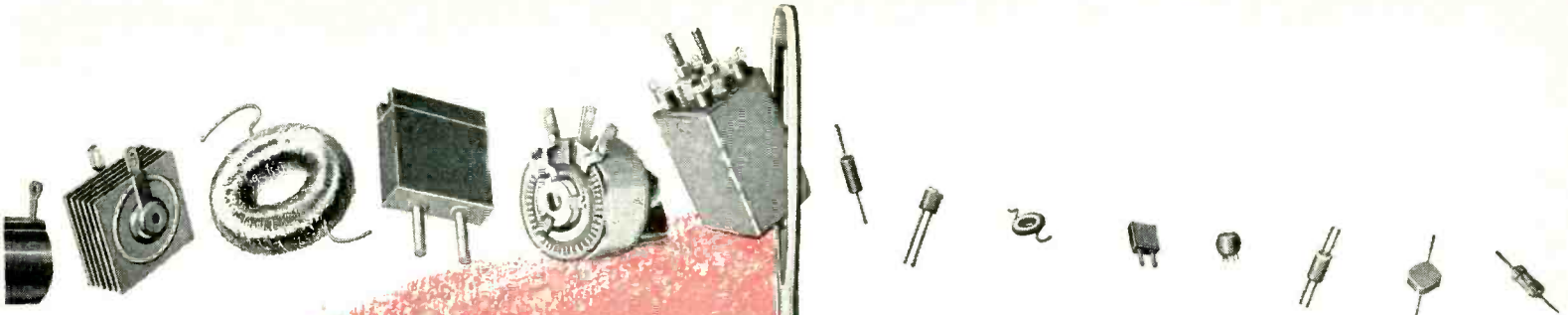
ACCESSORY UNITS
for Type 2001-2

L—for low frequencies, multi-vibrator type, 40-200 cy.
D—for low frequencies, counter type, 40-200 cy.
H—for high freqs., up to 20 KC
M—Power Amplifier, 2W output
P—Power Supply.

American Time Products, Inc.

580 Fifth Avenue New York 36, N. Y.

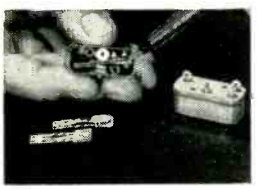
OPERATING UNDER PATENTS OF WESTERN ELECTRIC COMPANY



MINIATURIZATION

When there's only room for improvement

...there's a treasury of ideas in **KEL-F® PLASTIC**



Space saving insulation... machined from KEL-F Plastic rod.

Miniature Test Jacks for 500 volt RMS "HF" circuit...injection molded of KEL-F Plastic.

Contact Bar insulated with KEL-F Plastic...injection molded directly to beryllium-copper.

When you have to squeeze more and more into less and less space...when materials lack the specific properties you need for miniaturization, we suggest you look into the possibilities of KEL-F Plastic.

The development of KEL-F Plastic, a fluorocarbon polymer, was inspired by a vital problem of miniaturization in the field of electronics. What it accomplished then, it can repeat for your products.

KEL-F Polymer is a dense, tough thermoplastic with outstanding resistance to the effects of high and low temperatures. In wire insulation, tube sockets, connector blocks, printed circuit bases, transistor seals, and other applications its zero moisture absorption, non-wettability and dimensional stability can provide high level performance under severe conditions of temperature and humidity.

The compressive strength is high. Bearing loads of 8,000 psi result in only 4% to 5% permanent set. KEL-F Plastic can actually be used for structural members. Electrical properties are outstanding. They include superior resistance to arcing, surface flash-over and thermal cycling.

KEL-F Plastic is readily moldable by extrusion, compression, injection and transfer methods. Molding techniques are fully perfected, and molded components can be depended on to exhibit all the inherent characteristics of the original molding material.

KEL-F Plastic is available as a molding compound, or it can be obtained in rods, tubing, sheets and film from a number of suppliers. It is also available in dispersions, suitable for bake-coating of metals and certain non-metals. The full story of KEL-F Polymer should be in your active file. Write us.

®*Registered trademark for The M. W. Kellogg Company's Fluorocarbon polymers.*

Miniature Rectifier and mount for parts...injection molded of KEL-F Plastic.

THE M. W. KELLOGG COMPANY

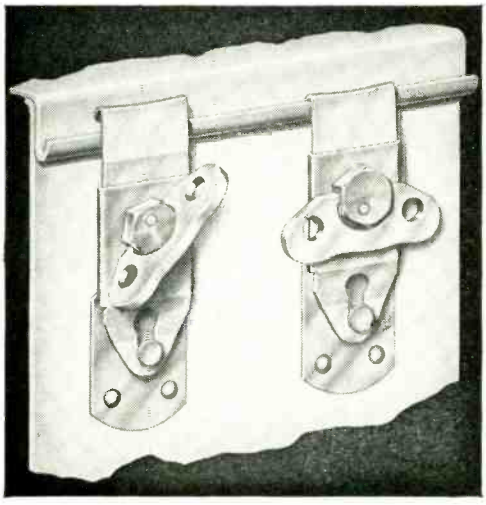
Chemical Manufacturing Division, P. O. Box 469, Jersey City, N. J.

SUBSIDIARY OF PULLMAN INCORPORATED

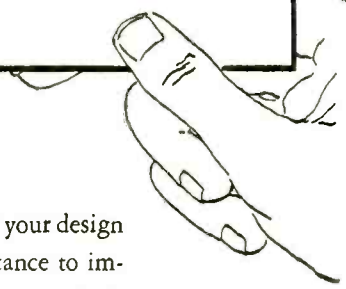
Want more information? Use post card on last page.

Have you a similar fastening problem?

File: Simmons LINK-LOCK



When the armed forces needed a positive, high-strength fastening device for instrument housings, transit cases, and storage boxes, Simmons developed LINK-LOCK. This *brand-new* device doesn't use springs, yet works with fingertip pressure through a unique mechanical arrangement: the vertical sliding latch is moved in and out of locking position by a disc rotated with a wing nut. The fastener is immune to low temperatures, is easy to operate even with arctic mittens, furnishes up to 450-lb. pull-down pressure. Open or closed, it lies flat against the side of the case it fastens.



LINK-LOCK may be the answer to your fastening problem. If your design involves heavy fastening pressures, watertight sealing, high strength, resistance to impact, ask about LINK-LOCK. Simmons can furnish it with special engagement-latch details, or for operation by bolt or screwhead instead of wing nut. Write for LINK-LOCK DATA SHEET today. It gives complete details and dimensions. A Simmons engineer will be glad to work with you on your fastening problems.

SIMMONS FASTENER CORPORATION, 1750 No. Broadway, Albany 1, New York

Simmons QUICK-LOCK SPRING-LOCK ROTO-LOCK LINK-LOCK DUAL-LOCK

JUST OUT: NEW 36-PAGE CATALOG WITH APPLICATIONS. SEND FOR IT!

INTER-OFFICE MEMO

SUBJECT: *A "new look" in Trade Shows*

Electronic Engineering Representatives ROAD SHOW

Now — the nation's newest electronic instrumentation and equipment will be brought to the doorstep of engineers in Greater New York City, New Jersey and Eastern Pennsylvania.

The First Annual EER Road Show, sponsored by the leading representatives of instrumentation and equipment manufacturers, will observe the following schedule:

Oct. 17—Westchester County Center
White Plains, N. Y.

Oct. 19—Garden City Hotel
Garden City, L. I., N. Y.

Oct. 21—West Orange Armory
West Orange, N. J.

Oct. 25—Hotel Sylvania
Philadelphia, Pa.

Free parking space. Admission free. Hours: 12 noon to 10 p.m.

You are cordially invited to attend whichever of these sessions is most convenient for you. The Road Show is another example of EER members serving your electronic equipment needs the truly modern way!

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BURLINGAME ASSOCIATES, LTD., New York, N. Y. — Allison Laboratories, Aremac Associates, Brush Electronics Co., Cascade Research Corp., Donner Scientific Co., Electro Instruments, Inc., Electro-Pulse, Empire Devices Products Corp., Gerber Scientific Instruments Co., Hycor Sales Co., Laboratory for Electronics, Labscope, Inc., Magnetic Research Corp., Narda Corp., N.J.E. Corp., Roger White Electronic Devices, Inc., Servo Corp. of America, Sierra Electronics Corp.

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RMC ASSOCIATES, New York, N. Y. — Beta Electric Corp., Budd Stanley Co. Inc., John Fluke Mfg. Co., Hewlett-Packard Co., Kay Lab, Pimex Inc., Sorenson & Co., Inc., Varian Associates.

I. E. ROBINSON CO., Upper Darby, Pa. — Beta Electric Corp., Hewlett-Packard Co., John Fluke Mfg. Co., Industrial Electronic Controls Co., Daytronic Corp., Kay Lab, Sensitive Research Instrument Co., Sorenson & Co., Inc., Varian Associates.

SYMBOL OF SERVICE
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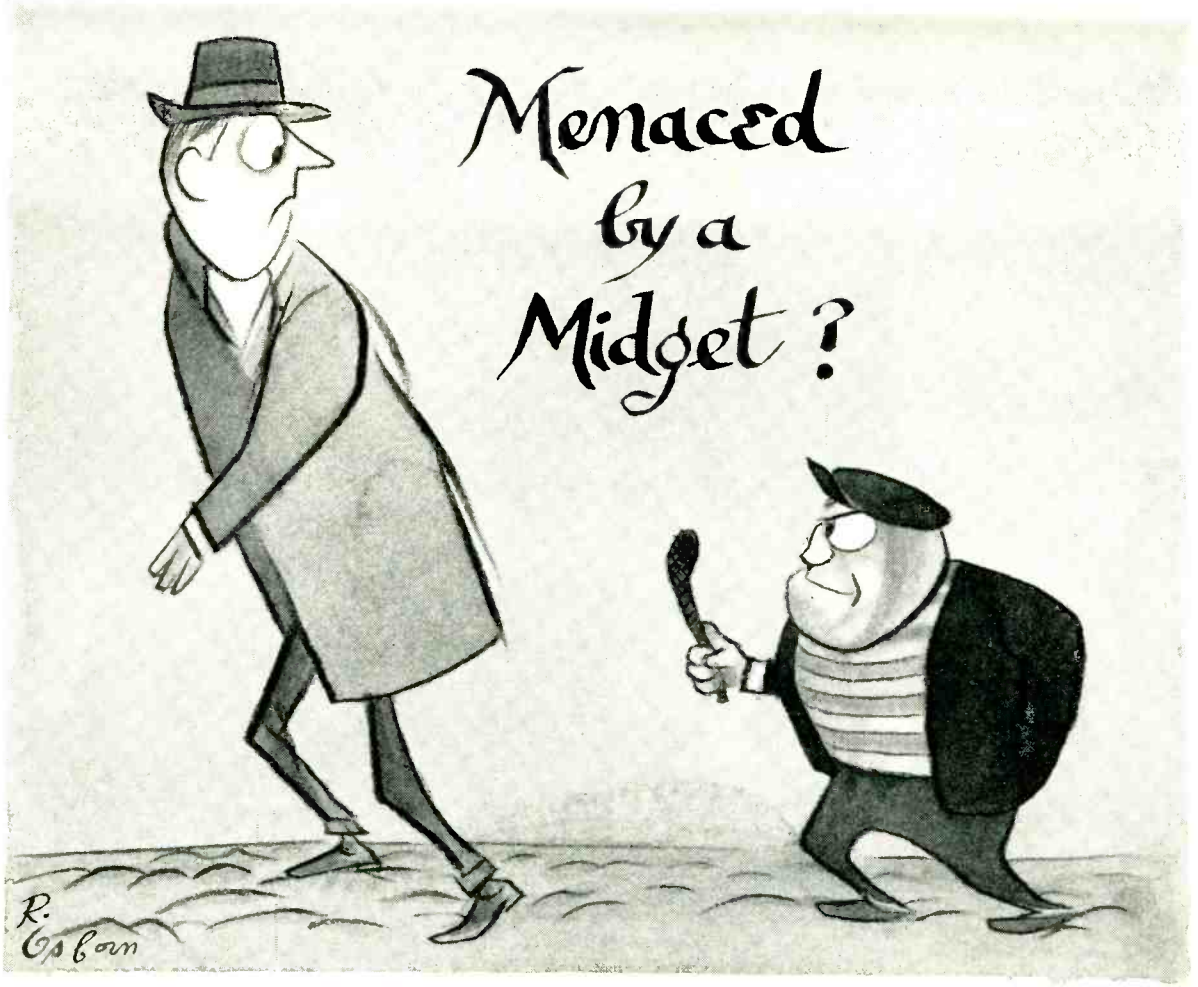
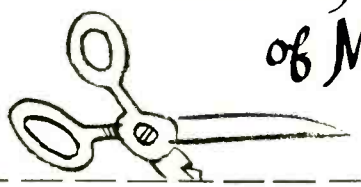
ELECTRONIC ENGINEERING REPRESENTATIVES



Being hounded by a problem in miniaturization? Are you harassed by a toughie in the increasingly critical field of design diminution, weight and size reduction, power and component capsulation? If you are, simply stop in at the nearest scissors store. Get a pair of pinking shears and cut out this coupon. It will get you the complete catalog of MPB's ✳ such as these

BALL BEARINGS ACTUAL SIZE



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YES! Send me your complete new MPB CATALOG

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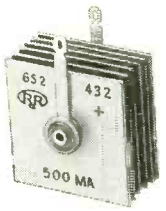
RADIO RECEPTOR

SELENIUM RECTIFIERS

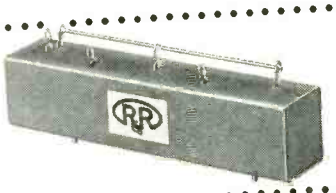
INDUSTRIAL TYPE RECTIFIERS

Years of service in every kind of application have proved the long life and dependability of these rugged units. Available in various voltage and current combinations up to several hundred kilowatts, they are useful in a multitude of industrial and power circuits such as power supplies, magnetic amplifiers, electro-plating, battery charging, etc.



RADIO TYPE RECTIFIERS

Millions of these stacks are in service in radio and TV circuits as well as many small power applications. Thoroughly dependable under all types of grueling conditions, they are specified by an increasing number of engineers in the U. S. and throughout the world. Available for black and white as well as color TV in ratings up to 750 MA.



EMBEDDED RECTIFIERS

For top protection in military and other applications calling for the strictest requirements. Recommended for use where size and weight are important considerations such as in aircraft.

HIGH TEMPERATURE TYPES

High temperature rectifiers are now available in the larger cell sizes up to 5" x 6" to operate without derating at 125°C. Radio Receptor research has brought the cost down so that the field is now wide open for use in many applications once considered prohibitive because of size and price.

HERMETICALLY SEALED UNITS

Built to special requirements to meet unusually severe conditions. Designed to meet individual needs.

If you have a problem involving rectification, submit your requirements and our engineering department will be glad to aid you in the solution . . . without obligation, of course. See our catalog in Sweet's Product Design File and write for our latest bulletin No. E-11

RECTIFIERS FOR MAGNETIC AMPLIFIERS

Special designs will be submitted to meet individual requirements. However in many cases standard Radio Receptor stacks will give highly satisfactory performance in mag-amp applications, saving both time and money. Let us study your specs and make recommendations.

Semiconductor Division

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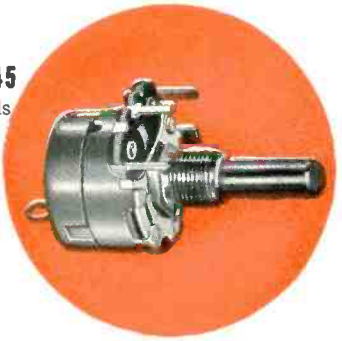
Really RR *Reliable*

FOR YOUR AUTOMATION PROGRAM

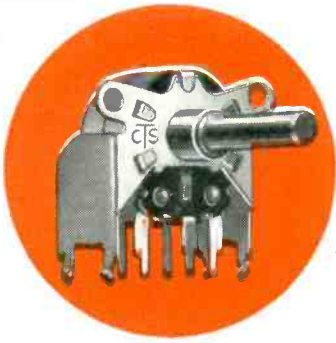
VARIABLE RESISTORS FOR PRINTED CIRCUITS

Type UPM-45
For TV preset control applications. Control mounts directly on printed circuit panel with no shaft extension through panel. Recessed screwdriver slot in front of control and 3/8" knurled shaft extension out back of control for finger adjustment. Terminals extend perpendicularly 7/32" from control's mounting surface.

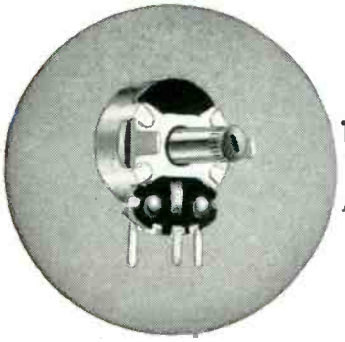
Type GC-U45
Threaded bushing mounting. Terminals extend perpendicularly 7/32" from control's mounting surface. Available with or without associated switches.



Type U70 (Miniaturized)
Threaded bushing mounting. Terminals extend perpendicularly 5/32" from control's mounting surface.



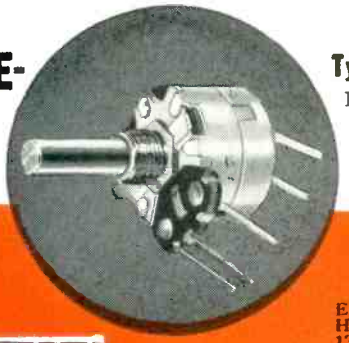
Type YGC-B45
Self-supporting snap-in bracket mounted control. Shaft center spaced 29/32" above printed circuit panel. Terminals extend 1-1/32" from control center.



Type XP-45
For TV preset control applications. Control mounts on chassis or supporting bracket by twisting two ears. Available in numerous shaft lengths and types.

Type XGC-45
For applications using a mounting chassis to support printed circuit panel. Threaded bushing mounting.

VARIABLE RESISTORS FOR SOLDERLESS "WIRE-WRAP" CONNECTIONS



Type WGC-45
Designed for solderless wire-wrapped connections with the use of present wire-wrapping tools. Available with or without switch and in single or dual construction.

The controls illustrated are typical constructions. CTS' years of engineering and technical experience makes available many other types for your automation needs.

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"Your best source for relays" is Potter & Brumfield, because of an enviable reputation earned through a *quarter century* of relay specialization.

Millions of relays of *all styles* and *sizes* designed and manufactured to meet customer specification.

From small sub-miniature, precision, sensitive relays to heavy duty power types, each fulfilling an exacting requirement.

Enclosed, hermetically sealed or open relay structures to meet demands of various environmental conditions.

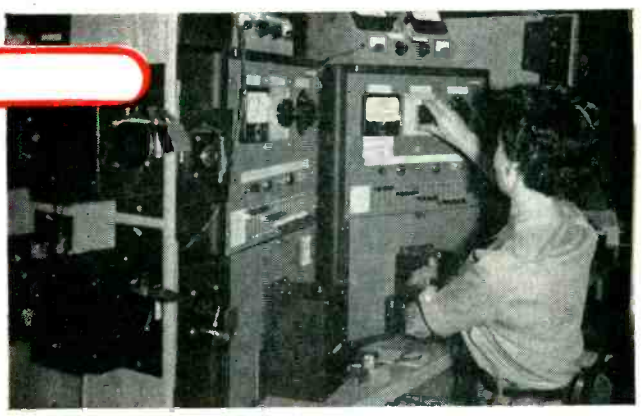
Priced competitively at all quality levels. Samples available for immediate shipment. Send your specification for recommendations and quotations.

ALL TYPES—ALL SIZES—FOR ALL APPLICATIONS

discriminating ~~most~~ engineers choose Potter & Brumfield

100% HI-POT TEST

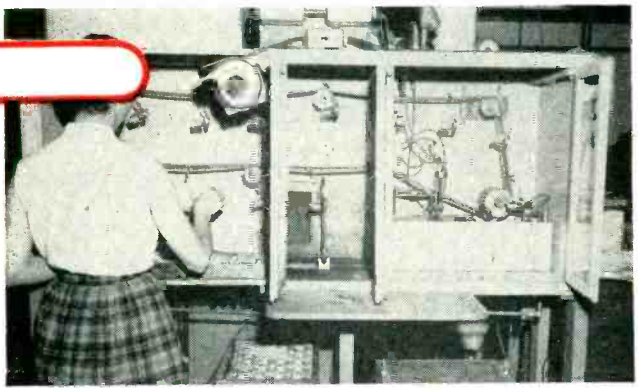
Some sealed relays have as many as ninety possible voltage breakdown points. This tester, developed by Potter & Brumfield, checks every breakdown point automatically with extra high voltage and for the necessary time interval.



ULTRASONIC CLEANING

Another Potter & Brumfield development, the use of Ultrasonic cleaning in relay manufacture.

Potter & Brumfield sealed relays are tops because they are thoroughly cleaned of all dirt, solder flux and other contaminants by silent sound.



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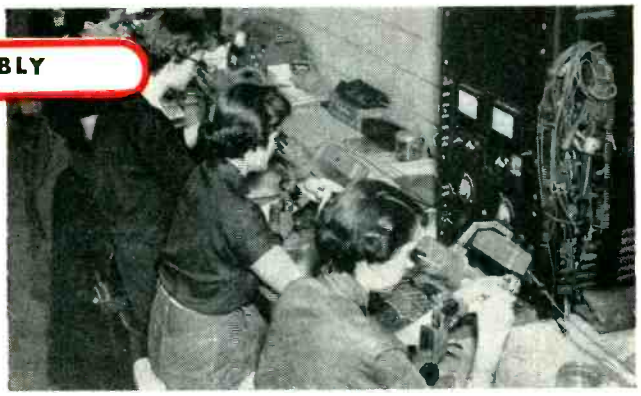
The small watch size parts of many Potter & Brumfield relays are inspected and assembled under ten power magnification.

Thus assuring the close tolerances necessary for long life and dependable operation of miniature and sub-miniature relays.



For quick delivery, over 350 different standard relays stocked by 500 Franchised Electronic Parts Distributors throughout the United States and Canada.

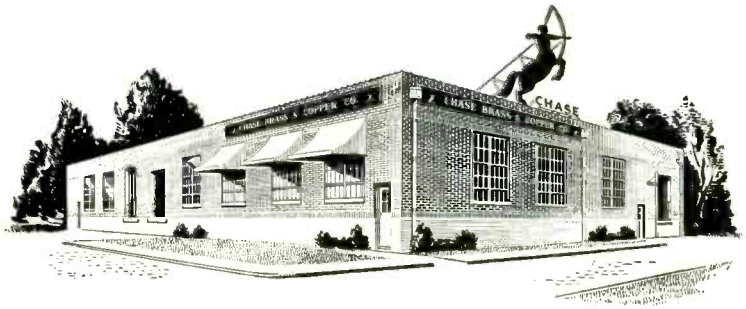
Another AMF Product

P&B Relays

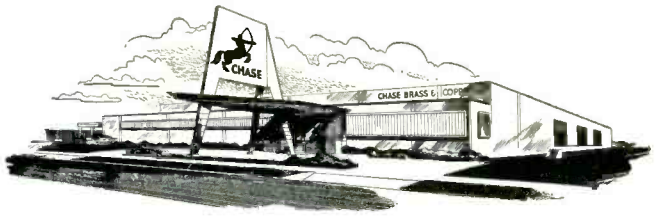
POTTER & BRUMFIELD MFG. CO., INC.
Princeton, Indiana

ALL TYPES—ALL SIZES—FOR ALL APPLICATIONS

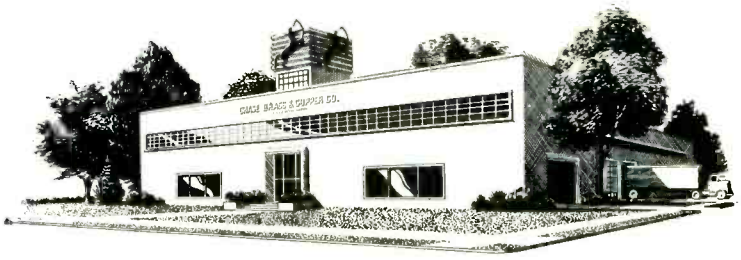
CHASE®



IS THE



PLACE



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CALL THE CHASE WAREHOUSE NEAR YOU!

The Nation's Headquarters for Brass & Copper

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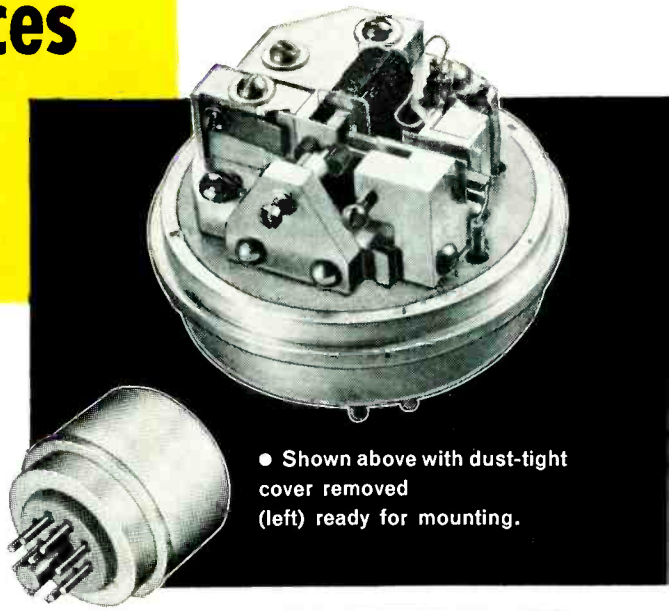
Baltimore	Cleveland	Houston	Milwaukee	Philadelphia	San Francisco
Boston	Dallas	Indianapolis	Minneapolis	Pittsburgh	Seattle
Charlotte†	Denver	Kansas City, Mo.	Newark	Providence	Waterbury

Here's the Relay for today's high speed devices

Highly Sensitive
No Contact Bounce
Billions of Operations

THE CLARE TYPE T
High Frequency
Impulse relay



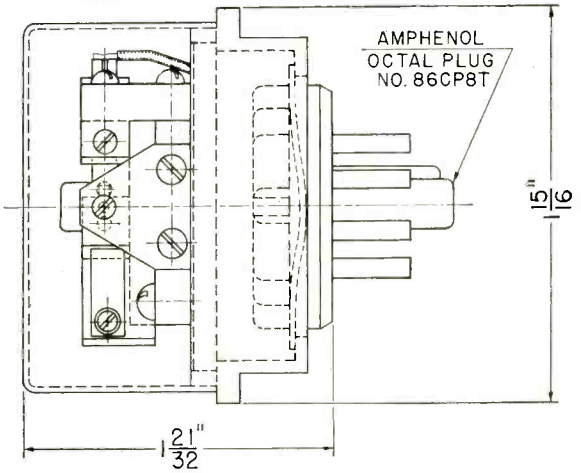
● Shown above with dust-tight cover removed (left) ready for mounting.

● Announcement of the CLARE Type T High Frequency Relay two years ago set off such a deluge of inquiries for samples and information that it is only just now that production facilities permit us to mention it again.

Originally designed for use in an analog computer, this relay is ideal for designs which call for a highly sensitive relay completely free from contact bounce and capable of billions of operations at extremely high speeds.

Pull-in time of this relay, for instance, is 120 microseconds. With dropout time of 100 microseconds, the relay follows up to 2500 cycles per second; aperiodic to 1000 cycles per second.

Manufacture of the CLARE Type T Relay, with its high speed, no bounce and other unusual characteristics, necessitated the development of entirely new techniques. It is built to extremely close tolerances, with a high degree of precision and fabricated under conditions of utmost cleanliness.



SPECIFICATIONS

MECHANICAL

Size: 1-15/16 in. dia. x 2-3/16 in. overall. Weight: 5 oz.

Mounting: Equipped with plug, to fit standard 8-pin octal socket.

Cover: Removable dust-tight cover.

Contacts:
- **Type:** Form A (s.p.s.t., normally open)
- **Material:** Platinum-iridium
- **Gap:** 0.0005 inch
- **Pressure:** 30 grams, min. (Coil energized with 50 ampere-turns)

Coil:
- **Type:** Single winding, bobbin-wound.
- **Wire:** Heavy formex.

ELECTRICAL

Operate Ampere-Turns: 8 to 20.

Release Ampere-Turns: 1 to 4 less than operate ampere-turns.

Nominal Ampere-Turns for High-Speed Operation: 16 to 40.

Speed of Operation: will follow 2500 cycles per second; aperiodic to 1000 cycles per second.

Operate Time: 100 to 180 microseconds.

Release Time: 60 to 120 microseconds.

Contact Bounce: None.

Contact Current Rating: 0.05 amp., max.

Contact Voltage Rating: 150 V., max.

Dielectric Strength: 500 V., rms.

Coil Resistance: up to 600 ohms.

Life Expectancy: 5 x 10^9 operations (determined by contact load).

TYPICAL CHARACTERISTICS

Coil Resistance: 135 ohms.

Coil Inductance: .35 Hy.

Operate Current: 10 to 12 ma.

Release Current: 8 to 10 ma.

Nominal Current: 40 ma., steady state; 20 ma., average.

Operate Time: 130 microseconds.

Release Time: 100 microseconds.

Energizing Circuit: Coil in plate circuit of vacuum tube with 300 volt plate supply.

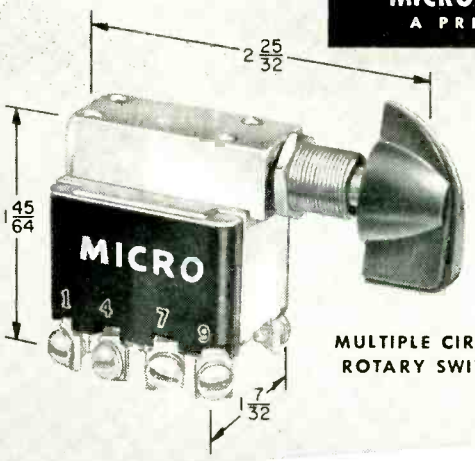
For full information on the CLARE Type T Relay —or for consultation on any relay problem—see your nearest CLARE Sales Engineer or write C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada. Canadian Line Materials Ltd., Toronto 13. Cable Address: CLARELAY.

Send for Clare Bulletin Number 117

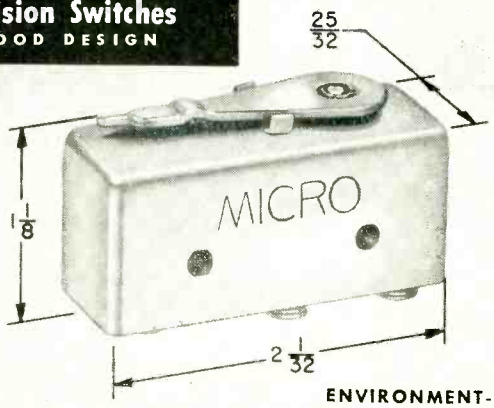
FIRST IN THE INDUSTRIAL FIELD

CLARE RELAYS

MICRO SWITCH Precision Switches
A PRINCIPLE OF GOOD DESIGN



MULTIPLE CIRCUIT ROTARY SWITCH



ENVIRONMENT-PROOF SWITCH

New MICRO SWITCH products meet exacting electronic requirements

Keeping pace with the ever-changing needs of the electronics industry has always been an important consideration of MICRO SWITCH engineering development.

New switches and new switch assemblies are always on the drawing boards and on test at MICRO SWITCH. Often designers find these switches fit, without change, the particular service at hand. At other times consultation with MICRO SWITCH engineering results in modification of an old design or development of one entirely new.

Whatever the task, MICRO SWITCH components either are or can be made available to give the utmost in reliable service performance. Does your current problem involve any switches like these?

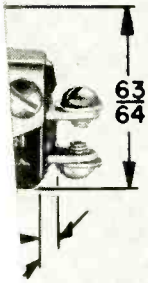
A Multiple Circuit Rotary Switch—Will handle up to 8 circuits at 20 amperes at 115 volts a-c.

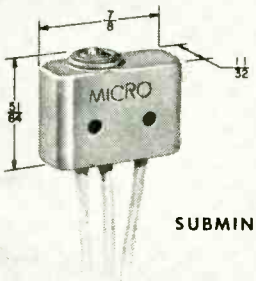
New Environment-Proof Switch—Provided with split contact circuit arrangement.

Sealed Subminiature Switch—Completely environment-proof, has high electrical capacity and long life.

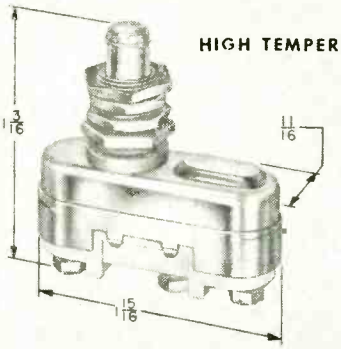
High Temperature Switch—Designed to operate perfectly in temperatures up to 1000° F.

MICRO SWITCH field engineers are conveniently located at 20 branch offices. Consultation with them involves no cost. It can save you much time and money.





SEALED SUBMINIATURE SWITCH



HIGH TEMPERATURE SWITCH

A complete line of snap-action and mercury switches

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
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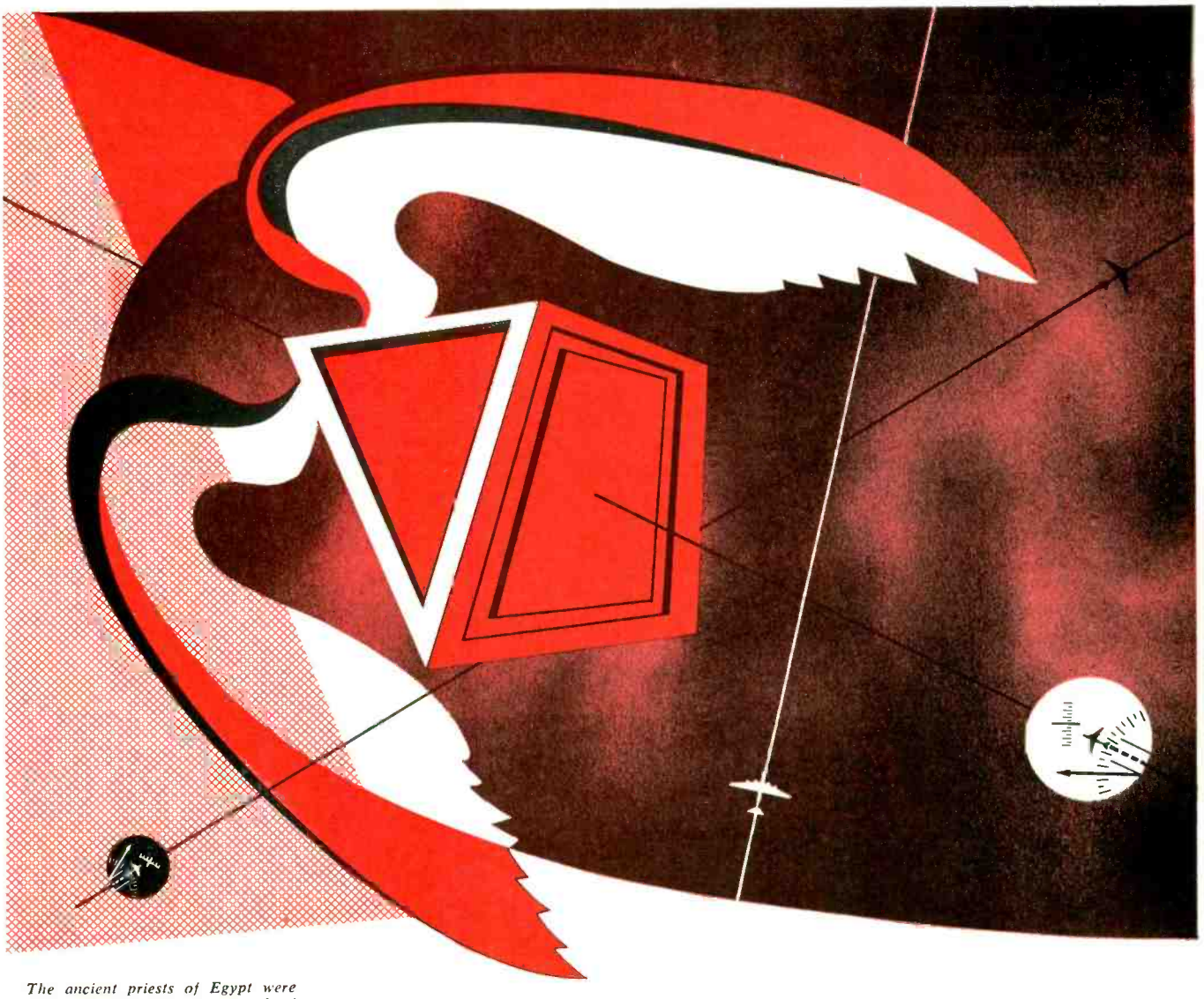
HONEYWELL



The ancient priests of Egypt were engineers whose great pyramid of Cheops was sextant, compass and slide rule—all in one. From sighting the Pole Star, to squaring the compass, to the mathematics of pi—it's all there in the pyramid of Gizeh.

flying pyramids

Wonder of the world for ages, Gizeh's pyramid was a fount of mathematical data—a tool to check measures, an aid to celestial navigation. Today's aircraft are "flying pyramids"—collecting and integrating instantaneous measurements for orientation and control. Kollsman activities cover these seven fields:

AIRCRAFT INSTRUMENTS
PRECISION CONTROLS
PRECISION COMPUTERS AND COMPONENTS
OPTICAL COMPONENTS AND SYSTEMS
RADIO COMMUNICATIONS AND NAVIGATION EQUIPMENT
MOTORS AND SYNCHROS
INSTRUMENTS FOR SIMULATED FLIGHT TRAINERS

Our manufacturing and research facilities . . . our skills and talents, are available to those seeking solutions to instrumentation and control problems.

kollsman INSTRUMENT CORPORATION

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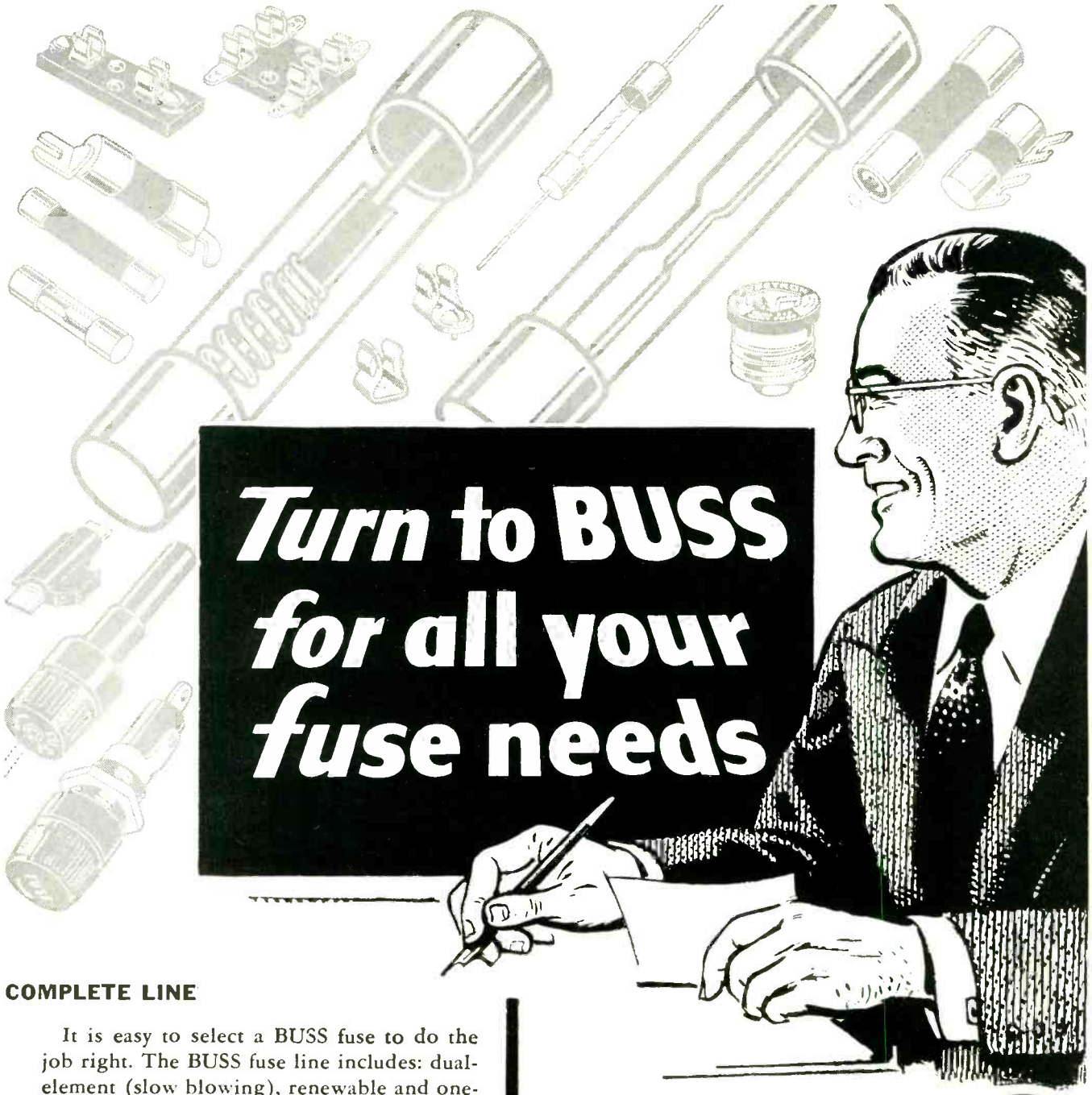


Turn to BUSS for all your fuse needs

COMPLETE LINE

It is easy to select a BUSS fuse to do the job right. The BUSS fuse line includes: dual-element (slow blowing), renewable and one-time types — in sizes from 1/500 ampere up . . . plus a companion line of fuse clips, blocks and holders.

BUSS FUSES ARE MADE TO PROTECT — NOT TO BLOW NEEDLESSLY

To assure unfailing dependability — every BUSS fuse normally used by the Electronic Industries is tested in a sensitive electronic device. Any fuse not correctly calibrated, properly constructed and right in all physical dimensions is automatically rejected.

With the cost of a fuse being so insignificant compared to the value of the equipment it protects and the value of your good name — it is just good business to refuse to take a chance on anything less than BUSS quality in fuses.

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

IF YOUR PROTECTION PROBLEM IS "DIFFERENT"!

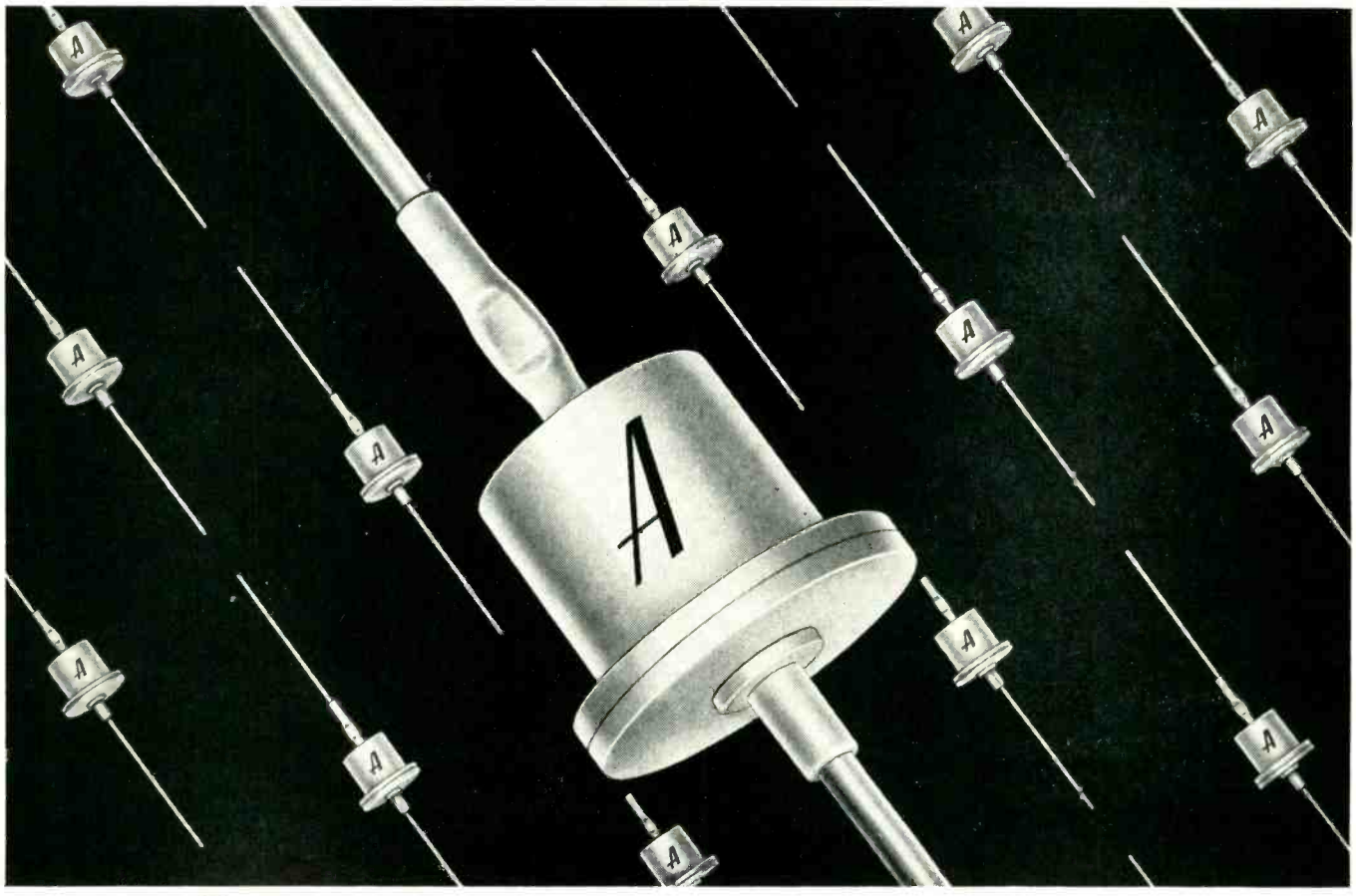
You can save engineering time by letting the BUSS fuse engineers help you select the fuse best suited to your particular conditions. If possible, the fuse selected will be available in local wholesalers' stocks, so that your device can be easily serviced.

Be sure to get the latest information on BUSS and FUSETRON small dimension fuses and fuseholders . . . Write for bulletin SFB.

Makers of a complete line of fuses for home, farm, commercial, electronic, automotive and industrial use.

ELRC 1055

BUSSMANN MFG. CO. (Division of McGraw Electric Co.)
UNIVERSITY AT JEFFERSON ST. LOUIS 7, MO.



AUTOMATIC...a dependable source for SILICON POWER RECTIFIERS

Medium Power Series of 6 Types. Ratings up to 600 P.I.V. and 300 Ma.

Featuring:

- **Infinitesimally small reverse leakage current (Reverse resistance of 1000 meg-ohms)**
- **Ambient temperature range: — 55°C to 150°C**
- **No de-rating up to 100°C**
- **Extremely low forward resistance (1 ohm)**
- **Highest rectification ratios (10⁶)**
- **Convenient coaxial pigtail leads**
- **All-welded hermetic seal for long life**

Automatic Silicon Power Rectifiers are ideally suited for use in all types of miniaturized equipment. Complete technical data covering the six types (1N440 to 1N445) already available is contained in a 4 page illustrated catalog available on request. Your inquiry will receive prompt attention.

ABSOLUTE MAXIMUM RATINGS (For 55°C Ambient)	1N440	1N441	1N442	1N443	1N444	1N445
Peak Inverse Voltage (volts)[1]	100	200	300	400	500	600
D.C. Output Current (ma.)[2]	300	300	300	300	300	300
Peak Forward Current (amps.)	1.5	1.5	1.5	1.5	1.5	1.5
Full Load Voltage Drop (volts)	1.5	1.5	1.5	1.5	1.5	1.5
Reverse Current at Rated P.I.V. (microamps.)	0.30	0.75	1.00	1.50	1.75	2.00

1. Continuous reverse voltage equal to the P.I.V. may be applied.

2. For ambient temperatures greater than 100°C, de-rate the D.C. output current by 60 ma. for each 10°C above 100°C.

NOTE: Silicon power rectifier types with higher peak inverse voltages than those shown above are available to meet specific requirements.

Every part Automatic uses ... Automatic makes.

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Subsidiary General Instrument Corporation

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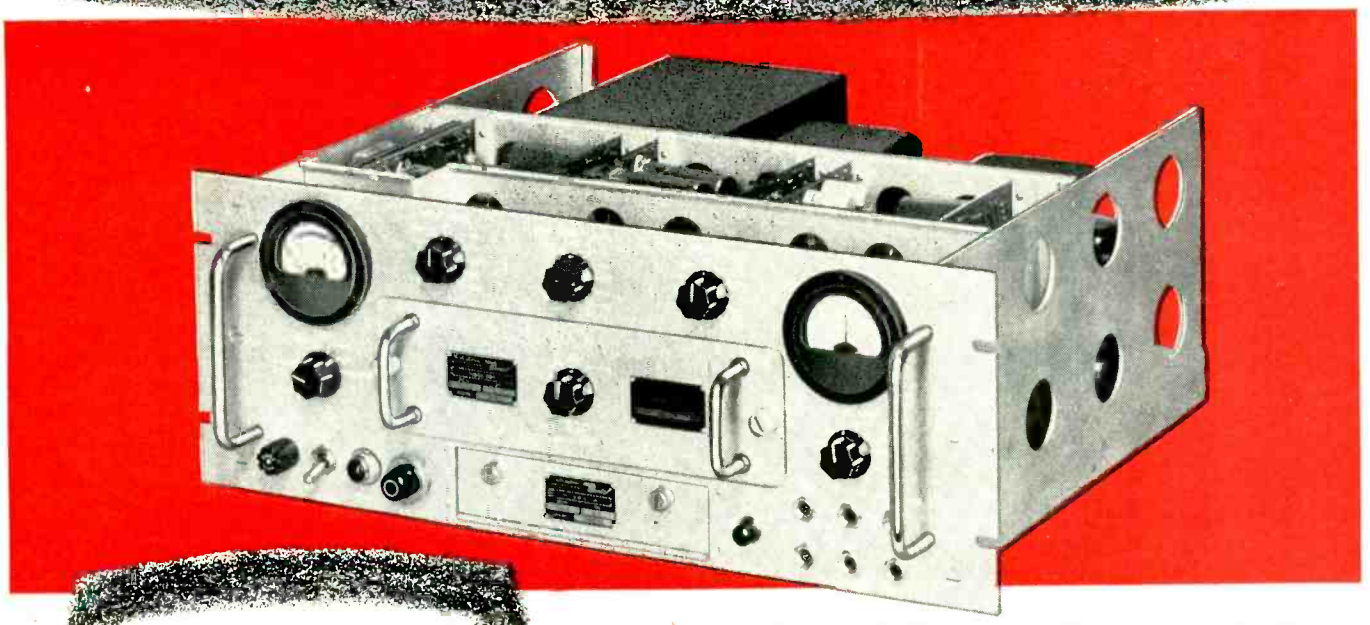
BENDIX - PACIFIC

DISCRIMINATORS

FOR FM/FM TELEMETERING RECEIVING STATIONS



CHARACTERISTICS

Center Frequency
250 cycles to 110 kc

Deviation
±5% to ±40% of center frequency

Frequency Response
DC to 40% of bandwidth

Input Signal
0.01 volt rms minimum per subcarrier and 15 volts rms maximum for composite of all subcarriers

Amplitude Modulation
Less than 1% of bandwidth change for 10 db input steps

Output
3 single ended outputs providing 20 ma of output current

Stability
±0.4% after one hour warming

Sensitivity Stability
±0.25%

Linearity
±0.1% from best straight line

Power Source
105 to 125 volts, 60 cycles, 200 watts nominal

The new Bendix-Pacific TDA-9 Subcarrier Discriminator provides the accuracy and stability necessary to permit expansion of Frequency Modulation telemetering systems into high precision and automatic data handling facilities.

Normal, extended or reduced intelligence frequency response is selected by a switch. Signals from proper impedances are of sufficient level to directly accommodate many of the commonly employed data recording and handling equipment without additional amplifiers. Freedom from drift and gain instability is maintained by a chopper-stabilized DC amplifier.

The design of the band pass filters used in the TDA-9 discriminator includes a flat response over the pass band, a linear phase shift characteristic to provide constant time delay of the intelligence signal, and selectivity to provide adequate channel rejection, preventing systems intermodulation.

Provisions for fine balance adjustment of center frequency from a remote location as well as wow and flutter compensation during tape recorder playback have been provided.

Standard discriminators are available for operation on all RDB bands. The unit is also operable over an extended frequency range with center frequencies of 250 cps to 110 kc without deteriorating the performance characteristics. Operation using wide deviations up to ±40% of the channel center frequency can be provided.

Bendix

PACIFIC DIVISION

Bendix Aviation Corporation

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AEROCOM'S 1046 H.F. TRANSMITTER

POWER + STABILITY

1000 WATTS WITH .003% STABILITY

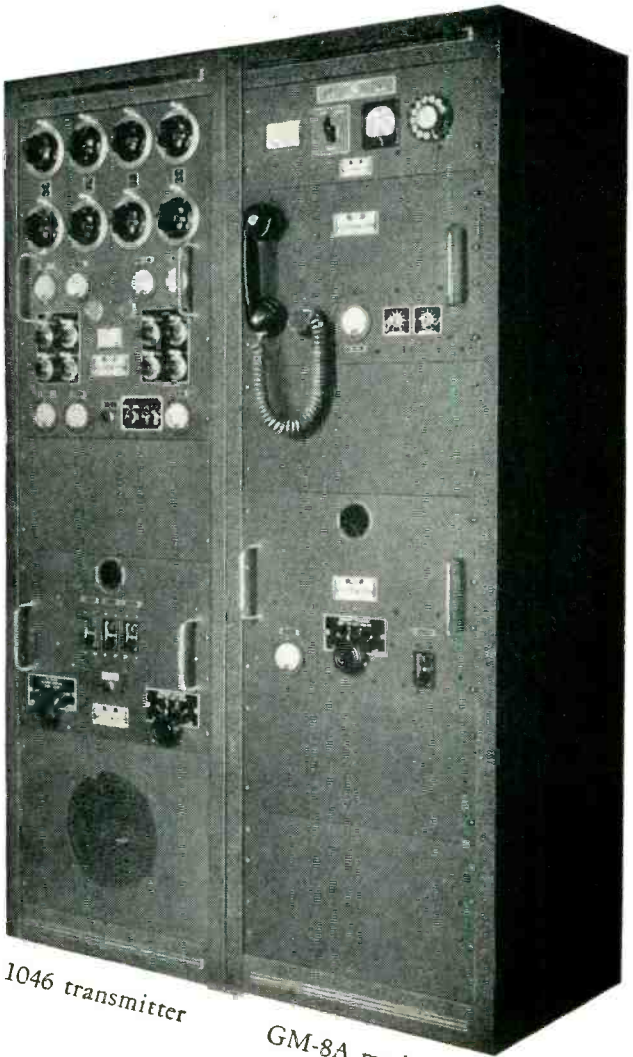
Rugged, versatile general purpose H. F. transmitter—Aerocom's 1046 packs 1000 watts of power and high .003% stability under normal operating conditions (0°to + 50°C.). Excellent for point-to-point or ground-to-air communications.

Multi-channel operation on telegraph A1, or telephone A3 with GM-8A modulator . . . new Aerocom 1046 can be *remotely controlled* with TMC-R at control position and uses only one pair of telephone lines. In A3 operation, the local dial control panel is located in modulator cabinet.

Transmitter cabinet has 8¾ inch panel space available for either local dial control panel or frequency shift keyer.

Model 1046 operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.0—24 Mcs. Operates on one frequency at a time; channeling time 2 seconds. Operates into either balanced or unbalanced loads. Operates in ambient -35° to+50° C. Power supply: nominal 220 volts, 50-60 cycles, single phase.

Complete technical data on request



1046 transmitter GM-8A modulator

AER-O-COM

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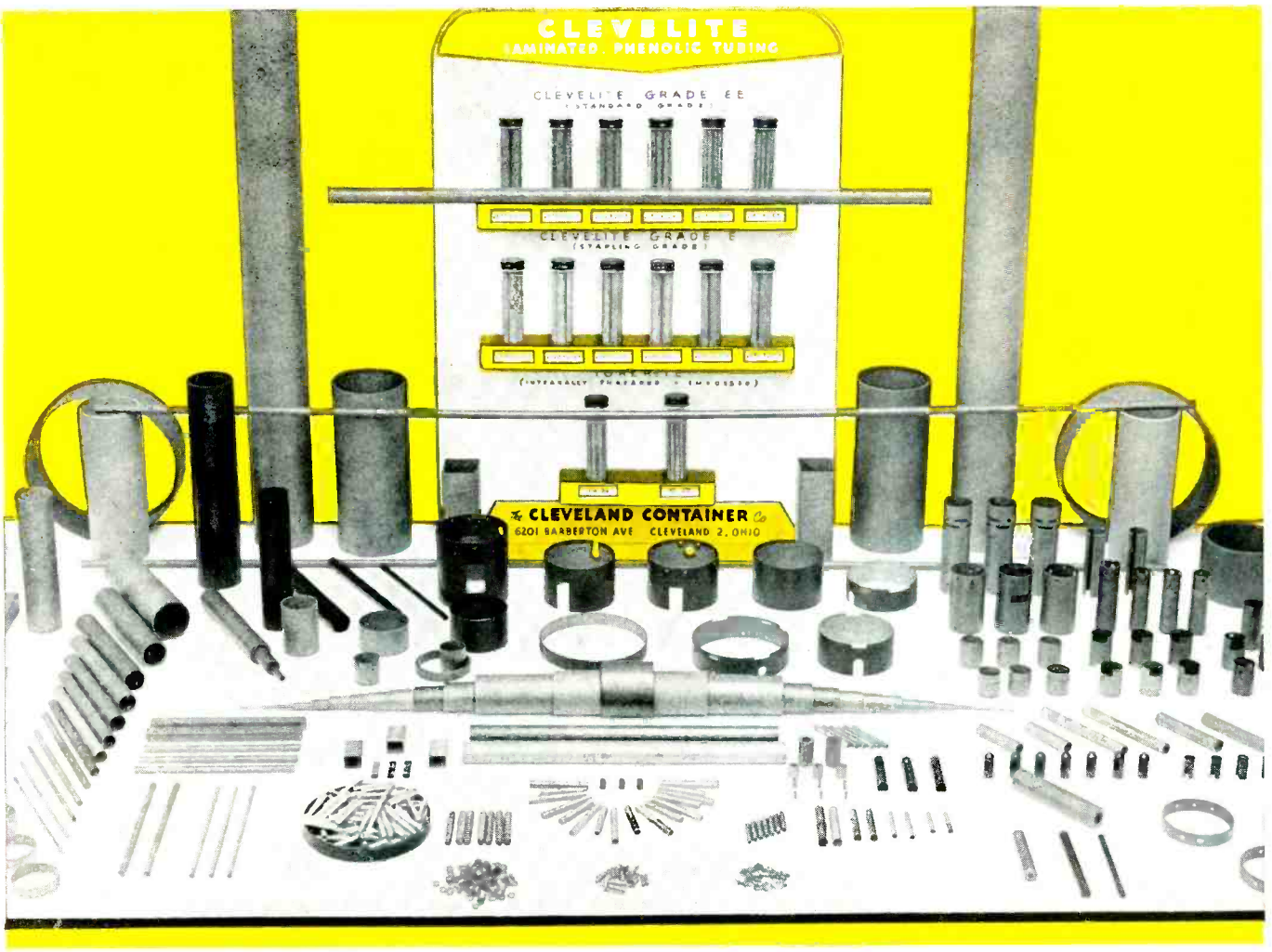

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This fine internally threaded and embossed tubing is now made to fit 8/32, 10/32, 1/4-28, 5/16-24, and 5/16-28 cores.

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INVESTIGATE this outstanding coil form!

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CLEVELITE* FOR EVERY USE

It possesses excellent electrical insulation properties, has good machinability, and is highly resistant to moisture.

Clevelite is structurally strong, very light and may be easily punched, machined or sawed . . . certain tough grades may be cold punched satisfactorily.

Clevelite chemical properties are also exceptional . . . unaffected by solvents and oils . . . resistant to normal strength basic acidic, and salt solutions.

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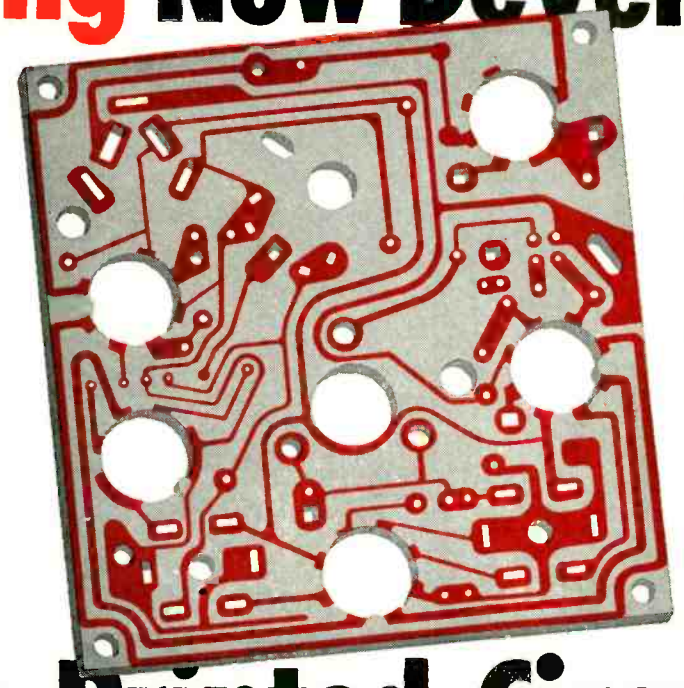
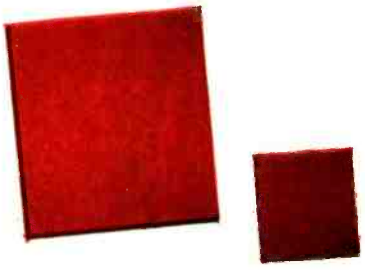
Exciting New Development





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Methode Manufacturing Corp.
Chicago, Ill.

in Printed Circuits!

New CuCLAD* copper-clad laminate offers unequalled bond strength, heat resistance, solderability, punchability, electrical performance!

Here's the foil-clad laminate you've been waiting for! It's CuCLAD LAMICOID® —made possible by an entirely new concept in bonding material, specially designed equipment developed exclusively by Mica Insulator Company. This new bond and unique bonding method give you unequalled performance that's consistent and dependable from sheet to sheet, lot to lot. *Trade-mark

You get all these advantages:

A STRONGER BOND WHICH *IMPROVES* WITH AGE AND HEAT
BETTER HEAT RESISTANCE
BETTER REACTION TO HOT SOLDER
BOND ELECTRICALLY EQUAL TO LAMINATE
IMPROVED ARC RESISTANCE
SUPERIOR PUNCHABILITY
UNIFORMITY

and CuCLAD LAMICOID is competitively priced!

CuCLAD LAMICOID is available *NOW*, in several grades. Tell us your requirements or problems—or ask to have a MICO Sales Engineer call.

LOOK AT THESE TYPICAL PRODUCTION RUN VALUES ON 6028 XXXP CuCLAD LAMICOID:

BOND STRENGTH—Guaranteed min: 6 lb.; avg. 9 lbs. (90° peel at 2 lbs/min.)	
SOLDER TEST—Guaranteed no blisters @ 230-240° C. for 10 seconds, 1" square floated on molten solder	
HEAT RESISTANCE—Guaranteed no change at 150° C. for ½ hour in air-circulated oven, air flow parallel to specimen	
PUNCHABILITY—Excellent	
SURFACE RESISTIVITY, megohms C-96/35/90	7.3×10^{4}
VOLUME RESISTIVITY, megohm cm. C-96/35/90	3.7×10^{5}
WATER ABSORPTION 1/16" th., E-1/105 + D-24/23 copper on	0.1%
1/16" th., E-1/105 + D-24/23 copper removed	0.7%

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MICA *Insulator* COMPANY

Schenectady 1, New York

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PYRAMID SOLID DIELECTRIC GLASSEAL® CAPACITORS FOR

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Especially sturdy capacitors capable of withstanding vibrational stresses of high acceleration and frequency, and severe shock conditions encountered in guided missiles and airborne equipment.

Utilize new, rugged compression-seal type, glass-to-metal solder-seal terminals. Terminals will *not* work loose or rotate under any operating conditions.

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

Operates normally under severe humidity conditions.

Production tests for voltage breakdown, capacitance, power factor, insulation resistance and seal are performed on a 100% basis.

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

1. Hermetically sealed in metallic cases.

2. Power factor less than 1%.

3. Subminiature in size.

4. Available in both inserted tab and extended foil constructions.

+ FACTORS

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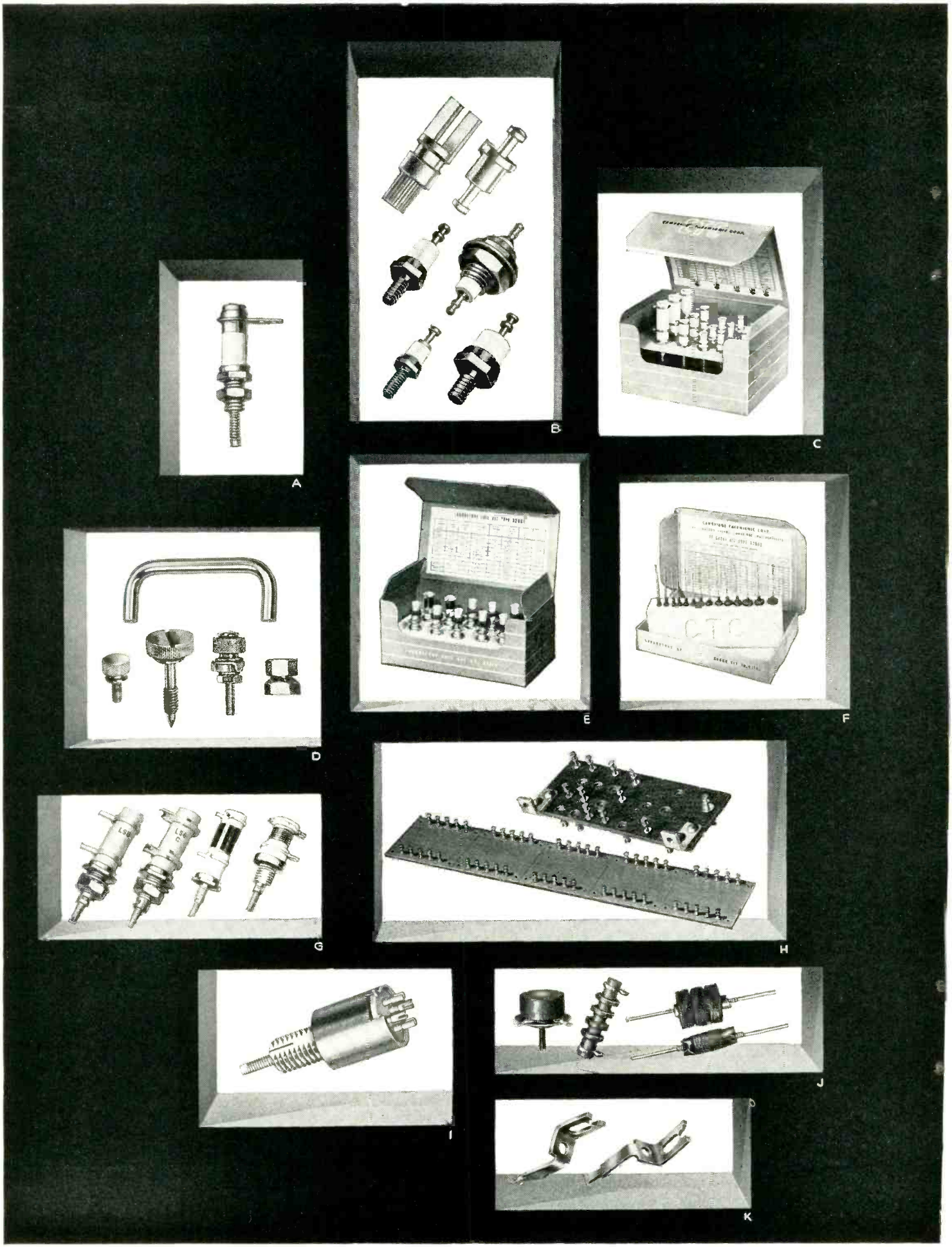
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One big family with a single thought

Whether you need terminals, clips, coils, chokes, capacitors — or any of a number of electronic components — you can be sure they're right if they're made by CTC.

One continuing basic idea governs the manufacture of every CTC product. And that idea is: *quality control*. We could not guarantee our products as we do without a constant check of numerous details that determine reliable performance. Our quality control engineers see to it that these manufacturing standards are consistently maintained — from close scrutiny of raw materials right through to inspection of finished product.

Pictured here are a number of components available at CTC including our three kits. These components come in standard form and are also custom engineered to meet your particular requirements. We would be glad to give you complete details, including specifications and prices, on any or all CTC units — as well as information on how CTC components can be specially designed to solve your electronic components problems.

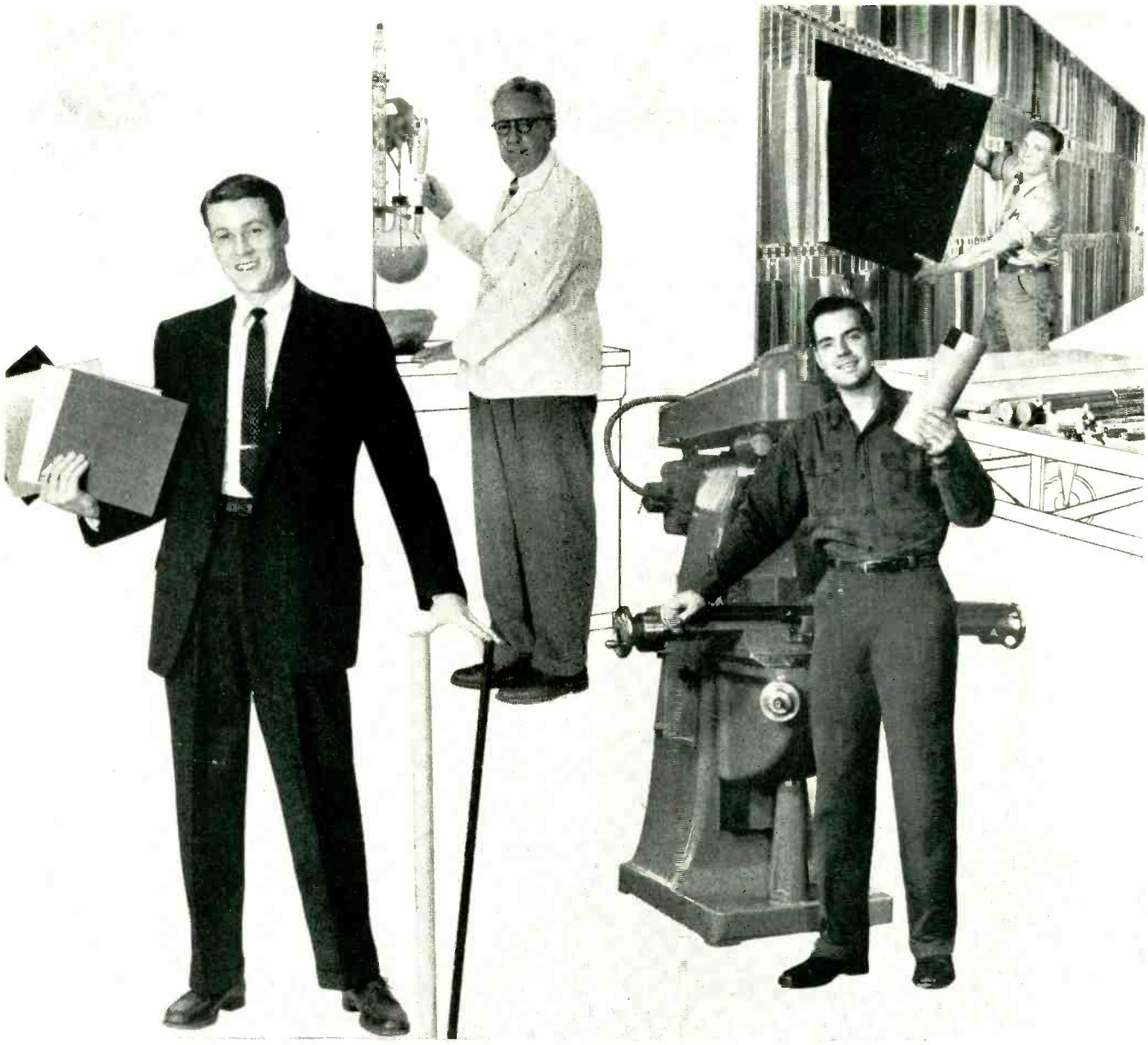
You will find it well worthwhile to use components that are *guaranteed*. Write to Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. West Coast Manufacturers contact: E. V. Roberts, 5068 West Washington Blvd., Los Angeles 16 and 988 Market Street, San Francisco, California.

CTC

CAMBRIDGE THERMIONIC CORPORATION

makers of guaranteed electronic components, custom or standard

◀ *CTC Components* shown include: A. capacitor; B. standard and insulated terminals; C. coil form kit; D. panel hardware; E. coil kit; F. RF choke kit; G. coil forms and coils; H. standard and custom terminal boards; I. shielded coil form; J. RF chokes; K. diode clips.



New Formica 4-point laminated plastics service--- valuable aid for the electronics engineer

Formica has just announced a new laminated plastics service of real value to you in your search for new materials to improve the performance and reduce the cost of electronic components.

This new service makes it easy for you to evaluate and apply Formica laminated plastics. Here's how it works:

1. Application engineering analyzes your application and recommends one of Formica's 53 standard grades . . . if it meets your requirements. This saves your time.

2. Research can produce a new grade with properties engineered to your exact specifications, thus saving time and lowering development cost.

3. Fabricating, molding and postforming bring Formica material to you in any shape or size—quickly, accurately and in volume.

4. Customer Stock Service: For the first time large stocks of standard sheets and rods are now ready for rapid delivery . . . to serve your fast moving production schedule.

For further information on how this unique new service can implement your product research and development, call your Formica district office, or . . .

Send for your free copy of the new "Formica 4" folder (form 584)

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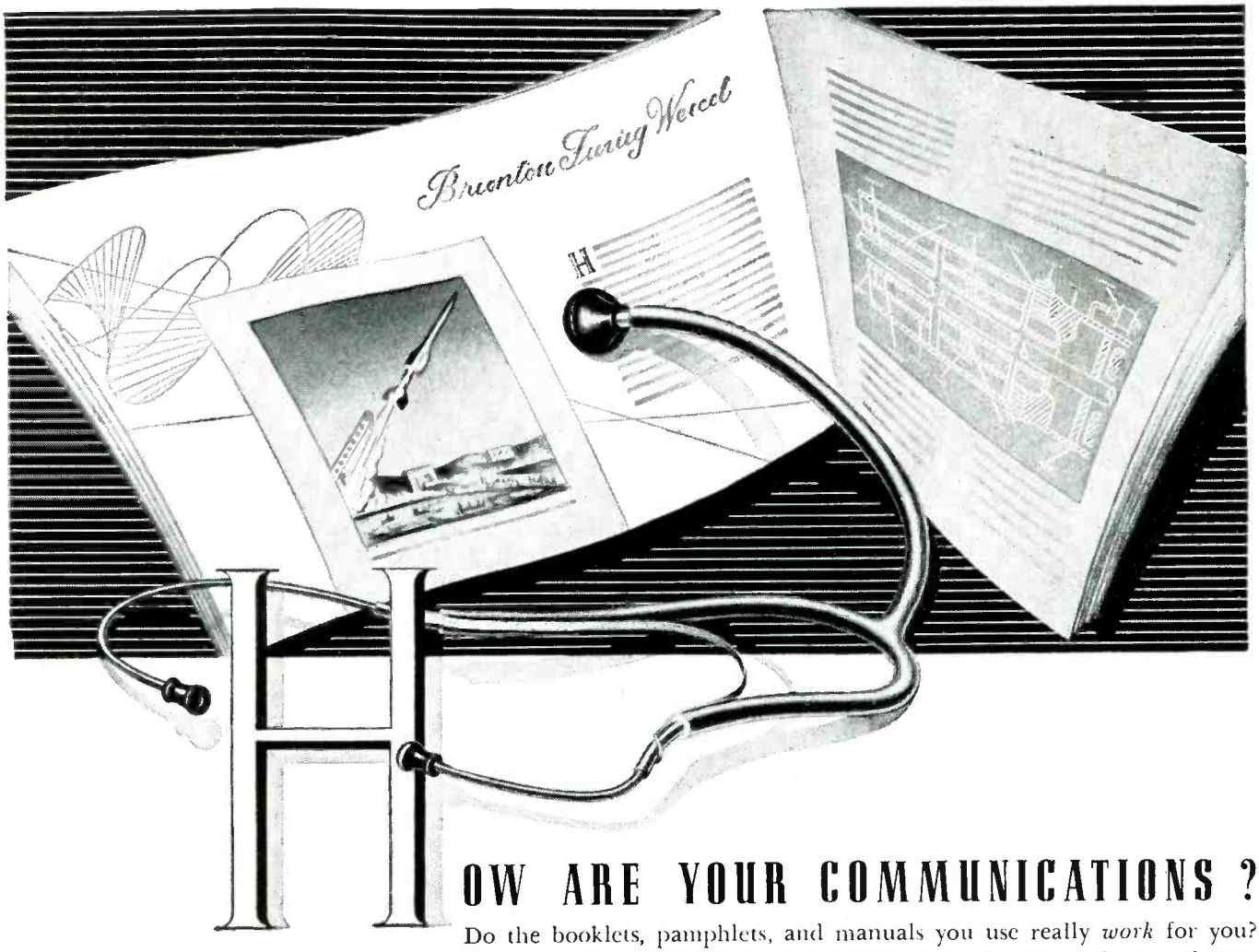

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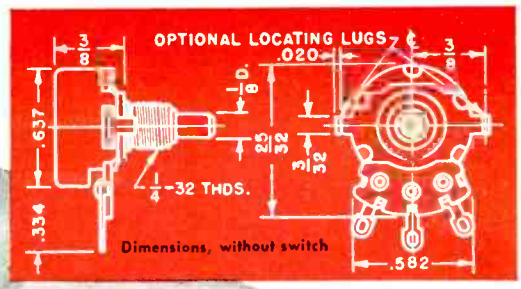
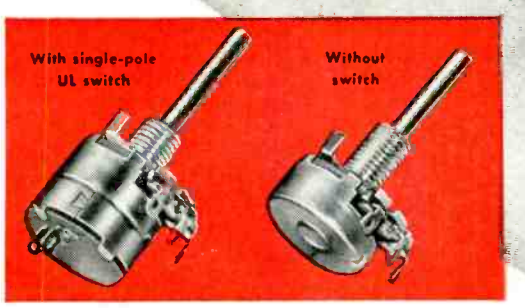
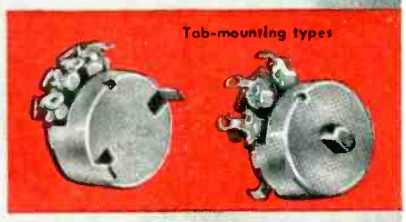


ACTUAL SIZE
with double-pole UL switch





NEW STACKPOLE MINIATURE CONTROLS

SERIES F

RATINGS: 0.3 watt through 10,000 ohms.
0.1 watt above 10,000 ohms.

MAXIMUM VOLTAGE: 350 volts.

SHAFT DIMENSIONS:

Diameter: 0.1235" to 0.1245".

Max. Depth FMS: 3/8" without switch. 3/4" incl. switch and terminals.

Std. Lengths: Same as furnished on Stackpole Type LR controls.

Screw driver slot: 0.040" ± 0.003 wide by 3/64" ± 0.010 deep. Random slot preferred.

Knurls for finger adjustment: 3/16" long.

Flats: 0.094" ± 0.002" by 3/8" ± 1/64" or to within 1/8" ± 1/64" of bushing, whichever is shorter.

Approximately 5/8" in diameter exclusive of terminals, these tiny units provide full Stackpole variable resistor quality in the smallest practical sizes yet produced. Stackpole composition carbon resistance element with gold-plated ring and contact hub springs assure quiet and stable operation. Resistance ranges, tapers, and other specifications to RETMA standards. Samples gladly supplied to quantity users on request.

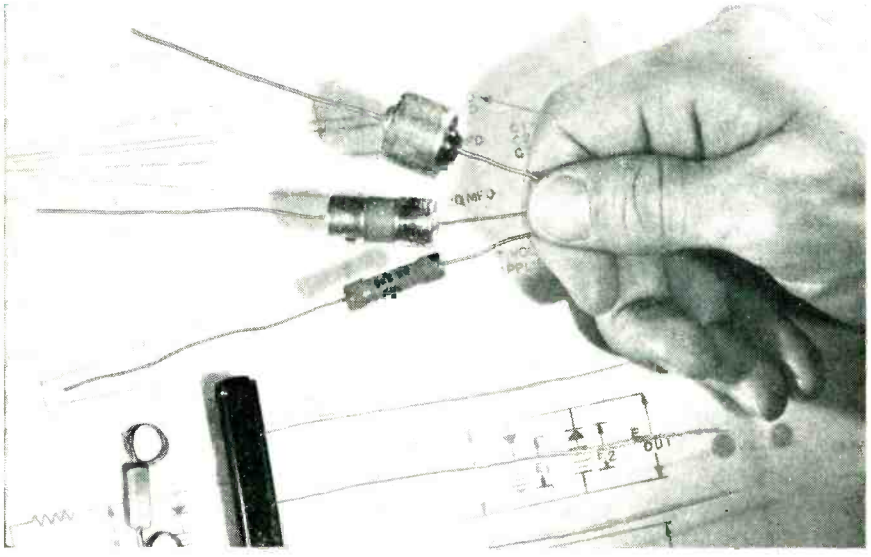
Electronic Components Division

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

In Canada: CANADIAN STACKPOLE LTD., 550 Evans Ave., Etobicoke, Toronto 14, Ont.

DESIGNER'S

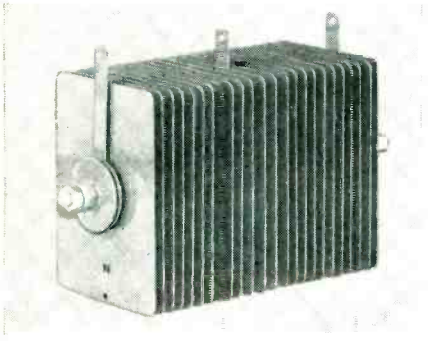
New G-E *Vac-u-Sel** component rectifiers top 80,000-hour-life expectancy



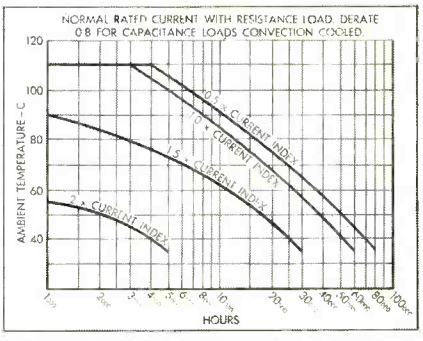
Life expectancy has now been raised from 60,000 to over 80,000 hours for General Electric's new miniature Vac-u-Sel rectifier stacks. Achieved by constantly improving processing techniques, this 20,000 hour increase in life is backed up by laboratory tests. Developed for electronic, industrial-control, and power applications, these units offer compactness and stability of electrical characteristics. Ambient temperature range is broad— −65 C to 130 C—and a wide variety of sizes, housings and finishes are available.

The "Selecto-Chart" shown below is part of a new application approach developed by G.E. It gives you greater freedom of design in selecting from the many rectifier sizes and types. Send for GEA-5935A, GEA-6273.

*Registered trade-mark of General Electric Co.



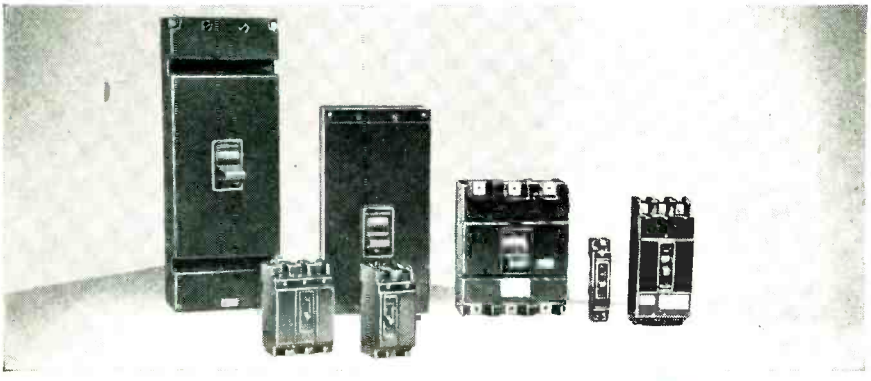
COMPACT RECTIFIER STACKS offer designers stable electrical characteristics.



INCREASE IN LIFE EXPECTANCY is shown in typical curves for 45-volt cells.

SELECTION IS EASY with new G-E Vac-u-Sel rectifier "Selecto-Chart."

G-E molded-case circuit breakers provide safe fuseless circuit protection



Thermal-magnetic trip elements in G-E molded-case circuit breakers help guard conductors against short circuits and sustained overloads. Operation is cool, life is lengthened through de-ionizing arc quenchers that quickly dissipate arcs.

Extra safety results from trip-free operating mechanism that opens contacts against overcurrents even if handle is held closed. Solderless lugs, straight-in wiring make installation simple.

Ratings from 10 through 600 amperes for circuits of 120, 240, 480, 600 volts a-c, and for 125, 250 volts d-c. GEC-1032.

GENERAL ELECTRIC

DIGEST

TIMELY HIGHLIGHTS ON G-E COMPONENTS

G.E. cuts radar transformer weights up to 35%

Small or large, narrow or wide, light weight, long life—whatever your requirements, General Electric will build high-voltage, oil-filled transformers and inductors to your specifications. The picture at left, for example, shows how G.E. cut 61 pounds from a typical radar power supply by redesigning with smaller embedded-layer coil. These corona-free components are suitable for many electronic applications other than radar.

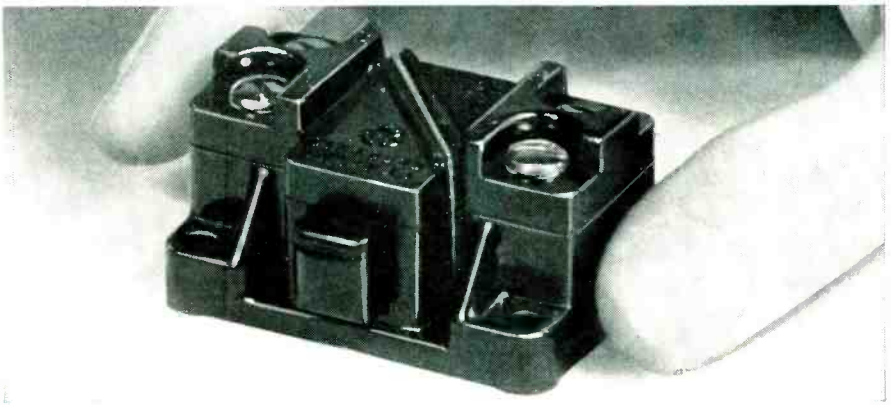
Among the advantages of these smaller and more reliable G-E components are: (1) more efficient cores permit weight savings to 11%, (2) alumina terminals add reliability, and (3) the use of Formex* wire and new embedded-layer winding techniques reduce coil sizes as much as 53%.

All G-E radar components are designed for compact installation. All can be manufactured to MIL-T-27 specifications. All have characteristics and features to meet a wide range of requirements. G.E.'s fully equipped model shop pools engineering and manufacturing skill to fulfill your needs. The shop can deliver prototype units for your experimental or system development projects—in a hurry—because work on your jobs begins immediately. Testing is strict. Vibration, thermal-cycling and moisture resistance tests are extra steps that can be taken by G.E. to assure components of the highest quality. Ask for Bulletin GEA-5963.

*Registered trade-mark of G.E. Co.

Two oz. switchette operates up to 50,000 ft. alt., from −70° F to 200° F

Versatile, corrosion-resistant and compact, General Electric Size 2 switchettes perform perfectly under extremes of altitude and temperature, combine low-inertia moving parts with high contact-tip force. Totally enclosed contact structure protects it from tampering and dirt. Screw-type terminals simplify wiring. For aircraft use where vibration is severe and space limited, its snap action and double-break-contact construction are especially valuable. Spring-return button on the housing can be actuated by lever, bellows, or other means. Bulletin GEC-207A.



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- ☐ **GEA-5963 Radar Transformers**
- ☐ **GEC-207A Switchettes**
- ☐ **GEC-1032 Molded-case Circuit Breakers**
- ☐ **GEA-5935A Miniature Vac-u-Sel Rectifiers**
- ☐ **GEA-6273 New Vac-u-Sel Component Rectifiers**

Name .....

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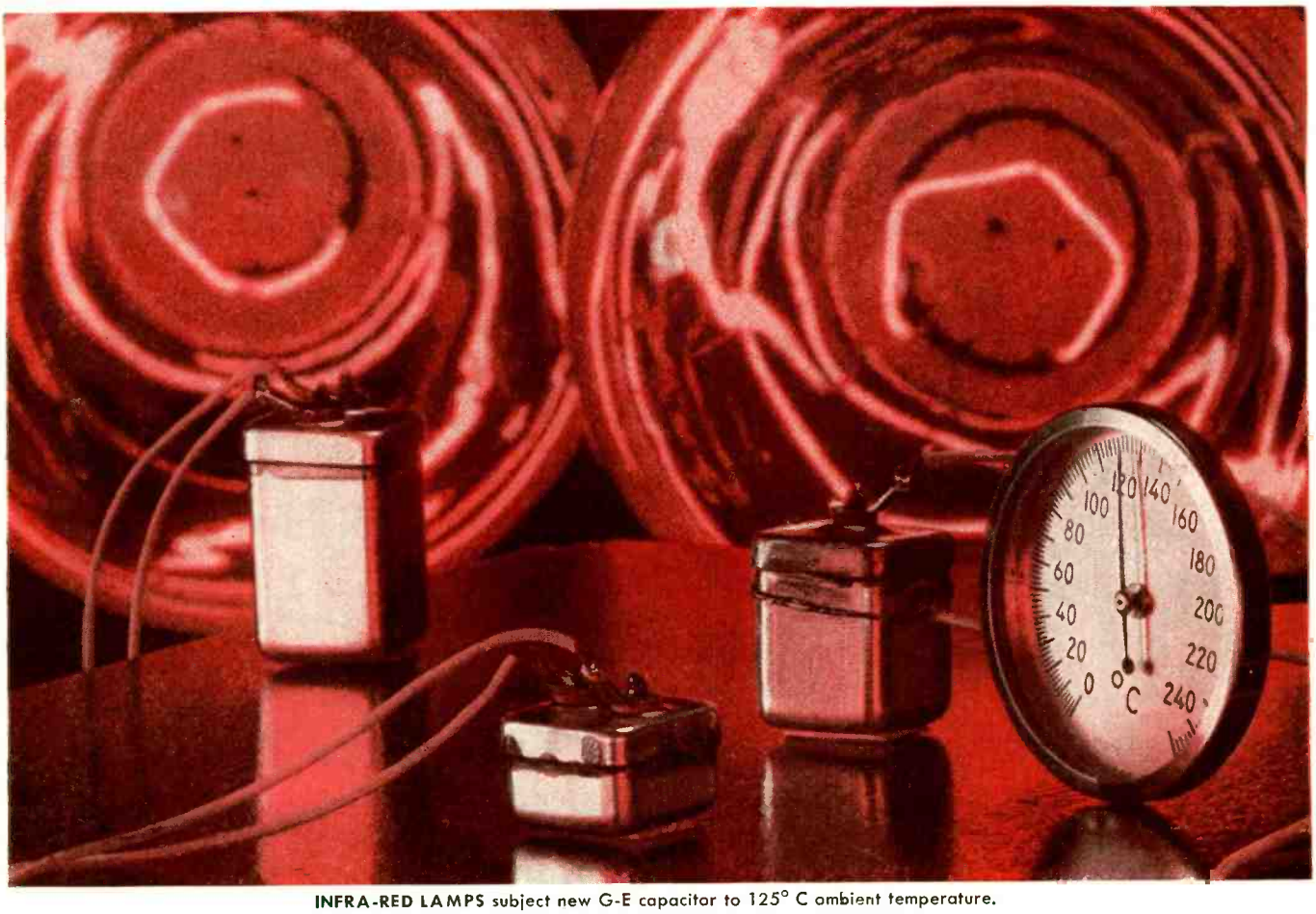
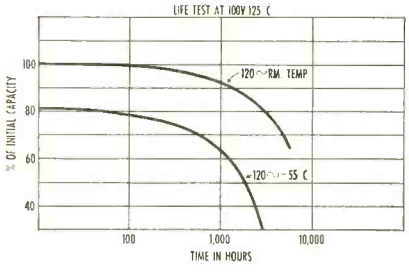
TURN PAGE FOR MORE G-E COMPONENT HIGHLIGHTS



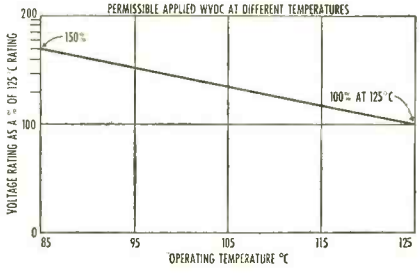
INFRA-RED LAMPS subject new G-E capacitor to 125° C ambient temperature.

New G-E high-temperature Tantalytic* capacitors operate in +125° C ambient at full voltage

Where quality, long life and small size are required in high-temperature, miniaturized, high-reliability equipment, specify General Electric's new 125° C Tantalytic capacitors. Designed to operate at full voltage in high temperature, they meet the tough requirements of miniaturized military equipment: energy storage, filtering, or by-pass applications in electronic ordnance, guided missile, navigation, communication, and control equipment.



LONG LIFE of G-E 125° C Tantalytic capacitors is shown by graph of life vs. loss of capacitance for typical 100-v d-c unit.



HIGHER VOLTAGES than 100 VDC can be applied with no life loss at ambients below rated +125° C as shown above.

Three rectangular case sizes permit ratings from 36 uf at 100 volts d-c to 180 uf at 30 volts d-c. All three sizes have same square base, varying only in height to maintain high volumetric efficiency at lower ratings.

Features: low leakage currents, long shelf and operating life, availability in polar and nonpolar construction for use in both a-c and d-c circuits. When operated at ambient of 125° C at rated voltage, units meet qualification requirements of 1000 hours with not more than 20 per cent loss in initial 25° C capacitance.

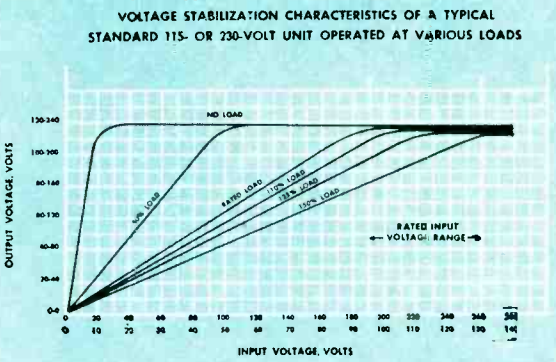
Unlike other types of Tantalytic capacitors, the foil construction offers chemically neutral electrolyte to minimize corrosion danger, plus excellent mechanical stability and freedom from electrical noise under shock or vibration. Ask for Bulletins GEA-6258 and GED-2620.

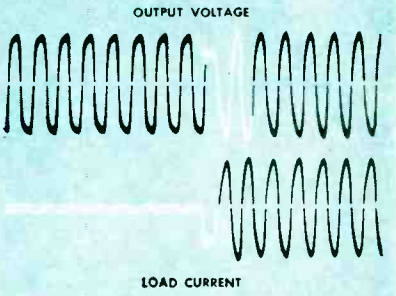
GENERAL ELECTRIC

DESIGNER'S DIGEST

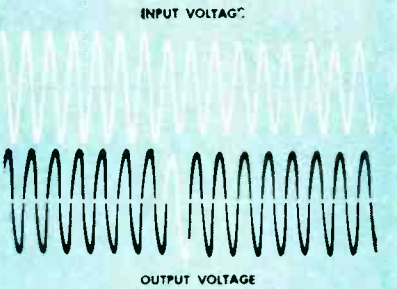
TIMELY HIGHLIGHTS ON G-E COMPONENTS

G.E. protects equipment with instantaneous voltage stabilization within ±1%

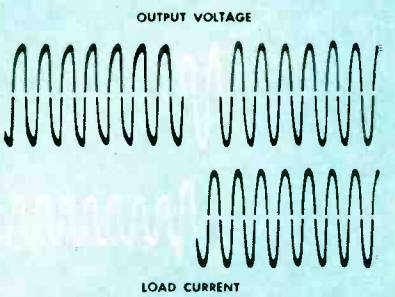




Output voltage is stabilized within two cycles as load current jumps from 0 to full load.



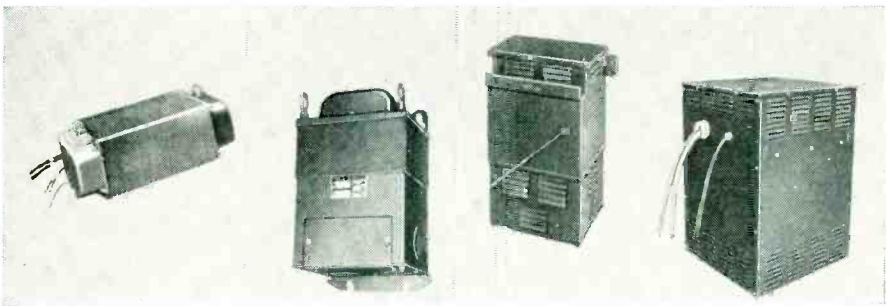
Output voltage is stabilized in less than 1½ cycles as input drops from 130 to 100 volts.



Output voltage is stabilized within two cycles as load current jumps from half load to full load.

General Electric voltage-stabilizing transformers are completely automatic. The compact units offer low losses, high input factor, fast response. They are easily installed, have no moving parts, and need virtually no maintenance. Often designers find standard units most satisfactory, either incorporated in new equipment or adapted to existing circuits. If special units are required, G-E engineers will co-operate in finding solutions for you. You can use them in literally hundreds of types of equipment. New applications and new methods of applying these voltage-stabilizing transformers are continually being discovered. The rapid responses of control with these units are shown graphically in the three curves at right, and typical characteristics above. Bulletin GEA-5754A.

G-E saturable reactors control individual power loads at low cost



Faced with fixed power sources, application and design engineers can draw on General Electric's "design pool" of more than 1000 different saturable reactor designs. This will simplify solving the problems they often face of controlling individual power loads manually or automatically at low cost. Very efficient even at light loads, a G-E saturable reactor provides control in an a-c circuit by direct current. Adjustment is smooth all the way. They can be satisfactorily utilized in a wide range of applications, including electrically heated furnaces and boilers, or milk pasteurizers and X-ray equipment. Apply them, too, in reduced-voltage starting, or continuously adjustable reactive load banks. G.E. can design them in a wide variety of a-c and d-c ratings to meet your special application needs. Bulletin GEA-6354.

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- ☐ GEA-6258 125C Tantalytic Capacitors
- ☐ GED-2620 Capacitors for Electronics
- ☐ GEA-6354 Saturable Reactors
- ☐ GEA-5754A Voltage Stabilizers

For information on other products, contact your nearest G-E Apparatus Sales Office.

Name.....
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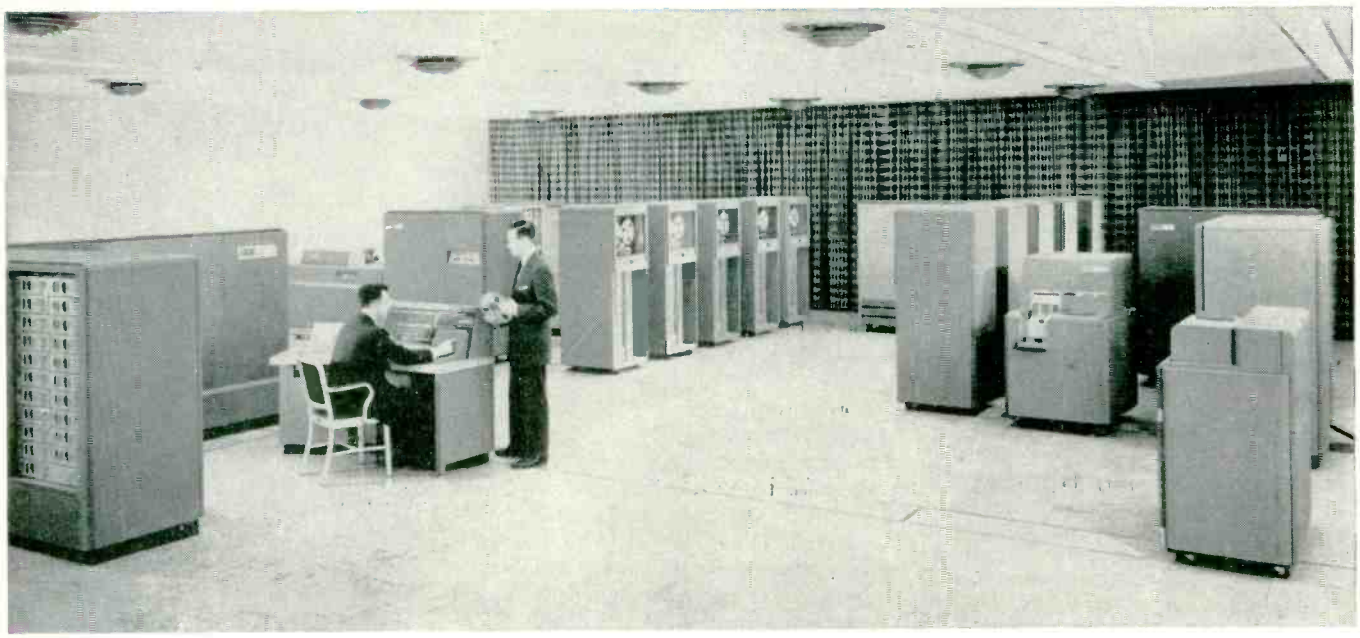
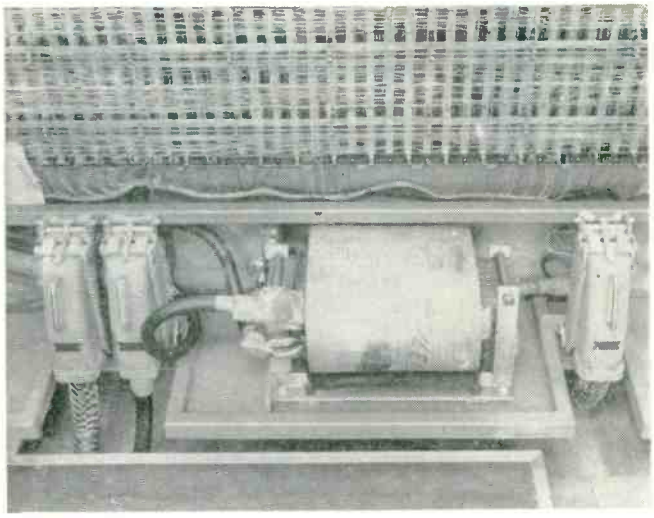
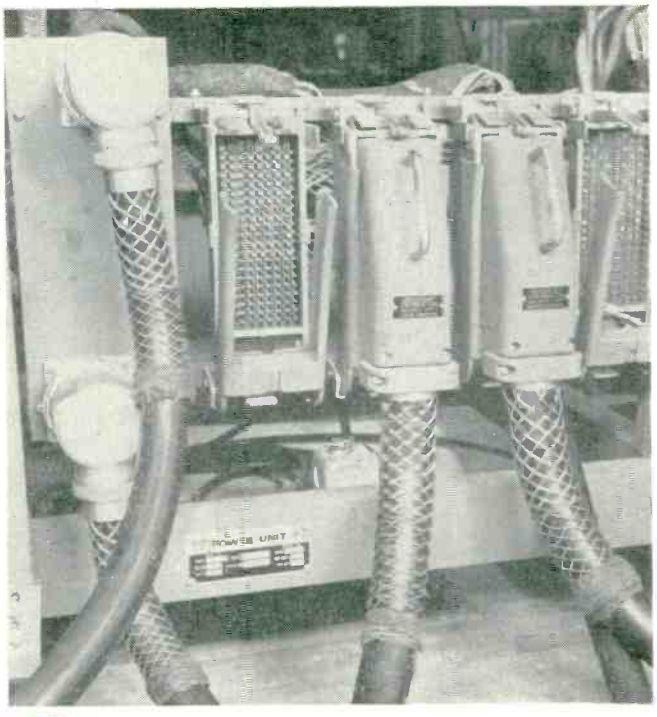
Want more information? Use post card on last page.



Designed for business use, the IBM 702 Electronic Data Processing Machine has its component units housed in separate cabinets. This permits assembly of the most efficient system to fit user's needs. Essentials are the arithmetical and logical unit, the operator's control console, magnetic tape units, an input card reader, and an output printer and card punch. One or more magnetic drums are also often included.

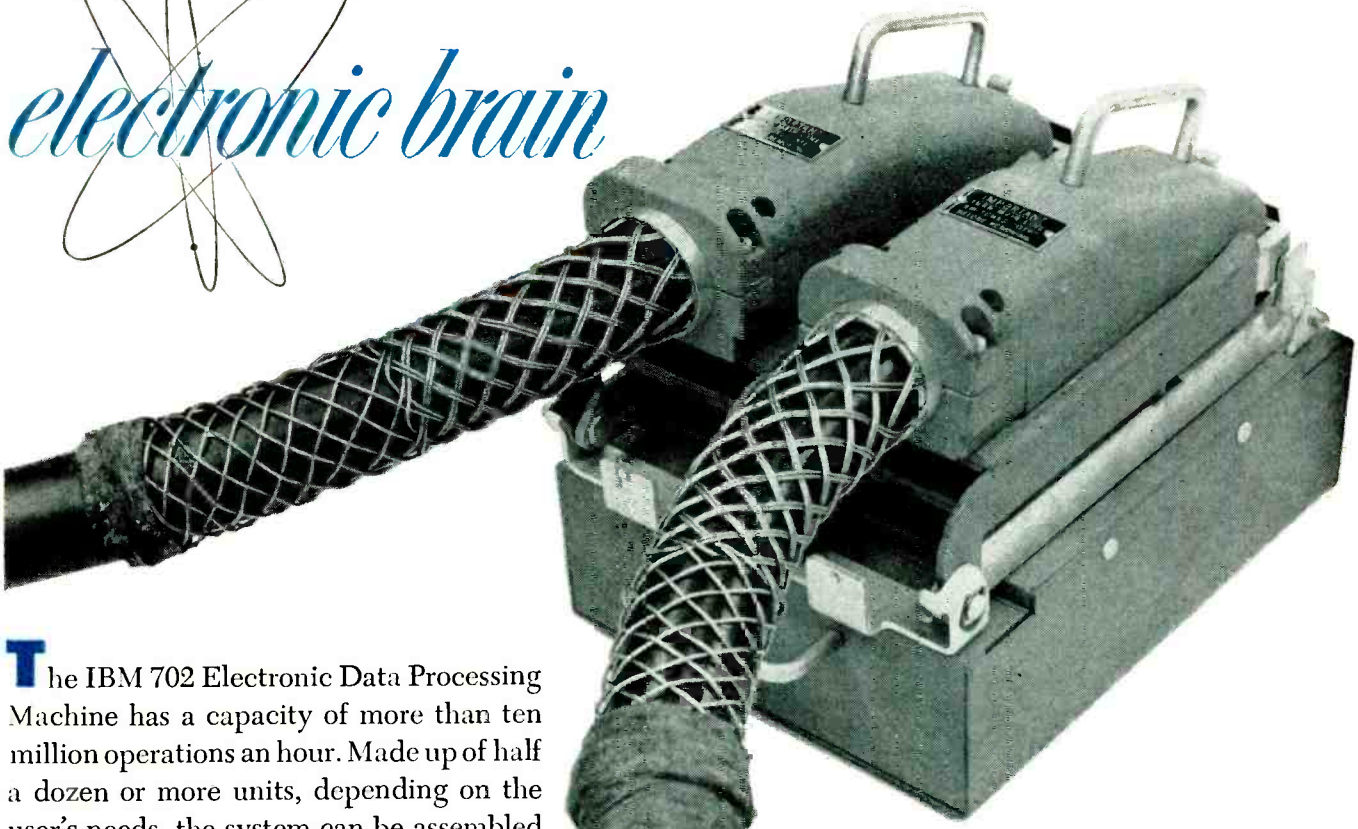


Three input-output cables are shown leading into the central processing unit of the machine. They are separated here by a filament transformer.



This picture shows the tape control unit employing two harness cables through which its signals are transmitted. Two power cables are at left.

electronic brain



Here, two cables are interconnecting two processing machine units through a junction box. Wire mesh reinforcements are strain relievers which keep cable from being pulled out of lead-ins accidentally. Cable made by **Plastoid Corporation**, Hamburg, N. J.

The IBM 702 Electronic Data Processing Machine has a capacity of more than ten million operations an hour. Made up of half a dozen or more units, depending on the user's needs, the system can be assembled to assure utmost flexibility of operation.

To carry the signals between the units, the manufacturer uses input-output cable covered with BAKELITE Brand Vinyl Plastic. The cable contains 52 conductors insulated with BAKELITE Vinyl Plastic and 40 miniature coaxial cables insulated with BAKELITE Polyethylene.

These BAKELITE plastics offer a number of safeguards and advantages for cable construction. Polyethylene has an exceptionally low and stable dielectric constant and low power factor. Vinyl plastic is flexible, tough and abrasion resistant—an excellent protective material for complex cable assemblies.

Your own particular application for wire and cable may well benefit from the use of BAKELITE Polyethylene and Vinyl plastics, as insulation or jacketing. Write Dept. KM-50 for data and engineering assistance.

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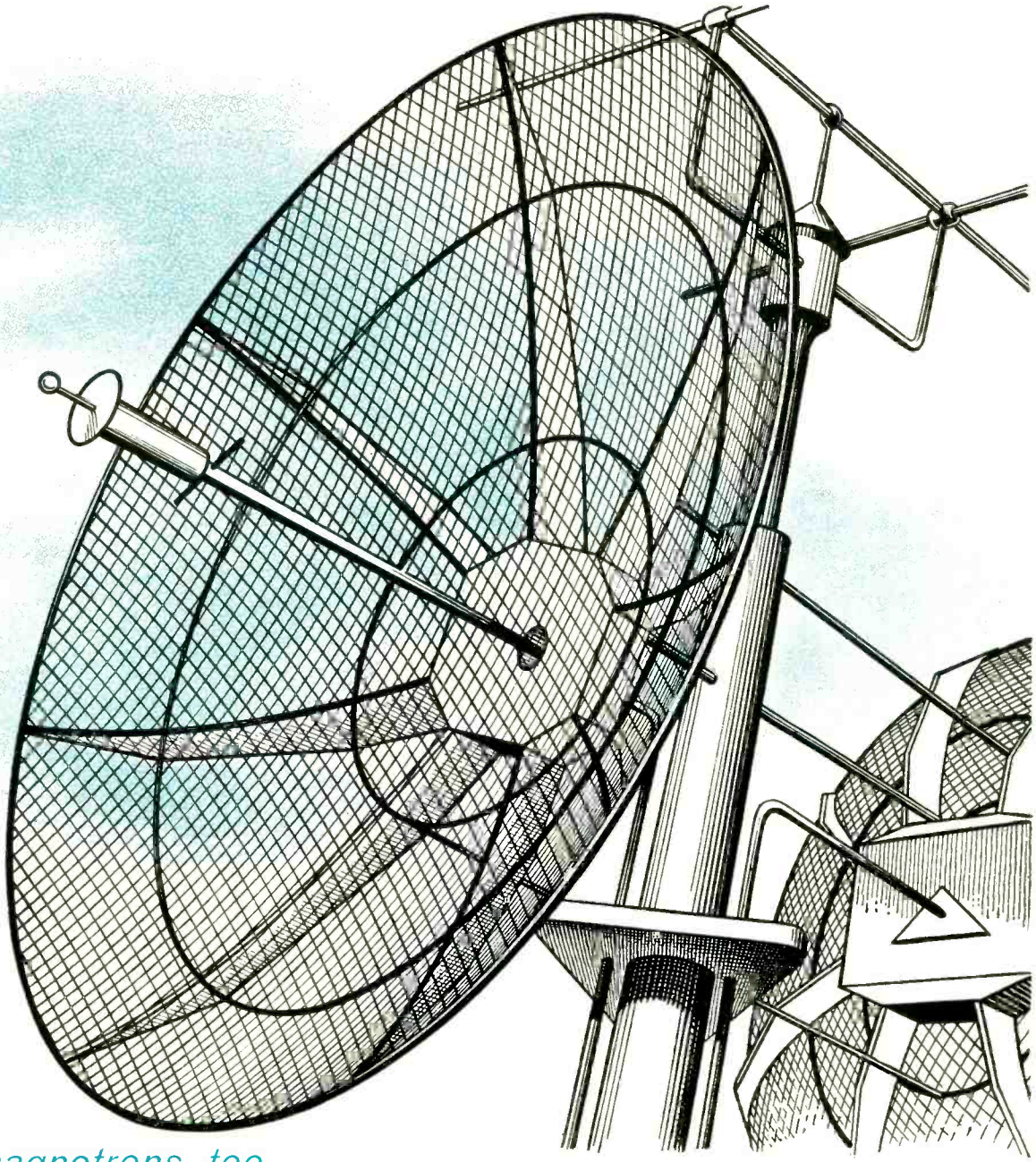

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CRUCIBLE PERMANENT MAGNETS

provide maximum energy. . . minimum size

In designing magnetrons for radar systems — or any very high-frequency oscillator application — you can be sure of a *consistently higher* energy product with Crucible alnico magnets. *This means more power from a minimum size magnet!*

Crucible alnico permanent magnets are made to meet practically any size requirement from a fraction of an ounce to several hundred pounds. And they're sand cast, shell molded or investment cast to the exact size, shape, tolerance and finish you need.

Crucible has been one of the largest producers of permanent magnets since the development of alnico alloys. Its unsurpassed magnet experience is backed by over 50 years of fine steelmaking. That's why the best solution to magnet problems starts with a call to Crucible. *Crucible Steel Company of America, Henry W. Oliver Building, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

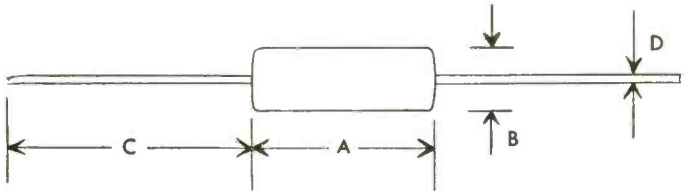
NOW

1/8, 1/4 and 1/2 watt *Molded* Precistors

IRC *molded* Deposited and Boron Carbon Precistors are now available in 1/8, 1/4 and 1/2 watt sizes. These 1% precision film type resistors combine the advantages of high stability, small size and low cost in either deposited carbon or boron carbon units. Ratings are based on full load at 70°C. ambient.

The *molded* plastic housing provides complete mechanical protection, minimizes the effect of moisture and improves load life characteristics.

Equivalent In Size To IRC's Popular Types BTS • BW½ • BTA



Precistor Types	IRC Size Equivalent	Dimension			
		A	B	C	D
MDA — MBA	BTS	13/32"	1/8"	1½"	.025"
MDB — MBB	BW½	5/8"	3/16"	1½"	.025"
MDC — MBC	BTA	23/32"	1/4"	1½"	.032"

MOLDED DEPOSITED CARBON PRECISTORS

Type MDA — 1/8 Watt

Type MDB — 1/4 Watt

Type MDC — 1/2 Watt

MOLDED BORON CARBON PRECISTORS

Type MBA — 1/8 Watt

Type MBB — 1/4 Watt

Type MBC — 1/2 Watt

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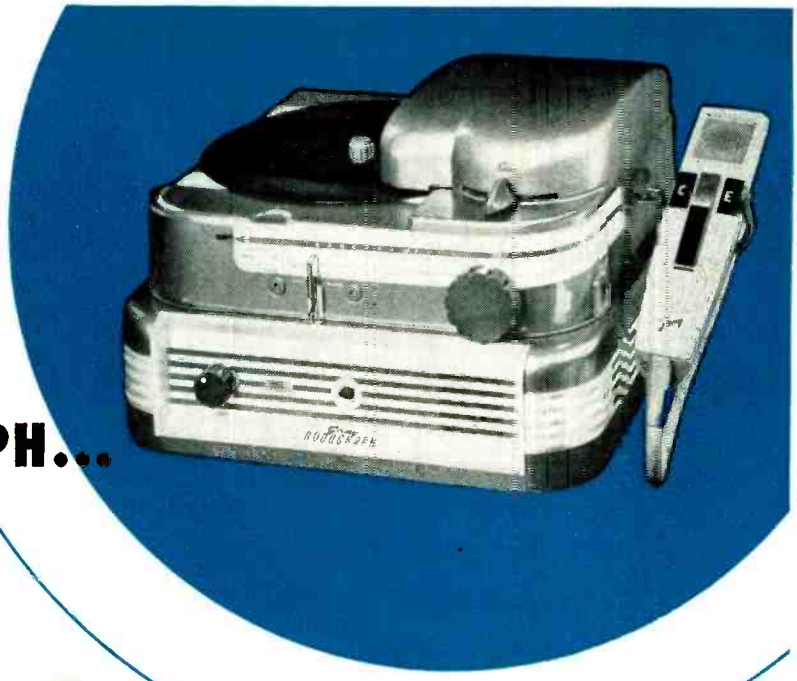
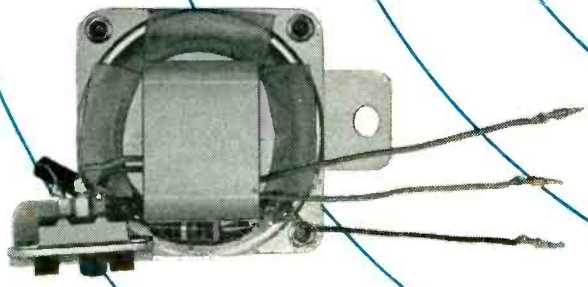
The NEW

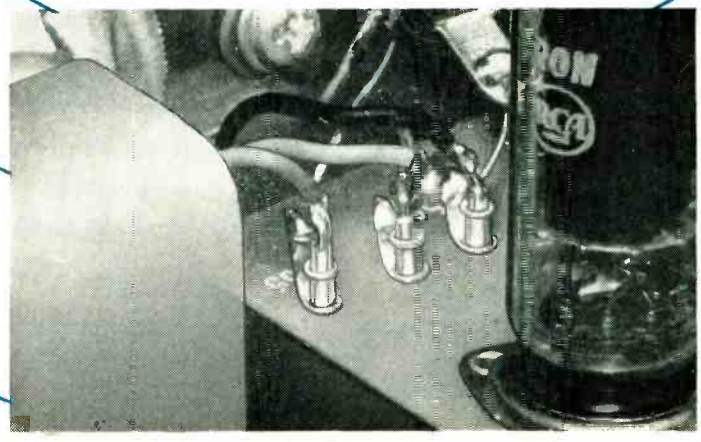
GRAY AUDOGRAPH...





...GETS A VOICE

IN A HURRY...



HUBBELL *Interlock* Sub-Miniature Plugs

TRADE MARK

Eliminate Soldering For Fast Installation Of Speaker Kit!

Now, one model takes the place of *three* in the new Gray Audograph line. These famous dictation machines are designed with built-in eyelets to receive Type "C" *Interlock* Plugs. When speaker-equipped models are ordered, specially designed speaker kits, wired with the Sub-miniature Plugs, are quickly and easily plugged in. Hubbell *Interlock's* exclusive *automatic locking-quick disconnect* feature makes possible a solderless, low contact resistance connection from the speaker kit to the panel eyelets. The tiny Type "C" Plugs are also easily and quickly disconnected for maintenance or replacement of speaker if necessary. Our Development Laboratory will cooperate with your Engineers to adapt *Interlock* for your specific applications.

Sub-miniature Plugs: Cat. No. 601C31 • For Further Information, Write Dept. A

HUBBELL

REG. U.S. PAT. OFF.

HARVEY HUBBELL, INC.

Interlock Electronic Connector Dept., Bridgeport 2, Conn.

SELF-LOCKING HUBBELL CONNECTORS

Pats. & Pdg. Pats.

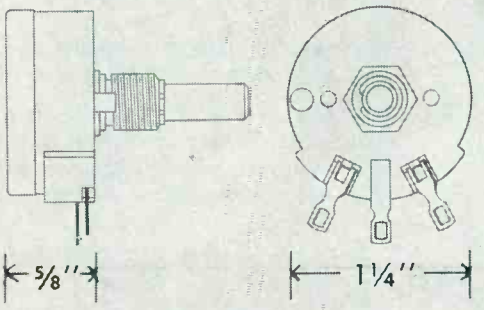
NOW

a *new* wire wound potentiometer

The mechanical and electrical features of Type 2W Rheostat-Potentiometer are designed for current and future electronic circuits. This modern, 2 watt unit offers maximum application adaptability plus typical IRC superior performance.

Electrical operation is improved by one-piece center terminal and collector ring, and direct contact between collector ring and contactor. Advanced mechanical design anchors winding securely to strip, locks element into position, and assures accurate location of terminals.

Equivalent To JAN-R-19
Style RA20 Specification



New IRC Design
Smaller and More Compact

2 Watt Power Rating

Based On 60°C. Rise
Above 40°C. Ambient

IMPROVED DESIGN FEATURES

- **Better Heat Dissipation**
- **Greater Dust Protection**
- **Increased Mechanical Rotation**
- **Increased Electrical Rotation**
- **More Resistance Values**
- **Double and Single Taps Available**

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Voltmeter Multipliers • Boron & Deposited Carbon Precistors • Insulated Composition Resistors • Power Resistors • Controls and Potentiometers • Low Wattage Wire Wounds • Germanium Diodes

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IRC

INTERNATIONAL RESISTANCE CO.
Dept. 234, 403 N. Broad Street, Philadelphia 8, Pa.
In Canada: *International Resistance Co., Ltd., Toronto, Licensee*

Send Bulletin describing Type 2W Potentiometers:

Name _____

Title _____

Company _____

Address _____

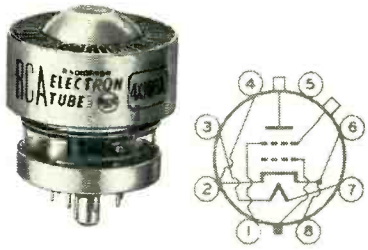
City _____ *State* _____

Want more information? Use post card on last page.

RCA DATA FOR

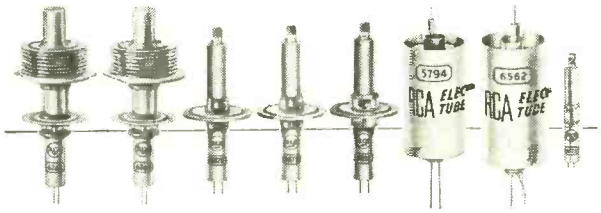
RCA "SPECIAL REDS" COVERED BY WARRANTY TO GIVE AT LEAST TWO YEARS OR 10,000 HOURS OF SERVICE

RCA "Special Reds"—built for long life—are specially designed to withstand extremes of temperature, humidity, atmospheric pressures, vibration, impact, and mechanical shock. Recommended especially for industrial electronics and airborne communications equipment.



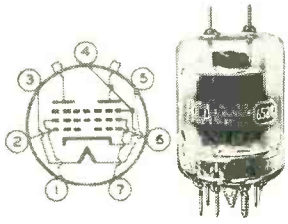
FOR DEPENDABILITY . . . RCA-4X150A BEAM POWER TUBE

RCA-4X150A . . . manufactured at RCA's modern Lancaster plant . . . is a compact, forced-air-cooled, beam power tube of coaxial-electrode construction—with a max. plate-dissipation rating of 150 watts. For UHF power amplifier, or oscillator service up to 500 Mc. Also may be used as wideband amplifier in video applications. The dependability of the RCA-4X150A has been proved in military and commercial applications.



RCA "PENCIL" TUBES FOR METEOROLOGICAL SURVEY, AIRCRAFT CONTROL EQUIPMENT, COMMUNICATIONS, AND UHF TEST EQUIPMENT

RCA-6263,-6264,-5876,-5675,-5893,-5794,-6562, and-6173 . . . eight types featuring small size, light weight, low heater wattage, good thermal stability, minimum transit time, low lead-inductance and low interelectrode-capacitances. These types include tubes for power amplifier, frequency multiplier, pulse detection and oscillator applications. Investigate these highly efficient tubes for your designs. For catalog information on RCA "Pencil" Tubes write for booklet RIT-104.



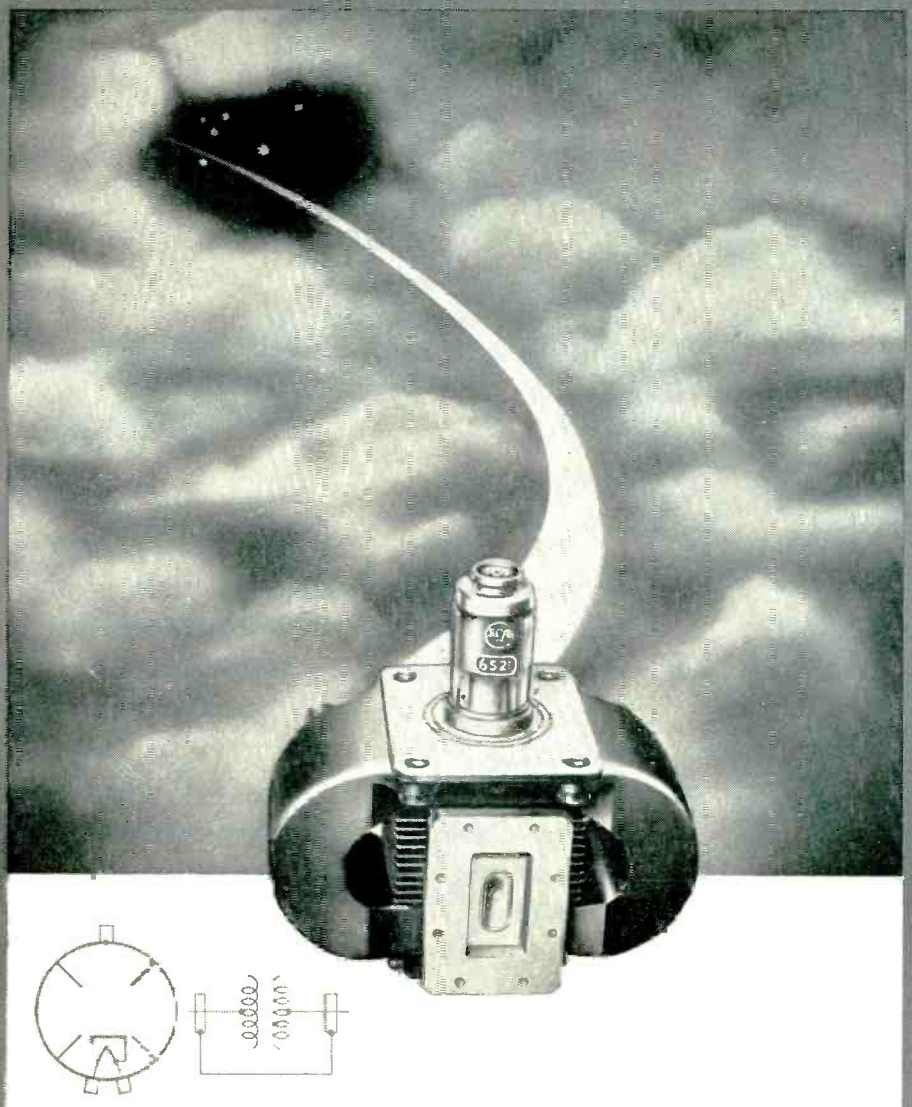
TWIN BEAM POWER TUBE FOR UHF COMMUNICATIONS SERVICES BETWEEN 450 AND 470 Mc

RCA-6524 . . . 25 watts max. plate dissipation (ICAS). As push-pull rf power amplifier in class C service (ICAS) at 462 Mc, the 6524 has a max. power input of 45 watts and can deliver a power output of approximately 20 watts. Features high power sensitivity, compact size, and sturdy construction. For use as push-pull rf power amplifier, frequency tripler, or audio modulator in fixed or mobile communications. (Medium-button septar 7, pin base.)

RADIO CORPORATION of AMERICA
TUBE DIVISION HARRISON, N. J.

DESIGNERS

ELECTRON TUBES
SEMICONDUCTOR DEVICES
BATTERIES
TEST EQUIPMENT
ELECTRONIC COMPONENTS



NEW "HEART THROB" OF THE AIRLINES

Air navigation, today, conquers stormy weather zones by means of "weather radar" which guides aircraft to the paths of least turbulence. The RCA-6521 Magnetron—the very heart of "weather-radar" equipment—was designed specifically for this service. Of the internal-resonant-circuit type with an integral magnet, the RCA-6521 is designed and conservatively rated for long, reliable performance as a pulsed oscillator at a fixed frequency of 5400 Mc. It is capable of giving a peak power output of 100 Kw.

TWO NEW RCA PUBLICATIONS

#PG101B . . . "RCA POWER & GAS TUBES" . . . 24 pages of technical data on 178 RCA vacuum power tubes including forced-air-cooled and water-cooled types, rectifier types, thyratrons, ignitrons, magnetrons, and vacuum-gauge types.

#RIT-104 . . . "RCA RECEIVING-TYPE TUBES FOR INDUSTRY AND COMMUNICATIONS" . . . 20 pages of technical data on 130 RCA small industrial tubes including "Special Reds", "Premium" types, "Pencil" and other types for special UHF applications, glow-discharge types, thyratrons, computer types, low-microphonic types, and many other types.

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West: MAdison 9-3671
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FOR TECHNICAL INFORMATION

Write: RCA, Commercial Engineering, Section J-19-R, Harrison, N.J. Use this coupon. Circle items in which you are interested.

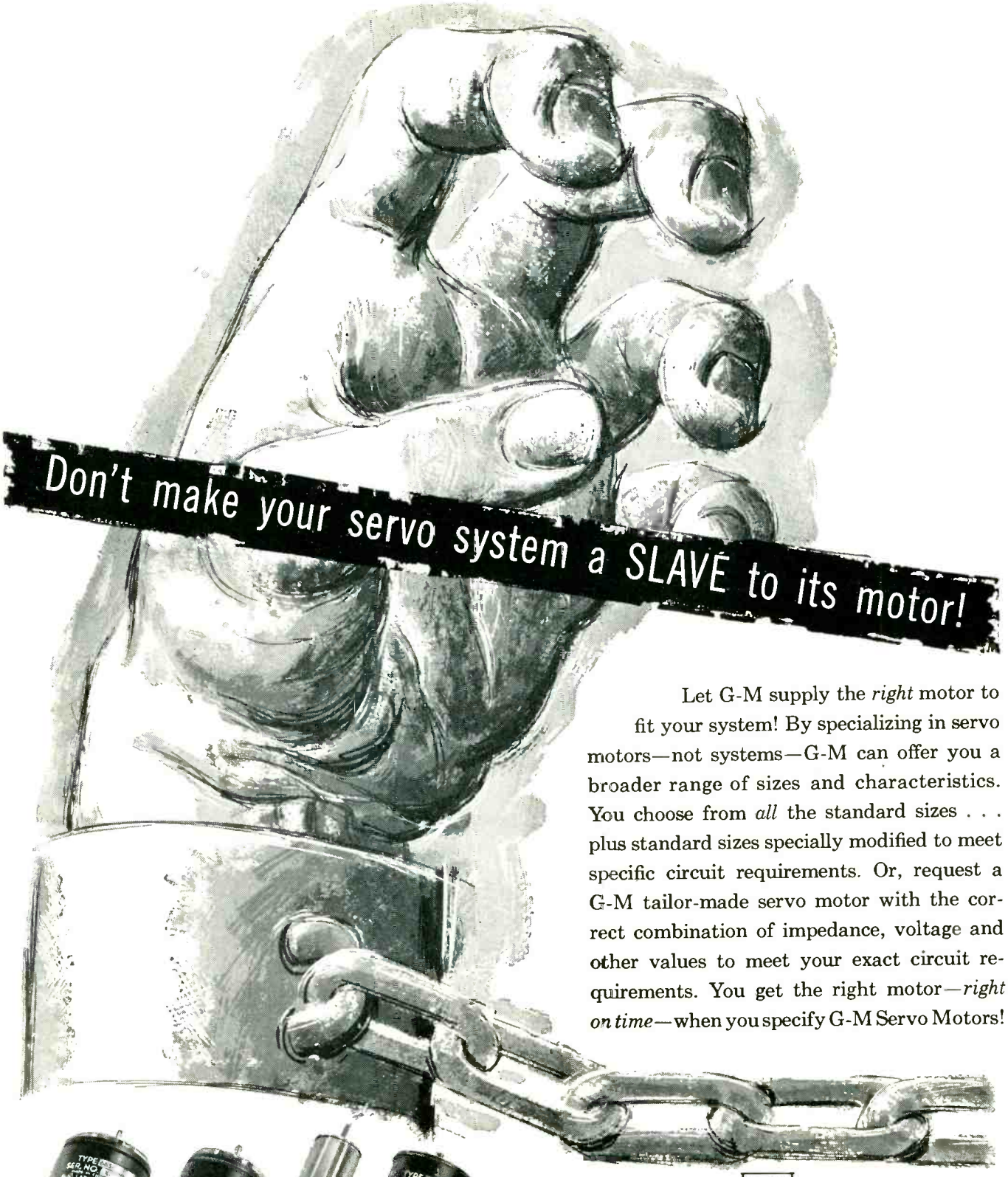
"Special Reds" 6521 4X150A 6524
Booklet #RIT-104 Booklet #PG101B

Name_____

Position_____

Company_____

Address_____



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WHY LEADING MANUFACTURERS USE RAYTHEON MAGNETRONS AND KLYSTRONS

A good test of any product is the company it keeps. The famous trademarks above belong to only four of the many distinguished companies which use Raytheon magnetrons and klystrons in their microwave equipments.

Manufactured under precision controls by skilled men and women, Raytheon microwave tubes give you the utmost in first-rate performance, long life, and continuous duty under demanding conditions.

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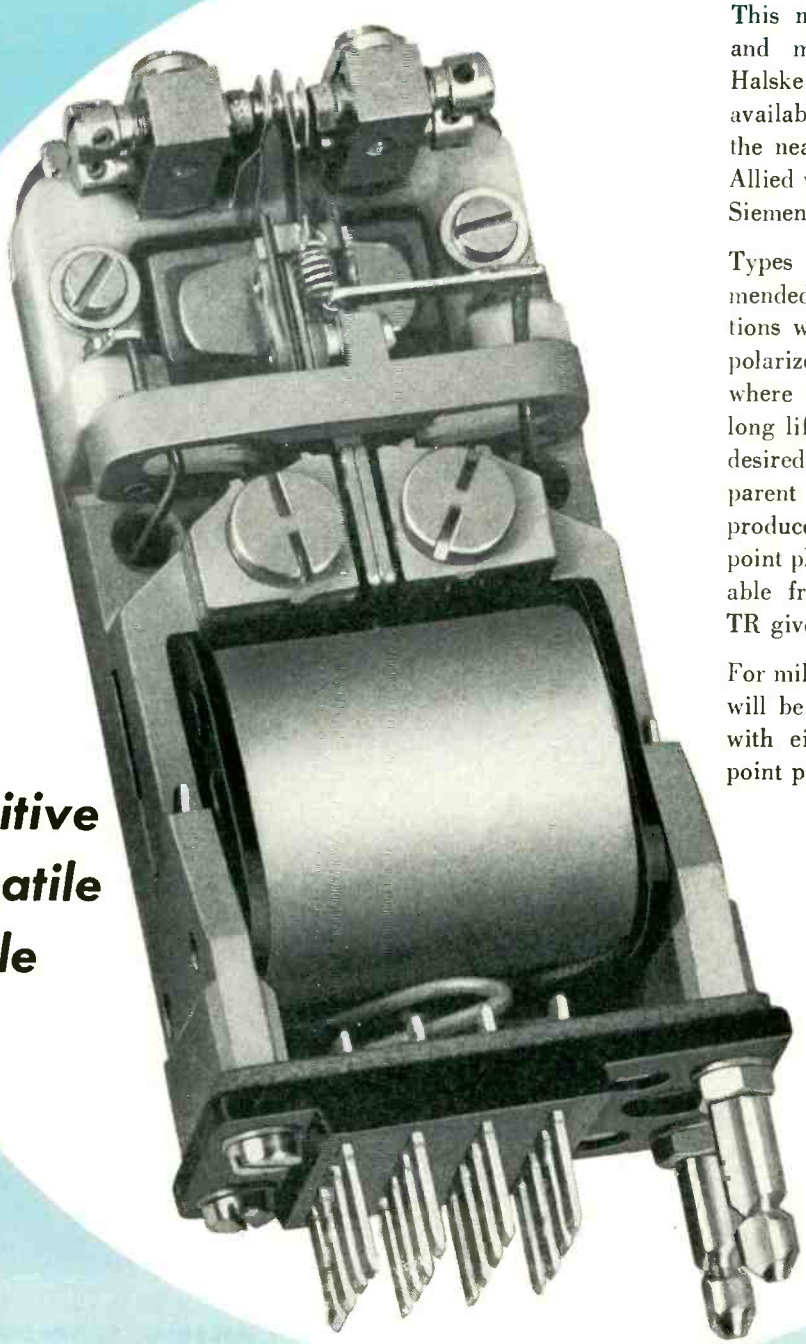
RAYTHEON MANUFACTURING COMPANY
Microwave and Power Tube Operations, Sec. PT-26
Waltham 54, Mass.

ALLIED'S NEW



Sensitive
Versatile
Stable

This new polarized relay, designed and manufactured by Siemens & Halske Company of Germany, is now available from Allied Control, and in the near future will be produced by Allied with the technical assistance of Siemens & Halske.

Types Trls 63 to 69 are recommended for use in industrial applications where the special features of a polarized relay are required, or where its inherent high sensitivity, long life and precision operation are desired. They are available with transparent or metal dust covers and are produced with solder terminals or 16 point plug-in bases (sockets are available from Allied Control). Bulletin TR gives complete details.

For military applications, these relays will be available hermetically sealed with either solder terminals or 16 point plug-in base.

7

POLARIZED RELAY

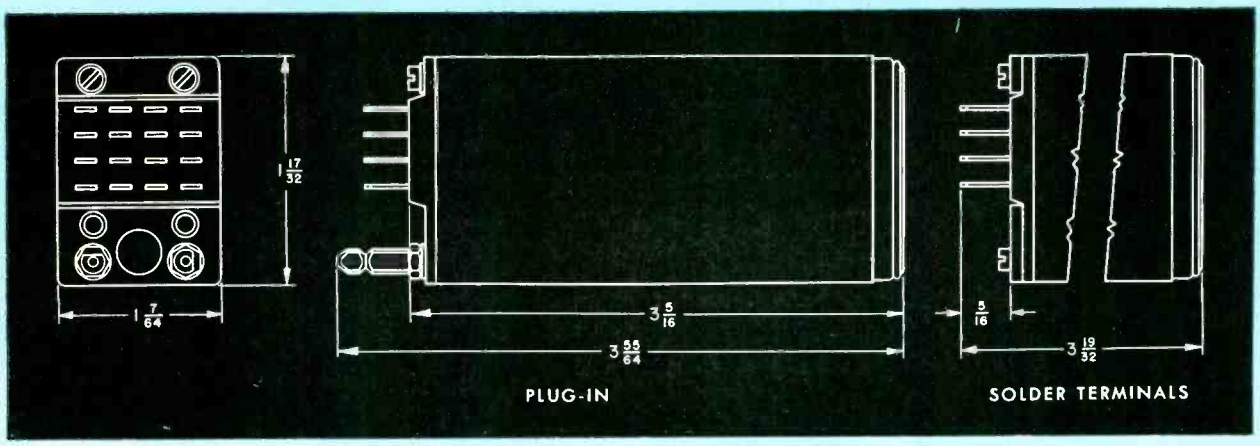
Specifications For Allied's Types Trls 63-69

Type Number		Trls 63	Trls 64	Trls 65	Trls 66	Trls 67	Trls 68	Trls 69
Description	Positions	2		3	2	2	3	2
	Operation	Magnetic Latch						
		High Contact Pressure	High Sensitivity	Null-Center	Magnetic Latch	Spring Biased	Null-Center	Spring Biased
Contact Arrangement		SPDT		SPDT	DPDT	SPDT	DPDT	DPDT
Circuit Symbols	for telegraphy							
	other purposes							
"Operate" Excitation	Amp. Turns	7	2	2.2	5.5	5	4	15
"Operate" Power	μ Watts	500	40	50	300	250	160	2250
Working Excitation	Amp. Turns	15	4	6	10	10	10	25
Working Power	μ Watts	2250	160	360	1000	1000	1000	6250
"Release" Excitation	Amp. Turns			2.2		2.4	4	5
Max. Rate of Operation	Oper./Sec.	200	200	200	200	100	200	100

Contacts:	Silver, General Purpose
	2 amp., 28v d-c resistive load
	Platinum Alloy A. Low-Level
	Applications up to 1 amp.
	Platinum Alloy B. Heavy Duty
	Applications above 1 amp.
	Max. Continuous Current 5 amps.

Dielectric Test Voltage	Coil to Frame	500v rms.
	Contact to Contact	350v rms.
	Contact to Frame	500v rms.
	Coil to Coil	150-500v rms.
Standard Coils	Resistances from 1.1 to 18,000 ohms	
	Max. number of windings	8
	Max. Continuous Loading	1 watt
Temperature	Max. Ambient	85°C

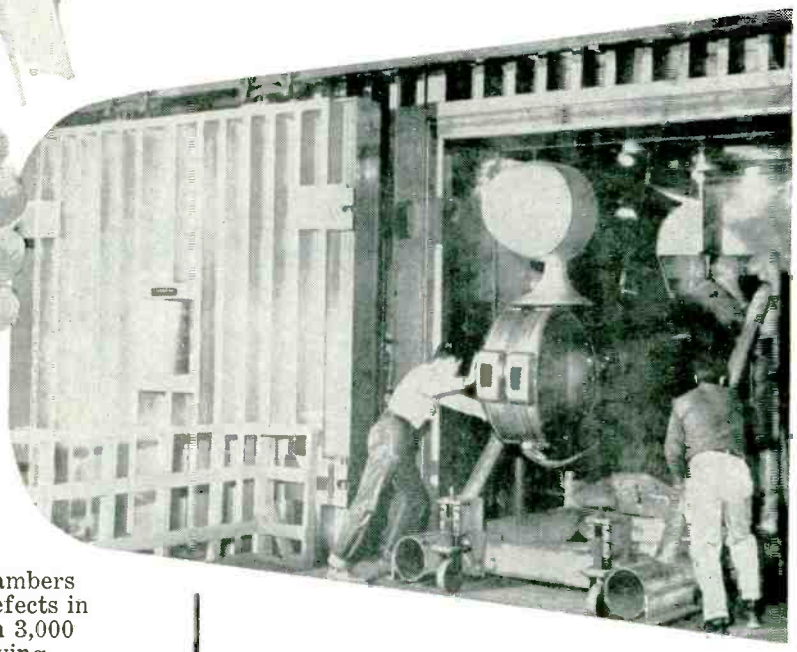
DIMENSIONS



ALLIED CONTROL

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

Tenney-Testing SAVED HIS LIFE



A TenneyZphere altitude chamber proved his equipment would not fail—even in emergencies.

Every day, all over the world, Tenney Test Chambers in military and civilian installations uncover defects in critical equipment and components. More than 3,000 Tenney Test Chambers are now in use, improving product performance and protecting life by duplicating every severe environmental condition accurately . . . dependably. This Walk-In Chamber tests fire control equipment at extreme temperatures and altitudes at the Crosley Division of Avco Manufacturing Corporation.

Tenney advanced-design, quality equipment brings accurate environmental testing within easy reach of every manufacturer.

TENNEY ALTITUDE CHAMBERS COVER ALL CONDITIONS

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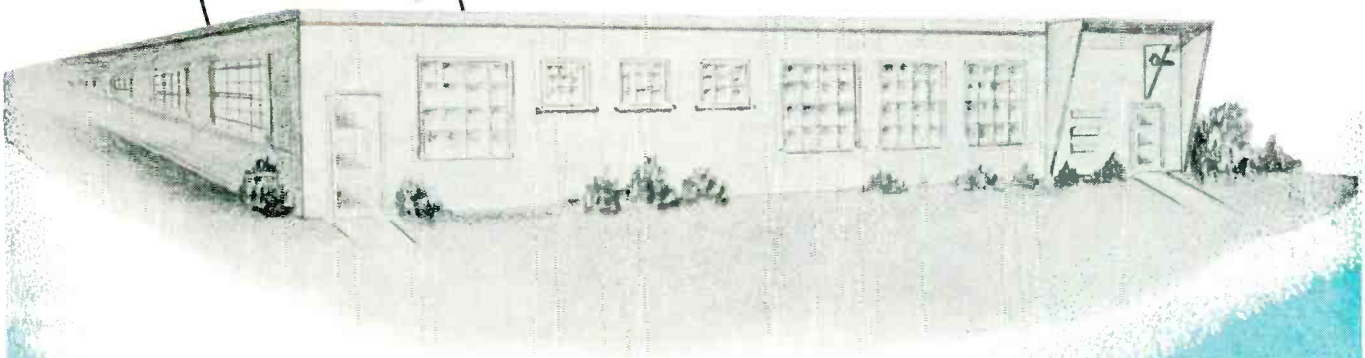
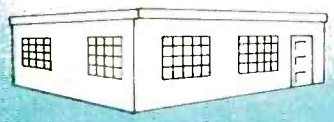


Our new, ultra modern plant incorporates the latest developments in production and research facilities. We will endeavor to make fullest use of these to give you the best in quality . . . the fastest in production. Your confidence in EPR made this growth possible. We will do our best to continue to deserve it.



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Wire Wound Resistors

EPR Means – Engineering • Production • Research

EPR

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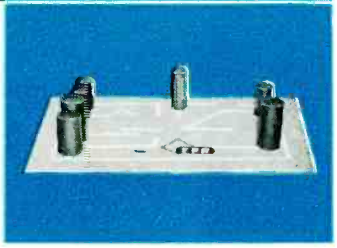
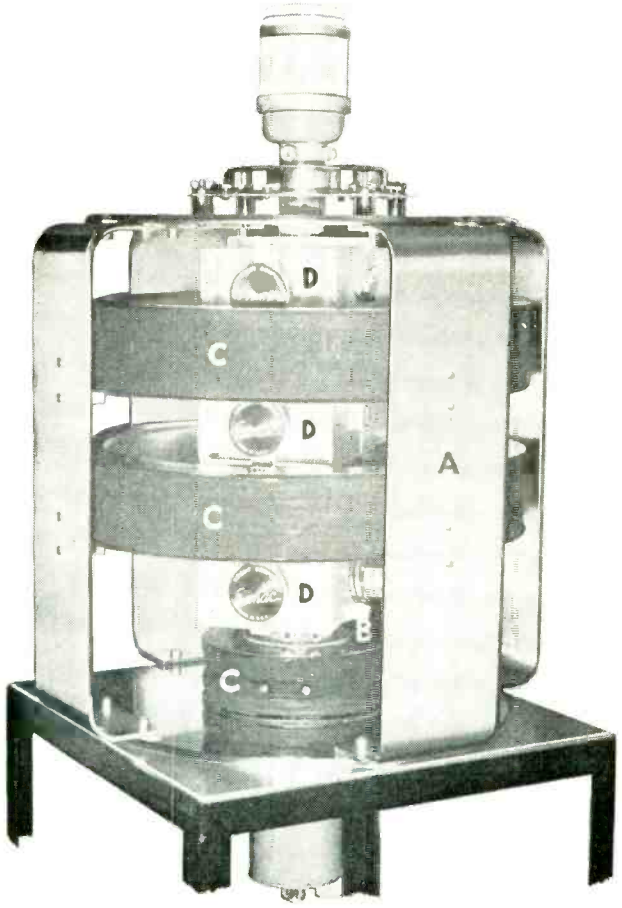
"PC" Resistors for Printed Circuit Applications



Eimac Amplifier Klystrons and Circuit Components

—the easy, economical approach to high power, UHF/microwave transmitters

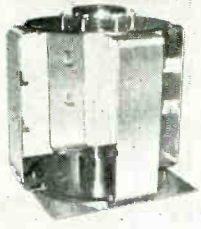


Design and construction of a high power UHF/microwave transmitter for beyond-the-horizon communication and other microwave applications is simple and straight-forward with an Eimac amplifier klystron and circuit components. In fact, it's easier to build than a low frequency Class C amplifier. Eimac high power amplifier klystrons, plus Eimac circuit components consisting of A) Magnetic framework B) RF output load coupler C) Magnetic beam-control coils and D) Convenient tuning wide range RF resonant cavities comprise the essential elements of a final amplifier package. By adding conventional power supplies, control circuits, driver and cabinets to the Eimac klystron-circuit component package, high power at UHF is easily obtained. Eimac developed klystron and circuit components provide equipment manufacturers with the easy economical approach to high power microwave transmitters. In many cases, existing low power equipment can be used as a driver for the higher powered amplifier.

Radio Frequency circuitry is completed outside the vacuum system of Eimac klystrons through circuit components. This allows unmatched economy by eliminating repurchase of costly RF circuitry with each tube replacement.

The reliability and performance of Eimac klystrons is proven, as they were employed extensively in established microwave scatter-type communication systems.

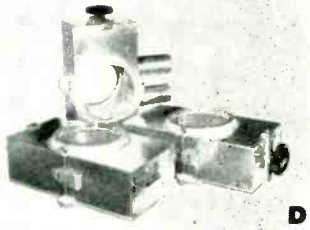
For an easy and economical approach to reliable high power microwave transmitting equipment, investigate the incomparable capabilities of performance-proved Eimac developed klystrons and klystron circuit components.



A
Magnetic frame work

B
Output load coupler

C
Magnetic beam-control coils



D
Resonant cavities

EIMAC AMPLIFIER KLYSTRONS

	FREQUENCY RANGE—MC	CW POWER
3K3000LA	400-600	2000w
3K3000LQ	760-980	2000w
3K20,000LA	470-580	5000w

	FREQUENCY RANGE—MC	CW POWER
3K20,000LF	580-720	5000w
3K20,000LK	720-890	5000w
3K50,000LA	470-580	10,000w

	FREQUENCY RANGE—MC	CW POWER
3K50,000LF	580-720	10,000w
3K50,000LK	720-890	10,000w
3K50,000LQ	850-1000	10,000w
4K50,000LQ	750-1000	10,000w

For further information write our technical service department.

EITEL-McCULLOUGH, INC.
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BJ
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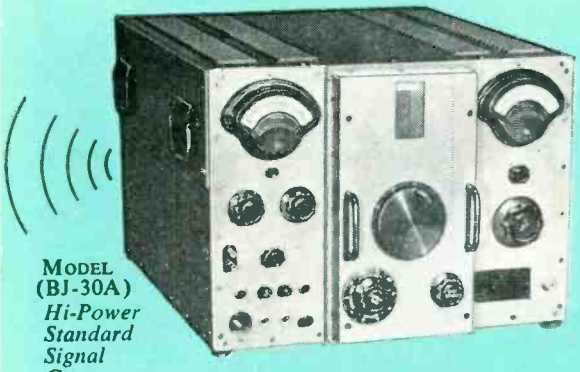
watts of real power to drive antennas



MODEL (BJ-30A)
Hi-Power Standard Signal Generator

AND MICROVOLTS TO MEASURE NOISE

5 watts RF output into 50 ohms impedance.

160 db range of attenuation —15.0 volts to 0.10 uV.

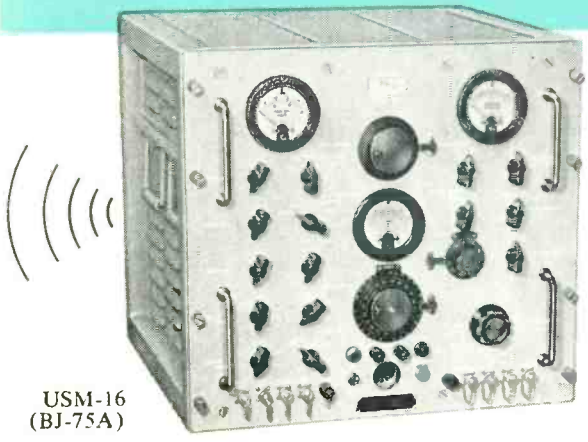
CW—AM—PM operation.

Master oscillator—tuned power amplifier circuit.

Continuous tuning 40 MC to 400 MC—spiral dial scale 4 feet long.

Dial calibrated at intervals of 1% frequency.

Leakage fields less than 0.1 uV/meter.



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(BJ-75A)

Multi-Purpose Standard Signal Generator

a clear, sharp crystal note

AT 440 MC!

FLEXIBILITY PLUS!... with AM, FM, PM or Sweep Modulation available at the flip of a switch

Continuous coverage 10 to 440 MC. Single band; no switching.

Tunes to within less than 1000 cps of desired frequency with respect to two-step temperature-controlled crystal calibrator.

Automatic frequency stabilization at any desired frequency.

Internal or external AM, FM, PM (alone or in conjunction with video pulse and Sync Out pulse). Sweep Frequency modulation with marker pip.

Output 0.1 uV to 0.224 volt (—127 to 0 dbm) into 50 ohm load. Selected output remains constant over full frequency range.

After warm-up, frequency drift is less than ±0.002% in eight hours at room temperature.

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British equipment manufacturers are making a vital contribution to the development of electronics in all fields of application. Their products are being exported to every corner of the world, earning a universal reputation for advanced techniques and excellent performance.

The majority of these electronic equipment manufacturers consistently use Mullard tubes. This choice is decided upon because they prefer the greater assurance of efficiency and dependability, and because the vast manufacturing resources of the Mullard organisation guarantee ready availability of Mullard tubes wherever they are needed.

Write to the undermentioned distributors for full details of Mullard tubes:—

In the U.S A. International Electronics Corporation,
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81, Spring Street, N. Y. 12, New York, U.S.A.

In Canada Rogers Majestic Electronics Limited,
Department 1B.
11-19 Brentcliffe Road, Toronto 17, Ontario, Canada.

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Electronic Tubes
used throughout the world

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Mullard is the Trade Mark of
Mullard Ltd., and is registered in most of the principal countries of the world.

MEV 25

MEMO

FROM: The custom engineering staff at NJE

TO: Designers of computers, telemetering equipment, TV transmitters, etc.

SUBJECT: Why SEMI-Regulated Power Supplies?

We receive over twenty-five requests each week for custom power supply quotations. Most of these requests are obviously built around vacuum-tube or mag-amp regulated power supplies.

Of course, we're in an excellent position to evaluate these specifications objectively—since we manufacture all seven types of electronic power supplies—over $50,000/month of them on a custom basis.

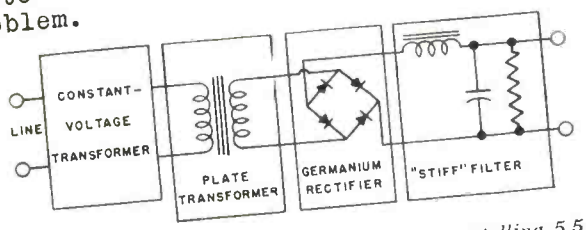
.....over thirty percent of these applications do not require regulated supplies. We usually recommend our ELG type, which is simpler, cheaper, and much more stable. Typical life expectancy is in excess of 30,000 hours without maintenance. No heat. No mag-amps. No saturable reactor. No "trick tubes". No tubes at all in fact.

No secret about it...brute force. We use the new semi-conductor power rectifiers, and really "stiff" transformers and filters, in conjunction with a line-regulating transformer. The high energy-storage of the filter provides excellent transient response. Zero response time, if you need it. Regulation compares favorably with vacuum tube types.

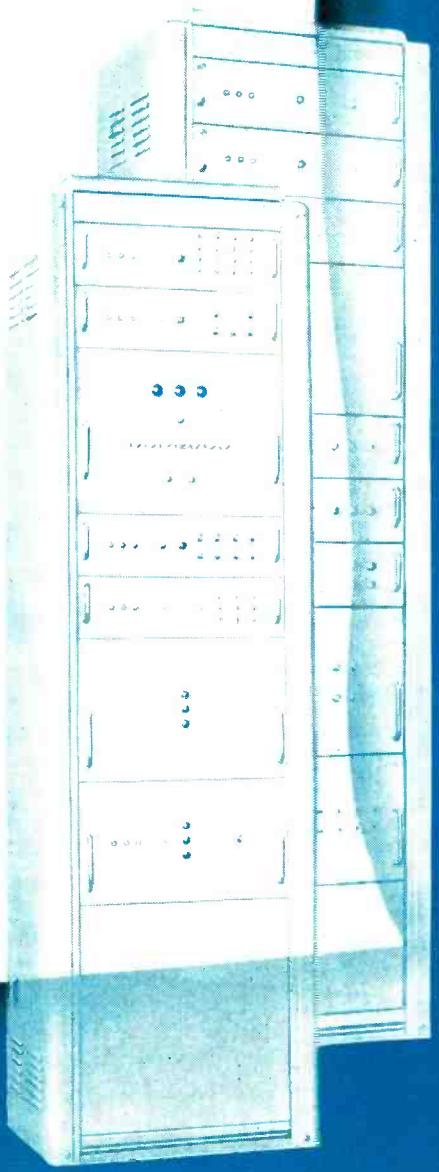
Cheaper, too.

Make sense?

Write—we're interested in your power supply problem.



A good example: *Thirteen outputs totalling 5.5 KW of well-regulated, well-filtered, transient-free DC power for a computer. Priced about $8,000. (Would have been about $15,000 with regulators.) Occupies two cabinet racks. (Would have been 5 racks with regulators.)*



For our complete line of electronic power supplies See electronics Pp. 113-120 BUYERS' GUIDE

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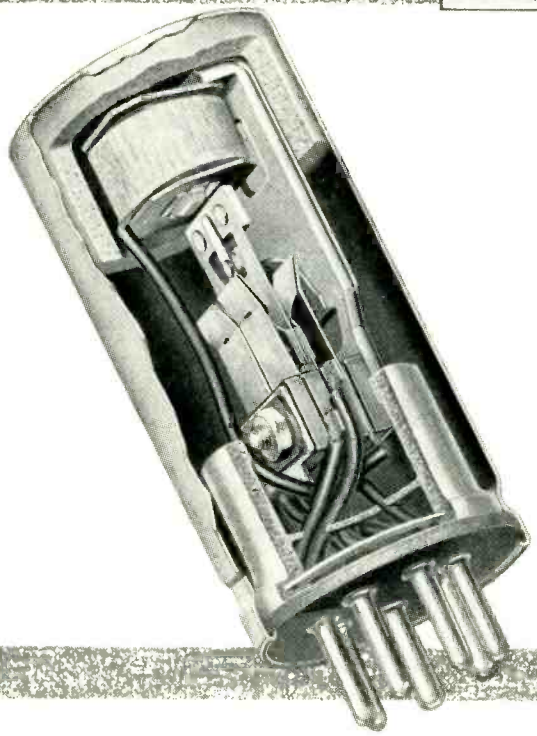
MALLORY



New 1700 series Mallory split-reed vibrator uses special alloy leaves which serve both as contacts and as springs . . . eliminating usual button contacts. Life is greatly increased, constancy of output improved, and driving power reduced.*

**Patent Applied For*

New Heavy Duty Mallory Vibrator

gives far longer life, constant output

For the peak in dependability and performance, plan to use this newest Mallory vibrator in your communications equipment. A completely new idea in vibrator design eliminates conventional contact buttons. The spring leaves themselves . . . made of special contact alloy . . . act as contacting members. This design provides greatly increased contact area, with these important advantages:

Consistently Longer Life. Tests made on heavy duty cycles prove up to 100% greater service can be expected . . . with a high degree of consistency.

Steadier Output. The decreased rate of erosion means less change in contact spacing, less variation in voltage.

Flare-Proof Starting. The new low-mass design permits wider contact spacing to prevent start-up flare . . . without need for greater driving power.

Exceptional Uniformity of characteristics is made possible by the simplified design.

Minimum Size for heavy duty ratings.

The new design is available in the split-reed type shown here, for 6/12 volt service, and in the Duplex heavy duty model without the split reed construction. For full technical data, and for a consultation on your specific power supply requirements, write or call Mallory.

COMPLETE POWER SUPPLIES

It may be that you can save time and reduce over-all costs by employing a complete Mallory Vibrapack® power supply. Vibrapacks can be engineered around the new heavy-duty 1700 series vibrator to give long, reliable service. Design includes precise balancing of critical components. Normal ratings are conservative. Compact-sized Vibrapacks fit readily into crowded layouts. For further information, advise Mallory of your specific requirements.

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W. W. MacDONALD, Editor

OCTOBER • 1955

CROSS TALK

►**TOMORROW'S AIRPLANE . . .** Electronics expert with one of the major airlines thinks the following equipment will be found in ships of the future:

Two vhf or uhf navigational systems, each with radio magnetic indicator and fpdi presentation.
Two uhf distance-measuring systems, perhaps part of the above navigational systems.
Off-set-course computer, possibly a theta-theta unit.
Two uhf glide slope receivers.
Two automatic l/mf direction finders.
75-mc marker beacon receiver with three-light audio system.
Two vhf communications transmitters and receivers, one of each with selcal.
H-F communications transmitter and receiver, each with selcal.
Radar safety beacon with cockpit flag warning of non-operation.
Airborne radar, pilot operated, with two scopes each with separate range marking.
Radar-above-terrain altimeter, 0-5,000 feet.
Proximity indicator system.
Autopilot-automatic approach equipment.
Cabin p-a system.
Two cockpit loudspeakers.
Isolation amplifier system.

If this prediction comes true, the efforts now being made to make electronic equipment smaller, lighter and more reliable will seem like childsplay.

►**LEND-LEASE . . .** In the past two months our curiosity has been excited by a number of phone calls from men who wanted to know if complex test equipment could be leased.

Computer time can be rented in a number of places around the country, and we recall that electron microscopes have at times been made available on this basis. But we do not know to what extent other types of lab equipment can be obtained.

Apparently there is some need for lend-lease plans among concerns having short-term r & d contracts.

►**FLYING SINGLE-SIDEBAND . . .** As speeds approach 600 mph there is sufficient doppler effect upon a 30-mc signal received by an airplane to shift frequency 30 cycles.

Experiments with single-sideband transmission of voice signals at such speeds have provided satisfactory communications. But when a plane moves much faster absolute frequency control does not reinsert the carrier at a suitable point.

Some military aircraft obviously fly too fast for conventional s-s. But we understand it may be possible to get around this curious situation by inserting a pilot tone and automatic frequency control.

S-S enthusiasts, as is well known, do not give up easily.

LOOKING AHEAD . . .

Satellite experiments will throw more light on radio propagation methods already utilizing upper-air particles in a different way. Use of new knowledge to provide completely reliable communications should be commonplace within 10 years

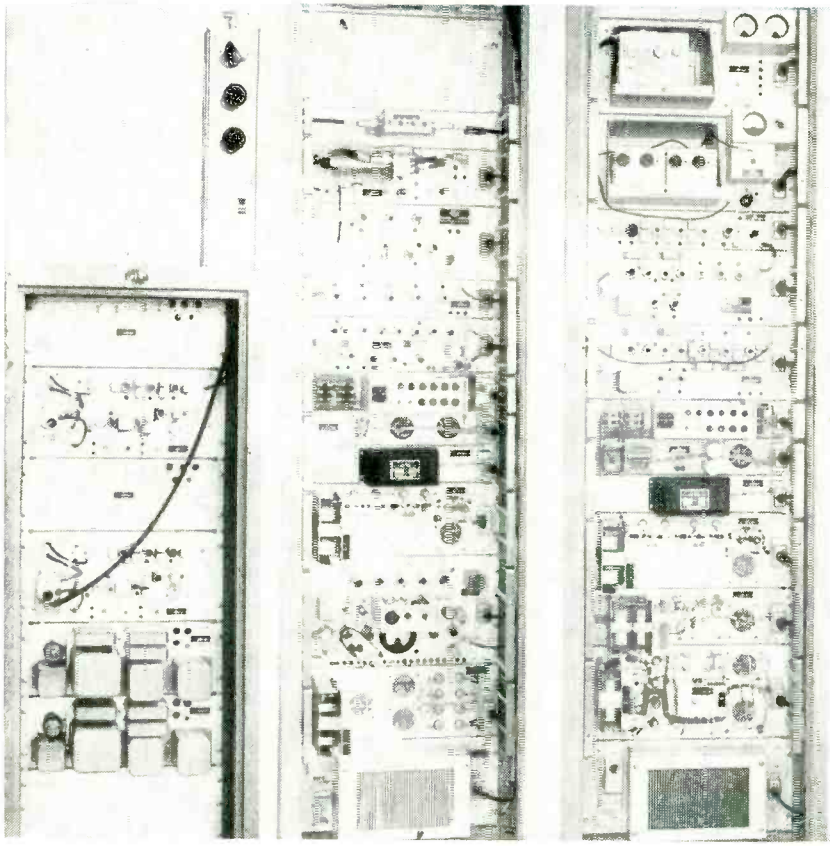
Electronic ignition systems are once more on the drawing boards. Advances in component design may make automotive engineers more receptive than they were some years ago

Geneva conference on nuclear energy has stimulated construction of reactors throughout the world. This should be quickly reflected in increased demand for electronic instruments associated with such programs

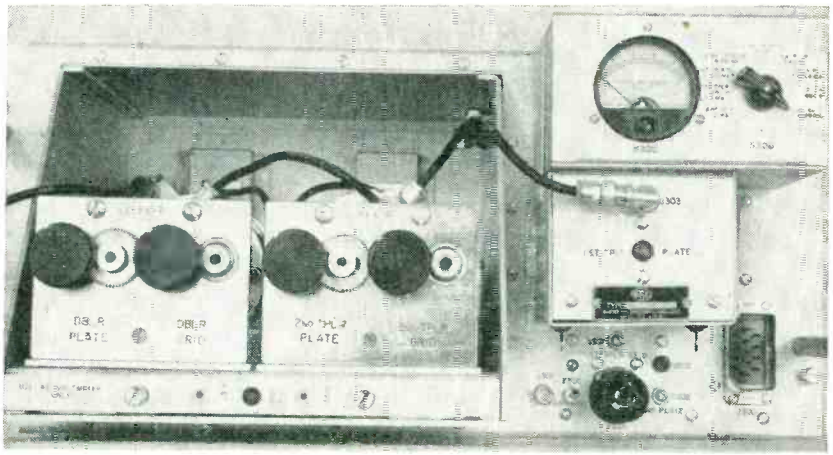
Long-distance reception of h-f signals will be on the increase for the next four or five years. Sunspot activity could be mixed blessing, delighting fringe audiences or bringing them troublesome interference

Beyond-Horizon Signals

SUMMARY — Bending of uhf waves, sometimes known as tropospheric forward-scatter, results in weak but continuous signals far beyond the optical horizon. Modern equipment techniques, using 10-kw klystrons, high-gain



Low-power equipment racks with covers removed. At left are receiver preselector (top), operating and standby r-f heads for diversity antennas. Center is the receiver bay. Exciter and 60-watt amplifier are shown at right



Power-output panel of the 10-watt exciter stage shown in rack above at right

By JAMES R. DAY

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Radio Engineering Laboratories, Inc
Long Island City, N. Y.

BEST present justification, for economic reasons or otherwise, for beyond-horizon circuits at uhf is for the transmission of many telephone channels on a single radio carrier. Line-of-sight circuits for this purpose usually employ frequency-modulated radio carriers; multiplexing is by frequency division and the modulation is generally single sideband suppressed carrier. The equipments to be described are also of this kind. Generally they comprise two-way radio terminals for the transmission of signals in a band from voice frequencies to 600 kc or more. This provides for up to the equivalent of 150 telephone channels.

Different Techniques

The outstanding differences between equipments for use in line-of-sight circuits of a few tens of miles and in beyond-horizon circuits of over 50 miles lie in the means taken to increase the radio gain for offsetting greatly increased span loss. Typical span losses for line-of-sight circuits approximate free-space values and may run 120 to 130 db. For beyond-horizon circuits[1,2] of 150 miles or more, they are in the neighborhood of 200 db. This 60 to 90-db difference must be made up by increased transmitter power, larger and higher-gain antennas and maximum exploitation of the method used.

For example, consider a transmitter of 5 watts output (7 db above 1 watt), two antenna and transmission line systems with a

Extend Communications

transmitting and receiving antennas and special receiving diversity combiners provide economical, fade-free multiplex communications circuits with repeaters spaced every 175 miles

total gain (over a half-wave dipole) of 45 db and a receiver of such a noise factor and deviation ratio that a signal 80 db below 1 watt is required for the planned signal-to-noise ratio. All these together will provide a span capability of 132 db. If more margin is required, it may be had by a modest increase in antenna size, an increase in deviation ratio and perhaps by a small increase in transmitter power.

Power outputs of 10 kw or more are available in practical and economic form over most of the uhf region suitable for beyond-horizon transmission. This represents a possible 35-db improvement over the example given. Antennas with gains over dipole up to 40 db are practical in some parts of the uhf band. This upper limit will be discussed further in connection with diversity reception. Allowing a conservative 5 db for line losses, two such antenna systems will give a 75-db contribution, or 30 db more than for the line-of-sight example.

Receiver Preamplifier

For economic reasons, the receiver in the first example is assumed not to have a preamplifier. By using the preamplifier described below and increasing the deviation ratio in the system, it is practical to set up with receivers requiring a signal of 90 db below one watt for a satisfactory signal-to-noise ratio.

Dual diversity employing combining will give 3 db for that fraction of the total time that the two signals are nearly equal in amplitude. Triple diversity will yield 5 db. Thus, in round numbers it is practical to improve on the line-of-sight example by something in the order of 80 db. This does not come

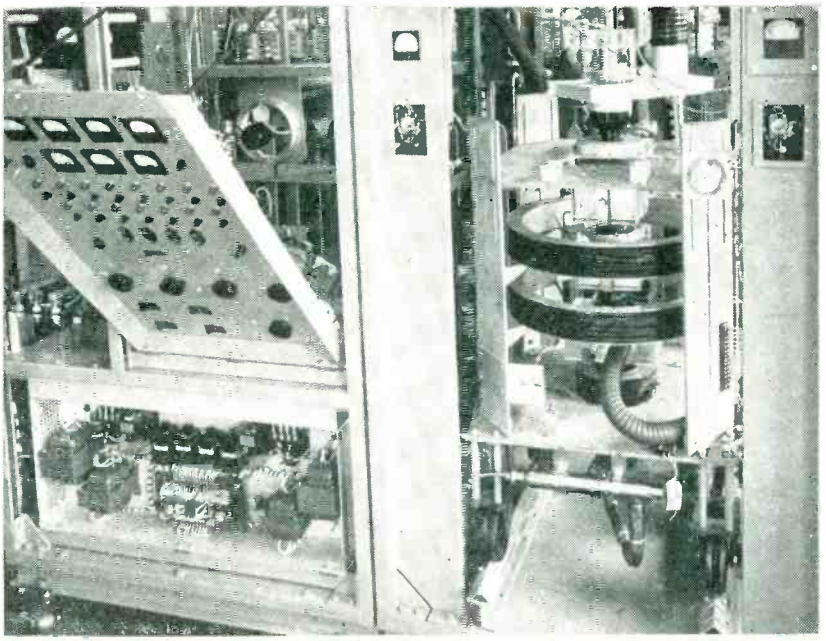
HOW SCATTER WORKS

The mechanisms of various forms of beyond-horizon propagation are presently in a stage of intensive study and some controversy. It is sufficient for busy communications engineers to recognize only a few facts.

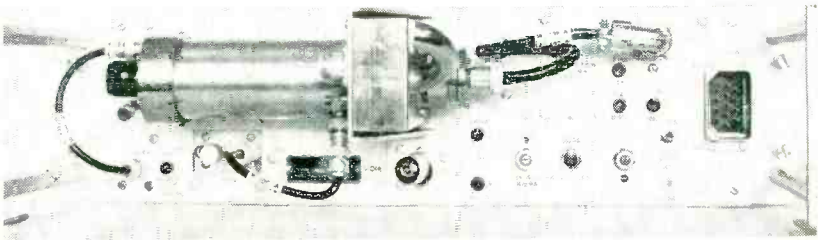
Long-distance (500 to 1,500-mile) communication at about 50 mc can result from ionospheric scatter. The general technique was summarized in ELECTRONICS on page 102 of the June, 1952 issue.

Beyond-horizon propagation at uhf has resulted in practical multichannel circuits up to about 200 miles. This mode of communications is often referred to as tropospheric forward-scatter. Multi-hop circuits can be extended thousands of miles.

For some engineering purposes, subject to variations resulting from changes in season, climate and terrain, the approximate rate of increase of tropospheric transmission loss is 18db per octave in the 100 to 200-mile region in addition to the free-space loss that occurs.—The Editors



Klystron amplifier (right) has 10-kw output at uhf and can be removed on dolly. Control circuits at left are visible with covers off and hinged panel let down



Receiver preamplifier for which circuit is shown in Fig. 5 provides much needed sensitivity for long-distance tropospheric service

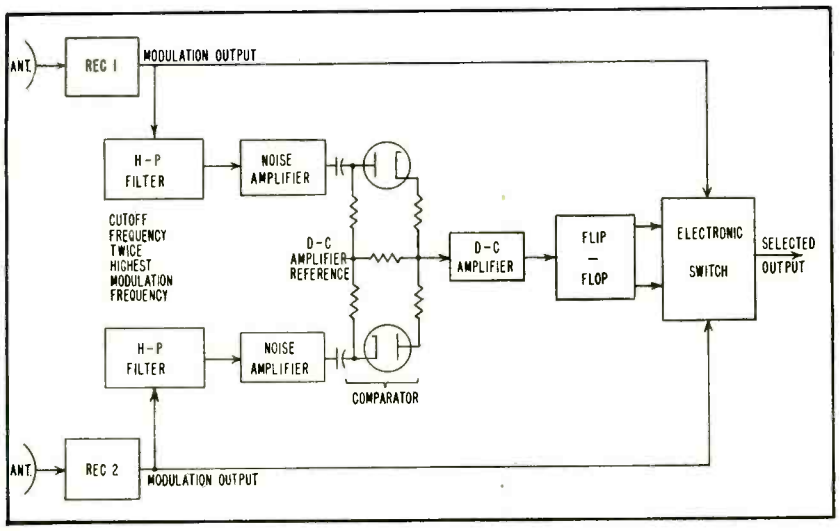


FIG. 1—Dual-diversity switch that serves as basis of the combiner circuit

easily or cheaply and the final margins are strongly dependent on thoroughness of design to yield every last db of system gain.

It has been long suspected and finally confirmed that the gain of a mirror or horn type antenna cannot be increased indefinitely by an increase in dimensions. For such increase to be possible would require that the phase and amplitude relations among all elements of the received wave remain stable with time and within ever-narrowing limits as the gain is increased. Figuratively speaking, it can be said that distance lends disorder and that antenna aperture increase beyond that necessary to give 40 to 45-db gain over a dipole are unprofitable.

Amplitude Fluctuation

Received signals well beyond the horizon are characterized by random short-time amplitude fluctuations. The distribution[3] is such that for 10 percent of the time the signal will be more than about 10 db below the short time median, 1 percent more than 20 db, 0.1 percent more than 30 db and so on. Since in most applications minimum circuit performance must be had for at least 99.9 percent of the time the situation above is unsatisfactory.

It has been found that as two antennas, initially coincident, are separated (particularly in a direction at right angles to the direction of transmission) the amplitude fluctuations of the two received signals, initially identical, become progressively unrelated. At separations of more than 150 wavelengths or so the correlation is negligible for practical purposes. With a switch that continuously selects the better of two such signals the losses versus percentage of time are halved and an otherwise useless circuit is made satisfactory by space diversity.

The devising of such switches served as the first practical approach to this problem. Since the rate of change of amplitude during this fading is rapid, the sensing means used to operate the switch must be fast, that is, derived from a source of good bandwidth. The noise amplitude well above the highest modulating frequency in an f-m receiver is inversely proportional to signal strength. If filtered off, amplified and rectified it provides a suitable switch control.

Figure 1 shows a block diagram of a complete dual-diversity switch. The condition of the flip-flop and hence the circuit selected depends on the polarity of the output of the comparator, the latter depending on the relative output of the noise amplifiers. Not shown but included is a common agc system for the noise amplifiers, which acts to enhance the difference in the noise-amplifier outputs, and hence the positiveness of action.

Similar switches operate an electronic switch at intermediate frequency. All these switches have a sensing speed in the order of one millisecond. The i-f switch followed by an independent limiter and final f-m detector has a minimum switching transient. The flip-flops operate in a few microseconds.

Diversity Combiner

Switches, however, have two grave disadvantages. No matter how well designed, they offer the strong likelihood of producing errors in any telegraphic information in the baseband. Since they merely select the better signal, during that portion of the total time when the radio signals are about equal, many profitless switchovers may occur, increasing the likelihood of errors.

Combining two or more signals in such fashion as always to present an optimum signal-to-noise ratio is a more attractive solution. This can be done simply.

In Fig. 2 are shown two or more generators in parallel. The pairs of generators represent the outputs of two receivers. Signals S_1 and S_2 are the modulation and are equal and in phase. Generators N_1 and N_2 are the totally unrelated noises present in the two receiver outputs. Resistors R_1 and R_2 represent internal impedances of the two branches. Since S_1 and S_2 are equal and in phase, no loop current flows and the output voltage E_0 is equal to $S = S_1 = S_2$. The quantities N_1 and N_2 being unrelated divide across the output giving two contributions

$$N_1 \frac{(R_2)}{(R_1 + R_2)} \text{ and } N_2 \frac{(R_1)}{(R_1 + R_2)}$$

When the radio signals are equal and the amplitudes squared of the N's are equal and assuming $R_1 = R_2 = R$ the combined noise output in E_0 is $N/\sqrt{2}$, which with S gives a 3-db improvement in signal-to-noise ratio. It can be shown that if the R's are caused to vary as the square of the individual N's, the output combination signal-to-noise ratio is always optimum and never poorer than the better of the individual ratios. Such a method is smooth and always better than switching. For that fraction of the time when the signal-noise ratios are the same or nearly so the gain for dual diversity is 3 db, 5 db for triple and so on.

Figure 3 shows an arrangement similar to that for switching except that the electronic switch has been replaced by a pair of cathode followers with their cathodes tied together for d-c. To each grid is applied the S and the N from the receiver as well as an appropriate control voltage C, which is derived from a noise amplifier-rectifier. Here the internal impedances of the cathode followers are the R's of Fig. 2 and they are caused to vary by the C's.

It is the relative value of the C's that affects this variation, in that if the C's change equally the relative situation between the cathode follower is unaltered. The proper law of variation of the C's versus noise to meet the optimum condition is easy to secure and keep by means of the agc on the noise amplifiers, using any medium or high-μ tube as cathode follower.

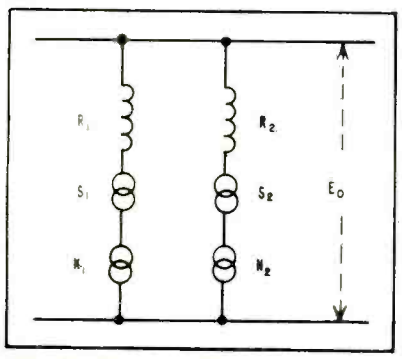


FIG. 2—Signal, noise and impedance relationship for a diversity combiner

For beyond-horizon circuits, owing to the type of fading encountered, some form of diversity is an absolute necessity. Combining in the form described provides an optimum solution.

Cost alone will not insure any path an excess of received signal. Sound margins are normally provided in systems design but with transmitter power, antenna gains and receiver noise figure pushed to the maximum economic extent, it is imperative to exploit the maximum possibilities of the system in all details of circuit design. Some of the more important of these are described below.

The common application of these equipments is in fairly long systems comprising many spans and yet requiring demodulation to base band at all stations. This requires that the design be predicated on full modulate-demodulate, rather than the so-called heterodyne method. In turn, this places unusually severe requirements on the modulator and demodulator. The equipments are capable of 20 to 40 repeats with signal to distortion noise ratios consistent with toll telephone circuit quality standards.

Linearity of Transmission

The Serrasoid modulator[4] used at each transmitter for f-m is the phase-shift type shown in Fig. 4. It produces a frequency-modulated wave by modulating the phase of a subcarrier whose stability is independently controlled by a crystal. In it a sawtooth wave of high linearity is generated as the subcarrier frequency. A short pulse is generated at half amplitude of the sawtooth in the unmodulated condition by applying the wave to a biased gate that is small in aperture relative to the sawtooth.

Modulation consists of varying the bias, causing the pulse to be advanced and retarded from the reference phase. The pulse train is converted to c-w by selective circuits at a harmonic of the subcarrier, and the final f-m signal derived by suitable frequency multiplication and heterodyning. This method is inherently ideal and can be made as linear as desired by refinements of circuit detail.

It is entirely aperiodic, requiring no adjustments and uses tubes only as switches, not depending on the shape of their characteristics. Whereas frequencies of 100 kc for the subcarrier are suitable when the top modulating frequency is 15 to 20 kc as in the broadcast version of the circuit, it is necessary to raise the subcarrier rate to 2 or 2.5 mc for 600-kc modulation. It is of interest that in the high-frequency modulator, for the operating distortion levels of 0.1 percent or less, departures from linearity constitute timing errors of less than 1 micromicrosecond.

Demodulator requirements are met by use of a discriminator of peak-to-peak width in excess of three time the deviation. Experience has shown that the f-m detector as such is properly considered as part of a demodulator system that includes the limiter. This is particularly true where low distortion is required. Frequency-modulation detectors are vulner-

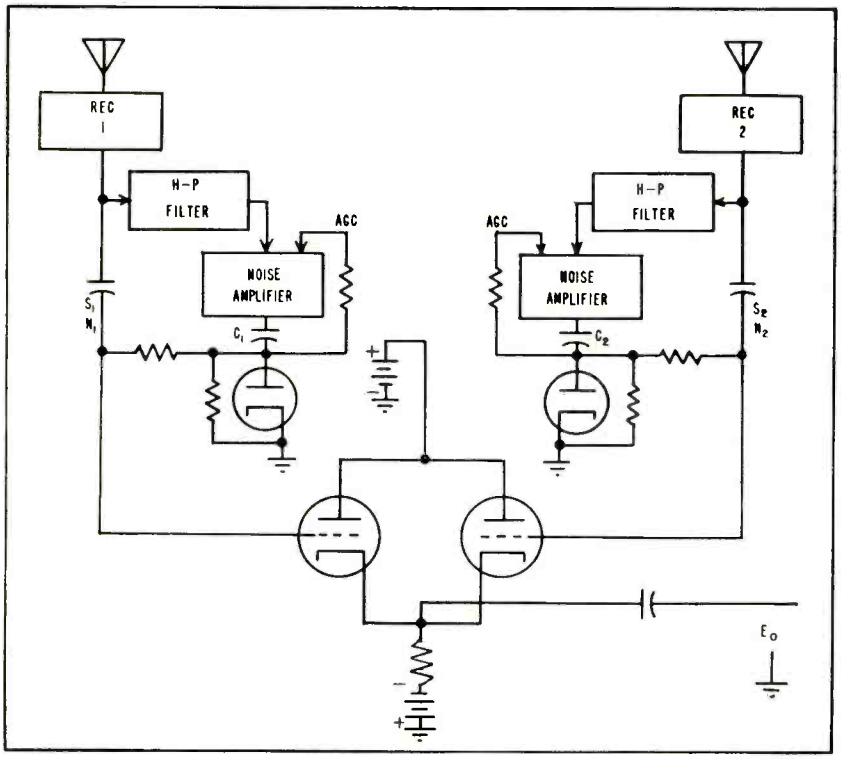


FIG. 3—Block and schematic representation of the dual diversity combiner circuit with a 3-db advantage

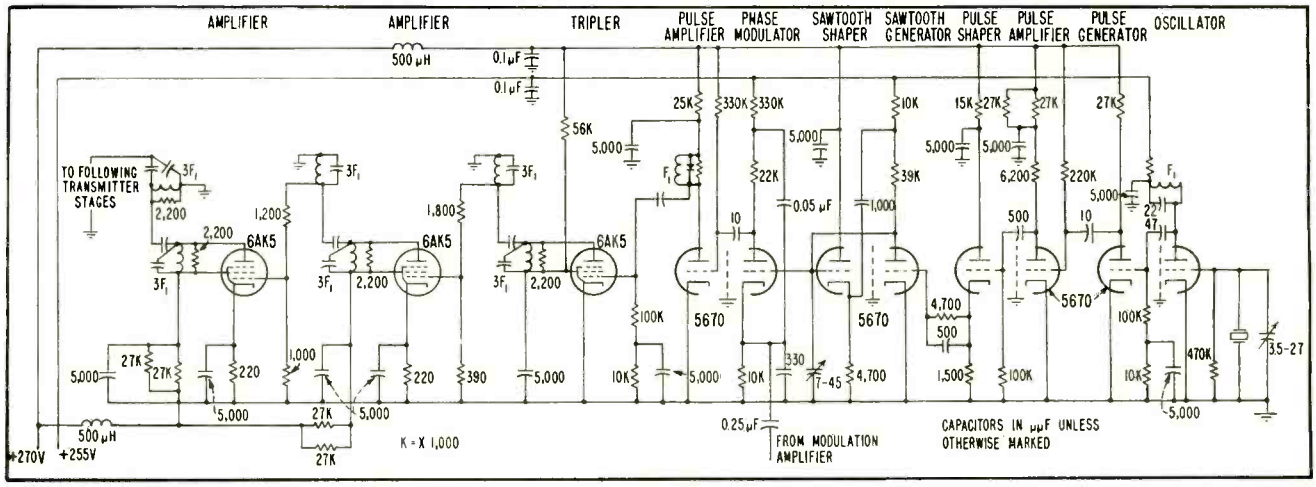


FIG. 4—Phase-shift modulation equipment is a modification of f-m broadcast type. Negative cathode returns are omitted for simplicity

able to changes in the wave shape of the i-f signal supplied to them. It becomes a problem in limiter design to secure constant wave-shape as signal amplitude changes and yet provide the amount and speed of limiting required to exhaust the f-m capabilities of the receiver.

After the modulator and demodulator elements, the elements affecting linearity are all the coupling circuits used in the transmitter and receiver. It is in the latter that the closest design is required. This is because bandwidth, which controls distortion also determines the operating threshold of the receiver and hence the ultimate fading margin of the receiver. By careful attention to the nature and location of the important coupling circuits, the delay distortion may be controlled to a linearity of better than 0.1 percent with a receiver noise bandwidth of about 2.5 times the peak-to-peak deviation.

Gain Stability

In any long system, where some of the individual channels may run through many repeaters, it is important that both the short and long-time gain stability at modulating frequencies be fairly high. The elements involved in this are the base-band amplifiers, the modulator and the demodulator. Provided the limiting section of the demodulator is well designed, the r-f parts do not affect gain as modulating frequencies.

Base-band amplifiers are stabilized by feedback. The modulator alone exhibits gain changes of less than 0.1 db up to the point of tube failure. The gain of the f-m detector is stabilized by the use of biased charging diodes, as in a ratio detector, but using a regulated fixed bias rather than the automatic self-bias of the usual form.

In effect this replaces the dynamic limiter of a ratio detector by a fixed bias limiter, yielding a detector slope independent of the i-f drive and hence, of the condition of previous tubes. The detector stability is also in the order of 0.1 db.

Equipment

Equipment is grouped as exciters, power amplifiers and receivers. An exciter rack comprises the modulator, transmitting converter and 10-watt output amplifier. The modulator panel includes the phase-shift modulator and a three or four fold frequency multiplier. Output is in the order of 20 milliwatts at around 10 mc. It is fed to a transmitting converter where the input signal is heterodyned to a frequency of $\frac{1}{18}$ or $\frac{1}{24}$ the final radio frequency and amplified to about 0.5 watt. Output stages use 2C39A or 2C39B tubes to feed the power amplifier in a separate cabinet.

Anode and bias power equipment is stabilized by circuit design so that power-supply regulation is not required for ±10 percent line changes. Heater supply generally incorporates stabilization to 1 or 2 percent for prolongation of tube life. Filtered air is supplied through a duct distribution system where required.

Diversity Receivers

Receiver assembly is based on a rack-panel design as shown in the photograph with one single receiver to a bay. The panels start with an r-f preamplifier comprising one stage of 6280/416B amplification (18 db) with double-tuned band-pass output. This unit feeds into a receiving converter where the r-f signal is converted by crystal-controlled heterodyne to an intermediate frequency near 30 or 60 mc, depending on application and amplified about 20 db. The selective amplifier follows, which comprises the bulk of the linear i-f gain, the controlling selectivity and the i-f agc system, feeding into the demodulator. This panel contains a multistage limiter, f-m detector and initial base-band amplifier.

The diversity combiner contains the noise amplifier-rectifier system and the cathode follower for this branch of the diversity arrangement. All diversity cathodes are tied together for d-c by interbay cables and each combiner contains an independent output base-band amplifier. This makes possible the immediate use of receivers in any diversity combination, or singly without diversity. Control, power supply and blower panels are gen-

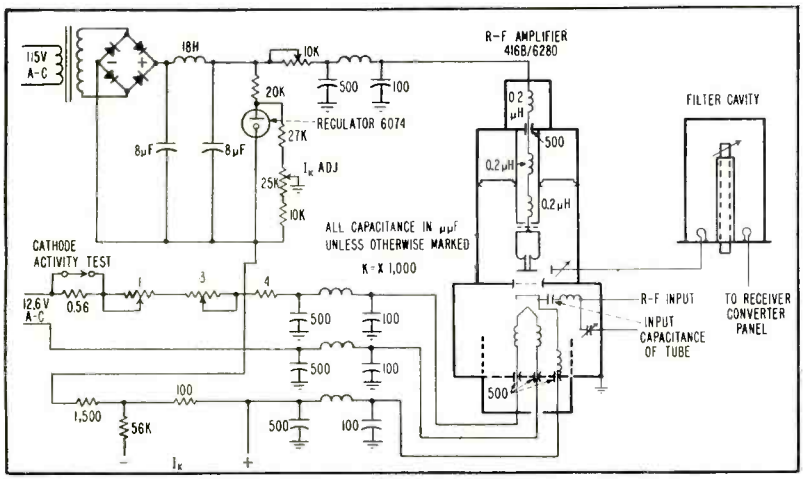


FIG. 3—Detail of the receiver r-f amplifier circuit showing use of 416B tube

erally similar to those for the exciter.

The power amplifiers used with these equipments employ Eimac external cavity klystrons. The 10-kw amplifier uses the four-cavity 4K50000L and the 1-kw amplifier the three-cavity 3K3000L. The larger tube is liquid cooled and the smaller is air cooled.

In the 10-kw unit the equipment is arranged in four frames. The power rectifier contains an Askarel-filled unit to supply unfiltered 17-kv at 2 amperes for the klystron beam. Rectifiers are twelve Eimac 2-240's in a three-phase full-wave bridge. The bombarder supply contains an Askarel-filled filament and bombarder anode source for 2,200 v at 0.75 amp. The 1-kw air-cooled unit is mounted in a single cabinet. The smaller tube uses a package heater.

A feature of these amplifiers, particularly in applications where there is a premium on bandwidth control for distortion purposes, is the absence of feedback. There is consequent complete independence of the individual tuning controls. The entire r-f system is at ground potential and is enclosed without break by blocking capacitors or otherwise. Leakage field is entirely negligible.

At the bandwidths required, the power gain of the four-cavity tube is over 30 db and of the three-cavity tube over 20 db, permitting the use of the same basic exciter for either output. In use, the input and output cavities are tuned to resonance and the intermediate cavity or cavities detuned. Intermediate cavity detuning is determined by minimum a-m output using a test deviation and a-m probe detector with an oscilloscope on the output. Tuning procedure for f-m linearity limits using the above indication takes about two minutes.

Random Noise Loading

In the development of these equipments an important adjunct tool has been random noise loading for evaluation of modulation-product generation or intermodulation. The modulation signal with frequency-division multiplex telephony during actual service is a relatively random affair, strongly resembling thermal noise.

The similarity is close enough to enable the rather close simulation of traffic by its use. The ideal way is to provide a filtered block of uniformily distributed noise as signal, extending over the entire base band except for a slot of width approximating a single-sideband telephone channel 4 kc wide with adjustable location in the baseband.

Power level is adjusted to represent the desired loading. Using an analyzer type meter at the output of the device under test, the ratio of power per unit of small bandwidth in the illuminated region and the dark slot is measured. This is a direct evidence of the average nonlinearity of the device under test.

As a practical matter, it has been found that, if the center 50 percent or more of the base band of these radio equipments is illuminated and the dark low and high ends used to secure ratios, the data yielded reliably indicates the traffic performance. This method is used in circuit design, production testing and field maintenance. It gives answers directly interpretable in terms of performance under traffic conditions. It is intrinsically simpler than measurements using tones. An f-m transmitter-receiver combination of the kind described here, with the illumination peaks extending to the rated complex deviation and exhibiting ratios in the order of 50 db, is comparable in linearity to this equipment.

The radio-frequency amplifier shown schematically in Fig. 5 exhibits an important feature for this class of equipment. The grid is grounded for d-c and the cathode is returned to a negative supply through a high resistance. This supply is in the order of 50 volts negative to ground and is stabilized. By this means, which is d-c feedback, the static tube current is heavily stabilized, resulting in considerably more uniform performance, including gain, throughout tube life. It likewise enhances prolonged effective tube life. All miniature tubes in addition to the 416B are so handled in both exciter and receiver. Negative cathode returns are not shown in Fig. 4 for diagram simplicity.

While the 416B tube originated as a low-power transmitting tube at 4 kmc, it has exhibited superior performance as a small-signal amplifier up to frequencies well in excess of 1,000 mc. Typically it provides maximum noise figures of 5 db at 500 mc and 8 db at 1,000 mc. Its transconductance is high enough and the transit time low enough in this range that no noise figure improvement by mismatch is secured.

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(4) J. R. Day, Serrasoid F-M Modulator, ELECTRONICS, p 72, Oct. 1948.

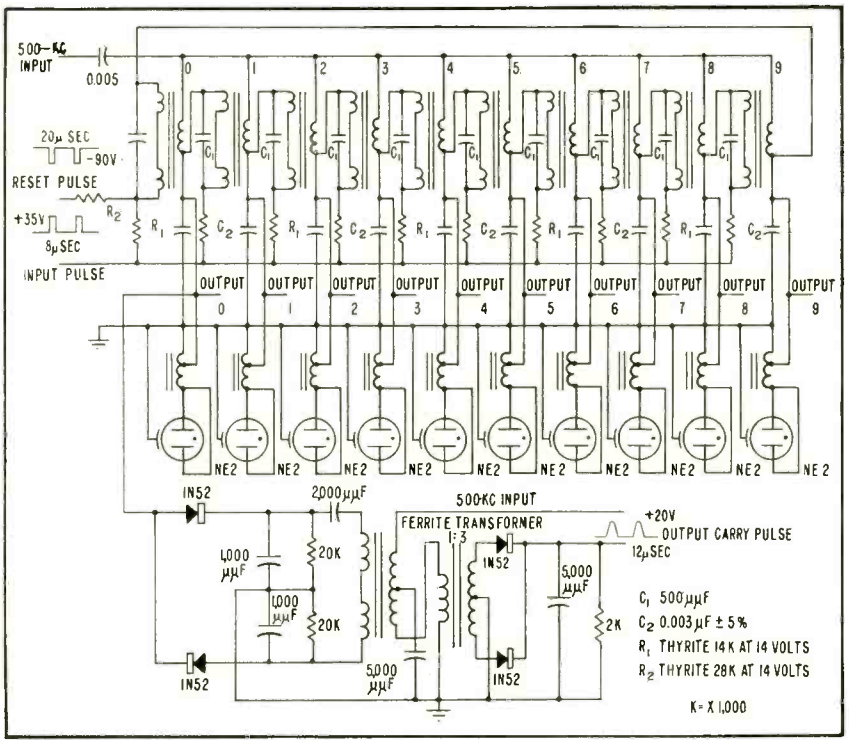
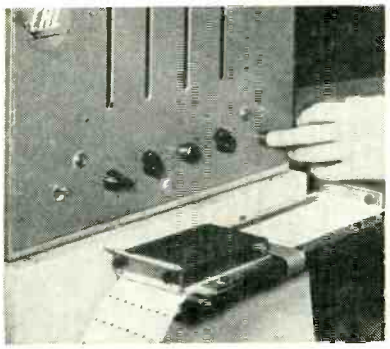
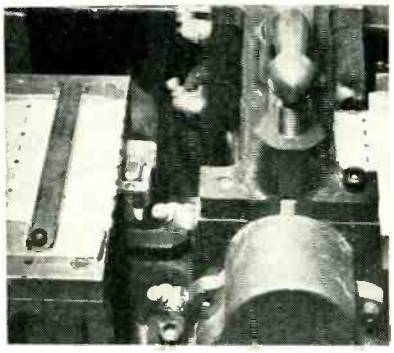


FIG. 1—Ferroresonant ring decade scaler eliminates vacuum tubes



Automatic reset repeats cycle



Selenium photocell mounting

Counting Labels With

SUMMARY — Industrial application of photocell device and predetermined counter gives precise count and automatic control of paper-tape winding machine. Decade counters provide direct readout of label units

By ERIC SWARTHE and CARL ISBORN

Pantek Co.
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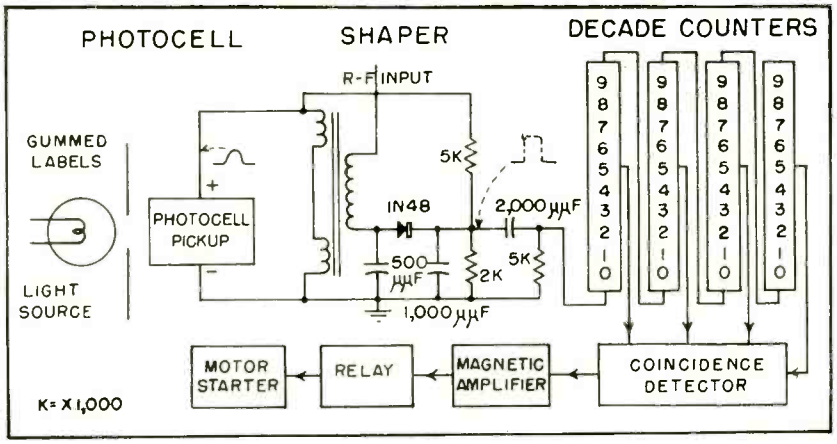
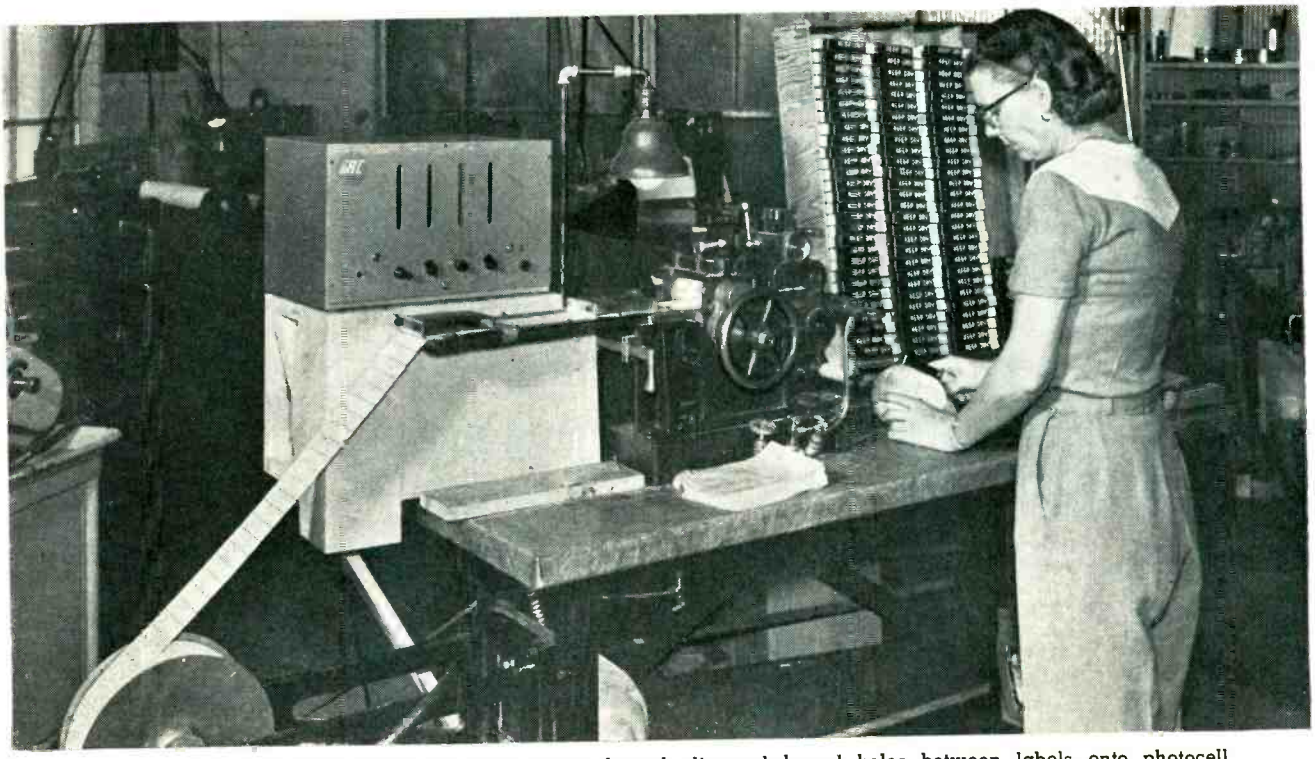


FIG. 2—Interconnection of units shows motor control actuated by light on photocell

THE LABEL MANUFACTURER'S PROBLEM of counting labels accurately is important because an error of 1 percent can amount to a loss of several thousand dollars a year. As labels vary in width, counting them by recording the revolutions of a pair of rubber-coated drive rolls requires computation. Slippage through the drive rolls makes accurate counting impossible and impairs the efficiency of the slitting operation.

A method of directly counting individual labels has been developed. A photocell pickup is used to detect the diamond-shaped hole between labels. The photocell output is fed into the input of a predetermining counter. This arrangement simplifies the mechanical



Label-counter is actuated by light (above machine) falling through diamond-shaped holes between labels onto photocell

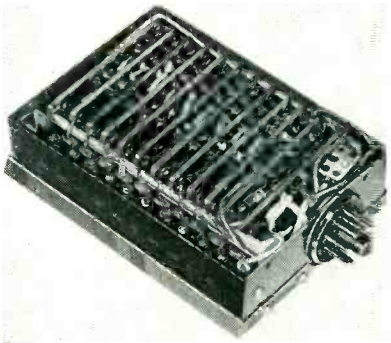
Ferroresonant Rings

problem of high-speed feed as the paper is pulled through the slitter knives by driving only the take-up reel.

The problem then is resolved into selecting a four-digit predetermined counter that can count at rates above 30 a second, is not over 10 inches high, 12 inches long and 11 inches deep and does not require maintenance by a technician. Use of ferroresonant ring elements permits building a counter to meet these needs.

The ring elements are built into decades as shown in Fig. 1. The system is connected as indicated in Fig. 2. A hermetically sealed selenium photocell is used.

The coincidence circuit employs only four 10-position rotary switches and four diodes. More control points can be added for other operations as required, such as for slowing down or speeding up the motor. The output of the coincidence gate is fed into a miniature magnetic amplifier that operates a relay. The relay controls the motor's magnetic starter coil in a conventional manner.



Plug-in decade counter assembly

While magnetic amplifiers could be used throughout, the motor starter is used instead for reasons of economy. The r-f power supply uses a selenium rectifier.

A characteristic of ferroresonant circuit operation is the all-or-none feature. The counter being made of true rings cannot, in the event of a malfunctioning component, divide by two or some other integer. It will either count correctly or not at all.

Should the counter malfunction, the service procedure is simple. If the indicators do not light, the r-f power supply has failed. The oscillator tube or the plug-in unit can be replaced. Plate supply failures are extremely rare because of the low power requirements—about 20 watts input.

Simplicity and reliability of ferroresonant circuit design make its use suitable for other applications such as frequency dividers, time-control circuits, frequency meters and memory systems. Other applications are production counters, shaft positioning, electrical replacement of gear trains and complex control systems.

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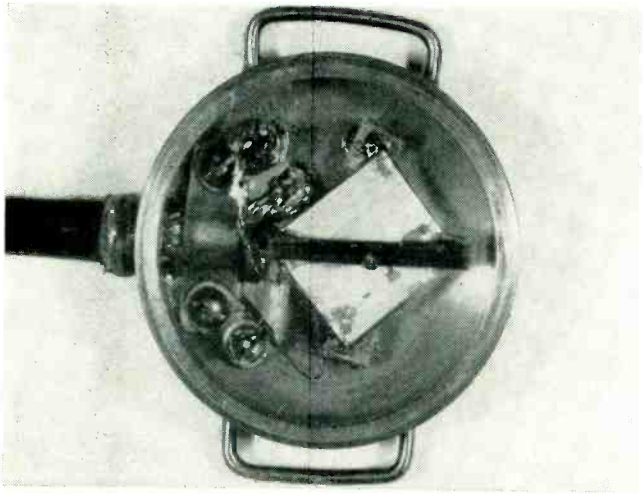

Brachial-artery pickup microphone with diaphragm removed is housed in Fleisher-type stethescope

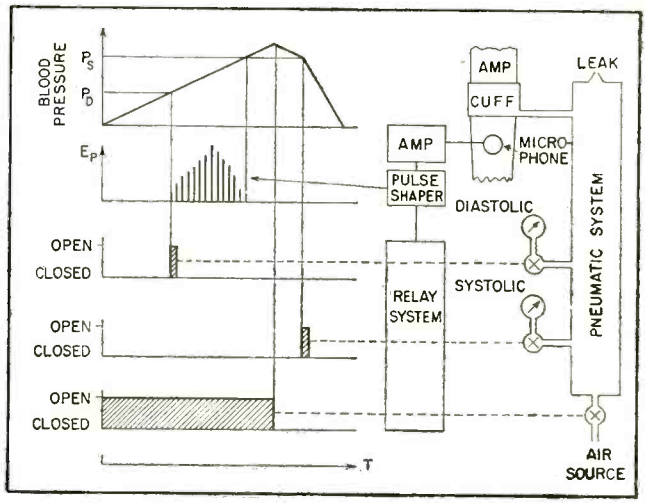

FIG. 1—Functional diagram shows interrelation of components for measuring blood pressure

By S. R. GILFORD* and H. P. BROIDA

National Bureau of Standards
Washington, D. C.

Physiological Monitor

SUMMARY — Selected physiological variables on patient undergoing anesthesia and surgery are monitored automatically. Changes are indicated on operating-room console and also continuously recorded. Design features provide safeguards against operating-room environmental hazards

CHANGES in the blood pressure, pulse rate and respiratory rate and minute volume of a patient under anesthesia are automatically detected by a physiological monitor that has been developed.

The monitoring equipment is housed in two sheet metal cabinets as shown in the photograph. The low cabinet on the right is the operating room console, which is made safe for use in the presence of explosive vapors by maintaining the enclosure at a positive internal pressure with respect to its surroundings. The large cabinet is placed in a location free of explosive vapors and houses the recorder and purging air supply as well as other circuit components whose proximity to the patient is not required. The units are interconnected by cable and air line permitting a maximum separation of about 20 feet.

Blood-Pressure Measurement

An indirect method of arterial blood-pressure measurement is used by adapting a clinical sphygmomanometer. Measurement is made by detecting the maximum and minimum arterial pressures from the points at which sound disappears when the arm artery is occluded.

Figure 1 is a functional diagram of the system showing the interrelation of the components. Pressure in the cuff (arm band used to measure blood pressure) increases as in the upper curve when the valve from the air source is opened. A microphone located over the brachial artery begins to indicate sounds as the pressure exceeds the diastolic value, P_d, approximately as illustrated in the second characteristic. This sound reaches a maximum and decreases, disappearing after the cuff pressure exceeds the systolic point, P_s.

The amplifier and relay circuit are arranged so that upon the inception of the first sound a solenoid valve opens permitting an attached gage to attain the diastolic pressure and then closes retaining this pressure. Pressure in the system continues to rise until systolic pressure is reached. Since it is not

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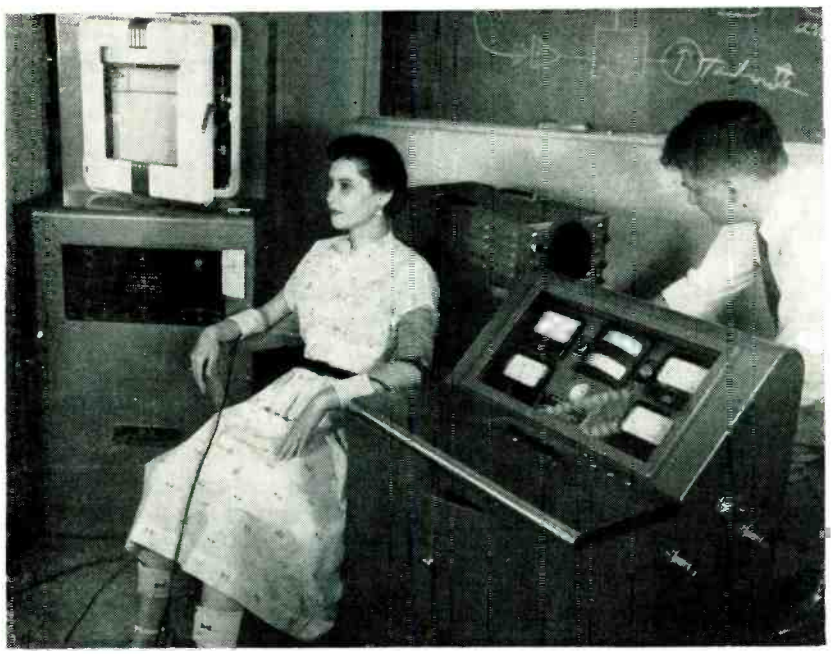


Physiological monitor in operation. Electrodes are connected to patient's arms and legs. Microphone is strapped over the brachial artery in arm

for Anesthesia

possible to determine the point at which sound disappears until that point has been passed, the pressure is carried beyond this point and the inflating source is removed from the system. A small orifice in the system permits pressure to decrease slowly and as the first sounds corresponding to the systolic pressure are received a second solenoid valve and gage are opened to retain this pressure. Following this, the cuff is rapidly deflated to minimize the period of pressure application.

The entire process proceeds automatically under the control of a program switch that initiates the measurement at 3-minute intervals. The systolic and diastolic pressure information is displayed on two electrical panel meters, which retain the measured value until a new determination is made.

Excessively high pressures are prevented by including a mechanical popoff valve, which opens and relieves cuff pressure when the system pressure exceeds a preset value. In addition, an adjustable electrical limit switch, set at a value reasonably well above the patient's systolic pressure, resets the system to its initial deflated state if the system pressure exceeds this value.

Safety Features

Application of pressure for long intervals of time is prevented in two ways. A solenoid-operated valve, normally functioning to discharge the air from the system at the end of each determination, is of the open type that would discharge the air in the event of power failure. A continuous slow leak makes it impossible to sustain pressure in the system without an active source.

Sound originating in the artery during the measurement of blood pressure is considerably attenuated by the time it emerges from the tissues and impinges on the microphone. Considerable sensitivity is required of the microphone-amplifier combination to detect the onset of sound and raise it to the level required to operate the threshold detector. This sensitivity had to be achieved while minimizing unwanted signals originating from microphone frictional noises and ambient acoustical disturbances in the immediate vicinity.

A suitable microphone, shown in a photograph, was developed by modifying a displacement type pickup. This unit has good response at the lower audio frequencies up to 100 cps, an important requirement for this application.

Circuit Details

Figure 2 is a schematic of the amplifier. The 5879 input tube (V_1) is required to keep hum level from the heater source at a minimum because of the small signals.

A total gain of approximately 10,000 is realized from V_1 and V_2. Triode V_{3A} brings the signal level up by a factor of five before going through the 3-section R-C filter.

The filter output is introduced into a pulse stretching and equalizing circuit in the form of cathode-coupled one-shot multivibrator V_4. Triode V_{3B} serves as a buffer stage which makes the triggering of the multivibrator less dependent on amplitude and waveform of incoming pulses. An NE-51 neon lamp connected to the plate of V_{4A}, the normally nonconducting triode of the multivibrator, flashes each time a pulse triggers the multivibrator. This indicator permits the operator to adjust gain control R_1 to the point where the proper sound level at the microphone operates the multivibrator.

This portion of the system converts sound pulses that are above a certain threshold level and have the proper frequency content into electrical pulses of uniform amplitude and duration. These pulses provide the information by which the relay and control circuits perform the measurement functions of the system.

The method of applying cutoff bias to the pulse amplifier requires a brief explanation. The two triode sections of V_5 are connected in a series arrangement. Signals from the multivibrator are applied to the grid of V_{5A} and the gating voltage is applied to the grid of V_{5B}. The negative gating bias can be applied to the grid of V_{5A} either when con-

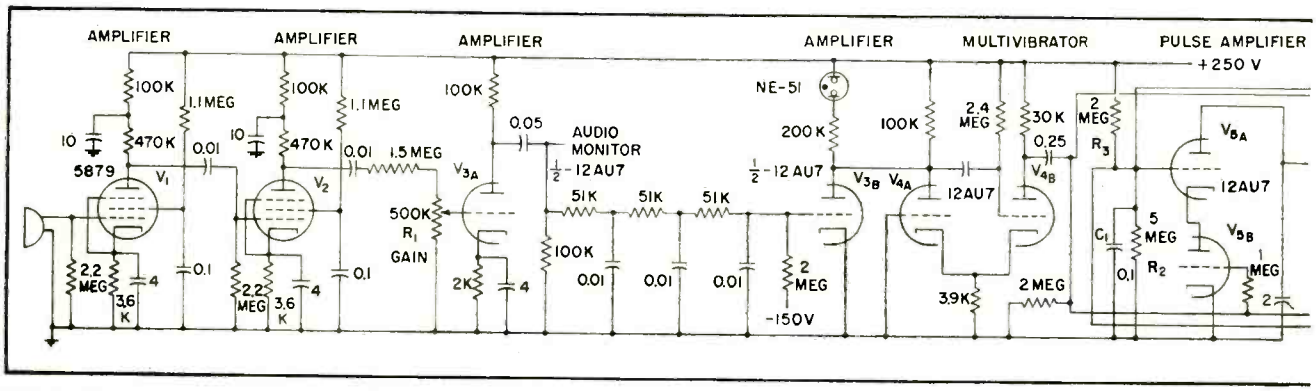


FIG. 2—Three-stage microphone amplifier feeds pulse-stretching and equalizing multivibrator. Output pulses trigger relay system

tacts of one of the relays or a pressure switch are closed. When these contacts are opened, positive bias is restored to the gating grid after a time delay determined by capacitor C_1 and resistors R_2 and R_3 permitting pulses on the input grid to operate another switching relay.

This time delay prevents electrical disturbances created by the opening and closing of the many relay contacts from introducing spurious signals into the system.

Heart Rate Measurement

The body responds to stress by changing the rate at which blood is pumped through the circulation by increasing or decreasing the pulse rate, depending upon the circumstances. It is particularly important in surgery and anesthesia to monitor pulse rate, since the action of some of the anesthetic drugs and surgical procedures tend to increase cardiac irritability.

The common clinical method of determining pulse consists of counting the number of cardiac actions, manifested in the momentary dilation of the radial artery, that occur in the given base period.

The system developed for determining heart rate is similar in principle to that determined by Sturm and Wood.[1] The point of departure results from a need to memorize and display the peak voltage reached by the timing capacitor.

The input from the patient electrodes, similar to conventional electrocardiogram leads, is applied to a differential-amplifier input stage, which is adjusted to give good discrimination against electrostatically induced interference from the power line. The resulting single-ended output is amplified by several additional stages and is applied to a pulse shaper in the form of a single-shot multivibrator. The signal level is adjusted to the point where the R wave (medical term for sharp-peaked waveform in cardiac potential) can trigger the multivibrator once for each cardiac cycle, causing a momentary actuation of a relay.

In the timing operation, the function of the relay is to transfer the voltage from a timing capacitor to a storage capacitor and to follow this by resetting the timing capacitor to zero voltage. The timing capacitor charges linearly between relay actuations and the maximum potential attained during this period is proportional to its duration. This voltage is transferred to the storage capacitor.

The electrocardiograph (ekg) amplifier and threshold detector portions of the cardiotachometer system are shown in Fig. 3. This unit amplifies the signal picked up at the patient electrodes to a level sufficient to trigger a one-shot multivibrator. The amplifier design is such that small signals from sources having large distributed capacitances in the presence of power-frequency fields can be amplified.

Input tubes V_1 and V_2 are connected as differential amplifiers. One input signal is applied to the grid of V_1 while the other input is applied to the cathode through cathode follower V_2, which operates near unity gain. To compensate for the departure of V_2 from unity gain, which affects the attainable differential action, the signal is fed back from the plate of V_1 through R_1 to the cathode of V_1 and adjusted for maximum differential action.

Plate and cathode lines are heavily decoupled to eliminate transients in the low-level amplifier stages. Electrolytic bypass capacitors paralleled with paper capacitors eliminate high speed transients.

The signal is passed from the differential stage to V_{4A} through a 6AU6 pentode stage of conventional design except for biasing. Bias is derived through the grid leak to eliminate the large cathode capacitor that would be required for cathode bias. In addition, R_2 provides a high-impedance path to prevent blocking on overloads.

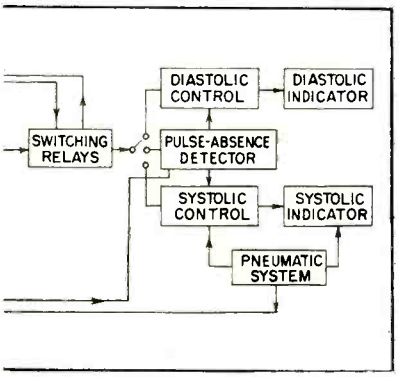
The output of V_{4A} is applied to a low-pass R-C filter, which discriminates against spurious high frequency noise signals. The signal feeding the filter is also brought out to a jack on the panel from which the electrocardiogram may be recorded. The signal from the filter is introduced into a pulse stretching and equalizing network in the form of cathode-coupled one-shot multivibrator V_5 and associated network.

Each R wave of the cardiac potential is of sufficient magnitude after amplification to trigger the multivibrator whose output then consists of a series of pulses of equal magnitude and duration that are in synchronism with the pulse. Duration of output pulses are adjusted to permit proper functioning of the tachometer (Fig. 4).

Triode V_{5B} to which these pulses are fed is a current amplifier which operates the relay on the cardiotachometer chassis (Fig. 4) for the duration of the pulse.

Pulse-Rate Indicator

The timing circuit in Fig. 4 consists of a linear sweep circuit plus



which controls measurement functions

a discharge gate for resetting the timing capacitor to zero. The sweep consists of R-C circuit R_1 and C_1, which is linearized by the feedback action of cathode follower V_{2B}. The action of V_{2B} is to raise the voltage across the R-C timing combination by an amount equal to the voltage that accumulates across C_1. In this way constant charging current is maintained into C_1 providing a linear voltage rise. Capacitor C_1 is discharged at the beginning of the timing cycle by thyratron V_1, which is momentarily made conducting.

Capacitor C_2 serves as a potential source for the R-C timing combination. It is made large compared to C_1 to maintain its potential constant during the period of the sweep. When C_1 is reset to zero, C_2 is restored to its original potential through diode-connected V_{2A}. The output of the timing circuit is derived from the cathode follower V_{2B}.

The relay transfers the timing potential from V_{2B} to memory capacitor C_3 before it reopens and applies a pulse to the grid of discharge gate V_1 for resetting the linear sweep.

Pulse rate information is stored in the form of a voltage on capacitor C_3 between pulses and is read out through a high-impedance vacuum-tube voltmeter. Triode V_3 is the input tube of the voltmeter whose impedance is increased by a feedback arrangement through V_4. This functions by maintaining the grid-cathode potential across V_3 small, thereby limiting the grid current to a small value.

The indicating meter is connected to cathode follower V_{4B} and is returned to a buck-out potential to obtain zero balance. The indicator is calibrated directly in terms of pulse rate and its polarity is chosen to read upscale for increasing rates.

The potential across the indicating meter is fed into the recorder circuit through a suitable dividing network. Capacitor C_4 is an integrator, which smoothes the data presented to the recorder. In its absence, the back emf generated by the meter movement is sufficient to cause the recorder to swing violently.

Indicator limits are set by R_2, which sets the scale factor, and R_3, which sets the lower limits of operation.

A calibration source is provided by a 1-rps synchronous motor, which produces one or two pulses per second through a system of cams and controls. This provides pulse rates of 60 and 120 pps which can be applied directly to the tachometer circuit through the relay.

Cardiac-Irregularity Indication

Under normal circumstances and for most individuals, the heart produces its alternate contractions and relaxations in a steady and rhythmical manner. Even when the pulse rate speeds up or slows down in response to exercise and sleep, the transition is smooth and the regularity is little disturbed. In anesthesia and surgery, there are a number of situations that can give rise to cardiac irregularity, sometimes with serious consequences.

In undertaking to design an instrument for the indication of cardiac irregularity, or arrhythmia as it is called, it is necessary to understand in more detail the character of the input signals from which the decision must be made about this irregularity. Clinically there are many different types of arrhythmia and these can be identified only after study of the electrocardiogram.

The rate of occurrence of irregularities was selected for measurement. Specifically, each deviation of the pulse intervals from equality by more than a limiting value is defined as an arrhythmic incident. The

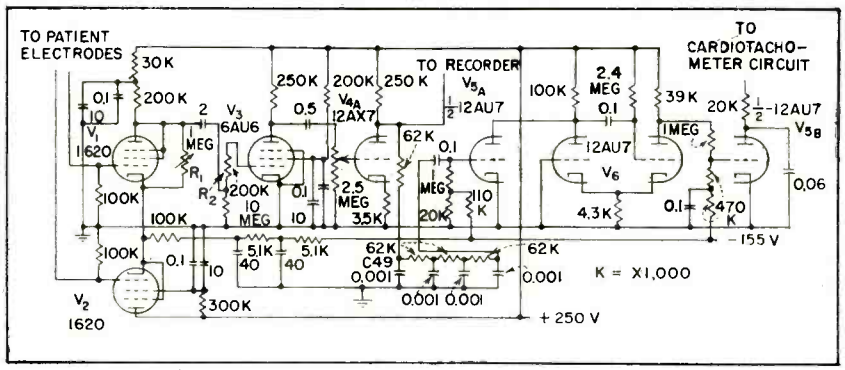


FIG. 3—Electrocardiograph amplifier is fed signals from electrodes placed on patient's arms and legs

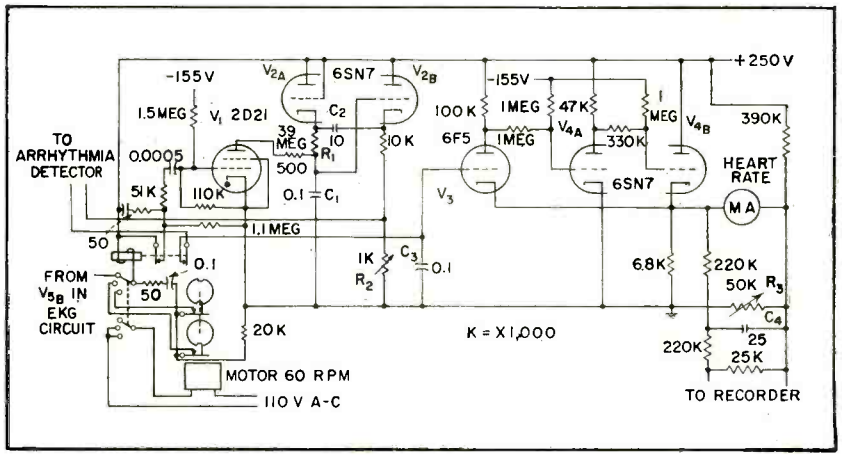


FIG. 4—Cardiotachometer circuit gives instant indication of heart rate on meter

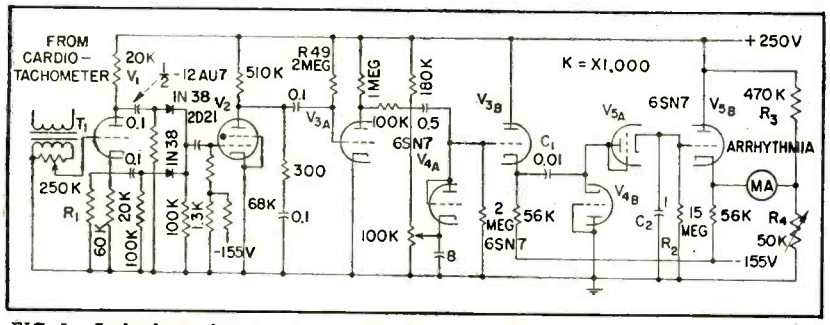


FIG. 5—Arrhythmia-detector gives indication of cardiac irregularities

time average of these incidents is the output of the system and indicates the irregularity duration.

The circuitry resembles that of an instantaneous tachometer. The arrhythmia detector derives its input at the point where the tachometer transfers its data to the storage or memory function. If the time intervals between pulses are equal, the storage capacitor in the memory system remains at the same potential except for a small loss through leakage. However, for any deviation between two successive pulses, current must flow from or to the storage capacitor, equalizing the voltage with that of the sweep circuit.

As the transfer switch closes, a pulse of current passes through a high-turns-ratio transformer and gives rise to a voltage on the output side that is introduced into a pulse-height discriminator. If this pulse is of sufficiently high amplitude the discriminator responds and produces an output pulse via the second pulse shaper that is fed into the integrator circuit. The time average of these pulses appears on the output indicator.

Circuit Details

Figure 5 shows the arrhythmia-detecting circuit, which derives its input from transformer T_1. The primary winding of T_1 receives the charging current of the storage capacitor during the interval that the information is transferred from the timing circuit. The polarity of the resulting voltage across the secondary impedance depends on whether the pulse time interval is greater or less than the previous interval. Since the threshold interval deviation detector must respond to either condition, it is necessary to put the input signal through a stage that converts signals of either polarity into the positive-going voltage required to trigger the threshold detector.

The converter stage developed around V_1 is a split-load phase inverter whose plate and cathode outputs are put through crystal diodes and then mixed. The diodes are connected so that only positive-going voltages appear across the output. A negative-going input to the converter stage appears as a positive signal via the plate output circuit. A positive-going signal appears positive at the output via the cathode route.

Depending on the level of this converted signal, which can be adjusted to the required interval deviation by R_1, the threshold detector in the form of biased thyratron V_2 can be made to fire. The result is a negative-going pulse at the plate, which is capacitance-coupled to normally fully conducting V_{3A}. The plate of this tube gives a positive-going pulse limited in amplitude by V_{4A}.

At this point, a pulse of fixed amplitude and duration appears each time the amplitude of the input pulse exceeds a predetermined threshold. The equalized pulses are accumulated and their time average obtained. The equalized pulse is put through V_{3B} and the output is applied to the series arrangement of C_1, V_{5A} and C_2. Capacitors C_1 and C_2 are so proportioned that only 1 percent of the applied voltage accumulates on C_2 for each pulse.

Diode V_{5A} prevents the discharge of C_2 and V_{5B} discharges capacitor C_1, making it ready for the application of the next pulse. Each succeeding pulse adds an approximately equal increment of charge to C_2. If C_2 were isolated, the voltage across it would continue to increase; however, the presence of R_2 shunting C_2 bleeds off charge from C_2 to make the voltage appearing across this R-C combination a function of the number of pulses received per unit time.

This voltage is the input for V_{5B}, which supplies the current for an indicating meter. The output current of V_{5B} corresponding to zero input is balanced out by returning the indicator to divider R_3R_4.

The accurate measurement of minute volume, the volume of air in liters brought into the lungs in a minute, is important in the estimation of respiratory adequacy.

A patient undergoing inhalative anesthesia is tightly coupled to an anesthesia apparatus through a face mask or endotrachial tube. The equipment for the measurement of volume and rate is placed in the out-flow tube.

A bellows-type positive-displacement flow meter was modified to provide an output shaft in place of the conventional dial indicator. Minute volume is by definition the volume of expired air passing through the meter in a minute. Consequently the angular rotation of the output shaft is measured for the timing interval and then displayed in the proper units. The system retains and displays this information during the period required to obtain subsequent minute volume data.

Respiratory rate is obtained also from the output shaft of the displacement meter by counting the number of times the shaft stops and starts during the 1-minute base timing interval.

It is not possible to identify personally all contributors to the development of this instrumentation. However, the advice, participation and interest of S. B. White, E. B. Touhy, John C. Rose, Edward D. Fries, Edward H. Partenope, Charles S. Coakley and Solomon Albert are gratefully acknowledged.

This research was supported jointly by the Veterans Administration and the Office of Basic Instrumentation, National Bureau of Standards.

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Automatic Programming Cuts Broadcasting Costs

SUMMARY —— Nonattended system permits continuous automatic a-m station operation for as long as 18 hours. Announcements and musical selections can be alternated in manner undetectable from live program. Automatic correction of timing errors assures split-second accuracy of station breaks

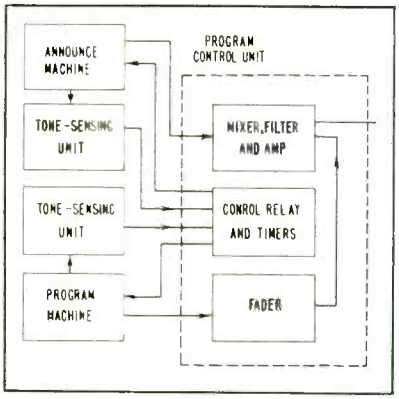


FIG. 1—Programming system

By PHILIP SMALLER

Project Engineer
Ampex Corporation
Redwood City, California

BROADCASTERS can solve the problem of making profits and maintaining or lowering rate levels in the face of increasing costs by increasing operating efficiency through use of automatic controls.

The programming system to be described permits automatic, nonattended broadcasting of program schedules as long as 18 hours. Program material played on the system is, in every way, identical to a live broadcast. Announcements and musical selections can be alternately played. Every 30 minutes a station break can be interposed. Following the station break, with smooth continuity, the succeeding half-hour program will start in perfect synchronism with real time.

Equipment

Two Ampex Model 450B long-playing tape reproducers are used for playback. One playback unit, called the program machine, is used to reproduce the music tape and the other, called the announce machine, is for reproducing the local-announcement tape. To record the local-announcement tape the system requires a Model 350 or comparable machine. In addition to these standard components, two special units are required. The first, the program-control unit, oversees the operation of the system during playback. The second unit, the record console, houses the necessary components for recording the voice announcements.

The system components are shown in Fig. 1. The music tape, with a 25-cycle control tone recorded after each selection, is placed on the program machine. The announce tape, with a 25-cycle control tone after each announcement, is placed on the announce machine.

Operating Sequence

The program machine plays the first selection. At the end of the selection the control tone from the music tape energizes relays that shut down the program machine and start the announce machine. At the end of the announcement, the control tone on the announce tape

Announcer seated in front of record console prepares announcement tape

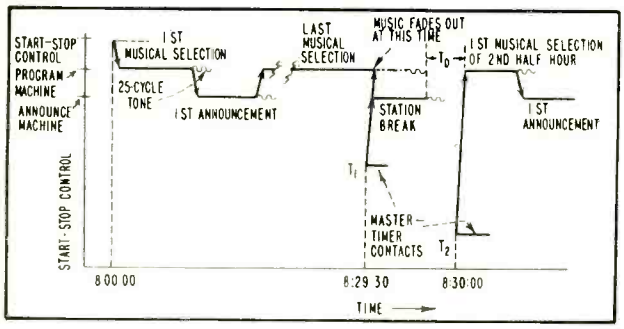


FIG. 2—Switching-sequence diagram for half-hour program

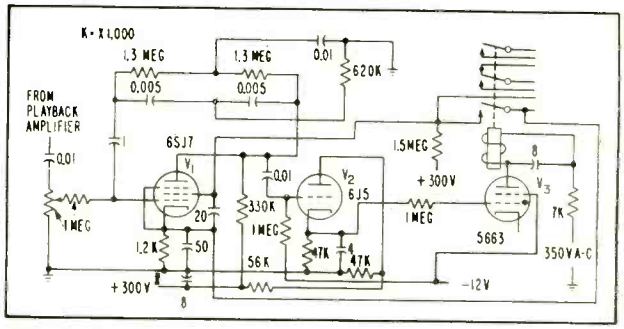
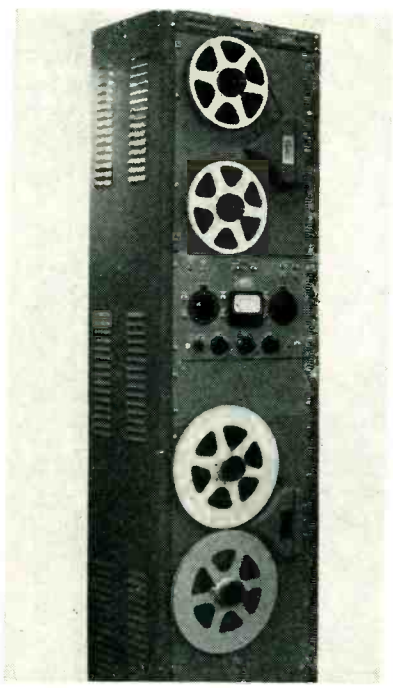


FIG. 3—Tone-sensing unit used in playback machines

shuts down the announce machine and starts the program machine. This flip-flop operation continues for the greater part of the program.

Audio output from the program machine is fed to both the program-control unit and the control-tone-sensing unit. If there is any 25-cycle signal in the output the sensing unit will energize the appropriate relays in the program-control unit to deenergize the capstan solenoid of the program machine and energize the capstan solenoid of the announce machine. Energizing and deenergizing the capstan solenoid instantly starts and stops the motion of the tape.

The program control unit also mixes the signals from both machines to a common output and filters out all the 25-cycle components. The fader circuit is necessary to reduce the level of the music during station break. A master timer controls the station breaks and a reversing timer reverses the direction of the program machine.



Program-control unit with two playback machines mounted in rack

Timing Errors

If the system is to be used for a long time interval, say for a period of two or more hours, it will be necessary to correct the system every half hour for timing errors. Figure 2 is a sequence diagram of a typical half-hour program. The half hour under observation is from 8:00 to 8:30. At time 8:00, the start switch is thrown and the first musical selection is reproduced.

At the end of the selection, the 25-cycle tone switches the operation to the announce machine. Similarly, at the end of the announcement, the tone switches the operation back to the program machine.

Since the restriction is imposed that the total running time of music and announcements be nominally 29:45 minutes in the half-hour program, it is certain that at time 8:29:30 the system is reproducing the last musical selection of the half-hour program. At this time, the master timer assumes control over the system operation and initiates the following sequence.

At 8:29:30 master-timer contact T_1 closes starting the announce machine for reproduction of the station break. At the instant the announce machine starts, the music from the program machine begins to fade out, but the machine continues to operate. Hence both machines are on at the same time. The listener hears the station break with the music barely audible in the background. When the music, which is timed to end some time between 8:29:30 and 8:30:00 reaches the end of the selection, the tone shuts off the program machine. The announce machine continues to the end of the station break, at which time it also shuts off, but is prevented from starting the program machine. At exactly 8:30:00, master-timer contact T_2 closes and the program machine starts for the beginning of a new half-hour program segment.

The time between the end of the station break and start of the program machine for the new half hour is dead air and is shown as T_p. This period can be made as small as desired. It may be reduced to zero by making the station break greater than 30 seconds, in which case it extends into the new half-hour. Regardless of how long the station break is, the program machine starts at 8:30:00 in order that the system stay in synchronism with real time. If the station break is still playing at 8:30:00, the program starts with the music faded under and then, when the station break ends, the music is allowed to fade in. This feature of overlapping music with announcements, with the music faded under, can be used at any time during the program.

The action of the switching circuits assure less than 2 seconds between the end of an announcement and start of the music.

Tone Sensing Unit

The tone sensing unit, which detects the 25-cycle control tone is shown in Fig. 3.

The first stage is a highly selective voltage amplifier achieved by using a parallel-T network tuned to 25 cycles in the feedback loop.

Second-stage triode V_2 is biased

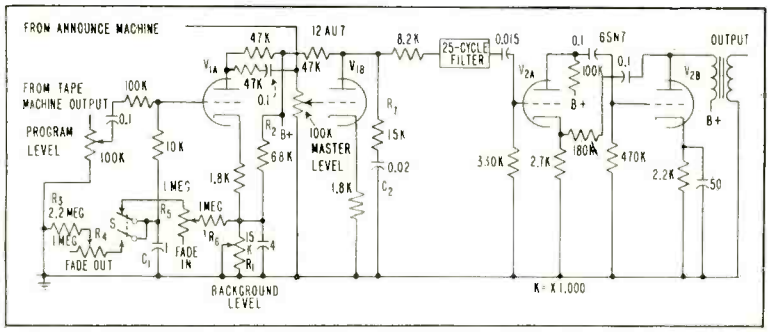


FIG. 4—Partial circuitry of electronic portion of program-control unit

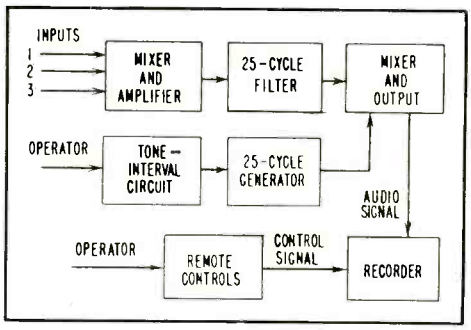


FIG. 5—Record-console block diagram

to cutoff until the 25-cycle tone is reproduced from the tape and amplified by V_1. Upon reproduction of the tone, V_2 starts conducting and a positive pulse is applied to the grid of thyratron V_3. The pulse has sufficient amplitude to start the thyratron conducting and thereby energize the relay. Since the plate of the thyratron is supplied with 350 v a-c, the tube extinguishes itself when the signal ceases and the grid returns to ground potential. Contacts on the relay in turn energize the appropriate relays in the program control unit and tape transports. Both the program and announce machines have their own tone-sensing units.

Circuits

Figure 4 is a simplified diagram of a portion of the circuitry in the program-control unit. The contacts on the program-control-unit relay responsible for the fading are shown as S.

Fading is accomplished as follows. The cathode of V_{1A} is biased approximately 35 volts positive by voltage divider R_1R_2. For normal operation of the tube, the contacts on S are closed as shown and the grid of V_{1A} is at the same positive potential as the cathode. When the relay is energized and the normally open contacts close, C_1, which was charged to +35 volts, begins to discharge to ground through the series combination of R_3 and R_4. The time constant of the discharge is adjustable by varying R_4. When C_1 is fully discharged, the grid is then at ground potential while the cathode is still 35 volts positive. This is sufficient bias to cut the tube off. The cutoff is gradual because of the shape of the transfer characteristics of V_{1A}.

To keep the distortion low during the fade-out, the input signal was reduced to less than 0.1 volt and the cathode resistor was left unbypassed. To achieve the fade-in, C_1 is allowed to charge to + 35 volts through resistors R_5 and R_6. The rate of fade-in is adjustable by varying R_6.

Bias level control R_7 varies the degree to which the signal is faded.

By increasing R_7, the tube is driven further into cutoff and the background level of the music decreases.

The parallel-T filter network following V_{1B} attenuates the 25-cycle signal before it reaches the transmitter. The bass-boost network, composed of R_7 and C_2 raises the 50-cycle response of the system to give an overall frequency response of ± 3 db from 50 to 7,500 cps at a tape speed of 3¾ ips. Ten db of feedback around the last two stages maintains the overall distortion through the system at less than 0.7 percent total harmonic. The signal-to-noise ratio is better than 55 db. The balanced output stage will feed a 600-ohm studio line at a 0-vu level.

Record Console

Figure 5 is the block diagram of the record console used to record the local announcement tape.

The line inputs are balanced and will accommodate input levels of 0 vu to ±10 vu. The 25-cycle parallel-T filter prevents any 25-cycle component introduced in either the microphone or line channels from being recorded on the announcement tape.

The tone generator is a phase-shift oscillator using a 6U8. Oscillations are initiated by removing the ground connection to the grid of the first stage of the 6U8. Since it requires several cycles for the oscillations to build up, the switching transient is negligible. A timer, which is energized whenever the announce tape is in motion, is used to indicate the exact amount of time the announcements have consumed.

In preparing the announce tapes, the following technique is used. Number of musical selections fixes the number of breaks in which announcements may be placed. Total running time of the music fixes the minimum time which must be consumed by the announcements. The combined running time of music plus announcements should be nominally 29:45

If more announce time is desired in the half-hour program, the announcer can overlap music and announcements with music faded under.

The announcer, in preparing the announce tape, starts the recorder and begins reading the announcements. At the end of each announcement he presses the tone button and the 25-cycle control tone is automatically recorded for a fixed interval. All announcements may be recorded without stopping the recorder. Following the last announcement the station break is recorded.

If no announcement is to be made following a selection, the announcer places the tone on the tape. Then, during playback the system will automatically continue on to the succeeding musical selection.

Figure 2 shows a typical sequence with the station break illustrated as being a few seconds less than 30 seconds in length.

The system can be modified to operate a multiple record changer so the latest record releases can be used.

Juke Box Uses

SUMMARY —— Solenoid-actuated selection storage levers are replaced by ferrite toroids in coin-operated automatic phonograph. Coincident write-in currents, each of half the required amplitude, eliminate group-switching relays. Automatic core-inspection equipment speeds mass production

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Chicago, Illinois

COINCIDENT-CURRENT magnetic matrices have been successfully used in laboratory[1,2,3] and commercial[4] digital computers. Although other applications of this random-access information-storage system have been suggested,[1] its use in an automatic phonograph is believed to be a new application.

The low speed of operation has made it possible to eliminate the complex vacuum-tube driving circuits used in computers and permits magnetic cores to compete economically with any other memory system. Basic design work on the phonograph selection system was completed in 1953[5] but much work was necessary to perfect the system and change over all phonograph production.

Coincident-Current Memory

In a digital computer using magnetic-core memory one binary digit is stored in each toroidal core. In the automatic phonograph using magnetic-core memory one selection is stored in each core. Each core has two normal states of magnetization. Remanent flux ϕ_R exists in either the clockwise or counterclockwise direction. One of these states is arbitrarily called zero or no selection. When a selection is written into the memory system the appropriate core has its magnetization reversed by a pulse of current through wires threading that core. This state is called one or a selection.

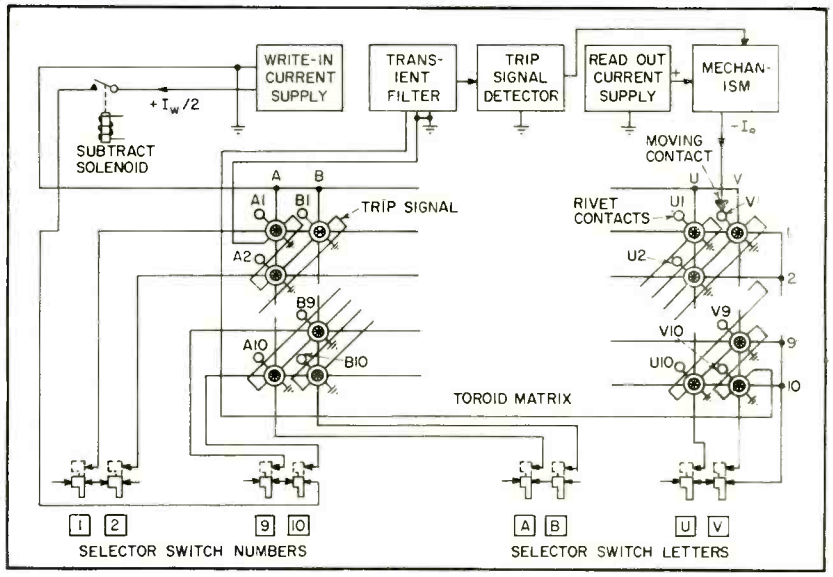


FIG. 1—Storage system uses coincident write-in currents and individual read out. Signal output is picked up on single wire threaded through all the cores

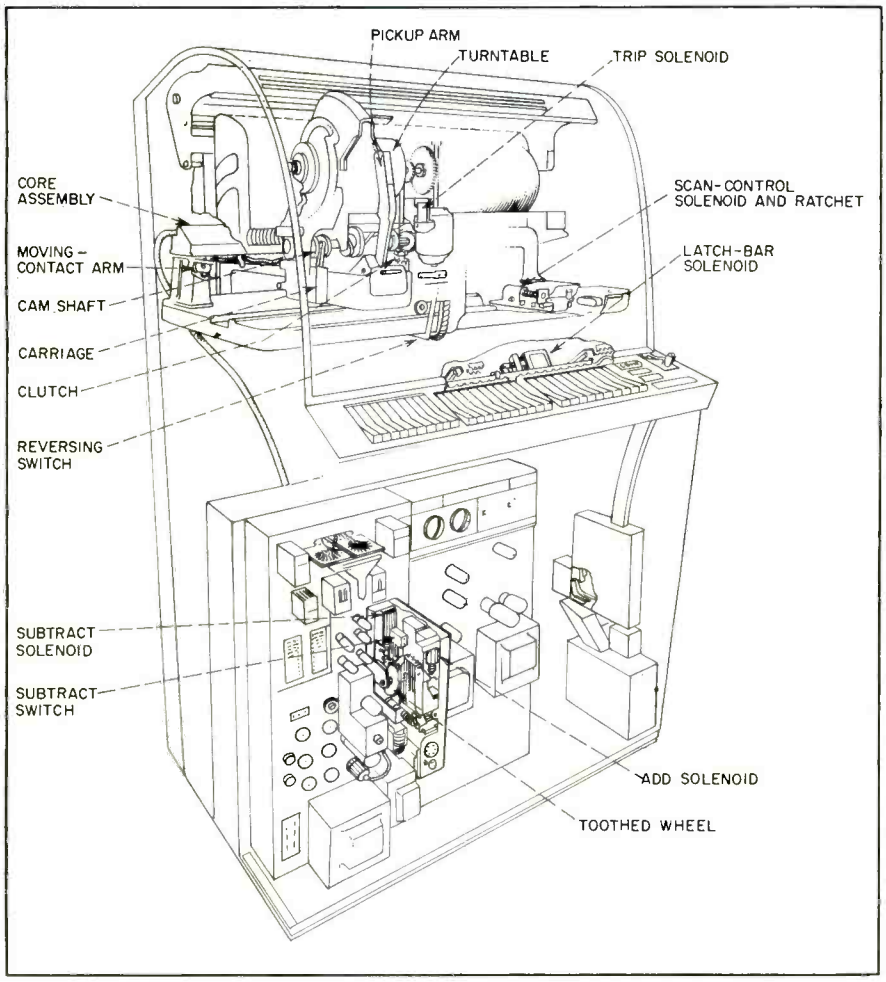
The matrix is an array of storage elements constructed such that any element in the array may be energized by the coincident operation of two input lines. The magnetic state of the ferrite core is set by the field of the currents in the two independent write-in wires threaded through the center of the core. Any core of the 200-core array in the phonograph can be reached by energizing 2 out of 30 wires.

In the phonograph, Fig. 1, each of the two wires selected simultaneously carries a current pulse of amplitude $+\frac{1}{2} I_w$. The current in a single wire is not large enough to change the magnetization of any core from zero to one, only the core at the intersection of the selected wires where the total magnetizing current is $+I_w$ will have its magnetization reversed. Of the remaining two wires of the four threaded through the core center, one wire supplies read-out current $-I_R$ and one is used for signal pickup.

Phonograph Operation

The Seeburg Select-O-Matic 200 is an automatic 45-rpm 200-selection phonograph mechanism.[6] The records are stored vertically in a row and played in a vertical position. See Fig. 2. The turntable is mounted on a carriage which moves on rails past the records. The carriage stops at the selected record, positions and plays the record. The carriage travels in one direction

Ferrite-Core Memory



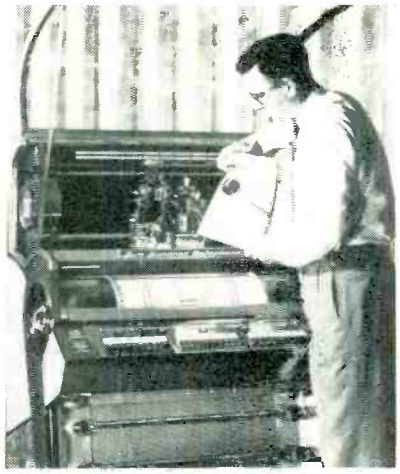


FIG. 2—Mechanical details of phonograph with parts in their relative position, left. Also shown are rear and front views of instrument

playing one side of selected records before reversing direction to play the opposite side of selected records.

Selection

When the customer drops coins through the slot, credit is made by energizing an add solenoid through coin operated switches. This solenoid drives a pawl which advances a toothed wheel a number of notches proportional to the total value of the coins inserted. A contact plate is rotated into position so that current is momentarily supplied to a solenoid which controls a latching bar behind the selector pushbuttons.

When the customer closes both a letter and a number switch with the pushbuttons, the switches are locked in position. A subtract solenoid rotates the toothed wheel a number of notches in the reverse direction proportional to the value of the selection played and closes a momentary subtract switch.

One set of contacts on this switch connects the write-in current supply capacitor C_w (Fig. 3) to the number selector switch, through one of 10 matrix row wires, back to the letter selector switch, through one of 20 matrix column wires to ground, magnetizing the core at the intersection of the two chosen matrix wires in the direction of a selection.

The same current flows through both write-in wires in the core. To keep the write-in current waveform stable this set of contacts is a silver-alloy connection. Low switching voltage and stable low resistance contact material prevent contact vaporization and erratic current flow during the first few microseconds of contact closure. The same subtract switch closes the circuit to the scan-control solenoid. This solenoid pulls a ratchet to the last of three pawl positions, closing the power switch to the motor in the carriage. Another contact of the subtract switch supplies current to a timing relay which opens the circuit of the subtract solenoid after a pre-determined interval.

Scanning

The carriage is driven past the record magazine starting from the right end of the magazine. Direction of travel is changed at each end by a reversing switch. Each time the carriage returns to the right end of the magazine the scan-control ratchet is stepped down one notch by a mechanical cancel lever. When the pawl returns to the first

position on the ratchet, the motor circuit is opened. Normally after two round trips the carriage returns to the right end of the magazine.

It is necessary to correlate the magnetization of each ferrite core in the matrix with one side of a record stored in the phonograph library. The cores are physically arranged in two rows parallel to the mechanism carriage rail, one row for right-to-left carriage travel for playing the right side of each record and the other row for the left side. Scanning of all 200 cores takes 40 seconds.

Read-out current $-I_R$ is applied to each core in turn of the appropriate row of cores from a moving contact arm on the carriage through an electrical contact at each core.

Current is supplied by the discharge of capacitor C_R through the 2D21 read-out thyratron shown in Fig. 3. Firing of the thyratron occurs during the time the contact arm is on an individual core contact and is synchronized by a star-wheel switch geared to the stationary rack. Due to the high read-out current and voltage a thyratron is required to ensure a positive acting switch free of bounce for a clean read-out current pulse.

Cores in which no selections have been written are in the zero state and are not affected by read-out current as the carriage travels by. If, however, a selected core is reached, that core's magnetization is reversed. A signal output wire threading all cores in the matrix is used to the sense the reversal of magnetization in any one of the cores, Fig. 1.

This signal is fed through a signal detector to operate a trip solenoid on the carriage. A low-pass filter is required to prevent transmission of relay switching transients. A ferrite pulse transformer with a step-up ratio of 1:15 in the signal detector eliminates a voltage amplifier but a pulse-stretching multivibrator is necessary to assure firing the trip thyratron during the positive half cycle of the alternating voltage on the thyratron plate.

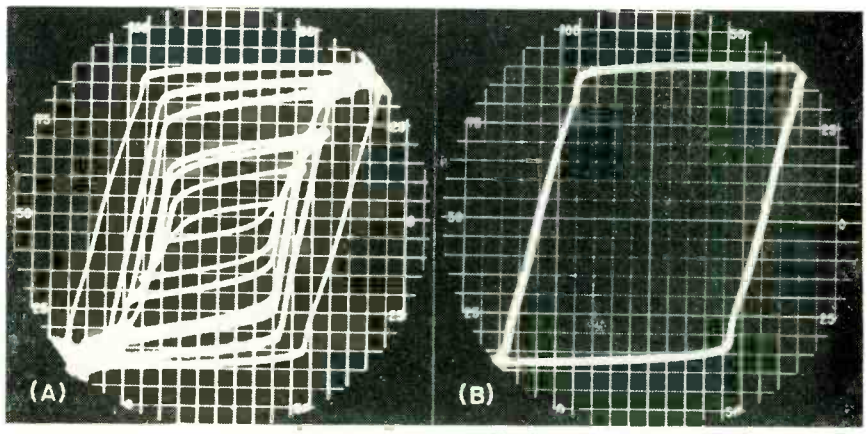


FIG. 4—Family of hysteresis loops of square-loop ferrite using 400-cps power (A). Also shown is curve for optimum value for coincident write in and read out (B)

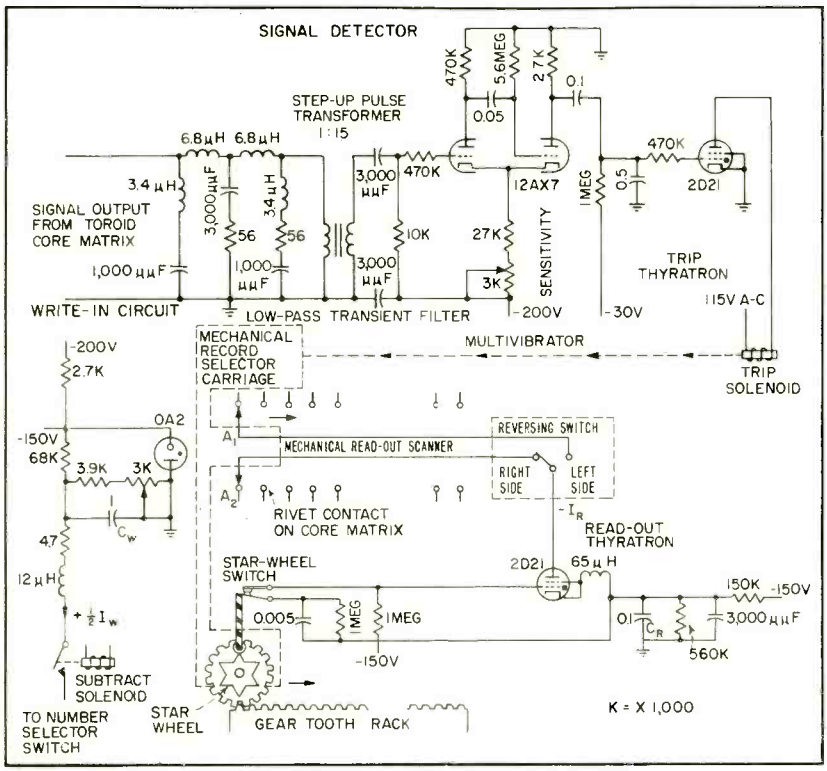


FIG. 3—Storage is effected by closing one number and one letter pushbutton. Subtract solenoid closes, discharging C_W through circuit. As mechanism scans past record, connection is made through read-out thyratron. Star-wheel switch closes discharging C_R through core

Record Play

When a selected core is found, the carriage is stopped and a record is played. To do this the trip solenoid disengages the drive clutch from the gear rack and connects the clutch to a cam shaft. The cam rotates 180 deg, operating levers which cause a transfer arm to raise the record into position, clamps the record to the turntable and sets the pickup arm on the record. At the end of the record a trip switch energizes the trip solenoid causing the rotation of the cam through the remaining 180 deg and return of the record to the magazine. The carriage resumes scanning until it is stopped by another selected record.

Memory-Core Response

Successful operation of a coincident-current system depends upon the squareness of the B-H hysteresis loop. The steep sides, nearly horizontal top and bottom and square corners are properties of a good memory core. Figure 4 shows a family of hysteresis loops of a square-loop ferrite using 400 cps power. As the driving currents are increased the hysteresis loop be-

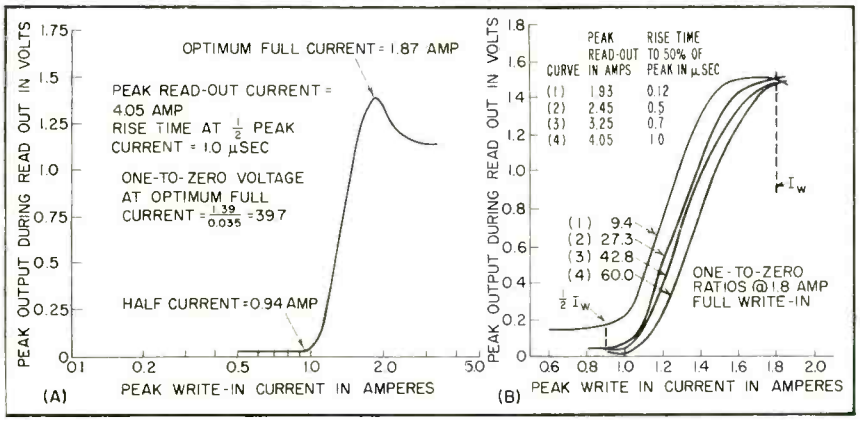


FIG. 5—Squareness curve (A) and family of squareness curves (B) for a test core of Ferroxcube 402 with 0.18 in. o-d × 0.09 in. i-d × 0.09 in. thickness

comes larger and improves in squareness. This indicates that there is a minimum amplitude of current pulses to obtain good coincident current operation.

A maximum amplitude of current is set by the effect of a half current $+\frac{1}{2}I_w$. A point is reached where the core saturates at the same current level regardless of the driving-current amplitude. A half current at these levels would tend to go over the knee of the curve changing the state of flux in the core. Due to losses at high frequencies it is difficult to obtain useful quantitative data at low frequencies for use on pulsed operation. Response of the core must be determined under actual pulsed conditions.

The driving currents must be such that it is easy to discriminate between the output of a selected core and an unselected core. In this system the output is used to trip a multivibrator. Thus the ratio of the amplitude of a one output voltage pulse to a zero should be a maximum. In this system a set of curves is helpful in determining the current amplitudes and waveforms for a maximum one-to-zero ratio. These are called squareness curves.

Using a read-out current which is sufficient to saturate the core, the write-in current amplitude is adjusted over a range to plot the output voltage during the read-out pulse as in Fig. 5A. Since the state of the core after write-in depends primarily on the peak current reached, effects of write-in current rise time are unimportant. This curve is used to determine the optimum write-in current amplitude I_w for a maximum ratio of one-to-zero signal by comparing the output voltage on the curve at the chosen value of I_w and $\frac{1}{2}I_w$. The same type of curve is plotted in Fig. 5B.

At the optimum value of write-in current found from Fig. 5A, the read-out current amplitude and rise time are independently adjusted to obtain a given signal voltage pulse width and amplitude. In this application the signal pulse must have a minimum pulse width to pass through the transient filter and trigger the multivibrator. With each set of read-out amplitude and rise time, write-in current is adjusted over a range to obtain a squareness curve. A family of curves is obtained from which it can be seen that the one-to-zero ratio improves as the read-out current amplitude increases and rise time decreases.

Therefore it is advisable to obtain as large a current for read-out as possible in this application. One-to-zero signal voltage ratios as high as 60 to 1 have been obtained by the unsymmetrical hysteresis loop used.

A capacitor is an excellent current source for this low-duty-cycle system. The matrix is a low impedance to the capacitor so that the rise time, amplitude and pulse width of the capacitor discharge current can be controlled by other elements in a series RLC circuit. By using a high power-supply source impedance, only a low capacitor charging current is required.

By solving

$$L\,di/dt + iR + \frac{1}{c}\int_o^t idt = E_c$$

for i (t) there are three cases:

Critically damped

$$i(t) = (E_c/L)t \exp(-Rt/2L)$$

Underdamped

$$i(t) = (E_c/L)[(1/LC) - R^2/4L^2]^{-\frac{1}{2}} \sin[(1/LC) - R^2/4L^2]^{\frac{1}{2}} \exp(-Rt/2L)$$

Overdamped

$$i(t) = (E_c/L)[(R^2/4L^2) - 1/LC]^{-\frac{1}{2}} \sinh[(R^2/4L^2) - 1/LC]^{\frac{1}{2}} \exp(-Rt/2L)$$

A normalized plot of current versus time is shown in Fig. 6A. The effect of adjustment of any circuit element can be quickly determined. Photographs of actual driving current and voltage output waveforms are shown in Fig. 6B and 6C.

Since high peak currents are easily obtained from the capacitor discharge current source and there is no need for extreme size reduction, a toroidal core is used which

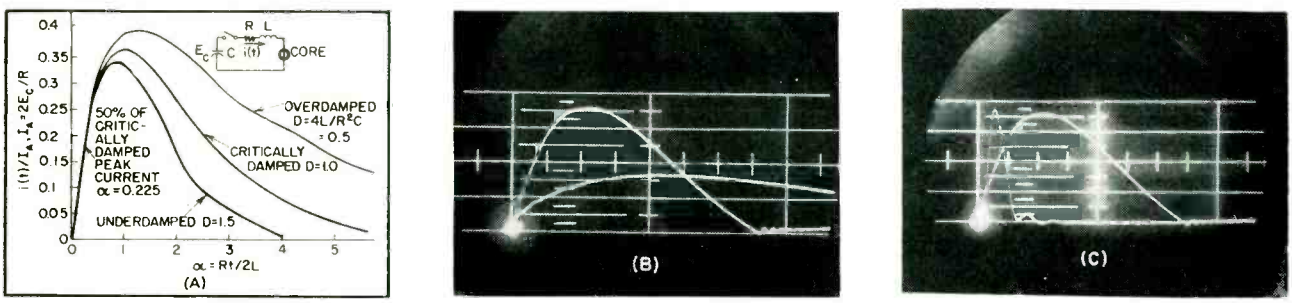


FIG. 6—Normalized plots of current in RLC circuit for various degrees of damping (A), write-in and read-out current waveforms (B) and read-in current and voltage waveforms (C)

is of larger dimensions (0.09 in. i-d × 0.18 in. o-d × 0.09 in. thick) than that in digital computer systems (0.05 in. i-d × 0.08 in. o-d × 0.025 in. thick). The larger core increased the signal voltage magnitude from 0.2 volt to over 1.0 volt per turn of pickup loop. Usable ferrite materials include Ferroxcube 402 and General Ceramics S-1.

Advantages

It is possible to obtain a definite reduction in equipment size through the use of a magnetic memory matrix, although there is no necessity for it in this application. The group-switching relays formerly used are eliminated in the coincident-current matrix. Since the read-out current pulse reverses the magnetization of the cores to the zero state, no cancel solenoid is required to reset the core. The cost of ferrite memory cores is expected to continue to decrease as larger-quantity production is reached, since material cost is a small part of the price and yield of a specified standard is likely to increase.

Cost per bit is reduced with greater matrix size because address equipment costs are independent of matrix size in low-speed memories. Elimination of selection levers has reduced the number of moving parts in the selection storage system to the two rows of read-out contacts. A brush wipes read-out contacts as the carriage travels along its rails. The life of the magnetic memory matrix is limited only by brush wear on the read-out contacts. Critical mechanical adjustments are eliminated. Since the magnetic state of the core is self-latching, there is no loss of storage with interruption of main power.

Inspection of Cores

Although the phonograph-selection storage matrix has been designed for mass production, the replacement of substandard cores requires rewiring. To prevent this, cores receive 100 percent inspection upon arrival. An automatic core-testing machine, shown in Fig. 7 feeds cores from a bin, spindles and tests them at the rate of 100 per minute. Each core is tested using current pulses identical with those employed in the memory matrix and through the cycle: I_R, 20 ($\frac{1}{2}I_w$), I_R, I_w and I_R.

A closed hysteresis loop is established by the fifth cycle. Glow-discharge-type decade counter tubes gate the read-out pulse amplifiers, turning them on at the beginning of the fifth cycle. To be accepted each core must pass both a half-write and full-write test.

FIG. 7—Automatic inspection device tests 100 cores a minute

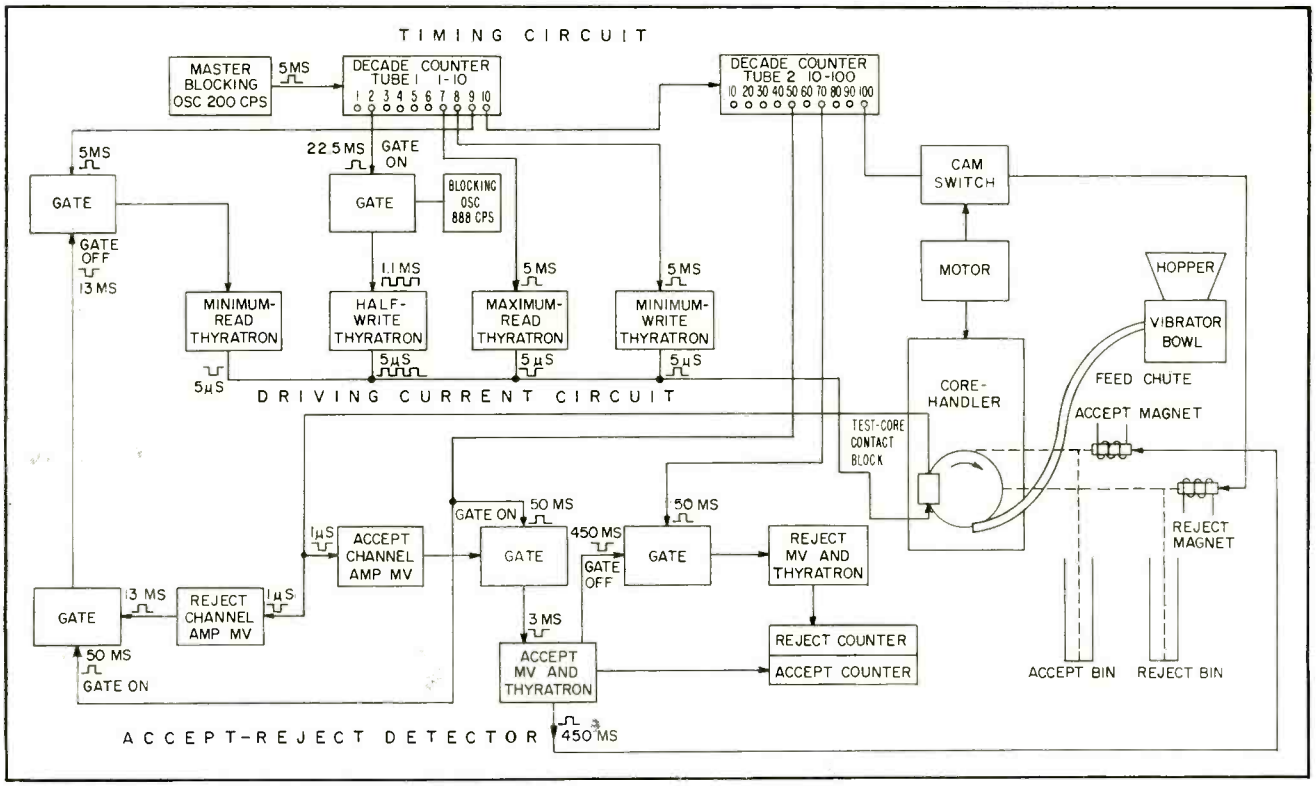


FIG. 8—Operation of core tester. Timing signals are supplied to ten-stage gas counting tubes. Driving currents are supplied by thyratrons

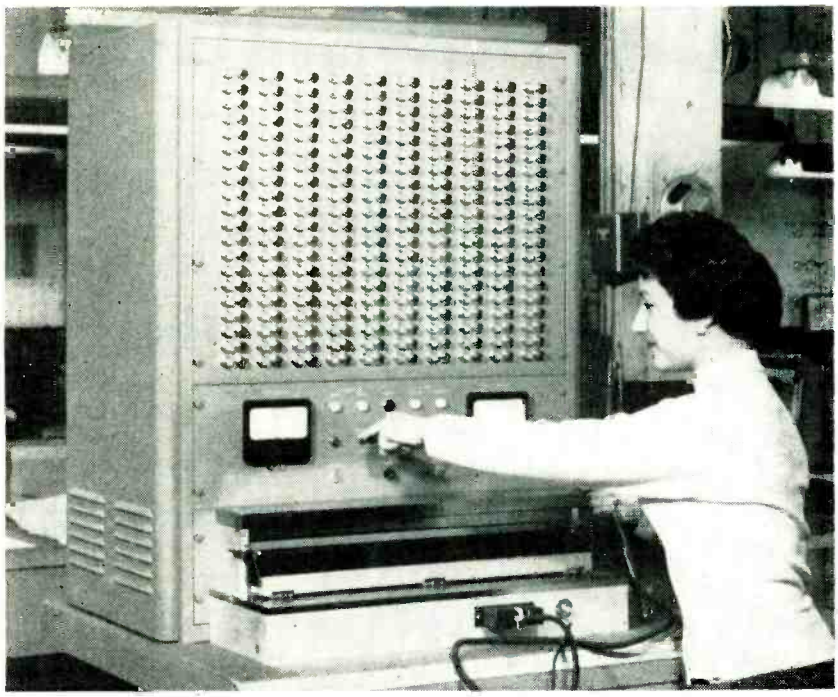


FIG. 9—Complete ferrite core matrix is plugged into unit for test. Entire assembly is checked in one minute

Rejection can occur either from too large a read-out voltage pulse following the twenty half-current write-in pulses or too small a read-out voltage pulse following the one full-current write-in pulse. The test equipment is periodically checked with standard cores chosen to be at the limits of tolerance. An accept or reject count is made on every core tested and an alarm is sounded after a preset number of either occurs without at least one of the other.

Figure 8 is a block diagram of the automatic core tester. Batches of cores are poured into a hopper. Then they are vibrated up a spiral ramp and fed down a chute in a single line to a loading point. Cam action causes a pin on one of four arms of a wheel to spindle the core. The arm moves along the arc of a circle bringing the core up to the test-position contacts where it remains for 415 milliseconds during the test.

At this time a cam switch resets decade-counter tube No. 2 to zero, starting the test cycle. A master blocking oscillator continuously triggers decade-counter tube No. 1 which operates the driving current thyratrons in sequence. After four complete cycles of driving current, the output from stage four of decade-counter tube No. 2 gates the accept and reject amplifier channels.

If the reject channel is triggered by a signal during the read current after the twenty half-write pulses, the gate to the full-read-current thyratron is closed and it will not be possible to trigger the accept channel. If the accept channel is triggered by an output during the read-current pulse following the full-write pulse, the accept pickoff magnet is energized for 450 milliseconds, the accept counter is stepped up one count and the reject count gate is closed.

If the accept channel is not triggered, the reject gate permits a pulse from decade counter No. 2 to operate the reject counter. After sufficient time for electronic testing to take place, the spindled core is moved to a second position along the arc of the circle. If the accept magnet has been energized, the core is pulled off the spindle and dropped into the accept bin when the magnet is deenergized.

During the time the spindle is moved to a third position, the reject magnet is energized by the cam switch, pulling the core off the spindle if the core had not been accepted. The core is dropped into the reject bin when the magnet is deenergized.

When each block of 20 cores is assembled with the letter write-in, read-out and signal output wires, the block is tested as an assembly. Write-in current is applied to all cores at once. Each core is then read out in sequence and checked against a standard. A breakdown voltage of 250 volts is applied between each of the wire to test for poor insulation.

After complete assembly each matrix is tested in a jig designed to write-in and read-out every selection in turn. This is done automatically without the use of moving contacts in $2\frac{1}{2}$ minutes. All outputs are compared with that of a standard core. An array of 400 panel lights (Fig. 9) indicates false signals or weak signals from each storage element. A dozen different types of wiring errors can be quickly pinpointed and corrected.

Other Applications

This use of ferrite memory cores in a slow speed system suggests their application in a large variety of equipment. Any memory system which would involve preselection of a certain number of items out of a group can be constructed of ferrite cores. In applications where a number of operations are to be programmed, such devices could be used. Libraries, filing controls, elevator operation and automatic sequence operation of machinery are typical examples.

It would also be possible to allot a number of cores to each item and identify each item by a binary code using the magnetic state of its cores. Such a system could be used in electronic inventory control.

The products and test equipment herein described are the results of the efforts of many engineers of the J. P. Seeburg Corporation. Their contributions are gratefully acknowledged.

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Subaudio Oscillator

SUMMARY —— Stable unit with beating oscillators near 2,000 cps has less than 0.2-cycle per hour drift and less than 1-percent distortion. Output up to 3 volts is constant within 2 percent over the frequency range. Novel high-level mixer circuit employs a pair of selenium rectifiers, avoiding complexity of either d-c or capacitance-coupled amplifier

NO ONE TYPE of oscillator for low frequencies has attained a general acceptance comparable to the wide use of Wien bridge type oscillators[1] in the audio-frequency field.

Nearly every possible means has been used for generating low frequencies: motor-driven potentiometers, photoelectric function generators, L-C oscillators using inductance tubes and L-C oscillators using the inductive properties of a thermistor. The regular Wien bridge oscillator circuit has been made to operate down to 0.3 cycle,[2] the phase-shift oscillator down to 1 cycle[3] and a three-phase, phase-shift circuit[4] down to 0.01 cycle. Another approach starts with a low-frequency multivibrator, from which the wave is shaped into a sinusoid.[5,6,7]

Beat-Frequency Advantages

The beat-frequency type of oscillator has important advantages over the common variety of R-C oscillator. It is the only type that can be used with an automatic response-curve recorder, because the whole frequency range is covered without switching. There are no output transients when the frequency dial setting is quickly changed. Output level is inherently constant over the whole frequency range.

The equipment to be described is simple. Beat-frequency oscillators have been built before for low-frequency work, using carriers in the 1,000-cycle region, but apparently have never been described in print. If a capacitor-coupled amplifier is used following the mixer, the low frequency limit suffers and if a d-c amplifier is used, circuit and operation tend to be complicated.

In the present oscillator there is no such amplification. The mixer is a pair of selenium rectifiers operating at high signal level. A balanced detector circuit eliminates any d-c component in the output; the a-c output signal is symmetrical within 5 percent with respect to ground. Thus the tube complement consists entirely of carrier oscillator and buffer amplifiers, with no tubes operating at low output frequency.

Circuit Design

The beat-frequency oscillator was invented in 1920 by Scriven of Bell Telephone Laboratories. His patent[8] explains the basic requirements: two similar, low-drift oscillators; buffers or other isolating means to prevent locking or pulling of the two oscillators and a detector or mixer.

The carrier oscillators in the present instrument use a stable circuit devised by Harris,[9] which has the virtue of unusual simplicity. The complete circuit, except for the conventional power supply, is shown in Fig. 1. The oscillators are a variation of the Colpitts type in which the cathode of the tube is tapped across a very low-impedance portion of the tuned circuit using capacitors. The inductors are high-Q toroids with dust cores of low temperature coefficient. Capacitors are silver mica or air dielectric except for the large 0.5-μf units. Variations in the capacitance of the 0.5-μf capacitors have very little effect on the oscillator frequency.

Temperature coefficient of frequency of the oscillators is essentially that of the tuned circuits themselves. The frequency stability problem is mainly one of keeping the temperature rise of the tuned circuits small and similar. Since the external field of toroids is so small, it is feasible to locate them physically close to each other without magnetic shielding.

The oscillator frequencies are about 2 kc. It is usual in beat-frequency oscillators to use a carrier frequency about six times that of the highest beat frequency desired, for example, 100 kc for 0-to-16 kc output. For a low-frequency instrument, however, practical considerations favor a relatively higher carrier frequency; for one reason, a higher Q is attainable in the inductors.

Each oscillator (V_1 and V_2) is followed by a cathode-follower buffer stage, using the other half of the dual triode. Direct potentiometer coupling between the tuned circuits and the cathode-follower grids provides necessary positive bias return for the latter with a minimum number of components. Both oscillators and buffers are fed plate voltage from a v-r tube to keep the amplitude constant with varying line

Tunes 0 To 50 Cycles

By LAWRENCE FLEMING
Chief Engineer

and WILLIAM W. FOLLIN
President
Electronic Engineering & Service Co., Inc.
Falls Church, Va.

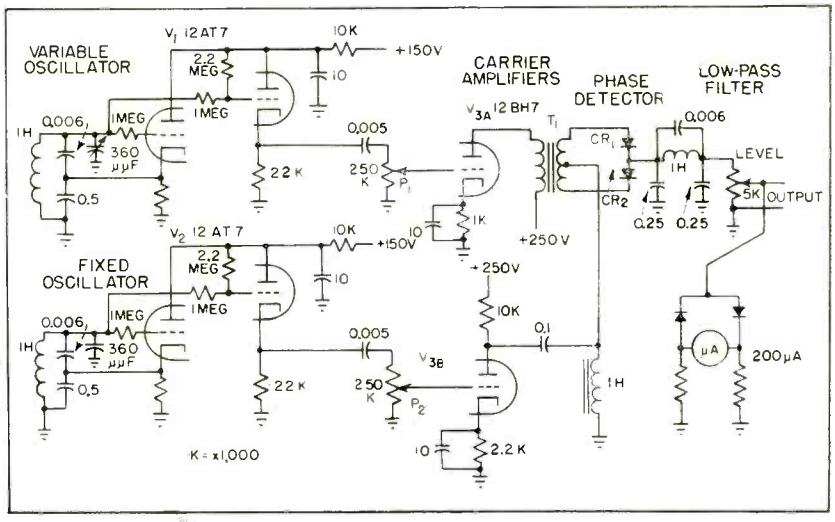

FIG. 1—Carriers in the order of 2,000 cycles are mixed at high level in a balanced selenium diode circuit. Output has internal impedance of 3,000 ohms maximum

voltage. The cathode-follower buffers feed carrier signals in turn to the respective halves of double triode V_3, the carrier output amplifiers.

When mixing two sine waves in a linear rectifier circuit one signal should be considerably larger than the other to obtain a beat signal of low distortion. The beat voltage depends mostly on the size of the smaller of the two signals; is essentially independent of that of the larger one.

Hence it is customary in such instruments to make the variable oscillator signal the large one and the fixed oscillator signal the small one, so variation of beat output with frequency is minimized. Triodes V_{3A} and V_{3B} are operated as amplifiers, delivering relatively large signals to mixer CR_1, CR_2. Screwdriver adjustments P_1, P_2 are provided to adjust the carrier levels for minimum distortion. Maximum beat voltage at the output terminals is 3 volts rms.

Mixer

Use of high-level diode mixers was suggested as long ago as 1935, but apparently never employed. It has little advantage in an audio-frequency oscillator, but in a low-frequency instrument it is the only way to remove all restrictions on the lowest attainable output frequency without using a d-c amplifier, with its attendant complications of multiple power supplies and balancing adjustments.

A further problem in mixing, once the high-level diode idea is adopted, is how to get rid of the steady d-c component that normally attends the rectification process. This is accomplished here by effect- provided to adjust the carrier levels tector.[10,11]

Mixer diodes CR_1 and CR_2 may be standard 115-volt selenium rectifiers. They are fed in series from the secondary of transformer T_1. The smaller carrier is then fed in between the transformer center tap and the junction of the two rectifiers, in series with the low-pass filter and output circuit.

Without any balancing adjustment on the rectifiers, the d-c component of the output is less than 5 percent of the peak a-c voltage, which is believed adequate for most applications. For precise symmetry of the output with respect to ground, there are several ways in which a balancing trimmer potentiometer can be connected.

The low-pass filter uses constants that are modified considerably from the theoretical, to satisfy requirements of low input impedance at the carrier frequency and tolerance to output load changes. Carrier rejection is enhanced by parallel-resonating the inductor with a capacitor at the carrier frequency. Carrier and noise are 60 db below the output level.

Output Metering

The zero-beat point can be checked against the dial reading and may be indicated by a zero-center d-c meter. However, if a rectifier is added to the meter, the meter system will also read a-c output at frequencies above 5 cycles or so, where pointer motion is small. Below 5 cycles the meter is no longer usable as an a-c indicating instrument, although the a-c output is actually the same; there is nothing in the circuit to cause any change in output.

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Multiplexing F-M

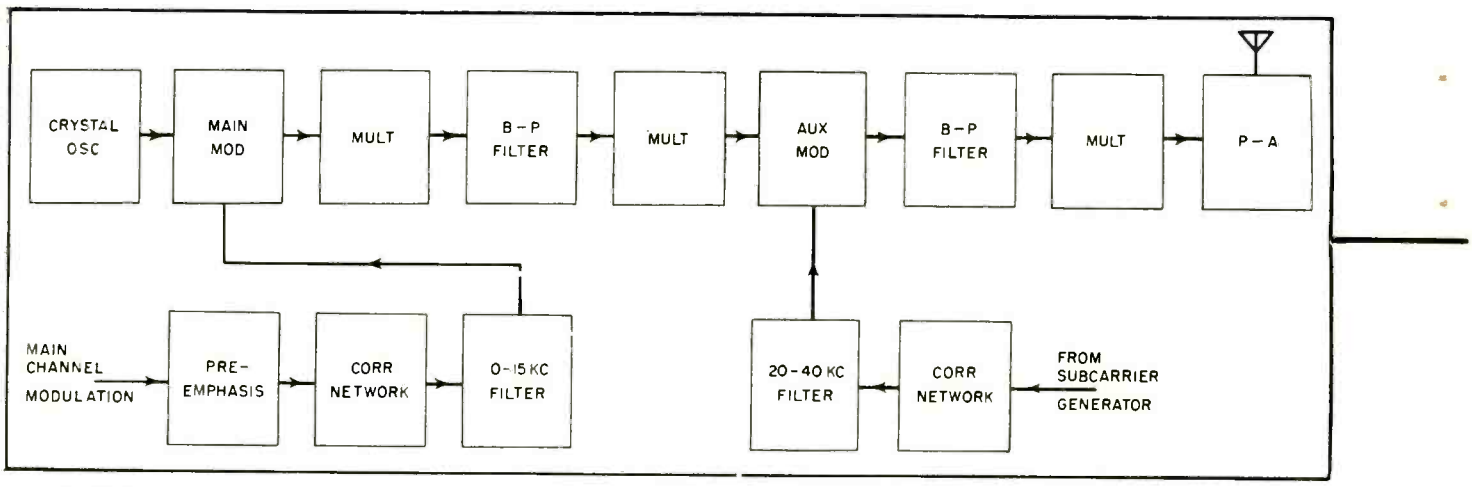

FIG. 1—Multiplex system modulator uses second phase-shift modulator at higher point in multiplication chain since less frequency deviation is needed for the subcarrier

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RECENT ACTION by the Federal Communications Commission makes possible, for the first time, extensive use of frequency-modulation broadcasting facilities in special commercial applications. Any f-m broadcast licensee may now obtain a subsidiary communications authorization (SCA) that permits him to transmit for pay a simultaneous multiplex program. A special receiver is employed to detect the subcarrier modulation. Audio muting or amplification can, in addition, be actuated by transmission of ultrasonic or so-called beep tones.

While these techniques are entirely feasible, good engineering practices must be employed to avoid crosstalk between the main and subcarrier channels. In general, only skillfully designed transmitters and receivers will meet high-quality commercial performance requirements. While present legal authorization extends only to multiplexing of entertainment and news, there are no technical barriers to employment of two or more subcarriers for narrow-band communications purposes.

Experiments carried on since 1934[1] clearly indicate the general nature of inherent problems and their successful solutions. At that time, four different sets of signals were successfully transmitted at 41 mc from station W2XDG located in the Empire State Building in New York City to Haddonfield, N. J., a distance of 85 miles. These signals comprised a musical program on the main channel, a facsimile program on a superaudible subcarrier on a second channel, a synchronizing signal for facsimile on a third and a telegraph order circuit on a fourth subcarrier frequency. Amplitude-modulated subcarriers were used at this time.

In April 1935, a frequency-modulated subcarrier was employed for simultaneous transmission of two broadcast music programs. There was substantial improvement as compared with the a-m subcarrier technique and this has since become accepted experimental practice. Operations under an SCA can only be carried out using f-m subcarriers.

Transmitter Problem

Exhaustive tests continuing over the years and particularly since 1948 show that considerable care must be paid to both the transmitter and receiver. These tests were carried on by the late E. H. Armstrong assisted by the author and others using laboratory facilities at Columbia University and those of the experimental f-m broadcast station KE2XCC at Alpine, N. J. In broadcasting where transmission is basically for entertainment, the effect of cross modulation in transmitters is much more severe than in communications. This is particularly so during the transmission of a separate program on a second channel when a diminuendo or a period of silence of that channel corresponds with a crescendo on the main channel. Experience indicates that cross talk above the level of the background noise of the second channel is objectionable. The energy content of the cross modulation with respect to signal level must be held to −50 decibels or less, or an energy content in the order of one one-hundred-thousandth part of the program level of the second channel. A ratio of 60 db or one part in a million is an attainable goal.

Since the auxiliary channel lies in the 20 to 40 kilocycle band and since the second and third harmonics of the upper half of the main channel modulation fall within that band, it will be clear that the transmitter problem will not yield readily to a solution by any direct method of modulation, for the free oscillator type of cir-

Broadcast Transmitters

SUMMARY — Long-term practical experiments prove that the main carrier of an f-m broadcast station can be modulated ±20 kc with an f-m subcarrier of 30 kc without affecting quality or disturbing receivers now in use. Signal-noise ratio in the auxiliary channel is better than 60 db

cuit does not lend itself to the required low-distortion level.

Present-day practice in f-m broadcast transmission uses the phase-shift method of producing frequency modulation. The invention by J. R. Day of the Serrasoid[2] type of modulator (which made use of an idea originally advanced by R. D. Kell) has solved, for simplex signaling, the problem of residual modulator noise in the phase-shift method of producing frequency modulation.

Background Noise

All phase-shift modulators have had to contend with transmitter background noise, which comes about basically because the limited initial frequency change that can be obtained in a phase-shift modulator entails a high degree of frequency multiplication to produce the ultimately required deviation of the transmitted wave. The high order of multiplication has the effect of enhancing those noise frequency modulations that result from the interaction of thermal and tube noise currents with the basic carrier in the oscillator and modulator circuits. An appreciable background hiss level was thus characteristic of the early phase-shift modulators (—65 db) which was reduced to values that were relatively unimportant for simplex signaling by the inventions of the double-channel, (—70 db) and the Serrasoid modulators (—80 db).

For multiplex signaling in the broadcast service, when an attempt is made to increase the frequency range of modulation, then, even with the Serrasoid modulator, the difficulty again manifests itself. This results because the fluctuation current components lying 20 to 40 kc distant from the oscillator frequency produce correspondingly enhanced frequency deviations within the range of subcarrier channels.

These deviations, after being enhanced by the same amount of frequency multiplication that is required for a 30-cycle modulating frequency, produce a level of background noise in auxiliary channels that is not acceptable. A second difficulty incident to introducing subcarrier modulation on phase-shift modulators lies in the cross-modulation introduced in the multiplier chain because of the selectivity characteristics required of the multiplier coupling impedances.

It is essential that the lower frequency stages be sufficiently selective to eliminate the frequency-modulation superimposed on the transmitted frequency at the basic oscillator frequency, a phenomenon that has its origin in the initial multiplier stages. Hence, the selectivity that is needed in the inter-multiplier coupling stages to remove this frequency modulation results in a lack of linearity in the phase characteristic for frequencies required to carry the subcarrier and so gives rise to cross modulation in those stages.

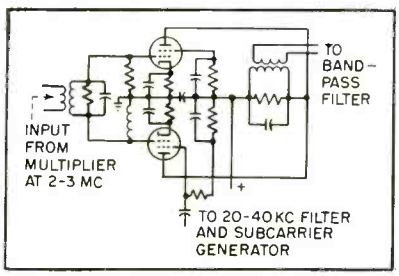

FIG. 2—Phase-shift modulator of the type used for subcarrier multiplexing

A solution for this difficulty has been found through segregation of the modulation functions shown in Fig. 1. Here the modulation and the initial multiplications of the main channel are carried out (with certain modifications) as in simplex operation. The modulation of the auxiliary channel is superimposed at a point in the multiplication chain where relatively few additional stages are required to obtain the necessary subcarrier swing at the radiated frequency. An appropriate point for introducing the auxiliary modulation is around the 2 to 3 megacycle frequency range where the amount of phase shift necessary at the subcarrier frequency to produce the required ultimate change in frequency of the radiated wave is in the order of 1 degree.

By contrast, the shift necessary at the modulator for the main channel is approximately 150 degrees (plus and minus) to obtain the full deviation range at 30 cycles.

Linearity Solution

As a consequence, no linearity problem results from the operation of two phase-shift modulators in cascade. A phase shift modulator like that in Fig. 2 may be employed. The cross-modulation problem in the multiplier coupling stages is avoided because it is possible to make the coupling circuits of the last few multiplication stages quite broad. This can be done because the frequency modulations imposed on the transmitted carrier by the basic oscillator frequency and by the fluctuation disturbances lying in the subcarrier frequency range are no longer a problem at this

point. The noise difficulties attendant upon operating a wide range frequency modulation system have been avoided by the narrowing down of the band width of the early multiplication stages of the main channel, so that the frequency changes introduced by thermal and tube noise component currents lying more than plus and minus 15 kilocycles from the oscillator frequency are not passed on into the auxiliary channel.

The cross-modulation problem is avoided by keeping the two channels separated until the normal circuit bandwith requirements permit the use of circuits sufficiently wide to insure the necessary phase linearity to prevent the effect. To generate the subcarrier, a Serrasoid modulator of standard design, multiplied the frequency up to 10 to 12 megacycles and heterodyned this frequency down to the subcarrier frequency of 27.5 kc by means of an appropriate crystal-controlled oscillator. The output current was then passed through a correction network and a band-pass filter to the auxiliary modulator. Usual pre-emphasis was employed. In practice, this method of obtaining the subcarrier channel has proved stable and reliable. While somewhat more apparatus is required than for other ways of obtaining the result, it is doubtful if their reliability or performance can equal that of the present method.

Receiver

Receiving equipment used in field tests comprised r-f amplifier, converter, crystal-controlled oscillator, five stages of 10.7-mc amplification, a double limiting system and phase-shift discriminator detector, making a total of 13 tubes.

The auxiliary channel receiver for which a circuit diagram is shown in Fig. 3 employs a 15.5-kc high-pass filter, resistance-coupled amplifier, band-pass filter and frequency-sensitive network. Following the limiters there is a gated beam detector tube followed by a 10-kc low-pass filter.

The 10-kc filter was used to prevent overload of the audio amplifier for the second channel by the subcarrier frequency. It is determined by the choice of 8 kc for the modulating band of the second channel.

In some experimental receivers, the low-pass filter configuration used to shift phase between V_{3A} and V_4 was replaced[3, 4] by a double-tuned capacitance-coupled circuit.

Use of multiple filter sections in the phase-shift network is predicated upon the ability to obtain straight-line phase shift over a wide range of frequency by this method as indicated in Fig. 4. The curve of interest is that marked $\alpha = \infty$.

Where requirements are less stringent, the simplified circuit shown in Fig. 5 can be used between points *A* and *B* on Fig. 3. It would be adequate for receiving a 5-kc subchannel on which 5-percent distortion and a signal-noise ratio of about 55 db could be tolerated.

Important considerations in evaluating the system include: the overall frequency response and distortion characteristics of the auxiliary channel; the cross talk from the main channel into the auxiliary channel for different modulation levels of the main channel as a function of main channel modulating frequency; and the signal to noise ratios of the two channels for various signal input levels to the multiplex receiver.

This data is based on a main carrier frequency of 93.1 megacycles, modulated ±20 kc, with a subcarrier of 27.5 kc. For field tests the program modulation of the main channel was held to ±50 kc. For the auxiliary channel ±5 kc corresponded to 100 percent modulation.

Multiplex Transmitter

Equipment was set up as shown in Fig. 1. To reduce crosstalk due to harmonics in the main channel modulating signal, a 15-kc low-pass filter was used ahead of the audio input to the main channel modulator.

The advantages of this arrangement are that the overall audio frequency response, the noise and distortion characteristics, that is, the basic performance characteristics of the main channel, remain unaffected by this modification. In addition, the signal-to-noise ratio of the auxiliary channel is improved. Crosstalk problem between the main and the auxiliary channel in the transmitter has been avoided by keeping the two channels separated until the normal circuit bandwidth requirements permit the use of circuits sufficiently wide to insure the necessary

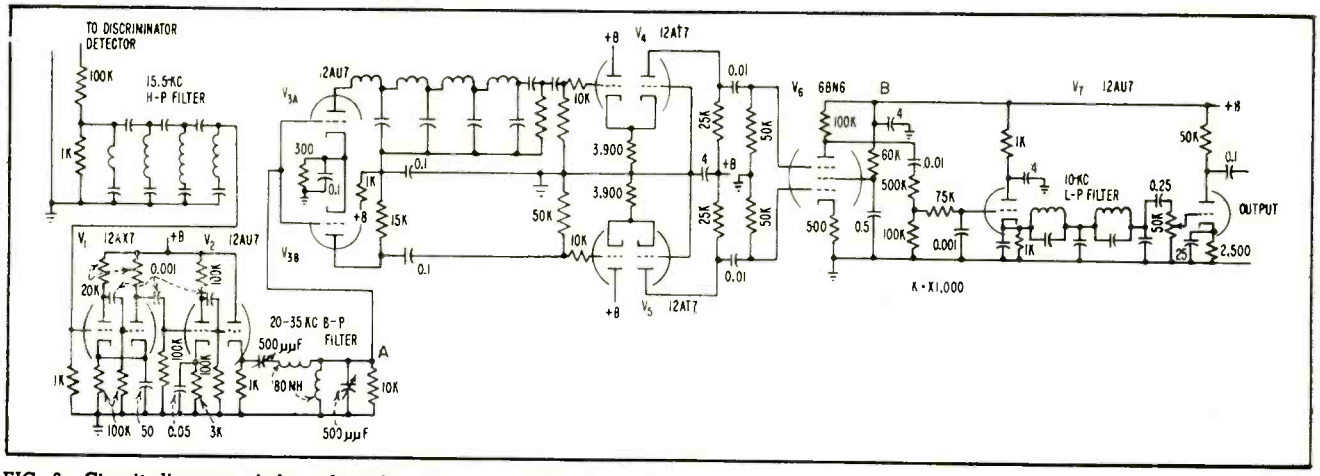

FIG. 3—Circuit diagram of the subcarrier receiver portion that follows discriminator of main-channel receiver

phase linearity to prevent the effect.

To contain the frequency range of the auxiliary channel modulation to the channel capability, an 8.5-kc low-pass filter was used ahead of the audio input to the auxiliary channel modulator.

The advantages of this method of generating the subcarrier are crystal control of the subcarrier with the attendant advantages of reliability and stability of operation and low noise and distortion characteristics of the modulator.

The usual 75 microsecond pre-emphasis circuits were available for use in both the main channel and the auxiliary channel.

Multiplex Receiver

The general arrangement of the receiving equipment used in the field tests and for making the measurements has been described under discussion of the receiver.

Field experience indicated the desirability of preceding this receiver with a fixed tuned 93.1-mc 6BK7 cascode amplifier. Such an amplifier was used ahead of the above described receiver in making the reported measurements. The input impedance of this pre-amplifier was approximately 75 ohms.

The auxiliary channel portion of the multiplex receiver which receives its signal from the main channel discriminator detector has been described.

Overall frequency characteristics of the auxiliary channel are shown in Fig. 6A. For these measurements no pre-emphasis was used in the auxiliary channel transmitter. The audio input was held constant so that for all modulating frequencies the deviation of the 27.5-kc subcarrier was ±5 kc.

The resultant frequency characteristic was obtained by subtracting the 75 microsecond de-emphasis characteristic from the measured characteristic to take into account the effect of the 75 microsecond de-emphasis network following the detector in the auxiliary channel receiver.

The roll-off above 6,000 cycles results from the cumulative effect of the low-pass filter at the input and the band-pass filter at the output of the auxiliary channel transmitter, the band-pass filter and the frequency-sensitive network in the auxiliary channel receiver and the 10-kc low-pass filter used to remove the subcarrier. These are factors within the control of the designer and are governed by the requirements of the system to be established.

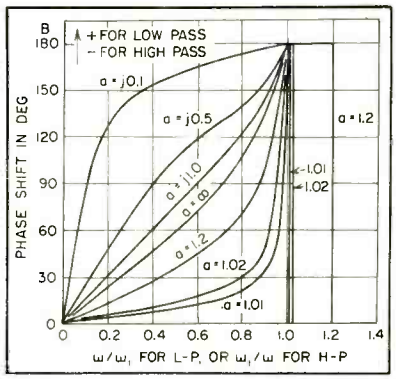

FIG. 4—Phase-shift per section for constant *k* filter

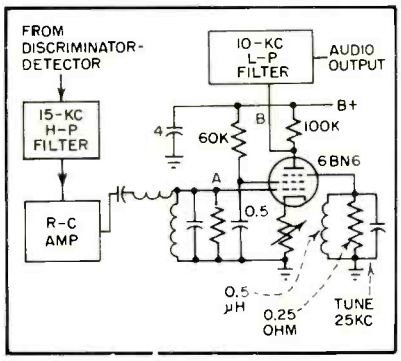

FIG. 5—Simplified receiver not used in accumulating data gives satisfactory reception

Overall distortion characteristics of the auxiliary channel is illustrated in Fig. 6B. Distortion measurements shown were made for 100 percent and 50 percent modulation of the auxiliary channel. A Hewlett-Packard model 330B distortion analyzer connected to the audio output terminals of the auxiliary channel receiver was employed in recording these data.

A public demonstration at Columbia University was made with this receiver. Subsequent work with a similar receiver has shown that the distortion can be held to less than 2 percent for ±5 kc deviation of the subcarrier for all the modulating frequencies involved. To do this requires closer attention to the design of the band-pass circuits and a different frequency-sensitive network. Here again, the system requirements would control.

Crosstalk in the auxiliary channel due to main-channel modulation is shown in Fig. 6C. For these measurements the deviation of the 93.1-mc carrier by the 27.5-kc subcarrier was ±20 kc.

To minimize the masking effects of hum and any residual subcarrier leakage in the output of the auxiliary channel receiver, a 500-cycle high-pass and a 15-kc low-pass filter were connected in cascade in the receiver output. The signal level was then established by modulating the subcarrier ±5 kc with a 600-cycle modulating tone. With this modulation removed and no modulation on the main channel, the noise in the auxiliary channel was down 69 db.

It should be noted that for these measurements the 93.1-mc signal level across the 75-ohm input to the external cascode was approximately 1 millivolt, at which level the noise in the main and auxiliary channels is independent of receiver noise and is determined by the respective transmitters. This will be evident on examining Fig. 6D.

Main Modulation

The curves shown are for three different modulation levels of the main channel. In each case the main-channel deviation was held constant and the frequency of the main-channel modulating voltage was varied. The curves show the resultant crosstalk measured in the auxiliary channel output in db below the level established by modulating the auxiliary channel ±5-kc with a 600-cycle modulating tone.

These measurements were made in the laboratory at Columbia University but were spot checked at a receiving location approximately 2.5 miles from KE2XCC at Alpine, New Jersey. The site was chosen to make the measurements independent of receiver noise and possible multipath effects. No significant differences were observed between the field measurements and the curves shown in Fig. 6C.

For normal program modulation of the main channel (peak deviation ±75 kc) the cross talk as measured with a Hewlett-Packard model 330B distortion analyzer

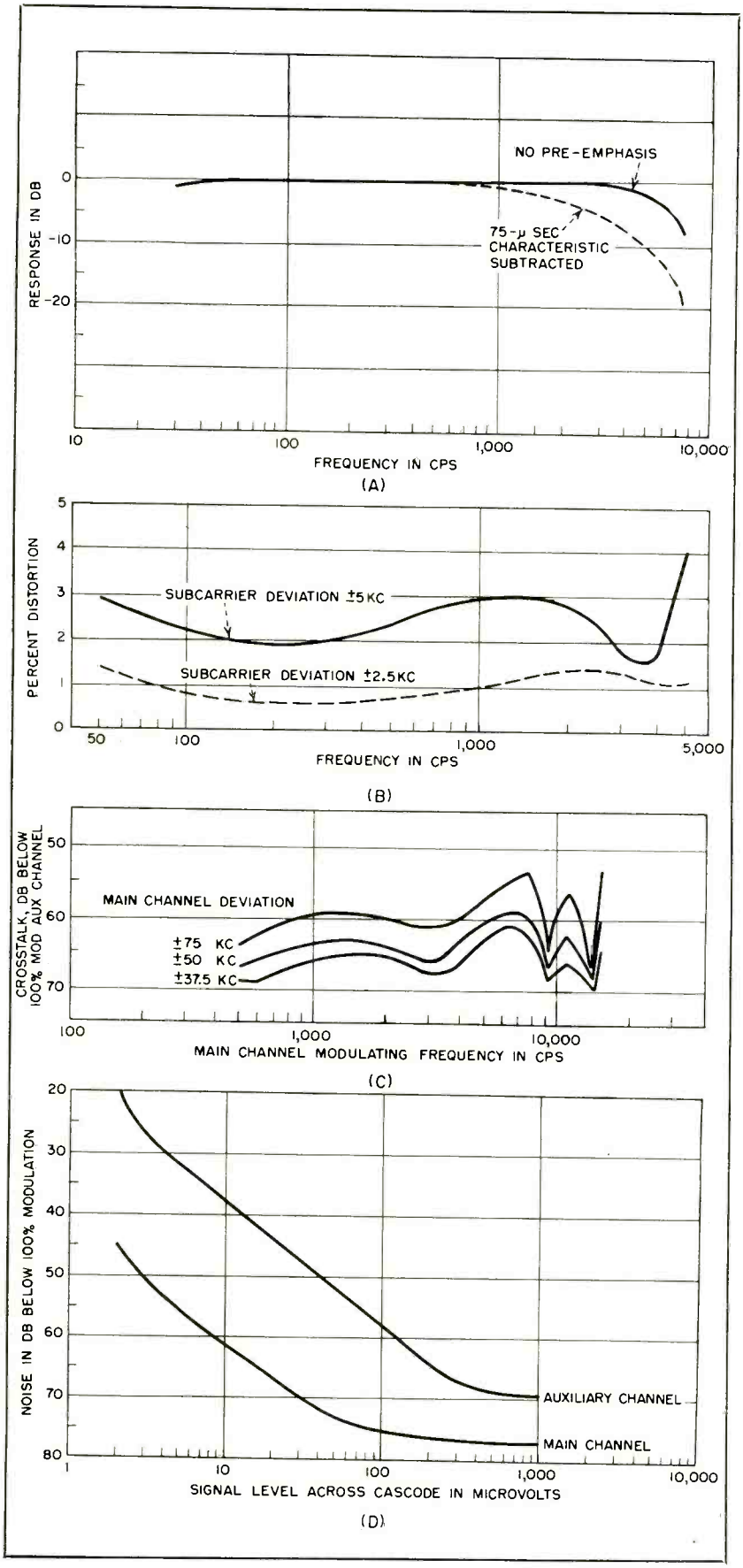

FIG. 6—Overall frequency characteristic of the auxiliary channel (A) overall distortion of the auxiliary channel for two subcarrier deviations (B) crosstalk in auxiliary channel owing to main-channel modulation (C) and signal-noise ratios of main and auxiliary channels using external cascode amplifier (D)

averages between −60 db and −65 db below full signal level for the auxiliary channel. For field tests where the peak deviation of the main channel was limited to ±50 kc, the crosstalk was usually difficult to measure.

Signal to noise ratios of the main and auxiliary channels are shown in Fig. 6D. For these curves, the 93.1-mc carrier was deviated ±20 kc by the 27.5-kc subcarrier.

The signal level for the auxiliary channel was established by deviating the subcarrier ±5 kc with a 600-cycle modulating tone. The upper curve shows the noise in db below this level as a function of the signal level across the 75-ohm input to the cascode preamplifier.

The signal level for the main channel was established by deviating the main carrier ±75 kc with a 600-cycle modulating tone. The lower curve shows the noise in db below this level as a function of the signal level as above.

For both curves the noise is measured in a 500-to-15,000 cycle band to eliminate the masking effects of hum and subcarrier leakage. This was found to be necessary in view of the high signal-to-noise ratios being measured.

It is of interest to note that for signals in excess of 500 microvolts across the input terminals, the signal-to-noise ratio of 69 db for the auxiliary channel and 77 db for the main channel are determined by the noise in the respective modulators.

Postwar laboratory development of the application of multiplexing to carriers in the 88 to 108-mc f-m broadcast band was begun in 1946, with field testing starting in the spring of 1949. This development was continued, with minor interruptions, until the present time and has included field experience with facsimile and program modulated subcarriers.

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Current Regulator for van de Graaff Magnet

SUMMARY —— Voltage and current feedback loops control the output of an amplidyne generator to provide the regulated current required by a 3.6 million electron-volt van de Graaff electrostatic accelerator. Filtering system removes hash, ripple and slip-frequency components from output

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IN THE 3-billion electron-volt Cosmotron, the protons enter the doughnut with an energy of 3.6-million electron-volts. This energy is imparted by the van de Graaff electrostatic generator. The energy level of the injected protons must be held constant to within 0.02 percent.

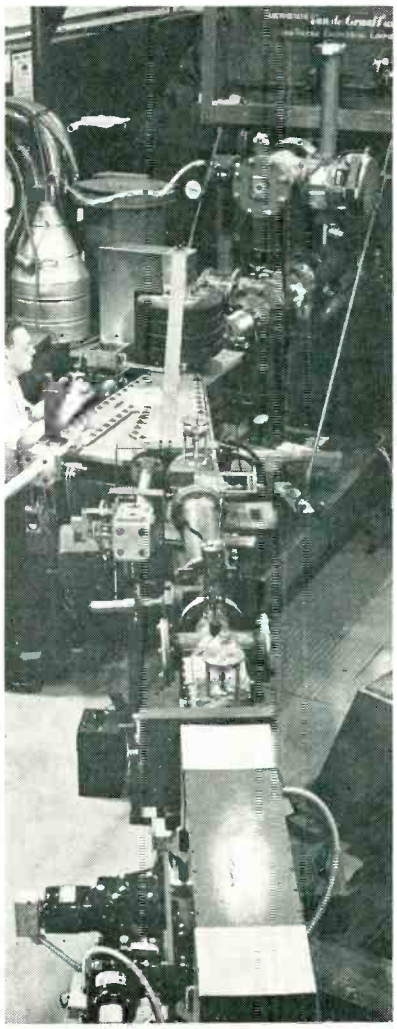
This initial energy level is determined by the strength of the field in the analying magnet. The analyzing magnet is used to separate the protons from the diatomic ions in the beam.

Since a high-gain feedback circuit regulates the voltage of the van de Graaff to maintain a constant angular deflection of the ions in the field of the magnet, the current in the magnet is the primary reference for the energy of the injected protons.[1]

Regulator Requirements

Examination of the behavior of a charged particle in a magnetic field indicates the requirements which must be imposed on the magnet current regulator. The radius of curvature of the particle path is $r = mv/He$ where m is the mass of the particle, e is the charge of the particle, v is its velocity and quantity H denotes the magnetic field strength.

The voltage of the Van de Graaff is related to the velocity by $V = mv^2/2e$. Eliminating v gives $V = H^2r^2e/2m$. Differentiating $\Delta V/V = 2\Delta H/H$. For 0.02-percent energy regulation the magnet current must be held to 0.01 percent. For design purposes 0.005 percent was specified.



Van de Graaff generator that feeds Brookhaven's Cosmotron

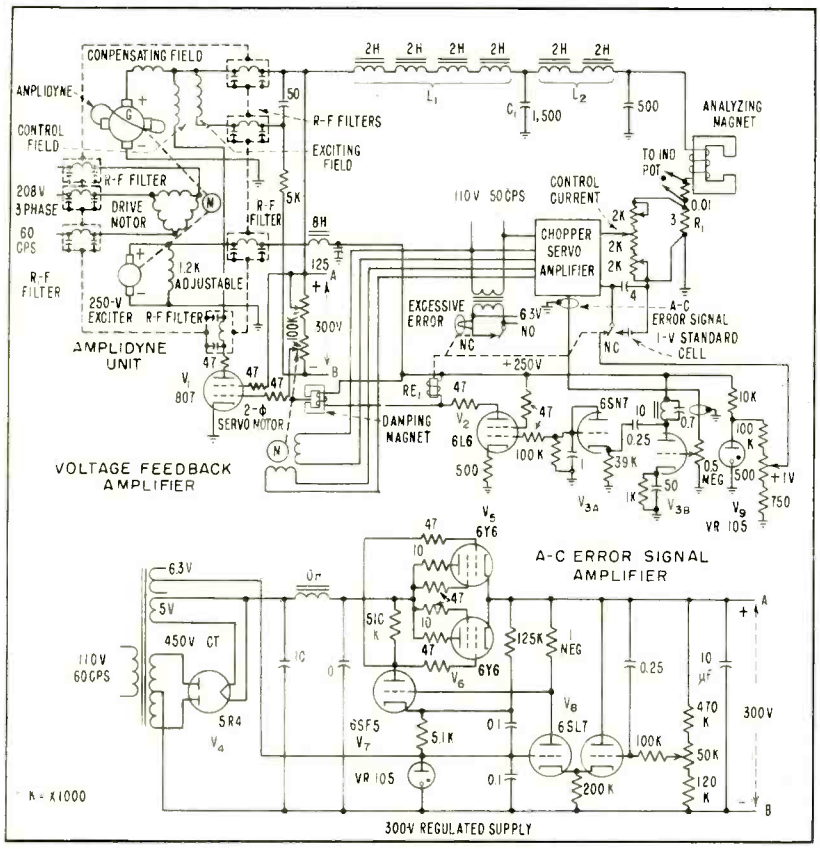
To provide for variable beam energy the current in the 90-ohm magnet coil is continuously variable from 1.0 to 2.5 amperes. The amplidyne generator is ideally suited to supply currents and voltages of this order. It provides an excellent means for controlling the load current over the full range without employing power dissipating devices.

Circuit Design

Examination of the amplidyne output voltage disclosed an assortment of noise. Commutator hash was spread out over a large portion of the r-f spectrum with broad peaks at 20 and 200 kc. Peak amplitude was 12 volts.

Commutator ripple was present with components at 30 and 2,000 cps. Peak amplitude was 15 volts.

A slip-frequency component caused by magnetic coupling between the driving motor and generator fields was evident. The frequency varied from 1 to 5 cps depending on output load. Peak



Voltage and current feedback loops, top, and 300-v amplidyne-field supply below

amplitude was 2.18 volts.

The slip-frequency component, along with fast line surges is handled by degenerative voltage regulation directly at the amplidyne output. At the lowest output current setting the amplidyne output voltage is 100 volts with a peak slip component of 2.18 volts at 1 cps. The filtering effect of the magnet will reduce the current fluctuations by the ratio of the impedance of the magnet at 1 cps to the d-c resistance. The magnet has an inductance of 40 henrys and a resistance of 90 ohms. A 2.18-percent voltage fluctuation will produce a current fluctuation of 0.0218 $|R/(R + j\omega L)| = 0.73$ percent at 1 cps.

To reduce this variation to the required 0.005 percent required a loop gain of $0.73/0.005 = 146$. The amplidyne has a voltage gain of 12.5 from control field to output. An 807, V_1 in the circuit diagram, with the 1,600-ohm amplidyne control field in its plate circuit provides a gain of 14, raising the loop gain to 200. This feedback loop effectively eliminates line-voltage variations and the slip-frequency variation from the output.

The bandwidth of the amplidyne response is only a few cps hence this loop cannot remove the commutator ripple from the output. Line-voltage fluctuations which are too fast for the voltage feedback loop are filtered out by the mechanical inertia of the armature.

Filtering

Commutator ripple is removed by a two-section L-C filter. The filter components are mounted on the chassis shown in one of the photographs. The total inductance and capacitance are divided unevenly to allow the first filter section to have the lowest possible cut-off frequency and leave the second section large enough to provide adequate attenuation of the 30-cycle component of the commutator ripple.

The first section has a cut-off frequency of 3 cps, enabling it to give some attenuation to the higher-frequency components of line transients which might get through the amplidyne. The second section with a cut-off frequency of 7 cycles is still effective against the 30-cycle component of the commutator ripple thus providing a two-section filter at this frequency.

Feedthrough-type radio noise filters are used to eliminate the r-f commutator hash. It was necessary to install a filter in each of the motor and generator leads where it enters the frame of the amplidyne. Even a short external lead between the machine and the filter would radiate enough noise to overload the sensitive input circuit of the servo amplifier in the current feedback loop.

Current Feedback

A second feedback loop is used to regulate the current to the magnet. A fraction of the voltage across the 3-ohm precision resistor, R_1, is compared with the terminal voltage of a 1-volt standard cell by a chopper-type servo amplifier and motor combination. The two-phase servo motor drives the 15-turn 100,000-ohm precision potentiometer in the 807 grid circuit with as little as 10^{-5} volts at the amplifier input terminals.

The voltage between the slider and the upper end of the potentiometer is placed in series opposition to the amplidyne output voltage. Thus the difference between the two voltages appears at the grid of the 807 and controls the amplidyne field excitation. Motor drive is always in the proper direction to adjust the magnet current to balance out the voltage at the input to the servo amplifier. By adjusting the current control potentiometer the voltage across R_1 may be selected to balance against the 1 volt from the standard cell for the desired output current.

Dynamic Stability

In the voltage feedback loop appreciable phase shift can take place in the L-C circuit formed by the inductance of the control field and the r_p of V_1 and in the amplidyne generator itself. Due to the high plate resistance of V_1 the response in its plate circuit is much faster than the amplidyne response. Thus it does not contribute enough phase shift to cause positive feedback to take place within the passband of the machine.

The current feedback loop in-

cludes the amplidyne, the large L-C filter in the amplidyne output circuit, the analyzer magnet, the Brown amplifier and the motor-potentiometer combination. At approximately 1 cps the total phase lag reaches 180 deg. At this frequency the loop gain is still far greater than one. Thus the condition for oscillation is fulfilled.

The extremely low frequencies involved make mechanical damping of the system more feasible than stabilization by electrical phase correction networks.

A copper disk, rotating in a magnetic field is gear driven from the output shaft of the Brown motor. Eddy currents in the copper disk produce a damping force which is directly proportional to its angular velocity. The low-speed, high-torque motor characteristic makes it necessary to use a pair of gears providing a stepup ratio of 12.5 to 1 between motor shaft and disk.

The disk, 6 in. in diameter and $\frac{1}{8}$ in. thick, rotates between a pair of magnet poles 2 in. square with a 0.2-in. gap length. The magnet is wound with 50,000 turns of No. 30 magnet wire. Critical damping occurs when the field in the magnet is approximately 3,250 gauss. This type of damping is extremely smooth, introducing virtually no static friction.

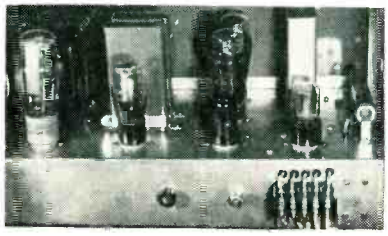
The large damping factor required for stability, if continually applied, would seriously limit the speed with which large current changes could be accomplished. Since damping need be applied only in the vicinity of zero error signal, this limitation is avoided by de-energization of the damping magnet for all but small error signals.

The output of the second stage in the servo amplifier is applied to one triode of a 6SN7, V_{3a}, operating as a tuned amplifier. The other half of the 6SN7 V_{3B}, is diode-connected to rectify the amplified signal, producing a negative d-c signal proportional to the absolute value of the error signal.

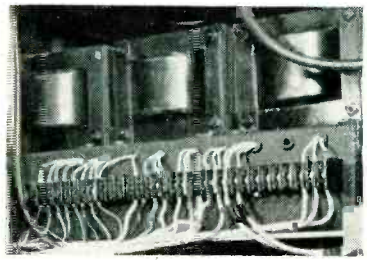
The damping magnet is in the plate circuit V_2, the grid of which is biased by the negative rectifier output. When the error exceeds about 0.5 percent V_2 is cut off and the damping magnet is de-energized allowing the motor to run freely.

Protective Measures

By tuning the input transformer, the servo amplifier impedance is raised from its original 400 ohms to 5,000 ohms. An additional 10,000 ohms in series can be tolerated,



Chassis of 300-v regulated amplidyne-field supply



Filter for commutator ripple uses 2-h, 2-amp chokes

leaving a sensitivity of 3×10^{-5} volt and raising the total input impedance to 15,000 ohms. For the maximum possible error input signal of 1.5 volts the current through the standard cell would be 100 μamp. Currents of only a few microamperes however, will destroy the stability of the standard cell.

This problem is solved by the use of an auxiliary reference voltage source using a VR105, V_9, and a voltage dividing network. When the magnet current error becomes smaller than 0.5 percent, the damping magnet circuit is energized. In this circuit is included relay RE_1 which simultaneously replaces the auxiliary reference source with the standard cell. At 0.5-percent error the input is 0.005 volt giving an input circuit current of 0.33 μamp which rapidly approaches zero as the error is corrected.

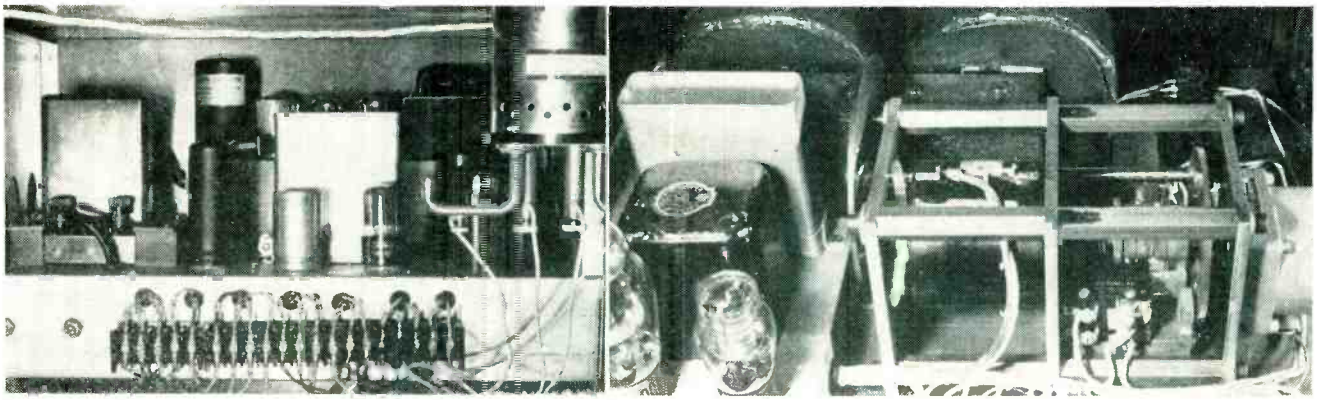
Performance

The voltage across the 3-ohm zero-temperature-coefficient resistor in series with the magnet has been observed to deviate less than 0.002 percent of the mean value for any magnet current setting between 1 and 2.5 amperes. The hysteresis effect in the magnet core reduces the actual magnetic field fluctuations to even smaller values. A fast line voltage step of 5 volts fails to change the magnet current measurably.

This work was performed under the auspices of the U. S. Atomic Energy Commission.

REFERENCE

(1) E. J. Rogers and C. M. Turner, Injection System—Part I—Van de Graaff Accelerator, *Rev Sci Inst*, Sept. 1953.



Current feedback circuit includes: servo amplifier, standard cell and error signal amplifier, left; servo motor, motor-driven potentiometer and magnetic damper, right

Portable Precision

The Front Cover

By J. B. LEVIN
Senior Engineer
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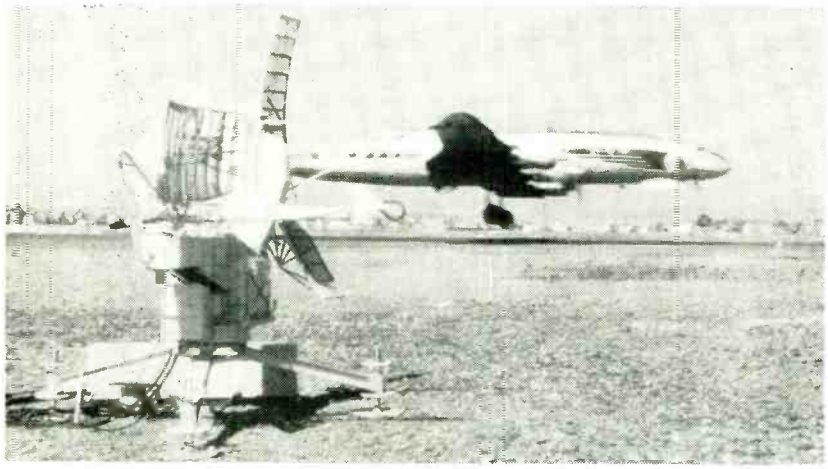
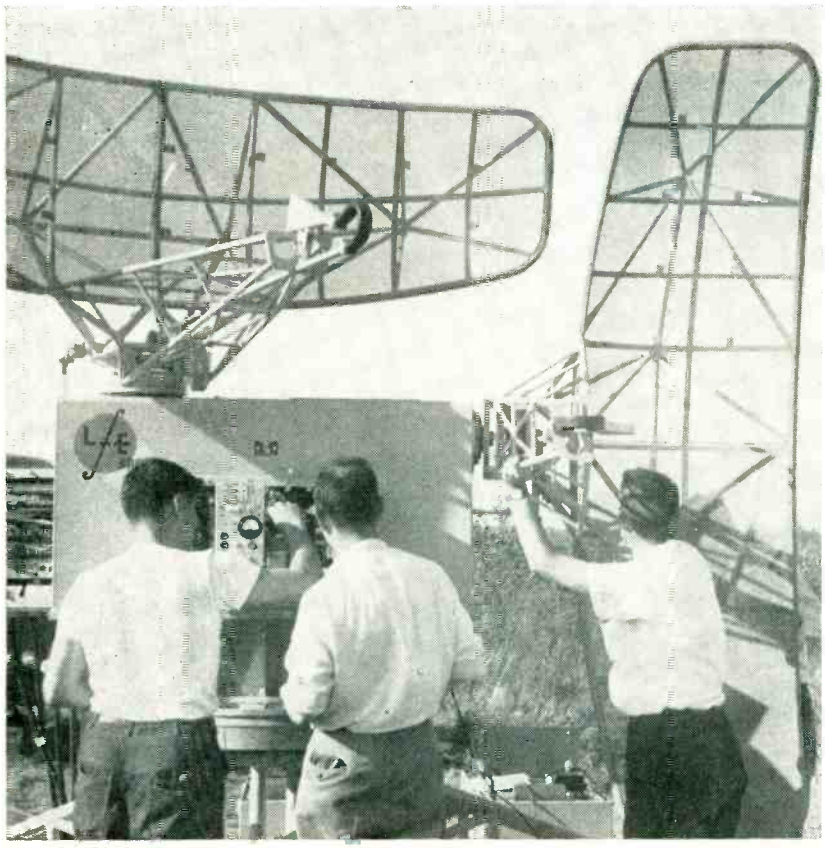


Portable SPAR approach radar unit is capable of guiding landing plane to within twenty feet of selected touchdown point. When radar is in operation plane would approach from right. The r-f head consisting of transmitter mixers, preamplifier and cfc unit are mounted in a pressurized compartment on the antenna pedestal



Set-up time for par unit is six hours. Rotatable pedestal provides coverage of more than one runway

ANY precision-approach radar must provide information regarding the accuracy with which landing aircraft are following a prescribed flight path and should include lateral deviation from the runway, vertical deviation from the glide path and distance to go to touchdown.

Small deviations of the aircraft from the glidepath or runway center line in the vicinity of touchdown must be clearly and accurately displayed. The absolute value of the range to touchdown is not required, but the position of the touchdown point must be precisely located with respect to the flight path.

In the SPAR approach control system described here, two corner reflectors are used to determine the touchdown point, the runway centerline and the elevation reference. All system errors are effectively calibrated out at touchdown. The accuracy is then limited only by the ability of the operator and errors, such as scintillation, inherent in the received signal. Because of these limitations, the specified deviation accuracy is taken to be 0.5 percent of the range from touchdown, ±20 feet.

Deviation and range information are displayed on a 17-inch rectangular tube with a P-19, long persistance phosphor. Two displays are time shared on one indicator, the elevation sector on top, azimuth on the bottom. A flight-path computer in each indicator generates functions representing the glide path and runway extensions as viewed from the antennas. These are displayed on the indicator along

Approach Radar

SUMMARY —— Military operations and smaller airports require lightweight, flexible gca radar for all-weather landings. This unit with six-hour set-up time, provisions for runway changing and clutter elimination provides touchdown accuracy of better than ±20 feet

with range marks and normal video, as shown in the photograph.

A beta-scan display (angle versus range) is used to give expansion of small errors at short ranges.

To achieve a high information rate, separate antennas are used for azimuth and elevation coverage. These scan their respective planes at a rate of 2 cps, with a phase difference of 90 deg between the motions of the reflectors.

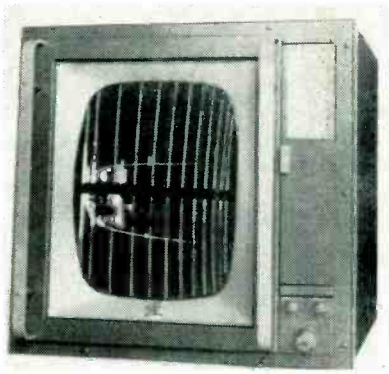
To achieve high angular accuracy and resolution, the antenna beamwidths are each 0.8 degree in the plane of scan.

This imposes the requirement of operating at a transmitter frequency high enough to limit the reflectors to a reasonable size. Although K-band might seem attractive, all-weather performance is poor at these frequencies and X-band is therefore used as the best compromise.

Clutter Elimination

Rain clutter may often completely obscure targets at X-band frequencies. This clutter may be minimized by circular polarization in the antenna feed but with an effective loss in system performance. Linear polarization should therefore be used in the absence of precipitation. Both types of polarization are provided, selectable by a solenoid-actuated polarization switch.

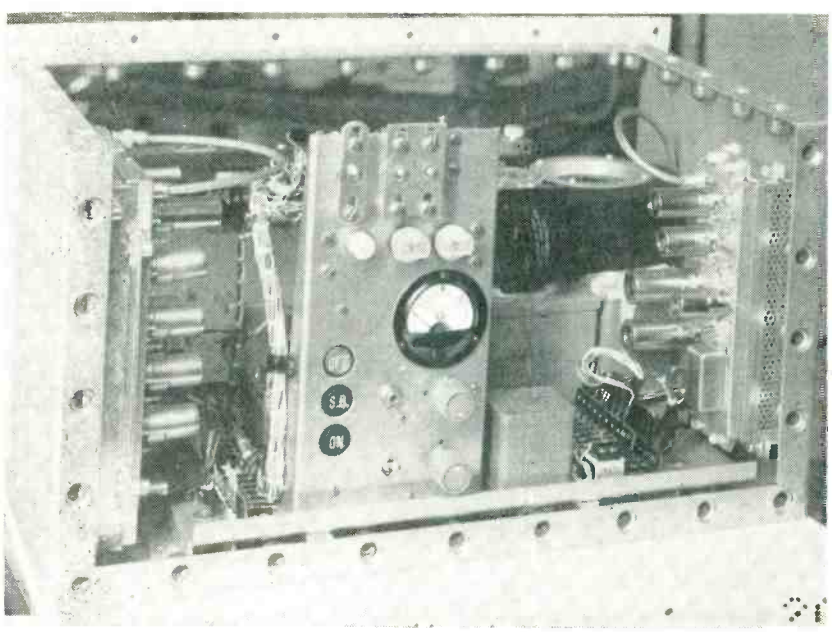
To permit maximum flexibility of siting, antenna coverage should be as wide as possible in the plane at right angles to the direction of scan. The radiation patterns follow a $\csc^2$ law to 30 deg in the wide plane of the antenna.



Beta-type display shows elevation of landing aircraft on upper section of screen and azimuth position on lower section

For the same reason, and to achieve sufficient coverage for aircraft deviating widely from the glide path, the antenna scan sectors extend from −1 deg to +9 deg in elevation, and −10 deg to +20 deg in azimuth, as shown in Fig. 1. The 30-deg azimuth sector also provides increased flexibility in siting.

The normal position of the radar is to the left of the runway, as viewed from an approaching aircraft. To get the same coverage for the right side of runway operation, the horizontal pattern can be reversed by inverting the dish.



Chassis of r-f section. Preamplifier is at right and afc at left. Magnetron is at right behind preamp and control panel

System Description

A block diagram of the system is shown in Fig. 2. The transmitter uses a 2J51 tunable magnetron operating in the 9,080-mc band at a prf of 2,000 cps, a pulse width of 0.5 μsec and a peak output power of 50 kw.

Transmitter power output is

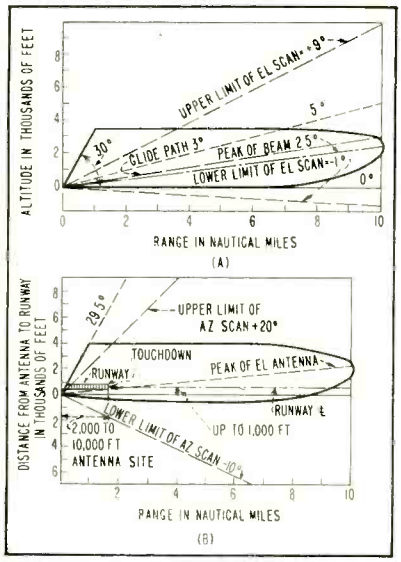


FIG. 1—Elevation (A) and azimuth (B) coverage of par antennas. For operation from right side of runway, azimuth pattern would be inverted

switched between antennas by a rotating-blade r-f switch coupled to the antenna drive motor. A 2K25-klystron local oscillator is locked 30 mc above the transmitter frequency by a 15-mc bandwidth afc circuit with high loop gain which insures stable receiver operation with short warm-up time. A balanced mixer and low-noise preamplifier with input circuits detuned to compensate for induced grid noise result in an overall system sensitivity of more than 100 dbm. A logarithmic i-f amplifier then amplifies the signals to a level of 1.5 v where they are rectified.

The signals are then further amplified to a level of 5.0 v and fed to the indicator through a coaxial cable. The logarithmic amplitude response of the i-f amplifier compresses the output signals to within the dynamic range of the crt without limiting. This prevents weak signals from limiting in the presence of clutter and also provides contrast between strong signals of different amplitudes. A compression ratio of 12 db at the output is achieved for a 60-db range of input signals.

Angle information is derived from miniature precision resolvers coupled directly to the reflector drive shafts. Resolver errors are adjusted to zero at touchdown and are less than $\frac{1}{4}$ deg over the operating range. The resolver outputs are demodulated and combined in the signal-data converter and then fed to the indicator through a single coaxial cable at a level of ±25 v.

In the indicator these voltages are fed to the vertical sweep circuits and the flight-path computer. The video is amplified to a 70-v level and then displayed on the crt together with 1-mile range marks and the output of the flight-path computer. The logarithmic 10-mile horizontal sweep provides expansion at ranges near touchdown where the greatest accuracy is required. The horizontal sweep circuits and high voltage power supply are similar to the flyback circuits commonly used in television receivers.

Signal Data Converter

The signal-data converter supplies regulated carrier voltage to the resolvers, demodulates and combines output voltages of the resolvers (varying from 0 to 25-v a-c peak) and feeds the resultant envelope voltage at low impedance through a coaxial cable to the indicator. The detector and amplifier portion has an overall linearity of ±0.25 percent.

A block diagram of the signal-data converter is shown in Fig. 3. A 2-kc oscillator supplies carrier voltage to the resolver stators and also serves as the basic timing oscillator for the radar. The input voltage to the resolvers is held constant to within 1 percent by a feedback amplifier in the oscillator circuit.

Output voltages of the resolver rotors, modulated according to the angular position of the reflectors, are returned to the signal-data converter where they are combined and sampled by the input gate. These voltages are then fed to the a-c feedback amplifier, which provides a low-impedance source for driving the keyed detector. The keyed detector provides an accurate means of demodulating the angle voltages without phase shift. The resultant slowly varying signal is then fed to the d-c feedback amplifier which provides a low-impedance source for driving the coaxial cable to the indicator.

The complete schematic diagram of the signal-data converter is shown in Fig. 4. Tubes V_1 and V_{2A} constitute a phase-shift oscillator whose frequency may be adjusted by R_1.

The power amplification to drive the resolvers is supplied by V_3 whose output is also rectified by V_6, amplified by V_8 and fed back to the suppressor grid of V_1 to provide amplitude stabilization of the oscillator. The output of V_3 is also fed to Miller amplifier V_{2B} where it is phase-shifted 90 deg and then shaped and clipped in V_{11}. Blocking oscillator V_{12} supplies 1-μsec

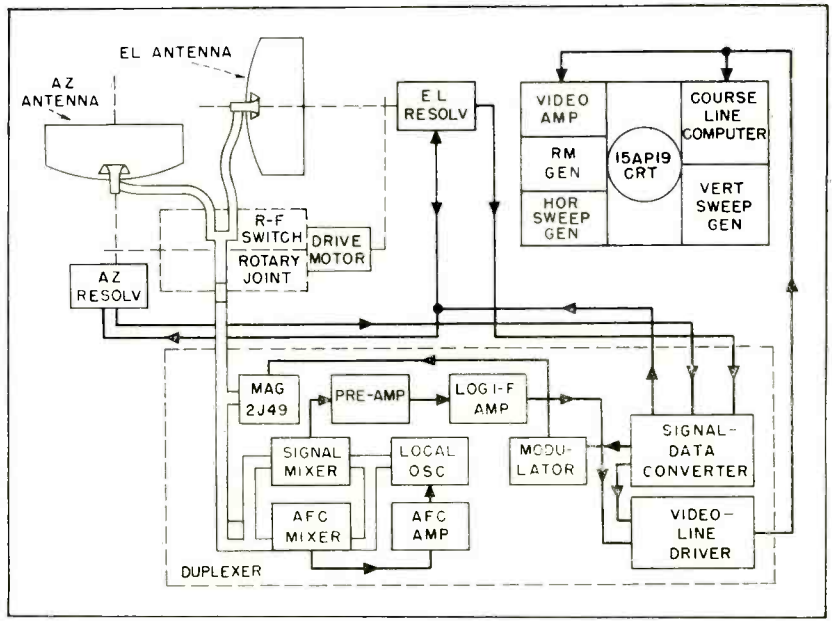


FIG. 2—Circuits within dashed box are mounted on antenna pedestal

sampling pulses to the grids of keyed detector V_7 and a trigger pulse to blocking oscillator V_{13}. This, in turn, supplies a 0.5-μsec system trigger to the indicator and modulator.

The output of the azimuth and elevation resolvers are fed to the grids of V_4 which are switched at the same rate as the antennas by the azimuth-elevation gate. This gate is derived from a snap-action switch on the pedestal and shaped by Schmidt trigger V_{10} and amplified by V_{11}.

The combined resolver outputs are then amplified in V_5 and V_{6A}, comprising a unity-gain a-c feedback amplifier, and demodulated by keyed detector V_7. The rectified output of V_7 is again amplified by V_{10} and V_{17} comprising the unity gain d-c feedback amplifier. Tube V_{20} is a constant current tube which reduces common mode gain and improves the d-c balance of V_{10}.

Constant current tube V_{18A} acts as an infinite impedance coupling resistor between V_{18A} and V_{17} resulting in increased open-loop gain and larger swing on the grid of V_{17B}.

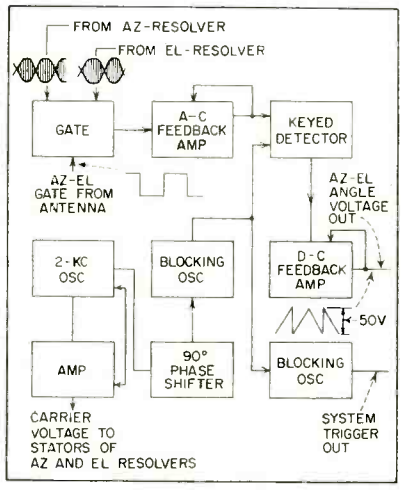


FIG. 3—Signal-data converter system with waveforms at various points

The output of V_{17B} is fed to the indicator through a coaxial cable. Video from the logarithmic i-f amplifier is amplified by V_{17A}, V_{16} and V_{15} and then goes to the indicator via coaxial cable.

Flight-Path Computer

The flight-path computer generates range marks as a function of angle voltage to precisely represent the projection of the glide path on the horizontal and vertical planes intersecting the runway, as viewed from the radar. The geometry is illustrated in Fig. 5. Angles θ and ϕ are between the sector edge and a point on horizontal or vertical projections of the glide path and are determined by the angular positions of the azimuth and elevation antennas.

The angles between the sector edge and a line parallel to the runway and the glide path are θ_o and

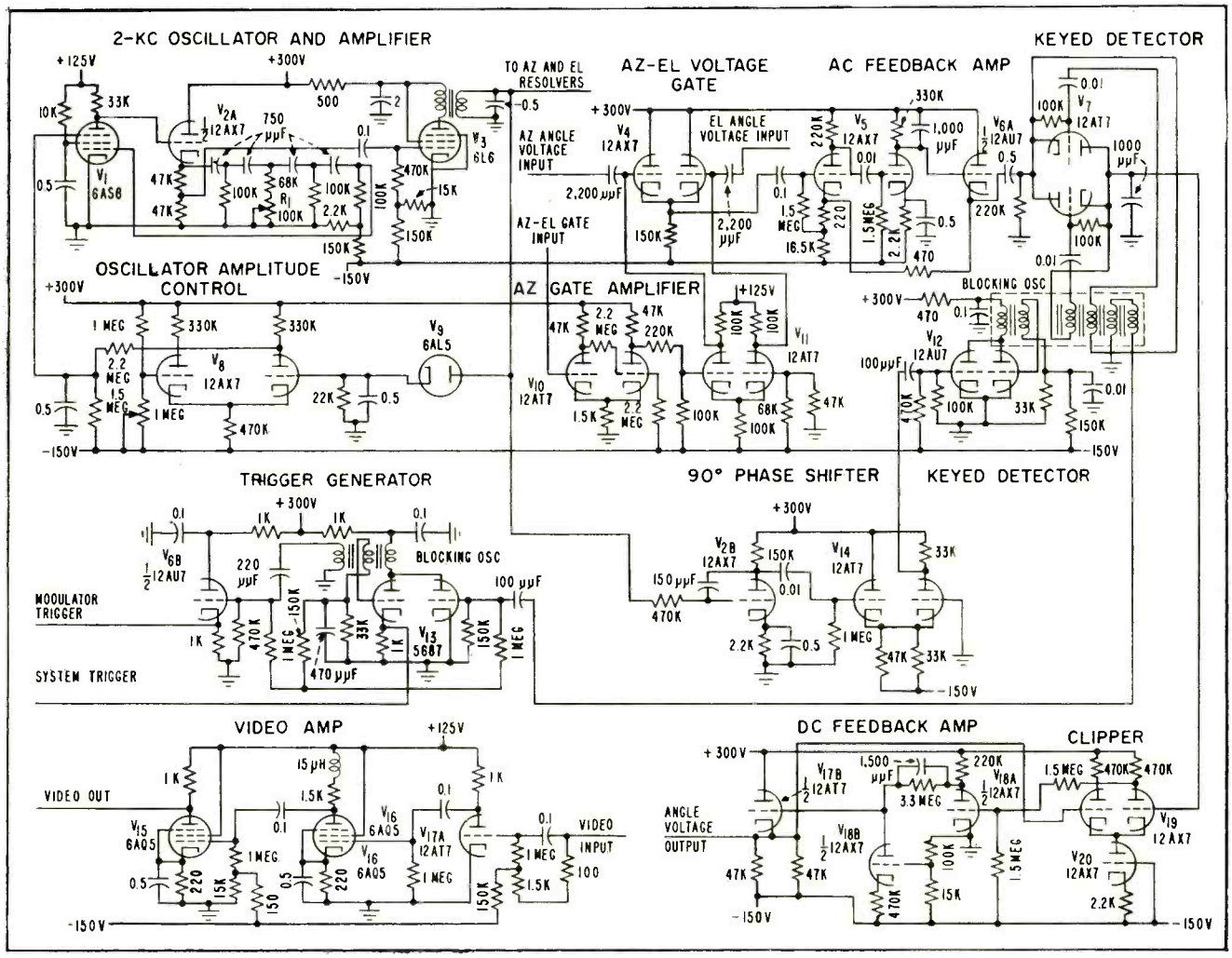


FIG. 4—Two-kilocycle phase-shift oscillator in signal-data converter provides basic timing signal for entire radar unit. Blocking oscillator V_{13} supplies 0.5-μ sec system trigger to indicator and modulator.

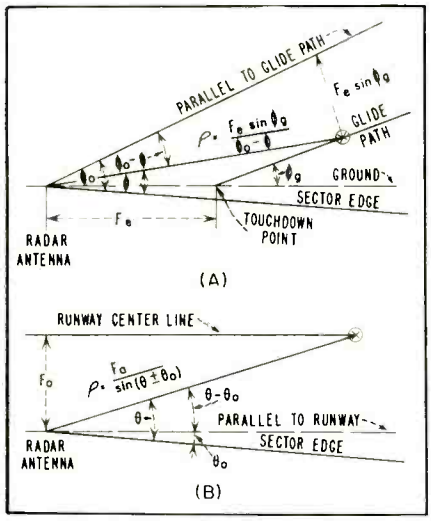


FIG. 5—Geometry of elevation (A) and azimuth (B) corrections

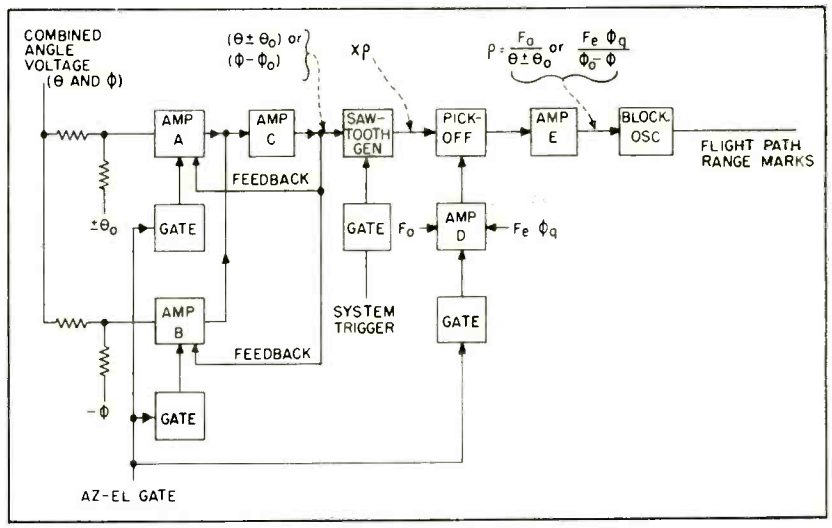


FIG. 6—Flight-path computer generates glide path and range lines for β-type display

ϕ_o, and are determined from a site survey and the orientation of the antennas. Angle ϕ_g is the glide angle and ρ is the slant range between the radar and a point on the glide path.

The flight-path computer must then generate range marks according to the relationships $\rho = F_e \phi_g/(\phi_o - \phi)$ during the elevation scan interval and $\rho = F_a/(\theta \pm \theta_o)$ during the azimuth scan interval.

Flight-Path Computer

A block diagram of the flight-path computer is shown in Fig. 6. The combined angle voltage from the signal-data converter is added separately through resistance networks to fixed but adjustable voltages proportional to ϕ in one case, and $\pm \theta$ in the other. The new voltages are then fed, respectively, to amplifier A and amplifier B, which are turned on an off by the az-el gate and together constitute a unity-gain feedback amplifier which provides a low impedance driving source for the saw-tooth generator. The saw tooth thus generated has a slope proportional to the output of amplifier C, is gated on at the time of the system trigger and runs for the full sweep duration.

The amplitude of the saw tooth voltage at any time is equal to the product of its slope and the elapsed time since the system trigger. The angle voltage is thus effectively multiplied by range. The saw tooth is then fed into one side of a pick-off circuit whose reference is a voltage proportional to the off-set distance F_a or $F_e\phi_g$. When the saw-tooth amplitude, proportional to $\rho(\theta \pm \theta_o)$ or $\rho(\phi_o - \phi)$, reaches the voltage F_a or F_e a pulse is emitted from the plate of the pick-off tube, shaped in amplifier E and then fed to the grid of the blocking oscillator. Thus, the time, and hence the range, of this pulse satisfies the

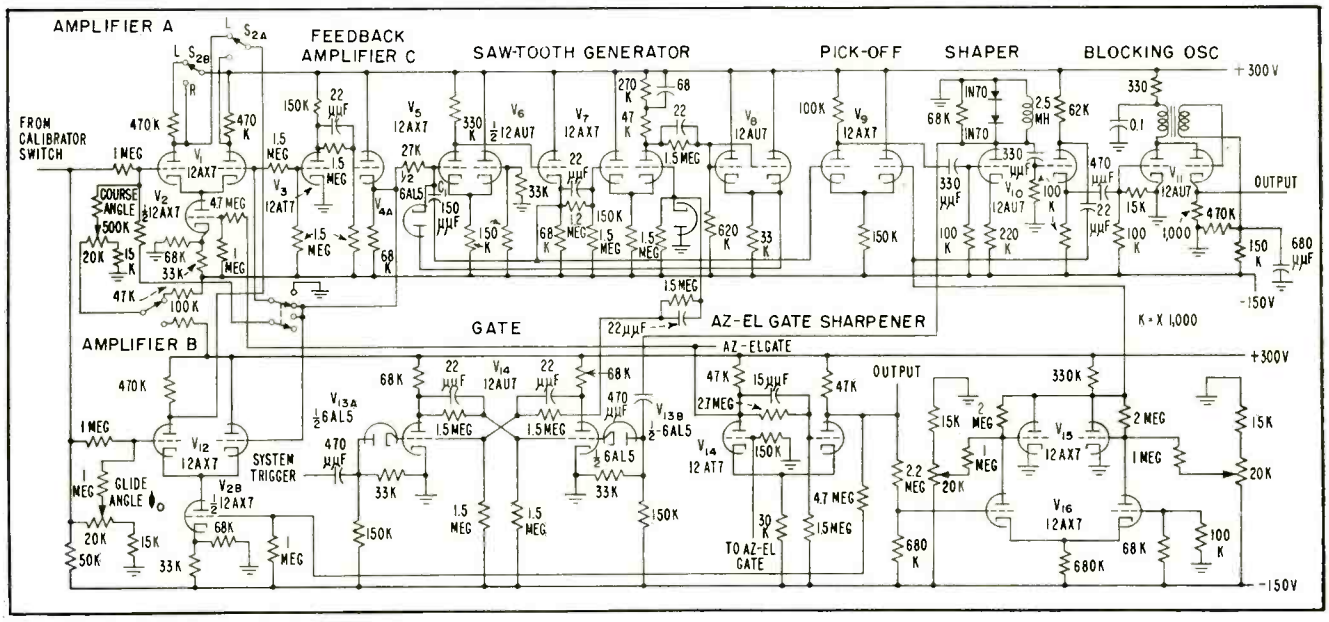


FIG. 7—Circuit of flight-path computer. Switch S_2 selects operation for right or left side of runway

conditions for ρ in both equations.

The complete schematic diagram is given in Fig. 7. Tubes V_1 and V_{12} correspond to amplifiers A and B in the block diagram, V_3 corresponds to amplifier C and V_4, V_5, V_6 and V_7 comprise the saw-tooth generator.

During the interval between sweeps, the saw-tooth gate generator clamps the right-hand grid of V_7 to ground through diode V_{4B} and V_7 is therefore in a conducting state. Amplifiers V_6 and V_7 in conjunction with cathode followers V_8 and V_5 amplify signals on the left-hand grid of V_5 and feed them back through diode V_{4A} which forces the left-hand grid to assume the same

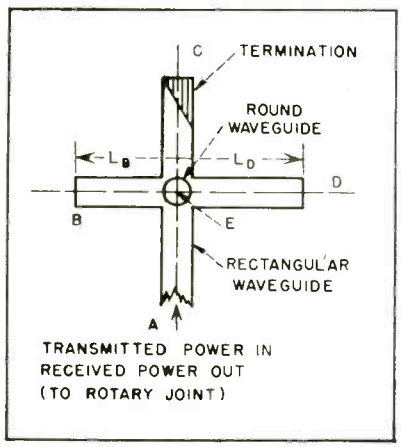


FIG. 8—Turnstile junction for selecting circular or linear polarization

potential as the fixed bias on the right-hand grid. This accurately fixes the starting voltage of the saw tooth. Any tendency for feedback to take place through capacitor C_1 is prevented by the much lower impedance presented to the grid of V_5 by the cathode of V_6.

At the time of the system trigger, the saw-tooth gate generator drives the right-hand grid of V_7 positive. This causes the grids and cathodes of V_8 to go negative, opens diode V_{4A} and opens the d-c coupled portion of the feedback loop. Amplifier V_6 and cathode follower V_8 then cause a constant current to flow in capacitor C_1 equal to the current flowing in R_1 due to the angle voltage and generates a highly linear rise of voltage at the cathode of V_6. The resultant saw tooth is fed to differential amplifier and pickoff to be V_{10}.

When the saw tooth on the left-hand grid of V_9 reaches a value equal to that of F_a or $\phi_g F_a$ on the right-hand grid, a negative pulse is fed to amplifier-shaper V_{10} whose output triggers blocking oscillator V_{11}. Meanwhile, the offset voltages, set up on the two potentiometers, are fed to the grids of V_{15}, which are gated by the azimuth-elevation gate through balanced modulator V_{16}. The voltage at the plate of V_{16} and the right-hand grid of V_9 is therefore proportional to either F_a or $\phi_g F_e$, depending on the condition of the az-el gate.

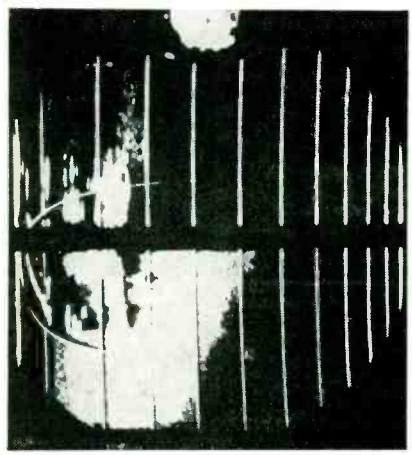
Polarization Switch

The polarization switch provides selection of either linear or circular polarization. The basis of the switching device is the turnstile junction, illustrated in Fig. 8. This is a hybrid junction having four arms of standard rectangular waveguide symmetrical about the H-plane and one arm of round or square waveguide connected to the junction in the plane of symmetry. The output of the duplexer is fed into A. Waveguides B and D are terminated in moveable short circuits, C is terminated in the characteristic impedance of the guide and E is connected to the antenna feed horn.

Any type of polarization may be propagated in the output arm with no energy propagated in C, depending on the position of the short circuits. Energy reflected back into the junction will be propagated in either A or C depending on the phase and amplitude characterisics of the signal. If the arms are adjusted to transmit linear polarization, components of the reflected energy polarized in the same direction will be propagated in A and the receiver. Components polarized orthogonally will be propagated in C, and dissipated in the termination.

In the case of circular polarization, a certain sense of rotation may be assigned to the vector representing the transmitted field. Upon reflection from a perfect specular reflector, the sense of rotation, as seen from direction of propagation, will be reversed. The effect of the various phase shifts in the arms of the turnstile will then be to cancel all energy entering A and to reinforce energy entering C. Consequently, to the extent that precipitation behaves like a specular reflector, the energy reflected from it will be dissipated in the termination and will not reach the receiver. Nonspecular reflectors, such as aircraft, will depolarize the signal to a certain extent, and the depolarized energy will enter the receiver. For a random scatterer this amounts to a theoretical loss of about 3 to 6 db. In practice the loss is generally somewhat less.

Measurements made with corner reflectors have indicated 50-db



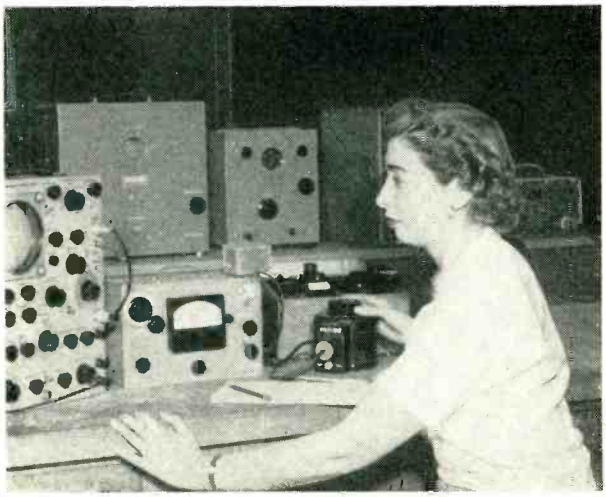
Circular polarization (top half) reduces clutter visible with linear polarization

specular target rejection in field tests on the polarizer. The effect of the polarizer on actual rain return is shown in Fig. 9.

In approximately 3,000 hours of field testing, over 1,500 approaches were flown with many different types of aircraft. Deviation errors at touchdown of 10 feet or less were achieved regularly.

The author wishes to acknowledge and thank N. Repella, P. A. Crandell, M. Rosen, J. L. Freedman and W. J. Charrow for their assistance in the development of the par system.

Extensive field tests and evaluation of the prototype unit were performed under the direction of N. Repella. Final production engineering of the equipment was accomplished under the direction of J. H. Cook.



Inspection of quartz crystal transmission characteristics

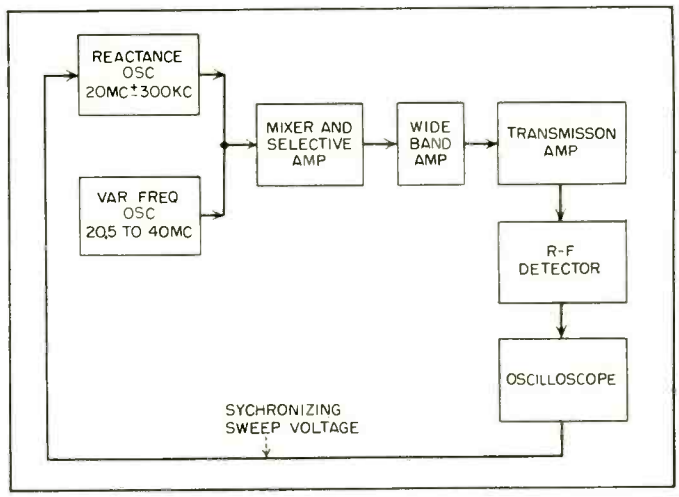


FIG. 2—Block diagram of crystal spectrum analyzer

Spectrum Analyzer

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SPECTRAL analysis of the response characteristics of a quartz crystal provides an efficient means for determining its Q factor under dynamic conditions. This technique also provides a reliable method for determining the existence and nature of any spurious resonances that may exist in proximity to the desired resonant frequency.

A spectrum analyzer is described which will, when used with an oscilloscope, display a visible frequency spectrum up to ±300 kc of the selected center frequency for any selected crystal in the frequency range from 0.5 to 20 megacycles.

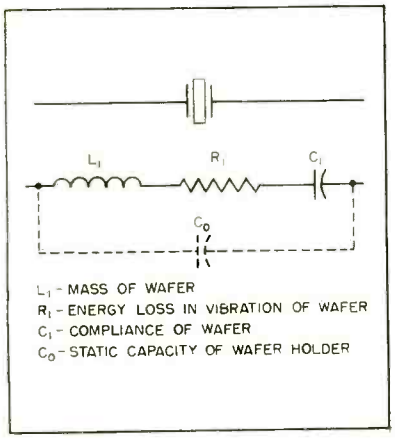

FIG. 1—Electrical equivalent circuit of a mounted quartz crystal

The major requirement for spectral analysis of high-Q circuit elements is that the network be scanned with a signal of slowly varying frequency and constant magnitude of voltage.

Mathematical treatments on the response of resonant circuits to varying frequency have been given by Hok[1] and Barber.[2] Interpretation of both analyses revealed that to reproduce accurately the response characteristic of a resonant circuit, the rate of change of the scanning frequency must be compatible with the bandwidth (±3-db points) of the scanned circuit.

Incompatibility will cause: ringing (a condition which results from a beat between the forced oscillation of the resonant circuit and the driving frequency of the system); error in the peak transmission current; apparent shift in the resonant frequency; and apparent increase in the bandwidth of the scanned crystal.

Quartz Crystal Characteristic

The equivalent electrical circuit of a quartz crystal is shown in Fig. 1 and is related to its motional impedance.[3] Since a quartz crystal possesses many inherent modes of motion, an equal number of electrical resonances may occur due to the elastic coupling between these vibrational modes. Existence of undesired resonances may create: an abnormally high effective resistance for series operation; a lack of positive selection of the desired frequency oscillation; and undesired shifts of oscillating modes at elevated temperature. In fabricating a precision quartz crystal, an attempt is made to suppress all but the desired mode of vibration by proper orientation of the wafer.

Analyzer Data

The crystal analyzer will provide an effective means of reproducing visually the true admittance characteristic of the finished plate, while revealing the existence and magnitude of any spurious resonance that may exist within the displayed frequency spectrum.

The crystal spectrum analyzer in Fig. 2 employs a sweep-frequency oscillator having a sweep width

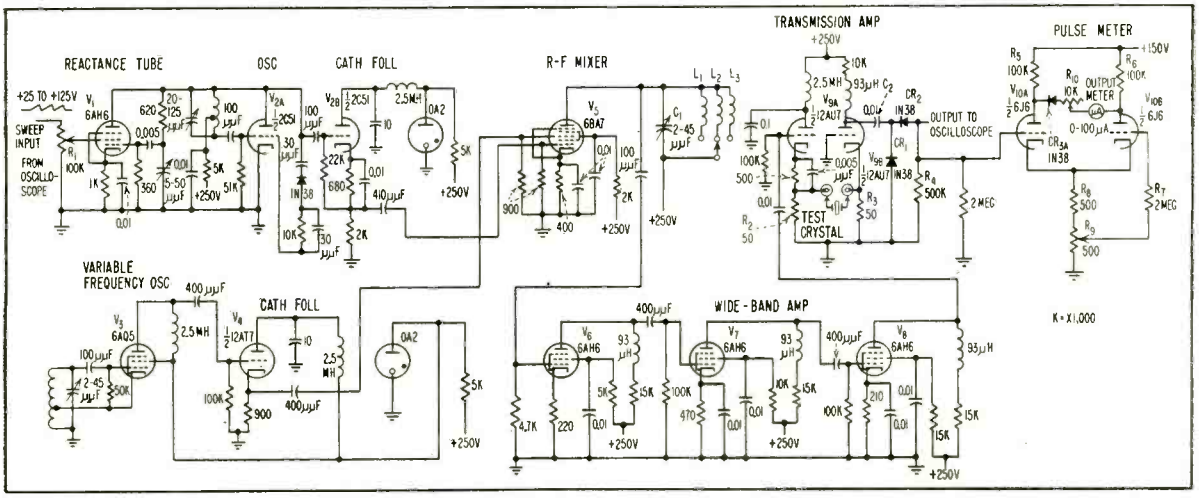

FIG. 3—Circuit diagram of crystal spectrum analyzer which has frequency range of 0.5 to 20.0 mc

for Quartz Crystals——

SUMMARY —— Sweep-frequency oscillator has constant output voltage over entire swept band for use in checking electrical characteristics of quartz crystals. Slow rate-of-change frequency gives accurate spectrum analysis

variable up to ±300 kc of a 20-mc mean frequency. This sweep-frequency is fed to a converter where it is mixed with a selected signal from a 20.5-mc to 40-mc oscillator.

The output of the converter which is designed to select the difference frequency of these two signals is coupled to a broadband amplifier. After amplification, the resultant sweep frequency is fed to a cathode-coupled transmission-type amplifier. Here the quartz crystal under investigation is inserted for an electrical analysis of its transmission characteristics throughout the applied sweep-frequency spectrum.

A diode detector is used to produce d-c voltages proportional to the magnitude of the r-f signal admitted to the final stage of the transmission amplifier by the quartz crystal. The detector output is applied to the vertical d-c amplifier of an oscilloscope whose time-base generator controls the repetition rate of the sweep-frequency oscillator. This arrangement provides a visual spectrum of the response characteristics of the quartz crystal unit throughout a maximum bandwidth of ±300 kc of its fundamental frequency. A circuit diagram of the system is shown in Fig. 3.

Reactance-Tube Oscillator

Modulating voltage for the reactance oscillator is applied directly to the screen grid of the reactance tube instead of the conventional arrangement of capacitance coupling to the control grid. By utilizing this method the previous limit for rates of modulation imposed by the capacitor in the control grid has been eliminated.

When applying this high-level sweep voltage (25-to-125 v d-c) to the screen grid, a varying r-f current, in quadrature with the capacitive current of the system, is generated. Variation of the current in reactance tube V_1 causes linear variation in the frequency of oscillation for this system. The magnitude of frequency deviation is controlled by the setting of potentiometer R_1. Tube V_{2B} is a cathode follower which isolates the system from external loads.

The variable frequency oscillator V_3 is a conventional Hartley type oscillator designed to oscillate over a frequency range from 20.5 mc to 40 mc. Tube V_4 is a cathode-follower which isolates the vfo from external loads.

Mixer-Selective Amplifier

Mixer tube V_5 is a 6BA7 pentagrid converter whose output feeds to a broadly tuned selective amplifier. The variable frequency oscillator signal is fed to the signal grid of the pentagrid converter, while the frequency-modulated signal is fed to the control grid. As these two signals are heterodyned, sweep voltages result that are sums and differences of the applied signals.

The tank circuit (C_1, L_1, L_2 or L_3) serves as a low impedance to the

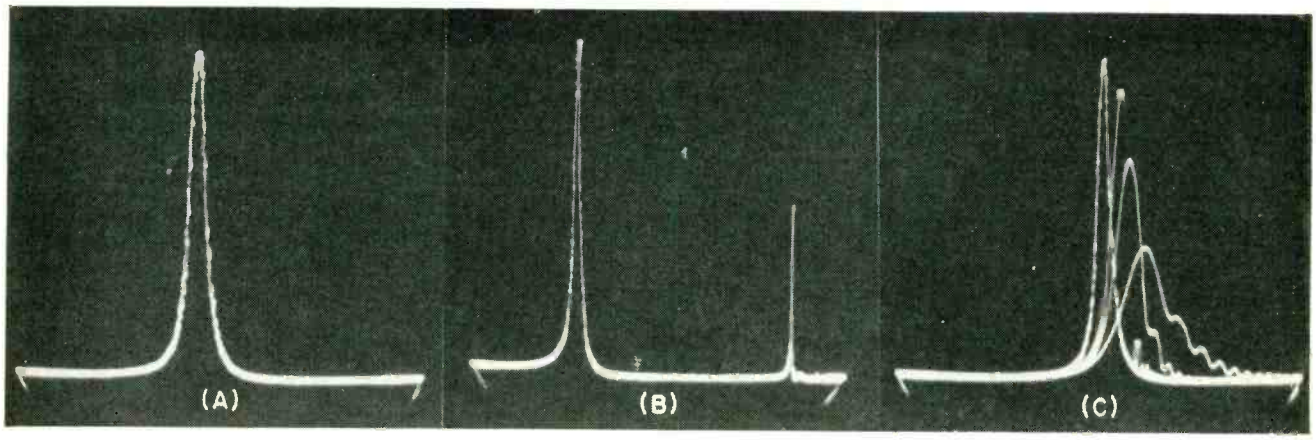

FIG. 4—Symmetrical response curve of a 6-mc crystal unit (A); undesired response to the right of the desired nominal frequency with a sweep width of 40 kc (B); and four sweep cycles of different rates of change of frequency (C)

sum of the signals (which are effectively grounded), and becomes a relatively high impedance to the difference frequencies which are the desired heterodyned signals. The low Q of the tank circuit is necessary to provide constant load impedance over the sweep width of the difference frequency of the two signals.

The wide-band amplifier consists of three stages V_6, V_7 and V_8 with shunt peaking in the plate load of each tube. The overall gain of the amplifier is approximately 20 db ±6 db from 100 kc to 20 mc. The output from the mixer tube is fed to this section so that sufficient voltage may thus be obtained to drive the crystal unit.

Transmission Amplifier

This amplifier was designed to measure the transmission characteristics of quartz crystals over a preselected frequency range. The necessity for this type of circuit may be realized from a review of the influence of external reactances on the dynamic evaluation of quartz resonators.[4]

Vacuum tube V_{9A} is a cathode follower which provides relatively constant input impedance over a wide range of frequencies. The output of V_{9A} is coupled from R_2 through the crystal unit under analysis to the cathode of V_{9B}. This section forms a grounded-grid amplifier whose output is determined by the magnitude of r-f voltage admitted to R_3 due to the admittance of the quartz crystal. The values of R_2 and R_3 were selected so that a minimum phase shift would occur due to the effects of stray capacitance associated with the measuring circuit.

R-F Detector

The network comprising C_2, CR_1, CR_2 and R_4 forms an r-f detector which provides a d-c voltage whose magnitude varies linearly with the amplitude of the r-f input voltage. Diode CR_1 serves to discharge capacitor C_2 which accumulates a negative charge during the conduction of diode CR_2. As the f-m signal is fed to the input of the transmission amplifier, V_{9A}, the output of V_{9B} varies in magnitude with the admittance characteristic of the test crystal.

This voltage is then rectified in the r-f detector stage and applied to the vertical plates of the oscilloscope. The frequency-modulating voltage applied to V_1 screen grid is obtained from the output of the oscilloscope's time-base generator. Therefore, the characteristic display on the oscilloscope represents an essentially linear frequency spectrum providing relative magnitudes of frequency response throughout the visible spectrum.

Vacuum-Tube Pulsemeter

This circuit is incorporated to provide a spurious frequency examination of a quartz crystal without the use of an oscilloscope. It consists of a direct-coupled bridge-type amplifier, V_{10} whose unbalance is effected by variations in the detected output from the r-f detector stage. This unbalance is indicated by a microammeter which is connected between the plates of V_{10A} and V_{10B}. Resistor R_5 and tube V_{10A} form one section of the bridge system, while R_6 and V_{10B} form the other section.

Balance of the system is accomplished by the setting of potentiometer R_9 which compensates in V_{10B} for the d-c level at the grid of V_{10A} due to direct coupling. Diode CR_3 is used as an unidirectional controller. Degeneration in the amplifier through R_8 and R_9 provides increased stability of the system against effects of line-voltage or tube-characteristic variations. Potentiometer R_{10} is used to limit the current through the meter. It is adjusted to provide ample deflection sensitivity for each crystal analysed.

The analyzer can be adapted to the investigation of mechanical i-f filters as well as other tuned circuits whose bandwidths do not exceed the sweep spectrum of the frequency generator.

The author wishes to thank John F. Alves who assisted in this development; Albin M. Snadyc for his technical supervision and George C. Neuschaefer for his helpful suggestions and encouragement.

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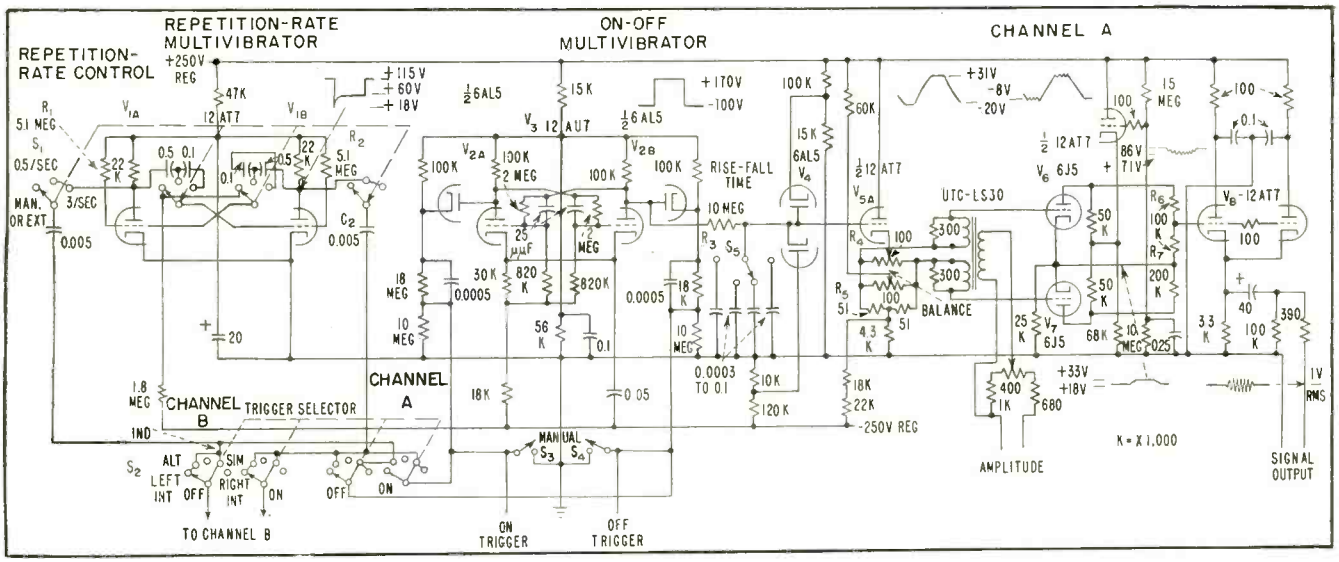

FIG. 1—With exception of repetition-rate multivibrator, V_1, channel *B* of electronic switch is a duplicate of channel **A**

Electronic Switch Eliminates Transients

SUMMARY —— Masking of signals by switching transients is reduced by balancing tube characteristics over entire operating curve. Designed for psychoacoustical research, the switch has applications in musical instruments, broadcasting and electroacoustics as well

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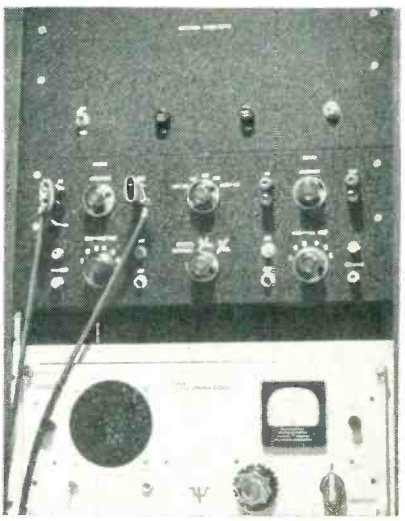
PSYCHOACOUSTIC investigation often requires paired sounds differing in physical parameters to be presented alternately to the ears of an observer. Various subjective attributes of sound can be determined in this way.

Equal loudness contours can be established by subjective comparison of the loudness of a test tone with that of a standard reference tone. Equal pitch contours are secured in essentially the same way.

Mechanical devices have been used for switching but more refined techniques and experiments require electronic control of the rise, fall and duration of the tone-pulse stimuli. Studies of the time element in speech communication and the intelligibility of interrupted speech also require the use of electronic

*Work done at Central Institute for the Deaf, St. Louis, Mo.



Rack-mounted switch for acoustical research. Monitor amplifier is at bottom with regulated power supply mounted at top of panel rack

switches controlling one or two channels.

Switch Design

The electronic switch described here was designed for auditory research but can be used in musical instruments, radio broadcasting, electroacoustics and industrial applications as well.

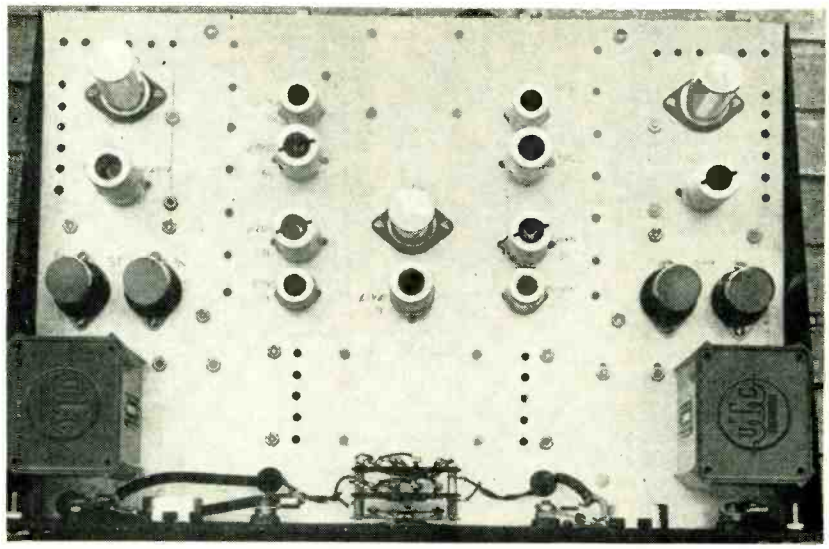
In conventional systems, switching of the signal is accomplished by biasing a tube to cutoff. This causes a large change in plate voltage which is superimposed on the signal. This fast voltage change is undesired but difficult to eliminate.

Steady-state plate current variations can be compensated relatively easily, but differences in transfer characteristics during the transition from off to on cause transients which are much more difficult to control. In psychoacoustic applications, this transition period may be an area of experimental interest. Unless precautions are taken to compensate for differences in the cutoff characteristics of the tubes used in balanced switches, the transition transient is usually only 20 to 30 decibels below the desired output signal.

In this circuit provision is made not only to balance switch-tube plate currents at the full-on condition but also at some intermediate point which can be shifted to make the best overall match along the entire transition characteristic. This balance is effected by means of separate adjustments which differentially control both the d-c level and amplitude of the switching voltages. The result is a reduction in the switching transient by 10 to 20 decibels more than in previous designs.

Construction

The present instrument consists of two identical but separate audio channels on the same chassis with a power supply. The channels can be turned on or off manually or automatically. This switching may occur alternately, simultaneously or independently. Automatic switching rates of one every two seconds or three per second may be selected internally. Externally controlled switching is also obtainable through jacks on the rear of the chassis.



Chassis arrangement has channel circuits at left and right, multivibrator in center

The rise and fall times of the signal are controlled by a six-position switch. Small adjustments of signal output may be made by means of the input attenuators which have a continuous range of three decibels.

Circuit Details

In the circuit diagram of Fig. 1, tube V_1 is an astable multivibrator used as the internal repetition-rate control. The timing of this multivibrator is determined by the grid resistors R_1 and R_2 and the plate-to-grid coupling capacitors switched in or out by S_1.

The output waveform from the plate of V_{1B} is shown on the circuit diagram. Only the negative-going edge of this waveform coupled through C_1 or C_2 is used as the trigger source for either turning on or off the corresponding channel. Switch S_2 is used to transmit these triggering pulses or comparable external pulses either simultaneously, alternately or independently to the on-off multivibrator V_3 in each channel.

The on-off multivibrator is bistable. The section conducting is determined by the negative triggering pulses through coupling diodes V_2. These control pulses may be derived from the repetition-rate multivibrator or from an external source. They may be obtained manually also by depressing either the on or off button on the front panel.

When a negative voltage pulse of sufficient amplitude appears on the cathode of V_{2A}, for example, the diode draws current, dropping the voltage on the plate of V_{3A}. This pulse is coupled to the grid of V_{3B}, cutting off plate current.

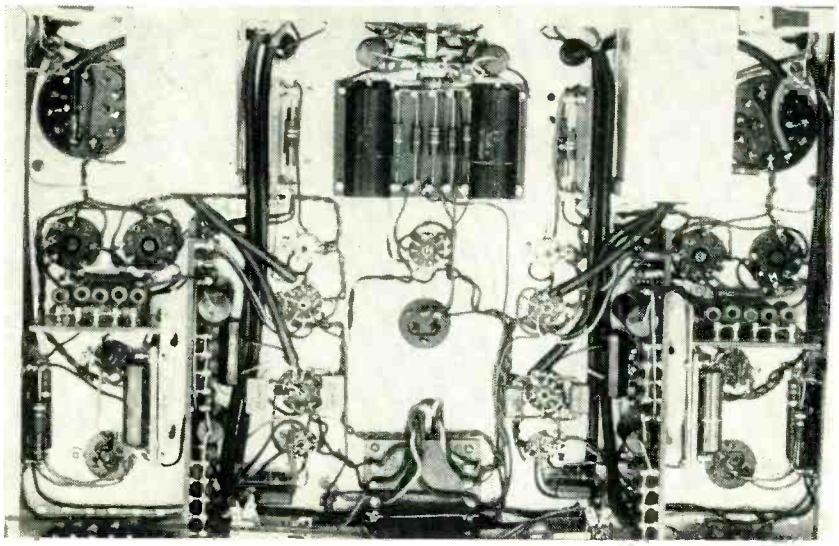
The plate voltage of V_{3B} then rises to +170 volts. This positive voltage step is coupled to the control grid of V_{3A}, turning that section of the tube on. This is one of the stable states of the multivibrator.

When a negative pulse is coupled through diode V_{2B} the reverse process occurs; V_{3A} is turned off and V_{3B} is turned on, resulting in a drop in plate voltage to −100 volts. This is so because the circuit returns to a −250-volt supply. This other stable state of the multivibrator turns the channel off.

As soon as one section of V_3 is conducting the coupling diode connected to it is made nonconducting because its cathode is then at a much higher potential than its plate. The diode thus effectively decouples the multivibrator from the trigger circuit. Only a negative pulse at the opposite diode can now get through.

Integrator

The switching voltage generated at the plate of V_{3B} is fed to an integrating and clamping circuit, producing the waveforms shown for this section of the circuit. The integrating circuit, which determines the rise-fall time of the signal, consists of R_3 and one of the six capacitors selected by switch S_5. Values of



Terminal board construction is used on electronic switch chassis

these capacitors range from 300 $\mu\mu$f to 0.1 μf. This circuit converts the vertical sides of the switching waveform to sloping sides with the rate of change of voltage depending on the time constant of the integrator.

The upper and lower limits of this waveform are clamped at predetermined levels by duodiode V_4. Linear rise and fall of the trapezoidal waveform requires that the rectangular switching voltage be as large as possible. For equal rise and fall times the rectangle must be symmetrical about the mean value of the trapezoid. This is another reason for a negative supply.

The trapezoid is fed to the grid of cathode follower V_{5A}. The maximum cathode voltage is about 31 volts, the optimum value for turning on the switch tubes with the least distortion. The minimum voltage at the cathode is −8 volts, low enough to cut off the plate current in the switch tubes.

The grid voltage of V_{5A} is purposely made to swing beyond the value needed to cut off the plate current. The extra time involved in this process thereby insures that the channel is not turned on before the other is completely off.

Balancing

Balance potentiometers R_4 and R_5 compensate for unbalance in switch tubes V_6 and V_7. Potentiometer R_4 connected directly to the output of V_{5A} changes the amplitude of the switching voltage, and the center tap of R_5 connects to the positive supply to change the average value of the trapezoid on one grid relative to the other.

The balance potentiometers are designed to change these variables by about one percent. This is sufficient to minimize the transient in the output of the switch tubes.

The audio signal from the input terminals is fed through the 3-db attenuator to the input transformer. The secondary of this transformer is split so that the signal is presented to the control grids of the switch tubes out of phase and in series with the switching voltage from the balance potentiometers.

Switching tubes V_6 and V_7 are arranged as a differential push-pull amplifier. When they are switched on the signal is picked off the plate of V_6 through R_6. This signal is not degenerated by the common cathode resistor, since it has out-of-phase signal currents flowing through it without any net signal voltage across it. This is indicated in the waveform at this point showing only the switching trapezoid at the cathode.

Because the plate resistors are twice as large as the cathode resistance and R_6 and R_7 are equal the voltage at their junction is one-half the supply voltage for these tubes, or 50 volts. This is true whether the switch is on or off. The differential arrangement of the switch tubes acts to keep the output independent of in-phase voltage changes at the grids produced by the switching waveform. The output is thus free of switching transients insofar as the tubes and associated components are balanced. One-percent resistors are used in this portion of the circuit. The bridge circuit which balances out the d-c shifts at plate and cathode was developed by the Grason Stadler Co. of Cambridge, Mass.

The discrimination of a differential amplifier against in-phase signals depends on equality of tube characteristics. They can not be made equal all the way from cutoff to full on but they are partially compensated for by the balance circuit.

The output of the switch tubes is fed to the double triode V_8 connected as a cathode follower. The high mutual conductance of the 12AT7 makes it very effective for this purpose. Its large amplification factor also helps to discriminate against power supply noise. This circuit provides a one-volt output into 600 ohms with the distortion down 45 to 50 db.

The peak-to-peak switching transient has been found to be less than one percent of the signal for eight out of ten 6J5 tubes when they were grouped in best matched pairs. To increase stability of the balance the tubes were aged 100 hours. The short-term stability of the circuit is exceptionally good because of the regulated power supply. But because the switch tubes are direct-coupled the balance is subject to the usual cathode emission drift and thus has to be checked occasionally.

Two instruments have been built aided by a grant from the National Institutes of Neurological Diseases and Blindness and are now in operation. One is being used for psychoacoustic research at Central Institute for the Deaf in Saint Louis. The other is to be used in connection with medical research on the brain at the University of Wisconsin in Madison.

The authors acknowledge the assistance of Gerard M. Shickman of Central Institute for the Deaf in construction of the first instrument.

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Simple Color Computer

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REDUCTION OF DATA describing the spectral characteristic of a reflecting or transmitting light source to CIE tristimulus values and trichomatic coefficients[1] involves a tedious series of operations.

An analog-type tristimulus-value computer has been constructed for performing colorimetric data reduction with a minimum of effort.

The instrument depends for its accuracy upon a precision microammeter. The meter is used not only for calibration, but also to set in data and to read out results. Ultimate accuracy which can be achieved is therefore controlled largely by the accuracy to which the meter scale can be read by the operator.

The complete instrument is designed in such a way that the calibration can be easily checked and has sufficient sensitivity to compute trichromatic coefficients for any radiance occupying a band of more than 10 millimicrons (mμ) thoughout a substantial portion of the visible spectrum. For wavelength ranges near the extreme red and blue ends of the spectrum, the sensitivity is somewhat reduced. Experience with the computer has shown that trichromatic coefficients may be determined within ± 0.005.

The tristimulus values for any radiance distribution $R(\lambda)$ are given by the expressions

$$X = \int_{400}^{700} R(\lambda)\,\bar{x}\,d\lambda$$
$$Y = \int_{400}^{700} R(\lambda)\,\bar{y}\,d\lambda \qquad (1)$$
$$Z = \int_{400}^{700} R(\lambda)\,\bar{z}\,d\lambda$$

where X, Y and Z are the tristimulus values; x, y and z are the CIE colorimetric weighting functions; $R(\lambda)$ is the radiance in question and the intergrals are understood to be taken over the visible interval from 400 to 700mμ.

Functions x, y and z are shown in Fig. 1 normalized against $z = 1.0$ at 450 millimicrons. They represent in effect the color mixture curves for a standard observer and the CIE hypothetical primaries X, Y and Z. The ordinates of the three curves are adjusted so that there is an equal area under each curve.

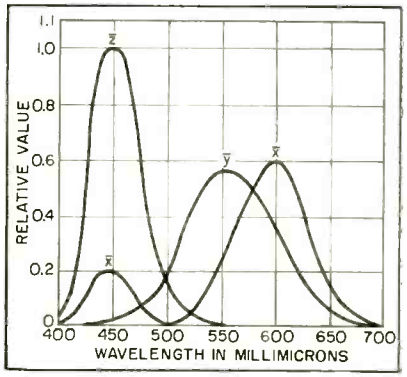


FIG. 1—Functions x, y and z normalized against $z = 1.0$ at 450 mμ

Integral Evaluation

Evaluation of the integrals in Eq. 1 is complicated by the fact that x, y and z are not analytic. However, their values have been calculated to a high degree of precision for every wavelength in the visible spectrum; a partial tabulation is given in Table I. In addition, it is only rarely true that the radiance $R(\lambda)$ can be written in a closed mathematical form. The indicated integrations are therefore invariably performed mechanically by one of the methods which are essentially equivalent to Simpson's rule. This calculation represents the bulk of the labor in colorimetric data reduction.

Having computed the quantities X, Y and Z the trichomatic coefficients x, y and z are obtained as

$$x = X/(X + Y + Z) = X/T$$
$$y = Y/(X + Y + Z) = Y/T \qquad (2)$$
$$z = Z/(X + Y + Z) = Z/T$$

where T represent total tristimulus value or $X + Y + Z$. Since only two of the trichromatic coefficients are independent of each other, it is customary to express a color by the three quantities x, y and Y. The CIE system of color specification is arranged so that the quantity Y carries information regarding the luminance of the color.

The tristimulus computer to be described performs the operations in Eq. 1 and Eq. 2 automatically.

To use the calculator, data on the radiance $R(\lambda)$ must be available at regularly spaced intervals throughout the visible spectrum. Specifically, it is desirable that the ordinates of $R(\lambda)$ be known at 10-millimicron intervals in the region from 400 to 690 millimicrons. The input elements to the computer comprise a group of 30 potentiometers, one for each such ordinate in the spectrum.

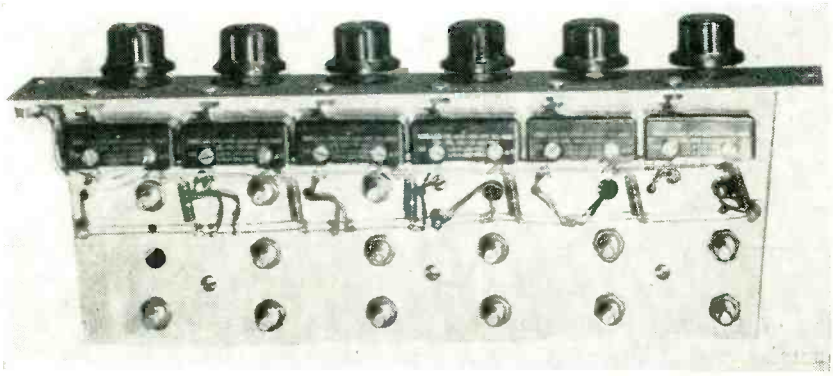
Control panel of tristimulus computer

Computer

A schematic representation of the five calculating panels of the computer is shown in Fig. 2. The input potentiometers at the top of

Gives Tristimulus Values

SUMMARY —— Trichromatic coefficients for CIE color-specification system are automatically computed by setting potentiometers to points on spectral transmission curve of filter or reflection curve of colored surface. Luminous efficiency of reflecting or transmitting surface may also be determined when absolute value of data is known



One of five computer subchassis. Each vertical row of controls and switches represents different wavelength channel

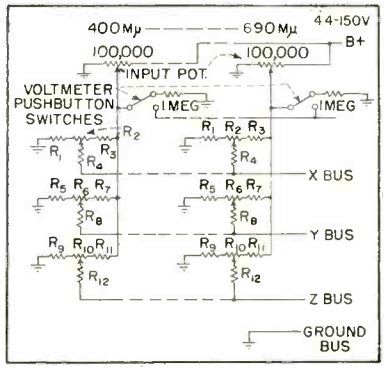


FIG. 2—Computer has identical set of controls for each wavelength

the diagram are all connected in parallel between a source of variable voltage and ground. Immediately adjacent to each of the potentiometer knobs, as shown in a photograph, a screw-headed pushbutton is provided, which may be depressed to connect the precision microammeter as a voltmeter to the arm of the potentiometer. Circuit resistance values are listed in Table II.

When operating the computer, each of the input potentiometers in turn is set to produce a voltage at its arm proportional to or equal to the value of the radiance ordinate at that particular wavelength by pressing the associated voltmeter button and reading the microammeter indication. When each potentiometer of the group has been adjusted, the data exists in the computer as a voltage distribution along the potentiometer string.

The arm of each input potentiometer in Fig. 2 is connected to a group of three networks. These networks may be thought of as voltage dividers. Their purpose is to weight the voltage existing on the potentiometer arm in accordance with the functions $\bar{x}$, $\bar{y}$ and $\bar{z}$. The voltage output from each of the dividers therefore represents one of the steps required in the mechanical integration of Eq. 1.

The output signal from each weighting network is delivered to a common busbar through a high value of series resistance. These busbars are labeled X, Y and Z in Fig. 2 and are terminated in a low resistance on the order of 50 ohms. As a result, by virtue of the high series resistance, the current delivered to each of the busbars by each of the networks is essentially proportional only to the setting of the corresponding input potentiometer and the value of the weighting function (attentuation) for that ordinate. The total current flowing in each of the three busbars is therefore proportional to the corresponding integral in Eq. 1.

The tristimulus value current on each of the three busbars is converted to trichromatic coefficient data by the circuit of Fig. 3, which performs the functions of Eq. 2. Switch S_1 determines the operating condition of the instrument. In position 1, the microameter is connected as a voltmeter for use in setting the original data into the machine. In position 2 (marked SET T = 100) all three of the tristimulus value busbars are connected through the meter to ground. For this position of the switch the meter reading is therefore proportional to $X + Y + Z$.

To obtain the trichromatic coefficients the meter-set control, Fig. 4, which varies the power supply potential of the instrument, is adjusted until the meter reads full scale or 100 units. This operation is in effect a normalizing process since it results in setting $T = X + Y +$

Table I—Tristimulus Values

Normalized against $\bar{z} = 1.0000$ at 450 mμ

Wavelength (mμ)	$\bar{x}$	$\bar{y}$	$\bar{z}$
400	0.0081	0.0002	0.0383
410	0.0245	0.0007	0.1170
420	0.0758	0.0022	0.3643
430	0.1602	0.0065	0.7819
440	0.1965	0.0130	0.9859
450	0.1897	0.0214	1.0000
460	0.1641	0.0339	0.9419
470	0.1103	0.0514	0.7266
480	0.0539	0.0784	0.4588
490	0.0181	0.1174	0.2625
500	0.0028	0.1823	0.1535
510	0.0052	0.2838	0.0893
520	0.0357	0.4007	0.0441
530	0.0934	0.4864	0.0238
540	0.1639	0.5383	0.0115
550	0.2446	0.5615	0.0049
560	0.3355	0.5615	0.0022
570	0.4301	0.5372	0.0012
580	0.5171	0.4909	0.0010
590	0.5791	0.4272	0.0006
600	0.5994	0.3561	0.0005
610	0.5658	0.2838	0.0002
620	0.4821	0.2150	0.0001
630	0.3625	0.1495	.....
640	0.2527	0.0988	.....
650	0.1600	0.0604	.....
660	0.0931	0.0344	.....
670	0.0493	0.0181	.....
680	0.0264	0.0096	.....
690	0.0128	0.0046	.....

Table II—Circuit values for calculating panels of Fig. 2

Wavelength (mμ)	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9	R_{10}	R_{11}	R_{12}
400	8.2 k	0	1 meg	1 meg	220	0	1 meg	1 meg	39 k	0	1 meg	1 meg
410	27 k	0	1 meg	1 meg	680	0	1 meg	1 meg	0	250 k	820 k	1 meg
420	0	100 k	1 meg	1 meg	2.2k	0	1 meg	1 meg	0	500 k	470 k	820 k
430	0	250 k	820 k	820 k	6.8 k	0	1 meg	1 meg	470 k	500 k	0	820 k
440	0	500 k	470 k	820 k	12 k	0	1 meg	1 meg	1 meg	100 k	0	1 meg
450	0	500 k	470 k	820 k	22 k	0	1 meg	1 meg	∞	0	0	1 meg
460	0	500 k	470 k	1 meg	33 k	0	1 meg	1 meg	1 meg	100 k	0	1 meg
470	0	250 k	820 k	1 meg	0	100 k	1 meg	1 meg	470 k	500 k	0	820 k
480	0	100 k	1 meg	1 meg	0	100 k	1 meg	1 meg	220 k	500 k	270 k	680 k
490	18 k	0	1 meg	1 meg	0	250 k	820 k	820 k	0	500 k	470 k	820 k
500	2.7 k	0	1 meg	1 meg	0	500 k	470 k	820 k	0	250 k	820 k	820 k
510	5.6 k	0	1 meg	1 meg	0	500 k	470 k	820 k	47 k	100 k	1 meg	1 meg
520	33 k	0	1 meg	1 meg	220 k	500 k	270 k	680 k	47 k	0	1 meg	1 meg
530	0	250 k	820 k	820 k	220 k	500 k	270 k	680 k	22 k	0	1 meg	1 meg
540	0	250 k	820 k	820 k	270 k	500 k	220 k	680 k	12 k	0	1 meg	1 meg
550	0	500 k	470 k	820 k	270 k	500 k	220 k	680 k	4.7 k	0	1 meg	1 meg
560	0	500 k	470 k	820 k	270 k	500 k	220 k	680 k	2.2 k	0	1 meg	1 meg
570	220 k	500 k	270 k	680 k	270 k	500 k	220 k	680 k	1.2 k	0	1 meg	1 meg
580	270 k	500 k	220 k	680 k	220 k	500 k	270 k	680 k	1.0 k	0	1 meg	1 meg
590	270 k	500 k	220 k	680 k	220 k	500 k	270 k	680 k	560	0	1 meg	1 meg
600	270 k	500 k	220 k	680 k	0	500 k	470 k	820 k	470	0	1 meg	1 meg
610	270 k	500 k	220 k	680 k	0	500 k	470 k	820 k	220	0	1 meg	1 meg
620	220 k	500 k	270 k	680 k	0	500 k	470 k	820 k	100	0	1 meg	1 meg
630	0	500 k	470 k	820 k	0	250 k	820 k	820 k	0	0	∞	1 meg
640	0	500 k	470 k	820 k	0	250 k	820 k	820 k	0	0	∞	1 meg
650	0	250 k	820 k	820 k	0	100 k	1 meg	1 meg	0	0	∞	1 meg
660	0	250 k	820 k	820 k	33 k	0	1 meg	1 meg	0	0	∞	1 meg
670	0	100 k	1 meg	1 meg	18 k	0	1 meg	1 meg	0	0	∞	1 meg
680	27 k	0	1 meg	1 meg	10 k	0	1 meg	1 meg	0	0	∞	1 meg
690	12 k	0	1 meg	1 meg	4.7 k	0	1 meg	1 meg	0	0	∞	1 meg

K = ×1,000

$Z = 100$ in Eq. 2.

Switch S_1 is next thrown to position 3 (marked X). For this connection, the Y and Z busbars pass directly to ground through a resistance equivalent to the meter resistance so that only the X busbar current flows through the meter itself. Because of the normalizing process the meter deflection is proportional to the contribution of X to the total tristimulus value T. If the full-scale meter reading is taken as unity, the meter reading therefore corresponds to the trichromatic coefficient x. The remaining positions of S_1 allow a measurement of the relative contributions of Y and Z to the total and therefore yield the trichromatic coefficients y and z.

The tristimulus computer may be used to calculate the luminous efficiency of a transmitting filter or a reflecting surface by a technique involving a comparison of the luminosity of the given radiance with that of equal-energy white.

Luminous Efficiency

The spectral characteristic of a Wratten No. 58 (tricolor green) filter is shown in Fig. 5. The ordinates of this curve represent the transmission of the filter at any wavelength relative to a perfectly transmitting medium. The maximum transmission occurs at approximately 530 millimicrons and has a magnitude of approximately 53.6 percent. The luminous efficiency of such filter or of any reflecting or transmitting medium is a measure of the luminance of the light from the sample relative to the luminance of a perfectly transmitting or reflecting medium when both are illuminated by the same intensity of equal-energy white light.

The luminous efficiency B of any spectral distribution is given by

$$B = Y/Y_e \qquad (3)$$

where Y_e represents luminance of the reference equal-energy white source. Calculation of the quantity B on the tristimulus computer may be made by taking advantage of the fact that, from Eq. 2

$$Y = yT \qquad (4)$$

so that

$$B = yT/Y_e \qquad (5)$$

The computation therefore depends only upon finding y and T for the spectral data and upon normalizing T to the same scale as Y_e. It is necessary that the absolute value of the data be known. The curve of Fig. 5 provides a typical example.

Calculation

Calculation is begun by setting all of the computer data input potentiometers to their maximum positions. This sets reference equal-energy white into the machine. Switch S_1 is then turned to the position for reading y and the meter-set control is adjusted for a scale reading of 100 on the meter. Note the meter-set dial reading for future use as this dial setting calibrates the computer for $Y_e = 100$ in Eq. 5. For any particular model of the computer, this dial reading should always be the same.

Switch S_1 is then turned to the SET-ORDINATES position. With any one data input potentiometer set to its maximum position, the meter-set control is adjusted to give a reading of 100 on the meter when the corresponding push button is depressed. The ordinates of the curve may now be set into the computer directly in terms of percentage transmission or reflectance.

For example, the data of Fig. 5

indicates the transmission of the filter to be 53.6 per cent at a wavelength of 530 millimicrons. The 530-millimicron input potentiometer would therefore be set to give a reading of 53.6 on the meter.

When all of the data has been set into the computer in this manner, the meter-set dial is set to the reading noted at the start of the computation which calibrated the computer for $Y_c = 100$. Switch S_1 is now set to the SET T = 100 position. The meter reading is noted; this gives the value of T/Y = absolute value of $T/100$ in Eq. 5.

The final factor y, in Eq. 5, must now be found. With the data input potentiometers and S_1 positions unchanged, the meter-set dial is turned until the meter reads full scale. Switch S_1 is then turned to the Y position and the meter reading noted. The luminous efficiency of the spectral characteristic is now the product of the last two factors noted according to Eq. 5.

It is well to remember during this last step of the calculation that the value of y always lies in the range of 0 to 1.0. The values of T and Y_c will usually be of the same order of magnitude. Attention should be paid to the scale factor when reading the value of T from the instrument.

Calibration and Adjustment

The microammeter is also used to insert the colorimetric functions $\bar{x}$, $\bar{y}$ and $\bar{z}$ into the instrument. The procedure depends upon successive measurements of the current contributed by each of the 90 dividing networks to their respective tristimulus value busbars. The reference used for this operation is the maximum value of the function $\bar{z}$ at the wavelength 450 millimicrons (Table I). This maximum value exceeds those of the other two functions and is arbitrarily taken as a unity-value weighting coefficient.

To proceed with the adjustment, all of the data input potentiometers, save the one corresponding to 450 millimicrons should be turned to zero. The 450-millimicron potentiometer should be set to maximum value. With the microammeter selector switch S_1 set to the z trichromatic-coefficient position the power-supply voltage (meter-set dial) and the meter shunt should be adjusted until a full-scale reading is obtained. The meter-set dial should not be changed during the remainder of the adjustment procedure, although the microammeter shunt may be manipulated to expand low readings if this appears desirable.

Having normalized the microammeter reading in this manner, the 450-millimicron input potentiometer is turned to zero. Next, with switch S_1 remaining on the z-trichromatic-coefficient position, each one of the data input potentiometers is, in turn, advanced to maximum. The division ratio of the corresponding $\bar{z}$ busbar dividing network is then adjusted so that the microammeter reading agrees with the tabulation of the $\bar{z}$ function in Table I. When each network is adjusted, the potentiometer is returned to zero and the operator proceeds to the next network. The location of the adjusting potentiometers is shown in the side-view photograph of one of the calculating panels.

When the entire group of 30 dividing networks for the Z busbar has been adjusted or checked, meter-selector switch S_1 should be thrown either to the X busbar or the Y busbar and the entire procedure repeated. It will be noted from Table II that a number of the division ratios are fixed. This is because their contribution to the overall current is so small that a precision adjustment is not required. It should be emphasized that throughout the entire procedure the value of $\bar{z}$ at 450 millimicrons provides the reference value for the adjustments. As the adjustment procedure is time consuming, it is desirable to check the power-supply voltage against this reference point from time to time.

Upon completion of the adjustment, a check of the accuracy which has been achieved may be made by advancing all the data-input potentiometers to their maximum value. The meter-set control should then be adjusted until the meter reads full scale. Transfer of the meter to the three trichromatic-coefficient positions should yield readings of 0.333 in each case. These are, of course, the trichromatic coefficients of an equal-energy white source.

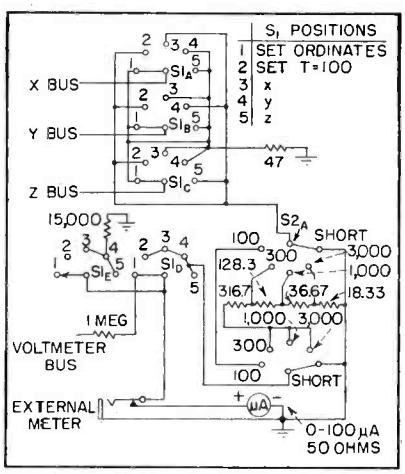


FIG. 3—Computer switching circuits

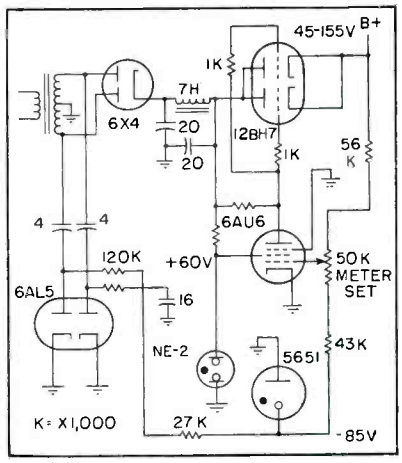


FIG. 4—Variable-voltage power supply. Meter-set control is 10-turn helical potentiometer

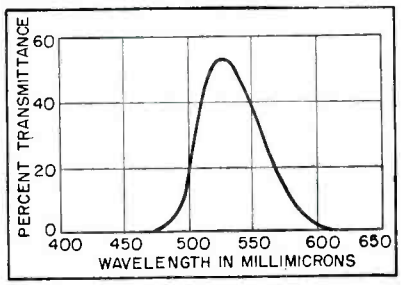


FIG. 5—Characteristics of Wratten No. 58 (tricolor green) filter

REFERENCE

(1) Commission International de l'Eclairage, Recueil des Travaux et compte des Seances—Huitieme Session, Cambridge, England, Sept. 1931.

Power Rating Parasitic Suppressors

SUMMARY — Incomplete bypassing of parasitic suppressors to harmonic currents imposes power requirements on the resistors. Chart enables designer to estimate power ratings of resistors used as parasitic suppressors

By JOSEPH A. HUIE
Penfield, New York

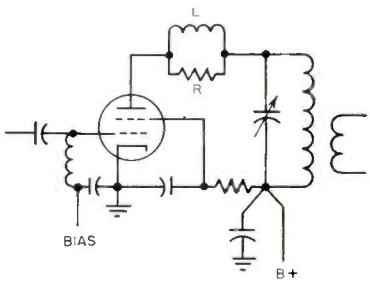


FIG. 1—R-L parasitic suppressor

ONE most common and effective method for preventing vhf parasitic oscillation in high-frequency amplifiers is use of a parallel R-L network in the plate lead of the amplifier as shown in Fig. 1. The coil is usually about 4 to 6 turns wound on a small form, often the resistor. The resistor value is normally between 50 and 100 ohms.

It is sometimes assumed that the coil at the operating frequency acts as a perfect bypass so the resistor carries no current and the wattage rating is not important. This is not strictly the case. The coil always has some reactance and at high operating frequencies this becomes an important consideration.

The curves relate the factor K to the inductive reactance-over-resistance ratio X_L/R at the fundamental frequency, where K is proportional to the square of the effective heating current through the resistor. Curves are given for three values of conduction angle in class-C amplifier operation. The curves were computed assuming $\alpha = 3/2$ and considering all harmonics up to the fourth.

Example

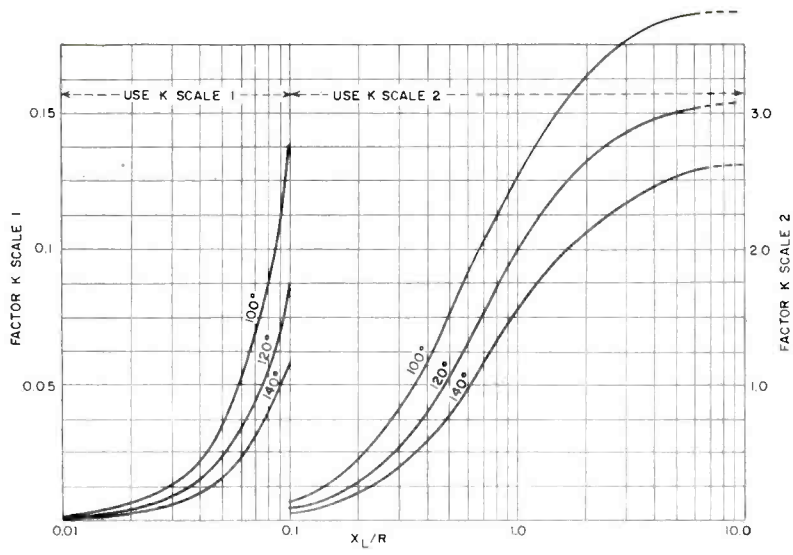
The power dissipated in the parasitic suppressor resistor is $I_{d\text{-}c}^2RK$, where $I_{d\text{-}c}$ is the d-c plate current in amperes, R is the resistance in ohms and K is the factor taken from the curves.

The following information is known: coil = $\frac{3}{8}$ in. dia × $\frac{5}{8}$ in. long, 5 turns; resistor = 47 ohms; $I_{d\text{-}c}$ = 200 ma.; conduction angle = 120 deg and frequency = 20 mc.

The coil inductance can be computed or measured to be about 0.115 μh. Then $X_L = 2\pi fL = 14.4$ ohms and $X_L/R = 0.308$.

From the curves K is found to be 0.6, so the power dissipated in the resistor is $I_{d\text{-}c}^2RK = 1.12$ watts.

If the amplifier is modulated 100 percent with a sine wave, the resistor power will be about 1.5 times the unmodulated power or 1.68 watts. A 2-watt resistor should then be used.



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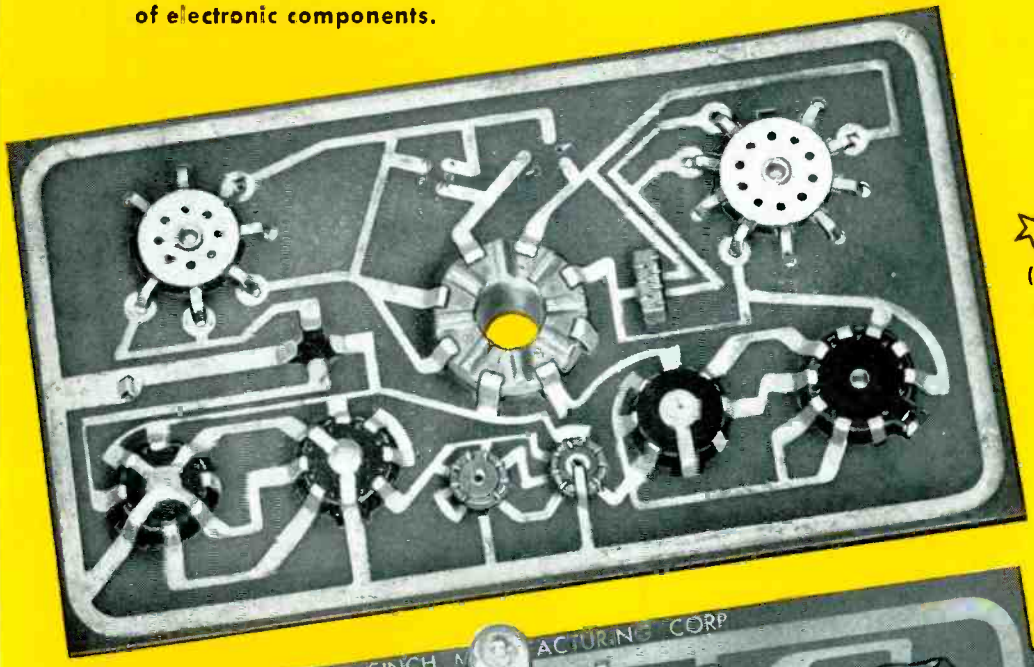
(Below) Seven pin stem type for tubes vertically mounted.



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Microphone Nomograph

SUMMARY —— Chart relates sound pressure level, microphone sensitivity and output in decibels and volts as aid in design of microphone systems and related equipment. Typical sound levels for common sounds are indicated

By WILLIAM B. CONOVER
Transformer Laboratories Department
General Electric Company
Pittsfield, Mass.

MICROPHONE response is usually expressed in decibels referred to 1 volt per dyne/cm². Thus a microphone which produces 1 volt when exposed to a a sound pressure of 1 dyne/cm² has a response of 0 db. Most microphones are far less sensitive than this.

Unless otherwise specified, the open-circuit voltage is used in arriving at the response figure.

The nomograph is based on the definition of pressure response in the American Standard Specification for Laboratory Standard Microphones.

Expressed symbolically, this definition becomes

$$\rho = 20 \log (e_o/p) \qquad (1)$$

where ρ = pressure response, e_o = open-circuit output voltage and p = pressure in dynes/cm². Equation 1 may be rewritten

$$\rho = 20 \log e_o - 20 \log p \qquad (2)$$

Sound pressure is commonly expressed in decibels relative to a reference pressure $p_o = 2 \times 10^{-4}$ dynes/cm². When so expressed it is called sound pressure level *SPL* and is defined by

$$SPL = 20 \log (p/p_o) \text{ decibels} \qquad (3)$$

Equation 2 and 3 yield

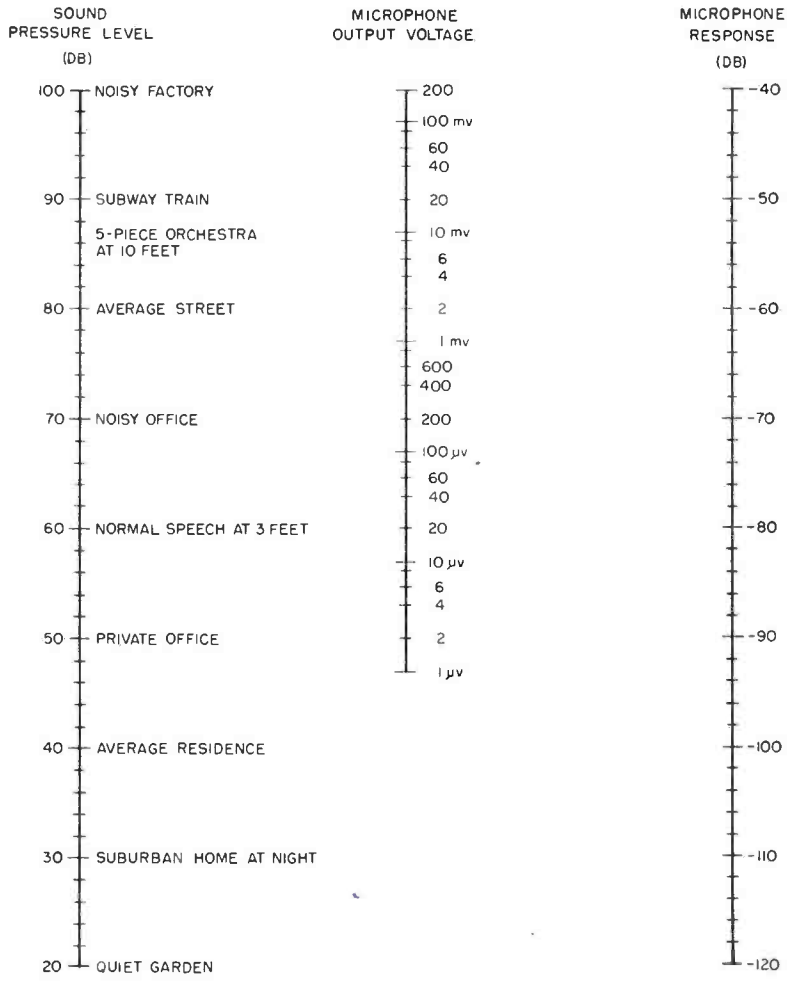
$$\rho = 20 \log e_o - SPL + 74 \text{ decibels} \qquad (4)$$

Should absolute sound pressures be required, they may be filled in on the lefthand scale by noting that 100 db = 20 dynes/cm², 80 db = 2 dynes/cm², 60 db = 0.2 dyne/cm² and so forth.

A microphone with a response of −50 db is to be used to measure sound levels of 35 db or more. For what minimum input voltage should the amplifier be designed?

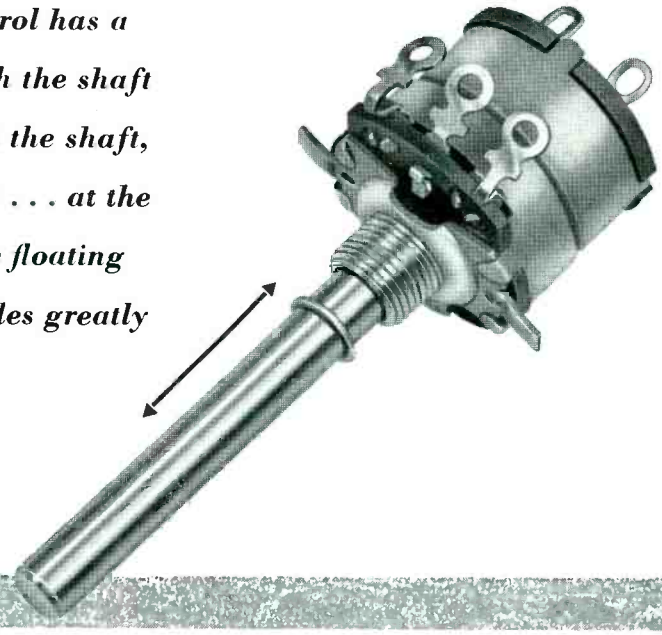
A straight line drawn between 35 db on the *SPL* scale and −50 db on the ρ scale intersects the e_o scale at about 35μv. This is the open-circuit microphone voltage.

Sound level in a jet-engine test control room is 112 db; a pneumatic chipper at a distance of 5 feet has a sound level of 122 db. At takeoff and 80 ft from the tail, an F-84 has a sound level of 130 db, all typical values.

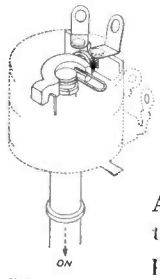


MALLORY

New Mallory volume control has a unique on-off switch. Push the shaft and the set turns off. Pull the shaft, and the set is switched on . . . at the same volume setting. New floating ring contact action provides greatly increased switch life.



New Push-pull On-off Action– in Mallory Volume Control Switches



Floating ring contact* *gives* extra long switch life

A new kind of contact is used in the Mallory push-pull switch to provide exceptionally long service. The circuit is made and broken by the movement of a ring of special Mallory contact alloy. The ring "floats" on a pin. Every time the switch is used, the contact ring rotates slightly, exposing a new portion of its surface to the stationary contacts. Contact wear and erosion are thus spread around the whole circumference of the ring . . . and contact life is thus substantially increased.

**Patent applied for*

THIS new sales feature can be designed into radio and television sets, by using the new Mallory volume control switch. To turn on and off, this switch operates by push-pull action instead of the conventional rotary motion. Two principal advantages of this new idea are evident:

Greater convenience to the set owner. He turns the set on at the same volume at which he turned it off . . . doesn't have to re-adjust.

Longer life of the volume control. Instead of being rotated through most of its travel every time the set is turned on or off, the control is moved only for minor volume adjustments. Consequently, there is far less mechanical wear on the carbon element.

Mallory volume controls, with high stability, long lasting elements, are now available with this new switch . . . in either the push-pull type or conventional rotary action. For complete data, write or call Mallory today.

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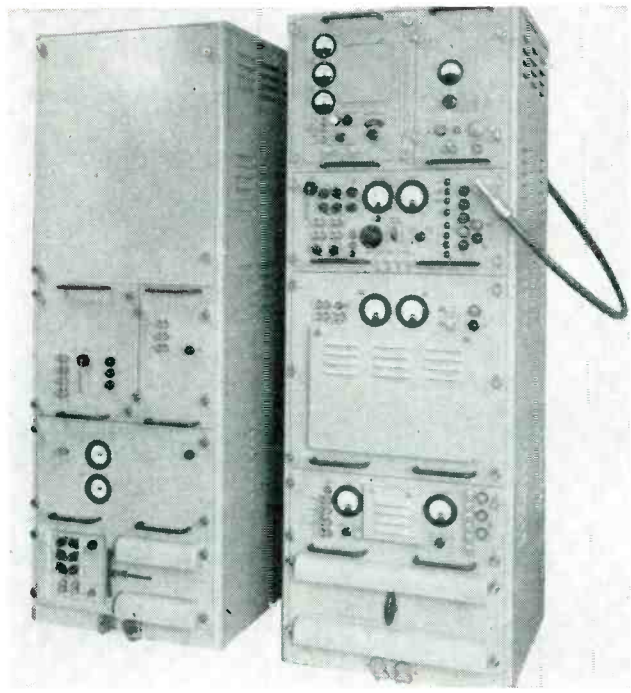
Electrons At Work

Edited by ALEXANDER A. McKENZIE

Experimental TACAN antenna atop 300-ft tower



Shipborne TACAN receiver and transmitter units

TACAN Navigation System Shows Bearing and Distance

TACAN (*TAC*tical Air *N*avigation) is a polar co-ordinate type of air navigation system combining a bearing facility and distance facility. The pilot receives from the ground station information that automatically displays degrees of bearing and distance in miles to locate the position of his aircraft. Bearing accuracy is better than plus or minus 1 deg and distance is accurate within plus or minus 600 feet plus 0.15 percent of the distance measured.

The entire system operates in the region of 1,000 mc. A single multichannel receiver-transmitter, operating with pulses, provides distance and omnirange information. Pulse coding is not used for channeling purposes, which makes it possible to add other functions such as localizer, glide path and marker beacon.

The distance indication facility (DME) is an outgrowth of radar ranging techniques whereby distance is determined by measuring round-trip time of travel of radio pulses. This is illustrated in Fig. 1. Each plane's interrogation pulses are wobbled or jittered to prevent ambiguities that might arise if regular pulses from two or more planes coincided. Actually, twin pulses are used with prearranged spacing of 12 microseconds. Both ground and air receivers contain twin-pulse decoders that reject single pulses or groups with other than prearranged spacing.

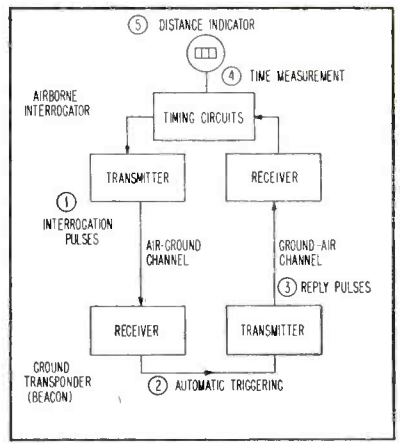


FIG. 1—Principles of DME operation

Bearing indication depends upon a complex transmitting antenna comprising a fixed center section and two coaxial rotating sections. The unit under its protective cover is a cylinder about four feet high and three and a half in diameter. No counterpoise is required, thus simplifying the siting of the ground station.

As shown in Fig. 2, (though not drawn to scale), r-f energy is fed to the central element, which is sta-

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The regulation analyzer is designed to measure DC voltage to 0.1%, the percentage change in DC voltage, and the RMS ripple of regulated and unregulated power sources.

DC VOLTAGE TEST RANGE: 1.018 volts to 1112 volts.
PERCENT REGULATION RANGES: Three sensitivity ranges are provided for measuring % regulation from .002% to 10%.

RMS RIPPLE RANGE: 0-100 volts in 11 ranges: 0-1, 5, 10, 50, 100, 500 millivolts. 0-1, 5, 10, 50,100 volts.

★ POWER SUPPLY VARIABLE LOAD — MODEL 910

The power supply variable load consists of an electronic load and a resistor load. The electronic load covers the range 60-600 volts from 0-600 ma. The resistor load covers the range 0-100 volts, 0-600 ma. Provision is made for automatically modulating either the resistor load or the electronic load 10 seconds on and 10 seconds off. In addition, the electronic load can be internally modulated with a 60 cycle square wave or externally modulated with a voltage wave of any shape or frequency.

★ LINE VOLTAGE ADJUSTER — MODEL 920

The line voltage adjuster provides for adjusting the line voltage from 95 to 135 volts AC for any fixed input voltage in the range 95 to 135 volts AC. The capacity of this unit is 3KVA. At any fixed output voltage setting, the output voltage can be decreased as a step function from 0 to 40 volts.

★ *Units are available separately*

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VOLTAGE REGULATED POWER SUPPLY UNDER TEST

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REGULATION: As shown in table for both line fluctuations from 105-125 volts and load variations from minimum to maximum current.

***REGULATION FOR BIAS SUPPLY:** 10 millivolts for line 105-125 volts. ½% for load at 150 volts.
† AC Voltage is unregulated.

OUTPUT	VOLTS	CURRENT	REGULATION	RIPPLE
1	0-600	0-500 Ma.	0.2 Volts	3 Mv.
2	0-150 Bias	0-5 Ma.	*	1 Mv.
3	6.3 AC	20 Amp.	†	

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tionary. It is actually a stack of discone radiators. Diameter is a few inches.

An inner cylinder of fiber glass with diameter of about 5 inches carries a vertical metal wire. As it rotates, it generates a cardioid pattern by interaction with the vertical antenna. Rotation rate is 15 rps. The aircraft receives, in effect, a 15-cps audio sine wave. A coded reference signal sent out by the reference pulse disk serves as timing reference.

When received on the aircraft, it is used to measure the phase of the pulse envelope wave resulting from the combination of vertical-wire rotation and double pulses. By this means, the bearing of the aircraft relative to the ground station can be determined and appropriately displayed.

However, there are limitations to the accuracy of the simple cardioid system. The antenna structure is therefore equipped with an outer cylinder about 33 inches in diameter. Nine wires, or parasitic antenna elements, are spaced uniformly 40 degrees apart. As these wires rotate integrally at 15 rps with the inner cylinder a resulting composite pattern is generated as shown in Fig. 3. The overall cardioid is still present, but superimposed upon it are nine secondary

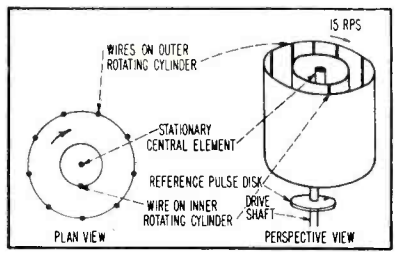


FIG. 2—Tacan antenna design explained in text

ripples with maxima spaced 40 degrees apart.

The composite envelope wave received on the aircraft and shown in rectangular coordinates in the lower half of Fig. 3 has a 9th harmonic frequency of 135 cycles per second.

By filtering and using both signals, small changes in bearing within any 40-deg sector can be detected, producing a vernier or fine indication. The ambiguity of the 135-cps phase measurement is resolved by the 15-cps phase measurement.

Avoidance of site errors, which are propagational rather than instrumentational, generally require that the ground beacon of an omnirange station be situated over very flat terrain with no large buildings or structures within a considerable distance.

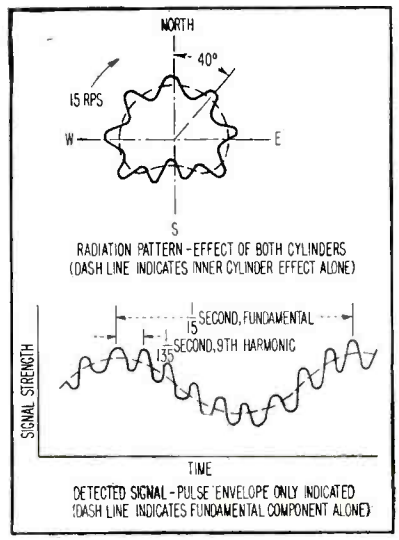


FIG. 3—Tacan fine omnirange principles resulting from triple antenna

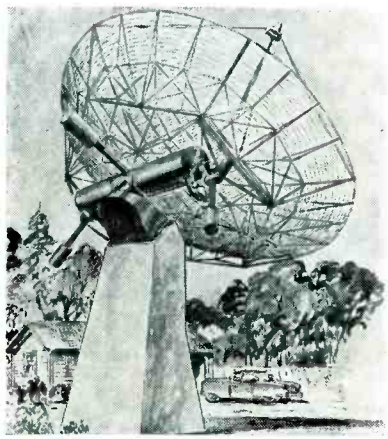
This type of error is minimized by use of the nine-lobed fine omnirange operation of Tacan, and is probably the system's most important feature.

This brief abstract of the basic Tacan system has been taken from a more complete report prepared by R. I. Colin, Assistant to the Technical Director, Federal Telecommunication Laboratories. The system was originated and developed by this division of International Telephone and Telegraph Corp. under contract with the U. S. Navy and Air Force.

Dynamic Spectrum Analyzer To Study Sun

DEVELOPMENT and construction of a new radio telescope for solar research has been announced by Donald H. Menzel, director of Harvard College Observatory. Technically known as the dynamic spectrum analyzer, it will be used to further basic knowledge of the sun by studies of the radio emission from active sunspots and other solar disturbances. The behavior of active regions in the sun's corona and chromosphere is closely related to many terrestrial phenomena such as magnetic and ionospheric disturbances, the aurora borealis and cosmic rays.

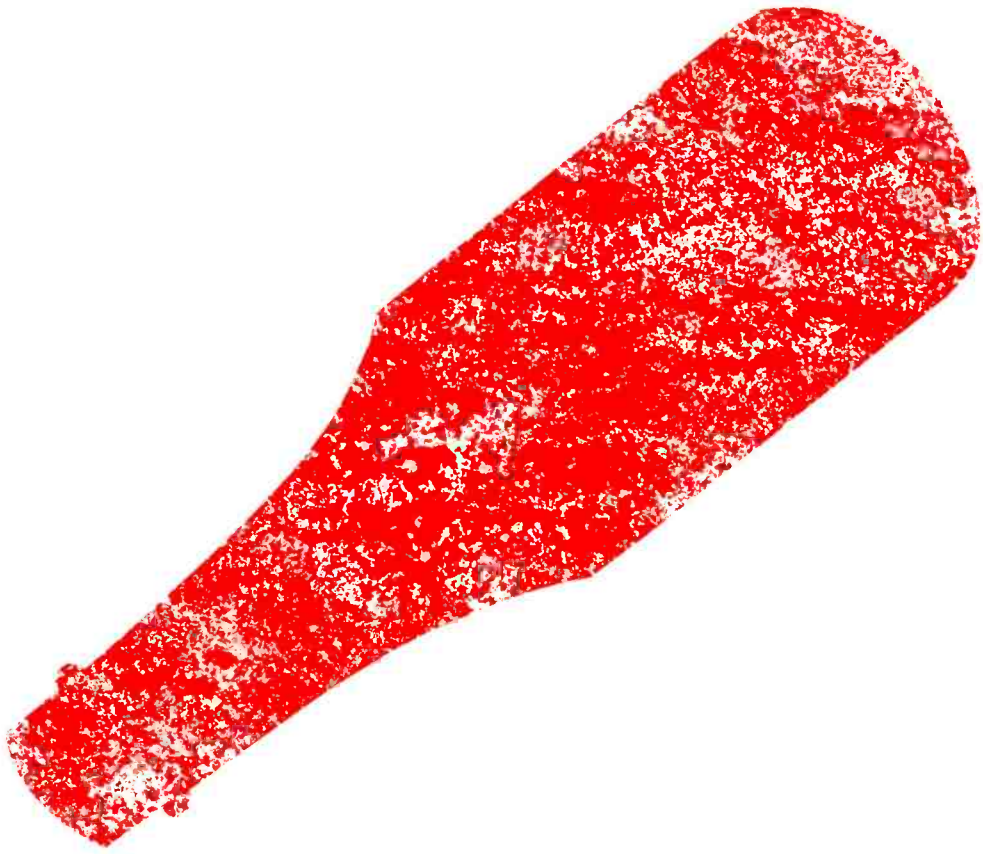
The radio telescope will consist of an antenna 28 feet in diameter, used in conjunction with highly sensitive receivers, which scan the frequency range from 100 to 600 megacycles ten times a second. This solar radio telescope, will be the first of its type in this country.



Artist's conception of the new Sacramento Peak radio telescope now under construction for installation next year

Henry Jasik, consulting engineer of Mineola, Long Island, serves as electronics consultant to the project and is responsible for carrying out antenna development. The large parabolic reflector and its equatorial mounting will be constructed by D. S. Kennedy Co. of Cohasset, Mass. Frequency-scanning receivers will be built at Airborne Instruments Laboratory, Mineola, Long Island.

The equipment will be placed in operation at the Upper Air Research Observatory at Sacramento Peak, New Mexico in the early part of 1956. This observatory, which is a joint scientific operation by Harvard and the Air Force, is now devoted largely to optical observa-



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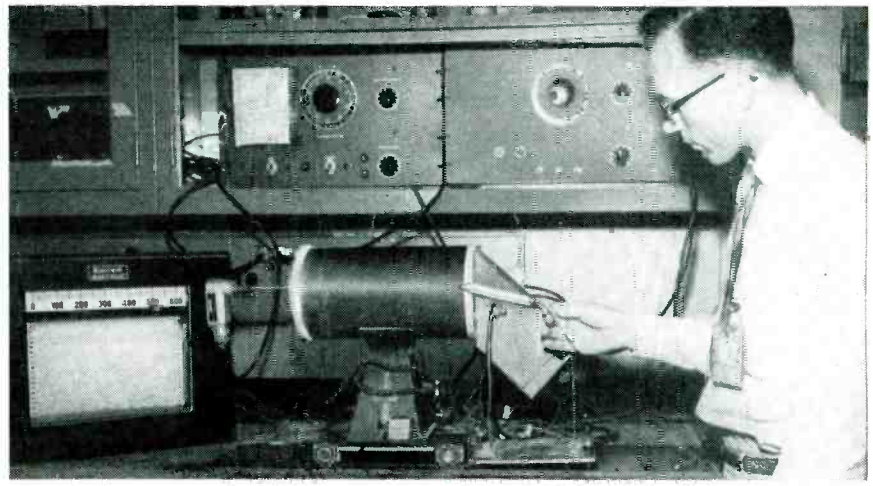
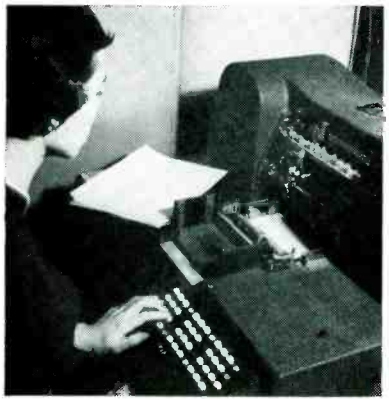
tions of the sun with coronagraphs and other specialized optical instruments. Construction of the new radio telescope has been made possible through financial support extended by the Geophysical Directorate of the Air Force Cambridge Research Center.

Properties of Lead Sulfide Crystals Changed

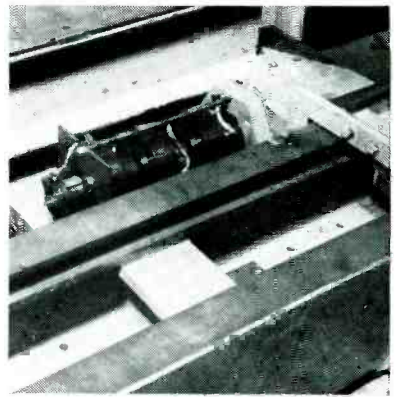


Electronically controlled apparatus developed by U. S. Naval Ordnance Laboratory in Silver Spring, Md. changes composition of PbS. Crystals and a quantity of sulphur are placed at opposite ends of a sealed evacuated quartz tube and put in a double oven to control crystal-vapor equilibrium and sulfur vapor pressure. Robert F. Brebrick of the Solid State Division, Physics Research Dept. is shown in the photograph

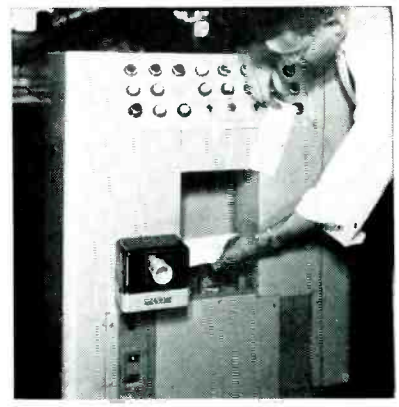
Card-Controlled Machines Are Thrice As Productive



Operating a standard business machine to punch holes in cards, the young lady simply follows the instruction program previously worked out for a specific job. A hand-punched hole made at the controlled machine can be used to change the instructions



Selsyn pickup unit installed on an 80-ton turret type punch press. This unit gives an automatic measurement of the table position to the numerical positioning control installation that carries out work orders contained in the previously punched cards



Business machine cards are loaded into GE positioning control director. A separate card is used for each punched hole. Direct-current feed drives the punch press as directed by selsyns in accordance with directions. Lights show sequence of work

Remote TV Camera Spots Forest Fires

RECENT TESTS of closed circuit television for fire control were made by Hancock Electronics Corp. of Oakland, Calif. for the California State Division of Forestry at Mount Danaher Station near Placerville.

The camera was mounted on the side of a 100-foot lookout tower and transmitted a picture to a fire dispatcher's office a few hundred yards distant. Mounted on a pan and tilt unit, full 360-deg pan with the camera was possible, either automatic or manual. Remote control of the lens turret was likewise obtained.

Tests showed that an eight-inch lens was best for general scanning and a 20-inch most desirable for detail. Best results were obtained with a Wratten K2 filter.

Television system used was a Vicon III that is flat to 8.5 mc. Output of the system is a composite video signal with equalizing pulses. A usable picture at ½ foot-candle is produced with better than 550

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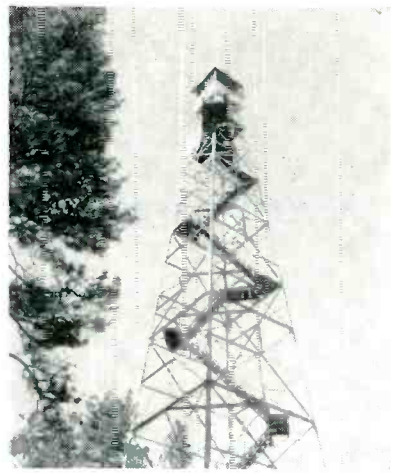


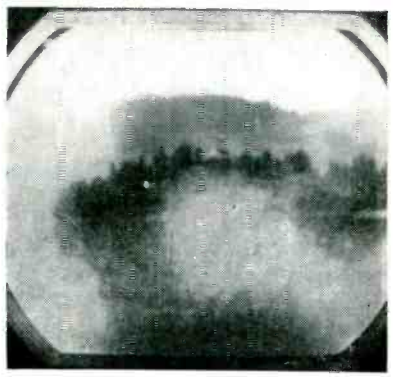
Cabin on Mt. Danaher lookout tower is 100 feet above ground

lines of horizontal resolution.

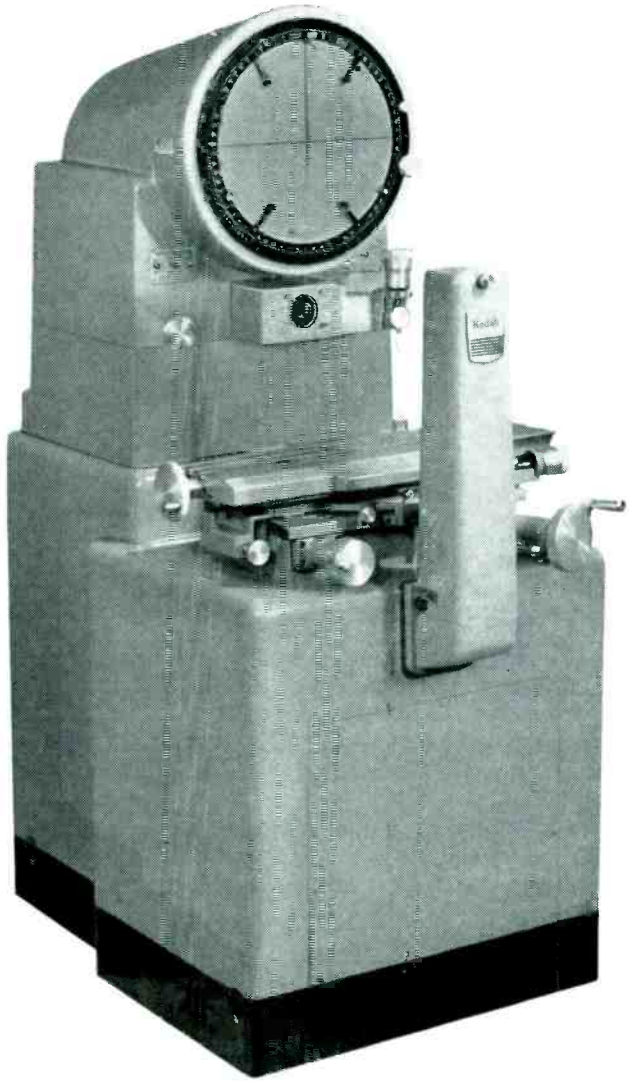
During tests, television was able to spot smokes ahead of human lookouts. Elapsed time between setting off a smoke and discovering it with television ranged from 3 to

Experimental pan and tilt equipment used with Vicon III and 16-in lens

9 seconds. Time elapsed between spotting the smoke by television and receiving a report from any lookout ranged from 20 seconds to 5 minutes. Average time was 2½ minutes. In two cases, the television camera



Slate Mountain View lookout, 8 miles distant through 20-in. lens



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The result: a projector that makes light work of checking heavy parts.

Mechanically, the Model 14-5 provides a large (26″ x 8″) work table built to handle heavy loads without measurable deviation. A full 17.5″ throat clearance helps you position cumbersome parts quickly and easily. Table travel of 8″ in both horizontal and vertical planes speeds measurement. A built-in helix table rotates 15° in either direction for gaging threads or similar parts.

Optically, the Model 14-5 incorporates all the unique developments that have made the Kodak Contour Projector, Model 2A, leader in its field: bright screen image for easy reading, six-station lens turret for instant change of magnification, and self-contained Surface Illuminator.

For complete information on the Model 14-5, write for the new 12-page booklet "Projection Gaging with Kodak Contour Projectors." It tells how this new precision projector can help you check parts and components to accuracies of the order of .0001″—quickly and economically.

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was able to pick up smokes at 20 miles. These could not be seen with binoculars.

Single-Tube Capacitance Transducer Circuit

By LAWRENCE FLEMING

Chief Engineer
Electronic Engineering & Service Co., Inc.
Falls Church, Va.

ELECTRONIC MEASUREMENTS of mechanical displacements are made with a variety of pickup or sensing devices: self-generating piezoelectric transducers; variable-resistance devices, variable-inductance and variable-capacitance transducers. The capacitance transducer is inherently the lightest and simplest of all. Its wider application has been handicapped, however, by the complexity of circuits required for sensitive and stable results.

The circuit described here uses only one tube operating in an r-f oscillator circuit. Indications are that sensitivity is primarily a function of the passive circuit parameters and depends only slightly on tube characteristics. Sensitivity is adequate for many applications. In a typical case, 50-mv a-c signal output is obtained from a surface vibrating at 0.001-in. peak amplitude,

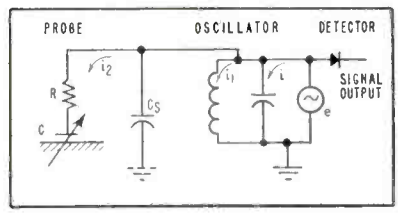
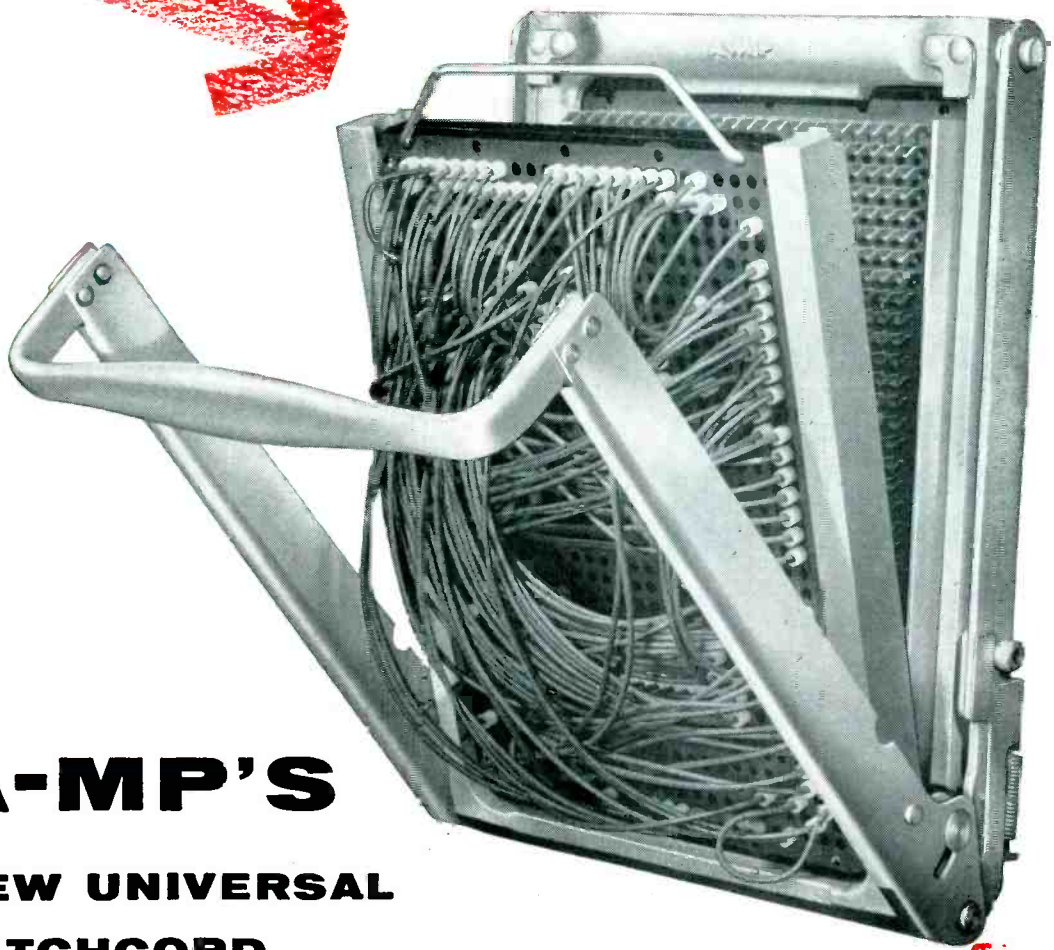


FIG. 1—Elementary circuit of capacitance transducer



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using a probe plate 1-cm square spaced 2-mm away from the vibrating surface. This represents roughly 1-percent modulation of a 0.5-$\mu\mu$f capacitance.

The probe or measuring head need contain only a resistor in addition to the capacitance plate itself. The probe can often be located a foot or two away from the tube and other circuits. Operation does not involve alignment of tuned circuits.

Figure 1 illustrates the principle of operation. An ordinary r-f oscillator has a capacitance C and resistance R in series connected across the tuned circuit. Capacitance C is the capacitance between the probe plate and the moving or vibrating object under investigation. The series resistance R is in the order of magnitude of the reactance of C at the oscillator frequency.

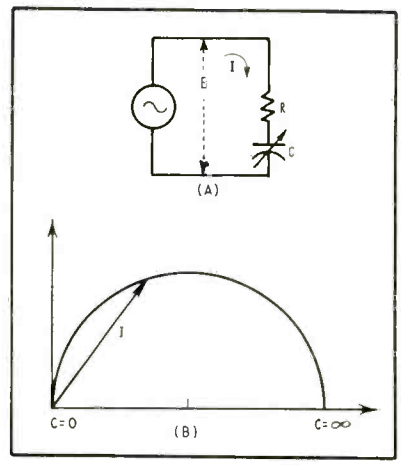

FIG. 2—Equivalent circuit of *RC* load (A) has locus of current values (B) as *C* is varied

Under these conditions, variations in C will be translated into variations in the resistive loading on the oscillator. The resulting amplitude variations in the r-f voltage are detected and the detector output constitutes the signal. Such f-m as may occur does not affect the result.

In actual practice, the impedance of the R-C combination will be low compared to the resonant impedance of the oscillator tuned circuit. The load current i_c will be much larger than the circulating current i_t. Provided the generator e is a constant-current source delivering an r-f current i, the detected voltage will depend only on i, R and C. In actual oscillators, a fair approximation to a constant-current source can be achieved, so that with a given cir-

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cuit the effective driving current i will depend essentially on the plate-supply voltage.

Figure 2 shows the locus of load current I in a series R-C circuit as C is varied. In the region near where $X_c = R$, a variation in C produces a change only in the real component of the current (conductance). This is the reverse of the situation where a varying resistance and fixed reactance are used to produce frequency modulation, by varying the reactive component

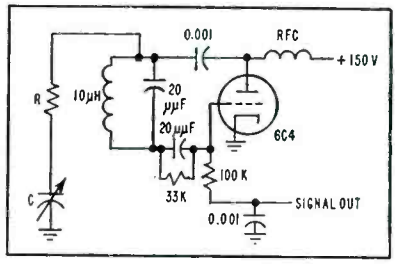


FIG. 3—Hartley oscillator circuit as used in capacitance transducer

of the admittance[1].

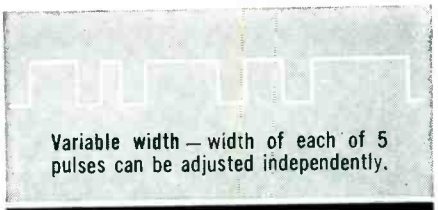
It can be shown that the rate of change of load current I with respect to capacitance C goes through a maximum when $R = \sqrt{2}\, X_c$.

Measurements show that the maximum sensitivity is obtained when R is much lower than the reactance of the capacitance C.

Referring to Fig. 1, C_s represents the stray capacitance to ground of the lead connecting the oscillator to the probe. Variations in this stray capacitance will change the frequency of the oscillator but will have comparatively little effect on conductance component of the loading, hence will produce little output signal.

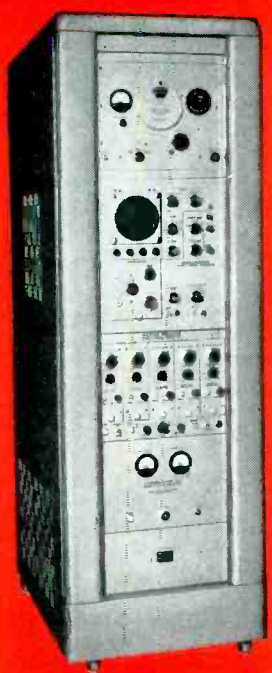
Measurements have shown a ratio of 50 and 300-to-1 between the signal produced by an increment in capacitance C after the resistor and those produced by similar increments in C_s or other capacitance directly across the tuned circuit. With the proper choice of oscillator coil, the tuned-circuit impedance can be made constant over a narrow range of capacitance change and thus the effects of reasonable changes in C_s canceled out.

In practice, an open wire a foot long generally introduces negligible disturbance. Shielding the lead is unnecessary since the impedance to



Variable width — width of each of 5 pulses can be adjusted independently.

Variable delay—delay between each of 5 pulses can be adjusted independently.



CODE MODULATED MULTIPLE-PULSE MICROWAVE SIGNAL GENERATOR Model B

Pulse-time modulation—input provided in each of 5 pulse channels for external pulse-time modulation.

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The Polarad Model B is an essential instrument for testing beacons, missiles, radar, navigational systems such as DME, Tacan, H. F. Loran, etc., where multi-pulse modulated, microwave frequency energy with accurately controlled pulse width, delay, and repetition rate is required for coding.

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Four Interchangeable Microwave Oscillator Units — all stored in the instrument . . . each with UNI-DIAL control . . . precision power monitor circuit to maintain 1 mw power output reference level . . . keying circuit to assure rapid rise time of modulated r-f output . . . non-contacting chokes.

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SPECIFICATIONS:

Frequency Range:
- Band 1 . . . 950 to 2400 mc
- Band 2 . . . 2150 to 4600 mc
- Band 3 . . . 4450 to 8000 mc
- Band 4 . . . 7850 to 10,750 mc

Frequency Accuracy . . . ±1%

RF Power Output . . . 1 milliwatt maximum (0 DBM)

Attenuator:
- Output Range . . . 0 to —127 DBM
- Output Accuracy . . . ±2db
- Output Impedance . . . 50 ohms nominal

RF Pulse Characteristics:
- a. Rise Time . . . Better than 0.1 microsecond as measured between 10 and 90% of maximum amplitude of the initial rise.
- b. Decay Time . . . Less than 0.1 microsecond as measured between 10 and 90% of maximum amplitude of the final decay.
- c. Overshoot . . . Less than 10% of maximum amplitude of the initial rise.

Internal Pulse Modulation:
- No. of Channels . . . 1 to 5 Independently on or off
- Repetition Rate . . . 40 to 4000 pps
- Pulse Width . . . 0.2 to 2.0 microseconds
- Pulse Delay . . . .0 to 30 microseconds
- Accuracy of Pulse Setting . . . 0.1 microsecond
- Minimum Pulse Separation . . . 0.3 microsecond
- Initial Channel Delay . . . 2 microseconds from sync. pulse
- Internal Square Wave . . . 40-4000 pps (separate output)

Pulse Time Modulation:
- Frequency . . . 40-400 cps any or all channels
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ground at 60 cps is extremely low.

Figure 3 shows a practical circuit operating at 10 mc. The oscillator is an ordinary class-C Hartley, with the grid providing the amplitude detection. The probe may be connected to either side of the coil.

A measured curve of signal output versus resistance R is shown in Fig. 4. Capacitance C was 10 $\mu\mu$f, modulated approximately 1-percent peak. Maximum signal output occurs at 160 ohms, where the oscillator amplitude, as measured by the

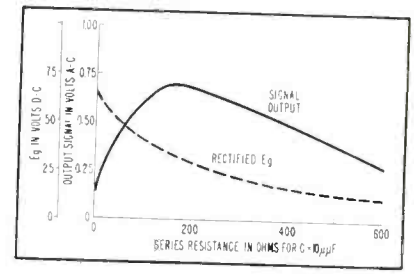

FIG. 4—Signal output and E_g as plotted against series resistance R. Capacitance C is 10$\mu\mu$f modulated about 1 percent

rectified d-c grid voltage, is down to about half its unloaded value.

Figure 5 shows another circuit that gives about twice the sensitivity to capacitance changes as the circuit of Fig. 3 but the value of R is more critical. Operating frequency is about 550 kc and the r-f voltage is low, to minimize radiation. For $C = 10$ $\mu\mu$f, maximum sensitivity occurs when $R = 15{,}000$ ohms. The tube here serves as a class-B oscillator and detector and as a signal amplifier. It is advantageous in some cases to insert an r-f choke in series with the cathode resistor.

Separate diode detectors, r-f oscillator-amplifier combinations and tuned circuits located in the probe and fed through a low-impedance line are among the elaborations possible for special applications.

The circuits shown appear to be quite applicable as condenser microphone preamplifiers. Calculations indicate a probable increase of about 10 db in output from a condenser microphone, over the circuit usually used, together with removal of difficulties owing to insulation leakage and elimination of limitations on low-frequency response.

This type of circuit is readily transistorized. Features of the cir-

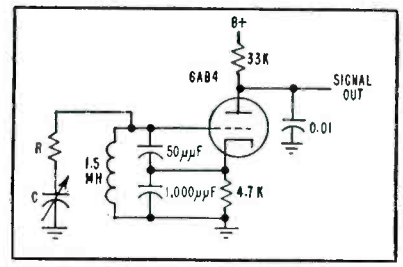

FIG. 5—Class-B Harris 550-kc oscillator circuit using single triode as oscillator-detector and signal amplifier

cuit described are covered in an application for U. S. patent.

Reference

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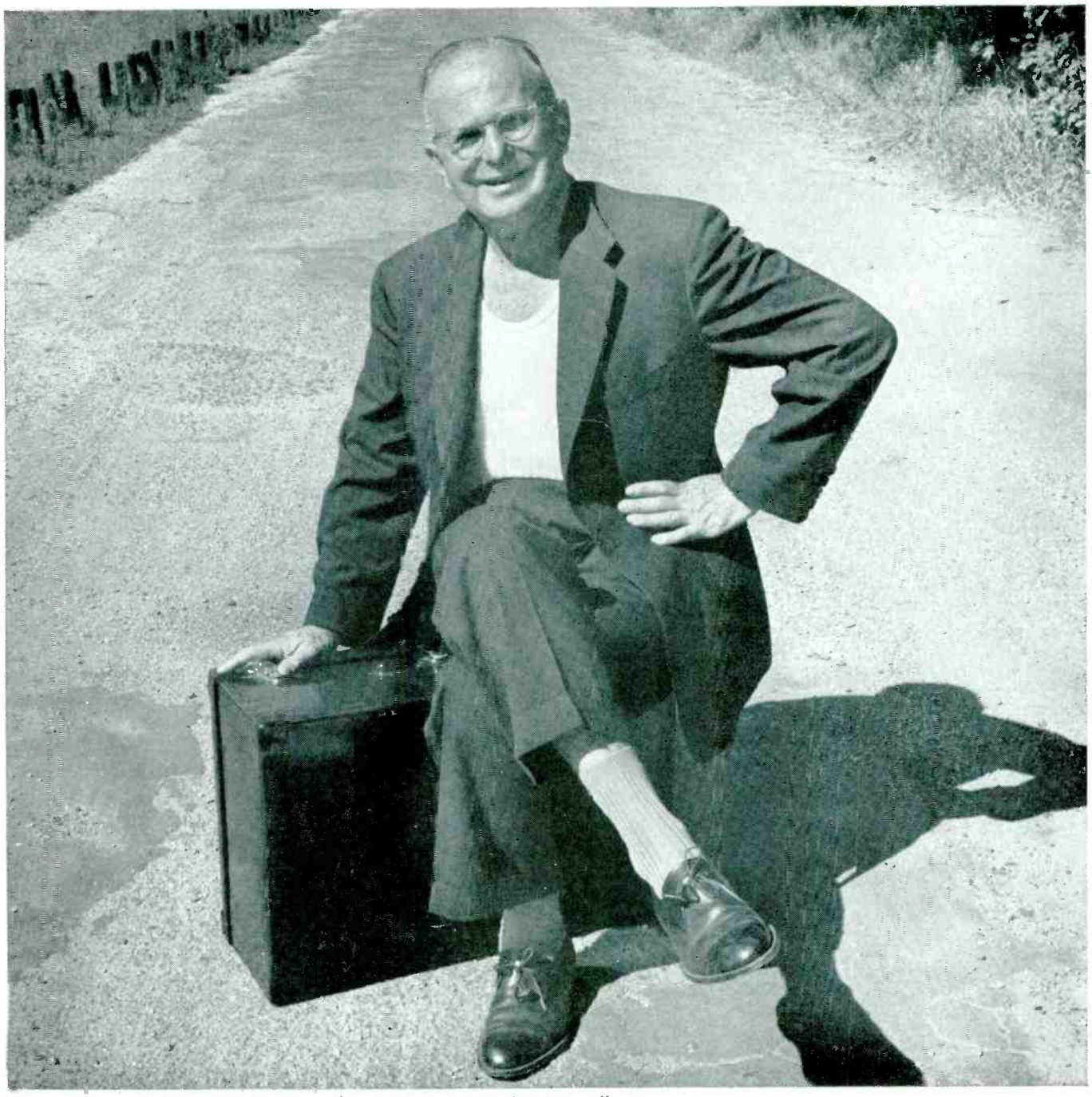
Improving Audio Quality of Mobile Radio

By RICHARD BUESING
General Electric Co.
Syracuse, N. Y.

OF THE SEVERAL TYPES of microphones available, the single-button carbon and the controlled-reluctance microphones are the most popular in two way mobile radio systems.

The carbon microphone has been chiefly used because of its high output level at low impedance, its freedom from inductive interference, and its ruggedness.

Its chief disadvantage is the high distortion produced. Harmonic distortion in the order of 10 percent and intermodulation distortion of approximately 30 percent are typical measured values. A further disadvantage is the requirement for excitation current. Since the element is composed of relatively loosely-packed carbon



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granules, there is an inherent hiss produced and can be noticed in the intervals between words. There is a variation between microphones of a given type, a factor which must be carefully considered in the design of the associated circuits. Finally, the carbon granules are subject to packing and wear and may eventually lose output and require replacement.

The methods of application of carbon microphones vary considerably. Their internal impedance is

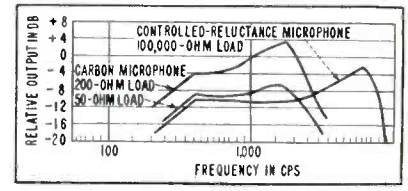

FIG. 1—Frequency response curves for carbon and controlled-reluctance microphones

approximately 100 ohms. Frequency response is as shown in Fig. 1. The 200-ohm load curve cannot be used as a pre-emphasis curve since the curve is not a true 6 db per octave pre-emphasis curve. It is not reproducible and provision must be made for wire-line input. Loading the microphone more heavily produces a curve similar to the curve taken with a 50-ohm load. Not only is the output flattened; it is reduced. The reduction is not intolerable since the output is approximately the same level that must be accommodated from wire lines. Excitation current may be taken from a battery, a bleeder across B+, or from a cathode or bias supply capable of furnishing the required power.

The controlled-reluctance cartridge was developed for Navy use when a microphone more rugged than those available was needed. A design was evolved in which the coil is stationary while the armature moves. The structure is rugged, capable of surviving shock, blast, humidity, vibration and temperature tests.

Harmonic distortion is in the order of 0.5 percent while the intermodulation distortion is only 1 to 2 percent. No excitation current is required and the stationary coil may be wound for various impedances. The most serious disadvantage lies in susceptibility to

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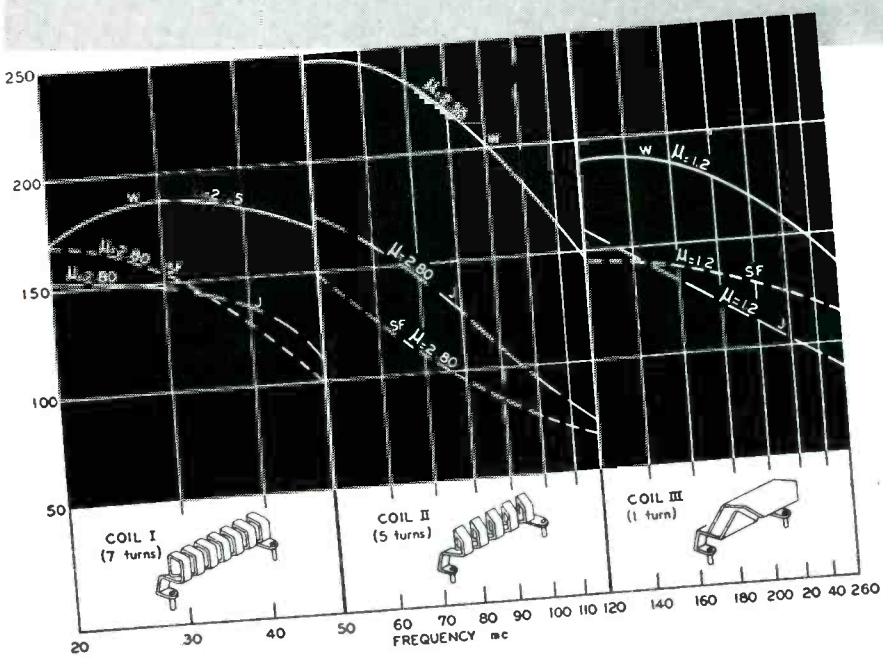

PHYSICAL CONSTANTS	W	J	SF
Percent retained by 325 mesh screen	trace	trace	trace
Weight-average particle diameter (Roller Analyzer) $d = \sum d_i^4 / \sum d_i^3$ (microns)	3	9	3
Surface-average particle diameter (Fischer Sub-Sieve-Sizer) $d = \sum d_i^3 / \sum d_i^2$ (microns)	2.5	4.5	2.5
Density of particles, g/cm³	7.35	7.35	7.81
Apparent density, g/cm³	2.6	2.8	3.0

Three types of G A & F Carbonyl Iron Powders are particularly satisfactory in cores designed for use at the higher frequencies. To assure low losses and good magnetic and temperature stability at 20 mc. to 300 mc., we invite you to test Types SF, J and W. These powders are microscopic, almost perfect spheres—ranging from 3 to 9 microns in diameter—with the same rigorous uniformity that characterizes all G A & F Carbonyl Iron Powders.

Today, Carbonyl Iron Powders—a total of ten types—are widely used in the production of cores for transformers and inductor coils—to increase Q values, to vary inductances, to reduce coil size, to confine stray fields or to increase the coupling factors.

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induction interference but proper shielding, reduces this problem to a minimum.

A typical frequency response curve for a controlled-reluctance microphone is shown in Fig. 1. The output level compares with that of the heavily-loaded carbon microphone. No circuit changes beyond the first grid were needed to convert from carbon to controlled-reluctance microphones, yet maximum flexibility is maintained. The input circuit shown in Fig. 2 is designed for proper modulation of the transmitter when the microphone is held within two inches of the lips and a normal conversational voice level is used. Bypassing R_1 adds another 2 db to the gain figure. Limiting action is sharp and symmetrical, but the circuit has a high articulation index when tested in conjunction with a broadcast-quality microphone, amplifier and speaker system.

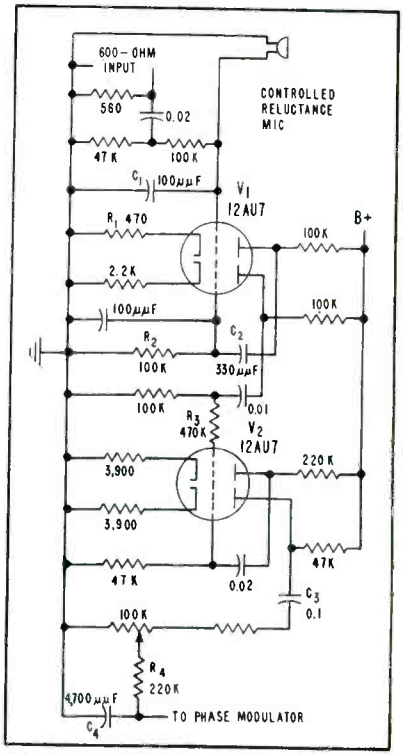

FIG. 2—Modulator input circuit used with controlled-reluctance microphone

Since the FCC requires that the deviation of the transmitter be controlled quite rigidly, V_2 is used as the modulation limiter.

It consists of two stages that operate as overdriven amplifiers. The first half-section is both plate

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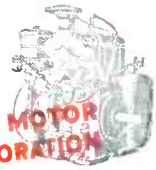

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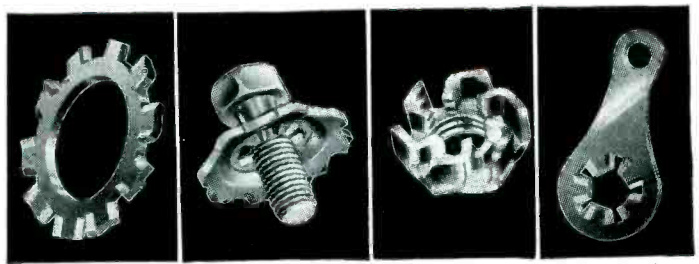

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and grid limited at signals above a specified level. Since the half-cycle limited by cutoff is more square than the half limited by plate saturation, the action is repeated in the second half of V_2. By virtue of the 180 deg reversal occurring in the first half of V_2, the output wave at C_3 is made symmetrical and square after being limited in the second half of V_2. Resistor R_3 is inserted in series with the grid of

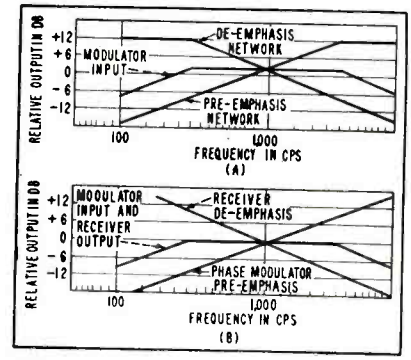
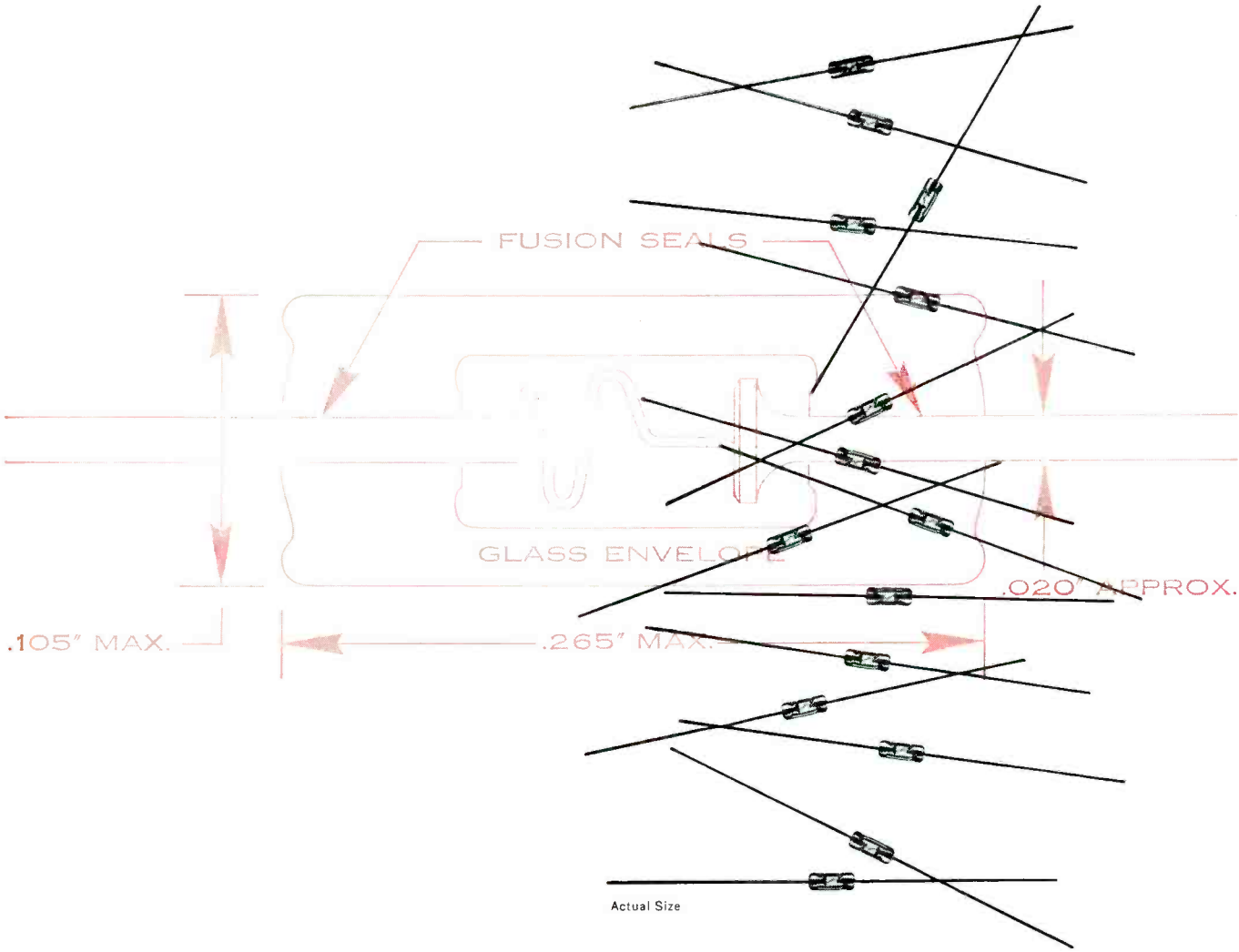


FIG. 3—Pre-emphasis and de-emphasis network characteristics for transmitter (A) and receiver (B)

the first half of V_2 to cause the tube to rebias itself to the correct operating point when it begins to draw grid current during limiting.

The transition from an output that increases linearly with input to an output constant with input level takes place with a 2-db difference in input level. With this sharp discontinuity, intermodulation distortion is reduced by a considerable amount. Since the output at C_3 is a square-wave at levels above the limiting threshold, it is necessary to attenuate the high-order harmonics found in the square wave before they are applied to the modulator. The network made up of R_4 and C_4 is the de-emphasis network that is used for the attenuating purpose. The lower the frequency at which this network can be made to cutoff, the more the high-order harmonics will be attenuated.

Figure 3A shows the frequency response of the networks. Since the voice-frequency band is approximately 300 to 3,000 cycles, this is the band over which the transmission characteristic must be maintained flat. The de-emphasis curve may then be tailored to cutoff at approximately 300 cps to



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provide maximum attenuation at high frequencies. The frequency band now slopes at a rate of 6-db per octave.

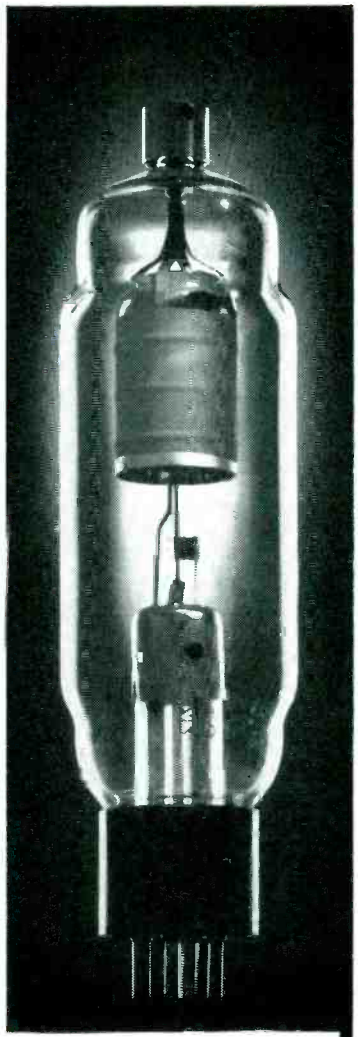
To attain a flat characteristic, a network to pre-emphasize the input to the limiter must be incorporated and is composed of capacitor C_2 and resistor R_2 which have a cut-off frequency of 3,000 cps. Adding the two curves results in a flat characteristic over the transmission band as shown in Fig. 3A.

Applying this curve to the phase modulator, which is inherently a pre-emphasis device, requires receiver de-emphasis, as shown in Fig. 3B, in order that a flat response may be reproduced at the receiver output. The audio amplifier, made up of both halves of V_1 in Fig. 2 makes up for the insertion loss of the pre-emphasis and de-emphasis circuits and raises the input level.

From the curves of Fig. 1, the carbon-button microphone would seem to emphasize highs. During listening tests, however, the carbon microphone sounded more bassy than the controlled-reluctance type. The reason for this is that the high order of intermodulation distortion in the carbon element produces

Fire Call Box

Replacement of the familiar red fire alarm signal box may be forecast by use of a new telephone system designed by Bell Labs. The present system is a telegraph; the new one a telephone system with which fire or police personnel can talk directly with the person placing the alarm. An automatic electronic voice recorder is recording the young lady's report. All reporting lines are under continuous test to insure service



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both the sum and difference of two frequencies appearing at the input. For example, if two frequencies, 300 and 500 cps, are passed through a nonlinear device, these two frequencies plus their sum, 800 cps, and their difference, 200 cps, will be produced at the output. The sum products tend to work themselves out of the upper pass band limit while the difference frequencies tend to bunch up at the lower end.

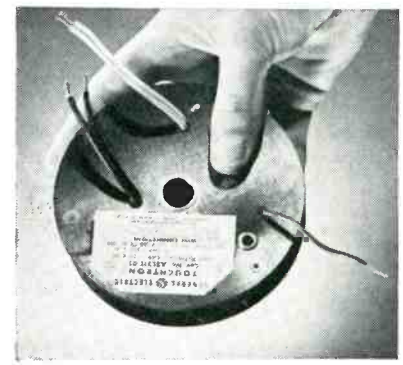
Fingertip Touch Actuates Circuit

PORTABLE LAMP control with the possibility of wide application in the medical field has been named Touchtron by General Electric. It is now being tested in situations that permit paralyzed or similarly handicapped people to operate devices merely by touching especially designed plates with either side of the face or hand.

Permanently connected to the power line, the device employs a half-wave rectifier to provide a direct voltage. Although dependent upon the magnitude of the a-c input, the d-c never reaches a potential sufficient to break down the control tube.

In series with the control tube is a latching relay that closes whenever the electrolytic capacitor is discharged by firing of the tube. Leads from the touch plates are connected to the firing electrode and also the anode side of the a-c line.

The impedance or conduction of the hand in bridging the plates



Entire electronic and electrical circuit can be packaged as shown to fit in base of lamp. Other conformations are possible for specific uses

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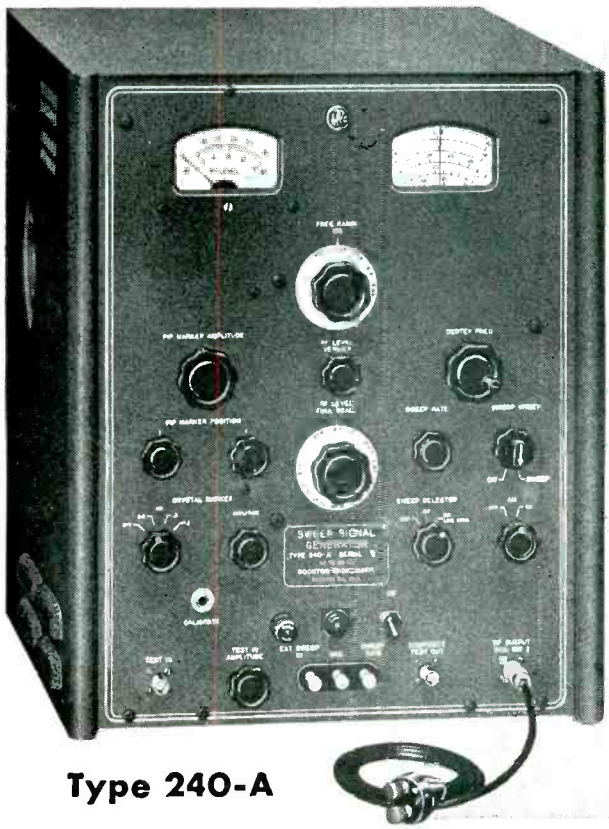
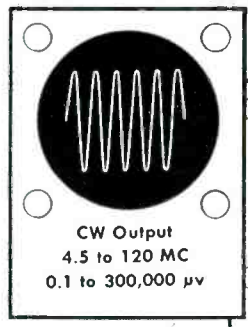
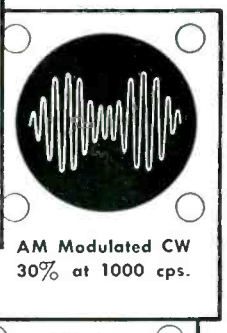


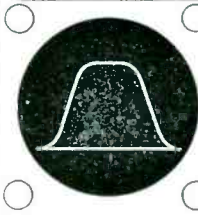
Type 240-A



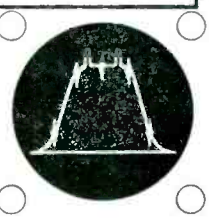
CW Output
4.5 to 120 MC
0.1 to 300,000 μv



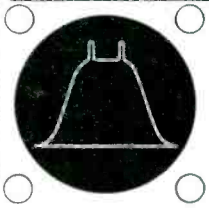
AM Modulated CW
30% at 1000 cps.



Broad Band Sweep
±1% to ±30% of
Center Frequency



Crystal Controlled
Identification of
Frequency—0.1, 0.5,
2.5 MC Spacing



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- **Crystal controlled frequency identification.**
- **Adjustable frequency-interpolation pip marks.**
- **Internal mixer for forming composite display signal.**
- **Accurate continuously-tuned CW with choice of internal AM.**
- **Internal crystal calibrator for CW.**
- **Wide range of calibrated output voltage.**

The Sweep Signal Generator Type 240-A is a continuously-tuned, accurate CW Signal Generator with internal AM. The output voltage is continuously monitored, indicated and calibrated over a wide range. The CW Signal can be calibrated against an internal crystal. Electronic sweep circuits are included which produce an output signal having an AGC-controlled constant-amplitude and a wide range of continuously-variable linear-frequency sweep widths. Two systems are included for frequency identification while sweeping. One of these is crystal controlled and the other is an interpolation system. An internal mixer adds the frequency identification information to the test receiver output signal prior to its connection to the display oscilloscope.

SPECIFICATIONS:

RF FREQUENCY RANGE: 4.5 to 120 MC continuously variable in five ranges.

RF FREQUENCY ACCURACY: ±1%.

RF OUTPUT VOLTAGE: 1 to 300,000 microvolts. 0.1 to 30,000 microvolts with external attenuator.

AMPLITUDE MODULATION: Factory adjusted to 30% from internal 1000 cps oscillator.

RANGE OF SWEEP WIDTHS: Continuously variable from ±1% of center frequency to ±15 MC or ±30% of center frequency whichever is smaller.

LINEARITY OF SWEPT RF FREQUENCY: Within 10% over middle 80% of sweep excursion, within 20% over remainder.

FLATNESS OF SWEPT RF OUTPUT: Within 7% under all conditions.

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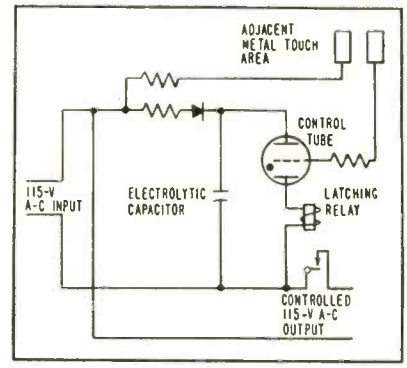


Basic circuit of the touch control designed for lamps

raises the potential of the firing electrode towards that of the anode and causes the tube to fire.

Sensitive Limit Detector

By John H. Porter

Rochester, New York

To provide an indication when a voltage exceeds a preset limit, some type of a differential device that generates sufficient power to operate an indicating or correcting mechanism is generally used. In regulated power supplies, for example, the output voltage is compared with a reference voltage in a tube. Subsequent plate-current variations are amplified and act to restore the level of the output voltage to some preset value.

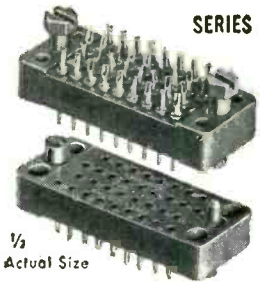
Differential amplifiers have been devised that generate an output current proportional to the difference in potentials applied to the two inputs and such amplifiers can be made substantially independent of the common level of the input signals. However, differential amplifiers in a simple form lack sensitivity and in general are dependent on the operating current of the relay.

Circuits that employ an a-c driven chopper as a switch to apply alternately the unknown and reference signals to the input of an amplifier and a phase detector to recover the polarity sense and amplitude scale and operate appropriate relays, are satisfactory when the input to the chopper is on the order of a few volts. These circuits can be made to have very high sensitivity. However, when an at-

precision Continental Connectors

MINIATURE

SERIES 20



⅓ Actual Size

Contacts: 7, 8, 9, 11, 14, 18, 20, 21, 26, 34, 50, 75, 104. For #20 AWG wire. Current rating: 5 amps. Voltage: 2100V. RMS.

SUB-MINIATURE

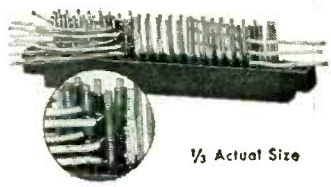
SERIES SM-20

Actual Size

Contacts: 7, 11, 14, 20, 26, 34. For #20 AWG wire. Current rating: 5 amps. Voltage: 1900V. RMS.

PRINTED CIRCUIT

SERIES PC



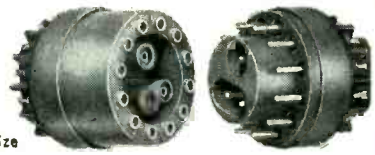
⅓ Actual Size

Solderless wire wrap (double rows of 22 contacts) or standard type printed circuit receptacle (6, 10, 15, 18, 22 contacts). Current rating: 10 Amps. Voltage: 2500V. RMS.

HIGH VOLTAGE AN-TYPE

SERIES 800

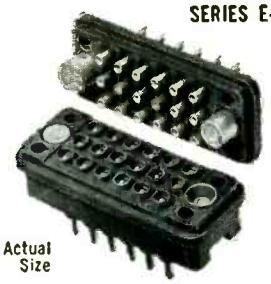
For AN-36 shell. 15 contacts. 3 high voltage contacts in center are removable. Current ratings: 10 and 20 Amps.



¾ Actual Size

EASY RELEASE

SERIES E-Z



½ Actual Size

Solder cup contacts, taper pin cups for solderless wiring or turret terminals. Current rating: 10 Amps. Voltage: 4500V. RMS.

MINIATURE AN

SERIES 1300

One-piece molded inserts. Current rating: 7.5 Amps. Voltage: 3000V. RMS.

⅓ Actual Size

POWER

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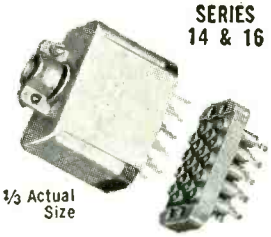
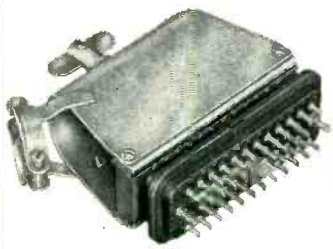


⅓ Actual Size

Contacts: 12, 18, 24, 34. Spring loaded contacts for easy release. Coaxial contacts and bayonet locks also available. Current rating: 10 and 25 Amps. Voltage: 4700V. RMS.

SPECIAL DESIGNS



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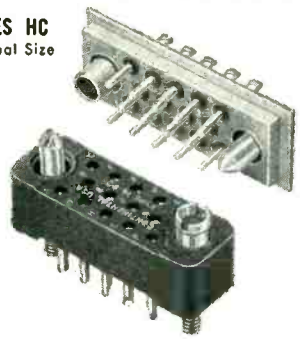
SERIES HC-20

¾ Actual Size

SERIES HC

¾ Actual Size



Hexagonal hermetic plug has solid glass insert. For pressurized electronic equipment. 4, 5, 7, 9 and 10 contacts.

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electronic sales division

DeJUR

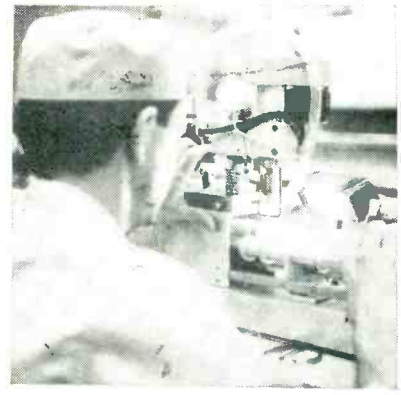
tenuator is used to reduce an unknown voltage to a comparable level, the small variations in the unknown will be likewise attenuated.

A circuit is shown that acts as the detector in a system wherein two voltages are mixed in a common input circuit, one voltage being the unknown and the other a reference voltage set to the level to be studied.

Ultimate, instantaneous sensitivity is in the order of 1 millivolt. Stability of the level at which the device changes states abruptly from conducting to nonconducting can be held to ±3 millivolts over an extended period by using components designed for long-term stability and a power supply of good regulation.

The reference voltage, e_2, is introduced in the summing network whose output to the grid of the tube is approximately $\frac{1}{2}(e_1 + e_2)$ with the constants given. If the reference voltage is so introduced, the stability and sensitivity of the limit detector itself remain at less than ±3 millivolts regardless of input level. Overall stability of the device is limited by the stability of the reference voltage supply. For small inputs, of the order of 1 or 2 volts, the reference voltage may simply be

Aseptic Machine Shop



Precise laboratory conditions, including control of humidity and temperature, will help increase reliability and life of deep sea amplifiers used on first telephone cable between North America and the British Isles. Technician is using precision drill to bore holes in components that are attached to repeater with Lucite pins. British and Canadian agencies have joined with American Telephone and Telegraph Co. to provide fade-free telephone service

International

qualifies for U.S. Army Signal Corps

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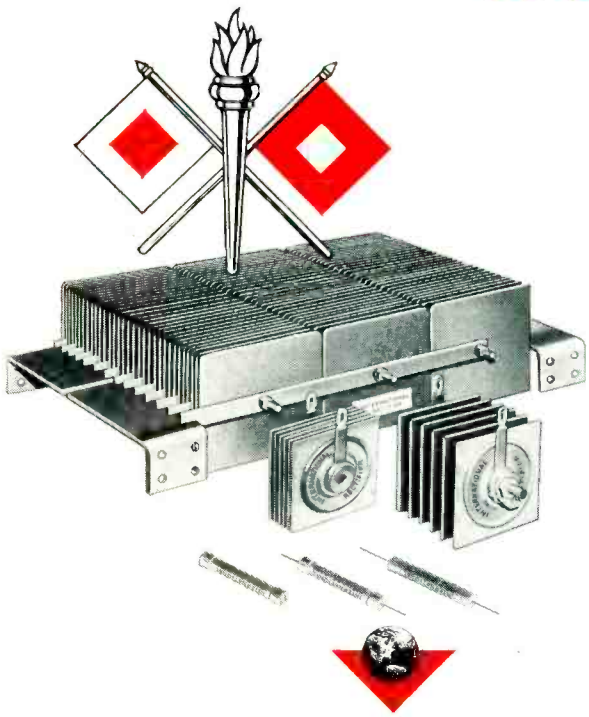
REDUCED INSPECTION QUALITY ASSURANCE PLAN



INTERNATIONAL RECTIFIER CORPORATION, world's largest supplier of industrial metallic rectifiers, has been qualified to manufacture under the United States Army Signal Corps Honor Inspection Program... the Reduced Inspection Quality Assurance Plan... RIQAP.

International Rectifier qualifies for this honor plan through years of consistently supplying products of high quality, equal to or better than the Accepted Quality Level established by the Government.

These high standards are rigidly maintained on *all* International Rectifier products, giving you unqualified assurance that every item delivered will equal or exceed the requirements necessary to meet the approval of RIQAP.

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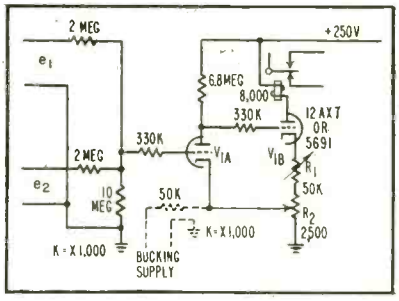
CORPORATION

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

WORLD'S LARGEST SUPPLIER OF INDUSTRIAL METALLIC RECTIFIERS

introduced as a bucking supply in the cathode circuit, as shown in dashed lines.

The detector has two stable states and depends on positive feedback in the cathode circuit for regeneration. Tube V_{1A} saturates readily with the large plate load and never draws over 25 microamperes. Tube V_{1B} is either cutoff or conducting



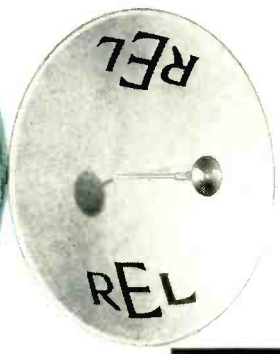
Reference voltage is introduced either at e_2 or as bucking supply to cathode of limit detector

depending on the grid input to V_{1A} and its plate-current differential is adjusted by R_1 to fit the characteristics of the relay used. With an 8,000-ohm relay and R_1 = 35,000 ohms, the current is either 0.8 or 2.5 milliamperes.

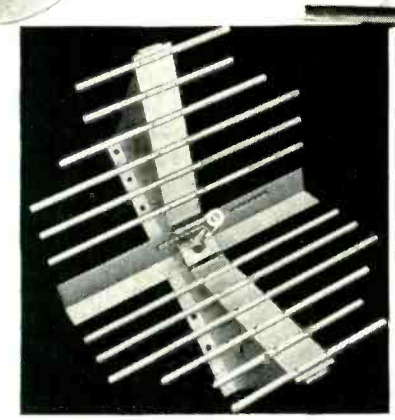
The input firing level is dependent linearly on both plate and filament potentials. A 0.1 percent variation in B+ will cause approximately 0.4-millivolt change in input firing level. This indicates that voltage reference tubes such as the 5651 are adequate to stabilize the plate supply. A 1 percent variation of filament voltage can cause a 7-millivolt variation in firing level, hence use of a constant voltage filament transformer is recommended. This effect is apparently caused by the contact potential variation since the grids are driven positive during conduction.

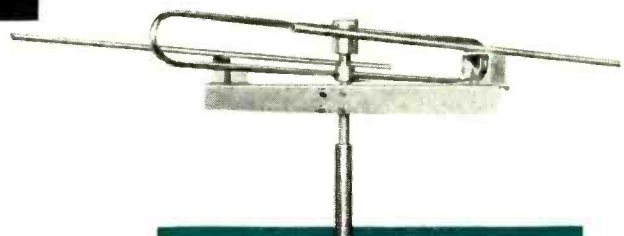
Adjustment of the feedback adjustment R_2 is rather critical, and should not be used as a gain or sensitivity control. The gain of the circuit is 8,000 or more during the transition from conducting to nonconducting states and constant at approximately 10 during either of the stable states. It is apparent that excessive feedback results in hysteresis and is evident in the form of backlash.

Insufficient feedback again allows the decision to be based on the relay



SKYHOOKS





New shapes are blossoming on the horizon these days, as more and more communications antennas show the trend from land lines to radio. Much of the equipment effecting this transition is engineered and manufactured by REL.

REL leadership stems from the highest standards of design, workmanship, and reliability. This is true whether it is a continental multiplex system, an "MTL" mobile transmitter link for broadcast station use, or any other specialized radio application.

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characteristics. An optimum adjustment can be attained where a nearly vertical input-output curve exists, and such that a 1 or 2-millivolt increment on the input grid causes a plate-current variation adequate to embrace the difference between pull-in and drop-out currents of the relay used.

Bias Supply Design for Bolometers

By EDWARD H. BRAUN
Microwave Antennas and Components Branch
Electronics Division
Naval Research Laboratory
Washington, D. C.

ELECTRONIC BOLOMETER biasing circuits are usually fairly elaborate, requiring separate power supplies and methods of limiting the voltage across the bolometer. In some cases the open circuit voltage across the bolometer holder is so large that if the bolometer is disconnected and then reconnected the bolometer will burn out. In addition there is some danger of shock to the operator if he removes the bolometer with the bias on.

The following circuit with the indicated parameters obviates these disadvantages. It is simple, requiring in most cases only two resistors, two capacitors and a wirewound potentiometer. The open-circuit voltage across the bolometer is only a few volts. The current drain is the same with or without the bolometer connected, and the bolometer current may be varied continuously from zero to any specified value with the same supply.

The circuit for use with a 200-ohm bolometer taking up to 10 ma is shown in Fig. 1. This supply draws 21 ma with or without the bolometer connected. The open cir-

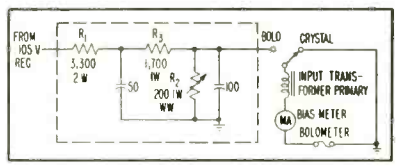


FIG. 1—Constant current drain bias supply protects against applying overvoltage to bolometer

Government model TS-148/UP Frequency-meter Range - 8470 to 9630 MC/S 5 MC/S max. error.
Sensitivity to CW - Spectrum Amplified Pos. - 80 db. below 1 watt for 1 inch deflection.

SPECTRUM ANALYZER

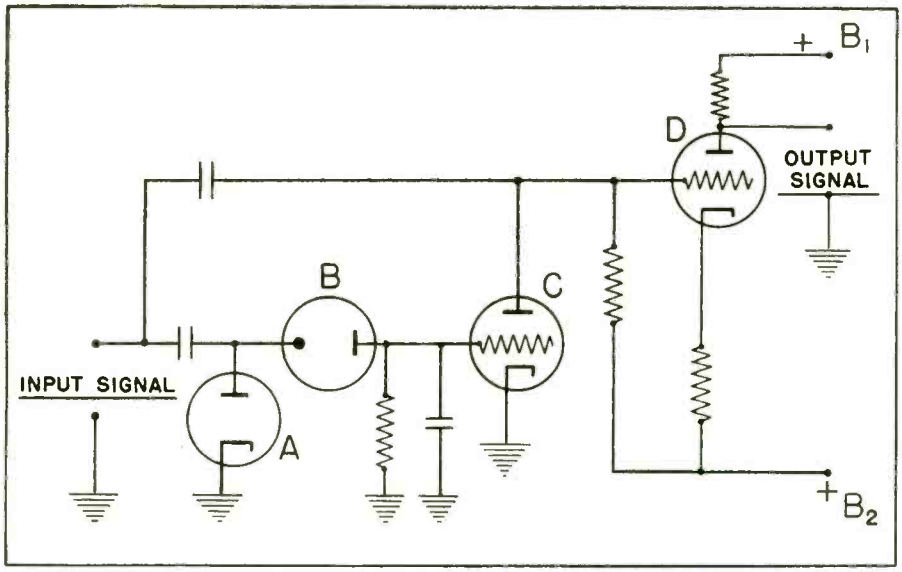
Spectrum Position - 55db. below 1 watt for 1 inch deflection. Maximum dispersion of spectra.
Attenuation - uncalibrated. Variable 3 to 70 db. 1.5 MC/S per inch.

GOVT. MODEL

TS-148/UP

NORTHEASTERN ENGINEERING, INC.

manchester, new hampshire



ELECTRONIC AMPLIFYING SWITCHING CIRCUIT

Both electronic switches and electronic amplifiers are used successfully in computer design. A very unusual circuit, patented by the Ford Instrument Company, combines positive switching action with amplification, and is particularly useful in such applications as multi-speed servomechanisms, in which several signals are to be applied selectively to operate the mechanism. When such a circuit is used, the inactive signals can be left connected without producing any noise whatever in the response to the active signal.

The key to the operation of this circuit is the voltage-doubler circuit consisting of diode A and gas tube B. When the signal voltage is below a specified level, gas tube B cannot fire and triode C draws a very large current, making the grid of tube D at almost ground potential. The cathode voltage of triode D is at a voltage B_2 above ground, thereby effectively cutting tube D off. If the signal voltage is above the specified level, gas tube B breaks down, cutting tube C off, thereby permitting tube D to conduct and actuate the servomechanism. The amplification produced by tube D, in addition to providing the required signal level at the servomechanism, contributes also to the effectiveness of the electronic switching, and the resultant circuit is more compact and has a higher parts economy than produced by the use of a separate switch and amplifier.

Electronic circuitry is but one of the many facets of Ford Instrument design and development. Ford Instrument engineers work every day with control systems, using mechanics, electronics, hydraulics, electro-mechanics, magnetics, and atomics. If you have a problem in automatic control, Ford Instrument stands ready to help you.

cuit voltage across an 8½ ma bolometer, for example, is about 3.5 volts. About 8 volts is required for burnout. The current requirement may be reduced at the expense of increasing the open-circuit voltage somewhat. Most bolometer amplifiers draw only about 10 to 15 ma and an additional 21-ma drain for the bias supply should not require

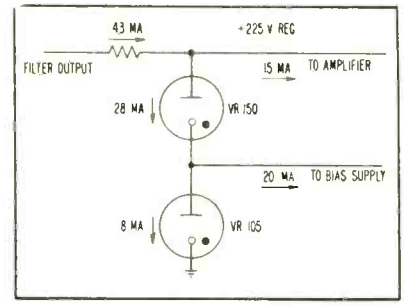


FIG. 2—Regulator circuit for bolometer bias supply

any significant changes in the power supply.

The bias supply should be fed from a power supply which is regulated, either electronically or by means of v-r tubes. The most suitable method is to use two v-r tubes in series in the main power supply with the bias supply tapped off one v-r tube as shown in Fig. 2. Current values are shown in the various branches.

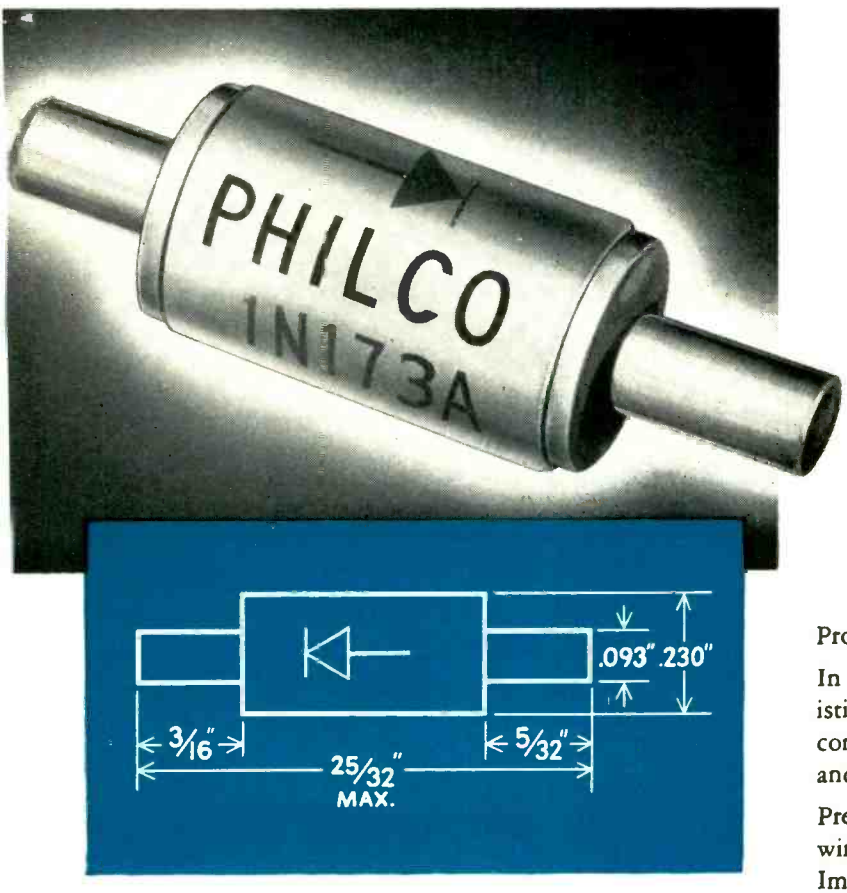
Other methods for providing the bias supply with regulated voltage are also suitable, but operating a separate v-r tube for the supply in parallel with v-r tubes in the main supply should be avoided, as difficulties may be encountered in igniting both tubes simultaneously.

It is advisable to build the entire bias supply in a shielded box. If this is impractical, it must be kept as far from stray fields as possible.

Several of these supplies have been built and have performed very satisfactorily with amplifiers having gains up to 25,000. There is no measurable increase in noise level when using the supplies, hence they should be suitable for use in amplifiers having considerably higher gain.

If i_u is the specified current drain of the supply, then

A New UHF Mixer Diode *Specifically Designed* for UHF Tuners



New PHILCO 1N173A

FEATURES

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- **Uniformity of characteristics**
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In dozen lots, or thousands, these mixer diodes have characteristics unexcelled in uniformity. Special Philco production and control techniques assure a new standard of dependable performance never before available in UHF mixer diodes.

Precise electric pulse "forming" welds the platinum alloy whisker wire and germanium crystal into a complete, integrated unit. Impregnated and sealed in a ceramic moisture-proof case, the Philco 1N173A maintains unusual stability regardless of shock, vibration or wide variations of temperature.

Design engineers find the exceptional uniformity of the Philco Mixer Diode the answer to high performance tuner operation over the entire UHF band. Exact impedance . . . low noise level . . . minimum Local Oscillator drive requirements . . . all the features that insure optimum performance are designed into the Philco 1N173A . . . and these diodes are available now! For complete information on the Philco 1N173A Mixer Diode write to Philco, Department E, today.

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GOVERNMENT AND INDUSTRIAL DIVISION • PHILADELPHIA 44, PENNSYLVANIA

In Canada: Philco Corporation of Canada Limited, Don Mills, Ontario

$$R_2 = \frac{V}{2}\left[\frac{1}{i_u} - \frac{1}{i_B} + \sqrt{\left(\frac{1}{i_u} - \frac{1}{i_B}\right)^2 + \frac{4R_B}{i_u V}}\right]$$

$$R_3 = \frac{1}{3}\left[\frac{V}{i_u} - R_2\right]$$

$$R_1 = 2R_3$$

where

V = regulated d-c voltage to the supply

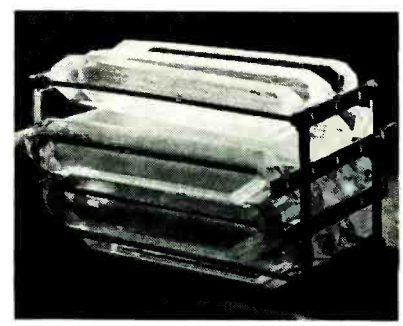
i_B = maximum bolometer current required in amperes

R_B = bolometer resistance in ohms

The open circuit voltage across a bolometer drawing the maximum current i_B is given by $V_{oc} = R_2 i_u$. The actual open circuit voltage across any bolometer having a resistance R_B and drawing less than the maximum current will be lower than this and may be obtained by recalculating R_2 (call this R_2') using for i_B the actual bolometer current (i_B') rather than the maximum current required from the supply. The actual open-circuit voltage across this bolometer will then be $V_{oc}' = R_2' i_u$. However this value (V_{oc}') is only used as a check; the circuit should be built using R_2 not R_2', so that currents up to the maximum current i_B may be obtained.

If for a given i_u the open circuit bolometer voltage V_{oc}' comes out too high, increase i_u and repeat the calculation. If V_{oc}' comes out very small then i_u may be reduced some-

Synthetic Quartz Commercially Available



Synthetic quartz crystals of electronic grade like those above in autoclave rack can be grown free of twins and other defects. By controlling size, shape and orientation to some extent, reduction of material waste and processing man-hours can result in economies. Output from Brush Laboratories, previously reserved to the Signal Corps, is now available commercially

"H-H long-life resistors"—the title earned by FIELD EXPERIENCE

The greatly increased protection made possible by the development of our high-temperature gray enamel is the most important improvement of these resistors, but it is not all. True, this enamel is thermo-shock-proof and crazeless; but in addition

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- **Stronger core** with higher resistance to vibration and shock.
- **Special alloy terminals** more securely fastened to the ceramic body by spot-welding — highly resistant to corrosion.
- **All wire connections** are protected by a positive non-corrosive bonding.

The fixed, the ferrule and the flat types are especially designed for and manufactured in accordance with MIL-R-26 specifications.

HARDWICK, HINDLE, INC. **Rheostats and Resistors** Newark 5, N. J. U. S. A.

what if necessary and the calculation repeated.

If it is desired to specify the open-circuit voltage initially rather than the current drain, then

$$R_2 = \frac{V\left[\frac{V_{oc}'}{i_B} - R_B\right]}{V - V_{oc}'}$$

where V_{oc}' is the open circuit voltage across a bolometer drawing the maximum current.

The current drain required by this supply is then

$$i_u = \frac{V_{oc}}{R_2}$$

If i_u is too large, V_{oc} must be increased.

The open-circuit voltage V_{oc}' which will exist across any other bolometer used with this supply, drawing a current i_B', is obtained as before from the product of R_2' and i_u.

The remaining parameters are calculated from R_2 as before, or directly in terms of V_{oc} from

$$R_3 = \frac{R_2}{3}\left[\frac{V}{V_{oc}} - 1\right]$$

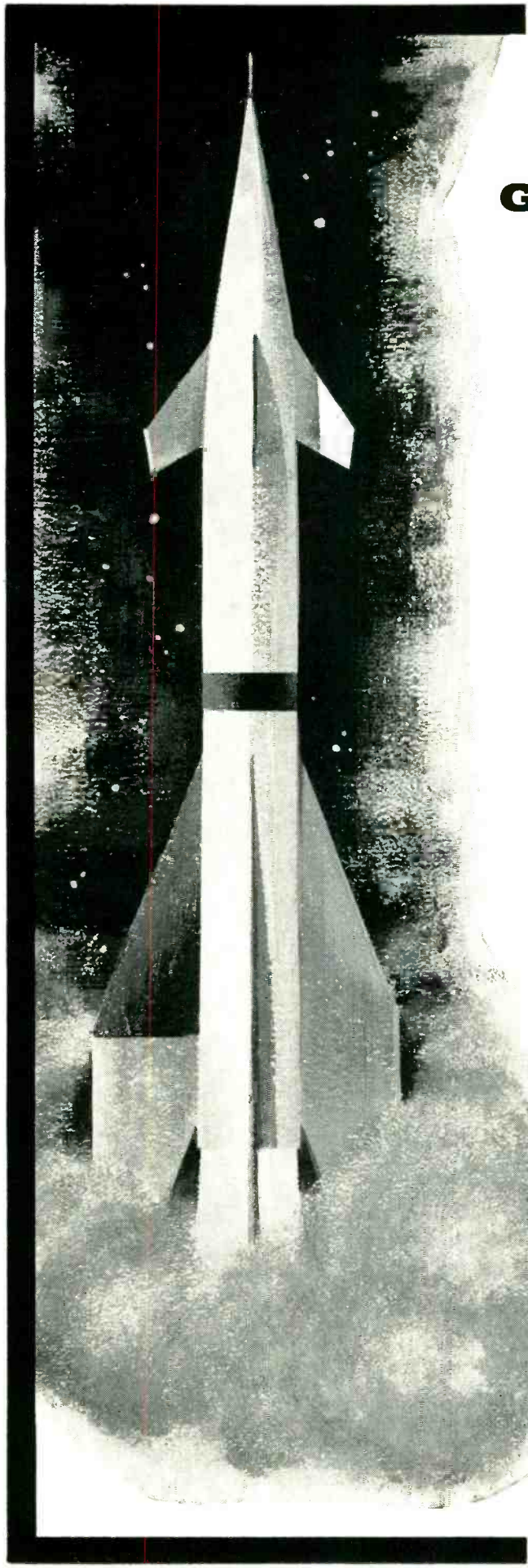
$$R_1 = 2R_3$$

The actual values of R_1, R_2 and R_3 calculated from the formulas will not be available in general as standard resistors. They may be changed to standard values if $R_1 + R_2 + R_3$ is kept approximately the same. In addition R_2 should not be made smaller than calculated, but the next larger standard size should be used.

Defense-Emergency Radio Van

CIVIL DEFENSE authorities in the city of Newark, N. J. have recently acquired a route-van type truck to provide emergency mobile communications. The unit, designed and

Mobile van obtains power from generator on trailer or other source



GOING UP!

...with Sylvania transformers sealed in "Scotchcast"

In a matter of seconds, rockets leave searing hot desert heat for freezing upper-atmosphere temperatures! That's one of the many reasons why Sylvania Electric Products, Inc., chose "SCOTCHCAST" for their new sealed-in-resin transformers used in many types of new military missiles and aircraft.

Wherever rigid military specifications call for insulated electrical components, one of the "SCOTCHCAST" Resins will do the job.

These epoxy-type resins, products of 3M Research, cure into a solid, shock-resistant, moisture-resistant insulation. And "SCOTCHCAST" sticks tight to most metals, plastics and conductors—is unaffected by acids, alkalies, solvents, oils and extremes of temperature.

A quick look at the features of these new Sylvania transformers shows many advantages gained by the use of "SCOTCHCAST":

MIL-T-27 GRADE 1 CLASS A
100K-200K Megohms IR values
after complete Mil-T-27 testing
Dielectric Strength: 1500 V/Mil
Extreme temperature range:
-65°C to 110°C
Reduced weight
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Permanent hand-etched marking
Non-inflammable
Minimum space

For more information on what "SCOTCHCAST" Resins can do for *you*, write Minnesota Mining and Manufacturing Co., Dept. CA-105, St. Paul 6, Minn.

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3M

Interior of insulated van showing radio equipment. Rack of portable radiotelephone transmitter-receivers stowed at the upper left

built by Instruments for Industry, Inc. of Mineola, N. Y., is packed with radio equipment capable of operating on frequencies assigned to police, fire, taxi, amateur and other services.

In the event of any serious emergency, the unit can be used as a main communications station or can be dispatched to cover an outlying district from which telephone service has been cut off.

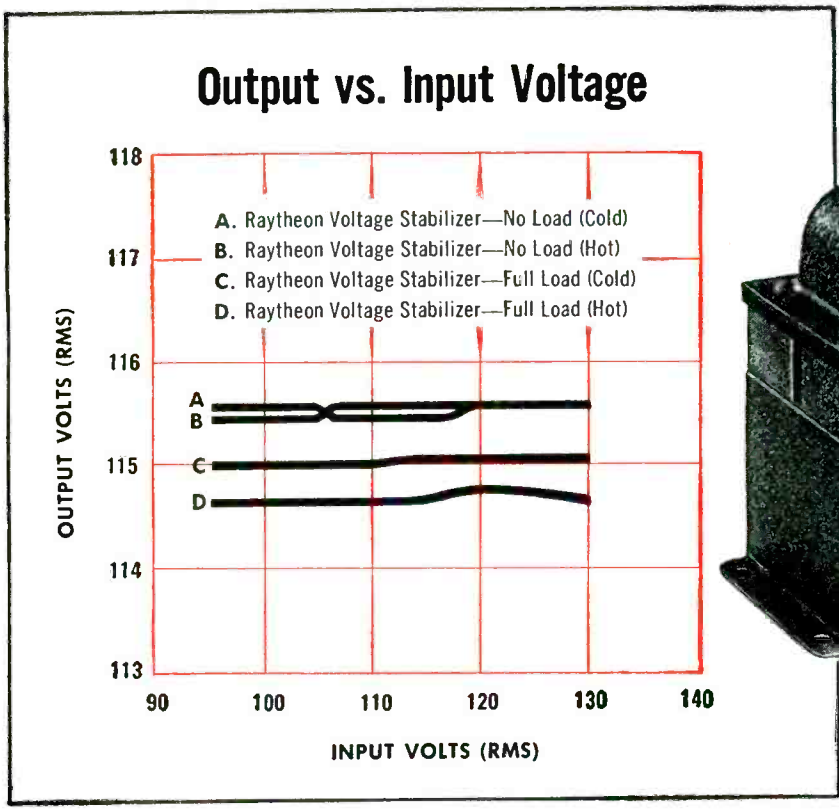
Antennas are mounted on the roof of the truck and power is supplied from the 10-kw gas-engine driven generator that is towed on a trailer. For fixed station use, a collapsible mast 50 feet high extends coverage.

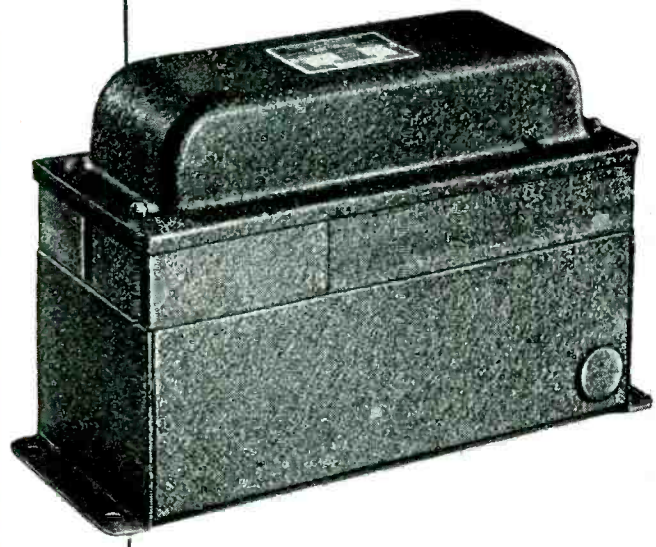
Tank Capacitor Energy Storage

LARGE QUANTITIES of energy for short time periods are conveniently obtained from energy storage capacitors that are charged to a relatively high voltage and discharged through the required load.

Such capacitors must have minimum internal inductance and resistance. Low-loss, low-inductance capacitors are likewise used in high-power radio-frequency generators.

The capacitor illustrated has been developed by Tobe Deutschmann Corp. for experimental applications in the field of nuclear research. It has an inductance of less than 0.08 microhenry and internal resistance corresponding to a Q in excess of 1,000. Electrical rating is 0.12 mi-





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When you incorporate a Raytheon Voltage Stabilizer in your equipment, you help assure complete customer satisfaction—for these important reasons:

1. Your equipment will operate as it was designed to, regardless of voltage variations of your customers' electrical source.

2. Since most components have maximum life when operating at their designed voltage, a Raytheon Voltage Stabilizer prolongs the life of components—and your equipment. A plus feature is provided by the short-circuit protection inherent in Raytheon Voltage Stabilizers.

3. Because Raytheon Voltage Stabilizers are superior to any other static type stabilizer under virtually all operating conditions, your equipment will work better and longer—characteristics your customers really appreciate.

Check these important points of Raytheon Voltage Stabilizer superiority

Raytheon Model VR-6113 (120 watts) chosen at random and compared with a similarly rated competitive model.

- Guaranteed to deliver accurate AC voltage within ±½% (competitive model 1%)
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crofarad at 50 kv peak with an allowable r-f current up to 40,000 amperes.

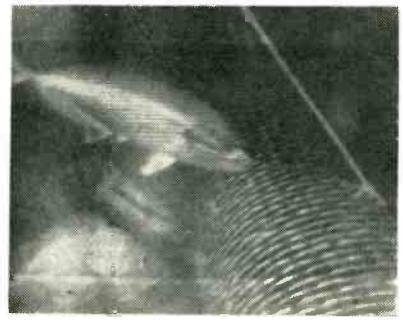
Balloons Gather Lightning Information

NINE balloon flights to altitudes between 60,000 and 100,000 feet will be launched in central Florida by Air Research and Development Command to study electrical charges set up by thunderstorms.

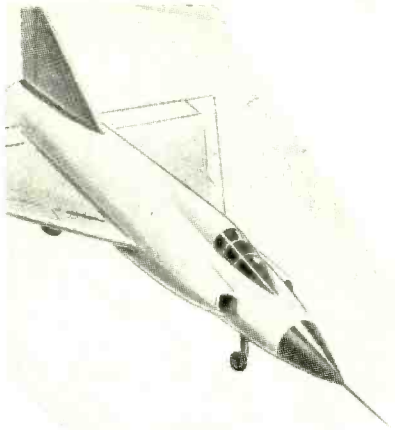
The balloons are designed to float horizontally at a specified altitude where instruments will measure the electrical field and currents caused by lighting discharges. The information is telemetered to the ground where it is to be evaluated as to its effect on weather and communications.

Radar stations at Patrick AFB and Pinecastle AFB will check height and position of thunderclouds and will likewise track the balloons in flight.

Interior Dept. Uses Underwater TV



Inquisitive fish snooping around shrimp trap are picked up by underwater television camera and their likenesses are displayed on a monitor screen. U. S. Fish and Wildlife Service has an RCA closed-circuit system for observations at 60 feet below the surface



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FAIRCHILD
PRECISION POTENTIOMETERS

Production Techniques

Edited by JOHN MARKUS

Silvering Ends of Resistors with Conveyorized Painting Setup

BANDS of silver are automatically applied to the ends of deposited carbon resistor bodies by a mechanized production setup engineered and constructed in the Kansas City plant of Electra Mfg. Co. Capacity is several thousand units per hour, which is about six times more than was obtained previously with a manual silvering operation.

Resistor bodies are dumped into the hopper of a Syntron feeder, for feeding end-to-end down a length of copper tubing to the painting machine. Here the resistor bodies are rotated while in contact with rubber ink-transferring wheels running in silver solution, for applying a silver band in accurately predetermined width to the body of the resistor at each end.

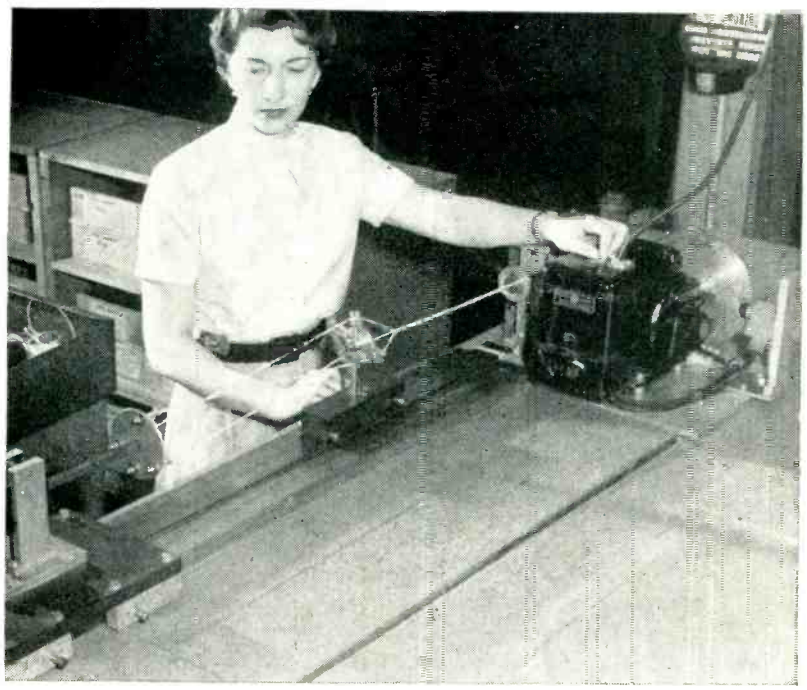
After coating, the resistor bodies drop between sprockets of a conveyor chain so designed that the resistors are supported only in their uncoated central areas. The chain conveyor takes the resistors through a baking oven that provides the required firing temperature.

Automatic silvering machine setup. Baking oven is at lower right. Caps with attached axial leads are pressed over resistor ends after firing

Constant-Tension Automatic Wire-Twisting Machine

A SIMPLE, completely automatic wire-twisting machine that reduces work time by approximately two-thirds over previous manual methods has been developed by Ford Instrument Co. for prototype and production wiring on complex electronic instruments. It can be run safely by an unskilled operator without sacrificing uniform quality.

With a few minor adjustments the machine can twist doubles, triples, or more if necessary, by employing friction drags that automatically compensate for the constantly decreasing length of wire and the increased load.



Machine setup for twisting three wires together with uniform pitch

The operator secures one end of the wires to a rotation head. Geared to this head is a large dial calibrated in feet. The dial is set for the exact length of wires to be twisted.

A tension device locked to the track at the desired length holds the wires at the opposite end in swivels which remove the individual spin in each wire as the twisting is being performed. The plate upon which the swivels are mounted is supported by a long rod.

The rod possesses a variable friction which automatically compensates for the shortening as the wires twist and prevents any stretching of the wires.

The operator's only remaining function is to press a switch atop an electric motor, starting the machine. A four-wheeled trolley with a wire guide affixed to it then travels along a 30-foot-long steel track from power supplied by the

tunes UP TIRED ASSEMBLY LINES

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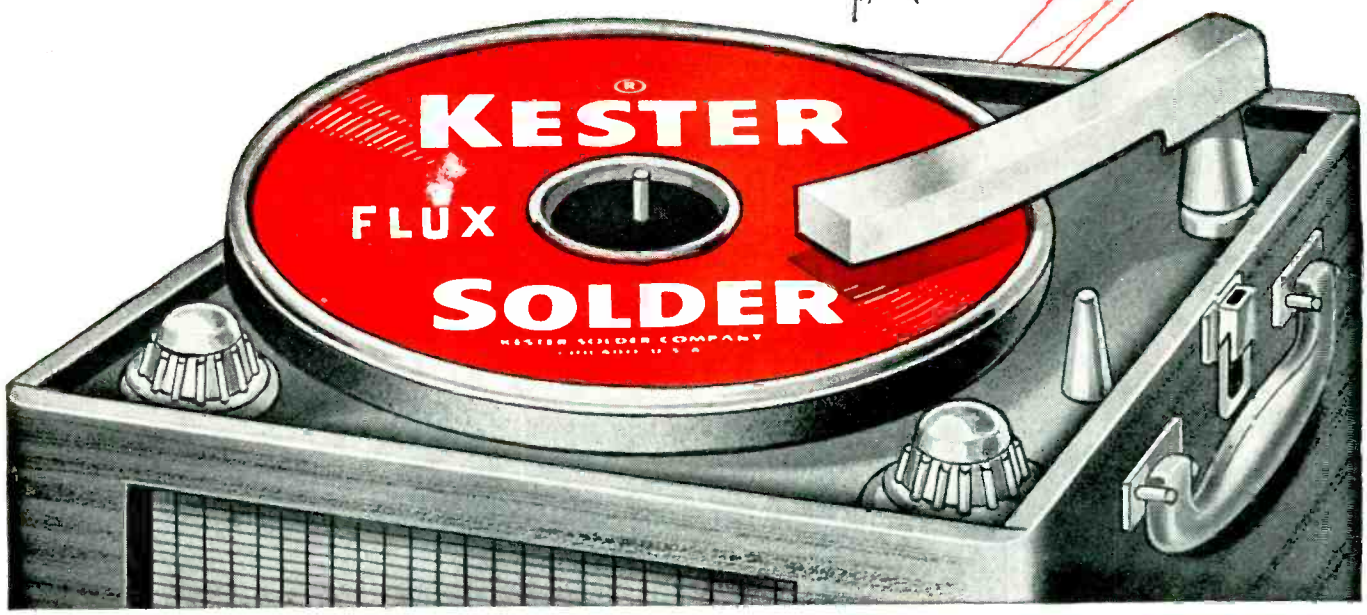

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4204 Wrightwood Avenue, Chicago 39, Illinois; Newark 5, N. J.; Brantford, Canada

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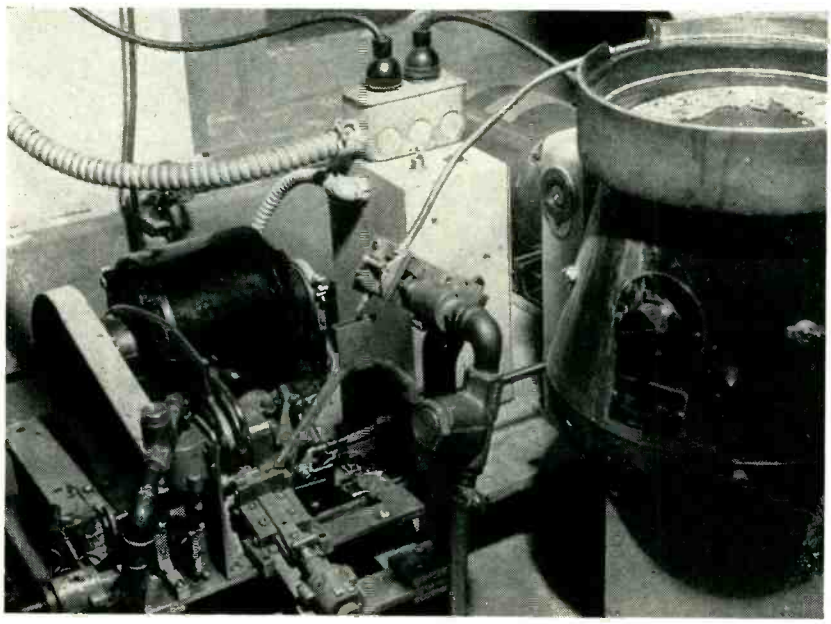
twisting action. When leads are completely twisted, a pin mounted on the dial trips a snap-action switch, instantly and automatically stopping the operation.

One advantage of such complete starting and stopping control is a fixed number of turns per foot throughout the length of wire.

Resistor-Spiraling Machine is Completely Automatic



Mechanized setup for bringing deposited carbon resistor bodies to specified value within 1-percent tolerance by spiraling. Associated control equipment is in separate cabinet under bench. Operator merely dumps resistor bodies into hopper of feeder at right and removes tray of finished resistors under machine

DEPOSITED carbon resistor bodies dumped into the hopper of a Syntron feeder are automatically spiraled to desired value within 1-percent tolerance on a mechanized setup developed by the engineering department of Electra Mfg. Co., Kansas City, Missouri. The production rate is several-hundred resistors per hour. The operator merely dumps a batch of resistors into the hopper and empties the tote tray as it becomes filled with spiraled resistors. The blanks used on this machine are previously sorted to a 2½-percent tolerance range to insure that they can be spiraled up to the desired precision value.

The vibratory feeder pushes resistor bodies end to end down a length of copper tubing to a gate controlled by an air cylinder. When a resistor has been spiraled to value and dropped into the tote box, this gate opens to release one resistor body into a funnel soldered to another short length of tubing. This brings the resistor into the insulated jaws of a miniature lathe. The jaws grip the resistor by its silver bands for measuring its value continuously during rotation by an electric motor drive. Sequenced air cylinders then bring a rotating cutter wheel against a resistor body and move the wheel longitudinally while the resistor rotates, to produce a spiral that serves to increase the electrical value of the resistor. When the desired value is reached, the measuring circuit withdraws the cutting wheel and opens the contact jaws.

Assembly Fixture for Ganged Precision Potentiometers

Placing third section on multigang potentiometer being assembled on phasing fixture having large calibrated dial

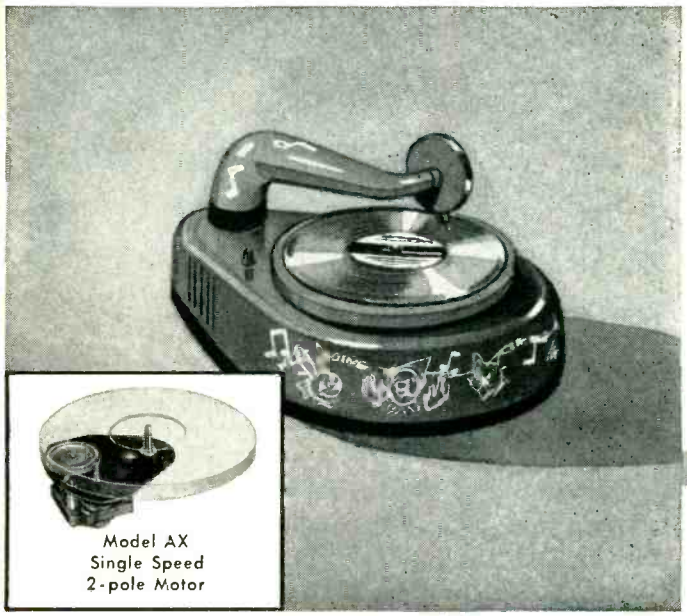
TO ACHIEVE the required precision of phasing when assembling two or more precision potentiometers on a common shaft, a combination assembly and checking fixture is used in Fairchild's Hicksville, N. Y. plant. The front plate is inserted first and clamped in position by tightening a knurled knob. The angle-checking plate of the fixture is then tightened with the next lower knob. A collet is tightened over the potentiometer shaft with the lowest knob of the fixture.

The first potentiometer element is now indexed by connecting to its terminals an indicator circuit that includes a 6-inch precision 100,000-ohm master potentiometer and a cathode-ray indicator. For a linear winding, the master is usually preset at its midpoint. The locking knob for the angle plate on the fixture is then loosened and the plate is rotated to null out the scope.

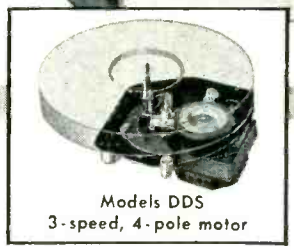
The master and the pot under test form two legs of a d-c resistance bridge, with a Waterman S-11A pocketscope connected between the wipers of the two pots. The d-c voltage applied to the bridge is 45 volts.

The combination of the three

From nursery phonographs . . . to hi-fidelity units



Model AX
Single Speed
2-pole Motor



Models DDS
3-speed, 4-pole motor

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Model D-10 — 4-pole,
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type for tape,
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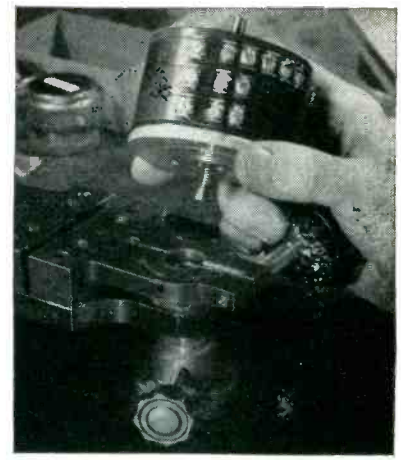


Removing assembled three-gang potentiometer from fixture

locking knobs and the angle plate permits setting each section in turn so that the 50-percent points are in phase. Connections are made to each section in turn during the assembly process.

After phasing a section, a switch is thrown to give a horizontal-line indication on the scope and the potentiometer is rotated while watching for grass on the pattern or loss of contact.

Stencilled Symbols Aid Assembly on Etched Wiring Boards

THE TIME required to bring a new moving-conveyor assembly line up to speed was greatly reduced in Westinghouse's Metuchen, N. J. plant by screen-printing an identifying number on each lead hole in the seven-tube etched wiring board and using similarly printed sche-

Hinged silk-screen frame used for applying numbers and component symbols to back of etched wiring board

PERFORMANCE IS BUILT INTO THIS CHOPPER

Painted case resists corrosion and is hermetically sealed to the base so that this chopper operates reliably in any atmosphere from sea level to 50,000 feet.

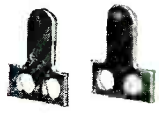
Permanent magnet polarizes switching to provide phase sensitive mechanical modulation of low-level signals.

Drive coil is conservatively rated for 6.3 volts RMS $\pm$ 10% at 400 CPS $\pm$ 5%.

Vibrating reed is resonant well above operating frequency to assure that switching phase of 65 degrees remains within $\pm$ 15 degrees for all operating conditions.

Buffer plate counteracts any tendency to chatter at make and break.

Ceramic insulators provide at least 100 megohms between contacts and case for use in high-impedance circuits.



Wiping action on fixed contacts, as in all Airpax choppers, help assure rated life of 2,000 hours.

Miniature 7-pin tube-type base rigidly supports internal assembly of this Airpax Type 300 chopper so that it withstands shock and vibration.

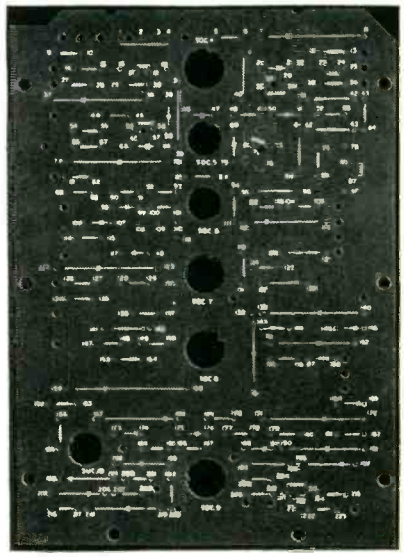
For complete specifications write to

AIRPAX PRODUCTS COMPANY
DESIGNERS ENGINEERS
MIDDLE RIVER BALTIMORE 20, MD.

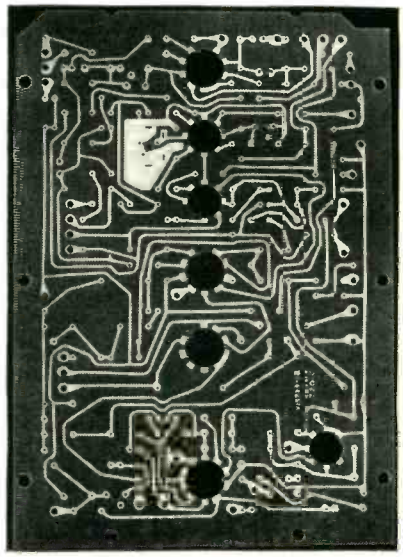
matic symbols and lines to connect pairs of holes for each component.

A sample board was prepared for each station on the line, containing only the components to be inserted there. The corresponding typed instructions were fastened over the board with rubber bands in such a way that the area there being loaded was not hidden. A typical assignment for one station involved inserting three bare jumper wires, one paper capacitor, three disk capacitors, two resistors and a ceramic filter plate.

The components are kept in dispenser bins supported in front of each operator by a metal frame. Cardboard cylinders with reinforced



Screen-printed pattern used as training aid on top side of etched wiring board



Bottom of same board, showing etched wiring pattern used for audio and sync stages of new Westinghouse tv receiver

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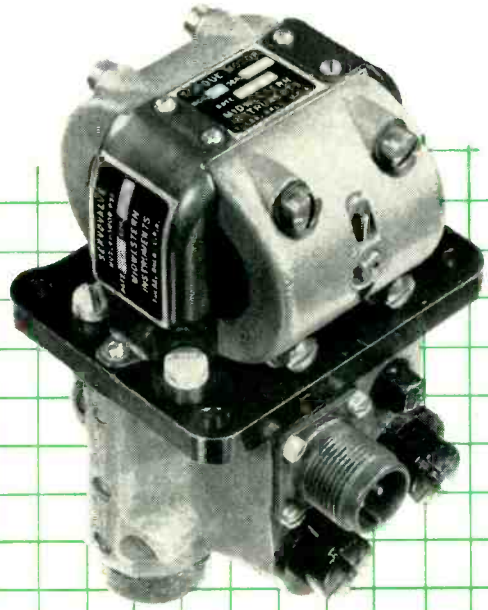
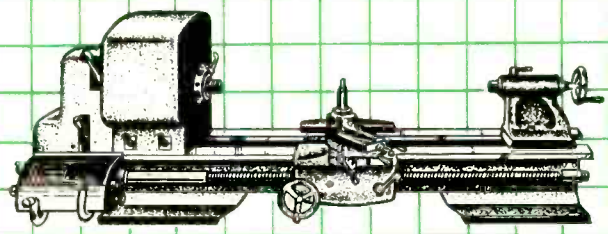
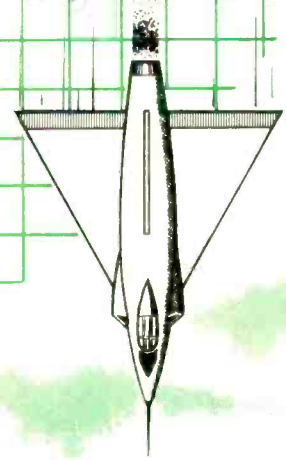


for Automation and Control





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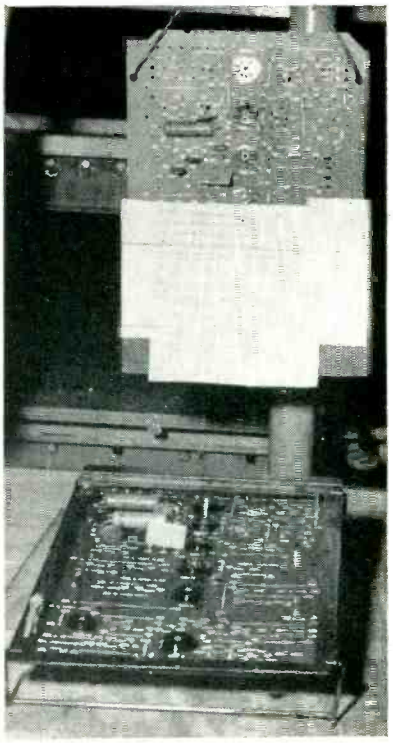


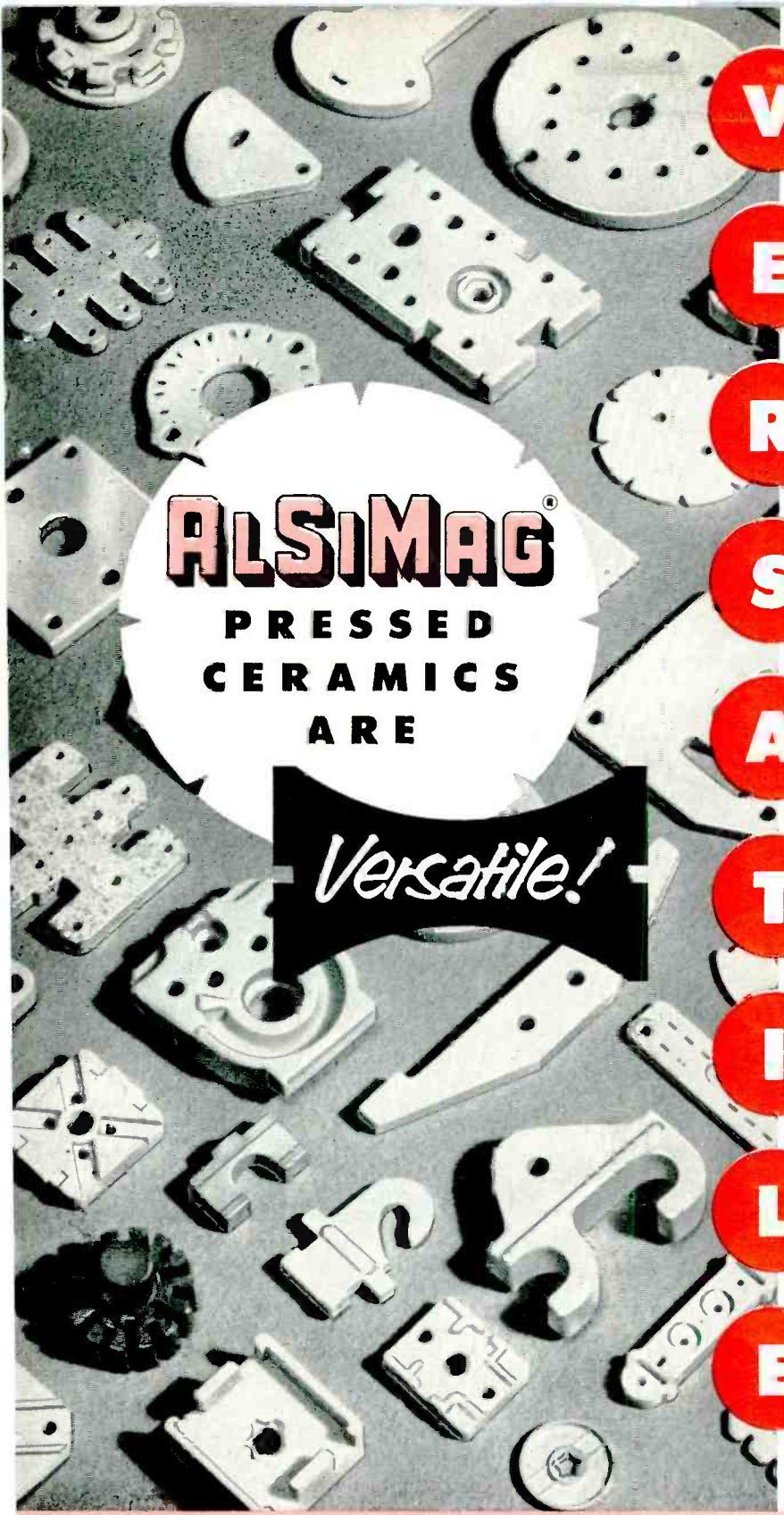
Sample board and instructions for inserting ten items at typical work position on belt conveyor line. Jaw of alligator clip is inserted through hole in metal pallet and board to lock board in position

metal tops and bottoms serve as the storage bins for the dispensers. The cylinders are held by spring clips, for easy replacement when empty.

When the variety of components required at a station calls for more than six bins, they are arranged in two tiers on a hinged frame. This frame is swung out for replacement of cylinders in the rear row, which are there supported by backward-facing spring clips.

Components are cut and formed in a preparation area before being

Typical work position on line, showing method of holding cardboard storage cylinders in dispenser bins. Boards are dip soldered without clinching leads



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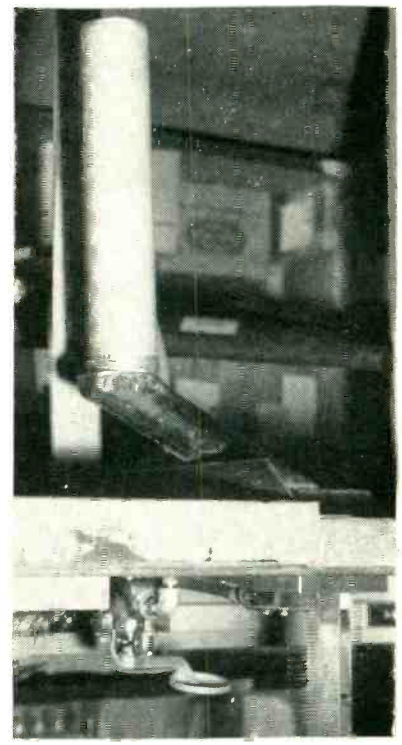
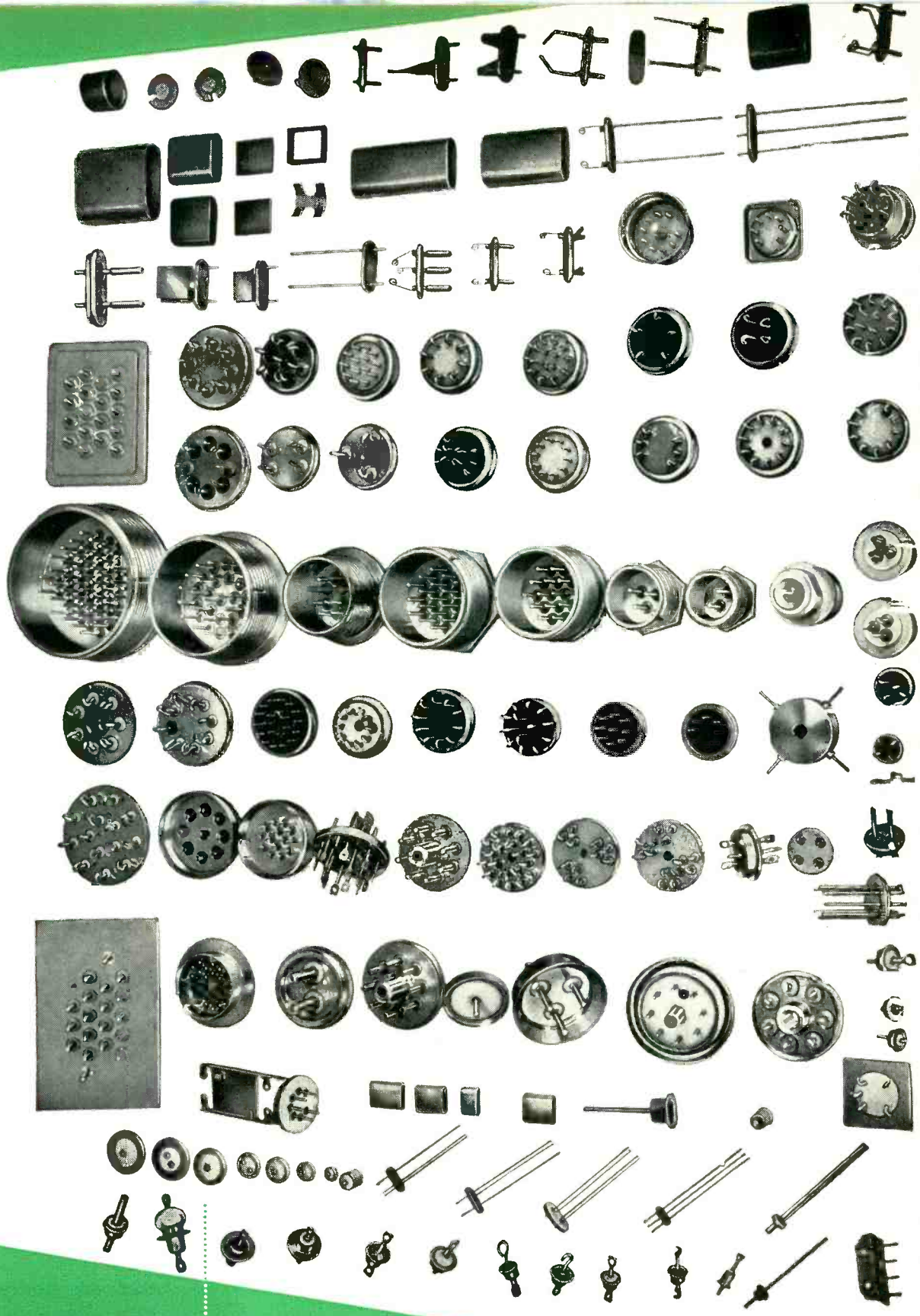
Method of swinging out dispenser frame for replacing cardboard cylinders in rear row. Hand is held over full cylinder as shown when placing in rack



Air-operated setup for cutting and forming resistor leads. Formed components drop down chute into cardboard cylinder. When filled, cylinder is unscrewed and taken directly to assembly line for use in dispenser bins

brought to the assembly line. Some of the semiautomatic machines used for this purpose feed the prepared components down a chute directly into the component storage cylinders. The threaded metal cap for the cylinder is soldered to the end of the chute after its top is cut out, to serve as a support for a cylinder during loading.

The etched wiring boards are supported in metal pallets having heavy wire legs that fit into drilled holes in a plain plywood pallet that rides on the belt conveyor. Each



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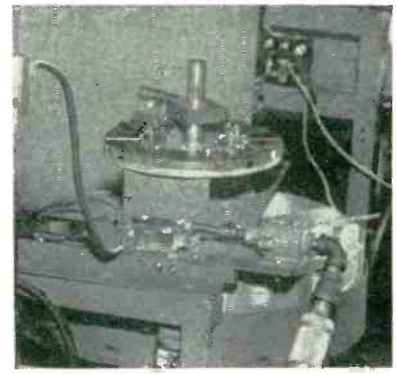
plywood pallet holds two wiring boards. The plywood pallets stabilize the wiring boards during assembly on the moving-conveyor line.

Sorting Silvered Resistors

AFTER silver terminal bands have been applied to deposited carbon resistor bodies and fired, the resistors are automatically sorted according to value by special mechanized setups engineered and developed by Electra Mfg. Co. for use in its own Kansas City, Mo. plant. The resistors are sorted into plus or minus 2½ percent ranges in preparation for spiraling to still more precise values on other machines. Quick-change contact jigs are available for each of the four sorting machines, so that several different sizes can be sorted on one machine during the course of the day with minimum lost time due to setup changes.

Mechanized setups for sorting silvered resistors into twelve value ranges

With the four machines and several sets of contact jigs for each, resistors ranging from 5 ohms to 15,000 ohms can be sorted automatically once the operator dumps a batch into the hopper of the Syntron feeder. The feeder lines up the resistors end to end and sends them down the length of copper tubing to the measuring position. Here a small air cylinder holds each resistor in turn against spring contacts. Under this measuring position is a rotating wheel containing 12 tote boxes, mounted on the same vertical shaft as the master contact jig assembly atop the machine. The



Closeup of sorting mechanism. Quick-change contact jig clamps onto vertical shaft on top. Circular pan holding 12 tote boxes is mounted on lower end of same shaft. Air cylinder in foreground holds resistor against contacts during measurement

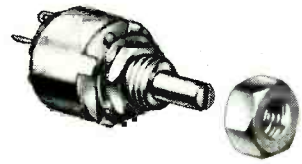
contact jig and the tote-box pan are driven in unison by an electric motor through a speed-reducing belt and rim drive much like that used in phonographs. When the correct tote box is under the resistor being measured, the contact-making air cylinder is released by the control circuit, allowing the resistor to drop. One operator can easily tend all four machines, emptying the filled tote boxes as required, since the time cycle of operation is relatively slow.

Shadowless Lighting for TV Assembly Line

SPECIAL shadowless lighting fixtures minimize the brightness of reflections from a cadmium-plated television chassis on the tv assembly line in Sylvania's new Batavia, N. Y. plant, while still providing a high level of illumination. Large-area light sources simulate the per-

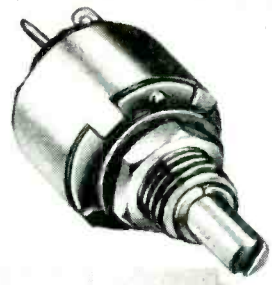
Chassis assembly line with new shadowless overhead lighting

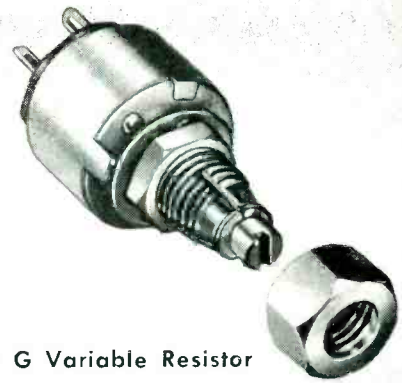
ACTUAL SIZE



Type G Variable Resistor

ENLARGED VIEW





Type G Variable Resistor

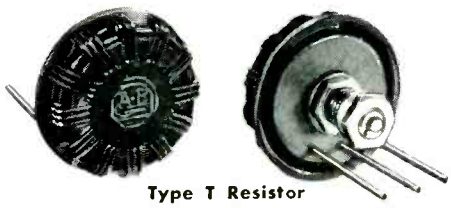
Contact Brush

Molded Resistor Ring

HIGH QUALITY

TYPE G

Continuously Variable 1/2 Watt Resistors

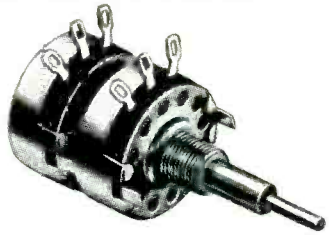


Type T Resistor

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

Type J Resistor

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



Dual Type J Resistor with Concentric Shafts

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

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

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

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

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

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formance of operating-room lights by eliminating shadows even with hands of assembly workers close to the chassis when soldering wires and making connections.

The new luminaire consists of two continuous rows of dual 90-watt open-end industrial units, mounted side by side and shielded by a continuous row of 32-inch square sections of framed white diffusing corrugated vinyl plastic. Corrugations are normal to the lamps for greatest brightness uniformity. Initial brightness of the plastic panels is 800 foot-lamberts.

The shielding is mounted approximately 2 inches below the reflectors and centered 54 inches above the center of the average chassis centers. A plastic panel can be lifted and slid over an adjacent section for lamp maintenance or the panels can be removed readily for cleaning.

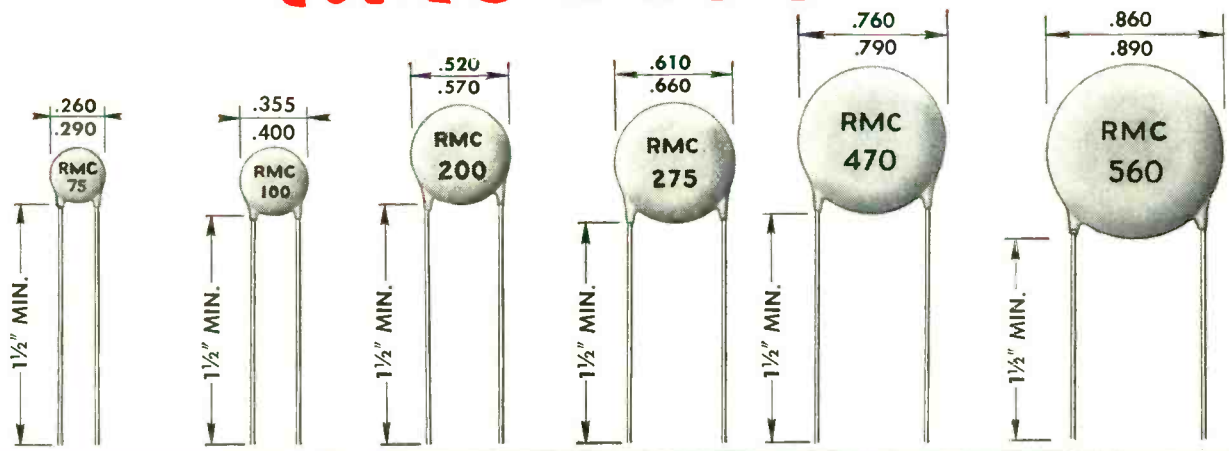
Automatic Screw Feeder for Power Screwdrivers

SPEED of screw fastening operations on electronic equipment has been stepped-up as much as 400 percent by a development of Pneuma-Serve, Inc., Cleveland, that feeds screws automatically and almost instantaneously from a hopper to a unique head fitting virtually any standard

Mechanized setup for inserting screws in housing at rate of one per second. Screws in hopper of work feeder at right are blown through plastic tubing one at a time by compressed air, to position under bit of screwdriver

the PROVED replacement for tubular ceramic and mica capacitors

RMC DISCAPS



TC	1/4 Dia.	5/16 Dia.	1/2 Dia.	5/8 Dia.	3/4 Dia.	7/8 Dia.
P-100	1- 3 MMF	4- 9 MMF	10- 20 MMF	—	—	—
NPO	2- 12	13- 27	28- 56	57- 62 MMF	63-100 MMF	101-150 MMF
N- 33	2- 12	13- 27	28- 56	57- 62	63-100	101-150
N- 75	2- 12	13 27	28- 56	57- 68	69-110	111-150
N- 150	2- 15	16- 30	31- 68	69- 75	76-140	141-150
N- 220	3- 15	16- 30	31- 75	76- 90	91-130	131-190
N- 330	3- 15	16- 30	31- 75	76-100	101-150	151-190
N- 470	3- 20	21- 40	41- 80	81-120	121-200	201-240
N- 750	5- 25	26- 56	57-150	151-180	181-300	301-350
N-1500	15- 50	51-100	101-200	201-250	251-330	331-560
N-2200	47- 75	76-150	151-200	201-275	276-470	471-560

Temperature coefficients up to N-5200 available on special order.

SPECIFICATIONS

POWER FACTOR: Over 10 MMF less than .1% at 1 megacycle. Under 10 MMF less than .2% at 1 megacycle.
WORKING VOLTAGE: 1000 V.D.C.
TEST VOLTAGE (FLASH): 1750 V.D.C.
CODING: Capacity, tolerance and TC stamped on disc
INSULATION: Durez phenolic-vacuum waxed
INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms
AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms
LEADS: No. 22 tinned copper (.026 dia.)
TOLERANCES: ±5% ±10% ±20%

These capacitors conform to the RTMA specification for Class 1 ceramic condensers

The capacity of these condensers will not change under voltage

Leading manufacturers of electrical and electronic products have proved by their continued use that Type C DISCAPS replace tubular ceramic and mica capacitors at lower cost.

Type C DISCAPS are available for varied applications in a wide range of capacities and temperature coefficients. These capacitors feature smaller size, lower self inductance, and greater dielectric strength. Rated at 1000 working volts, Type C DISCAPS assure trouble-free performance and cost no more than ordinary 600 volt capacitors. Specify Type C DISCAPS for your product, their many mechanical and electrical advantages combine with a lower initial price permitting substantial production cost reductions. These capacitors are available for use with printed wire circuits.

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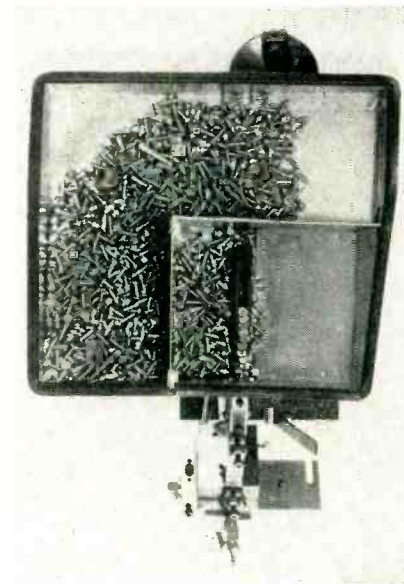
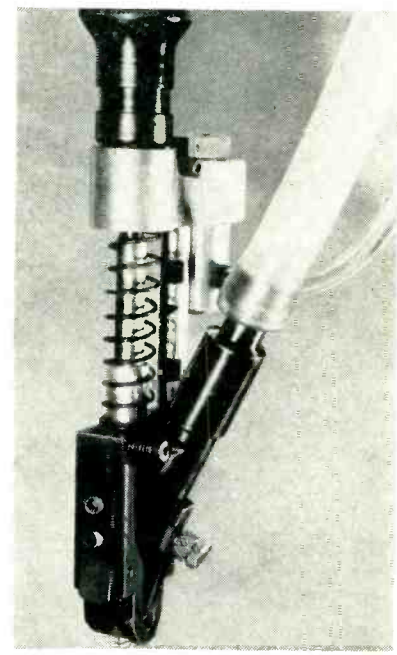


Top view of screw feeder. Screws selected by elevator at bottom of smaller pickup hopper are fed to magazine track which delivers them to plastic feed tube. Larger area of hopper holds 4-hour reserve of screws

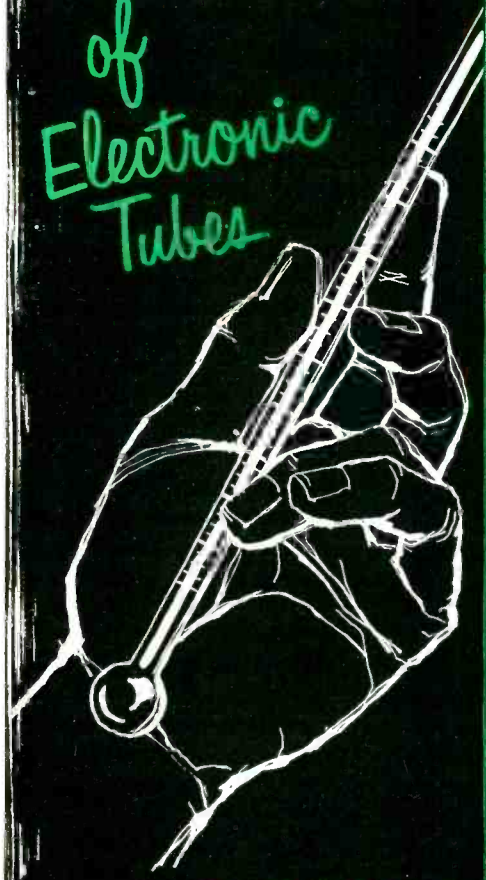
power screwdriver.

Even in highly mechanized plants using power screwdrivers, screws until now have been placed and started by hand. In some instances, special devices have been developed to deliver screws to the fastening point. However, equipment of this type must be rigidly fixed, requiring that parts to be fastened be brought directly underneath the



When bit of screw-feeding device retracts after driving screw home, next screw is automatically and almost instantly blown into position through transparent plastic feed tube

LIQUID COOLING of Electronic Tubes



WITH **Eastern**

COOLING UNITS

By a sustained program of research, Eastern continuously extends the uses of the latest units in electronic tube cooling, pressurizing electronic equipment, and pumping fuels and hydraulic fluids. Research and testing laboratories, a model shop, and three manufacturing plants provide the specialized equipment and manpower to turn out fully qualified units to meet appropriate government specifications.

From our extensive line of existing units, adaptations of these units, or completely new designs, Eastern can provide equipment to handle your project well. Your inquiry is welcomed.

EASTERN INDUSTRIES, INC.
100 SKIFF STREET
HAMDEN 14, CONNECTICUT

Eastern Cooling Units provide coolant liquid for maintaining within safe operating temperature limits liquid cooled electronic tubes or similar devices. The units are completely self-contained and usually comprise such components as heat exchangers, fans or blowers, liquid pumps, reservoirs, flow switch, thermostat, etc.

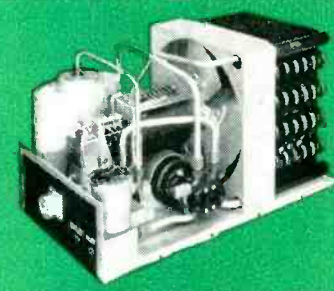
Cooling units can be modified as required for varying conditions encountered in land or sea as well as aircraft service. Almost all units are designed to meet such specification as MIL-E-5400 and MIL-E-5272.

The units shown below are intended only to illustrate the varying requirements which can be satisfied. By utilizing fairly standard components and designs based on broad experience in this field, Eastern is able to provide at minimum cost equipment exactly suiting a specific requirement.

Eastern welcomes your consultation on liquid cooling problems ranging from 200 to 20,000 watts dissipation.

Write for Aviation Products Bulletin 330.

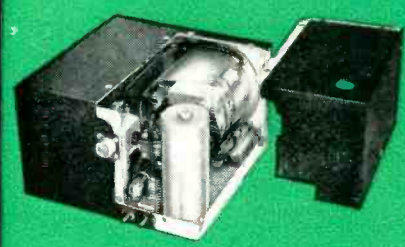
MODEL MB-175, TYPE 200 DISSIPATION: 2,000 watts. ALTITUDE RANGE: sea level to 50,000 feet. POWER REQUIRED: 28 volts D.C. WEIGHT: 25 pounds. SIZE: 10" x 15-15/16" x 10¼" high.



MODEL E/HT-205, TYPE 200A DISSIPATION: 1600 watts. ALTITUDE RANGE: sea level to 5,000 feet. POWER REQUIRED: 28 volts D.C. WEIGHT: 25 pounds. SIZE: 10" x 21" x 10" high.

MODEL MB-177, TYPE 202 DISSIPATION: 1700 watts. ALTITUDE RANGE: sea level to 50,000 feet. POWER REQUIRED: 110 volt, 400 cycle, 3 phase. WEIGHT: 27 pounds. SIZE: 10" x 19 15/32" x 7⅞" high, per JAN-C-1720A, size B1-D1.

MODEL E/HT-210, TYPE 200 DISSIPATION: 1500 watts. ALTITUDE RANGE: sea level to 10,000 feet. POWER REQUIRED: 208 volts, 400 cycle, 3 phase. WEIGHT: 35 pounds. SIZE: 11¼" x 19½" x 12½" high.



MODEL E/HT-200, TYPE 201 DISSIPATION: 1,000 watts. ALTITUDE RANGE: sea level to 50,000 feet. POWER REQUIRED: 28 volts D.C. WEIGHT: 14½ pounds. SIZE: 10" x 10" x 6" high.

MODEL NO. 5-A DISSIPATION: 1,000 watts. ALTITUDE RANGE: sea level to 5,000 feet. POWER REQUIRED: 100 to 110 volts D.C. WEIGHT: 10 pounds. SIZE: 7⅞" x 13½" x 9-1/16" high.

Screw passing through feed tube

driver manually or by conveyors.

The Pneuma-Serve removes this limitation on production methods. Screws pass in a split second from a hopper, holding enough screws for 5 to 8 hours' work, through a plastic hose to a special head mounted on a power screwdriver. The head grips screws in such a way that they may be driven at any angle, in any plane. After one screw has been driven, the next is automatically fed and instantly positioned. The operator may take the driver and head assembly to work stations as far as 20 feet from the hopper.

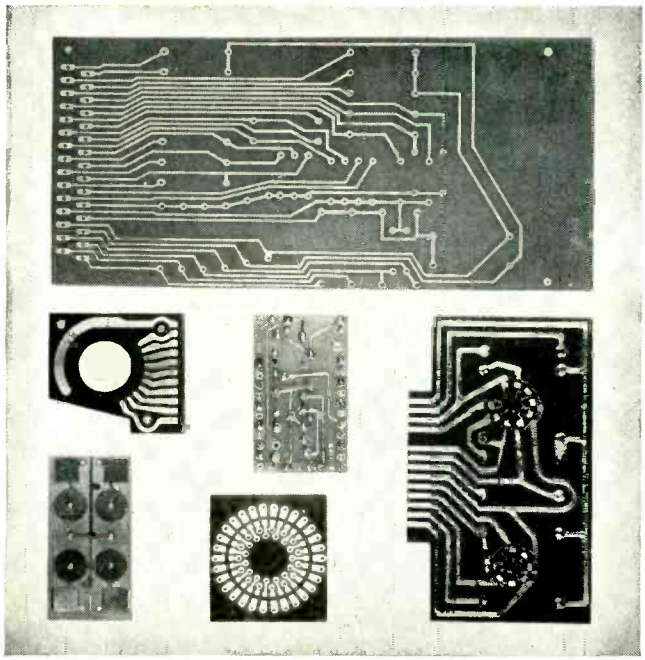
A large variety of types and sizes of screws up to ¼ inch in diameter and up to 1¼ inches in length may be handled. The machine will accommodate virtually any head style, including bolts or screws with washer attached, self-tapping screws, sheet metal screws, machine screws and wood screws.

Capping Resistors

A VISE with contoured jaws is closed by an air cylinder to press lead caps over the silvered ends of deposited carbon resistors in the Kansas City plant of Electra Mfg. Co. The operator first places the caps, with attached axial leads, in slotted recesses in the jaws of the vise. Next, the body of the resistor is set into position on a support between the jaws. An air valve is then pressed

Removing capped resistor from air-operated vise used for assembly

For the most dependable printed circuits, you need the high bond strength, workability, heat-resistance of C-D-F DILECTO® METAL-CLAD LAMINATES



Printed circuits based on C-D-F materials are being used with great success in military electronic equipment, commercial television and radio sets, telephone switchboards—even sub-miniature radiosonde equipment and hearing aids.

Photos courtesy of Photocircuits, Inc., Glen Cove, N. Y.

HIGH BOND STRENGTH—C-D-F's special adhesive for metal-clad Dilecto bonds the copper foil to the plastic without affecting the laminate's superior electrical properties. Heat-resistance, dissipation factor, dielectric constant, dielectric strength, and insulation resistance of the Dilecto base remain unaffected. The closely-bonded foil can be etched cleanly and dipped in hot solder to 220°C. (428°F.) for ten seconds with a guarantee of no blistering or separating. Metal-Clad Dilecto can be punched or machined either before or after etching.

EXCELLENT WORKABILITY—On all five Dilecto metal-clad grades, you can solder, punch, saw, and assemble components either by hand or automatically. Thanks to the inherently superior workability of the plastics laminate over that of ceramic-type materials, Dilecto can be dropped, jammed into tight chassis, and otherwise treated roughly on the assembly line and in service.

HIGH HEAT-RESISTANCE—Metal-Clad Dilecto Laminates are made of phenolic, epoxy, or Teflon* resin for various conditions of service and assembly, and have either cellulosic paper or woven glass-fabric base. All are ideally suited to printed-circuit applications in which heat-dissipation is a major problem. Continuous exposure to high ambient operating temperatures in enclosed electronic equipment has no significant effects on Dilecto's electrical and physical properties.

UNLOAD YOUR HEADACHE HERE! C-D-F, a big, reliable source of supply, can help you get the most for your printed-circuit money by reducing rejects, lowering fabrication costs, assuring dependable quality every time. Send us your print or problem, and we'll gladly supply appropriate test samples free. See our catalog in the Product Design File (Sweet's) or send for the new 20-page Dilecto catalog. Let your nearby C-D-F sales engineer (listed in Sweet's) help you right from the design stage!

TYPICAL PROPERTY VALUES

	Copper-Clad PHENOLIC (Grade XXXP-26)	Copper-Clad PHENOLIC (Grade XXXP-24)	Copper-Clad EPOXY (Grade GB-116E)	Copper-Clad EPOXY (Grade GB-181E)	Copper-Clad TEFLON* (Grade GB-116T)
BOND STRENGTH—0.0014" foil (Lbs. reqd. to separate 1" width of foil from laminate)	5 to 8	5 to 8	8 to 12	8 to 12	5 to 8
MAXIMUM CONTINUOUS OPERATING TEMP. (Deg. C.)	120	120	150	150	200
DIELECTRIC STRENGTH (Maximum voltage per mil.)	800	800	700	650	700
INSULATION RESISTANCE (Megohms) 96 hrs. at 35°C. & 90¾ RH	50,000	50,000	30,000	20,000	Over 10^6 megohms
DIELECTRIC CONSTANT 10^6 Cycles	4.20	4.20	4.90	4.95	2.85
DISSIPATION FACTOR 10^6 Cycles	0.026	0.026	0.019	0.018	0.0006
ARC-RESISTANCE (Seconds)	10	10	60	80	180
TENSILE STRENGTH (psi.)	16,000 x 13,000	14,000 x 11,000	46,000 x 42,000	48,000 x 44,000	23,000 x 21,000
FLEXURAL STRENGTH (psi.)	21,000 x 18,000	19,000 x 16,000	60,000 x 55,000	75,000 x 65,000	13,000 x 11,000
IZOD IMPACT STRENGTH edgewise (ft. lbs. per inch of notch)	0.40 x 0.35	0.40 x 0.35	6.5 x 6.0	13.5 x 11.5	6.0 x 5.0
COMPRESSIVE STRENGTH flatwise (psi.)	28,000	27,000	60,000	62,000	20,000
BASE MATERIAL OF LAMINATE	Cotton rag paper	Cotton rag paper	Fine-weave, medium-weight glass cloth	Medium-weave, medium-weight glass cloth	Fine-weave, medium-weight glass cloth
COLOR OF UNCLAD LAMINATE	Natural greenish	Natural Brown	Natural	Natural	Natural

All these standard grades are available with 0.0014", 0.0028", 0.0042", or thicker electrolytic or rolled copper foil on one or both surfaces. Other metal foils and other resin-and-base combinations can be supplied on special order.

*duPont Trademark

CDF Continental-Diamond Fibre

CONTINENTAL-DIAMOND FIBRE DIVISION OF THE BUDD COMPANY, INC.

NEWARK 16, DELAWARE

with the right hand to close the vise, thereby pressing the caps firmly in position. A Redington air-actuated counter is paralleled with the vise air cylinder to give a production count automatically.

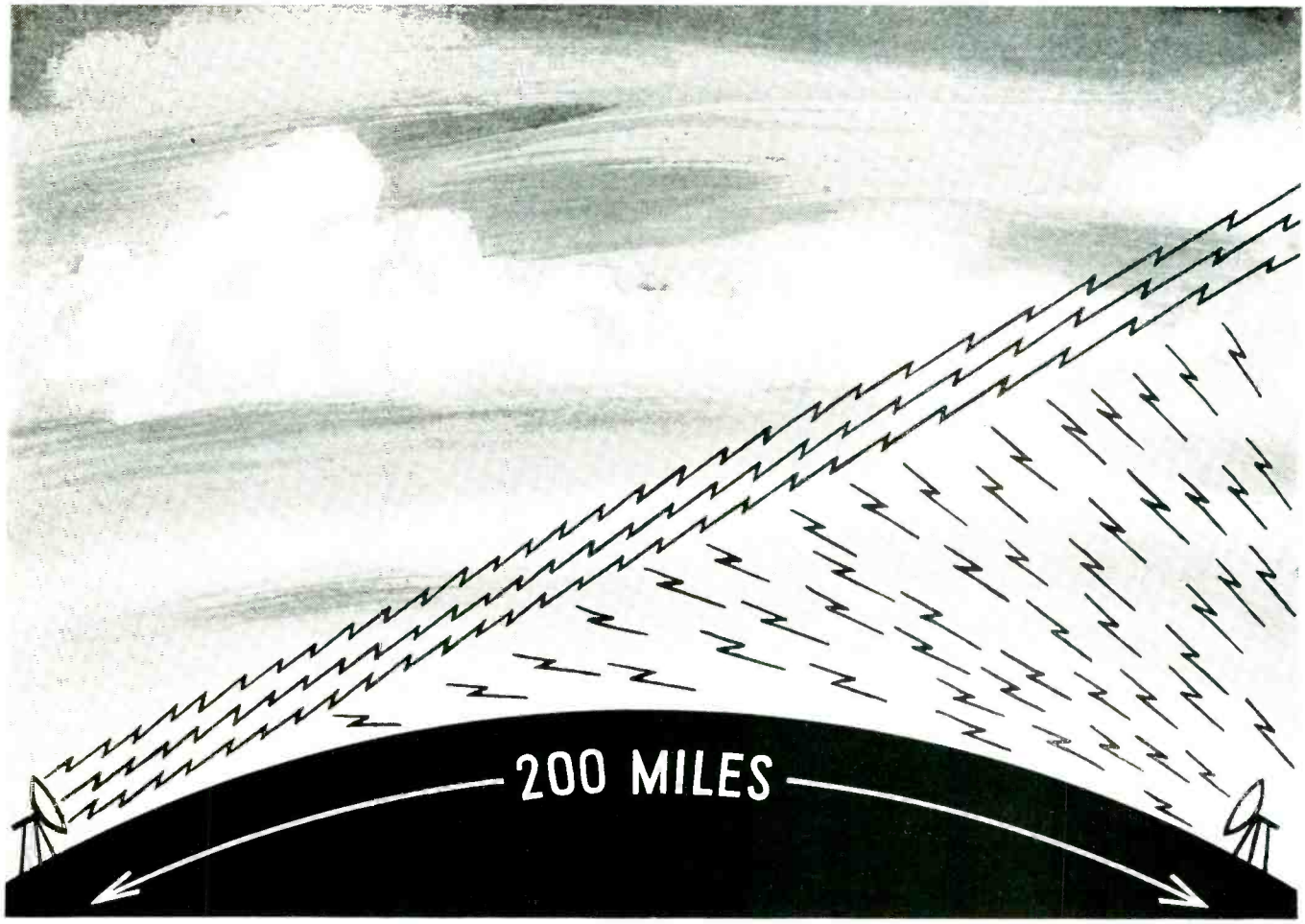
Magnet Controls Torque in New Air Screwdriver

A NEW TORQUE-CONTROLLED air gun known as the Magnamatic, announced by Chicago Pneumatic Tool Co., disengages fully the instant that proper torque is attained. The tool stays disengaged until the screwdriver or nut runner is removed from the work. The human element in determining proper fastener tightness is removed entirely from the driving operation. Because the clutch jaws remain separated, the objectionable ratcheting or impacting action and other undesirable features found in conventional clutches are eliminated.

The life of clutch components is greatly increased, due to the absence of any hammering action; screw bits last as much as twenty times longer due to the total absence of impacting; damage to screw heads and surface finishes of products is greatly diminished and the objectionable noise of an impacting clutch is eliminated.

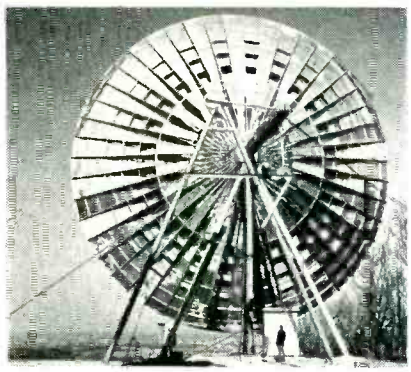
To get maximum efficiency from a threaded fastener, it usually

Driving assembly screws in filter units with new magnetic-clutch air tool



Highly schematic drawing illustrates the possible distribution of energy in ultra-high-frequency "over-the-horizon" transmission. The effect is similar to that of a powerful searchlight whose beam points into the sky. Light can be seen miles away from behind a hill even when the searchlight lens is invisible.

Something new on the telephone horizon



This experimental 60-foot antenna (rear view) photographed at Bell Laboratories in Holmdel, New Jersey, is designed for study of "over-the-horizon" phenomena.

Telephone conversations and television pictures can now travel by ultra-high-frequency radio waves far beyond the horizon. This was recently demonstrated by Bell Telephone Laboratories and Massachusetts Institute of Technology scientists using "over-the-horizon" wave propagation, an important recent development in the radio transmission field.

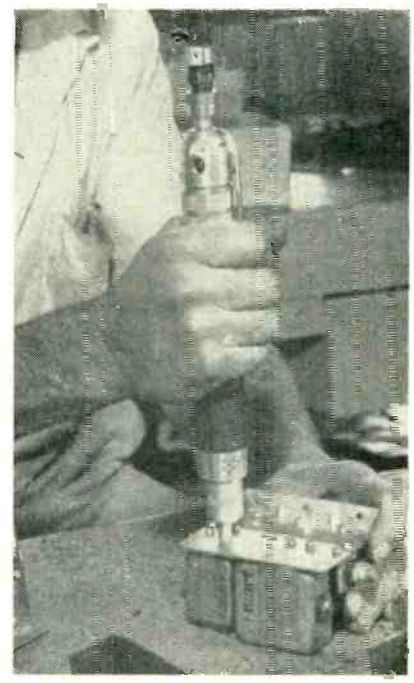
This technique makes possible 200-mile spans between stations, instead of the 30-mile spans used for present line-of-sight transmission. It opens the way to ultra-high frequencies across water or over rugged terrain, where relay stations would be difficult to build.

In standard microwave line-of-sight transmission, stations are so spaced that the main beam can be used. But now, with huge 60-foot antennas, and much higher power, some signals drop off this main beam as it shoots off into space. These signals reach distant points beyond the horizon after reflection or scattering by the atmosphere. The greater power and larger antennas of the "over-the-horizon" system permit recapture of some of these signals and make them useful carriers. The system will be a valuable supplement to existing radio relay links.

BELL TELEPHONE LABORATORIES

Improving telephone service for America provides careers for creative men in scientific and technical fields.

Want more information? Use post card on last page.



New tool drives screws to optimum tightness in plastic housing of tape recorder, avoiding distortion of housing

should be driven to from 80 to 85 percent of its breaking or stripping load. A screw that is driven too tightly may strip its threads, break or distort the part or cause ultimate failure of the assembly. Failure also can occur if the fastener is too loose because of low fatigue resistance.

The new tool permits desired torque to be applied consistently over high production runs without reliance on operator skill, with increased tool life, and at higher production rates.

Torque setting is achieved by screwing a permanent magnet assembly in or out of the upper clutch jaw. This adjustment changes the depth of engagement and the angle of contact of the teeth on the clutch jaws.

The top drawing in Fig. 1 shows the clutch set to deliver maximum torque. The magnet assembly has been screwed as far into the upper jaw as it will go, allowing the lower jaw to move to the left until the armature plate contacts the magnet assembly. The teeth of the jaws are now at their maximum depth of engagement and the torque required to cam the lower jaw out of and away from the upper jaw will be high because of the steep angle of contact of the teeth.

The lower drawing shows the

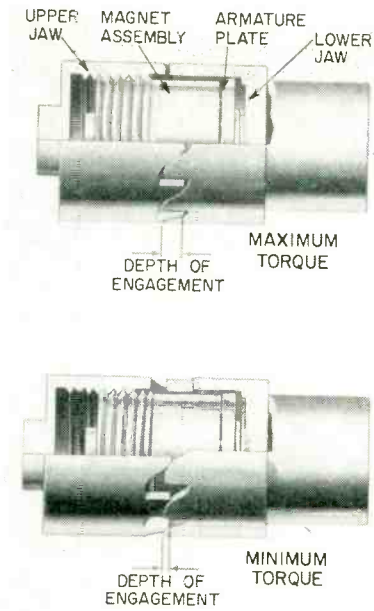


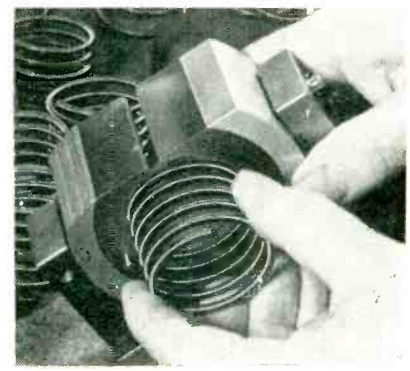
FIG. 1—Screw adjustment in magnetic clutch

clutch set to deliver minimum torque. The magnet assembly has been screwed out of the upper jaw. With this setting, the armature plate contacts the magnet assembly before the jaw teeth are fully meshed. With the teeth so engaged, the angle of contact is relatively small and a considerably small torque will cause the lower jaw to cam out of the upper jaw.

Cutting and Flattening Helices for Potentiometers

RESISTANCE elements for single-turn precision potentiometers are wound on straight wire cores, coiled into a five-turn helix, sawed apart and then flattened to give single-turn elements that fit into the cups of linear precision potentiometers, in the Hicksville, N. Y. plant of Fairchild Controls Corp.

The first step in the cutting-apart



Inserting helix in holding fixture

Keeping in step with fast-stepping PRINTED WIRING...

CLAROSTAT
PRINTED WIRING
CONTROLS and RESISTORS

SERIES 43 CONTROL

- 1 ohm to 50,000 ohms. Wire-wound. Plus/minus 10%. Closer tolerances available. 2-watt rating.
- 1⅛" diameter X 9/16" deep.
- Terminals reversed to meet printed-wiring requirements.
- Rotation: Mechanical, 300°; effective, 280°.

SERIES 39 CONTROL

- Screwdriver-adjusted for semi-permanent settings.
- Available as rheostat or potentiometer. Wire-wound. 2-watt rating.
- Terminals designed for printed-wiring connections.
- 4 ohm to 5,000 ohms; plus/minus 20%.
- ¾" diameter X ⅜" deep.

STANDEE® RESISTOR

- Terminals designed for printed-wiring circuitry. Spring-clip action locks STANDEE securely during soldering phase of assembly.
- Available in 10 watts to 30 watts.
- 6000 to 21,000 ohms. (Wattage and Ohmage based on length).
- Five lengths — 1½" to 4"
- Plus/minus 10%. Closer tolerances available.
- Resistance element wound on glass fiber core, sealed in steatite tube.
- Standee permits maximum heat dissipation above printed-circuit mounting panel.

Three typical printed-wiring components by Clarostat. Others available. Ease of installation in sub-assemblies of printed-wiring circuitry, accounts for low cost factor. Always, there's a Clarostat control or resistor to meet every application need.

Let us collaborate in your printed-wiring and other automation requirements and problems. Latest Engineering Data on request.

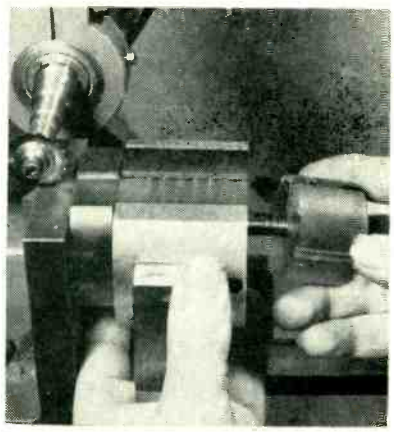
CLAROSTAT®

Controls and Resistors

CLAROSTAT MFG. CO. INC., DOVER, NEW HAMPSHIRE

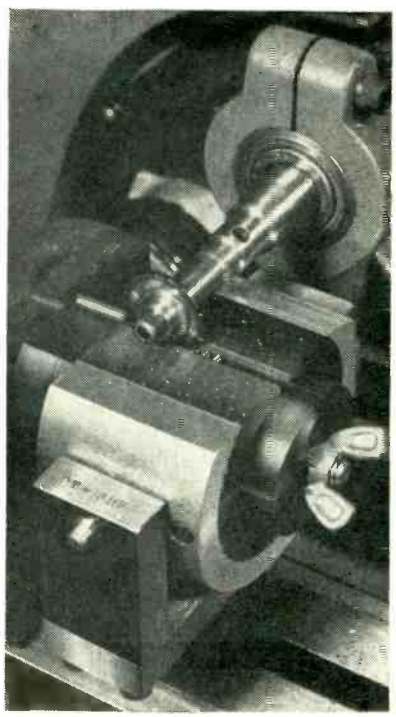
In Canada: Canadian Marconi Co., Ltd., Toronto 17, Ont.

Manufactured under license in Great Britain by A. B. Metal Products Ltd., 17 Stratton St., London W. 1, Concessionaires for British Commonwealth except Canada.



Inserting compressing plug over bolt anchored in anvil of machine to hold fixture in position and tighten helix

Moving lever of armature undercutter to move helix through cutting wheel



Cutting helix into single-turn windings. Thumb nut is placed over bolt to hold fixture in position and tighten helix

now selenium rectifiers designed for printed circuits!

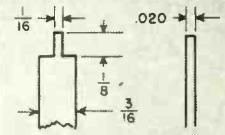
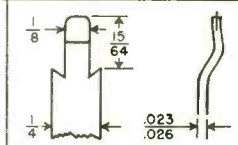
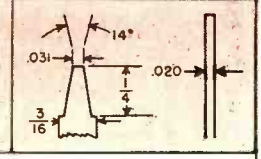
Four output ratings from 65 to 150 milliamps, and a choice of three terminal styles, are now available from Federal to meet your printed circuit requirements.

The new terminal designs cut your assembly and soldering costs . . . permit rapid *automatic* or *manual* insertion into printed circuit boards.

Terminal shoulder stops keep the rectifier plates off the board. Result: rectifier cooling is improved and extra board area is freed for additional printing!

And, as with all Federal selenium rectifiers, *you can count on* their long life, high output voltage, low temperature rise, excellent humidity resistance, and UL acceptance.

TERMINAL TYPES

TYPE	DESCRIPTION	DETAIL DRAWING
a	**Square Tipped**—for light-gauge printed circuit boards up to 1/16" thick.	
b	**Snap-In**—for 1/16" printed circuit boards subject to vibration or inversion. Terminals lock rectifier in place.	
c	**Tapered**—for maximum ease of insertion in heavy-gauge printed circuit boards up to ⅛" thick.	

FEDERAL PRINTED CIRCUIT RECTIFIERS

FTR No.	1266	1279	1265	1308	1444	1357	1297	1445	1400	1383	1494	1495
DC Output ma (maximum)	65	65	65	65	65	75	75	75	100	100	100	150
AC Input V (rms maximum)	130	130	130	130	130	130	130	130	130	130	130	130
Terminal Type	A	B	A	B	C	A	B	C	A	B	B	B

Federal

A DIVISION OF ITT

For more information on Federal Printed Circuit Rectifiers phone NUtley 2-3600, or write Dept. F-913.

Federal printed circuit rectifiers can be designed for your application in ratings up to 195 volts AC and 600 milliamps DC

Federal Telephone and Radio Company

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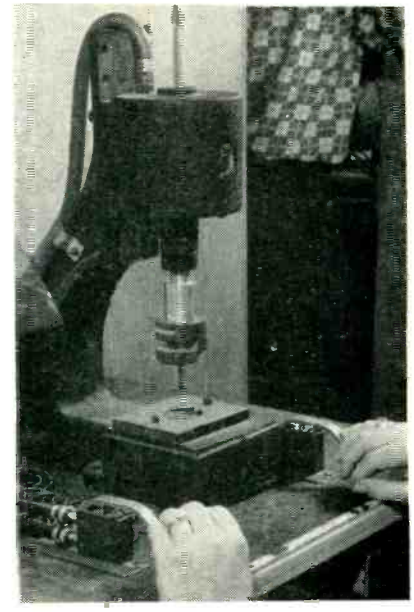
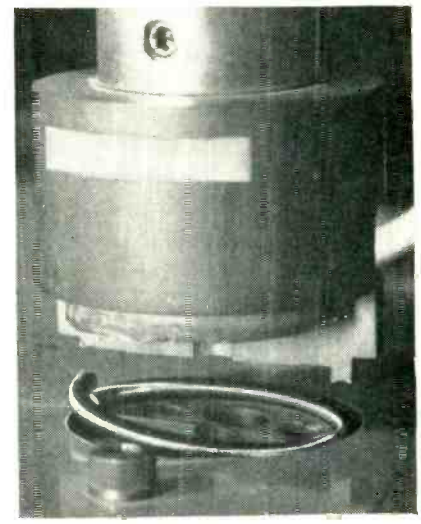
COMPONENTS DIVISION • 100 KINGSLAND ROAD • CLIFTON, N. J.

In Canada: Standard Telephones and Cables Mfg. Co. (Canada) Ltd., Montreal, P. Q.
Export Distributors. International Standard Electric Corp., 67 Broad St., New York



Pneumatic hammer setup used to flatten single-turn windings



Contoured flattening head and anvil with winding in position

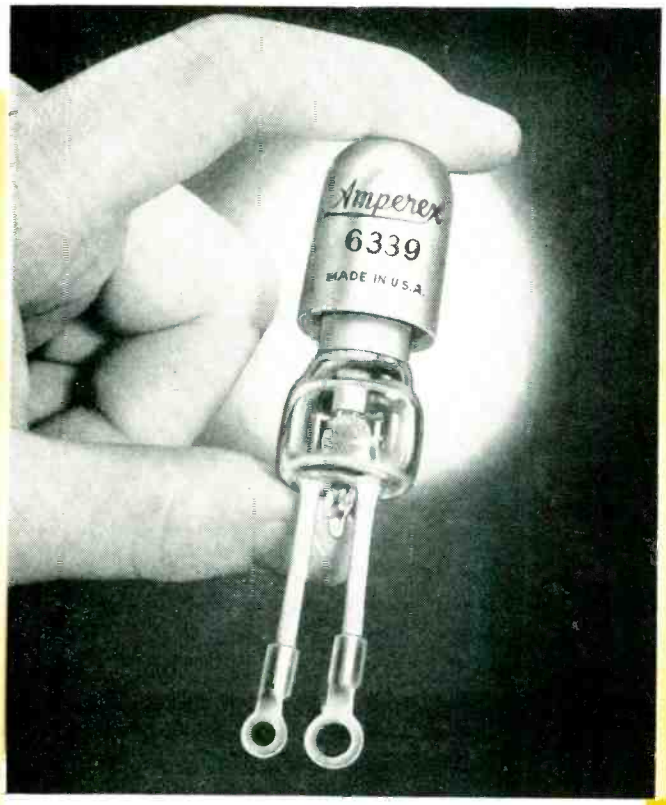
operation involves inserting the five-turn helix into a circular plastic-lined holding fixture having a slot through which the blade of the cutting saw can run. With the helix in position, the fixture is slipped over a bolt on the anvil of an armature undercutter made by Hullhorst Tools Inc., Toledo, Ohio. A special plug is inserted in the other end of the fixture, and a thumbscrew is placed over the bolt and tightened to compress the helix and at the same time fasten the fixture to the anvil. A lever attached to the bed of the machine is then used to move the helix through the high-speed cutting wheel.

Individual turns are flattened with a pneumatic hammer having

NEW

high-power rectifier

MINIATURIZED BY amperex®



Only 2" (without leads) and ¾" in diameter, the AMPEREX 6339, a miniaturized, ruggedized version of the 3B29, operates under more stringent conditions than its prototype. This miniature, high-vacuum, external-anode, clipper diode and rectifier tube is designed to be enclosed in a complete liquid-cooled package, including power supply and pulse modulator components. It may also be operated in air at reduced ratings, in applications where liquid cooling is not required.

PARTIAL DATA — AMPEREX 6339

Filament Voltage	6.3
Filament Current	1.55

IN OIL Maximum Ratings

Peak Inverse Voltage	10,000	16,000 volts
Peak Current	400	250 ma
Average Current	100	65 ma dc
Silicone Oil Coolant Temp.	−65°C to +165°C	

Typical Operation (Three-phase, Bridge, Choke Input Filter)

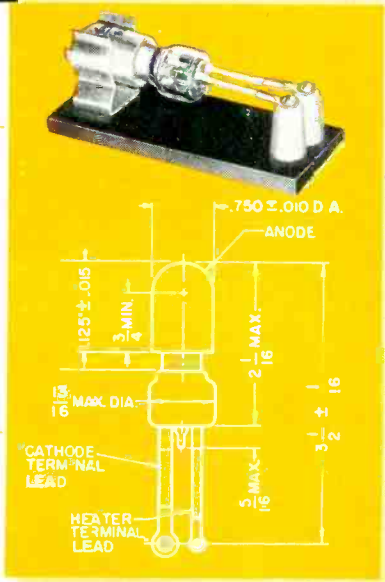
No. of Tubes	6
Peak Inverse Voltage	16,000 volts
Peak Anode Current	195 ma
Average Anode Current (per tube)	65 ma dc
Output Voltage	14,000 volts dc
Output Current	195 ma dc

IN AIR Maximum Ratings (sea level)

	Without Auxiliary Cooler	With Auxiliary Cooler
Peak Inverse Voltage	12,000	12,000 volts
Peak Current	200	400 ma
Average Current	50	100 ma dc
Ambient Temperature	−55 to +85	−55 to + 85°C

Typical Operation (Three-phase, Bridge, Choke Input Filter)

No. of Tubes	6	6
Peak Inverse Voltage	12,000	12,000 volts
Peak Anode Current	100	200 ma
Average Anode Current (per tube)	33	67 ma dc
Output Voltage	10,500	10,500 volts dc
Output Current	100	200 ma dc



The AMPEREX 6339 may be mounted in a standard 60 amp. fuse clip, as illustrated. For high-power operation in air, an auxiliary cooler which will also serve as a mount may be used. Flexible leads terminating in #6 and #8 lugs are used for heater and cathode connection. These allow the tube to be mounted in an extremely small space, and the leads may be brought out to any convenient terminal strip or stand-off insulator.

AMPEREX 6339 ..... **$35.00 net**
See it at your local electronic parts distributor, or write direct to factory for detailed data sheets.

RETUBE WITH amperex

amperex ELECTRONIC CORP.
230 Duffy Ave., Hicksville, L. I., N. Y.
In Canada: Rogers Majestic Electronics, Ltd.
11-19 Brentcliffe Road, Leaside (Toronto 17)

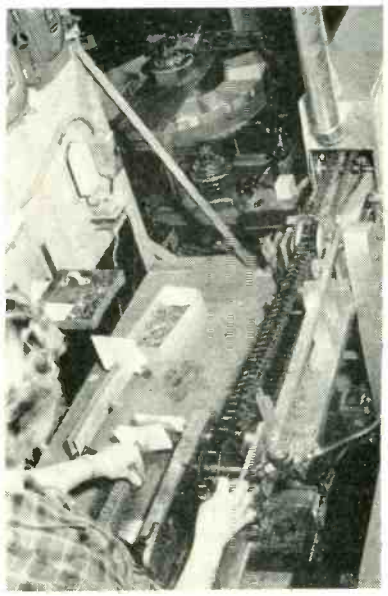
contoured faces made from reinforced fiber. This hammer setup bends the ends of the single turn just far enough in the opposite direction so that they meet precisely when they spring back after the hammer is released.

Use of fiber and plastic on all tools prevents damage to the fine resistance wire during this processing action.

Resistor-Varnishing Setup

A MOISTURE-RESISTANT varnish coating is applied to finished deposited carbon resistors by a semiautomatic mechanized setup in the Kansas City plant of Electra Mfg. Co. Machine capacity is over 10,000 resistors per day.

The operator transfers resistors one by one from a metal tote rack to the projections of a motor-driven feed wheel at the input end of the machine. This wheel takes the resistor bodies through a varnish bath, then transfers the resistors automatically to a short conveyor chain running at a slant so surplus varnish drains off one end of the resistor without forming tears. At the other end, this draining chain runs between two motor-driven



Loading resistors on feed wheel at input of varnishing machine. The comb-like metal tote racks used for these resistors have slots through which the leads project, with the bodies of the resistors fully protected. Resistor bodies are not touched by hand until after they have received the varnish coating

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Good-ALL capacitors

marbelite

Premium capacitors at economical cost. This small, compact style is impregnated with a tough, plastic material used exclusively by Good-All. The paper tubes are heavily impregnated. Ends are sealed with thermo-setting plastic. Marbelite will not crack or dry out—assures long service life and superior field performance. MYLAR or paper dielectric.

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High heat and humidity resistance at low comparative cost. Good-All's thermo-setting plastic end seal bonds securily to the leads and to the tubular ceramic case. The seramelite capacitor series includes pin-type design in which both leads emerge from the same tube end. MYLAR or paper dielectric may be specified.

film-x

A family of hermetically-sealed capacitors with MYLAR dielectric. All types provide high insulation resistance and low power factor. In the temperature range up to 85°C an appreciative space saving is gained through the use of Film-X. For higher ambient temperatures, Good-All has designed its "HT" series of high-temperature MYLAR capacitors.

military

To extend our service to customers, we have designed a wide line of capacitors to Mil-C-25A specifications. Current QPL listings will supply approval information. Design and production facilities are kept available for specialized work in conjunction with new or unusual requirements. MYLAR equivalents are available for all CP-type capacitors.

printed circuit

Many capacitor designs for printed circuits are in quantity production for Good-All customers. A special printed circuit bulletin which illustrates various lead and case arrangements is available. Other designs can be created to meet the electrical and mechanical needs of new applications. Special packaging for magazine feeding can be provided as required.

service plus...

We pride ourselves on out-doing other large capacitor manufacturers in providing customer service. Flexible production scheduling, *plus* efficient paperwork handling, *plus* excellent shipping facilities make Good-All service the best in the industry. Our engineers are ready to work with you on special applications. *Write, wire or phone for specifications and quotations.*

GOOD-ALL ELECTRIC MFG. CO.

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wheels that pick up the resistors by their leads and transfer them to a clean conveyor chain for transport through a long baking oven. A single electric motor working through a reduction gear drives all conveyors and wheels, insuring precise synchronism of feed.

Packaging Resistors for Automatic Unloading

THE PROBLEM of loading ½-watt carbon resistors into a bulk shipping carton holding 2,500 resistors, with the units neatly oriented to give an automation pack that can be fed directly into automatic handling equipment, has been solved in the Philadelphia plant of International Resistance Co. with a unique vibrator-activated loading machine.

The resistors are dumped into the

Setup used for achieving perfect alignment of resistors as they are fed into shipping carton. Operator at top distributes incoming batch of 2,500 resistors approximately equally to the five chutes of the loading machine. Operator at bottom removes loaded cartons and puts empties in position

input of this machine in bulk lots of 2,500 at a time and counted out by weighing. An operator on an elevated platform spreads out these resistors and breaks up tangled batches as they slide down a wide metal chute under the action of a motor-driven oscillating feeder. About half-way down, this chute has longitudinal partitions that align the resistors parallel with their direction of motion in five

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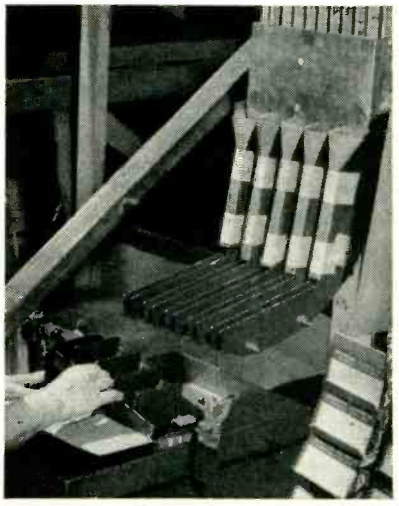
rows. The resistors drop lead-first off the main chute into five narrow secondary chutes running almost vertically downward and then gradually curving to an almost horizontal angle at the output.

The secondary chutes are attached to the main chute and receive the same ¼-inch vibratory stroke at 490 rpm.

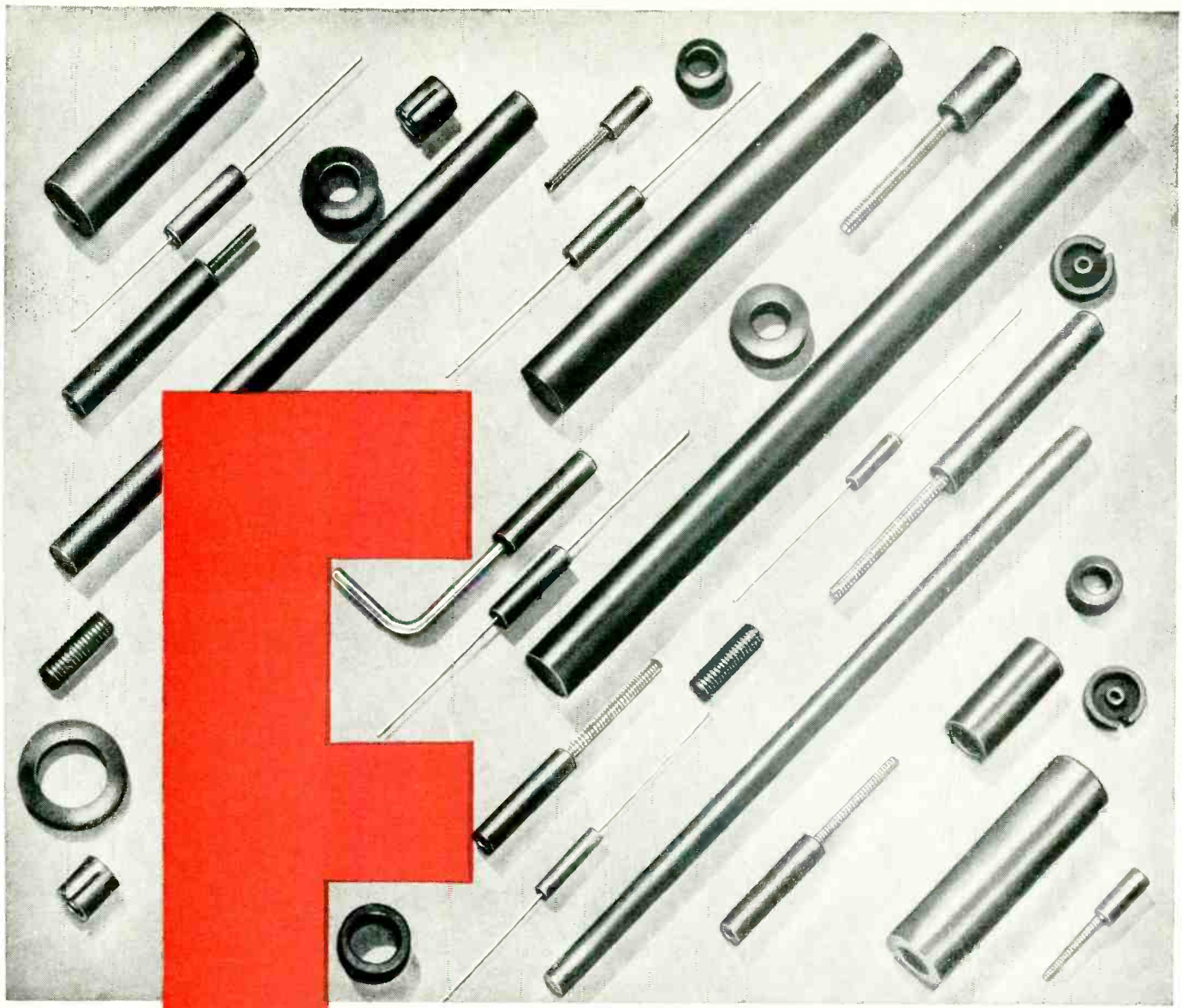
An operator at the output of the loading machine first places an empty cardboard carton in the holding fixture, which is mounted on a shaper mechanism. Next, she inserts in the carton a temporary alignment frame having four metal separators. These divide the shipping carton into five sections, each directly under one of the five output chutes. Finally, a sheet metal back-plate is placed over the separators and locked in place by pushing down holding clamps.

As resistors emerge from the secondary chute, they hit the back-



Placing separator frame in empty carton that rests on top of shaker mechanism

Placing baffle over separator frame



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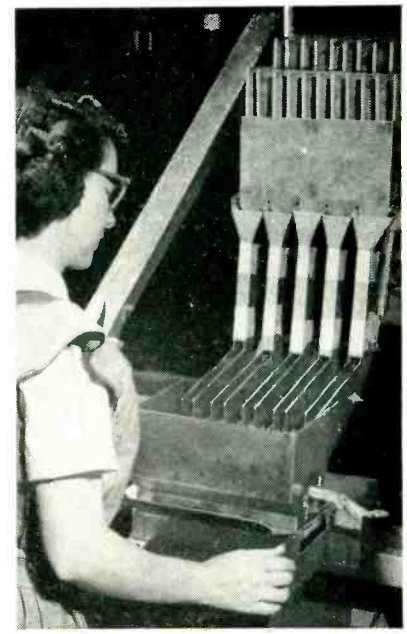
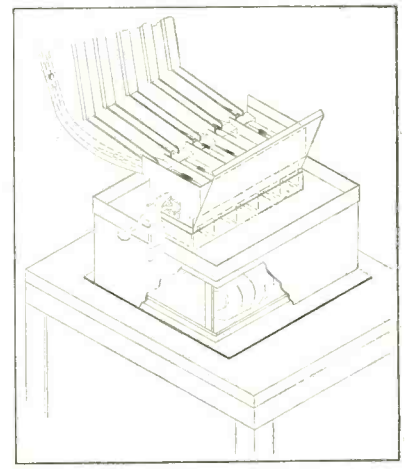


Resistors sliding down five output chutes hit baffle plate end-on with just sufficient momentum to drop flat into carton below, giving desired alignment of resistors in carton

plate end-on and drop into their respective compartments. While being filled, the carton and inserts are shaken by the shaker mechanism, which serves to slide the resistors back and forth so that their bodies interweave while still remaining parallel. This gives maximum utilization of carton space. A combination of 490-rpm speed and ¼-inch stroke proved optimum for keeping the resistors in perfect alignment as they drop into the shipping carton at the output of the chutes.

When all the resistors of a batch have dropped into the carton, the



Isometric sketch of shaker-box assembly and output chutes. Electric motor driving eccentric weight arrangement in box causes resistors to slide back and forth past each other in carton for maximum utilization of space

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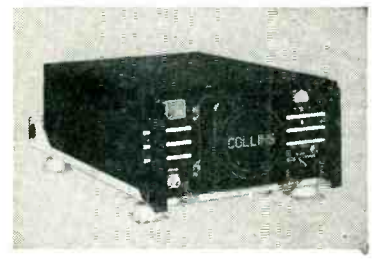

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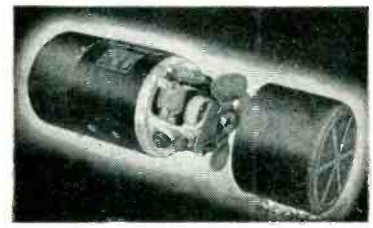

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Placing corrugated cardboard over resistors in carton, after having first inserted vertically ribbed strips against ends of resistor leads to achieve pack that will not shift during shipping

operator removes the baffle and the separator assembly, takes out the loaded carton and then reloads in readiness for the next batch.

At the final carton-closing position, another operator places strips of corrugated cardboard against the ends of the leads on each side, with the corrugations vertical and exposed on the sides facing the resistors. The resultant ribbing preserves the perfect alignment of the resistors despite vibration and rough handling during shipment.

To prevent bending of leads during insertion of the ribbed cardboard strips, the operator first inserts a metal plate between the lead ends and the side of the carton. She then pushes the leads just enough with this plate so the cardboard strip can be inserted between the plate and the carton. The metal strip is then removed and the procedure repeated for the other side. An ordinary cardboard corrugated piece is then placed over the resistors horizontally and the cover is tucked in to complete the package.

Tube-Aging Conveyor

A CONVEYORIZED aging rack having sufficient design flexibility to permit use with over 20 different types of tubes is widely used in a CBS-Hytron tube plant. The mechanized

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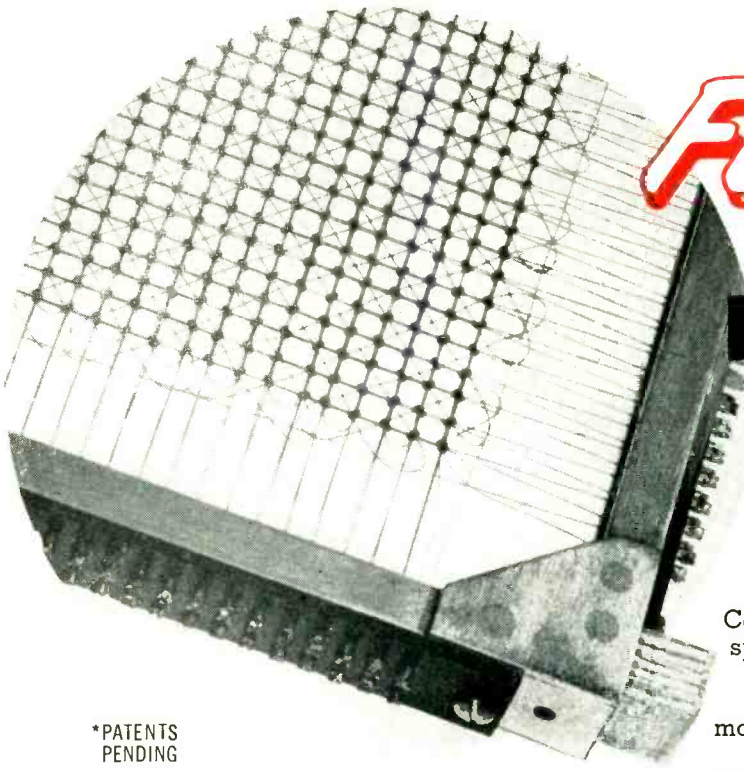

*PATENTS PENDING

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MAGNETIC MEMORY CORES*

General Ceramics initiated the development of Rectangular Hysteresis Loop Ferrites, for which it has applied for patents and which it markets under the name Ferramic S-1* and S-3*. The application of these materials to Computer Memories has so vastly improved the speed, accuracy and reliability that this system of memory is replacing all others. The reduction in initial installation costs and maintenance have further enhanced the value of this development and has so increased the reliability and speed of digital computers that the use of this type is becoming more and more wide spread.

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General Ceramics has supplied all Square Hysteresis Loop Ferrite Cores for all of the presently operating large scale magnetic memories. Our experience in manufacturing these millions of Ferrite Memory Rings is available to you to help solve your problems. We can supply you with unassembled and tested cores, or with fully assembled matrices to fit your needs.

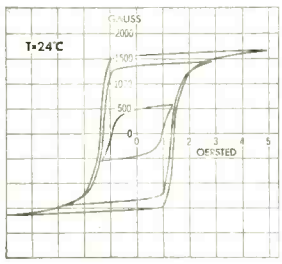

Diagram illustrates flux-current characteristics of ferrite toroid with nearly rectangular hysteresis loop. In addition to high volume resistivity and low loss factor, high efficiency is maintained at both high and low frequencies. Response time is approximately 1.0 microsecond.

Specify FERRAMIC S-1* and S-3* Memory Cores — Developed and Produced by General Ceramics

STANDARD CORE SIZES

SMALL F-394	MEDIUM F-426	LARGE F-262
.080" O.D.	.100" O.D.	.375" O.D.
.050" I.D.	.070" I.D.	.187" I.D.
.025" THICK	.030" THICK	.125" THICK

TABLE OF MAGNETIC PROPERTIES

		FERRAMIC "S-1"	FERRAMIC "S-3"
Initial permeability (1 Mc)	μ_o	40	45
Maximum permeability (DC)	μ_{max}	515	1800
Saturation Flux Density (DC) gauss	B_s	1780	2000
Retentivity (DC) gauss	B_r	1590	1920
Coercive Force oersteds	H_c	1.5 max.	.65 max.
Switching Time microseconds	τ	1	>4
Br/Bs Ratio		0.90	.96
Maximum Squareness Ratio $\frac{\phi(=Im)}{2}/\phi(Im)$	R_s	0.8	.95
Optimum Magnetomotive Force (oersteds)	H_m	2.0	.80

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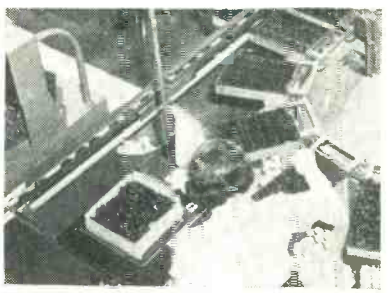
Tube-aging conveyors, moving counterclockwise, are loaded by operator at left end, who receives tubes from a chute running behind each conveyor to its corresponding seal-off machine at the right

aging system greatly reduces floor space requirements as compared to the conventional fixed racks that would be required for 100-percent aging of tube production. In addition, the machine cuts down in-plant transportation and delay cycles while allowing long aging schedules to be used.



Loading position on conveyor. Tubes come down a chute at rear from seal-off machine and roll off chute down table to within easy reach of operator

After tubes have been finished and exhausted, they travel down a chute from the seal-off machine to one end of the aging conveyor. Here an operator picks up the tubes and loads them into sockets on the conveyor. Under each socket panel is a lamp bank, connected so that lamps are in series with the elements of the tubes.

As the aging conveyor moves slowly counterclockwise, various voltages are picked up through sliding contacts on segmented busbars. These voltages are set up beforehand with controls on the center

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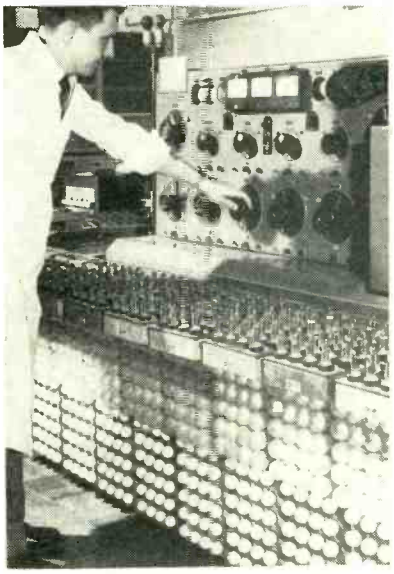
panel inside the oval of the conveyor.

The tubes being aged travel about three-quarters of the distance around the conveyor, to two test stations. At each there is one operator who removes the tubes, makes a quick shorts test, then

Preheat and test stations alongside output end of conveyor. Hexagonal preheating fixture has six panels, each holding nine tubes, and is rotated manually

plugs them into a hexagonal preheater. The second operator at a test station takes tubes from the preheater and performs the final tests. The preheater is rotated manually counterclockwise by the first operator when she has filled one of its panels, thereby bringing another panel of preheated tubes in front of the second operator for testing.



Setting controls that determine aging voltages applied to tubes along each section of conveyor. Tube socket panels and associated lamp banks are easily unhooked from conveyor for changing over to others for a different tube type

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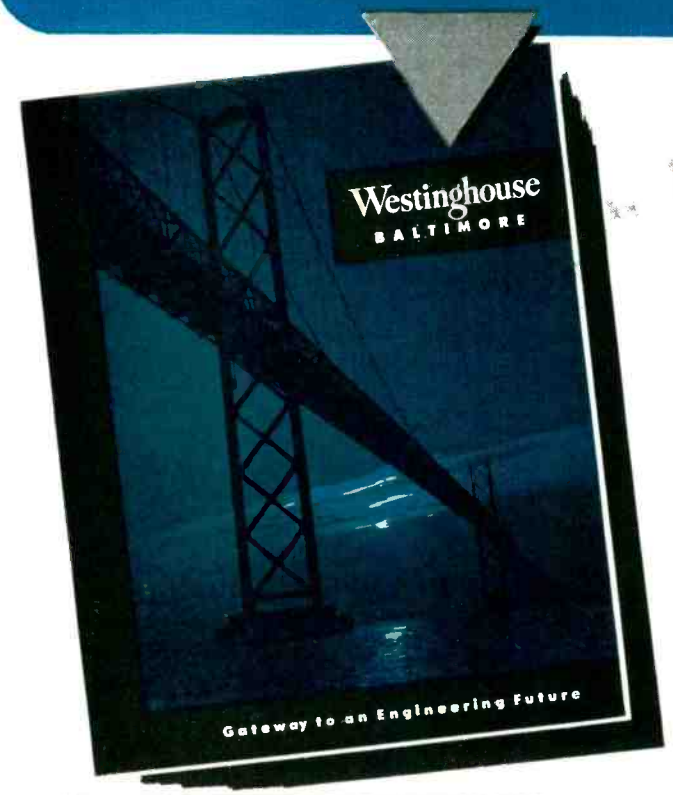

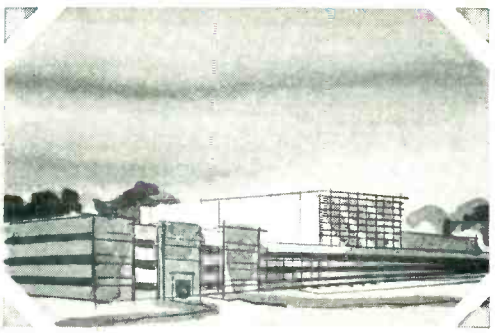

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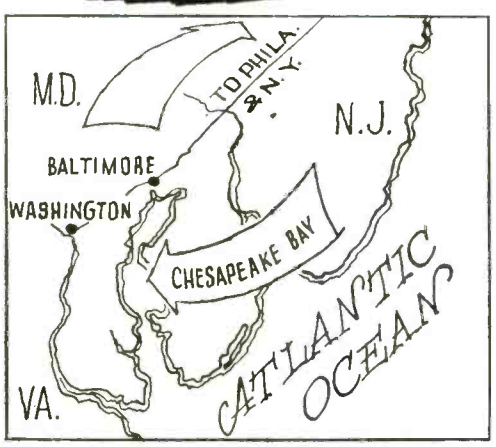

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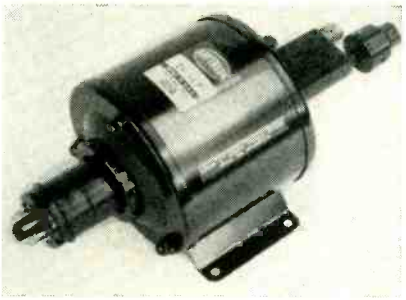


RAYTHEON MFG. CO., Waltham 54, Mass. Known as backward-wave oscillators, these tubes sustain oscillation by energy interchange between an electron beam and a guided electromagnetic wave. Conventional applications include local oscillators, sweep-frequency signal generators, high-speed afc circuits and laboratory microwave signal sources. The new tubes outperform other microwave oscillators not only in bandwidth capability (with a single type covering a 2,000-mc range), but also in low pulling figure, freedom from hysteresis and long-line effects, and freedom from spurious modulation when modulated at high frequencies. These tubes will find applications in mobile tv relays, and as modulators for terminal stations of microwave radio links.

POWER TETRODE

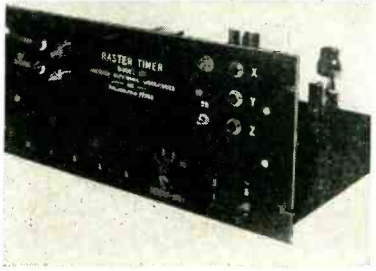
is the radial-beam type

EITEL-MCCULLOUGH, INC., San Bruno, Calif., has available the Eimac 4X250B, a radial-beam power tetrode unilaterally interchangeable with the 4X150A in nearly all cases. This new bantam, cooled by convection and forced air, is intended for modulator, oscillator, amplifier and frequency multiplier application at all frequencies into uhf. Its integral-finned anode, plus other design improvements, make it considerably easier to cool than the 4X150A. A newly designed, highly efficient oxide cathode and the lower seal temperatures enables the 4X250B to meet the most critical standards. Electrical advancements permit an increased plate dissipation rating of 250 w, plate voltages to 2,000 v and doubled plate power of 500 w. A single 4X250B in a coaxial-cavity amplifier circuit will deliver up to 300 w of useful power output at 400 mc. Its high transconductance makes the tube useful at relatively low plate voltages.

RASTER TIMER

for physical problem study

AMERICAN ELECTRONIC LABORATORIES, INC., Philadelphia, Pa. The oscilloscope display timer makes possible detailed study of phenomena separated in time. Applicable to a variety of special physical problems, these units may be used for sonar, geophysical research, system control reactions, electrophysiological research and many other studies. The device provides the ordinary oscilloscope with a time-base in the form of a 10-line raster containing accurate timing calibration markers. Two models are available. The raster timer 101 has a raster range of 10 ms to 0.1 sec and a sweep range of 1 ms to 10 ms; the 101A has a raster range of 1 to 50 sec and a sweep range of 0.1 to 5.0 sec. Timing calibration markers in both units are controlled to 0.1 percent or better. Both models are packaged suitable for rack or bench use.



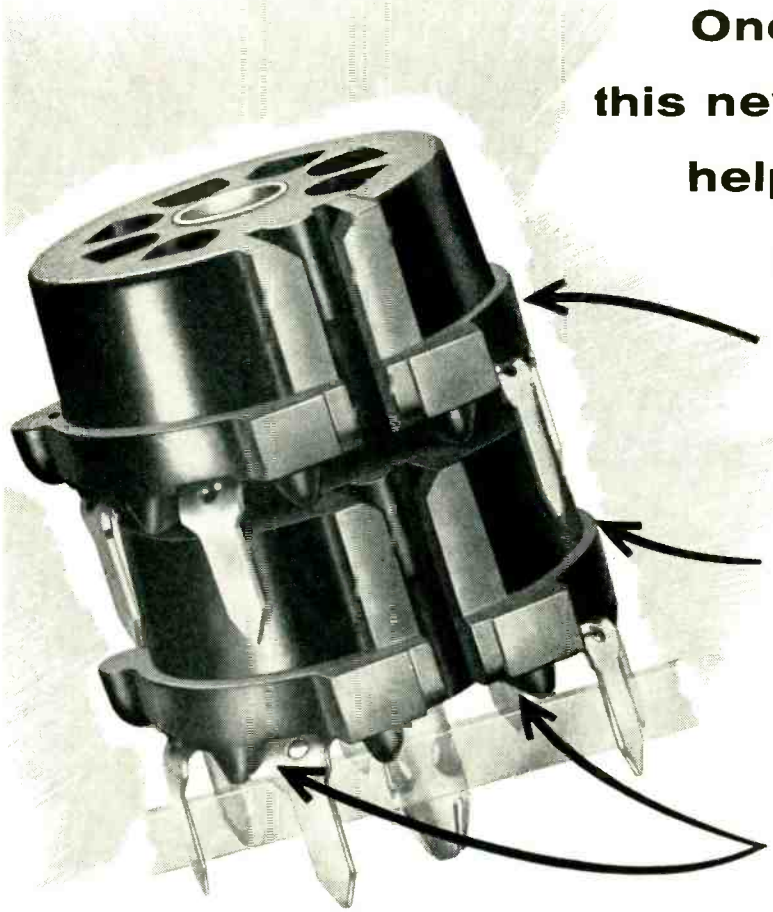
NEW TUBE TYPES

for tv circuits

SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa., announces two new tubes for vertical and horizontal tv

3 ways better...

One look tells you 3 ways this new Sylvania socket can help you produce a better printed circuit chassis



1. "It supports"

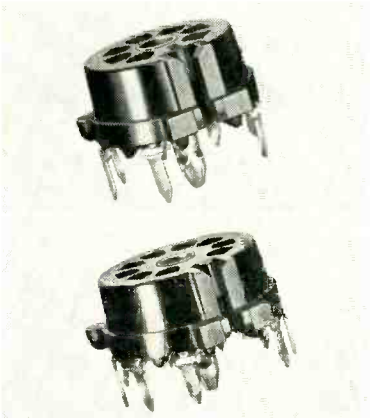
new collar design supports the metal tube shield isolating it from the printed circuit board and contact tails. Short circuits are eliminated.

2. "It stacks"

designed for foolproof nesting to accommodate automatic assembly techniques. Ground-strap slot keys sockets for proper orientation.

3. "It sits up"

contact-tail barriers keep the socket perched higher off the printed circuit board for greater heat dissipation and freedom from flux contamination.



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circuit applications. Type 6CS7 is a miniature 9-pin, medium mu, dual triode with dissimilar sections and is suitable for vertical deflection and oscillator applications using conventional transformer supply voltage. The output section has a plate dissipation rating of 6.5 w, high perveance, and an absolute peak positive pulse plate voltage of 2,200 v. The other triode section of this dual purpose tube is intended for service as an oscillator, detector or amplifier. The tube is also designed for series string or conventional parallel operation. The 25DN6 is a beam power pentode rated for tv service as a horizontal deflection amplifier and was designed particularly for use in off-the-line series string sets utilizing low B+ voltages. The tube has a desirable low plate knee characteristic at zero bias.

PHASE COMPARATOR

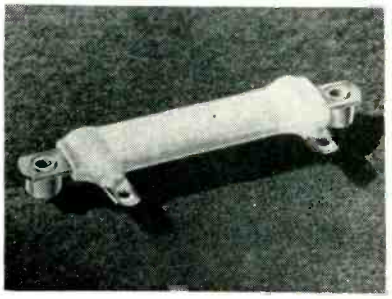
for lab or production line

LINK AVIATION, INC., Binghamton, N. Y. Model 201 phase comparator, for accurate phase measurement in the laboratory or on the production line, is designed especially for use in the computer field where phase shift is an important factor. The instrument permits precision measurement of phase relationship of in-phase and out-of-phase voltages, measuring input voltages from

1.0 to 120 v through a frequency range of 60 cycles to 400 cycles with an accuracy of 0.33 milliradian at 400 cycles and 0.1 milliradian at 60 cycles. Effective angle of phase comparison is + 1 radian around 0 and 180. A null voltage measurement on a vtvm provides the phase angle measurement. Model 201 is ideal for phase measurements of transformers, amplifiers, tach generators, resolvers, synchro control transformers and analog computer circuitry.

POWER RESISTOR

has built-in mountings

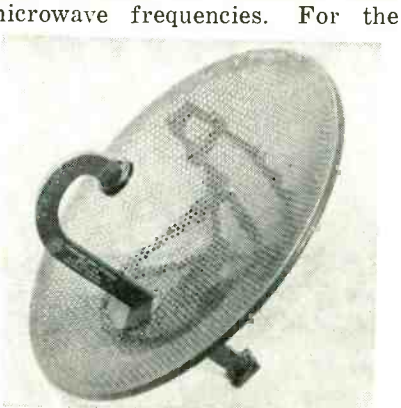


WARD LEONARD ELECTRIC CO., 115 MacQuesten Parkway South, Mt. Vernon, N. Y. The Ministrip 20-w miniature power resistor has been added to the Stripohm resistor line. Each resistor has a strong oval shaped ceramic core on which a special alloy resistance wire is wound and silver brazed to tightly banded tab terminals. Winding is sealed and protected by Vitrohm vitreous enamel. Nonremovable solid brass brackets extend through the core supplying a convenient, simplified method of mounting. Features include: space-saving design; low, built-in mounting brackets; and oval-shaped core for maximum strength. The resistors are conservatively rated at 20 w based on 300 C rise. They feature stock resistance values to 50,000 ohms maximum, tolerance ±5 percent.

ANTENNAS

can be used as laboratory tools

COLOR TELEVISION, INC., 935 E. San Carlos Ave., San Carlos, Calif. Parabolas (as illustrated), horns, dipoles and dipole arrays with precision gain calibration to 0.2 db are now offered as accurate laboratory tools to be used in the determination of propagation gain. The various types cited cover the frequency spectrum from 100 mc to 50,000 mc. From 2,600 to 50,000 mc, and for gains of 20 db and more, parabolas are generally used. For lower gains in the same frequency region, horns are most widely useful, and can be supplied on short delivery in a series of nine sizes covering the commonly used microwave frequencies. For the frequency spectrum down to 100 mc, dipoles and dipole arrays are provided. Special requirements as to frequency, gain and mechanical design can be met on all these antennas.



GAS THYRATRON TUBE

for motor-control service

RADIO CORP. OF AMERICA, Harrison, N. J. The 3D22-A is a gas thyratron tube of the negative control type. The sensitive four-electrode thyratron with indirectly heated cathode was designed for use in relay and grid-controlled rectifier

Now available the revolutionary ELECTRO TEC process* for your LARGE SLIP RING ASSEMBLIES

featuring

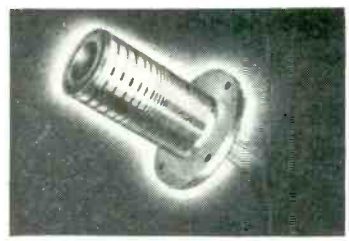
• LOWER COST • CLOSER TOLERANCES • ONE-PIECE CONSTRUCTION • JEWEL-LIKE FINISH • UNIFORM RING HARDNESS • REDUCED WEIGHT

Now a Complete Service in all sizes of Slip Ring Assemblies

An assembly with 14 concentric, hard silver rings electro deposited into machined plastic blank. Dovetail locks rings in place. Machined blank insures accuracy. Diameter approx. 11", thickness approx. 5/16".

Cylindrical assembly with 25 rings. Three wide rings accommodate large contact area brushes for high current capacity. Length 14", O.D. approx. 5 3/8".

An assembly with 30 rings of various widths to accommodate various current requirements. Unit is approx. 4-5/16" long, designed for flange mounting.



Cylinder type assembly approx. 3 3/4" long with 24 hard silver rings. 1 5/8" O.D. with wall thickness less than 1/4".

*PAT. NO. 2,696,570

ELECTRO TEC is now tooled up, with new expanded facilities for production of large Slip Ring Assemblies to exact customer specification. Sizes range up to 36" in diameter, either cylindrical or disc type.

The exclusive ELECTRO TEC PROCESS*—the electro-deposition of hard silver rings into an accurately machined plastic blank—consistently yields a high degree of dimensional accuracy, excellent concentricity, and a jewel-like ring finish. This process also eliminates expensive tooling and mold charges, frequently lowers costs to 30% of other methods of manufacture. The silver rings are uniformly hard for long life—70-95 Brinell.

ELECTRO TEC one-piece construction precludes dimensional variation due to accumulated errors. The plastic base is fully cured before rings are plated into it, thus preventing separation of base material from the rings.

ELECTRO TEC LARGE SLIP RING Assemblies are widely used in Radar Equipment, Fire Control Systems, Test Tables and many other critical applications. Light weight combined with rugged durability recommends their use in airborne applications.

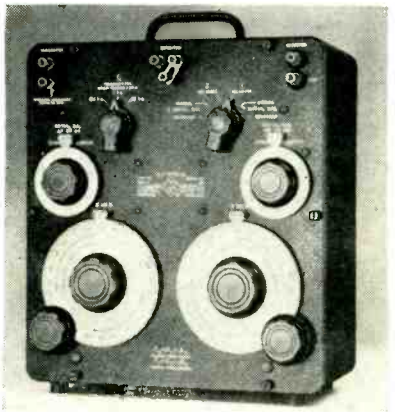
Every user knows the ELECTRIC TEC reputation for quality and superiority in miniature and sub-miniature slip ring assemblies.

Our Engineering Department is available for consultation on any of your slip ring problems without obligation.

ELECTRO TEC CORPORATION

SOUTH HACKENSACK • NEW JERSEY

applications, particularly those involving motor-control service. In power control service it is operated so that its output voltage to the load is varied by varying the time of firing during the a-c input cycle. When used for d-c voltage control, two 3D22-A's in a full-wave circuit with resistive load are capable of handling up to 660 w at a d-c output voltage up to about 410 v. When used for a-c voltage control, two of the tubes in a full-wave circuit are capable of handling up to 800 w. The 3D22-A uses a T16 bulb and can be mounted in any position. It is 4⅝ in. long, with a maximum diameter of 2⅜ in.



Z-Y BRIDGE
measures a-f impedance

GENERAL RADIO Co., 275 Massachusetts Ave., Cambridge 39, Mass. Type 1603-A Z-Y bridge can be balanced for any impedance connected to its terminals. From short circuit to open circuit, real or imaginary, positive or negative, a bridge balance can be obtained with ease. Nominal accuracy of the bridge is 1 percent over the 20-cycle to 20-kc range. The bridge reads directly the resistive and reactive components, or the conductive and susceptive components, depending on the value of the unknown. An outstanding feature of the bridge is its ability to measure impedances which are grounded, ungrounded or balanced to ground. Price is $335.

PRINTED CIRCUIT KIT
available in several sizes

TECHNIQUES, INC., 135 Belmont St., Englewood, N. J. Designed pri-

MISSILE TEST EQUIPMENT For over ten years Farnsworth has participated in the design, development, and production of guidance and control systems and special test equipment for such missile programs as Terrier, Talos, Sparrow, and others. Numerous "firsts" in this field have been accomplished as a result of contributions in the form of missile receivers, control systems, power supplies and complete system analyses.

INDUSTRIAL TELEVISION Standard model 600A is the result of Farnsworth's more than 30 years experience in the design and production of complex military and industrial equipment—engineered especially for industrial, educational and business use.

IMAGE CONVERTER TUBES Used in any application where it is necessary or desirable to "see in the dark." Convert an infrared image into a visible image. Applications: medical and biological research, hot-body observation, temperature distribution, crime detection, security, and photography.

INFRARED VIEWER This unique, compact, easy to handle viewer is a valuable tool for crime detection, research and industrial application. Observation of objects or scenes in the dark is easily accomplished when they are illuminated by infrared radiation.

PHOTOMULTIPLIER TUBES Responsive in the near infrared spectrum featuring sensitivities as high as 50 amperes per lumen of incident radiation. Applications include photometric measurements for industrial and scientific uses.

IMAGE DISSECTOR A highly versatile TV camera tube particularly well adapted for use as a slide or facsimile scanner. This tube can be constructed in a variety of types to meet special requirements.

RADAR RANGE CALIBRATOR, AN/UPM-11A A precision instrument incorporating both "Radar" and "Beacon" functions. The equipment operates as a radar transponder in that pulsed r-f energy fed into the equipment results in a series of return echo pulses being fed back from the equipment to the radar under calibration. This simulates radar targets at accurately determined ranges.

PORTABLE CABLE TESTER Designed for testing all radio frequency cables that will accommodate, or can be adapted to, type "HN", "N", or "BNC" connectors. It will supply a d-c voltage up to 12,000 volts provided the current drain is negligible, and current surges of at least 3,000 amperes peak into a load of 0.05 ohm at room temperature.

Farnsworth

DIVISION OF IT&T

vision *. . . beyond the range of sight . . .*

This is the Farnsworth

iatron

the tube with

SUN-LIKE BRILLIANCE AND MEMORY, TOO!

BRILLIANCE! Display brilliance up to 10,000 foot-lamberts. Ideal for projection purposes.

MEMORY! Image storage and presentation of several minutes duration. Operator-controllable.

RESOLUTION! Excellent detail. 300 TV lines.

Write Dept. F-21 for complete details.

RESEARCH

Applied Physics, Circuit Research, Solid State Physics, Low Temperature Physics.

RADAR

Transmitters and Receivers, Computers, Microwave Components, Pulse-Coding and Circuitry.

ELECTRON TUBES

Photomultipliers, Storage Tubes, Image Tubes, Infrared Tubes.

MISSILE

Guidance and Control Systems, Test Equipment.

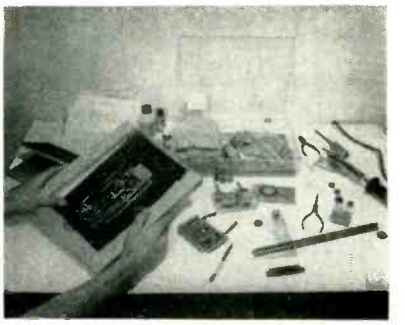
Another Farnsworth achievement . . .

one of many complex electronic products developed, designed *and produced* for defense and industry . . . backed by over a quarter of a century of continuous success and leadership in the field of electronics . . . the key to amazing tomorrows.

FARNSWORTH ELECTRONICS COMPANY · *FORT WAYNE, INDIANA*

a division of International Telephone and Telegraph Corporation

Want more information? Use post card on last page.



marily as an aid in prototype development, this comprehensive kit of materials will enable industrial and research laboratories to process their own etched-wire printed circuit models. An assortment of sizes of XXXP copper-clad phenolic laminate is provided, including double surfaced as well as single surfaced boards. Special printed circuit tube sockets of 10 different types will allow design engineers to experiment with numerous variations of model design.

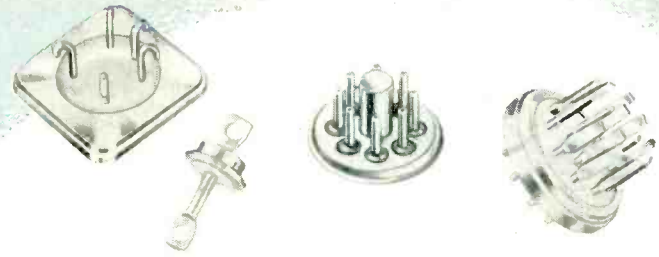
SIGNAL GENERATOR
with a 10-500 mc range

MARCONI INSTRUMENTS, 44 New St., New York, N. Y. Model TF-801B signal generator, with a frequency range from 10 to 500 mc, features longer oscillator tube life, high output (2 v), down to 0.1 μv, low f-m insured by tuned amplifier, 50-ohm output from piston attenuator calibrated in volts, db and dbm, internal modulation 0 to 90 percent metered, external modulation from d-c to 3 mc maximum. The unit has capacitance-coupled, contactless coil turrets.

IMPEDANCE METER
tests 5-mc quartz crystals

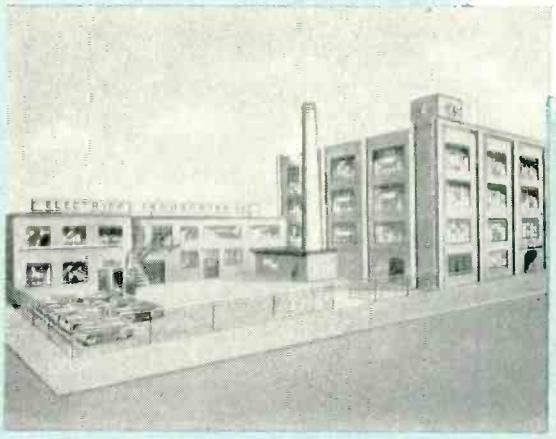
RADIO FREQUENCY LABORATORIES, INC., Boonton 3, N. J. Model 991 crystal impedance meter is designed

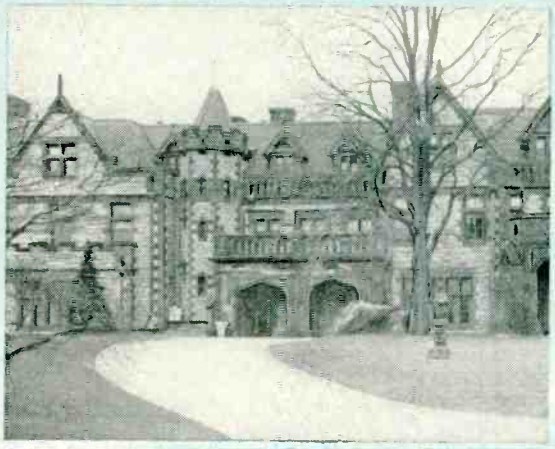
E-I OFFERS..



8 DESIGN ADVANTAGES

Cushioned Glass Construction
High Dielectric Strength
Design Standardization
Vacuum Tight Sealing
Vibration Resistance
Super Durability
Maximum Rigidity
Miniaturization





-and COMPLETE FACILITIES

MAIN PRODUCTION FACILITIES IN NEWARK, NEW JERSEY The Newark plant houses the main engineering and production facilities at E-I. Designing, tooling and assembly departments include the most modern methods and equipment known to industry, today.

CONTINUING RESEARCH KEEPS PACE WITH INDUSTRY'S NEEDS. The complete research laboratory located in Irvington-on-Hudson in New York assures products that anticipate the ever more critical requirements of the electronic industry.

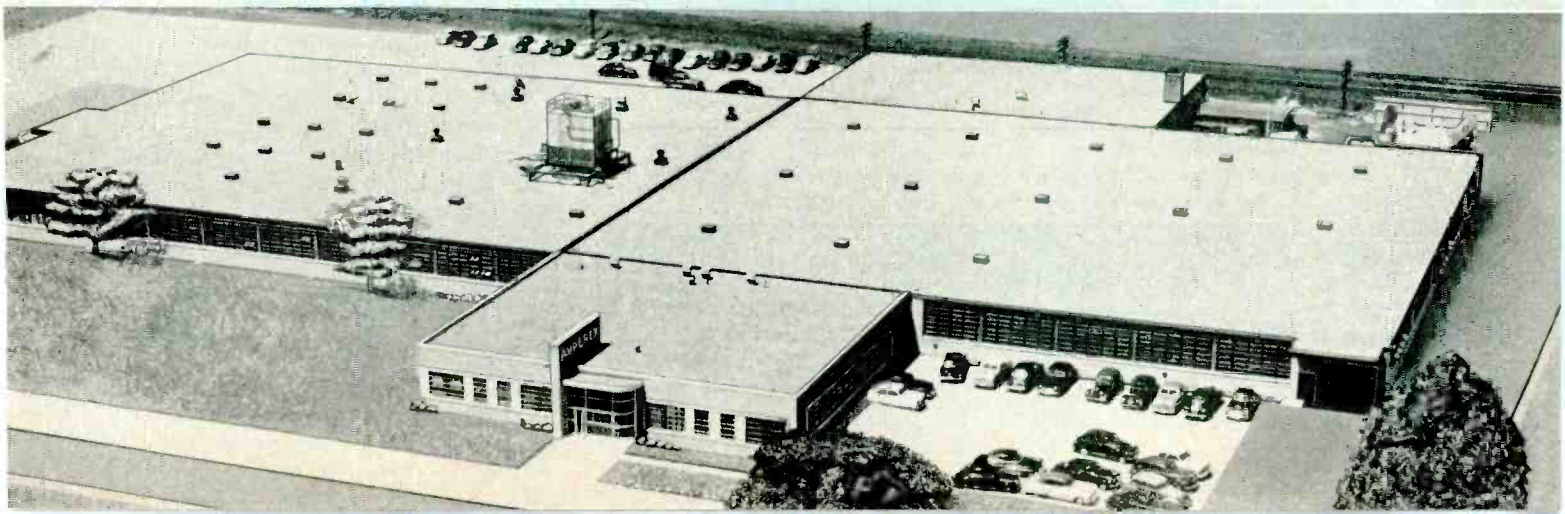
THE HICKSVILLE PLANT ON LONG ISLAND IS EQUIPPED for all types of electronic production. The Hicksville facility is one of the oldest producers of transmitting tubes, x-ray tubes, magnatrons and all forms of glass-to-metal seals.

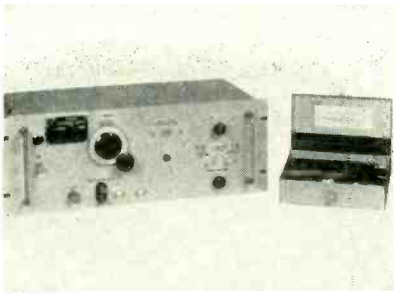
E-I HEADQUARTERS—for Compression Seals, Multiple Headers, Sealed Terminals, Condenser End Seals, Threaded Seals, Transistor Closures, Miniature Closures, Color Coded Terminals, etc.

One **dependable** source for all hermetically sealed terminal requirements

ELECTRICAL INDUSTRIES

Division of Amperex Electronic Corp. — 44 SUMMER AVE., NEWARK 4, N. J.



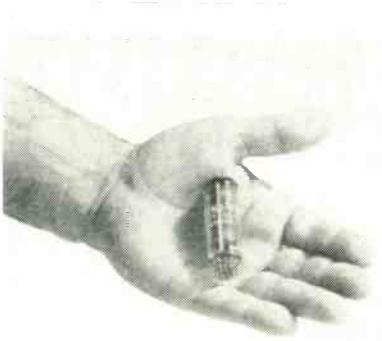


to test the recently developed 5-mc overtone quartz crystals used in primary frequency standards. The oscillator circuit suppresses oscillation at undesired frequencies and provides the required gain and phase shift. An avc type circuit controls the drive level on the crystal. With a close tolerance oven and a 5-mc overtone crystal, the model 991 becomes a primary frequency standard. The equipment consists of a crystal oscillator circuit, a crystal drive level control circuit, a standard front panel test network, and an electronic regulated power supply. Fifteen precision calibrating resistors ranging in value between 100 and 200 ohms are supplied in a small metal box. Overall dimensions of the meter are 19 in. long by 10½ in. wide by 7 in. high.

TRANSFORMERS
with up to 10 ratio taps

HYCOR CO., INC., 11423 Vanowen St., North Hollywood, Calif., announces a cataloged line of minature precision voltage ratio transformers. The precision units are specially useful where voltage division or multiplication is required to accuracies up to 0.01 percent. They are available in plastic encapsulated form or in hermetically sealed cases. Units having up to 10 ratio taps are available. Accuracies are

maintained with moderate output loading.



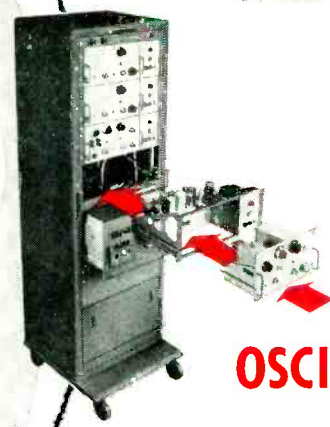
AMPLIFIER TUBE
for car radios

TUNG-SOL ELECTRIC INC., Newark 4, N. J., has developed an audio power amplifier tube designed specifically for car radios. The 12AB5 is intended to be used either singly or in push-pull for power output stage use. Using the 9-pin all glass miniature envelope, the 12AB5 provides a wider margin of safety than previously found in the smaller 7-pin types 6AQ5 and 12AQ5. Because there is no compromise with household radio or tv needs, the 12AB5 will therefore provide greater reliability and service life.

DISPLAY OSCILLOSCOPE
features 40 input channels

ELECTROMEC, INC., 5121 San Fernando Road, Los Angeles 39, Calif. A new large screen display oscilloscope features 40 input channels. It provides a vertical line graph 9 in. high by 12 in. wide on a 17-in. cylindrical face crt. Each vertical line

SANBORN 150 SERIES



1 to 8 channel systems with interchangeable preamplifiers

. . . versatile answers to the wide variety of problems in

OSCILLOGRAPHIC RECORDING

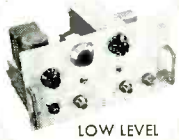

CARRIER


AC-DC


DC COUPLING

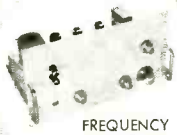

SERVO MONITOR


LOG-AUDIO


LOW LEVEL


INPUT NETWORK


AC WATTMETER


FREQUENCY DEVIATION


WIDE BAND


RMS VOLT/ AMMETER

SANBORN equipment allows you to record accurately and graphically almost any phenomena in the 0 to 100 cps frequency range — such as stress, strain, vibration; pressure, displacement, thickness; flow, force, load, position, RPM, tension, velocity, acceleration, temperature. Systems may be assembled to record simultaneously as many as *eight* channels of information — all alike, all different, or a combination of both, depending upon your selection of plug-in preamplifiers or "front ends" displayed at the left.

Should requirements change, the preamplifiers may be interchanged by simple plug-in to the Driver Amplifier-Power Supply unit of each channel, thus equipping the basic system for the new requirements. In addition to this versatility of *application* you also gain advantages in greater over-all *economy* and increased *operating* efficiency.

SANBORN SYSTEM FEATURES INCLUDE:

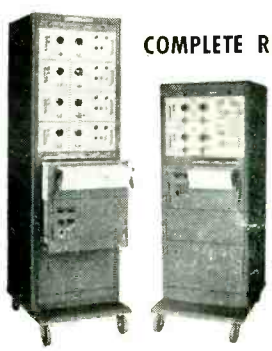
- Inkless recording in true rectangular coordinates
- Driver Amplifier (current feedback), improved regulated Power Supply, individual ON-OFF and stylus temperature controls IN EACH CHANNEL.
- Recorder slides out for easy paper loading, better view of recording, making notations on record.
- High-torque (200,000 dyne cm) galvanometer
- Many chart speeds — from 0.25 to 100 mm/sec.
- Controls for timing, manual and remote coding

The equipment illustrated indicates the scope of the Sanborn "150" line. Other components, not shown, include a Wide Band Driver Amplifier and Power Supply, and a Master Oscillator Power Amplifier. All Sanborn equipment is available for assembling into complete systems, or as separate components for integration as "original equipment" in existing apparatus.

Sanborn engineers will be glad to help solve your recording problems, with either standard or specially modified equipment. Write for complete specifications and performance data on any system.

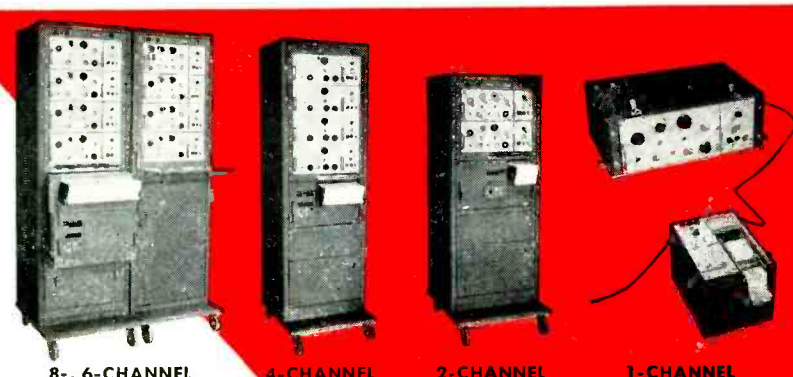
SANBORN COMPANY

CAMBRIDGE 39, MASSACHUSETTS



COMPLETE RECORDING SYSTEMS

Designed primarily for recording outputs of analog computers, or other applications where 1 volt/cm sensitivity is usable. In 8-, 6-, 4-, 2-, and 1-channel models. One dual-channel DC Amplifier for every TWO channels.

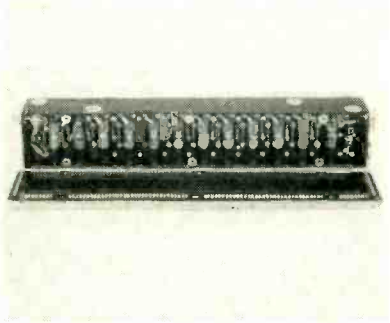


8-, 6-CHANNEL 4-CHANNEL 2-CHANNEL 1-CHANNEL

terminates in a dot to permit rapid and accurate readability. The output of each of the 40 amplifiers is scanned each ¼ sec. Frequency response of each channel is within 2 percent from 10 cps to 10 kc and down no more than 3 db at 50 kc. Sweep linearity is approximately 2 percent with a system linearity of 1 percent. Jitter and crosstalk are negligible.

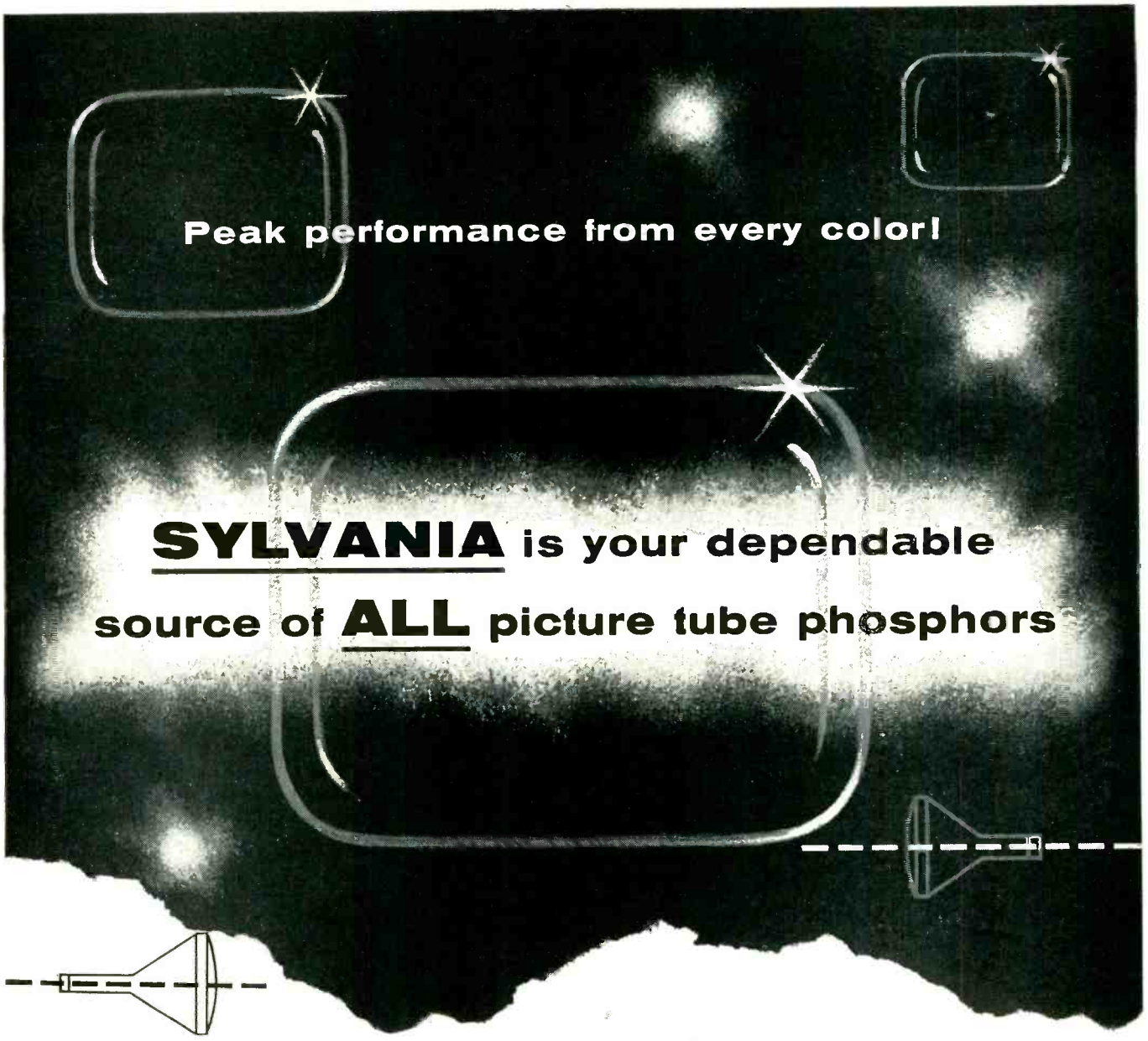
UHF MIXER DIODE
for use in tuners

PHILCO CORP., Philadelphia, Pa., has announced a new uhf mixer diode specifically designed for uhf tuners. The 1N173A tuner diode is manufactured by a special process which results in excellent uniformity characteristics for high performance tuner operation over the entire uhf band. The diodes are moisture-proof and maintain stability regardless of shock, vibration and temperature variations. The company can make the uhf mixer diode available to all other tuner manufacturers.



I-F AMPLIFIERS
are subminiature type

THE W. L. MAXSON CORP., 460 W. 34th St., New York 1, N. Y., has developed a new series of subminiature i-f amplifiers used in airborne radar systems and broadband re-



Whether you need phosphors for black-and-white or color picture tubes, Sylvania's long experience, highly developed production facilities and exacting quality control add up to *dependability.*

All Sylvania tube phosphors are rigidly inspected for purity, particle size, brightness and uniformity of color. There is a full range of phosphor formulations available to meet your requirements, including special blends for maximum cross-burn resistance. All Sylvania phosphors can be supplied in 1000-lb. lots to eliminate color-matching problems.

To help you secure long-lasting screen brightness and good color, Sylvania also manufactures high-purity *potassium silicate.* Exact control of potassium-to-silica ratio assures maximum wet-screen strength.

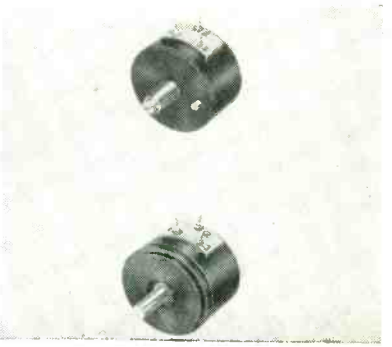
For complete information about high-performance Sylvania phosphors and TV Picture Tube components, write to:

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

SYLVANIA

Lighting • Radio • Electronics • Television • Atomic Energy

ceivers. Gains of over 100 db are obtained simultaneously with bandwidths over 12 mc at center frequencies of 30, 60 or 90 mc. Design and construction provide complete shielding and absence of regeneration even with covers removed. The amplifiers are built to meet rigid military specifications and contain tubes having a rated life of over 5,000 hr. Measurements are 12 in. × 2 in. × 1 in. Each model consists of a low-noise cascade amplifier followed by three flat staggered triples. The last triple feeds an infinite impedance detector and a cathode follower output stage. A bias adjustment is incorporated in each unit to control the gain over a range of at least 40 db.



POTENTIOMETERS in intermediate size

DE JUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City 1, N. Y. The C-158 precision ganging potentiometers (1⅝ in. in diameter) are ideal for applications requiring high accuracy in limited space. Multiple ganged units can be electrically phased independently without disassembly. Precious metal contacts are used exclusively, including the company's three wiper contact brush. All single and ganged assemblies are completely enclosed by permanent dust-covers. Both threaded bushing and servo-mounting types are available. Complete specifications and other features are described fully in the illustrated technical bulletin C158-455.

POWER SUPPLY for electrostatic spraying

SCIENTIFIC ELECTRIC, 105-119 Monroe St., Garfield, N. J., has developed

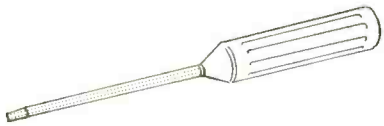
TAYLOR
Laminated Plastics
Vulcanized Fibre

Shop Talk

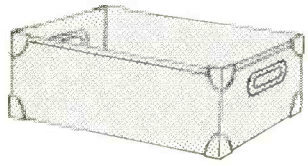
TAYLOR FIBRE CO.
Plants in Norristown, Pa. and La Verne, Calif.

PHENOL—MELAMINE—SILICONE—EPOXY LAMINATES • COMBINATION LAMINATES • VULCANIZED FIBRE • POLYESTER GLASS ROD

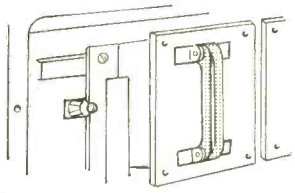
Tips for designers



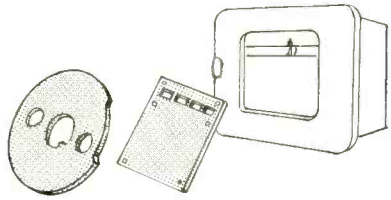
Insulated fibre screw drivers, made of high dielectric strength Taylor Fibre, are electrically safe, physically tough.



Tote boxes must withstand severe usage . . . an ideal application for tough, durable Taylor Vulcanized Fibre.



Fuse box handle formed from Taylor G-5 Melamine Laminate has high electrical and mechanical strength . . . provides high resistance against corrosive fumes.



Cam and terminal board for recording instrument is made of Taylor Grade XP Laminate . . . noted for its electrical insulating properties and ease of machining.

TAYLOR FABRICATING FACILITIES

Your production can be simplified . . . schedules safeguarded . . . inventory headaches cured . . . and over-all costs reduced by having Taylor fabricate finished parts to your specifications. Efficient, modern facilities are ready to serve you. Get in touch with Taylor about your specific requirements.

Tip of 2″ diameter Taylor Built-Up Vulcanized Fibre Rod used as drift pin for driving out stuck roll-up shafts in paper mill. Heavy sledge hammer blows on end of rod could not split apart the laminations at bond joints.

Taylor Built-Up Fibre withstands severest impact

The unretouched photograph above shows the strength and toughness of Taylor Built-Up Vulcanized Fibre. This is the tip of a 2″ diameter x 36″ long built-up fibre rod after more than a year's use as a crowbar and drift pin in a paper mill.

It was used as a bar to lift and pry 800 lb. objects. It was pounded with a 16 lb. sledge hammer in its use as a drift pin to drive out stuck roll-up shafts. Despite this severe and repeated abuse the rod was unbent. *And note that hundreds of sledge hammer blows have not severed the adhesive bonds between laminations.* Rather it is the fibre itself which has first failed. This is proof that built-up fibre is just as strong and as tough as homogeneous fibre.

Wherever exceptionally thick sections are required—for rods, plates, blocks—Built-Up Fibre can be produced in thicknesses up to 3 inches. Laminations are bonded together with specially developed adhesives to make a tough, solid mass.

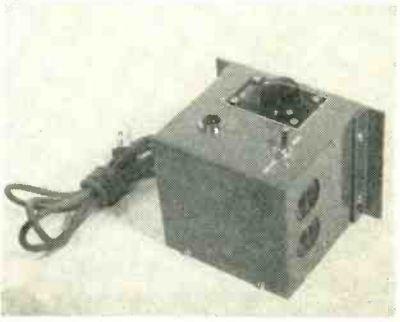
For many applications, Taylor Built-Up Fibre can be used as a direct replacement for more expensive homogeneous commercial fibres. Moreover, it is available in a fraction of the delivery time. Outstanding physical and electrical properties make it the ideal material for heavy switchgear, arc barriers, insulating plates, rods, cutting blocks, bumper blocks . . . and a variety of similar uses.

Ask your Taylor representative about the numerous profitable applications for versatile Taylor Vulcanized Fibre and Taylor Laminates in your product. There are literally thousands of uses for economical, easy-to-form Taylor products.

a new Ionic high potential power supply for electrostatic paint spraying. Model HV-140 is supplied as a 2-piece, remote-controlled unit. The new electronic power supply unit is capable of producing a peak of 140 kv. For complete technical information, contact the company.

NULL INDICATOR
features high sensitivity

SHALLCROSS MFG. CO., Collingdale, Pa. Unlike spotlight galvanometers, the type 1965 null indicator is unaffected by mechanical vibration of any sort. This, coupled with its high sensitivity and a response time of less than 1 second, allows measurements to be made rapidly and accurately under many adverse conditions. Current sensitivity is greater than 2×10^{-10} ampere. Voltage sensitivity is better than 1 μv per mm scale division. Input impedance is 5,000 ohms. The null indicator and its integral 115 v, 60-cycle, power supply are housed in a cabinet only 17 in. deep by 6 in. wide by 8½ in. high. Weight is 14 lb. Complete technical details are given in engineering bulletin L-42.

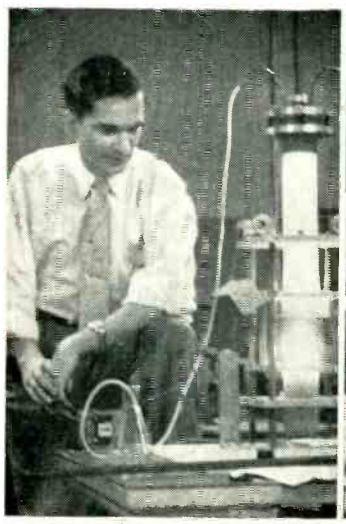


OVERLOAD RELAY
is fast acting, precise

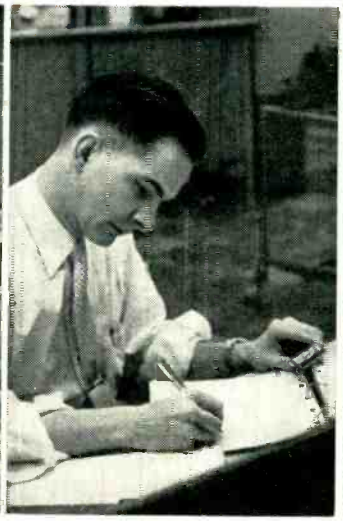
MORROW PRODUCTS, INC., 3339 Forbes St., Pittsburgh 13, Pa., an-

TUNG-SOL

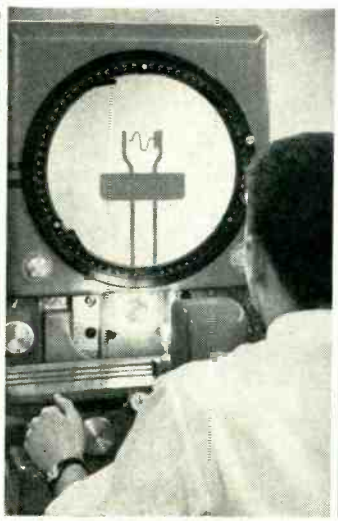
Acknowledged quality leadership . . . in research, design, development and manufacture . . . of all the basic components on which the science of electronics is founded.



Research



Design



Development

Manufacturing

Aluminized Picture Tubes

Color Picture Tubes

Special Purpose Tubes

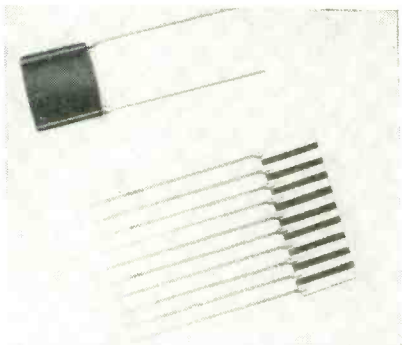
Radio and TV Tubes

Semiconductors

TUNG-SOL ELECTRIC INC., Newark 4, New Jersey

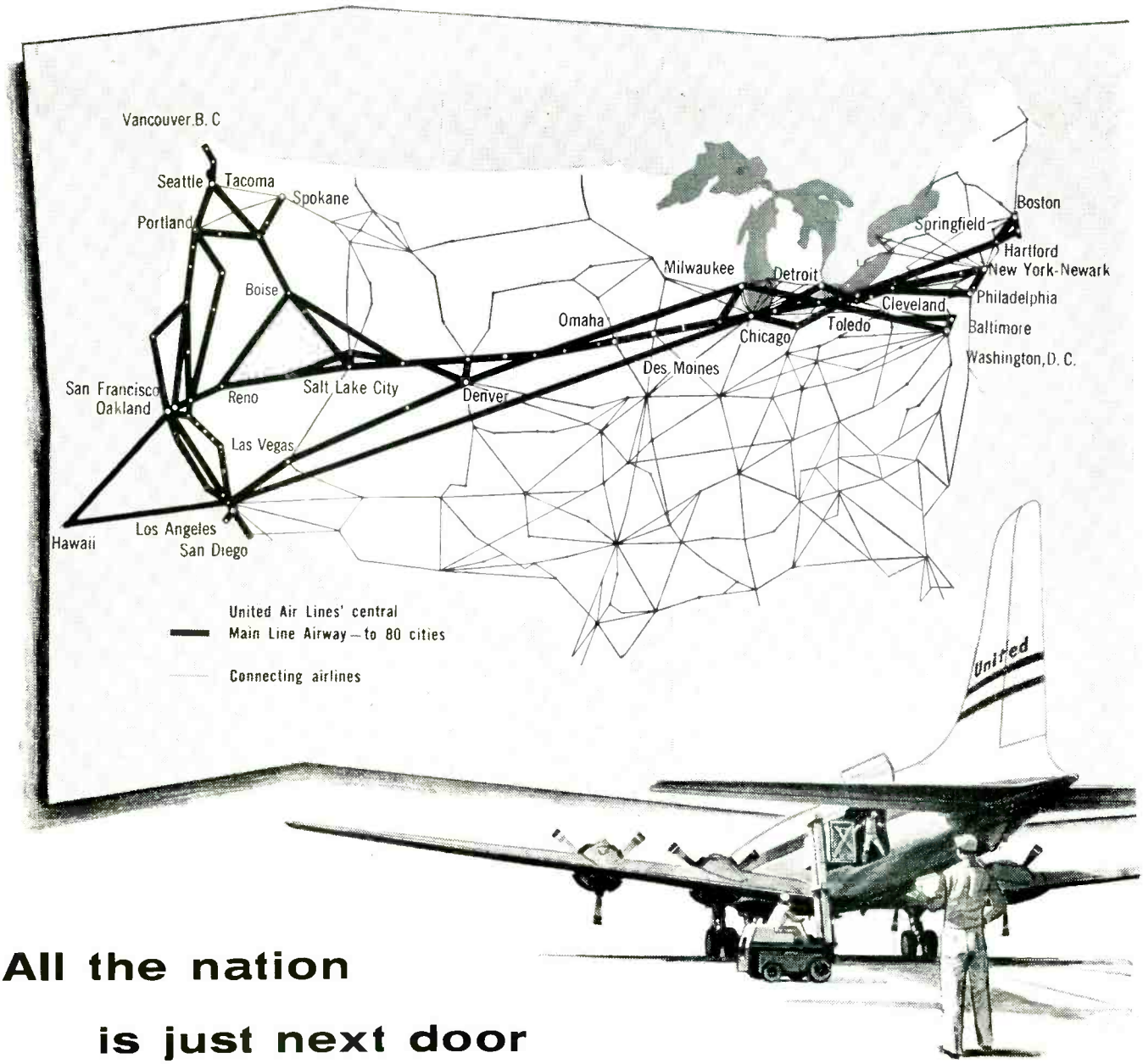
SALES OFFICES: ATLANTA, CHICAGO, COLUMBUS, CULVER CITY, DALLAS, DENVER, DETROIT, NEWARK, SEATTLE.

nounces an electronic relay intended for use wherever fast acting and precise electrical overload protection is desired. It may be adjusted to operate reliably with a current differential as small as 0.05 ampere, or if intended for use on over voltage, the voltage differential would be of the order of 50 mv. The unit drops out within 10 μsec. This model is available in ratings to 600 v at 1,000 amperes for a-c or d-c loads. The heart of the unit is a thyratron control tube with an spdt relay connected in its plate circuit. The operating characteristics of this tube may be varied by the control dial which is suitably calibrated in volts or amperes so that the thyratron will fire only after a certain voltage is applied to its grid circuit. Time delay apparatus is not required with this electronic relay.



PRECISION RESISTOR
is single-section, card-type

THE DAVEN CO., 191 Central Ave., Newark 4, N. J., announces availability of a new single-section, card-type, precision resistor, series 1300. The new series is wafer-thin and is specifically designed for applications where there is a lack of space for the ordinary round precision wire-wound resistor. The new unit is completely encapsulated for protection against humidity and extremes of temperature, and is especially adaptable for circuits using transistors, in guided missiles and airborne communication and navigation equipment. On values up to 100,000 ohms, the resistor is $\frac{1}{2}$ in. by $\frac{1}{2}$ in. by $\frac{3}{32}$ in. thick. On values from 100,000 ohms to 1 megohm, the card is $\frac{5}{8}$ in. by $\frac{5}{8}$ in. by $\frac{3}{32}$ in. thick. Operating characteristics feature precise operation from —55 C



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United's Main Line Airway follows the bustling business belt across the nation. No matter where you ship you are only a few hours away, sometimes merely minutes, from cities along this strategic route.

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to +125 C. Wattage rating on each section is 0.6 w and standard tolerance is ±1 percent. Accuracies can be obtained to ±0.1 percent.

BANDPASS FILTER
adjustable 20 cps to 200 kc

KROHN-HITE INSTRUMENT CO., 580 Massachusetts Ave., Cambridge 39, Mass., announces model 310-AB continuously adjustable band-pass filter with unity passband gain and 24 db per octave slopes outside the passband. Both the high and low cutoff frequencies are independently adjustable from 20 cps to 200 kc. This provides maximum flexibility of adjustment of both the band center frequency and the bandwidth. By using power supply regulation the internal hum and noise has been reduced to less than 1 mv. Calibration accuracy is ±10 percent. Model 310-AB is especially useful in the audio and ultrasonic frequency range for noise measurements, harmonic and frequency analysis, and for psychoacoustics and electromedical research. The unit measures 12 by 7 by 8 in. overall and sells for $275.

CERAMICONS
for miniaturized circuitry

ERIE RESISTOR CORP., Erie, Pa. The new high capacitance Ceramicons are rectangular, have a phenolic dipped coating, wax impregnated No. 22 hot tinned copper leads, and are made in 3 sizes: style 892, 034 in by 0.34 in.; style 893, 0.58 in. by 0.43 in.; and style 896, 0.75 in. by 0.56 in. Life test is 400 v d-c 1,000 hr at 85 C; flash test, 600 v d-c; and power factor, 2.5 percent maximum at 1 v rms 1 kc. These Ceramicons are designed especially for use in transistor and other min-

from **Transitron®**

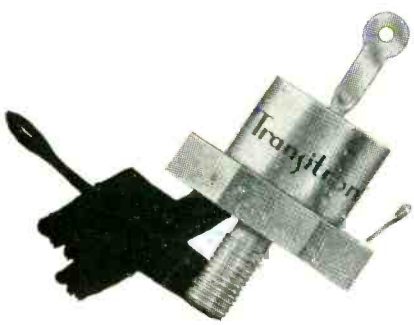
SILICON RECTIFIERS

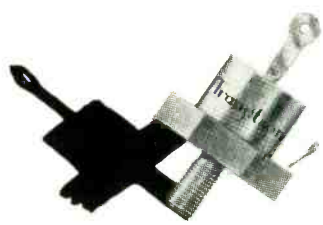
. . . Three power ranges now in production

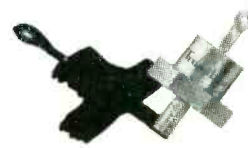
Transitron's silicon rectifiers are designed for reliable operation up to 150° C. They offer major savings in both size and weight and long term stability through hermetic sealing.

Because of their high forward conductance and high inverse resistance, Transitron's silicon rectifiers are extremely efficient. They are ideally suited for high temperature power supply and magnetic amplifier applications.

Write now for bulletin TE 1321!







HIGH POWER

RATINGS AT 135°C

TYPE	Peak Recurrent Inverse Voltage (Volts)	Maximum RMS Voltage (Volts)	Maximum Average Forward Current (Amperes)
1N411	50	35	10
1N412	100	70	10
1N413	200	140	10

MEDIUM POWER

RATINGS AT 135°C

TYPE	Peak Recurrent Inverse Voltage (Volts)	Maximum RMS Voltage (Volts)	Maximum Average Forward Current (Amperes)
SR-10	50	35	5
SR-11	100	70	5
SR-12	200	140	5

POWER

RATINGS AT 135°C

Power Supply Types			Magnetic Amplifier Types		
TYPE	P.I.V. (volts)	Idc (ma)	TYPE	P.I.V. (volts)	Idc (ma)
1N341	400	400	1N332	400	400
1N343	300	400	1N334	300	400
1N345	200	400	1N336	200	400
1N347	100	1000	1N338	100	1000

Transitron®
electronic corporation
melrose 76, massachusetts


Glass Diodes


Transistors


Power Transistors


Silicon Diodes

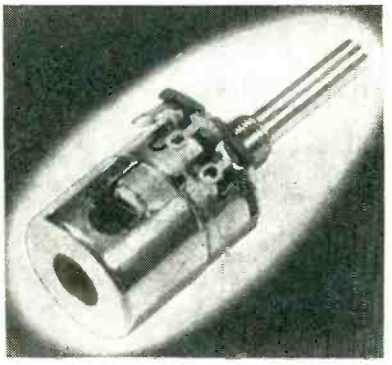

Silicon Rectifiers

T®

...iaturized circuitry. They have a value range from 0.0022 to 0.1 μf and a 200-v rating. A data sheet giving complete specifications is available.

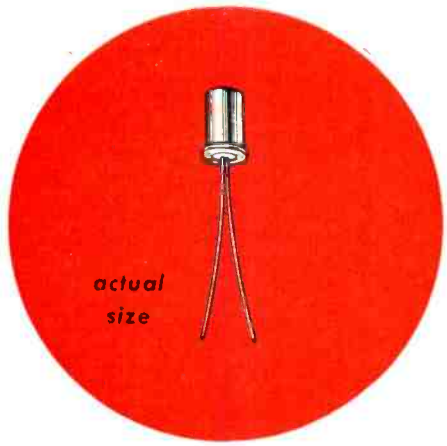
MINIATURE CELL
uses indium as an anode

ELGIN NATIONAL WATCH CO., Elgin, Ill., has developed a button-size expendable battery that will not leak, swell or gas. It packs enough energy to operate special military miniature electronic devices at virtually standard voltage for 2 years. The cell uses indium as an anode. Use of new type of cathode makes it possible to increase working volume of the cell by eliminating bulky barriers and separators. The cell delivers about 1.15 v. A typical industrial application might be for portable electronic monitors. It is also particularly useful as a low-voltage source of energy for transistorized circuitry.



SHIELDING COVER
for power switch terminals

CLAROSTAT MFG. CO., INC., Dover, N. H., has developed a positive-lock-



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Specific Applications:

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- Matched "Quads"
- Matched Pairs
- Function Generators
- Diode-Capacitor "Memory" Units
- Magnetic Amplifiers
- Diode as Constant Voltage Source
- Surge Protection
- Clipping and Limiting

IN 29 RANGES . . . maximum reverse working voltage

TYPES	eb	max. V	TYPES	eb	max. V
IN138A		18	A3B		3.3
IN137A		36	A4B		3.9
IN200		6.8	A5B		4.7
TO		TO	A6B		5.6
IN222		470			

(Licensed by Western Electric Co., Inc.)

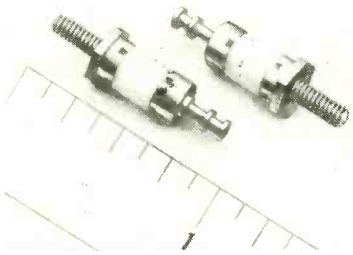
Immediate Delivery in all Quantities

NATIONAL SEMICONDUCTOR PRODUCTS, 930 Pitner Avenue, Evanston, Illinois
Semiconductor Division Phone: Davis 8-0800

NATIONAL FABRICATED PRODUCTS, INC., Chicago 47
Manufacturers: sockets, plugs, terminal strips, receptacles, contacts, lugs, and other electronic components

Want more information? Use post card on last page.

ing, snap-on type terminal-shielding cover, which is available with its factory-mounted series AE power switches. This metal cover, insulated by a fiber liner, is designed to meet UL approval on sets utilizing above-chassis-mounted controls with switches. The cover not only acts as a mechanical guard, but also has the effect of shielding inductive fields. For further information, request new product announcement form No. 753798.



TEFLON TERMINALS
are vibration-proof

CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge 38, Mass. The X-2168 Teflon insulated terminal has high dielectric strength and low capacitance. When mounted, the overall height of the assembly is $\frac{5}{8}$ in. The 3-48 threaded mounting stud is $\frac{1}{4}$ in. in length. The solder terminal is brass with copper flashing on which 24-carat gold has been applied. Both stud and terminal are attached to the Teflon by a unique method that makes the terminal vibration-proof. Complete specifications and prices are available from the company.

TIME DELAY RELAY
permits electrical interlock

AGA DIVISION, Elastic Stop Nut Corp. of America, Elizabeth, N. J. An electrical interlock in a circuit which allows pushbutton control can now be obtained by use of an instant action auxiliary switch in a new model Agastat time delay relay. The model NEL Agastat is for operation on energization. Time delay of the NEL is pneumatically controlled and provides a readily adjusted and accurate timing interval from 0.1 second to 10 or more minutes. The unit measures $2\frac{1}{2}$ in. wide.

NEW.... SIGNIFICANT....

Uniline®

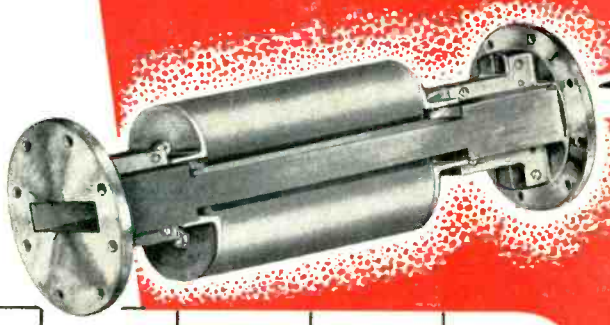
S band SERIES

OF MICROWAVE LOAD ISOLATORS

The important load isolation functions of Unilines are now available to designers and users of microwave systems and test equipment operating in the S-Band.

New, inherently rugged mechanical designs permit safe operation at substantial peak and average powers. Cascade Research has designed these units to optimize isolation-to-insertion loss-ratio. Special techniques have made possible a reduction in size and weight of the integral permanent magnets. As in all Unilines, no external power source is required.

These Unilines can also be furnished as an integrated part of a microwave circuit and may include such elements as directional couplers, hybrid junctions, twists, bends, mixers and crystal holders. Unilines with even greater power ratings are now under development.



MODEL	28-32A	28-32B	28-32C	28-32D	SL-132	SL-133	SL-131
FREQUENCY RANGE	2.8-3.2 KMC	2.8-3.2 KMC	2.8-3.2 KMC	2.8-3.2 KMC	2.0-2.4 KMC	2.0-2.4 KMC	1.7-2.0 KMC
FORWARD ATTENUATION (TYPICAL)	1.6 DB	1.2 DB	0.8 DB	0.4 DB	1.0 DB	1.0 DB	1.0 DB
REVERSE ATTENUATION (TYPICAL)	27 DB	20 DB	13 DB	6 DB	20 DB	20 DB	20 DB
V.S.W.R. (TYPICAL)	1.20	1.20	1.20	1.20	1.20	1.20	1.20
AVER. TRANSMITTER POWER INTO V.S.W.R. OF 2:1	350 WATTS	350 WATTS	350 WATTS	350 WATTS	350 WATTS	350 WATTS	350 WATTS
PEAK POWER INTO V.S.W.R. OF 2:1	400 KW	400 KW	400 KW	400 KW	150 KW	400 KW	150 KW
WAVEGUIDE SIZE	RG-48/U	RG-48/U	RG-48/U	RG-48/U	——	RG-105/U	——
WAVEGUIDE FLANGES	UG-53/U	UG-53/U	UG-53/U	UG-53/U	COAX TYPE "N" OUTPUT	UG-437/AU	COAX TYPE "N" OUTPUT

APPLICATIONS

LOAD ISOLATION: Will provide substantial isolation between source and load with negligible loss in transmitted power.

ELIMINATES LONG LINE EFFECTS present where antennas are located remotely.

REDUCES PHASE DISTORTION by eliminating multiple reflections.

PROVIDES SMOOTHER TUNING, greatly reduces mismatch presented to a magnetron by the antenna, eliminates tendency of magnetrons to lock on some frequencies or fail to operate on others.

SMOOTHS OUT POWER VARIATIONS WITH TUNING: Magnetron power output to Uniline is maintained at maximum despite changes in line parameters due to changes in frequency.

KLYSTRON, OSCILLATOR-AMPLIFIER BUFFER: Addition of Uniline between oscillator and amplifier can markedly reduce possible pulling and power incanstancy.

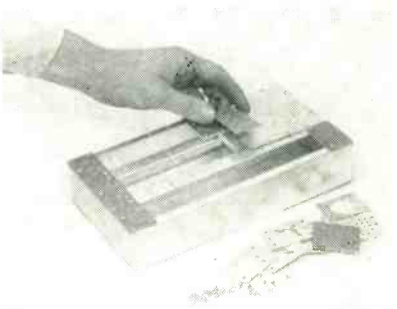
CASCADE RESEARCH

CORPORATION

53 VICTORY LANE,
LOS GATOS, CALIF.

WRITE FOR DETAILED TECHNICAL LITERATURE

3⅜ in. deep and 4½ in. high. Affixed to its front is a normally closed double-throw Micro Switch. Contacts of this switch are kept in open position by a lever connecting the auxiliary switch and the core of the Agastat. When the Agastat coil is energized, the core jumps up and these contacts close instantly allowing interlock. Simultaneously the time delay period starts and continues to the preadjusted time delay at which the main switch trips transferring contacts. In deenergization, auxiliary switch contacts change to open position and the main contacts transfer.



EXPANDABLE CHASSIS
for lab breadboard use

UM & F MFG. CORP., 10929 Vanowen St., N. Hollywood, Calif., has developed a new type of expandable chassis design for laboratory breadboard use. Almost any size chassis may be assembled by using the various parts available in the patented SeeZak line which includes side and end rails, tops and bottoms, rail extenders, prepunched prototype panels and rail feet. Novel interlocking corners make assembly easy and give strength to the entire chassis, whether screwed together or not. These chassis have been designed for maximum adaptability to circuit design.

PRESSURE SENSITIVE TAPE
for wiring diagrams

LABELON TAPE CO., INC., 450 Atlantic Ave., Rochester 9, N. Y. Many manufacturers now use wiring diagrams printed on pressure sensitive tape and affixed directly to apparatus, instead of diagrams printed separately in booklets or instruction sheets. The affixed dia-

Which one of these Genisco centrifuges meets your requirements for testing components under simulated operational G-loadings?

. . . as required by Mil 5272A, procedure II

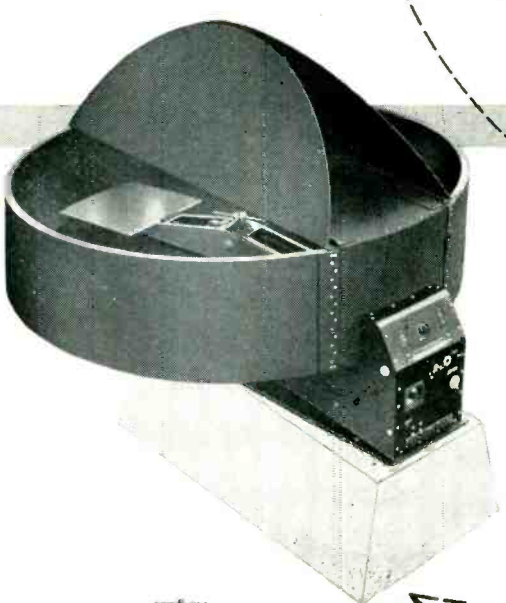
Genisco G-Accelerators provide a quick, precise means of testing components in an acceleration environment similar to that encountered in actual operation.

They are extremely accurate machines, easy to operate and built to withstand years of hard use.

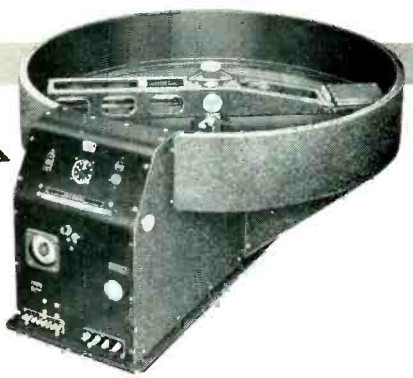
These features particularly suit them for large volume testing programs, as well as for precise laboratory prototype development.

More than 100 Genisco G-Accelerators of various capacities are now in use throughout the world.

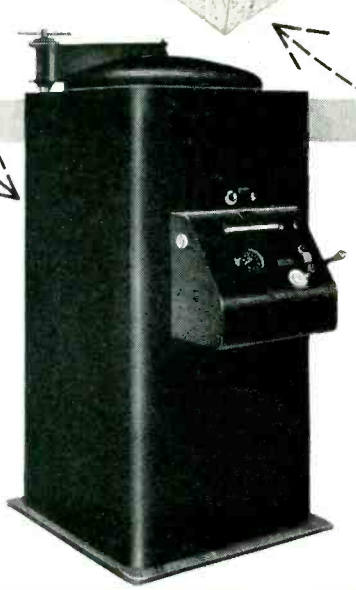
Complete technical information on all models and accessories is available. Please direct your inquiry to: Contracts Manager, Genisco, Inc., 2233 Federal Avenue, Los Angeles 64, California.



MODEL C159 The larger capacity of this machine permits whole system components and complete packages to be tested. Two objects, each weighing 100 pounds and 24" x 24" x 18" in size, can be accommodated simultaneously. G-range of the machine is 0.024 G to 75 G's. Maximum centrifugal capacity is 2000 G-pounds. Nominal radius of gyration 48".

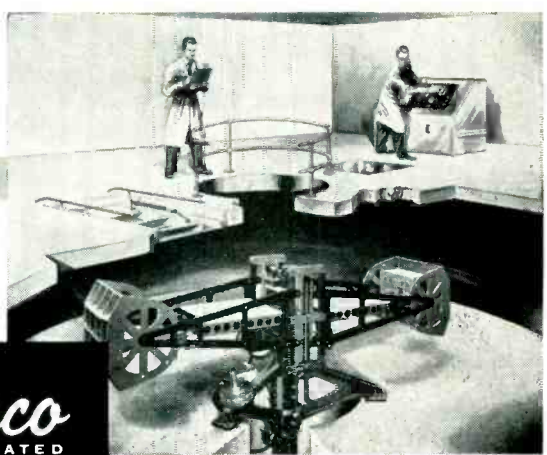


MODEL B78 Used primarily for testing relays, switches, tubes, motors, valves, and other small components, and to calibrate and evaluate accelerometers. Accommodates objects weighing up to 25 lbs.; has G-range of 0.017 G to 120 G's. Maximum centrifugal capacity is 1200 G-pounds. Nominal radius of gyration 24".



MODEL D184 A high-speed machine, designed to test accelerometers and other instruments under acceleration forces from 1 to 850 G's. Full centrifugal capacity is 1000 G-pounds. Nominal radius of gyration 12".

MODEL E185 This newest and largest Genisco centrifuge was recently built for the U.S. Air Force. Two mechanical or electronic packages, each weighing up to 300 pounds, can be subjected to an acceleration environment of up to 65 G's simultaneously. Nominal radius of gyration of the machine is six feet. An automatic dynamic balancing system automatically compensates for any excessive unbalance in the machine during test runs.



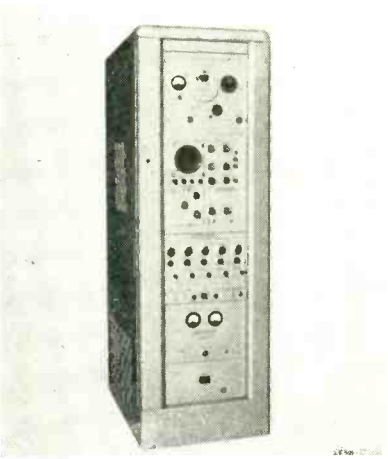
ACCESSORIES ADD TO OPERATING EASE A number of accessories including a strobe system, air system, optical system, tub cover, access doorway, and slip ring systems, designed to give greater operating convenience, are available for Genisco G-Accelerators, Models B78 and C159.

Modifications in any basic machine or accessories to meet your particular requirements will be carefully considered.

Genisco INCORPORATED

RELIABILITY FIRST

grams cannot become misplaced or lost, thus providing an obvious advantage to the ultimate user and eliminating requests to the manufacturer for new wiring diagrams to replace those that cannot be located. Samples of diagrams printed on both acetate film and flatback pressure sensitive tape are available.



MICROWAVE GENERATOR is code modulated

POLARAD ELECTRONICS CORP., 43-20 34th St., Long Island City 1, N. Y., has announced a new code modulated microwave generator with 5 independently adjustable pulse channels, equipped with 4 interchangeable r-f microwave oscillator heads, and providing a precision oscilloscope. The model B was designed to provide code modulated carrier from 950 to 10,750 mc for beacons, missiles and radar. Each of the pulse channels has variable pulse width and delay, and also has an external ptm input. Repetition rate is variable. The entire instrument operates from a built-in a-c line voltage regulator to insure stability. The modulator is equipped

with electronically regulated low voltage d-c supply. The universal regulated klystron power unit automatically selects the proper voltage for any of the plug-in microwave oscillator units.

MAGNETIC AMPLIFIER
for airborne servo systems

SPECIALTIES, INC., Skunks Misery Road, Syosset, L. I., N. Y. Part No. T1616JC, a 6-w, 115-v, 400-cycle magnetic amplifier is designed specifically for instrument type airborne servo systems. The unit operates directly from a synchro control transformer or potentiometer, without preamplifier or demodulator. A 3-stage fast response half-wave bridge circuit is used which is capable of a 20-cycle bandwidth when driving a BuOrd servo motor Mk7 in a closed-loop system using simple circuitry. This hermetically sealed amplifier features less than a 0.07-v drift with respect to wide changes in line voltage and frequency or temperature.

RELAY
to 10-k ohm coil resistance

KURMAN ELECTRIC CO., 35-18 37th St., Long Island City, N. Y. A newly designed coil and magnetic structure is featured in the series 23C relay. Coil resistances up to 10,000 ohms are now available and standard adjustments are as low as 7 mw for an spdt contact arrangement. The new relay weighs only 1½ oz and occupies 1.5 cu in. It is well suited for use with cadmium sulphide photocells (as both a-c and d-c versions are operated directly

Engineering | Design
Research | Development

cu. ri. os i. ty (kyoor. i. os′ i. ti), *n.*,
the desire to learn or know about anything; inquisitiveness.

This is, quite frankly, a bid for inquisitive engineers—creative men who desire to learn more about the future and what it may hold for them.

For at Goodyear Aircraft we have a policy of "progressive curiosity"—a continuous pioneering into new fields, new materials, new methods, new structures—and it has paid off in a host of new advancements important in the progress of missiles, jets, airships, helicopters, radar, plastics, metals and electronics.

It has paid off because this forceful, creative thinking has attracted engineers really *seeking* the challenge of new concepts.

The challenge at Goodyear Aircraft – and the security that goes with it – can spell a rewarding future for you.

The fields are as broad as the challenge. Goodyear Aircraft is unique in its scope, rock-solid in its stability – contributing importantly in virtually every phase of aeronautics and related fields, backed by the resources of the world's largest rubber company.

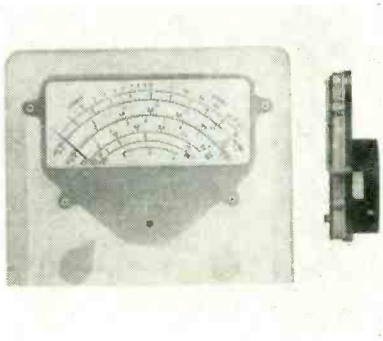
Whatever your engineering experience, *you owe it to yourself to get the facts on Goodyear Aircraft.* Write for application form or send your resumé to: C. G. Jones, Personnel Department, Goodyear Aircraft Corporation, Akron 15, Ohio. Plants in Akron and Litchfield Park, Arizona.

They're doing big things at

GOODYEAR AIRCRAFT

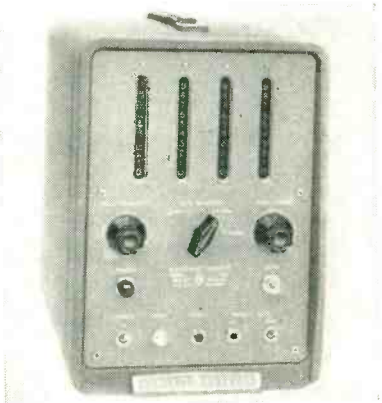
THE TEAM TO TEAM WITH in AERONAUTICS

from the photocells with minimum current drain), also for all control applications, in either plate circuit or battery operated circuitry.



LARGE-SCALE METER
has 6 in. × 2½ in. dial face

MARION ELECTRICAL INSTRUMENT Co., Manchester, N. H. Model SS56 meter is especially useful where rapid, accurate readings must be made from a distance or where several scales must be combined in one instrument. It is available as a moving coil permanent magnet type in all d-c ranges. It has a nominal 2 percent accuracy, available to ½ percent as the application requires. A variety of scale ranges permits its use as a basic component in many types of test equipment. Although the Plexiglas cover allows for exterior or edge lighting, the SS56 is also supplied with provision for internal scale illumination.



INDUSTRIAL COUNTER
features high accuracy

HEWLETT-PACKARD Co., 275 Page Mill Road, Palo Alto, Calif., has announced an industrial counter that can measure frequency, speed, rpm, random events, weight, temperature, pressure, acceleration and

Riveting With a Hammer in Blind or Open Applications

Elimination of special riveting tools can mean faster production, lower costs, no down time.

J. K. BARRY, M. E.

The use of blind rivets installed with only an ordinary hammer from one side of the job offers a highly simplified method of fastening. Speed, convenience and *low installed cost* make Drive Riveting preferable not only for blind joints, but for fastening many parts that can be reached from either side.

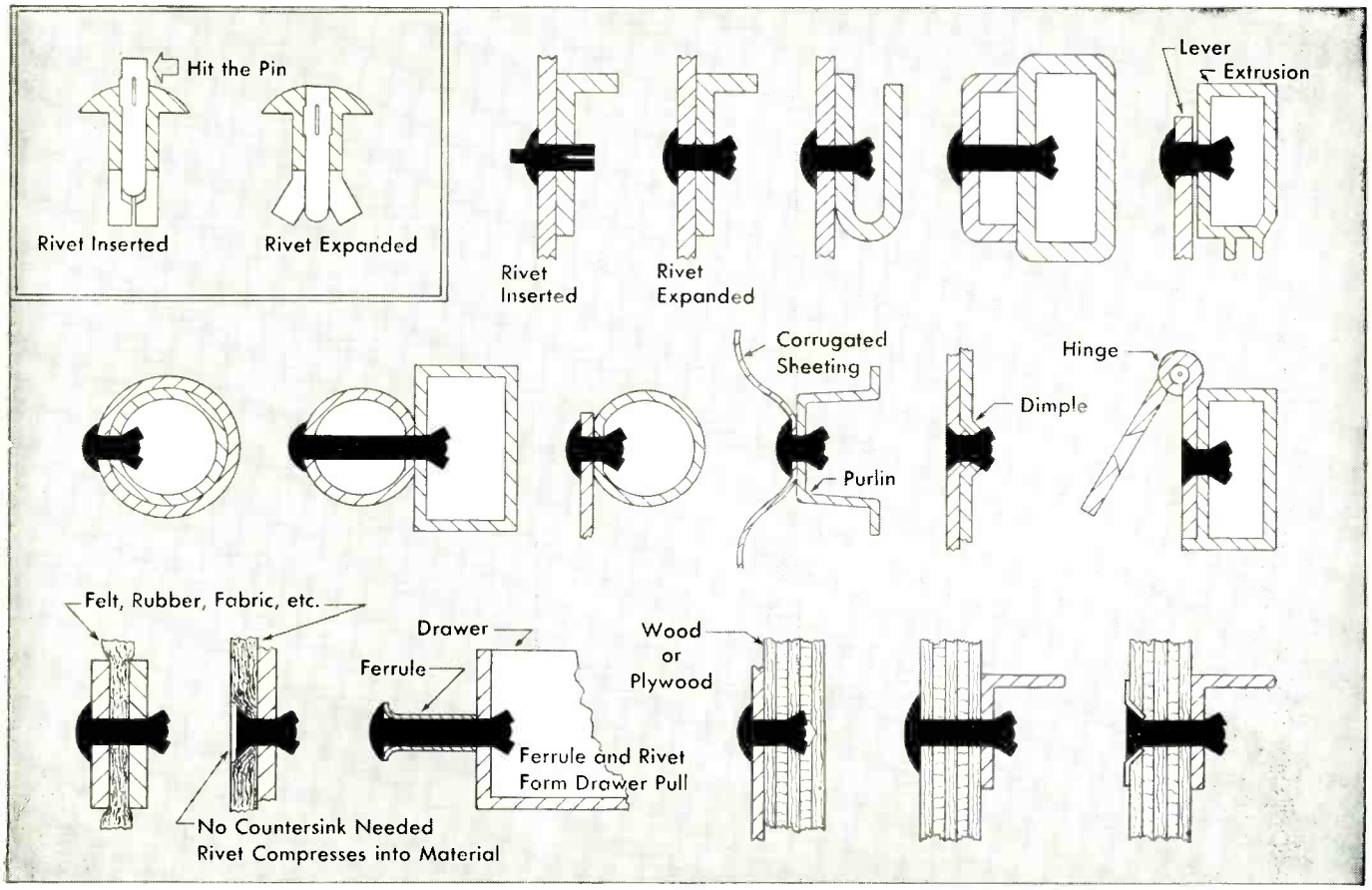
The Southco Drive Rivet has a cored, slotted body with a grooved pin protruding from its head. When the rivet is inserted through parts to be fastened, the pin is driven flush with the rivet head causing the expanding prongs to form a blind head behind the rear sheet. No further finishing is necessary, since the pin seats itself permanently to complete the smooth head contour.

Drive Riveting has five major advantages:

1. No investment in special tooling.
2. No lost time for tool repairs.
3. No limitation on the number of men who can install rivets.
4. Speed comparable to nailing.
5. Only one man is needed.

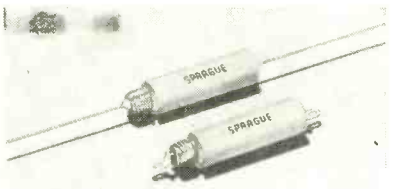
Widely used in truck bodies, storm doors, metal buildings and hundreds of other industrial applications, Southco Drive Rivets make a secure, vibration-proof joint. A wide range of head styles, diameters and grip lengths is available.

RECOMMENDED APPLICATIONS FOR DRIVE RIVETING



SOUTHCO Division, South Chester Corporation, 233 Industrial Hwy., Lester, Pa.

many other phenomena. Model 521A provides direct numerical readings in cps, rpm or rps from 1 cps to 120 kc. Period of count is either 0.1 or 1 second, and the count display time can be varied at will. The instrument uses conventional power line frequency for counting time base; or is available with a plug-in crystal time base for measurements of more precise accuracy. Model 521A includes three accessory power supplies of −150 v d-c, +300 v d-c and a 6.3 v a-c filament supply. Connections are also supplied for photocells and an external standard.

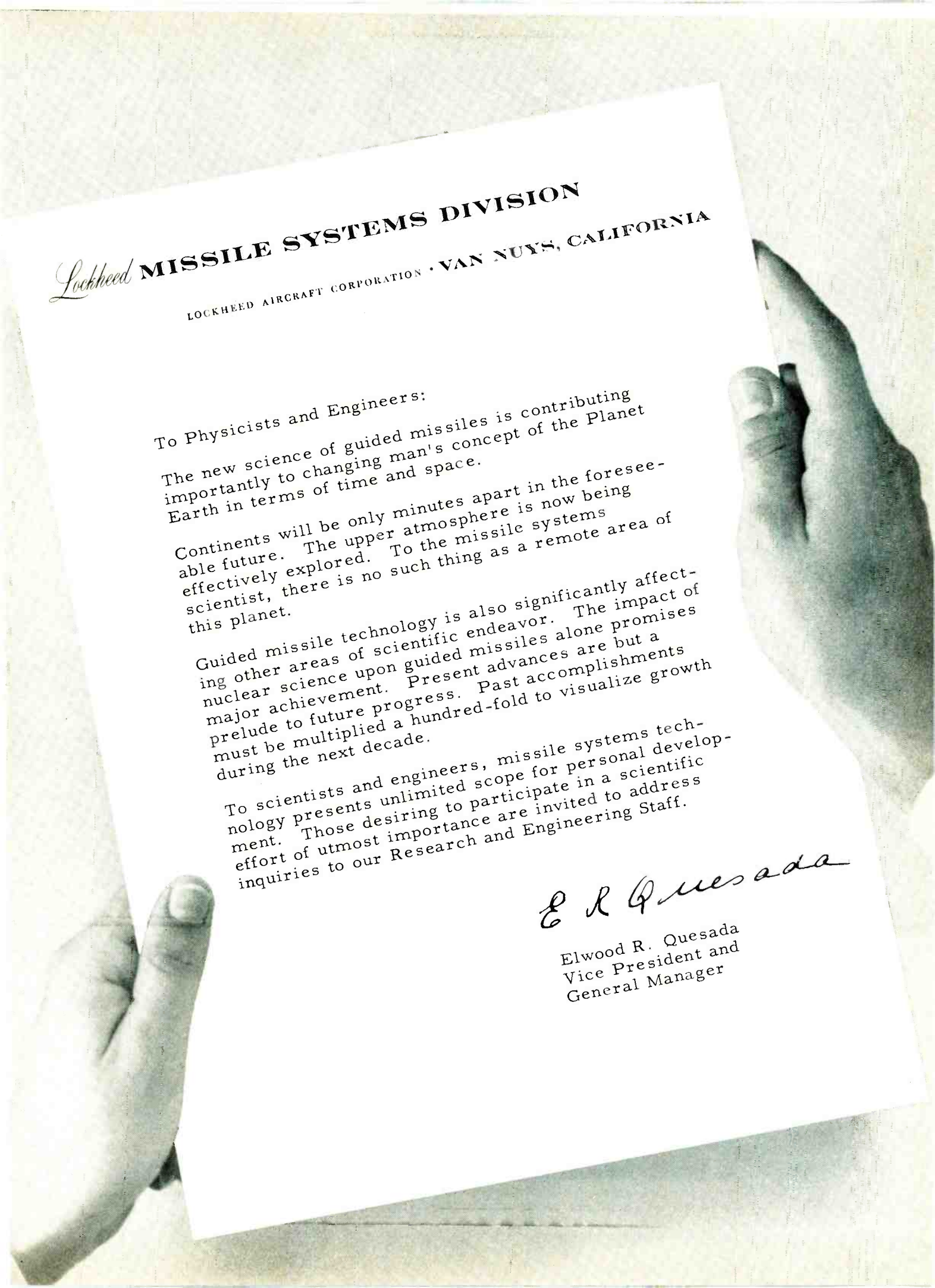


CAPACITORS
rated for 125 C operation

SPRAGUE ELECTRIC CO., 35 Marshall St., North Adams, Mass. Type 118P metallized paper capacitors are rated for operation at 125 C without voltage derating and with high insulation resistance. The capacitors withstand dielectric test of twice rated voltage. Other features include self healing dielectric, complete hermetic sealing with glass-to-metal solder-seal terminals, and corrosion-resistant cases. Both standard wire leads and solder tab terminals are available. These capacitors are finding widest application in military electronics and in allied industrial applications such as control devices, where both reliability of service and economy of space are important. They meet environmental tests of MIL-C-25A. Complete details regarding sizes, ratings, performance characteristics, and mounting and terminal styles available are given in engineering bulletin 224.

MICROWAVE POWER METER
reads direct in mw or dbm

HEWLETT-PACKARD CO., 275 Page Mill Road, Palo Alto, Calif. Direct, automatic readings of microwave power levels from 0.1 to 10 mw or



Lockheed MISSILE SYSTEMS DIVISION

LOCKHEED AIRCRAFT CORPORATION · VAN NUYS, CALIFORNIA

To Physicists and Engineers:

The new science of guided missiles is contributing importantly to changing man's concept of the Planet Earth in terms of time and space.

Continents will be only minutes apart in the foreseeable future. The upper atmosphere is now being effectively explored. To the missile systems scientist, there is no such thing as a remote area of this planet.

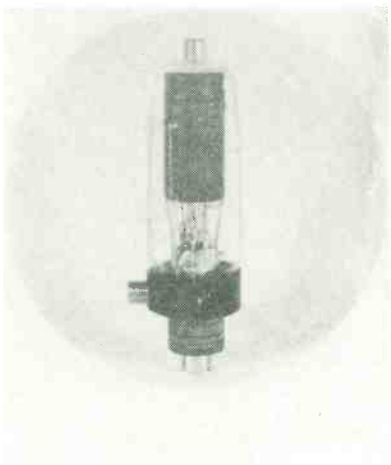
Guided missile technology is also significantly affecting other areas of scientific endeavor. The impact of nuclear science upon guided missiles alone promises major achievement. Present advances are but a prelude to future progress. Past accomplishments must be multiplied a hundred-fold to visualize growth during the next decade.

To scientists and engineers, missile systems technology presents unlimited scope for personal development. Those desiring to participate in a scientific effort of utmost importance are invited to address inquiries to our Research and Engineering Staff.

E R Quesada

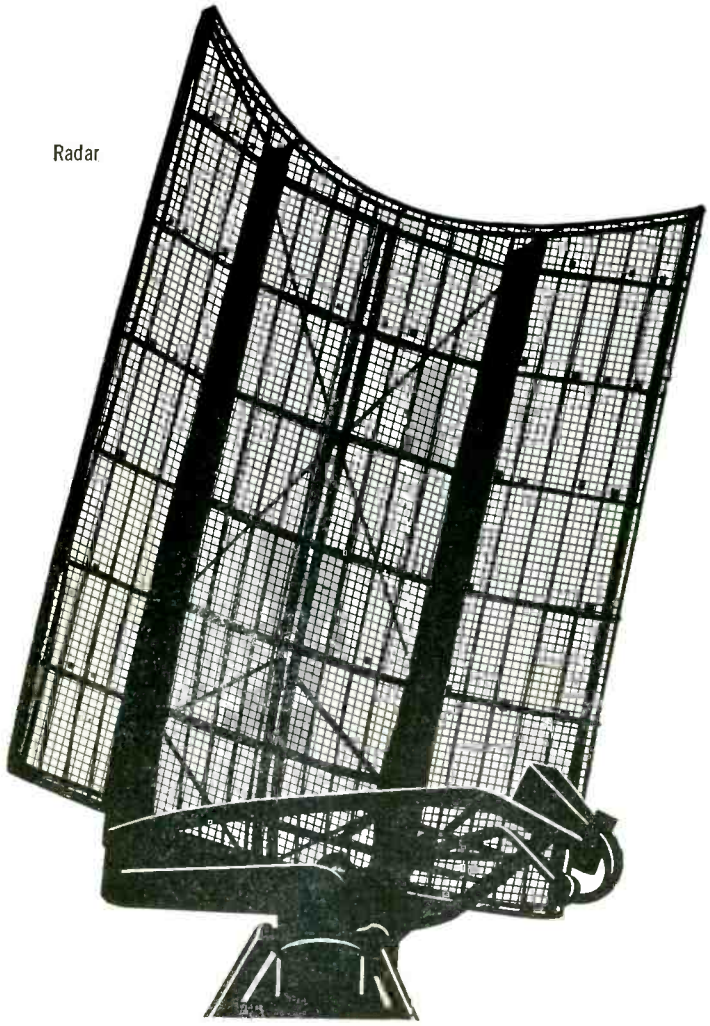
Elwood R. Quesada
Vice President and
General Manager

from −20 to +10 dbm are now available in the model 430C microwave power meter. It eliminates computation and adjustment during measuring. Operation of the instrument is entirely automatic, and it may be used with a wide variety of bolometer mounts having either positive or negative temperature coefficients. Frequency range depends on the bolometer mount employed, and either an instrument fuse, barretter or thermistor may be employed. Price of the unit is $250.



THYRATRON
is mercury-vapor filled

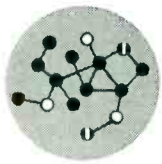
NATIONAL ELECTRONICS, INC., Geneva, Ill. An indirectly heated cathode, shield grid, 2.5 amperes d-c thyratron, NL-5560, has been developed. It is mercury-vapor filled for long life. Ratings are: heater volts, 5; heater current, 4.5 amperes; peak inverse and forward volts, 1,000; average anode current, 2.5 amperes; peak anode current, 15



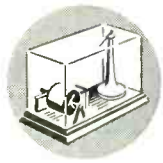
Radar

Navigation

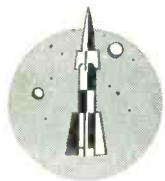
Timing



Nucleonics



Geophysics



Ordnance

PRECISION DIGITAL DELAY GENERATOR

FOR GENERAL-PURPOSE LABORATORY USE

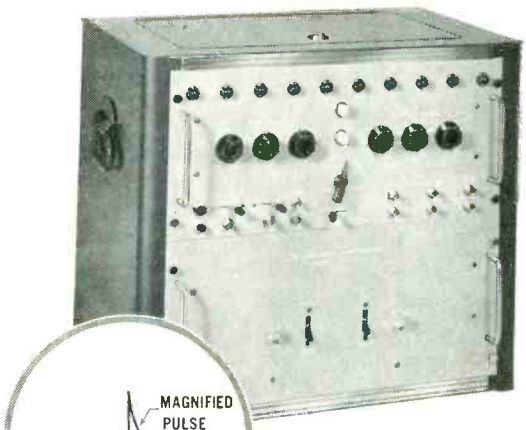
Generates pulses accurately spaced in time with respect to an internally generated reference pulse—range 0 to 100,000 microseconds

Complete generality permits numerous and varied uses such as radar range calibration, target simulation, generation of secondary frequency standards, elapsed time measurements, phase measurements, etc. Fields of application include Radar, Navigation, Telemetry, Nuclear Studies, Computor Research, Geophysics, Ordnance, and any other fields in which timing is significant.

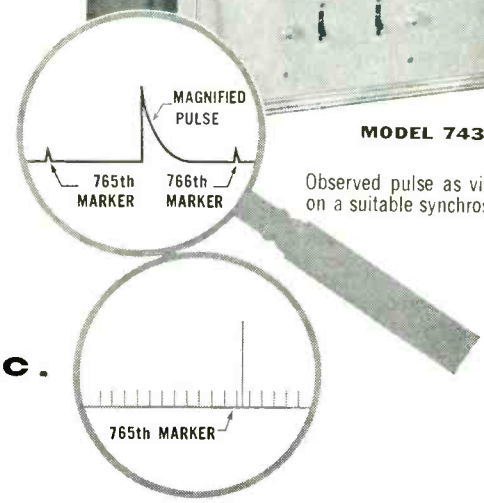
The ability to generate a specific delay at accurate variable repetition rates sets this instrument apart from any other pulse or delay generator in the field today. Write for full details.

Pulses can be supplied under either one-shot conditions or at variable repetition rates. Both pulse delay and repetition period can be established in increments as small as 1 microsecond.

The repetition period can also be externally triggered, in which case two independently variable delayed pulses are available. Accuracy of both repetition period and pulse delay are held to one part in 10^6 by the thermostatically controlled crystal oscillator. The digital circuitry and the built-in self-checking features make continuous calibration unnecessary.



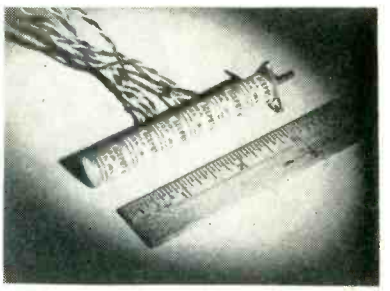
MODEL 743



Observed pulse as viewed on a suitable synchroscope

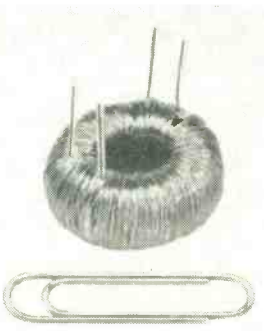
KAISER METAL PRODUCTS, INC.
BRISTOL, PA.

amperes; anode averaging time 15 seconds; and cathode heating time, 5 minutes. A data sheet is available.



SMALL POTENTIOMETER
is space and weight saving

ACE ELECTRONICS ASSOCIATES, 125 Rogers Ave., Somerville 44, Mass. The No. 500 Acepot, subminiature wire-wound precision potentiometer only ½ in. in diameter, is now being made in special ganged control units of high precision and accuracy. These ganged Acepots have the accuracy required by many computer and servo control applications. They are available in the resistance range from 200 to 100,000 ohms. Due to the large number of turns of fine resistance wire in the element and the precision accuracy with which they are spaced, standard accuracy of linear units is ±0.3 percent independent linearity. A further advantage is the small torque required. Standard torque is 0.035 oz./in. at 20 C. Complete specifications, application data sheet and prices are available from the company.



TOROID COILS
used with transistor boards

FORREST MFG. CO., 5962 Smiley Drive, Culver City, Calif., announces a line of toroid coils for use with transistors in both subminiature and printed circuits. The coils are designed for quick inser-

NEW Tektronix Portable Oscilloscope

gives you Laboratory Performance ...in the FIELD!

The Tektronix Type 310 is fully capable of performing much of your laboratory work, yet has the physical characteristics desirable for work away from your bench. It handles easily and fits into tight spots, simplifying field maintenance of complex electronic equipment. The high performance of the Type 310 can help you speed up your field work... its low weight and small size can ease your equipment handling problem.

Complete accessibility to tubes and components is maintained by a unique step-chassis construction, hinged at the rear. Accurate calibration and excellent linearity permit reliable quantitative measurements—you read time and amplitude directly from the screen. Functional panel design and versatile control system contribute to operator convenience, making this new oscilloscope an easy-to-use field and lab instrument.

IN THE FIELD

IN THE LAB

TYPE 310 CHARACTERISTICS

Portability
Overall dimensions—6¾" wide, 10" high, 17" deep.
Weight—only 23½" pounds.

Transient Response
Risetime—0.09 μsec.

Sensitivity
DC to 4 mc—0.1 v/div to 50 v/div in 9 calibrated steps, 0.1 v/div to 150 v/div continuously variable. AC-Coupled—3 db down at 2 cycles. AC-Coupled only, 2 cycles to 3.5 mc—0.01 v/div to 0.1 v/div in 3 calibrated steps.

Versatile Triggering
Internal, external, line... ac- or dc-coupled, and AUTOMATIC TRIGGERING.

Flat-faced CRT
3WP with 1.8-kv accelerating potential. Edge-lighted graticule with ¼" divisions.

Wide Sweep Range
0.5 μsec/div to 0.6 sec/div, continuously variable. 18 calibrated sweeps from 0.5 μsec/div to 0.2 sec/div. Accurate 5-x magnifier extends calibrated sweep range to 0.1 μsec/div.

Horizontal Input
Sensitivity—1.2 v/div.

Voltage Calibrator
Square wave, approximately 1 kc—0.05 v to 100 v in 11 steps.

Jewel Warning Light
Indicates when controls are at non-calibrated settings.

Power Requirements
105 to 125 v, 60 to 800 cycles, 175 watts.

DC-Coupled Unblanking

All DC Voltages Electronically Regulated

Type 310 Cathode-Ray Oscilloscope—$595
f.o.b. Portland (Beaverton), Oregon

Please call your Tektronix Field Engineer or Representative for complete specifications, or write to:

Tektronix, Inc.

P. O. BOX 831 • PORTLAND 7, OREGON
CYPRESS2-2611 • CABLE: TEKTRONIX

tion through transistor terminal boards—the windings are terminated in lugs, or solid wire leads. Leads can be tinned for dip soldering, or brought to any pin arrangement. Sizes range from $\frac{5}{8}$ in. o-d $\times$ $\frac{1}{4}$ in. to $\frac{7}{8}$ in. o-d $\times$ $\frac{3}{8}$ in.; inductance values up to 2 henrys. Units are finished with hard-setting epoxy resin, or are sealed in cans to meet MIL specifications.

VIDEO LINE MONITOR
for station camera chains

KAY LAB, 5725 Kearney Villa Road, San Diego 12, Calif., has developed a new broadcast video monitor, model ARM-13A, which provides complete monitoring facilities for broadcast station camera chains at a competitive price. The monitor is complete with A scope and illuminated calibrated scale which allows direct measurement of the height of the composite video signal. By means of a switch two lines or two fields of video information may be viewed on the A scope. Separate h-v power supplies are used for both the 10-in. kinescope and 3-in. A scope. The 1-v power supply is fully electronically regulated. The 10-in. kinescope is a flat-faced, tinted, aluminized crt. Video amplifiers provide an 8-mc bandwidth resulting in an extremely fine resolution of 600 lines. A special control provides for synchronization on sync pulses stripped from the composite video or by synchronization with pulses taken directly from the station sync generator at the choice of the operator.

DYNAMOMETER
has several improvements

WESTERN GEAR, Electro Products Division, P. O. Box 182, Lynwood,

All New!

RCA WO-91A 5" 'SCOPE FOR BLACK and WHITE and COLOR TV

Only $229.50 User Price (Optional)

RCA WO-91A 5" OSCILLOSCOPE
Complete, ready-for-use, including new WG-300A low-capacitance, dual-purpose probe, shielded input cable and instruction book.

NOW—AN ALL-NEW OSCILLOSCOPE with features usually found only in more expensive instruments. It has all the 'scope functions you need to do both black-and-white and color TV service work . . . speedily and with top-grade results! Check a few of these work-simplifying features . . . "low-capacitance/direct" probe . . . preset "V" and "H" sweep positions . . . automatic probe-disconnect calibration control. And look at the added features of this instrument:

- *Dual-band response. Response flat to 4.5 Mc in wide-band position.*
- *Voltage-calibrated, frequency-compensated, 3-to-1 step attenuator for "V" amplifier.*
- *Simplified, semi-automatic voltage calibration for simultaneous voltage measurement and waveshape display.*
- *VTVM-type graph scales marked in peak-to-peak volts—read voltage amplitude directly from screen.*
- *Vertical-polarity reversal switch for "upright" or "inverted" trace display.*
- *Sturdy one-piece low-capacitance/direct probe minimizes circuit loading.*
- *Z-AXIS input facilities permit direct modulation of the cathode-ray tube grid.*
- *Preset "V" and "H" sweep positions for speedy, automatic lock-in at "vertical" and "horizontal" frequencies.*
- *"Plus" or "minus" internal-sync selector.*
- *Shielded vertical-input connector and shielded cable for minimizing hum and stray field pick-up.*
- *Positive-lock internal sync.*

FREQUENCY RESPONSE: Wide-band position, within-1 db from 10 cps to 4.5 Mc; Narrow band position, within-1 db from 10 cps to 0.5 Mc; within-6 db at 1.5 Mc.

SENSITIVITY: 0.05 volt peak-to-peak per inch (0.018 volt rms) in narrow-band position; 0.15 volt peak-to-peak per inch (0.053 volt rms) in wide-band position.

RADIO CORPORATION of AMERICA
TEST EQUIPMENT **HARRISON, N.J.**

See the ALL-NEW WO-91A at your RCA Distributor. Order now for early delivery.

Calif. Incorporating several improvements, a new model Dyna-Chek dynamometer, model DM-4, has been announced. It checks hp, torque and rpm of electric motors in continuous duty from 1 hp or less. It can also be used for testing motors rated at more than 1 hp and up to 2 hp in intermittent service and handles motors in these power categories turning as high as 15,000 rpm.

FEEDBACK VOLTMETER
measures from —70 to +36 dbm

THE SOLARTRON ELECTRONIC GROUP LTD., Thames Ditton, Surrey, England. Type BM.519 precision feedback voltmeter is of use in communications establishments. It features a wide coverage of input levels, provision for measurement at all common characteristic impedances, and display on a clearly scaled 6-in. meter. A coaxial output for cro is available, enabling waveform monitoring to be carried out simultaneously with measurement. With a normal frequency coverage of 15 cps to 100 kc the instrument may be usefully employed at frequencies up to 400 kc, with little reduction in accuracy.

MERCURY JET SWITCH
features low noise

DETROIT CONTROLS CORP., 1650 Broadway, Redwood City, Calif. A new multiposition high-speed switch for commutating, sampling or chopping functions utilizes a jet stream of mercury in a unique fashion as the pole or wiper arm. No brushes or slip rings are involved. Absence of spring-loaded contacts allows long life at high speeds with no contact bounce. Noise is less than 10 μv into 100 ohms. Speeds up to at least 10,000 rpm can be achieved,

NEW 17 POUNDS OF PRECISION:

DU MONT TYPE 331
CATHODE-RAY OSCILLOGRAPH

- Developed in close cooperation with a leading manufacturer of computers
- DC to 4 mc vertical bandwidth (Transient response, 0.08 μsec)
- Precise measurement of time intervals (from 2.5 seconds to 0.08 μsec)
- Accurate voltage calibration over range from 0.4 to 400 volts full scale
- Flat-face, tight-tolerance Du Mont Type 3WP- Cathode-ray Tube provides excellent deflection linearity and freedom from field distortions
- Three-times undistorted sweep expansion of *any* calibrated sweep. Any expanded portion may be positioned on screen

ADDITIONAL FEATURES

Illuminated calibrated scale

High impedance test probe supplied

May be continuously operated horizontally or vertically

Beam-gate output at front panel for triggering external devices

Swing-away chassis construction assures accessibility of all components for convenient maintenance

Probe, instruction manual, and other accessories stored in front panel cover

AND BEST OF ALL, THE PRICE IS ONLY **$585**

Never before has so much high-quality performance been compressed into so small a package. Here, in well under a cubic foot, (7⅞" x 9" x 17½") are *complete* facilities for high-precision observation and measurement of signals from d-c to 4 mc and beyond.

With its wide-band features and excellent pulse response (0.08 μsec) the Type 331 is particularly well suited for maintenance of computers and radar systems, or wherever portability—without sacrifice in performance—is required.

And in this day of cluttered work benches, the compact design of the Type 331 means that for general applications, you have laboratory performance in half to a quarter the surface area occupied by other instruments of comparable function.

For complete details, write to the address below for the technical bulletin.

IMPORTANT SPECIFICATIONS

Cathode-ray Tube: Type 3WP.

Deflection Factor: (full gain) a-c or d-c input, 0.2 p-p volts full scale (1.8").

Frequency Response: (any control setting) flat from d-c to down not more than 30% at 4 mc.

Calibrated Sweeps: 0.5 second to 0.5 μsec per major scale division (0.45"); expansion of 3X available on all ranges.

Amplitude Measurement: 0.4 to 400 volts full scale in 7 ranges.

Size: 7⅞" x 9" x 19½" overall including cover; weight without cover, 17½ lbs.; with cover 19¼ lbs.

DU MONT

TECHNICAL SALES DEPARTMENT • ALLEN B. DU MONT LABORATORIES, INC.
760 BLOOMFIELD AVENUE, CLIFTON, N. J.

and as many as 120 circuits per revolution can be sampled. Thousands of hours of maintenance-free operation can be expected.

POWER SUPPLY
has new construction

BECKMAN INSTRUMENTS, INC., Shasta Division, P. O. Box 296, Richmond, Calif. Model 702A power supply is a regulated power source of conventional circuitry featuring a compact method of mechanical construction. It provides output voltages from 0 to 600 v, continuously variable, with currents up to 200 ma. Regulation is maintained at ¼ percent or better with ripple less than 10 mv peak to peak. A variable negative output of 0 to 150 v is also provided for bias, as well as 6.3 v at 8 amperes. Positive and negative terminals are insulated from the chassis, permitting high voltage to be used above or below ground. Price is $205.

PULSE OSCILLATOR
features wide range

ELECTRO-PULSE, INC., 11811 Major St., Culver City, Calif. Model 3420A pulse oscillator features a wide

Get in touch with Budd-Stanley

FOR WAVEGUIDE AND MICROWAVE TRANSMISSION EQUIPMENT

. . production skill and experience.

. . unique manufacturing methods to meet unusual specifications.

. . unexcelled facilities from model shop to assembly line.

. . transmission lines and associated elements manufactured and tested to your specifications.

Q*uality*
E*conomy*
D*ependability*

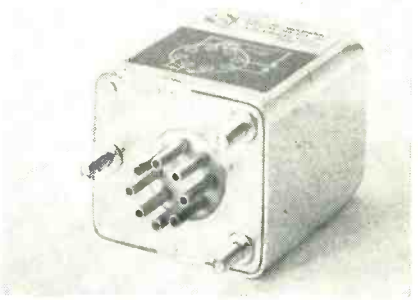
Write, wire or phone

BUDD-STANLEY CO. INC.

43-01 22nd St., LONG ISLAND CITY 1, N. Y. • *Phone* STillwell 6-1706 • *Cable Address* "BUDDSTAN"

Want more information? Use post card on last page.

range of pulse spacing from 0.3 μsec (3.3 mc repetition rate) to 11,000 μsec (90 cycle repetition rate) in 5 ranges. The basic oscillation period is set up by a specially designed multivibrator which has several feedback paths. Two output blocking oscillator pulses—either of which can be positive or negative—are available from the front panel, spaced by the half period of the multivibrator oscillator. These pulses are 0.1 μsec wide above 100 kc and widen out to approximately 0.5 μsec below 100 kc, with an impedance level of 250 ohms, or below, and with variable amplitude to 25 v open circuit. Typical applications for the instrument include flip-flop resolving time studies, clock pulse generators, test and development of high speed circuitry, magnetic core set and reset triggers, and wide range trigger source.



TAPER-PIN RELAYS
in 2, 3, and 4-pole models

ELECTRO-MECHANICAL SPECIALTIES CO., INC., 6819 Melrose Ave., Los Angeles 38, Calif., has introduced a new series of relays hermetically sealed with taper-pin terminals for solderless connection. They are available in 2, 3 and 4-pole models, and surpass MIL-R-5757B and MIL-R-6106A specifications. They are especially designed for use in jet aircraft, guided missiles and other airborne equipment.

FIELD INTENSITY METER
covers 14 to 250 kc

STODDART AIRCRAFT RADIO CO., INC., 6644 Santa Monica Blvd., Hollywood 38, Calif. The NM-10A radio interference and field intensity meter covers a frequency range of 14 to 250 kc. It is designed for lab

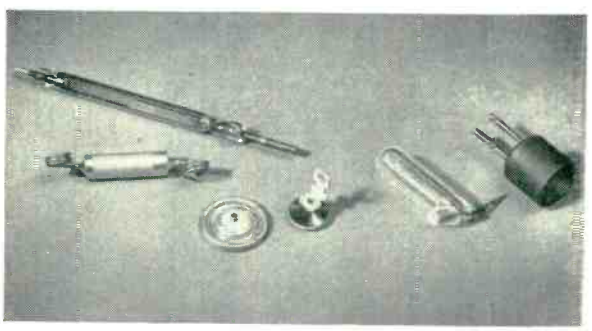
Need close-tolerance tubular parts like these? Just send drawing

Superior Tube has special facilities for doing complete job — efficiently, fast

Save handling costs. When you need special close-tolerance tubular parts, let Superior Tube make them for you complete. Engineering assistance is available. Or just send drawing, indicating size, shape, metal analysis, temper and degree of finish desired.

Superior Tube's special facilities provide for flaring, cutting, deburring, expanding, bending, rolling ends, grooving, beading, coiling, flattening, punching, deep drawing, reducing, drilling, chamfering, shearing, slotting. A wide choice of different alloys of closely controlled analysis is available.

For prices and complete information on fabricated tubular parts on glass sealing alloys, write Superior Tube Company, 2500 Germantown Ave., Norristown, Pa.



GLASS SEALING ALLOYS

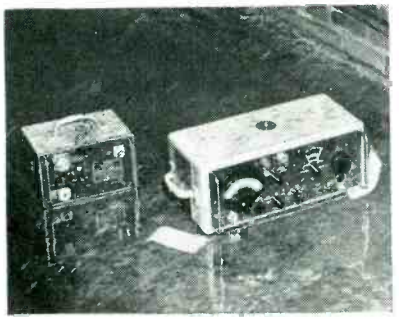
Glass-to-metal seals for conductor leads into vacuum tubes, hermetically sealed chambers, or controlled atmospheres. Typical uses are shown above, left to right: voltage regulator, capacitor, capacitor cap, button terminal, recording pen, refrigeration sniffer. Superior offers six standard uniform-expansion alloys cold drawn to close tolerances in Seamless or WELDRAWN* tubing.

*TM Superior Tube Co., Reg. U.S. Pat. Off.

Superior Tube

The big name in small tubing

All analyses .010" to ⅝" OD. Certain analyses in light walls up to 2½" OD.



or field use for field intensity measurements of carrier current systems, the signal level at points along the system, and for surveys of conducted or radiated interference. A complete selection of accessories is available, expanding its utility. The a-c power supply permits operation from 105 to 125 v or 210 to 250 v a-c, 50 to 1,600 cps. The NM-10A is identical to the Navy AN/URM-6B, a class 1 instrument, as shown in MIL-I-16910 (SHIPS).

L-F AMPLIFIER available in two models

WHITE INSTRUMENT LABORATORIES, 203 E. Riverside Drive, Austin 4, Texas. Models 211 and 212 amplifiers, when used with matching twin-T feedback networks, become size and weight saving filters or band-pass amplifiers in the 5 cps to 500 cps range. The amplifier and feedback network are separate plug-in units, with all units completely interchangeable. The one tube model 211 has a voltage gain of 15 and a Q of 8, when used with a type 552 network. Model 212, using two tubes, has a gain of 80 and a maximum Q of 40 with the type 542 network. Power supply requirements are 200-300 v d-c regulated

For current limiting and for obtaining lagging power factors without distortion —

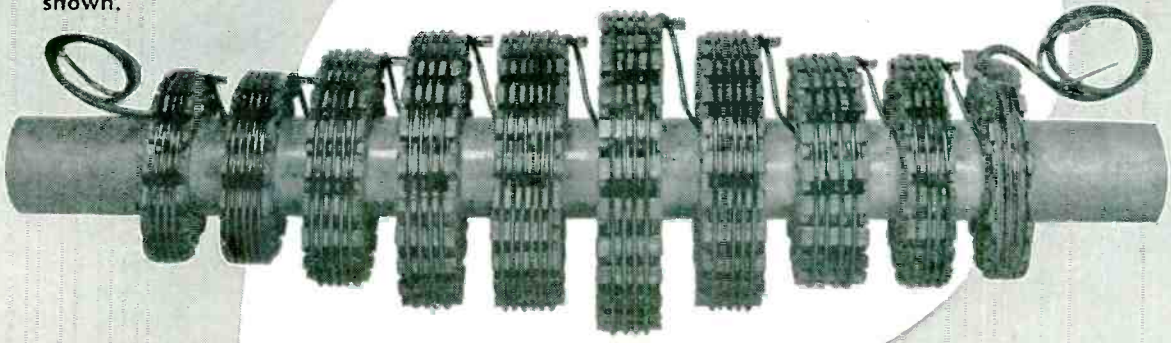
NWL Air Core Reactors

Capacity of ¼ to 2000 Amperes and 25 to 400 cycles.

For lowest possible capacitance and non-resonating peaks —

NWL Radio Frequency (R.F.) Chokes

Available in sizes 1 ampere and larger. In illustration below terminal is not shown.



NWL

ESTABLISHED 1920

NEMA

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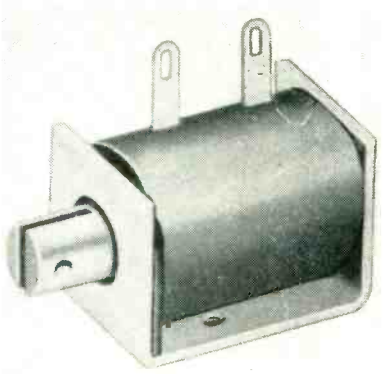
Write for complete information

WINDING LABORATORIES, INC.

P. O. Box 455, Dept. 107 TRENTON, N. J.

plate supply and 6.3-v filament supply.



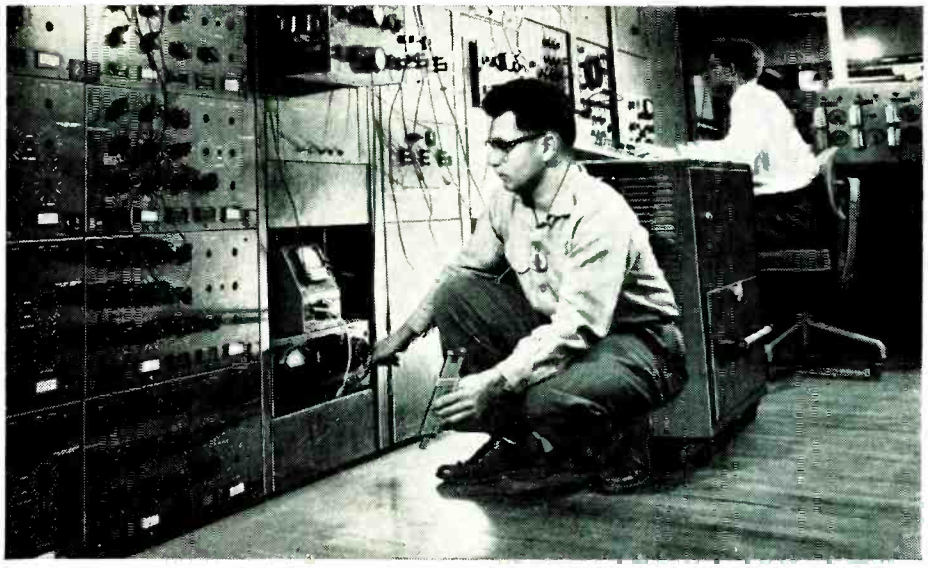
SOLENOID
is small and rugged

DORMEYER INDUSTRIES, 3418 N. Milwaukee Ave., Chicago 41, Ill., has available a new compact solenoid for limited space applications requiring high power and rugged performance. The shading coil is embedded in the plug for greater efficiency and high seated pull. It operates in any position and is supplied as standard with solder terminals or can be furnished with flexible leads. Regularly rated at 115 v, 60 cycle, a-c, it is available on special order for any other a-c, voltage or frequency.

TRIMMING POT
for aircraft requirements

BOURNS LABORATORIES, 6135 Magnolia Ave., Riverside, Calif. Model 160 Trimpot was designed to meet the aircraft and missile industries' demand for a subminiature trimming potentiometer having high temperature and power rating characteristics. It has a −65 F to 350 F operating temperature range. Power rating is 0.6 w at 100 F and 0.4 w at 200 F. Resolution as low as 0.25 percent is obtained over the 25-turn adjustment range. Resistance elements, precision wound with Evan-

NORTH AMERICAN AVIATION HAS BUILT MORE AIRPLANES THAN ANY OTHER COMPANY IN THE WORLD



North American Aviation Has Unequalled Opportunities for

ELECTRONIC, ELECTRICAL, INSTRUMENTATION ENGINEERS and PHYSICISTS

North American offers you major projects, advanced facilities and experienced organization . . . where you can become a key figure in research, design and testing of the electronic and electro-mechanical components that will form the "brains" for airborne vehicles of tomorrow.

You can join the leading company in advanced aircraft design and production. To create a favorable climate for ideas, North American has eliminated the "coordinator." You work on your ideas—follow them through to completion. You may gain recognition for your efforts in the form of Patent Awards and Suggestion Awards.

SPECIAL OPPORTUNITIES:

ELECTRIC MOTOR DESIGN GROUP: A new group is now being formed to design specialized electric motors. This is an unusual challenge for men with fractional H.P. A.C. and/or D.C. motor design experience. You'll work with new metals, new ideas . . . you'll design the electrical motors needed for future aircraft designs.

FLIGHT CONTROLS GROUP: A newly formed section of our Flight Controls Group will tackle special problems of controlling flight stability at supersonic speeds. Openings exist at all levels of experience, including research-directive positions. You'll probe the future in advanced stages of research . . . particularly in the development and testing of high response electrical and mechanical closed loop systems and components . . . in the evaluation of Mach censors, gyros, accelerometers, force transducers.

ENGINEERING RESEARCH LABORATORY: New positions for all types of electrical and electronic engineers exist at all levels of experience in our Research Laboratory. These positions have been created by North American's leadership in research . . . you will take up where our research has led. You'll work closely with the world-recognized engineers . . . on the team that's engineering ahead for a better tomorrow.

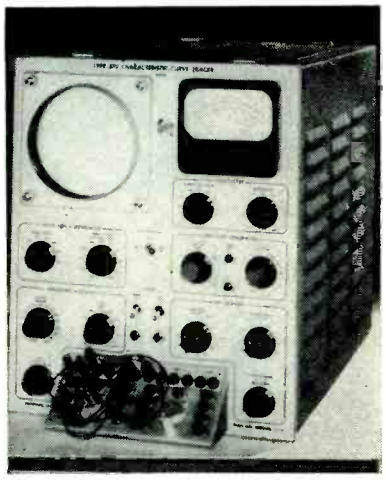
Write today:

Engineering Personnel Office, Attention: Mr. L. W. Stevenson, Department 56-EL, Los Angeles 45, California

ENGINEERING AHEAD FOR A BETTER TOMORROW

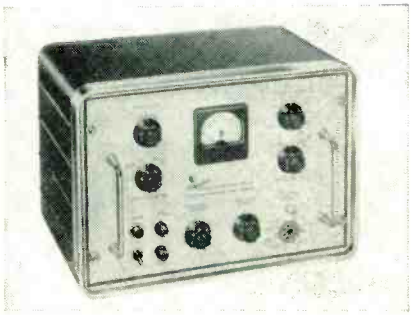
NORTH AMERICAN AVIATION, INC.

ohm wire, provide excellent temperature coefficient characteristics in standard resistances from 10 ohms to 10,000 ohms. Electrical settings are securely maintained during severe shock, vibration and acceleration. Size is $\frac{1}{4}$ in. × $\frac{5}{16}$ in. × $1\frac{1}{4}$ in. Acceleration is 100 g. Standard resistance are 10, 20, 50, 100, 200, 500, 1,000, 2,000, 5,000 and 10,000 ohms.



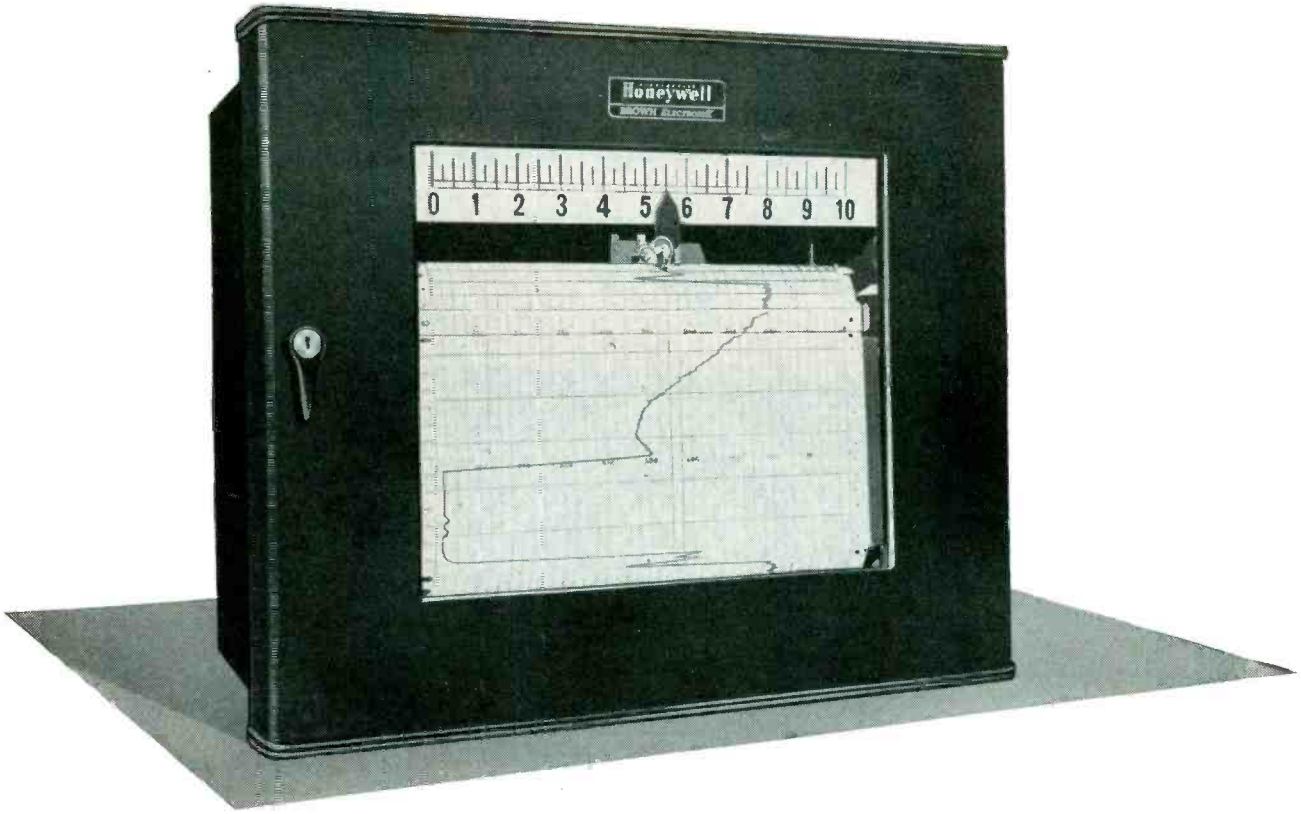
TRACER
plots v-t characteristics

TEKTRONIX, INC., P. O. Box 831, Portland 7, Oregon. Type 570 characteristic curve tracer presents an accurate graphic analysis of v-t characteristics. It displays families of characteristic curves on the face of a crt, calibrated to permit accurate current and voltage readings directly from the screen. Curves per family are adjustable from 4 to 12; and 6 different characteristic curves are plotted. Weight is 67 lb. Price is $925.



POWER SUPPLY
for klystron tubes

POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC., 202 Tillary St.,



Fast, sensitive recording of d-c data *from high impedance sources*

BY MEANS of a recently developed model of the widely used *ElectroniK* instrument, d-c voltage and current data can be recorded from high impedance sources . . . with excellent sensitivity, speed and precision. This recorder needs no external preamplifier. Designed to have high input impedance, it causes negligible loading effect on high impedance circuits or sensing elements.

It is also applicable to low-level current measurements in conjunction with spectrographs, photo-cells and other current-producing devices.

It records at high speed, with negligible damping effect by the source. Standard pen speeds are 24, 12, 4½ or 2 seconds for full scale travel.

It has high sensitivity . . . is supplied for ranges of 2 or 10 mv full scale.

Stray a-c voltages, of full scale value for the 2-second instrument, and of 10 times the span for the 24-second model, are rejected with no significant loss in sensitivity.

The amplifier is readily withdrawn for use in high impedance servo systems, and can be supplied as an individual unit for such purposes.

Your nearby Honeywell sales engineer will be glad to discuss the many possibilities this *ElectroniK* instrument offers for your research. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Approximate Maximum Sensitivities

	3x Amplifier	1x Amplifier
Span	2 mv	10 mv
Voltage sensitivity	1×10^{-6} volts	3×10^{-6} volts
Current sensitivity	8×10^{-12} amperes	2.5×10^{-11} amperes

● **REFERENCE DATA**: Write for Instrumentation Data Sheet No. 10.0-14.

MINNEAPOLIS **Honeywell**
BROWN INSTRUMENTS

H HONEYWELL *First in Controls*

★Advt. No. 7134

Brooklyn 1, N. Y. Type 809 klystron power supply provides beam voltages from 250 v to 600 v at 65 ma, reflector voltages from 0 to −900 v at 50 μa, square wave modulation between 400 and 2,000 cps, and sawtooth modulation at line frequency. By the use of improved circuitry, ripple and regulation are kept within tolerances comparable to much more expensive units. A special feature is the ease of changing from c-w to square wave modulation for peak power measurements because the top of the square wave is automatically clamped to the previously chosen reflector voltage. The klystron reflector is protected against positive voltages by a clipper. Price is $350.

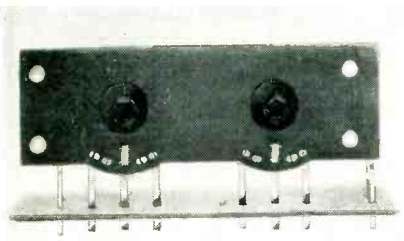
SILICONE TAPE
features rigidity

MINNESOTA MINING AND MFG. CO., 6 Argyle Terrace, Irvington 11, N. J. Especially designed for the manufacture of dry type transformers, the SG-300 special silicone resin treated tape is also available in full 36-in. roll form, or in sheets. It has high dielectric strength, good compatibility with varnishes, good mechanical strength, and the tough coating prevents cut through. This material provides for a reduction in space, and because of its special type of coating, can be formed around a small radius. Four thicknesses are available at present, but others are being developed. Samples and preliminary data are available.

TIMING RECEIVER
has 6-7 db noise figure

WEST COAST ELECTRONICS CO., 5873 W. Jefferson Blvd., Los Angeles, Calif., has developed a receiver designed especially for missile and

aircraft test range instrumentation. Model 2 PCM timing receiver is a highly sensitive, low-noise figure, superheterodyne designed for reception of pulsed signals in the 152 to 174 mc range. It accepts and reproduces pulses from 1 to 20 μsec long. The receiver noise figure is 6 to 7 db, and its bandwidth is 1 mc. Its fully automatic gain control, which maintains essentially constant output with input signals whose levels vary from 5 μv to 10,000 μv, and its frequency stability of $\pm$0.005 percent make manual adjustments unnecessary. The receiver mounts in a standard 19-in. relay rack, and is 10½ in. high. It requires a power supply delivering 100 ma, 200 v regulated d-c and 6.3 v a-c.



CARBON CONTROLS
for printed circuits

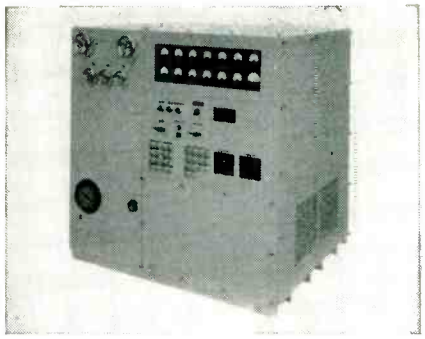
P. R. MALLORY & CO., INC., Indianapolis, Ind. Strip-type carbon controls, with the resistance wafers mounted directly on a phenolic panel, are now available in a design specifically intended for printed circuit applications. The controls have straight, tinned terminals which project through punched slots in the printed sheet for dip soldering. They are mounted at right angles to the chassis by means of shouldered tabs. To save space, multiple sections can be mounted about ½ in. behind each other. The shafts of the rear section extend through holes factory-punched in the front strip. Single, dual and triple sections are available, in resistance values from 250 ohms to 10 megohms.

ANTENNA BRIDGE
is accurate and sensitive

JAMES MILLEN MFG. CO., INC., Malden, Mass. The 90672 antenna bridge is an accurate and sensitive bridge for measuring impedances in the range of 5 to 500 ohms at

 For additional information on all items on this page, use post card on last page.

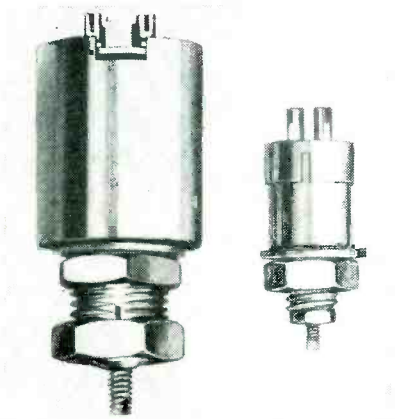
radio frequencies up to 200 mc. It employs no variable resistors. The variable element is an especially designed differential variable capacitor capable of high accuracy and permanency of calibration over a wide range of frequencies. A grid dip meter such as the 90651 may be used as the source of r-f signal. The bridge may be used to measure antenna radiation resistance, antenna resonance, transmission line impedance, swr, receiver input impedance and other r-f impedances. By the antenna bridge, an antenna matching unit may be adjusted so as to provide the minimum swr on the radiation system at all frequencies.



UHF AMPLIFIER
uses 100-w driving power

AIR ASSOCIATES, INC., Teterboro, N. J. Model 23A, a 1-kw vhf/uhf amplifier, amplifies 100 w to over 1,000 w. The new unit will be used for ground-to-aircraft communications. It measures only 4 ft wide, 4 ft high and 3 ft deep. The amplifier operates over a frequency range of 225 to 400 mc. Modulation frequency is 200 cps to 20 kc. The unit's modulation capability is sufficient to produce 320 w of sideband power. Distortion characteristic is less than 3 percent at full modulation. The r-f output and in-

put impedance are each 52 ohms. Frequency response is within 2 db of the 1,000 cycle reference level; carrier-noise characteristic is 50 db below full modulation. Spurious radiation value of the unit is 60 db below carrier power. Model 23A's power input requirement is 208 v, 3 phase, 4 wire, 60 cycles. The unit is completely self-contained including the heat exchanger for the r-f tube.

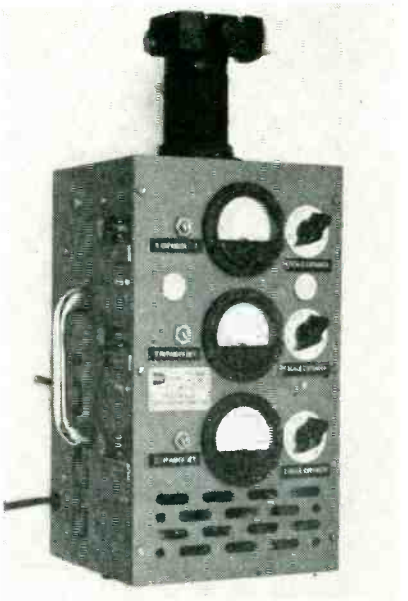


SHIELDED COIL FORMS
in two new sizes

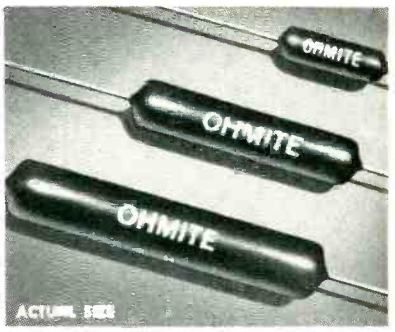
CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge 38, Mass., has introduced two new shielded coil forms. The LS-10 is $\frac{5}{8}$ in. in diameter, by $1\frac{5}{16}$ in. in overall height when mounted, including terminals. The LS-11 is $\frac{5}{16}$ in. in diameter and has an overall height when mounted of $1\frac{7}{32}$ in. Each mounts by a single mounting stud. Both are highly shock resistant, with mechanically enclosed, protected coil windings. These assemblies are ideal for such applications as i-f strips, r-f coils and oscillator coils. They are available as coil form assemblies, or wound to customer specifications.

SPECTROPHOTOMETER
indicates color on 3 meters

TELECHROME INC., 632 Merrick Road, Amityville, N. Y. Model 1602-A tristimulus spectrophotometer is designed for use by tv stations, electronic laboratories and others interested in precise color measurements from various light sources. Its sensitivity is insured by the



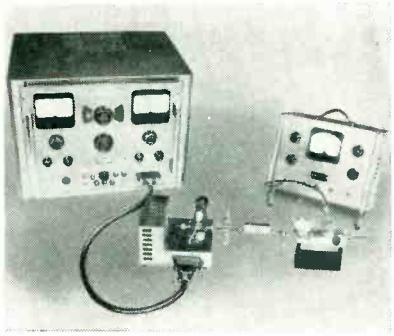
use of 3 built-in high-gain amplifiers having gains of over a million times. Light is split by semitransparent mirrors and special filters into 3 multiplier phototubes producing taking characteristics which closely approximate the X, Y, Z distribution curves. Contained in a 6 in. × 7 in. × 12 in. housing, the instrument contains its own optical system, beam splitters, optical filters, multiplier phototubes, meters and regulated power supply.



SMALL RESISTORS are vitreous-enameled

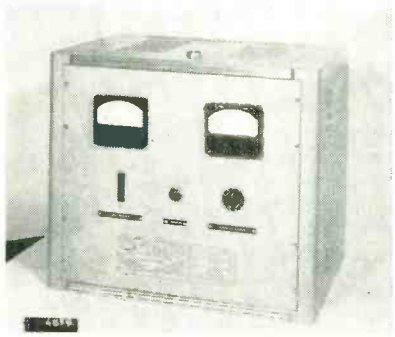
OHMITE MFG. Co., 3678 Howard St., Skokie, Ill., has announced a line of small, power-type resistors with axial leads. These are wire-wound units with steatite cores and a special-formula vitreous-enamel coating. The resistance wire and terminal lead are both welded to the end cap, thus assuring perfect and permanently stable electrical connections. All parts are thermally balanced, so as to expand and contract as a unit. The axial-lead re-

sistors are available in an extensive range of sizes and wattage ratings. The smallest resistor is only $\frac{1}{4}$ in. diameter by $\frac{19}{32}$ in. long overall and is rated at 3 w. Two sizes, rated at 5 and 10 w, are carried in stock in a wide range of resistance values.



FIVE-MM EQUIPMENT
operates over 50 to 75 kmc

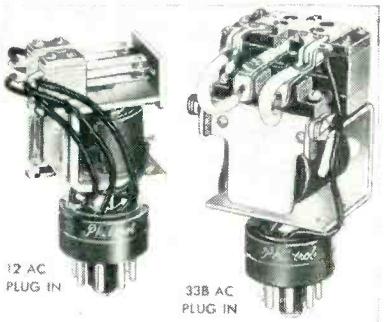
THE ELECTRONICS & X-RAY DIVISION, F-R Machine Works, Inc., 26-12 Borough Place, Woodside 77, N. Y., has developed a new and completely specified line of 5-mm equipment that operates over the full waveguide frequency range of the RG-98/U waveguides: 50 to 75 kmc. A slotted section flap attenuator, tunable detector mount, E/H tuner, frequency meter, termination, sliding short, horn, harmonic generator, bends, tees, transmission line stand, klystron tube mount and power supply are available. Equipment is also available for RG-97/U waveguide. Literature will be sent on request.



D-C POWER SUPPLY
for computer applications

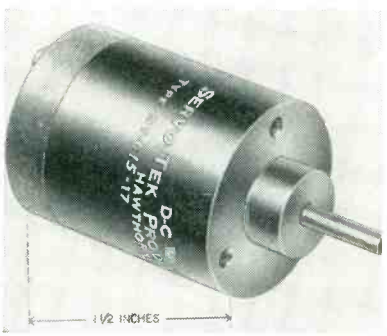
BART-MESSING CORP., 229 Main St., Belleville 9, N. J., has announced development of a new lightweight, compact regulated d-c power supply unit, known as the Sel-Rex Reactronic, designed specifically for

computer and similar applications requiring close voltage regulation. Features include: automatic voltage regulation with magnetic amplifier control for smooth adjustment over the entire range; static regulation ±1 percent from no load to full load; ripple voltage limitation of 1 v peak to peak; and maintenance free operation with nonwearing static components—no vacuum tubes or moving parts. Equipped with time-tested and proven selenium rectifiers, the units are available from 4 to 300-v capacities, at all current values from 1 ampere.



PLUG-IN RELAYS
in two new models

PHILLIPS CONTROL CORP., Joliet, Ill., has added to its relay line two new plug-in models. One is the Phil-trol 33B general purpose power relay available in either a-c or d-c, 2-pole, 3-pole or 5-pole models. The other is the smaller type 12 Phil-trol relay available in a-c or d-c, for operation up to 230 v. Performance characteristics, specifications and data sheets on both relays are available.



P-M MOTORS
noted for small size

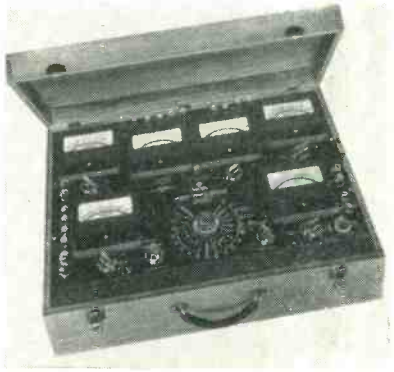
SERVO-TEK PRODUCTS CO., INC., 1086 Goffle Road, Hawthorne, N. J. A new line of 4 d-c motors, incorpo-

rating a permanent-magnet field assembly, have an overall body length of less than 1½ in., with a weight of less than 3 oz. The new line incorporates a housing which is fully machined from solid aluminum, low torque ball bearings, an anodized finish and improved mechanical construction. It has a rotable brush holder which can be adjusted for best commutation and power output. Other mechanical features include a flat wafer-type commutator with brushes removable from the rear of the motor. A close control is held on all dimensional tolerances which permits their incorporation into precision servo devices, gear trains and similar devices. Various electrical characteristics are available with a range of operating voltages from 6 to 80 v, no load speeds from 3,000 to 20,000 rpm and power output up to 11 w, or approximately 1/70 hp.

SAMPLING SWITCH
with 1, 2 or 3 poles

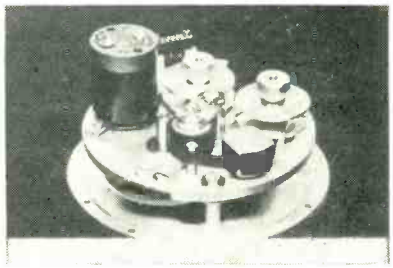
GENERAL DEVICES, INC., P. O. Box 253, Princeton, N. J., has announced a new high-speed precision sampling switch with integral motor and planetary gear reduction. It is available with 1, 2 or 3 concentric poles, 60 contacts per pole, utilizing their exclusive semimolded contact plate construction for longer service-free life and greater dimensional stability. Connections to each pole are made by convenient length wire leads molded into the plate and attached to compact multipin connectors. This provides plug-in connection and greater ease of inspection. The switches are available

with constant force Perma Brush for extended life and more predictable performance. They are equipped with 60 or 400 cycle a-c, 6 to 115 v d-c motors and gear reduction assemblies. They measure 3⅜ in. in diameter × 2 in. long, with ¾ in. diameter by 1 in. long hub.



MAGNETIC TESTER
for core loss measurement

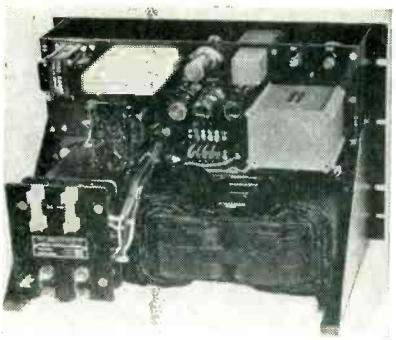
SENSITIVE RESEARCH INSTRUMENT CORP., 9-11 Elm Ave., Mt. Vernon, N. Y. The new universal magnetic testing set is a complete unit designed to make measurements that conform to the methods and specifications of the ASTM. Functions are: the determination of B-H curves; the determination of hysteresis loops; core loss testing using Epstein frame or standard E and I cores; measurements of total flux of hard magnets; measurements of magnetic field strength; and a-c and d-c permeability tests. Instrumentation consists of a d-c ammeter, a-c ammeter, rms voltmeter, flux voltmeter, low power factor wattmeter, multirange fluxmeter and Epstein frame. Price is $2,475.



ACCELEROMETER SYSTEM
with tape playback unit

GULTON MFG. CORP., Metuchen, N. J. A new tape-recording ac-

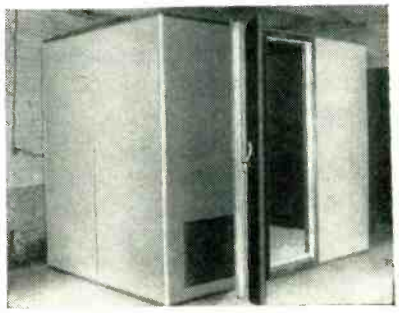
celerometer system can reliably measure accelerations up to ±60 g in guided missiles, air, sea and land vehicles, underwater devices and ordnance equipment without the use of direct cable or wireless connections. The Glennite model KAT1 is comprised of two basic units—a self-contained self-recording accelerometer and a tape playback unit—and provides for an instantaneous 30-second permanent tape recording of vibration and shock accelerations in moving devices which can be read through any standard recording instrument such as a galvanometer, oscilloscope, meter or direct-writing recorder. The accelerometer, containing a miniaturized electronic circuit, weighs only 3 lb and is housed in a rugged aluminum cylinder 4½ in. in diameter and 3 in. high.



VOLTAGE REGULATOR
with 220-v output

NORTH AMERICAN PHILIPS CO., INC., 750 South Fulton Ave., Mt. Vernon, N. Y., has announced a new voltage regulator designed for use with the company's diffractometer and spectrograph units as well as for other applications. It utilizes a 6V6, two 6SL7's and a magnetic amplifier. The unit operates on a line voltage of 185 to 250, 60 cycles at an ambient temperature of 40 C maximum. Output voltage is 220; output current, 12.5 amperes maximum; output load, 2.75 kva maximum. Load power factor is 0.7-1.0 inductive; regulation is 0.05 percent; harmonic distortion, less than 5 percent; and time constant, 0.2 sec. When the line switch is turned on, voltage will stabilize in approximately 1 minute. If the overvoltage protective relay operates, output falls to less than 150 v. Overvoltage relay

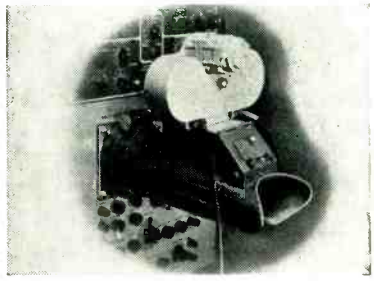
is reset by turning the regulator off and waiting 10 seconds before turning it on again. Two screwdriver adjustments are provided at the rear of the chassis. One is for waveform and is set at the factory. The other is for output voltage and provides 220 v ±2 v.



SHIELDED ENCLOSURES

for microwave applications

ACE ENGINEERING & MACHINE CO., INC., 3644 North Lawrence St., Philadelphia 40, Pa., has announced a new series of versatile enclosures for microwave and rfi applications. Additional microwave absorption characteristics are achieved by incorporating two new especially designed materials into the basic structure. Lightweight McMillan hair-mat type 8 is used on walls, doors and ceiling. Floor absorption is provided by McMillan plastic foam block type B, which can be walked on without any loss of electrical characteristics. Major application of the new rooms is expected to be simulation of free space for microwave testing in the electronics, aviation and allied industries.



HIGH-SPEED CAMERA

records oscilloscope traces

BREA INSTRUMENTS, P. O. Box 248, Brea, Calif., has announced the model OC-1, a new high-speed 35-mm camera for continuous record-

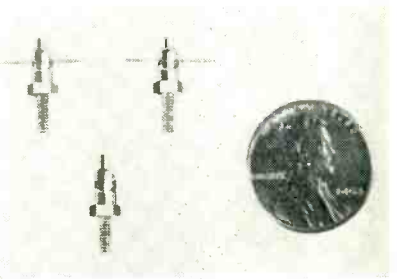
ing of oscilloscope traces. Weighing only 6 lb, with a film capacity of 100 ft, the camera may be mounted directly on the bezel of any 5-in. oscilloscope. The illustrated installation features simultaneous binocular viewing and recording, illuminated identification card and flashing lamp time reference. Film transport rate may be set between 1 and 300 ips by a continuously variable remote motor control. Lower speeds can be achieved by gear substitution and higher speeds up to 400 ips can be reached with special starting acceleration control. An f/1.5, 50-mm coated lens with iris diaphragm is offered, giving an image reduction ratio of 4.5 in the usual 5-in. oscilloscope installation.

RESISTANCE WELDING CONTROLS

feature printed circuits

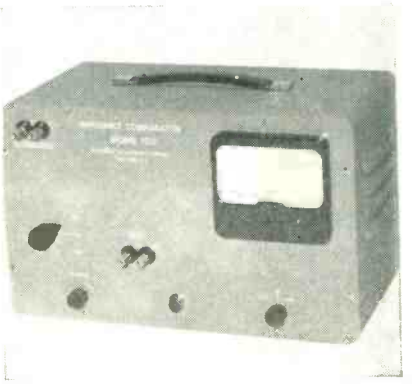
WESTINGHOUSE ELECTRIC CORP., P. O. Box 2099, Pittsburgh 30, Pa. A new line of resistance welding controls feature printed circuits and a weld-safe circuit for the protection of equipment and work in process. Circuit components and tubes have been reduced to the minimum number necessary for proper functioning. This reduces panel weight by 30 percent. Heavy-duty, long-life components are used for maximum operating life. Capacitors, for example, are rated at 600 v even though circuit voltages are normally 115 v. The ignitron tubes are protected from excessive operating heat by a thermostatic switch snap mounted on the outer water jacket which locks out welding current at a preset tempera-

ture. The inside sheet of the water jacket is constructed so that thermal contact with the thermostat is maintained.



DIODE CLIP
is spring loaded

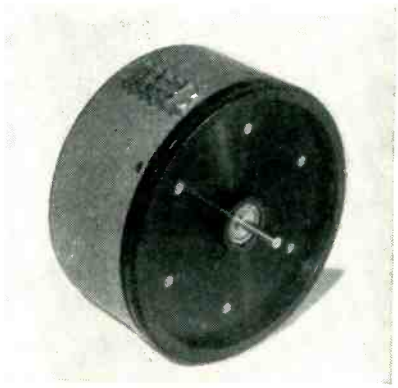
CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge 38, Mass., announces a new spring loaded diode clip that securely holds fragile diode pig-tail leads from 0.005 in. to 0.35 in. in diameter. The clip is made of brass and is finished in 0.0002 in. bright alloy plate. When mounted it is $\frac{11}{32}$ in. in overall height. Mounting stud is $\frac{7}{32}$ in. long, hexagonal with a 2-56 threaded stud. For further specifications, information and prices write direct to the manufacturer.



COMPONENT TESTER
a direct-reading unit

INDUSTRIAL TEST EQUIPMENT CO., 55 E. 11th St., New York 3, N. Y. Model 1010 impedance comparator is particularly suited to the rapid testing of resistors, capacitors and inductors. The circuit consists of a bridge, two arms of which are precision matched resistors. The two remaining arms are the standard and the component under test. Any voltage resulting from bridge unbalance is amplified and fed to a phase discriminator. The percent-

age deviation of impedance is then read directly in both sign and magnitude on a large zero-centered meter. Three full-scale ranges are provided: ±5, ±10 and ±20 percent. Impedance limits are: resistance, 5 ohms to 5 megohms; capacitance, 50 $\mu\mu$f to 20 μf; inductance, 100 μh to 80 henry. Two operating frequencies are available: 1,000 cps and 10,000 cps. Special circuitry provides a low time constant and eliminates the necessity for operating pushbuttons.

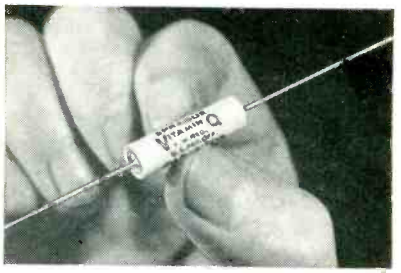


POTENTIOMETER
is a comparison standard

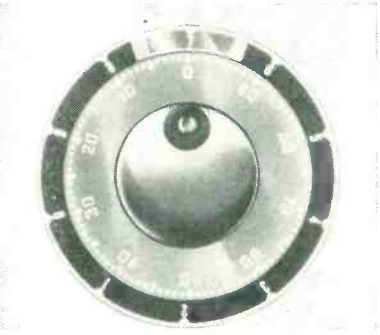
ANALOGUE CONTROLS INC., 37 W. 20th St., New York 10, N. Y. The MP-10 potentiometer is a comparison standard rotation-to-voltage transducer for basic measurement, potentiometer testing and calibration, and analog multiplication. It features linearities to 0.002 percent. The unit is not susceptible to torque overloads or burnout. A Teflon shaft seal and high leakage construction prevent internal loading. Resistance range is 5,000 to 200,000; resistance tolerance, 5-percent standard; temperature coefficient of resistance, ±20 ppm per deg C. The o-d is 10 in., facilitating extremely high resolution.

CAPACITORS
for 125 C operation

SPRAGUE ELECTRIC CO., 35 Marshall St., North Adams, Mass., has announced new hermetically sealed, Vitamin Q impregnated ceramic case capacitors for operation at temperatures up to 125 C. Use of a ceramic shell instead of a metal one on the new Pacer capacitors



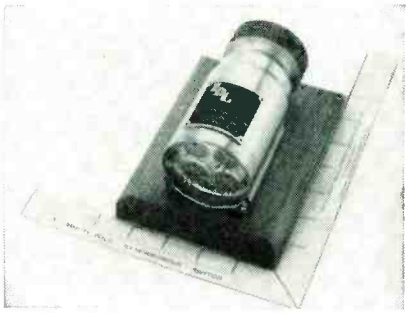
keeps capacitance between the capacitor section and ground at an absolute minimum. The hermetically sealed ceramic shell, with glass-to-metal solder seals, provides excellent resistance to the effects of humidity and temperature, and extreme stability under all operating conditions. Impregnation with Vitamin Q, the company's inert synthetic impregnant, means top performance at high temperatures—with no voltage derating necessary for continuous operation at temperatures up to 125 C. Complete performance characteristics, ratings and sizes are in engineering bulletin 226.



TURNS-COUNTING DIAL
increases readability

HELIPOT CORP., 916 Meridian Ave., South Pasadena, Calif. The 900 series Duodial turns-counting dial permits greater sensitivity of adjustment and increases readability. The diameter and overall dimensions remain the same as the superseded W series. In the new series the index has been changed from a solid bar to a triangle which zeroes in on the outer-dial number. The lines formerly between numbers have been replaced by a triangular index located over each numeral. It is available in 4 models, identical except for calibration of the outer dial, and is designed for use with all Helipot multiturn precision potentiometers, and other

devices having a ¼-in. diameter shaft. The Duodial consists of two coaxial dials—the inner counting hundredths of each turn; and the outer, the number of completed turns.

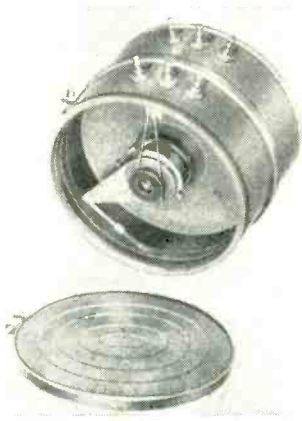


ROTARY SWITCH
is high-speed device

INSTRUMENT DEVELOPMENT LABORATORIES, INC., 163 Highland Ave., Needham Heights 94, Mass., has available a high-speed rotary synchronous multiple-pole switch commutator for missile and aircraft applications such as telemetering, switching radar data presentation and commutating thermocouple signals. A 12,000-rpm, 115-v, 400-cycle, single-phase motor drives the brush assembly at 10 rps with only 7 w of power. Three sets of carbon-type brushes bear on precious metal segments to provide BBM operation without riding on filler material yielding low noise and long life. The case is hermetically sealed and provided with radiating fins for motor cooling. The switch can carry 0.1 mv to 100 v from 3 μa to 50 ma current. Life is in excess of 500 hr, meeting MIL-STD-202 specification requirements. Size is 2½ in. in diameter × 5¾ in. long. Weight is 2½ lb.

GANGING POTS
are completely enclosed

DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City 1, N. Y. A new series of fully enclosed ganging potentiometers are economically priced for electronic applications that do not require the extended refinement of more expensive high precision types. The 3-in. independent phasing potentiometers have a power rating of 8 w. They feature precise 360-deg external phasing,



adjustable or fixed taps and linear or nonlinear resistance elements. Contacts are made from precious metals. Specifications and diagrams are given in technical bulletin 360-455.

REFERENCE DIODES
available in 2 new types

NATIONAL FABRICATED PRODUCTS, INC., 2650 W. Belden Ave., Chicago 47, Ill. Two new Siliconductors known as the Zener reference diodes, types 1N429 and 1N430, have been introduced. These silicon junction diodes are designed for use in reference voltage sources wherever the absolute value of an electrically sensed variable is important such as the control and indication of gas turbine temperature; for fire control and aircraft autopilot systems; for guided missile and computer applications, and for other applications in a variety of equipments. Voltage reference units employing the diodes have been temperature cycled for more than 1,000 hours and show a stability of better than 1 percent.

Literature

Parabolic Antennas. Prodelin Inc., 307 Bergen Ave., Kearny, N. J. A new 2-color 14-page bulletin describes parabolic antennas used for radio and tv microwave relay. Antennas described are of the mesh-reflector, dipole-feed type in

4, 6 and 10-ft sizes. Catalog data, complete with applications, photos and ordering information, are contained in bulletin 428. Bulletins 428-1, 2 and 3 include radiation patterns for the 4, 6 and 10-ft sizes respectively.

Switch Catalog. Unimax Division of the W. L. Maxson Corp., 460 W. 34th St., New York 1, N. Y. A new 24-page catalog describes numerous types of Unimax switches: high-sensitivity, metal-cased, immersion-proof, general-purpose, AN-type, JAN-type, direct-current and subminiature switches. A complete pictorial index aids in quickly selecting the right switch for any application. This new catalog presents each switch type with photographs and detail drawings, shows the many types of actuators available, gives base and terminal data, physical dimensions, operating characteristics and electrical ratings.

Universal Magnetic Testing Set. Sensitive Research Instrument Corp., 9-11 Elm Ave., Mt. Vernon, N. Y. Volume 22 No. 1 of *Electrical Measurements* covers the universal magnetic testing set which contains six 4-in. scale length multirange indicating instruments, a separate Epstein frame, and the necessary internal switches to set up core loss and hysteresis measurements. Included are a description of each of the instruments, mechanical details of the testing set and prices.

Subminiature Relay. Luther Mfg. Co., 7312 Varna Ave., North Hollywood, Calif. has available a brochure dealing with the model M-1000 hermetically sealed subminiature relay. Basically the design of the relay described consists of the incorporation of a permanent magnet in an electromagnetic circuit of high efficiency and performance. With this arrangement it is possible to achieve the high armature torques necessary to overcome high contact pressures and actuate large contacts in a subminiature configuration.

TV Wobbulator. Campagnie Generale De Metrologie, Annecy, France. Type 210 wobbulator, in-

tended for design adjustment and checking of wide-band amplifiers such as are used in tv and f-m, is illustrated and described in a single-sheet brochure. Information on accessories and technical characteristics of the instrument are included.

Potentiometer. DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. Two pages in color give features and specifications on the new 1⅝ in. precision ganging potentiometer designed for applications requiring high accuracy in limited space. Write for technical bulletin C150-455.

Electronic Measuring Instrument. Fielden Instrument Division, Robertshaw-Fulton Controls Co., 2920 N. Fourth St., Philadelphia 33, Pa. The proximity meter, a precision electronic instrument that measures without touching the specimen, is described in a new 28-page booklet. The instrument discussed can detect a change in temperature of 0.001 deg C, or variations as minute as one millionth of an inch. A variety of applications are described.

Adjustable Range Recorder. Leeds & Northrup Co. 4934 Stenton Ave., Philadelphia 44, Pa. A two-page data sheet E-ND46(4) describing the Speedomax adjustable zero, adjustable range recorder is available. Complete specifications of stocked and special purpose recorders are given together with a description of the instrument and the operation of the range and zero dials. Optional features including reversible chart drive, pen lifters, optional range dial calibration and multiple point recording are cited and complete ordering instructions are given.

Fasteners. Shakeproof, Division of Illinois Tool Works, St. Charles Road, Elgin, Ill. Volume 4, No. 1 of *Fastening Forum* deals with Keps preassembled nut and lockwashers that feature free-spinning, spring-action and uniform quality. The bulletin illustrates and describes Mastic-Seal Keps for protection against moisture and dust. Included are tabular

data on machine screw and hexagon nut series Keps. Also discussed are special products such as a sealing lock washer, a Plasti-Rokut and a new anvil-type molding clip.

Precision Measuring System. Hewlett-Packard Co., 275 Page Mill Road, Palo Alto, Calif. Volume 6, No. 12 of the *Journal* deals with a simple precision system for measuring c-w and pulsed frequencies up to 12,400 mc. The 6-page bulletin includes illustrations and specifications of the model 540A transfer oscillator.

Tape Recording Equipment. A-V Mfg. Corp., 730 Fifth Ave., New York 19, N. Y. A new 16-page brochure fully describes and illustrates 9 basic building-block components and a series of accessories functionally designed to make up A-V magnetic tape recording systems of from 2 to 14 channels for instrumentation data. Block diagrams show methods of planning desired systems by interconnecting the various A-V plug-in units and components. The equipment, designated type 7, is for direct recording in the range of 300 to 100,000 cps. Request bulletin 103.

D-C Power Supply. Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif. Bulletin MR2432-100X describes the extremely compact 28-v 100-ampere regulated and filtered power supply now available. The bulletin lists the unit's specifications and also contains operating curves showing the response time, load and line regulation characteristics. The bulletin also shows a circuit block diagram and the theory of operation of this tubeless magnetic amplifier regulated d-c power supply.

Germanium Power Rectifiers. International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif. Bulletin GPR-1 lists ratings and specifications on germanium power rectifiers. It describes two styles: Style C—natural convection cooled, and Style F—fan cooled. Also included in this bulletin are the complete operating instructions and the typical dynamic characteristic curves for these two styles. A

typical example of the small compact unit assembly is the type 53-0383, which occupies an approximate volume of 4 in. by 10¾ in. by 10½ in. and is rated at 42 v d-c, 1,500 amperes, connected in a dual three-phase, half-wave circuit with interphase transformer.

Two-circuit Limit Switch. Micro Switch, a division of Minneapolis-Honeywell Regulator Co., Freeport, Ill. Preliminary data sheet 104 illustrates and describes the 1LS1 small two-circuit limit switch designed for all types of industrial applications where space limitation is a prime factor in switch selection. Dimensional drawings, characteristics, contact arrangement and price are included.

Dosimeter Reader. Specialty Engineering & Electronics Co., 79 Clifton Place, Brooklyn 38, N. Y. A single page bulletin illustrates and describes the model 95A phosphate glass dosimeter reader. The instrument discussed incorporates the necessary ultraviolet lamp, multiplier phototube, v-t amplifier, indicating meter, optical filters and reference standard. Specifications are given.

Switches and Governors. Synchro-Start Products, Inc., 8151 North Ridgeway Ave., Skokie, Ill., has issued an 8-page bulletin with full information on their line of speed sensitive switches and overspeed governors. It includes dimensional drawings of the overspeed, underspeed, one, two and three switch governors with explanations of the various types of take off and connectors. Ask for bulletin 504S.

Cable Connectors. Communication Products Co., Inc., Marlboro, N. J. Catalog No. 255A is a 36-page, well-illustrated booklet dealing with Magicseal and flare-type connectors for Styroflex cable. The connectors described are positive seal, pressure tight, weatherproof, and require minimum tooling. Included is a technical data table on Styroflex and Spirafil coaxial cable.

T-W Amplifier. Raytheon Mfg. Co., Waltham 54, Mass. A 4-page technical information bulletin illus-

trates and describes the type QK-523 traveling-wave tube power amplifier designed for use with an electromagnetic solenoid in c-w operation over the 6,400 to 7,200 mc range with an average gain of 15 db and a maximum power output of 4 w. Characteristics are outlined tabularly and diagrammatically.

Subminiature Potentiometer. De-JUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. Two pages in color describe and illustrate the series C-078 precision potentiometers with only $\frac{7}{8}$ in. diameter and weighing only $\frac{1}{2}$ oz. The subminiature potentiometers discussed feature many of the advantages of full-size potentiometers. For complete information, write for bulletin C078-455.

Radar Transformer Bulletin. General Electric Co., 1 River Road, Schenectady 5, N. Y. Oil-filled transformers and inductors for radar and other electronic applications are described in bulletin GEA-5963. The bulletin cites the radar transformer model shop, where prototype units can be designed and built in a hurry. Design features of the regular production models are described: smaller, lighter and more efficient coils of Formex insulated wire with embedded-layer winding; improved cores of cold-rolled, grain oriented silicon steel; and alumina solder-sealed terminals.

D-C Power Supplies. Opad Electric Co., 69 Murray St., New York 7, N. Y., has issued a 2-page catalog sheet describing a line of low-cost general-purpose d-c power supplies. Twenty-two standard models are covered with unfiltered outputs ranging from 6 to 230 v d-c and 0.6 to 150 amperes. All models feature continuously adjustable outputs, 2-percent accuracy panel meters, input and output overload protection, compact, portable design. In addition to listing the electrical ratings and their corresponding model numbers, the bulletin also includes detail information on the minimum general specifications to which all

For additional information on all items on this page, use post card on last page.

units conform. Request bulletin No. 178.

Power and Gas Tubes. Radio Corp. of America, Harrison, N. J., has available a completely revised edition of the power and gas tubes booklet. The 24-page booklet, Form No. PG-101B, contains technical data on 178 vacuum power tubes including forced-air-cooled and water-cooled types ranging in output capability up to 500 kw; gas, mercury-vapor and vacuum rectifier tubes; gas and mercury-vapor thyratrons; ignitrons; magnetrons; and vacuum-gage tubes. Each tube type is covered by a text description, tabular data, and a base or envelope connection diagram. Photographs are shown for representative tube types. Copies of the booklet are available at 20 cents.

Z-Y Bridge. General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass. Volume 30 No. 2 of the *Experimenter* covers the type 1603-A Z-Y bridge, a new approach to audio-frequency impedance measurement. The bridge described can be balanced for any impedance connected to its terminals. A panel view, diagrams, applications and specifications are included.

Connectors and Cable for A-M Broadcasting. Communication Products Co., Inc., Marlboro, N. J. Bulletin 355 is a 4-page folder describing Styroflex connectors and cable for a-m broadcasting. Included are descriptions, charts and a line drawing showing a typical a-m installation.

Relay Catalog. Magnecraft Electric Co., 3350 B West Grand Ave., Chicago 51, Ill. A new relay catalog includes a range of short and long form telephone type relays for a-c and d-c, subminiature d-c relays, improved versatile latch-in relays, relays with bifurcated (twin) contacts, miniature relays with heavy current contacts, relays with time delay, plug-in relays, relays with snap-action contacts, and 400-cycle relays of exceptional reliability. The catalog also illustrates and gives dimensions of many popular her-

metically sealed and dust proof enclosures.

Ministrip Resistor. Ward Leonard Electric Co., Mt. Vernon, N. Y. Catalog No. 15, supplement A, illustrates and describes the 20-w Stripohm type Ministrip resistor. Included is information on chief features, application, construction, watt ratings and dimensions.

Indicating Pyrometers. Barber-Colman Co., Rockford, Ill. Bulletin F6048-1 describes Wheelco indicating pyrometers. The instruments described are available in two styles in ranges up to 3,600 F. Instrument scales of the units described are mirrored to avoid parallax errors. The baked and processed coil is supported by two pivots, resting in two sapphire jewels. A combination indicating pyrometer and multiposition switch is also described in the new bulletin.

Ultrasonic Gage. Branson Instruments, Inc., 430 Fairfield Ave., Stamford, Conn. A new 4-page folder on the Vidigage ultrasonic resonance thickness gage describes operating principles, typical applications and features. The unit discussed measures a wide range of thicknesses, detects laminar discontinuities and internal defects, and is easily operated by nontechnical personnel. The folder is well illustrated and specifications are included.

Ruggedized Panel Instrument. De-JUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. Two pages in color describe and illustrate the new 1½-in. series of ruggedized panel instruments (model 131) designed for size and weight reduction in electronic equipment subject to shock, vibration or temperature extremes. Features include watertight seal, D'Arsonval movement, and high flux density magnets. Write for bulletin R131-455.

Test Set Data. Baird Associates, Inc., 33 University Road, Cambridge, Mass. Data sheets on two new types of test sets are available. Bulletin TP-103 outlines the

characteristics of the company's semiconductor minority carrier lifetime test set. A block diagram describes operation in detail. Data are included on the following components: shutter pulser, pulsed light source, bias supply and other units. Bulletin TP-104 discusses the company's semiconductor resistivity test set, designed especially for measurement of the resistivity of semiconductors in the range of 0.1 to 100 ohm-centimeters. Method of operation is explained, with a block diagram of a typical installation.

Coaxial Cable. Communication Products Co., Inc., Marlboro, N. J. Bulletin CT covers Spirafil semi-flexible coaxial cable for broadcast, communications, microwave and community antenna. The cable discussed consists of a solid copper center conductor, a solid polyethylene filament helix and a tubular outer aluminum conductor. Included in the bulletin are a description, a cutaway section of the cable, attenuation vs frequency charts and a table of nominal characteristics.

Cable Joints. Anaconda Wire & Cable Co., 25 Broadway, New York 4, N. Y. Complete, step-by-step pictorial directions for making all types of cable joints in the company's neoprene-jacketed Durasheath cables are contained in a pocket-size booklet. Prepared for use by both engineers and cable splicers, the booklet tells its story in nine clear photographs supplemented by simple 1-2-3 written instructions. Complicated drawings and tables are eliminated.

Power Supply. The Geri Specialty Co., P. O. Box 103 Upland, Calif. An illustrated data sheet covers the model 140 precision voltage-regulated electronic 400-cycle power supply and frequency standard. Applications, specifications and typical performance curves are given.

Tone Signaling Units. Hammarlund Mfg. Co., Inc., 460 W. 34th St., New York 1, N. Y., has available a 6-page brochure describing in detail the operating features

and performance of the company's supervisory tone equipment of modular design. The brochure describes how these audio tone signaling units transmit and receive signaling, dialing, telemetering, supervisory controls and other information, over wire lines, telephone or power line carrier, and radio microwave communication circuit.

Vulcanized Fibre & Laminated Plastics. Taylor Fibre Co., Norristown, Pa., has available a sheet embodying the most up-to-date information on standard NEMA grades of vulcanized fibre and laminated plastics and their corresponding government grade designations.

Signal Generator. Hewlett-Packard Co., 275 Page Mill Road, Palo Alto, Calif. Volume 6, No. 10 of the *Journal* covers the 15 to 21-kmc 10-mw signal generator. Illustrations, specifications and charts are included.

Instrumentation for Laboratory and Industry. Berkeley division of Beckman Instruments Inc., 2200 Wright Ave., Richmond 3, Calif. Short form catalog C-701 is now available. It describes a line of frequency meters and extenders, universal counters and timers, digital recorders and data converters, preset counters, and controllers, and electronic analog simulating equipment. The company's systems engineering facilities and nuclear instrumentation are noted.

Electron Microscopes. North American Philips Co., Inc., 750 South Fulton Ave., Mt. Vernon, N. Y., has available an 8-page booklet titled "Questions and Answers on Electron Microscopes." The booklet explains such things as shadow casting, use of the same instrument for electron diffraction, resolution, visual and camera work, specimen preparation, negative and positive replicas, as well as electron and lens theory.

Ganging Potentiometers. DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. A 2-page

 For additional information on all items on this page, use post card on last page.

illustrated color bulletin describes features and specifications of the new 3-in. fully-enclosed ganging potentiometer for applications requiring high precision at relatively low cost. Write for technical bulletin 360-455.

Electronic Digital Computer. Logistics Research, Inc., 141 S. Pacific Ave., Redondo Beach, Calif. The ALWAC III, a high-speed, low-cost fully-automatic electronic digital computer is described in detail in a 4-page, 2-color illustrated brochure. The instrument described reduces design time, eliminates the need for expensive pilot plant operation, and provides answers to routine calculations with speed and accuracy. The brochure contains a table of specifications.

Miniature Sensitive Relay. Magnadyne Co., 84 So. Water St., Port Chester, N. Y. A 1-page catalog sheet gives technical data, specifications and dimensional drawings of a dpdt miniature sensitive (40 mv) hermetically sealed relay. The model No. 10 described is built to comply with MIL-R-5757-B specifications.

Para-Flux Reproducers. Radio Music Corp., 84 So. Water St., Port Chester, N. Y. A 4-page catalog shows a new microgroove head, made to plug in a standard Para-Flux tone arm, which automatically provides correct record pressure for l-p records. No changes in arm are necessary for any of the 4 reproduction heads—universal, vertical, lateral, or microgroove; just plug into tone arm. The new head described is presently being used by many radio and tv stations where top quality reproduction is necessary.

Insulating and Jacketing Materials. Bakelite Co., A Division of Union Carbide & Carbon Corp., 30 E. 42 St., New York 17, N. Y. Issue No. 83 of Kabelitems reprints a paper delivered on quality control of vinyl and Polyethylene electrical insulating and jacketing materials. Raw materials and properties desired in ultimate application of the material are listed.

ABC...and the Reader

BACK IN 1914—forty-one years ago—a group of advertisers, advertising agencies and publishers joined in a project that has come to mean a great deal to the millions who, like you, read business magazines. The project, initiated at a time when circulation claims were rarely verified, was intended to achieve and maintain higher standards of integrity in publishing and advertising practice by providing means to audit paid circulation. Out of that effort came an organization known as the Audit Bureau of Circulations, a voluntary, non-profit, cooperative association, known for short as ABC. Its symbol appears at the head of this page.

We are proud that McGraw-Hill publications were among the founders and charter members of the Audit Bureau of Circulations.

Today the Bureau numbers 3,670 members. These include advertisers, agencies, and publishers of newspapers, farm papers, general magazines and business journals such as this one. These publisher members hold their memberships and their right to display the ABC symbol in their publications only so long as they live up to the circulation standards that are established through the Bureau.

It is one thing to set up high standards; it is another to see that those standards are maintained. This latter and all-important function is performed by a staff of auditors maintained by ABC to check periodically on the circulation practices of the publisher members. When a business magazine, such as this one, joins the Bureau it agrees that the ABC auditors shall have "the right of access to all books and records." Their inspection may dig into the files of original subscription orders, payments from subscribers, paper purchases, postal receipts, arrears of payments, editorial expenses and many other significant items. Sometimes the auditors go behind the records and seek verification of purchase and payment from subscribers themselves.

The information thus obtained and certified by the Bureau then becomes available to the public and constitutes an authoritative report on the publication's circulation practices.

The advertisers and agencies benefit directly from the ABC because it provides a generally recognized factual yardstick by which the circulations of member publications can be measured and appraised. Every paragraph in an ABC report on a business publication gives the advertisers data that help them make intelligent use of the publication as an advertising medium.

But the ABC renders a service of vital concern to the *reader* as well. The Bureau audits paid circulation only, and it is through this payment, whether by subscription or newsstand purchase, that the reader keeps the editorial policy of a publication responsive to his needs. His decision to buy or not to buy records his judgment on each publication, and the ABC-audited and certified circulation reports make the sum of these judgments known to all concerned.

So the editors of ABC publications must constantly keep their editorial services up to the mark if they are to survive a competition in which the reader's right to buy or not to buy is paramount. Each paid magazine or newspaper will prosper or fail as it wins or loses the voluntary patronage of thousands or millions of readers. And—the ABC is scorekeeper in this vital contest.

Thus the publisher who submits his publication to the supervision and discipline of ABC affirms in the strongest possible manner his recognition that his primary obligation is to his readers and that he owes the standing of his publication to a voluntary demand by those readers.

All this is what makes the ABC brand on a publication so important to its readers. That respected symbol, testifying to the advertising value of the publication, serves also as a constant reminder to all concerned that the reader's willingness to pay for an ABC publication is the basic reason why it stays in business.

McGraw-Hill Publishing Company, Inc.

Plants and People

Edited by WILLIAM G. ARNOLD

Manufacturers enlarge engineering staffs and promote personnel to new positions. Plant and facility expansions continue as companies make acquisitions or begin new construction. Industry associations continue activities

U. S. Color Television Shown At German Fair

AT THE International Trade Fair held in Hannover, Germany, a demonstration of color television was presented by Telechrome of Amityville, N. Y.

The exhibition was visited by U. S. Secretary of Commerce, Sinclair Weeks. Shown at the Telechrome exhibit are, left to right: Sinclair Weeks; Lower Saxony Finance Minister, Alfred Kubel; H. Charles Riker, vice-president; J. R. Popkin-Clurman, president of Telechrome.

More than 3 tons of the firm's color tv equipment were flown to Hannover where closed-circuit color programs were shown to engineers, industrialists, scientists and other visitors attending the fair.

More than 2 million visitors came to Hannover from 80 countries.

Texas Instruments Names Owens Transistor Chief

HARRY L. OWENS has joined Texas Instruments as chief engineer of the semiconductor products division.

Previously, he was chief of the solid state devices branch at the Signal Corps Engineering Laboratories at Fort Monmouth, N. J.

Owens has been associated with the Army Signal Corps for 13 years, four years on active duty and nine years in civil service, and is currently a major in the Signal Corps reserve. In his most recent position, he supervised the research, development, and standardization of semiconductor devices—including transistors, diodes, and microwave crystals—for military application. He was responsible for technical surveillance of industrial preparedness contracts in the semiconductor field.

At Texas Instruments, he will be responsible for the development and engineering of germanium and silicon semiconductor products.

Owens is co-author of the McGraw-Hill book, Transistors, Theory and Applications.

Olympic Radio, Victoreen Instrument Drop Merger Plans

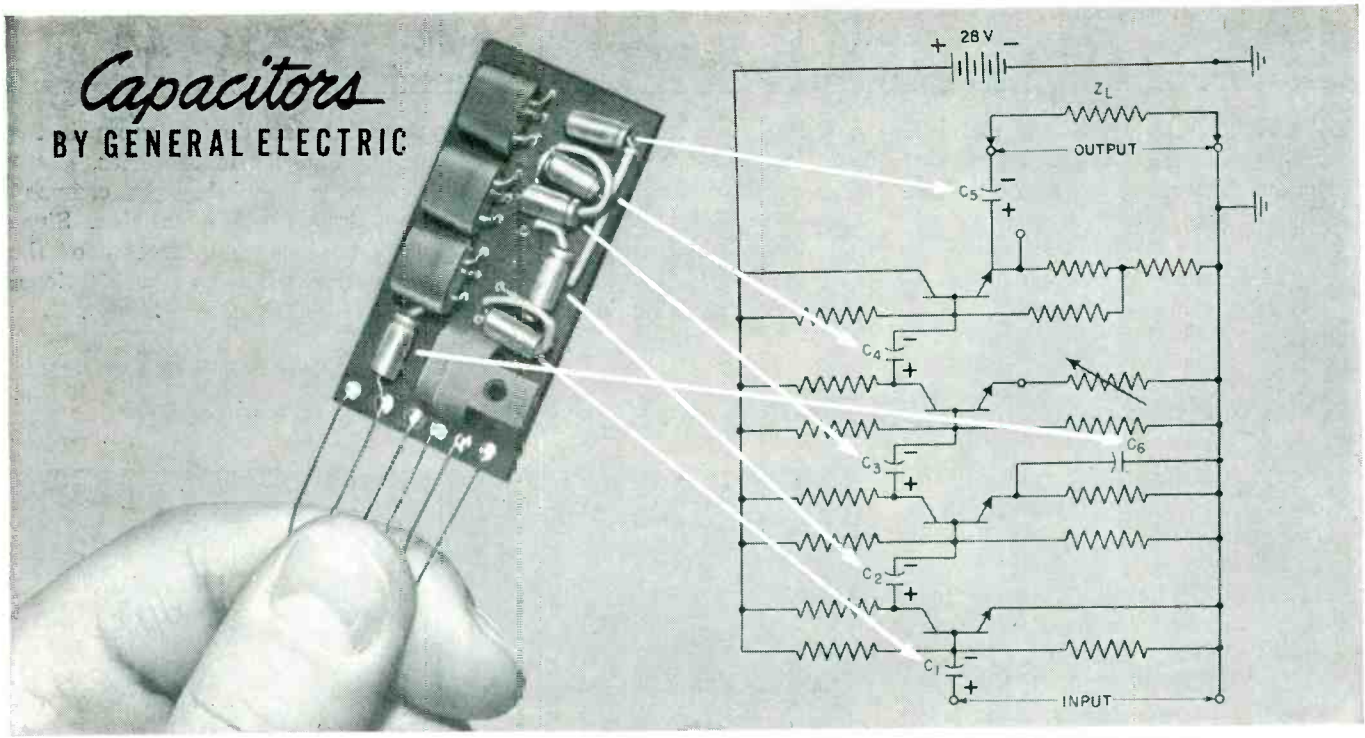
PLANS for the merger of Olympic Radio & Television and Victoreen Instrument Co. into Nuclear Electronics Corp. at this time have been terminated pending further study by the companies involved.

Victoreen announced that Earl M. Pollock has been named chief engineer of the instruments division.

He was associated with E. I. DuPont's Deepwater, N. J. laboratory for several years.

He joins Victoreen after six years with El-Tronics of Philadelphia where he was first a research physicist, then vice-president in charge of sales and later technical director.

In his new post Pollock will assume responsibility for carrying through a part of Victoreen's expansion in the medical, government and prospecting fields.



New RC coupled, silicone transistor servo amplifier was developed for aircraft and guided missile applications. Small size of six G-E Micro-miniature Tantalytic* capacitors permitted size reduction to .68 cubic inches.

COMPACT SIZE, DEPENDABILITY, CREATE . . .

New use for tiny G-E Tantalytic capacitors in subminiature plug-in servo amplifier

Six G-E Micro-miniature capacitors rated at 8 microfarads and at 4 volts are used by the engineers at Plastics and Electronics Corp., Buffalo, N. Y., in their new RC servo amplifier. The $\frac{1}{8}$ by $\frac{5}{16}$ inch dimensions of the tiny capacitors enable the amplifier to be assembled and encapsulated in plastic in a 1 by 2 by $\frac{1}{3}$ inch space.

Five of the capacitors (C1 to C5 above) are used for coupling while the sixth (C6) is for bypassing.

Because the amplifier was designed for critical aircraft and missile applications, capacitors were needed which combined small size, high ratings, and reliability.

"We chose G-E Tantalytic capacitors because they were the smallest, most dependable units with the high capacitance required for low impedance transistor devices," said Plastics and Electronics' chief engineer, Thomas L. Robinson.

If you have a design problem calling for an extremely small, high microfarad capacitor (particularly for transistorized circuits) fill out the coupon below. We will send you complete specification data and descriptive information on G-E Micro-miniature Tantalytic capacitors. For specific application information, contact your nearest G-E Apparatus Sales Office.

*Registered trade-mark of General Electric Co.

Progress Is Our Most Important Product

GENERAL ELECTRIC

General Electric Co.
Section F442-26
Schenectady 5, N. Y.

Please send me Micro-miniature Tantalytic Bulletins GEA-6065 and GET-2405.

Name ..... Title .....

Company .....

Address .....

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

Want more information? Use post card on last page.

Motorola Appoints Managers Of Arizona Transistor Factory

AT MOTOROLA'S transistor plant in Phoenix, Ariz., John T. Hickey was named general manager, Virgil E. Bottom was named director of research and development and Edmund G. Shower was named product production manager.

Hickey, with Motorola since 1948, has been functioning in Phoenix as staff assistant to D. E. Noble in charge of the transistor operation since its inception.

Bottom, since 1953, has been development physicist in charge of the solid-state devices group in the firm's Phoenix laboratories.

Shower is joining the company to assume his new position. Since 1952 he has been director of the transistor division at National Union Electrical in Hatboro.

Navy Electronics Heads Visit New Kay Lab Plant

VISITORS at Kay Lab's new plant in San Diego, Calif. included heads from the U. S. Navy Electronics Laboratory in San Diego. With Richard T. Silberman, second from left, president and general manager of Kay Lab are, left to right, Comdr. William B. Bernard, N.E.L.'s senior program aide; Capt. Henry E. Bernstein, commanding officer and director; Dr. F. N. D. Kurie, technical director in charge of the scientific department, and G. T. Lorance, deputy technical director.

International Resistance Acquires Iowa Branch

INTERNATIONAL Resistance Co. has acquired a new branch plant in Burlington, Iowa.

Transfer of operations and actual production is expected on or about December 1, 1955.

The plant has 56,000 sq ft of floor space situated on a six and one-half acre site. Initially, only a portion of the available manufacturing space will be utilized, and the company will employ about 75 people during the first six months. Ultimately, employment is expected to increase to 500—approximately 80 percent women. Other than key personnel who are being transferred from the Philadelphia plant, these employees will be sought in the Burlington area.

This will be IRC's fifth branch plant, in addition to its seven wholly-owned subsidiary companies and five overseas licensees. All manufacture resistors and related electronic components.

CBS Expands, Selects Semiconductor Operations Manager

APPROXIMATELY one-fourth of CBS-Columbia's manufacturing facility in Long Island City, New York, has been converted to government and industrial operations.

Conversion of this space to government and industrial operations was completed in August.

The additional space will permit the firm to increase its government and industrial electronics design, development and manufacturing operations.

Robert K. Hartman has been appointed director of industrial and defense contracts of CBS. He will be in charge of the administration of research, developmental and production contracts for CBS-Columbia, CBS-Hytron and CBS Laboratories.

Prior to this appointment, Hartman was vice-president in charge of industrial and military manufacture of CBS-Columbia.

At CBS-Hytron, B. H. Alexander has been appointed as manager of semiconductor operations. Dr. Alexander will be responsible for all semiconductor development, engineering and manufacturing. His office will be located at the Lowell, Mass. plant where the firm's transistors and crystal diodes are manufactured.

The appointment of Leo E.

Benjamin H. Alexander

Dwork as chief engineer of the Lowell semiconductor plant was also announced.

Dr. Alexander has participated in classified work for the Atomic Energy Commission. Before coming with CBS-Hytron, he was engineering manager in charge of semiconductors at Sylvania Electric.

At Carnegie Institute of Technology he was awarded a metals research laboratory fellowship and later became an assistant professor. He was also an adjunct professor at Brooklyn Polytechnic Institute and New York University.

Dwork, the newly appointed chief engineer, has had broad experience in semiconductor engineering. He is the author of several papers on transistors.

Albert J. Harcher has been appointed plant manager for CBS-Hytron at Kalamazoo, Mich. He replaces Leonard A. Freeman, who has resigned. Harcher will be responsible for all manufacturing and

Albert J. Harcher

engineering activities at the Kalamazoo works.

Harcher has been active in cathode-ray tube engineering for over 20 years. In 1941, at CBS Laboratories, he assisted Peter Goldmark in early research on field-sequential color television.

He joined CBS-Hytron in 1948 as chief engineer of the Newburyport tv picture-tube plant. In 1953 he was promoted to plant manager of this activity, responsible for both color and black and white tube manufacturing.

Previous to his employment at CBS-Hytron, he served as chief engineer for the Lansdale Tube Co. His earlier experience also included employment at Westinghouse research laboratories and at RCA.

Bendix Constructs Research Lab

A MILLION-DOLLAR laboratory will be constructed in the Detroit area by the Bendix Aviation Corp. for its research laboratories division.

The new building, on which construction has begun, will provide 85,000 sq ft of floor space. It is expected the building, to be located on a 46-acre site, will be ready for occupancy next August.

The research laboratories division is engaged in work in guided missiles, nuclear technology, machine-tool control, industrial instruments, computers and applied physics.

The division was formed in 1942 as a central research laboratory to serve all divisions of the corporation, and to maintain basic research in industrial science.

Sylvania Selects Microwave Lab. Head

GERALD C. RICH of Los Altos, Calif. has been appointed manager of the microwave tube laboratory of Sylvania Electric Products at Mountain View, Calif.

Rich, manager of technical liaison at the electronic defense laboratory, a sister installation of MTL at Mountain View, succeeds

Gerald C. Rich

Richard B. Leng who resigned.

He joined the tube engineering section of Sylvania in 1935, and was transferred five years later to Kew Gardens, N. Y. as a technical group leader.

After spending four years in Phoenix as a research project leader with a firm there, he joined Sylvania's electronic defense laboratory as head of the microwave section. Subsequently he was moved up to head the technical liaison section.

Datamatic Names Two, Buys New Factory

JOSEPH J. EACHUS has been appointed as systems director and J. Ernest Smith as director of engineering for Datamatic Corp.

Datamatic is engaged in the development and production of large, high-speed data processing equipment for business and government use. The company is owned jointly by Minneapolis-Honeywell Regulator Co. and Raytheon Manufacturing Co.

The newly formed firm has purchased a new one-and-a-half-story factory building in Newton Highlands, a suburb of Boston, Mass.

Dr. Eachus, a former member of the faculty at Purdue University, has been engaged in research and development work for the Department of Defense. Smith was formerly assistant vice-president and director of engineering for Raytheon. He holds numerous patents relating to modulating systems, radio-relay control systems

and other communication systems. He will be responsible for Datamatic's research, design and development engineering.

At present the company is carrying on its operations in leased facilities in Waltham. It expects to complete transfer of operations to the new 40,000 sq ft location by October 1.

General Electric Promotes Engineers

GE has reorganized the manufacturing section of its radio and television department.

Franklin Greene, Jr., formerly manager of the department's Bleeker Street radio plant at Utica, N. Y., is appointed manager of television manufacturing.

William N. Maddox, formerly manager of the department's Auburn, N. Y. plant, is appointed manager of radio manufacturing.

The Auburn plant, formerly used by the department for making high fidelity components and television sub-assemblies, has been taken over by the company's electronic components department, and the radio and television department activities carried on there have been moved to the Syracuse plant.

In GE's cathode ray tube subdepartment Channing Dichter has been named as manager of industrial and military product engineering.

He will be responsible for development, design and production of industrial and military cathode ray tubes.

He joined G.E. in September 1951. Since that time, he has held various positions in the cathode ray tube sub-department. He first served as a physicist in the engineering section until he was appointed supervisor of new products engineering in September 1952. In September 1953, he was named supervisor of materials and processes development, a position he held until his recent appointment.

Joseph W. Dreher was named manager of engineering administration in the cathode ray tube subdepartment.

Previous to his present position, he had been employed in employee relations since September 1946,

where he was concerned with the procurement of technical personnel.

Lloyd E. Swedlund was appointed manager of monochrome tube product engineering in the cathode ray tube sub-department. He joined G.E. in February 1954 in the cathode ray tube engineering section where he has been employed until his present appointment.

Westinghouse Air Brake Expands, Appoints Two

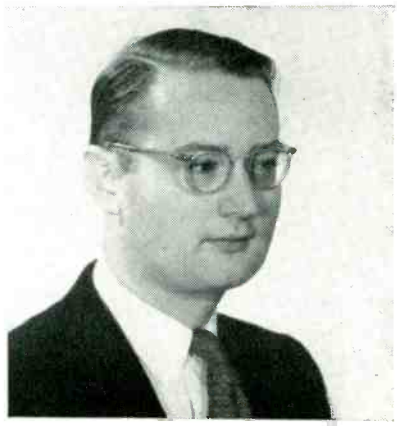
THE WESTINGHOUSE Air Brake Co. has purchased the capital stock of Corvey Engineering Co. of Alexandria, Va. Westinghouse Air Brake entered the electronics field in 1951 with its purchase of Melpar. The acquisition of Corvey further broadens Westinghouse activities in the electronics industry.

Corvey engages in electronics research and development and also provides specialized engineering services to industry and government. J. M. Cryer is president of the company. He is assisted by H. W. Riley, Colonel, USA, Ret., and by A. A. Varela.

Corvey currently employs about 150 people and its sales for the past year exceeded $1 million. The company has plants in Alexandria, Va. and Washington, D. C. The firm is in the process of acquiring additional space in Alexandria so that it can concentrate all its activities there.

Melpar announced that Robert S. Butts has been promoted to the position of assistant chief engineer.

Prior to joining the firm, he was



Robert S. Butts

associated with the Crosley Radio Corp. and Federal Telecommunication Laboratory. He joined Melpar in 1947, and has held a number of technical managerial positions within the organization since that time.

Robert E. Miller was promoted from section head to project manager of a group of sections dealing with electronic research and development resulting in complete systems for the armed services.

Prior to joining Melpar, he was associated with several defense agencies as chief of a technical division. He also served on a technical management board and as an associate member of the acoustics-in-air and electronic counter-measures panels of a research and development board.

Hycon Plans Plant Expansion

CONSTRUCTION in LaVerne, Calif. of three new buildings for Hycon Manufacturing Co. of Pasadena at a cost of approximately $1 million is expected to get under way by January, 1956, pending anticipated approval of site planning by LaVerne city officials.

The project will include a 24,000 sq ft administration building, to house the special products division and administrative personnel; and two 48,000 sq ft manufacturing units, to contain the military electronics, electronic test equipment, and photographic products divisions.

The buildings are expected to be completed around June 1, 1956.

Plans for future development of the 67-acre site call for construction of 4 more manufacturing plants in the next five years.

Du Mont Schedules Corporate Change

REVISION of its capital and corporate structure is planned by Allen B. Du Mont Laboratories.

The plans, to be submitted to stockholders for approval in October, cover the following:

Creation of the Du Mont Broadcasting Corporation to own and operate television stations WABD in

New York and WTTG in Washington, and the Du Mont 67th Street Tele-Centre. Stock of the new corporation will be distributed to the parent company's common stockholders on a ratio of one share of the new corporation to 2½ shares.

Reclassification of class A common stock and class B common stock, authorized and outstanding, to one class of common stock.

Increase of the number of directors from 8 to 10.

Creation of the office of chairman of the board and election of all company officers by the board of directors.

Reservation of 90,000 shares of common stock on which purchase options may be granted to company executives.

In addition, the stockholders will be asked to approve a long-term contract with Dr. Du Mont which provides, in addition to salary, options to purchase 35,000 shares of the company's common stock. It also is understood that Dr. Du Mont shall be elected chairman following approval of plans by the stockholders.

Brown Instrument Names Gray

TRUMAN S. GRAY, associate professor of engineering electronics at MIT, has been named consultant on nuclear energy by the Brown Instruments division of Minneapolis-Honeywell Regulator Co. In 1949 he supervised the installation

of the instrumentation for the control of the Brookhaven National Laboratory reactor.

Previously he was employed as consultant to the Army Quartermaster Corps and a number of industrial firms.

General Dynamics Expands in the West

A BROAD expansion of the West Coast activities is planned by the Stromberg-Carlson Division of General Dynamics Corp.

In San Diego, Stromberg-Carlson will take over from the Convair division the production of the Charactron tube.

In Los Angeles, Stromberg-Carlson has acquired the former Electronic Control Systems, which specializes in automation, electronic computers and data handling systems. Stromberg-Carlson previously was a part owner.

Production of the Charactron tube will continue at the present plant in San Diego, but under Stromberg-Carlson management.

The division's Charactron staff will be augmented and other electronic work will be undertaken. Cathode ray tube and electronic personnel will be added.

Convair has had patent rights to the Charactron tube since 1950. The tube converts data in electrical form into legible message symbols at speeds of 10,000 characters per second.

Leonard Mautner, assistant vice-president of Stromberg-Carlson, will be in charge of Stromberg-Carlson-West Coast, and resident manager of the firm's San Diego facilities. Alexand F. Brewer, also an assistant vice-president of Stromberg-Carlson, will be resident manager of Electronic Control Laboratories at Los Angeles. Both Brewer and Mautner have been associated with Electronic Control Systems since its inception two years ago as a West Coast affiliate of Stromberg-Carlson.

Howard L. Foote has been appointed staff assistant to A. H. Bergeson, vice-president in charge of engineering at Stromberg-Carlson.

In his new capacity, he will act as executive secretary of the new

research and development technical committee. In addition, he will be responsible for project analysis and various technical matters of the office.

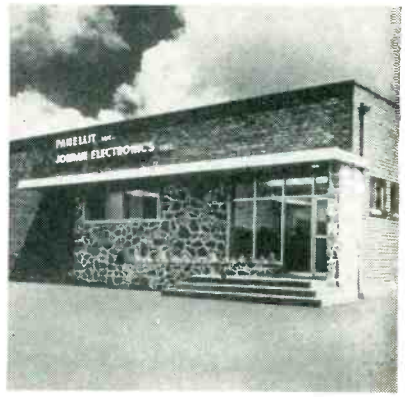
He has been a member of the Stromberg-Carlson research laboratory doing work on a miniaturized, hermetically sealed range receiver for the U.S. Navy, and an airborne wire recorder for the Air Force. He also spent three years as technical publications editor. Recently he has worked with the wire communications group in the development of toll ticketing equipment, with emphasis on toll charge computers.

Charles D. Perrine, Jr. will rejoin Convair division of General Dynamics Corp. as assistant division manager-engineering at its guided missile plant in Pomona, Calif.

He first was employed by Convair in October, 1950, as staff assistant in the San Diego division's electronics and guidance section. Named assistant chief engineer for electronics and missiles June 1, 1951, Perrine was made assistant division manager-engineering at Pomona in September, 1952. He resigned 11 months ago to accept a position as director of engineering for the Bendix pacific division at North Hollywood.

From 1945 until 1950 Perrine was manager of the electronics department of Fairchild Engine and Airplane Corporation's guided missiles division at Farmingdale, N. Y.

Jordon Electronics Moves To New Plant



JORDAN Electronics, manufacturers of radiation monitoring instruments completed a new building to

house the company's administrative offices and manufacturing facilities. It is located in Alhambra, Calif. and contains about 12,000 sq ft, more than double the size of former facilities in Pasadena. The site allows for eventual expansion to about 40,000 sq ft.

Jordan is a wholly-owned subsidiary of Panellit, of Skokie, Ill., manufacturers of control centers, data handling and information systems for industrial processing.

Gross Named Raytheon Engineering Head

FRITZ A. GROSS has been appointed manager of Raytheon's equipment engineering division. He was formerly chief engineer of the division.

He assumes the responsibilities formerly held by J. Ernest Smith, who will continue in his present capacity as vice-president and director of engineering for Datamatic Corp., which was recently formed under joint ownership of Raytheon and the Minneapolis-Honeywell.

Gross joined Raytheon in 1933 to work on special vacuum tube development. Later, he was transferred to the firm's equipment operations on design and development. His new assignment places him at the head of the firms largest single group of engineers.

Raytheon also announced plans to expand its equipment engineering force in the Chicago area.

The firm already has tripled the space available to the engineering personnel at the Chicago division.

The division will concentrate all its efforts on applied research and engineering development programs in the general fields of electronic and infrared equipment. H. N. Beveridge is manager of the division.

Lewyt Buys Ford Instrument Plant

LEWYT CORP. has purchased a six-story manufacturing plant in Long Island City, N. Y.

Formerly occupied by Ford Instrument Co., a division of Sperry-

Rand Corp., the building was purchased in a $2 million cash transaction.

In addition to the building, which has 315,000 sq ft of manufacturing and office space, an adjacent parking lot of 11,000 sq ft was also purchased. The building, it was said, has expansion facilities for about 25 percent of its present space. The firm plans to consolidate its electronics plant, air conditioning plant and vacuum cleaner plant in the new location.

Mossman to Head Industrial Electronics

JOHN E. MOSSMAN has been elected president of The Industrial Electronics Co., of Hanover, Mass. Industrial Electronics purchased Monitor Controller Co., manufacturers of motor controls, and will operate that company as a division. Mossman resigned as president of Phillips Control Corp. of Joliet, Ill., and as a director of Thor Corp. to accept the new assignment.

He started in the field in 1929 with Automatic Electric Co. of Chicago. In 1937 he helped form and was vice-president of C. P. Clare and Co. of Chicago leaving that post in 1945 to start Phillips Control Corp.

New Firm Formed In Princeton, N. J.

HAMNER Electronics Co. has been formed in Princeton, N. J. The corporation represents an association of Princeton physicists, chem-

ists, engineers and physicians organized to develop, manufacture and market advanced-design instruments for research, testing, medical and industrial applications.

Emerson Labs Appoints Nine Engineers

NINE principal electronics engineers have been appointed by Emerson Research Labs division of Emerson Radio, in Washington, D. C. They are Paul B. Arnstein, formerly electronics engineer with the guided missile fuze laboratory of the Diamond Ordnance Fuze Laboratories; Richard F. Blake, formerly a senior project engineer at the Naval Research Laboratory; William S. Carley, who was senior research associate at the Naval Ordnance Laboratory; Samuel K. Fagin, who was computer group leader with the engineering and research division of ACF Industries; Harvey D. Faram, who was formerly an electronics engineer with the guided missile fuze laboratory of the Diamond Ordnance Fuze Laboratories; Morten Gale of Ryan Aircraft Corp. where he was employed as electronics engineer; Nick George, Jr., who was formerly associated as an electronics engineer with the guided missile fuze laboratory of the Diamond Ordnance Fuze Laboratories; Chester C. Kurinsky, formerly senior mechanical engineer with the Aircraft Transformer Corp. and Robert E. Morrison, who was an electronic scientist with the guided missile fuze laboratory of the Diamond Ordnance Fuze Laboratories.

RCA Selects TV Head, Readies New Warehouse

CHARLES P. BAXTER has been appointed general manager of the RCA Victor television division. He has served as assistant general manager of the division since 1949.

Henry G. Baker, who has been vice-president and general manager of the division, will serve in a staff advisory capacity on sales and merchandise policies and programs relating to consumer prod-

ucts. He will continue as vice-president and report to Mr. Seidel. He has been with RCA since 1943.

Baxter joined the firm in 1939 as an analyst and consultant on field operations. He was promoted in 1941 to operations manager of commercial research in Chicago, and in 1945 was named controller of the Home Instrument Department of RCA Victor. Four years later, he was appointed assistant general manager under Baker.

The RCA tube division announced that plans have been completed for occupation of a modern tube warehouse and office building in Los Angeles. It will provide 5,000 sq ft of office space and 50,000 sq ft for warehousing.

Standard Coil Sets Up in Canada

J. R. Johnson

STANDARD COIL Products Co. has formed a wholly-owned Canadian subsidiary, Standard Coil Products (Canada).

The new company has acquired a 30,000 sq ft plant in Toronto for the manufacture of its television tuner lines and general purpose coils. Standard Coil has been supplying the Canadian market from its plants in Chicago, Ill. and North Dighton, Mass.

Jere Cavanaugh has been appointed general manager of Standard Coil Products (Canada) Limited and Edward Swanson as assistant general manager.

The firm also announced that J. R. Johnson has been appointed

as technical assistant to the president of Standard Coil. Johnson, who has been with the company for seven years, most recently as general manager of the Los Angeles plant, will assist G. E. Swanson in coordinating engineering development, production and sales.

Westinghouse Elects Top Officers

GWILYM A. PRICE, president of the Westinghouse Electric Corp. since January, 1946, was elected chairman and president of the firm. The board chairmanship at Westinghouse has not been occupied since 1951.

Mark W. Cresap, Jr., was elected executive vice-president and deputy chief executive officer. Since April, 1951, he has been vice-president and assistant to the president of Westinghouse.

Latham E. Osborne, whose 45-year career at Westinghouse has covered all the distance between a tool clerk's job and the executive vice-presidency, was elected vice-chairman of the board.

John K. Hodnette, formerly vice-president in charge of the apparatus products divisions, was elected vice-president-general manager responsible for supervision of the operations of all of the company's product groups.

A. C. Monteith was appointed to fill the position left vacant by Hodnette's promotion, directing manufacture and distribution of basic electrical equipment for utility and industrial applications. Since 1948 he has been vice-president in charge of engineering and research. Succeeding Monteith in that post is John A. Hutcheson, director of the Westinghouse research laboratories since 1949, and a vice-president since 1950. A new director of research will be appointed later.

Westinghouse also announced that Louis Martin has been appointed general sales manager of the tube division.

Martin came to the firm from Standard Coil Products Co. where he was general sales manager during the past four years.

He has been in the television and

radio industry for the past 31 years, including 15 years with RCA. He served there in tube application engineering, technical writing, set design engineering, commercial tube sales and finally manager of equipment sales for the tube division.

Martin replaces John Curtis, who has been named a staff assistant to R. T. Orth, vice-president.

In another move, Westinghouse unveiled its privately-financed factory designed to produce parts for atomic power plants. The plant is located in Cheswick, Pa.

An instrumentation laboratory has been installed at the plant to advance the art of reactor instrumentation and control.

The Cheswick plant itself, which is part of the Westinghouse atomic power division, currently has a manufacturing area of about 87,000 sq ft. About 200 persons, including shop and office personnel, currently are employed in the operation.

Di Toro Joins Polytechnic Research

MICHAEL J. DI TORO has joined the Polytechnic Research & Development Co. in Brooklyn, N. Y. as chief electronic engineer.

He will be responsible for the planned expansion into different electronic fields. He has formerly been connected with several major electronic laboratories where he was instrumental in the development of electroacoustical transducers, telemetering, delay lines, speech compression, noise reduction, submarine detection and long-

range radio communication systems. He has presented over 30 papers and holds over 40 patents in the above fields. For a time he was associate director of the microwave research institute of the Polytechnic Institute of Brooklyn.

Dr. Di Toro is also adjunct professor at the graduate school of electrical engineering of the Polytechnic Institute of Brooklyn, where he teaches evening courses in communications.

RCA, Seeger Whirlpool Merger Planned

THE BOARD of directors of Seeger Refrigerator, RCA and Whirlpool Corp. plan a new company to be formed under the name Whirlpool-Seeger Corp. It will own and operate the businesses now carried on by Seeger and Whirlpool and the stove and air conditioning divisions of RCA. The new company will have total assets of approximately $130 million and a net worth of about $85 million.

Sears Roebuck is a stockholder in both Whirlpool and Seeger and plans to continue as such in the new company. RCA will have a stock interest in the new company but the total stock holdings of RCA and Sears will constitute less than 50 percent of the total outstanding stock. By agreement between RCA and Sears, the common stock owned by each in excess of 20 percent of the total outstanding stock will be voted by the president of Whirlpool-Seeger. It is proposed that Walter G. Seeger, chairman of the board of Seeger, will be chairman of the board of the new company, and that Elisha Gray, president of Whirlpool, will be the president and chief executive officer of the new company. The balance of the new company's management personnel will be selected principally from the merging businesses and both Sears and RCA will have minority representation on the board of directors.

RCA will enter into an agreement covering the use of the RCA trademark in combination with Whirlpool on products of the new company. Commencement of the use of this combined trademark

will be timed with the introduction of new merchandise lines during 1956.

The merger is subject to approval by the stockholders of the merging companies.

Lovins Joins Photovolt Corp.

PHOTOVOLT CORP. of New York, makers of photoelectric and electronic measuring instruments, has added Gerald H. Lovins, to its staff. He has had over 21 years' experience in the laboratory instrument field, including 15 years as research director of American Instrument Co. Lovins will devote most of his time to the development of new products.

Stanford Expands, Names Terman

A $90,000 expansion of the Stanford University electronics research laboratory is underway, financed with gifts from two electronic manufacturers.

The donors are Gilfillan Brothers of Los Angeles and Hewlett-Packard Company of Palo Alto. Construction of a new Gilfillan wing on the north end of the laboratory and extension of its Hewlett-Packard wing on the south has begun. Completion is expected before the end of the year. The laboratory's floor space will increase by nearly 8,000

sq ft, or by approximately one-fourth its present size.

The heads of both companies are alumni of Stanford.

Earlier gifts from Gilfillan have provided engineering scholarships at Stanford, and funds for a program of instruction and research in transistors.

In addition to building the laboratory's student instruction wing in 1951, Hewlett-Packard supports two engineering fellowships.

Stanford also announced that Frederick E. Terman, dean of the Stanford school of engineering, has been appointed provost of the University.

Dr. Terman, who will also continue as engineering dean, will succeed Douglas M. Whitaker, provost since 1952, who has resigned to become vice-president for administration of the Rockefeller Institute for Medical Research in New York.

Dr. Terman will be the second ranking administrative officer of the University.

The appointment caps his 30th year on the Stanford faculty. He was appointed instructor in electrical engineering in 1925. In 1937 he became full professor and head of the electrical engineering department and in 1945 dean of the school of engineering.

During World War II he headed the Radio Research Laboratory set up at Harvard University by the Office of Scientific Research and Development.

In 1941 he was elected president of the IRE and was awarded its Medal of Honor in 1950.

Ford Instrument Appoints Essex

ALOIS B. ESSEX has been appointed administrative engineer of Ford Instrument Co., division of Sperry Rand Corp.

He joined Ford in 1933 as production clerk. Prior to his appointment he was project supervisor on U. S. Army fire control equipment.

In his new post, he will be responsible for planning the engineering department work load, inter-departmental liaison, establishment of departmental procedures and policies

affecting sales proposals, delegation of responsibility through various stages of each engineering project and evaluation of new techniques to determine the feasibility of patent application.

EP&EM Elects New Officers

W. L. Larson

WILFRED L. LARSON, president of Switchcraft, of Chicago, was elected chairman of the Association of Electronic Parts and Equipment Manufacturers at the midsummer meeting of the trade group, composed of 120 midwest electronics firms.

Larson, who had been vice-chairman of EP&EM, succeeds Theodore Rossman, of Pentron Corp., Chicago, as chairman.

J. Wayne Cargile, sales manager of Permo, of Chicago, was elected vice-chairman, and Helen Staniland Quam, of Quam-Nichols Co. of Chicago, was re-elected for her eighteenth annual term as treasurer.

Howling Joins T. A. Edison

DENNIS HOWARD HOWLING has joined the staff of the Edison Research Laboratory of Thomas A. Edison Incorporated, West Orange, New Jersey. He will work on the development of heat measurement and control.

While at St. Andrews University in Scotland Howling was the recip-

ient of the Rosen prize, the Neil Arnot prize and three honor medals in physics. The firm also announced that Donald Tuomi has joined the lab as a research engineer.

He was previously with Baird Associates of Cambridge, Mass; MIT as research staff member engaged in government sponsored semiconductor research; Ohio State University Research Foundation as a research associate investigating the chemistry of the formation of photoemissive surfaces; the SAM Laboratory, Manhattan District, New York, and from 1943 to 1954 he was employed as a research scientist at Columbia University and Carbide and Carbon Chemicals Corp.

Carrier Division Plans Expansion

A PLANT expansion is planned for the Spectrol Electronics division of Carrier Corp. in San Gabriel, Calif. The move is expected to increase production of the division by about 300 percent. Spectrol produces precision potentiometers.

All of the assembly and testing of potentiometers will be done in the new building which is to be completed by September, 1955. The present building will be used solely for administration, engineering and product development. Spectrol was part of the former Affiliated Gas Equipment, which was merged into Carrier Corp. earlier this year.

Consolidated Engineering Names Nunan

J. KNEELAND NUNAN, president of Consolidated Vacuum Corp., has been named to the newly created post of vice-president and staff advisor to the president of Consolidated Engineering Corp.

In his new position, Nunan will act as a special advisor to president P. S. Fogg on company policy matters relating to management, marketing, and public and stockholder relations.

Succeeding Nunan as president of the Rochester, New York, high-vacuum equipment subsidiary is Hugh F. Colvin, who will also continue in his present post as vice-

president and general manager of Consolidated Engineering.

Thomas H. Remington, member of a Rochester legal firm, was appointed to fill the vacancy created by Nunan's resignation from the board of directors of the vacuum-equipment company.

Nunan joined Consolidated Engineering as vice-president in charge of sales in January, 1953, was made executive vice-president of Consolidated Vacuum in March of the same year, and in December, 1954, was named president.

English Firm Appoints Tube Chief

A. V. Krause

20TH CENTURY Electronics of England has appointed A. V. Krause as head of cathode ray tube development. He was formerly senior engineer in the vacuum tube development section of Cinema Television. He had previously been with Standard Telephones and Cables valve division and Mullards.

Smith-Vaniz Named CGS Vice-President

WILLIAM Reid Smith-Vaniz, assistant chief engineer for CGS Laboratories of Stamford, Conn., has been named vice-president of the firm.

He was largely responsible for the development of the all-elec-

tronic computer that converts International Morse code signals from a regular radio receiver into suitable electric pulses for a standard teleprinter, producing a printed message exactly as transmitted at point of origin.

He joined CGS in 1952. His work in the company has largely been in the field of analog and digital computer techniques.

Waldorf Instrument Elects Vice-President

SIEGFRIED SUSSKIND has been elected vice-president in charge of engineering and electronic products for Waldorf Instrument Corp. of Huntington, N. Y. He will be in charge of the engineering division and in addition assume direct responsibility for the electronic products of the company.

Gladden Forms Lincoln Electronics

GLADDEN Products Corp. of Glendale, Calif., manufacturers of hydraulic and pneumatic components for aircraft, has formed a new wholly-owned subsidiary, Lincoln Electronics.

The new subsidiary will concentrate on the manufacture of subminiature permanent-magnet motors, electrical actuators, servo motors and blowers, chiefly for use by the aircraft industry.

The firm, now located in Vernon, Calif., expects to move to the Glendale area.

Keith Sorenson, formerly president of Technical Industries of Los Angeles, is manager of the new subsidiary and vice-president of Gladden Products.

Republic Foil to Make Etched Foil

REPUBLIC FOIL and Metal Mills of Danbury, Conn., producer of aluminum foil for non-electrolytic types of capacitors, has formed Republic Etched Products, for the purpose of etching extra high purity aluminum foil for use in electrolytic types of capacitors. John W. Douglas, president of Re-

public Foil and Metal, is president of the new company.

Construction of a plant in Danbury and installation of equipment will commence under the supervision of Republic Foil and Metal Mills, in cooperation with the engineering staff of Societe Pour Le Traitement Des Metaux Et Alliages, Froges, France, whose manufacturing techniques will also be employed. This company, which is better known as SATMA, is European producer of etched foil and is a supplier of domestic users.

Basic metal will be furnished by Ets. Charles Coquillard, Froges, France, and will be rolled by Republic Foil and Metal Mills, Inc., using methods employed by Coquillard.

Republic Etched Products has replaced the International Selling Corp. of New York, as sole distributor for SATMA etched foil in the western hemisphere, and will furnish the French product until the transition to domestic production has been completed.

Actual sales of the extra high purity products will be handled by the sales department of Republic Foil and Metal Mills.

Rugby Radio Extension Opened in England

A LARGE extension of Rugby Radio station in England has been officially opened. At a luncheon given by Marconi's Wireless Telegraph Co. at the official opening were C. S. Franklin, center, who, working in collaboration with Guglielmo Marconi, was responsible for the Marconi-Franklin short wave beam

system; left, R. J. Kemp, deputy engineer-in-chief of Marconi and right, L. H. Harris, engineer-in-chief of the General Post Office. The new station has taken three years to build. The cost is estimated at more than $2.8 million. Twenty-eight high-power radio transmitters will ultimately be surrounded by about 100 antennas. The station can work on most of the systems of telephony and telegraphy transmission used in different parts of the world. Each transmitter can handle several messages at the same time. The transmitters can be started, stopped, changed to different frequencies and connected to different antennas as required.

Waveforms Selects Research Head

B. W. ST. CLAIR has been appointed director of research of Waveforms. Dr. St. Clair will be responsible for the company's contract research program and instrument development. He was formerly with Freed Electronics & Controls Corp. and Syracuse University's radio isotopes laboratory.

Air Associates Plans Merger

AIR Associates and Great American Industries have signed an agreement providing for the merger of the two companies pending stockholders' approval. Great American, a Connecticut corporation, manufactures cellular rubber products, intercommunication systems and specialized electrical devices.

Sprague to Expand Carolina Plant

THE SPRAGUE ELECTRIC CO. will build an additional 25,000 sq ft of manufacturing space at its West Jefferson, N. C. plant.

Of the total, 20,000 sq ft of assembly space will be added to the main building of the one-story

plant and a separate 5,000 sq ft building will also be constructed. The plant manufactures electrolytic capacitors.

City College Elects Froehlich

PROFESSOR Cecile Froehlich has been elected chairman of the electrical engineering department of the City College of New York. She is the first woman to become a department chairman in the 108-year history of the college and is the only female instructor of electrical engineering in New York City, according to the school.

Before coming to the United States in 1941 from Germany, she worked for engineering concerns in Germany and Belgium. She has taught graduate courses at New York University and lectured before the AIEE in addition to her City College duties. Dr. Froehlich has also served as technical research consultant to the Federal Telecommunications Laboratories of IT&T.

At the college, she was instrumental in founding the Society for Women Engineers.

Universal Winding Names Morlok

UNIVERSAL Winding Co. appointed Edward Morlok as superintendent of assembly. Prior to joining Universal, he headed up the manufacturing engineering department of

GE in Bloomfield, N. J. Prior to that, he was assistant factory manager for Bendix Aviation Corp. In his present capacity, he will be responsible for all of Universal's assembly departments.

Litton Adds Medical Electronics Firm

LITTON Industries has acquired the Automatic Seriograph Corp. of College Park, Md. producers of specialized electronic equipment used in conjunction with X-ray machines.

The company, acquired through transfer of an undisclosed amount of stock, is the tenth to be integrated into Litton Industries in the past twenty months.

Resistor Firm Moves To New Plant

EASTERN Precision Resistor Corp., formerly located in Richmond Hill, N. Y., has moved to a new, larger plant in Brooklyn, N. Y.

General Instrument Appoints Engineers

RESPONSIBLE for planning and execution of the new semi-conductor production program at Automatic Manufacturing Corp., subsidiary of General Instrument Corp., are Maurice Friedman, Paul S. Heflin and Robert W. Hull. First of the firm's new products in semi-conductor field is a silicon power rectifier.

J. B. Rea Acquires Another Company

J. B. REA CO. of Santa Monica, Calif., acquired the equipment, inventory and personnel of the Robey Rotor Co. of Culver City, Calif. manufacturers of gyroscopes, blowers and miniature motors for aircraft and guided missiles.

The move adds a new division to the Rea Company, an electronics firm now engaged in research, development and manufacturing in the automatic control and data pro-

cessing fields. The division will supply Rea with specialized equipment for use in its automatic control and business data processing systems. Oscar Robey, founder of Robey Rotor, will continue as manager of the new division.

Recently, the Rea Co. added a subsidiary firm, the J. L. A. McLaughlin Corp. of La Jolla, a research and manufacturing firm in the long-range communications field.

Ampex Establishes Research Department

AMPEX CORP. has established a separate research department directed by Walter T. Selsted.

Formerly, research activities at Ampex were carried on by engineers from two product divisions, audio and instrumentation. These engineers will continue applied research in specific engineering problems related to present equipment being manufactured.

The new research department will be engaged in the study of basic principles in the new fields now associated with magnetic recording.

Selsted joined Ampex in 1949 and was one of four original engineers employed. Previously, he worked with the Pacific Broadcasting Co. and the University of California Radiation Laboratory.

Ampex also announced that Arthur P. Kromer has been added to the manufacturing engineering

Walter T. Selsted

group as chief industrial engineer.

He was previously associated with the Lincoln Laboratories of MIT in charge of the production coordination office for their digital computer division.

Before that he was 12 years with the Western Electric as assistant superintendent of manufacturing engineering for electronic equipment and for government contract work on radar and guided missiles.

Otarion Appoints Engineering Director

WILLIAM H. GREENBAUM has been appointed director of engineering for Otarion, hearing aid maker of Dobbs Ferry, N. Y.

He had been associated, for 13 years, with another manufacturer of hearing aids.

I T & T Purchases Kuthe Laboratories

I T & T HAS purchased Kuthe Laboratories, of Newark, N. J. The purchase price covers all outstanding capital stock of the company, which will be integrated into the I T & T System. Herman Kuthe, who founded the company, will continue as president.

Constantin Opens Second Plant

L. L. CONSTANTIN & Co., manufacturers of glass to metal vacuum seals and other electronic components, has opened a second plant in Clifton, N. J.

The new plant of 15,000 sq ft is equipped for volume manufacture of glass to metal vacuum seals.

Plastics Lab Expands Plant

DEBELL & RICHARDSON, plastics research and development laboratories, have purchased the mill and water power of the A. W. Dolge Co. in Hazardville, Conn.

The acquisition will nearly double present floor space with the addition of 20,000 sq ft of working area. The space will be devoted to new chemical and engineering laboratories.

New Books

Automatic Feedback Control System Synthesis

By JOHN G. TRUXAL.
McGraw-Hill Book Co., Inc., New York, 1955, 675 *p*, $12.50.

THIS text on advanced servomechanisms is a distinct contribution to the available books on the subject. It differs from almost all current books in its attention to exclusively advanced topics. In this reviewer's opinion, it is the first book presenting the popular advanced topics, hitherto described in widely scattered papers, in an integrated and lucid manner, equally suitable as a graduate text or a reference for servomechanisms engineers.

Elementary servomechanisms theory, as presented in most current volumes, has become standardized in its coverage, which implies that a generally accepted approach to this topic has evolved. This approach, based upon the experience of instructors and practicing engineers, has emphasized frequency response methods, which in the past have resulted in the most rapid development of synthesis techniques. In contrast to the frequency response approach, transient methods have been relatively neglected. However, the final performance of a critical servomechanism must generally be judged by its response to a nonsinusoidal input and it is here that one must return to transient methods. Similarly, in problems relating to sampled data systems, nonlinear systems, etc, the transient approach becomes almost an essential tool. Thus, in advanced servomechanism theory, the transient analysis methods naturally occupy a more essential role, and one which Prof. Truxal has fully recognized.

Arrangement

The author divides his presentation into five principal areas: (1) A complete coverage of the Laplace transform from an advanced (engineering) viewpoint, emphasizing the relation between shifting pole and zero positions, and the effect in the time and frequency domains. (2) A coverage of feedback theory,

including signal-flow diagrams and system design methods for most easily controlling desired characteristics with feedback. (3) The synthesis of networks for shaping frequency response, going much further than the standard popular lead, lag and lead-lag networks. (4) Statistical methods and systems, including random noise. (5) The basic techniques of nonlinear system analysis and the synthesis of nonlinearities to improve dynamic performance.

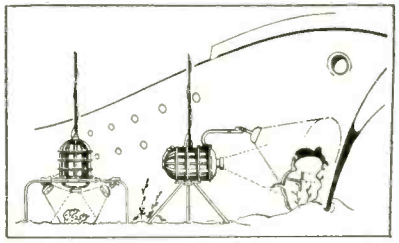
Some of the specific topics included in the above five general headings are Evans' root-locus method applicable network synthesis techniques, statistical design principles, sampled data systems, and nonlinear systems.

The unique character of this book and its excellent organized treatment of the above topics should make it an invaluable reference work for student and advanced systems designer.—SIDNEY A. DAVIS, *Chief Development Engineer, Servomechanisms, Inc., Long Island, New York.*

Underwater Photography and Television

By E. R. CROSS.
Exposition Press Inc., New York, 1954, 258 *p*, $6.00.

PROBLEMS related to the use of underwater closed-circuit television gear are numerous and often difficult. Much has been accomplished but there are still many problems left unsolved. This hand-



Underwater tv in action

book of equipment and techniques is an attempt to gather and collate existing knowledge in the field, something that has not been done heretofore.

Unfortunately, just one chapter is specifically devoted to the subject

of underwater television. However, other chapters cover water pressure and the attendant necessity for adequate camera housings and waterproof seals, underwater visibility and the related lighting difficulties, as well as the proper selection of lenses and filters. These are an integral part of the entire picture involved in the use of underwater tv equipment. The main part of the text covers photography, diving and a rather comprehensive bibliography, which should prove extremely valuable.

The underwater tv chapter goes into detail concerning appilcations of tv equipment in underwater work with specific mention of actual salvage operations. It also touches on problems directly related to tv cameras and their use, such as: moisture condensation, photosensitive tubes and spectral sensitivity. Much attention is given to the lighting problem underwater. The author's diving experience has resulted in the presentation of valuable information relating to f/stops, distances and foot candles of illumination needed when using image-orthicon cameras.

This reference text should prove of some value to those desiring to know: how far the state of the art has progressed; what the present-day problems are and where the future of under water tv lies.—E.B.P.

Fundamentals of Radar

By Stephen A. Knight. *Pitman Publishing Corp., New York,* 1955, 150 *p,* $3.00.

A brief and highly readable description of the principles and operation of the major units of a radar set. The book is written on the technician's level and is nonmathematical in its approach.

The author describes principles of echo ranging, triggering and sweep circuits, cathode-ray-tube indicators, pulse transmitters and receivers, transmission lines, waveguides and directional antennas. Some details of modern radar systems such as servo systems range-marker presentations, moving-target indicators, identification friend or foe, t-r and atr tubes etc are omitted. But this does not diminish

the value of the book as an introduction to the subject or as a quick review for someone not currently in the field.—J. M. C.

Introduction To Nuclear Engineering

BY RICHARD STEPHENSON. *McGraw-Hill Book Co., New York*, 1954, 387 *p*, $8.00.

THIS BOOK is the second text on nuclear engineering to be published within the year and evidences the need for an organized presentation of the declassified material on nuclear reactor design, and the engineering developments that accompany the successful operation of a reactor. It is a tribute to the efforts of the AEC and nuclear engineers of this country that such a good overall picture can be presented. Stevenson states that this book was written for engineers, and he wisely concentrates on the nuclear field leaving out material that can be found in conventional engineering text books. It would seem to me that the first chapter, which is a brief review of nuclear physics, might also better be left to the texts on nuclear physics, of which there are now a number appropriate to nuclear engineers.

Content

He starts off in Chapter II with a discussion of fission and nuclear chain reactions. This is followed by a chapter describing a number of reactors which are typical of the various ones that have been built. Chapter IV develops the theory of thermal reactors to the point where critical size can be calculated. The next two chapters, on shielding and reactor materials, consider the interrelations between radiation, both gamma and neutron, and materials used in the internal and external structure of reactors. Some idea of the way a reactor behaves and means for controlling its behavior follow. The separation of fissionable material is covered in the chapter on isotope separation. The chemical processing of ores for uranium and spent reactor fuels for fission products, unconsumed fissionable fuel and converted fertile material is indicated in Chap-

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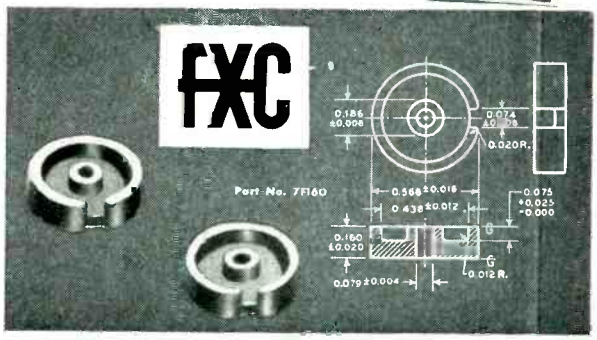

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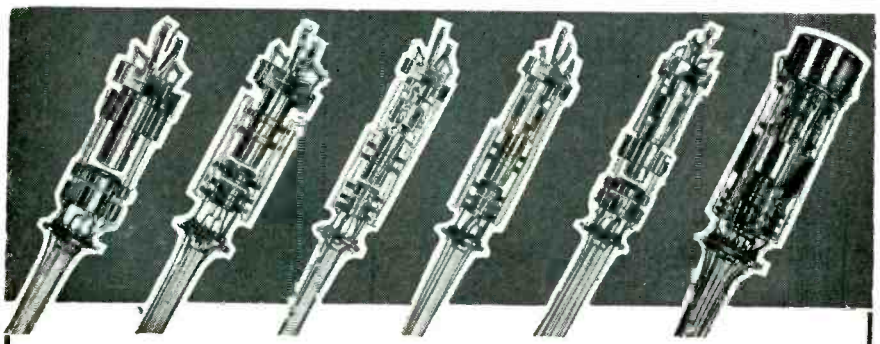

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ter IX. The final chapter describes some of the techniques needed for handling radioactive material.

Problems

The problems at the end of each chapter are excellent. The writing is clear, and I would recommend the book for use in a class for senior or graduate engineers interested in preparing themselves for intelligent understanding of the nuclear engineering field.

It should be clear that a thorough mastery of the material of the book will not qualify a student to design a workable power reactor. However, it does convey an understanding of the problems in nuclear engineering and some methods of attacking them.—CLARKE WILLIAMS, *Chairman, Nuclear Engineering Dept., Brookhaven National Lab., Upton, L. I., N. Y.*

Astronomical Photo-Electric Photometry

EDITED BY FRANK BRADSHAW WOOD. *American Association for the Advancement of Science, Washington D.C.*, 1953, 141 *p*, $3.75.

THIS 141 page monograph is a collection of papers presented at a symposium of the Astronomy Section of the American Association for the Advancement of Science in Philadelphia on December 31, 1951.

The great sensitivity of multiplier phototubes makes them extremely valuable for measuring the light of faint astronomical objects. Nine authors contribute from their experience to bring the reader a range of phototube techniques.. A bibliography of 575 papers is included and a short treatise on the basic theory and limits of sensitivity is given by Whitford.

The book will be of value to research workers interested in phototube applications. — JOHN D. KRAUS, *Ohio State University, Columbus, Ohio.*

Scientia Electrica

S. HIRZEL VERLAG, ZURICH, SWITZERLAND. *Issues of about 40 pages each appear in irregular sequence, No. 1 & 2—4 Swissfranco, No. 3-4, 80 Swissfranco.*

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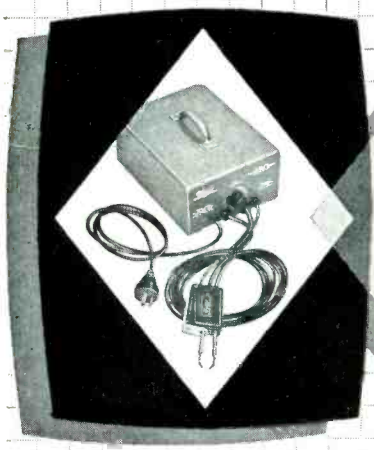

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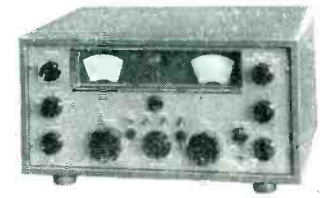

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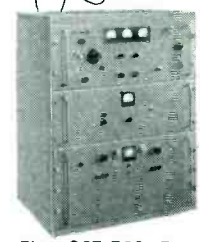

The GPT-750 Transmitter was designed for radio telephone, telegraph, frequency shift and facsimile operation an all frequencies from 2 to 32 mc. It is conservatively rated at 900 watts output CW or FS and 500 watts output radio telephone, continuous commercial service. Complete details available on request, in bulletin 174-E.

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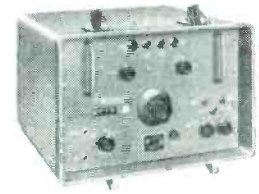

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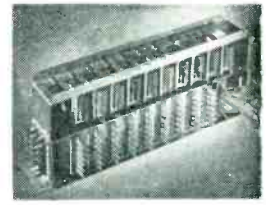

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trical engineering at the Swiss Federal Institute of Technology in Zurich. Some of the authors are active at the university, others in industry. Each of the first three issues contains three papers; further issues are scheduled to appear in irregular sequence, and some later ones may already be available but have not reached this reviewer.

Subjects

The papers deal with a wide variety of subjects in electrical engineering, with considerable emphasis on power transmission. Here are the first nine titles: transistors in power stages; fine migration on switch contacts; corona losses on high-voltage lines; absolute voltago measurement; plastic insulation at high voltage; equivalent circuits for the loss-free transformer; progress report on some insulating materials; audio control pulse transmission over power systems; statistics of arc-back in thyratrons. Papers scheduled for later issues deal with control systems for electrical drives, behavior of electrical machinery with periodically varying voltage and frequency, selected problems of current or voltage stabilization, etc.

Transistors and Fine Migration

Among all the papers mentioned, only the one on transistors belongs in the electronic field; this one was written by M. J. O. Strutt who leads the seminar and edits the publication.

To this reviewer who cannot qualify as an expert on any of the subjects listed, some of the papers seem unusually stimulating. One excellent example is the paper on fine migration between contacts. Knowing very little about the subject, we are first reminded that there is course migration—caused by arcing—and fine migration—metal migrates from anode to cathode even when no visible sparks are produced. Next we learn that fine migration occurs because just as the contacts part, the last tiny bridge of metal liquefies. This in itself would not account for the asymmetry observed; we are now reminded of the Thomson effect: current through a homogeneous

conductor produces extra heat in regions where a temperature gradient exists, and this extra heat is positive or negative depending on the polarity of the gradient. Thus the location of the hottest point on the liquid bridge is shifted. Available data for the Thomson effect indicate that the metal should migrate in the opposite direction, but the authors show through measurements that the effect changes polarity at elevated temperatures, and they finally prove their point by compensating for the effect through introducing an artificial asymmetry which successfully suppresses fine migration.

Evaluation

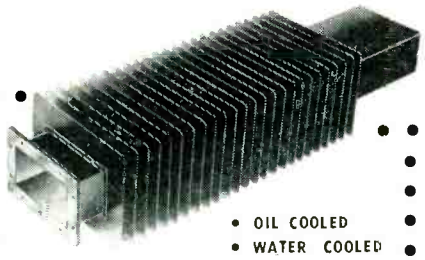
These papers were evidently written for an audience composed of specialists in many different fields; every author had to make his point with greater clarity than might have been necessary in a group of listeners thoroughly familiar with his subject. For this reason, perhaps, and also because these papers often go back to fundamental physics, they seem more interesting to this reviewer than many articles in electrical engineering journals. —ROBERT ADLER, *Research Department, Zenith Radio Corporation, Chicago, Illinois.*

Zur Theorie Der Elektronenstrahlrohren Mit Periodischem Aufbau

BY DR. HEINRICH DERFLER, *Verlag Leemann Zurich, Zurich, Switzerland*, 1954, 54 *p.*, 6.25 *Swiss francs.*

THIS SMALL 53-page booklet on the theory of periodic traveling wave tubes must remain a book for specialists in a rather narrow field of endeavor, for although the mathematics and even the physical background of pertinent electromagnetic theory are explained at length, the tubes themselves are barely described.

The book is divided into two parts: A general treatment, by one of the several available methods, of the interaction between an electron beam and the waves propagating within a periodic guide and an application of the formulas ob-



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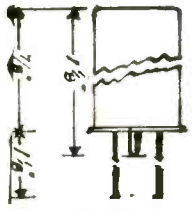

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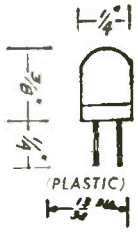

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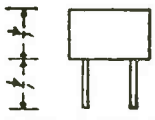

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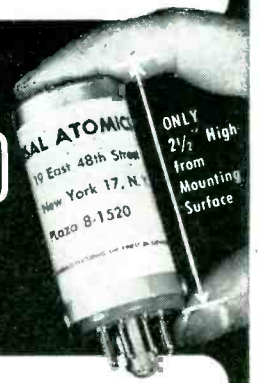

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tained to particular kinds of structures.

The general theory is a mixture of two approaches: A small-signal field approach within the beam which leads to the usual relations between current, space charge, axial electric field and velocity, and a correlation by analogy between the quantities thus defined and the currents and voltages at each stage of an array of equal quadrupoles. The impedances defining the quadrupoles represent the effects of the shape of the guide. The analogy exists only in cross-sections separated by the spacial period of the guide. Sets of difference equations ensue which are simply solved. Focusing by an infinite-axial magnetic field is assumed. No effort is made to derive the quadrupole impedances from the geometric parameters of the guide. The use of a continuous Fourier integral for expressing the axial field, instead of introducing the concept of space harmonics and thus only a Fourier series, leads to a lengthy and quite unnecessary approximate integration in the complex plane.

The theory is applied to the multicavity klystron, the disk-and-rod structure and the space harmonic amplifier. By choosing to represent the three types of structures by simple quadrupoles well suited to show the analogies and differences between the structures, the author obtains a clear and concise representation of the basic properties of those tubes.

The book, although published in 1954, was written in 1952 which may account for the lack of mention of the backward wave properties of space harmonic amplifiers and oscillators. This omission is regrettable in view of a lengthy discussion on the stability of a forward space harmonic amplifier which closes the book.—PHILIPPE A. CLAVIER, *Research Department, Zenith Radio Corp., Chicago, Ill.*

Elements of Radio Servicing

BY WILLIAM MARCUS AND ALEX LEVY. *McGraw-Hill Book Co., Inc., New York, 2nd Edition*, 1955, 566 *p*, $6.00.

STEP-BY-STEP procedure for servicing superheterodyne receivers is

described with a fair amount of elementary radio theory in this book. The dynamic servicing technique is stressed with the authors giving the reader an early introduction to the signal generator. The book winds up with an outline of servicing procedure augmented by case studies of receiver faults and a chapter of tips on setting up the service bench.

New material in this edition includes information on the electronic multimeter and chapters on battery and three-way portables; and f-m receivers.

The book is written on the vocational school level and will be useful to anyone desiring a practical knowledge of radio servicing. It is designed to correlate with a series of six McGraw-Hill text films.—J.M.C.

Thumbnail Reviews

Abstracts of the Literature on Semiconducting and Luminescent Materials. By the Electrochemical Society. John Wiley & Sons, Inc., New York, 1955, 169 p (paper), $5.00. Bibliography with brief summaries prepared by staff of Battelle Memorial Institute covering literature from Jan. 1, to Dec. 31, 1953. Subject and author indexes are included.

Multipole Fields. By M. E. Rose. John Wiley & Sons, Inc., New York, 1955, 99 p, $4.95. Application of group theory methods in the description of the electromagnetic field. A general knowledge of quantum mechanics and electromagnetic theory is assumed.

Conversion Factors and Tables. By O. T. Zimmerman and Irvin Lavine. Industrial Research Service, Dover, N. H., 2nd Edition, 1955, 501 p, $5.00. Main section of book is alphabetical list of conversion factors recently recalculated in line with latest accepted fundamental values. New material includes foreign conversion factors and monetary equivalents, table of physical constants and expanded conversion table section.

28 Uses for Junction Transistors. Sylvania Electric Products, Buffalo, New York, 1955, 48 p, 25¢ (paper). Manual of practical applications for junction transistors. Theory is held to a minimum but a bibliography of more detailed transistor theory is included.

Bibliography and Abstracts on Electrical Contacts. ASTM, Philadelphia, Pa., 1955, 80 p, $1.00 (paper). Supplements original work published in 1944, republished in 1952. Includes all new references collected up to January 1,

NEW BOOKS (continued)

1954. Subject and author indexes are given together with brief abstracts of papers.

Electricity. By Eric de Ville. Penguin Books Inc., Baltimore, Maryland, 1955, 159 p, 65¢ (paper). Traces development of science of electricity and magnetism from early discoveries to television, radar and atomics. Written for the layman.

Elements of Television Servicing for Bench and Field. By Abraham Marcus and Samuel E. Gendler, Prentice-Hall, Inc., New York, 1955, 587 p, trade $7.35, text, $5.50. Designed for classroom teaching, this book describes techniques for servicing television receivers both in the shop and the customer's home. Includes material on uhf circuits and theory and practice of servicing color tv receivers.

Operation TV. By Stephen E. Madas. Vantage Press, New York, 1955, 81 p, $2.50. Written for the television viewer without technical knowledge, this book explains how the set works and how to adjust it for the best picture. This is not a fix-it-yourself book. Portions are included on color receivers.

Elementary Theory of Nuclear Shell Structure. By Maria Goeppert Mayer and J. Hans D. Jensen. John Wiley & Sons, Inc., New York, 1955, 269 p, $7.75. Discusses topics such as nuclear spins and magnetic moments, quadrupole moments, beta decay and isomeric transitions. Contains extensive tables and graphs of nuclear data.

Bibliography on Hearing. By Psychoacoustic Laboratory, Harvard University. Harvard University Press, Cambridge, Massachusetts, 1955, 599 p, $7.00. Contains well over 10,000 titles including all entries in earlier work. Entries are listed alphabetically by author. A classification by subject is also included.

Tables of Sines and Cosines for Radian Arguments. By National Bureau of Standards. Government Printing Office, Washington, D. C., 1955, 278 p, $3.00. Extended and corrected reissue of mathematical tables published in 1940. Table of conversion factors from degrees to radians and conversely is provided.

TV Field Servicing Manual, Vol. 4. By Harold Alsberg. John F. Rider Publisher, Inc., New York, 1955, 160 p, $2.40 (paper). Servicing data for General Electric, Hallicrafters and Hoffman television receivers.

Picture Book of TV Troubles, Vol 3. By John F. Rider staff. John F. Rider Publisher, Inc., New York, 1955, $1.80 (paper). Abnormal waveforms and pictures for various video i-f and video amplifier circuit troubles.

Almost Periodic Functions. By A. S. Besicovitch. Dover Publications, Inc., New York, 1955, 108 p, $3.50 (cloth), $1.75 (paper). Reprint of summary of two stages of development in Bohr's theory of almost periodic functions.

The Continuum and Other Types of Serial Order. By Edward V. Hunting-

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ton. Dover Publications, Inc., New York, 1955, 82 p, $2.75 (cloth), $1.00 (paper). Reprint of a book which appeared first in 1905 as a reprint from the *Annals of Mathematics*.

Basic Vacuum Tubes and Their Uses. By John F. Rider and Henry Jacobowitz. John F. Rider Publisher, Inc., New York, 208 p, $3.00 (paper), $4.50 (cloth). Explains function of diodes, triodes and multielectron tubes in nonmathematical terms. Cartoons are used to illustrate flow of electrons. A few basic circuits are given.

Biennial Report 1953 and 1954. By National Bureau of Standards. Government Printing Office, Washington, D. C., 162 p, 60¢ (paper). Electronic developments reported include Dyseac high-speed computer, x-ray televising and automatic production of electronic equipment.

TV Repair Questions and Answers (Front Ends). By S. Platt. John F. Rider Publisher, Inc., New York, 1955, 128 p, $2.10 (paper). Includes material on antennas, transmission lines, mechanical and electrical details of tuners, uhf converters and boosters.

Some Characteristics of Image Orthicon Camera Tubes. H. L. Wuerffel and D. E. Webb. Naval Research Laboratory, 1955, 43 p, distributed by Office of Technical Services, Washington, D. C., $1.25 (paper). Highly technical discussion illustrates how image othicon tubes may be operated in a variety of ways which differ from standard television operation.

ASTM Standards On Glass and Glass Products. American Society For Testing Materials, Philadelphia, Pennsylvania, 1955, 136 p, $1.50 (paper). Supercedes the previous edition published in 1950. Includes specifications for cellular glass insulating block, glass containers, insulators and textiles. Eighteen methods of test, three specifications and one list of definitions are given.

Picture Book Of TV Troubles—Volume 4—AGC Circuits. John F. Rider Laboratories Staff. John F. Rider Publisher, Inc., New York, 1955, 96 p, $1.80 (paper). Photographs of faulty tv test pattern displays and crt waveforms enable the technician to troubleshoot faults in television receiver agc circuits.

Selling Your TV-Radio Service. General Electric Tube Department. John F. Rider Publisher, Inc., New York, 1950, 64 p, $1 (paper). Deals with the business side of TV-radio service. Methods discussed have increasing sales. Includes direct mail, window and store display and various advertising media.

TV Repair Questions and Answers—Video Circuits. Sidney Platt. John F. Rider, Inc., New York, 1955, 128 p, $2.50 paper. Uses question and answer approach to discuss troubleshooting faults in video circuits of TV home receivers. Book covers video i-f circuits, detectors, amplifiers, d-c restorers and agc circuits.

Backtalk

Jeeps and Electrons

DEAR SIRS:

WE NOTED with interest your article, p 12, Aug. 1955, titled "Auto Industry Eyes Electronics". However, through some error, you failed to mention the Electronics Division of Willys Motors, Inc. at Toledo, Ohio.

This division was formed in early 1951 with the first major project being the design and development of mobile training units for the Martin missile. During the past four years, all types of test equipment have been designed and built for Government missile projects.

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LOWELL M. SHUCK

Assistant Manager
Electronics Division
Willys Motors, Inc.
Toledo, Ohio

I-F Transistor Transformers

DEAR SIRS:

I WAS delighted to see the referenced article featured on the cover of the August issue of ELECTRONICS, as well as its designation as an ELECTRONICS Reference Sheet.

There are, however, some errors in the article as published which should be corrected. Undoubtedly there will be several letters regarding the errors and this will be the easiest way to answer them.

The only serious errors involve the computation of taps and turns ratios, Eq. 3, 4 and line 42, column 3, p 160, which will give incorrect results if used as they stand.

The equations should be cor-

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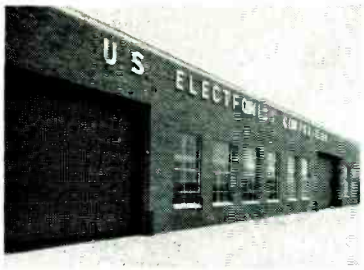

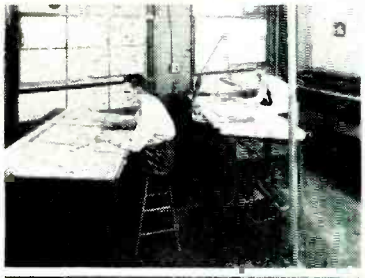

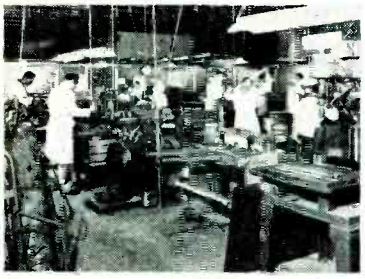

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rected to read:

$$n = \sqrt{R_g/R_g'} \quad (3)$$

$$n' = \sqrt{R_L/R_g'} \quad (4)$$

line 42, column 3, p 160

$$n' = \sqrt{R_L/R_g'} = \sqrt{50/120{,}000} = 0.0205$$

Other errors, not so serious since they will not result in incorrect end results, are as follows:

(1) In the Summary "Designed" should read "Design"

(2) Lines two and three, column 3, p 157 should be deleted

(3) Line three, column 2, p 158 should read $\Delta f = BW/2$

(4) Line 23, column 1, p 161 "— Eq. 2 and 4 may be —" should read "— Eq. 2 and 6 may be —"

(5) Line 26, column 1, p 161 "for $(f_o/\Delta f > 1)$" should be "for $(f_o/\Delta f >> 1)$"

(6) The denominator of the equation immediately following should read $2+(\Delta f/f_o)$ instead of $2+(f\sqrt{f_o})$

(7) The denominator of the next equation should read $(f_o/\Delta f)+\frac{1}{2}$ instead of $(f_o/\Delta f)+2$

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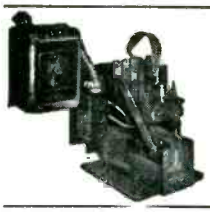

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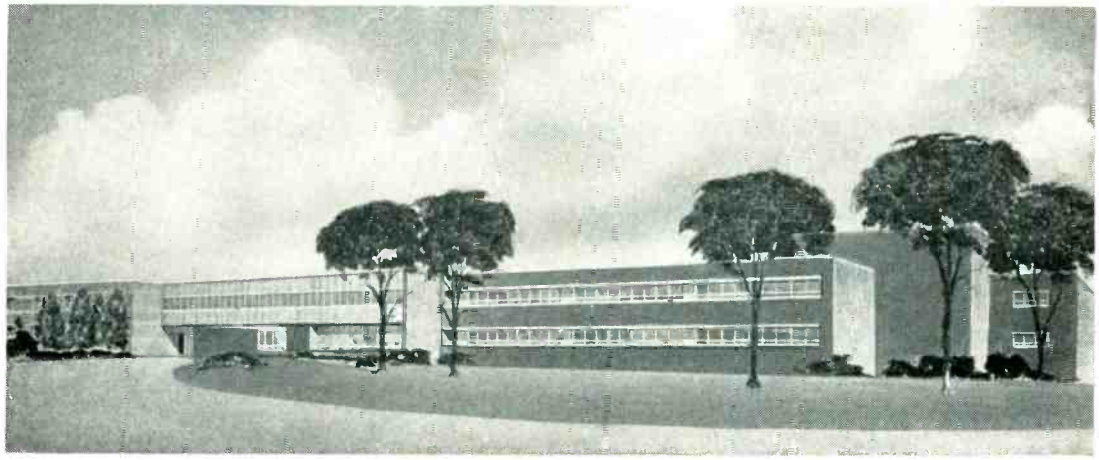

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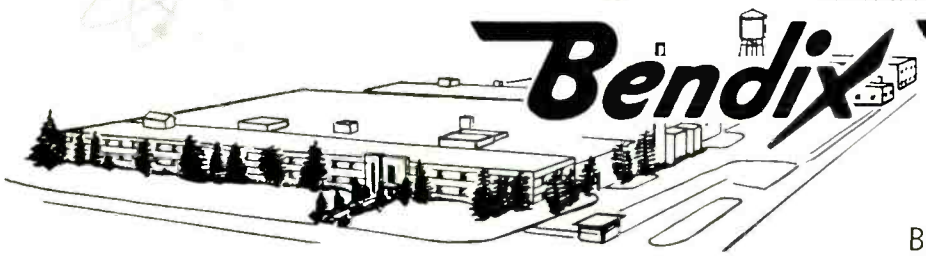

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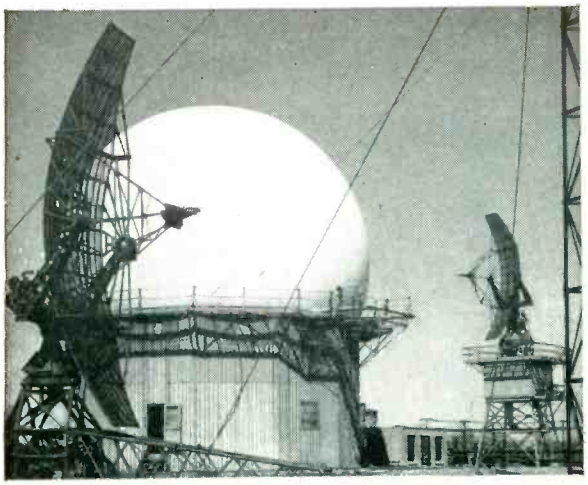

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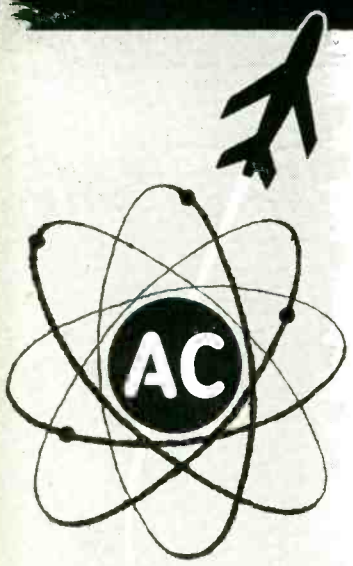

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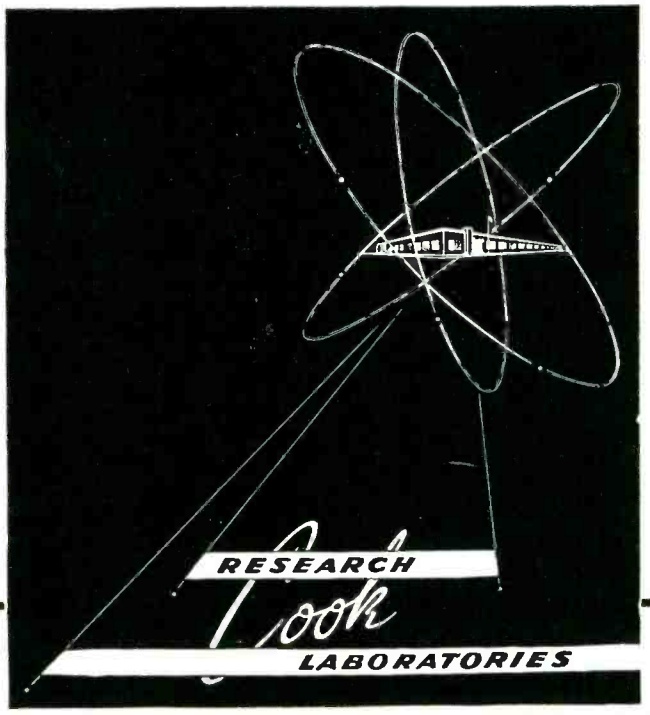

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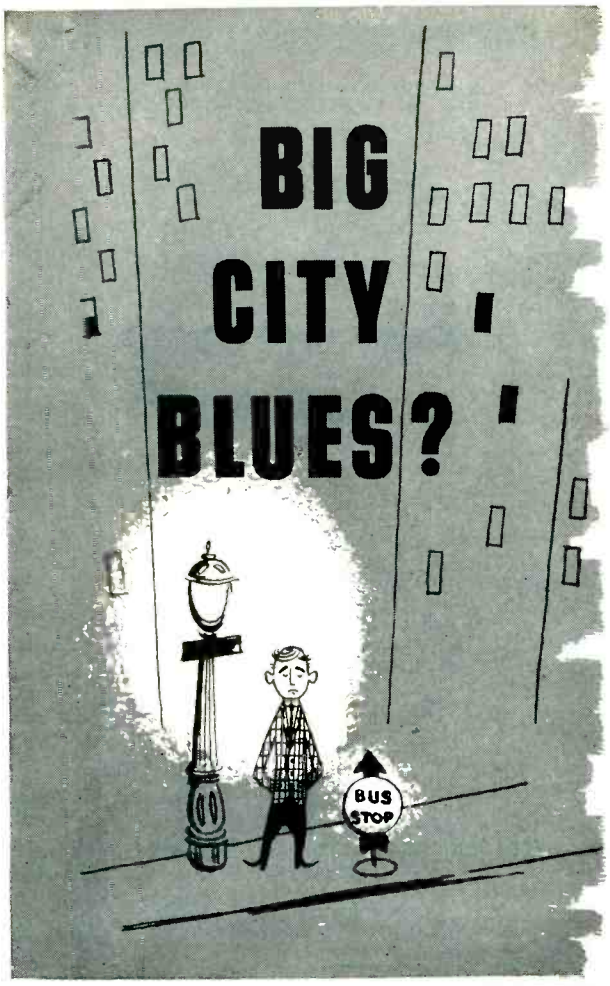

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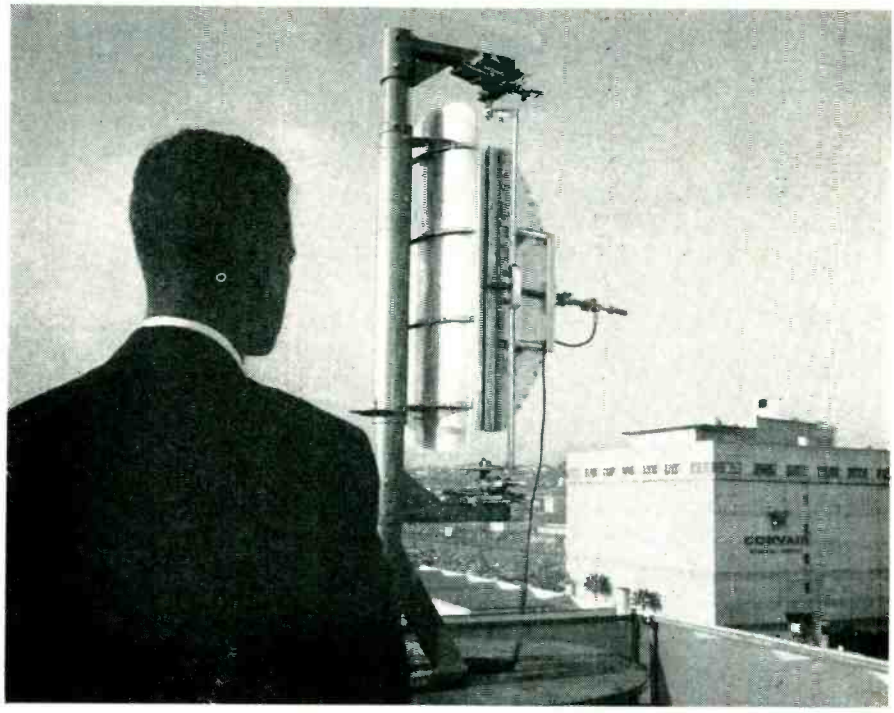

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WE MAINTAIN OUR OWN FULLY EQUIPPED TESTING LABORATORY TO TEST AND GUARANTEE ANYTHING WE SELL

Wholesale, Industrial and Institutional Sales Only

MARINE, GROUND AND AIRBORNE—RADIO, RADAR, AND SONAR—IN STOCK

TEST SETS
TS-3A/AP
TS-10A and B
TS-12/AP
TS-13/AP
TS-14
TS-16/AP
TS-35A/AP
TS-36/AP
TS-61/AP
TS-62/AP
TS-74/UPM
TS-89/AP
TS-98
TS-101/AP
TS-104
TS-110
TS-125/AP
TS-131
TS-173/UR
TS-184
TS-278
TS-323
TS-UPM-1
OAA
OAP
OBU
LAE
LM
LU
IE-19
1-46
1-56
1-208
1-222
SCR-211
AND OTHERS

TRANS-MITTERS
TAJ
TAQ
TBL
TBK
TBM
TBN
TCE
TCP
TDE
TDQ
TDO
AND OTHERS

RECEIVERS
ARB
ARC-1
ARC-3
ARC-4
ARC-5
AR-88
ART-13
CR-91
SLR
RAK
RAL
RAO
RBB
RBO
RBG
RBL
RBA
RBM
RCH
BC-224
BC-312
BC-314
BC-344
BC-348
AND OTHERS

FIELD EQUIPMENT
SCR-274
284
300
399
503
536
808
828
BC-191
375
603
604
610E
683
684
923
924
1000
1306

MICRO WAVE ACCESSORIES

Flex. Wave Guide—12" long, UG-51, 52 flanges, new, at $12.50
Flex. Wave Guide—E-plane 90° gooseneck bend, rect. plain flanges, guide is equiv. to RG-51/u. Airtron #30940, new 9.50
Flex. Twist—E to H, RG-51/U size, UG-51/U & rect. plain flange, Airton #30810, new, at 9.50
Rigid W. G., Silver pl. brass, RG-51/U with UG-51, 52 flanges, 6' long 21.50
Rigid W. G., RG-51/U, 13" long, 2 UG-51 flanges, new, at 10.00
CG-85/APQ-7, Alum. W. G., RG-51 with two UG-52 flanges, 60° & 22° H plane bends, 22" long, new, at 22.50
Elbows, Sil. pl. brass, RG-51 with UG-51, 52 flanges, mitered, 90° H-plane 14.50
Elbows, Sil. pl. brass, RG-51, two UG-52 flanges, mitered, 90° E-plane 13.50
Elbow, RG-51, UG-51, 52 flanges, 90° H-plane and 22° E plane bends 11.50
Bi-directional Coupler—UG-51, 52, Type N take offs, Broadband 27.50
Rotating Feed Arm Assy's. P/O AN/MPG-1 Sil. pl. brass RG-52, new ..... write
Magnets, Alnico V, for 3 & 10 cm Magnetrons various gap widths, 15 lbs... 16.00
Transformer, Output for 725A etc. with fil. wndg. and magnetron well 21.50
Utah Pulse xfmr. Philco #352-7190
Rotating Antenna parts—for AS-18/APS-15, AS-17/APS-3 etc. Drive motors, torque units, wave guide, feed horns, gears etc. ..... write

. . . and crystal mounts, Klystron mounts, duplexers, l.f. strips, converters and many special bends and devices too numerous to list. Send sketch if possible.

TEST EQUIPMENT

TS-13/AP-X BAND RADAR TEST SET—Measures power, freq. signal-to-noise ratio. I.F. Bandpass, etc. Input—115/1/60—800 ..... WRITE
TS-35A/AP-X-BAND—Measures transmitted power & frequency of Radar Transmitters also used for receiver adjustments ..... NEW .. WRITE
TS-100/AP—TEST SCOPE, type A, R, J & X indications, gated & ungated sweep. Int. or Ext. trigger ..... WRITE
ECHO BOX, 3 cm, motor driven, new ..... $ 97.50
ECHO BOX, 10 cm, motor driven, new 97.50
TS 34, SYNCHROSCOPE, portable 237.50
TS 110, S BAND ECHO BOX, hand tuned 275.00
Waveguide Termination, TS-332 UG-39 flange 27.50
Dummy Load—TS-231/AP, UG-51 flange, Low power 37.50
10cm Lecher Line Wavemeter CG-60ABO ..... WRITE
SWR Measuring Eqpt. Model OAK complete with Accessories ..... WRITE
TS-131/AP Pick up Ass'y ..... WRITE
TS-184/AP ..... WRITE
TS-204/AP—SWR Meas. Eqpt ..... WRITE

COMMUNICATION EQUIPMENT

125 WATT 300-600 KCS and 3-18.1 MCS; CW and MCW; Master Oscillator
400 WATT CW, 50 Watt, Phone; 1.5-4 MCS AC Input, Master Oscillator Mfg. Federal
500 and 1000 WATT Low Frequency CW Transmitter 175-600 KCS; AC or DC Input
500 and 1000 WATT High Frequency CW Transmitter 2-18.1 MCS; 350 Watts Phone
1 KW FM Transmitter; Broadcast, 40-50 MCS AC Input; Mfg.-G. E.
2 KW Transmitter; 300-2000 KCS; CW, MCW, Phone 440/3/60 Input; Mfg.—Westinghouse

MOTOR GENERATORS AND CONVERTERS

50, 60, 400 and 800 cycle and DC Power Supplies

28dc to 110/1/800 @ 1kva $49.50
(Overall length: 12 inches)
110dc to 110/1/800 @ 350va 150.00
110ac to 110/1/800 @ 350va 235.00
110kc to 110/1/400 @ 2kva 395.00
220-440/3/60 to 110/1/400 @ 2kva 435.00
32dc to 110/1/60 @ 350va 100.00
110dc to 110/1/60 @ 350va 100.00
110dc to 28dc @ 250va 95.00
110/1/60 to 28dc @ 250va 115.00
220/1, 3/60 to 28dc @ 250va 115.00
110dc to 110/1/60 @ 1.25kva 135.00
220 to 110/1/60 @ 1.25kva 145.00

Partial Listings

Write For Others

SYNCHROS & SELSYNS

5F	$45.00	7G	$70.00
5G	45.00	2J1F1	10.00
5CT	45.00	2J1G1	10.00
5SDG	27.50	2J1H1	10.00

Torque Unit Pioneer 12602-1-A with CK-5 Motor and AY-43 Autosyn $34.50

RADAR BEACONS

AN/CPN ..... 3 cm.
AN/CPN-8 ..... 10 cm.
YJ and YG ..... for shipboard use
AN/CPN-6 ..... 3 cm.
AN/CPN-8 ..... 10 cm.

— • —

SA, SF, SG, SD, SJ, SK, SN, SQ — both equipment and spare parts

PRECISION RESISTOR

20 MEGOHM, 20 K.V. METER MULTIPIER $50.00

SPECIAL PURPOSE and TRANSMITTING TUBES

Tube	Selling Price	Tube	Selling Price	Tube	Selling Price	Tube	Selling Price	Tube	Selling Price	Tube	Selling Price	Tube	Selling Price
01A	$ .25	2J32	29.50	4J25	150.00	204-A	60.00	705A	2.75	860	4.25	1636	1.25
OC3	1.00	2J33	32.50	4J26	150.00	211	.95	706A-GY	39.50	861	22.50	1642	1.25
OD3	.95	2J34	32.50	4J28	150.00	FG-235A	39.50	707B	14.50	865	1.15	5516	8.50
C1A	5.75	2J36	95.00	4J29	150.00	250TH	21.50	708A	2.75	812A	1.95	5611	99.50
C1B	3.75	2J39	35.00	4J31	150.00	250TL	19.25	714AY	19.50	874	1.00	7193	.50
10Y	.35	2J49	65.00	4J33	150.00	FG-271	45.00	715B	9.50	889R	write	8011	.35
VR-92	.45	2J50	70.00	4J34	150.00	FG-274A		720DY	47.50	891R	write	8012	1.75
1B22	1.75	2J56	132.50	4J42	200.00	286A	7.75	721A	3.25	892	write	8014A	55.00
1B24	12.00	2J61	47.50	4J51	250.00	304TH	8.75	723A/B	18.50	892R	write	8020	2.75
1B35	6.25	2J62	47.50	4J52	245.00	304TL	8.75	725A	19.50	2x2/879	.65	8025	7.00
1N23B	2.75	2K22	35.00	5C29	29.95	307A	2.75	726A	22.50	1614	2.25	9001	1.10
2C33		2K25	22.50	5D21	14.50	TR317	5.50	730A	25.00	1616	1.50	9002	.95
2C34	.75	2K29	32.50	5J26	125.00	339A	27.50	807	1.35	1619	.50	9006	.35
2C40	10.50	2K33A	75.00	6C21	29.50	371B	1.25	813	13.25	1624	1.75	K-1069P7	write
2C44	.75	2K45	85.00	7BP7	7.75	388A	1.75	829A	10.75	1625	.50		
2D21	1.00	2K55	75.00	7MP7	17.50	415GL	37.50	829B	12.75	1626	.35		
2D29	1.95	3-38A	1.50	12DP7A	45.00	417A	15.00	832A	9.95	1629	.45		
2E22	2.95	3B22	1.75	FG-17	4.25	446A	1.75	833A	45.00				
2E24	3.50	3B24	5.50	FG-57	15.50	446B	3.50	836	3.75				
2J21	13.50	3C31/C1B	3.75	FG-95	22.50	464A	7.50	837	1.45				
2J26	15.00	3E29	14.75	FG-97	39.50	WL531	5.00	843	.35				
2J27	15.00	4C35	15.00	98R	2.75	WL651/656	39.50	849	27.50				
2J31	23.50	4D32	22.50	114B	.35	WL670	9.75	851	45.00				

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AN/ASQ-1 and 1A MAGNETOMETERS
This is an airborne magnetometer used to measure the magnetic flux of the earth and to locate submarines and other metallic objects by their distortion of the magnetic field. Sensitivity 2-3 gamma or better. POR.

AN/GSQ1-A SPEECH SCRAMBLERS
Speech scrambler for use on any comm. channel to insure privacy. We can supply complete installations of this equipment 28v DC input. Also 110v 60 cyc.

SCR-291A DIRECTION FINDER
Automatic ground direction finder covering 1.5mc-30mc. Provides instant bearings on a C.R. indicator of any signal in its range. This equipment is transportable and can be set up quickly. 110v 60 cyc. POR.

P.P.I. REMOTE RADAR REPEATERS
We can supply the following types of remote Radar P.P.I. Repeaters. The main radar provides the Synconizing, Syncro. and Video. Pulses to operate the Repeaters. These repeaters may be used with any marine ground or airbourne.

VC 7" P.P.I. Upright deck mount Repeater. 4 Ranges are provided from 4-200 miles. Input 110 Volt 60 Cyc.

VD 7" P.P.I. Deck mount Repeater. This unit is very similar to the VC but is completely Waterproof and may be used on deck. The ranges are the same as the VC. Input 110 Volt 60 Cyc.

VE 7" P.P.I. Table mount Repeater. This is a very compact set. 4 ranges are provided from 4-200 miles. Input 110 Volt 60 Cyc.

VF 9" P.P.I. Deck mount Repeater. This is a very late model Repeater enabling 20 radars to be fed into it. 4 Ranges from 4-200 miles are provided. Input 110 Volt 60 Cyc.

VG 12" P.P.I. Plotting Table Projection Repeater. This is a very elaborate Remote Indicator. For use in a plotting center. Up to 20 Radars may be fed into it. This set utilizes a Skiatron tube to provide data that can be retained on the screen and can be erased at will. Input 110 volt 60 Cyc.

Accessories are available such as repeater adaptors enabling the set to be used at a greater distance than normal. Input switches to select the radar to be viewed etc.

SCR-682-A RADAR
10CM high power long range harbor surveillance and early warning RADAR. This equipment is a 3000 mc mobile search radar that can be transported in a truck. The equipment incorporates a 7" PPI for operation up to 240,000 yards. Azimuth accuracy is ± 1%. Range accuracy is 100 yards at 10,000 yard range and 5000 yards at 240,000 yard range. Trans. output is approx. 225 KW. pulse width is one microsecond. Antenna beam width is 6°. Input is 110v 60 cyc. Can be supplied with or without operating shelter or antenna tower. POR.

We can supply many types of radars, test sets, communications equipments, manufactured after 1947. Write us if you cannot find it.

AN/APR-4 38-4000 MC RECEIVER
This is a precision receiver covering 38-4000 mc. The set utilizes 5 tuning units with direct reading dials in megacycles. The receiver has a wide and narrow band-width 30mc. I.F. strip which may be selected at will. An output meter is provided to measure signal strength. Outputs are provided for a pulse analyzer and pan adaptor. Each tuning unit has an automatic sweeping mechanism which enables any portion of the tuning range to be scanned automatically. Input 110v 60 cyc. POR.

500-1300 MC SIGNAL GENERATOR
This is a high precision signal generator covering 500-1300 mc. A precision attenuator is built in providing accurate determination of output from 0-100,000 microvolts. Either CW or pulsed carrier output with the following characteristics are provided. Pulse rate 60-2,500 CPS. Pulse length 2-30 microseconds. Output line 50 Ohm impedance. Accuracy better than one percent. Input 110 v 60 cyc. With calibration charts. Price.$249.50

90-600 MC SIGNAL GENERATOR
This set covers 90-600 mc. with an accuracy of one percent or better. C.W. or pulse output with the following characteristics are provided. Output from 0-100,000 microvolts 2-30 microseconds long. Pulse rate 60-2500 cyc. Pulse delay 3-300 microseconds. Output 50 ohm line. Input 110v 60 cyc. Price.....$249.50

CF-3A CARRIER REPEATER
This is a transportable 4 wire carrier telephone repeater. This set amplifies all signals when used in an intermediate position on a carrier system to extend the range. DC signaling and telegraph communications can be performed to the terminal equipments or to other repeaters. Monitoring and transmission circuits are built in. Power input 110 or 220v or 12v DC. This set can be used with all CF terminals and commercial equipments. Brand New in original cases. POR.

AN/APA-17 DIRECTION FINDER
This is an automatic direction finder covering 300-1,000 mc to be used with the APR-1 and APR-4 radar search receivers. The bearing is presented on a cathode ray screen in a cardoid pattern. The set can be used in aircraft or on the ground. Input 110v 480 cyc and 28v DC. POR.

RADAR BEACONS
X and S Band High and Low Power Racons

We can supply the following Beacons in Portable and Stationary Models. The X-BAND models will operate with the new Weather Radars

AN/CNP-6 X-Band high power Radar Beacon. This is a 40 KW set for use at an Airport. This set will Interrogate X-BAND Radars up to 200 miles. Variable Coding is provided as well as monitoring facilities. Input is 110 V 60 CYC.

AN/CPN-8 S-BAND HIGH POWER Airport Beacon. This is a very compact set. This set will Interrogate S-BAND Radars up to 200 Miles. Variable Coding and monitoring facilities are provided. Input 110 Volt 60 Cyc.

AN/CPN-17 S-BAND High power version of the CPN-6 with all the latest improvements. Input 110 Volt 60 Cyc.

AN/UPN-4 X-BAND Very lightweight Portable Beacon. This set will interrogate X-BAND Radars up to 60 miles. Variable Coding is provided. Input 12 Volts D.C. Weight Approx. 40 Lbs.

AN/UPN-1 and 2 S-BAND Portable beacons. This set will interrogate a S-BAND Radar up to 60 Miles. Variable Coding is provided. Input is 12 Volts D.C. and 110 Volts 60 Cyc. Weight Approx 50 Lbs.

BLOWERS:

12/24 VDC—AC CAST ALUMINUM BLOWER (Pictured at left)—100 CFM; 3" intake; 2" outlet, Shunt Motor 4"x2"; 3000 RPM @ 24 VDC..$5.95

6 VDC SINGLE—100 CFM—No. 6100 .....$4.95

6 VDC FLANGE—150 CFM—No. 6150 .....$6.95

24 VDC DUAL—20 CFM—Min—No. 2420.....$7.95

10 CFM BLOWER (Pictured—right) 27.5 VDC; 1/100 HP.; 7000 RPM; Oster Motor C2BP-1A; L-R Mfg. Co. Bakelite Blower #2, overall size: 3-½" x 4-½". Price $5.95
Same as above, 12 VDC operation: Price $5.95

115 V. 400 CYCLE—10 CFM—Eastern Air Devices Motor J31A—7200 RPM. 1/100 HP. L-R #2 Blower Assy. Overall Size: 4-½" x 3-½". No. 3110....$5.95

10 CFM BLOWER (Pictured at left)—28 VDC—.6 A; 5000 RPM. Pioneer Motor SS-2345. Aluminum Blower Housing; Overall Size: 4-½" x 3-¼" Price $5.95

115 V. 60 CYCLE BLOWERS:

115-VAC 60 cycle SINGLE TYPE—100 CFM; 2-¼" intake; 2" outlet. Complete size: 5" x 6" —No. 1C939 ..... **$8.95**

115 VAC 60 cycle DUAL TYPE—100 CFM; 4" intake; 2" Dis. Each side. Complete size: 8" x 6" —No. 1C880 ..... **$13.95**

115 VAC 60 cycle COMPACT TYPE—108 CFM; Motor built inside squirrel cage; 4-⅛" intake; 3⅝" x 3" Dis. Complete size: 4-½" W x 8-⅜" H x 8-⅛" D—No. 2C067 ..... **$14.95**

115 VAC 60 cycle FLANGE TYPE—140 CFM; 3-½" intake; 2-⅛" Dis. Complete size: 7-½" W x 7-¼" H x 6-¾" D—No. 1C807..... **$13.95**

115 VAC 60 cycle FLANGE TWIN—275 CFM; 4-⅛" intake; 3-¼" x 3" Dis. Complete size: 11-¾" W x 3-⅜" H x 8-1/16" D— No. 2C069 ..... **$21.95**

115 VAC 60 Cycle BLOWER—200 CFM; 4" intake; 3" x 5" outlet. Overall size: 8" x 7" x 6". Bodine Motor NSI-33. Removed from New Equipment. #BOD-200 ..... **$14.95**

115—VAC 60 Cycle BLOWER—100 CFM; 3-¾" intake; 2" outlet: Rd. Flange with Flap Director. Overall size with bracket; 8" L x 6-½" W x 7" H. Removed from New Equipment. Diehl Motor FB-2106-6 No. FDBL-2106..... **$6.95**
Same as above, but with 12- Curved Director. No. CDBL-2106 ..... **$7.95**

Previously Adv. Items Still Available. WRITE!

RECEIVER—TRANSMITTER
F M 20—28 M C.

BC-500 RECEIVER—TRANSMITTER: FM Crystal Control on 5 Channels, 100 KC separation 20-28 MC.
TRANSMITTER: 25 Watt output. 7 tubes: 1/1625, 1/12A6, 3/12SJ7; & 2/12SA7.
RECEIVER: 11 Tubes; 1/12SL7, 2/12A6, 3/12SA7, 3/12H6, 2/12U8, & 1/12SJ7.
DYNAMOTOR SUPPLY: Receiver 28 VDC 1.2 A. input; output 250 VDC 60 MA. Transmitter 28 VDC 4.1 A. input; output 550 V. 120 MA.
CONTROL PANEL: For Local Control and outlets for Remote also. Heavy duty 5" speaker. Size: 12" x 25" x 9½". Weight: 65 lbs.
Price: NEW: **$59.50**
BC-923 RECEIVER—4 Preselected Channels—Freq. Ranges 27-29.5—29-32—31.5-34.4 and 34.4-38.9 MC. Complete w/16 Tubes: 1/12SA7; 3/12SC7; 2/12SG7; 2/12SJ7; 1/VR-150; 1/6H6; 1/6SJ7; 2/6SL7; 1/6V6; 2/6AC7; 1/NE-20; & DC-14 Crystal 1000 KC; Crystal Calibrator, and Speaker. Power required: 12 or 24 VDC & 275 VDC 150 MA. Size: 6-¾" x 11-5/16" x 11-½"..... NEW: **$34.95**
12 Volt Dynamotor f/BC-923 REC.....$5.95—AC Power Supply 115 V 60 cycle f/BC-923.....$22.50—Plug f/Rear of BC-923.....$1.00

METERS:

WESTON AC AMMETER
(Pictured in portable leather case, with Test Leads, 2½", 0-15 AC and 0-3 AC Scale $5.95

DC AMMETER HOYT:
In portable metal case, with Test Leads, 4½", Fan. Mirrored Scale—0-15 ADC.....$4.95
0-3 RF AMMETER IS-128 — 2½" Rd. Flush Mtg. Calibrated F/Non Mag Panel. P/O BC-233 Transmitter .....NEW: $2.95
0-8 Amp RF w/Thermocouple IS-89; 2½" Rd..$4.95
0-15 AC-DC—2½" Rd.; IS-122.....$4.95
0-500 Milliamp DC—2½" Rd.; IS-22.....$4.95
0-250 MA DC—3" Sq. Defur.....$3.95
0-1 MA DC—Simpson; 3-½" Rd.....$3.95
0-2 MA DC—Westinghouse; 3-½" Rd.....$2.95

INVERTERS & GENERATORS:
AC-DC GENERATOR—Output 115 VAC 800 cycle 10.5 A. & 28.5 VDC; 60 A. at 2400 RPM. ⅞" spline shaft. Bendix Eclipse No. NEA-3. NEW: $18.95
PE-218—Input 28 VDC 100 A.; output 115 V. 400 cycle 1 Phase, 1500 VA. Used: $14.95—New: $39.95
PE-115 or PE-206—Input 28 VDC 36 A.; output 80 Volt 800 cycle 7.2 Amps.....Like New: $5.95
TYPE 800-1-D—Input 28 Volt 62 A.; output 115 Volt 7 Amp. 1 Phase 800 cycle.....NEW: $24.95

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OVERSTOCKED SALE!
600 VOLT OIL CONDENSERS

Terrific values—below mfrs. cost on Brand New Stock.

(All CP70 Types)

1.0 mfd.	$.49	6.0 mfd.	1.25
2.0 mfd.	.69	8.0 mfd.	1.49
3.0 mfd.	.79	10.0 mfd.	1.95
4.0 mfd.	.95	*15.0 mfd.	1.79

*Not CP70 Type.

LARGEST VARIETY AVAILABLE IN ALL TYPES OF CONDENSERS.

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Phone: WORTH 4-0865

COMMUNICATIONS EQUIPMENT CO.

VHF ANTENNA

Sig. Corps. AN154. 150-200 mc. Consists of 3 vertical dipoles working against a mesh reflector, 90 in. x 40 in. Spacing between elements is ½ wavelength. Unit comes complete with portable carrying chest and 1/12 HP lobing motor (synchronous, 115 vac 60 cy.). Antenna folds up to 46 in. sq. x 18 in. height. Shpg. wt. approx. 200# (as shown) **$27.50**

DYNAMOTORS

TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT AMPS	Price
DBAR83	14	...	375	.150	$6.50
35X-059	19	3.8	405	.095	4.35
POSX-15	14	2.8	220	.08	8.95
DM33A	28	7	540	.250	3.95
23350	27	1.75	285	.075	3.95
B-19	12	9.4	275	.110	6.95
			500	.050	
DA-3A*	28	10	300	.260	3.95
			150	.010	
			14.5	5.	
PE 73CM	28	19	1000	.350	12.50
BD69	14	2.8	220	.08	8.95
DAG-33A	18	3.2	450	.06	2.50
BDAR 93	28	3.25	375	.150	6.95

‡ Less filter. * Replacement for PE 94.
† Used, Excellent.
PE 94, Brand New 5.95

INVERTERS

800-1B Input 24 vdc, 62 A. Output: 115 V, 800 cy. 7A. 1 phase. Used, excellent $18.75
PE-218H: Input; 25/38 vdc, 92 amp. Output 115V 300/500 cy 1500 Volt-ampere. NEW $32.50
PE206: Input; 28 vdc. 36 amps. Output: 80 V 800 cy. 500 volt-amp. Dim. 13 x 5½ x 10½. New.... $22.50
EICOR—ML 3011-5. Input: 13.75 V; 18.4A. Output: 115 V/400~, 3ϕ, 0.95 PF 100 VA. New $59
PU 7/AP. Input: 28 vdc/160A. Output: 115 VAC. 400~, 1ϕ, 500 VA., 21.6 Amp. Volt, and Freq. Reg. Used, Exc. $75

PULSE NETWORKS

H-605: 25 KV, 1.5 usec. Type "E" Network. 400 PPS, 50 ohms Z. $62.50
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
7-5E3-3200-67P, 7.5 KV. "E" Circuit, 3 microsec. 200 PPS, ohms Imp. 3 sections $12.50
H-616 10KV. 2.2 usec., 375 PPS, 50 ohms Imp. $27.50
H-615 10KV. 0.85 usec., 750 PPS, 50 ohms Imp. $27.50
KS8865 CHARGING CHOKE: 115-150 H @ .02A. 32 40H @ .08A. 21 KV Test $37.50
G.E. 25E5-1-350-50 T2T, "E", CKT. 1 Microsec. Pulse @ 350 PPS. 50 OHMS Impedance $69.50
KS9623 CHARGING CHOKE: 1611 @ 75 MA, 380 Ohms DCR. 9000 Vac Test $14.95
G.E. 6E3-5-2000, 50 P2T, 6KV., "E" Circuit 0.5 usec /2000 PPS/50 ohms/2 sections $7.50

PULSE MODULATORS

MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp.) Duty Ratio: .001 max. Pulse duration: 0.5, 1.0, 2.0 microsec. Input voltage: 115 v. 400 to 2400 cps. Uses 715B 4-89-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 ASD. delivers 50 Kw peak output at 9000 mc. at .001 duty. Complete with pulser unit and all tubes. Mfd. Sperry $210

PULSE TRANSFORMERS

RAYTHEON WX 4298E: Primary 4KV., 1.0 USEC. SEC: 16KV-16 AMP DUTY RATIO: 001 400 CYCLE FIL. TRANS. "BUILT-IN" $32.50
WECO: D-163247 For Modulator of SCR 720... $22.50
4P37 (West'h'se). Pri: 50 ohms 750V. Sec. 15 KV/1000 ohms .001 Duty. Biflar: 12.6V/2.5A $32.50

GE #K-2449A
Primary: 9.33 KV, 50 ohms Imp.
Secondary: 28 KV, 450 ohms.
Pulse length: 1.05/5 usec @ 635/120 PPS, PK Power Out: 1,740 KW
Biflar: 1.5 amps (as shown) $62.50
GE #K-2748-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. Biflar rated at 1.3 Amp. Fitted with magnetron well $24.50
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. Biflar: 1.3 Amp. Has "built-in" magnetron well $32.50
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. Biflar 1.3 Amp. Fitted with magnetron well.. $29.50

VACUUM TUBES

1N21	28¢	5J23	$34.50	700B	$8.75
1P5GT	45¢	5J30	$14.50	700D	$8.75
1P30	$1.10	5J33	$4.75	703A	$1.50
2C21	35¢	C5B/5C30	$1.10	704A	95¢
2C22/7193.	7¢	7C4/1203A.	$.18	705A	75¢
2C26A	8¢	9GP7	$3.45	706A	$9.75
2J21A	$2.25	10Y	10¢	706D	$14.75
2J22	$2.50	15R	15¢	706EY	$9.75
2J2G	$2.50	39 44	8¢	706CY	$9.75
2J27	$3.00	QK59	$39.50	708A	$2.10
2J29	$18.50	QK60	$35	709A	$2.45
2J31	$13.95	QK61	$50	713A	85¢
2J32	$14.50	QK62	$54	C-722A	90¢
2J38	$9.00	CEQ-72	59¢	725A	write
2J37	$9.50	ML-100	$69.50	730A	$8.50
2J39	$8.25	HY 14B	25¢	800	65¢
2J48	$22.50	227A	$2.50	801	25¢
2J56	$48.50	268A	$2.25	837	85¢
2J62	$6.75	316A	50¢	843	19¢
3EP1	$1.75	355A	$12.50	861	$12
3FP7	$1.10	356B	$10.50	864	19¢
4J34	$23.50	393A	$4.50	876	75¢
4J38	$85	417A	$6.10	CK1005	35¢
4J42	$47.50	CL471A	$2.10	1625	20¢
5FP7	$1.10	WL531	$2.75	1619	15¢
5GP1	$4.50	532 1B32	$1.10	1626	10¢
5HP4	$3.50	GL559	75¢	1629	10¢
				8012	$1.75

BARGAIN SPECIALS

500 MC. RECEIVERS, Type ASB. Uses lighthouse cavity-tuned RF Amp. and Mixers, plus GL-446 oscillator. I.F. is 60mc. New, less tubes. $7.50
CAPACITOR, Split Stator, 30-200 MMF, per section, 6 KV. working, air space—0.168", Mfg. Cardwell. $14.50
POWER SUPPLY and modulator, MP-28. For TA-12 transmitter. Dynamotor rated: Input: 28 VDC/14.8A. Output 540V/450 MA. New. $21.50
TU-6 Tuning Units for BC 375 transmitter. Brand New, complete with case $3.95
RANGE CALIBRATOR. Sickles, Mod III. For Accurate checking of Sweeps, Markers, and Range Scopes ..... $185.
PANORAMIC ADAPTER AN/APA-10. A Combined Panoramic Adapter and Scope. Has 3 inputs for feeding in receiver I.F.'s of 455KC, 5.2 Mc or 30 Mc. Designed also to be used as regular scope for testing other equipment. Has both vertical and horizontal push-pull amplifier inputs, etc. Complete with 21 tubes including 3" CR tube and instruction manual. For operation on 115V 400~ **$115.00**
MN 28Y Control box, unit of MN 26 compass. New $5.75
Noise filters, Mallory NF1-1. 100 amp/35 vdc. $1.00
Power supply unit, navy type—EL-2. Input: 115 vac, 60 cy. Output: 135 vdc 10 ma, 90 vdc/5ma; 3 vdc 360 ma. New, complete with spare parts box. To be used with model TBX radio gear. $9.50
Coaxial switch, 12 position, with type "N" fittings. Type SA-14/SPR-1 ..... $27.50
Amplifier, Altec A-127. 15 Watts output with response from 20-20,000 cps. Operates from 115 v, 60 cps. Std. rack panel mtg. Used, excellent. $103
Pulse analyzer, type APA-6. With 3 in. scope. $235
BC 602 Control box for SCR 522 (pushbutton). $3.75
24-volt Transformer. Input 115 v/60 cy. Output 24 v/3A $1.79
Phase-shifter. Helmholtz type: 0-360 deg. shift $2.50
Capacitor, oil-filled, 0.25 mfd./25,000 volts dc. $15
Hydrophone. MODEL MI-2. A lattice of 3 crystals in a disk-like structure; 17-37 Kc $27.50
AN/CRW-2A Remote control receiver, for operating target planes, etc. New, with soundproof mounting box $34.50
TEL. REPEATER, EE 89, complete with tubes and tech. manual $17.50
TEL. REPEATER, EE 99, with 12 vdc. vibrator power supply (DP 204) $49.50
F.T.&R. 101-A. Two-wire applique, contains equalizing devices, and balancing circuits. Used for adapting 2-wire military circuits to 4-wire systems $47.50
RADAR TRAINER, Model 15-C. Brand new, complete with pulse generator, power supply, main unit, all cables and instruction book $125
UNDERWATER MICROPHONES, Model JH—Consists of a mosaic of 7 crystals. May be used at 17-37 Kc. omnidirectional. 50 ohm output. $27.50
SA-1A/APA-1 Motor Driven Coaxial Ant. Switch DPDT. Continuous Operation from 24VDC. Completely Enclosed $24.50
MP-22 MAST BASE Mobile Antenna Mount.. $1.59
SA1A/APN-1 Altitude Limit Switch for APN-1 Altimeter $7.95

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For Rural Areas, Hotels, Commercial Steamers, Ball Parks, Etc.

U. S. NAVY type PAE-1 Electric Megaphone equipment is designed for voice reinforcement in much the same manner as, but to a greater degree than, the familiar acoustic megaphone. Consists of Megaphone Unit (which combines a microphone and reproducer in a single assembly.) Portable Amplifier which electrically amplifies the output signal of the microphone section of the megaphone and feeds this amplified signal to the reproducer section. Charging Rack for recharging the self-contained storage battery of the portable amplifier. BRAND NEW **$129.50**

X BAND – 1" x ½" WAVEGUIDE

AT-68/UP 3 Cm Horn with type N. feed for receiver measurements, etc. New (as shown) $7.45
ROTARY JOINT (AIS-6) Sperry PTF #658275. 180 deg. rotation, choke-to-choke. Has "Built-in" Di-Coupler, 20 DB., with "N" Takeoff $22.50
PARABOLOID DISH, 18" diam. Spun Aluminum, 8" Focus. For AN/APS-6 ..... $4.95
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FLEXIBLE SECTION 9 in. long. Cover-to-Cover. $5.50
3CM. DIPOLE FEED, 15" L. for APS-15 ..... $14.50
MITRED ELBOW, Cast aluminum, 1¼" x ⅝" W.G. W.E. Flanges. "E" Plane $3.50
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. $35.00
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RG52/U Waveguide in 5' lengths, fitted with UG 39 flanges to UG40. Silver plated ..... per length $5.00
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Pressure Gauge Section with 15 lb. gauge $10.00
Directional Coupler, UG-40/U Take off 20db $17.50
MAGNET AND STABILIZER CAVITY For 2J41 Magnetron $24.50
90 degree elbows, "E" or "H" plane 2¼" radius.. $8.50
ADAPTER, waveguide to type "N", UG 81-U, p/o TS 12, TS-13, Etc. $7.50
ADAPTER, UG-163/U round cover to special PTL Flange for TS-45, etc ..... $2.50 ea.

3 CM. TEST SETS

TS 12/AP. For standing wave measurement of plumbing, TR/ATR boxes, crystal mixers, antennas, etc. The TS 12 consists of two basic units: Unit 1 is a high gain stable amplifier followed by a 3-inch meter which reads SWR directly. UNIT 2 consists of waveguide accessories, including a slotted line, probes, dummy load, adapters, etc. Either bolometer or crystal input may be used. Both units are portable, self contained. Operates from 115 v. 60-800 cps. New*
TS 13/AP. Signal source 9305-9445 mc, 50 microwatts. Comes with a wavemeter, thermistor-bridge power meter, and calibrated attenuator. Oscillator is a klystron type 723/a-b which may be internally (self-synch) or extremely pulsed. Controls are provided for FM operation, variable pulse delay, pulse width and phasing. Operates from 115 v. 600-800 cps. New*
**Send for pricing and delivery schedules*

10 CM.—RG48/U Waveguide

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 $12.50
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 $15.00
BEACON LIGHTHOUSE cavity p/o UPN-2 Beacon 10 cm. Mfg. Bernard Rice, each $27.50
MAGNETRON TO WAVEGUIDE Coupler with 721-A Duplexer Cavity, gold plated $31.50
721A. TR BOX complete with tube and tuning plungers $12.50
McNALLY KLYSTRON CAVITIES for 707B or 2K28, 2700-2900 MC $4.00
HOLMDELL-TO-TYPE "N" Male Adapters, W. E. #D167281 ..... $2.75
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
K-Band, X-Band Eqpt. Available ..... Send for List

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Model 15: 30 Mc Center frequency. Bandwidth 2.5 Mc gain figure: 65 db. Uses 5 stages of 6AC7's. Has D. C. Restorer and Video Detector A.F.C. Strip included. Input impedance: 50 Ohms. Less tubes. $17.50
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UG 40A/U	$1.85	UG 52A/U	$3.40

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TS 45/AP Meter Micro amps 0–100	50.00
TS 46/AP wavemeter (micro amps) DC 0–200	15.00
TS 146/UP 115 V 1 ph. w/horn & coupler	450.00
TS 134/UPM wavemeter	25.00
TS 133/UPM wavemeter	20.00
TS 100/AP wavemeter checked	40.00
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I-210 Test Set for SCR 300. 3F9-210	6.50
I E 36 Test Set for SCR 522 less meter . . . new	5.50
I E 46 w/BC 906 freq. meter 180–220 MC	9.50
BC 1068 Receiver 157–211 MC	3.50
I-196A Sig. Gen. 150–234 MC	4.50
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BC 412	Oscilloscope 12 V, 120 W comp.	17.50
BC 434	Control boxes for SCR 269	1.75
BC 232	Control w/switch-jacks-sockets . . . new	.20
BC 335	Control w/switch-jacks-potentiometer . . .	.20
BC 461	Reel control box . . . new	1.00
BC 966	w/18 volt motor 10 tubes	5.50
BC 659	Rec-Trans. 6 to 12 V for SCR 609–610 . . .	12.50
BC 604	Transformer 2Z6494A/T3	.40
BC 446J	Transmitter 200–400 KC, 100 W, 115–230 V, 60 cy, 1320 VA . . . used	200.00
B 357	Receiver w/meter IS 122 Meter . . . 100 @	1.75
BC 800	w/FT 416-BD142—cables . . . boxed new	40.00
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FL 15	3Z1890–15 10 A. 30 VDC . . . new	.16
FL 5		.40
FL 6	Filter power for DM 21 . . . new	1.50
FL 8	Filter power for DM 21 . . . new	1.00
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T-30	New .35 used 1000 for	100.00
ID11/APS-4		2.00
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Pump Unit	—air mileage—air position indicator AN 5842–1 . . . new	4.50

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Crystals	Sets of 80	4.00
	Sets of 120	5.20
	Misc. type 30.00 per 1000	
	FT 241—FT 243—FT 500	
IN 21	Crystal tube . . . 5000 @	.07
Coil	3C625–20 for SCR 609–610 . . .	.15
M359	Coupling	.10
TRC–8	Chests AB48/TRC–8 w/sledge hammer, ropes, cables, antenna 2A–248–41.1 in chest CY 54	12.50
3Z7702–4/S1	Oak wood support for S4/TPS–3 . . . 500 @	1.50
Choke	3C382 for SCR 609–160 . . .	.15
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CU 92 Antenna coupling Unit for BC 348 . . .		4.50
Indicator freq. meter model 637		4.50
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Radar target reflector has ascent of 1000 ft per min. . . new		.50
ANBH-1	. . . new	.40
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Pilot control box for RL24C interphone w/2 cables 10 ft. lg. & PL55 & 68		3.50
Navigators sta. box for RL 24C interphone w/jack etc.		.75
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MK II Control box Russian tank . . . new		.75
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Metal coating to resist high temp. in cont. w/2 pint solutions; 1 brush, 1 spatula . . . 100 boxes @		.50
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MD 7/Navy mod. like BC 456 w/tube		3.50
Oil temp. gage ST Warmer 442010–108		.35
Potentiometer 400 ohm 4A2557/24–37		.10
YJ1 Radio complete . . . new		55.00

Modif. kits 2Z5727–88 w/tubes 5OC5—35W4—12AT6—12AW6		4.50
M 299 Microphone adapter		.75
Vibrator VB–8 . . . new		.25
Recorders BC 791 . . . new		40.00
Podder cond. assy. 2S274N/C4 for MN 26		.75
MC 203 . . . new		2.50
BG 81 for BC 221 . . . new		1.50
Balloons inflate 13 ft		1.50
Balloons inflate 6 ft		.75
Balloons inflate 2 ft		.25
JK 33 & JK 34 & JK 48 . . . new		.10
SW 225 Switch for ART-13		.75
MC 211		.20
Circuit breaker 3H900–0–22 for PE 101		.75
CPN–8 comp. w/case CY 68/CPN–8 w/monitor coder TS 121/CPN 8; modified receiver coder T50/CPN–8. voltage control CN11/CPN–8		325.00
ARC–1 Autotunes . . . new		2.75
ARC–1 Autotunes . . . used		1.00
TRC–1 Connector 2Z3063–33 . . . new		.25
TRC–1 Transf. 2Z9635–23 . . . new		.75
CS 70 Cases for TC–2 control office for M 205 4C2870 . . . new		6.50
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Brushless all type motors		
JK 48 w/cord . . . new		.10
MC 125 Remote control w/dial—crank—filling . . .		.25
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BN–1 105–125 VAC, 50–425 cy w/rec. trans. CT 250 ACW Modulator CFN 43ACB. Antenna CTZ 66AFJ, Cabinet CFN 10233 . . . new	95.00
AN/TRT–1 2S5012–1 Radio Set . . . new boxed	22.50
GP–7 650–1500 KC, 3000–9050 KC w/3 meters . . . 20 @	11.50
T87/TRT–1 comp. w/spare tubes LM27 C152/TRT–1 crystals	35.00
T9/APQ–2 200–500 MC, 20 Watt	15.00
BC 223	12.50
T15/RAC–5 Xmtr. w/crystal–tubes 500–800 KC	25.00
T39/APQ–9 Radar 80/115 V, 400–2600 cy @ 26 V . . . new	15.00
T 5 Vacuum tube Xmtr. 250–500 KC	25.00
GF 11/RU–16 3000–3675 KC, 3675–4525 KC; 6000–7350 KC, 7350–9050 KC; 4 bands w/antenna current meter type DW 32	3.25
500 KC Transmitter w/reel of wire copper 300 ft . . . new	5.00
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GO–9 Transmitter equip. 300–600 KC & 300–18100 KC cw/Xmtr. CAY 52193, CAY 52192. Rectifier CAY 20103; all band . . . new	35.00
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FT 244 for SCR 522	4.00
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MT 277	.75
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MT 42	.50
MT 96/APS–3 for MD 5 . . . new	1.00

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W.E. D162241 . . . new	.25
2S 270/K 12 w/6 tubes 532A, 2 cond. connectors, clamps, fuses, insulators, 2 cables 15 ft. ea. w/PL 259 tubing assy. etc . . . new boxed	5.50
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Meter Test 0–35 milliamperes DC triplett #0221–T . . . new	.95
Microammeter 0–500 2" scale length DeJur type 210 . . . new	3.50
J 17/ARC–5 . . . 2000 @	.25
J 84/APS–3 Junction box 2Z5600–84 w/fittings for cable part of APS–4 300 ea. . . . new	1.25
J 47 Keys . . . new	.75
JK 24 Jack	.05
BC 721 Walkie Talkie Coil & Crystal sets, 3C2610–2. consists of: 1 ea. Antenna coil C418 550 K; 1 ea. tank coil C419A 5500 K; 1 ea. Crystal FT–243 5500 KC; 1 ea. Crystal FT–243 5950 KC	.60

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Output: 26 volts; 400 cycles, 6 volt ampres, 1 phase. Input: 24 VDC; 1 amp. $19.95

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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

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Output: 115 VAC, 400 cyc; single phase; 1.53 amp; 8000 rpm. Input: 13.5 VDC; 29 amp.....$65.00

MG153 HOLTZER-CABOT
Input: 24 VDC; 52 amps. Output: 115 volts—400 cycles, 3-phase, 750 VA and 26 volt—400 cycle, 250 VA. Voltage and frequency regulated.....$95.00

PIONEER 12130-3B
Output: 125.5 VAC; 1.5 amps. 400 cycles single phase, 141 VA. Input: 20-30 VDC, 18-12 amps. Voltage and frequency regulated $69.50

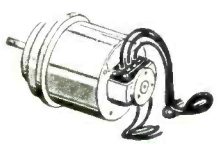
12116-2-A PIONEER
Output: 115 VAC; 400 cyc; single phase; 45 amp. Input: 24 VDC, 5 amps. $39.95

10285 LELAND ELECTRIC
Output: 115 volts AC, 750 VA, 3 phase, 400 cycle, .90 PF and 26 volts, 50 VA, single phase, 400 cycle, .40 PF. Input: 27.5 VDC. 60 amps, cont. duty, 6000 rpm. Voltage and frequency regulated. $59.50

10486 LELAND ELECTRIC
Output: 115 VAC; 400 cycles; 3-phase; 175 VA; .80 PF. Input: 27.5 DC; 12.5 amps; cont. duty.....$90.00

PIONEER 10042-1-A
DC Input 14 volts; output: 115 volts; 400 cycles, 1-phase; 50 watt....$39.50

10339 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 $49.50



SYNCHRONOUS SELSYNS

110 volt, 60 cycle, brass cased, approximately 4" dia. x 6" long. Mfd. by Diehl and Bendix.

QUANTITIES AVAILABLE
REPEATERS .....$20.00 ea.
TRANSMITTERS .....$20.00 ea.

SYNCHROS

GENERAL ELECTRIC MOD. 2J15M1; 115-57.5 volts, 400 cycle.....$22.50
KOLLSMAN AUTOSYN MTR. TYPE-403; 32 VAC; 60 cycl; single phase. $9.95
BENDIX AUTOSYN MTR. TYPE-851; 32 VAC; 60 cycle, single phase. $9.95
MICROSYN UNIT TYPE 1C-006A. $15.00
IF SPECIAL REPEATER; 115 volt-400 cycle $15.00
2J1F3 GENERATOR; 115 Volt-400 cycle $10.00
5CT CONTROL TRANSFORMER; 90-50 volt; 60 cycle.....$45.00
5F MOTOR; 115-90 volt; 60 cycle $45.00
5SDG DIFFERENTIAL GENERATOR; 90-94 volts; 400 cycle...$30.00
BENDIX TRANSMITTER TYPE C-78248; 115 volt; 60 cycle.....$22.50
DIFFERENTIAL TYPE C-78249; 115 volt; 60 cycle $5.00
BENDIX REPEATER TYPE C-78410; 115 volt; 60 cycle $37.50
REPEATER, Type C-78663, AC Synchronous 115 volt, 60 cycle....$9.95
DIEHL REPEATER TYPE FJE 22-2; 115 volt; 400 cycle; secondary 90 volt. $27.50
5G GENERATOR; 115/90 volt; 60 cycle $45.00
7G SYNCHRO GENERATOR; 115/90 volt; 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 volts; 400 cycle $12.50
2J1H1 DIFFERENTIAL GENERATOR; 57.5/57.5 volt; 400 cycle.$12.50
2J1G1 CONTROL TRANSFORMER; 57.5/57.5 volts; 400 cycle....$7.50
2J5H1 SELSYN GENERATOR; Mfr. G.E.; 115/105 volts, 60 cycle...$27.50

SIMPLE DIFFERENTIAL

Size: 2-5/32" long x 1¼" dia.; bearing one end ½" D.D., Shaft Size: 1" long, threads 8-32-¾" long, with bearing shaft ⅛" dia. x ¼" long. Gear on shaft end 1-7/16" dia., gear on bearing end 1¼" dia. Drive gear 25/32" dia.

Stock No. 101

$3.95 ea

TYPE 12121 INVERTER

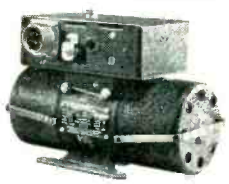
mfd. by Eclipse Pioneer input 24 volt D.C., 18 amp, 12000 r.p.m. output 115 volts, 400 cycle, 3-phase, 250 volt amp., .7 pf

Stock No. 139 **$49.50 ea.**

TYPE 12133 INVERTER

mfd. by Eclipse Pioneer input 26/29 volt D.C., 28 amps output 115 volt, 3 phase, 400 cycle, 250 volt amp., .8 pf

Stock No. 140 **$59.00 ea.**



DUAL SIMPLE DIFFERENTIAL

1:1 reverse ratio on both. Size: 3¼" long x 1-7/16" dia. Shaft size: ⅛" and 5/32".

Stock No. 110

$7.50 ea

SIMPLE DIFFERENTIAL

1:1 reverse ratio. Size: 6¾" long x 2¾" dia. Shaft size: 11/32".

Stock No. 111

$7.50 ea.

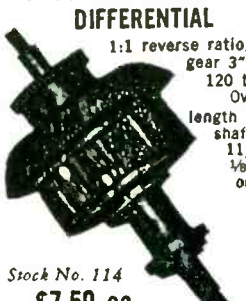
SIMPLE DIFFERENTIAL

Size: 5½" long x 2¼" dia. Shaft size: ⅜" on one end and 11/32" on other end. Hub is 1-3/32" dia. on each end.

$7.50 ea. *Stock No. 112*

PRECISION PLANETARY DIFFERENTIAL

1:1 reverse ratio, ring gear 3" dia., 120 teeth. Overall length 5¼". shaft dia. 11/32", ⅛" key on one end.



Stock No. 114

$7.50 ea.

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SOLA Constant Voltage TRANSFORMER

End Fluctuating Line Voltage

OVER 60% OFF . . . the factory price of a 1-input 2,000 VA unit! And here's another bonus! This Air Forces 2,000 VA overstock, Sola Cat. No. 30768, has 4 inputs! 90-125 V., 190-250 V., 60 cy. or 50 cy. Isolated secondary is constant 115.0 V. ± 1% from no-load to full-load of 17.4 amp. So, if you choose, use it as a 220:115 V. step-down. And slash $147.50 off the factory 1-input price!

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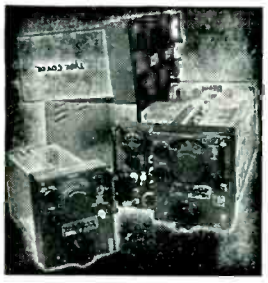

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OA3	.90	EL-3CJ	7.00	6SK7Y	.40	WE-123A	5.00	WE-350A	2.85	807W	4.00	1630	.40
OA5	4.00	3C22	60.00	6SN7WGT	2.00	WE-124A	3.75	350B	2.85	808	1.40	1631	1.40
OB2	.75	3C23	3.50	6SU7GTY	2.25	VT-127A	2.35	WE-351A	6.00	809	2.70	1632	.50
OB3	.75	3C24	2.50	7BP7	5.00	F-128A	19.00	WE-352A	15.00	810	10.00	1633	.75
OC3	.70	3C31	2.25	7CP1	15.00	HF-130	.90	F-353A	2.00	811	3.00	1634	1.35
OD3	.70	3C33	9.50	7EP4	10.00	VR-150	.70	WE-353A	3.50	811A	3.50	1635	1.50
EL-C1B	2.25	3C37	25.00	9GP7	5.00	FG-154	15.00	WE-354A	14.00	812	2.25	1636	1.20
EL-1C	1.50	3C45	6.50	9LP7	3.50	HK-154	5.00	WE-355A	15.00	813	11.00	1641	1.50
1B22	1.35	3D21A	3.75	9MP7	7.50	VT-158	9.75	WE-359A	3.00	814	1.75	1642	.50
1B23	3.00	3D22	9.75	10Y	.25	FG-166	16.50	WE-368A	2.00	815	1.50	1644	1.00
1B24	5.50	3DP1	3.75	CE-11V	2.50	FG-172	16.50	371A	1.50	816	1.50	1649	1.00
1B27	10.00	3DP1A	7.50	12A6	.50	QK-181	20.00	371B	1.50	822	10.00	1654	3.50
1B32	1.00	3E29	9.00	12DP7A	35.00	FG-190	7.50	F-375A	15.00	826	.75	1655	2.00
1B35	4.50	3EP1	2.00	12GP7	15.00	HF-200	12.50	WE-388A	1.50	828	7.50	1656	6.50
1B38	30.00	3FP7	2.00	12J5WGT	1.50	CE-201	3.50	WE-393A	5.00	829	6.00	1661	6.00
1B40	3.00	3FP7A	5.00	12K8Y	.50	CE-203	5.00	394A	1.85	829B	9.00	1846	35.00
1B42	4.50	3GP1	2.50	12L8GT	.85	203A	4.75	WE-394A	3.50	830B	.85	1851	1.75
1B59	10.00	3HP7	3.00	LM-15	100.00	203Z	5.00	WE-396A	3.00	832	3.75	1904	10.00
1C21	2.00	3J21	50.00	NE-16	.30	204A	25.00	WE-404A	10.00	832A	5.00	1960	.50
1P23	2.00	3J31	35.00	FG-17	3.25	WE-205B	.75	410R	100.00	833A	30.00	1984	10.00
1P30	2.00	3K27	150.00	RK-19	.85	207	50.00	WE-417A	12.00	834	5.75	2000T	150.00
1P32	1.00	3KP1	7.25	RK-20A	8.00	211	.50	WL-417A	3.85	835	5.00	2050	1.00
1P34	1.75	3RP1	7.25	TZ-20	1.75	WE-211C	10.00	WE-418A	12.50	836	2.00	2051	.65
1P36	2.50	4-400A	40.00	CE-21C	3.00	WE-211D	8.00	WE-421A	14.00	837	.90	2172	12.50
1Z2	2.00	KC-4	75.00	RK-21	.85	WE-212E	25.00	GL-434A	10.00	838	.90	2183	5.00
VG-2	10.00	4AP10	3.75	RK-22	3.50	217A	1.50	446A	.50	842	2.25	ZB-3200	75.00
2AP1	4.50	4B22	6.50	CE-23C	1.40	217C	3.00	446B	1.85	843	.35	R-4100	6.25
2AP1A	5.00	4B23	9.00	PJ-23	2.00	WL-218	20.00	450TH	35.00	845	5.00	R-4330	10.00
2AS15	5.00	4B24	5.50	RK-23	2.50	CE-220	.50	450TL	35.00	845W	8.50	5528	3.75
2B21	1.00	4B25	8.00	HK-24	2.85	CE-221	8.00	451	5.00	846	100.00	5550	25.00
2B26	1.50	4B26	3.00	HK-24G	2.00	221A	2.00	WL-460	10.00	849	22.50	5551	25.00
2C21	.50	4B27	3.50	CE-25A/B	2.00	CE-222	1.50	464A	2.25	851	10.00	5553	100.00
2C22	.35	4B28	3.00	RK-25	2.50	CE-224	5.50	WL-468	15.00	852	5.00	5556	6.75
2C24	.75	4B30	.75	25T	2.85	CE-225	3.00	RH-507	35.00	860	3.00	5557	3.25
2C25	.35	4B32	10.00	25TG	1.40	CE-226	3.00	CK-510AX	.50	861	15.00	5560	20.00
2C26A	.50	4C22	7.50	FG-27A	12.00	WE-231D	2.00	WL-525	12.50	864	.35	5610	1.00
2C33	.75	4C25	3.00	CE-28D	2.50	RX-233A	.75	527	25.00	865	.50	5625	75.00
2C34	.35	4C27	3.50	RK-28	2.50	CE-235A	5.00	WL-530	25.00	866A	1.10	5632	7.50
2C39	7.00	4C30	1.50	28D7	.75	235R	50.00	WL-531	7.50	866 JR	1.50	5645	6.50
2C39A	10.00	4C35	15.00	28D7W	1.50	WE-242A	5.00	WL-532A	1.00	868	2.00	5650	85.00
2C40	7.50	4E27	8.75	CE-29	1.25	WE-242C	8.00	WL-535	10.00	869B	24.50	5651	1.35
2C42	13.50	4J52	35.00	CE-30C	1.25	WE-249B	2.85	WL-538	.50	GL-872A	2.50	5654	1.50
2C43	7.50	4X100A	20.00	Twin 30	7.50	WE-249C	2.85	GL-553	2.00	CE-872A	1.50	5656	7.00
2C44	.35	EL-5BHD	9.00	HY-30Z	2.65	250R	4.75	559	.50	872A	1.35	5670	1.85
WE-2C51	3.00	EL-5B2.5	6.50	CE-31V	2.40	250TH	20.00	GL-564	1.50	874	.50	5687	2.50
2C53	10.00	5AP1	2.00	FG-32	6.00	250TL	15.00	575A	15.00	876	.75	5691	4.75
2D21	.65	5B21	2.00	FG-33	15.00	WE-251A	47.50	WL-579B	10.00	878	.50	5696	1.00
2D21W	1.40	5BP1	2.50	RK-33	.50	WE-252A	9.50	KU-610	4.75	879	.35	5703	1.15
2E22	2.00	5BP1A	10.00	RK-34	.35	WE-253A	5.00	HY-615	.50	884	1.00	5720	11.50
2E24	2.25	5BP2A	6.00	35TG	3.00	WE-254A	6.00	WL-629	1.25	885	1.00	5725	1.90
2E25	1.85	5BP4	2.50	RK-38	6.50	HK-257B	9.00	WL-630	1.00	902P1	3.25	5726	.75
2E26	3.25	5C21	6.00	RK-39	1.50	WE-257A	3.50	631-P1	6.25	905	2.00	5728	9.00
2J21A	2.75	5C22	28.00	T-40	2.35	FG-258A	100.00	WL-632A	17.50	913	15.00	5740	44.00
2J26	4.75	5C30	1.00	TZ-40	3.50	WE-259A	12.50	WL-655/658	100.00	917	2.50	5763	1.00
2J27	4.75	5CP1	2.00	CE-42C	1.50	WE-261A	10.00	WL-670A	8.00	918	2.00	5801	2.50
2J29	15.00	5CP1A	10.00	RK-44	1.00	WE-262B	7.00	WL-681/686	25.00	919	2.40	5827	2.50
2J30	15.00	5CP7	7.00	QK-47	50.00	WE-264C	3.00	WE-701A	1.85	920	3.00	5829	1.00
2J31	14.50	5D21	6.50	RK-47	1.75	WE-267B	10.00	702A	.50	921	1.00	5842	12.00
2J32	14.50	5D23	7.00	CE-48	1.75	WE-268A	7.50	702B	1.00	922	1.20	5847	10.00
2J33	14.50	5FP7	1.35	RK-49	2.85	WE-271A	10.00	703A	1.50	923	1.40	5932	4.00
2J34	14.50	5FP14	5.00	HY-51B	.85	WE-272A	5.00	WE-704A	.85	924	1.35	5933	4.00
2J36	15.00	5GP1	5.00	FP-54	44.00	WE-274A	4.75	705A	.75	925	2.00	5948	250.00
2J37	5.00	5J26	100.00	HK-54	2.00	WE-274B	2.00	707A	3.50	926	2.50	5963	.90
2J38	10.00	5J29	6.75	T-55	3.50	274B	.75	707B	4.50	927	1.00	5981/5650	85.00
2J39	10.00	5J30	6.75	RK-57	4.50	WE-275A	5.00	WE-708A	.75	928	2.50	5998	15.00
2J40	15.00	5J32	20.00	RK-58	.90	276A	3.00	WE-709A	1.00	929	1.25	6011	4.75
2J50	35.00	5JP1	15.00	QK-59	25.00	WE-282A	7.50	710A	.50	930	1.25	6013	10.00
2J51	150.00	5JP2	7.00	QK-60	25.00	WE-283A	4.00	713A	.35	931A	2.70	6031	4.75
2J53	25.00	5JP4	7.00	RK-60	1.50	WE-285A	5.00	714AY	25.00	954	.30	R-6160	2.00
2J55	50.00	5JP5A	7.00	HY-61	1.25	WE-286A	6.00	715A	2.00	955	.35	R-6175B	1.00
2J56	75.00	5JP11	15.00	QK-61	25.00	287A	3.50	715B	4.85	956	.35	R-6200	.65
2J61	15.00	5LP1	7.50	RK-61	3.00	WE-295A	5.00	715C	12.00	957	.35	R-6210	15.00
2J62	4.75	5LP1A	25.00	QK-62	25.00	WE-296A	25.00	WE-717A	1.00	958A	.35	UX-6653	.75
2J62A	50.00	5NP1	3.00	RK-62	1.75	HF-300	17.50	717A	.50	959	1.50	8001	8.75
2JB51	.35	5R4GY	.90	RK-63	20.00	WE-300B	5.00	WE-719A	9.50	991	.30	8002R	18.50
2K25	14.75	5R4WGY	2.50	HY-65	1.85	CE-302	3.50	721A	.90	CK-1005	.25	8005	4.25
2K28	35.00	5X3	3.00	RK-65	7.00	EL-302.5	5.00	721B	7.25	CK-1006	2.00	8008	6.00
2K30	100.00	5Z2P7	75.00	FG-67	9.00	CE-303	2.25	722A	3.50	CK-1007	.75	8011	.50
2K33A	65.00	5Z4P11	150.00	RK-69	2.00	WE-304B	7.50	723A/B	9.00	CK-1009	5.00	8012	1.00
2K41	75.00	EL-C6A	6.00	RK-72	.50	304TH	10.00	WE-724A	.85	CK-1026	3.00	8012A	2.50
2K45	45.00	EL-C6J	5.50	RK-73	.50	304TL	12.50	WE-724B	.85	R-1100	5.00	8013	2.75
2K54	10.00	EL-C6L	3.75	HY-75	3.00	WE-305A	3.00	WE-725A	3.25	R-1130B	10.00	8013A	3.75
2K55	7.50	EL-6C	8.00	RK-75	.85	307A	.85	WE-726A	7.00	1500T	85.00	8016	2.50
2P21 (Image orthicon)	50.00	6AC7W	.85	VR-75	1.00	CE-309	3.25	WE-726B	30.00	1602	2.25	8020	1.25
2V3G	1.50	6AJ5	1.15	75TL	4.75	WE-310A	3.50	WE-726C	24.00	1603	3.40	8021	.75
2X2	.35	6AJ6	2.00	VR-78	.50	WE-310B	5.00	WE-730A	7.50	1608	3.75	8022	.75
2X2A	.90	WE-6AK5	1.35	FG-81A	5.00	WE-311A	5.00	731A	1.50	1609	9.25	8023	1.50
3A4	.50	6AK5W	1.50	VR-90	.75	WE-313C	2.85	WE-732A	2.00	1610	2.25	8025	1.50
3A5	.50	6AL5W	.75	CV-92	3.50	316A	.50	WL-735	2.00	1611	1.50	8025A	2.25
3AP1	4.85	6AN5	3.00	FG-95	20.00	WE-323A	10.00	WL-741	1.40	1612	1.25	8026	3.50
3B21	5.00	6AR6	1.25	HF-100	7.50	323B	4.50	750TL	42.50	1613	1.00	PD-8365	50.00
3B22	1.50	6AS6	1.35	ML-100	75.00	327A	2.50	WL-759	12.50	1614	1.50	9001	.85
3B23	3.50	6AS6W	1.50	100R	5.00	WE-328A	3.50	WL-786	16.50	1616	.50	9002	.65
3B24	1.35	6AS7G	1.85	100TH	6.50	WE-329A	7.50	800	1.50	1619	.35	9003	.90
3B24W	5.00	6BM6	25.00	WE-102D	2.50	WE-331A	7.50	801A	.50	1620	3.25	9004	.35
3B25	3.00	6C21	20.00	FG-105	12.00	WE-332A	25.00	802	2.50	1621	1.50	9005	1.00
3B26	3.00	6G4	2.00	VR-105	.70	WE-336A	5.00	GL-803	2.00	1622	1.50	9006	.25
3B28	5.50	6J4	3.25	VU-111S	1.00	WE-337A	6.00	803	1.40	1623	2.35		
3B29	6.75	6J6W	1.25	HY-114B	.75	WE-339A	12.50	804	9.00	1624	.95		
3BP1	2.50	6L6WGB	3.35	WE-121A	3.50	WE-347A	3.50	805	4.50	1625	.30		
		6Q5G	2.00	WE-122A	1.50	WE-348A	5.00	806	7.50	1626	.25		

The prices quoted above are FOB shipping point

western engineers

ELK GROVE, CALIFORNIA

GEORGE WHITING, OWNER

All tubes are new individually cartoned, fully guaranteed

FOR SALE

WHOLESALE ONLY . . . MINIMUM ORDER $25.00

ARC-5 SETS

R21/ARC-5	3000-6000 KC Receiver	$5.50
R22/ARC-5	6000-9100 KC Receiver	5.50
R23/ARC-5	190-550 KC Receiver	7.50
R24/ARC-5	520-1500 KC Receiver	5.50
R25/ARC-5	1500-3000 KC Receiver	7.50
R26/ARC-5	3000-6000 KC Receiver	5.50
R27/ARC-5	6000-9100 KC Receiver	5.50
R28/ARC-5	100-156 MC Receiver	5.50
T18/ARC-5	2100-3000 KC Xmtr.	5.50
T19/ARC-5	3000-4000 KC Xmtr.	5.50
T20/ARC-5	4000-5300 KC Xmtr.	5.50
T21/ARC-5	5300-7000 KC Xmtr.	5.50
T22/ARC-5	7000-9100 KC Xmtr.	7.50
T23/ARC-5	100-156 MC Xmtr.	5.50

COMMAND SETS SCR-279

BC 453	190-550 KC Receiver	7.50
BC 454	3000-6000 KC Receiver	3.50
BC 455	6000-9000 KC Receiver	3.50
BC 456	Modulator Mod	3.50
BC 457	4000-5300 KC Xmtr.	5.50
BC 458	5300-7000 KC Xmtr.	5.50
BC 459	7000-9100 KC Xmtr.	5.50
BC 696	2000-4000 KC Xmtr.	10.00
BC 942	100-156 MC Xmtr.	7.50

MOTORS

PE 143	Generator	210.00
PE 79	Generator	410.00
PE 120	Inverter 6-12 or 24 V out 90/145 V for SCR 609-610 ea.	5.50
PE 77D	Generator 250 W 110 V D.C. new	95.00
PE 75	Generator sets 2.5 KVA, 120 V 60 cy w/7 hp eng	350.00
PE 99	Gas 100 V, 60 cy, 3 ph, 7.5 KVA new	350.00
PE 95	Mounting front 3H4595A/M2 new	7.50
PE 118	new	5.50
PE 73		4.50
Power supply	Rec. 30 full wave inp. 95-125-190-250 V AC, 25-40-50-60 cy; out 120 V DC, 0.9 A, 1 ph new	20.00
Power supply	3H4330-10 for Xmtr ET8026 inp. 6 V DC, 11 A; out 500 V DC, 75 MA new	20.00
RA 87	Power supply 95-250 V, 50/60 cy AC supplies 115 V DC, 50/60 cy motors DC output 0.400 A @ 115 V AC output 500 VA new	25.00
Motor	#DK-3 Reversing	2.50
PE 118	Inverter	4.00
PE 206	Inverter	12.00
PE 218	Inverter	7.50
PE 103	Inverter	15.00
PE 103	Circuit breaker 3H 900-0-22, 24 V, 0.22 A	.35
PE 112	Power Unit	5.00
PE 112	Inverter	5.00
PE 126	Dynamotor	10.00
PP 104	Power supply	5.00
DM 64A	inp. 12 V; out 260 V; 5.1 A, 5000 RPM new	22.00
DM 35D	12 V new	7.50
DM 35	spare parts 3H 1635 C/SP2	1.75
DM 42A	new	5.75
DY 8/ARC-5	Motor new	2.00
DY 2/ARR-2	new	2.50
DY 12/ART 13	new	18.50

ARC-3 MATERIAL

T 201 Col 55011 2Z9641	1000 @	.35
T 202 55020 2Z9641-196		.35
T 203 55135 2Z9641-19		.35
T 204 55134 2Z9641-198		.35
T 205 55135 2Z9641-197		.35
C-118/ARC-3 Push button switch 9 sec. SPST, S 501 Col. 56200 3Z9824-83.1, 120 ea. new		1.75

CAPACITOR

3DB 6-10	6 MFD 400 V ref 70 for BC 348 new	.75
3DA 5-53.1	for SCR 609-610	.15
3DA 350-8	C 103 for R5/ARN 7	.50
3DA 500-47	for BC 348 500 new	.40
3D 9147A2-1	Capacitor for BC 654	2.50
3DB 2-338	C 105 3 sect. for R5/ARN 7	.50
2-330F	C 106 3 sect. for R5/ARN 7	.50
3DB 4E 5-1	C 102 for R5/ARN 7	.50
3DB 5-9	C 65 for R5/ARN 7	.75
3DB 50-27	CA 325 for R5/ARN 7	.50
3DB 50-35	C 104 for R5/ARN 7	.50

CORDS

CD 478 5 ft. 1 cond.	new	.10
CD 494 for Ts 13—TS 15 w/PL 55 & 68		1.50
CD 508W/8W 141 & JK 48 w/2 cords and PL-68		.50
CD 571 7 cond. w/2 plugs for SCR 211, T 39, BC 745		.60
CD 716 w/JK 56 and PL 55	new	.50
CD 814 13 ft. 9" for RC 109	new	.75
CD 874 6½ ft. 2 cond.	new	.75
CD 944	new	25.00
CD 1099 w/RG 54/AV for RC 184	new	1.50
CD 1216 w/PL 55	new	.40
CD 1250 w/PL 291	new	.15
CD 335	new	35.00
CD 802		1.75
CC 59 w/PL 11	new	.50
CO 335 cable 14 ft. w/SO 300 plug for SCR 399 new		10.00
CD 605 6½ ft. lg. w cond color coded 6000 ea.	new	.04
CD 365 w/2 PL 108 for R5/ARN 7	new	.75
CD 620 Cord for HS-30	new	.10
CD 411 Cable w/PL-114 for BC 191—BC 375—SCR 210		.75
CD 358 Cable w/PLS 64 for BC 191—BC 375—SCR 210		.75
CD 410 Cable w/PLS 64 for BC 191—BC 375—SCR 210		.75
CD 747 w/2 plugs—2 clamps for SCR 268		.65
IF 50-G1-4 Cable 5 cond for PE 157		.25
CD 814 Cable for RC 109A		1.25
Cable 3E1571A/1.39" for SCR 511		.60
Cable 3E1571A/2 27" for T 39		.40
CC 65 36" w/PL-47	new	.20
CC 65 36" no plug	new	.05
CD 604 w/C 410 and PL-54	new	.25
CX 179/AIC coiled cord microphone extends to 10 ft.	new	1.50
IF 4B1-3.130 Cable stud Bendix		2.50
3E 1605-1.12 CD 605 w/PL 55 & CD 410		.50

CONDENSER

3DB 500-28	500 MFD 200 V for GR-8	.40
CA 60	3 MFD new	.40
CA 59	3 MFD 150 V new	.40
CA 270	1000 MFD 500 V for BC 222 new	.40
CA 275	4 MFD 50 V new	.40
CA 276	3X0.1 MFD 200 V for BC 312	.40
CA 277	for BC 312 new	.40
CA 284	50000 MMF for BC 312 new	.40
CA 325	for BC 223	.75
CA 326	3 sect. for BD 87	1.00
CA 329	for BC 312	.40
CA 335	for EE 8	.25
CA 389	1 MFD 600 V for RM 29	.15
CA 411	250,000 MMF 200 VDC for BC 620	.10
C 182	25 MF 50 V for BC 653	.15

Headset Wireless #19 w/hand micro new		3.50
HS-33 w/plug & cushions used		2.50
HS-33 w/plug & cushions new		5.00
HS-23 w/plug & cushions used		2.75
HS-23 w/plug & cushions new		4.00
HS-38 w/2 Rec. ANB11 cord & Plug new		1.00
HS-18 w/2 Rec. R-14 cord & Plug new		1.00
HS-30 new		1.00
H 16/U w/2 Rec.-Plug PL 55 & cord		1.50
HS 22 w/cord & PL 55 w/receivers new		.60
Head & Chest sets EE 70 w/2 receivers, Transmitters, Cord new		1.00
2Z 5731-337 impedence matching kit MX 337/UR for Headset AN/URA-1		.35
Headset Adapter MC 385A		.20
Headbands W.E. 11A w/padding for W.E. 716 Receiver 700 ea new		.25
W. E. Headset 716 w/11A Headband		.75
Cushions, rubber		.15

HANDSETS

TS 15 w/cord & plug PL-68 & PL 55	4.50
TS 9 w/cord & push to talk switch	3.50
Receiver Caps	.10

R5/ARN-7 MATERIALS

Capacitor			
3DA 350-8	C 103	new	.50
3DB 2-338	C 105 3 sect.	new	.50
3DB 2-330 F	C 106 3 sect.		.50
3DB 4E5-1	C 102		.50
3DB 50-27	CA 325		.50
3DB 50-35	C 104	new	.50
3DB 5-9	C 65	new	.75
3DKA 25-10.1		new	.35
Dehydrator	2Z3608-8	new	1.50
Relay	2Z7698-1 AC66689-1	new	1.00
Cable	CD 365	new	.75

TUNING ASSY for R5/ARN-7

Ref 600 Stk. #2C 3035-5/T3			3.50
603	2C 3035-5/T7		2.50
608	2C 3035-5/T5		3.50
Transformer 2Z K9638-6		new	.75
Tuning Assy. Ref. 603		new	2.50
Tuning Assy. Ref. 608		new	3.50

R5/ARN-7 MATERIAL

Transformer			
T-13 2C3010A/T3		new	.30
	2C3014A/T22	new	.75
T-58 2Z9638-6		new	2.00
Terminal Board 2C3014A/T4		new	.75
Contact Distr. 2A270A/8		new	.75
Tuning OSC 2C3010B/T42		new	1.00
Tuning Assy. 2C3014A/T39		new	1.50
Tuning Assy. 2C3014A/T40		new	1.50
Tuning Assy. 2C3014A/T41		new	2.50
Coil RF 3C1081C Ref 170		new	.50
MC 124 Cable			1.00

BC 610 MATERIAL

C 447 B Tank coil	new	3.00
TU-47, TU-48, TU-49, TU-50, TU-51, TU-52	new	4.00
Test Sets	new	6.50
Speaker Phone Hallicrafter 14166		
J44 keys		.75
Channel strip rubber 2Z2200-6		.15
Relay 2Z7550-4		1.25

BC 611 MATERIAL-WALKIE TALKIE

C 360 Coil	new	.10
C 363 Coil	new	.10
C 365 Coil	new	.10
C 366 Coil	new	.10
C 369 Coil		.10
C 372 Coil		.10
C 374 Coil		.10
2Z535A/C2 Capacitor	new	.15
Cap. microphone & earphone, blk. annodized, Alvin, 37 holes 2000 ea.		.15
2Z3351-51 Cover assy. Rec. button #TA 7 w/button cover plate		.75
Cover top assy. 2C5351C/A2.1 com	new	.75

BC 348 MATERIAL

CU 92 Antenna coupling unit		4.50
Transformer output	new	1.50
Tuning assy. Ref. 190	new	2.50
Tuning assy. Ref. 193	new	2.50
Capacitor 3DB6-10, 6 MFD, 400 V ref 70		.75
Capacitor 3DA 500-47	new	.40
Detector Unit assy. Ref. 192	new	2.50
RF Unit assy. Ref. 191	new	2.50
Tube Sockets 2Z8678.20		.10
Tube Sockets 2Z8670.3		.05

SCR 522	Kits of 16 Brushes & 3 lamp Indicators new	.25
SCR 522	Receiver w/tubes	20.00
SCR 522	Transmitter w/tubes	20.00
SCR 522	Case CS 80	1.00
SCR 193	Bracket 2A 1250-11	2.00
SCR 609-610		
BC 659	Rec.-Xmtr. 6 to 12 V	12.50
CS 79	Case	3.50
PE 120	Inverter 6-12 or 24 V out 90/145 V	5.50
Crystals	sets of 120	5.50
Cable clamps	2Z1409-20	.05
Coils	3C 625-20	.15
Capacitor	3DA 5-53.1	.15
Coil choke	3C 362 new	.15
2Z3352.1	Cover assy. chain & gasket	.15

TUBES

3B24	1.75
B32/532A	.50
3FP 7	.75
2J 21	1.50
2J 22	2.00
707A	2.00
829B	4.50
2J 26	3.00

TRANSFORMER

2C9643-189 for SCR 619-BC 1335	new	1.00
2C-6494A/T3 for BC 604		
2ZK9638-6 for R5/ARN-7		.75
T 201 2Z9641 COL 55011 for ARC-3		.35
T 202 2Z9641-196 COL 55020 for ARC-3		.35
T 203 2Z9641-195 COL 55135 for ARC-3		.35
T 204 2Z9641-198 COL 55135 for ARC-3		.35
T 205 2Z9641-197 COL 55135 for ARC-3		.35
KS 8716 2C6494A/T3 for BC 604		.60
2Z9635-23 TRC 1		.75
T 201 Plate transf. for GO9 120/3600 V, 800/800 cy WEMCO 382535		1.00
T101 Transformer for APN-9		.40
C 68 4A 2969		.15
Relay Leach $1054 6A @ 115VAC	new	.50
2Z7698-1 Relay for R5/ARN-7		1.00
2Z7650-4 Relay for BC 610		1.00
2Z6750-K1 Relay for BC 800		.35
SW 172 Leich Relay		.50
SW 182 Leich Relay		.50
Switch rotary 3Z9825 80.3 6 pos. 5 sec 6 pole for SCR 543 new		.75
Switch assy. rotary 4 cont. 5 pins ARC-3030-2 for BC 231		.10
Tube Socket 2Z8678.20	new	.10
Tube Socket 2Z8670.3	new	.05
GN 33 Generator 12 V DC, 15 VAC, 375-870 cy	new	1.50
GN 38 Generators		3.50
GN 37 Generators, hand driven 8 V, 3.25 A & 500 V @ 0.1 ADC	new	5.00
GN 45 Generator	new	5.00
SCR 269F Instruction Book		1.50
Pump Unit—Air mileage—position AN 5842-1	new	4.50

RECEIVER

R 32/ARW-2		20.00
110 V, 1 ph, 60 cy, 1.38 A, 140 W	new	40.00
BC 434 3 band receiver 200-1750 KC		15.00
RL-7 w/tubes & motor		3.50
RL-9 w/tubes & motor		3.50
R4A/ARR-1 234-258 MC w/CKT for 6 channel opr. on 540-830 KC		7.50

ANTENNAS

CUF 69083 for DAQ Radio cross loop & sense	new	17.50
2A 2099-485/21 for FT 485		50.00
AN 104 Copper		1.25
AN 102 w/hardware 8 ft high	new	15.00
AS5/APS-2 Parabolic antenna 24 VDC w/motor-cables	new	40.00
SA 13/U S or D change over antenna & capacitor type 962D1	new	.75
2A 294-1 Telescope 44" Antenna		.75
A 62 Phantom Antenna	new	.75

Coil 2C8008A/D6 for BC 191-BC375	.40
Coil 3C362-24 for SCR 511	.25
Coil 3C362-25 for SCR 511	.25
Coil 3C362-26 for SCR 511	.25
Coil 3C362-34 for SCR 510	.25
Coil 3C362-35 for SCR 510	.25
Coil 3C336-11 Ohmite coil choke for SCR 522	.20

COIL

3C 328-2 for PA2	new	.25
3C 328-3 for SCR 625	new	.25
3C 328-28 for BC 800	new	.25
3C 299-360 C360 for BC611	new	.10
3C 299-363 C363 for BC611	new	.10
3C 299-365 C365 for BC611	new	.10
3C 299-366 C366 for BC611	new	.10
3C 299-369 C369 for BC611	new	.10
3C 299-372 C372 for BC611	new	.10
3C 299-374 C374 for BC611	new	.10
Coil & Shield Assy. 2C5360A/A9 for BC620		.15
W E 120 C-S 3C1376 C-8	new	.60
C447 B Tank Coil for BC610	new	3.50
2C4923A/C9 & 2C4923A/C10 coils for BC923A	new	.20
2C5360A/A6 Coil RF for BC 620	new	.10
Booster coil Eclipse 513N 24 V type B for 4M 2500 Packard Engines used on DC planes	500 ea.	4.50
2C8006A/D3 Coil for BC191		.50
2C8006A/D6 Coil for BC191		.75
BC 191 & BC 375 Resistor assy. w/MT 6 brkt. 1.2 Ohm 75 W 2C6191A/R5	new	.15
Choke Magnetic for PE 108 3H4600-108B/C4		.60
2C6530-653A/S 9 6 pos. multi ckt. SW assy for BC653		2.00
Autopilot Amplifier C1	new	9.50
Auto. pilot Mark 1V S-4 directional Gyro control	new	4.50
Rotor & Shaft assy. #203956 Sperry		2.75
TU 5 for BC 191, BC 375		2.00
TU 6 for BC 191, BC 375		2.00
TU 7 for BC 191, BC 375		2.00
TU 8 for BC 191, BC 375		2.00
TU 9 for BC 191, BC 375	new	2.00
TU 10 for BC 191, BC 375	new	2.00
TU 26 for BC 191, BC 375	new	4.00
TU 22 for BC 191, BC 375	new	4.00
TU 47 up to TU 52 for BC 610		4.00

TALLEN COMPANY, INC.

159 CARLTON AV. — **TRiangle 5-8241** — **BROOKLYN 5, N. Y.**

TEST EQUIPMENT

FLUXMETER. Measures magnetron magnets from 500 to 4000 gauss. New.....$14.95
FREQ. METER. TS-127/U. Range 375-725 Mcs. New with manual.....$34.50
PANADAPTER. AN/APA-10. For 115v., 60 cy. operation. New with manual.....$145.00
TEST OSC. TS-47/APR. 40-500 Mc. on fundamentals and 2000 Mcs. and above on harmonics. Pulse and sine wave mod. New with manual.$149.50
FREQ. STANDARD. Telrad 18A. Puts out 1000/100/10 crystal check points. New.....$23.95
RECEIVER. MX-24/APR-1. For use with tuning units TN-1, 2, 3. Nice condition.....$97.50
RECEIVER. BC-1068A. Tunes 158 to 210 Mcs. Includes 14 tubes. For 115/60/1.....$29.50
PULSE TIMER. Navy Type CUZ-50AGD. For 115/60/1. Includes tubes.....$65.00
OSCILLATOR. AN/APT-2. Radar Jammer. Tunes 450-710 Mcs. New, inc. tubes.....$29.75
OSCILLATOR. AN/APT-5. Radar Jammer. Tunes 300-1600 Mcs. Brand new, with PP-104/APT-5 Power Supply Tubes, etc.....$169.50
TEST SET. S Band. Navy Type LZ. Complete setup including Sig. Gen. Scope, Power Meter, Ant., Cables, Etc. Brand New.....$250.00
MODULATOR. Type BC-1203. For 115v., 60 cycle operation. With tubes.....$125.00
MODULATOR. Type BC-423B. Radiates 205 Mc. signal pulsed at 4,098 cps. For 115/60/1. New.....$19.50
PULSE ANALYZER. Airborne model ID-59/APA-11. New.....$149.50

HI-VOLT OIL CAPACITORS

ALL TOP BRANDS

Mfd.	KV	Price	Mfd.	KV	Price
.001	50	22.50	.2	50	29.50
.01	5	2.50	.25	15	9.95
.02	8	4.50	.25	20	15.95
.02	20	6.75	.25	50	44.50
.025	50	17.95	.5	25	39.50
.025/.025	50	34.50	1.	7.5	6.95
.1	3	1.75	1.	15	29.50
.1	4.5	3.50	1.	20	42.50
.135	7.5	6.95	2.	5.5	9.50

TRANSFORMERS

STEPDOWN. G.E. 6kva. Pri: 230/460. Sec: 115/125, 60 cy, 1ph. New.....$49.50
HI-POT. Westhse. Pri: 115/60/1. 15,000 v.c.t. @ 60 ma. Oil filled. Sec. c.t. ungrounded. New.$29.50
PLATE POWER. Raytheon. Pri: 440/220/60/3. Sec: 1310v. @ 0.67 Amps.....$39.50
RESONANT CHARGING. G.E. Type Y-3502-A. Output peak 22,800v. Kva. 2.18. Linear within 3% from .0195 to .195 Amps. New.....$79.50
PLATE POWER. Kenyon #S-10716. Pri: 220/60/1. 3 sec. coils. 1420-0-1420, 1420-0-1420, 1300-0-1300. Each 350 ma. New.....$35.00
FILAMENT. Raytheon U-5819. Pri: 440/220/60/1. Sec: 5 v.c.t. @ 30 amps. New.....$9.75
CHOKE. Oil-filled. 16 H @ 450 ma., 125 ohms. Insulation 6,000 v. New.....$9.75
SCOPE. Pri: 115/60/1. Sec. #1:4400v. rms. @ 4.5 ma., Sec. #2: 5 v.c.t. @ 3A. Insu. 15 KV..$6.75
MODULATION. For RCA type 250K transmitter, which uses a pair of 828 tubes to modulate a pair of 810's. Weight 143 lbs.....$49.50

INVERTERS

Leland Elec. Co. PE206A. Input: 28DC at 38 Amps. Output: 80V. 800 cy. 1 Ph., 485VA. New....$16.50
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13 tube double conversion receivers, frequency range 450-600 MC. This unit employs 446A lighthouse tubes in the RF section, mixer and oscillator circuits. First IF frequency of 55 MC has two stage of amplification, second IF frequency of 16 MC has 4 stages of amplification. Two video stages follow the second, detector. With schematic and tubes 8-6AC7, 3-446, 16AG7, 1-6H6. New Condition.....$9.95

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INDEX TO THE SEARCHLIGHT SECTION ADVERTISERS

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CONDENSERS

TRANS. MICA CONDENSERS

Mfd	Wvdc	Price	Mfd	Wvdc	Price
.00001	600	.20	.001	8000	3.98
.000024	2500	.35	.0015	600	.23
.000025	1200	.29	.0015	2500	.53
.00003	600	.24	.0015	5000	2.25
.00003	1200	.28	.002	600	.27
.00003	2000	1.25	.002	1200	.39
.00003	2500	.35	.002	2500	.63
.00004?	2500	.30	.002	5000	2.25
.00005	600	.23	.002	6000	2.40
.00005	1200	.29	.0024	5000	2.25
.00005	2500	.33	.0025	600	.28
.00005	5000	1.25	.0025	1200	.43
.000051	5000	1.75	.0025	2500	.65
.00007	2500	.26	.003	600	.31
.000075	5000	1.45	.003	1200	.52
.0001	600	.24	.003	2500	.73
.0001	1200	.27	.003	5000	1.65
.0001	2500	.36	.003	5000	2.25
.0001	5000	1.95	.004	600	.29
.00015	600	.23	.004	1200	.49
.00015	2500	.33	.004	2500	.91
.00015	5000	1.95	.005	600	.35
.0002	600	.23	.005	1200	.45
.0002	1200	.29	.005	2500	.98
.0002	2500	.34	.005	3000	1.65
.0002	5000	1.95	.006	600	.36
.00025	600		.006	1200	.55
.00025	1200	.19	.006	3500	1.65
.00025	2500	.35	.0062	2500	.94
.00025	5000	1.95	.0075	5000	1.75
.00027	1200	.27	.008	600	.35
.00027	2500	.36	.008	1200	.57
.0003	600	.23	.01	600	.48
.0003	2500	.36	.01	1000	.50
.0004	600	.23	.01	1250	.69
.0004	1200	.29	.01	1250	.69
.0004	2500	.29	.01	2500	.94
.0004	5000	1.95	.012	1200	.64
.00047	2500	.40	.014	600	.45
.0005	600	.23	.014	1200	.64
.0005	1200	.29	.015	600	.55
.0005	2500	.39	.015	2000	1.75
.005	3000	1.25	.02	600	.21
.0005	5000	2.45	.02	1200	.99
.005	7500	2.95	.02	2000	1.60
.0062	3000	1.25	.03	600	.65
.00068	2500	.28	.03	1200	1.18
.00089	1200	.28	.039	600	.67
.001	600	.23	.25	250	1.95
.001	1200	.32	.4	600	3.25
.001	2500	.49	2x.1	250	1.98
.001	4500	1.65	.115	2000	4.65
.001	5000	2.25			

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Mfd	Volts	Price	Mfd	Volts	Price
.001	50KV	24.95	2	5000	12.50
.0023	16KV	6.95	2	7500	21.9
.01	5000	.79	2	10KV	35.95
.01	10KV	4.95	2	12.5KV	59.50
.012	25KV	12.95	2	20KV	89.75
.02	8000	4.75	2X2	600	.85
.02	10KV	5.25	3	1000	.98
.02	20KV	10.95	3	2000	2.50
.025	50KV	22.95	3	4000	8.99
2X.025	50KV	34.50	3X3	150	.29
.03	7500	4.50	3X3	400	.68
.035	10KV	5.95	4	500	.59
.05	7500	2.95	4	600	.79
.08	12.5KV	8.95	4	600TLA	.98
.1	1500	.39	4	1000	1.89
.1	2000	.45	4	1500	2.65
.1	2000	.89	4	2000	2.95
.1	2500	.98	4	2500	4.95
.1	3000	.69	4	3000	6.99
.1	3000	1.19	4	4000	13.95
.1	7500	.95	4	5000	24.95
.1	7500	4.25	4	7500	39.95
.1	10KV	6.35	4	10KV	59.95
.1	12KV	6.95	5	220AC	1.19
2X.1	2000	.89	5	330AC	1.39
2X.1	7000	3.50	5	600	1.19
2X.1	6000	2.29	5	1000	1.89
.2	10KV	8.50	5	1500	1.98
.2	15KV	13.95	2X5	400	.89
.2	50KV	39.50	3X5	600	1.19
3X.2	4000	2.85	3X5	400	1.29
.25	1500	.88	6	600	1.69
.25	2000	.98	6	330AC	1.69
.25	3000	1.45	6	1000	2.30
.25	4000	1.98	6	1500	2.95
.25	6000	.85	7	110AC	.79
.25	20KV	18.95	7	600	.98
.25	25KV	40.00	7	600	1.35
.25	32KV	49.50	7	800	1.75
.25	50KV	62.95	7	5000	29.95
.3	2000	.59	8	500	.99
2X.25	2000	1.10	8	600	1.49
.4	10KV	10.90	8	600AC	4.25
2X.4	7500	5.25	8	800	1.89
.5	1500	.59	8	1000	2.78
.5	2000	1.19	8	1400	3.05
.5	2500	1.49	8	1500	3.65
.5	3000	2.39	8	2000	5.95
.5	5000	3.09	8	2500	6.50
.5	7500	6.25	2X8	600	1.89
.5-.1	2000	.39	10	50AC	.65
2X.5	600	.69	10	600	1.19
2X.5	9000	12.95	10	600	2.25
.5	25KV	45.95	10	1000	3.75
.65	12.5KV	13.95	10	1500	4.25
1	500	.55	10	2000	5.95
1	1000	.69	10	6000	59.50
1	1500	.99	12	600AC	3.75
1	2000	1.85	14	50	.99
1	2500	2.20	15	330AC	3.50
1	3000	2.95	15	400	1.29
1	5000	6.25	15	440AC	3.85
1	4000	5.95	15	1000	3.95
1	6000	6.50	15	1500	5.40
1	7500	8.95	15	5000	63.50
1	7500	14.50	20	330AC	3.35
1	10KV	22.50	20	600	1.69
1	15KV	26.95	24	500	1.89
1	20KV	45.95	28	1000	5.95
1	25KV	49.50	30	330AC	5.25
1	25KV	65.00	30	2500	12.95
1	25KV	75.00	50	330AC	6.50
1.75	330AC	.69	70	220AC	6.50
2	600	.55	80	4000	45.50
2	600	.65			
2	1000	.79			
2	1000TLA	1.29			
2	1500	1.15			
2	2000	2.80			
2	2500	3.45			
2	3000	4.25			
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4	3.50	6.45	11.35	14.35	21.75
6	4.00	7.75	12.85	17.30	29.75
10	5.90	11.45	19.50	24.80	41.35
12	7.25	14.35	22.10	29.75	44.25
20	13.05	25.05	37.25	48.75	78.50
24	14.25	28.75	44.50	57.65	81.00
30	17.95	34.35	56.50	71.00	109.00
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1N48	.40	VXR130	.75	5517	2.15
1N56	.85	FG172	45.00	5553/655	95.00
1N64	.70	HF201A	27.50	5633	8.00
1N65	.75	QK181	35.00	5634/SD828E	7.00
1N69	.60	203A	2.50	5637	5.50
1N70	1.20	204A	00.00	5638	8.00
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1P23	1.90	211/VT4C	.50	5642	1.00
1P30	2.00	212E	15.00	5644	8.50
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2C53	10.75	245A	15.00	5654	1.65
2E30	1.60	246A	10.00	5656	6.50
2E35	1.95	249A	3.50	5670	1.75
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4J36	75.00	GL562	50.00	5879	1.40
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Surp	19.00	703A	1.25	5932	6.50
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4X500F		708A	2.00	6021	5.00
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Surp	85.00	717A	.50	6096	1.50
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T28V12ACC	12 Amp (1% Ripple)	145.00
T28V12A2CC	12 Amp 0.01% Ripple	199.00
T28V24A†	0–28 VDC at 24 Amp	135.00
T28V24ACC†	24 Amp (1% Ripple)	195.00
T28V24A2CC†	24 Amp 0.01% Ripple	279.00
T28V50A†	0–28 VDC at 50 Amp	260.00
T28V50ACC†	50 Amp (1% Ripple)	370.00
T28V100A†	0–28 VDC at 100 Amp	469.00
T28V100ACC†	100 Amp (1% Ripple)	650.00

Variable 75 to 135 VDC Completely Built, Ready to go. Includes F. W. Selenium Bridge Rectifier 4" Rectangular Volt & Ammeter Over-Load cutout Degrees cont. service.

Specify for 115 or 230 VAC/1 phase, 60 cy Input

T120V5AC	75 to 135 WVDC at 5 Amp	$170.00
T120V5ACC	5 Amp (1% Ripple)	218.00
T120V10AC	75 to 135 WVDC at 10 Amp	316.00
T120V10ACC	10 Amp (1% Ripple)	266.00

New Variable 0 to 6 & 12 Volt/12 Amp

DC POWER SUPPLY

Battery Eliminator Charger Model RR Plater Aircraft Marine or any DC Rad. Has Hvy Duty Selenium Rectifier, 2 Meters V. & A. Designed for Cont. Service and up to 20 Amp intermittent overload. **New Model T612V12AC SPECIAL** $29.95

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CE156M 6000MFD 15V ..... $1.25; 2 for $2
CE603M 3080MFD 30V ..... $3.98; 2 for $7

NEW SONIC SOUND GENERATOR

115 VAC Input
Cleans! Agitates! Washers & Mixes
"TAB" SPECIAL **$19.99**
Write For Complete Details

PLANETARY DRIVE

6:1 & 1 to 1 RATIO
Reg. $6.29 ..... **"TAB"** @ $2
SPECIAL ..... 3 For $5

INFRARED SNOOPERSCOPE

SEE IN DARK TUBE

Image-Converter Tube. Hi-Sensitivity simplified design 2" dia. Willemite screen—Resolution up to 350 lin/in. Tubes & Data **"TAB" Special...$6.98; 2 for $11**

Snooperscope Pwr Supply 1800VDC/35MA. Using Doubler Crkt. Transformer, Sockets, Resistors, Capacitors and Diagram 115V/60cy Oper... $6.98

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#17300-24 Precision Adjustable Knob Air Control —100 to +400°F/10A/115VAC.
Special @ ..... $4.95 ea; 2/$8

$1.25 ea.
Lots of 24
Lots of 12 @...$1.50 Ea.
Sold Singly @...$1.79 Ea.

4 MFD 12000VDC or 10 MFD 600VDC
Any Ass'mt

SPECIAL "TAB" BUYS

MINIATURE DIEHL PM MOTOR
Type FD6-21, RPM 10,000/27.5VDC
&excellent mtr for Fan cooling. "TAB" Special @ $30.00
HAMS, INDUSTRIALS-COOL THAT TUBE!
Diehl Miniature mtr & Fan ..... $3.95; 12/$42
Bourns Miniature Precision "Trimpot" 2000 Ohms—**Special & for $10**
Fairchild Type 736 Five Gang Precision Potentiometer, 3 units 10,000 Ohm, one 25,000 Ohm one with 2 taps accy ±0.5%, 3.5 Watts, SERVO mtg. Reg $100.00—**"TAB" Special $12 ea; 3/$30**
Thermister W.E. D168391 ..... $2.49 @; 3/$6
Varistor W.E. 17A/CUO ..... $1.49 @ 3/$4
Varistor W.E. 38C/CUO ..... $2.49 @ 3/$6
Varistor W.E. 48A/CUO/SPL ..... $1.50; 3/$4
Miniature Hi Q Inductor—0.5Hy. Hi accy Mu metal core... **Only $1.25; 6 for $5**

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1% ACCURACY GTD
Special 20¢ Ea. 10 of One Value **15¢ ea.**

100 of One Value $10
10 Ass'td Values $2.50

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1.2MFD/2400WVDC ..... 69c @, 12/$7
1.5MFD/3000WVDC ..... $1.69; 4/$5
20MFD/2000WVDC ..... $5; 4/$19
25MFD/1000WVDC ..... $6; 2/$10
48MFD/1000WVDC ..... $10; 2/$15
1.4 & 0.3MFD/1800WVDC ... $1.50; 3/$4

"JJ" POTENTIOMETERS

25¢ ea DUAL 35K/5K 60K/5K

¼" Shaft; ¼" Bushing—Write for Comp-ete Listins

POCKET AC-DC MULTITESTER

Hi-accy precision VOM. 1000 Ohms per V. **READS AC & DC** Volts 0, 5, 25, 250, 1000V **DC MA:** 0, 1, 10, 100MA. **Ohms:** 0–10, 100K-8 ze 1¾D x 4¾L x 3¼W. Ten: Leads. Singly @ ..... $9.95; Lots of 3 @ ..... $9.45 ea

THOR ELECTRIC DRILLS

201J ¼" Eentric Speed Drill w/Jacobs chuck. 2400 RPM 115VAC/DC $14.95
400J ¼" Electric Speed Drill w/Jacobs chuck 650 RPM 115VAC/DC $29.95

NEW "TABTRON" SELENIUM RECTIFIERS

ENGINEERED for INDUSTRY

"TAB" manufactures power rectifiers to your specifications. From one amp up to and above 1000 amps, convection or fan cooled, single or 3 phase. "NEMA" & JAN. Specs. Write for catalog.

FULL WAVE BRIDGE • DATED & ONE YEAR GTD

Max Amp	18VAC* 14VDC	36VAC* 28VDC	54VAC* 42VDC	72VAC* 56VDC	130VAC* 100VDC	266VAC* 217VDC	Ctr Tap AC*DC 30/12	3 Phase 120VAC	Bridge 240VAC 150VDC	300VDC
1	$1.30	$2.30	$3.70	$4.45	$7.40	$22.25	$2.10	$14.90	$28.95	
2	1.95	2.70	5.30	5.85	9.10	28.85	2.35	15.90	30.90	
3	2.90	4.10	5.75	7.90	12.70	36.85	2.65	17.40	33.50	
4	3.45	6.40	11.10	14.30	21.70	38.85	2.95	18.90	36.95	
6	3.95	7.70	12.35	17.25	29.65	54.85	3.75	20.90	39.95	
10	5.85	11.35	19.20	24.65	41.30	84.85	4.75	36.90	71.95	
12	7.20	14.25	21.75	28.75	43.75	99.85	5.95	41.90	81.95	
20	12.95	24.85	36.85	47.25	77.00	160.85	7.95	50.90	97.95	
24	14.05	28.55	43.25	56.00	78.25	190.85	8.95	89.90	159.95	
30	17.75	33.50	55.50	69.00	106.50	235.85	9.95	117.90	225.95	
36	22.10	41.50	64.75	84.25	131.00	285.85	14.95	134.90	269.95	
50	29.40	54.00	97.35	106.35	171.00	405.35	23.95	179.90	369.95	

RECTIFIER & XFMR COMBO, Up to 28VDC at 24 Amps Cont. Duty . . $60

WRITE FOR OUR NEW RECTIFIER & POWER SUPPLY CATALOG PR655

"TABTRAN" Rectifier Xfmrs

Sec'd Volts (DUAL†) 18-15-9-0:0-9-15-18V

5 Amp†	$8.65; 2 for $15.75
12 Amp†	$16.50; 2 for $32
24 Amp†	$35.50; 2 for $70
*50 Amp	$58.50; 2 for $115
*100 Amp	$107; 2 for $210

18 Volt 2 Amp ..... $1.98; 2 for $3.50

† Wndgs in Series at Ratings shown: Parallel 2xAmps; Voltage one half max.
* Dual Pri 115 & 220V 60cy: Tapped 36VCT

"TABTRAN" Rectifier Chokes

CR6001/1 Amp/0.1 HY/1.4 Ohm ..... $4.50; 2 for $8
CR6002/2 Amp/0.1 HY/.67 Ohm ..... $5.75; 2 for $11
CR6003/5 Amp/.07 HY/.6 Ohm ..... $7.90; 2 for $15
CR6004/12 Amp/.01 HY/.1 Ohm ..... $14.50; 2 for $28
CR6005/24 Amp/.004 HY/.025 Ohm ..... $29.50; 2 for $58

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Variable DC Power Supply Full Wave Rectification 6000MFD Condenser Filter Reads for Operate Input 115V 50cy Output 6.3V or 12.6 Amp

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5DCF ACC/5 amp/1% Ripple	$38.98

Heavy Duty Battery "Fast" Charger Rectifier

13-0-13V(CT) 100 Amp Fan Cooled or 34 Amp Air Cooled. Rep'mt 6V Booster Charger.
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16-0-16V(CT) Fan Cooled for 12V/60A and 6V/100A Booster Chargers.
Model CR30 ..... $11; 3 for $30

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OA3	.98	4J47	485.00	703A	1.48	5670	2.24	5959	37.25
OB2	.64	4J52	649.95	704A	.98	5672	1.55	5965	1.78
OB3/VR90	.84	4X150A	36.00	705A	.98	5676	1.55	6027	179.95
OC3/V105	.82	5C22	29.50	710A	1.68	5686	2.99	6072	3.99
OD3/V150	.78	5D21	9.48	715B	11.90	5687	3.59	6080	5.99
1AD4	3.95	5U4G	.46	717A	.35	5692	6.48	6099	1.55
1AG4	1.35	6AN5	3.60	721A	.98	5693	5.49	6101	1.55
1AX2	1.25	6AS6	1.60	723AB	9.98	CK5694	3.70	6110	6.55
1B3	.66	6AS7G	2.98	724A	2.94	CK5697	3.70	CK6111	8.95
1B24	4.98	6J6	.48	724B	.96	CK5702	2.80	6119	6.48
1B46	1.88	6SN7	.56	725A	4.49	5704	2.25	6121	9.00
1B63A	42.50	6V6GT	.56	807	1.19	5713	173.50	GL6136	1.89
1D21	3.49	6X4	.42	807W	4.98	5718	5.99	6146	4.87
1Q23	150.00	7C25	125.00	814	2.48	5719	5.99	6164	64.95
1X2A	.62	8D21	99.00	815	3.98	5721	189.55	6199	49.99
2C39A	16.90	12AU7	.54	829B	8.49	5722	6.39	6201	3.99
2C51	2.50	12AX7	.58	832A	5.49	GL5727	1.77	6270	199.95
2D21	.75	FG17	3.01	864	.34	5732	3.94	6271	159.95
2E22	1.89	19BG6	1.38	927	1.36	5736	159.95	6273	199.95
2E24	2.48	24G	1.96	954	.18	5744	2.39	8005	4.97
2E26	1.78	HK24	4.90	955	.66	5749	1.72	8012	1.09
2E32	7.07	35Z3	.46	956	.32	5750	3.10	8013	4.91
2E43	1.49	TZ40	4.49	957	.51	5751	3.09	8014A	50.15
2J30	50.50	50L6	.60	CK1005	.56	5764	55.99	8020	2.95
2J42	99.50	71A	.74	1612	1.98	5765	55.99	8025A	2.95
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2K28	29.50	QK155	699.99	1616	.79	CK5783	5.55	9002	.96
2K29	Q	QK202	99.99	1619	.34	CK5787	4.95	9003	.98
2K30	130.00	203A	7.38	1620	5.01	5794	8.99	9006	.15
2K33	219.48	215	10.38	1625	.44	5812	2.99	C-Ray Tubes	
2K39	Q	233A	2.92	1626	.16	5814	1.28		
2K41	175.00	250R	10.95	1629	.22	5819	49.99	3BP1A	6.55
2K42	149.55	HK254	18.00	1632	.68	5820	69.00	3CP1S1	5.98
2K43	130.00	250TH	15.00	1633	.98	5823	1.29	3DP1	4.81
2K44	Q	304TH	15.00	1642	.62	5825	11.99	3DP1A	6.80
2K48	110.00	304TL	15.00	1644	.99	5828	6.70	3EP1	4.71
2K50	315.00	316A	.48	1850A	99.00	5840	5.05	3FP7	1.91
2P23	298.00	388A	1.99	2050	.98	5841	7.98	3FP7A	6.91
3B24W	8.48	394A	1.96	2050W	2.48	5842	11.00	3GP1	1.91
3C22	72.50	434A	3.94	2051	.68	5844	1.00	5BP1	1.98
3C24	3.98	446B	24.98	5514	4.69	5852	7.57	5CP1A	14.49
3D21A	7.99	450TH	75.49	5516	5.51	5857	19.50	5CP5	3.58
3D23	325.00	820AX	2.05	5517	2.22	5863	49.94	5HP1	3.91
3X2500A	125.00	512AX	1.35	5586	150.25	CK5875	2.05	5JP1	14.95
4-65A	19.49	531DX	1.89	5588	119.99	5876	12.49	5JP2	7.94
4-125A	19.09	536AX	1.55	5634	7.50	5879	1.59	5LP1	6.91
4B23	16.98	538DX	.98	5640	11.57	5881	2.70	5SP7	100.00
4B27	4.98	544DX	2.50	5641	6.59	5893	7.55	7RP7	6.50
4C35	16.95	571AX	4.45	5654	1.72	5927	89.45	AND OTHERS WRITE	
4J26	79.55	608CX	.97	5656	9.98	5932	5.00		

NEW!! HI SENSITIVITY

6KV DC & AC
27 Range
MULTITESTER
(Not a Kit)

"TAB" 60 $21.95 ea.
IN LOTS OF 3

A complete precision test instrument. **20,000 Ohms per Volt DC, 10,000 Ohms p/v AC.** 38 microampere movement, 8 easy to read scales—DC 0–6, 30, 120, 600, 1200, 6000 Volts AC 0–6, 30, 120, 600, 1200 Volts. Current 0–60 us, 6, 60, 600 ma. Resistance 0–8K, 80K, 800K, 8 megohms. Decibels Cal 600 ohm —20 to +6, 20, 34, 40, 60 DBs. Capacity 250 mufd to 10mfd. Inductance 10 to 1000 millhys. Hi accuracy, versatile, 1% Precision Resistors, Scale 3", Plastic engraved panel. Rugged metal case. 11th 4¾" x 6¾" x 2¾". Complete w/batteries & leads. RF Diode Probe included for signal measurement. Shpg. wt. 4 lbs.
"TAB" SPECIAL ..... @ $22.95 ea
HV PROBE, 30,000 Volts ..... @ $5.95 ea

TRANSFORMERS

ALL 115V 60 CYC INPUT

2500V/20MA, 6.3V/6A, 2.5V/1.75A 4/HC412 Scope Replmnt. $7.98
1600VCT/5MA, 6.3VCT/3A, 6.3 VCT/10A, 2.5VCT/8A $7.95
900V/35MA, 2X2.5V/2A, Xclnt 1800V DblLR TWO 2X2 PIL WNDGS $1.98
778VCT/200MA, 5V/3A, 6.3VCT/6A THORDARSON ..... $4.98; 2 for 59; 6 for $24
770V/2.5MA, 2.5V/3A HVINS HMSLD includes FILTER PARTS 4/scope. ..... $3.69; 2 for $6.00
550VCT/250MA, 5V/2A, 6.3VCT/2.5A, 12.6V/3.5A CSD RCA ..... $4.50; 2 for $8.00
420VCT/90MA, 6.3V/1.9A, W/INPUTS 6, 12, 24, 115VDC @ $1.49

WRITE FOR BARGAIN FLYER
$ $ Real Money Savers $ $

RHEOSTAT SALE

6 Ohm 25W ..... .98; 12/$7
15 Ohm 25W ..... .98; 12/$7
20 Ohm 50W ..... .98; 12/$7
50 Ohm 25W ..... 1.10; 10/$7
1500 Ohm 25W ..... 1.10; 10/$7
2500 Ohm 25W ..... 1.10; 10/$7
5000 Ohm 25W ..... 1.25; 10/$9
10K Ohm 50W ..... 1.95; 10/$14

New! *Quality* VOLTAGE REGULATOR

$ $ Popularly Priced $ $
ONLY $16.98
Line Voltage Stabilizer

Stabilizes line voltage within plus or minus 3% regardless of **VOLTAGE & FREQ.** shift. Ideal for **INDUSTRIAL, LAB** or **TV & RADIO** use. Insures full size, strength, & sync of TV picture regardless of line voltage. Automatically operated ..... regulator turns on & off with set or Equipment. **TROUBLE FREE, QUIET,** needs no adjustment. Universal Use—from 100 to 300 Watts. Input 100-125V Output 115V plus or minus 3% 50/60 cycles—
Sold on "TAB" Money Back GUARANTEE. ORDER SIX ADDITIONAL 10% DISCOUNT

230 to 115V Autoformers

For 220V/50cy Input. To 110–120V or Step up. †With Cord, Plug & Receptacle.

TPA050/50W.*	$2.58
TPA075/75W.†	3.65
TPA100/100W†	4.00
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TPA500/500W†	8.28
TPA750/750W†	11.79
Model TPA1000/1000 Watts/1 KW†	16.98
TPA1500/1500W†. $22.80; TPA2000/2KW	$34

* Less Cord Plug & Receptacle.

New Variable Voltage X-fmrs

SUPERIOR-GR-STACO-UTC

0-132V-1.25A*	$7.99
0-135V/3A*	11.98
Cased/0-135V/7.5A*	21.95
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Cased/0-270V/3A*	24.95
Uncased/0-270V/3A*	18.95
Cased/0-135V/15A*	41.98
Cased/0-270V/9A*	41.98
Uncased 0/27V/7.5A†	54.67
Cased 0-270V/9A†	86.50
Cased 0-270V/12A†	103.00
Cased 0-270V/15A†	132.00
Cased 0-270V/30A	163.00
GR50A/0-135V/45A/LN	100.00
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(LN) Like New (*) New (†) 3 Phase New
Industrials 6 or more 10% disc.

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60 Draw 34¼H, 18W, 9"L Draw 3W, 2½H, 8"L, 65 lbs. ..... Spec. $35
100 Draw As Above 135 lbs. $59
27 Draw 37H, 30¾W, 14"L Draw 3H, 9W, 12"L, 120 lbs. ..... **"TAB"** $34

"GRAIN OF WHEAT" *Lamps*

323-3 VOLT Clear ..... 5 for $1
321G-28 VOLTS & Shutter Green ..... 4 for $1

HI-MEG HI-VOLT RESISTORS

.75 MEG "MVP" 10W/10KV ..... 69c 12 for $6.00
2 MEG 5W/10KV ..... 89c 12 for $9.00
2.5 MEG "MVP" 5W/7.5KV. ..... 79c 12 for $8.00
7 MEG "MVP" 10W/10KV. ..... $1.00 12 for $10.00
12 MEG 10W/10KV ..... $1.50 12 for $15.00
20 MEG "MVO" 15W/50KV. $2.00 12 for $20.00
50 MEG "MVE" 25W/40KV. $2.50 12 for $25.00
10 MEG "MVP" 10W/10KV. $2.00 12 for $20.00
Lots Fifty 20% Disc.; Lots 100 Disc. 40%

IN23B *Crystal Diode*

"TAB" SPECIAL ..... **$1.25 ea** 9 for $10 100 for $100
IN21 ..... 6 for $1.00

MICA CONDENSERS

MFD	WVDC	Price
.03	600	59c; 100/$50
.01	1200	40c; 100/$32
.001	1200	20c; 100/$15
.002	1200	25c; 100/$21
.015	2500	$1; 100/$80
.002	2500	75c; 110/$60

SPECIAL "TAB" BUYS

Giannini Density Unit mfg. for Sperry part #672340, consists twin Altimeter Bellowe actuating Precision Potentiometers, Temp Comp cost over $200—**"TAB" Special $20 ea.** ..... 2 for $30
Same except Sperry part #709632 only one bellows actuated resistor—**Special $12 ea.** ..... 2 for $20
Thermister W.E. 1C ..... $1.49 @; 3 for $4
Varistor W.E. 41A/CUD/SPL ..... $1.50 @ 3/$4
Varistor W.E. D97966 ..... $2.49 @ 3/$7
Varister W.E. D163906 ..... $3c; 3 for $1
Delay Line—Millen 1 mu sec ..... $2.95; 4/$9
Delay Line—ESC #2200/0.4 mu sec ..... $2; 6/$10

"TAB" HI-FI SPEAKERS

Inbuilt network, 2 wires needed for HF & LF Response. **Famous HI-FI mfg. 15" Coaxial** PM & 5" Tweeter, 25W/20–17500 cy **Model P25CO** $19.50
12" Coaxial PM & 3½" Tweeter, 12W/45–15000 cy ..... $12.75; 3 for $35
8" Coaxial PM & 2½" TW, 8 Watts/70–15KC **Model P8CO**.... $7.98; 2/$15

CIRCUIT BREAKERS

Heinmann Magn. Bkrs. Amps: 3, 5, 7, 9, 10, 12, 30, 40, 80. @ $1.98 ea; 12/$20; 50/$75
Sq. D & CH Toggle Sw. Bkrs. Amps: 5, 10, 15, 20, 25 ..... ea. .98
Klixon Therma Push Button Bkrs. Amps: 5, 10, 15, 30, 35 @ .89; 10/$7.98 ..... 50/$34
Asst'd One Each Twelve Types @ $9

NEW G.E. PHONO CARTRIDGES

Original Boxed, $, $, $, Back Gtd

RPX050A .001 & .002	$6.98
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RPX041A Single (S) .001	5.25

THAT'S A BUY **"TAB"** THAT'S A BUY

Dept. 10E5 111 Liberty St., New York 6, N. Y., U.S.A. PH. RECTOR 2-6245 CABLE: "TABPARTS"

Money Back Guarantee (Cost of Mdse. Only) $5 Min. Order FOB N. Y. C. Add shpg. charges or 25% Dep. Prices Subject to Change Without Notice

INDEX TO ADVERTISERS

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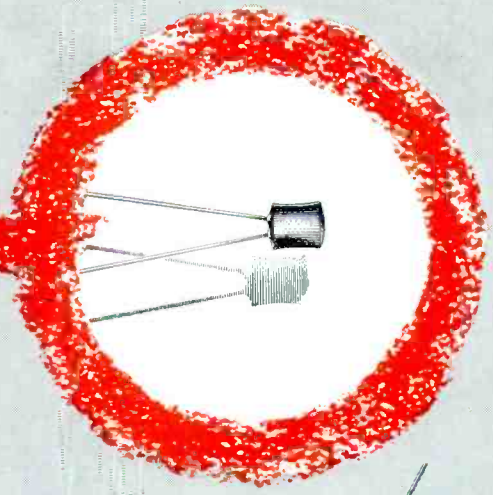
For maximum resistance in minimum space!

NEW Lollypop Precision Resistor
Davohm Type 1273

It's no trick at all with Daven's unique and extremely small size resistor to achieve ease of mounting in new printed circuit and transistor assemblies. The trick is inside this tiny unit . . . it's a completely new specialized winding technique developed by Daven, which enables them to use extremely fine sizes of resistance wire to obtain two or three times the resistance value that was previously supplied on a bobbin of this size.

You can't lick Daven's new wire-wound Lollypop Resistor

Only 1/4" in diameter by 5/16" long, yet is available in values as high as 400,000 ohms:

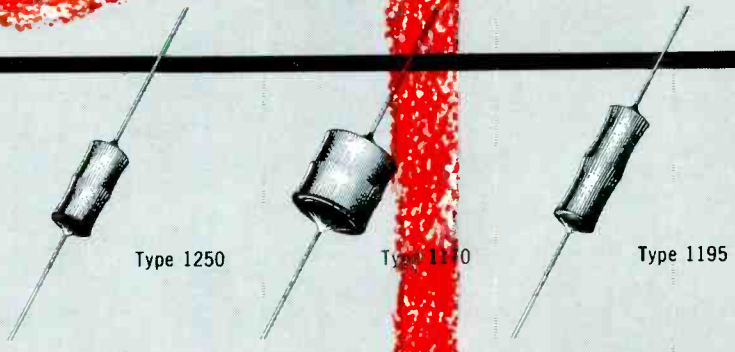


- Fully encapsulated
- Exceeds all humidity, salt water immersion and cycling tests as specified in MIL-R-93A Amendment 2
- Operates at 125°C continuous power without de-rating
- Can be obtained in tolerances as close as ±.02%
- Standard temperature coefficient is ±20 PPM/°C. Special coefficients can be supplied on request

Below are other miniature encapsulated Daven resistors, part of the largest selection of precision wire-wound resistors available:

	Type 1250	Type 1170	Type 1195
Max. Ohms	450K	2 Meg.	760K
Dia.	1/4	1/2	1/4
Length	1/2	1/2	3/4
Max. Watts	1/8	1/3	1/4

All Daven resistors can be operated at 125°C continuous power without de-rating.



Write for complete resistor catalog.

THE DAVEN CO.

191 Central Avenue, Newark 4, New Jersey

WORLD'S LARGEST MANUFACTURER OF ATTENUATORS

RCA-2N77. For low-power af applications such as in hearing-aid devices.

RCA-2N109. For af amplifiers and class B p-p power output stages of battery-operated portable receivers. Two 2N109's in class B p-p circuit will give a power output as high as 150 mw.

RCA-2N104. For low-power af service in communications and other types of electronic equipment.

RCA-2N105. For low-power af applications, such as in hearing-aid devices and other applications where extremely small size is required.

Shown actual size

Exceptional Uniformity
Extreme Stability
—throughout life!

RCA HIGH-QUALITY TRANSISTORS

For applications where extreme stability is paramount . . . for circuits where very low collector cutoff current is essential . . . for services that require exceptional uniformity of characteristics . . . RCA-developed transistors provide consistent high-quality and dependable performance. *Closely-controlled processing and manufacturing techniques assure high-level performance initially and THROUGHOUT LIFE!*

Here again is specific technical evidence of RCA's continuous effort to provide advanced-quality products. For a quick rundown on the ratings and characteristics of the four transistors pictured here, see the chart. For complete technical data, call your RCA Field Representative—or write RCA, Commercial Engineering, Harrison, New Jersey.

The RCA-2N77, -2N104, -2N105, and -2N109 are hermetically sealed, germanium p-n-p alloy-junction types—and each carries the RCA one-year warranty!

	RCA-2N77	RCA-2N104	RCA-2N105	RCA-2N109
MAX. RATINGS (Absolute Values):				
Collector Volts	−25	−30	−25	−20
Collector Ma.	−15	−50	−15	−50
Collector Dissip. (mw)	35	up to 150*	35	50
Operating Temperature (°C)	50	70	50	50
TYPICAL OPERATION:†				
Collector Volts	−4	−6	−4	−4.5
Collector Ma.	−0.7	−1	−0.7	−13
Alpha (Collector-to-base connection)	55	44	55	70††
Power Gain (db)	41	41	42	30**
Power Output (mw) approx.	—	—	—	75**
Source Imped. (ohms)	2450	1400	2300	375 per base connection
Load Imped. (ohms)	20,000	20,000	20,000	100 per collector
Noise Factor (db)	6.5 av.	12 max.	4.5 av.	—
Cutoff Freq. (kc)	700	700	750	—
Figure of Merit for High Frequency Performance (Mc)	1.7	1.6	2.6	—

* Depends on temperature and circuit parameters
†† Large-Signal
† In common-emitter circuit at 25°C, ambient temp.
** For 2 transistors in class B of circuit, and maximum distortion at 10 percent

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ELECTRON TUBES HARRISON, N.J.