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SEPTEMBER · 1952

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Width	61/64
Height	1 13/32
Mounting	1 1/8
Screws	4-40 FIL.
Cutout	7/8 Dia.
Unit Weight	1.5 oz.

MINIATURE AUDIO UNITS...RCOF CASE

Type No.	Application	MIL Type	Pri. Imp. Ohms	Sec. Imp. Ohms	DC in Pri., MA	Response ± 2db. (Cyc.)	Max. level dbm	List Price
H-1	Mike, pickup, line to grid	TF1A10YY	50,200 CT, 500 CT*	50,000	0	50-10,000	+ 5	$16.50
H-2	Mike to grid	TF1A11YY	82	135,000	50	250-8,000	+21	16.00
H-3	Single plate to single grid	TF1A15YY	15,000	60,000	0	50-10,000	+ 6	13.50
H-4	Single plate to single grid, DC in Pri.	TF1A15YY	15,000	60,000	4	200-10,000	+14	13.50
H-5	Single plate to P.P. grids	TF1A15YY	15,000	95,000 CT	0	50-10,000	+ 5	15.50
H-6	Single plate to P.P. grids, DC in Pri.	TF1A15YY	15,000	95,000 split	4	200-10,000	+11	16.00
H-7	Single or P.P. plates to line	TF1A13YY	20,000 CT	150/600	4	200-10,000	+21	16.50
H-8	Mixing and matching	TF1A16YY	150/600	600 CT	0	50-10,000	+ 8	15.50
H-9	82/41:1 input to grid	TF1A10YY	150/600	1 meg.	0	200-3,000 (4db.)	+10	16.50
H-10	10:1 single plate to single grid	TF1A15YY	10,000	1 meg.	0	200-3,000 (4db.)	+10	15.00
H-11	Reactor	TF1A20YY	300 Henries-0 DC, 50 Henries-3 Ma. DC, 6,000 Ohms.					12.00

RC-50 CASE

Length	1 5/8
Width	1 5/8
Height	2 5/16
Mounting	1 5/16
Screws	#6-32
Cutout	1 1/2 Dia.
Unit Weight	8 oz.

COMPACT AUDIO UNITS...RC-50 CASE

Type No.	Application	MIL Type	Pri. Imp. Ohms	Sec. Imp. Ohms	DC in Pri., MA	Response ± 2db. (Cyc.)	Max. level dbm	List Price
H-20	Single plate to 2 grids, can also be used for P.P. plates	TF1A15YY	15,000 split	80,000 split	0	30-20,000	+12	$20.00
H-21	Single plate to P.P. grids, DC in Pri.	TF1A15YY	15,000	80,000 split	8	100-20,000	+23	23.00
H-22	Single plate to multiple line	TF1A13YY	15,000	50/200, 125/500**	8	50-20,000	+23	21.00
H-23	P.P. plates to multiple line	TF1A13YY	30,000 split	50/200, 125/500**	8 BAL.	30-20,000	+19	20.00
H-24	Reactor	TF1A20YY	450 Hys.-0 DC, 250 Hys.-5 Ma. DC, 6000 ohms . . . 65 Hys.-10 Ma. DC, 1500 ohms.					15.00

SM CASE

Length	11/16
Width	1/2
Height	29/32
Screw	4-40 FIL.
Unit Weight	8 oz.

SUBMINIATURE AUDIO UNITS...SM CASE

Type No.	Application	MIL Type	Pri. Imp. Ohms	Sec. Imp. Ohms	DC in Pri., MA	Response ± 2db. (Cyc.)	Max. level dbm	List Price
H-30	Input to grid	TF1A10YY	50***	62,500	0	150-10,000	+13	$13.00
H-31	Single plate to single grid, 3:1	TF1A15YY	10,000	90,000	0	300-10,000	+13	13.00
H-32	Single plate to line	TF1A13YY	10,000****	200	3	300-10,000	+13	13.00
H-33	Single plate to low impedance	TF1A13YY	30,000	50	1	300-10,000	+15	13.00
H-34	Single plate to low impedance	TF1A13YY	100,000	60	.5	300-10,000	+ 6	13.00
H-35	Reactor	TF1A20YY	100 Henries-O DC, 50 Henries-1 Ma. DC, 4,400 ohms.					11.00

The *impedance ratings* are listed in standard manner. Obviously, a transformer with a 15,000 ohm primary impedance can operate from a tube representing a source impedance of 7700 ohms, etc. In addition, transformers can be used for applications differing considerably from those shown keeping in mind that impedance ratio is constant. Lower source impedance will improve response and level ratings . . . higher source impedance will reduce frequency range and level rating.

---

* 200 ohm termination can be used for 150 ohms or 250 ohms, 500 ohm termination can be used for 600 ohms.

** 200 ohm termination can be used for 150 ohms or 250 ohms, 125/500 ohm termination can be used for 150/600 ohms.

*** can be used with higher source impedances, with corresponding reduction in frequency range. With 200 ohm source, secondary impedance becomes 250,000 ohms . . . loaded response is —4 db. at 300 cycles.

****can be used for 500 ohm load . . . 25,000 ohm primary impedance . . . 1.5 Ma. DC.

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REFLEX RESNATRON FOR UHF TV—Connections and cooling system in experimental setup of tube developed by engineers at Westinghouse Research Laboratories, East Pittsburgh (See p 116) . . . . . *COVER*

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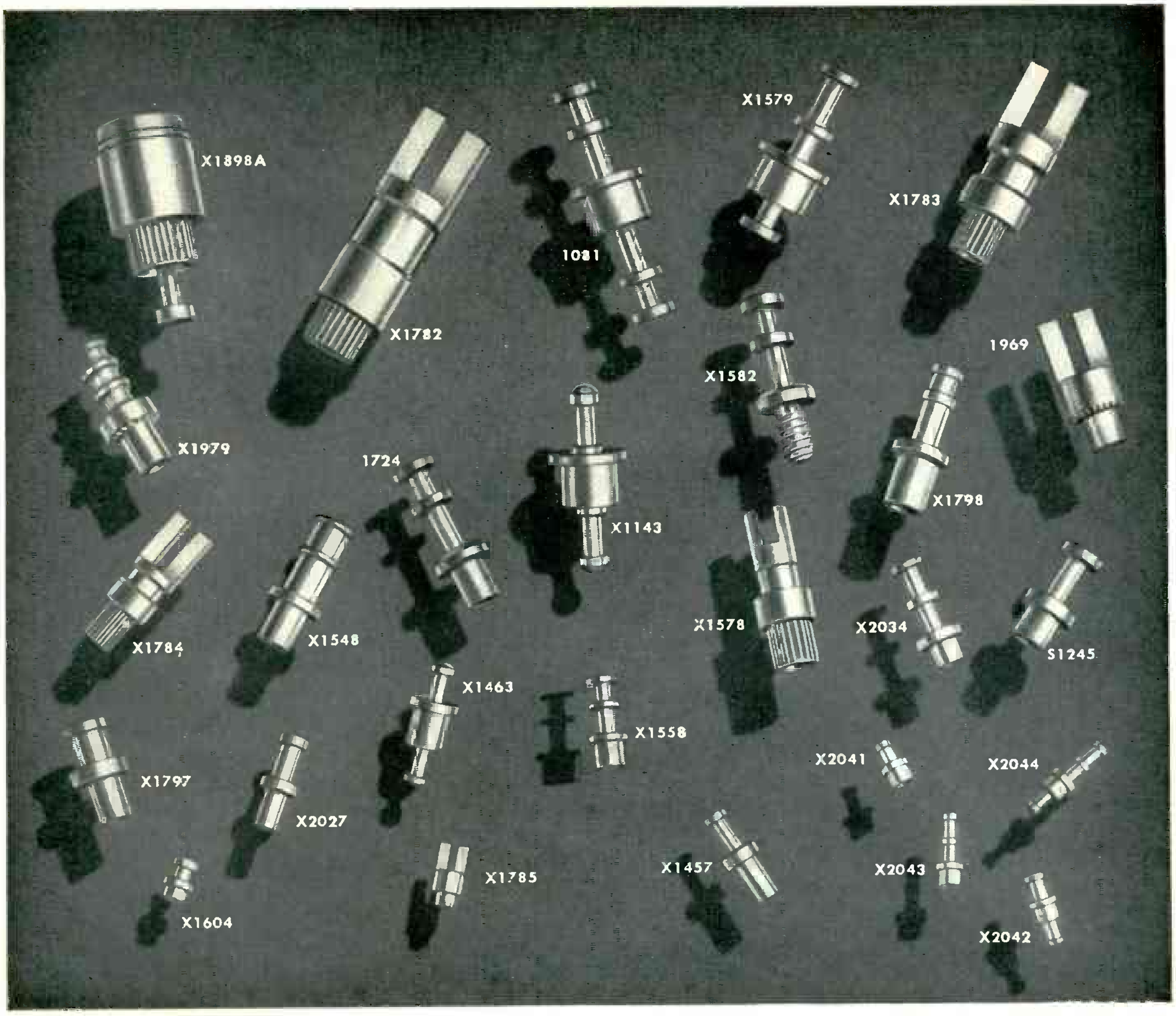

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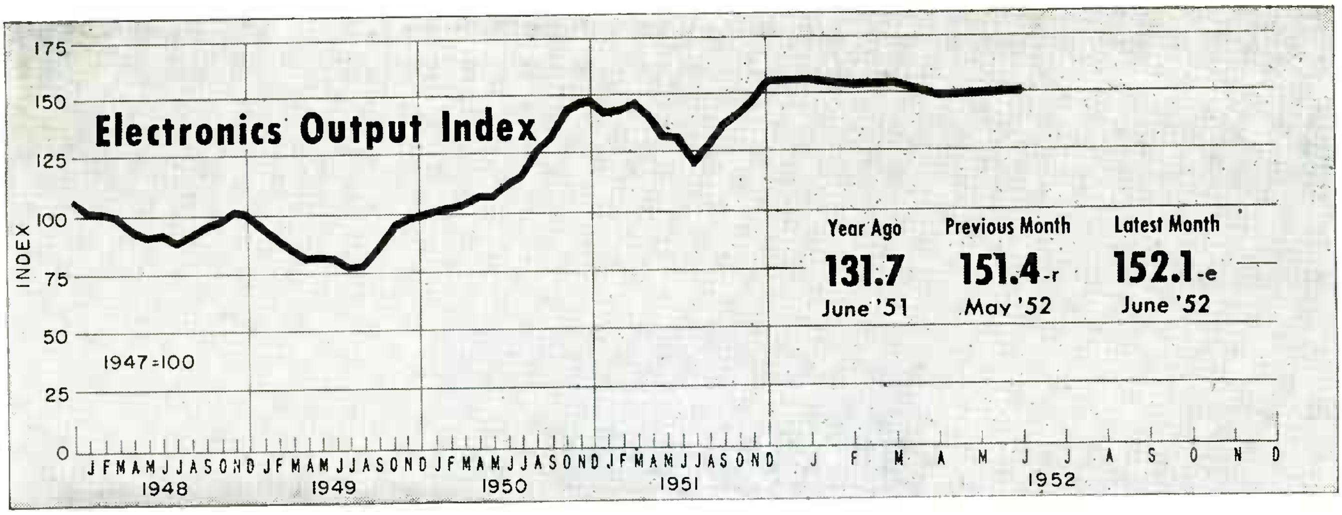


FIGURES OF THE MONTH

RECEIVER PRODUCTION

	Year Ago	Previous Month	Latest Month
(Source: RTMA)	June '51	May '52	June '52
Television sets	326,547	309,375	361,152-p
Home Radio sets	346,135	404,515	422,158-p
Portable sets	228,454	128,351	205,186-p
Auto sets	494,202	215,478	246,909-p

RECEIVER SALES

(Source: Licensee figures)	Apr. '51	Mar. '52	Apr. '52
Television sets, units	285,498	370,905	349,015
Electric radio sets, units	485,970	380,846	354,518
Battery sets, units	136,981	68,339	82,873
Auto sets, units	1,057,484	204,990	235,651
Television sets, value	$49,061,450	$62,988,663	$58,872,294
Electric radio sets, value	$11,222,433	$7,963,825	$8,594,861
Battery sets, value	$2,592,267	$1,332,640	$1,495,919
Auto sets, value	$26,076,566	$5,912,217	$6,700,718

RECEIVING TUBE SALES

(Source: RTMA)	June '51	May '52	June '52
Receiv. tubes, total units	27,667,099	23,636,484	24,365,462
Receiving tubes, new sets	17,055,759	15,807,449	15,770,335
Rec. tubes, replacement	7,462,606	4,178,292	5,187,557
Receiving tubes, gov't	313,065	2,433,605	2,477,569
Receiving tubes, export	2,835,669	1,217,138	930,001
Picture tubes, to mfrs.	221,759	247,724	285,975

BROADCAST STATIONS

(Source: FCC)	July '51	June '52	July '52
TV Stations on Air	107	108	109
TV Stns CPs—not on air	2	0	21
TV Stns—Applications	424	716	838
AM Stations on Air	2,287	2,355	2,356
AM Stns CPs—not on air	101	65	95
AM Stns—Applications	282	323	300
FM Stations on Air	647	629	627
FM Stns CPs—not on air	11	19	18
FM Stns—Applications	7	9	12

NETWORK BILLINGS

(Source: Pub. Info. Bureau)	June '51	May '52	June '52
AM/FM—ABC	$2,720,268	$3,323,092	$3,001,314
AM/FM—CBS	$6,201,963	$4,989,424	$4,590,536
AM/FM—MBS	$1,191,691	$1,820,521	$1,632,977
AM/FM—NBC	$4,739,193	$3,861,882	$3,708,014
TV—ABC	$1,437,593	$1,501,148	$1,276,250
TV—CBS	$2,900,782	$5,602,634	$5,385,820
TV—DuMont	$564,478	$775,063	$758,356
TV—NBC	$4,244,240	$6,822,982	$5,904,546

TV AUDIENCE

	Year Ago	Previous Month	Latest Month
(Source: NBC Research Dept.)	July '51	June '52	July '52
Sets in Use—total	13,093,600	17,627,300	17,983,200
Sets in Use—netw'k conn.	11,045,800	16,656,500	17,955,000
Sets in Use—New York	2,435,000	3,005,000	3,040,000
Sets in Use—Los Angeles	1,002,000	1,200,000	1,215,000
Sets in Use—Chicago	940,000	1,160,000	1,185,000

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	June '51	May '52	June '52
Aeronautical	34,061	32,852	32,603
Marine	29,544	35,476	35,500
Police, fire, etc.	9,129	10,965	11,143
Industrial	9,551	13,056	13,680
Land Transportation	4,253	4,966	5,027
Amateur	90,585	110,931	113,092
Citizens Radio	560	1,175	1,401
Disaster	2	65	71
Experimental	475	357	488
Common carrier	815	970	985

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	May '51	Apr. '52	May '52
Prod. workers, electronic	247,200	268,300	266,600-p
Prod. wkrs., radio, etc.	157,000	168,100-r	167,200-p
Av. wkly. earnings, elect.	$61.05	$63.75	$64.96-p
Av. wkly. earnings, radio	$57.41	$59.51-r	$60.87-p
Av. weekly hours, elect.	41.0	40.3	40.6-p
Av. weekly hours, radio	40.2	39.7	40.1-p

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	July '51	June '52	July '52
Radio—TV & Electronics	233.6	288.9	295.7
Radio Broadcasters	225.3	276.7	282.4

INDUSTRIAL EQUIPMENT ORDERS

	Quarterly Figures		
	Year Ago	Previous Quarter	Latest Quarter
(Source: NEMA)	1st '51	4th '51	1st '52
Dielectric Heating	$520,000	$560,000	$150,000
Induction Heating	$4,270,000	$3,400,000	$2,400,000

INDUSTRIAL TUBE SALES

(Source: NEMA)	1st '51	4th '51	1st '52
Vacuum (non-receiving)	$6,550,000	$14,300,000	$11,320,000
Gas or vapor	$2,230,000	$3,170,000	$3,100,000
Phototubes	$410,000	$400,000	$500,000
Magnetrons and velocity modulation tubes	$1,400,000	$6,670,000	$8,460,000

p—provisional; r—revised; e—estimated

INDUSTRY REPORT

electronics—SEPTEMBER • 1952

Manufacturers Set for UHF-TV Antenna Rush

High-gain systems seen necessary for satisfactory reception in most locations

ANTENNAS FOR uhf television have had manufacturers trimming and bending steadily ever since uhf-tv was officially announced. This relatively new commercial application of spectrum space will not enjoy the gradual break-in period that vhf-tv had. Uhf licensing puts pressure on the manufacturers, since consumers are accustomed to vhf conditions which promise to be difficult to duplicate at uhf.

Antenna manufacturers' plans vary from simple wire dipoles to elaborate arrays of pipe, screen and tubing. Several new-to-the-public designs will appear, including single-mast rhombics, flat, corner and parabolic reflectors, Yagis, consisting of rows of smaller-than-usual elements, and arrays of stacked elements in V's, X's, O's and Δ's.

▶ **Time Will Tell**—One set manufacturer claims a built-in antenna that will pick up acceptable signals in 8 out of 10 locations. At the same time an antenna manufacturer uses the 8 out of 10 figure to describe locations that will require high-gain outdoor antennas for satisfactory reception. Another manufacturer says tests prove that high-gain antennas of the corner and parabolic reflector type will be needed at locations more than 15 or 20 miles from a uhf station.

The presently popular flat 300-ohm twin lead will in many cases be too lossy for use at uhf frequencies. Tubular twin lead and even coaxial cable will often take its place.

Many problems have yet to be solved—indeed, many problems have yet to be discovered. On occasion, New York can receive Bridgeport experimental uhf-tv signals when Bridgeport cannot receive Bridgeport, and so on. It remains to be seen if antennas can be designed to cope with such irregularities.

Military Planners Take Look Ahead

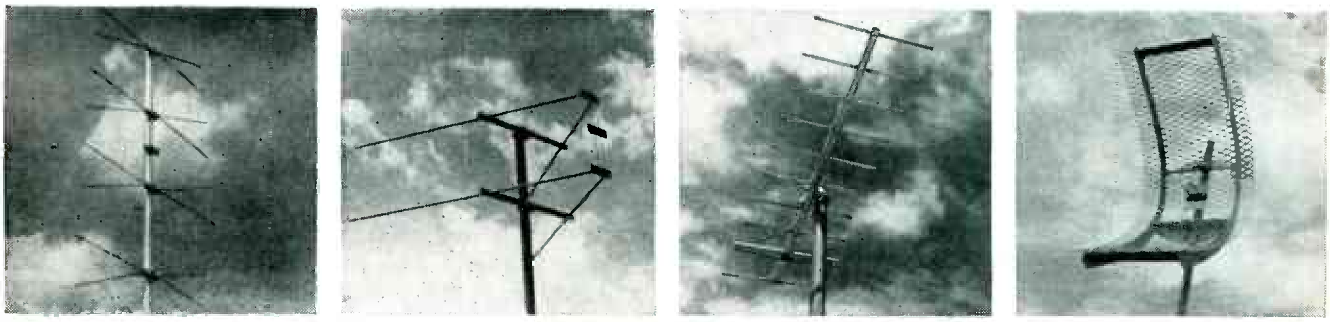
Seek means of holding production nucleus for special electronic items

MILITARY planners are anticipating the day when production of magnetrons, crystals, synchros and other items used extensively in military equipment is cut back as government orders dwindle.

Complete shutdown could well prove tragic in the event of a war that allowed for no preparatory time.

▶ **Present Goal**—Announced current aim of the military, to create a vast industrial capacity while only producing the quantities of end-items actually needed, is said to be rapidly nearing fulfillment. Government planners intimate that existing and scheduled electronics capacity, particularly for components, can with very few exceptions produce the initial military requirements of full mobilization. Remembering how fast capacity evaporated after V-J day, however, they now seek practical ways of encouraging industry to maintain a broad electronics production base as military requirements stretch out over longer periods.

▶ **Possibilities**—No perfect solution is likely. Where highly specialized skills are needed, involving training



Good high-gain television antennas will be even more essential at uhf than at present vhf. Typical of new configurations that will appear is Taco's line of uhf high-gain sky hooks periods as long as 18 months, some planners favor keeping a nucleus of operators producing these items beyond current needs.

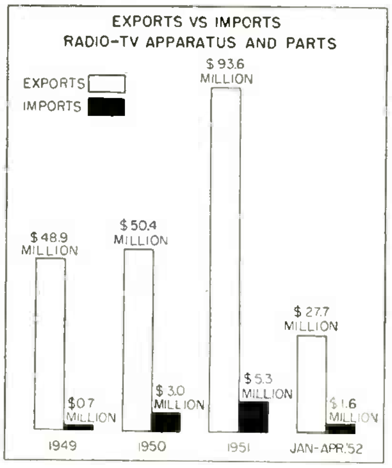
Where production equipment is specialized but no high skill is required, warehousing of certain production equipment for military items is being considered. Synchros are an example here; these being variations of small electric motors, workers and much of the equipment can be diverted to civilian needs.

▶ **Funds**—Military budgets contain large sums for industrial mobilization planning. Some authorities want to use part of these funds to preserve and keep up-to-date the strategic electronic mobilization base we now have. As the first step toward this, a detailed study of each component parts field has been suggested. It is recognized that component manufacturers will be hardest hit by an eventual slackening of military orders.

Electronic Imports Low; Trade Gap Widens

Radio-tv apparatus and parts imports running 50 percent below last year

ELECTRONIC imports are showing the same marked decline this year that is evident in total U. S. imports. Despite a substantial increase for April, radio-tv apparatus and parts imports (which represent most of the dollar volume of all electronic imports) total only $1,685,639 compared to last year's $2,308,620 for the same period.



As shown in the graph, yearly imports of radio-tv apparatus and parts have steadily increased since 1949 and last year reached the highest volume since the war. But 1951 U. S. exports of radio-tv apparatus and parts almost doubled the previous year's volume, making the gap between exports and imports of this equipment the largest in history.

With the import trend downward and exports increasing, this year's scale of trade in electronics will be even more unbalanced.

▶ **Leading Countries**—Since 1950 Canada has exported more radio-tv apparatus and parts to the U. S. than any other country and continues to lead at present. France became important as a U. S. electronic equipment supplier in 1951. She replaced the United Kingdom

(Continued on page 8)

Missile Computer Ready for Navy

Big Navy computer for air defense points towards better business machines

EXPERTS from Special Devices Center, Office of Naval Research, are tickled pink with their new digital automatic computer soon to be installed at Point Mugu, California. Fed with radar and telemeter information from guided missiles launched by BuAer technicians, it will not only analyze the flight pattern, but will also recheck its own computations.

Since the overall cost of some launchings approximates a half million dollars (the missile itself contributes only a part of this cost) the value of immediate analysis and correction is apparent. At present, observations are amassed on each flight, but it takes a team of workers 20 or 30 days to evaluate the results.

Test setup of RAYDAC before shipping to Point Mugu, California

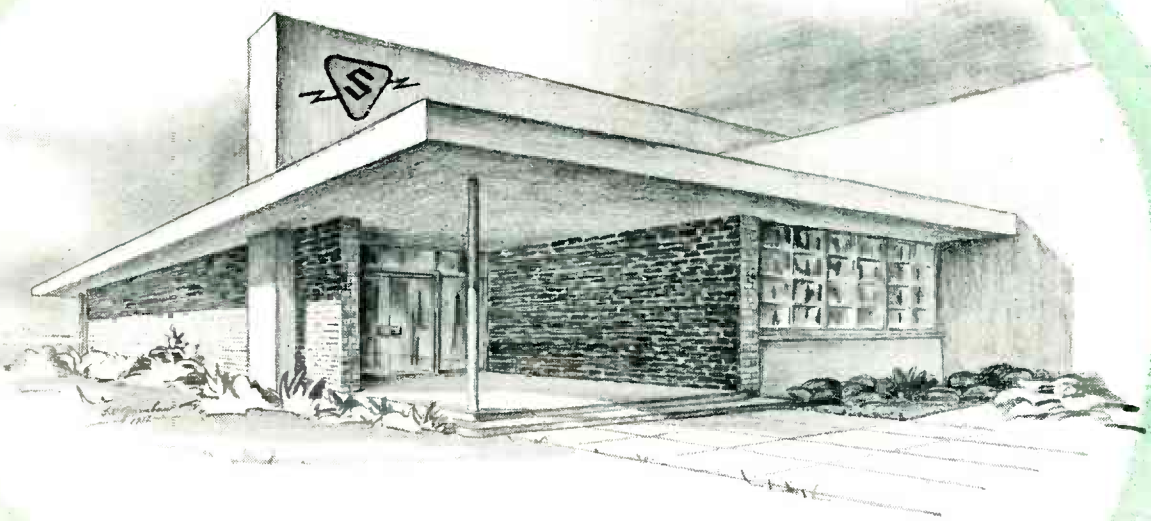
▶ **Machine Has Conscience**—Because it has so far proved impossible to design a perfect computer, this one has been equipped with a conscience that keeps it worrying about its own accuracy. In event of a mistake, the machine stops.

Despite its size, 44 feet long plus a control console, it requires 25 kilowatts of power, 5,000 tubes and 18,000 germanium diodes.

Experts are pleased by Raydac's diminutive proportions as compared with such versatile marvels as the Whirlwind computer, which require several times the space.

Heat from many tubes and components requires the use of massive castings attached to hollow supporting channels through which a liquid refrigerant is pumped. The enclosing room must also be air conditioned to prevent condensation of moisture on the cooling pipes and frames.

Raytheon Manufacturing Co., which has been laboring over it since 1948, says Raydac can't think but will produce 1,900 additions, 1,900 subtractions, 1,100 divisions or 1,400 multiplications a second from coded data and instructions fed in. Results are printed on a teletypewriter.



Sylvania to Serve West Coast Electronics Market from California Location

Sylvania has announced that construction is under way on a modern, completely equipped Electronics Division plant and laboratory in Mountain View, California.

This up-to-date facility of 35,000 square feet is being made available to West Coast manufacturers as a source of electronic components including semiconductor devices, microwave components, and special purpose tubes.

A research and development laboratory will be included to handle design and applications problems on these and other related products.

The addition of this California location to Sylvania's existing electronics facilities marks another step in the company's long-term plan to provide the finest quality products and fastest service to all markets.

For complete information on Sylvania Electronic Products, write Dept. E-2609, Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.

SYLVANIA

ELECTRONIC PRODUCTS; ELECTRONIC TEST EQUIPMENT; RADIO TUBES; TELEVISION PICTURE TUBES; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS then in second place and continues to hold that position according to latest figures. Prior to 1950, the Netherlands was the top foreign electronics supplier.

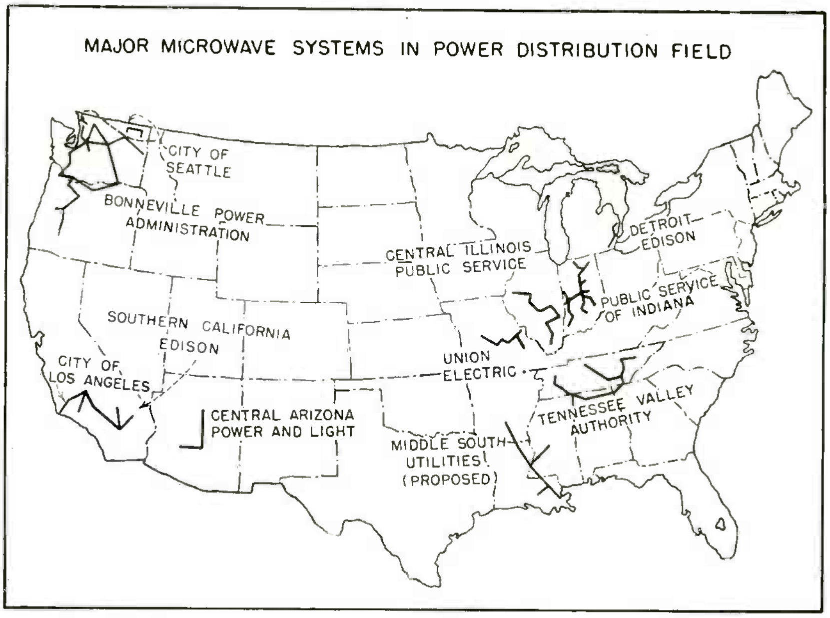
For any of the leading suppliers, the total yearly dollar volume of equipment sold to us is very small when compared to U. S. exports to these countries. For example, radio-tv apparatus and parts imports from Canada for the whole peak year of 1951 totalled less than $1.5 million, while monthly U. S. exports of similar equipment approached $1 million.

▶ **Tariffs**—The U. S. government appears anxious to increase imports and decrease tariffs so that foreign countries, especially in Western Europe, will have dollars available for defense purposes and for buying more U. S. exports.

Tariffs now are estimated to be about 15 percent on the majority of electronic items. On precision electronic equipment such as the electron microscope the tariff is nearer 40 percent. With foreign labor costs only ⅓ of U. S. rates, manufacturers of such equipment in this country feel that duties are fair and should be maintained so that the nation will not become dependent on foreign production.

Pocket Volume Control

Hearing-aid-type earphone and variable attenuator for sound-level adjustment are features of a new Airphone device, CAA approved for use with aircraft radio receivers



NEW radio-relay systems appear, as . . .

Power Companies Go Microwave

Federal projects set trend but private users are numerous and increasing steadily

MICROWAVE RADIO will soon furnish multichannel communication for nearly 30 electric power companies. The systems will span more than 3,000 miles and use 219 towers.

Largest systems will be operated by the federal government through the Bonneville Power Administration and Tennessee Valley Authority. Bonneville, with 206 miles of microwave radio relay in operation, plans 1,006 miles using 47 towers. TVA will begin operating its first links this month; a 461.5-mile system is planned using 36 towers.

Large nongovernment systems include Central Illinois Public Service (400 mi), Union Electric of Missouri (250 mi), Public Service of Indiana (180 mi), Central Arizona Light and Power (150 mi) and Southern California Edison (146 mi). Other large systems are planned by Middle South Utilities and Carolina Power and Light.

▶ **Smaller Users**—Use of microwave by power companies is not limited to large systems. ELECTRONICS surveyed 12 power companies whose present systems total only 323.7 miles. Their investment is now $295,781, but they report that within the next five years $914,000 will be spent to expand facilities; $183,000 is earmarked for this year.

Outlook is bright for microwave sales in the electric power field. A large purveyor of power-line carrier equipment, backbone of power-company communications, discloses that most new inquiries request an estimate for alternate microwave facilities. Microwave has two advantages over carrier: additional channels are available at slight extra cost, and power-line relaying by microwave goes on if lines come down.

▶ **Uses of Microwave**—Multichannel communication by microwave fits well into the complex operations of a power utility. Telephone channels are available for load dispatching, system operation and maintenance. Teleprinter and facsimile channels speed administrative functions. Channels are available for generator load control and supervisory channels permit unattended operation of remote stations. Automatic fault-finding

(Continued on page 10)

equipment that locates both permanent and transient line faults uses a video timing pulse transmitted by microwave.

Telemetering is becoming increasingly important. Not only are power, voltage and frequency telemetered but also stream-gage readings to determine river flow for hydroelectric stations.

TV Tower Delivery Lagging

New cp's may have to improvise until steel is available; aluminum towers may be used

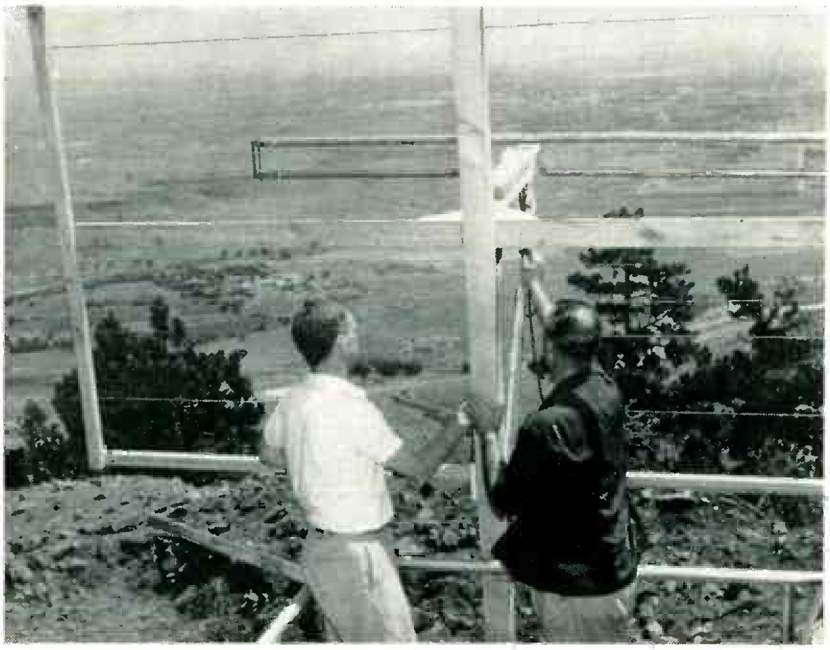
STEEL fabricators estimate that tv tower deliveries for new tv cp's may not be forthcoming until the first quarter of next year as a result of the recent steel strike and the consequent delivery restrictions imposed by the government. They say that the heavy angle, solid round and tubing steel needed for tower construction is not available in the quantities necessary and won't be for three to six months. As a result, many of this year's crop of new tv towers may be replicas of KFEL's 25-foot wooden support (see below).

Television transmitter manufacturers who handle tower arrangements for their customers are more optimistic, however. They say that two-week delivery can still be made on smaller towers but admit that the larger ones may not be delivered for months. It is reported that some companies, in an effort to bypass the bottleneck, are considering the use of aluminum for tower construction and are having pilot models made for testing.

▶ **Tower Facts**—TV towers on the average use from 250 to 450 tons of steel, depending on the height, the antenna's weight and whether or not the structure is to be self-supporting or guyed. Guyed antennas use less steel, are easier to erect and thus cost less. If land is available at the transmitter site, it is likely that cp holders will use this type.

Before the recent rise in steel prices, tower costs ranged from about $8,000 for a 200-foot structure to as high as $143,000 for a 1,000-foot tower. New steel prices may raise these costs as much as $2,700 more.

▶ **Outlook**—The steel industry has made rapid strides in getting back into production since the strike. Latest reports show that steel output is already up to 80 percent of capacity and will be at full capacity much sooner than many observers predicted. This fast come-back coupled with the past output performance of the steel industry, especially during World War II, indicates that the steel tv tower bottleneck may be broken even before it is seriously felt.



Breaking The TV Tape

First post-freeze television station on the air, Denver's KFEL-TV brought its viewers the Democratic National Convention via this temporary composite-dipole transmitting antenna. Located on Lookout Mountain and beamed toward the heart of the city 2,200 feet below, the antenna is mounted on a wooden structure

Manufacturers Study Spare-Parts Business

Most production orders for parts include estimated 10-year demand for spares

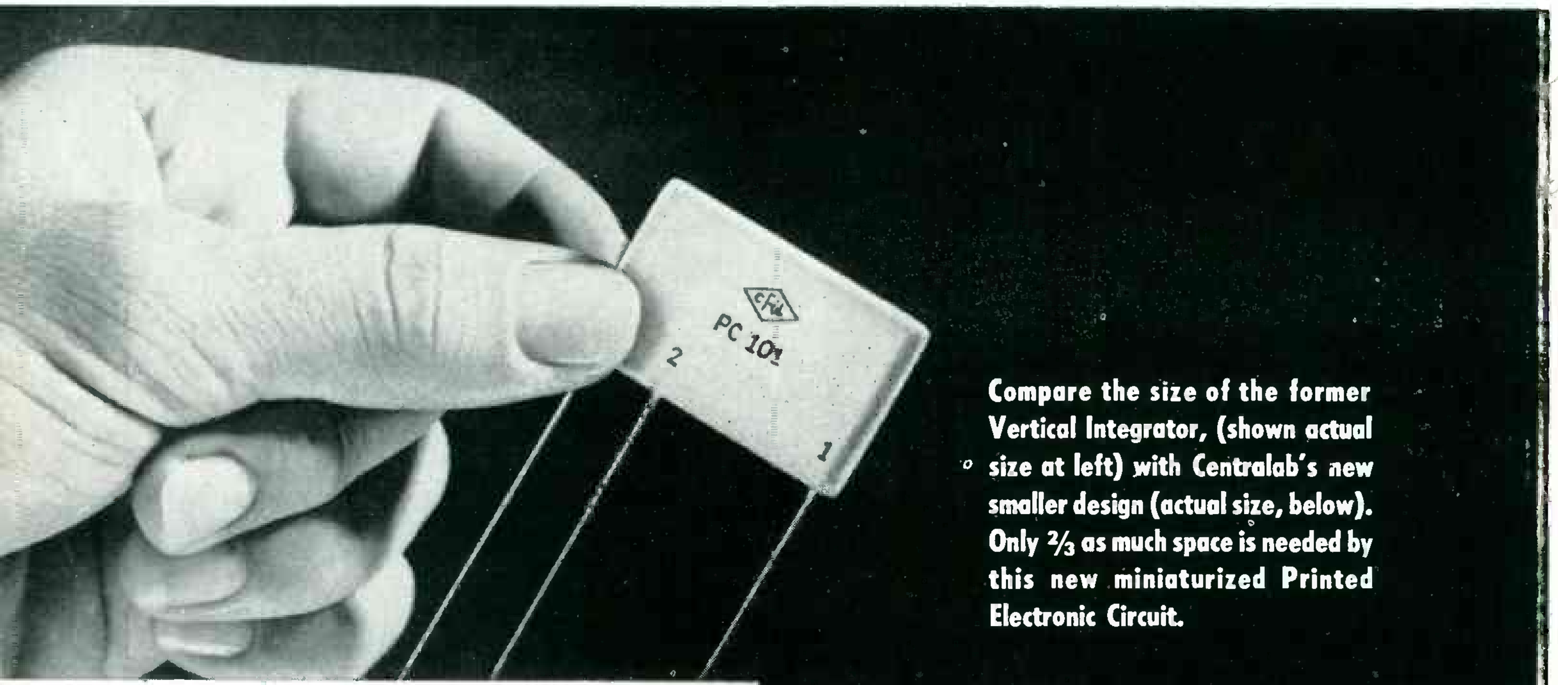
THE PHILOSOPHY of rendering a service rather than merely selling a product is creeping back into the thinking of more and more electronic equipment manufacturers. This means seeing that each product gives good service for its expected life span, long past the original guarantee or warranty period.

Although extensive stocking of spare parts has generally been considered a red-ink nuisance by industry, a number of far-sighted electronic firms have found that with proper planning and management this part of the business can break even or show a small profit. The essential requirements include an efficient setup for estimating and ordering spare parts concurrently with production orders.

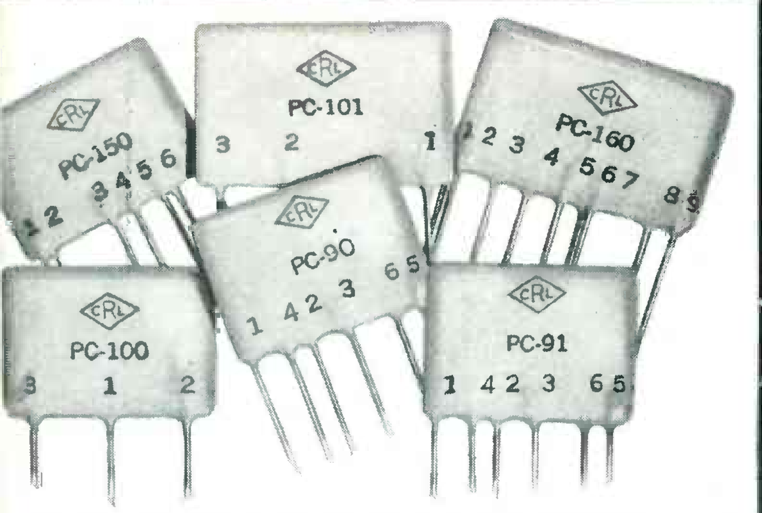
▶**Crystal Ball**—No formulas will tell exactly how many or what kinds of spare parts will be needed during the useful life of a given product, before production is even started. Yet this is the time when

(Continued on page 14)

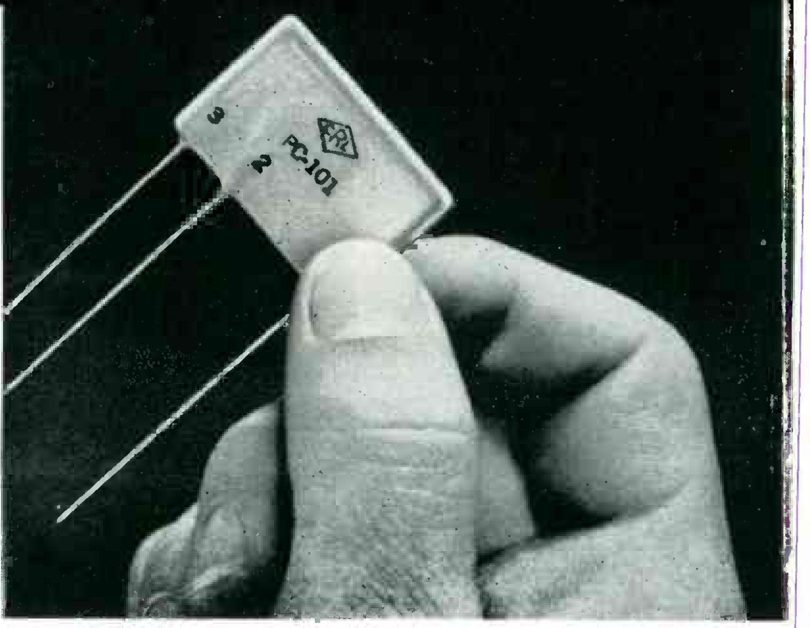
CENTRALAB now offers smaller sizes in PRINTED



Compare the size of the former Vertical Integrator, (shown actual size at left) with Centralab's new smaller design (actual size, below). Only ⅔ as much space is needed by this new miniaturized Printed Electronic Circuit.



Don't overlook the savings achieved by new, reduced prices on this "bargain group" of PEC's. Check coupon for bulletins. Pentodes (Bulletin 42-128), Vertical Integrators (Bulletin 42-126), Audets (Bulletin 42-129), Pendets (Bulletin 42-149).



Now — Centralab gives you even more versatility . . . still greater savings in electronic design. Yes, the prices of several Printed *Electronic* Circuits have been reduced. What's more, these components have been miniaturized to still smaller sizes. We've achieved maximum compactness plus top performance . . . at a new low price.

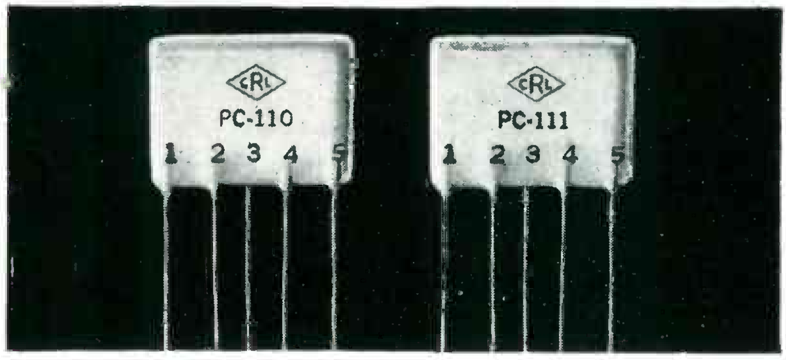
If your designs specify the capacities fulfilled by Pentodes, Vertical Integrators, Audets, or Pendets — look forward to savings ranging from 0.1 to 7 cents per unit.

Actually, these miniature components have always saved you money in time and labor. Now, for the first time, their *first cost is less* than that of the components they replace.

Add up these savings — lower first cost . . . less production time and labor . . . reduced purchasing and inventory requirements. No wonder volume users find they can save thousands of dollars with Centralab Printed *Electronic* Circuits.

even greater savings,
ELECTRONIC CIRCUITS

Save time and money . . . space and weight with these PEC's



FILPLATES (2 resistors and 2 capacitors) for bypass and filter application in TV, FM and AM, where filter networks of comparable component values and layout are needed. 28% less soldered connections. Save vital low wattage resistor stocks. Technical Bulletin 42-131.

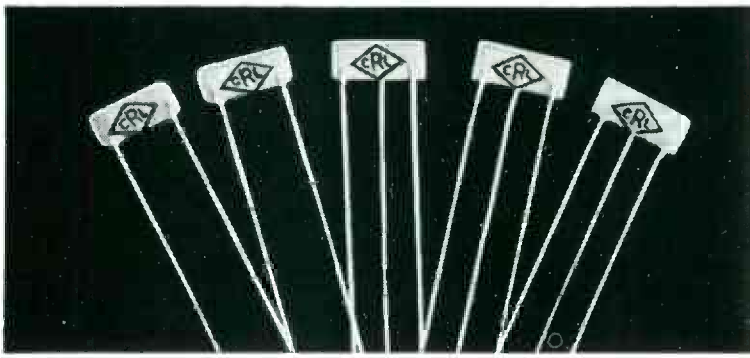
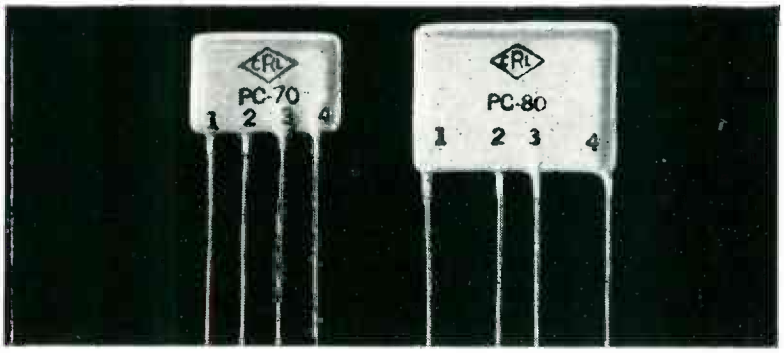


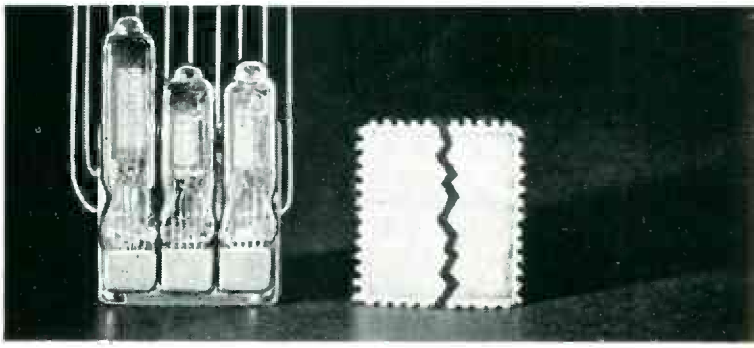
PLATE CAPACITORS AND RESISTOR-CAPACITORS. Excellent for miniature use. Actual size photograph. Because of size, they readily fit all types of miniature and portable electronic equipment — overcome crowded conditions in TV, AM, FM and record player chassis. Technical Bulletin 42-132.

60% Less Soldered Connections with Centralab Triode Couplates



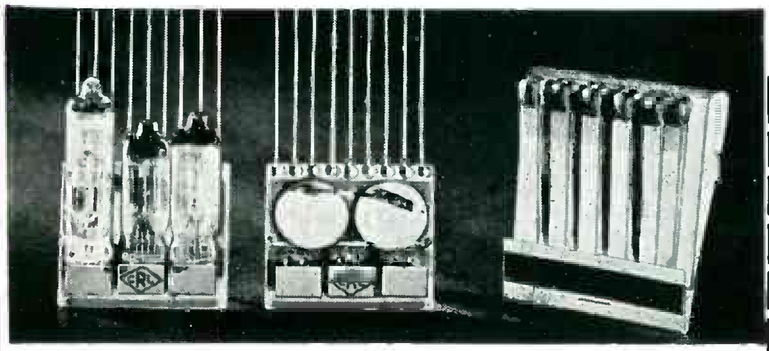
CENTRALAB TRIODE COUPLATES replace 5 components normally used in audio circuits. Triode Couplates are complete assemblies of 3 capacitors and 2 resistors bonded to a dielectric ceramic plate. Available in a variety of resistor and capacitor values. Technical Bulletin 42-127.

New Model 3 AMPEC — A Sub Miniature 3-Stage Speech Amplifier



CENTRALAB'S CONSTANT RESEARCH produced this amazing development in Printed *Electronic* Circuits.. The remarkably small dimensions of this new amplifier unit are approximately 1$\frac{1}{32}$″ x $\frac{15}{16}$″ x $\frac{11}{32}$″. Check coupon for Technical Bulletin 42-130.

Standard Model 2 AMPEC Miniature 3-Stage Speech Amplifier



AMPEC — A full 3-stage speech amplifier. Provides highly efficient performance. Size 1¼″ x 1⅛″ x ⅝″ over tube sockets! Used in hearing aids, mike preamps and other applications where small size and outstanding performance count. Technical Bulletin 42-117.

Centralab

A Division of GLOBE-UNION INC., Milwaukee 1, Wis.

Centralab, A Div. of Globe-Union Inc.
914 East Keefe Avenue, Milwaukee 1, Wisconsin

Please send me the Technical Bulletins on Printed Electronic Circuits as checked below:

☐ 42-128 ☐ 42-129 ☐ 42-131 ☐ 42-127 ☐ 42-117
☐ 42-126 ☐ 42-149 ☐ 42-132 ☐ 42-130

Name..

Address...

Company...

Title..

replacement parts must be ordered, in order to obtain the spares at the same low price as production components.

One example of a successful spare-parts operation is that maintained by RCA. Their catalog of home-instrument service parts lists more than 16,000 items, and about 25,000 additional parts are stocked for other product lines.

Over two-thirds of the employees in RCA Service Parts activity have been in it over 15 years. Their experience in crystal-gazing is considered largely responsible for the success of the activity. Initial orders for spare are for estimated 10-year needs, but may be for much longer periods on special parts for some equipment.

▶**Yearly Parts Sales**—One manufacturer estimates the dollar-volume of his spare-parts business per year as ½ percent of the accumulated past sales of all its products, both figures being in terms of what the manufacturer gets.

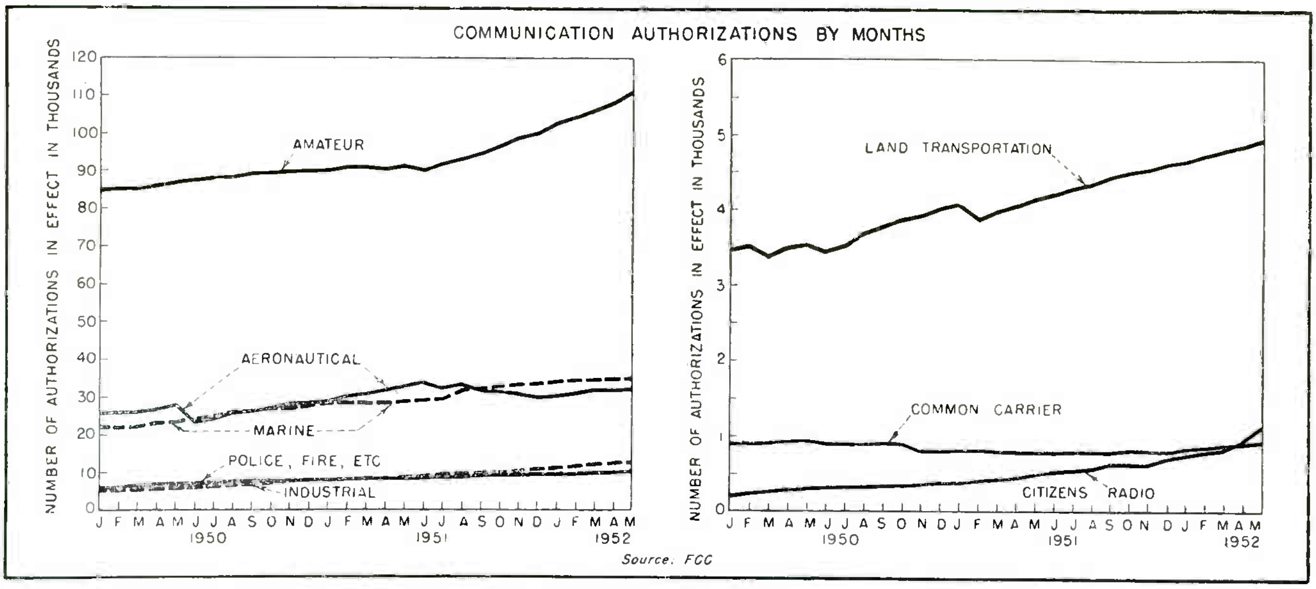
Discarding of early production is drowned out in this percentage by the exponential rise in electronic production and sales during the past ten years.

Capacitor Makers Plan Factories In Brazil

Two new radio capacitor factories are to be set up in Brazil, one by Cornell-Dubilier, the other by a U. S. group yet to be named by the Radio and Television Association of Sao Paulo.

Low-priced sets are made almost entirely from locally produced components.

Brazil's 18 manufacturing plants, located mainly in the Sao Paulo area, expect to produce 500,000 radio receivers this year.


COMMUNICATION AUTHORIZATIONS BY MONTHS

Source: FCC

Communication Authorizations Near Quarter Million

Increasing demands for spectrum space show up in latest analysis of FCC figures

GRAPHIC proof of increased crowding in the radio spectrum is presented in the accompanying plot of monthly communication authorization statistics, seventh item on the "Figures of the Month" page (p 4). Amateurs and land transportation equipment users are mainly responsible for the continuous upward trend.

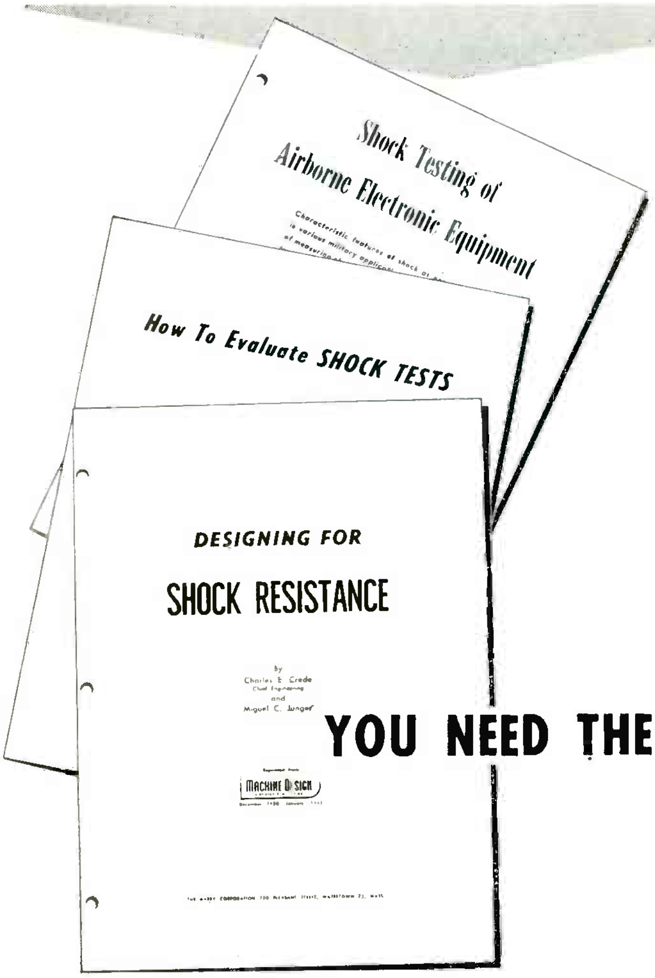
Communication authorization figures presented monthly by ELECTRONICS include station licenses and other authorizations issued by the FCC for ten classes of stations. They give a rough index to the number of communication stations actually authorized to be on the air, but this does not apply in certain fields, notably land transportation, where a single license may cover a number of stations.

▶**Everything Going Up**—The accompanying charts show the trend in communication stations from January 1950 in eight of the ten listings. All classes of communication stations, except common carrier, have followed an upward trend during this period. Most numerous are the amateur stations, which now exceed 100,000 by a substantial margin. The amateur curve showed a sudden spurt as of June 1951, coinciding with the issuance of novice licenses, for which beginners can qualify under substantially less stringent requirements than formerly applied.

Figures, supplied monthly by the FCC, show the status of each class of authorization as of the first of the month in each case. Most of the listings are self explanatory. Our entry "police, fire, etc." corresponds to the FCC "public safety service" category. Further break-

(Continued on page 16)

IF SHOCK IS YOUR PROBLEM



YOU NEED THESE 3 ENGINEERING REPORTS

"Designing for Shock Resistance" sets forth the principles used by the Navy Department in design of shock-proof equipment for shipboard applications. *Published in "Machine Design" Dec. 1950 — Jan. 1951.*

"Shock Testing of Airborne Electronic Equipment" describes the characteristics of shock and tells how shock testing machines are used. *A paper presented at the Dayton Airborne Electronics Conference, 1951; later reprinted in "Tele-Tech".*

"How to Evaluate Shock Tests" tells how mechanical structures respond to shock and shows how such response can be evaluated under controlled test conditions. *Originally published in "Machine Design" December 1951.*

These Barry reports are part of the complete service we offer in handling shock and vibration problems. When you have an isolation problem, call the nearest Barry representative, or ask our field engineering service to help you.

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SALES REPRESENTATIVES IN

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

downs (for which space is not available) are available from the FCC under "industrial." The industrial users include power, petroleum, forestry, special, low-power industrials, relay press, motion picture, agriculture, and land radio location. Separate figures on common carrier services (experimental, domestic land mobile, fixed public telephone and fixed public telegraph) are also available from the FCC.

TV Type Scan Improves Search Radar Displays

Memory tube stores ppi picture, tv provides image for comfortable daylight viewing

IMPROVED presentation of surveillance radar images is made possible by a new CAA-developed system.

The cathode-ray tubes normally used for ppi presentation are inherently low in light output and require at least partial darkness for viewing. With the new system of presentation, an RCA graphechon memory tube monitors the ppi screen and stores a complete picture of the situation. A television scanning system looks at the memory tube and presents a brightened image on an ordinary television picture tube that can be viewed in a normally-lighted room.

The new system permits viewing surveillance radar in the control tower, where such information is most necessary in air traffic control. Further advantage lies in the ease with which repeaters may be tied in to the system for auxiliary viewing positions.


Improvement brought about by new CAA-developed radar presentation system is vividly illustrated by photograph showing the old (right) and the new (left)

Electronic Pilot Controls Rescue Craft

REMOTE control system for emergency life boats, primarily for use in rescuing fliers downed in enemy waters, has been successfully tested by Bendix Aviation Corporation.

In the tests, new type lifeboats equipped with an automatic pilot capable of shortwave radio remote control were dropped from an aircraft to "survivors" adrift below. By means of pushbutton radio from the aircraft, the lifeboats were guided directly to the survivors, after which they were headed along a preset compass course by the same radio control from the plane.

The heart of the phantom pilot, invented by Blair Dickinson, is a photoelectric cell which teams up with a light beam in the compass and an automatic rudder to start swinging the boat on course whenever it deviates a fraction of a degree from the desired heading.

Business Is Good

This table shows net sales and profits for first half of 1952 for various companies active in electronics and allied industries. Figures for first half of 1951 are given for comparison.

Company	Sales 1952 (6 mos.)	Sales 1951 (6 mos.)	Net Profit 1952 (6 mos.)	Net Profit 1951 (6 mos.)
General Electric	$1,171,202,000	$1,184,735,000	$57,119,000	$70,326,000
Westinghouse	681,378,000	590,562,000	31,507,000	31,564,000
Radio Corp. of America	305,838,000	302,333,000	11,300,000	15,703,000
Philco	165,156,000	171,023,000	4,289,000	5,741,000
Sylvania	104,227,000	103,823,000	3,399,000	5,681,000
Admiral	83,015,000	103,587,000	2,523,000	4,093,000
Motorola	69,793,000	73,450,000	3,130,000	3,757,000
Stewart Warner	62,202,000	51,410,000	1,810,000	2,209,000
Zenith	46,926,000	53,008,000	1,336,000	1,586,000
Stromberg-Carlson	19,861,000	14,960,000	580,000	169,000
Lear Inc.	17,903,000	8,660,000	426,000	222,000

Aluminum Wiring

Copper shortage stimulates interest in more plentiful metal; soldering bugs being solved

ELECTRONICS ENGINEERS have been reluctantly experimenting with hard-to-solder aluminum wire as insurance against any more serious future shortage of copper. And, surprisingly enough, this investment of man-hours is beginning to pay off.

Chief hope lies in development of equipment for continuous tinning of bare aluminum wire. Once tinned, it become just as easy to use as tinned copper wire.

▶ **Ultrasonics the Answer**—A new Mullard 1,000-watt ultrasonic driver for large solder pots is said to make tinning feasible even at the high speeds required by wire-manufacturing plants. The driver vibrates standard lead-tin solder at around 20,000 cps, producing cavitation that destroys the tenacious oxide film on aluminum. The solder then alloys with the cleaned metal surface.

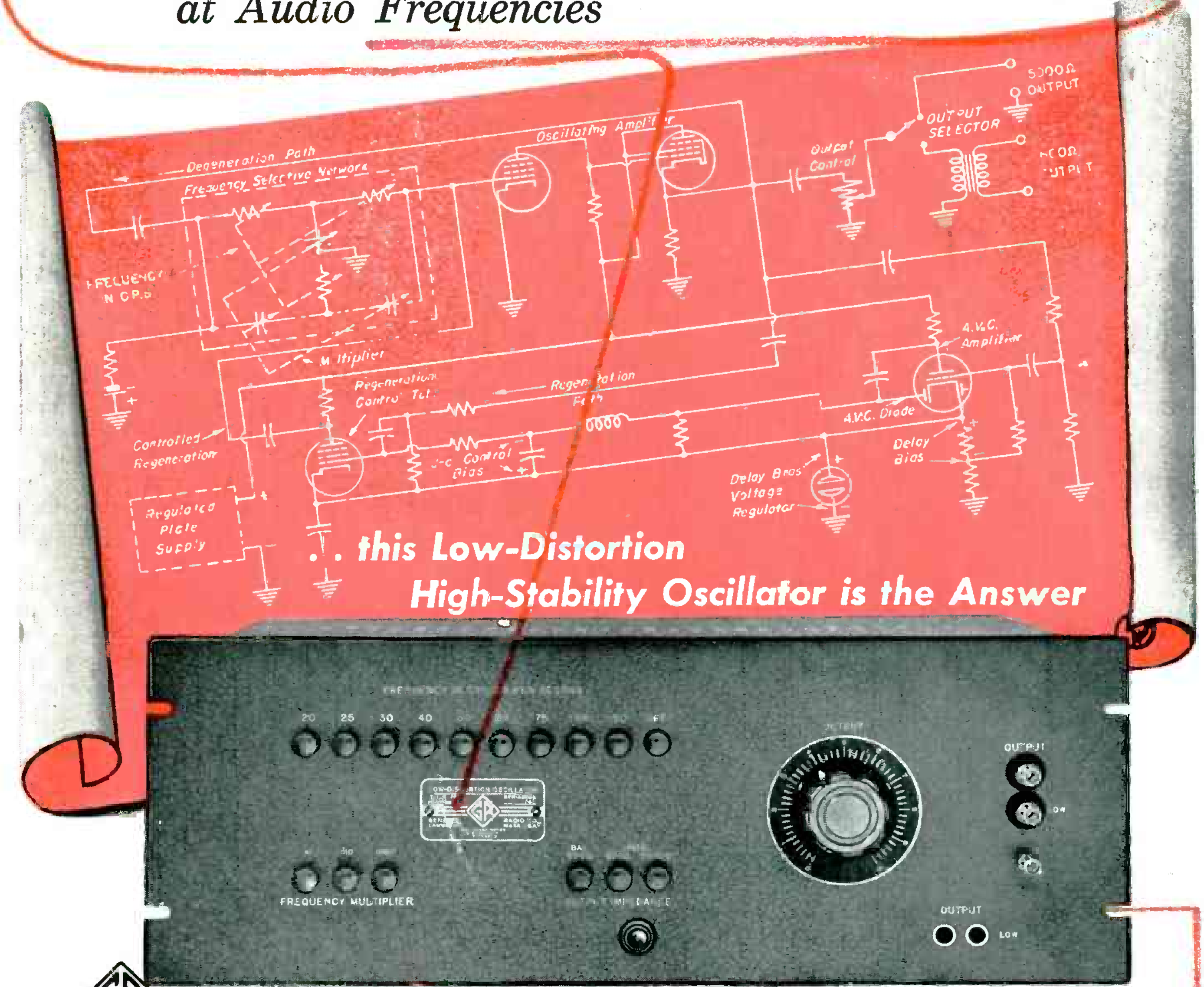
Some 150 smaller ultrasonic solder pots are already in use in this country for tinning the ends of aluminum leads.

▶ **Pros and Cons** — Aluminum's lighter weight for a given conduc-

(Continued on page 18)

for DISTORTION and BRIDGE MEASUREMENTS

at Audio Frequencies



The GR Type 1301-A Low-Distortion Oscillator provides an exceptionally pure waveform . . . less than 0.1% distortion between 40 and 7,500 cycles, and not more than 0.15% at all other frequencies.

For distortion measurements and audio facility checks at broadcast stations or in the laboratory, for production checking of high-fidelity audio equipment, and where distortion measurements must be made rapidly and yet with confidence in the results, this instrument has proven most useful.

Type 1301-A Low-Distortion Oscillator	**$425**
Type 1301-P1 Range Extension Unit (2 to 15 c.p.s.)	**$80**

Very Low Distortion — *frequency selective network provides complete degeneration of all frequencies above and below frequency adjusted to*

5,000-ohm output — distortion less than 0.1% from 40 to 7,500 cycles; less than 0.15% from 7,500 cycles to 15 kc; less than 1% with Extension Unit from 2 to 40 cycles

600-ohm output — distortion less than 0.1% from 50 to 7,500 cycles; 0.25% from 20 to 50 cycles and 0.15% above 7,500 cycles

Rapid Coverage of Audio Range — *27 fixed frequencies between 20 and 15,000 cycles selected by push buttons. Any desired frequency between steps obtained by plugging in external resistors. Type 1301-P1 Range Extension Unit covers 2 to 15 cycles*

High Stability — *internal voltage regulator eliminates frequency drift due to variations in plate supply. Changes in load have no effect upon frequency. Frequency drift not greater than 0.02% per hour after the first ten minutes operation*

Constant Output — *AVC diode controls regenerative tube bias, holding output constant to within 1 db over the entire range. Three Outputs: 5000 ohms unbalanced, 600 ohms balanced and unbalanced. Outputs: 18 mw into 600 ohm and 100 mw into 5,000 ohm loads*

Accurate Frequency Calibration — *adjusted to within ±(1½% + 0.1 cycle)*

No Temperature or Humidity Effects — *operation is substantially independent of climatic changes normally encountered*

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Mass.

90 West Street NEW YORK 6 *920 S. Michigan Ave.* CHICAGO 5 *1000 N. Seward St.* LOS ANGELES 38 tivity has tremendous appeal in airborne equipment.

▶ **Cost**—The cost of aluminum (from one-third to one-half that of copper in the larger wire sizes) makes the white metal attractive for many other commercial applications.

On the other side of the picture, the greater bulk of aluminum for a given conductivity possibly precludes its extensive use in iron-core components and other parts having critical space factors for windings.

In the military category, the Navy is experimenting with aluminum conductors for wiring in submarines, because of the metal's ability to resist acid fumes. The Signal Corps is experimentally dropping aluminum wire out of airplanes when establishing telephone lines across rough terrain. Here the lighter weight, and resistance to corrosion, are assets.

The Atomic Energy Commission has been ordering hundreds of pounds of No. 22 aluminum wire monthly, for an unrevealed use.

Commercially, the Bell System has gone to aluminum conductors for some of its multiconductor cables because of shortage of copper wire. Splices are made with squeezed-on sleeves. Gages currently used are No. 17, 20, 22 and 24.

Motors for dishwashers and washing machines have been wound successfully with aluminum wire when copper supplies ran out.

Bare aluminum wire for grounding television antennas is now available at about half the price of equivalent copper wire. Much the same wire has long been used by farmers for electric fences and by housewives for clotheslines.

▶ **Auto Uses**—Firms are now using 0 and 00 gage aluminum wire for battery and starter cables of automobiles. The ends are tinned using ultrasonic solder pots, after which terminal lugs can be sweat-soldered conventionally. Compression-type terminals are also being used; these have long been satisfactory in the electric power field, where new high-voltage transmission lines use aluminum conductors almost 100 percent today.

Navy's New Electronic Plane

The shark-like fin on top, and the "balloon" below this Lockheed Super Constellation are huge radomes incorporated in Navy's new WV-2. Exact mission of WV-2 is secret, but official reports describe it as a high-flying radar sentinel for domestic defense

Electronics Expansion Program Set by U.S.

ELECTRONICS industry has been called on by the Defense Production Administration to complete a $396 million expansion in manufacturing facilities by 1954. Already a total of $288 million for expansion has been certified through government-incentive fast-tax-amortization certificates, so that only $108 million more will actually be promoted.

High on the list of facilities to be expanded are those used to produce such items as special-type radar antennas, hydrogen-thyratron tubes, transistors, dies for mica separators, industrial television and highly specialized end equipment.

The total electronics expansion program of $396 million was set after a study of the level of production necessary to support our permanent military preparedness program. Consideration was given to such factors as stockpiling, allowance for civilian consumption, increases in technological change, costs, delays and scarce material substitutes.

Microwave Radio Relay Aids Airport Control

MICROWAVE LINKS installed at several international airports are making a major contribution to air safety. Used to transmit signals between airport control towers and air-to-ground antenna arrays, they keep major antenna arrays out of the path of incoming planes. Air-to-ground communication is improved since receivers are removed from the ignition noise area. Antenna towers in many cases may be erected atop neighboring mountains to extend the range of air-to-ground signals.

First of these installations links Mexico City airport with the receiving station at Maria Licia, nine

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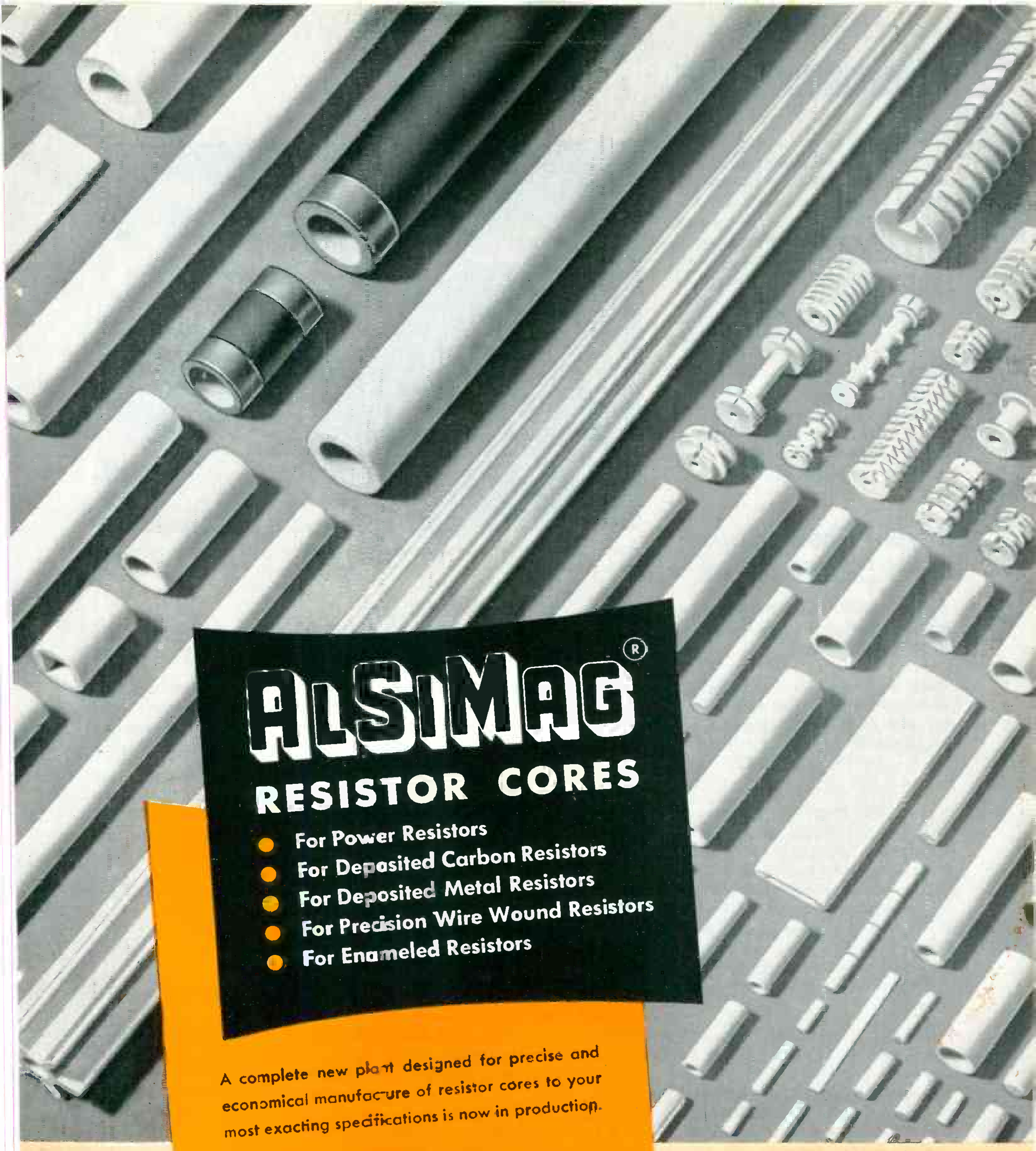

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- For Deposited Metal Resistors
- For Precision Wire Wound Resistors
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A complete new plant designed for precise and economical manufacture of resistor cores to your most exacting specifications is now in production.

50TH YEAR OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENNESSEE

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SOUTHWEST: John A. Green Co., 6815 Oriole Drive, Dallas 9, Dixon 9918 • NEW ENGLAND, 1374 Massachusetts Ave., Cambridge, Mass., Kirkland 7-4498
LOS ANGELES, 5603 North Huntington Drive, Capitol 1-9114 • CHICAGO, 228 North LaSalle St., Central 6-1721 • ST. LOUIS, 1123 Washington Ave., Garfield 4959

miles away. Aeronautical Radio de Cuba operates a similar link at Havana airport. Both of these links employ Federal equipment.

Aeronautical Radio of San Francisco operates microwave links using Motorola equipment at Seattle, San Francisco, Honolulu, and Tokyo. At Honolulu, the microwave equipment is used to carry signals over the mountains around the airport and bring planes in over a 1,200-foot path in the mountains to the airport at sea level.

United Radio Communications of San Francisco has recently ordered a microwave remote-control link from the General Electric Co.

Raydist Checks Speed of SS *United States*

Radiolocation system finds new application about new luxury liner in speed tests

ANOTHER "first" was added to the already lengthy list established by the new liner *United States* when an electronic system was used for the first time in determining speed at sea.

▶ **The Old Way**—Under normal procedures, a ship's speed is determined by using a stopwatch and a measured-mile course. The only course capable of meeting the deep-water requirements of the *United States* was at Guantanamo Bay, Cuba. However, the water there was too warm for efficient condenser operation under full throttle operation.

▶ **And the New**—Raydist, a precise radiolocation system developed by Hastings Instrument Co., enabled the speed trials to be conducted in the open sea. The system continually measured the distance between a floating buoy and the ship with an accuracy of one part in 5,000.

The system proved reliable and easy to use. Before the first mile run was completed, the speed attained during the first half of the run had been calculated and delivered to the bridge.

Radar-controlled camera overlooking New Jersey's busy Route 4 photographs license plate of any New York-bound car doing 55 mph or more

Lawful Cyclops Snaps Speeders

MYTHOLOGICAL Cyclops was a one-eyed, lawless giant who forged thunderbolts for Zeus. His fabulous modern counterpart, using a camera eye triggered by a microwave radar thunderbolt, is aligned on the side of law and order. He gets the goods on speeders whose contribution to modern slaughter would amaze even the old giant.

Many motorists are already familiar with radar speed indicators in use by Connecticut State Police and others. Ordinary radar sends out a pip of energy that is reflected from an obstacle. The time between sending and receiving indicates the distance. When the obstacle is changing distance, the time difference between two successive reflections can be used to determine the speed.

The Radar Control Devices Co., taking technology one step farther, has married 32,000-megacycle radar to a 16-mm movie camera that snaps one frame at a time. Mounted on a pole and aimed up the road, it photographs the license plate as it records date and time. Speed is not indicated, but the device is set to trigger whenever an approaching car exceeds the legal maximum. In a 50-mph zone, for example, it might be set to operate the shutter at 55 and above. Cars approaching at 54.9 would not be photographed.

▶ **Leased Cop**—The company, still operating at the production-prototype stage, plans eventually to rent equipment to municipalities at a cost between $30 and $50 a day, servicing the device daily and delivering a roll of developed film to the police within a day of the infraction.

Diathermy Users Given One More Chance

FCC extends deadline for compliance with radiation regulations to June 30, 1953

A YEAR'S EXTENSION has been granted by the FCC for medical diathermy users to comply with Section 18.51 of the Rules and Regulations governing radiation from such equipment. This action results from pleas from users claiming inability to meet the original dead-

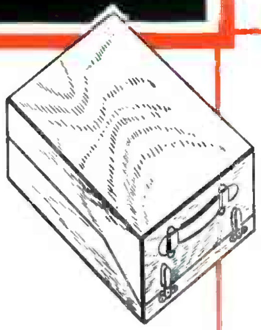
(Continued on page 22)

marion's NEW metertester

MODEL M-2

MEASURES SENSITIVITY AND RESISTANCE

for testing and calibration of D. C. instruments in the laboratory and on production lines



Marion's New Metertester (Model M-2) retains proven Marion features but increases application flexibility. In addition to improved circuitry for sensitivity measurement it also measures internal resistance of sensitive instruments without exceeding full scale rating of the instrument under test.

FEATURES

- Regulated Power Supply
- Stepless Vacuum Tube Voltage Control
- Illuminated 8½" Mirror-Scale Standard Instrument, Hand Calibrated
- Marion Ruggedized Null Indicator movement for bridge balance indication
- Decade of .1% accurate Manganin Wire Wound Resistors
- Direct Reading Bridge Circuit using Helipot
- Complete. No accessories required

SPECIFICATIONS

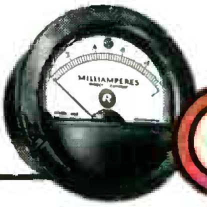
ACCURACY: Overall better than ¼ of 1%
RESISTANCE RANGE: 0-5000 ohms
POWER SOURCE: 115V A C 60 cycles
CASE SIZE: 15⅛" x 10⅛" x 5⅜"
WEIGHT: 15 lbs.

SENSITIVITY RANGES

0-25UA
0-50UA
0-100UA
0-200UA
0-400UA
0-500UA
0-800UA
0-1 MA
0-5 MA
0-10 MA
0-100 Volts

The New M-2 Model can also be used for additional purposes, such as a precise source of DC current and voltage and as a precision Wheatstone bridge in the 0-5000 ohm range.

For further information write Marion Electrical Instrument Co., 401 Canal Street, Manchester, N. H., U. S. A.



marion meters

Reg. U.S. Pat. Off.

MANUFACTURERS OF RUGGEDIZED, HERMETICALLY SEALED AND STANDARD PANEL INSTRUMENTS line because of curtailed production of new models during the defense buildup.

Procrastinators are warned by the FCC, however, that any further requests for extensions will be handled on an individual basis, with consideration given to efforts made in each case to replace nonconforming equipment during the period for which extension is being granted.

NUMBER OF EMPLOYEES	L-F AND H-F COMMERCIAL RADIO	VHF AND UHF COMMERCIAL RADIO	BROADCAST TRANSMITTERS	BROADCAST RECEIVERS	TELEVISION TRANSMITTERS	TELEVISION RECEIVERS	RADAR AND NAVIGATIONAL EQUIP	METEOROLOGICAL EQUIPMENT	CARRIER EQUIPMENT	UNDERWATER LOCATING DEVICES	X-RAY TUBES, EQUIPMENT	BROADCAST TUBES	RECEIVER TUBES	SPECIAL-PURPOSE TUBES	MINIATURE TUBES	SUBMINIATURE TUBES	ANTENNA MASTS	BATTERIES	TEST EQUIPMENT	RESISTORS	CAPACITORS	WIRE AND CABLE	POWER TRANSFORMERS	R-F AND A-F TRANSFORMERS	RECTIFIERS, DRY	CERAMIC INSULATORS
1,600	X			X			X	X	X		X	X	X	X				X	X	X	X	X	X	X	X	X
700									X													X	X	X		
1,250							X	X											X							
440							X			X																
300																						X	X	X		X
11,500	X	X	X				X		X								X		X				X	X	X	X
150	X	X																								X
3,000				X		X					X			X							X		X	X	X	
14,500																		X			X					X
400									X										X		X		X	X		
700							X	X		X																
4,100																			X	X	X	X				X
160					X	X													X							
1,500											X								X							
1,300																			X				X	X		
1,200	X			X																						
4,000				X		X																				
1,700			X	X			X												X							
2,400								X											X				X	X		
800				X																						
4,000	X	X	X	X	X	X	X		X		X	X	X	X	X	X	X				X		X	X	X	
450							X												X							
400																			X				X	X		
5,360									X								X					X				
1,050											X								X							
2,250							X							X						X						
2,350	X	X	X	X	X	X	X				X	X		X	X	X		X	X							
600																				X	X					
1,000																	X			X			X	X	X	
660																				X	X					
740			X	X			X	X											X						X	X
2,500																	X		X	X	X					X
370											X															
1,550	X	X		X		X																				
200											X															
3,300											X															
3,500							X			X									X	X	X	X	X	X	X	X
10,000	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
3,500																	X		X	X						X
600																				X						
1,000	X			X			X										X		X	X	X				X	
1,200				X			X		X			X	X	X	X				X		X	X			X	
4,860													X													
10,300	X	X	X	X	X	X	X					X	X	X	X	X	X		X	X	X					
190																					X		X	X		
2,800																		X							X	
3,800									X										X							X
240																							X	X		
450				X					X										X		X	X				X
300		X			X	X	X		X																X	

Electronics Industry of Western Germany

Electronic equipment and components are being made by 74 firms employing 158,000 people in Western Germany, according to an Office of Economic Affairs tabulation. Product breakdowns and employment figures are given here for 50 of these firms, of which the four largest are Robert Bosch, Brown Boveri, Telefunken and Siemens & Halske

Small Electronic Firms Share in Navy Contracts

Of $900 million in prime electronic contracts awarded by the three Navy bureaus, Aeronautics, Ships and Ordnance, approximately $200 million was awarded to small companies during the first 10 months of this fiscal year.

The ratio is in keeping with the Navy's overall procurement figures, which show that for the same period small business in all lines received $1,795 billion or 22.7 per cent of the total Navy procurement dollar.

By the end of the current fiscal year it is estimated that small business will have received over $2 billion in prime Navy contracts, compared to $1.2 billions last year.

Remote Gearshift Moves Robot TV Camera

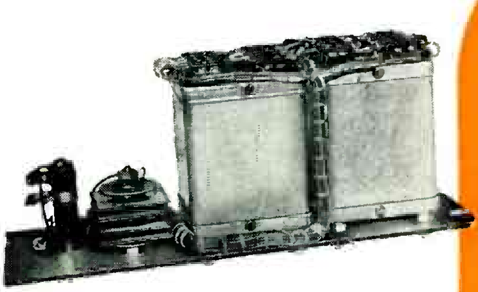
Armed services get preview of versatile television pickup for viewing dangerous operations

Moving objects can be followed with a camera equipped for remote as well as manual control, demonstrated by engineers of General Precision Laboratory of Pleasantville, N. Y. If desired, continuous remote control can be switched off and pushbutton movement to any one of six preset positions used. Often proposed as a means of viewing dangerous operations from a distance, television has so far been limited to a single-angle shot for each camera.

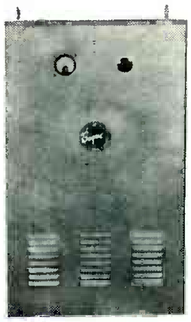
▶ **How It Works**—Heart of the system is the standard GPL camera with four-lens turret in which lens selection, focus and iris settings are already connected for remote control. This camera is mounted upon a newly designed pan-and-tilt pedestal and the five different operational features wired through a 1,000-foot cable to a miniature control unit somewhat resembling the gear shift lever on the steering

(Continued on page 24)

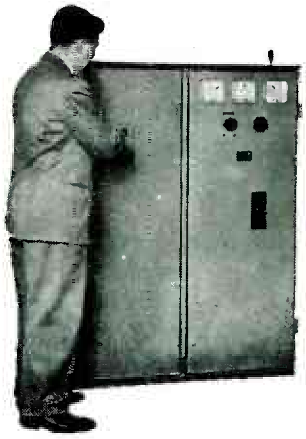
Bogue Magnetic Amplifiers
for
PRECISION CURRENT
CONTROL WITHOUT
MOVING PARTS



Bogue Power Supplies
for
CONTROLLED CURRENT &
VOLTAGE — OUTPUT REGULATED
TO 1%, LESS THAN 1% RIPPLE



Bogue Control Panels
for
ALL TYPES OF PRECISION
AUTOMATIC PROCESS
AND ELECTRIC CONTROL



HIGH QUALITY AC or DC CURRENT its production and control

that's where Bogue's outstanding engineering ability is best able to help you, today!

Full control in one plant over the design of specialized equipment, plus extreme precision in production results in a quality of equipment not ordinarily available in an assembled unit.

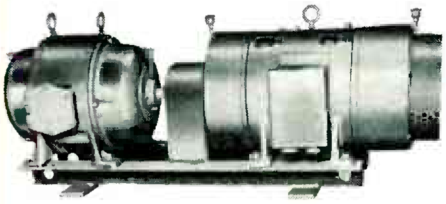
The following high quality is available in Bogue-built power equipments: Practically pure DC supplies with voltage regulation and ripple held to within a small fraction of a percent . . . 1 KW to 150 KW; AC supplies at frequencies up to 20 KC with voltage regulation and harmonic content held to within a small fraction of a percent . . . 1 KW to 150 KW.

If you have a requirement along these lines, give us a call — engineers who are really experts in their chosen fields will be glad to discuss your problems.

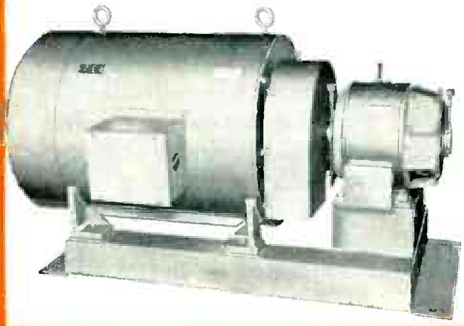
SINCE 1892 SPECIALISTS IN FINE MOTORS & GENERATORS
Bogue

BOGUE ELECTRIC
MANUFACTURING CO.
PATERSON 3,
NEW JERSEY

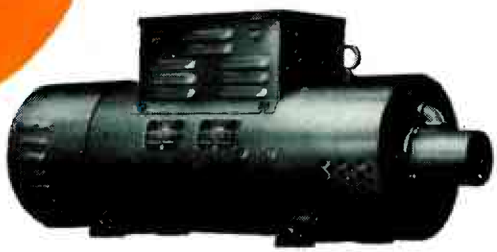
Bogue DC Generators
for
LOW RIPPLE
PRACTICALLY PURE
DC CURRENT



Bogue 400 Cycle Power
for
LABORATORY • PRODUCTION
TESTING OF
ELECTRONIC EQUIPMENT



Bogue Motor Alternators
for
CONVERTING DC POWER
TO SPECIFIED FREQUENCIES
OF ALTERNATING CURRENT



BOGUE PRECISION POWER

column of an automobile (see technical description and photographs beginning p 252 of this issue).

Servomechanical devices make the camera and its pan-tilt pedestal slave to the orders transmitted from the control unit by the remote cameraman. In addition to continuous servo-manual control, the unit has a memory that enables shifting instantly to any of six preset positions. Other refinements include automatic rate pan, which keeps the camera moving in the desired direction at any uniform speed and a stiffness control. The latter operates only in the manual position and can be adjusted to eliminate jerky movement when making panoramic shots under difficult conditions.

Although suggested for use in military action as a robot observer, its inventors also think the device may have advantages over manned cameras in overcoming the hazards of maneuvering in political conventions and other public gatherings.

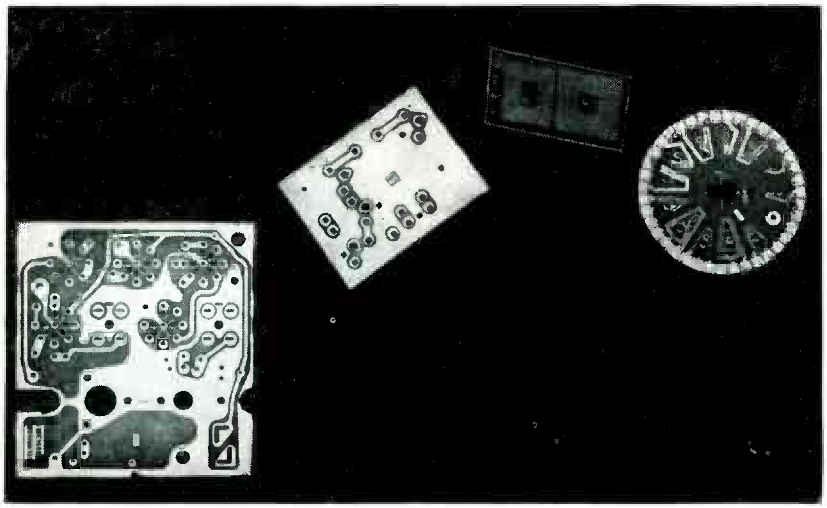
Public Tests Plated Circuit Radios

New process shows promise for automatic production methods in radio and television

LARGE-SCALE commercial application of plated circuits has resulted from a six-year million-dollar research and development program at Motorola. Suitability of plated circuitry was verified by marketing some 10,000 radio sets incorporating chasses fabricated by the new process. No news from consumers turned out to be good news, and as a result the company plans to adapt the process to other models of home and portable radios and eventually to television receiver production.

► **Placir**—The plated circuit process, called "placir" consists of plating a thin copper pattern on a stamped plastic base. This replaces the conventional chassis and much of the usual sub-chassis wiring. Sockets are made at the time of plating by boring holes in the plastic base. All of these operations are done by automatic machinery.

The process is expected to permit high-speed production of radio and television sets, with advantages in small size, light weight, improved operating characteristics and greater reliability.



Plated parts for a 5-tube miniature broadcast set and television receiver—products of Motorola's million-dollar "placir" process

BBC Adopts F-M for VHF Broadcasting

BRITISH Broadcasting Corporation, queen mother of government-operated radio systems, finds her plan for complete national coverage by three programs running into a dead end.

Failure of the Copenhagen Wavelength Plan for Europe, increased jamming by skywave-propagated foreign signals and technological difficulties in maintaining synchronized transmitters on exactly the same frequency are partial roadblocks. Worst trouble is plain lack of radio roads or channels.

► **More Paths**—Usual cure for allocations ills is to whack out new trails higher up in the frequency spectrum. Britain has long had available 88 to 100 megacycles, but has been loath to use frequency modulation, which makes the region habitable. Ignition noise is bad here for standard broadcast amplitude modulation. After extensive tests, BBC is enthusiastic about f-m and has extensive plans for coverage of the United Kingdom.

What will this mean to American manufacturers? Probably little. Coupled to dollar shortages in Britain is the generally cool attitude of receiver manufacturers, busy with tv, towards producing enough good f-m sets to satisfy even the U. S. market.

Auto Radio Business Triples in Six Years

Set manufacturers compete with automobile business itself; both do well

In 1946 there were approximately 8 million radio-equipped passenger cars in the U. S. Today, the Broadcast Advertising Bureau estimates that there are over 24.5 million. This represents more than 65 per-

(Continued on page 26)

KROHN-HITE is Setting the Pace for Low Frequency Electronic Instrumentation

QUALITY INSTRUMENTS with PROVEN PERFORMANCE

moderately priced

★ Oscillators — .009 cps to 520 kc


Models 400-A, 420-A, 430-A
12" wide, 7" high

The Models 400-A, 420-A, and 430-A are compact RC Oscillators with outstanding performance, moderately priced. The Models 400-A and 420-A provide both sine and square wave output.


Models 410-A, 400-C, 420-C
19" wide, 8¾" high

The Models 410-A, 400-C, and 420-C are designed with sturdy steel cabinets for rack panel mounting. These units feature sine and square wave output. The Model 400-C provides either balanced or single ended output.

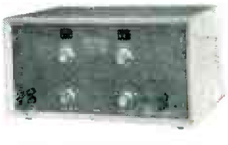
Model	Featuring	Frequency Range	Distortion	Output	Power Consumption	Price
400-A	Sine and Square Wave True RC Oscillator Compact Design	.009 cps to 1.1 kc	1%	25 mw/10 v	45 watts	$350.00
410-A	Sine and Square Wave Amplitude ±.25 db Low Distortion	.02 cps to 20 kc	1/4%	10 mw/5 v	150 watts	$950.00
420-A	Sine and Square Wave Audio and Sub-Audio Compact Design	.35 cps to 52 kc	1%	25 mw/10 v	45 watts	$290.00
430-A	Wide Range Compact Design Outstanding Value	5 cps to 520 kc	1%	50 mw/10 v	45 watts	$145.00
400-C	Sine and Square Wave Rack Panel Balanced Output	.009 cps to 1.1 kc	1%	100 mw/10 v	65 watts	$375.00
420-C	Sine and Square Wave Rack Panel Audio and Sub-Audio	.35 cps to 52 kc	1%	100 mw/10 v	65 watts	$325.00
440-A	Push-Button Controlled Excellent Resetability Low Distortion	.01 cps to 100 kc	1/10%	100 mw/10 v	120 watts	$450.00

★ Filters — .01 cps to 200 kc


Models 310-A and 360-A
12" wide, 7" high

The Models 310-A and 330-A are variable band-pass filters with unity pass band gain and 24 db/octave outside the pass band. Both high and low cut-off frequencies are independently adjustable over the entire frequency range.

The Models 350-A and 360-A are variable rejection filters which provide either a rejection band in which the gain falls at a rate of 24 db/octave or a sharp single frequency null. Both high and low frequencies are independently adjustable.


Models 330-A and 350-A
18" wide, 10" high

Model	Type	Featuring	Frequency Range	Noise & Hum	Power Consumption	Price
310-A	Band-Pass	Variable Band-Width Zero db Insertion Loss 24 db/octave Slope	20 cps to 200 kc	3 mv	40 watts	$275.00
330-A	Band-Pass	Low Internal Noise Zero db Insertion Loss 24 db/octave Slope	.02 cps to 2 kc	0.1 mv	50 watts	$450.00
	Band-Pass	Audio and Sub-Audio Range 24 db/octave Slope Variable Band-Width	0.2 cps to 20 kc	0.1 mv	50 watts	$450.00
340-A	Servo	Proportional-Plus-Derivative Proportional-Plus-Integral Servo-Design Filter	.01 cps to 100 cps	10 mv	40 watts	$350.00
350-A	Rejection	Low Internal Noise Rejection Band or Null 24 db/octave Slope	.02 cps to 2 kc	0.1 mv	50 watts	$450.00
360-A	Rejection	Variable Rejection Band Variable Null 24 db/octave Slope	20 cps to 200 kc	5 mv	40 watts	$275.00

ABOUT THESE INSTRUMENTS

The Oscillators and Filters described here are being effectively used in a growing number of interesting applications for engineering, research, and production.

WRITE FOR A FREE DESCRIPTIVE CATALOG

All instruments are fully guaranteed for one year against defective materials and workmanship.

Prices Net F.O.B. Cambridge

KROHN-HITE INSTRUMENT COMPANY
580 MASSACHUSETTS AVENUE
CAMBRIDGE 39, MASS., U.S.A.

cent of the nation's 37 million automobiles and 22 percent of all radios in the U. S.

Much of the growth has taken place since 1949. Over 14 million car sets have been produced since then, equaling about 75 percent of automobile production for the period.

▶ **Leaders**—A leading factor in the huge auto-radio business is General Motors, whose Delco division has produced more than 7 million auto sets. In 1950 alone, Delco made nearly 2 million of the 4.7 million sets produced that year by the entire industry. It makes radios for all GM divisions and for other car manufacturers as well. However, not all GM divisions use Delco sets exclusively. Some of them purchase from outside radio companies.

No other car manufacturer makes its own sets, so that a very substantial market is available for auto radio producers. For example, the Ford Motor Company is a good customer of such firms as Bendix, Motorola and Sylvania. The Chrysler Corporation uses Motorola sets and buys from Philco as well.

These two car manufacturers, along with General Motors, have accounted for much of the auto-radio business, although a large volume is also done through regular radio outlets and mail-order chains. Between 1949 and 1951 the following percentages of cars sold have been radio-equipped: General Motors, 74.1 percent Ford, 70.4 percent; Chrysler, 66.7 percent.

▶ **Outlook**—Despite past performance, the immediate trend in car-radio production and business is not dazzlingly bright. A 50-percent decline in auto set production has taken place this year, reflecting the slump in auto sales last spring. Units produced during the first half of the year total 1,543,877 while in 1951 production had reached 2,969,632 for the period.

But auto-radio manufacturers are optimistic about the future. The effect of the steel strike, even though it may cut total car output, has put the automobile back into a seller's market—and that is when auto-radios really sell.

MEETINGS

Sept. 3-13: International Electrotechnical Commission Meeting, Scheveningen, Netherlands.

Sept. 5-7: Fourth Preconference ISA Instrument Maintenance Clinic, Cleveland, Ohio.

Sept. 8-10: American Standards Association, Third National Standardization Conference, Museum of Science and Industry, Chicago, Ill.

Sept. 8-12: National Instrument Conference and Exhibit, Cleveland, Ohio.

Sept. 10-12: Convocation of the Centennial of Engineering, Congress Hotel, Chicago, Ill.

Sept. 13-22: Italian Radio and Television Fair, Sports Palace, Milan, Italy

Sept. 20: Cedar Rapids Section, IRE, Communications Conference, Roosevelt Hotel, Cedar Rapids, Iowa.

Sept. 22-25: NEDA Third Annual Convention and Manufacturers' Conference, Ambassador, Atlantic City, N. J.

Sept. 23-30: Conference on Instruments and Measurements, Stockholm, Sweden.

Sept. 29-Oct. 1: Eighth Annual National Electronic Conference and Exhibition, Hotel Sherman, Chicago, Ill.

Oct. 1-3: Canadian Electrical Manufacturers Association, General Brock Hotel, Niagara Falls, Ont.

Oct. 6-8: NAED, Fall Meeting of the Pacific Zone, Hotel del Coronado, Coronado, Calif.

Oct. 13-17: AIEE Fall General Meeting, New Orleans, La.

Oct. 20-22: Radio Fall Meeting, RTMA Engineering Department, Hotel Syracuse, Syracuse, N. Y.

Oct. 20-24: National Metals Show, Philadelphia Auditorium, Philadelphia, Pa.

Oct. 21-23: Twenty Ninth Annual Session, Communications Section, Association of American Railroads, Edgewater Gulf Hotel, Edgewater Park, Miss.

Oct. 26-29: NAED, Meeting of Board of Governors, Grove Park Inn, Asheville, N. C.

Oct. 28-30: AIEE Middle Eastern District Meeting, Commodore Perry Hotel, Toledo, Ohio.

Oct. 29-Nov. 1: Audio Fair, Hotel New Yorker, New York, N. Y.

Nov. 5-7: Sixteenth Annual Time and Motion Study and Management Clinic, Sheraton Hotel, Chicago, Ill.

Nov. 10-13: NEMA, Haddon Hall, Atlantic City, N. J.

Nov. 10-30: International Radio and Electronics Exhibition, Bombay, India.

Nov. 17-18: AIEE, Technical Conference on Recording and Controlling Instruments, Benjamin Franklin Hotel, Philadelphia, Pa.

Nov. 19: American Standards Association, 34th Annual Meeting, Waldorf Astoria, N. Y.

Nov. 21-22: Fourth Annual IRE Regional Papers Technical Conference, President Hotel, ter Conference, Park Shera-

Dec. 10-12: IRE-AIEE Computer Conference, Park Sheraton Hotel, New York, N. Y.

Jan. 14-16, 1953: Joint AIEE-IRE Conference on High Frequency Measurement, Washington, D. C.

Feb. 5-7: IRE Southwestern Conference and Electronics Show, Plaza Hotel, San Antonio, Texas.

March 23-26: IRE National Convention, Waldorf-Astoria Hotel and Grand Central Palace, New York, N. Y.

May 11-13: National Conference on Airborne Electronics, Dayton, Ohio.

Business Briefs

▶ **FCC** has granted a special temporary authorization to RCA to operate four modified Signal Corps transmitters at the site of WOR-TV. They will be used to obtain data concerning the effect of antenna height on tropospheric and ground wave propagation in the upper portion of the uhf television band (842-845 mc).

▶ **Sale** of aircraft-quality steel by warehouses, for use in military electronic and communications equipment bearing allotment symbols A-7, was authorized by the National Production Authority on July 30.

▶ **Transistor** licensees under Western Electric patents now total 26 domestic and nine foreign firms.

▶ **Savings** of over $2.5 million in labor and metal costs will be effected as a result of a new schnorkel-sub extensible radio and radar mast design. The new mast is made from monel-covered low-alloy steel tubing instead of stainless steel billets, according to the Navy.

To You, Belden's Golden Anniversary Means

—product performance that can come only from a "know-how" that has grown through actual service since the early days of the electrical industry.

—an ability to cooperate in pioneering new wires to meet or anticipate industry's growing needs.

In the years that follow This Belden Program Is

—TO BE CONTINUED

AVOID VERBAL ORDERS

Must check cord
assembly department—
Too many rejects—
Costs us money—
Too much inspection
required—
Too much lost production
time—
Too many service calls—
Engineering should
look into those
Belden Cords

Complete Cord Sets

Finished to your exact requirements. Save production time. Cut out rejects and failure in service.

A scrap of paper that led to a
Class A product improvement. Let us
prove that these savings are possible
in your plant, too.

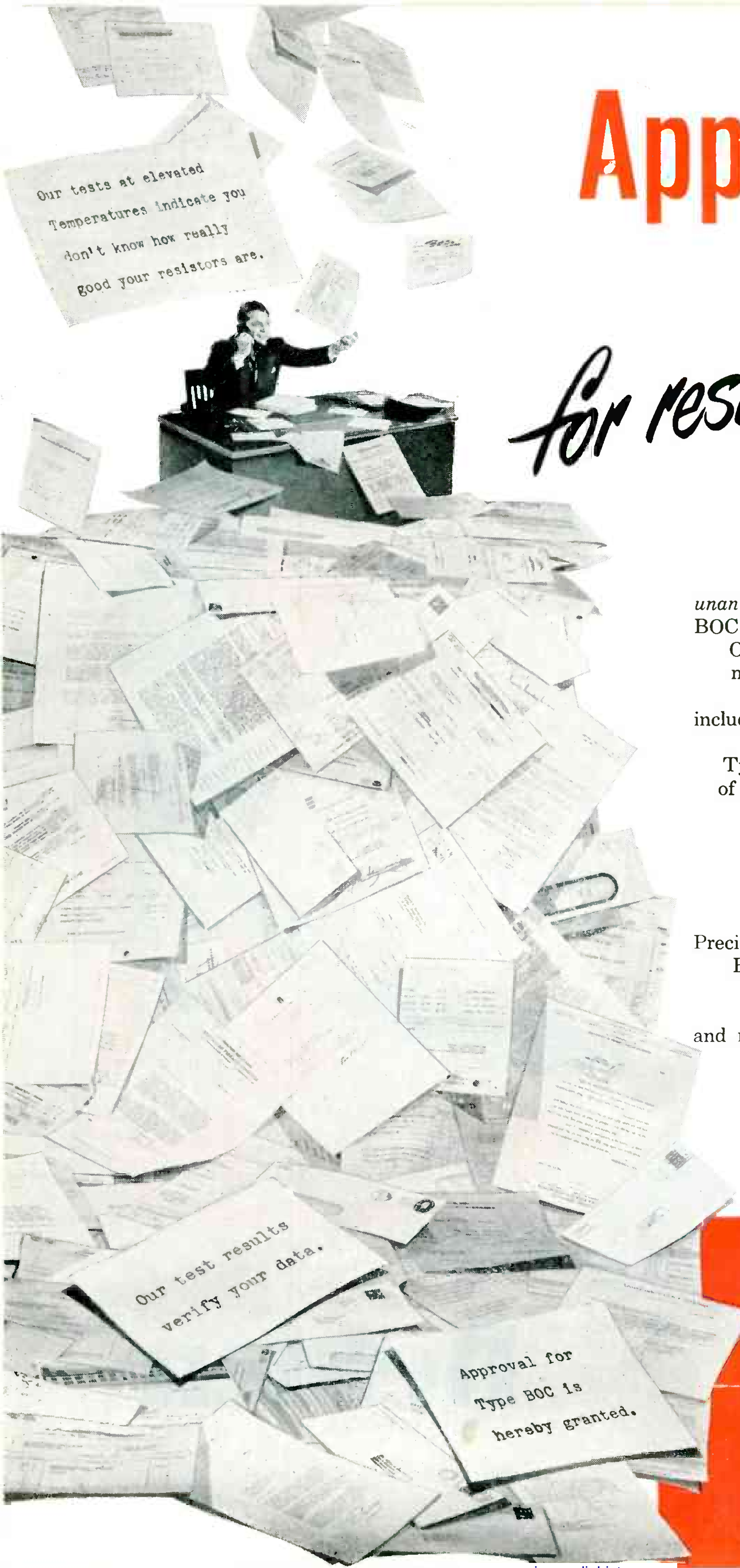
WRITE: Belden Manufacturing Co.
4625 West Van Buren Street
Chicago 44, Illinois

Corditis-Free Cords by

Belden

WIREMAKER FOR INDUSTRY

Approval is for resistors *too!*



Our tests at elevated temperatures indicate you don't know how really good your resistors are.

Our test results verify your data.

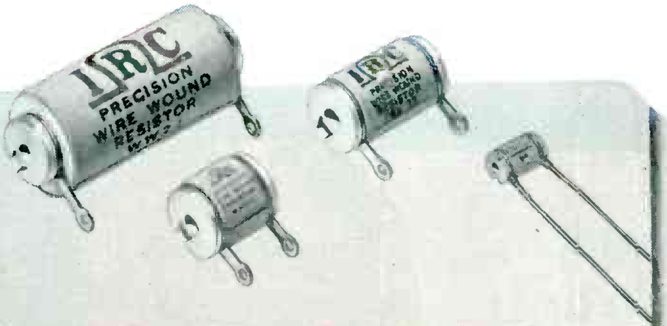
Approval for Type BOC is hereby granted.

In all our experience, no resistor has been so extensively tested—*and so unanimously approved*—as IRC's new Type BOC Boron-Carbon ½-watt PRECISTOR. Of the 3,000,000 already manufactured, more than 100,000 were given the most stringent tests-in-production, including critical temperature cycling and 500-hour load-life tests. Result:—Type BOC conforms to *all* requirements of MIL-R-10509A! Also, customers have conducted their own laboratory and field tests—and they express their approval of Type BOC in letters like those shown here.

In the case of IRC's new JAN Type Precision Wire Wounds and Advanced Type BT Resistors, too, rigid quality control and continued testing have won industry-wide approval. Most stable and reliable of all precision wire wounds, Type WW's far surpass JAN-R-93 Characteristic B Specifications. And Type BT's continue to meet and beat JAN-R-11 Specifications.

IRC

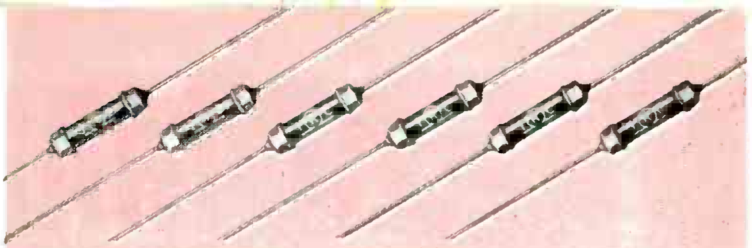
important



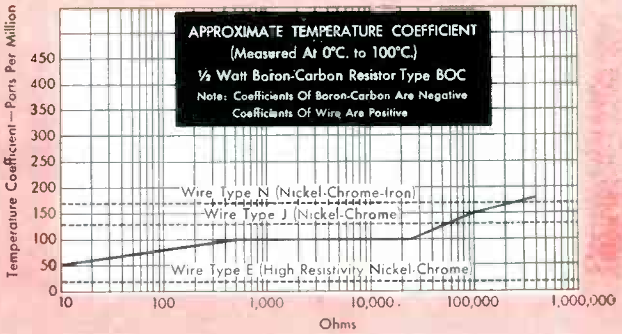
New JAN Type Precision Wire Wound Resistors Excel JAN-R-93 Characteristic B Specifications

	Original Resist.	1st Cycle % Chge	2nd Cycle % Chge	3rd Cycle % Chge	4th Cycle % Chge	Resist at End of 100 hrs load	Total % Chge	% Chge from Last Temp Cycle to End of 100 hrs. load %	Resistance Chge at End of 100 Hrs Load only % (no cycling)	
1	100,010	+.04	+.04	+ 05	+.05	100,050	+.04	— 01	100,040	—.0[illegible]
2	100,000	+ 03	+.04	+.03	+ 05	100,060	+ 06	+.01	100,000	0
3	100,000	+.01	+.02	+.02	+.05	100,000	0	+.05	100,050	—.02
4	100,000	+ 02	0	+.02	+.02	100,000	0	—.02	100,040	— 01
5	100,010	+ 03	+.04	+ 04	+.05	100,000	0	—.05	100,030	— 03
6	100,000	0	+ 03	+.04	+ 04	100,100	+ 1	+ 06	99,980	0
7	100,000	+ 04	+.05	+ 04	+ 04	100,070	+ 07	+.03	100,000	0
8	100,000	+.03	+ 05	+ 05	+ 05	100,050	+ 05	0	100,000	0
9	100,000	+ 04	+ 03	+ 05	+ 04	100,010	+ 01	—.03	100,050	0
10	100,000	+ 02	+ 02	+ 02	+ 04	100,010	+ 01	—.03	100,000	0
11	100,000	0	+.01	+.01	+.03	100,000	0	—.03		

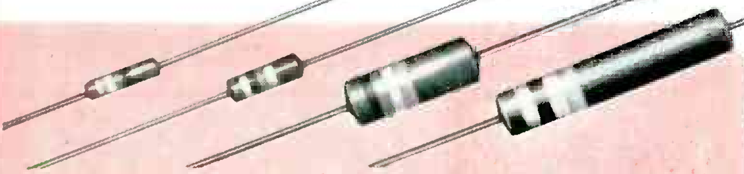
Most *reliable and stable* of all wire-wound precisions, these new Type WW's have proved their superiority in unbiased tests. Severe cycling and 100-hour load tests resulted in virtually zero changes in resistance. Other stringent tests proved JAN Type WW's high mechanical strength, freedom from shorting, resistance to high humidity. New winding forms—new winding technique—new type insulation—and new terminations assure long life, accuracy, ruggedness in service. IRC JAN Type WW's are becoming the choice of leading producers of military equipment. Get full technical data in Catalog Bulletin D-3.



Type BOC Boron-Carbon ½-Watt Resistor Surpasses Signal Corps Specification MIL-R-10509A



The ultimate in *stable, reliable* non-wire-wound resistors, Type BOC's are especially designed for military electronic equipment—radar, gunnery control, communications, telemetering, computing and service instruments. Greatly improved temperature coefficients of resistance permit their use in place of costlier wire wound precisions in many critical applications. Lower capacitive and inductive reactance suit them to circuits where wire-wound stability is needed. Small size makes them ideal in limited space. *Tolerance:*—1%, 2% and 5%. *Resistance Values:*—10 ohms to ½ megohm. Send for full technical data in Catalog Bulletin B-6.



Type BT Advanced Fixed Composition Resistors Meet and Beat JAN-R-11 Specifications

Type BTS Meets and Beats Rigid G Characteristic

These are the famous Advanced Type BT's whose characteristics set new performance records for fixed composition resistors. They combine a unique filament-type resistance element with exclusive construction features to assure extremely low operating temperature and excellent power dissipation. Yet they are compact, light in weight, fully insulated. Intensive tests by independent agencies have proved their superiority under actual field conditions. For full technical data, send for Catalog Bulletin B-1.

Boron-Carbon PRECISTORS • Power Resistors • Voltmeter Multipliers • Insulated Composition Resistors • Low Wattage Wire Wounds • Volume Controls • Voltage Dividers • Precision Wire Wounds • Deposited Carbon PRECISTORS • Ultra HF and High-Voltage Resistors • Insulated Chokes • Selenium Rectifiers

Wherever the Circuit Says —⩘⩗—

INTERNATIONAL RESISTANCE COMPANY
401 N. Broad Street, Philadelphia 8, Pa.
In Canada: **International Resistance Co., Ltd., Toronto, Licensee**

J. F. ARNDT & CO. ADV. AGENCY

Mail Coupon Today for Full Details of These IRC Resistors

INTERNATIONAL RESISTANCE COMPANY
403 N. Broad St., Philadelphia 8, Pa.

Please send me full data on the following checked items:—

- ☐ Type BOC Boron-Carbon PRECISTORS
- ☐ Type WW Precision Wire Wound Resistors
- ☐ Type BT Advanced Fixed Composition Resistors
- ☐ Name and Address of Nearest IRC Distributor

NAME ____________________

TITLE ____________________

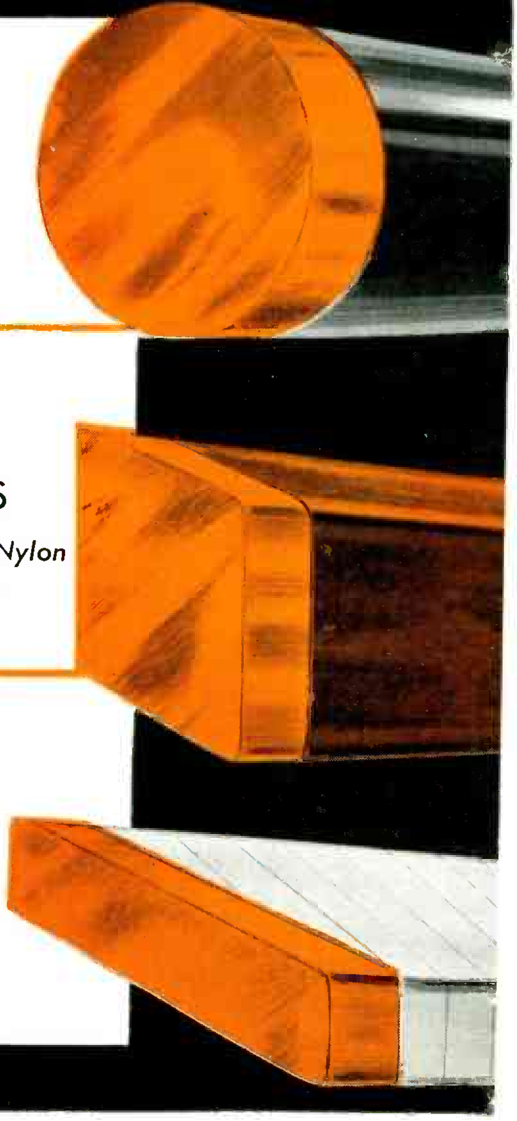
COMPANY ____________________

ADDRESS ____________________

CITY ____________ ZONE ______ STATE ______

IF MAGNET WIRE IS

PHELPS DODGE has the



✓ MOST COMPLETE AND UP-TO-DATE LINE OF MAGNET WIRE IN THE INDUSTRY

✓ EVERY TYPE OF INSULATION TO MEET DESIGN REQUIREMENTS

Black Enamel • Formvar • Sodereze® • Bondeze® • Nylon
Glass • Paper • Cotton • Multiple Combinations

✓ AVAILABLE IN ALL SIZES AND SHAPES—ROUND, SQUARE, RECTANGULAR . . .

Over 400 different types!

"It takes the best

PHELPS DODGE COPPER PRODUCTS
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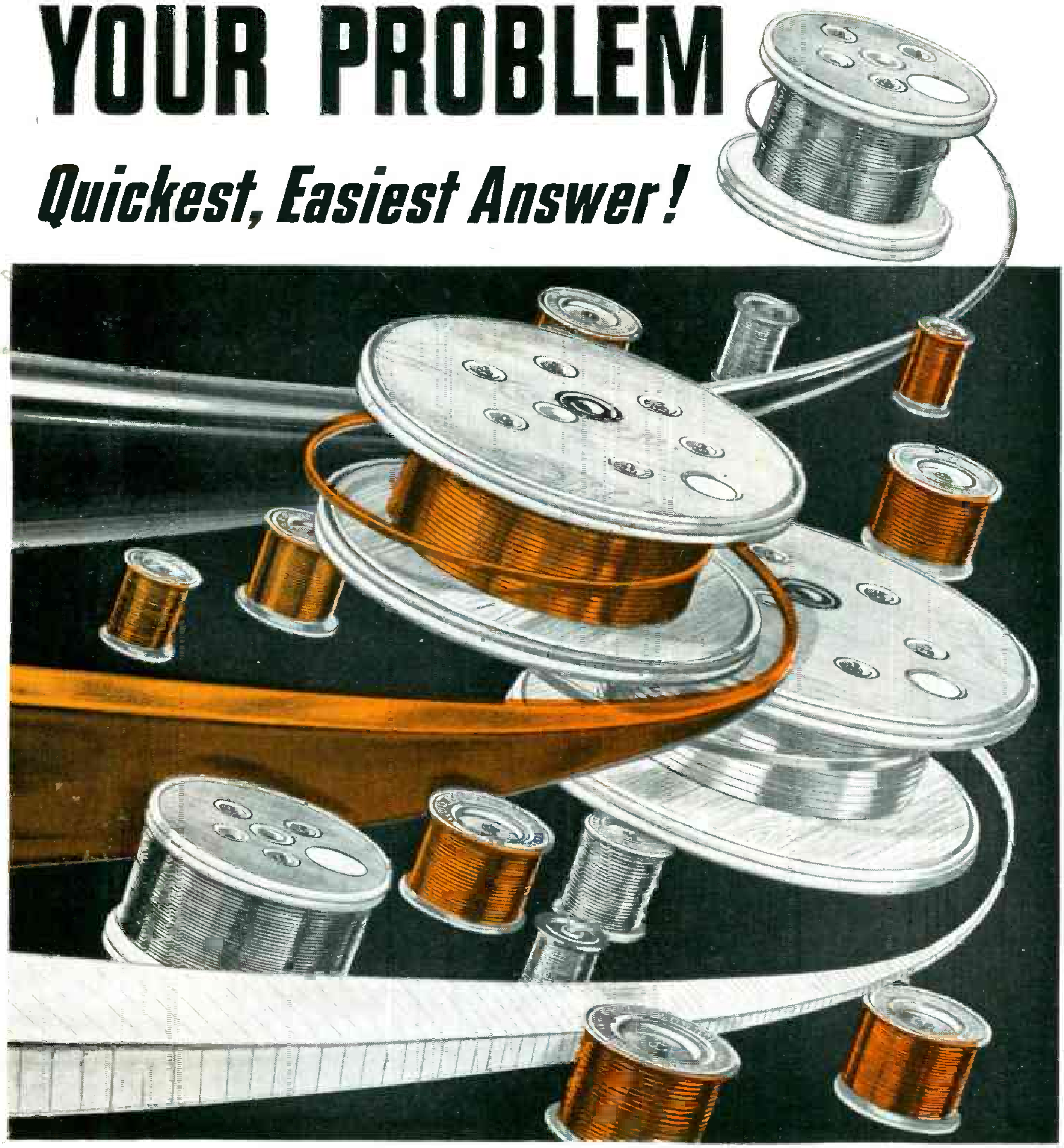
YOUR PROBLEM

Quickest, Easiest Answer!



to make the best!"

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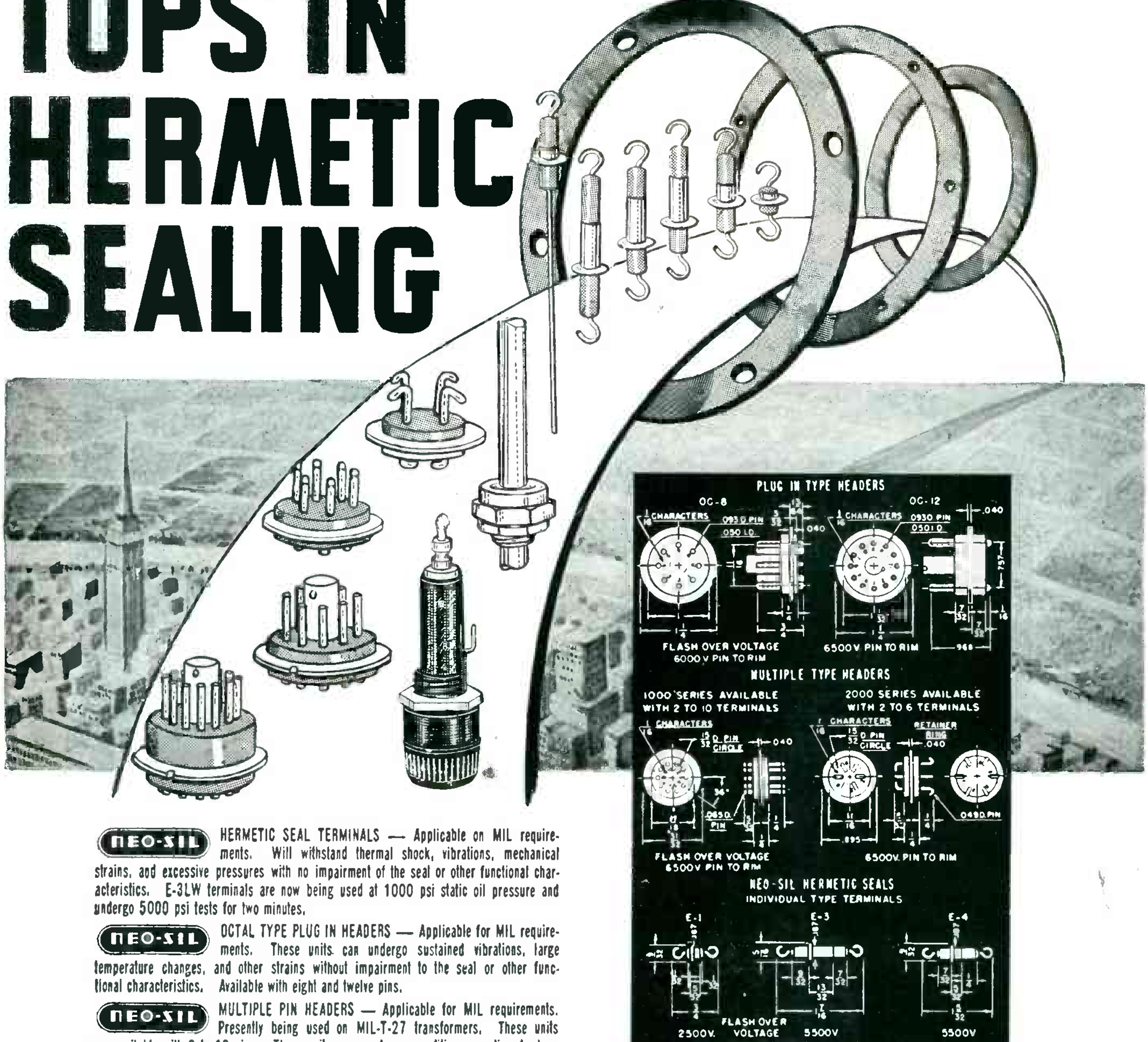
FORT WAYNE, INDIANA

TOPS IN HERMETIC SEALING



TEST DATA

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

Volume Resistivity at 800 Volts d-c

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

Dielectric Constant and Dissipation Factor

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

Dielectric Strength at 60 cycles
Volts per mil — 370

Durometer Average — 80 ± 5

Temperature — Rated as a Class A material conservatively + 175° to —70° centigrade.

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

NEO-SIL HERMETIC SEAL TERMINALS — Applicable on MIL requirements. Will withstand thermal shock, vibrations, mechanical strains, and excessive pressures with no impairment of the seal or other functional characteristics. E-3LW terminals are now being used at 1000 psi static oil pressure and undergo 5000 psi tests for two minutes.

NEO-SIL OCTAL TYPE PLUG IN HEADERS — Applicable for MIL requirements. These units can undergo sustained vibrations, large temperature changes, and other strains without impairment to the seal or other functional characteristics. Available with eight and twelve pins.

NEO-SIL MULTIPLE PIN HEADERS — Applicable for MIL requirements. Presently being used on MIL-T-27 transformers. These units are available with 2 to 10 pins. These units can undergo conditions mentioned above with no impairment to the seal or other characteristics.

NEO-SIL FUSE HOLDERS, HERMETICALLY SEALED — Available for 3-AG and 4-AG fuses. These units are completely sealed from moisture with or without the cap or fuse inserted. They are applicable on pressurized and gas filled components.

NEO-SIL CABLES, HERMETICALLY SEALED — The cables are hermetically sealed at the plug on thru to the panel.

NEO-SIL ROTARY WATERSEAL PANEL ASSEMBLIES — These units have an excellent seven year customer history on gas filled pressurized components. They are available for 1/4" shafts and for potentiometers and switch bushings.

NEO-SIL LINE CORDS WITH PLUGS FOR EUROPEAN USE, HERMETICALLY SEALED — These units are completely sealed at the plug and are being used on pressurized units.

NEO-SIL GASKETS, METER, PANEL, COVER, ETC. — Molded from Neoprene for complete sealing.

NEO-SIL ADAPTERS, U. S. TO EUROPEAN, AFRICAN, SOUTH AMERICAN SOCKETS — Our 200A and 300A together will adapt virtually all standard plugs, sockets, and lamp sockets of the above mentioned areas.

NEO-SIL COIL FORMS, CRYSTAL CONTACTS, and other molded bakelite and Neo-Sil rubber units.

We welcome your inquires on any phase of design, development or production.

NEO-SIL
CORPORATION

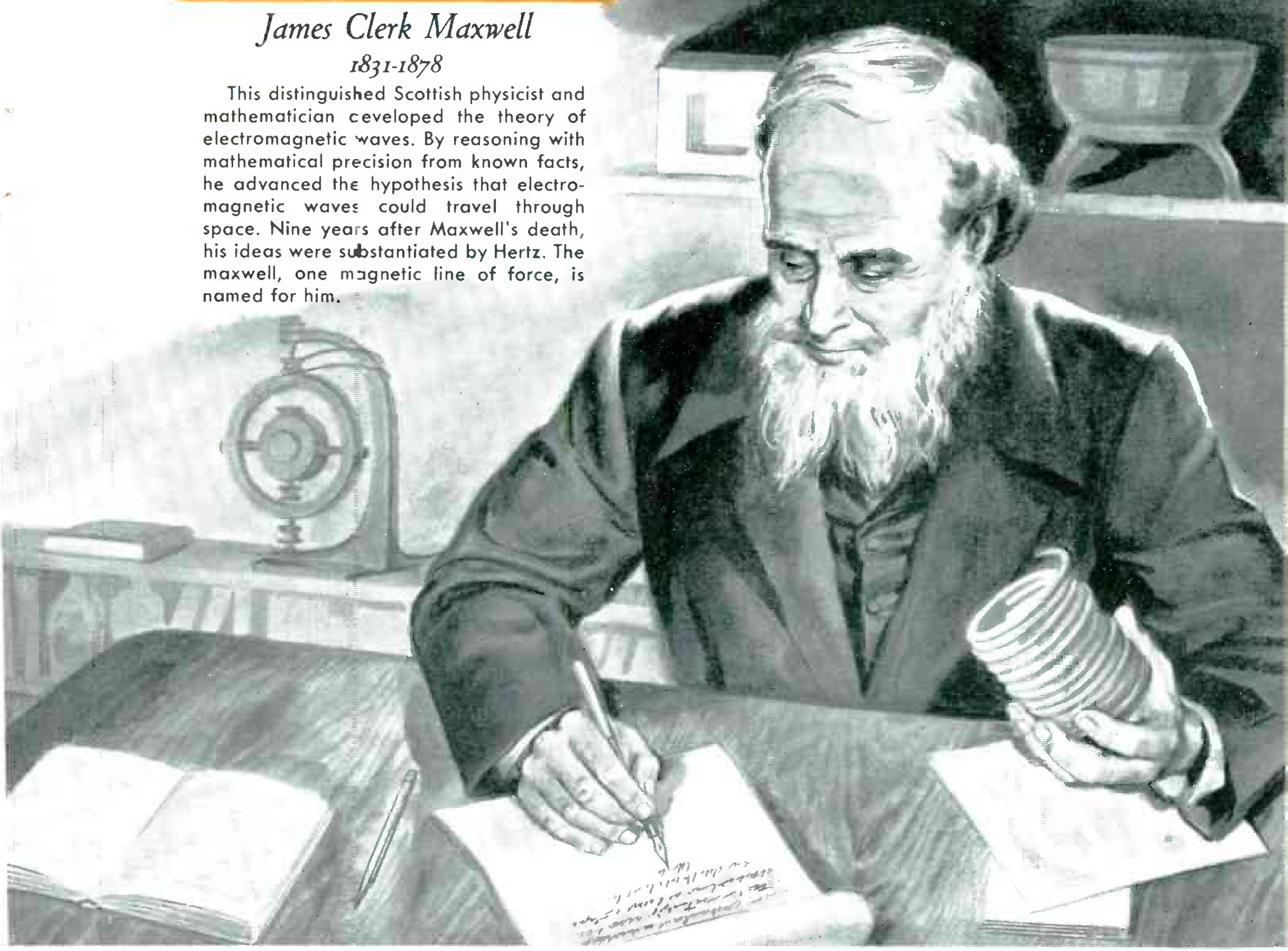
26 CORNELISON AVE., JERSEY CITY 4, N. J.

MAXWELL ...FIRST to forecast Electromagnetic Waves

James Clerk Maxwell

1831-1878

This distinguished Scottish physicist and mathematician developed the theory of electromagnetic waves. By reasoning with mathematical precision from known facts, he advanced the hypothesis that electromagnetic waves could travel through space. Nine years after Maxwell's death, his ideas were substantiated by Hertz. The maxwell, one magnetic line of force, is named for him.



From an original drawing made for OHMITE.

OHMITE® ...FIRST in Rheostats ...today

Be Right with

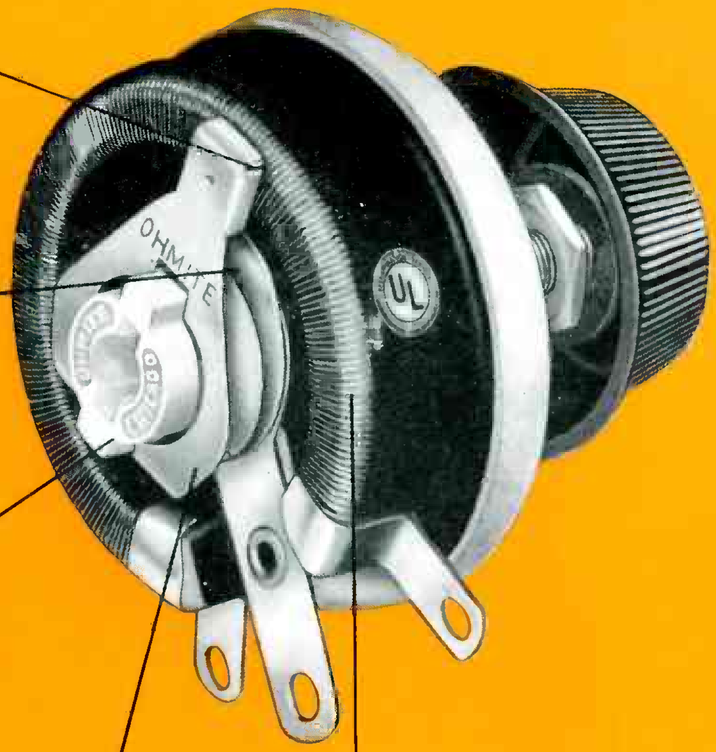
OHMITE

RHEOSTATS
RESISTORS
TAP SWITCHES

More manufacturers have standardized on Ohmite rheostats for their products . . . more companies are buying these rheostats for their own use . . . than any other make on the market. The reason for this preference . . . Ohmite rheostats provide longer life and unfailing dependability even under adverse operating conditions. It pays to standardize on Ohmite.

MORE OHMITE® RHEOSTATS SOLD THAN ALL OTHER MAKES COMBINED!

and here are some *Reasons why!*



METAL-GRAPHITE BRUSH

Perfect contact with negligible wear on the wire is insured by the metal-graphite contact brush (varied to fit the current and resistance) and the large, flat contact surface.

LARGE SLIP-RING AND SHUNT

Current is carried directly to the slip-ring by a pigtail shunt of ample size, assuring an uninterrupted connection at all times. Large slip-ring minimizes mechanical wear.

SHAFT INSULATED FROM LIVE PARTS

High-strength ceramic hub insulates shaft and bushing from all live parts. Testing at 3000 volts a.c. will not cause flashover.

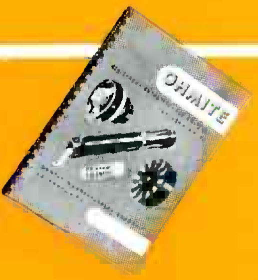
UNIFORM CONTACT PRESSURE

Tempered steel contact arm forms a long spring which assures uniform contact pressure. Pivoted action of brush maintains "flush-floating" contact.

LOCKED-IN WINDING

Special alloy resistance wire is wound over a ceramic core. Each turn is permanently locked in place by vitreous enamel.

WRITE on Company Letterhead for Complete Catalog



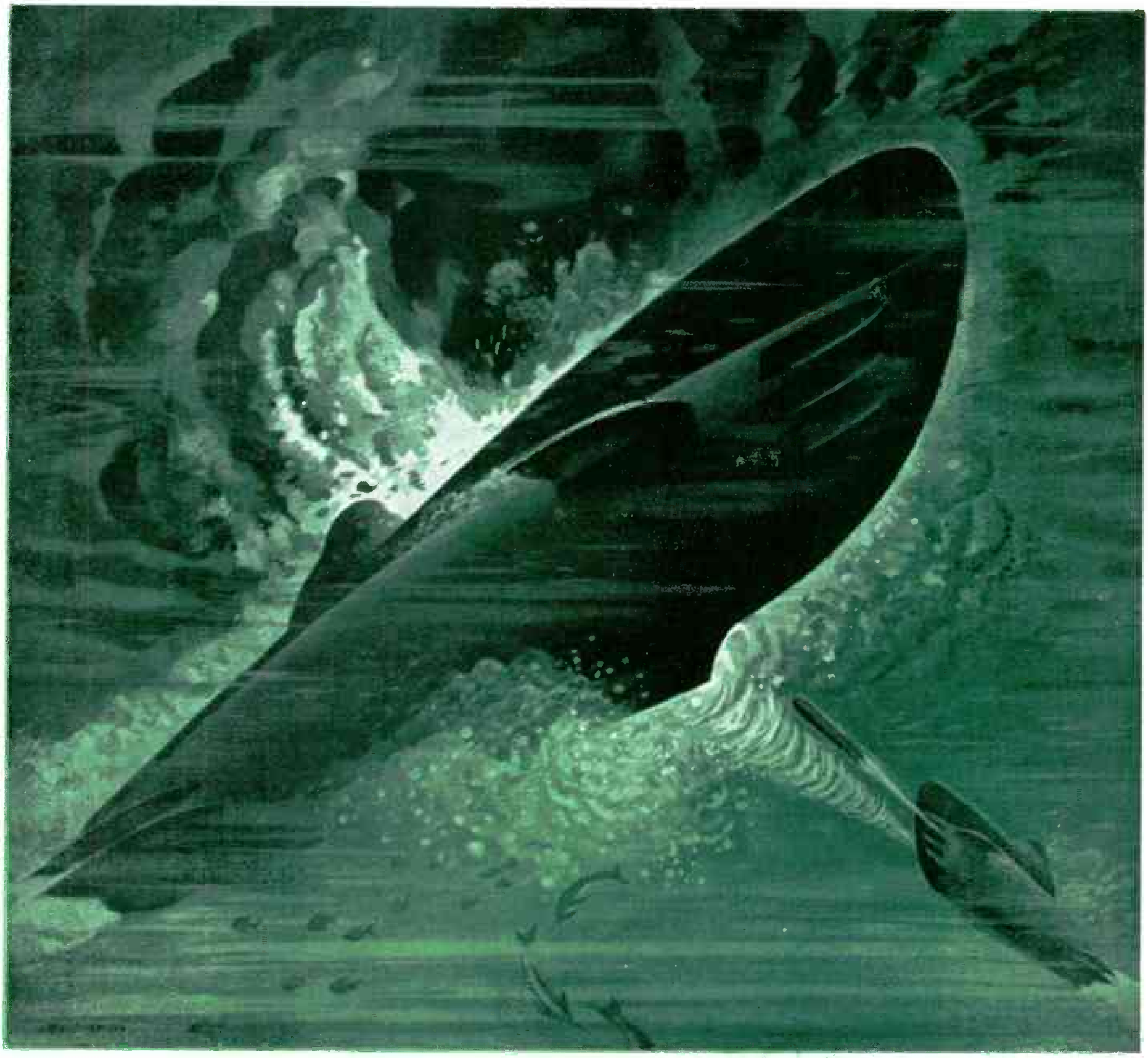
There are a lot of other good reasons, too, for the Ohmite rheostat's position as "best-seller." Its all-metal and ceramic construction contains nothing to char, burn, shrink, or deteriorate . . . it provides a smooth, evenly graduated, close control . . . and it is engineered to Ohmite's high standards. The industrial buyer can select rheostats from Ohmite's extensive series of ten stock sizes, ranging from 25 to 1000 watts, or special units can be made to order.

OHMITE MANUFACTURING CO.
4817 FLOURNOY STREET, CHICAGO 44, ILL.

Be Right with

OHMITE®

RHEOSTATS • RESISTORS • TAP SWITCHES



Deep-sea dog fight

Our sea battles of the future may be fought by high-speed submarines on the eeriest battleground of all time — deep beneath the sea. For the first time in naval history submarines are now being designed expressly to track and destroy other submarines while totally submerged.

The detection and missile-guiding systems which make this possible are the result of bringing the magic of electronics to problems of automatic control and computation too complex for rapid solution by man. Working closely with the Armed Forces for 34 years, Arma Corporation has played a leading part in this field in basic research, design, development and production.

Electronics provides a whole new arsenal of defense weapons. In important areas of this field Arma is pacing the developments. *Arma Corporation, Brooklyn, N. Y.; Mineola, N. Y.; Subsidiary of American Bosch Corporation.*

ARMA ADVANCED ELECTRONICS FOR CONTROL

INTERNATIONAL RECTIFIER CORPORATION

**EL SEGUNDO
CALIFORNIA**

HERMETICALLY SEALED

Diameter . . . . 3/16" to 1-1/4"
Length . . . . 9/16" to 10"
Current: half-wave . . 1.5 ma to 60 ma
Voltage: DC output . . . . . . 20 volts to 4,000 volts

PHENOLIC CARTRIDGE

Diameter . . . . ⅛" to 1"
Length . . . . ½" to 12"
Current: half-wave . . 1.5 ma to 60 ma
Voltage: DC output . . . . 20 volts to 10,000 volts

SELENIUM DIODES

Diameter . . . . 0.100" to 0.300"
Length . . . . 0.210" to 0.250"
Output Voltage . . . . 20V to 80V
Output Current . . . 200 ua to 1.5 ma
Temperature Range —50°C to 100°C

Selenium Rectifiers

A recent month's production included Rectifiers to supply 40 microamperes, 1,000 volts, and Rectifiers with a capacity of 140,000 amperes, 14 volts.

POWER STACK
30 Kw DC Power
Considered to be the largest single Selenium rectifier stack produced.

Owned and managed by Engineers who are specialists in the design and manufacture of Selenium Rectifiers. Submit your problems for analysis and we will be glad to offer our recommendations.

INTERNATIONAL RECTIFIER CORPORATION

General Offices: 1521 E. Grand Ave., El Segundo, Calif. • Phone: El Segundo 1890
Chicago Branch Office: 205 West Wacker Drive • Phone: Franklin 2-3889

MUST YOUR EQUIPMENT BE RADIO INTERFERENCE FREE?

IF YOURS IS A TOUGH RF INTERFERENCE PROBLEM — LET FILTRON SOLVE IT....

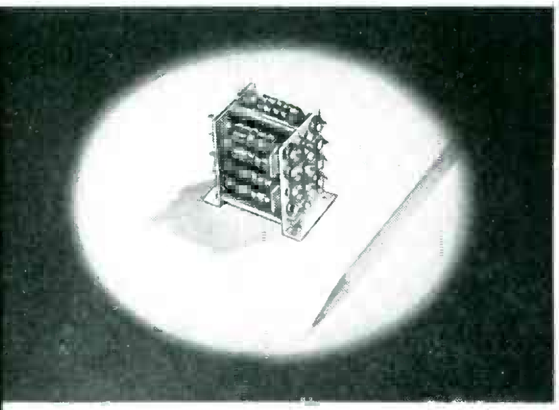
FILTRON'S engineering department, cooperating with engineers of leading companies, has solved RF Interference Suppression problems throughout the country.

If your equipment must meet the RF Interference limits set by the military specifications, consult with FILTRON'S engineers in the earliest stages of design. FILTRON can furnish RF Interference Suppression Filters whose size, weight and overall configuration will fit into your equipment.

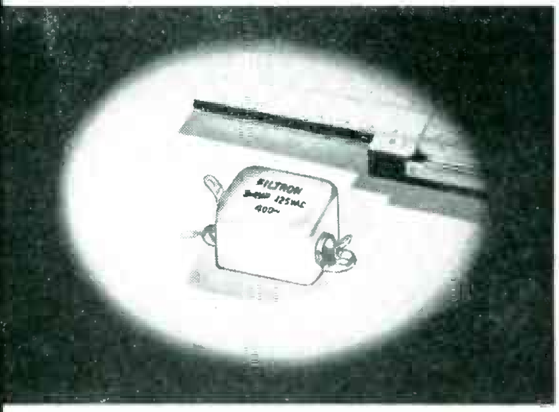
FILTRON has *custom designed* over 1000 different types of RF Interference Suppression Filters for equipment that meets military RF Interference Suppression limits and specifications.

FILTRON'S completely equipped screen rooms are always available for the RF Interference testing of your units and equipment.

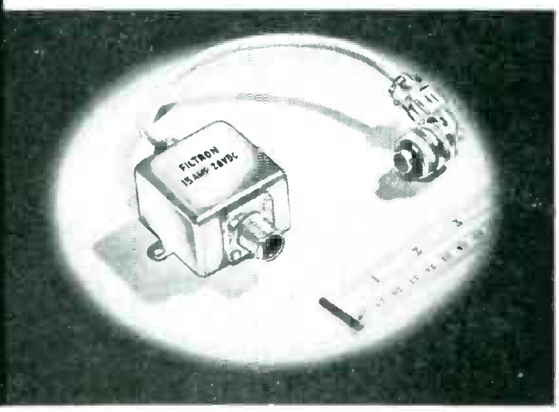
An inquiry on your company letterhead
will receive prompt attention.



8 circuit miniaturized filter for wide band RF Interference Suppression.



Miniature 3 amp. – 125 VAC – 400~ filter – hermetically sealed – size 1⅛" x 1" x 11/16"



15 amp. – 28 VDC filter, size 2" x 2" x 1¼", with pressurized AN connectors – high attenuation from 150 KC to 400 MC.

FILTRON can best solve your RF Interference problems because:

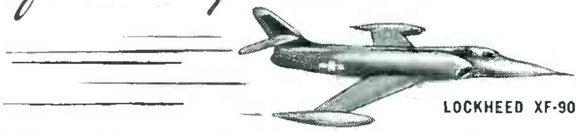
- **FILTRON'S** engineering, research and design divisions are staffed by experienced RF Interference Suppression filter engineers.
- **FILTRON'S** modern shielded laboratories are equipped to measure RF Interference from 14 KC to 1000 MC in accordance with military specifications.
- **FILTRON'S** production facilities, comprising a capacitor manufacturing division, coil winding division, metal fabrication shop, metal stamping and tool and die shops, are exclusively producing the highest quality components for FILTRON'S RF Interference Suppression Filters.
- **FILTRON'S** extensive production facilities permit us to meet your delivery requirements. NOW!

RF INTERFERENCE SUPPRESSION FILTERS FOR:

Motors
Generators
Inverters
Electronic Controls
Dynamotors
Power Plants
Actuators
Gasoline Engines

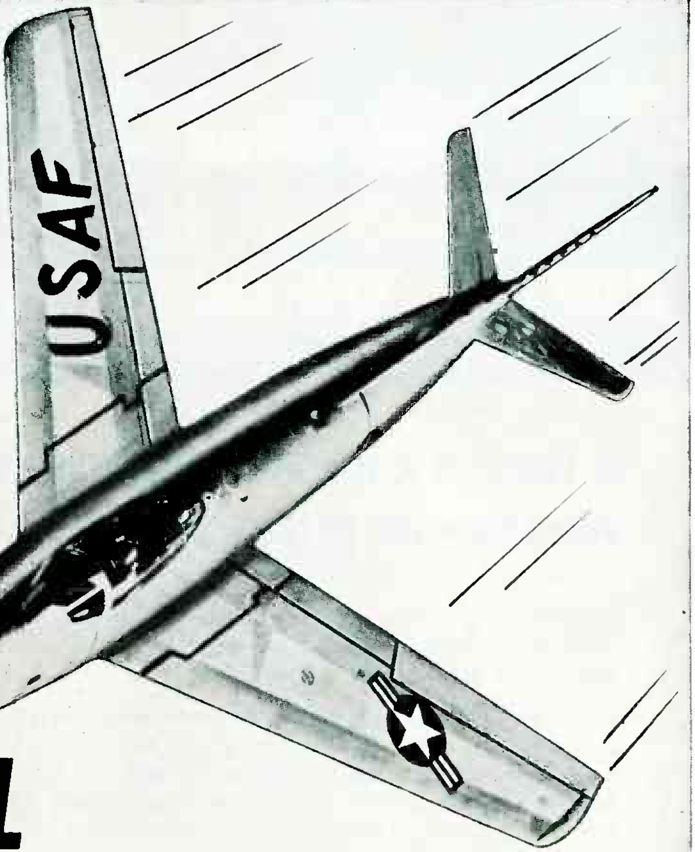
And other RF Interference producing equipment

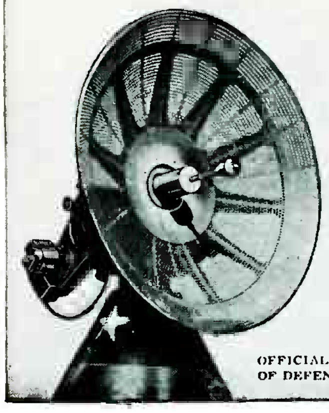
filtered by **FILTRON**

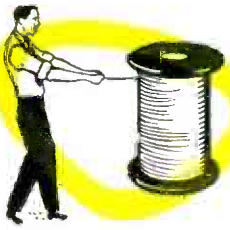


LOCKHEED XF-90

THE FILTRON CO., INC.
FLUSHING, LONG ISLAND, NEW YORK
LARGEST EXCLUSIVE MANUFACTURERS OF RF INTERFERENCE FILTERS


USAF





A variety of ingenious tension devices to meet all requirements.

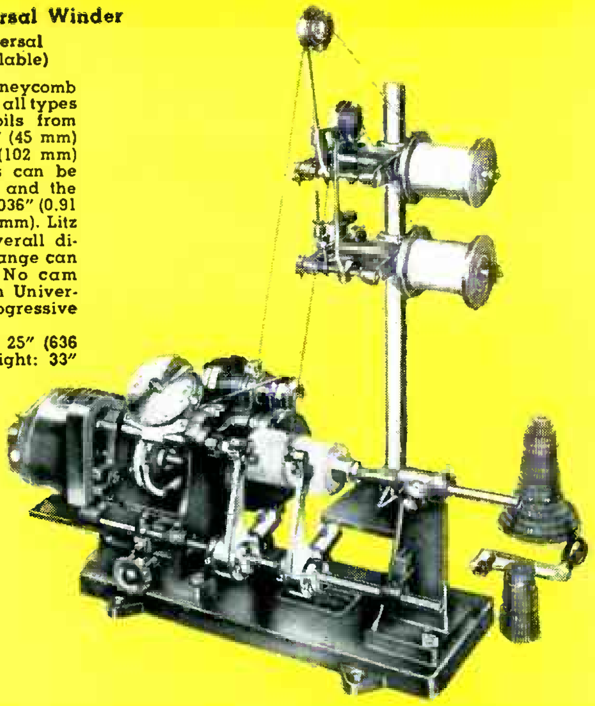
Extremely easy and rapid gear changes, making for quick set up.

Wide range of wire sizes handled on each machine.

"Douglas" WW Universal Winder

(Progressive Universal Winder also available)

A universal or honeycomb winding machine for all types of wave wound coils from 3/32" (2.4 mm) to 1¾" (45 mm) wide and up to 4" (102 mm) diameter. Two coils can be wound at one time and the wire range is from 0.036" (0.91 mm) to 0.0024" (0.06 mm). Litz wires having an overall diameter within this range can also be handled. No cam changes required on Universal Winder or Progressive Universal Winder. Bench Space: 25" x 25" (636 mm x 636 mm). Height: 33" (840 mm).



From England... the most rugged most versatile coil winders in the world!

"DOUGLAS" & "MACADIE"

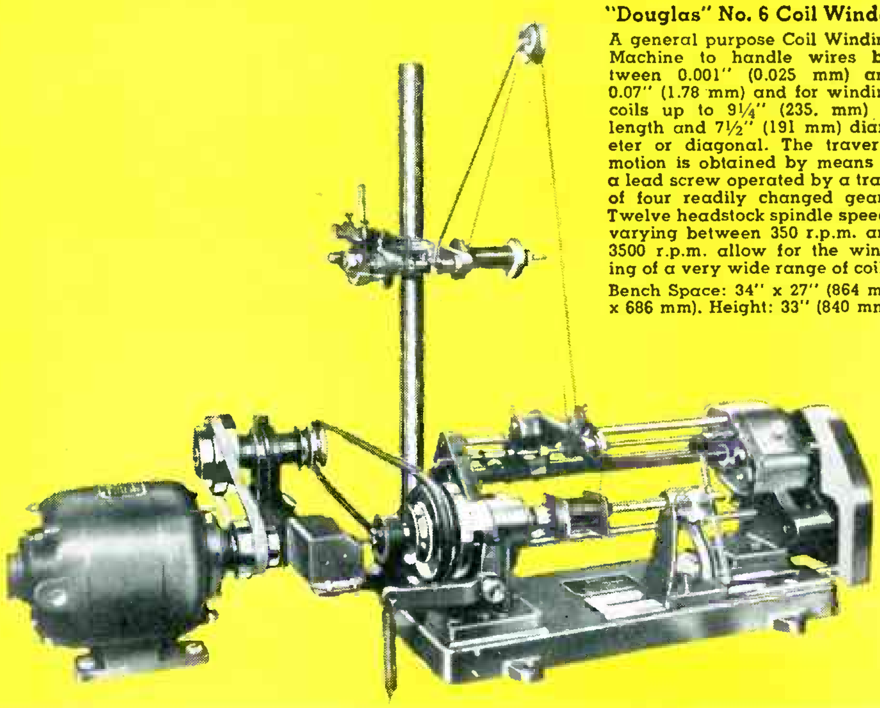
Automatic Coil Winding Machinery

"Douglas" No. 6 Coil Winder

A general purpose Coil Winding Machine to handle wires between 0.001" (0.025 mm) and 0.07" (1.78 mm) and for winding coils up to 9¼" (235. mm) in length and 7½" (191 mm) diameter or diagonal. The traverse motion is obtained by means of a lead screw operated by a train of four readily changed gears. Twelve headstock spindle speeds varying between 350 r.p.m. and 3500 r.p.m. allow for the winding of a very wide range of coils. Bench Space: 34" x 27" (864 mm x 686 mm). Height: 33" (840 mm).

Very high winding speed.

Precision manufacture... heavy castings ...oversize shafts... extreme ruggedness... designed expressly for production.



"Douglas" & "Macadie" automatic coil winding machines are precision-built to meet the demands of the most exacting engineer, and have established enviable records for production output and long life in plants throughout the world. Easy to set up, they will duplicate coils at highest speeds with absolute accuracy. Models are available for every coil winding application, from single, universal, solenoid, or bobbin to multi-winder with automatic paper insertion. Engineering service facilities and stocks of spare parts are available from New York.

Built by the Automatic Coil Winding and Electrical Equipment Co., Ltd., London, England.

BRITISH INDUSTRIES CORPORATION 164 Duane St. N. Y. 13, N. Y.

COMPLIMENTARY CATALOGUE

BRITISH INDUSTRIES CORP. DEPT. E-9
164 Duane Street, New York 13, N. Y.

Gentlemen: Please send complete catalogue of "Douglas" & "Macadie" automatic coil winders.

Name ....
Firm ....
Position ....
Street ....
City ....State..........

650 VTVM

There's Nothing finer for Television

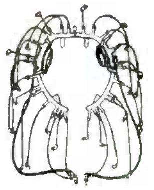
This combination of features explains why

- Complete frequency coverage with one probe, 20 cps to over 110-mc. Insulated and shielded RF tube probe, found usually only with laboratory instruments, is included.
- Peak to Peak ACV and RF with probe.
- One volt full scale reading on AC & DC.
- One main selector switch, all ranges.
- ACrms—Peak to Peak
- 32 Ranges
- Zero center mark for FM discriminator alignment plus any other galvanometer measurements.
- High input impedance 11 megohms on DC.

U.S.A. Dealer Net $\$69^{50}$ • *Prices subject to change without notice.*

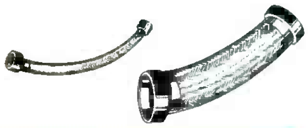
TRIPLETT ELECTRICAL INSTRUMENT CO., BLUFFTON, OHIO

Triplett



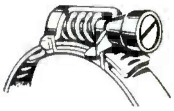
IGNITION SHIELDING

Complete harness assemblies with detachable unit leads or rewirable leads. Igniter or ignition lead assemblies for jet and reciprocating aircraft engines and military vehicles.



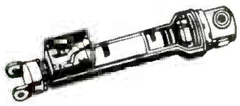
FLEXIBLE METAL TUBING

For electrical shielding, mechanical protection, fluid lines, conduits and ducts, pressure lines, and high and low temperature applications. Material, shapes and sizes to specification.



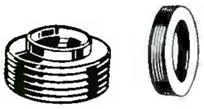
"AERO-SEAL" HOSE CLAMPS

Precision worm drive — for aircraft, automotive, marine, special-purpose and industrial use. Vibration-proof — will not work loose. Corrosion-resistant steel.



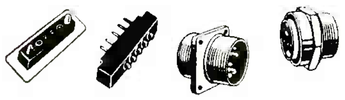
ACTUATING SYSTEMS

Electrical, mechanical, and hydraulic actuators for aircraft controls, valve closures, landing gear, or virtually any other type of equipment to manufacturer's specifications.



WELDED DIAPHRAGM BELLOWS

"Job engineered" to meet your requirements and make possible the use of bellows in applications where they could not previously be considered.



SPECIALIZED CONNECTORS

For electronic, aircraft, ordnance and communications equipment. Water-tight or pressure sealed types, panel types, quick disconnects, or other types for your new and special applications.

A Quarter Century of Design Experience backs BREEZE MARK products

You benefit from 25 years of engineering design and manufacturing experience when you call on Breeze for precision production. Breeze offers an extensive line of quality products for aviation, communications, automotive and general industry. In addition, Breeze offers complete engineering services for the design and development of specialized electrical and mechanical devices.

Breeze products meet the latest government specifications.

BREEZE
CORPORATIONS, INC.

41 South Sixth St., Newark 7, N. J.

If you

want to **get tough**

in your assemblies,

In the heavy-weight division — fixed and adjustable Greenohms — up to 200 watt.

specify

greenohm*

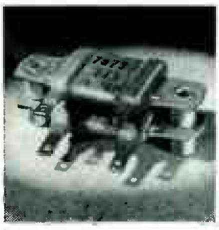
power resistors

* The green-colored power resistors so conspicuous these days in dependable radio-electronic and electrical assemblies, are GREENOHMS. *No tougher resistors made.* That statement is sustained by laboratory tests. Likewise by countless case histories out in the field.

Unimpaired wire winding firmly imbedded in exclusive cold-setting inorganic cement. Exceptional heat conduction and surface radiation. Heavy overloads handled without damage. Severe heat-shock resistance permits extreme on-off operation without flinching. And Greenohms last and last.

Choice of standard types. Also in virtually unlimited special types. Wide selection of resistance values, wattages, taps, terminals, mountings. And remember, *Greenohms cost less* though they offer you more!

Greenohm Jr. — point-to-point wired power resistor sealed in ceramic tubular casing. 4, 7 and 8 watt.



Flat Greenohms for flat mounting individually, or for stacked arrays. 30 to 75 watt.

In the bantam-weight division — 5 and 10 watt fixed Greenohms.

Standees — convenient above-chassis mounting Greenohms in ceramic casings. 10 to 25 watt.

What is the ideal resistance value? That's easy. With the Clarostat Power Resistor Decade Box inserted in actual circuit, handling actual load, you try the six knobs for anything from 1 to 999,999 ohms. When right operating conditions are attained, read resistance directly off dials. Quick, simple, positive, economical.

you can **stand pat** *with* **clarostat**

Engineering data on request. Send us your resistance or control requirements for engineering aid and quotations. Try Greenohms!

CLAROSTAT

Controls and Resistors

CLAROSTAT MFG. CO., INC., DOVER, NEW HAMPSHIRE
In Canada: Canadian Marconi Co., Ltd., Toronto, Ontario

Avoid "Electronic Heart Failure"

See how Alden "Ever-Functioning" Principles KEEP YOUR ELECTRONIC EQUIPMENT ALWAYS OPERATIVE UNDER CONDITIONS OF ACTUAL USE

Electronic-controlled equipment — a plane, T-V set, machine—functions badly or not at all when its electronic heart goes bad; always a nuisance, sometimes with loss of life. To keep the electronic heart always going is the Alden Concept and we furnish you all needed econo-made components to build this Ever-functioning Heart Principle into your equipment.

BUILD STRONG

1) **Extreme resistence to getting out of order,** by simple, rugged components and unique "function-cell" design principles.

ISOLATE TROUBLE

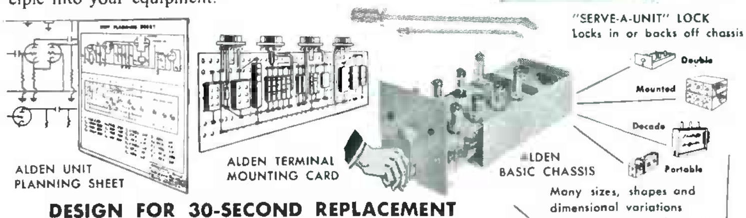
2) **Preventative sensing of trouble,** by tiny indicators and test points super-easy to build in wherever needed.

PLUG-IN SPARES

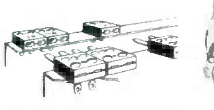
3) **30-second replacement of inoperative units,** through plug-in unit construction of spare elements, whether tiny packages or complete chassis.

LAYMAN MAINTAINS

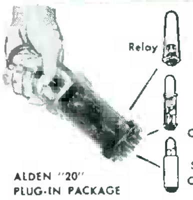
4) **Continuous operation assured,** because untrained user personnel can locate trouble, make replacement, without needing to know exact nature of trouble.



Many sizes, shapes and dimensional variations

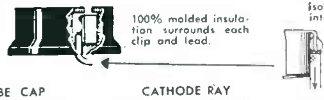


ALDEN BACK CONNECTORS
Positioned on back of chassis. Provide orderly, color coded, guided slide-in arrangement of all leads to and from chassis. Avoids rat's nest of congested wiring and back connecting thru conventional plugs.



ALDEN "20" PLUG-IN PACKAGE

ALDEN UNIT CABLE
Quick sure means of isolating and restoring inter-unit circuit.



FAMOUS TOP-CONNECTED CONTACT CONNECTORS

100% molded insulation surrounds each clip and lead.

Solder bonded for great strength in vertical direction.

YOUR EQUIPMENT

DESIGN FOR 30-SECOND REPLACEMENT

Alden Planning Sheets and Terminal Mounting Cards are thought-through to help your "function-cell" planning of circuitry giving functional sub-units that can be monitored and instantly replaced, without tools.

Mount on standard Alden Basic Chassis, Alden Plug-in Packages, and Alden Unit Cables that slide on, plug in, lock in or eject easily, with obvious color coding so layman can make no mistake.

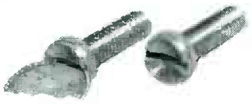
SENSING ELEMENTS TO FORSEE, LOCATE TROUBLE

MINIATURE PAN-i-LITE

MINIATURE TEST JACK

MINIATURE FUSE HOLDERS

These tiny components give complete miniaturized sensing service, especially designed for Alden Plug-in Unit Construction, and so flexible they can be standardized for all your equipment. See details below.



ALDEN TARGET SCREWS
Have arced head for power driver; can be coin operated in field. With bullet-directional ends for sure locating fast production.

TUBE CAP CONNECTORS

All types, with leads tailored to your needs. We have the metal parts for every possible tube cap, with both molded and wire insulation, to meet any current or frequency.

CATHODE RAY TUBE CONNECTORS

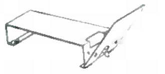
Alden principles of minimum - space requirements, forward connected contacts — here in action give perfect insulation with the economy of simplicity.

STATIC MAGNETIC MEMORY

Alden Basic Unit ready for adaptation to your requirements for medium speed pulse techniques and computers.

SIMPLICITY AND ECONOMY OF MANUFACTURE — EASE OF SERVICING AND MAINTENANCE

MINIATURE TERMINALS
For simple assembly on Alden Terminal Cards, one-motion terminals, staked into place; ratchet slot holds lead while soldering.



HINGED CHASSIS PANEL
Hinged front panel allows rheostats, indicator lights, jacks, etc., to be mounted on panel as another easy-to-work sub-assembly.

Alden Ever-Functioning Principles enable you to get into production quicker and to save time and money in manufacture. Circuits are organized in "function-cells", giving easy, natural subdivision of labor. All parts are accessible and assemble with the minimum number of operations by standard methods of eyelet, rivet, spot weld or press fit into simple punch holes. When it comes to servicing in field, shop, or office, your equipment maintenance is reduced to 30 second changeovers. Basic replacement elements are small enough in weight and size to be shipped by parcel post for repair.

SAVE ENGINEERING LAYOUT & PRODUCTION TIME — WHY WORK YOUR ENGINEERS ON PROBLEMS ALREADY SOLVED?

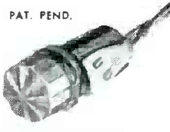
Let your engineers concentrate on circuity and electronic design problems, which can then be carried forward by Alden Principles into ideal groupings of "function-cell" sub-assemblies to get "Ever-functioning" results. Component problems are already solved: utilize econo-made Alden components thought-through and integrated to supply your electronic and electrical equipment needs to: chassis-and-package; circuitize; connect; fasten; memorize-and-direct; sense; indicate.

Ready-made, these components conserve design effort and eliminate procurement headaches.

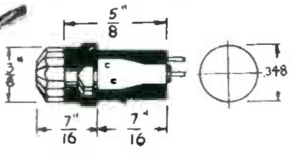
GET THE WHOLE OF THIS VITAL STORY. SEND FOR ALDEN'S "HANDBOOK OF ELECTRICAL-ELECTRONIC COMPONENTS—IDEAS, DESIGNS, TECHNIQUES."

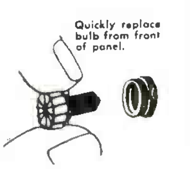
"Pan-i-Lite" Indicator Light Really MAKES SENSE. Why use any other?

PAT. PEND.



Bulb and Lens are 1 pc. instantly replaceable with unbreakable spares.





Quickly replace bulb from front of panel.

The panel lights you've used — were bulbs easy to replace? Were spares durable and always on hand? Did the user have to call a service man to replace a light? Was it hard to find panel room to build in the light you wanted? Did your equipment look like a Christmas tree, with a confusing glare of lights?

At last — here's a Pan-i-Lite so well thought out you need never use any other. You know a dead light means danger. Pan-i-Lite's 1-piece bulb-and-lens is so easily replaceable, it's never neglected. Spares are unbreakable, easily kept in kit, vest pocket, or taped right in a recess of equipment. Instantly replaceable. Glow like a red hot poker, yet never with glare that gives false signal. Tiny Pan-i-Lites punch into a .348" drill hole, take about ½" behind panel, mount on centers .44" apart, allowing 729 Lites per sq. ft. of panel.

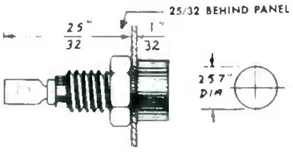
Now you can use indicator lights wherever needed. Avoid hazard of dead light, because bulb replacement instant, easy, by anyone. For ALL indicator needs, standardize on Pan-i-Lite, the light that really makes sense!

Send for Samples of 3 Pan-i-Lites with 4 brilliant color replacement bulbs. Laboratory Work Kit No. 33, price $6.00.

Get instant voltage checks from front of your equipment panel . . .

ALDEN MINIATURE TEST POINT JACK

FITS ANYWHERE
TAKES UP TO 8,000 V.



. . . 1 JACK TO STANDARDIZE ON

For a front panel test point of any critical voltage in your equipment, use this Alden Miniature insulated Jack. Standard on major Govt. contracts and equipments. Soldered in "nothing flat", it takes very little space, can be located in any accessible place—all you need is a ¼" hole, yet stands up to 8,000V. breakdown test.

Special punch press beryllium copper contact — retains live action over thousands of insertions — has generous solder tab with wire hole for rapid, fool-proof soldering.

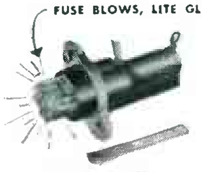
Insulation: available with phenolic insulation for low water absorption, high heat resistance and excellent aging characteristics, in red, black, brown (MIL-P-MA) and blue, green, tan colors. Also available with nylon insulation in brilliant black, red, white, orange, blue, yellow colors.

Send for Laboratory Work Kit No. 9 containing 27 Jacks and 1 Test Prod. $5.00.

"Fuselite" spots blown fuses instantly — follows U. S. Govt. Miniaturization principles

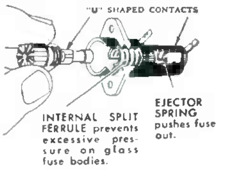
Build ultra-modern convenience and control into your equipment with fused circuits monitored by Alden "Fuselites". Thumb-and-finger replacement of fuses from front of panel. "Fuselite's" minimum space requirements, ease of assembly, low cost make it practical to have indicatoring fuse holders in all circuits — a convenience your users need.

FUSE BLOWS, LITE GLOWS

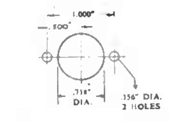


FUSELITE—440.4/7FH
220V, 110V, 28V Circuits

THUMB-AND-FINGER FUSE REPLACEMENT



SAFETY TYPE
440FH Safety Type with coin-slotted fuse post head.



Mounts with standard production tools. Rivets or spot welds to panel. 1 13/32" behind panel. Generous solder tabs.

Send for Laboratory Kit No. 32, giving your model shop a comprehensive assortment of fuseholders and fuses to help solve almost all your miniature fusing problems. $10.00

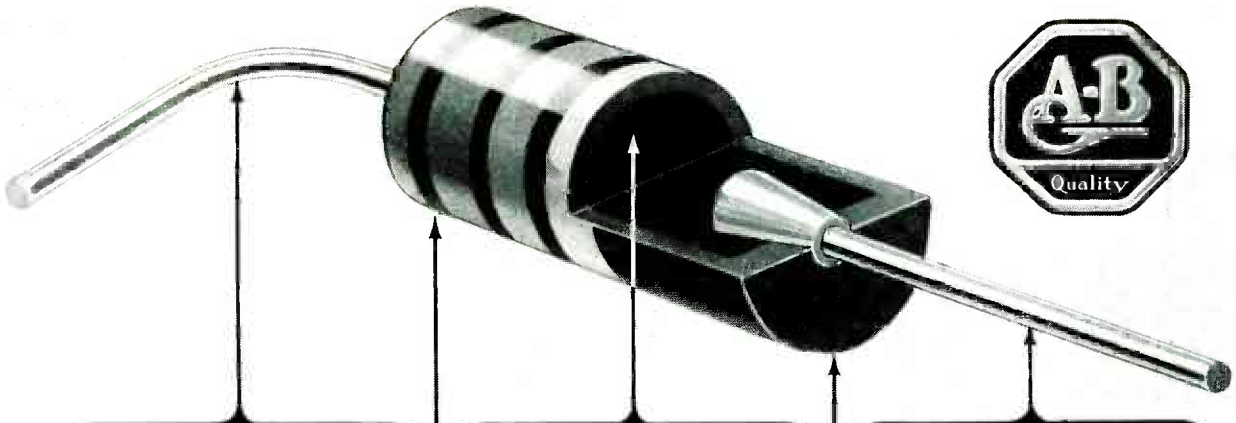
OTHER KITS TO SEND FOR:

Kit #4 Alden "20" Plug-in Packages	$10.00*	Kit #26 Basic Terminal Staking Tools	$15.00*
Kit #24 Alden Basic Chassis	$26.50*	Kit #8 Target & Cap Captive Screws	$ 3.00*
Kit #25 Terminal Card Mtg. System	$11.50*	Kit #29 Color Coded Back Connectors	$ 4.50*

**Prices shown are for sample kits only— For production runs send us your schedule.*

NA-ALD

ALDEN PRODUCTS COMPANY 127 North Main Street, Brockton, Mass.



DIFFERENTIALLY TEMPERED

The tinned leads of Bradleyunits are differentially tempered. This graduated softness of leads near the body of the resistor prevents sharp bends and damage to the resistor.

STRONG INSULATING SHELL

The resistor element of all Bradleyunits is encased in a strong plastic shell, which insulates the resistor completely. Hence, these units can be closely grouped with safety.

IMBEDDED TINNED LEADS

The leads of all Bradleyunits are enlarged at the resistor end to produce a conical section. Ample contact and greater mechanical strength are thereby obtained.

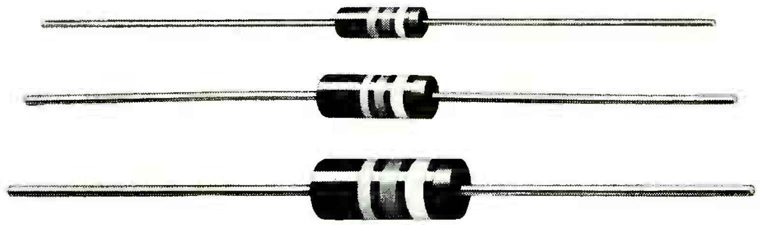
STANDARD R.T.M.A. CODING

Bradleyunits are made in all standard R.T.M.A. values from 10 ohms to 22 megohms in ½ and 2 watt sizes, and from 2.7 ohms to 22 megohms in 1 watt size. Standard color coding.

ACCURATE RESISTANCE VALUES

For stability and permanence, Bradleyunits are rated at 70 C . . . not 40 C. Available in three tolerances—plus or minus 5%, 10%, or 20%. They withstand heat, cold, and moisture.

Look Inside for ALLEN-BRADLEY RESISTOR QUALITY



Bradleyunits are solid molded resistors with high mechanical strength. Due to the plastic shell in which they are encased, they need no wax impregnation to pass salt water immersion tests.

Bradleyunits are small in size . . . but super in quality performance demanded by electronic engineers. Under continuous full load for 1000 hours, the resistance change is less than 5 per cent.

They are packed in honeycomb cartons that keep the leads straight and avoid tangling of the resistors during assembling operations.

Let us send you a complete Allen-Bradley resistor chart.

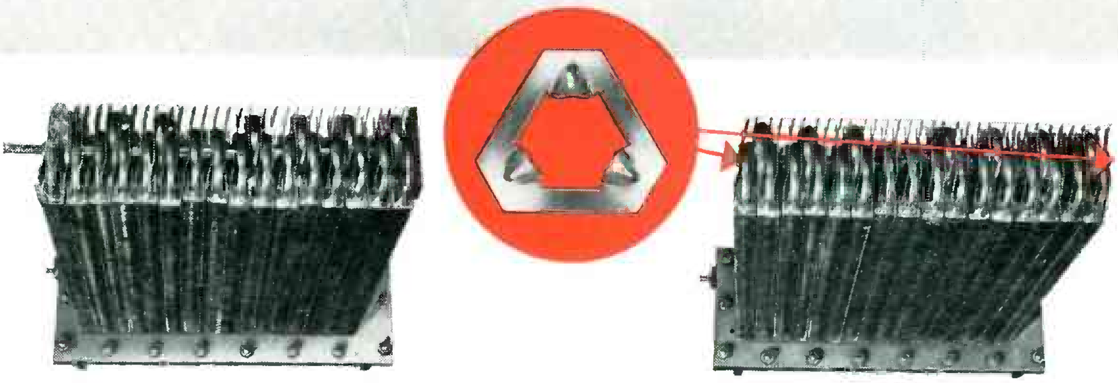
Allen-Bradley Co., 110 West Greenfield Ave., Milwaukee 4, Wis.

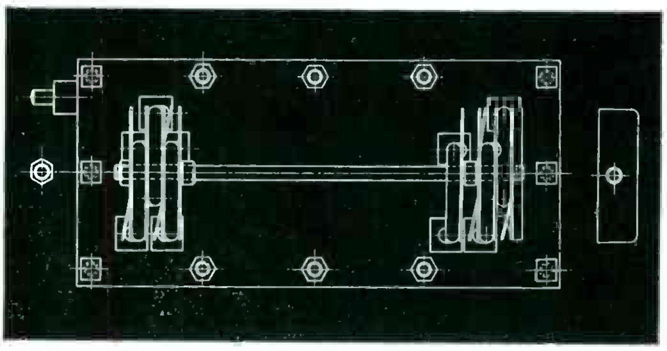
ALLEN-BRADLEY

FIXED & ADJUSTABLE RADIO RESISTORS

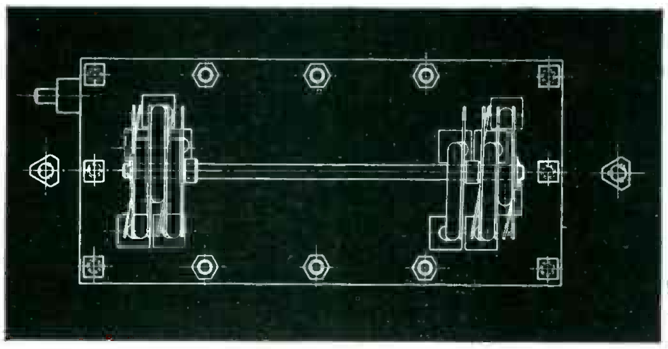
Sold exclusively to manufacturers QUALITY of radio and electronic equipment

2 WALDES TRUARC TRIANGULAR RETAINERS REPLACE NUTS... CUT MATERIAL AND ASSEMBLY COSTS 52%





OLD WAY—Tie rod for thermal tubes required threading at both ends, a jam nut at top, a drilled and tapped cast iron tube-rest at bottom. Assembly was slow, costly.



NEW WAY—Truarc Retainers (triangular type) simply push into position at both ends of rod...hold securely without grooves, threads, or nuts. Assembly is inexpensive, speedy!

When the Grinnell Co., Providence, R. I. redesigned their Thermolier Unit Heater to include Waldes Truarc Retaining Rings, they were able to cut down on scarce raw material... eliminate the many machine operations entailed in nut fastening—for a savings of 26½¢ per unit! Truarc Triangular Retainers are self-locking...have unusually high thrust capacity...can be applied at high speed by unskilled labor.

Re-design with precision engineered Truarc Rings and you too will cut costs. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to hold parts together better, with a never-failing grip. Quick, easy to assemble and disassemble.

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

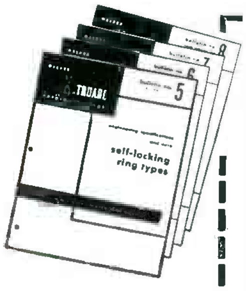
WALDES TRUARC RINGS MADE THESE SAVINGS POSSIBLE...

OLD WAY		NEW WAY	
Parts:	*Cost Per Unit*	Parts:	*Cost Per Unit*
tube rest, threaded rod, jam nut	$.306	plain rod, 2 Truarc Rings	$.060
Assembly	.202	Assembly	.183
	$.508		$.243

TOTAL SAVINGS PER UNIT WITH TRUARC RINGS $.265

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

SEND FOR NEW BULLETINS



WALDES
TRUARC
REG. U. S. PAT. OFF.
RETAINING RINGS
WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

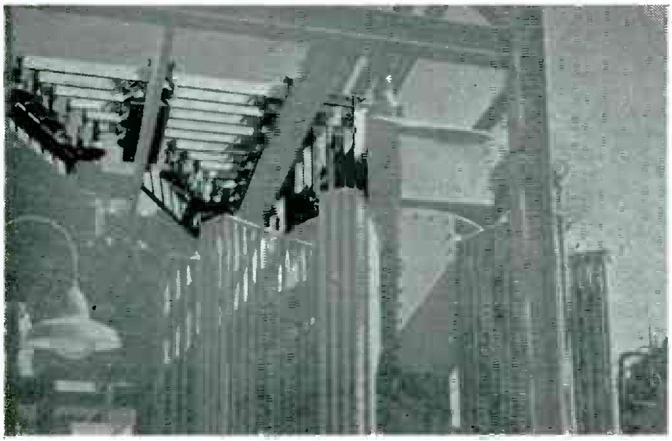
WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,382,947; 2,382,948; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,509,081 AND OTHER PATENTS PENDING.

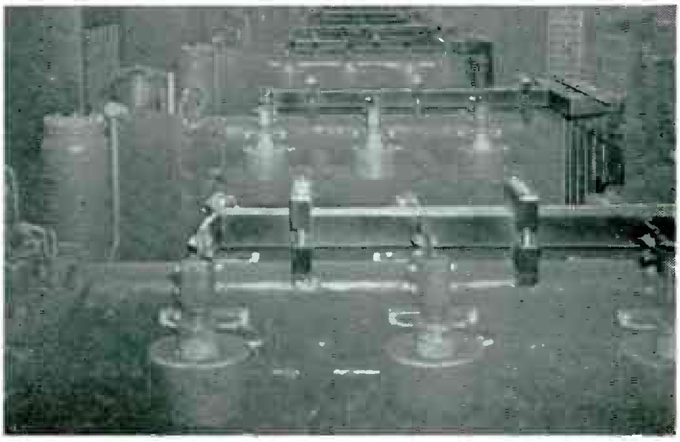
Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send engineering specifications and data on Waldes Truarc Retaining Ring types checked below. E-094

- ☐ Bulletin #5 Self-locking ring types
- ☐ Bulletin #6 Ring types for taking up end-play
- ☐ Bulletin #7 Ring types for radial assembly
- ☐ Bulletin #8 Basic type rings
- ☐ Send me information about the Waldes Grooving Tool.

Name____________________
Title____________________
Company____________________
Business Address____________________
City__________ Zone_____ State________ 5678

It takes a Lot of Copper to make a Lot of Chemicals!





These photographs show a lot of copper bus bar in a new plant of a great chemical company, whose name and location cannot be disclosed. The copper carries heavy currents to electro-chemical equipment for the production of valuable products used in national defense and in industry. Revere furnished 325,000 pounds of bus bar for this service, the bar going into substations, rectifier stations, and cell houses. In addition, at the time of installation the Revere Technical Advisory Service collaborated with the customer in working out some difficult details in the design of switches. If you need electrical conductors, remember that copper has the highest electrical conductivity of all the commercial metals, that Revere makes bus bar, and that the Revere Technical Advisory Service is always ready to work with you on any problem concerning copper and its alloys or aluminum alloys. Call the nearest Revere Sales Office.

REVERE

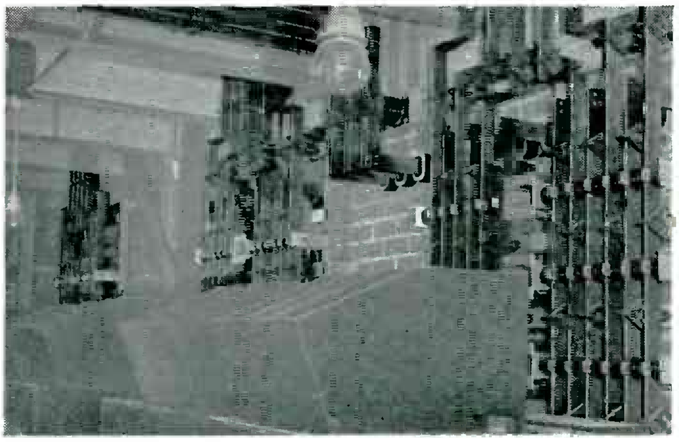
COPPER AND BRASS INCORPORATED

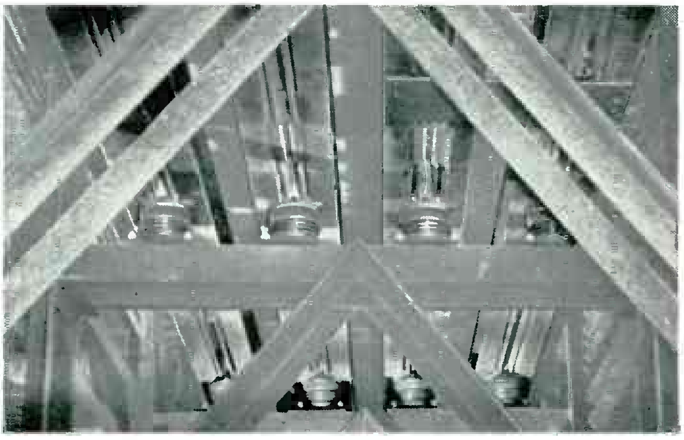
Founded by Paul Revere in 1801
230 Park Avenue, New York 17, N. Y.

• • •

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.— Sales Offices in Principal Cities, Distributors Everywhere

SEE REVERE'S "MEET THE PRESS" ON NBC TELEVISION EVERY SUNDAY





For Industrial Electronic Designers.....

A NEW WAY TO GET GREATER CIRCUIT RELIABILITY!

Now, when designing equipment, you can freely specify 5-Star Tubes knowing they will be available in quantities when you need them. Greatly expanded G-E output offers you . . . for the first time . . . an assured supply of these famous types that are *designed and built for highest reliability.*

Take advantage of 5-Star availability, to develop new electronic circuits that excel in their dependable performance . . . in freedom from tube replacements . . . in lower maintenance needs.

Gain the benefits of

- Buyer preference because your equipment is more dependable.
- Lower designing costs! 5-Star Tubes come to you uniformly predictable in performance.
- Lower manufacturing costs in your plant! Fewer rejects from tube causes mean fewer units to be reworked.
- Lower warranty-servicing costs on your equipment in users' hands.

Prompt study of G-E 5-Star advantages will strengthen your competitive position and point the way to important savings. Ask for the facts . . . by return mail, or visit from a G-E tube engineer! *General Electric Company, Tube Department, Schenectady 5, N. Y.*

5-STAR TUBES ★★★★★

When designing new circuits, most of your tube needs can be met with high-reliability 5-Star types now in production...as the prototype-vs.-5-Star list below demonstrates.

STANDARD TYPES	REPLACE WITH THESE 5-STAR TYPES
2C51	**GL-5670**— h-f medium-mu twin triode.
2D21	**GL-5727**— thyratron.
5Y3-GT	**GL-6087**— full-wave rectifier.
6AK5	**GL-5654**— sharp-cutoff r-f pentode.
6AL5	**GL-5726**—twin diode.
6AQ5	**GL-6005**—beam power amplifier.
6AS6	**GL-5725**—dual-control sharp-cutoff r-f pentode.
6AU6	**GL-6136**—sharp-cutoff pentode.
6BA6	**GL-5749**—remote-cutoff r-f pentode.
6BE6	**GL-5750**—pentagrid converter.
6C4	**GL-6135**—medium-mu triode.
6SK7	**GL-6137**—remote-cutoff r-f pentode.
12AT7	**GL-6201**—high-Gm medium-mu twin triode.
12AU7	**GL-5814**—medium-mu twin triode.
12AX7	**GL-5751**—high-mu twin triode.
12AY7	**GL-6072**—low-noise medium-mu twin triode.
......	**GL-5686**—beam power amplifier.

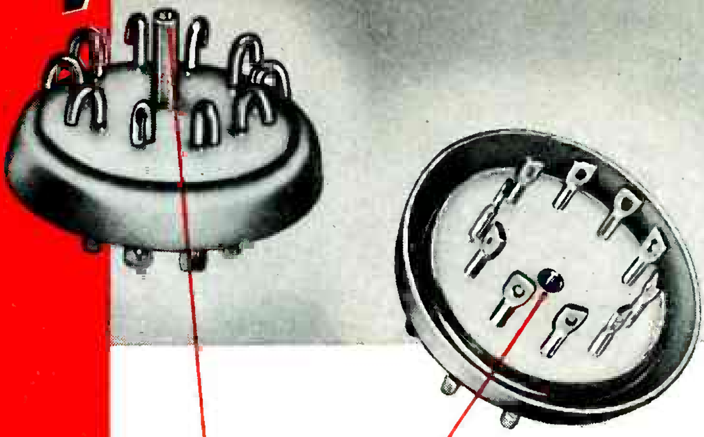
Booklet ETD-548 contains a cross-reference table of ratings and characteristics for application use when substituting 5-Star Tubes for standard types. Wire or write for it!

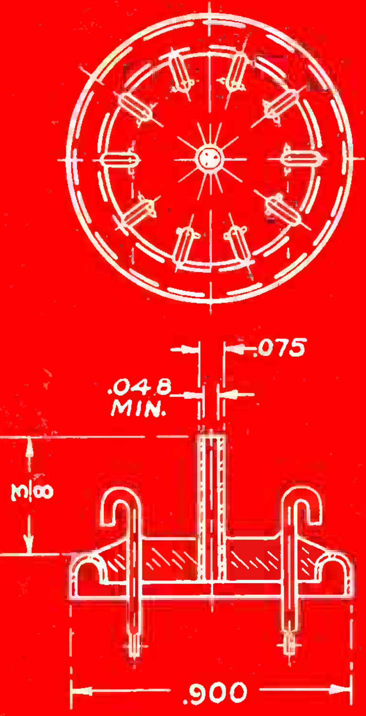
GENERAL ELECTRIC

163-1A3

SEAL

For EVACUATING Or GAS FILLING ENCLOSURE





- Series 900 Multi-Terminal Header is made with a central exhaust tube through which a relay enclosure may be exhausted without the need for additional holes in the can or cover. The complete assembly can then be filled with inert gas, such as helium or dry nitrogen. The exhaust tubing is soft-annealed, thin-walled and hot tin dipped to facilitate pinching off and sealing.
- On the bottom side of the header, the tubing is flush with the ceramic, thus allowing maximum space inside the can. The length of the tubing extending through the top may be increased to meet specific requirements.

Ceramic-Metal, Multi-Terminal Headers with exhaust tubulations are also available in Hermetic Seal's 800 Series, 750 Series and 600 Series.

For your requirements in hermetic seals, for information and help in planning a product, consult the one and only dependable source for quality seals and be right every time.

Write for your copy of Hermetic's new 32-page brochure, the most complete and informative presentation ever made on hermetic seals.

SEALED IN by HERMETIC HEADERS

HERMETIC SEAL PRODUCTS CO.

FIRST & FOREMOST IN MINIATURIZATION

31 SOUTH SIXTH STREET, NEWARK 7, NEW JERSEY

REMEMBER THIS AD?

This message to the industry appeared in Trade Magazines *a year ago.*

And, the Tarzian Tuner for full range coverage was demonstrated at Bridgeport early in October, 1951.

Read the ad again, won't you, in the light of present-day circumstances.

Don't you agree that the full band—all channel—approach is the ONLY logical, and HONEST, approach to UHF.

Let's be HONEST with the American Public and ourselves about UHF

A message from Sarkes Tarzian, president of Sarkes Tarzian, Inc., the largest producer of switch-type tuners.

> *"You can fool some of the people all of the time and all the people some of the time, but you can't fool all the people all the time."*
> —Abraham Lincoln

● In the early days of commercial Television (1946-47) even the major manufacturers of receivers thought that a 7 to 9 channel tuner was sufficient to take care of reception in any area. They maintained the distributors and dealers could easily retune or change strips to suit their own needs.

We believed *then* that since 13 channels were available for Television, tuners should be designed and built to use the Full Range of Television frequencies. We built only tuners then—as we are building now—to take care of *all* channels. It was only a matter of a year or two until all manufacturers were doing the same thing . . . providing Full Range coverage.

Today, we have a similar problem facing the industry. The FCC has indicated that the frequency range from 470 megacycles to 890 megacycles (UHF) will be opened shortly for about *seventy* new Television Channels. These, of course, in addition to the twelve now available for VHF. This allocation will allow several thousand more Television stations to operate all over the United States.

Is the Television industry going to face this challenge honestly and courageously? Is it going to design and manufacture Television sets so that the American Public—in the years to come—can get Full Range Ultra High Frequency when it wants it?

Or, is the industry going to temporize . . . be opportunistic . . . and *insinuate* it has the answer to UHF through *single* channel strips? Wherein, each time the set owner adds a UHF channel strip in his tuner he loses the possible service of a VHF channel!

Is the industry going to live up to its responsibility and provide for Full Range UHF? Or, is it going to try to avoid immediate engineering and manufacturing problems (which it must eventually face) by just providing LIMITED RANGE receivers now . . . letting the public, distributors and dealers "hold the bag" in the future?

We believe the logical—and <u>honest</u>—approach to the UHF problem is to design and produce VHF tuners <u>now</u> that easily—and at nominal cost—may have added to them at a later date Full Range (70 Channel) coverage whenever the customer wants UHF service.

We have such a VHF Tuner available *now* to the industry. It's the Tarzian TT16. Cost of this tuner to the manufacturer is about the same as that for the regular VHF Tuners in general use now. However, by using the TT16 Tuner the manufacturer can honestly show his customer that the set *is designed* for Full Range UHF Service. Cost-wise, the manufacturer is ahead, because the TT16—which includes this added feature—costs no more than regular VHF Tuners. We estimate that the additional cost to the set owner for Full Range UHF Service will be less than the cost of adding 2 or 3 channel strips . . . piecemeal.

The manufacturer, by adopting this policy of producing sets which now—or later—can have incorporated Full Range UHF Service, enjoys these advantages:

1—He has a distinct competitive advantage over other manufacturers who do not follow this plan and can offer only *partial* UHF.

2—He eliminates future problems and headaches for himself, his distributors, and the dealers by giving the buyer Full Range Service once and for all.

3—He contributes his efforts towards placing UHF Television on a sound basis. By giving the buyer what he rightfully expects, he gains the confidence of his customer . . . adds prestige and value to his product, and his own name on that product.

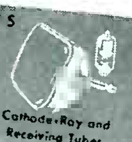
So, let's be honest with the American Public and Ourselves about UHF, and provide for Full Range UHF Service NOW.

TARZIAN MADE PRODUCTS

Tuners

Air Trimmers

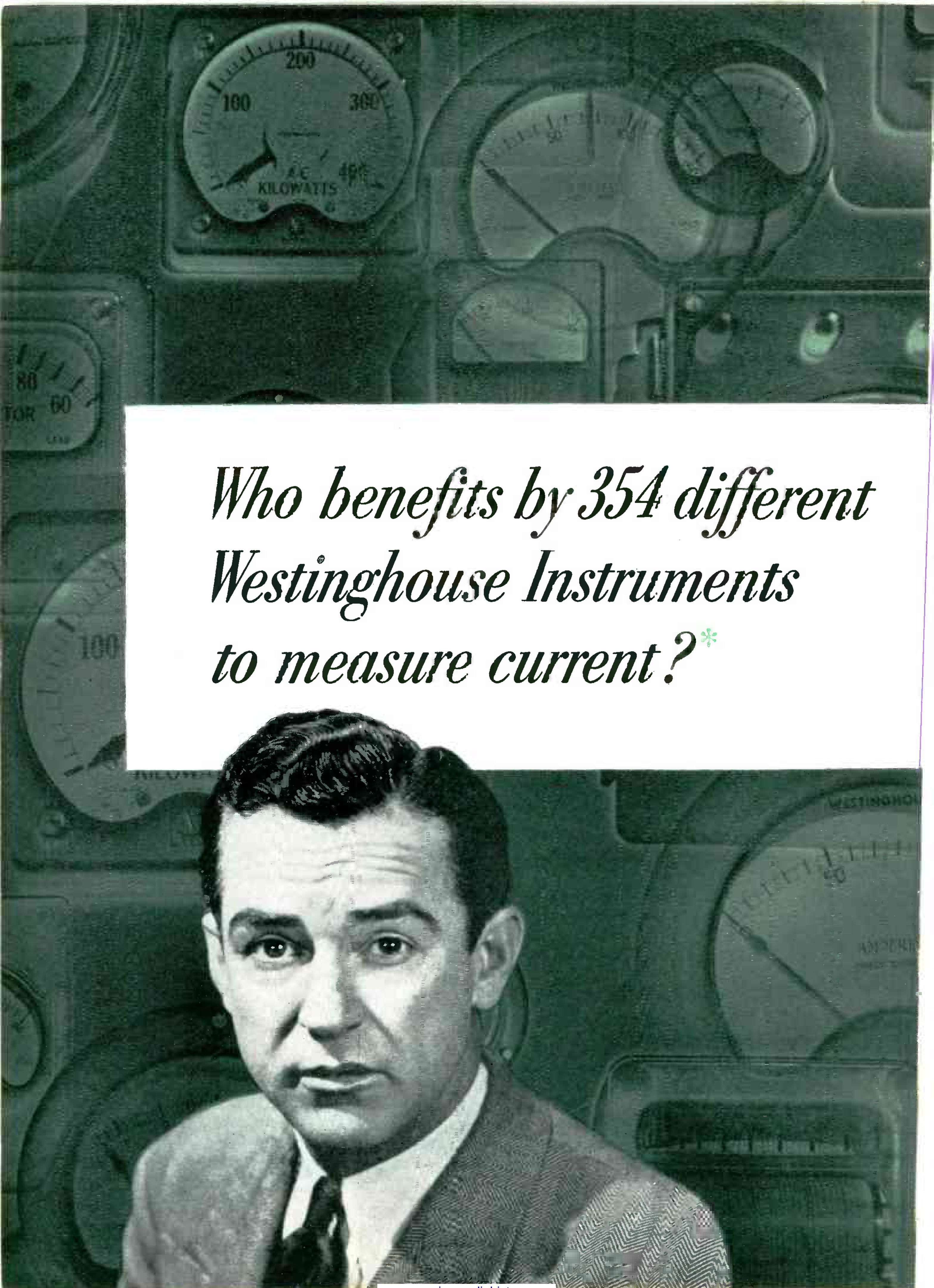
Selenium Rectifiers



Cathode-Ray and Receiving Tubes

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

Sarkes Tarzian, Inc.
TUNER DIVISION
Bloomington, Indiana


200
100
300
400
A-C
KILOWATTS
80
60
100
WESTINGHOUSE
50

Product Engineers

The wide variety of Westinghouse Instruments helps you to realize primary design objectives—to make your product look better, perform better, sell better. For any application there's extra design freedom in the unusual diversity in size, types of mounting, accuracy and styling . . . the almost unlimited variety of ratings and style combinations. And the performance of all Westinghouse Instruments meets ASA Standards.

Production Chiefs

Proper instrumentation of production machines, processes or power supply can help you to attain more production, closer quality control or lower production costs. Whether your needs involve measurement of amperes, volts, watts, vars, power factor, frequency or synchronism, there's a Westinghouse Instrument for the job. The line also includes many types to measure position, time, temperature and speed. And Westinghouse Instrument Application Engineers are ready to assist you in applying them most effectively.

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In the full line of Westinghouse Instruments, you have a complete source of supply—one responsibility—for all of your electrical measurement needs. Moreover, Westinghouse offers you faster service because all designs are keyed to chassis stocking and assembly procedures.

Benefit this way!

Here's an example. A leading pipeline company, in a radical departure from conventional pipeline instrumentation, is using Westinghouse Electrical Measuring Instruments in pumping stations for pressure and flow indications at various points on the system. The result: More efficient control without fire hazard; greater accuracy; substantially less maintenance—a big, long-range saving! So if you design a product, produce it, or buy for it . . . specify Westinghouse Electrical Measuring Instruments!

J-40420

*

The extensive coverage of Westinghouse current-measuring Instruments is further emphasized by the fact that there are 32 different instruments just to measure microamps.

For complete information about all Westinghouse Electrical Measuring Instruments, write for Booklet B-4696. Address: Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

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

WESTINGHOUSE W

INSTRUMENTS

TYPE 252, JAN-R-19, Type RA20

2 watt, $1\frac{17}{64}$″ diameter variable wirewound resistor. Also available with other special military features not covered by JAN-R-19. Attached Switch can be supplied.

	RA20, JAN Shaft Type SD		RA20 High Torque, JAN Shaft Type SD	
Resistance	CTS Part	JAN-R-19 TYPE	CTS Part	JAN-R-19 TYPE
50±10%	B8079	RA20A1SD500AK	X3496	RA20A2SD500AK
100±10%	W6929	RA20A1SD101AK	L9388	RA20A2SD101AK
250±10%	X3497	RA20A1SD251AK	M9879	RA20A2SD251AK
500±10%	W6931	RA20A1SD501AK	X3498	RA20A2SD501AK
1000±10%	W6932	RA20A1SD102AK	X3499	RA20A2SD102AK
1500±10%	W6933	RA20A1SD152AK	M9809	RA20A2SD152AK
2500±10%	W6934	RA20A1SD252AK	L9103	RA20A2SD252AK
5000±10%	W6935	RA20A1SD502AK	L9104	RA20A2SD502AK
10,000±10%	W6936	RA20A1SD103AK	H8979	RA20A2SD103AK

TYPE 25, JAN-R-19, Type RA30 (May also be used as Type RA25)

4 watt, $1\frac{17}{32}$″ diameter variable wirewound resistor. Also available with other special military features not covered by JAN-R-19. Attached Switch can be supplied.

	RA30, JAN Shaft Type SD		RA30 High Torque, JAN Shaft Type SD	
Resistance	CTS Part	JAN-R-19 TYPE	CTS Part	JAN-R-19 TYPE
50±10%	X3502	RA30A1SD500AK	W2837	RA30A2SD500AK
100±10%	X3503	RA30A1SD101AK	X3504	RA30A2SD101AK
250±10%	X3505	RA30A1SD251AK	X3506	RA30A2SD251AK
500±10%	X3507	RA30A1SD501AK	M7566	RA30A2SD501AK
1000±10%	X3508	RA30A1SD102AK	S2444	RA30A2SD102AK
1500±10%	X3509	RA30A1SD152AK	X3510	RA30A2SD152AK
2500±10%	X3511	RA30A1SD252AK	S2736	RA30A2SD252AK
5000±10%	Q1409	RA30A1SD502AK	X3512	RA30A2SD502AK
10,000±10%	X3513	RA30A1SD103AK	R1561	RA30A2SD103AK
15,000±10%	X3514	RA30A1SD153AK	L9107	RA30A2SD153AK

Immediate delivery from stock

JAN-R-94 AND JAN-R-19 TYPE MILITARY VARIABLE RESISTORS

167 types

Preference given to orders carrying military contract number and DO rating. Other JAN items or special items with or without associated switches can be fabricated to your specifications. Please give complete details on your requirements including electrical and mechanical specifications.

UNPRECEDENTED PERFORMANCE CHARACTERISTICS

Designed for use in military equipment subject to extreme temperature and humidity ranges including jet and other planes, guided missiles, tanks, ships and submarines, telemetering, microwave, portable or mobile equipment and all other military communications.

For further information, write for Stock Sheet No. 162

NEW 38-PAGE ILLUSTRATED CATALOG—Describes Electrical and Mechanical characteristics, Special Features and Constructions of a complete line of variable resistors for military and civilian use. Includes dimensional drawings of each resistor. Write today for your copy.

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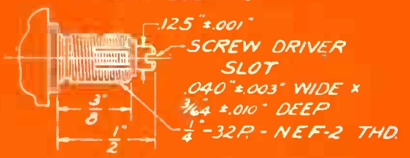
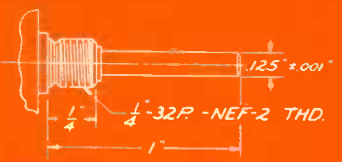
SHAFT TYPES
AVAILABLE
ON STOCK CONTROLS

CTS SHAFT TYPE LT-2
LOCKING BUSHING



MOUNTING HARDWARE ASSEMBLED
MOUNTING NUT 3/8″ HEX × 1/32″
LOCK NUT 3/8″ HEX × 1/8″
LOCK WASHER #1914A

CTS SHAFT TYPE RE



MOUNTING HARDWARE ASSEMBLED
MOUNTING NUT 3/8″ HEX × 3/32″
LOCK WASHER #1914A

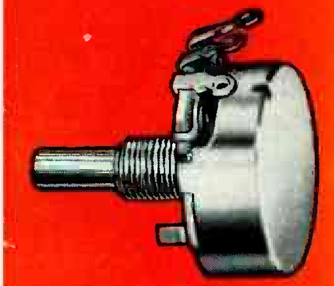
TYPE 65

½ watt 70° C, ¾" diameter miniaturized variable composition resistor.

Resistance	CTS Part CTS Shaft Type RE	CTS Part Locking Bushing CTS Shaft Type LT-2
250±10%	X3516	X3530
500±10%	X3517	X3531
1000±10%	X3518	X3532
2500±10%	X3519	X3533
5000±10%	X3520	X3534
10,000±10%	X3521	X3535
25,000±10%	X3522	X3536
50,000±10%	X3523	X3537
100,000±10%	X3524	X3538
250,000±10%	X3525	X3539
500,000±10%	X3526	X3540
1 Meg±20%	X3527	X3541
2.5 Meg±25%	X3528	X3542

TYPE 95, JAN-R-94, Type RV4

2 watt 70°C, 1⅛" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94. Attached Switch can be supplied.



Resistance	JAN-R-94 TYPE RV4 JAN Shaft Type SD	JAN-R-94 TYPE RV4 JAN Shaft Type RJ	CTS Part Non-JAN Locking Bushing CTS Shaft Type LT-1
100±10%	RV4ATSD101A	RV4ATRJ101A	W3160
250±10%	RV4ATSD251A	RV4ATRJ251A	W3161
500±10%	RV4ATSD501A	RV4ATRJ501A	W3162
1000±10%	RV4ATSD102A	RV4ATRJ102A	W3166
2500±10%	RV4ATSD252A	RV4ATRJ252A	W3163
5000±10%	RV4ATSD502A	RV4ATRJ502A	W3164
10,000±10%	RV4ATSD103A	RV4ATRJ103A	W3167
25,000±10%	RV4ATSD253A	RV4ATRJ253A	W3168
50,000±10%	RV4ATSD503A	RV4ATRJ503A	W3169
100,000±10%	RV4ATSD104A	RV4ATRJ104A	W3170
250,000±10%	RV4ATSD254A	RV4ATRJ254A	W3171
500,000±10%	RV4ATSD504A	RV4ATRJ504A	W3172
1 Meg±20%	RV4ATSD105B	RV4ATRJ105B	W3173
2.5 Meg±20%	RV4ATSD255B	RV4ATRJ255B	W3165
5 Meg±20%	RV4ATSD505B	RV4ATRJ505B	W3159

TYPE 45, JAN-R-94, Type RV2

¼ watt, ¹⁵⁄₁₆" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94. Attached Switch can be supplied.

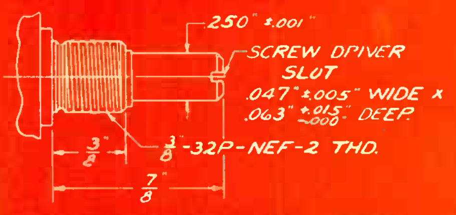
Resistance	RV2, JAN Shaft Type SD CTS Part	 JAN-R-94 TYPE	CTS Part Non-JAN Locking Bushing CTS Shaft Type LT-1
100±10%	A5876	RV2ATSD101A	A5922
250±10%	A5877	RV2ATSD251A	A5923
500±10%	A5878	RV2ATSD501A	A5924
1000±10%	A5879	RV2ATSD102A	A5925
2500±10%	A5880	RV2ATSD252A	A5926
5000±10%	A5881	RV2ATSD502A	A5927
10,000±10%	A5882	RV2ATSD103A	A5928
25,000±10%	A5883	RV2ATSD253A	A5929
50,000±10%	A5884	RV2ATSD503A	A5930
100,000±10%	A5885	RV2ATSD104A	A5931
250,000±10%	A5886	RV2ATSD254A	A5932
500,000±10%	A5887	RV2ATSD504A	A5933
1 Meg±20%	A5888	RV2ATSD105B	A5934
2.5 Meg±20%	A5889	RV2ATSD255B	A5935

TYPE 35, JAN-R-94, Type RV3

½ watt, 1⅛" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94. Attached Switch can be supplied.

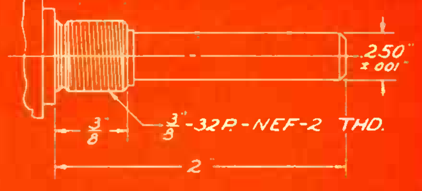
Resistance	RV3, JAN Shaft Type SD CTS Part	 JAN-R-94 TYPE	CTS Part Non-JAN Locking Bushing CTS Shaft Type LT-1
100±10%	A5861	RV3ATSD101A	A5907
250±10%	A5862	RV3ATSD251A	A5908
500±10%	A5863	RV3ATSD501A	A5909
1000±10%	A5864	RV3ATSD102A	A5910
2500±10%	A5865	RV3ATSD252A	A5911
5000±10%	A5866	RV3ATSD502A	A5912
10,000±10%	A5867	RV3ATSD103A	A5913
25,000±10%	A5868	RV3ATSD253A	A5914
50,000±10%	A5869	RV3ATSD503A	A5915
100,000±10%	A5870	RV3ATSD104A	A5916
250,000±10%	A5871	RV3ATSD254A	A5917
500,000±10%	A5872	RV3ATSD504A	A5918
1 Meg±20%	A5873	RV3ATSD105B	A5919
2.5 Meg±20%	A5874	RV3ATSD255B	A5920
5 Meg±20%	A5875	RV3ATSD505B	A5921

JAN SHAFT TYPE SD



MOUNTING HARDWARE ASSEMBLED
MOUNTING NUT 9/16" HEX. × 3/32"
LOCK WASHER #1920A

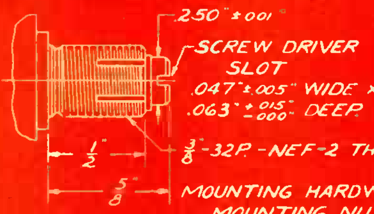
JAN SHAFT TYPE RJ



MOUNTING HARDWARE ASSEMBLED
MOUNTING NUT 9/16" HEX. × 3/32
LOCK WASHER #1920A

CTS SHAFT TYPE LT-1

LOCKING BUSHING



MOUNTING HARDWARE ASSEMBLED
MOUNTING NUT 9/16" HEX. × 3/32
LOCK NUT 1/2" HEX × 5/32
LOCK WASHER #1920A

Consider these

Brown Electronic Components

Brown Converters are precision, vibrator-type converters for use with any system requiring the conversion of low power direct voltage signals of the order of 100 microvolts to 60 or 400 cycle alternating voltages.

The Brown 60 Cycle Balancing Motor combines reversibility and low inertia . . . is designed to have a tapered curve of speed versus voltage and, at the same time, to maintain high torque at low speeds.

*The **ElectroniK** Amplifier is a precise, rugged and reliable "continuous balance" system which is rapidly becoming the heart of a host of devices and apparatus requiring automatic zeroing or standardizing.*

. . . in research, testing and other applications

Great numbers of these special Brown Electronic Components are daily playing a vital role in the efficient and effective performance of a variety of servos. Just like the thousands of modifications of the *ElectroniK* Potentiometer which are serving in extensive programs of scientific research and development . . . the qualities of these components are recognized and valued not only in the laboratory but also by a growing list of manufacturers of highly sensitive research equipment.

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MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4428 Wayne Ave., Philadelphia 44, Pa.

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● *Important Reference Data*

Write for Data Sheets No. 10.20-1, 10.20-2, and 10.20.3 . . . and for Bulletin 15-14, "Instruments Accelerate Research."

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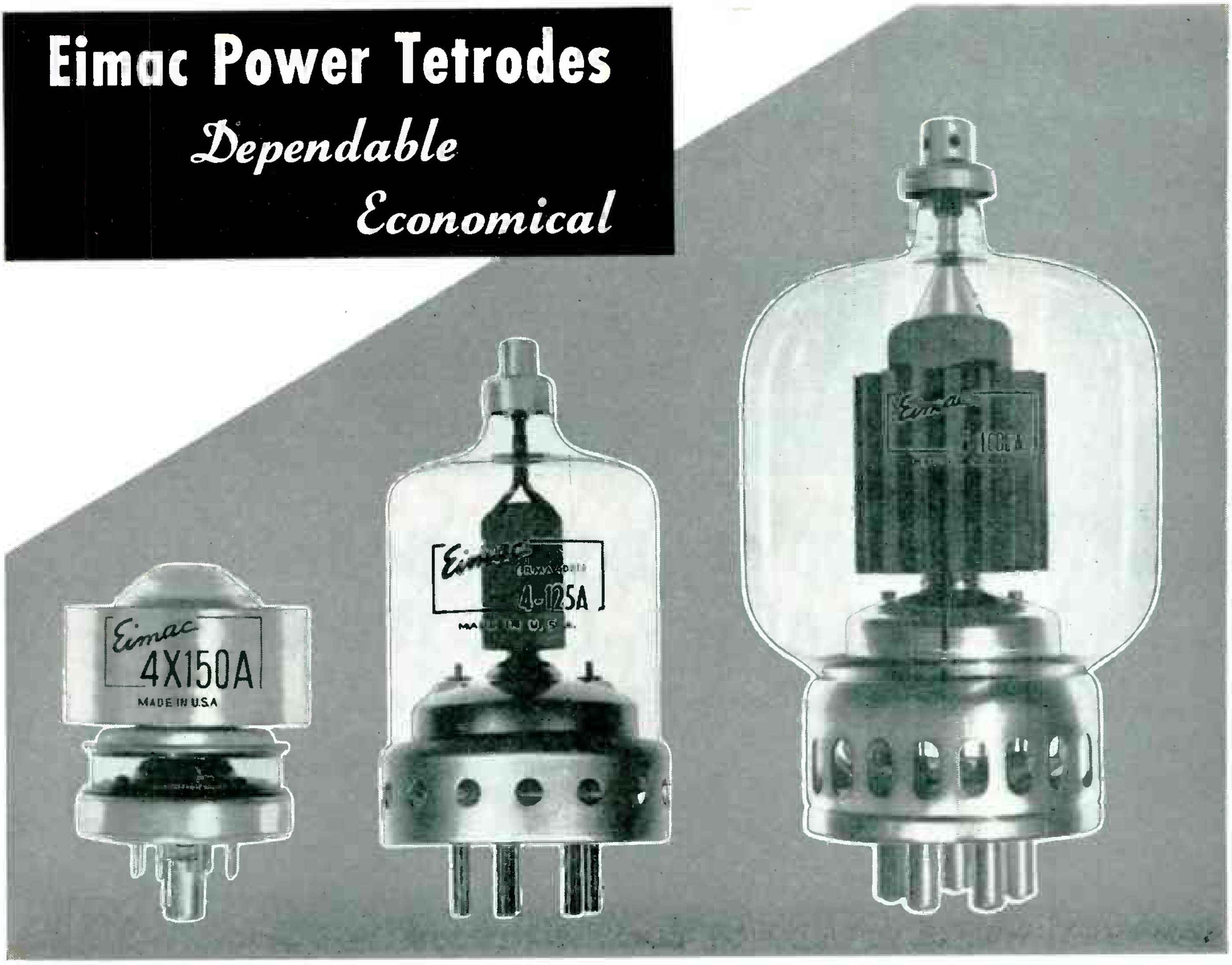
Economical



Years of dependable operation have established Eimac tetrodes as economical, incomparable performers. Economical because of low driving power, long life and simple circuit requirements. Incomparable because of the many Eimac features, including high power gain, ability to withstand great amounts of mechanical and thermal shock and stability of operation. Eimac tetrodes range in plate dissipation ratings from 65 to 20,000 watts and operate over the spectrum from audio frequencies to the ultra high frequencies of television. Eimac tetrodes are used as oscillators, modulators or amplifiers by those who demand the ultimate in transmitter performance.

We invite consultation concerning your electronic problems and needs. For free information about any of Eimac's complete line of power tetrodes write our application engineering department.

Now available for 25 cents is the Eimac application bulletin number eight, "The Care and Feeding of Power Tetrodes". This 28-page booklet was written by vacuum tube engineers to help you get the most out of your tetrodes.

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Leads

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400 CYCLE, Hermetically Sealed ELAPSED TIME INDICATOR

ACTUAL SIZE

SMALL AND LIGHT ENOUGH FOR AIRBORNE EQUIPMENT. FAR EXCEEDS SPECIFICATION MIL-I-7793 (AER).

TRIGGER TRIP
TIME DELAY RELAY

A FUNDAMENTALLY NEW APPROACH TO THE DESIGN OF DELAY TIMERS . . . SPECIALLY DESIGNED FOR MILITARY USAGE . . . HERMETICALLY SEALED . . . READILY ADAPTABLE TO SPECIAL APPLICATIONS.

1/2 SIZE

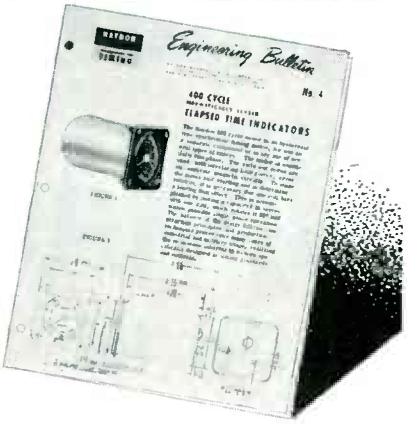
with Advanced Timing Design

NEW HAYDON ELAPSED TIME INDICATOR OFFERS OUTSTANDING ADVANTAGES

HAYDON* introduces with considerable pride this new 7008 Series Elapsed Time Indicator which offers a major advance over previously available equipment.

Designed specifically for 400 cycle operation in airborne equipment, the barrel diameter is only 1.525", length 2-45/64", weight 6 oz., power consumption less than 3 watts. Indicates in units of tens of hours up to 10,000 and repeats.

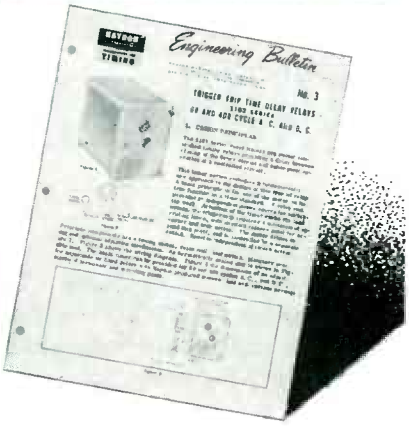
This meter indicates operating time of components with specific life or servicing requirements. This unit offers the unusual advantages of small size, hermetic sealing and 400 cycle operation for such applications as electronic devices, where tubes or other components should be replaced at specified intervals. Running time indicators can prevent unnecessary servicing, insure timely maintenance that protects against failure in operation. For full particulars write for Engineering Bulletin No. 4.



NEW TIME DELAY RELAYS

for 60 and 400 cycle A.C., and D.C.

The HAYDON 5103 trigger trip Time Delay Relay is designed so that the synchronous motor performs its true function as a time standard. Switching work is accomplished by a relay coil, which, when energized, cocks the load switch for release at the end of the delay time. Hair trigger release point assures snap action. The time cycle is necessarily completed before the motor is de-energized, since an inherent safety factor is provided in control of the motor by a separate switch, which is opened only after closure of the load circuit. Reset is fast and positive, upon release of the relay, due to low friction and inertia in the single moving element. Since the controlled switch is independent of the operating circuit, various A.C. and D.C. voltages and various frequencies can be handled, both in the line circuit and in the controlled load. Engineering Bulletin No. 3 contains complete data, write for it.



HAYDON TIMING MOTORS and TIMING DEVICES

HAYDON specializes in the manufacture of timing components for standard applications and also in the design and mass production of custom-engineered timers for volume applications. The basic element of all HAYDON timers is our own rugged industrial motor.

This means that HAYDON timing devices can be depended upon to give long, quiet operation. They are small and compact and offer designers unusual latitude in that they may be mounted and will operate in any position. For military applications various motors are available either separately or in many types of timers; HAYDON engineers will be pleased to review your requirements and specifications. Write for literature you need.

HAYDON Manufacturing Company, Inc.

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There is now available a single furnace that does away with the need to purchase equipment for each phase of your high-vacuum, high-temperature work. Because of its modest price, it will fall within the budget of most laboratories.

With this new furnace you can melt and solidify — melt and pour — add to the melt — stir — look into the hot zone — measure hot zone temperatures — introduce controlled atmospheres — degas — heat treat. It's a complete, versatile unit, capable of handling the widest variety of metallurgical research work. Write today.

FEATURES —

- Ultimate vacuum of less than 5×10^{-5} mm. Hg.
- Heating element temperatures up to 2000° C.
- Temperature controllable within ± 5° C.
- Hot zone reaches temperature within one minute.
- No refractories used in hot zone.
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- Utilizes single turn low voltage resistance element of tungsten.
- Integral power supply.
- Either manual or automatic temperature control or both.

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National Research Corporation
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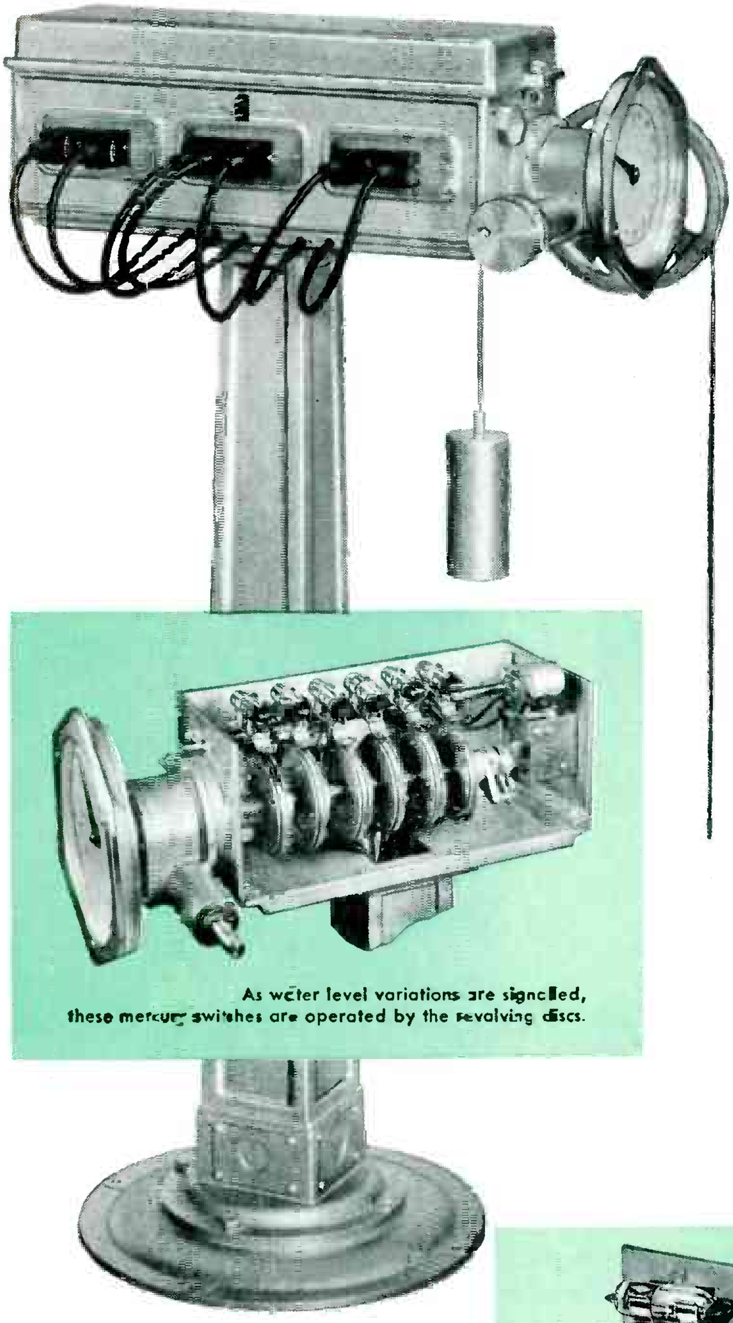
Seventy Memorial Drive, Cambridge, Massachusetts

SELECTROL required a switch with

5 OUTSTANDING FEATURES

...FOUND THEM ALL IN HONEYWELL MERCURY SWITCHES



As water level variations are signalled, these mercury switches are operated by the revolving discs.

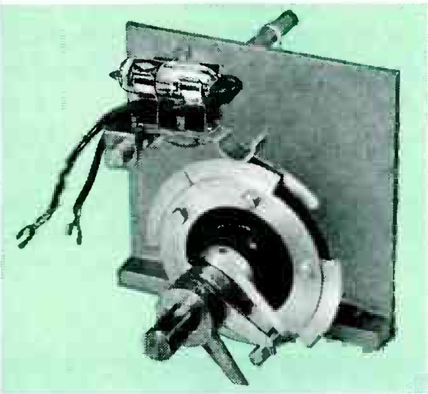
Seven Honeywell Mercury Switches provide selective operation of this SELECTROL pump programming control. Steel tape (right) leads from tank floats to signal water level. Changes in water level cause switches to open or shut off pumps.

When engineers of the Automatic Control Company, St. Paul makers of equipment for liquid level and pressure control, designed their SELECTROL automatic pump controls for sewage disposal plants and water works, they required switches with five vital characteristics. These switches must be—

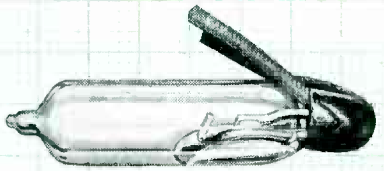
① Highly resistant to humidity
② Unaffected by corrosive gases
③ Operated by low energy input
④ Capable of wide overtravel
⑤ Flexible in adjustment

Honeywell Mercury Switches fully met all these requirements—and were selected for this widely used system of controls. The glass enclosures provide protection from atmospheric conditions. The switch used in this application is operated on a maximum tilt of 5 degrees. Unlimited overtravel is inherent in the switch design.

There are over 90 designs of Honeywell Mercury Switches from which to select the exact switch characteristics to meet your specific problems. MICRO field engineers are located near you to help in the selection of switch characteristics, mountings, actuating linkages, lead supports, terminal blocks, embedments and enclosures. You are invited to contact the nearest MICRO branch office for complete information.



Segments on this disc are adjustable to permit switch to operate and start or stop pump at predetermined levels.



Let a MICRO Engineer
show you how you can
"use Honeywell Mercury Switches as a principle of good design"

MICRO
MAKERS OF PRECISION SWITCHES
FREEPORT, ILLINOIS

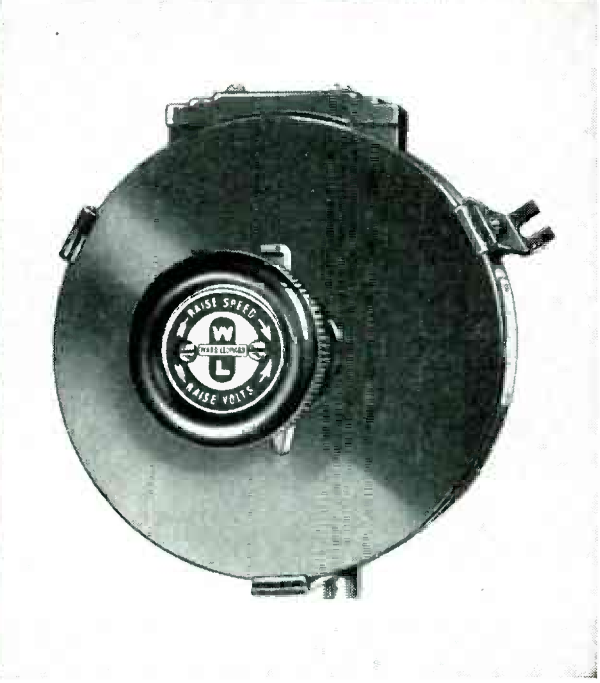
A DIVISION OF
MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

H
HONEYWELL

The Electric Candy Floss Machine Co.

"A pink cotton candy machine rheostat must provide exact temperature control"

says John G. Pettyjohn, John G. Pettyjohn Company, Knoxville, Tennessee, representative for Ward Leonard Electric Company.



Spinning sugar into fine, fluffy floss for pink cotton candy requires precise heat control. Unless a high degree of heat is closely controlled, candy becomes too thick or too thin. Since these machines are used at circuses, traveling carnivals, resorts, and similar places, machines must be ruggedly built. They must also be able to compensate for variance in voltage and surrounding temperature, depending upon the location.

The Electric Candy Floss Machine Company, Nashville, Tenn., uses Ward Leonard VITROHM plate rheostats in the heater circuits on the spinner heads of their new super deluxe candy floss machines for two reasons: (1) VITROHM rheostats are the only rheostats they have found that would stand up and give good service, (2) they are able to get a much better grade of candy.

Ward Leonard rheostats are available in several multiples of resistance values to meet various operating conditions. Special purpose rheostats requiring non-standard values and tapers can also be supplied.

Our engineering department is always ready to work with you to design the most economical rheostat for your particular application. Write for Rheostat Bulletin 60A.

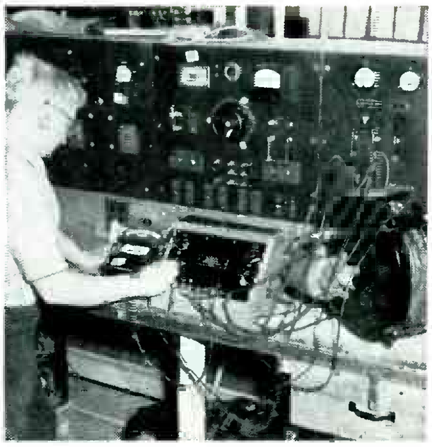
WARD LEONARD

WARD LEONARD ELECTRIC COMPANY

MOUNT VERNON, NEW YORK

Result-Engineered Controls Since 1892

ERICK SCHNEIDER, a company employee for over 23 years, operates a hydraulic press for securing the bushing assembly to the rheostat base plate.



MOTOR-DRIVEN RHEOSTAT undergoes a thorough electrical test prior to final inspection. Ian Scott, a company employee for 17 years, is the electrical tester.

VITROHM rheostat construction assures smooth, precise control and long life

Five features of VITROHM rheostat construction important to efficient operation are:

(1) Pressed steel plate forms a rigid, durable, but lightweight base.

(2) Resistance element of special alloy wire, of low temperature coefficient of resistance assures permanent resistance values.

(3) Stationary contacts are solidly anchored to the resistance element by a patented Ward Leonard process assuring a perfect junction.

(4) Movable contact is made of solid metal graphite having self-lubricating properties for smooth operation.

(5) VITROHM insulation applied over the resistance wire holds the wire and contacts in place and protects them against corrosion, mechanical damage.

Consult Ward Leonard on the adaptability of standard or modified electric controls to meet your particular needs.

HEAT-RESISTANT FINISH is automatically applied and infrared baked. Arthur Vasold removes finished plates and loads sandblasted plates on continuous conveyor.

REVOLVING BALL MILLS grind the frit to the exact fineness needed to produce the perfect vitreous enamel used in the manufacture of the VITROHM rheostat.

DISTRICT OFFICES AND REPRESENTATIVES

Atlanta 5, Georgia	C. B. Rogers and Associates
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Vancouver, B. C.	D. M. Fraser, Ltd.
Winnipeg, Man.	D. M. Fraser, Ltd.

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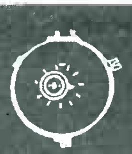
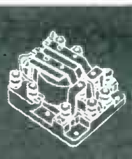
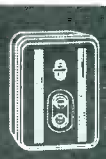
New York 4, N. Y.	Ad. Auriema, Inc.



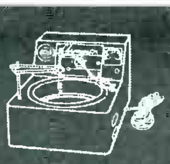
RHEOSTATS



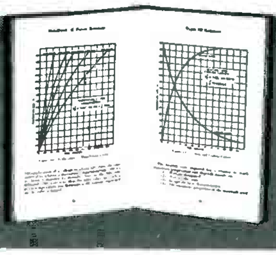
RELAYS



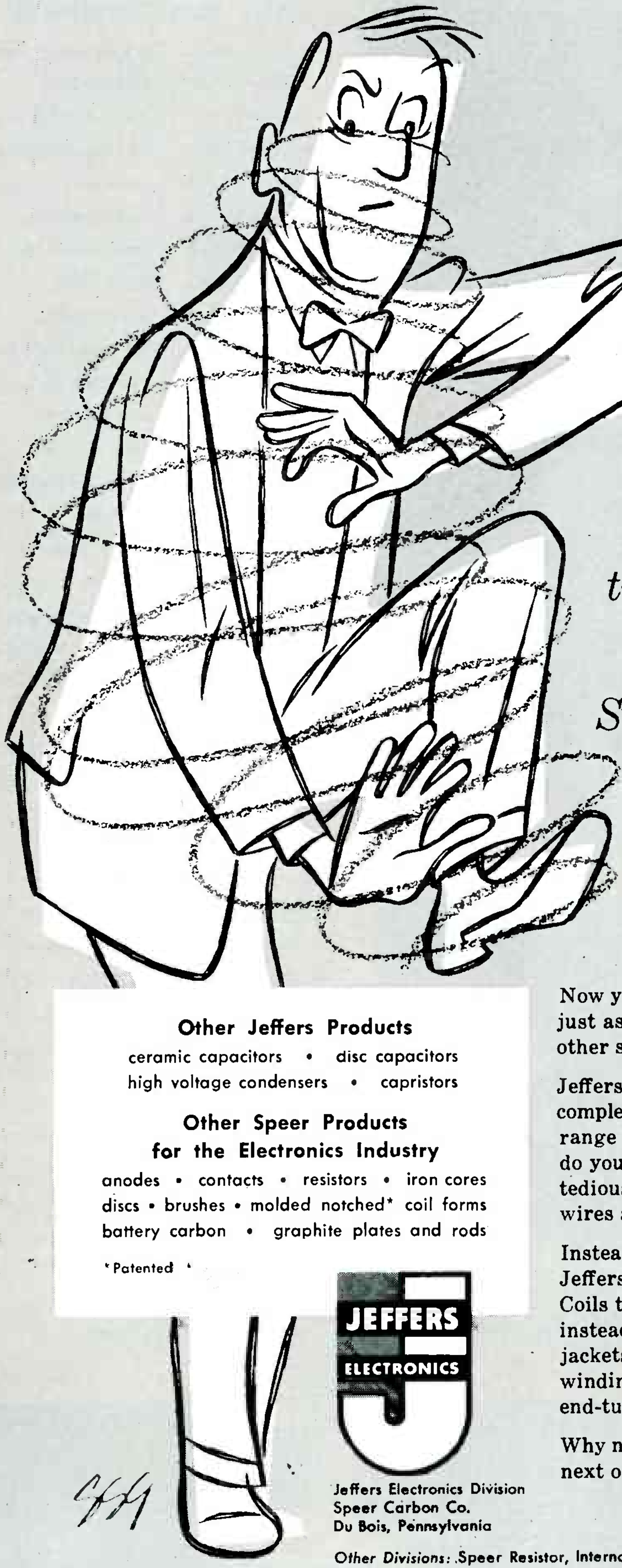
MOTOR CONTROLS



CHROMASTER



Ward Leonard's complete engineering textbook, "Handbook of Power Resistors," $3. per copy.



All wound up

trying to make your own R. F. Choke Coils?

Standardize on **Jeffers R.F. Choke Coils-**

save time, labor and expense

Now you can stock a wide range of R. F. choke coils just as you do resistors, capacitors and other similar components.

Jeffers Electronics is ready to deliver to you a complete line of R. F. choke coils with the widest range of inductance values available. No longer do you have to waste time, labor and money on slow, tedious hand assembly from miscellaneous forms, wires and coatings.

Instead you receive a standardized product from Jeffers, completely assembled and ready for use. Coils that are well made, too. Insulated copper wire instead of bare wire for windings . . . husky, molded jackets instead of those fastened by glue. All windings are soldered to leads . . . shorted end-turns completely eliminated.

Why not give Jeffers R. F. choke coils a try on your next order? *Write today for our specification sheets.*

Other Jeffers Products

ceramic capacitors • disc capacitors
high voltage condensers • capristors

Other Speer Products for the Electronics Industry

anodes • contacts • resistors • iron cores
discs • brushes • molded notched* coil forms
battery carbon • graphite plates and rods

*Patented

JEFFERS ELECTRONICS

Jeffers Electronics Division
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for electronic advancement

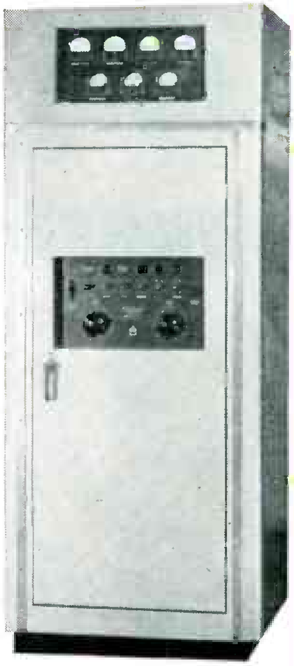

28 Volt D.C. Motor
Actuated Coaxial Switch
Model CA-71

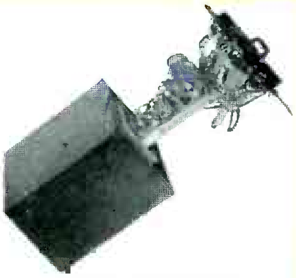

Lobing Switch
Model CA-31

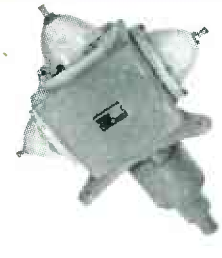

Manual Coaxial Switch
Model CA-36


Motor Actuated Coaxial Switch
Model CA-26


1P-2T Coaxial Switch
Model CA-20


High Voltage Power Supply Unit
Model BP-01


RF & Power Switch
Model CA-60


Antenna Switch
Model CA-57


Polar Recorder
Model PRS-1A

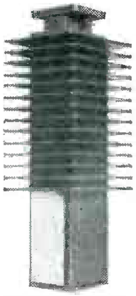

Transfer Switch
Model CA-19


Logarithmic Amplifier
Model BA-01

Ever since the electronic industry wore diapers, the research facilities of Thompson Products have been helping in its development. In fact, many of the major electronic developments owe part of their creation to Thompson research or Thompson-made equipment.

We are proud of our contributions—and, we think, justfully so. On the other hand—we *should* do a top job! We are equipped to solve tough problems. Thompson has two great plants—one in Cleveland, another in Columbus, Ohio—devoted exclusively to research engineering and manufacturing of electronic equipment. And our vast facilities stand ready, willing and able to help you solve your every problem—whether today's production or tomorrow's design—in coaxial switches, antennae, specialized test equipment or wave guide and coaxial components and accessories.

For complete information, we invite you to write, wire or telephone!


Dummy Load
Model BL-07

YOU CAN COUNT ON THOMPSON

Thompson Products, Inc.

ELECTRONICS DIVISION

2196 Clarkwood Road • Cleveland 3, Ohio

Your Copy

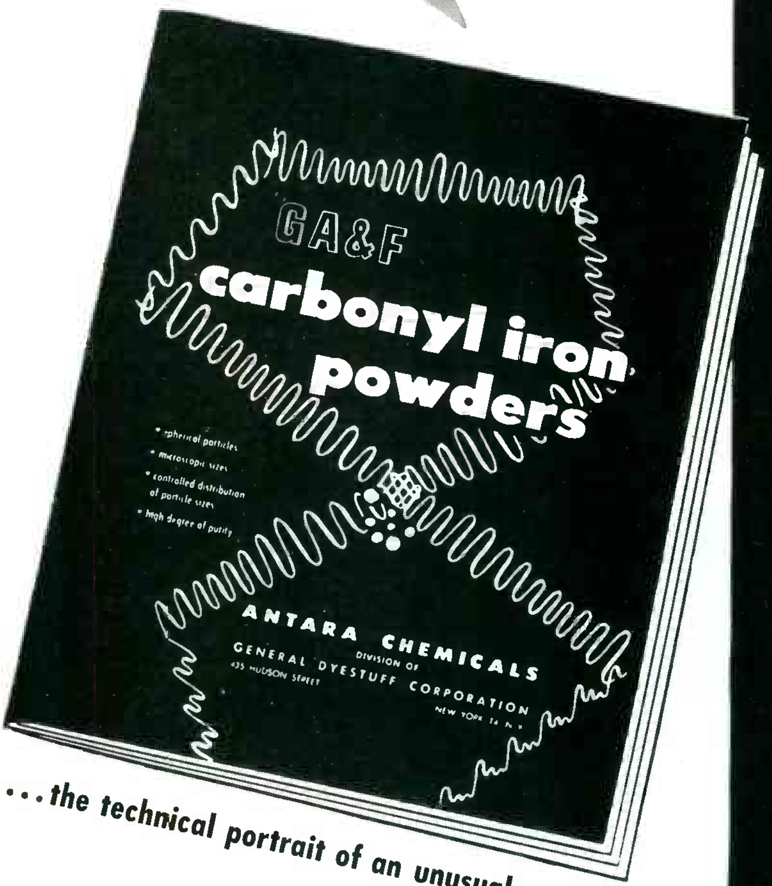
of this important new book will be mailed *on request*

G A & F Carbonyl Iron Powders are unique . . . This new book is unique . . . Here is the most comprehensive treatment ever given to the characteristics and applications of Carbonyl Iron Powders. (The 3-page bibliography alone is a valuable addition to your reference library.)

This book was written for the manufacturer or engineer who wants a maximum of facts with a minimum of verbiage. 80% of the story is told with photomicrographs, diagrams, performance charts and tables. Established applications are fully covered; new applications are suggested. Ask your core maker, your coil winder, your industrial designer, how G A & F Carbonyl Iron Powders can improve the performance and reduce the cost of the equipment you manufacture. Write us—without obligation—for your copy of this new book. Kindly address your inquiry to Department 30.

ANTARA® CHEMICALS
DIVISION OF
GENERAL DYESTUFF CORPORATION
435 HUDSON STREET • NEW YORK 14, NEW YORK

G A & F® Carbonyl



GA&F

carbonyl iron powders

- spherical particles
- microscopic sizes
- controlled distribution of particle sizes
- high degree of purity

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...the technical portrait of an unusual product

For data on: Turn to page:

5

Iron Powders . . .

MEMBER
mpa
METAL POWDER ASSOCIATION

LAPP GAS-FILLED CONDENSERS

For duty at high voltage and high current, Lapp Gas-filled Condensers offer the advantages of extreme compactness . . . low loss . . . high safety factors . . . puncture-proof design . . . constant capacitance under temperature variation . . . grounded tuning shaft . . . complete reliability—electrically and mechanically. Models for capacitances up to 60,000 mmf; current ratings to 525 amps at 1 mc; voltages to 100 kv peak.

Write for description and specifications.
Radio Specialties Division, Lapp
Insulator Co., Inc., Le Roy, N. Y.

Lapp

BULLETIN 953

E-I INDIVIDUAL, COLOR-CODED

Hermetically Sealed

TERMINALS

Illustration shows typical applications of E-I colored terminals. Case and covers are not supplied.

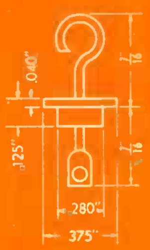
These terminals are available with glass inserts colored in standard, easy-to-identify RMA color code—black (0), brown (1), red (2), orange (3), yellow (4), green (5), blue, (6), purple (7), grey (8) and white (9). Colors are not lacquer or enamel applied to the glass surface, but a vivid coloring of the glass itself, providing positive, permanent identification without sacrifice of dielectric properties or surface insulation qualities. See reverse side of this sheet for complete information.

ELECTRICAL INDUSTRIES, INC · 44 SUMMER AVE., NEWARK 4, N. J.

E-I *Data & Specifications on*
COLOR-CODED TERMINALS

When ordering these terminals specify the color as a suffix to the code number. For example: CCS-80W-HP-GREY. The types listed below are the only E-I terminals available in color.

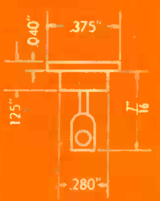
TYPE CCS-80W-HP



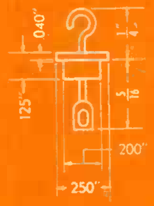
***RMS TEST VOLTS:**
1800 VOLTS
****CURRENT CAPACITY:**
16 AMPS
WIRE DIAMETER
.080"
HOLE DIAMETER
.090"
LOOP INSIDE DIAMETER
.120"
MOUNTING HOLE
19/64 DRILL

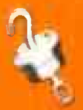
TYPE CCS-80W-P

***RMS TEST VOLTS:**
1800 VOLTS
****CURRENT CAPACITY:**
16 AMPS
WIRE DIAMETER
.080"
HOLE DIAMETER
.090"
MOUNTING HOLE
19/64 DRILL



TYPE ABS-40W-HP

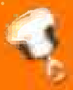


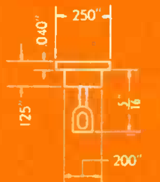


***RMS TEST VOLTS:**
1000 VOLTS
****CURRENT CAPACITY:**
5.5 AMPS
WIRE DIAMETER
.040"
HOLE DIAMETER
.045" x .080"
LOOP INSIDE DIAMETER
.070"
MOUNTING HOLE
#6 DRILL

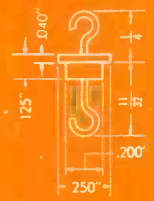
TYPE ABS-40W-P

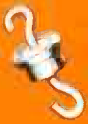
***RMS TEST VOLTS:**
1000 VOLTS
****CURRENT CAPACITY:**
5.5 AMPS
WIRE DIAMETER
.040"
HOLE DIAMETER
.045" x .080"
MOUNTING HOLE
#6 DRILL





TYPE ABS-40W-HH





***RMS TEST VOLTS:**
1000 VOLTS
****CURRENT CAPACITY:**
5.5 AMPS
WIRE DIAMETER
.040"
LOOP INSIDE DIAMETER
.070"
MOUNTING HOLE
#6 DRILL

FOR OTHER TYPES

—of E-I
SEALED LEADS AND MULTIPLE HEADERS
consult these
new catalogs—

E-I Bulletins contain complete data, engineering drawings and recommended applications. Call or write mentioning the bulletin numbers listed

BULLETIN 949-A
Hermetically Sealed Leads
BULLETIN 950-A
Hermetically Sealed Headers
BULLETIN 951
Hermetically Sealed Octal Plug-in Headers
BULLETIN 952
Type 73S and 90SR Plug-in Headers
BULLETIN 954
Hermetic End Seals and Sealed Covers

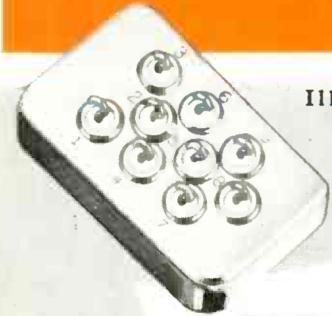


Illustration shows typical applications of E-I colored terminals. Case and covers are not supplied.

*At 90% Humidity at Sea Level. **Continuous Duty for 40°C Rise. NOTE: All Fractional Dimensions ± 1/32". On Decimal Dimensions ± .005".

The devices shown in this bulletin are covered by patents pending and all rights are reserved.

PHOTOS
ACTUAL SIZE

ELECTRICAL INDUSTRIES • INC
MANUFACTURERS OF SPECIALIZED ELECTRONIC EQUIPMENT
44 SUMMER AVE., NEWARK 4, NEW JERSEY

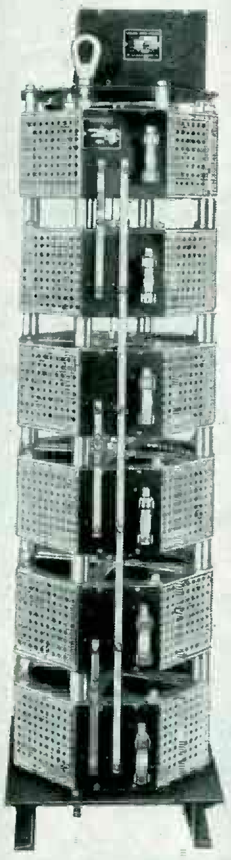
EI
INC

Printed in U.S.A.

FROM 150 VA

TYPE 10
INPUT: 120 VOLTS, 60 CYCLES, 1 PHASE
OUTPUT: 0-120/132 VOLTS, 1.25 AMPERES, 150/165 VA

TO 100 KVA



TYPE MW1156L-6Y
INPUT: 230 VOLTS, 50/60 CYCLES, 3 PHASE
OUTPUT: 0-230 VOLTS, 90 AMPERES, 35.8 KVA

POWERSTAT

Variable Transformers

PROVIDE A CONTINUOUSLY-ADJUSTABLE SOURCE OF A-C VOLTAGE

EFFICIENTLY
ACCURATELY
DEPENDABLY

Today's requirements for variable a-c voltage control are numerous. Variable transformers are needed for applications involving loads as low as 100 watts and as high as 100 KVA. Only POWERSTAT variable transformers are provided in a range of models to fulfill the demands of individual needs. Standard types are available for manual or motor-driven operation in ratings of 115, 230 and 460 volts; 25, 50/60 and 400/800 cycles; single and three phase; 0.15 to 100 KVA. Oil-cooled and Explosion-proof POWERSTATS are offered for use in corrosive and hazardous atmospheres.

All POWERSTATS feature excellent regulation, high efficiency, conservative ratings, zero waveform distortion and accurate adjustment to fractions of a volt. Mechanical construction is rugged and provision has been made for easy bench, wall or back-of-panel mounting.

Whatever your variable a-c voltage needs, there is a POWERSTAT variable transformer to do the job — and do it better.

SEND NOW FOR COMPLETE INFORMATION

THE SUPERIOR ELECTRIC CO.
BRISTOL, CONNECTICUT

- **STABILINE AUTOMATIC VOLTAGE REGULATORS**
- **POWERSTAT VARIABLE TRANSFORMERS**
- **VARICELL D-C POWER SUPPLIES**
- **VOLTBOX A-C POWER SUPPLIES**
- **SUPERIOR 5-WAY BINDING POSTS**
- **POWERSTAT LIGHT DIMMING EQUIPMENT**

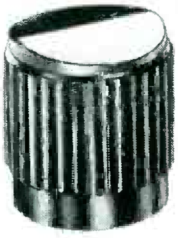
The SUPERIOR ELECTRIC Co.,
209 Thure Ave., Bristol, Conn.

Please send free copies of the POWERSTAT bulletins P550 and P252.

NAME ____________
POSITION ____________
CO. NAME ____________
CO. ADDRESS ____________
CITY ________ ZONE ____ STATE ____

To Guarantee
QUALITY BEYOND QUESTION
in RAYTHEON®


70 SERIES ROUND


90 SERIES SKIRTED ROUND


125 SERIES DIAL SKIRTED ROUND


90 SERIES POINTER


90 SERIES SKIRTED POINTER


175 SERIES CRANK

Standard Control Knobs

So that you may specify them with confidence for the finest electronic and electrical equipment, Raytheon Standard Control Knobs must pass these quality control tests:

HUMIDITY — 48 hours of 95% relative humidity at 65°C.

SALT SPRAY — 50 hour fog test in accordance with Specification QQ-M-151.

VIBRATION — tested in 3 planes from 10 CPS to 33 CPS at an amplitude of .072" for 3 minutes each way in accordance with Specification 40T9.

IMPACT — blows of 400, 800 and 1200 foot pounds through each of 3 axes in accordance with Specification 40T9.

HIGH TEMPERATURE — 4 hours at 85°C combined with torque test.

TORQUE — 25 to 50 pound-inches applied in one direction, then opposite while under high temperature test.

ROTATION — crank knobs rotated 200,000 times with 1½ pound load applied intermittently to handle during each rotation.

EXTREME TEMPERATURE — knobs subjected for 2 hours to 95% relative humidity at plus 65°C, then minus 40°C for 2¼ hours, then quickly back to room temperature.

RAYTHEON STANDARD CONTROL KNOBS are made in five basic sizes and six functional styles of tough, durable "Tenite II" (cellulose acetate butyrate), injection molded with anodized aluminum inserts and dual setscrews. Black knobs available in "matte" or "mirror" finish.

RAYTHEON
MANUFACTURING COMPANY
EQUIPMENT SALES DIVISION
DEPT. 6270-KA, WALTHAM 54, MASSACHUSETTS
DISTRICT OFFICES: BOSTON, NEW YORK, CLEVELAND, CHICAGO, NEW ORLEANS, LOS ANGELES (WILMINGTON), SAN FRANCISCO, SEATTLE
INTERNATIONAL DIVISION: 19 RECTOR ST., NEW YORK CITY

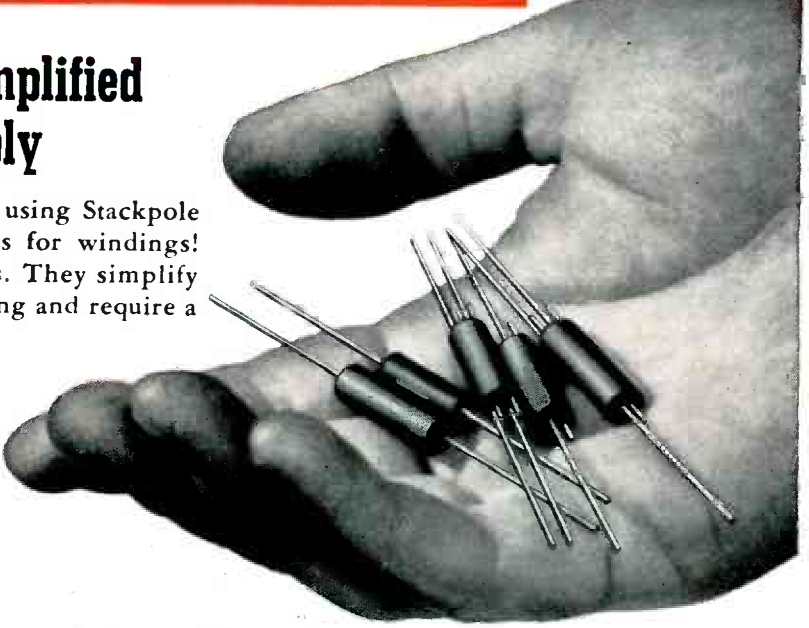
RAYTHEON PRODUCTS INCLUDE: WELDPOWER* welders; Voltage stabilizers (regulators); Transformers; Sonic oscillators for laboratory research; Standard control knobs; Electronic calculators and computers; Radio, television, subminiature and special purpose tubes; and other electronic equipment. *Reg. U. S. Pat. Off.

A lot better than "Gimmicks"... and Just as Cheap in the Long Run!

Because they're so much easier to install, Stackpole Type GA low-value capacitors cost no more than makeshift twisted-wire "gimmicks" in the long run. What's more, they offer much greater stability, higher Q, better insulation resistance and higher breakdown voltage. They are far superior mechanically and eliminate the inductive characteristic common to twisted wires.

Samples on letterhead request.

Two big little helps to BETTER DESIGN and PRODUCTION



For Smaller Coils... Simplified Equipment Assembly

Chances are you'll gain in several ways by using Stackpole Molded Coil Forms as mechanical supports for windings! They cost little. They permit smaller coils. They simplify equipment assembly with point-to-point wiring and require a lot fewer soldered connections. Forms are available with iron core sections that increase Q materially while decreasing the amount of wire needed for a given inductance. Stray magnetic fields are greatly reduced.

Electronic Components Division
STACKPOLE CARBON COMPANY
St. Marys, Pa.

STACKPOLE

FIXED and VARIABLE RESISTORS • SPECIAL RESISTORS • LINE and SLIDE SWITCHES • IRON CORES • CERAMAG® CORES (FERRITES)

Here's how BENDIX *extends the utility of*

Bendix makes scores of products in this field alone

Whether you are seeking the ultimate ceiling of flight or sounding the depths of the seas . . . whether your interests are faster transportation or factory automation . . . whether you are forwarding industrial progress or national defense, electronics and Bendix can speed you to your goal. Bendix produces electronic devices and components for industries of every type—and Bendix engineers are constantly revealing new applications of this immensely useful science. Here are a few suggestive examples from a constantly lengthening list.

Aviation — Modern planes and guided missiles typify the peak advancements of electronics—and Bendix is deeply engaged in both fields.

BENDIX-BUILT BRAINS
control aircraft, guided missiles

Pioneer in the use of VHF radio for aviation, Bendix builds a complete line of airborne transmitting and receiving equipment. Bendix electronic navigation aids include radio compasses, a wide range of remote indicating instruments and controls, ILS bad weather landing systems, and Omni-Range equipment. Other electronic muscles and brains for this field are exemplified by the Bendix automatic pilot and by the OMNI-MAG, which automatically solves complicated orientation, navigation and landing approach problems and gives the answer to the pilot as a single pointer reading.

In the kindred field of guided missiles Bendix-built brains include even more advanced electronic guidance and navigation devices, and electronic maneuvering, stability and fuel system controls. And for closely allied work in meteorology, Bendix radiosonde equipment is carried aloft by balloon or rocket to transmit and record vital facts about upper air conditions.

Radar—Active in radar from its very inception, Bendix engineers have developed a whole range of search and surveillance radar equipment from the smallest airborne models to the largest fixed stations, as well as mobile trailer and portable field units. Over the years, Bendix GCA radar has guided aircraft to thousands of safe landings at airports closed in by bad weather.

BENDIX RADAR
safeguards the nation

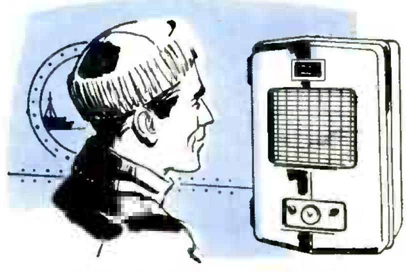
Industry — The knowledge gained in these advanced operations has been used by Bendix to forward progress in many other fields. Bendix experience has evolved the VHF railroad radio which speeds freight on leading lines, and the new Centralized Radio Control that links the entire communication facilities of a railroad into a system enabling dispatchers or operators to talk to conductors of any train over any distance or any terrain.

BENDIX CRC SYSTEMS
add to railroad efficiency

The same outstanding quality and performance is available in a mobile radio unit for taxicabs, police and fire vehicles, buses, trucks and factories. Featuring exclusive Clear Channel Construction, this unit produces better selectivity, sensitivity and watt output for current input than any other mobile radio.

BENDIX MOBILE RADIO
speeds transport and commerce

A further example of the wide utility of Bendix electronic equipment is supplied by the electronic depth recorder. Originally produced as a navigation aid to show a constant visual picture of the ocean floor, it has also proved invaluable for locating schools of fish—and is in world-wide use by commercial fishermen. A smaller model finds fishing holes for week-end fishermen. Other Bendix electronic actuating, computing and remote indicating devices have equally practical potentials limited only by the ingenuity of the users. To guarantee Bendix quality, Bendix builds most of its own electronic components, such as elec-



BENDIX DEPTH SOUNDER
makes fishing pay

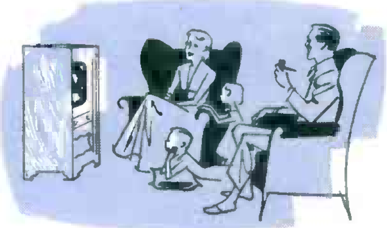
SEE
Brilliant Bendix TV
The Finest Picture Science
has ever Produced.

PRINCIPAL DIVISIONS **BENDIX RADIO:** auto, railroad, mobile, aviation radio; radar. **BENDIX RESEARCH LABORATORIES. ECLIPSE MACHINE:** Stromberg* carburetors; electric fuel pump; starter drives; coaster brakes. instruments. **RED BANK:** dynamotors; inverters; special vacuum tubes. **PACIFIC:** telemetering; hydraulic and electrical **MAGNETO:** aviation and small engine magnetos; diesel fuel injection; electrical connectors. **BENDIX ECLIPSE OF CANADA,**

ELECTRONICS

trical connectors, a wide range of ruggedized electronic tubes, servo-mechanisms and dynamotors. All are available to other manufacturers for the production of electronic devices for use in the rapidly expanding electronic-mechanical applications.

Entertainment—Bendix electronic experience reaches the general public in the form of superior home radio, automobile radio, and television. As you would expect, Bendix auto radios set new standards for fidelity and trouble-free operation, while Bendix Television offers the finest picture science has ever produced and brings to fringe areas a new concept of television performance.



BENDIX TELEVISION
sums up TV progress

This considerably abbreviated list will suggest that if electronics enter your picture in any way you ought to know more about Bendix. For this purpose Bendix offers you a 40-page book "Bendix and Your Business," which discusses Bendix electronic devices and also tells about the hundreds of additional products which are helping industry to improve present lines, create new products, speed production and cut manufacturing costs. A copy is yours for the asking.

Learn how Bendix can better any business, including yours. Write on your letterhead for a free copy of the informative 40-page book, "Bendix and Your Business," to Bendix Aviation Corporation, Fisher Building, Detroit 2, Michigan.

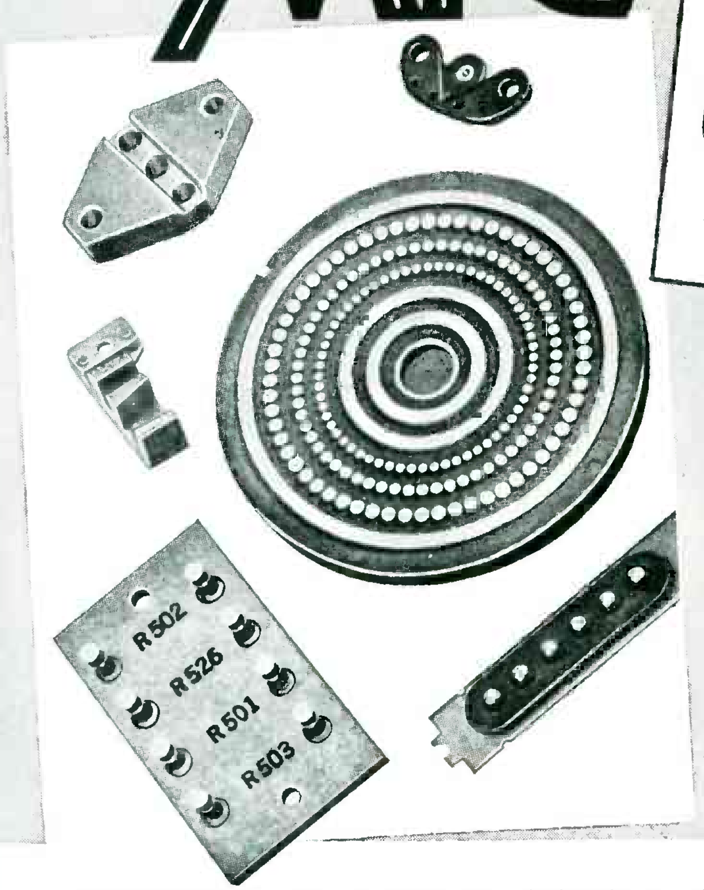
Bendix
AVIATION CORPORATION

THE NAME MILLIONS TRUST

PRODUCTS: automotive brakes; power steering; carburetors; aviation brakes; landing gear; fuel metering. BENDIX AVIATION MARSHALL ECLIPSE: brake blocks; brake lining. ECLIPSE PIONEER: aviation instruments and accessories; foundry. FRIEZ weather actuators; depth recorders. ZENITH* CARBURETOR: heavy duty and small engine carburetors. SKINNER PURIFIERS: filters. SCINTILLA LTD.—Windsor, Ontario. BENDIX INTERNATIONAL—72 Fifth Ave., New York 11, N. Y. Cable "Bendixint" New York. *REG. U.S. PAT. OFF.

For better products at lower cost-

SPECIFY MYCALEX



Glass-Bonded Mica INSULATION

- MOLDS AND MACHINES TO CLOSE TOLERANCES
- MOLDABLE WITH METAL INSERTS
- CAN BE TAPPED, THREADED, SLOTTED
- AVAILABLE IN RODS, SHEETS, SPECIAL SHAPES
- MOLDED IN PRACTICALLY ANY SHAPE OR SIZE
- LOW-LOSS FROM 60 CPS TO 24,000 MCS

MYCALEX glass-bonded mica insulation is the one highly adaptable, versatile insulating material that combines every desirable characteristic required in a modern dielectric. Although far superior to lower cost dielectrics, MYCALEX offers considerable advantages over many materials costing several times as much. MYCALEX is available in various grades, each featuring specific characteristics to meet particular needs. Since proper application of the right grade of MYCALEX has resulted in simultaneous product improvement and lower cost in hundreds of instances, it's good business to check with MYCALEX before specifying sheet, rod, fabricated or molded insulation.

JAN APPROVED

MYCALEX 410 is approved fully as Grade L-4B under National Military Establishment Specification JAN-I-10, "Insulating Materials, Ceramic, Radio, Class L."

MYCALEX 400 is approved fully as Grade L-4A under National Military Establishment Specification JAN-I-10, "Insulating Materials, Ceramic, Radio, Class L."

Write for 20-Page Catalog Today!

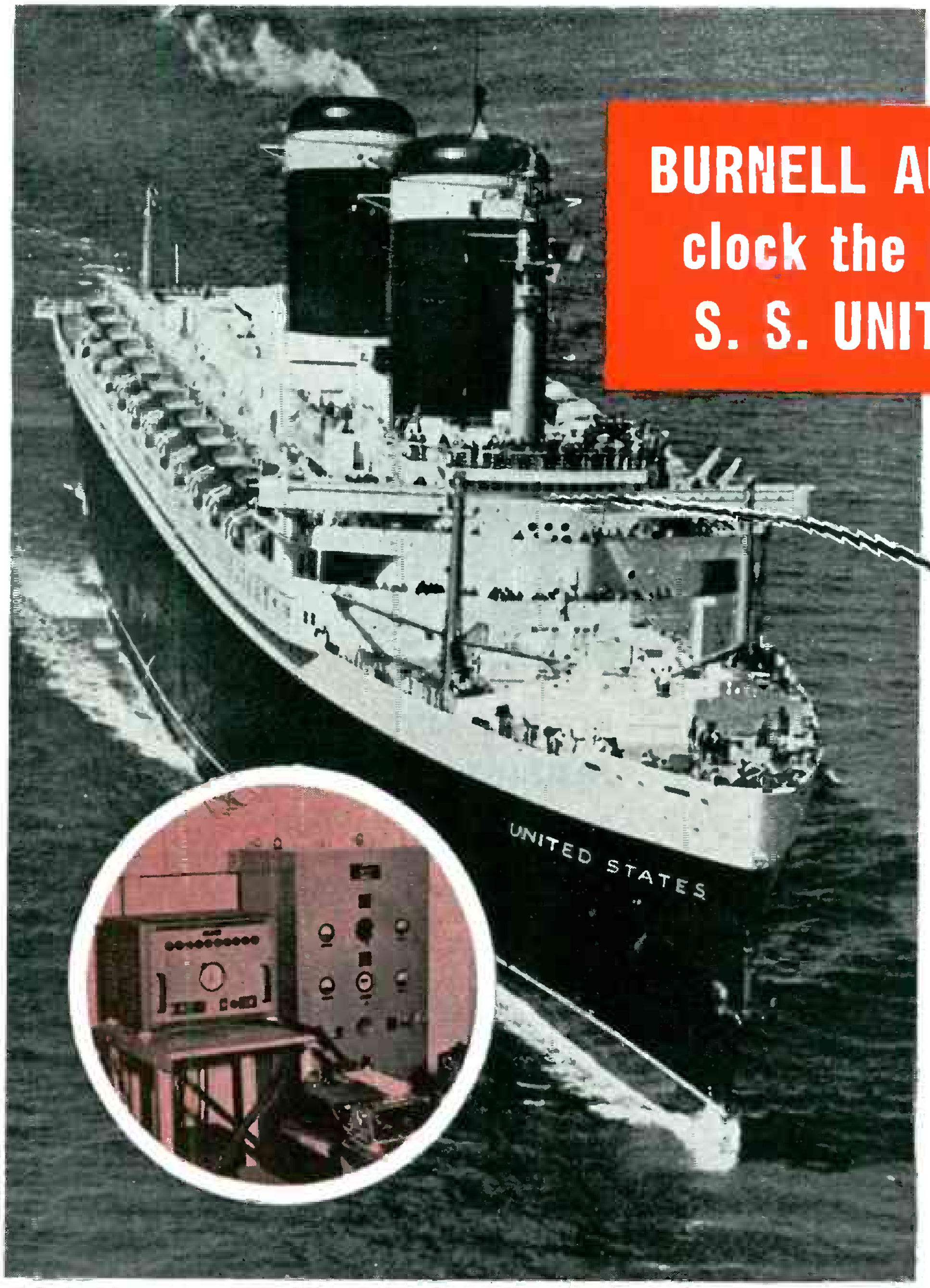
A valuable compilation of engineering data and manufacturing information on electrical insulation that you'll surely want for your technical file. Request it today—no obligation.

CHARACTERISTICS

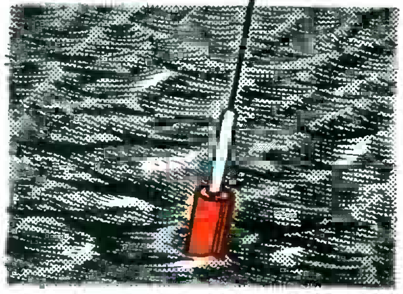
MYCALEX GRADE	400	410	410X
POWER FACTOR, 1 MC	0.0018	0.0015	0.012
DIELECTRIC CONSTANT, 1 MC	7.4	9.2	6.9
LOSS FACTOR, 1 MC	0.013	0.014	0.084
DIELECTRIC STRENGTH, volt/mil	500	400	400
VOLUME RESISTIVITY, ohm-cm	2×10^{15}	1×10^{15}	5×10^{14}
ARC RESISTANCE, seconds	300	250	250
MAX. SAFE OPER. TEMP., °C	370	350	350
WATER ABSORPTION % 24 hrs.	NIL	NIL	NIL

SINCE 1919
MYCALEX
THE INSULATOR
TRADE MARK REG US PAT OFF

MYCALEX CORPORATION OF AMERICA
Owners of 'MYCALEX' Patents and Trade-Marks
Executive Offices: 30 ROCKEFELLER PLAZA, NEW YORK 20 — Plant & General Offices: CLIFTON, N.J.



BURNELL AUDIO FILTERS clock the speed of the S. S. UNITED STATES



WE ARE PROUD TO ANNOUNCE THAT *ONLY* BURNELL & COMPANY AUDIO FILTERS WERE EMPLOYED IN THE HASTINGS INSTRUMENT COMPANY RAYDIST EQUIPMENT ABOARD THE S. S. UNITED STATES ON ITS RECORD SHATTERING RUN.

"Although the forces of nature combined to make the speed run AND the speed measurement extremely difficult, our raydist equipment using BURNELL filters surmounted all handicaps and exceeded specified accuracy", said Mr. Hastings.

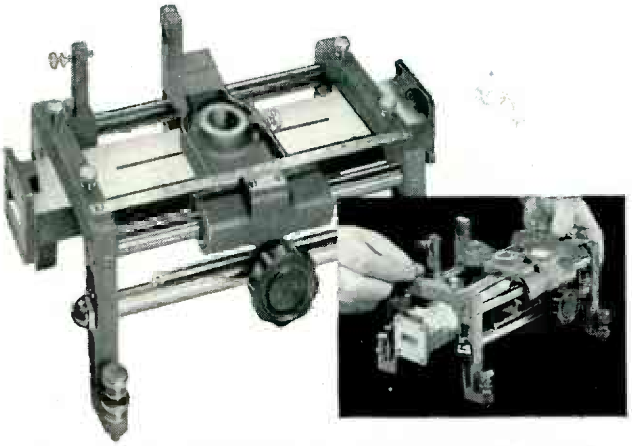
WE ARE HAPPY TO ADD THIS TO OUR EVER INCREASING LIST OF TESTIMONIALS ON THE QUALITY OF BURNELL'S TOROIDS AND AUDIO FILTERS.

Exclusive Manufacturers of Communications Network Components

Burnell & Company
YONKERS 2, NEW YORK
CABLE ADDRESS "BURNELL"

New

-hp- WAVEGUIDE INSTRUMENTS



-hp- 809B UNIVERSAL PROBE CARRIAGE

Model 809B Carriage is a basic unit in the new line of *-hp* broad band waveguide equipment. It consists of a precision built mechanical assembly operating with any of five *-hp-* 810B Waveguide Slotted Sections covering frequencies from 3.95 to 18.0 kmc. It also operates with *-hp-* 806B Coaxial Slotted Section, 3.0 to 12.0 kmc. (Slotted section data on opposite page.)

Model 809B is a compact, lightweight, easily portable instrument that simplifies waveguide measurements over many frequency bands and eliminates costly special probe carriages covering each band. Mating waveguide sections can be interchanged in 30 seconds or less. The equipment will operate with any *-hp-* probe or detector mount shown on the opposite page. A centimeter scale with vernier reads to 0.1 mm. A dial guage may be mounted for more accurate readings.

Precision three-point suspension of the carriage utilizes two linear and one conventional ball bearings. Each is equipped with dust seals and permanent lubrication and moves on ground stainless steel rods. Accuracy is superior or equal to the most expensive custom-made slotted lines. Model 809B—$160.00. (Does not include slotted sections.)

NEW INTEGRATED INSTRUMENTS GIVE UTMOST FLEXIBILITY, CONVENIENCE—LOW COST!

Hewlett-Packard Broad Band Waveguide Instruments are based on an entirely new design approach. The fundamentals of this new concept are:

1. Each instrument is of simplest construction consistent with its basic function and covers the entire frequency range of its waveguide size.
2. An integrated set of instruments is available for each commonly-used waveguide: 3″ x 1½″, 2″ x 1″, 1½″ x ¾″, 1¼″ x ⅝″, 1″ x ½″ and .702″ x .391″.
3. New, simple mechanical design, incorporating novel electrical circuitry, insures high accuracy, stability and quality, yet makes possible quantity production at low cost.

With new *-hp-* waveguide equipment, you select the exact instruments you need. Each is designed in its most fundamental form, yet is integrated mechanically and electronically with the complete *-hp-* waveguide line. You are assured maximum operating flexibility, efficiency, convenience and economy.

For complete details, see your -hp- field representative or write direct

HEWLETT-PACKARD COMPANY

2522A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U. S. A.

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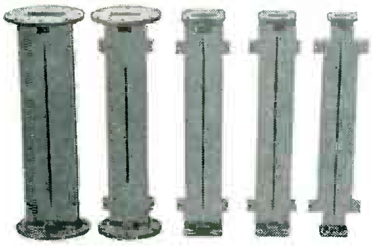
Complete Coverage! HEWLETT-PACKARD

BROAD BAND COVERAGE
(Full Frequency Range of Waveguide)
HIGH ACCURACY
INTEGRATED UNITS
SIMPLIFIED DESIGN



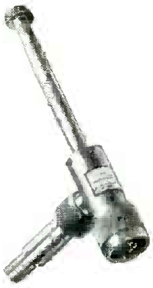
*-hp-*810B WAVEGUIDE SLOTTED SECTIONS

The broad band *-hp-* 810B series consists of accurately machined waveguide sections in which small longitudinal slots are cut. They fit the *-hp-* 809B Carriage in a precisely indexed position. An *-hp-* traveling probe mounted on the Carriage samples the waveguide's electric fields and makes possible accurate plotting of variations along the entire length of probe travel. Slotted sections are carefully machined from normalized aluminum castings, and the slot ends are tapered to reduce reflection to *less than 1.01 VSWR.* A high order of accuracy is thus maintained. Model 810B is offered in 5 common waveguide sizes covering all frequencies 3.95 to 18.0 kmc. Sizes: 2″ x 1″, 1½″ x ¾″, 1¼″ x ⅝″, 1″ x ½″ and .702″ x .391″. Price, $90.00 each.

-hp- S810A WAVEGUIDE SLOTTED SECTION

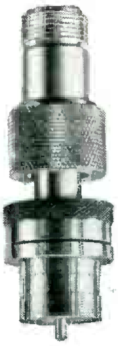
This instrument is a slotted waveguide section complete with a built-in, precision probe carriage mounted directly on the waveguide section. The instrument uses either *-hp-* 442B Broad Band Probe singly or in combination with *-hp-* 440A Detector; or *-hp-* 444A Untuned Probe. Model S810A is offered in the 3″ x 1½″ waveguide size only (2.6 to 3.95 kmc). It measures 12¾″ long. Price: $450.00

-hp- 806B Coaxial Slotted Section. This instrument covers all frequencies 3.0 to 12.0 kmc and fits *-hp-* 809B Carriage. Special fittings mate with Type N connectors for minimum VSWR. Impedance is 50 ohms to match flexible coaxial cables.



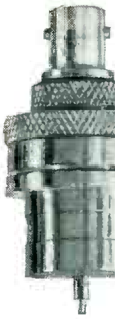
-hp- 440A DETECTOR MOUNT

Simple, easy-to-use instrument for detecting rf energy in waveguide or coax systems, 2.4 to 12.4 kmc. Only one tuning adjustment. Uses crystal or bolometer. Fits Type N plug. When used with *-hp-* 442B becomes sensitive, easily tuned waveguide detector. $85.00



-hp- 442B BROAD BAND PROBE

A probe whose penetration depth is quickly adjustable and may be locked in place. Sampled rf appears at Type N jack, permitting direct connection to receiver, analyzer, etc. Shielded and damped against spurious resonances. Fits *-hp-* 809B, other ¾″ dia. mountings. $50.00



-hp- 444A UNTUNED PROBE

A 1N26 crystal plus a small antenna in convenient housing. Probe penetration quickly and easily varied and locked in place. No tuning needed; range 2.4 to 18.0 kmc. Sensitivity better; loading more constant than tuned probes. Fits *-hp-* 809B, S810A or other ¾″ dia. holes. Includes crystal, $50.00

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

hp INSTRUMENTS – Complete Coverage!

NEW GENERAL ELECTRIC ALL-PURPOSE OSCILLOSCOPE

Versatile 5-Inch Model ST-2B Outperforms Competition in Laboratory and Industrial Applications

NO MATTER how broad the requirements of your laboratory, chances are you'll find most of them listed in the comparison chart below. Four well-known makes* of conventional scopes are analyzed, feature by feature, against the General Electric ST-2B. *On every point*, the G-E unit is an investment in high-quality, long-term performance.

Write us for complete new bulletin ECL-4. *General Electric Company, Section 492, Electronics Park, Syracuse, New York.*

* *Names on request.*

WHAT DO YOU LOOK FOR IN A SCOPE? STUDY THIS FACTUAL COMPARISON.

CHARACTERISTICS	G-E ST-2B	MFTR. B	MFTR. C	MFTR. D	MFTR. E
Sufficient band width for pulse work	Yes	Yes	Yes	Yes	No
High gain AC/DC amplifiers	Yes	Yes	No DC amplifier	No DC amplifier	Yes
Triggered sweep	Yes	No	No	No	Yes
Good stability	Yes	Yes	Yes	Poor	Yes—if tube selection is employed
Choice of cathode ray tube screen persistence	Yes	Cannot use long persistence C. R. tube	Yes	Cannot use long persistence C. R. tube	Yes
Low capacity probe	Yes	Yes	No	No	Yes
Direct connection to deflection plates	Yes	No	Yes	Yes	Yes
Identical vertical & horizontal amplifiers	Yes	Yes	No	No	No
Low microphonics	Yes	No	Yes	Yes	Yes
Z-axis modulation input jack	Yes	No	Yes	Yes	Yes
Convenient amplitude calibrator	Yes	Single Voltage only	Single Voltage only	Single Voltage only	Single Voltage only

SPECIFICATIONS

FREQUENCY RESPONSE

Vertical Amplifier
DC— —0 to 400 kc, +0, −20%, not more than 50% down at 700 kc.
AC— —10 cycles to 400 kc, +0, −20%, not more than 50% down at 700 kc.
Probe— —2 cycles to 400 kc, +0, −20%, not more than 50% down at 700 kc.
Response independent of gain or attenuator setting.

Horizontal Amplifier
DC— —0 to 400 kc, +0, −20%, not more than 50% at 700 kc.
AC— —10 cycles to 400 kc, +0, −20%, not more than 50% down at 700 kc.
Response independent of gain or attenuator setting.

SENSITIVITY

Vertical	AC— 10 mv. rms/inch DC— 28 mv. dc/inch
Horizontal	AC— 15 mv. rms/inch DC— 42 mv. dc/inch
Probe	130 mv. rms/inch
Deflection Plates Direct	
Vertical	22 volts rms/inch
Horizontal	25 volts rms/inch

SWEEP

Range—Triggered or recurrent—2 cycles to 30 kc (may be extended downwards by adding external capacity across panel jacks).
Sync— ±Internal, ±line and —Ext. (requires —.3 volts peak to peak for external sync).
Sweep Expansion—At least 4 times tube diameter.

PHASE SHIFT—Negligible phase shift between amplifiers from 0 to 300 kc.

BLANKING—Z-axis blanking requires 20 volts peak to blank.

CALIBRATION—Seven voltages available by selector switch: .1, .3, 1, 10, 30, 100 and 300 volts peak to peak ±15%.

DIRECT CONNECTIONS TO DEFLECTION PLATES—Available through capacitors—internal positioning circuits still function.

AMBIENT TEMPERATURE RANGE—0° to 40° C.

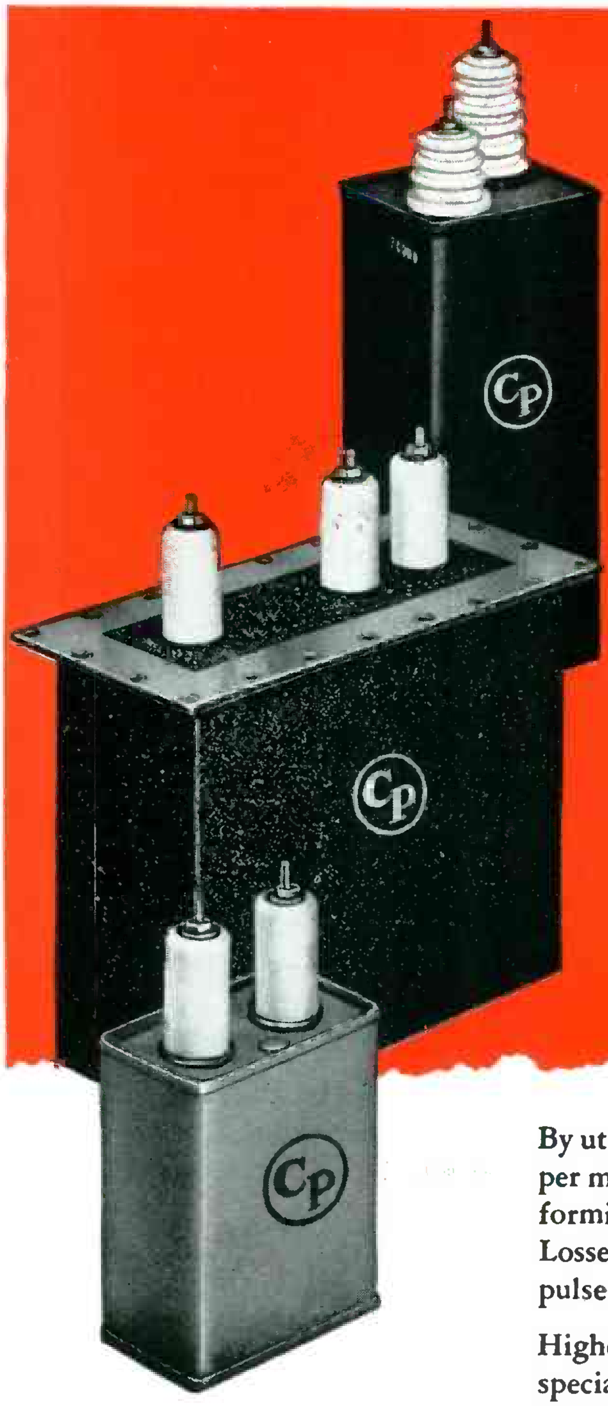
POWER REQUIREMENTS—105-125 volts, 50/60 cycles power consumption approximately 120 watts. (By a simple wiring change, may be operated from 210-250 volt line.)

TUBE COMPLEMENT
4— 6BK7
4— 5879
2— 12AU7
1— 1B3GT
1— 5Y3GT
1— OA2
1— 884
Model 4ST2B1— 5UP1
Model 4ST2B2— 5UP7
Model 4ST2B3— 5UP11

SIZE
Height—15½ inches
Depth—17 inches
Width—10 inches
Weight—45 pounds

You can put your confidence in—

GENERAL ELECTRIC



Pulse Forming Networks

Specified where Size, Efficiency, Economy and Weight are Important

By utilizing Plastic Films which allow higher volt per mil loading of capacitor dielectric, our pulse forming networks are made in minimum sizes and weights. Losses are considerably lower in comparison to pulse forming networks using other types of dielectric.

Higher temperatures are permissible due to our special dielectric and the use of silicone impregnants. Other characteristics are long life, stable performance at high temperatures, and ranges of voltages up to 60 KV. Highly functional designs make "CP" pulse forming networks preferred where efficiency and economy and small size are essential.

Send us your requirements and we will recommend and design a Pulse Forming Network to solve your need.

MANUFACTURERS
Glassmike Capacitors
Plasticon Capacitors
HiVolt Power Supplies
Pulse Forming Networks

Condenser Products Company
Division of New Haven Clock & Watch Co.

7517 North Clark Street • Chicago 26, Illinois

a NEW instrument and

The NEW Type 304-A, succeeding the world-famous Type 304-H, is more than simply a new instrument — more than a new combination of established circuits. It represents a significant development in the science of instrumentation. The Type 304-A, *a true electronic voltmeter,* reflects a new concept of oscillography.

THE DU MONT

TYPE 304-A

The new Type 304-A is in *every* respect a true electronic voltmeter. Every feature of the well-known Type 304-H has been re-evaluated with this concept in mind. All the features that made the Type 304-H so valuable as a *qualitative* instrument have been preserved and augmented to enable not only *qualitative* analysis, but rapid, accurate *quantitative* measurement of amplitude as well.

AMPLITUDE CALIBRATION The novel amplitude calibrating system of the Type 304-A permits signal measurements directly in volts from the screen. Unlike electro-mechanical devices, the new Type 304-A is not restricted to measurement of sinusoidal signals — or to peak-to-peak readings of voltage. The Type 304-A may be used to measure any amplitude portion of the input signal, and has a sensitivity of 0.1 p-p volt full scale, or 0.025 p-p volt per inch.

NEW CATHODE-RAY TUBE A wholly new cathode-ray tube is employed in the Type 304-A. This tube, designated Type 5ADP-, was specifically designed to permit accuracy of measurement. This new flat-faced tube is precision-built to tolerances far more stringent than is the practice in conventional tubes. The angular alignment between x and y deflection systems is held to 90° ±1°, as contrasted to ±3° in conventional cathode-ray tubes. The various distortions and aberrations inherent in all cathode-ray tubes are held to a minimum. The new design of the electron gun and deflection-plate structure assures a deflection sensitivity as much as twice that of equivalent tube types, as well as a smaller spot size, with no sacrifice in brilliance. Also incorporated is an auxiliary focus control which reduces the effects of astigmatism to a minimum. Thus by the inclusion of this new tube and its auxiliary circuitry, an unusually fine, bright trace is achieved, enabling a degree of resolution—and hence a degree of accuracy—heretofore impossible in instruments employing medium accelerating potentials.

HEATER REGULATION Regulation of the heaters of the Y-input stages has been incorporated to promote stability of the amplifier.

SYNC LIMITING Sync limiting, on both recurrent and driven sweeps, assures stable operation, even for varying synchronizing levels, and freedom from horizontal jitter that might tend to interfere with precise analysis.

ILLUMINATED CALIBRATED SCALE A new edge-illuminated scale, calibrated in fifth inches, with every fifth line accentuated, is incorporated in the Type 304-A. Accentuated lines are numbered so amplitude may be read directly.

● ● ● ● ●

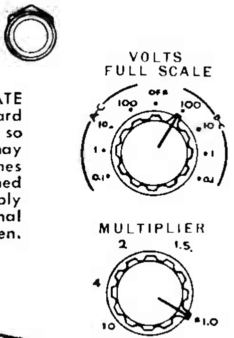
The Type 304-A represents one more step in the development — by Du Mont — of the cathode-ray oscillograph from a purely qualitative instrument to its rightful position as the most versatile, most complete analytical device available.

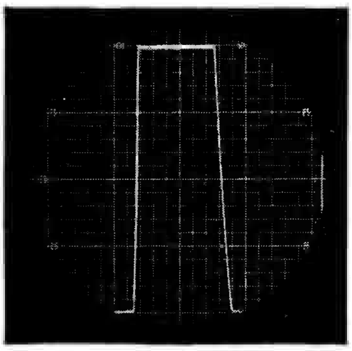
Domestic Price $333

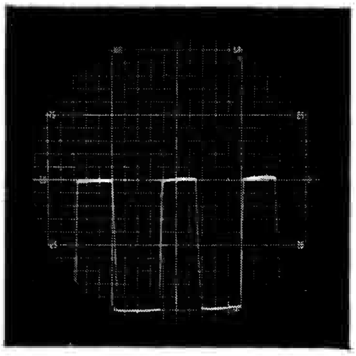
a NEW concept in oscillography!

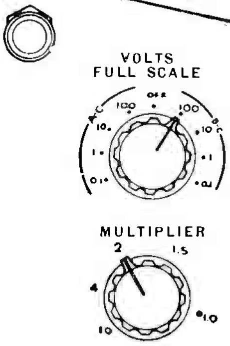
Calibrating the Type 304-A is as simple and easy as "zeroing-in" a vacuum-tube voltmeter.

TO CALIBRATE, depress the front-panel CALIBRATE button to apply the squarewave voltage standard to the screen. Adjust the MULTIPLIER control near 1 so squarewave peaks are at 0 and 100. Amplitude may now be read directly from the scale where 4 inches vertically represents 0.1, 1, 10 or 100 volts, as determined by the VOLTS FULL SCALE selector. Simply depressing the CALIBRATE button returns the signal applied to the Y-input terminals to the screen.









MULTIPLIER CONTROL permits calibration of scales to other values. For example, to calibrate for 200 volts full scale, the multiplier control is adjusted near 2 so peaks of squarewave occupy space from zero to 50. Amplitude may now be measured directly in volts simply by multiplying the settings of the MULTIPLIER control (2) by the product of the scale reading times the VOLTS FULL SCALE setting (100). Use of the MULTIPLIER control extends the range of the Type 304-A to 1000 volts of full scale. Use of precision attenuator, having 1% resistors, permits the accurate calibrating standard to be inserted in back of the attenuator without effect from the attenuator setting.

SPECIFICATIONS:

CATHODE-RAY TUBE — New Flat-Face Type 5ADP-

ACCELERATING POTENTIAL — 3000 volts.

Y-AXIS: ***Deflection Factor*** — 0.1 p-p volt full scale (equivalent to 0.025 p-p volt per inch). Direct to deflection plates. 32-39 p-p volts per inch.
Frequency Response — (at all gain and attenuator control settings) Direct Coupling: Flat at 0 to down not more than 10% at 100,000 cps. Capacitive coupling, down not more than 10% from 10 to 100,000 cps. Down not more than 50% at 300,000 cps. Provision for balanced input on 0.1 volt full-scale range.
Undistorted Deflection — More than 4 inches. Expansion equivalent to 20 inches.
Input Impedance — to amplifier (single ended) 2 megohms, 50 μμf. (Balanced) 2 megohms, 35 μμf. Direct (balanced) 3 megohms, 20 μμf. (single ended) 1.5 megohms, 20 μμf.

X-AXIS: ***Deflection Factor*** — through amplifier, 0.3 p-p volt/in. Direct 40-50 p-p volt/in.
Frequency Response — (at all settings of gain and attenuator controls) Direct coupling: Flat at 0 to down not more than 10% at 100,000 cps.; down not more than 50% at 300,000 cps. Capacitive coupling, down not more than 10% from 10 to 100,000 cps. Down not more than 50% at 300,000 cps.
Undistorted Deflection — More than 4 inches. Expansion equivalent of 30 inches.
Input Impedance — To amplifier, 2.2 megohms, 50 μμf. Direct (single ended 1.5 megohms, 20 μμf. Balanced, 3 megohms, 20 μμf.

LINEAR SWEEPS: ***Sweep Frequency*** — Recurrent and driven sweeps continuously variable in frequency from 2 to 30,000 cps. Maximum sweep writing rate, 1"/μsec. Provision for sweeps of extra-long duration, ½ sec. of sweep secured for each μf of external capacitance.
Synchronization — from signal of either polarity.
Sync Limiting — on both driven and recurrent sweeps.

VOLTAGE MEASUREMENT — Squarewave standard applied for calibration by front panel push button.
Voltage Range: VOLTS FULL SCALE, 0 to 0.1, 1, 10, 100 volts, Multiplier: x1 to x10. Overall accuracy, 5%.

INTENSITY MODULATION — 15 volts blanks beam at normal intensity settings.

CALIBRATED SCALE — Variable illumination. Numbered calibrations for Direct Amplitude measurement.

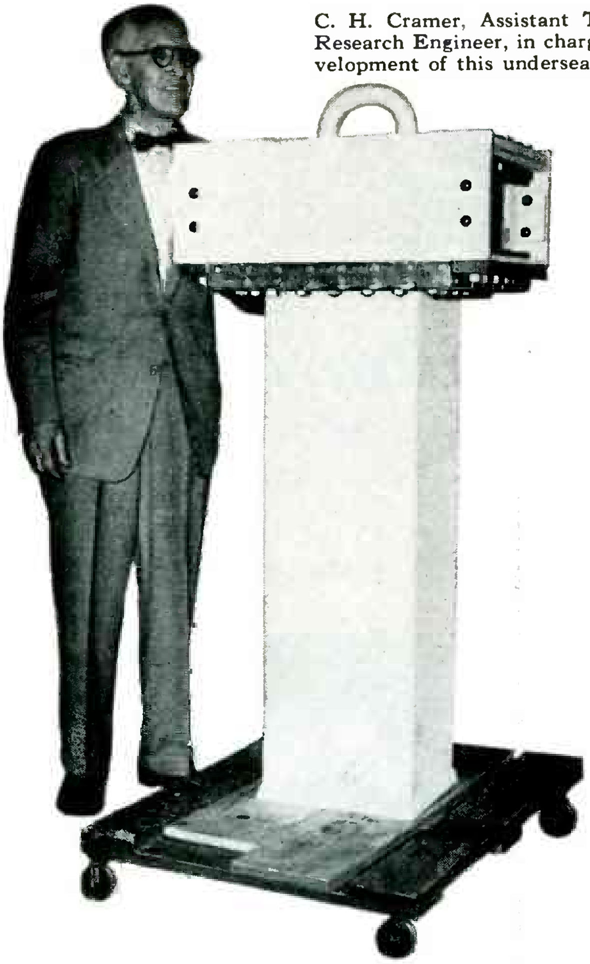
PRIMARY POWER — 115 or 230 volts, 50-400 cps. 110 w.

PHYSICAL CHARACTERISTICS — Metal cabinet with grey wrinkle finish. Dimensions: height 13½", width 8¾", depth 19½". Weight 50 lbs.

DU MONT *for Oscillography*

Write for technical bulletin A-04-A for complete details.

INSTRUMENT DIVISION ALLEN B. Du MONT LABORATORIES, INC., 1500 MAIN AVE., CLIFTON, N. J.



C. H. Cramer, Assistant Transmission Research Engineer, in charge of the development of this undersea amplifier.

Working under Pressure

HOW MONEL HELPS BEAT CORROSION AND STRESS 200 FATHOMS DOWN

The demand for increased cable capacity in Western Union's Transatlantic Cable System called for an amplifier to step up operating speed of the older cables.

And the amplifier had to operate on the ocean floor, 200 to 300 fathoms down.

A tall order for Western Union engineers? Here's how they filled the bill . . . with the help of Monel®.

* * *

First, a three-stage vacuum tube amplifier (using Nickel and Nickel Alloy components) was designed to boost and reshape the signal, thus facilitating increased message capacity.

Then, a case was designed to protect this delicate apparatus against the tremendous pressures and corrosive action of the sea waters. For important parts of this, they turned to Monel.

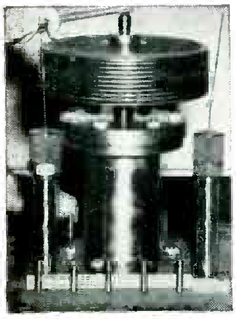
Monel was selected for the insulating glands where the cable enters and leaves the amplifier because it has the strength to withstand the stress of tremendous undersea pressures. And Monel provided the corrosion resistance so necessary for a submarine application.

For the pressure-equalizing bellows, and for nuts and bolts at many critical fastening points, tough, fatigue resistant Monel is also used.

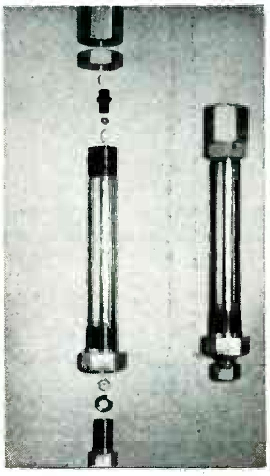
This first installation on the cable from Bay Roberts, Newfoundland, to Penzance, England, has proved a success. Western Union is now installing similar units on other transatlantic cables. Installations on eight more are planned.

Are you looking for a metal that offers exceptional advantages . . . corrosion resistance, strength, good temperature characteristics, etc.? Then you may find that metal among the Inco Nickel Alloys.

Although these metals are now restricted or on extended delivery, for help in selecting the right metal to meet your extreme conditions or exacting requirements when they are again freely available, write to Mr. B. B. Winter.



Pressure equalizer. The bellows, the tubular cable entrance glands at left and right, as well as nuts and bolts, are Monel.



Components of cable entrance glands made entirely of Monel.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

Nickel INCO Alloys

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL
"S"® MONEL • NICKEL • LOW CARBON NICKEL • DURANICKEL®
INCONEL® • INCONEL "X"® • INCOLOY • NIMONICS

Men who design, engineer and buy America's products rely on..and use..National Laminated Plastics because..

"National's quality control program starts with engineering research on the raw materials used and the development of material specifications. The next step is the preparation of process specifications for the various manufacturing operations. The final step is the testing of all products against specifications. We develop such specifications for all of our new products. For standard grades, we actively co-operate with A.S.T.M., N.E.M.A., and Government agencies in establishing standard values for essential properties. Rigid adherence to this program of quality control makes National products dependable—uniform."

Gerald H. Mains
Director of Research, Phenolite Div.
National Vulcanized Fibre Co.

George Holton, in charge of electrical testing laboratory, measuring dissipation or power factor at 1000 cycles of silicone Fiberglas sheet, Grade G-7-834, in a study of electrical characteristics of this new grade. The silicone Fiberglas material has heat resistance up to 250°C. and the lowest dissipation factor of any thermosetting laminate yet available.

National Laminated Plastics nationally known—nationally accepted

NATIONAL VULCANIZED FIBRE

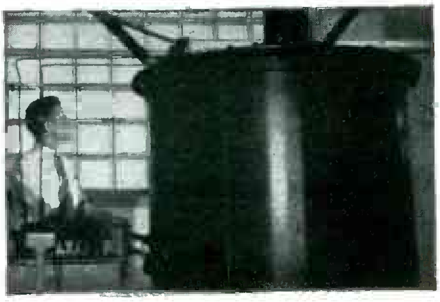
A tough horn-like material with high dielectric and mechanical strength. Excellent machinability and forming qualities, great resistance to wear and abrasion, long life, lightweight. Sheets, Rods, Tubes, Special Shapes.

PHENOLITE Laminated PLASTIC

Phenolite possesses an unusual combination of properties—a good electrical insulator, great mechanical strength, high resistance to moisture; ready machinability, lightweight. Sheets, Rods, Tubes, Special Shapes.

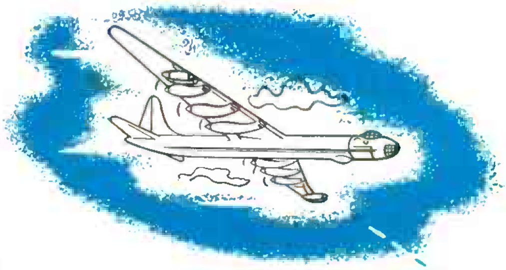
National Vulcanized Fibre Company

Wilmington Delaware
Offices in Principal Cities
Since 1873



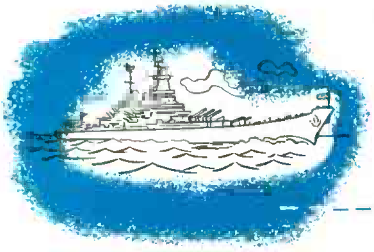
C. A. Mellinger, electrical engineer, testing dielectric breakdown of phenolic laminated sheet to meet requirements of N.E.M.A. standards for high dielectric strength. Test is made after sheet has been soaked in hot water (50°C) for 48 hours. This transformer makes possible tests up to 100 kilovolts.

Francis Corcoran tests the flexural strength of a piece of ⅛th inch thick Phenolite, Grade XXX-401, against the requirements of MIL-P Specification 3115B, type PBE. He uses a testing machine which employs hydraulic pressure to determine the number of pounds per square inch required to break the specimen supported as a beam.



MILITARY

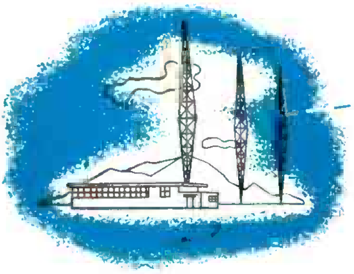
dehydrators



FOR AIR, LAND AND

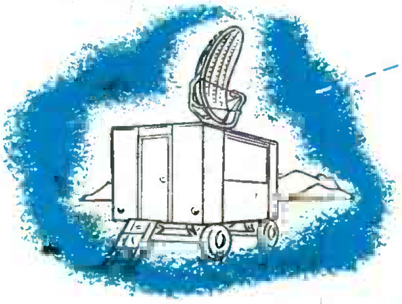
TYPICAL APPLICATIONS IN WHICH CP DEHYDRATORS PROVIDE YEAR 'ROUND TROUBLE-FREE AUTOMATIC SERVICE:

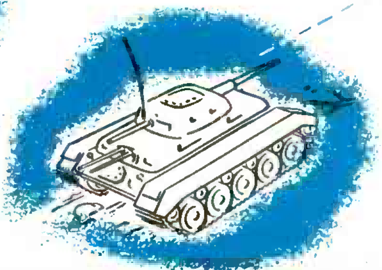
- Purging and pressurizing transmission lines, waveguides and associated apparatus.
- Pressurizing large cavities and other radio and radar equipment enclosures.
- Fog prevention in precision optical systems.
- Corrosion prevention in precise servo amplifier assemblies.
- For raising and maintaining the power handling capacity of high voltage systems and apparatus and innumerable other similar applications.

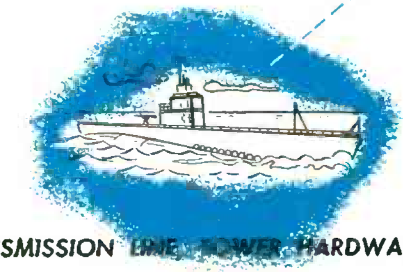


CP DEHYDRATORS OFFER THE FOLLOWING UNIQUE FEATURES:

Low dewpoint • operating pressure up to 100 lbs. per square inch fully automatic operation • continuous duty performance • low noise level • minimum vibration • long service life with minimum maintenance







MANUFACTURERS OF COAXIAL TRANSMISSION LINE, TOWER HARDWARE,

SEABORNE SERVICE

...Custom Designed for every Government and Military Application

CP dehydrators are readily adaptable to the critical requirements of the Armed Forces. Standardized parts permit rapid assembly of equipments suitable for practically any specialized need at minimum cost and without prolonged delay. Over a decade of CP experience in dehydrator design and manufacture insures products of long life and dependable service with an absolute minimum of maintenance. Inquiries are invited.

COMMUNICATION PRODUCTS COMPANY • Inc

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MARLBORO, NEW JERSEY
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DIPOLE ANTENNAS, SWITCHES, Q-MAX LACQUER AND CEMENT

IF YOU MAKE OR USE

ELECTRICAL EQUIPMENT

IT WILL PAY YOU TO SPECIFY

FIBERGLAS* *insulating materials*

High tensile strength, plus small diameter, in yarns used in electrical insulation permits the reduction of weight and bulk of electrical equipment.

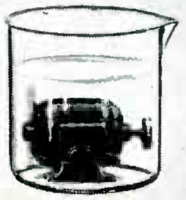
That's why more and more wire and cable and electrical apparatus manufacturers are turning to insulating materials made with Fiberglas yarns.

Fiberglas yarns are glass in fibrous form. Even the smallest diameter Fiberglas yarn surpasses all other high temperature textile yarns in break strength. Fiberglas-braided wires and cables are thinner, lighter, easier to install. Fiberglas tapes, varnished cloths, sleeving and tubing, cords and laminates also save space . . . permit the design of less bulky wire, cable and apparatus. And, despite lack of bulk, Fiberglas-based insulating materials permit uprating of equipment and service under higher operating temperatures.

So, if you make or use electrical equipment, remember to specify FIBERGLAS.

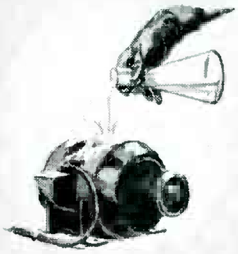
Owens-Corning Fiberglas Corporation, Electrical Sales Division, Dept. 860, 16 East 56th Street, New York 22, New York.

FIBERGLAS YARNS ALSO GIVE YOU THESE COST-SAVING ADVANTAGES



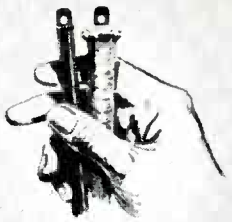
MOISTURE RESISTANCE

Wire, cable, and apparatus resist moisture better, if they're made with Fiberglas materials.



OIL AND ACID RESISTANCE

Fiberglas insulating materials resist the ravages of oils and acids.



EXCELLENT SPACE FACTOR

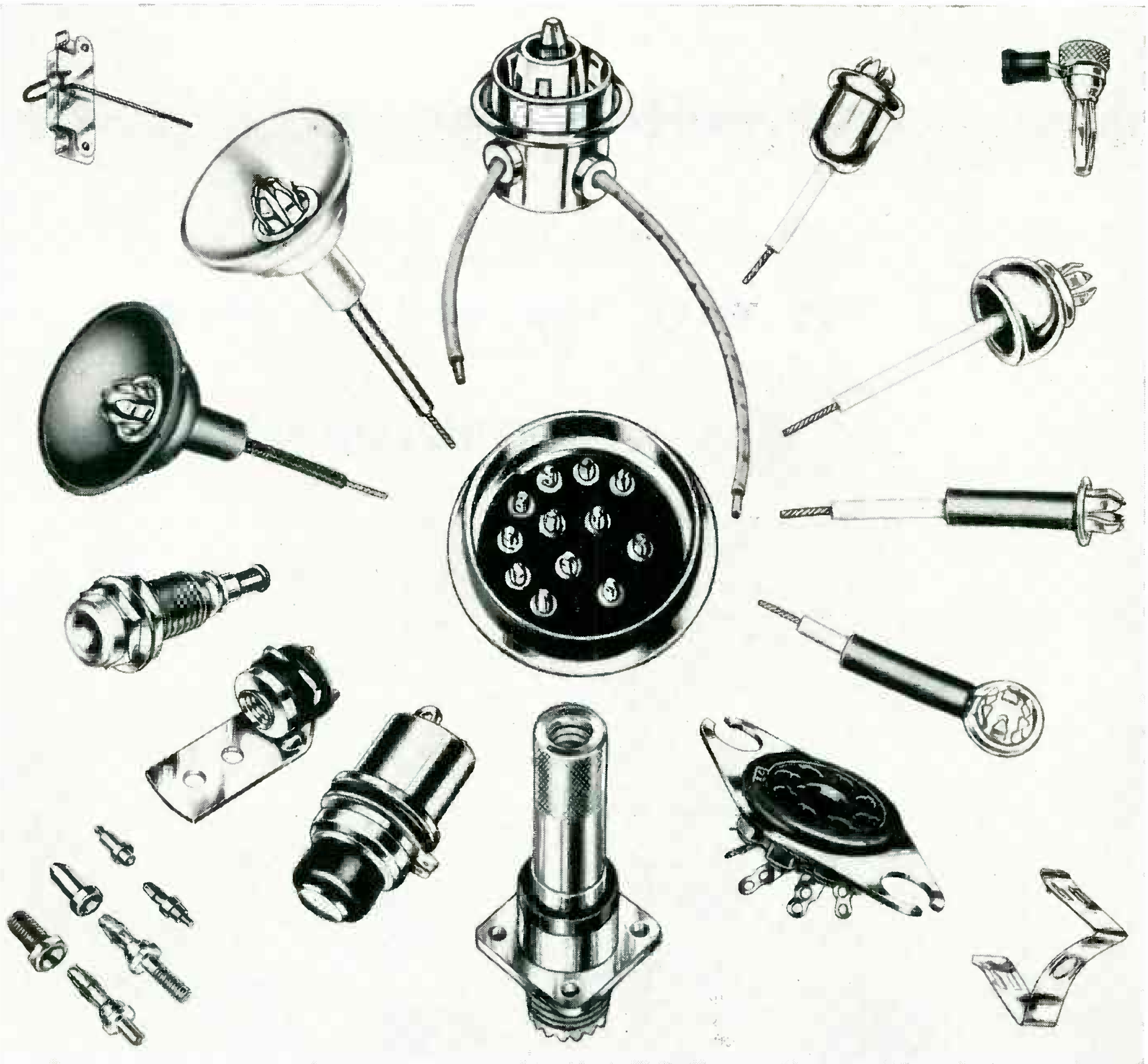
Tough, small-diameter Fiberglas yarns permit design of smaller, lighter high temperature electrical equipment.

HEAT RESISTANCE

Fiberglas insulating materials resist break-down under heat.

GOOD GUIDE TO A GOOD BUY!

*Fiberglas is the trade-mark (Reg. U. S. Pat. Off.) of Owens-Corning Fiberglas Corporation.



Special Electrical Components

. . . switches, connectors, tube caps, shock mounts, miscellaneous stampings and moldings . . . designed and manufactured by Ucinite for manufacturers of electronic equipment of all kinds . . . for use in defense and civilian installations.

With an experienced staff of design engineers . . . plus complete facilities for volume production of metal parts and the assembly of metal to plastic and ceramic parts, we are capable of supplying practically any need for special electrical components in this general classification. Call your nearest Ucinite or United-Carr representative for full information, or write direct.

ELECTRICAL ASSEMBLIES
Ucinite
RADIO AND AUTOMOTIVE

The
UCINITE CO.
Newtonville 60, Mass.
Division of United-Carr Fastener Corp.

Specialists in
ELECTRICAL ASSEMBLIES,
RADIO AND AUTOMOTIVE

50,000 FEET UP!

NEW CBS-HYTRON 5Y3WGTA gives you at 50,000 feet*...

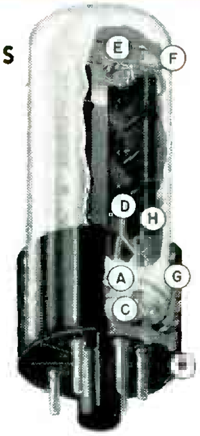
1. Full sea-level ratings
2. JAN-1A ruggedization
3. Single-ended convenience

*Adjusted rating chart available for higher altitudes.

CONSTRUCTIONAL HIGHLIGHTS 5Y3WGTA

For high altitudes: A. Cavity stem (patent pending). B. Barrier base. C. Optimized lead spacing. All three offer maximum isolation and insulation of high-voltage leads for stratosphere operation.

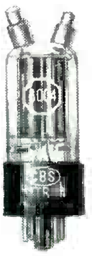
For ruggedization: D. Four-point mount support. E. "Mouse-trap" filament tensioner springs. F. Resilient superstructure cross springs. G. Low-pass mechanical filter between base and mount structure to absorb high-frequency components of shock. H. Cataphoretic-coated filament.



Is your aircraft equipment climbing up . . . up . . . up? Need an all-purpose rectifier — preferably ruggedized — to meet the challenge? High-altitude 5Y3WGTA . . . also the original ruggedized filamentary-type tube . . . is your answer.

At 50,000 feet* CBS-Hytron 5Y3WGTA offers you: Same maximum current and voltage ratings (with safe bulb temperatures) as the standard 5Y3GT at sea level. Plus JAN-1A ruggedization to withstand destructive shock, vibration, acceleration, and impact. And single-ended construction . . . convenient for both new and older equipment. (The 5Y3WGTA is interchangeable with the 5Y3GT or 5Y3WGT.) Check the 5Y3WGTA's ratings . . . its rock-solid construction.

90,000 FEET UP! New CBS-HYTRON 6004



Climbing higher still? Plate connections to top caps of 6004 push ceiling far into stratosphere. CBS-Hytron 6004 operates at 90,000 feet — higher at adjusted ratings — free from arc-over and at safe bulb temperatures. See comparative data for ratings.

COMPARATIVE DATA

Max. Ratings	5Y3WGTA	6004
Operating altitude	50,000 ft.*	90,000 ft.*
Peak inverse plate voltage	1,400 v†	1,000 v††
Peak plate current per plate	400 ma.	400 ma.
Bulb temperature	185° C	185° C
JAN-1A ruggedized	Yes	No
Basing	Single-ended	Double-ended

*Adjusted rating chart available for higher altitudes.† At 50,000 feet.†† At 90,000 feet

CBS HYTRON RADIO TUBES

MAIL TODAY FOR COMPLETE DATA ▶

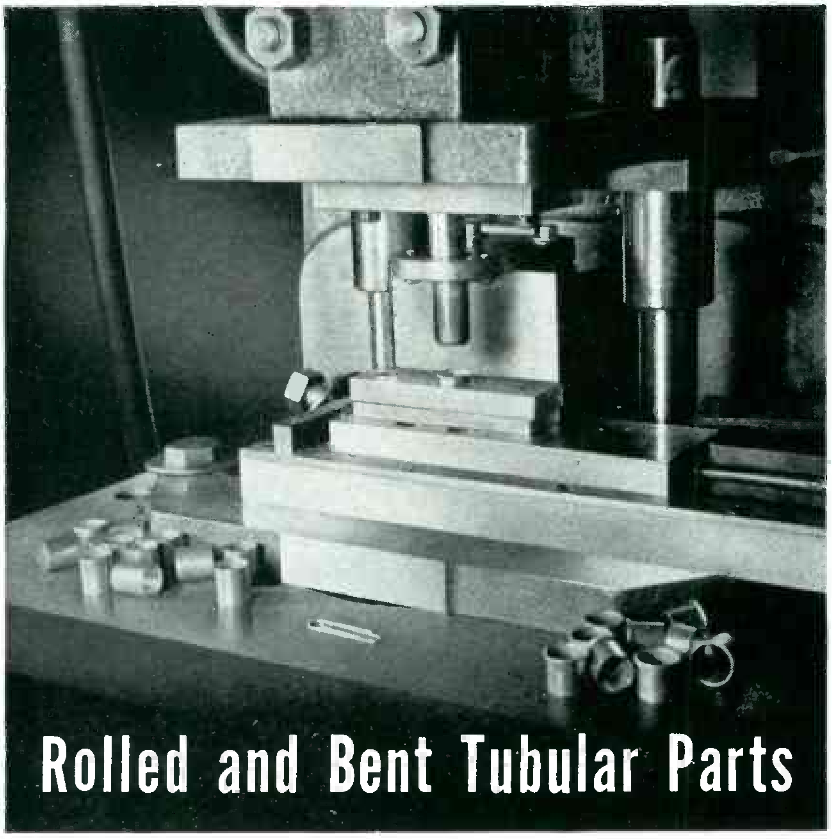
MANUFACTURERS OF RECEIVING TUBES SINCE 1921
HYTRON
RADIO AND ELECTRONICS CO.
A DIVISION OF COLUMBIA BROADCASTING SYSTEM, INC.

SALEM, MASSACHUSETTS

HYTRON RADIO & ELECTRONICS CO.
Salem, Massachusetts

Please send me full data (including adjusted rating chart for higher altitudes) on CBS-Hytron high-altitude rectifiers: 5Y3WGTA and 6004.

YOUR NAME..
(please print)
COMPANY..
STREET ADDRESS..
CITY AND STATE.. E



Rolled and Bent Tubular Parts

—a Superior Specialty

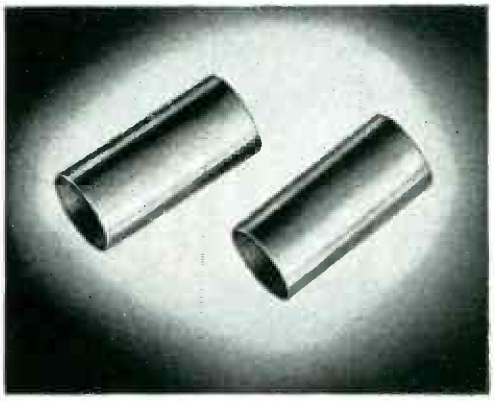
Men, experience, and machines-that-do-everything-but-talk, are generally the answer to a problem of obtaining parts of complex shape and precise dimension.

Here at Superior, customers for parts of this kind get a particularly good answer. We have the experienced men with a solid background of tubular parts production who are willing and able to take the time and care required for top-quality products. And we have the machines.

The delivery end of one of them is shown above. The part coming out came into our plant as a 2" tube, went through several redraw and annealing operations, was finally cut to exact length, tumbled to remove cutting burrs, then rolled by a controlled process to the precise dimensions established by customer specifications.

There's nothing spectacular in the story . . . it's just the outline of one of the many jobs that we know how to do well. Behind the story, however, is a thought for you.

Our production story is backed by our ability, facility and desire to help you. If you are an experimenter in electronics or a manufacturer of electronic equipment and you need a tubular part to do a tough job well, better check with us. We'll be glad to assist with research, development, and design aid toward the solution of your problems. Tell us about them by writing Superior Tube Company, 2500 Germantown Ave., Norristown, Pennsylvania.



Cutting and Tumbling. Cutting machines and jigs of many types and sizes are combined with extensive tumbling equipment to permit fast, accurate production of quantities of parts at Superior.

Fabrication. Parts can be readily rolled at either or both ends, flared, flanged, expanded, or beaded (embossed) as required. The anode above is one of many such parts we produce at high speed and low cost.

The Finished Part. Final stage in the fabrication of the part, shown above at three stages of production, is a bend nicely controlled for both precise angle and freedom from other, unwanted distortion.

This Belongs in Your Reference File
. . . Send for It Today.

NICKEL ALLOYS FOR OXIDE-COATED CATHODES: This reprint describes the manufacturing of the cathode sleeve—from the refining of the base metal; includes the action of the small percentage impurities upon the vapor pressure and sublimation rate of the nickel base. Future trends of cathode materials are also evaluated.

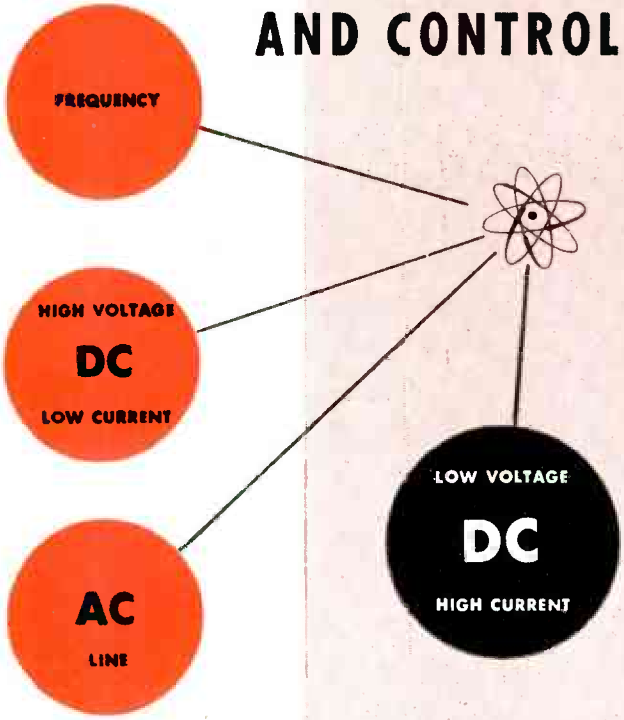
Superior
THE BIG NAME IN SMALL TUBING

All analyses .010" to ⅝" O.D.
Certain analyses (.035" max. wall) Up to 1⅛" O.D.

***SUPERIOR TUBE COMPANY** • Electronic products for export through Driver-Harris Company, Harrison, New Jersey • Harrison 6-4800*

SORENSEN

REGULATES AND CONTROLS *electronically*



Nobatron Model E-6-5

The NOBATRON* maintains stabilized DC voltage under changing line and/or load conditions.

A complete line of catalog models are available, with output voltages of 6, 12, 28, 125, and 200 VDC, from 5 to 350 amperes.

Sorensen Nobatrons eliminate battery and generator troubles. They combine high regulation accuracy with maximum dependability and minimum maintenance.

All models are attractively finished. Most can be furnished either for relay rack mounting or in cabinets for bench-top use. Most units are metered; all are adequately protected against overload by suitable fuses and breakers.

COMMON NOBATRON SPECIFICATIONS

Input voltage range	95-130 VAC, single φ, 50-60 ~ High-current units 208/115, 3φ, 4-wire, wye.
Output voltage range	Adjustable ± 10% with rated accuracy, — 25% with lesser accuracy.
Regulation accuracy	± 0.2% from 1/10 to full load.
Ripple voltage	1% RMS. Time constant 0.2 seconds.

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

WIDER OUTPUT VOLTAGE RANGE MODELS

Nobatron-RANGERS* are designed to meet the demand for power supplies similar to the Nobatron but with wider output voltage ranges.

Nobatron-RANGERS are continuously adjustable over extended output ranges, yet provide regulation accuracies of ±0.25% against line and/or load. Other specifications are identical to those of the standard Nobatrons.

Three models are available, the SR-30, SR100, SR-2. Capacities, respectively, are 3 - 30 VDC at 3 - 30 amperes, 3 - 135 VDC at 1 - 10 amperes, and 100 - 300 VDC at 1 - 10 amperes.

Investigate NOW the cost of a NOBATRON installation versus the overall cost of less satisfactory DC sources.

OTHER SORENSEN ISOTRONIC PRODUCTS INCLUDE:

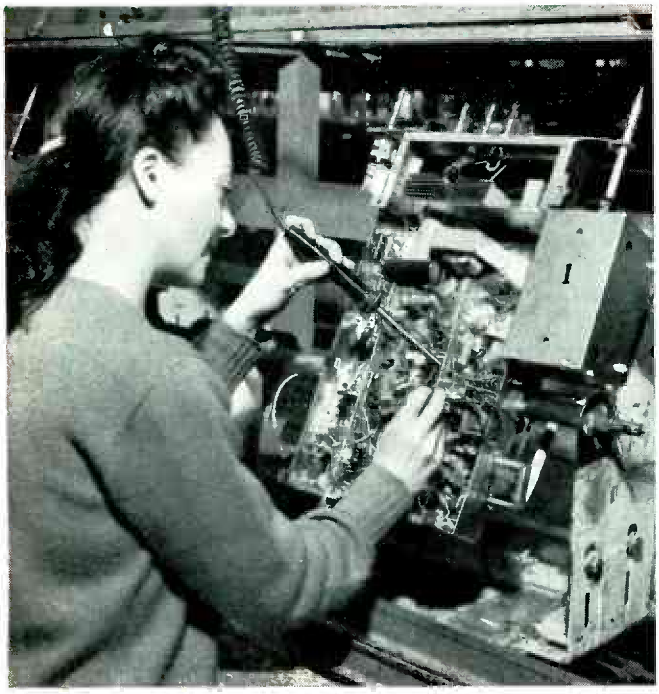
B-NOBATRONS (high-voltage, low-current DC Supplies)
FREQUENCY CHANGERS
VARIABLE AUTO TRANSFORMERS
SATURABLE CORE REACTORS
AC LINE REGULATORS

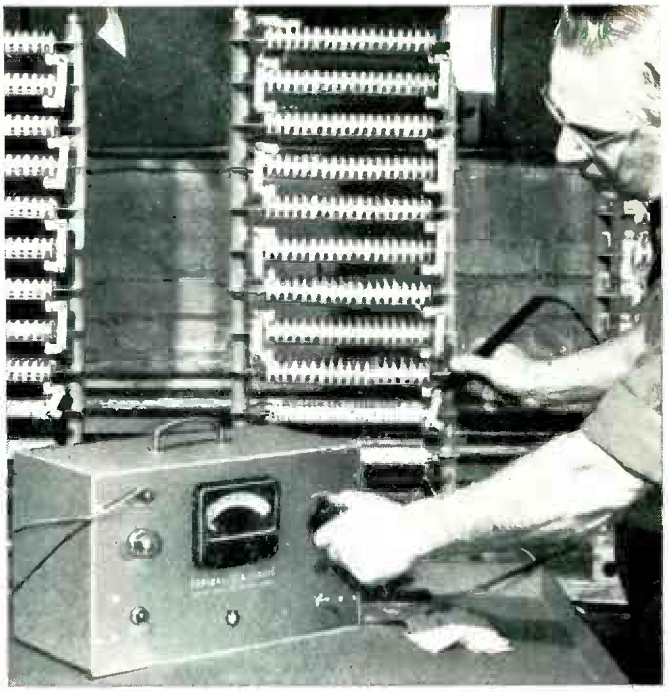
SPECIFY SORENSEN

For Complete Information Write

SORENSEN & COMPANY, INC.
375 Fairfield Avenue
Stamford 1, Conn.

DESIGNER'S


1. New, fast-heating G-E iron weighs only 8½-oz.


2. New G-E portable hi-pot tester is easy to operate.

Two ways to speed your production

Reach hard-to-solder places with this new thin-shank iron

"As easy to use as a pencil," say operators who use General Electric's new lightweight soldering iron.

Its thin, $\frac{5}{16}$-inch-diameter shank lets the ¼-inch tip into places a regular iron can't touch. Operators can solder more joints per minute—and with fewer rejects—because the iron's lightness, balanced design and comfortable handle all reduce fatigue.

Long-lasting G-E Calrod* heater provides quick heat-recovery properties, gives plenty of heat for uniformly strong soldered joints. Maintenance of this 60-watt, 120-volt iron is low because the long-life Ironclad tip need not be filed or dressed. Send for Bulletin GED-1583.

*Reg. Trade-mark

Eliminate cages and barriers with this new insulation tester

Now you can perform high-potential tests on your equipment with minimum danger to personnel. That's because the current output of General Electric's new high-potential insulation tester is limited to 5 milliamperes—well below the "let go" value.

Testing time is cut, too—no need to set up cages, barriers, or tape. Tester is portable, weighs only 22 lbs. Simply plug it into any 115-volt a-c outlet and start testing.

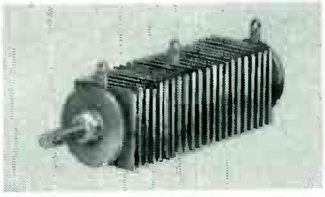
Line surges are virtually eliminated in output. Flash-overs can't burn insulation. Neon light on panel gives warning *before* insulation breaks down. Output is adjustable from 0 to 3500 volts, with test capacitance up to .006 muf. Bulletin GEC-700.

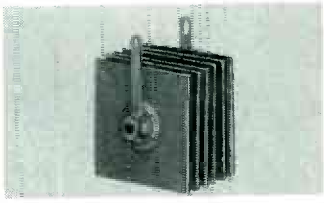
GENERAL ELECTRIC

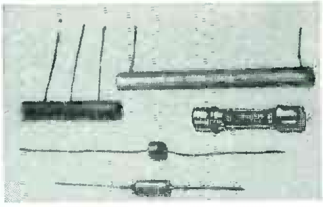
DIGEST

TIMELY HIGHLIGHTS ON G-E COMPONENTS

Four ways G-E selenium rectifiers meet your d-c power requirements


Standard stack construction


Tube-mounted construction


Miniature cell assemblies

Selenium rectifiers provide the electrical designer with versatile and flexible means of getting the right quantity of d-c power. But not all selenium rectifiers are alike. Here are four important "quality points" you'll find in G-E units in comparison with competitive equipment:

1. Lower forward resistance—for higher output and cooler operation—plus lower costs in other circuit components.
2. Less back leakage—for higher efficiency as well as higher output.
3. Cooler operation—the result of the above characteristics—since there is less heat to dissipate, less ventilation is needed.
4. Slower aging—which extends expected life at rated output to over 60,000 hours.

And of course the G-E line is complete, to meet all your design needs.

For a complete refresher on rectifier fundamentals, circuits, and applications, send for the new 28-page G-E booklet prepared to aid the design engineer. Check Bulletin GET-2350.

Dual-rated capacitors simplify design problems

Meet your design needs, standardize, and cut inventories with these G-E fixed paper-dielectric capacitors. Equally applicable to a-c and d-c, they come in many case styles, with ratings from 236 through 660 volts a-c and 400 through 1500 volts d-c. All units are treated with Pyranol* and hermetically sealed to prevent leakage or contamination. Check Bulletin GEC-809.

Current-sensitive relays stand severe vibrations

G-E current sensitive d-c relays are available with d-c pickup ratings in steps from 4 to 1500 ma. They are especially applicable to circuits using limited power for energizing coils—as in aircraft. Lightweight and corrosion-proof, these relays withstand severe vibration and operate at rated current through a wide range of altitudes. See Bulletin GEC-834.

EQUIPMENT FOR ELECTRONIC MANUFACTURERS

A partial list of the thousands of items in the complete G-E line. We'll tell you about them each month on these pages.

Components

Meters and Instruments
Capacitors
Transformers
Pulse-forming networks
Delay lines
Reactors
*Thyrite
Motor-generator sets
Inductrols
Resistors
Voltage Stabilizers
Fractional-hp motors
Rectifiers

Timers
Indicating lights
Control switches
Generators
Selsyns
Relays
Amplidynes
Amplistats
Terminal boards
Push buttons
Photovoltaic cells
Glass bushings
Dynamotors

Development and Production Equipment

Soldering irons
Resistance-welding control
Current-limited high-potential tester
Insulation testers
Vacuum-tube voltmeter
Photoelectric recorders
Demagnetizers

*Reg. trade-mark of General Electric Co.

General Electric Company, Section D 667-21
Schenectady 5, New York

Please send me the following bulletins:

Indicate: √ for reference only
X for planning an immediate project

☐ GEC-700 High-Potential Tester
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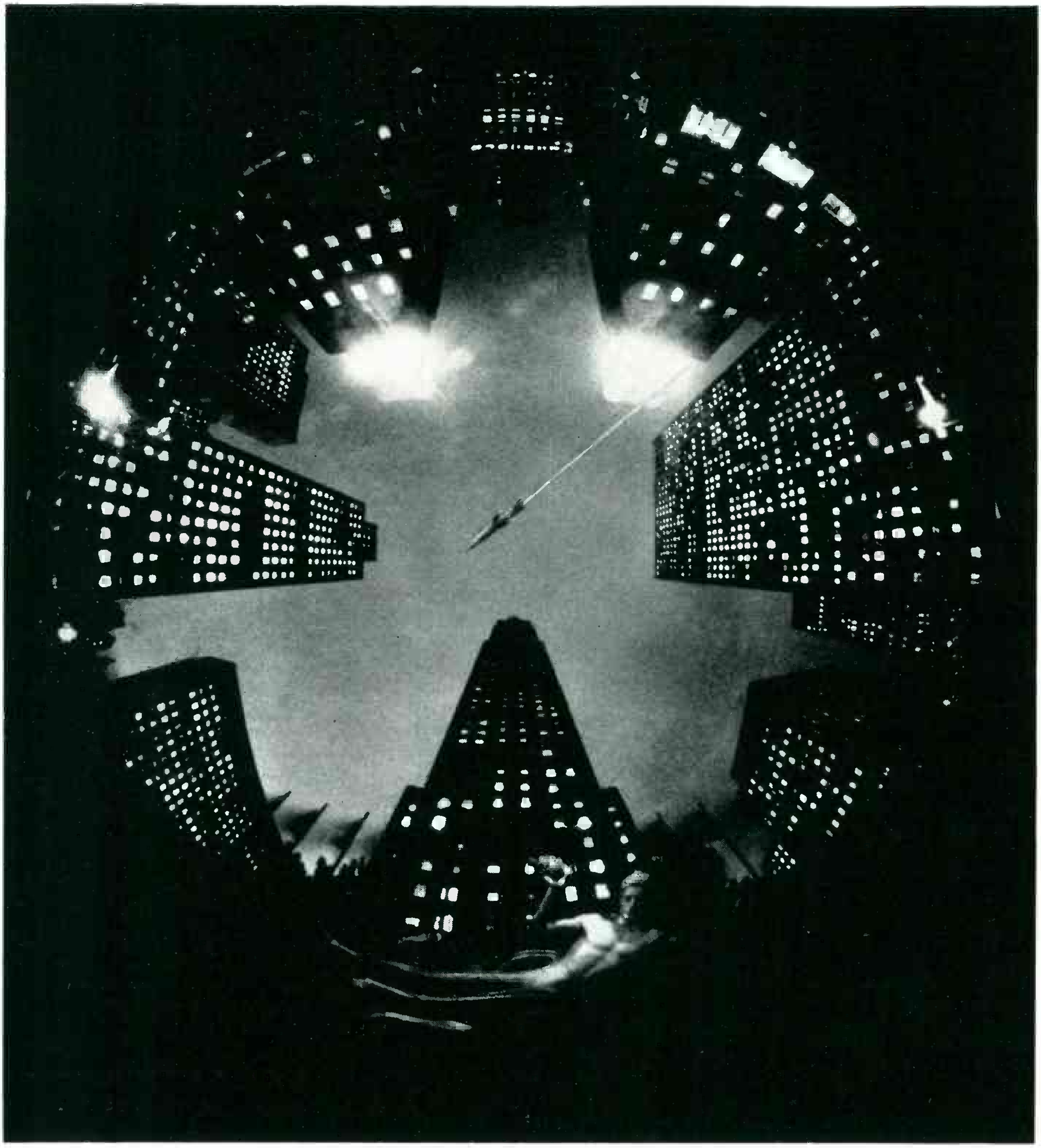

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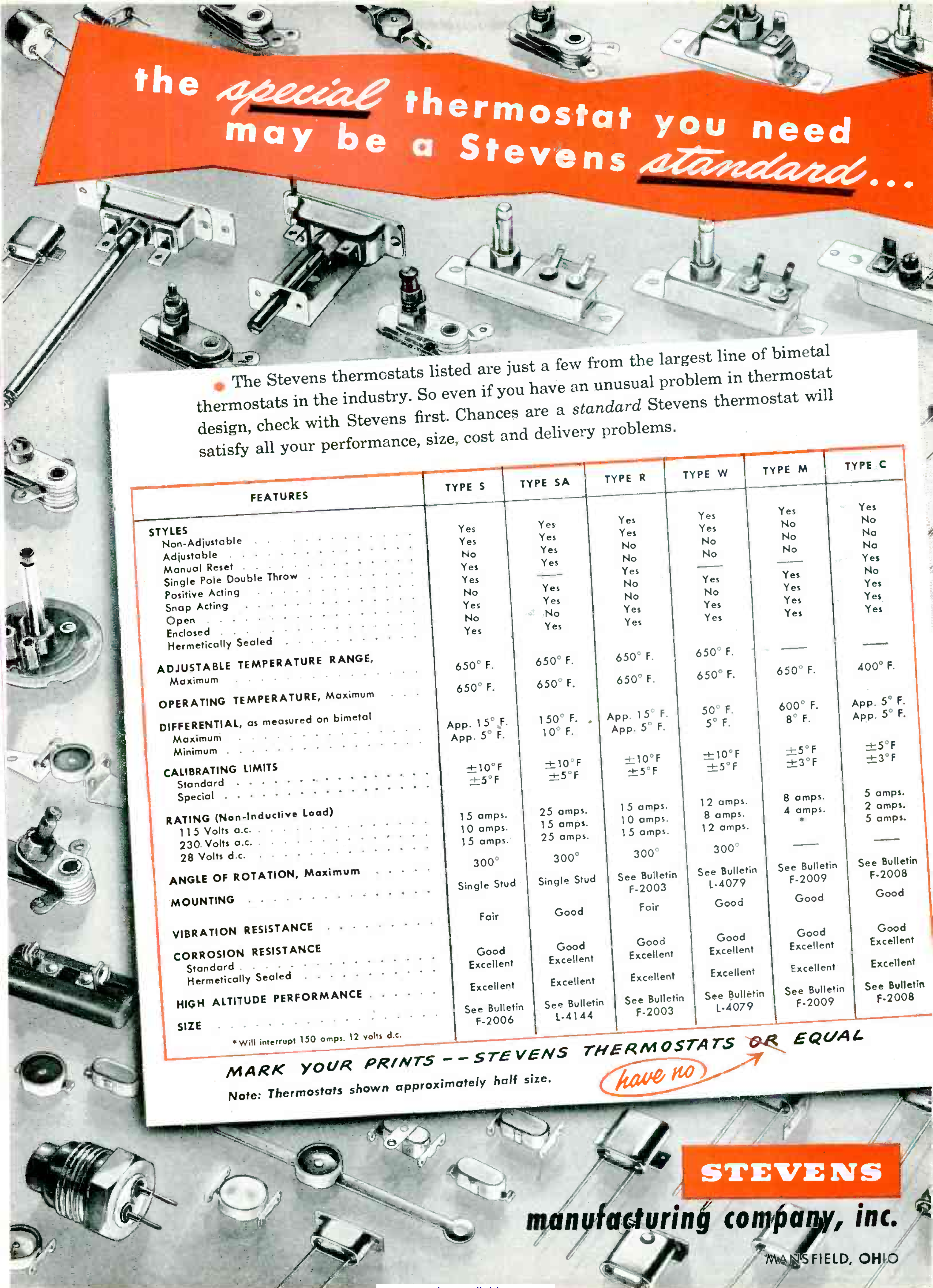

the *special* thermostat you need may be a Stevens *standard*...

The Stevens thermostats listed are just a few from the largest line of bimetal thermostats in the industry. So even if you have an unusual problem in thermostat design, check with Stevens first. Chances are a *standard* Stevens thermostat will satisfy all your performance, size, cost and delivery problems.

FEATURES	TYPE S	TYPE SA	TYPE R	TYPE W	TYPE M	TYPE C
STYLES						
Non-Adjustable	Yes	Yes	Yes	Yes	Yes	Yes
Adjustable	Yes	Yes	Yes	Yes	No	No
Manual Reset	No	Yes	No	No	No	Na
Single Pole Double Throw	Yes	Yes	No	No	No	Na
Positive Acting	Yes	—	Yes	—	—	Yes
Snap Acting	No	Yes	No	Yes	Yes	No
Open	Yes	Yes	No	No	Yes	Yes
Enclosed	No	No	Yes	Yes	Yes	Yes
Hermetically Sealed	Yes	Yes	Yes	Yes	Yes	Yes
ADJUSTABLE TEMPERATURE RANGE, Maximum	650° F.	650° F.	650° F.	650° F.	—	—
OPERATING TEMPERATURE, Maximum	650° F.	650° F.	650° F.	650° F.	650° F.	400° F.
DIFFERENTIAL, as measured on bimetal						
Maximum	App. 15° F.	150° F.	App. 15° F.	50° F.	600° F.	App. 5° F.
Minimum	App. 5° F.	10° F.	App. 5° F.	5° F.	8° F.	App. 5° F.
CALIBRATING LIMITS						
Standard	±10°F	±10°F	±10°F	±10°F	±5°F	±5°F
Special	±5°F	±5°F	±5°F	±5°F	±3°F	±3°F
RATING (Non-Inductive Load)						
115 Volts a.c.	15 amps.	25 amps.	15 amps.	12 amps.	8 amps.	5 amps.
230 Volts a.c.	10 amps.	15 amps.	10 amps.	8 amps.	4 amps.	2 amps.
28 Volts d.c.	15 amps.	25 amps.	15 amps.	12 amps.	*	5 amps.
ANGLE OF ROTATION, Maximum	300°	300°	300°	300°	—	—
MOUNTING	Single Stud	Single Stud	See Bulletin F-2003	See Bulletin L-4079	See Bulletin F-2009	See Bulletin F-2008
VIBRATION RESISTANCE	Fair	Good	Fair	Good	Good	Good
CORROSION RESISTANCE						
Standard	Good	Good	Good	Good	Good	Good
Hermetically Sealed	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
HIGH ALTITUDE PERFORMANCE	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
SIZE	See Bulletin F-2006	See Bulletin L-4144	See Bulletin F-2003	See Bulletin L-4079	See Bulletin F-2009	See Bulletin F-2008

*Will interrupt 150 amps. 12 volts d.c.

MARK YOUR PRINTS -- STEVENS THERMOSTATS ~~OR~~ EQUAL

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Note: Thermostats shown approximately half size.

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Magnivision provides brilliant cool illumination. Seeing is believing and the unique combination of Magnivision's distortion-free lens and the shadowless lighting assist operators on all inspection and assembly work.

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By calling Karp in *early*, your "packaging" problems can be ironed out as you solve your functional problems. And with its creative engineering staff, its vast assortment of available dies, its 77,000 square feet of facilities, Karp can show you how to cut costs and delivery time. We'll be glad to talk it over with you.

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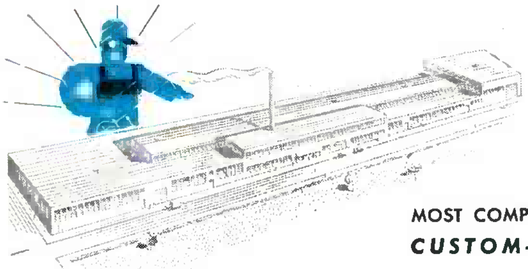

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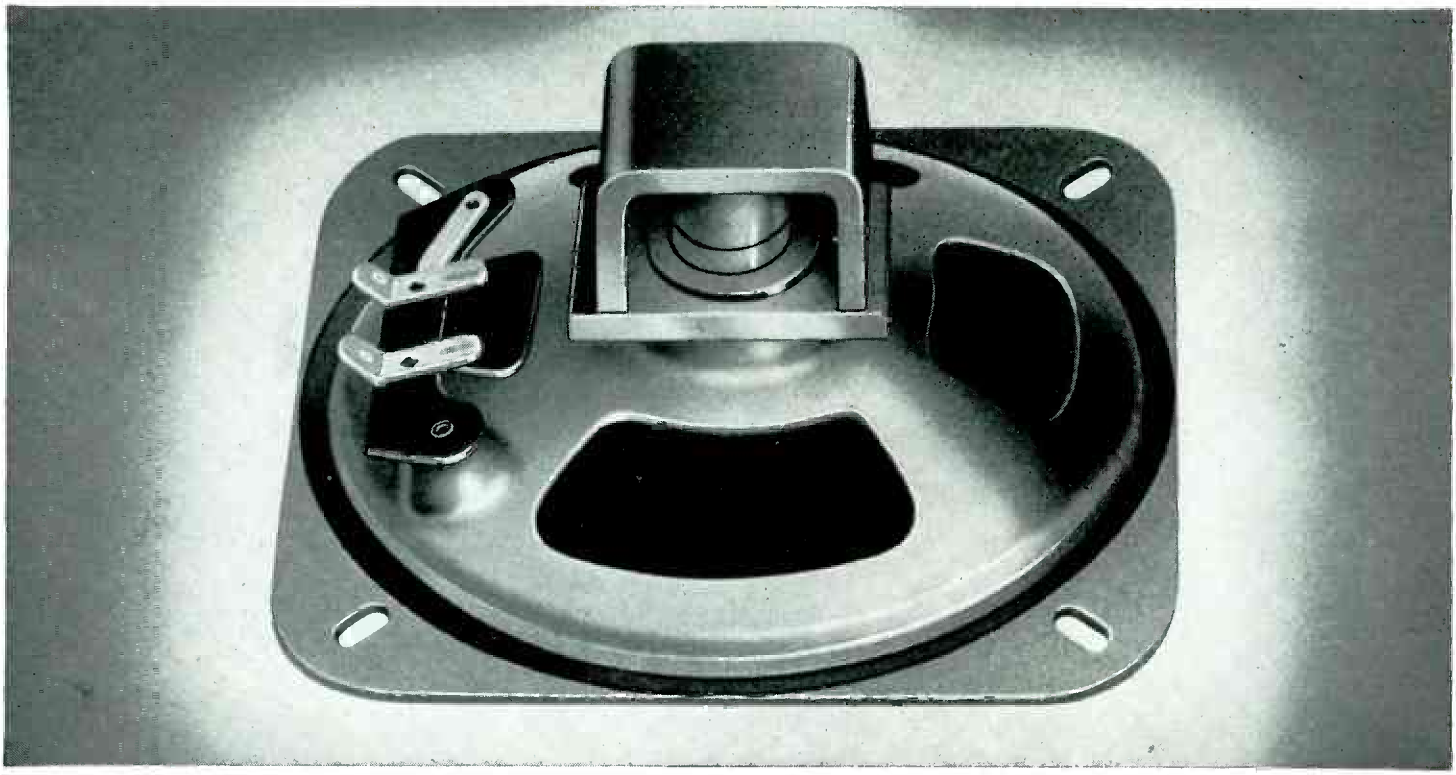

SPEAKERS—In radio and TV speakers, Carboloy Permanent Magnets replace larger electro magnets in the field structure. Current passing through *uniform* field of these high-energy magnets causes voice coil and cone to vibrate in proportion to voltage; *tone is truer!* Carboloy Permanent Magnets never fail; never need maintenance. Are also used in TV focusing assemblies.

How Carboloy permanent magnets improve electrical products

CONTROLS—Switches in compact Minneapolis-Honeywell controls use permanent magnets to give safer snap action, help quench arcs. The magnets are exceptionally stable; provide uniform high energy for the life of the control.

Want to cut down product size, weight? Build a better-performing product for less money?

Then check the possibility of using Carboloy Alnico permanent magnets wherever you need *lasting* magnetic energy.

Carboloy permanent magnets are simple, self-containing sources of energy that *never* fail. They are powerful in small sizes. Need no outside power supply, no maintenance. They help reduce fabrication costs by eliminating wires, coils and operating parts. Above all, they let you simplify design . . . build a lighter, more compact, finer-performing product at a saving.

On these pages you'll see how others got the jump on competitors by using permanent magnets. Perhaps you'll get an application idea from reading about them.

FREE SERVICES

If so, check Carboloy magnet engineers for free, expert advice and an assist in design and application. Look to Carboloy production lines, too, for the uniform, high-energy Alnico magnets you'll need for best results — all sizes, all shapes; cast or sintered to your specifications.

Send coupon for free Magnet Design Manual PM-101 and Standard Stock Catalog PM-100.

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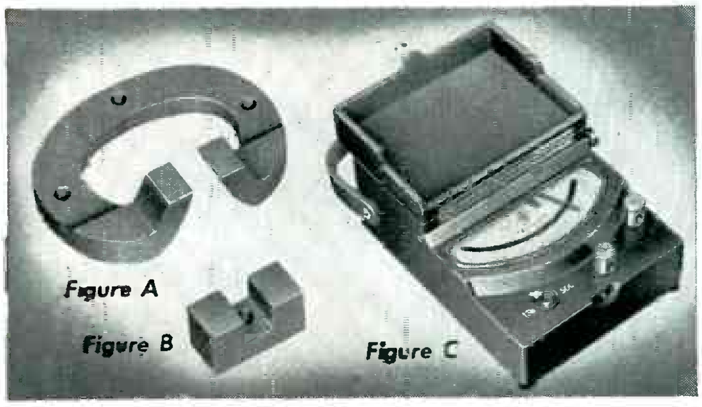
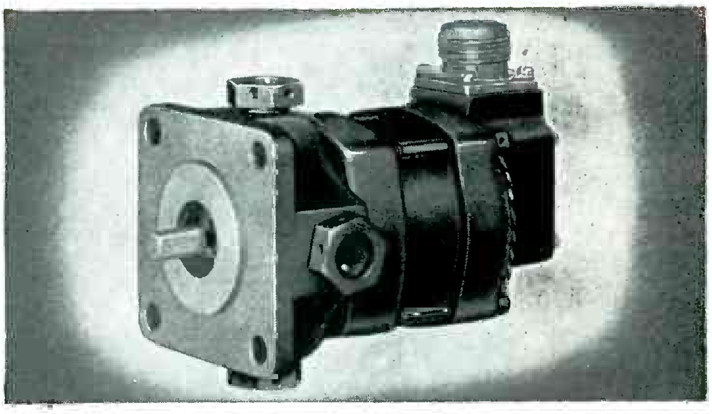
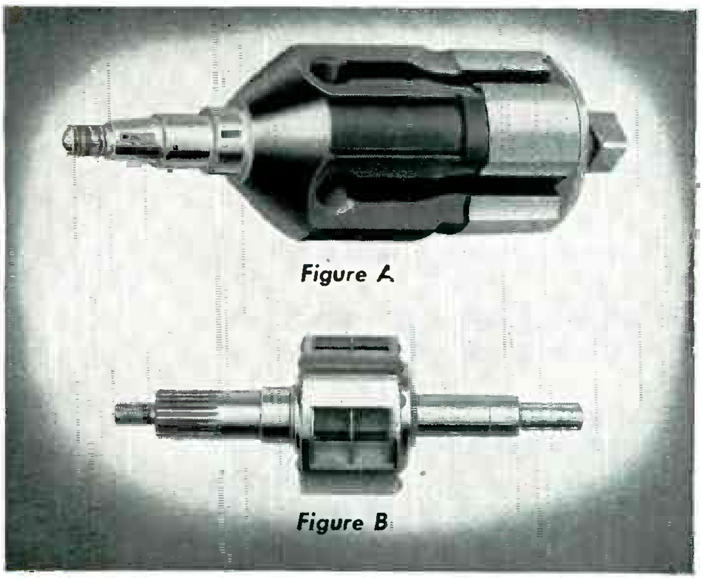
DEPARTMENT OF GENERAL ELECTRIC COMPANY
11139 East 8 Mile Blvd., Detroit 32, Michigan



INSTRUMENTS—Fig. A is damping magnet once used in GE indicators. Fig. B is tiny Carboloy magnet now used. It permits smaller indicator design (Fig. C), cuts materials and assembling costs . . . speeds up calibrations.



GENERATORS—When GE engineers had only 6" x 6" area for jet's tachometer generator, they whipped design problem with a tiny permanent magnet. It eliminated coils and wires, supplied the powerful energy required.



MAGNETOS—To Scintilla Magneto Division, Bendix Aviation Corp., weight savings are vital in their aircraft products. Fig. A shows chrome rotor weighing approximately 4 lbs. 9 ozs. Fig. B shows newer model rotor using Carboloy Alnico. It weighs only 2 lbs. 4 ozs.

ADVANTAGES OF CARBOLOY PERMANENT MAGNETS

1 Simple — no operating parts
2 Uniformly powerful
3 Permanent source of energy
4 No coils to wire
5 Cool-running
6 No operating costs
7 No power failures
8 Combine electrical and mechanical features
9 Simplify mechanical assemblies
10 Uninterrupted operation
11 Moisture-resistant
12 Create savings

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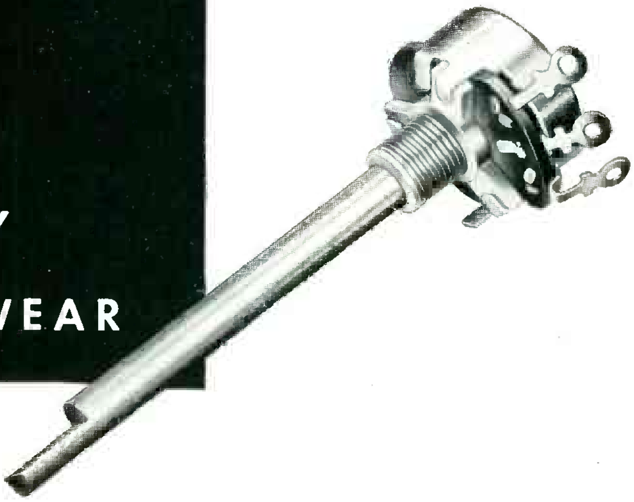

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Now . . . from Mallory . . . you can get a carbon control that takes the toughest service conditions in stride. It's the Q series Midgetrol® . . . a new version of this outstanding control, with added features that make it applicable to the most severe requirements:

NEGLIGIBLE HUMIDITY DRIFT: carbon is deposited under precise control on a base material which affords greatly improved stability under humid conditions.

IMPROVED INSULATION: selected for unusually high insulation resistance and extremely low moisture absorption . . . thoroughly fungus-proofed.

SALT SPRAY RESISTANCE: all metal parts pass 100-hour salt spray test.

LONGER ROTATIONAL LIFE: hard nickel silver contacts limit wear, assure long service.

For special service, these additional features can be supplied:

WATERPROOFING: gasket-sealed shaft bushing packed with silicone grease, and gasket-sealed panel mounting.

VIBRATION-PROOFING: lock-type split bushing prevents shaft rotation even under heavy vibration.

Q series Midgetrols are supplied in values from 5000 ohms to 10 megohms in all standard JAN tapers. Single or dual units are available, with or without attached switch.

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Look to Mallory for Q series wire wound controls made especially for Military service . . . now available with all the construction features listed for Q series Midgetrol carbon controls.

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CROSS TALK

►**SPACE** . . . Since 1932 there has been a steady increase in the number of observed solar and galactic sources of radio signals. The frequencies of these signals lie between 18 and 30,000 mc, high enough to penetrate the ionosphere yet low enough to avoid absorption by molecules of the atmosphere.

Until last year all radiations had the character of noise, occupying broad frequency bands. It was then observed that neutral hydrogen atoms, principal constituent of interstellar gas, radiate on the sharply fixed frequency of 1,420.4 mc. This makes it possible in radio astronomy to measure, by means of Doppler shift in frequency, the velocity with which gas masses approach or leave us. Similar observations are also possible for gas masses located behind dark nebulae, as the latter are opaque to light but transparent to radio waves.

Much can be learned about what goes on in outer space by applying the new technique. Thus it appears to us that international setting aside of the specific frequency referred to for such work is a distinct possibility.

►**PHOTISTORS?** . . . Transistors, like germanium diodes, can be made photosensitive. This is well known to people who make them but little use has so far been made of the intriguing phenomenon that could provide compact controls responsive to light variations.

Few stones are being left unturned these days in the field of transistor design. So it wouldn't surprise us if photosensitive transistors soon saw the light of day, perhaps by mid-1953. First uses might be semicommercial, telephone switching systems and the like.

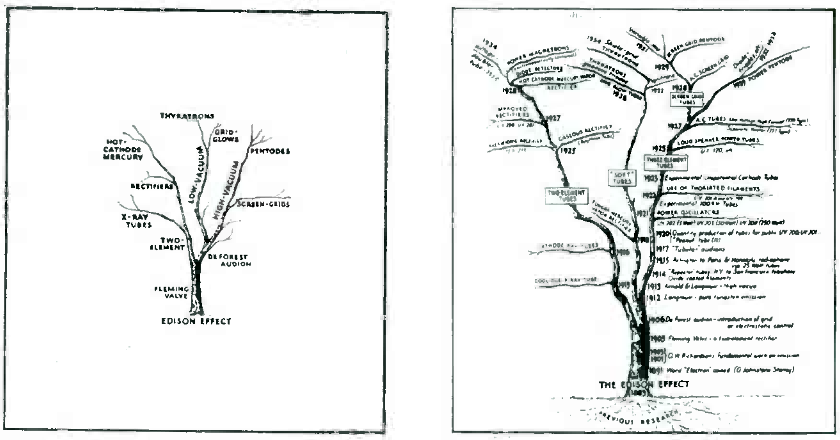
►**HELP** . . . Dear to our heart are companies that circulate among their engineers memos telling how to write good technical reports, Consolidated Vultee being the most recent example. Good internal reports frequently make good papers for outside publication without much modification, and this is an editorial staff's idea of Utopia.

Westinghouse has prepared a paper entitled "Opportunities for the Engineer Who Likes to Write" for publication by college magazines, and this one really gives us a leg up on a broad scale. Couldn't have done better ourselves if we had written a piece to stir up more good copy for ELECTRONICS.

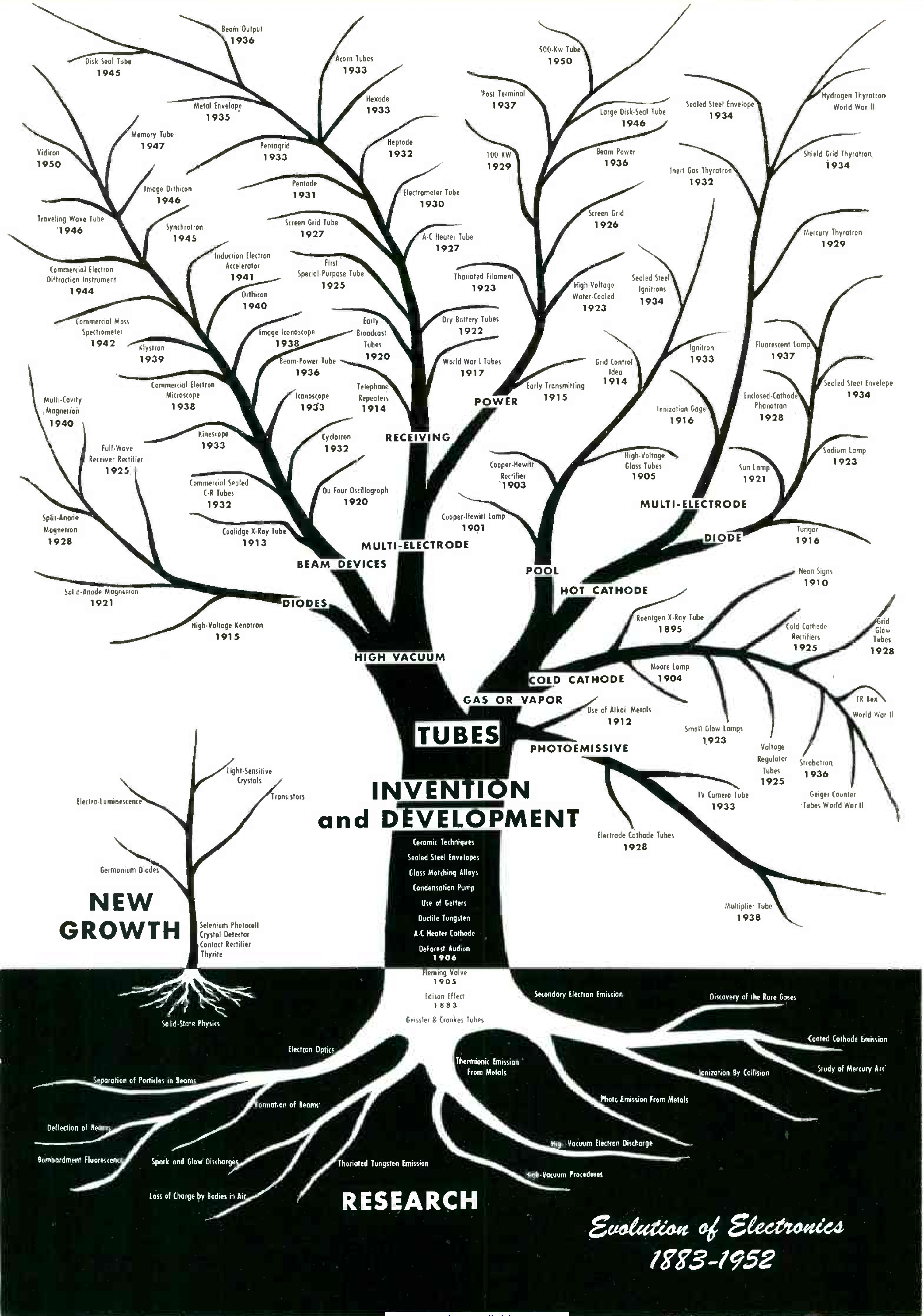
►**TREES** . . . Back in 1930 ELECTRONICS published a family tree tracing the genealogy of tubes. It was a relatively simple sapling (*below, left*) having just a few branches.

By 1934 well-watered roots had really taken hold, so we did the job again (*right*). The number of branches had more than doubled, and the tree had gained considerably in height.

Now, 18 years later, we've taken another look. The result is the tree occupying the entire following page within this issue (p 98). It has, once again, grown tremendously in stature, and there are some fourscore branches. In addition, a new and promising sapling stemming from studies of solid-state physics has taken root in the shade.



The family tree of electron tubes grows up—1930—1934—and ➡


Beam Output 1936
Disk Seal Tube 1945
Acorn Tubes 1933
Metal Envelope 1935
Hexode 1933
Memory Tube 1947
Pentagrid 1933
Heptode 1932
Vidicon 1950
Image Orthicon 1946
Pentode 1931
Electrometer Tube 1930
Traveling Wave Tube 1946
Synchrotron 1945
Screen Grid Tube 1927
A-C Heater Tube 1927
Induction Electron Accelerator 1941
First Special-Purpose Tube 1925
Commercial Electron Diffraction Instrument 1944
Orthicon 1940
Thoriated Filament 1923
Commercial Mass Spectrometer 1942
Image Iconoscope 1938
Early Broadcast Tubes 1920
Dry Battery Tubes 1922
Klystron 1939
Beam-Power Tube 1936
World War I Tubes 1917
Commercial Electron Microscope 1938
Telephone Repeaters 1914
Iconoscope 1933
Multi-Cavity Magnetron 1940
Kinescope 1933
Cyclotron 1932
RECEIVING
POWER
Full-Wave Receiver Rectifier 1925
Commercial Sealed C-R Tubes 1932
Du Four Oscillograph 1920
Split-Anode Magnetron 1928
Coolidge X-Ray Tube 1913
MULTI-ELECTRODE
BEAM DEVICES
Solid-Anode Magnetron 1921
DIODES
High-Voltage Kenotron 1915
HIGH VACUUM
500-Kw Tube 1950
Post Terminal 1937
Large Disk-Seal Tube 1946
Sealed Steel Envelope 1934
Hydrogen Thyratron World War II
100 KW 1929
Beam Power 1936
Inert Gas Thyratron 1932
Shield Grid Thyratron 1934
Screen Grid 1926
Mercury Thyratron 1929
High-Voltage Water-Cooled 1923
Sealed Steel Ignitrons 1934
Grid Control Idea 1914
Early Transmitting 1915
Ignitron 1933
Fluorescent Lamp 1937
Sealed Steel Envelope 1934
Ionization Gage 1916
Enclosed-Cathode Phanotron 1928
Cooper-Hewitt Rectifier 1903
High-Voltage Glass Tubes 1905
Sun Lamp 1921
Sodium Lamp 1923
Cooper-Hewitt Lamp 1901
MULTI-ELECTRODE
DIODE
Tungar 1916
POOL
HOT CATHODE
Neon Signs 1910
Roentgen X-Ray Tube 1895
Cold Cathode Rectifiers 1925
Grid Glow Tubes 1928
Moore Lamp 1904
COLD CATHODE
GAS OR VAPOR
TR Box World War II
Use of Alkali Metals 1912
Small Glow Lamps 1923
TUBES
PHOTOEMISSIVE
Voltage Regulator Tubes 1925
Strobotron 1936
TV Camera Tube 1933
Geiger Counter Tubes World War II
INVENTION and DEVELOPMENT
Electrode Cathode Tubes 1928
Multiplier Tube 1938
Ceramic Techniques
Sealed Steel Envelopes
Glass Matching Alloys
Condensation Pump
Use of Getters
Ductile Tungsten
A-C Heater Cathode
DeForest Audion 1906
Fleming Valve 1905
Edison Effect 1883
Geissler & Crookes Tubes
Light-Sensitive Crystals
Transistors
Electro-Luminescence
Germanium Diodes
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Selenium Photocell
Crystal Detector
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Thyrite
Solid-State Physics
Secondary Electron Emission
Discovery of the Rare Gases
Electron Optics
Coated Cathode Emission
Thermionic Emission From Metals
Ionization By Collision
Study of Mercury Arc
Separation of Particles in Beams
Formation of Beams
Photo Emission From Metals
Deflection of Beams
High Vacuum Electron Discharge
Bombardment Fluorescence
Spark and Glow Discharges
Thoriated Tungsten Emission
High-Vacuum Procedures
Loss of Charge by Bodies in Air
RESEARCH
Evolution of Electronics
1883-1952

Evolution of Electronics

By W. C. WHITE
Research Laboratory
General Electric Co.
Schenectady, N. Y.

History of electronics industry is charted as family tree on which roots represent basic research and branches represent resulting commercial types of tubes. Growth of tree since last publication in 1934 corresponds to expansion in market for electron devices

THE many new tube developments since the last publication of this tree (ELECTRONICS, p 147, May 1934) make the choice of branches for this revision most difficult. Space limitations have necessitated the omission of many devices and developments that might well be thought desirable to include. In addition, the electronics field has come to include new phenomena. As one example, for many years the mercury-arc rectifier was considered apart from the field of electronics; now it is an active and important branch of the science.

Significance

The roots of this tree are the many basic research results that have made our science grow and which are expressed in general terms rather than specific items. In contrast, the main trunk represents inventions, new materials, techniques and processes applicable to a wide variety of electron tubes.

The large main divisions of the trunk and the main branches represent one way of grouping the many products that have resulted from engineering development. There are a few cases where a particular product is in more than one classification.

In a sense, the height of the tree is a measure of engineering development and commercialization. On the other hand, its breadth is based on research results. As in nature's tree, it may well be said: "A tree spreads no wider than its roots."

Dates

The assignment of definite dates to an abbreviated title for some product or development is always a difficult problem. No attempt has been made to include dates for research roots or the more practical items included in the main trunk.

In the case of the individual branches that are dated, a few words of explanation are desirable, particularly in view of the fact that space limitation necessitated brief titles; thus, qualifying words to make the item more specific could not be included.

Where possible, the dates apply to the year the product was commercially available. This is satisfactory, of course, and fairly definite for receiving and transmitting tubes, but is not practical for devices such as the synchrotron, betatron, electron diffraction instrument and the several forms of camera tubes. Also, in some cases products developed during World Wars I and II were not generally available for several years or until the lifting of security restrictions permitted commercialization.

Therefore, on branches where commercial availability is not a good criterion, the dates used indicate either when the item was available on special order, was well described in a technical publication, had restricted availability to certain commercial groups or for certain applications, or was available to military groups.

Semiconductor Sapling

The sapling sprouting at the lower left is an attempt to record the beginnings of semiconductor devices, the newest growth of our science. It is probably not too far-fetched to consider it as having sprouted from a seed dropped from the parent tree, even though its roots were in general different from those of the parent tree. It was purposely located under the diode main branch of the larger tree as probably the one from which the seed dropped, at least from an engineering viewpoint.

It will be most interesting ten years from now to see how this sapling has grown. There may be many new branches, and by then the teen-age offspring may have caused withering or stunting of the growth of some branches of the parent tree.

Magnetic Sorting of

By **D. G. GUMPERTZ**

Industrial Electronic Engineers
Hollywood, California

THE NEED for tin cans that are able to direct themselves through multiple-choice paths arises from the fact that fruit comes to the cannery from the field with quality grades intermixed. All of this fruit must be processed immediately. Since each quality grade may be packed as slices, halves or other cuts with light, medium, heavy or other syrups, the canning operation involves handling numerous grades and varieties simultaneously in unlabeled cans.

In the magnetic can-marking system to be described, now in use at the California cannery of Schuckl & Co., Inc., each can is given sufficient intelligence so that it may, in effect, say, "I contain peach halves, choice quality, and am to go to syruper No. 7, then to cooker No. 4 and finally to warehouse area No. 40".

Operation of System

Figure 1 is a simplified diagram of the cannery operation. Fruit comes into the loading dock, is prepared by washing, grading, peeling and slicing, and is then distributed to as many as 150 packing tables or filling machines.

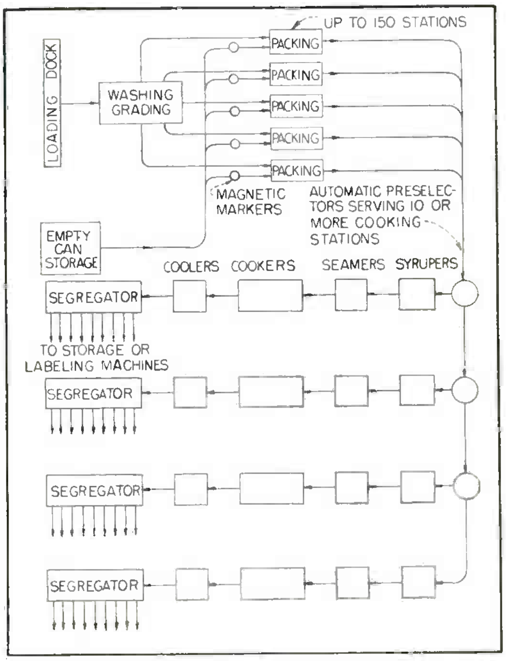


FIG. 1—Arrangement of work positions for magnetic sorting in large continuous-process cannery

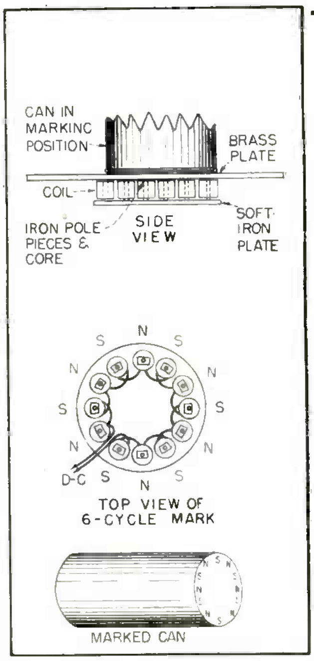
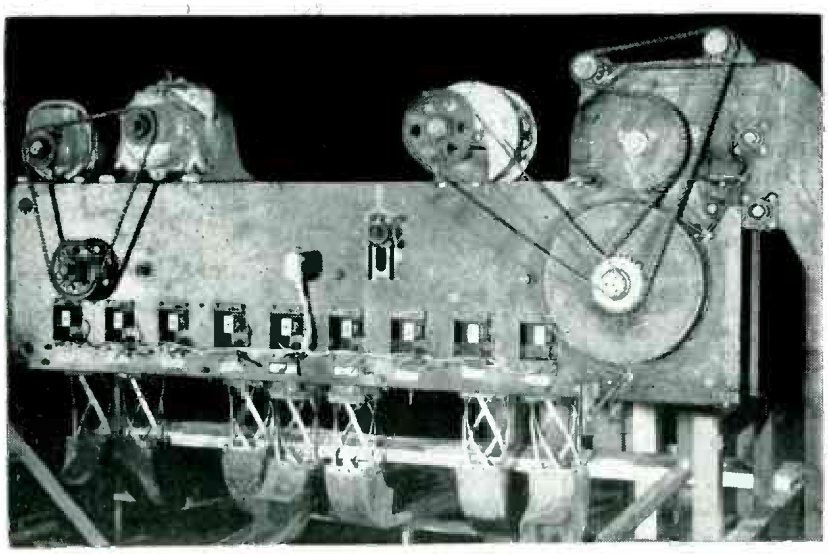


FIG. 2—Details of can-making arrangement

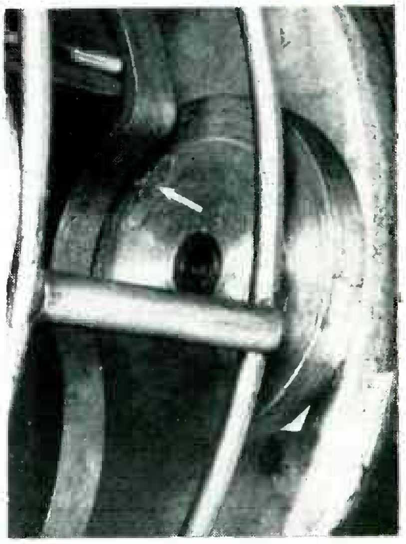
Empty cans are fed continuously to magnetic markers just ahead of each packing station by an overhead distributing system. Each can is magnetized around its bottom with the number of magnetic cycles of N and S polarity assigned to the fruit it will receive at the packing station. Nine different markings are used, permitting simultaneous processing of nine fruit varieties per cooker in the same size cans.

Filled cans are dispatched to the proper syruping, closing and cooking lines by automatic preselectors which may or may not be electronic. The cans are upright and still open at this point, hence their contents can readily be identified without electronic identification.

Many of the varieties take the same cooking time and temperature,



Drive side of sorter, showing use of chains for accurate timing required to achieve nine-channel sorting at rate of 300 cans per minute



Aluminum spinner disc, with arrow pointing to location of embedded pickup

Unlabeled Food Cans

Crimped bottoms of cans are magnetized in nine different patterns before filling with fruit in cannery, for automatic electronic sorting after sealing and cooking. Identification is by frequency analysis of voltage induced in 3,600-rpm spinner coil

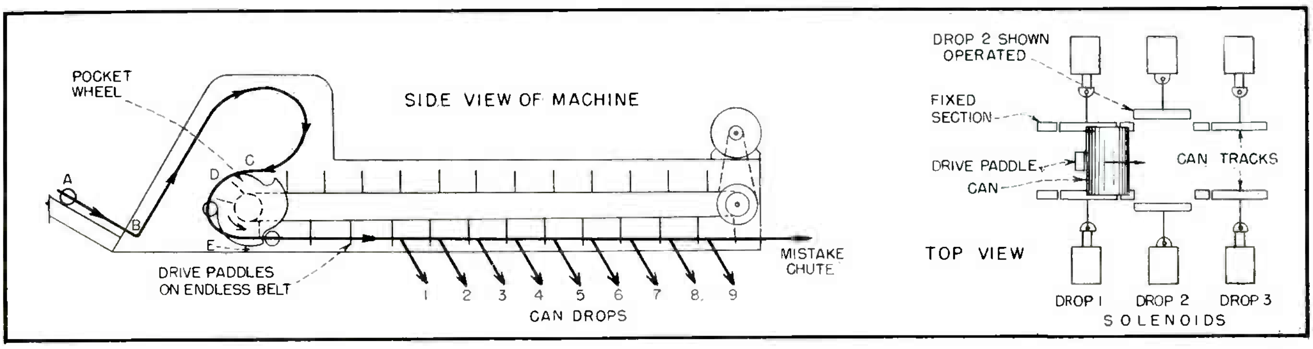


FIG. 3—Can drop arrangement in nine-channel magnetic sorter. Cans enter at left and roll in direction of arrows. Track-spreading solenoids operate after previous can has been cleared and before desired can arrives, so that can drops into proper channel

and may therefore be run through the same cooker. The cans must be closed before cooking, by crimping on the lids with seamers, but cannot be labeled before cooking because the steam and water jets of the cooking process would remove the labels. Magnetic marking solves this problem, increasing cooker utilization by allowing intermixed varieties to be run in the same cooker.

Upon emerging from the cooker, the cans are cooled and fed to a segregator. This automatically sorts the cans electronically by reading the magnetic markings, then directs them to the proper labeling machine or warehouse area.

In cooking operations where cans are cooked in retorts and are therefore scrambled, it is desired that one particular end of the can be up when labeled. Since the magnetic sorter can tell which end of the can has been marked, it is a simple matter to detect those cans that are upside down, divert, twist and recombine them.

Magnetic Marking

There must be practically no cost involved in marking the cans, as a large cannery may process as many as a million cans per day. Even a small unit cost would add up to a

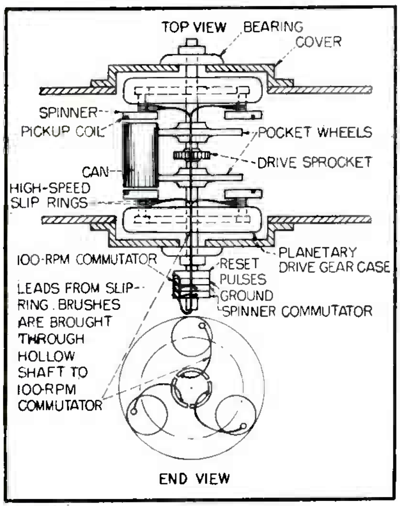
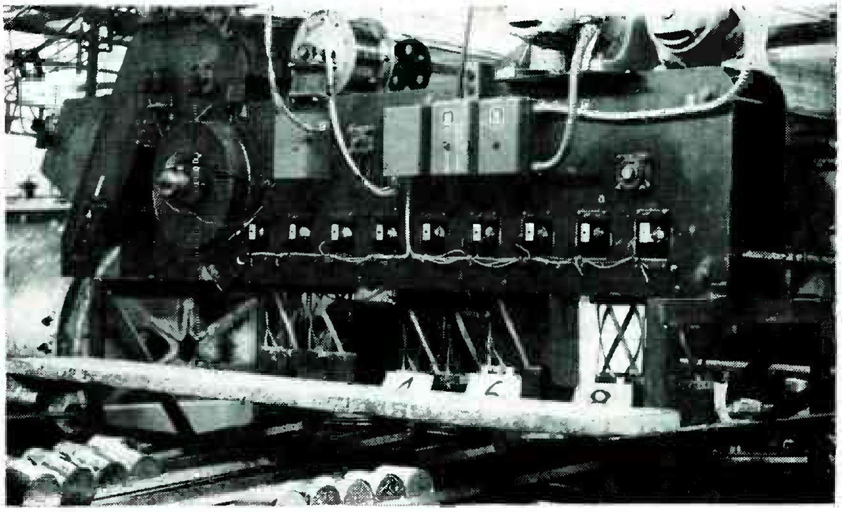
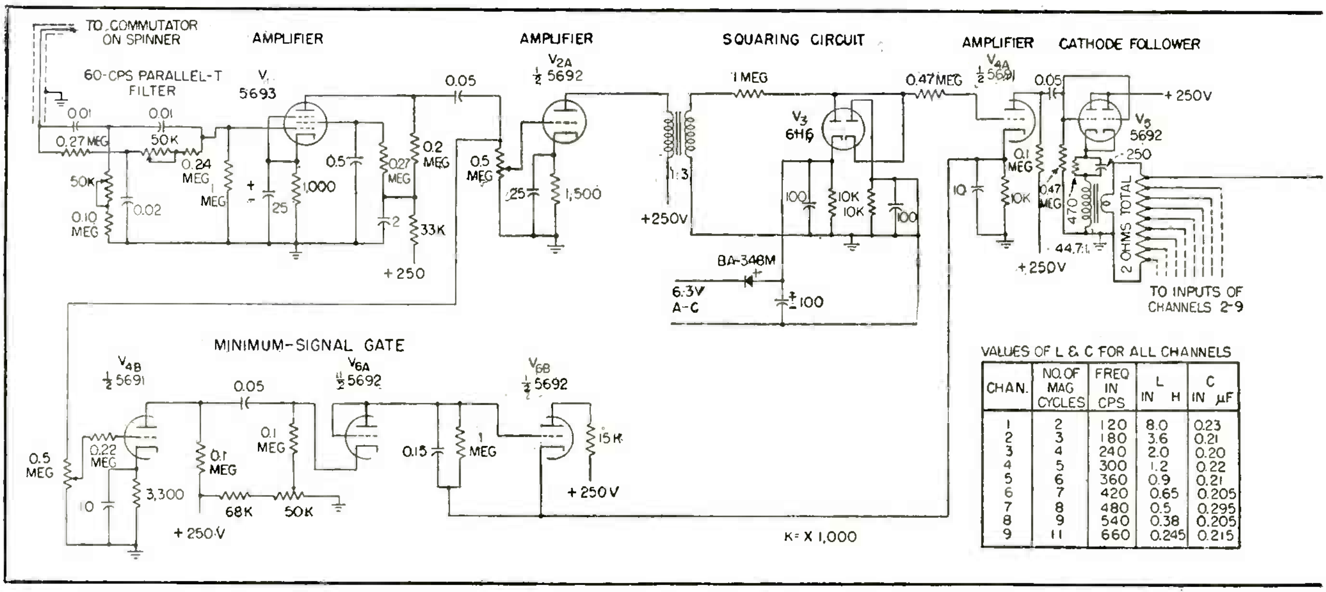


FIG. 4—Spinner mechanism used for reading markings on cans. Commutators feed output signal to amplifier



One side of nine-channel sorter, with covers and some dropout chutes removed. Cans all enter at left, and drop into output chutes going off on either side of machine. Unmarked cans go to mistake chute at right. Memory drum is on top



VALUES OF L & C FOR ALL CHANNELS

CHAN.	NO. OF MAG CYCLES	FREQ IN CPS	L IN H	C IN μF
1	2	120	8.0	0.23
2	3	180	3.6	0.21
3	4	240	2.0	0.20
4	5	300	1.2	0.22
5	6	360	0.9	0.21
6	7	420	0.65	0.205
7	8	480	0.5	0.295
8	9	540	0.38	0.205
9	11	660	0.245	0.215

FIG. 5—Circuit of nine-channel magnetic sorter. Only one frequency-selective channel is shown, since the other eight are

sizeable marking expense per season. The cost of electric power for magnetic marking is roughly 0.00005 cents per can, or 50 cents per million cans.

The best keeping quality is obtained with a perfectly symmetrical alternate-pole sinusoidal distribution of magnetic poles in the bottom rim of each can. Five thicknesses of the sheet metal are here work-hardened as they are folded over on each other during manufacture of the can, improving the permanent magnetic characteristics. A six-cycle mark is illustrated in Fig. 2. The external field adjacent to the rim is about 6 gausses after processing the fruit in the can.

Magnetic Decoding

Information is picked off the can by a magnetic pickup head embedded in an aluminum disk which spins at constant synchronous speed adjacent to the bottom of the can. The frequency of the output signal then depends upon the number of alternate magnetic poles placed on the can by the marker. The output voltage is about 2 volts for a freshly marked can, and 200 to 600 millivolts for processed cans. Below 30 millivolts the signal-to-noise ratio is generally so poor that the can is automatically rejected as unreadable.

Decoding is accomplished by automatic frequency measurement. With this method, missing magnetic cycles do not affect accuracy of sorting. If a filled closed can is dropped on concrete on one edge so as to smash in a portion of the rim, one or more magnetic cycles will be destroyed. This introduces some modulation and sidebands but does not affect the accuracy of reading frequency even though more than 50 percent of the perimeter is destroyed.

Nine-Channel Sorter

Operation of a nine-channel magnetic sorter is shown in Fig. 3. Cans enter at the left, after cooking, and are picked up by a flight bar elevator. From this they transfer to a three-pocket wheel rotating at 100 rpm to give a feed rate of 300 cans per minute. All cans are on their sides. A chain drive insures speed accuracy.

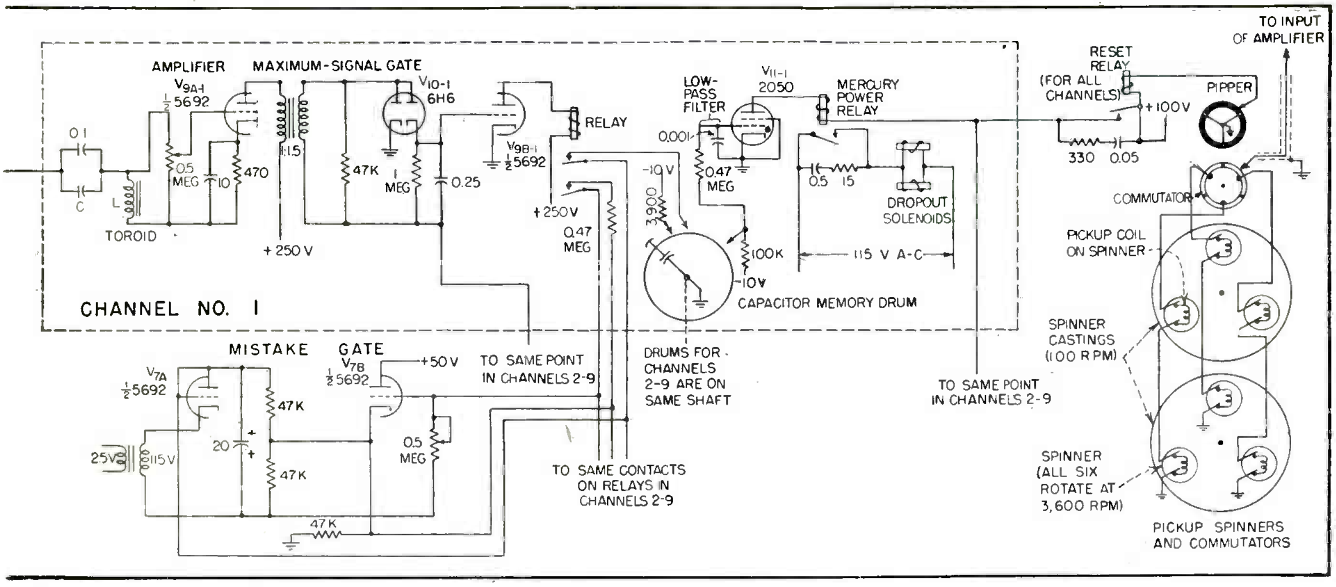
On the pocket wheel are spinners that read the magnetic marking on each can as it goes once around the wheel. The can is then transferred to a track, down which it is moved by a chain-driven paddle arrangement. Only the rims of the cans ride the track. Nine sections of the track are independently removable under solenoid control in response to the reading of the markings by the spinner, to drop the can into the correct chute. Heavy spring tension is constantly applied to the cans from above as they travel over the can drops, making each can spring downward when it reaches an open drop.

If not diverted, a can continues through the machine and goes out the end into the mistake chute. If nine different cans are run through in the order 9-8-7-6-5-4-3-2-1, nothing happens until the machine is full, then all nine cans spring down simultaneously.

Construction details of the spinners and pocket wheels are given in Fig. 4. The six spinners, each with an embedded pickup coil, are so mounted that one travels around with each end of each can. This is achieved by driving the spinner-supporting casting at 100 rpm the same as the pocket wheels. Through planetary gear drive, each spinner rotates at 3,600 rpm with respect to the bottom or top of a can.

Operation of Spinners

Pickup coils on opposite pairs of spinners are connected in series, to read the magnetic marking on one end of the can regardless of which way the can enters the machine. Commutating brushes connect only one pair of spinners at a time to the amplifier input, for reading of markings and memory-drum storage of the drop-actuating voltage just before the can leaves the pocket wheel. The slip rings and brushes also serve to generate reset pulses that close the can drops each time



identical except for input tuned circuits. Industrial-type tubes are used wherever possible, to obtain maximum reliability

after a can drops down. The spinners do not decode, but only pick off a signal frequency which the selective amplifier decodes.

The spinner output signal is fed to an amplifier through a minimum-signal gate that detects and rejects unmarked cans. The amplifier feeds nine frequency-selective channels, each responding to a different can output frequency.

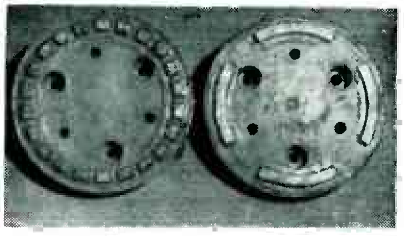
The output of an actuated channel is stored long enough in a rotating electrostatic memory drum to allow the can to travel through the machine to the proper drop-out chute. The memory drum then releases the voltage needed to actuate a thyratron which operates the drop-out solenoids of that chute.

Circuit Details

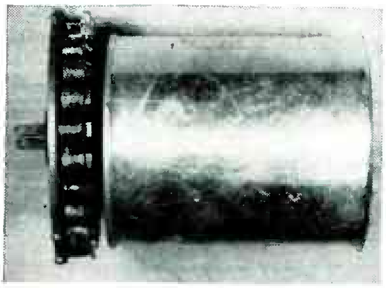
The frequency-measuring circuit for a nine-channel magnetic sorter is shown in Fig. 5. The signal frequency picked up from a can by a spinner is fed through shielded cable to the amplifier input, through a parallel-T 60-cps rejection network that attenuates interfering signals. These may be due to the earth's field, to modulation occurring when cans are off center in the decoder, or to a-c pickup. (At 3,600 rpm, the pickup coil generates a 60-cps voltage when cutting the earth's magnetic field.)

After amplification by V_1 and V_{2A}, the signal is converted to square waves of constant amplitude by V_3. After further amplification by V_{4A}, the square waves are fed to cathode follower V_5; here a 2-ohm wire-wound resistor across the output transformer is tapped to provide the same input voltage to each of the nine paralleled frequency-sensitive channels that follow. A signal from the cathode of V_{4A} is picked off and fed to minimum-signal gate circuit V_{4B}-V_{6A}-V_{6B} which prevents random operation by unmarked cans.

If the can being read is destined for channel 1, it will have a two-cycle mark and give a 120-cps signal. The L-C combination at the input of channel 1 will accept this frequency but the inputs of the other eight channels will reject it. Amplifier V_{9A-1} in channel 1 then feeds a signal of approximately 100 volts through maximum-signal gate V_{10-1} to triode V_{9B-1}, causing the output relay of this stage to operate and charge the capacitor associated with channel 1 in the memory drum. After the correct predetermined delay, the capacitor has rotated far



Can-magnetizing heads for producing 11-cycle and 2-cycle markings



Eleven-cycle marker head in correct operating position against can

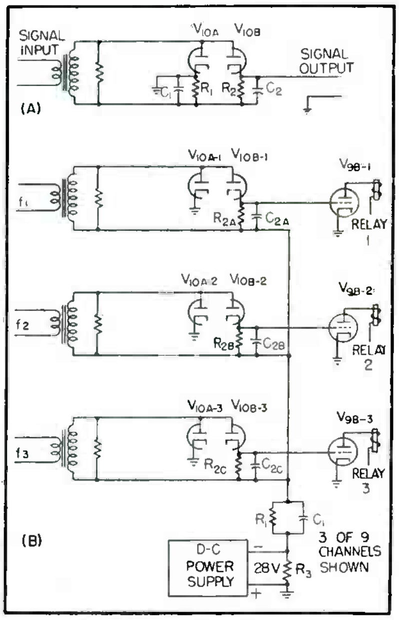


FIG. 6—Operation of maximum-signal gate

enough to discharge into the grid circuit of thyratron V_{11-1}, pulling in a mercury relay that actuates the dropout solenoids for channel 1. The solenoids are energized when the can is about 2.5 inches away, as solenoid operating time is 30 milliseconds. Two solenoids are used per channel, one for each side of the track.

Thyratron plate voltage is removed after each dropout operation by a reset relay controlled by a pipper commutator mounted on the commutator shaft. The exact reset time is set by adjusting the inner rotatable brush of the pipper slipring assembly.

Whenever a can arrives that has been badly abused and activates two or more of the frequency-selective channels, mistake gate V_{7A}-V_{7B} acts to cancel out the activation of the channels, so that the can rolls through the entire machine and out the mistake chute as desired.

Minimum-Signal Gate

Without a minimum gate circuit, unmarked cans would occasionally trip out any chute at random, as the wide-band (non-frequency-sensitive) amplitude of the signal from unmarked cans is 15 to 25 millivolts. With the minimum-signal gate circuit of V_{4B} and V_6 set to trigger open at approximately 50 millivolts, all unmarked cans are rejected as mistakes.

When no marked can is present, V_{6A} is nonconductive and V_{6B} conducts heavily, biasing V_{4A} well beyond cutoff. With sufficient signal, V_{6A} conducts, biasing off V_{6B} and causing V_{4A} bias to drop to the normal operating value. For positive action, the voltage gain and positive bias must both be as high as practical.

Squaring Circuit

Biased double-diode squaring circuit V_3 eliminates amplitude variations. Cans generating volts or millivolts can then be run intermixed, with uniform output voltage for each can at the grid of V_{4A}.

Cans that have been accidentally dropped on one side will have a weaker magnetic field on that side and give a 60-cps modulation envelope as the spinner scans the perimeter at 60 rps, but squaring eliminates this undesired modulation also. Harmonics are introduced by the squaring operation, but these are rejected by the following maximum-signal gate.

Maximum-Signal Gate

The maximum-signal gate is required primarily because of frequency modulation of the desired signal when there is mechanical misalignment of marker and spinners with the can. With the spinner traveling at 60 rps, the sweep rate or modulating frequency is 60 cps and the sidebands are spaced at 60-cps intervals, precisely on frequencies of adjacent sorting channels.

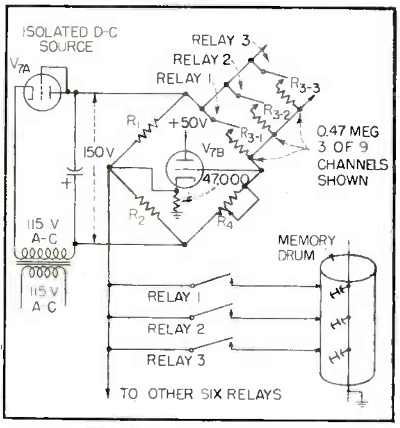


FIG. 7—Mistake gate circuit

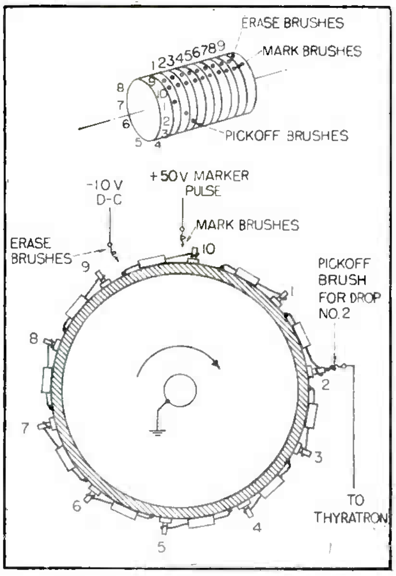


FIG. 8—Memory drum details

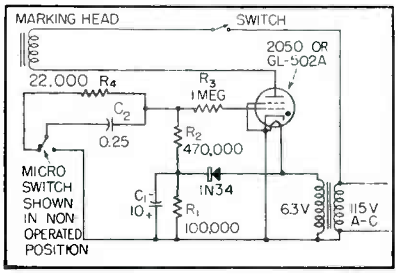


FIG. 9—Marker control circuit

The maximum-signal gate accepts the signal of maximum amplitude, rejecting all others. If one or more signals are within X percent (1 to 20 percent, adjustable) of each other, the gate will pass both signals so that the following mistake gate may reject all signals as unsure.

The basic circuit for the maximum-signal gate is shown in Fig. 6A, where $R_1 = R_2$ and $C_1 = C_2$. Output is taken from between the cathodes. The voltages developed across these RC circuits are equal for any signal voltage and frequency input, hence the output is zero. However, when several such circuits are interconnected as in Fig. 6B, with R_1 - C_1 common to all, the desired sideband rejection is obtained.

Assume that a can intended for channel 2 gives 100 volts at its correct frequency f_2, 70 volts at sideband f_1 on one side and 30 volts at sideband f_3 on the other side. The desired signal f_2 produces + 100 volts across R_{2B} and − 100 volts across $R_1 + R_3$, resulting in zero bias on the grid of V_{9B-2} so that the signal goes through the gate. Undesired signal f_1 produces + 70 volts across R_{2A}, leaving a net negative bias of 30 volts on V_{9B-1}. Similarly, undesired signal f_3 produces + 30 volts across R_{2C}, leaving a net negative bias of 70 volts on V_{9B-3}. Channels 1 and 3 thus remain cut off as desired. With no signal input the d-c bias source of − 28 volts keeps all other units cut off.

Mistake Gate Circuit

The mistake gate cancels instantly any doubtful measurements, so the can rolls through the entire machine and out the end as a mistake. As shown in Fig. 7, the circuit consists of a resistance bridge supplied by an isolated d-c source, controlling a triode gate in series with the main power supply. Each channel relay, operated through the maximum-signal gate of the channel, has two sets of normally open contacts. One set connects a 0.47-megohm resistor into the mistake bridge, and the other set connects the output of V_{7B} directly to the marker brushes on the memory drum.

If only one channel relay closes, the bridge balance is such that the grid-to-cathode potential of V_{7B} is + 25 volts, and the plate resistance drops to a few thousand ohms; the resulting cathode rise of + 50 volts with respect to ground is applied to the memory drum through the other set of contacts on the operated relay.

If a second relay should close, indicating an unsure reading, the balance of the mistake bridge is shifted so that − 30 volts is applied to the grid of V_{7B}, raising the plate resistance to a high value and instantly dropping the outgoing memory-drum voltage to effectively zero. thus cancelling both relay indications.

Memory Drum

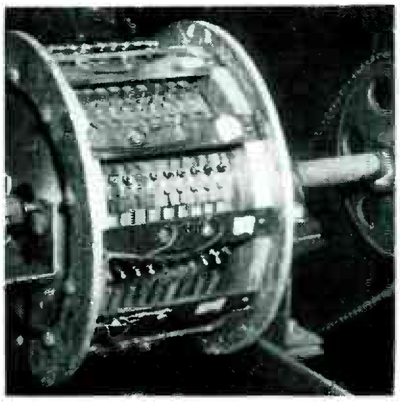
The memory drum consists of 9 disks. each containing ten 0.5-μf capacitors, rotating in synchronism with the machine drive. Mark, erase and pickoff brushes serve each disk, as shown in Fig. 8. Pickoff brushes are so mounted that the amount of time from charge to discharge is proportional to the travel time of the can down the machine. When a memory capacitor passes its pickoff brush, a 50-volt pulse is fed to the grid of thyratron V_{11} to activate the dropout solenoids of its channel.

A low-pass filter in the thyratron grid circuit permits use of unshielded conductors from the memory drum to the electronic unit without firing other thyratrons through the distributed capacitance between the grid lines.

Marker Circuit

Figure 9 gives the circuit used for marking cans magnetically. The 1N34 diode supplies across R_1 a negative bias of 9 volts for the grid of the type 2050 thyratron, making it normally nonconducting. When the snap-action switch is operated by an arriving can, C_2 is shunted to ground, reducing the grid voltage temporarily. The thyratron then fires, and continues to conduct for approximately three a-c cycles until C_2 is recharged through the 470,000-ohm limiting resistor to the cutoff voltage of the tube. Then, even though the control switch remains operated, the system automatically cuts off. When the control switch is released as the can moves on, C_2 is quickly discharged through R_4 and the system is ready for another marking operation.

Marker installation on can run. with cover of marker circuit control box removed



Memory drum with cover removed

At a marking rate of 60 cans per minute, the average power fed to the marking head is approximately 20 watts even though marking power is 800 watts, as the duty cycle is only about 25 milliseconds per second.

Operating Reliability

A nine-channel sorter must handle 300 cans per minute, 20 to 22 hours per day for 3 to 4 months continuously. This amounts to about 40 million operations per machine per season, hence mechanical and electromechanical parts must be designed for 1 billion machine operations wherever possible.

Electronic reliability is achieved through ultraconservative selection of components and operating conditions. Size and weight do not matter, and cost is secondary to reliability. Therefore, high-quality transformers, relays (extremely reliable when properly applied), and similar nondeteriorating parts are employed extensively.

The use of vacuum tubes is held to a minimum consistent with overall circuit considerations. Tubes used are industrial or ruggedized types wherever possible. If commerical types must be used, a conference is held with the tube manufacturer's technical representative to select a tube type and a set of operating conditions that will yield maximum reliability and life.

Accuracy must be essentially 100 percent, as even an extremely small percentage error would cause large numbers of cans to be misdirected.

Simplicity of operation is a must, as nonskilled persons will operate the equipment.

Quick serviceability is attained by packaging all electronic items as plug-in units. On-the-spot servicing is not attempted. Instead, the entire electronic package is replaced with a spare when trouble occurs, and the faulty package is returned to the factory for service.

A continuous process cooker cannot be stopped on less than one-half hour notice. If it were stopped with no notice, every can of fruit in the cooker—perhaps 6,000 cans—would be ruined. With cans stacking up at the rate of 5 per second, the atmosphere is not conducive to calm deliberation regarding what happened to grid bias on V_{909}.

Development of this machine was aided and expedited by many members of the canning industry. Special thanks go to the following men and concerns: Morris O'Brien, F. E. Booth Corp.; Carl Kingsbury, Stokely Fine Foods, Inc.; Barney Murray, F. M. Ball & Co.; Ted Harrer, president, Atlas-Pacific Engineering Co., Inc., our licensees; Emil Rutz, president, and all the personnel of Schuckl & Co., Inc., who have made the first commercial installation of this machine.

Transistor

By **RICHARD F. SHEA**
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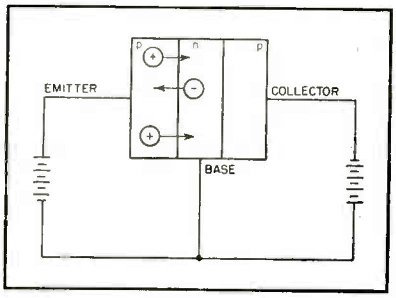


FIG. 1—A diffused junction transistor of the *p-n-p* type

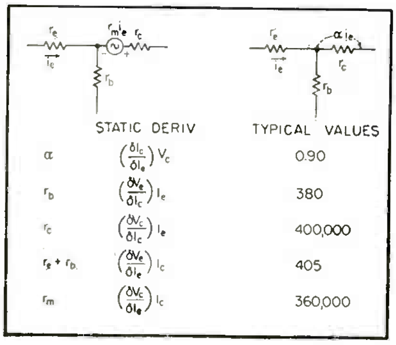


FIG. 2—Two equivalent mesh circuits for transistors

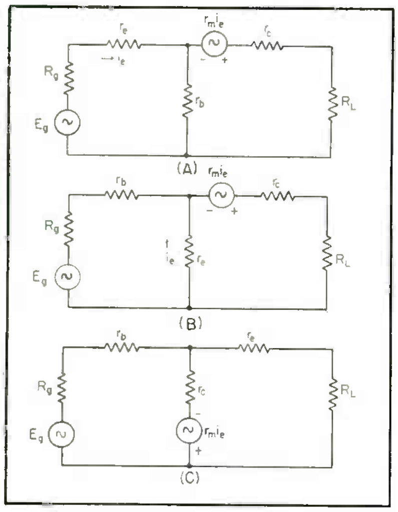


FIG. 3 — Equivalent circuits of the three common transistor connections. Grounded-base (A), grounded-emitter (B) and grounded-collector (C)

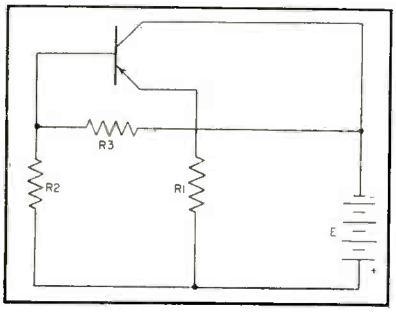


FIG. 4—Use of one battery to supply both collector voltage and emitter current

THE RECENT ADVENT of the junction transistor has made possible advances in the application of transistors to audio amplification. Two factors have contributed significantly; one, the greatly improved noise figure, and the other, the ability to operate at extremely low power levels. Transistors may now be utilized as low-level input stages to obtain high power outputs at good efficiencies.

Diffused Junction

Figure 1 illustrates the basic construction of this company's diffused-junction transistor. A section of *n*-type germanium serves as the base. Two *p*-type areas are obtained by diffusion of suitable end materials. One of these areas serves as the emitter, the other as collector. The result is a *p-n-p* junction transistor. Potentialities of this design for high-power operation are due to the ability to make comparatively heavy connections to the two junctions and to the base, providing good heat transfer to a suitable external radiator.

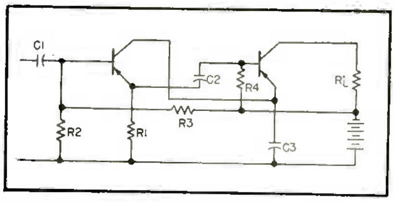


FIG. 5—Circuit for minimizing power loss in transistors

Equivalent Mesh

A device such as the transistor may be represented by an equivalent mesh. Figure 2 shows two circuits used in most transistor applications. In both circuits there is an emitter resistance r_e, a base resistance r_b and a collector resistance r_c. In one there is also shown a transfer resistance r_m which, when multiplied by the emitter current, produces a voltage in the collector circuit. The other circuit utilizes a current generator αi_e in parallel with the collector resistance. The circuits can be interchanged as convenient.

Figure 2 also contains some representative values. The junction transistor is too new for these values to be frozen at this time but they do give the relative order of magnitude of the various resistances. The value of any of these resistances depends critically upon the operating point.

Three circuit configurations are

Paper presented at the Symposium on Progress in Quality Electronic Components, Washington, D. C.

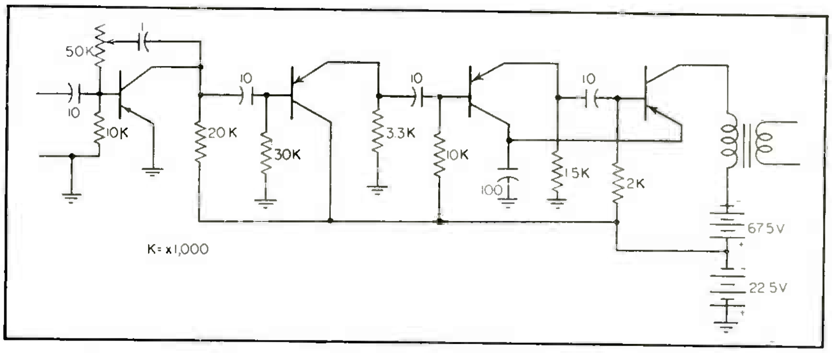


FIG. 6—Single-ended transistor amplifier suitable for intercom systems has an output of 150 milliwatts

Power Amplifiers

How to get the maximum power gain and power efficiency from junction transistors when used in class-A and class-B audio amplifiers. Complete circuits suitable for phonograph amplifiers, speech amplifiers and intercom systems are described

used commonly with transistors. These are grounded-base, grounded-emitter and grounded-collector connections. With a grounded-base connection, the signal is applied to the emitter, the amplified signal is taken from the collector and the base is grounded. With a grounded-emitter connection, the signal is applied to the base, the amplified signal is taken from the collector and the emitter is grounded. In the grounded-collector configuration, the collector is grounded, the signal is applied to the base and taken from the emitter. Figure 3 illustrates these three circuits.

The grounded-base circuit is somewhat similar to the grounded-grid operation of vacuum tubes, the grounded-emitter arrangement corresponds roughly to conventional practice and the grounded-collector is similar to the cathode follower.

Differences between tube circuits and transistor circuits are brought out in Table I showing typical values of input resistance, voltage amplification and power gain for the three circuit arrangements described. For this table, the representative values given in Fig. 2 were used together with two common values of load resistance. In all cases, the input resistance of a transistor amplifier stage is lower than is usually obtained with tube circuits. Transistors must be thought of as power-operated devices rather than voltage-operated devices. Power gain becomes the major criterion and the power efficiency of a transistor amplifier assumes great importance.

As stated previously, junction transistors are capable of operating at extremely low power levels with dissipation comparable to the power levels of the signals being amplified. The preamplifier stages of an audio amplifier may be operated at fractions of a volt on the collector and fractional milliampere current drains. Power supplied to the collector increases with the output power. In a complete power amplifier, the total power consumption may be little more than about three times the output power. This is in contrast to the much greater power requirements of conventional tube amplifiers.


Phonograph amplifier using single-ended class-A amplifier chassis on left and push-pull class-A amplifier on right

Bias Currents

The previous discussion of power requirements sounds attractive but with transistor amplifiers, emitter and collector bias currents must be supplied. This is in contrast to tubes which require bias voltages. Ideally, a transistor should be supplied from a constant-current source for the emitter and a constant-voltage source for the collector. The reason for this is the necessity of minimizing collector-current variations caused by temperature changes and to insure maximum interchangeability of transistors. A constant-current supply means power dissipation and the resultant inability to realize all the potential high efficiency of transistors.

Figure 4 shows a common method of utilizing one battery to supply collector voltage and emitter current. A resistor R_1 is inserted in the emitter lead. Two other resistors R_2 and R_3 form a voltage divider across the battery to set the base voltage. If the values of R_2

and R_3 are low enough, the base potential is relatively constant and, in effect, there is a voltage inserted between base and emitter through R_1. This provides a comparatively constant current feed to the emitter.

Constancy of the emitter current is a function of the power dissipated in resistors R_1, R_2 and R_3. In some cases it may be necessary to dissipate several times the collector dissipation in these resistors to hold the emitter current constant. If the transistor under question happens to be the final unit in an amplifier operating at relatively high power level, the loss of power in the resistors may be serious.

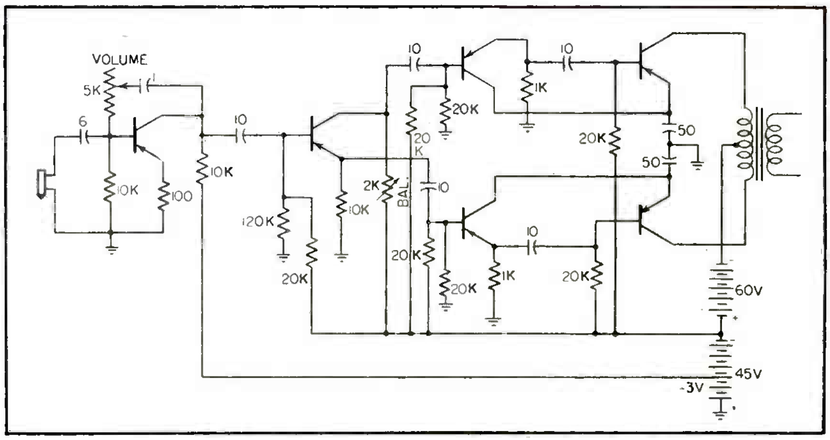


FIG. 7—Push-pull class-A transistor amplifer

Table I—Typical Transistor Characteristics

	R_L = 1,000			R_L = 10,000		
	Gr. Base	Gr. Em.	Gr. Coll.	Gr. Base	Gr. Em.	Gr. Coll.
Input Res.	64	625	10,380	71	585	80,380
Voltage Amp.	14.1	14.1	0.94	123.5	123.5	0.99
Power Gain	127	1,240	9.2	11,650	102,000	7.9

Cascade Amplifier

A circuit for minimizing the loss described is shown in Fig. 5. In this circuit two transistors are used in tandem. The emitter of the second transistor is connected directly to the collector of the first. The first one is stabilized by the method described with resistor R_1 in the emitter lead and a voltage divider supplying the base voltage. The first transistor operates to supply a constant current to the emitter of the second to stabilize it against drift or other temperature changes.

By choosing the proper resistance values most of the battery voltage can be applied to the second transistor, leaving a low voltage on the first. The current through the two transistors is essentially the same, with the power dissipation in the first much less than in the second. By dissipating a relatively low amount of power in the bias-setting network, a high degree of stability in the second high-power unit is maintained. This process helps to achieve more nearly the maximum potential efficiency of the device.

The first transistor also serves to supply power amplification. This is accomplished, Fig. 5, by means of the bypass capacitor between the common collector-emitter connection and ground and the coupling capacitor from the first emitter to the second base. In this manner, the first transistor is operated as a grounded-collector amplifier, the second as a grounded-emitter and both contribute power gain to the amplifier. The complete tandem amplifier presents a considerably higher input resistance than the output stage would alone, thereby improving the ability to drive the amplifier.

It is possible also to operate the first transistor grounded-emitter, by inserting a resistor between the collector and the emitter of the second unit. The emitter is grounded effectively by the bypass capacitor. The coupling capacitor is connected from the base of the second unit to the collector of the first. This circuit will provide higher gain at the cost of an extra resistor plus some increase in supply voltage.

Practical Circuits

Figure 6 illustrates a single-ended transistor amplifier utilizing the arrangement just described. The amplifier has an output of about 150 milliwatts, an overall power gain of 70 db and requires a total battery consumption of 570 milliwatts. Such an amplifier can provide very economical audio output for such devices as intercommunicating systems.

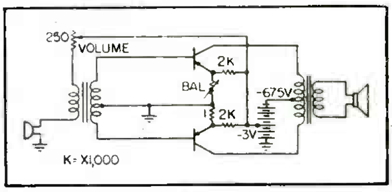


FIG. 8—Push-pull class-B amplifier for speech use

A more elaborate arrangement using push-pull class-A operation is shown in Fig. 7. An amplifier employing this circuit has been driven by the lower-power amplifier of Fig. 6 and delivers an output of one watt with ten-percent distortion.

Figure 8 shows a push-pull class-B amplifier for speech use where higher distortion is permissible in exchange for the improved efficiency and insignificant standby power. A typical application is in an electronic megaphone completely self-contained. This unit has about 500 milliwatts of audio power, yet consumes only 100 milliwatts of power at low levels including about 50 milliwatts for the microphone, rising to about 850 milliwatts at full output. Power is obtained from one hearing-aid-type battery.

Low-Power Deflection for Wide-Angle C-R Tubes

Use of narrow-neck tube and specially-shaped deflection yoke permits wider angles of deflection with increased deflection-power efficiency. Reduces weight, cost and complexity of deflection equipment and improves ratio of face diameter to tube depth

By CARLO V. BOCCIARELLI

Research Division
Philco Corporation
Philadelphia, Pennsylvania

THOUGH the cathode-ray tube is the only device capable of translating fast electrical impulses into visual information, its size and clumsy shape cause it to be a major dimensional limitation on the apparatus into which it is incorporated. It occupies a large volume of valuable space in such apparatus, and its operations require auxiliary equipment of considerable size, weight, and power consumption.

Increasing the deflection angle would make it possible, not considering the host of attendant difficulties, to improve the ratio of face diameter to tube depth (and hence decrease the crt volume for a given face dimension). However, the needed deflection power rises roughly as the square of the deflection angle. Since the power requirements are substantial even at moderate accelerating voltages and narrow (50-degree) deflection angles, this rapid rise soon makes further increases totally impractical (in standard practice) because the weight, cost and complexity of the deflecting apparatus become excessive.

This article describes a design which will make practical the utilization of c-r tubes having deflection angles up to 90 degrees. The design accomplishes this by maximum use of the available magnetic energy.

Figure 1A represents diagrammatically the conditions that exist in the deflection region of standard crt. Approximately uniform flux fills the whole cylindrical volume and then diminishes in the end fields. The electron beam entering from the left and on axis is deflected along circular arcs by the magnetic field.

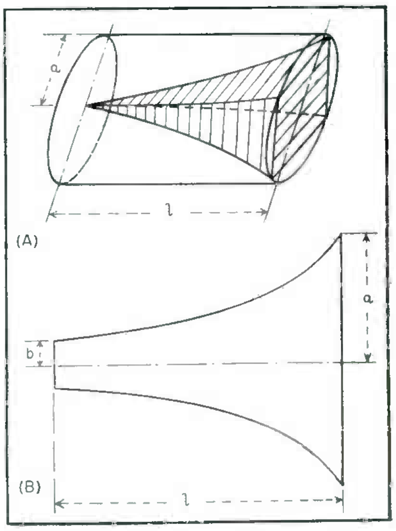
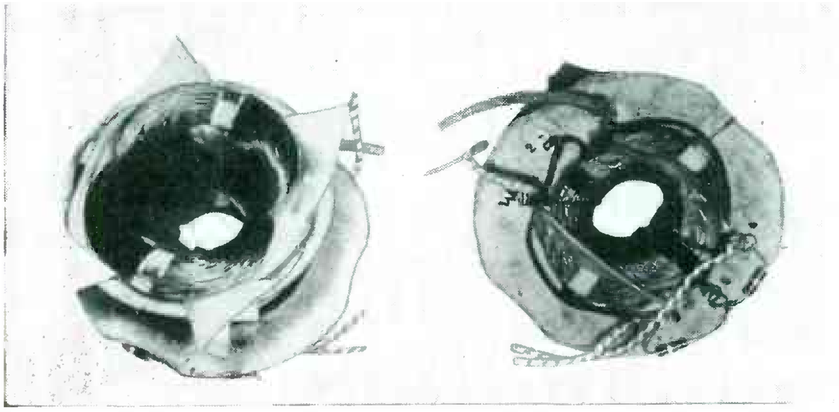


FIG. 1—Sketch shows flux conditions existing in deflection region



Front (left) and back (right) views of complete 55-degree yoke employing flared sections shown in Fig. 2

No purpose is served by deflecting the beam any farther than the arc that just grazes the tube envelope in leaving the deflection region. At this point, the envelope is expanding into the larger bulb and the electrons proceed along straight lines to the tube face.

Figure 1A shows that two volumes may be defined in the deflection region. In the first (the shaded portion), the electrons are deflected and proceed to the tube face. All electrons deflected in the second region (the unshaded portion) hit the glass envelope. No useful purpose is served by filling the volume of this second region with flux. However, in the standard crt, the magnetic energy expended per unit volume is the same for both regions.

A rough approximation shows that the total volume filled with flux is to the useful volume as a^2l is to $\frac{1}{3}\,a^2l$ if the volume of a cone of radius a and volume height l is used instead of the still smaller solid shown. Thus, at least $\frac{2}{3}$ of the magnetic energy is usually wasted. It would therefore seem logical to reduce the size of the deflection yoke to conform more closely with the useful portion of the deflection volume. If this could be achieved while keeping the flux constant, a maximum 3-to-1 improvement in the energy required for deflection could be obtained.

For the case of uniform flux, the distribution of turns needed to fit an expanded neck is not difficult to determine but becomes very difficult to achieve in practice. This is due to the fact that the number of turns in each cross-section must increase as they proceed from the gun side toward the screen side.

For practical reasons, it would be desirable to keep the number of turns constant through all cross-sections. However, the flux would be denser in the smaller section than in the wider section. Thus, it is not immediately apparent whether this method would be profitable.

There is also the question of possible resulting aberrations in the crt spot. Finally, the path taken by the electrons under the new conditions should be investigated.

Analysis shows that a very convenient mathematical expression can be derived and that an interesting form of contour is one whose cross-section is given by an exponential taper. The whole deflection region now looks like an exponential horn as shown in Fig. 1B. For this form, the energy required is $(b/a)^2$ times the energy required by a cylindrical yoke with the same length and radius. Consequently, for equal yoke inductance, the current will be diminished by the square root of this factor.

The exponential contour, while it is convenient for the purpose of showing the reduction in required energy which can be effected by using a flared form of yoke, does not necessarily represent the optimum. Other contours, for example conforming to arcs of circles or to hyperbolas, will yield similar reductions and may be better suited for manufacturing.

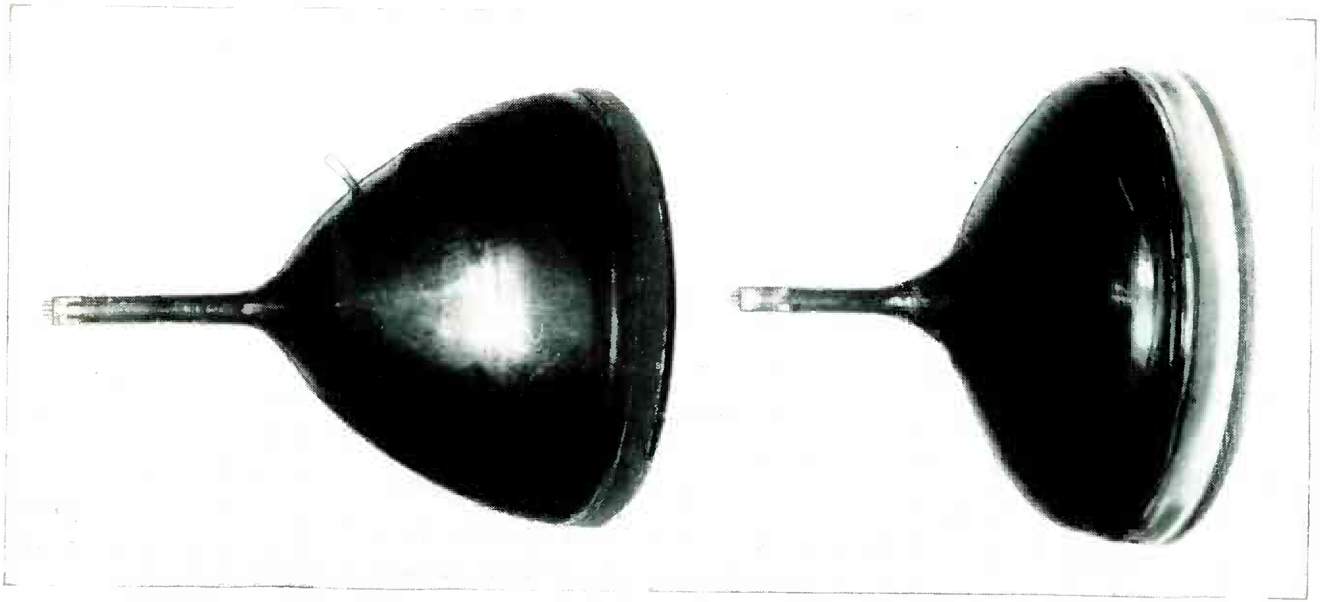
Analysis also shows that the aberrations to be expected from this new yoke are analogous to those expected for the cylindrical yoke. Hence, one would want to adopt a cosine[1] distribution of turns. However, the following precaution, which is of less consequence for cylindrical yokes, must be observed. It is important that no geometrical correction be attempted in the narrow neck portion of the yoke but only toward the large end of the flare where the beam deflection is a smaller fraction of the field. There the wire can be redistributed to achieve the desired field correction without causing a material field variation across the beam. Conversely, correction for spot distortion may be achieved in the first portion without altering materially the final geometry.

Practical Design

Difficulties were presented in obtaining windings of the form established on the basis of the preceding considerations. These were solved by forming the coils in the grooves of a rotating arbor. The coils were wound with Bond-eze wire, a special wire which is coated with a plastic that, when heated by passing current through the wire, melts and forms the turns into a rigid coil.

Flared yoke sections are shown in Fig. 2.

Concurrently with the development of the yoke, a tube development was initiated which resulted



Flared 55 and 90 degree tubes for use with high-efficiency deflection system. Stems have 0.9-inch diameter

in a commercial tube of standard deflection angle and an experimental tube of wide deflection angle.

A maximum neck diameter of 0.900 inch was chosen because it permitted the use of the standard 9-pin T-6½ miniature stem. Using this stem obviated the development of a new untried stem and permitted the use of a standard socket. In addition, the 0.900-inch neck diameter made possible the use of a standard 0.500-inch diameter cathode-grid assembly, eliminating the necessity for redesigning this portion of the electron gun.

Having chosen the neck diameter, the method of exhaust became an important consideration. Conventional exhaust through a glass tubulation in the stem was ruled out because of the difficult stem development, fragility of the glass tubulation by reason of its necessarily small size, and the reduced pumping speed through such a small tubulation. In addition to the above objections, a metal tubulation in the stem would present an electrical break-down and leakage problem.

This left the possibilities of a metal or glass exhaust tube emerging from the cone of the tube. This position for the glass exhaust tube has been used extensively in England. Its principal drawbacks are a high breakage rate in manufacture and an objectionable, unprotected, fragile tip on the finished tube.

The method finally adopted was to use a metal exhaust tube in the cone. This could also serve as the high-voltage anode connection in the finished tube.

To take proper advantage of the small neck diameter, the neck must flare out into the cone section of the tube with a specified contour. The use of conventional pressing techniques in the manufacture of the desired tube appeared likely to be difficult. The recently developed method of centrifugal casting was tried. After numerous initial difficulties, this method produced satisfactory tube envelopes.

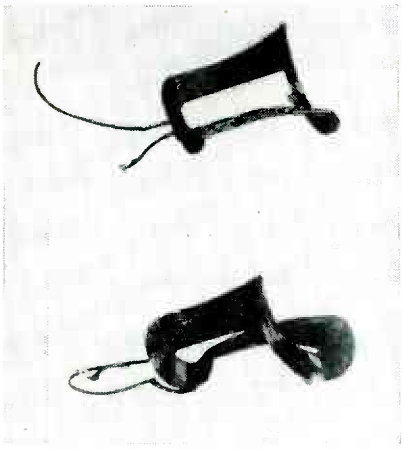


FIG. 2—Two views of flared deflection yoke sections designed for high-efficiency wide-angle deflection system

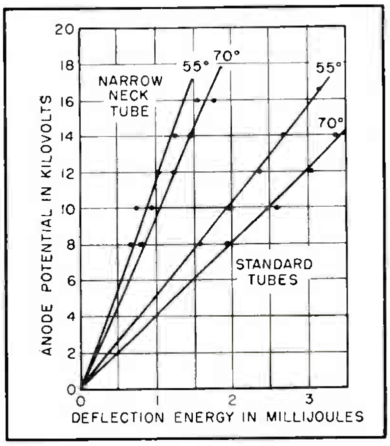
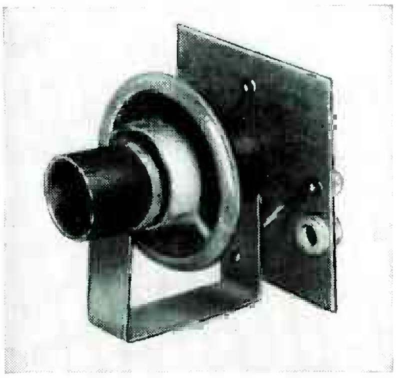


FIG. 3—Curves show deflection energy required for various anode voltages



Special transformer using cylindrical slug of ferrite delivers over 10 kv for less than 500 ma peak deflection current

Tube Types

The energy required to achieve a certain deflection in a cathode-ray tube, for instance one having a standard 55-degree deflection angle, can be plotted versus the high voltage. As shown in Fig. 3, a series of points lying roughly on a straight line results. On this line, the lower voltages (1 to 10 kv) correspond to the region where a standard 10-inch tube might be operated. The higher anode voltages along this line correspond to the region characteristic of a 12-inch tube, then of a 16-inch tube, and so on. The straight line results because the increase of deflection current for equal deflection angles is proportional to the square root of the high voltage; hence, deflection energy expressed as $\frac{1}{2} Li^2$ is directly proportional to the high voltage. Perfectly straight lines are not to be expected, however, because the influence of various losses will affect the readings.

The deflection-energy characteristics of other tube types may be similarly represented by straight lines; the more efficient the tube type the steeper the slope of the line. Thus Fig. 3, which represents actual measurements, condenses a great deal of information about the requirements of various tubes.

The total energy available for deflection and high voltage may be classed in two ways, the first where deflection requirements dominate and the second where the high voltage requires a more substantial portion of the total energy. All standard tubes fall in the first class and consequently demand a closed transformer core which permits all available energy to be stored in the tube neck; that is, in the yoke deflection field. The narrow-neck tubes fall in the second class and must use a type of transformer which permits the storing of energy both in the tube neck and in the air around the transformer. As a result of these differences, the ratios of deflection current to high voltage available with each tube type vary greatly. Eventually, a very simple transformer, using a cylindrical slug of ferrite, was developed. This transformer performs very creditably, developing better than 10 kv for less than 500 ma of peak deflection current.

The author wishes to acknowledge particularly the contributions of George Pratt of Lansdale Tube and of Theodore Malkin, Frederick Bernstein, and Albert Rittmann of Philco Research.

REFERENCE

(1) Philco Research Report No. 171.

Saturable Reactors

New ferrite materials under influence of externally-applied d-c magnetization are used in saturable reactors for use in r-f tuned circuits. Inductance variation is made by means of potentiometer across d-c voltage source

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REMOTE TUNING of radio-frequency circuits has been accomplished in many ways. Most methods currently in use are extremely complicated and involve combinations of intricate gears, motors, servos and precise adjustable reactance elements.

In contrast, the system to be described uses no moving parts, and yet the variable inductance range available is useful in such applications as transmitting tank circuits, transformers and antenna tuners. A ferrite-core saturable reactor furnishes the variable inductance with control provided by a simple d-c circuit. In the case of antenna tuners located remotely, further simplification is derived by carrying the d-c control current for the remote saturable reactor over the coaxial line feeding r-f to the antenna, using chokes and capacitors for isolation.

This system was discovered during the development of a coupling network to match the output of a 12-watt, 2 to 4-mc, marine transmitter to a 19-foot vertical antenna. In the installation the antenna would be as far as 25 feet from the transmitter and control room. The customer stipulated coaxial cable for the antenna lead and automatic matching of the antenna to the transmitter with changing frequency.

Because the transmitter was designed to operate from different supply voltages, such as 12 and 24 volts d-c and 110 volts a-c, it was both undesirable and impractical, for reasons of simplicity and reliability, to incorporate moving parts such as relays and motors.

This paper describes a coupling network that is pretuned so that selecting any crystal position in the transmitter will find the antenna tuned for maximum output without any further adjustments.

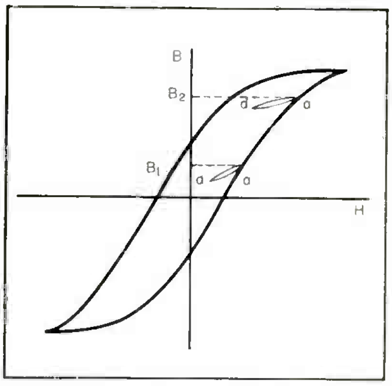


FIG. 1—Typical magnetization curve shows change in incremental permeability cause by change in d-c magnetization

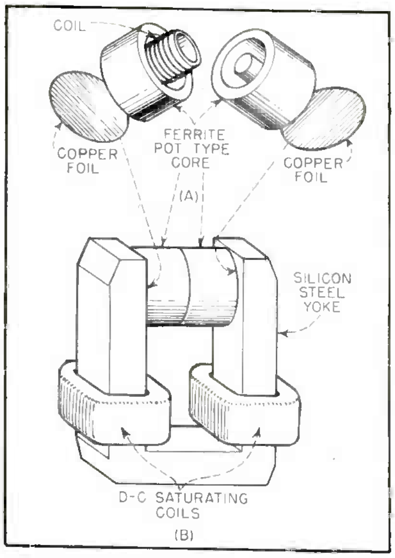


FIG. 2—Pot-type ferrite core and coil are shown in (A). This pot is placed in jaws of silicon-steel d-c magnetization yoke as shown in (B). Copper foil restricts r-f flux from entering steel

The antenna is shorter than a quarter wavelength and its radiation resistance is in the order of 2 ohms or less so it is necessary to have a loading coil at the end of the cable to tune the antenna to the various frequencies of operation.

In the transmitter, the coaxial cable must be effectively matched to the tank coil. The customary method for doing this is to couple the cable directly to the tank coil. However, this type of coupling requires several variable elements and may necessitate the use of an r-f current meter.

A method of matching, that utilizes a d-c meter only and eliminates the need for extra adjustments, has been developed.

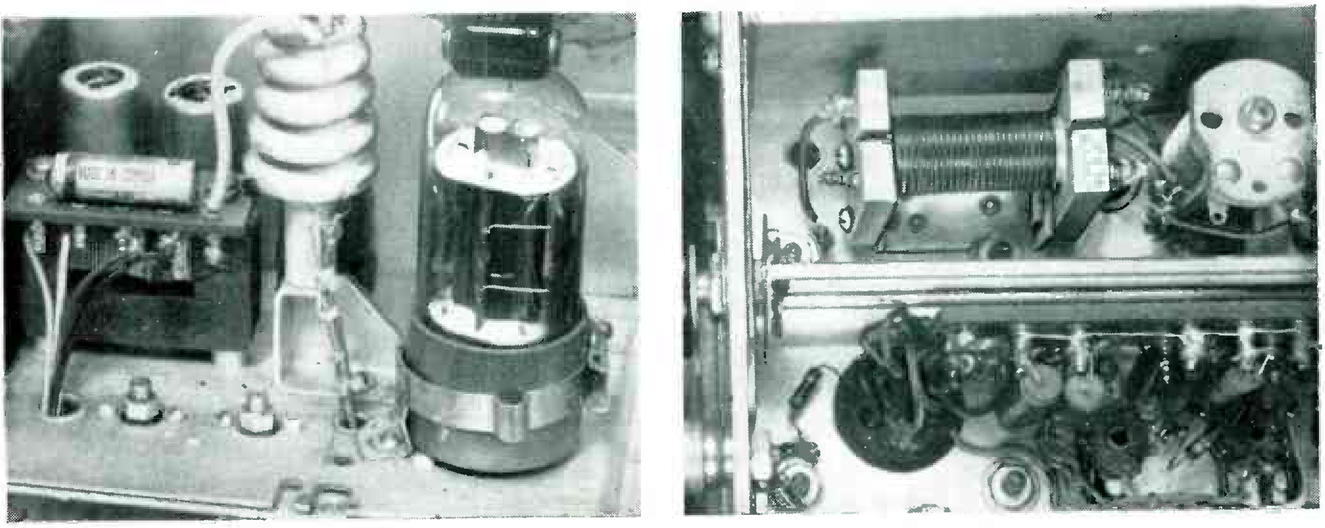
Antenna Loading Coil

If an iron-core coil has a small a-c magnetization superimposed on a d-c magnetization, the effective permeability offered to the a-c is called the incremental permeability (See Fig. 1). This is found to vary with d-c magnetization *B*. The a-c magnetization causes the minor hysteresis loop *a-a*. The incremental permeability may be taken as the slope of the line joining the points *a-a* providing the minor hysteresis loop is fairly narrow.

The slope changes as the d-c magnetization changes from B_1 to B_2. Thus the incremental permeability and hence the incremental inductance may easily be controlled by a variation of d-c magnetization.

A loading coil with a magnetic core material must meet several requirements for this application. The inductance must be continu-

as R-F Tuning Elements



Photograph of marine 12-watt transmitter using saturable reactor tuning inductances shows ferrite core impedance step-down transformer (left). Ferrite core transmitter tank coil has Q of 200 at 3 mc

ously variable from 15 to 100 μh. The Q must be reasonably high throughout the frequency band. The coil must not distort the modulated wave. The resultant coil must operate satisfactorily in the temperature range from—20 C to 65 C.

The maximum permeability of a given type of core material is generally measured using a toroid without an air gap and this permeability is a function of the core material only.

In general, however, the effective permeability is dependent on the air gap in the core and the leakage flux and will approach the value of the maximum permeability when both are reduced. Theoretically the incremental permeability of iron may be varied between the permeability of air and the effective permeability of the core. However, in practice the magnetomotive force necessary to reduce the permeability to that of air is prohibitive and a lower limit is reached beyond which it is not practical to go.

To obtain the necessary inductance range a core with high maximum permeability is necessary and this core material must be available in a shape which keeps the leakage flux to a minimum. These two qualifications are met by a ferrite material and it can if properly used be made to meet the remaining conditions. Powdered iron is not suitable in this application because material having the necessary high permeability results in coils with a Q below the required minimum.

Numerous core shapes and various types of ferrite materials have been tried. The shape chosen is a pot-type core as shown in Fig. 2A. This type of construction keeps leakage flux to a minimum yielding a high effective permeability and the inductance range is covered with a reasonably small number of d-c ampere-turns. The air gap between the two halves of the core keeps the a-c flux from causing appreciable change in loading-coil inductance hence preventing distortion of the modulated output of the transmitter. An inductance range as high as 250 to 1 is obtainable with a gapless core, however, the effective permeability varies so quickly with the applied a-c field that nonlinear distortion of the modulated wave becomes prohibitive.

Effect on Q

It is interesting to note that the Q of the reactor increases with d-c magnetization. In one case a coil wound on ferrite material had a Q of 5 at 4 mc, however, by applying some d-c magnetization a Q of 165 was obtained. Apparently the core losses remain low up to a critical frequency, depending on the type of ferrite, at which time an internal resonance occurs in the core with resultant high losses. By applying d-c magnetization the frequency at which the internal resonance occurs may be raised, thus giving a high Q up to a much higher frequency.[1]

Variation of inductance and Q with d-c mmf for the type of construction shown in Fig. 2B is given in Fig. 3. For the d-c flux path. low reluctance is desirable to keep the necessary mmf to a minimum. The d-c flux path includes a silicon steel yoke and a pot-type core, while the r-f flux path is contained in the pot-type core alone. To shield leakage r-f flux from the transformer iron, a thin copper sheet is placed between the ferrite and the yoke. The improvement in Q afforded by the copper is of the order of 2 to 3 times. This copper sheet must be kept as thin as possible to keep the d-c reluctance low.

The presence of hysteresis in the yoke tends to make reproducibility of results uncertain. However, if the desired loading-coil inductance is always approached by increasing values of d-c mmf the uncertainty

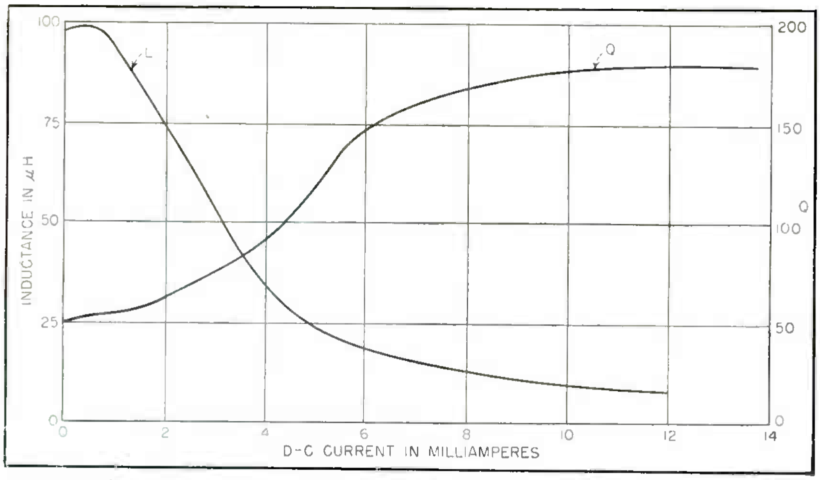


FIG. 3—Curves show effect of changing d-c magnetization on Q

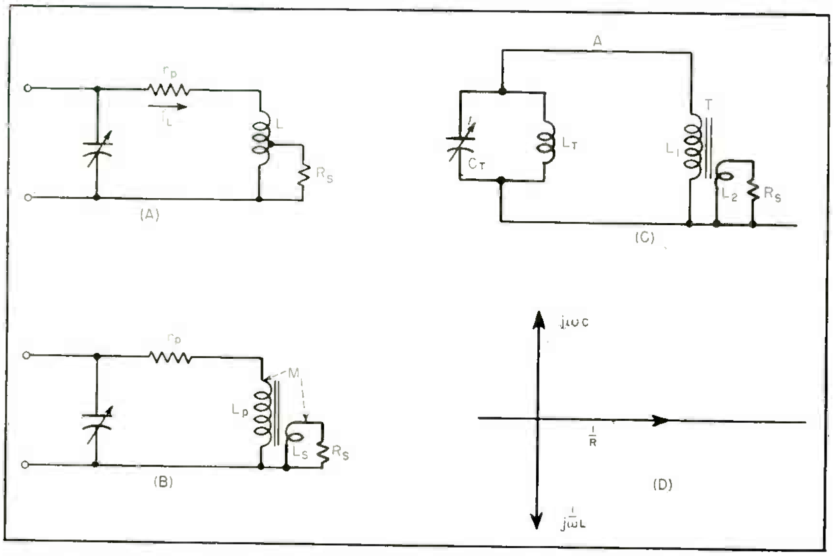


FIG. 4—Evolution of r-f matching circuit employed in 12-watt 2 to 4-mc transmitter using ferrite core tuning elements

is reduced to a satisfactory level. In the actual construction this is accomplished by using break-before-make contacts in the switch.

The stability of the system as regards temperature depends on the permeability variation of the ferrite and the change in resistance of the d-c winding. One of the main drawbacks in the use of ferrites is the comparatively large variation of permeability with temperature. The most suitable material for this application was found to be Ceramag 6 (Stackpole). It was found to have the lowest temperature coefficient among the materials suited for r-f use.

The remaining temperature variation is counteracted by resistors having a negative temperature coefficient. A thermistor with the required coefficient is easily found but a power of the order of 20 milliwatts heats the elements so much that the resistance drops. However, this difficulty is easily overcome by coupling several thermistors in parallel. The result is a circuit element with a negative temperature coefficient and an otherwise constant resistance in the useful current range.

Matching Network

It has always been a problem to match an antenna to the final stage of a transmitter over any appreciable range of frequencies. The conventional design methods usually result in 2 or 3-knob adjustments between the power amplifier anode and the antenna unless reduced output can be tolerated.

In this particular case it is a question of coupling a 50-ohm load to a tank circuit in which the capacitor is the variable element. The obvious solution is a simple tap, as shown on Fig. 4A, together with the equivalent circuit, Fig. 4B. The impedance presented to i_L is

$$Z = Z_p + \frac{(\omega M)^2}{Z_s}$$

where

$$Z_p = r_p + j\omega L_p$$

and

$$Z_s = R_s + j\omega L_s$$

If the transformer is ideal we find

$$Z = \frac{L_p}{L_s} R_s$$

without any reactive components. The Q is obviously zero giving zero discrimination against harmonics. The tank coil must apparently exhibit a leakage between the primary and secondary parts to be at all practical.

Substituting for Z_p and Z_s in the expression for Z gives

$$Z = r_p + j\omega L_p + \frac{\omega^2 M^2}{R_s + j\omega L_s}$$
$$= \left[r_p + \frac{\omega^2 M^2 R_s}{R_s^2 + (\omega L_s)^2} \right]$$
$$+ j\omega \left[L_p - \frac{\omega^2 M^2 L_s}{R_s^2 + (\omega L_s)^2} \right]$$

If ωL_s is large compared to R_s, the coupled resistance and the resulting inductance are independent of frequency. The largest usable inductance is determined by the circuit capacitances. An L_p of approximately 40 μh is the highest inductance the circuit capacitance will allow. The resulting L_s is approximately 1 μh, and ωL_s at 2 and 4 mc is then 13 and 26 ohms respectively. Both are smaller than 50 ohms.

Without going into too much detail it will be clear that both the resistive and inductive components vary with frequency. Attempts have been made to use the geometrical center of the band ($\sqrt{2 \times 4} = 2.83$ mc) as the basis and manipulate the coupling and secondary inductance, but a satisfactory result is not obtainable without the introduction of an extra control such as variable coupling. This complication was not acceptable, however, and as a result this simple method had to be abandoned.

Figure 4C indicates the adopted method. If the transformer T is ideal it will place pure resistance

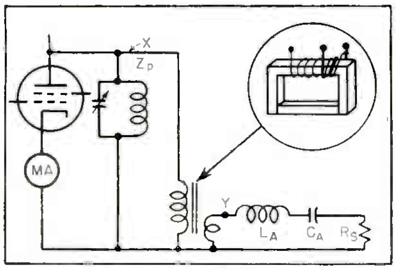


FIG. 5—Output matching circuit uses step-down transformer

$(L_1/L_2)R_s = R_p$ in parallel with the tank circuit.

The tuning will not be affected if the circuit is broken at A. The vector diagram (Fig. 4D) shows the admittances in the network and it is obvious that $j\omega C$ and $1/j\omega L$ will cancel regardless of R.

If we can make a transformer with negligible leakage over the required frequency range we will have a very simple and easy tuning procedure. Referring to Fig. 5, break the circuit at X and tune the tank until the d-c milliameter shows normal dip. Reconnect the circuit. The transformer with its complex secondary impedance will introduce a reactive admittance component across the tank and thus detune it. By tuning L_A to resonance with C_A (the antenna capacitance) the load on the secondary will be R_s alone. The impedance Z_p is now a pure resistance $(L_p/L_s)R_s$ and according to Fig. 4D will not disturb tuning of the tank circuit. No readjustment of the capacitor is necessary.

The transformer uses a core made of ferrite with a very high permeability and an air gap as small as the diamond grinding technique permits. The material is varnished to guard against moisture and the wire is wound directly on the core. The temperature coefficient and material tolerances are not significant as long as the permeability is high.

The coupling has been used successfully in the transmitter. The circuit is broken by unscrewing the coaxial cable connector and tuning of antenna coil L_A is done in the transmitter proper. It is not necessary to touch the tuning unit at the base of the antenna.

The d-c control current may be transferred to the antenna unit through the coaxial cable together with the r-f and from a variable d-c source at the transmitter. Figure 6 shows the circuit. A stable voltage from VR tube V_1 is applied to tuning tube V_2 and a voltage divider consisting of the resistor R and four high-resistance potentiometers in parallel. The d-c flows from the cathode through an r-f choke, the coaxial cable, another r-f choke and through the control coil L_c and the thermistor combination for temperature compensation to ground.

The selenium rectifier S prevents fly-back voltage from developing when the d-c circuit is broken. Winding L_c is on two bobbins with about 20,000 turns on each. Without S, the fly-back voltage could reach 1,200 volts.

The r-f current flows from the secondary of the transformer through the large capacitor C_1 the coaxial cable, another capacitor C_2 and through the antenna tuning coil L_A to the antenna.

A switch selects the desired tank capacitor and grid voltage potentiometer.

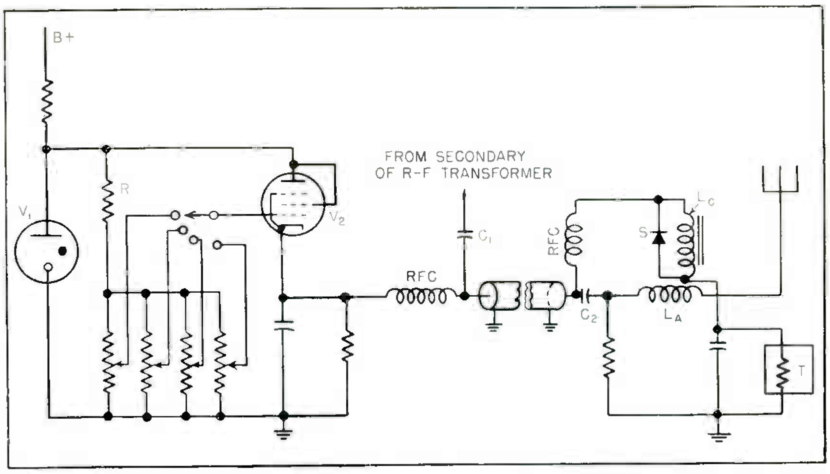


FIG. 6—Circuit shows simplicity of accomplishing automatic antenna tuning as various frequency crystals are switched. Control current for antenna tuner saturable reactor is carried on coax along with r-f

Tank Coil

The successful use of ferrite in the two components treated so far led to the application of ferrite in the tank coil as well. This coil must have an inductance of approximately 40 μh. Such a coil with an air core occupies considerable space. By winding directly on a ½-inch rod of ferrite the length is reduced to 1½ inches. The Q varies from 210 at 2 mc to 180 at 4 mc and the temperature coefficient is so low that no change in inductance is indicated by the standard Q meter in the temperature range 0 to 50 C. The use of ferrite for the tank coil has the added advantage that the Q of the tank circuit stays virtually constant through the band giving constant sharpness of tuning dip.

The loaded Q, however, varies over the band in the ratio of 1 to 2 so the sharpness of the dip with the antenna connected varies. In the actual equipment this was not objectionable as it is counteracted by a suitable taper in the potentiometers. Compensation for the nonlinear variation of inductance L_A with d-c current is obtained simultaneously.

Automatic Tuning

It would be desirable to make the tuning of L_A automatic, thus eliminating the potentiometer tuning, but it was found that a minimum of two extra tubes was necessary. The nature of the transceiver did not justify this extra circuitry. Automatic tuning, however, would satisfy two requirements. Both tuning and temperature variations would automatically be accomplished. Another project may justify its development.

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(1) R. M. Bozorth, "Ferro-magnetism," 1951, D. Van Nostrand Co.

Negative repeller bends electron beam back through output cavity to accelerator electrode. Wideband modulation is accomplished with low modulating power by swinging repeller voltage. Efficiency is high at high-power levels in uhf region

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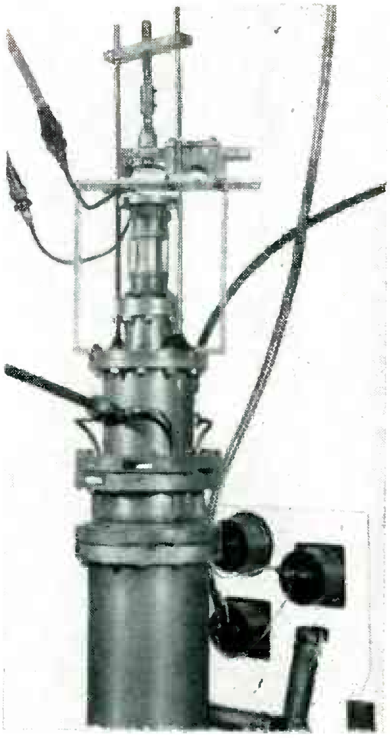

Reflex resnatrons of this type are capable of producing over 2,500 watts at 560 mc with 8-mc modulation

Reflex Resnatron Shows

EMERGING as a byproduct of a conventional resnatron investigation at Westinghouse, the reflex resnatron has exhibited characteristics that show it to be well suited for uhf television transmitter output stages.

The conventional[1,2] resnatron is essentially a two-cavity device, operated so that electrons are density modulated or bunched in the grid-cathode gap of the first cavity and then highly accelerated into the accelerator-anode gap of the second cavity. All high-frequency circuit elements are integral parts of the cavity systems, and dielectrics such as glass are external to the fields to which they could present losses.

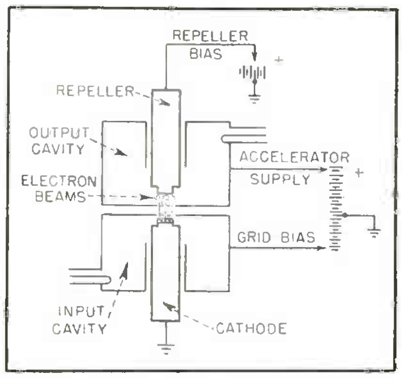

FIG. 1—Simplified cross-section drawing shows action of negative repeller in turning back electron beam

A factor contributing however in even larger measure to the high-efficiency characteristic of this device, is the geometrical confinement of electron trajectories to well-defined, intense field regions. Nevertheless this in turn permits, by the additional use of high voltages, establishment of efficient electron transit-time relationships with respect to the phases of the alternating voltage. This feature of high efficiency is bought, to some extent, at the expense of bandwidth, for the high voltages necessary to transfer energy to or from the electron beam during a single transit demand correspondingly high shunt resistances. This consideration is pertinent in view of certain properties of the reflex resnatron.

Reflex Operation

The reflex resnatron is similar to the conventional resnatron in most respects, except that the anode is operated at a negative potential with respect to the accelerator grid such that the electron beam terminates, not at the anode, but at the accelerator. Figure 1 shows schematically the physical design of the reflex resnatron. Two reentrant quarter-wave cavities in geometrical opposition are traversed axially by an electron beam. The two opposing end faces of the inner cylinders constitute, respectively, cathode and repeller or negative anode. The intervening cavity end faces function as control grid and accelerator, respectively, their insulation for static potentials being maintained by the use of chokes.

As in the conventional resnatron,

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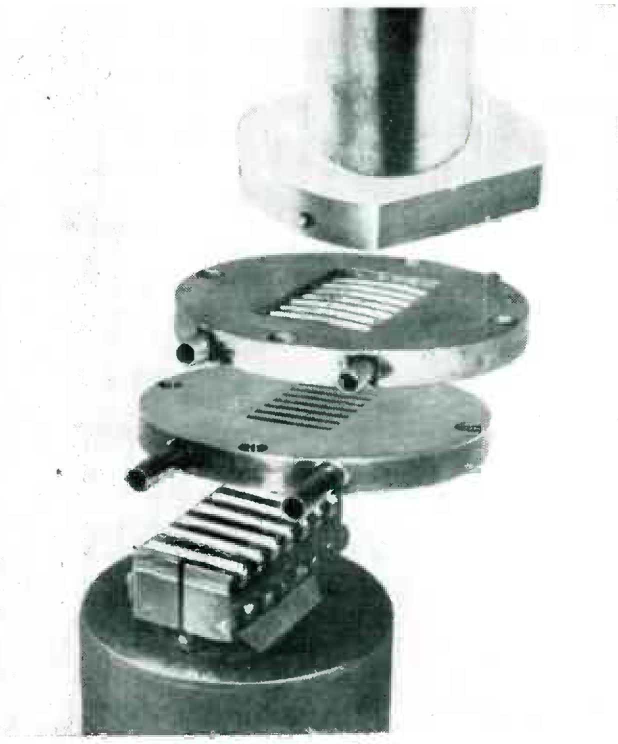
* Now at Lincoln, Kansas



Exploded view of electron-beam-forming section of reflex resnatron shows grid and filament construction. All electrodes are water cooled

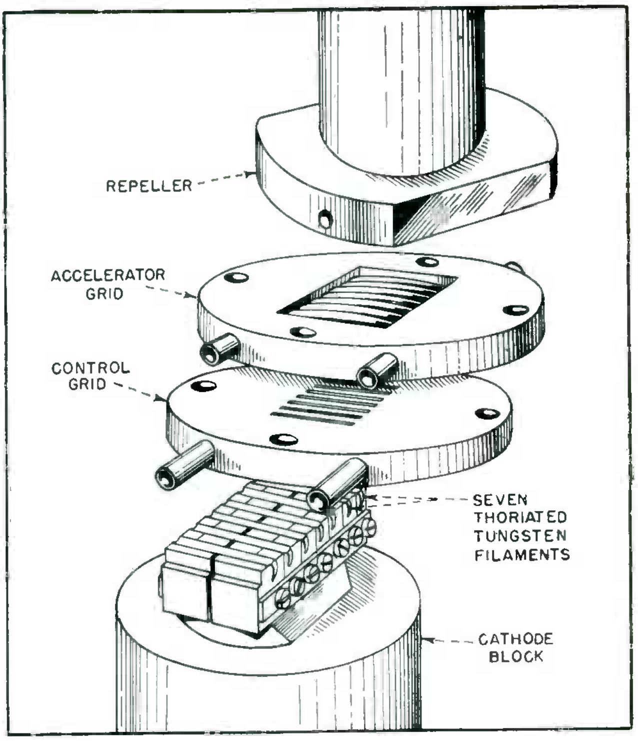


FIG. 2—Seven filaments, control and accelerator grid apertures are accurately aligned to prevent electrons from hitting grids on way to output cavity

Promise for UHF TV

a high-frequency driving field is maintained between cathode and grid which, with a suitable static bias, permits density-bunched groups of electrons to enter into the high static accelerating field between grid and positive accelerator.

It is in the gap of the output cavity that a marked deviation from usual resnatron operation occurs. The electron bunches which enter through the accelerator are confronted, aside from the high-frequency field to which they render work, by a retarding static field which permits them to penetrate the gap up to the neighborhood of the repeller and then reflects them back onto the accelerator.

This twofold interaction with the output field requires only approximately half the opposing high-frequency voltage necessary for single transit. This leads to a reduction of the optimum loaded shunt resistance by a factor of four, as a theoretical limit, and therefore to a corresponding increase in the bandwidth of the output cavity.

Conversion Efficiency

As will be explained later, the efficiencies of energy conversion are rather sensitive to variations of the retarding field so that the output power can be modulated by swinging the repeller voltage. Since few, if any, electrons will arrive at the repeller, one obtains the gratifying result that power modulation is possible with small demands on the modulating system at the wide bandwidth given by the output cavity. Meanwhile the high power and efficiency capabilities, characteristic of the resnatron, remain essentially intact in reflex operation. The necessary grid driving powers can be obtained either in amplifier or oscillator operation. However, the operating conditions of the tube lend themselves particularly to amplifier action.

It is necessary to define the position of the reflex resnatron in the general classification of reflex devices, particularly with respect to the Barkhausen oscillator and the reflex klystron. The Barkhausen oscillator is a triode in which electrons oscillate around a positive grid under the action of a negative anode field. The resnatron cavity characteristics of space and time focusing of the electron bunches are here entirely absent, and hence available powers and efficiencies are small.

The reflex klystron is a klystron oscillator in which input and output cavity are folded back into a single resonator. Its action as a converter of velocity bunched electron groups into density bunches remains however unchanged. In contrast to this, the reflex resnatron, although it maintains much of the time and phase focusing features of the original tube, is essentially a two-cavity amplifier which exhibits a rather unique interaction between electron beam and output field. It is therefore basically different from all other reflex devices.

Transit-Time Effects

The time of flight of the electron during its twofold crossing of the output gap must fulfill a number of conditions for maximum conversion efficiency. The electron entering the gap must first of all encounter a retarding phase of the high-frequency field to render energy to it. This field, in combination with that produced by the static repeller voltage, must bring the electron to rest near the repeller at such a time that when the electron falls back towards the accelerator, it again experiences in the main a retarding phase of the high-frequency field.

Equations can be set up for the ideal of a single electron per cycle, which can be physically realized in an amplifier by permitting a vanishing angle of flow of electrons to pass the control grid. There results then, by the use of Lagrangian multipliers, a corresponding set of conditions. The total transit angle must be 314.4 electrical degrees, equal times being spent by the electron during its transit while the high-frequency field is first aiding, then opposing that of the repeller. Moreover, the repeller voltage has to fulfill a certain condition of resonance with respect to the power and the accelerator voltage. When the repeller voltage is different from its optimal value, the electrons are turned back at different points in the gap so that the subsequent variation in the timing of electron interactions between the electrons and the field will lead to reduced conversion efficiencies. Graphical analysis shows that for the case of normal angles of flow, the theoretical conversion efficiency of the electron energies amounts to nearly 90 percent.[3] Deviations from the condition of resonance will result in loss of output power. Therein lies the possibility of modulation by swinging the negative repeller voltage. It can be shown by the same graphical means[3] that if the repeller voltage is varied through a range of values which are more positive than the resonance point, the changes of power will be much larger than in the more negative range. This is indeed borne out by modulation curves taken with the experimental tube.

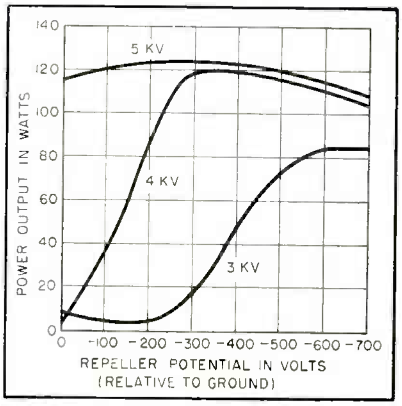


FIG. 3—Modulation curves for low-power operation of reflex resnatron. Note that maximum power peak moves toward low repeller voltage (more positive) region for higher accelerator voltages

Tube Construction

The most important design consideration centers around the electron-beam-forming structure shown exploded in Fig. 2. The structure consists of filaments and control grid, located in the region of highest field intensity in the input cavity, and accelerator grid and repeller, located in the corresponding section of the output cavity.

The filaments consist of U-shaped tantalum channels partly filled with sintered thoria-tungsten powder. The channels serve the triple function of heating the electron-emissive material, supporting it, and initially focusing the beam. The channels are positioned by thin elastic strands which permit lateral thermal expansion of the filaments without appreciable change of the gap spacing. The use of such channels has special merit of reducing interelectrode capacitance.

Other filament designs have also been used with this tube. However, any design has to provide a satisfactory compromise between two conflicting requirements—to combine beam-focusing properties with high field intensities. Beam focusing is necessary to prevent electrons from striking the grids. High field intensities are needed for high emission and short interelectrode transit times. Focusing properties could be tested either with a rubber model or, more effectively, by determining the potential line contours with an electrolytic tank and subsequent mapping of the spacial electron trajectories according to well-known methods. Transit times were determined analytically.[3] In this manner, the necessary recess of the emissive surface with respect to the equipotential sidewalls was determined, with the result that negligible current loss to the control grid was observed.

The openings in the two grids are aligned with the filaments. The repeller of this experimental tube extends a flat surface toward the gap, spaced at such a distance from the accelerator that the resonance condition mentioned above can be fulfilled for sufficient gap penetration of the beams at the desired range of voltages and frequencies.

In usual resnatron practice the anode is provided with an alignment of slots or recesses. This is done to reduce the detrimental effect of secondary electrons by delaying, in the resulting inhomogeneous fields, their appearance in the gap until a retarding phase of the field confronts them.

Such slots do not appear to be necessary in the reflex resnatron. The repeller is struck by but few electrons, and the resulting secondaries may indeed rather enhance the desired effect, while those produced on the accelerator are inhibited by the static field. A flat repeller surface was chosen for this reason, and also because such geometry was particularly suitable for a comparison of experiments and theory.

A fraction of the reflected beam will leave the output cavity through the accelerator openings, but only a minor portion of the electrons will actually enter the cavity twice. This small, but undesired, effect can be further reduced by providing the repeller with a centrally projecting rim or knife edge so as to distort the field somewhat and increase the lateral velocity component of the electrons.

All electrodes are water cooled, particular emphasis being placed on the accelerator which has to dissipate most of the losses and can at present absorb more than 5 kilowatts continuously. Figure 2 shows the center section of the tube. The most suitable coupling conditions for driving and output power were determined by a combination of Rieke charts and Q-circles.[4]

The experimental tube was continuously pumped during operation. This made it possible to rotate the output loop during operation, use demountable gasket joints in the flange connections, and accomplish tuning by moving plungers through sliding vacuum seals. A commercial tube in which all characteristics have been previously established does not need these liberties of adjustment and can therefore be sealed. The cathode block supporting the filaments is split, the two halves being separately water cooled and insulated by a thin mica sheet so as to maintain the filament heater voltage in the order of 2 volts.

Performance

Initially the repeller of the tube was provided with two wide-spaced fins permitting the emission from filaments to approach the surface through a moderately inhomogeneous field. This made it possible to operate the resnatron either conventionally, while the anode was positive (or of equal potential with the accelerator), or in reflex action with the anode as a negative repeller.

The effect of secondary electrons in conventional operation was in this construction already very much reduced. At the same time reflex operation was still fairly effective since the same resonance condition was valid for most of the electrons. The merits of the two types of operation could then be compared directly. It was found that the reflex resnatron produced nearly the same amount of output power, but more than double the bandwidth when compared with the resnatron.

So far the results obtained for the reflex resnatron with flat repeller are as follows. At a frequency of 560 mc power outputs of 2,600 watts have been obtained with a bandwidth of about 8 mc, a power gain of about 5, and an overall efficiency of 38 percent, while the repeller was held 6,500 volts negative with respect to the accelerator potential of 8,000 volts.

Of particular interest are the modulation curves which were measured statically by varying the repeller potential and observing the resulting output power for various parameters of the accelerator voltage. The output power depends, of course, also on the value of the beam current. Thus Fig. 3 shows modulation curves for three operating points of the accelerator voltage at low currents and correspondingly low powers. Figure 4 shows such curves at relatively high currents and powers. Although the two charts were taken with small intervening changes in the construction of the tube and much changed grid driving conditions, a typical behavior is demonstrated in both.

First of all, the repeller potential for maximum power shifts towards more positive values when the accelerator voltage is increased. This can be qualitatively explained by stating that the effect which greater velocities of entry into the gap have on the transit times of the electrons and their resonance with field variation can be cancelled by a longer path or, in other words, deeper gap penetration.

Secondly, an asymmetry of the modulation curves is noted inasmuch as the increase of power with repeller voltage is much steeper when coming from the positive side towards the maximum than when approaching it from negative values. The reason for this lies in the fact than when the transit times become longer than the optimal value as a result of more positive repeller voltages, the electrons arrive at the accelerator during a more positive phase of the high-frequency field from which they then draw power. If however the transit times are somewhat too short, the electrons arrive in any case against a negative phase with much less variation in conversion efficiency.

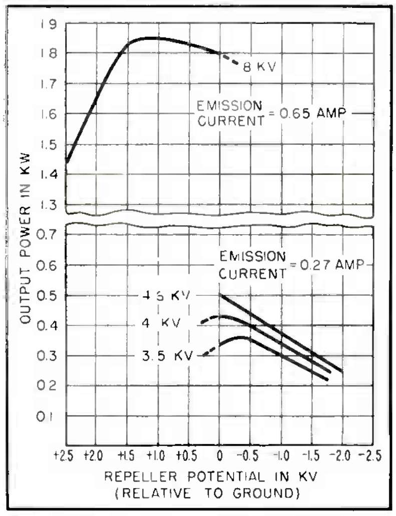


FIG. 4—At higher output levels, linear modulation characteristics are also obtainable. Curves for various accelerator voltages are shown

It is obviously perferable to modulate the reflex resnatron on the steep part of the curve, if the current to the repeller is held negligible. The power necessary for modulation is then almost entirely that required by the static interelectrode capacitance for the variation of the repeller potential at signal frequency.

New designs are possible which will utilize the reflex principle somewhat more effectively, for example by a further gain in bandwidth. Such a scheme would, for instance, include the separation of the static repelling field from the cavity gap which could be crossed twice or more by the beam. These latter schemes lead however beyond the scope of this discussion which demonstrates that the reflex resnatron is not only interesting in its own right, but might well claim a highly competitive role in the uhf power field.

The authors wish to express their appreciation for the many helpful discussions and suggestions by Dr. J. W. Coltman.

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Coast Guard cutter "Courier" assigned to Project Vagabond can broadcast on short waves from inverted pyramid antennas forward. Receiving whips are aft

Project Vagabond

Floating radio relay station carries complete receiving and recording equipment for programming 150-kw broadcast transmitter and two 35-kw high-frequency transmitters. Designed for interim service at a shoreside location, the installation could also operate at sea using special antennas

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VOICE OF AMERICA'S need for a powerful, portable radio-broadcasting plant is met by the installation aboard the U. S. Coast Guard cutter "Courier." It will serve principally as a temporary relay station during the construction period of permanent overseas relay bases.

Avoiding the approximate 18-month delay between acquisition of an overseas site and the completion of construction, the "Courier" can start broadcasting within a few hours of arrival at a new location. Another advantage of the floating relay station is its flexibility—the ability to move into areas dictated by political necessity, and the ability to shift location as a deterrent to Soviet jamming.

The vessel used for the project is a C1-M-AV1 Maritime Administration coastal cargo ship built in 1945. It has several advantages for this project. A smaller vessel would force undue crowding of electronic equipment. Excessive ballast would be required to get a larger ship down in the water. The "Courier" has its engine room and stack aft, thereby facilitating the installation of the balloon deck amidships, directly over the medium-wave transmitter.

Operations

The station is designed to receive short-wave broadcasts from VOA transmitters in the States and relay them simultaneously on regular broadcast and short-wave frequencies, thus increasing the coverage of the VOA at strategic points overseas. The station can also originate programs in its own studio, or record programs received on short waves, for playback at peak local listening periods.

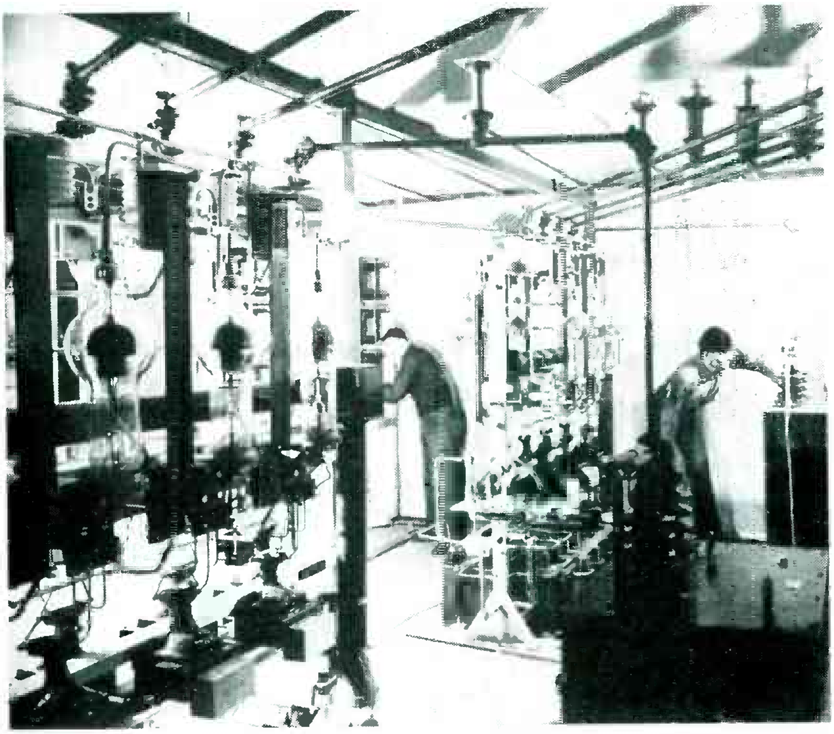
The main transmitter is RCA BTA-150-A broadcast equipment rated at 150 kw antenna power. It uses four 9C21 water-cooled tubes in the final amplifier, high-level-modulated by four more 9C21's. The antenna for this transmitter, which operates anywhere between 540-1,600 kc, is a $\frac{5}{8}$-in. diameter phosphor-bronze cable supported by a Navy ZKA barrage balloon.

Normally, the balloon carries 600 ft of $\frac{1}{2}$-in. nylon line between the balloon junction fitting and the top of the antenna. The nylon serves the dual purpose of getting the balloon above ground-turbulent air currents and absorbing the shock of sudden gusts. The ZKA is 69 ft long, 35 ft in diameter and has a static lift of 600 lb at sea level. It has a ratio of lift over drag of about 1.8 to 1, so that its lift increases as wind velocity increases.

Although it tends to fly into the wind like a kite, the ZKA has flown in 40-knot gusts without deviating from the vertical position by more than 30 degrees. A special winch, insulated from the deck by large tower-base insulators, makes it convenient to change antenna length for different frequencies without cutting the cable. A special 36-in. insulator with corona shield is used at the top of the antenna.

The floating relay station carries four 350-ft steel towers in the hold. They are used for a directional array on medium waves whenever the vessel is anchored at a fixed location for an extended period of time. The towers are fed by an open six-wire line mounted on pilings. An emergency antenna can also be used on medium waves. Strung between the masts, this antenna is not very efficient and would be used only as a last resort.

Short-wave transmitter (left) and 150-kw broadcaster (center) are located around hold. Massive hatch in deck (this side of control console) gives access to power-supply equipment in lower hold



Power supply for 150-kw transmitter is in lower hold. Rectifier units shown here are placed behind transmitter

Two Collins high-frequency transmitters are also installed aboard the "Courier." These are modified type 207-B1 equipments rated at 50 kw for c-w telegraph and 35 kw broadcast power to the antenna. The antennas for the two short-wave transmitters were developed by Weldon & Carr especially for this project. They are designed to maintain a fairly constant input impedance over a range of 3.5 to 1 in frequency. Nominal input impedance is 175 ohms, making it convenient to feed them with a 12-in. square-duct form of unbalanced line with $\frac{3}{8}$-in. inner conductor.

The antenna is essentially one-half a folded dipole, mounted vertically, with the center portion expanded to broaden its usable bandwidth. The feed end is mounted on an insulator and the far end is bolted directly to the ship's hull.

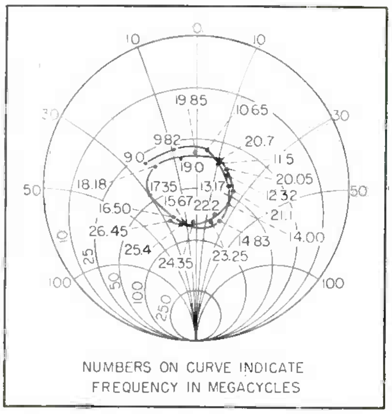
A combination studio, control room and receiving room is located aft of the ship's wheelhouse. Eight vertical whip receiving antennas are spaced around the afterpart of the ship. A rejection filter is installed at the base of each whip antenna, to attenuate the frequencies being used by the shipboard transmitters. Each antenna is brought in by coaxial line to a patch panel in the receiving room.

Two Collins-Crosby dual-diversity exalted-carrier receivers and two Northern Radio-Hammarlund dual-diversity receivers are installed in the receiving room. Two of these receivers are equipped for either frequency-shift teleprinter or broadcast reception. Two Link Radio 960-mc stl receivers are also permanently installed. The 960-mc program transmitters and their 4-ft parabolic antennas are carried in the hold and are set up whenever the vessel is stationed long enough in one spot to put up a shore-based receiving station with triple-diversity rhombics.

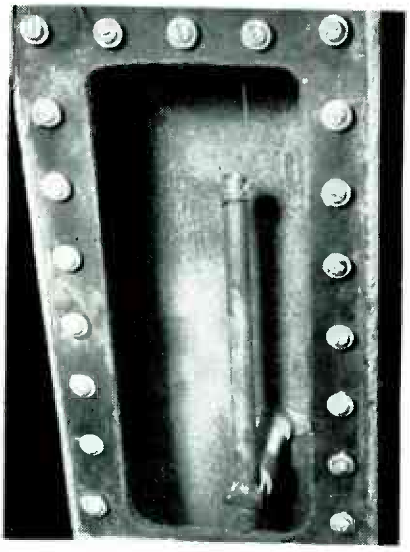
A 50-watt 250-mc cue-circuit transmitter-receiver is used between the shore-based receiving station and the ship.

A broadcast consolette in the receiving room controls two Fairchild gimbal-mounted turntables equipped for recording and playback. Two Ampex tape recorders are also installed in the receiving room.

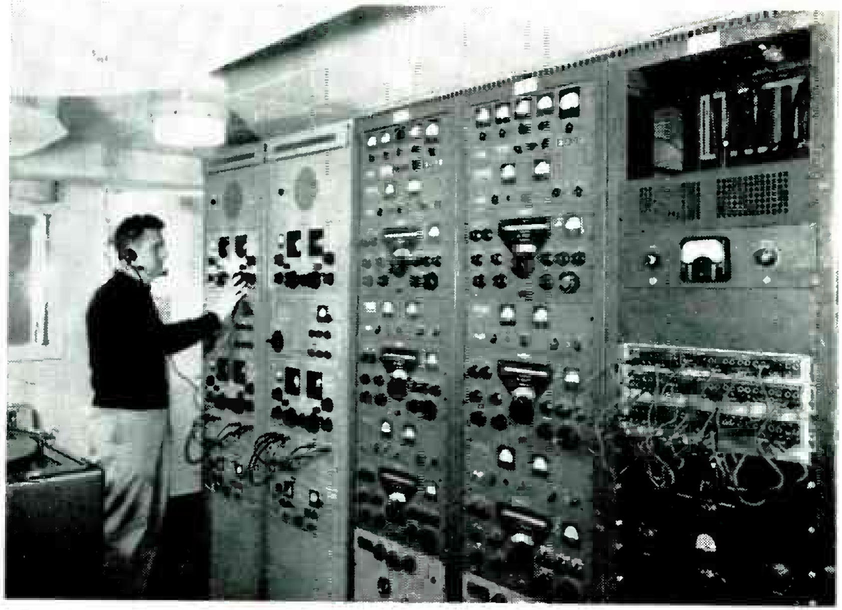
The communications room is lo-



Smith-chart plot of the special short-wave broadcast antenna



Massive coaxial line with temporary lead to broad-band antenna



Receiving equipment and recording devices are aft. Direct or delayed broadcasts can be arranged using diversity receivers shown

Inverted pyramids are mounted upon special superstructure. One end is grounded and other is mounted upon insulator

cated directly below the receiving room and contains necessary radioteletypewriter printer equipment for two-way operation, either encrypted or in plain language.

Special precautions were taken to prevent damage to equipment in heavy seas and from engine vibration. All three of the large transmitters are set on foundations comprising a 3-in. layer of cork and 8-in. reinforced concrete slabs.

Sway bracing welded to bulkheads prevents large transformers and other tall units from shifting in rough weather.

Project Vagabond was completed under the direction of George Q. Herrick, Chief, Division of Radio Facilities, Plans and Development, Broadcasting Service, U. S. Department of State.

Electro-Optical Shutters for Ballistic Photography

Equipment developed for Kerr electro-optical shutters gives either a single pulse or ten identical pulses spaced 25, 50 or 100 microseconds apart. A modified line modulator employing capacitor discharge through a type 4C35 hydrogen thyratron and very low-impedance load produces a 50,000-volt pip

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As a solution to the problem of high-speed photography of self-illuminated objects in exterior ballistic studies, it was decided to utilize the properties of the Kerr electro-optical shutter. To accomplish this it was necessary to design an electronic circuit that would produce either one pulse, one microsecond wide with a magnitude of 40,000 volts, or ten similar pulses, spaced either 25, 50, or 100 microseconds apart.

Line Modulator

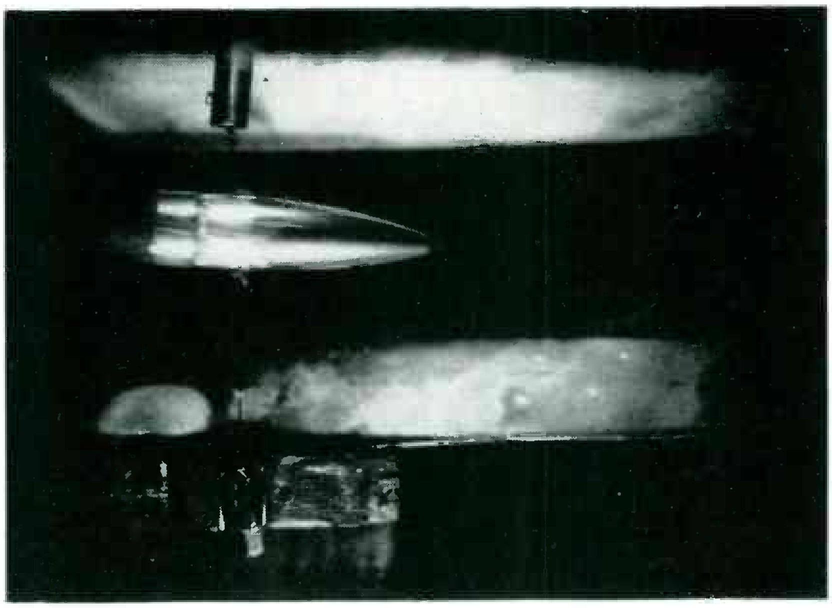
Resort was made to the line-modulator method in which the pulses are generated at the output-voltage level. The approach used was that of charging a capacitor and then discharging it by means of a switch through a very low-impedance load. The R-C time constant of the circuit could be so low that the output voltage would actually be a pulse of very short duration. The capacitor used was 0.02 microfarad and the load was 50 ohms as represented by a loaded pulse transformer. The time constant of this circuit was therefore one microsecond. The switch used was a 4C35 hydrogen thyratron whose purpose was to reduce its impedance to a minimum during the pulsing operation.

When the thyratron fires, the voltage drop across it is approximately 70 volts and therefore the entire capacitor voltage (which is the B-supply voltage) is developed across the transformer. The circuit is actually a modified line modulator circuit in that the pulse width is determined by the high-voltage circuit. One advantage of this system is that the pulse width can be varied within very wide limits merely by switching in different size loading resistors.

Because the width and shape of the output pulse are determined in the high-voltage section, the precision needed to shape the triggering pulse is greatly reduced. The 4C35 thyratron operates satisfactorily as a switch because it satisfies the following criteria. The firing time can be precisely controlled. The tube conducts current until the network is discharged and then becomes an open circuit. The voltage drop across the tube while conducting is sufficiently low. Peak operating voltage is sufficiently high. The tube performs satisfactorily with respect to temperature, pressure and age; and it has satisfactory life.

Recovery Time

For use in a multiple-shot case one additional requirement is necessary; namely, that the tube recover in a shorter time than the time required between pulses. In this case the deionization time determines the maximum repetition



A 0.50 caliber projectile travelling at approximately 3,000 feet a second breaks the trip wire (at its center) to operate the flash system

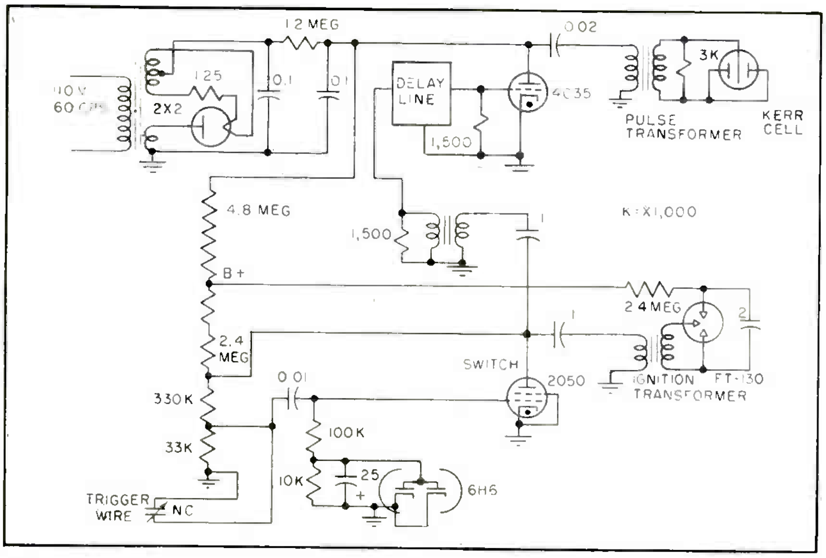


FIG. 1—The first system used a single-shot pulse generator to trigger a stroboscopic flashlamp and a Kerr cell

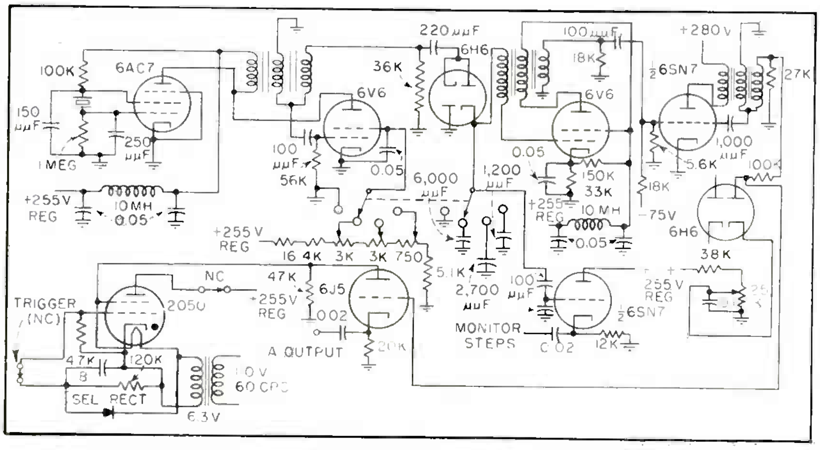


FIG. 2—Pulse generator and multiple trigger circuits for several rapidly recurring photographs are used to energize the thyratron counters in Fig. 3

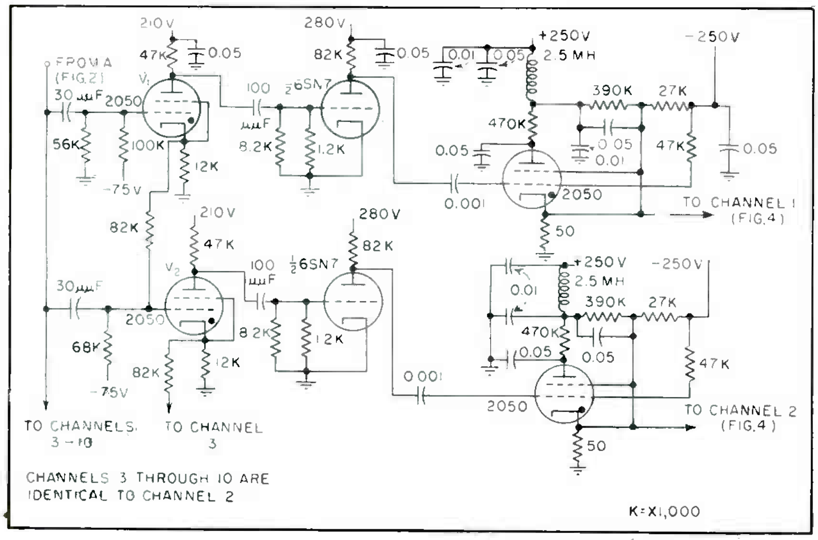


FIG. 3—Two sets of counter amplifiers and driver tubes are shown; ten are used. They make possible multiple shots of the same projectile

rate that can be used. Extensive tests showed that the 4C35 hydrogen thyratron could not serve for the pulse repetition rate required. Two methods were investigated for cutting down the deionization time. First, a slight mismatch was introduced in the circuit to provide an inverse voltage. Second, a negative grid bias was introduced to sweep out any positive ions remaining in the cathode space.

Using these methods it was found that the minimum deionization time possible was about 70 microseconds. Since a deionization time greater than 25 microseconds could not be tolerated, it was decided to use a circuit that would contain 10 hydrogen thyratrons. In this fashion the deionization time of any thyratron would be unimportant.

Single-Shot Circuit

Figure 1 shows that the 2050 thyratron switch will normally be cut off by the bias on the 6H6 rectifier. This will allow the two 1-μf capacitors in the plate circuit of the 2050 to charge up to approximately 250 volts. It will also allow the 0.02-μf capacitor in the plate circuit of the 4C35 to charge up to approximately 5,000 volts and the 2-μf capacitor in the light source unit to charge up to approximately 1,500 volts.

When the triggering wire is broken, a positive pulse from the bleeder is applied to the 2050 grid through the 0.1-μf grid capacitor. This permits the 2050 to fire and short the two 1-μf capacitors in its plate circuit to ground. One of these capacitors discharges through the primary of the ignition transformer in the light-source unit, producing a secondary voltage of sufficient amplitude to break down the FT-130 tube. The ionization in the flash tube allows the discharge of the 2-μf light-storage capacitor through the FT-130 tube, thus giving off a brilliant flash of short-duration light.

The other 1-μf capacitor in the 2050 plate circuit will discharge through the primary of a small pulse transformer. The resulting secondary pulse is then delayed about 3.75 microseconds before it fires the 4C35 hydrogen thyratron.

The firing of the 4C35 switch shorts the 0.02-μf capacitor to ground, allowing it to discharge through the primary of the pulse transformer. The secondary voltage is applied to the Kerr cell, thus opening the electro-optical shutter. The delay line allows the shutter to open when the light flash is at its peak value.

Multiple-Shot Circuit

The low-voltage pulse-forming circuit shown in Fig. 2 operates as follows. The type 6AC7 oscillator comprises a 120-kc crystal oscillator driving a 6V6 blocking oscillator at the same frequency. This in turn feeds a 6H6 diode counter circuit that has counting ratios of 12-to-1, 6-to-1 or 3-to-1 with output frequencies of 40, 20 and 10 kc. The output of the counter triggers a single-shot blocking oscillator (6V6) whose repetition rate depends upon the counter ratio. The output is then amplified in half a 6SN7, sent through a 6H6 clipper stage and then put into a type 6J5 output cathode follower.

With the hydrogen-thyratron counter circuit described below for triggering the high-voltage circuit, it is not necessary to limit the number of pulses to ten. The counter will give only ten output pulses for ten-plus input pulses. It is therefore only necessary to determine and control the starting time of the pulses. This is accomplished by supplying the plate voltage of the cathode follower through a 2050 thyratron that is used as a trigger tube. The output tube will then be inoperative until the thyratron is fired, after which it will act as a cathode follower and supply pulses to the thyratron counter circuit from the blocking oscillator.

The second half of the 6SN7 is used as a cathode follower to provide oscilloscope monitoring of the signal output from the diode counter.

A series of pulses from the circuit of Fig. 2 is fed into the counter circuit of Fig. 3 that uses ten 2050 thyratron tubes. The purpose of this ring counter is to divert the first ten pulses to as many 4C35 hydrogen thyratrons. Bias is applied to the grids of all the 2050 thyratrons so that they are normally nonconducting. However, the bias in the first tube is made less than that for the other nine tubes. Each 2050 has a load comprising both cathode and plate resistors. The plate resistors are made small enough so that when a tube fires, it will continue to conduct. The triggering pulse is of such magnitude that only the first tube with low bias will fire, even though the pulse is applied to all the tubes. The grid return of V_2 is to the cathode of V_1; hence the voltage drop across the cathode of V_1 is applied in opposition to the bias on V_2, lowering it sufficiently to fire on the next pulse. The firing of V_2 lowers the bias on the third tube in a similar fashion, and this sequence continues until all of the ten tubes fire.

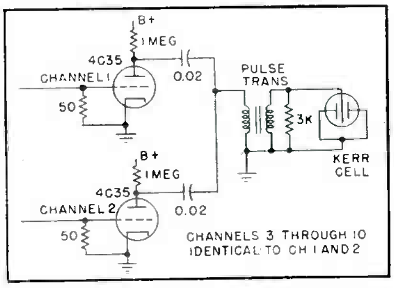


FIG. 4—Kerr cell is driven to multiple operation by thyratrons triggered from ten channels

If it is desired to fire only n tubes, the $(n+1)$ tube may be removed, thus breaking the cycle. Once the tubes have been fired, further trigger pulses have no effect on them. The circuit is reset by opening the plate-voltage supply lead.

A single stage (a half 6SN7 and grid-driver 2050) follows the output of each channel of the thyratron counters to pulse the high-voltage circuit.

Kerr-Cell Gates

Referring to Fig. 4, the high-voltage circuit consists of ten 4C35 hydrogen thyratrons. The cathodes of all the thyratrons are grounded, and from the plates 0.02-μf capacitors are connected to a common pulse transformer. The other side of the pulse transformer is grounded. To decrease loading effects on the power supply, the plates are returned to the high voltage through one-megohm resistors. The impedance of the grid circuits has to be maintained at a low level to prevent the first tube from triggering the second tube before the second pulse arrives.

This would normally happen because the storage capacitor and the primary of the pulse transformer form an oscillatory circuit even though it is so damped that there is only one overshoot. The overshoot of the pulse reaches the grid of the second tube by dividing between the plate and grid capacitances. If the grid impedance is high enough, voltage is developed across it to fire that tube. Reducing the grid resistor of the 4C35 to 50 ohms remedies this situation.

The high-voltage power supply uses a 2X2 in a conventional half-wave rectifier circuit whose output voltage can be varied from 0 to 6,000 volts. This voltage may be adjusted and observed from the lower front panel.

Performance

Tests on the completed circuit show that the desired output of one-microsecond pulses, up to 50,000 volts in magnitude, with the appropriate spacings of 25, 50, or 100 microseconds can be obtained. It is necessary to have all leads shielded, r-f filters in the B+ leads of the trigger tubes (2050's), and bypass capacitors in the filament, power-supply, and a-c supply lines to insure satisfactory operation of the circuit at maximum voltage (6,000 v input). Otherwise, stray pickup and noise that appear in the plate circuit of the 2050 counter tubes would cause the trigger tubes to fire continuously. This is undesirable because the hydrogen thyratrons keep firing sporadically. Also as an aid in reducing the stray pickup, the grid-to-ground impedance of the 6SN7 amplifiers is reduced by shunting the 8.2K grid-to-ground resistor with a 1.2K resistor.

The equipment described was developed under a contract between New York University and Frankford Arsenal, Department of the Army, by the Research Division, College of Engineering.

Fabricating Circuits

CIRCUIT ANALYSIS has been facilitated at Loyola University by a plastic-breadboard method of mounting components.

Anyone engaged in the development of electronic circuits is sure to find this method more convenient than the chassis, breadboard or haywire layouts in general use. As the photograph shows, the method is essentially that of imbedding circuit components in a sheet of thermoplastic material. Many plastics currently available, such as Plexiglass, Lucite and Polystyrene work very nicely. The technique is currently in use at Hughes Aircraft for electronic circuit development.

Besides an inherent tendency to appear neat, the plastic sheet provides a maximum of mounting convenience and access, together with a minimum of time and effort spent in fabrication. Many variations in actual procedure exist, and the creative minds of development men will find a fertile field for their own innovations. Some of the methods used thus far are described below.

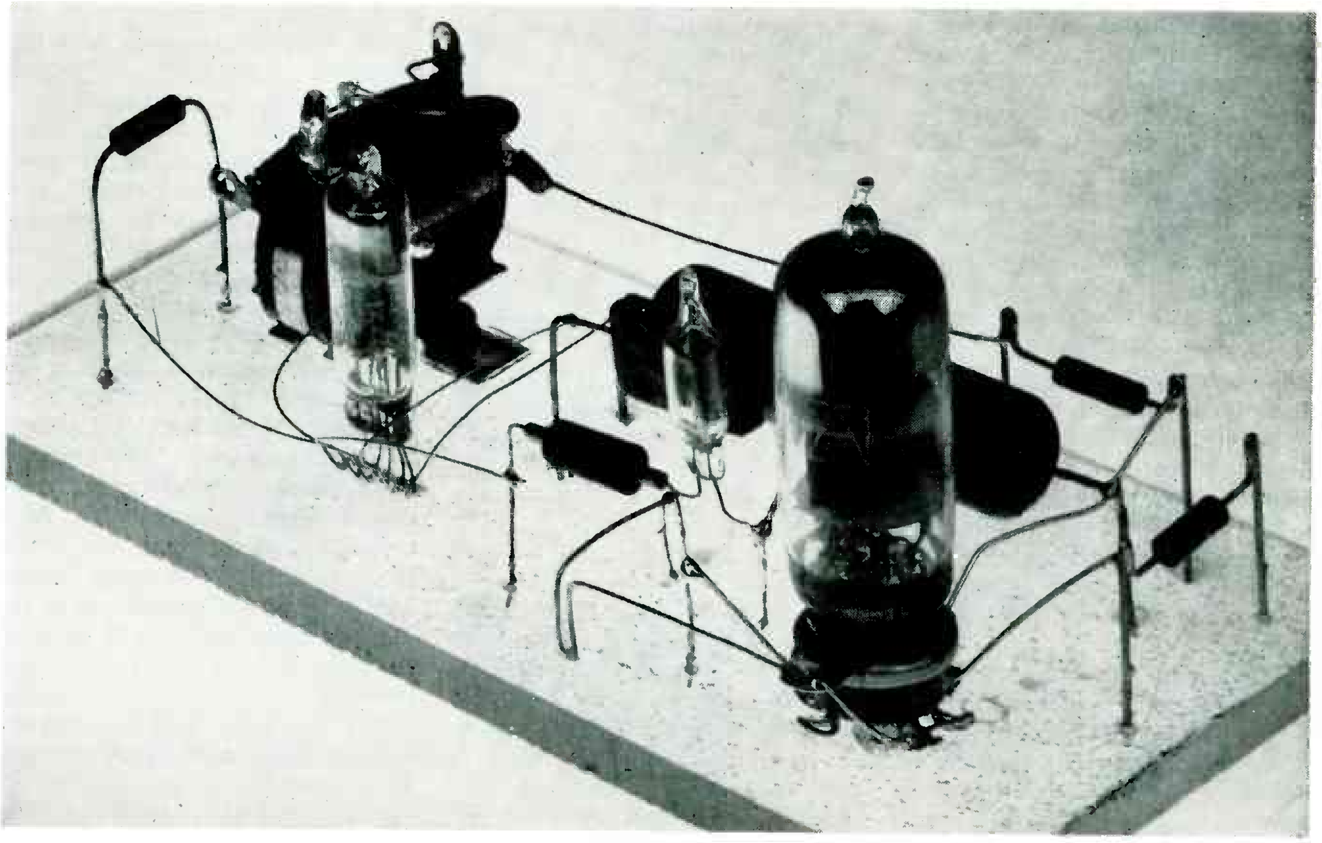
Mounting Small Components

To mount small resistors and capacitors, simply apply a hot iron to the component lead and push it into the plastic material with pliers. The heated wire melts the plastic and slides in easily. When the plastic cools a very strong supporting bond results. Conventional mounting procedures using terminal boards have the disadvantage of terminals being either too far apart, or, worse, too close together. The plastic sheet provides any desired amount of spacing and the support leads themselves become handy solder terminals.

For development work, a large economy of components is achieved, since it is unnecessary to cut the leads or bend them around terminals. Another important time-saving factor lies in the exclusive use of bare wire for interconnections. This is possible since any long wire may be held rigidly in place by simply pushing it into the plastic with the hot iron tip.

Mounting Larger Parts

Components such as tube sockets, transformers and potentiometers can usually be mounted in a secure fashion merely by heating appropriate parts of them with the iron and pushing them into the plastic material. The photograph show how this can be done. Should a given component require the use of screws, several alternative schemes for inserting them work



Components mounted on a plastic breadboard with a hot soldering copper. Using the technique for the first time, a student prepared this layout in five minutes

on Plastic Breadboards

Quarter-inch thermoplastic sheet supports components during circuit development or for class demonstrations. Wire leads, lugs or hardware can be imbedded in the plastic using a hot soldering iron and slight pressure. Method is quicker and more convenient than conventional breadboard layouts

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nicely. Most people are familiar with the ease with which these plastics may be drilled or tapped.

A quicker method is merely to push small screws into the plastic while holding a hot iron to them. the plastic flows readily into the threads forming a tight bond similar to that found in fiber lock-nuts. When the plastic cools, the screws can be turned out for changing parts and perfect threads will remain in the hole for reinsertion.

Drilling Holes

For larger screws and items such as phone jacks and potentiometer shafts, a different approach is useful. Using an iron tip with a diameter about the same as the threaded part, the hot tip is forced through the plastic sheet and held a moment to allow the surrounding plastic to soften. The iron is then removed and the threaded part quickly inserted. It must be held in place while the plastic cools. Perfect threads will form about the shaft and the part may be tightened or loosened as desired.

Connector Plugs

When plug-and-jack contacts are needed for power connections to the chassis, a locating jig is easily made by drilling out a piece of thermosetting (heat-resistant) material such as Bakelite, Micarta or Masonite. Stiff wires can be inserted into the thermoplastic sheet to form the needed plug. Such an arrangement permits easy connection to chassis in use and eliminates the lead cable problem when the chassis are stored.

Teaching Circuits

A small plastic sheet is marked with the schematic diagram of a circuit and the components mounted as suggested, each one positioned next to its corresponding symbol. A View-Graph or Opaque projector is used to project an image of the circuit upon a large screen. Power is applied and the circuit is functioning while this is done. A projection oscilloscope is used to display the waveforms present at various circuit points upon the same screen. A large image of a vtvm is also projected on the screen to show voltage readings. This is a most effective method of bringing together the theoretical development of circuit analysis and the practical application of such theory. Using suitable calibration devices, actual circuit constants are inserted into the general formulas developed and results displayed for direct proof of the theory under discussion.

The Opaque projector is better for preliminary work since it shows the circuit components in their true colors and aids in teaching color codes and emphasizing voltage ratings. When the circuit components are carefully arranged to lie near the same plane, the depth of focus permits lettering or numbering on small parts to be read easily. This type of projection requires a semi-dark room however, and note taking is difficult unless shadow boxes are used to illuminate writing areas.

For class participation work, or demonstration laboratory, the View-Graph, which does not show color, but instead projects a clearly defined silhouette, works nicely. The View-Graph may be used in fairly strong light, enabling students to collect data and take notes. If the group demonstration lectures are followed by individual experiment sessions on the same plastic-circuit preparations, it is found that the coverage rate and comprehension of material presented are both greatly increased.

In advanced laboratory work where actual fabrication or modification of circuits is done, a standard size plastic sheet 6 by 3 by ¼ in. is used together with an aluminum support rack. For this purpose the plastic behaves co-operatively, holding components rigidly or releasing them readily upon application of heat. The components for the chassis in the photograph were all mounted in five minutes by a student who was utilizing the technique for the first time. The economy achieved by repeated use of the same components enables students to have a more expensive group of parts for research or development work than would otherwise be possible.

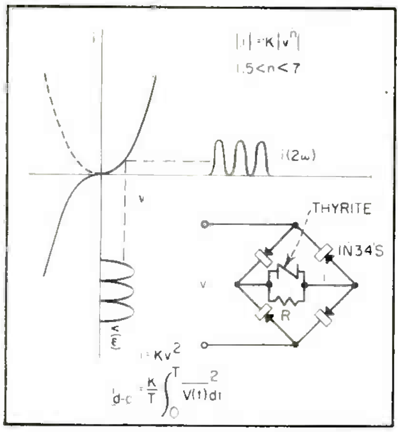

FIG. 1—Full-wave crystal diode switch converts zero-point symmetry to equivalent zero-axis symmetry

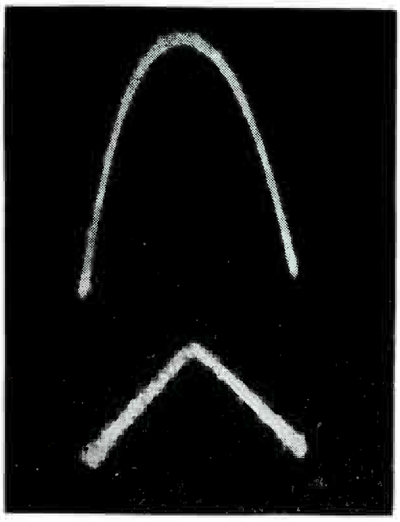

FIG. 2—Transfer admittances for squarer (bottom) and Thyrite network replaced by linear resistor (top) are shown. Parabola is indicative of $i = kV^2$

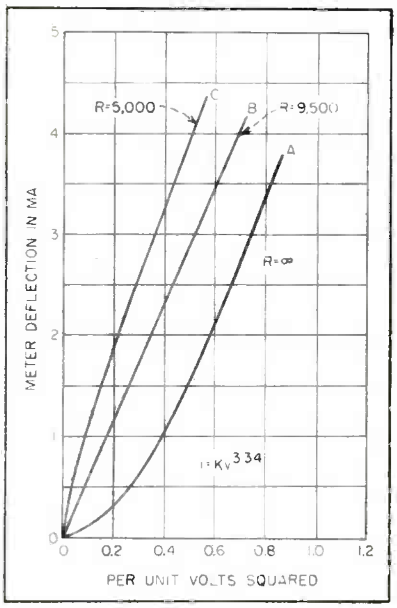

FIG. 3—Proper shunt resistance will allow for good squaring action over current range indicated

Mean Square

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IN EVALUATING complex voltage and current waveforms it is most significant to make comparisons in terms of root mean square values. Popular types of power instruments have been available for many years that read true rms values up to frequencies of about 500 cycles.

At audio frequencies, the conventional types of vacuum-tube voltmeters are generally peak or average-reading instruments. Although the scale is calibrated to indicate the rms value of a sine wave, the reading is ambiguous for complex waveforms. An instrument that indicates the rms value of a complex waveform at audio frequencies with high sensitivity, is a valuable tool in the study of nonsinusoidal waveforms.

One rms voltmeter commercially available is the Diotron[1]. This instrument reads the heating capacity of a waveform by the novel use of an emission-limited diode. Unfortunately the diode emission depends on its previous history (overloads) and the associated d-c amplifiers require frequent zero-setting. Another rms indicator is included in a commercial power level recorder[2], which employs vacuum tubes for squaring the input signal. This technique is rather popular in squaring circuits[3, 4]. The critical choice of tubes and operating points is a basic limitation to this technique.

This article describes a voltmeter which by using nonlinear elements instantaneously squares any input signal. A D'Arsonval meter movement in the output gives an indication of the mean square of that input signal. The meter reading is linear in volts squared and by recalibration, the square root of the mean square can be read directly. The nonlinear network requires a low-impedance driving source and a preamplifier

Squaring Circuit

The squarer employs Thyrite as the nonlinear element. This material has an extreme voltage coefficient which results in an instantaneous volt-ampere characteristic which is symmetrical about the origin and follows:

$$|i| = k\,|v|^n$$

where n varies between 1.5 and 7. Thyrite materials which have the lower resistance range are generally the least nonlinear or have the lower exponents.

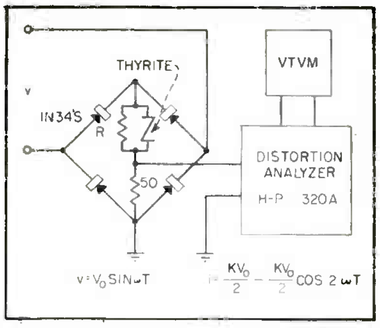


FIG. 4—In dynamic squaring technique used, minimum second harmonic distortion is sought with sinusoid applied

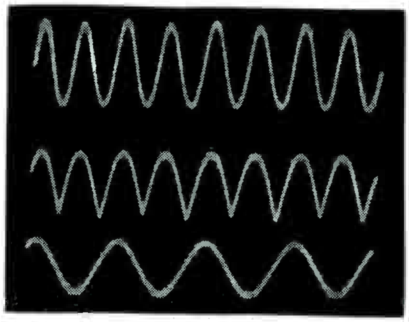
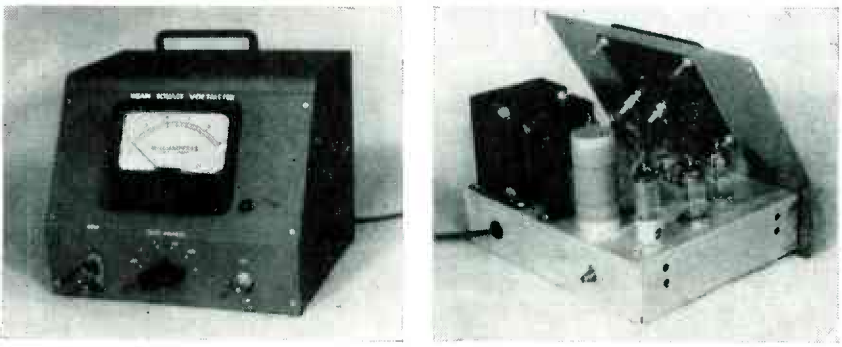


Fig. 5—Sinusoidal input (bottom) results in second harmonic sinewave (top) applied to squarer

Vacuum-Tube Voltmeter

Zero-setting and balancing controls are eliminated and output scale is linear in power and square-law in voltage. Nonlinear resistance network squaring action is accurate to ±2.5 percent for current range of 50 to 1. Top frequency is 500 kilocycles


Two views of mean square voltmeter show simplicity of construction and operation

Nonlinearity can be reduced within limits by shunting the unit with a resistor or putting a resistor in series. The former technique is to be preferred since the composite resistance decreases, increasing the overall sensitivity. Starting with Thyrite having an exponent slightly greater than 2, it is a relatively simple matter to shunt and linearize it, so that the overall exponent is made closely 2($n = 2$), for a single quadrant. For a given range to be optimumly squared, the shunt resistance depends on the current level or nominal resistance level and the Thyrite exponent.

Although the combination of Thyrite and shunt resistance has an exponent of 2 in a single quadrant, the unit is bilateral and has zero-point symmetry. The zero-point symmetry must be converted to zero-axis symmetry for true squaring action. By interposing a full-wave bridge rectifier before the Thyrite, automatic switching is obtained which produces the required zero-axis symmetry. This action is shown in Fig. 1. The rectifier allows the Thyrite to operate in only one quadrant, which results in the electrical equivalent of a true square-law characteristic.

Figure 2 is an oscillogram of the bridge output current as a function of applied voltage for a linear resistance and a squared Thyrite element. The instantaneous volt-ampere characteristic can then be treated as $i = kv^2$.

The crystals used as rectifier elements do not significantly disturb the squared characteristic. The lowest nominal Thyrite impedance in the range used is about 4,000 ohms and the forward resistance of 1N34 crystals is around 100 ohms. The nonlinearity of the crystal in the zero current region is of small importance since the true square-law characteristic should have infinite resistance at the origin. To guarantee squaring, including the crystal effects, it is convenient to choose the proper shunt resistor by squaring with a-c applied voltages. Plotting current vs voltage squared for different shunts indicates the transition to a square-law characteristic, as shown in Fig. 3.

The Thyrite material used in this case had an exponent of 3.34 before shunting it with a linear resistor. At a shunt resistance value of 9,500 ohms, the combination has an exponent of 2.0 for the current range indicated. A 5,000-ohm shunt results in an overall exponent less than 2.0. The higher exponent Thyrite is used to show the large alteration in exponent that is possible. Starting with an exponent slightly greater than 2, experience indicates that the squaring can be made to within ± 2.5 percent for a current range of 50 to 1.

Distortion Analysis

A rapid method for choosing the shunt resistor and checking the overall performance of the squarer, requires the use of a distortion analyzer.

A 50-ohm resistor is connected in series with the squaring combination as shown in Fig. 4. The voltage developed across the resistor is passed on to the distortion analyzer. For true squaring action, an input sinusoid of the form

$$v = V_o \sin \omega t,$$

will result in a current

$$i = \frac{kV_o^2}{2} - \frac{kV_o^2}{2} \cos 2\omega t$$

The magnitude of the second-harmonic voltage across R, when divided by R, will give the current flowing (both peak a-c and d-c components are equal). This current should correspond to the sensitivity of the output meter. The a-c signal applied can be 200 cps and the distortion in the 400-cps output can be measured. By proper shunting, the distortion can be minimized for a chosen range.

It is important that the distortion in the driving source be as small as possible to avoid additional error. Likewise the internal impedance of the signal source must be extremely small or the nonlinear current drawn by the squarer will distort the output voltage. Oscillograms of observed waveforms are shown in Fig. 5. The fundamental frequency signal is first rectified as indicated. The current through the Thyrite-resistor combination exhibits good waveform and it is of second-harmonic frequency.

The d-c milliammeter in the output of the squarer indicates the mean square current irrespective of the waveform. A one-milliampere meter is convenient for the Thyrite used (8396839GR1). Approximately 4 volts rms are necessary to give full-scale deflection.

The input impedance of the composite squarer is bilateral and nonlinear, and varies approximately inversely with the amplitude of the applied voltage. It is important that the driving impedance be small so that the voltage applied to the squarer is identical to the input signal. Current drawn from the driving source by the network has only odd harmonics. This is a result of the bilateral nonlinear input resistance.

Driver Circuit

Special precautions are necessary in the design of the driver circuit for the nonlinear squarer. Since the impedance of the squarer varies inversely with the instantaneous voltage, applied signals having high peak to rms ratios (crest factor) can result in momentary impedances as low as 700 ohms. An extremely low internal impedance is required of the driver so as to preserve the complex voltage waveform.

The ordinary cathode follower is not sufficient and the coupling capacitor for d-c isolation adds to the driver impedance at low frequencies. As a point of interest, an electrolytic capacitor cannot be used for coupling because of its high leakage current.

The circuit of Fig. 6 is a satisfactory driver. The cathode-follower impedance is further reduced by feedback to a nominal 6 ohms and the overall gain is unity. The application of feedback, as indicated after the isolation, permits the use of a 4-μf metallized paper capacitor. It requires in the neighborhood of 4 volts at the input of the driver to pass an average current of 1 ma in the output meter. A preamplifier and attenuator are necessary to increase the overall sensitivity and provide all the aspects of a conventional voltmeter.

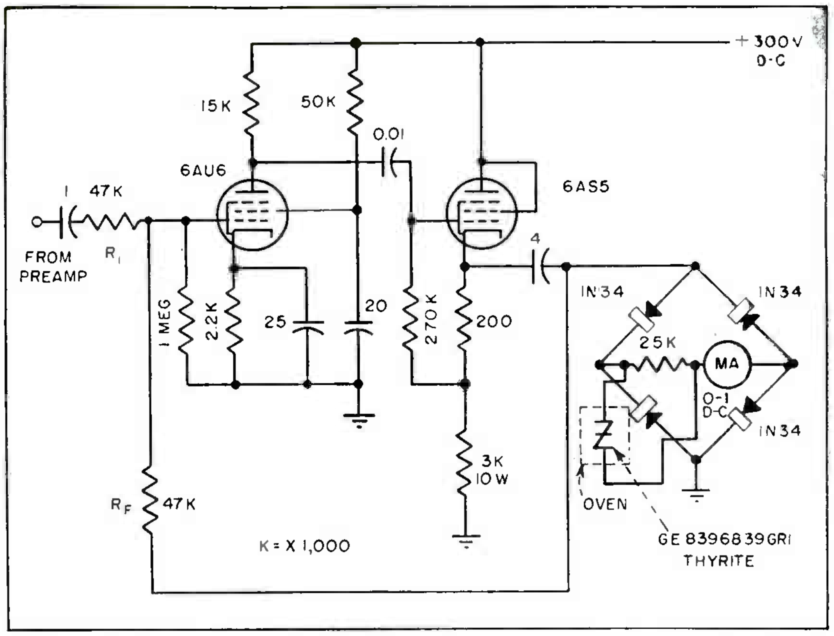


FIG. 6—Typical driver circuit with 6-ohm internal impedance and overall gain of unity

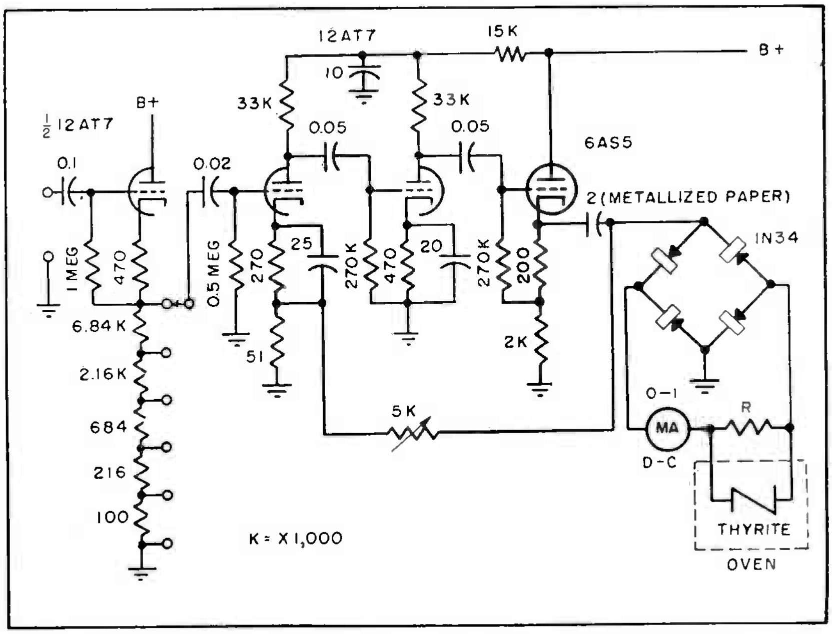


FIG. 7—Mean square voltmeter circuit. Overall feedback reduces internal resistance, stabilizes gain and improves frequency response

Another, and more efficient, driver circuit is shown in Fig. 7. By feeding back part of the output signal to the input stage the output impedance is reduced to approximately 8 ohms and the frequency response is considerably improved. The feedback factor of 0.023 combined with an overall gain of 570 makes the driver relatively independent of supply voltage variations and tube aging ($A\beta = 13$).

As shown, an input signal of 0.1 volt results in full-scale deflection for the output meter. The output stage is capable of 20-ma swings with negligible distortion. The overall gain is adjusted by means of the 5,000-ohm feedback resistor for the particular Thyrite-resistor combination's sensitivity.

By incorporating a cathode-follower driven attenuator before the driver the circuit becomes a practical mean square voltmeter. Each 10-db attenuation step corresponds to a 0.1 reduction in overall sensitivity. In Fig. 8 the linearity with overloads is compared to that of normal full-scale current. By replacing the output meter with a 20-ma meter, the input signal can be increased by a factor $\sqrt{20}$ with no loss in linearity. In replacing meters for this test it is obviously important to maintain the same total resistance in the squaring unit.

A frequency-response characteristic for the voltmeter at the first attenuator position is shown in Fig. 9. The response falls after 500,000 cycles. Changing the attenuator position will have no effect up until this region. Since the detector response is mean square, a 1-percent change in amplifier gain will produce a 2-percent change in output current.

Complex waves can have high crest factors. Pulses, for example can have large amplitudes and small rms values. Since all amplifiers have an overloading limit, a compromise must be reached compatible with the waveforms to be studied. By passing sufficient current through the cathode follower and by proper design of the preamplifier, crest factors of 6 based on full-scale sensitivity can be tolerated before clipping, and as much as 20 ma can pass instantaneously or continuously through the 1-ma meter. The problem of overloading arises since a meter in conventional use can suffer severe overloads. A commercial 1-ma meter can pass 25 ma providing the pointer is brought up to the full-scale stop slowly. Damping of 0.5 second can be built into the meter or a large capacitance can be placed across the movement to achieve proper results.

Miscellaneous Details

The ultimate high-frequency range is limited by the high shunt capacitance of the Thyrite and the amplifier frequency response. Since the dielectric constant of the Thyrite material used is about 100, high frequencies are adversely affected and the squarer is no longer accurate. Therefore, complex waves having high-frequency components greater than 500,000 cps will be measured with error.

Fortunately, the higher frequency terms generally contribute little to the total rms value. The overall mean square linearity is ± 2.5 percent of full scale.

The temperature sensitivity of the Thyrite can introduce an error. The Thyrite temperature coefficient of resistivity is about −0.5 percent per deg C.

The effects of temperature are apparent from the curves of Fig. 10 which were taken for the case of the Thyrite oven off and then on.

Although the meter can be calibrated with sine-wave signal inputs, it is of greater meaning to check the calibration with complex waveforms. A thermocouple-type r-f milliammeter was used to measure the rms value of a complex current passing through a 10-ohm resistor. The voltage drop across the 10-ohm resistor can be passed on to the voltmeter and the reading should correspond to the rms input voltage squared. The r-f milliammeter can be compared to an accurate d-c milliammeter for initial calibration.

The sum of two voltages of different frequency and amplitude checked excellently with the thermocouple readings. Waveforms with excessive 3rd harmonic (that is, exciting current in a transformer) were measured correctly. A half-rectified sinusoid checked satisfactorily, after the d-c component was removed. A d-c meter was inserted in series with an a-c meter and the rms a-c current was

$$I_{a\text{-}c} = [I_T{}^2 - I_{d\text{-}c}{}^2]^1/^2$$

where I_T was the thermocouple reading. A check with triangular and rectangular pulses also gave a correct meter indication. The response to complex waveforms was very satisfactory.

The authors wish to extend their thanks to the Rome Air Development Center, Griffiss Air Force Base, Rome, New York, who made possible this work under contract AF28(099)-33. The cooperation of J. L. Potter, Chairman of the Department of Electrical Engineering is appreciated.

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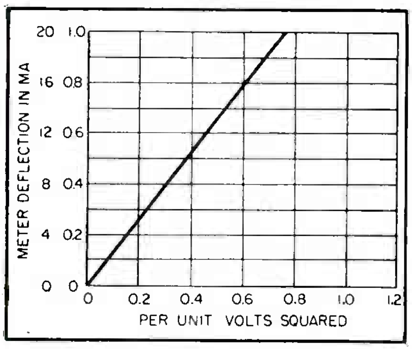


FIG. 8—Square law, as shown for sinusoidal inputs, is identical for 0 to 1 and 0 to 20-ma scales

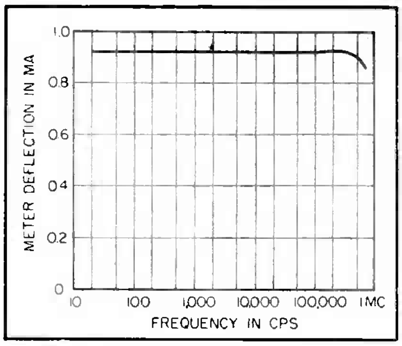


FIG. 9—Frequency-response curve for voltmeter indicates useful response up to 500 kc

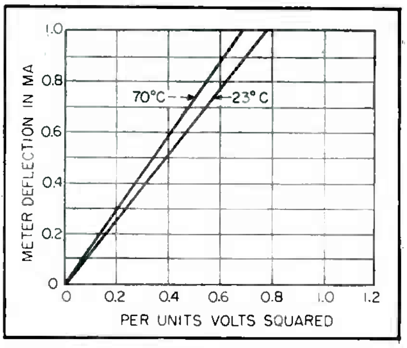
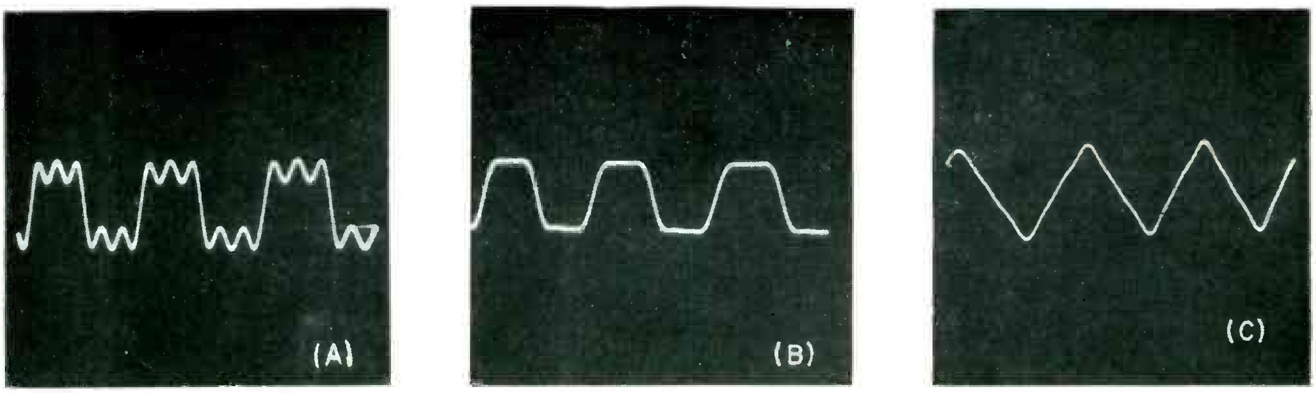


FIG. 10—Curves show temperature dependence due to Thyrite coefficient of —0.5 percent per deg C



Oscilloscope photos show complex waveforms synthesized by gen-

Synthetic Waveforms

Complex waveform generator, set to duplicate unknown waveform, shows harmonic percentages and phase shifts on control settings. Can be used in phasing-out harmonic distortion in high-power amplifiers, measuring circuit phase shift, testing components and calibrating test instruments

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EFFECTS of supply-voltage harmonics on airborne electronic equipment have been studied using the complex waveform generator to be described to duplicate on a dual-beam oscilloscope the waveform under analysis. As may be seen from the photograph, the generator has nine variables which can be set to produce a desired waveform. These variables are the amplitudes of the fundamental, second, third, fourth and fifth harmonics, and the phases of the four overtones. The parameters of the synthetic waveform are then read from control settings.

The instrument has proved useful in amplifier design problems wherein a pure sine wave output is obtained at high power levels by introducing out-of-phase harmonic distortion to phase out harmonics generated in the amplifier. The generator has been found a useful instruction aid in demonstrating some aspects of the Fourier series. Commercial applications include testing instrument calibration for various phase and harmonic conditions and measuring phase shift in circuits and components. A commercial model of the device is shown in the photograph.

The generator output waveform can be adjusted from a sine wave to any wave shape within the limits of its nine variables. The general waveform can be expressed by the equation:

$$f(t) = E_1 \cos(\omega t + \phi_1) + E_2 \cos(2\omega t + \phi_2) + E_3 \cos(3\omega t + \phi_3) + E_4 \cos(4\omega t + \phi_4) + E_5 \cos(5\omega t + \phi_5) \quad (1)$$

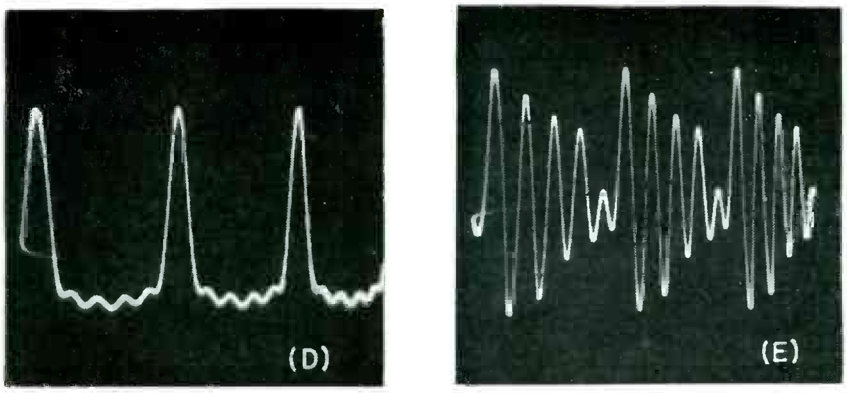
The variable functions are: E_1, E_2, E_3, E_4, E_5, ϕ_2, ϕ_3, ϕ_4, and ϕ_5.

The amplitudes of the fundamental, second, third, fourth and fifth harmonics are variable from 100 percent of fundamental amplitude to zero, and the phase angles of the second, third, fourth and fifth harmonics are variable from zero to 360 degrees.

The need for an instrument of this sort in the past led to the development of electromechanical generators. None of these instruments attained popular use because of the inherent limitations of frequency range and excessive cost. The generator described is comparatively simple and dependable. It makes use of established principles and circuits to obtain precisely synchronized harmonics and to permit shifting the phase angle of the harmonics relative to the fundamental.

Theory of Operation

The block diagram (Fig. 1) indicates the method by which the various harmonics are obtained. A variable intermediate-frequency signal and a fixed i-f signal are heterodyned to obtain a variable audio-frequency signal. Both the fixed and variable i-f signals are multiplied in frequency and heterodyned to obtain the various harmonics of the audio fundamental. The phase of the harmonics is shifted in the fixed intermediate channel ahead of each multiplier.



erator. Table I gives relative harmonic content for each waveshape

Table I—Synthetic Waveforms

Harmonic Index	(A)	(B)	(C)	(D)	(E)
Fund	100	100	100	100	12
2nd				70	28
3rd	30	22	10	50	40
4th				28	70
5th	30	5	2	16	100

Harmonic Content In Percent

Speed Wave Analysis

By ARTHUR A. MAHREN

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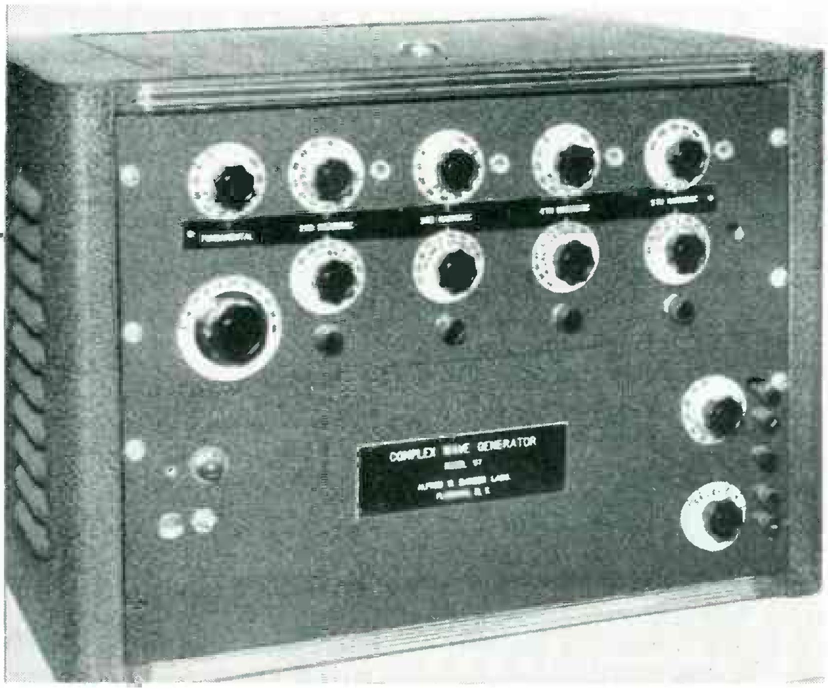

Dials of commercial model of complex waveform generator

Shifting the i-f phase angle produces a corresponding shift in the heterodyned audio-signal phase angle. This may be demonstrated in the heterodyne equation.

The variable-frequency intermediate signal is represented by

$$e_y = E_y \cos(\omega + \Delta\omega)\,t \qquad (2)$$

where $\Delta\,\omega t$ is the difference in frequency between the fixed and variable oscillators.

The fixed-frequency signal is

$$e_x = E_x \cos(\omega t + \phi) \qquad (3)$$

where ϕ is the shift in phase angle of the fixed-frequency signal before it is heterodyned. The heterodyned output current, assuming square-law detection, is:

$$i = a\,(e_x + e_y)^2 \qquad (4)$$

Expanding Eq. 4 and substituting Eq. 2 and 3:

$$i = a\,E_y^2 \cos^2(\omega + \Delta\omega)\,t + a\,2\,E_x\,E_y \cos(\omega + \Delta\omega)\,t \cos(\omega t + \phi) + a\,E_x^2 \cos^2(\omega t + \phi) \qquad (5)$$

The first and third terms, being of higher frequency, are neglected. By expanding the middle term of Eq. 5, Eq. 6 results:

$$i = a\,E_x\,E_y \cos(2\,\omega\,t + \Delta\,\omega\,t + \phi) + a\,E_x\,E_y \cos(\Delta\,\omega\,t - \phi) \qquad (6)$$

The second term, $aE_xE_y \cos(\Delta\omega t - \phi)$, is the audio term which shows that the phase-angle shift that took place in the fixed i-f signal appears in the audio term after being heterodyned.

Phase-Shift Calibration

The phase-angle shift ϕ in the i-f channel appears in the audio term. Since the phase-angle shift takes place at the intermediate frequency, multiplying the frequency also multiplies the phase shift. The phase angle need be shifted only 180 degrees at the intermediate frequency to appear as a 360-degree shift in the second-harmonic audio signal, the third harmonic need be shifted only 120 degrees, the fourth 90 degrees and the fifth 72 degrees.

Since phase shifting takes place at a fixed frequency, no tuning adjustment is necessary in the phase shifters as the variable-frequency oscillator is tuned to obtain a variable audio frequency. The phase-shift dial calibrations hold regardless of any change in the audio frequency. Phase shift in the variable-frequency i-f channels is minimized by making the tuned multiplier channels sufficiently broad band to maintain a relatively constant phase angle as the vfo is tuned through the band. There is no change in audio amplitude as the phase angle is changed.

The amplitudes of the intermediate variable and fixed-frequency signals are adjusted at the frequency converters to provide relatively pure audio signals. In the experimental generator and in the production units there is less than one percent of harmonics present in the fundamental and harmonic audio channels over the fundamental frequency range of 25-3,000 cycles.

The various audio outputs are added in a resistor. Decoupling of the audio signals minimizes cross-talk between channels.

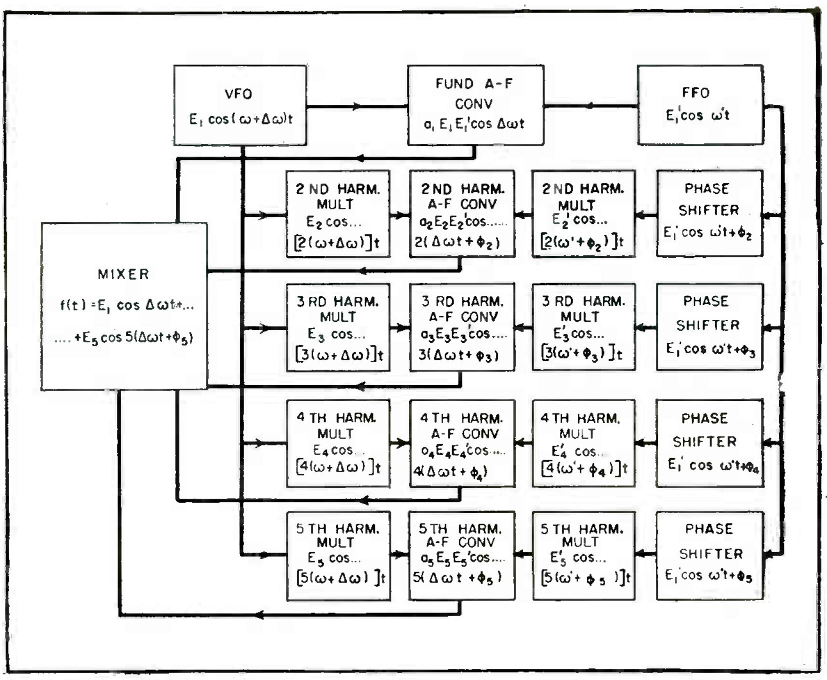

Fig. 1—Block diagram shows how the amplitudes and phases may be varied to synthesize a given complex waveform

Circuit Details

Figure 2 shows the fundamental channel and one (the fourth harmonic) channel. The fixed-frequency oscillator is crystal controlled at 100 kc. The variable-frequency oscillator is a temperature-compensated Hartley oscillator with a tuning range from 100 to 103 kc. Buffer stages isolate the oscillators from the 6L7 frequency converter. The audio fundamental is available at the plate circuit of the frequency converter. The fundamental and fourth-harmonic audio mixers and output cathode follower are shown in Fig. 3.

The variable i-f multiplier consists of one stage of multiplication and one stage of amplification. The amplifier stage is necessary since the multiplier and amplifier tuned circuits are low Q to provide the necessary bandwidth for minimum phase shift within the tuning range. Without the amplifier there would be appreciable fundamental present in the harmonic output.

The phase-shift system used in the fixed-frequency channel is designed around standard, commercially-available components. It utilizes the fact that a shift of phase is obtained when a circuit is tuned through a fixed resonant point. For about a 45-degree shift on each side of resonance this shift is fairly linear, facilitating calibration of the phase-shift dials. In the second and third harmonic phase shifters, where a 180-degree and a 120-degree shift is required, two such circuits separated by an amplifier are used.

Small Phase Shifts

Where the phase shift required is less than 90 degrees, the circuits are trimmed and padded so that the full rotation of the phase-shift capacitor is utilized for the required phase shift. An additional phase-shift stage is provided in each channel with a separate control knob labelled PHASE-ZERO adjust. This is provided so that the main phase-shift dials can be set to read zero phase shift regardless of phase distortion in any amplifier used in conjunction with the generator.

The fixed-frequency multipliers and amplifiers are similar to those of the variable-frequency channels.

The generator contains an output from which the complex waveform is available at one volt with a 500-ohm output impedance. A synchronizing output is provided from which an oscilloscope may be synchronized with the audio fundamental so that the oscilloscope sweep will remain synchronized at the same part of the fundamental cycle as the waveshape is altered.

A vtvm output connected to a switch is provided so that the level of the fundamental and each harmonic may be monitored. In addition, the harmonic amplitude dials are calibrated. The phase-shift dials are calibrated in plus and minus 180 degrees from 0 degrees, providing a 360-degree total shift in phase in each of the harmonic channels.

Wave Analysis

Wave analysis, for waveforms of fairly high harmonic content, may be accomplished by synthesizing, with the generator, the waveform to be analyzed, and reading the harmonic content from the instrument. This may be done by applying the waveform to be analyzed to one gun of a dual-beam oscilloscope and matching the waveform under analysis with the generated wave. By superimposing one wave on the

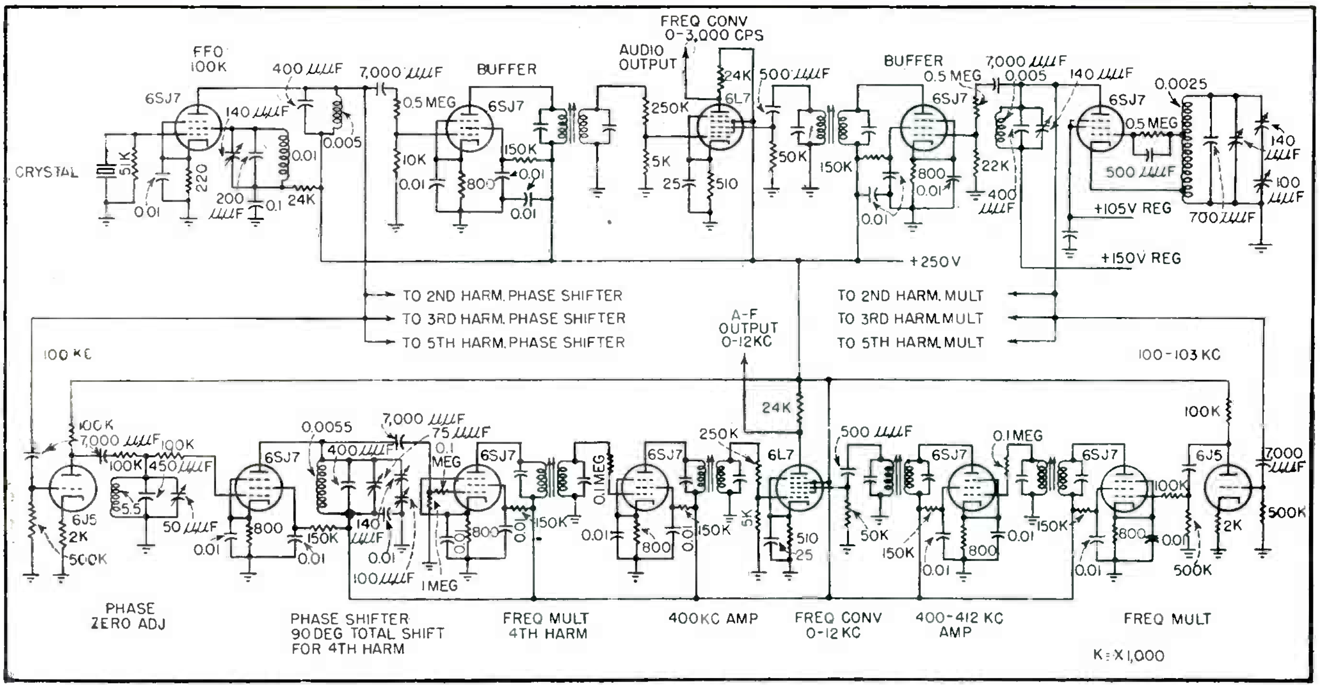

Fig. 2—Schematic of fourth-harmonic channel illustrates processes of phase shifting and frequency multiplication that produce harmonics independently variable in phase and amplitude

other a fair degree of accuracy may be obtained. This method permits the harmonic analysis of waves of much higher frequency than is possible with present commercial analyzers, since the frequency of the wave to be analyzed may be many times greater than that of the synthesized wave. The frequency of the wave that may be analyzed is limited only by the oscilloscope used.

A greater degree of accuracy in wave analysis, but at a frequency range limited by the fundamental range of the generator, may be obtained by using the generator to phase out the harmonics of the waveform under analysis. The synchronizing output is shifted in phase by 180 degrees and fed into an amplifier whose distortion is to be measured. If the amplifier itself has 180 degrees of phase shift, the phase need not be shifted, but since most amplifiers do have some phase distortion, an auxiliary phase shifter is desirable.

The output of the amplifier and the output from which the complex waveform is obtained are mixed in a linear device, such as a resistor. The fundamental amplitude from the generator is then adjusted for minimum deflection in a vtvm or an oscilloscope connected across the mixing device. The fundamental amplitude necessary for minimum deflection is taken as the basis of the harmonic percentages. The second, third, fourth and fifth harmonic amplitudes and phases are then adjusted for further minimum. If the output is observed on an oscilloscope, the phasing out of the harmonics is facilitated. The amplitudes and phase displacement of the harmonics are obtained from the generator dials.

Other Applications

The output sine wave of one of the harmonic channels may be used in checking phase shift of a component. The portion of the sweep where the sine wave crosses the axis on an oscilloscope connected to the output of the generator is noted.

The component or circuit to be tested is then connected between the generator and the oscilloscope. With the oscilloscope sweep synchronized by the fundamental, which remains unchanged in phase, a shift in phase of the signal due to the circuit being tested will be indicated on the oscilloscope by the harmonic sine wave being displaced along the sweep axis on the screen.

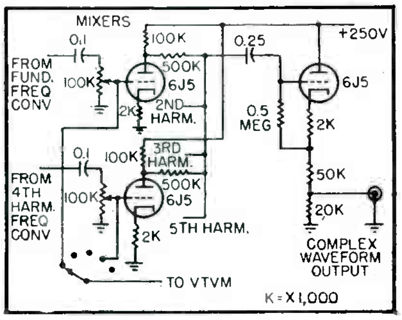

Fig. 3—Fundamental and fourth-harmonic mixers, showing amplitude controls and output cathode follower

The harmonic phase-shift dial is then adjusted so that the position of the sine wave on the sweep axis is the same as it was when the oscilloscope was connected directly across the output of the generator. The phase shift necessary to bring the pattern back to its original position is the phase shift introduced by the circuit under test, and is read directly from the phase-shift dial.

The generator can also be used to solve the problem of maintaining a constant phase shift between two voltages as the frequency is changed.

Finding Phase Shift

By performing extra vector-rotating operations on the standard Smith transmission-line chart, the phase and magnitude of the voltage and current at a point on a line can be determined relative to the voltage and current at the termination

THE SMITH CHART[1] gives the impedance at a point on a transmission line when the impedance of the termination is known. But, in addition, the engineer often wishes to know the phase shift introduced by the section of line and the magnitude of the voltage and current with respect to the voltage and current at the termination.

By the use of extra operations, the Smith chart will give this extra information. It is also possible and useful to find the impedance and the phase and magnitude of the voltage and current referred to the voltage and current at the termination, when the termination is an impedance containing a negative resistance. A tube feeding power into one end of a line is such an impedance at the fundamental frequency.

A specific case where this information is useful is to be found in the design of grounded-grid oscillators which feed high-Q resonant circuits through transmission lines.[2,3] The procedure to be followed in solving such problems will be explained by using specific examples.

Termination with Positive R

In the first example, the termination is an impedance containing a positive resistance. Assume line attenuation to be zero. The impedance will consist of a resistance of $2.0Z_o$ ohms in series with an inductance of $1.4Z_o$ ohms. Assume also that it is necessary to know the following quantities 65 electrical degrees from the termination: (1) the impedance; (2) the phase and magnitude of the voltage relative to the voltage across the termination; (3) the phase and magnitude of the current relative to the current in the termination.

The impedance of the termination (volts per unit current) is found at point A in Fig. 1.[1] The diametrically opposite point B is the admittance (amperes per unit potential difference). Vectors drawn from O to A and B represent the phase and magnitude of the termination voltage and current[4].

On the Smith chart the scale is chosen such that a current vector equal in length to the voltage vector represents a current $i = V/Z_o$, where Z_o is the impedance of the transmission line. The points A' and B' represent the impedance $(Z = 0.5Z_o - j0.7Z_o)$ and admittance $[(Y = (0.68/Z_o) + (j0.94/Z_o)]$ respectively at a point 65° toward the generator. Vectors drawn from O to A' and B' represent the voltage and current at this point. The angle between them is correct, but the angle between the voltage vector at 65° and the voltage vector at 0° is incorrect.

To show all vectors with the correct magnitude and phase relations, the vectors OA' and OB' are rotated counterclockwise 65° as shown. This rotation is required because the voltage and current vectors at the termination are formed by the addition of a transmitted wave (voltage and current represented by OC) and a reflected wave with voltage vector CA and current vector CB.

The transmitted and reflected waves must be advanced and retarded 65° respectively.[5] On the Smith chart the transmitted wave OC remains fixed, while the reflected wave is retarded 130° (130° clockwise). Hence, to restore the proper spatial relations in the vector diagram, the triangle $A'\ OB'$ must be rotated 65° counterclockwise about O. This gives the vector $V(65°)$, which is 0.7 times the magnitude of the voltage at 0° and ahead in phase by 25.5°, and the current vector $I(65°)$, which is 2.0 times the magnitude of the current vector at 0° and is ahead in phase by 115°.

Termination with Negative R

When the terminating impedance contains a negative resistance it is usually called a generator. It is customary to consider that the generator will determine only the magnitude of the voltage across the line, while the voltage distribution will be determined solely by the passive termination at the other end. If a generator is feeding power into a line which presents a definite impedance, say an inductance in series with a resistance, then the generator itself must look like an impedance consisting of a capacitance in series with a negative resistance. It is therefore legitimate, and often useful, to calculate voltage and current distributions on the line using the impedance of the generator as a starting point.

To use the Smith chart in this case, the impedance of the generator is first determined. The impedance looking into the line will then appear to be an inductance in parallel with a positive resistance. The impedance elsewhere on the line and the phase and magnitude of the voltage and current relative to the voltage and current at the generator can then be found as in the first example, except that the direction of all rotations should be reversed in this case.

With Smith Chart

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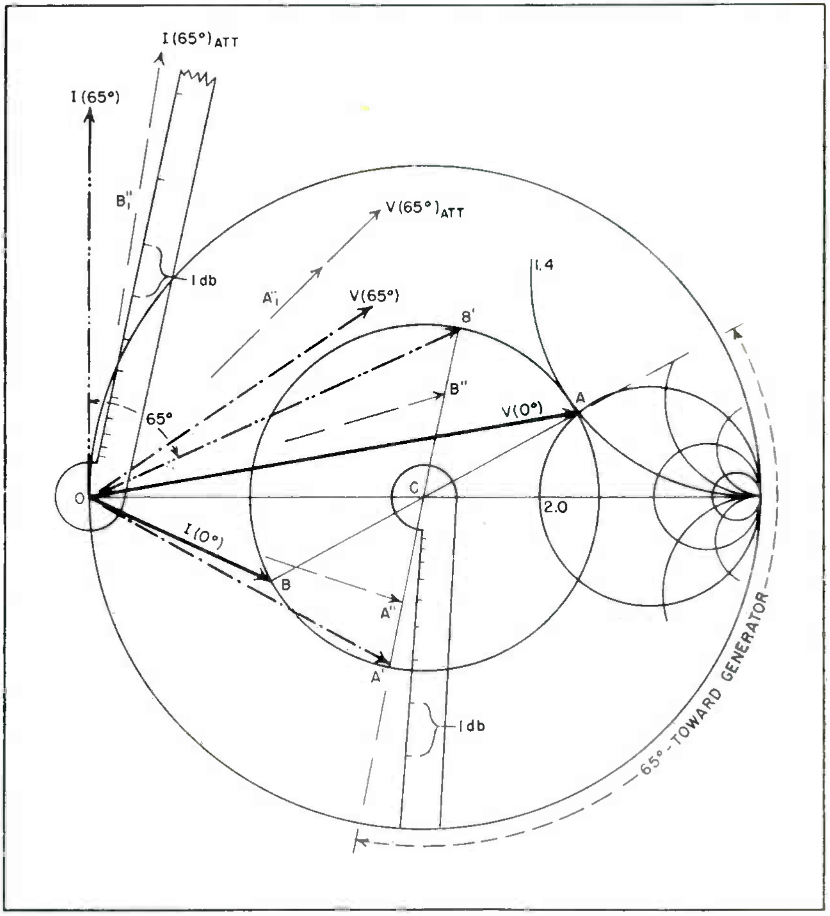

FIG. 1—Method of using chart when line termination contains positive resistance

As an example, consider an amplifier tube connected to a tank circuit which is in turn connected to a 100-ohm transmission line. Assume that the other end of the line is coupled in some manner to a resonator. Assume that operation is to be class C, with 2 kv on the plate and 1 amp plate current. The fundamental component of the plate current will then be around 1.8 amp peak.[6] With an assumed r-f swing of 1,800 volts, the tube can be represented by a 1,000-ohm negative resistance in parallel with the capacitive reactance of the tube elements.

Assume also that the tank circuit is detuned so that a net capacitive reactance of 1,000 ohms appears in parallel with the tube. This is not standard practice since standing waves are produced on the line, but occasions do arise where it is desirable (such as a low-voltage point where the line enters a vacuum system). The 100-ohm line is thus terminated by a parallel combination of 1,000 ohms of capacitive reactance and 1,000 ohms of negative resistance.

This example is solved in Fig. 2. Looking into the transmission line (away from the generator), there must be an impedance which looks like a 1,000-ohm positive resistance in parallel with a 1,000-ohm inductance. Finding this point on the Smith chart is standard procedure, giving 0.001 amp per volt for the currents that flow in the two branches of the termination for 1 volt applied across the termination. Since the line has an assumed Z_o of 100 ohms, multiply by 100 to get 0.1 for both the resistance and reactance circles.

The intersection at A locates the tip of the current vector OA. The diametrically opposite point B is the impedance ($Z = 5Z_o + j5Z_o$) and also locates the tip of the voltage vector OB which leads the current vector by 45°. These two vectors represent the voltmeter and ammeter readings when measuring the impedance looking toward the passive load and also the power flowing into the line. If power flowing into the generator is measured, it proves to be negative.

Since power is $VI \cos \theta$ (where $\cos \theta$ is the power factor), $\cos \theta$ must be negative, or the angle between voltage and current is over 90°. In effect this involves switching ammeter connections so that the ammeter reads backwards. In Fig. 2, the voltage and current looking into the generator are represented by $V(0°)$ and $I_g(0°)$ where $I_g(0°)$ is the vector obtained by reversing OA.

To find the phase and magnitude of the voltage and current 30° along the line from the generator, new points A' and B' are found by rotating 30° counterclockwise (away from the generator). The impedance looking toward the passive termination is $0.29Z_o + j1.35Z_o$ (or $29 + j135$) and the admittance is $(0.15/Z_o) - (j0.7/Z_o)$. The vectors OA' and OB' represent voltage and current 30° along the line and have the correct magnitude and phase relative to each other but not relative to the voltage and current at 0°, so they are each rotated 30° clockwise, giving vectors $V(30°)$ and $I(30°)$.

If the voltage and current looking toward the generator are desired, the vector $I(30°)$ must be reversed. From Fig. 2, the voltage 30° along the line lags the voltage at the generator by about 3.7° while the current lags by 36°.

The advantage in considering the generator as the termination lies in the fact that the voltage and current at the far end of the line are calculated for the desired operating conditions at the tube. The coupling network between load and line is then designed to fit this voltage and current. In feedback oscillator circuits the phase shift introduced by the line is often important and is easily estimated by the above method.

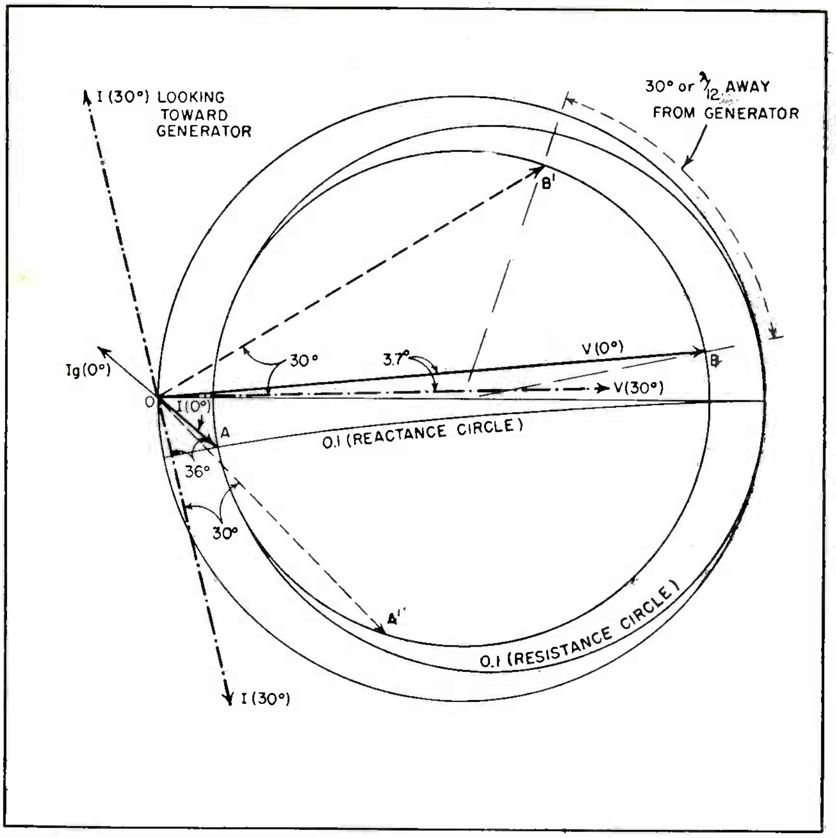

FIG. 2—Procedure when terminating impedance is a generator containing negative resistance

Attenuation

Imagine that the transmission line in the example of Fig. 1 is terminated in its characteristic impedance and the attenuation is such that a wave traveling toward this termination will suffer a power loss of 1 db in going 65° along the line. The termination causes reflections so there will be a transmitted and a reflected wave present. This means that the voltage and current vectors in these waves will be attenuated by 1 db each.

In Fig. 1 the transmitted voltage and current vectors are both represented by OC (OC really consists of two parallel vectors), while CA and CB represent the voltage and current in the reflected wave. In moving back along the line 65° from the termination, the transmitted voltage and current should be increased by 1 db each and the reflected voltage and current should be decreased by 1 db[5]. On the Smith chart, however, the transmitted vectors OC are kept constant, while the reflected voltage and current vectors CA and CB are decreased by 2 db each.

To account for a 1-db attenuation in power in Fig. 1, decrease the reflected voltage and current vectors CA and CB by 2 db each, which locates the points A'' and B'' and a new impedance ($Z = 0.72 Z_o - j0.52Z_o$) at the 65° point on the line. So far this is standard procedure.

The voltage and current at this point are represented by the vectors OA'' and OB''. They have the correct phase and magnitude with respect to each other but not with respect to the voltage and current at the termination. To set things right, these vectors are rotated 65° counterclockwise, giving vectors OA_1'' and OB_1'', which are then stretched by 1 db. The vectors $V(65°)_{att}$ and $I(65°)_{att}$ now represent the voltage and current 65° along the line with correct phase and magnitude.

Since the voltage and current vectors can become quite large when going farther away from the termination, it is useful to extend the attenuation scale used with the Smith chart as far as necessary. The extended scale rotates about O as shown in Fig. 1. The amounts by which the vectors OA_1'' and OB_1'' must be stretched can also be found by multiplying OA_1'' and OB_1'' by the square root of the ratio CA'/CA''.

Attenuation in a line often implies that Z_o is complex. In the above example Z_o has been assumed to be real. When Z_o is complex, the numbers defining the resistance and reactance circles on the Smith chart are obtained by dividing the terminal impedance by the complex value of Z_o. If Z_o is represented by $Z_o'e^{j\theta}$, the angle between the termination voltage and current vectors (drawn from O in Fig. 1) will be reduced by the angle θ, which is the angle of the line. The diagram is therefore an incorrect spatial representation of the terminal impedance. After performing all the previously described rotation operations, the angles between different voltage vectors or different current vectors will be correct, but the angle θ must be added to the angle from current to voltage in order to obtain the correct spatial picture of the impedance.

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Video Test Signal Generator

Output signal consists of simulated horizontal sync pulse, blanking pedestal and five discrete sinusoidal frequencies. Duration and amplitude of signals are adjustable by operator. System speeds up and increases accuracy of response measurements which may be made by unskilled operators after a brief instruction period

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VIDEO FREQUENCY response checks of television equipment can be made quickly and accurately using the test signal generator shown in the photograph. The test set generates its own horizontal synchronizing pulses for checking video systems that require such pulses in normal operation.

Speed Plus Accuracy

The video test signal generator to be described and a typical test signal are shown in the photographs. The synchronizing pulse is so located on the blanking pedestal that no front porch is produced. This simplifies the device without detracting from its usefulness for production testing.

Referring to the exterior view, the five large knobs control the five frequencies generated. Each of the five small knobs, directly below these, controls the amplitude of one of the five frequencies independent of the other four.

Starting from the left, the first oscillator is variable in ¼-megacycle steps from ½ to 1½ megacycles. The remaining four are continuously variable, one covering each of the following ranges: 1 to 2.1 mc, 1.4 to 3 mc, 2.2 to 3.8 mc, and 3 to 5.4 mc. A coarse frequency calibration for each control is engraved on the panel. The ranges are made to overlap so that in most cases a particular frequency can be set on one oscillator, and the response at nearby frequencies can be investigated by varying one of the adjacent oscillators.

Method of Operation

Most video systems are designed to operate with 75-ohm unbalanced lines in and out. Therefore, the low-impedance output of the generator is connected to the input of the video system to be checked and the system is properly terminated. An oscilloscope having an input impedance that is high compared to 75 ohms for all frequencies to be tested may be bridged across the input of the system without disturbing the normal conditions.

Adjustment

The generator is adjusted to produce frequencies throughout the frequency band to be checked and the amplitudes are adjusted to give uniform response on the oscillo-

Ten knobs across front of generator control frequency and amplitude of gated signals. Knob in upper right-hand corner sets overall gain

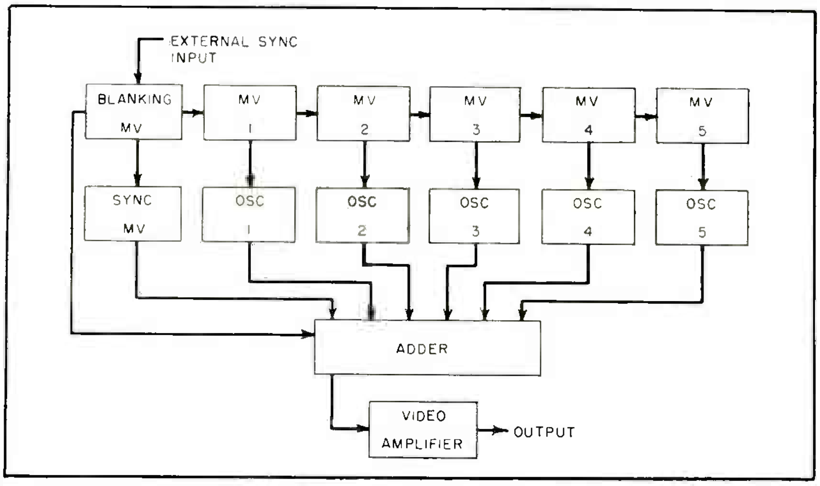


FIG. 1—Block diagram shows how oscillators at various frequencies are keyed on in sequence during horizontal trace of test oscilloscope

scope. The oscilloscope is then changed from the input to the output of the system and the test signal is observed. Any variation from uniform response is caused by the system and can be measured directly.

A typical test is illustrated. In the input-output patterns shown, the test frequencies are 1.0, 1.5, 2, 3, and 4 mc. The amplifier being tested has a sag in the response near 2 mc and cuts off between 3 and 4 mc.

Certain precautions must be taken with such an approach. The frequency response of the oscilloscope must be at least comparable to that of the system, otherwise overloading may occur in either the oscilloscope or the system while attempting to produce uniform input. It should be emphasized, however, that the response of the oscilloscope does not have to be flat. Also, only five discrete frequencies are being checked at one time, and there may be holes in the response. Therefore, it may be necessary to set all the oscillators to a new group of frequencies or to vary them one at a time to investigate the complete spectrum. With these exceptions there is very little chance for error.

One other problem is obvious. If both the input and output of the system being checked are available, the same oscilloscope can be used on both the input and the output. If both are not available, oscilloscopes with bandwidths greater than the system must be used or the response of the oscilloscopes used must be known, by previous check, to be identical.

Circuitry

The generator has several additional controls within the cabinet that provide increased usefulness in a variety of applications. The operation of these controls will be apparent from a description of how the composite signal is produced. A block diagram of the unit is shown in Fig. 1.

The blanking multivibrator[1] is nonsymmetrical and has a basic repetition rate of 15,750 cps. However, it may be varied somewhat from this frequency. This tube generates not only the basic control frequency but also the blanking pedestal. It is very simple to lock this multivibrator, and therefore the entire instrument, to an existing television system by injecting horizontal synchronizing pulses into this stage.

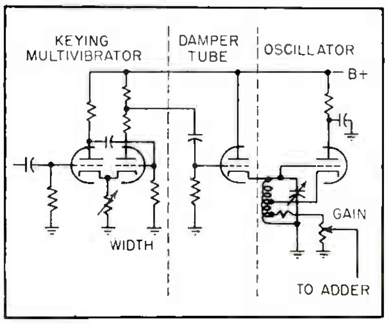


FIG. 2—Keyed oscillator circuit that produces smooth pulses by undamping tuned circuit of oscillator

Two multivibrators are synchronized with the blanking multivibrator. The first is also nonsymmetrical and produces a signal which, when added to the blanking pulse, forms the synchronizing pulse. The second, marked MV 1 in Fig. 1, is the first in a chain of multivibrators and oscillators. The blanking pulse is differentiated and the trailing edge spike is used to trigger MV 1. This tube produces the keying pulse which turns on the first oscillator (OSC 1).

The duration of the keying pulse is determined by the cathode resistor of the multivibrator. This control will determine the duration of the frequency produced by OSC 1. The trailing edge of the keying pulse produced by MV 1 is differentiated and used to start MV 2, which also controls an oscillator.

The chain is continued, each oscillator being started by the trailing edge of the preceding keying pulse multivibrator. Note that the sum of the on times of the five oscillators does not have to correspond to the time between synchronizing pulses. For most purposes it is desirable to have the five frequencies contained completely between synchronizing pulses.

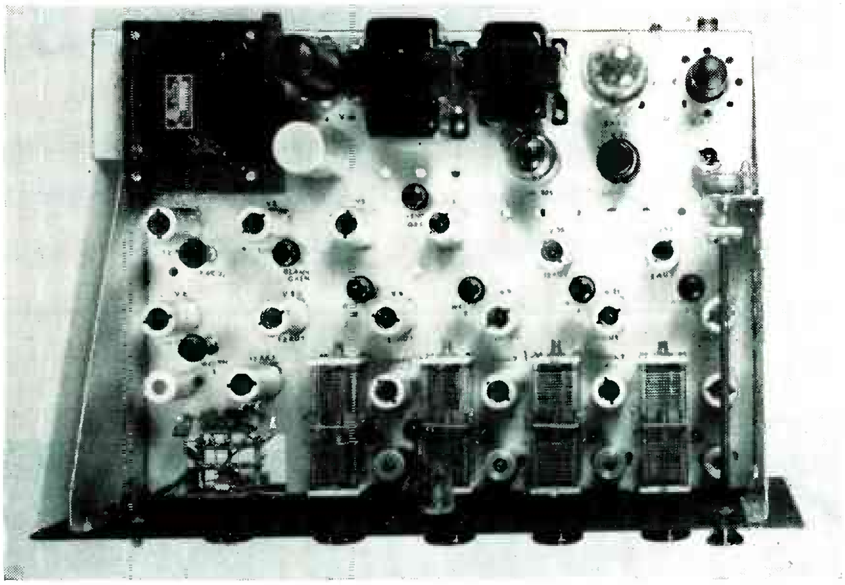
In a few applications, however, it is useful to have a signal on the back porch, and this generator provides for this contingency. For example, an NTSC color signal can be partially simulated by spreading the first three frequencies over the usual video portion of the space between sync pulses, making the amplitude of the fourth oscillator zero and the duration of its keying pulse just long enough so that the fifth oscillator starts on the back porch of the blanking pedestal. Thus the fifth oscillator can partially simulate the color synchronizing burst.

The height of the sync pulse and the blanking pedestal are adjustable. By setting the level of all the burst frequencies to a relatively low value and then adjusting the height of the blanking pedestal, the amplitude linearity of a system which utilizes d-c setting can be investigated since this adjustment moves the test frequencies through the amplitude range of the system under test.

The output of each oscillator is

obtained from a tap on the oscillator coil. Variations in the frequency of the oscillators due to changing the amplitude controls are minimized by resistance isolation. The amplitude of the signal obtained from each oscillator is determined by front-panel controls. The blanking pulse, the sync pulse, and output of the oscillators are added by means of individual triodes working into a common plate load. This provides a minimum of loss in the adding process and provides considerable isolation between oscillators.

The composite signal is carried through a normal video amplifier containing a gain control so that the peak-to-peak value of the composite signal can be adjusted. A cathode follower provides impedance matching between the video amplifier and the low-impedance load.



Top view of generator chassis clearly shows placement of parts and frequency-determining elements

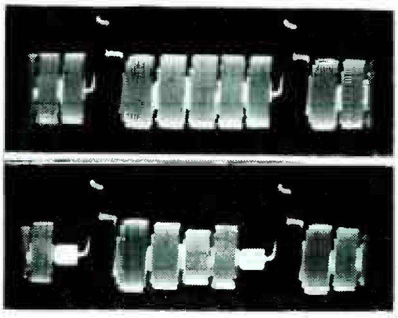
Oscillator Requirements

Circuitwise, the only part of the test generator requiring special comment is the oscillator, which must be designed to start and stop without injecting a pedestal or d-c component in the output. The oscillator must start and stop rapidly, and the amplitude must remain constant over the frequency band covered. The signal generated must be reasonably sinusoidal.

Although the oscillators used do not completely satisfy all of these requirements, they are satisfactory and far superior to other systems that were tried. The circuit of one of the keying multivibrators and its oscillator is shown in Fig. 2.

Each oscillator is prevented from operating by loading the tuned circuit with the cathode impedance of a triode. When this damper tube is driven to cutoff by the keying pulse, the load is removed and the oscillator comes up to full amplitude quite rapidly. The keying pulse does not appear in the output since the cathode current of the damper tube flows through the inductance in the resonant circuit which has very low d-c resistance.

The component values for each oscillator must be individually chosen to produce the most nearly sinusoidal waveform with a minimum of amplitude variation as the frequency is changed. Many satisfactory variations of the oscillator circuit are possible depending upon what is wanted in the final device. One system used in an earlier design used the multivibrator keying pulse to shock excite the tuned circuit and the tube was used as an amplifier with just sufficient gain to compensate exactly for the losses in the tuned circuit. The result was an excellent sine wave that came up to full amplitude in the first half cycle and maintained constant amplitude for as long as required. The defect was that changing the tuning of the LC circuit changed its operating Q. Thus a different amplifier gain was needed to prevent build-up or decay in the amplitude of the waves produced. The elimination of this "flatness" control was considered well worth the slower rise time and increased distortion in the lower frequencies of the present unit.



Typical input (top) and output (bottom) oscillograms show results of test on video system that has a sag in its response near 2 mc and cuts off between 3 and 4 mc

Results

This generator is particularly suited for checking extensive television systems. The test signal can be introduced at some convenient input point and simultaneous checks can be made at many intermediate points. In this way both gross errors and cumulative errors can be detected and localized.

The worth of the instrument was demonstrated in connection with system checks involving television network facilities. Tests made with this new generator in preparation for color television demonstrations originating in New York and viewed in Washington, D. C., in October 1951, demonstrated that for this particular circuit the combined system was not flat. The presence of the test signal greatly simplified the installation of the necessary compensation.

One advantage of this test signal over the video sweep method was totally unexpected. It is a psychological advantage. Even persons having only casual knowledge of frequency test procedures are firmly convinced of the accuracy of the method when one points to an oscilloscope which actually shows a series of cycles for each frequency.

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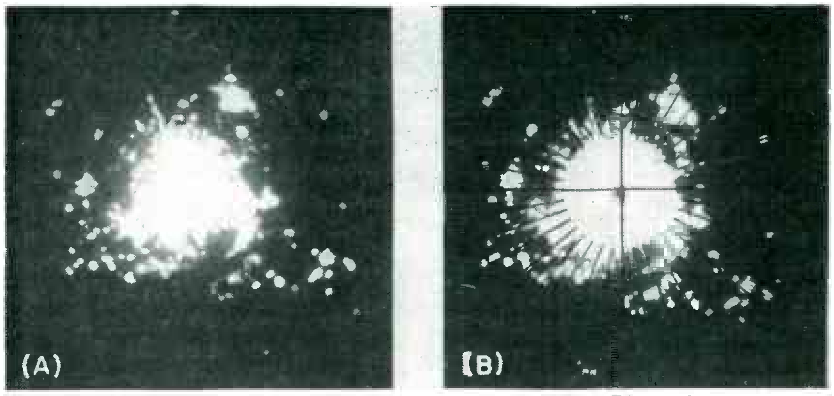
Narrow-Band Link

Video signal compressed to 2.3 kc bandwidth, is relayed from radar station to central control point over telephone lines or radio link. System integration properties may be useful for detecting small objects such as submarine periscopes or schnorkel breathing tubes



Normal radar video (A) and Rafax band-compressed video (B) as shown on two ppi scopes placed side-by-side. Rafax video shows improved definition achieved by integrating several radar pulses using crt-screen storage properties

BANDWIDTH COMPRESSION allows radar information to be relayed to a control center over a leased telephone line.

The Rafax bandwidth compressor accomplishes this by integrating the data on the face of a cathode-ray tube and scanning the tube face at a slow rate. The photographs show normal radar video and Rafax video on two oscilloscopes mounted side by side.

Figure 1 shows the over-all operation of the radar-relay link. The radar set shown has its own ppi display. Its video is also fed into the Rafax equipment which preserves the main information content of the radar video but at a much lower bandwidth.

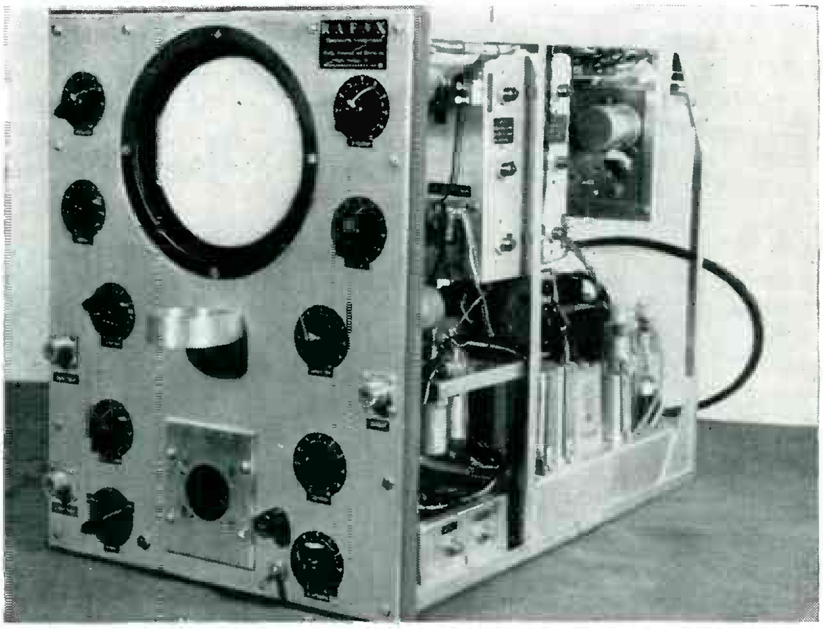
The output of the equipment is a narrow-band signal which includes the compressed video and a synchronizing signal. It is relayed over leased telephone line to the central point at which the radar information is desired. There the signal-adapter unit generates the proper signals to operate a ppi display on which is constructed a reasonable facsimile of the original ppi picture.

The relayed signals contain enough information to operate the yoke-drive motor for the ppi, and to furnish a sync pulse to start the sweep.

Bandwidth Compressor

Normal radar video is applied to the intensity grid of the Rafax cathode-ray tube. The circle generator operates in synchronism with the radar pulse repetition rate, so that the trace executes a complete circle on the crt screen for every radar pulse. Thus the video display shows a definite linear relationship between the range of a given target and the angle at which that target appears on the scope.

Since the persistence of the phosphor is such that echoes received from a target due to one radar pulse do not die out before the next echo from that target due to the next



Modified test oscilloscope displays radar data on a circular A-type trace

Relays Radar Data

By **JOHN L. McLUCAS**
Technical Director
Haller, Raymond and Brown, Inc.
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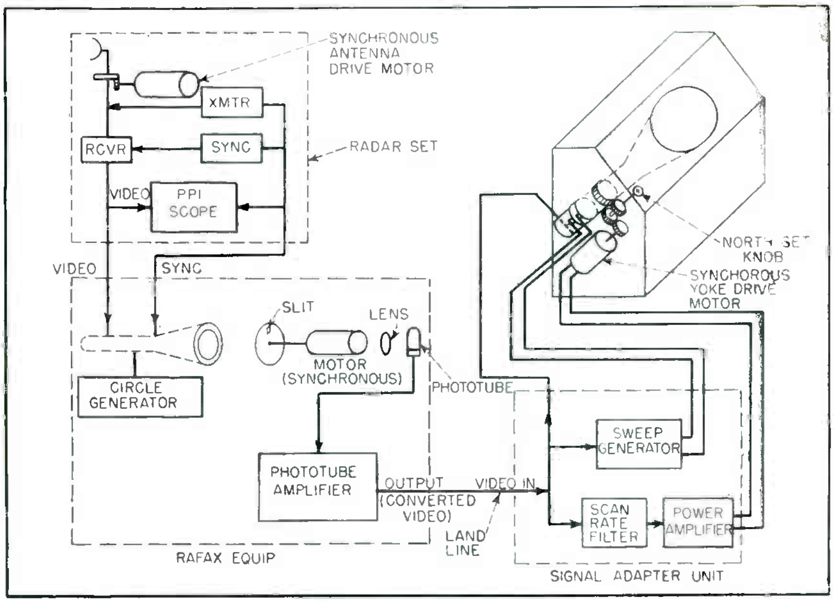


FIG. 1—Block diagram shows narrow-band radar-relay system. Radar video is displayed on circular-sweep cro. Relatively slow mechanical scanning integrates data stored on scope face reducing radar video bandwidth for transmission over land line or radio link

pulse is received, the phosphor acts as a storage or integrating device. By choosing the proper ratio between radar pulse repetition rate and persistence, any reasonable number of pulses may be integrated. The integrated effect of many pulses can be observed by a phototube which scans the circle at some relatively slow rate.

The photographs show the essential parts of the Rafax bandwidth compressor. The oscilloscope on which the radar data are presented is a Dumont 303 modified to incorporate the phototube amplifier and circle generator circuits. The photograph of the complete assembly with the phototube light shield removed shows the rotating scanner and phototube mounted above the scope face.

Theory of Operation

Assume that the radar set has the following characteristics: pulse-repetition rate, 1,000 pps; beamwidth, 2 deg; and antenna scan rate, 10 rpm.

A point target at some distance from the radar set, say 25 miles, will be illuminated during the time that it takes the beam to move through an angle of 2 deg. At 10 rpm. the target is illuminated for 1/30 second. If it is desired to integrate the echoes received from a point target, the integration time should be about 1/30 second. About 33 pulses will be received from a given target during the time it is illuminated by the radar.

Since integration tends to insert a delay in the information channel, over- integration cannot be tolerated. While an old signal still lingers on the scope, a new signal cannot take its place until the storage time interval is past.

The scanner samples the stored information on the screen at some slow rate. The rate of scanning should be fast enough so that no target is passed over between scans. Thus if a target appears on the scope for 1/30 second, a scanner rotation rate less than 30 per second will allow some targets to initiate and complete their display without the scanner ever seeing them. A direct relationship must exist between three parameters, the time the target is illuminated, the integration time of the phosphor, and scanner rotation time.

If the integration time is less than the target illumination time, not all echoes will be integrated; if it is greater there will be an aperture effect causing smearing of the target over too large an area on final presentation. Further, the scanner must rotate at least once during the time a target appears.

Since the time of appearance of a target is equal to the target illumination time, the scanner should perform at least one rotation per antenna beamwidth. A fair compromise sets the storage time at some large fraction of the target illumination time. For the chosen time of 1/30 second for illumination time, the phosphor storage time should be between 1/60 and 1/30 second. The former gives a cleaner picture with little smearing, the latter gives a somewhat better signal-to-noise ratio.

The scanner rotation time should be no greater than the target illumination time and can be as fast as the storage time. For minimum bandwidth considerations, the slower figure (1/30 second) is best.

System Constants

The whole design is thus based on the radar set to which it is attached. With the parameters specified earlier, a complete system follows:

The radar antenna rotates at 10 rpm, one revolution every 6 seconds. Individual point targets (aircraft) are illuminated for 1/30 second, 2 deg beamwidth assumed. The storage time is about 1/30 second, which is equal to one time constant of the phosphor decay exponentia

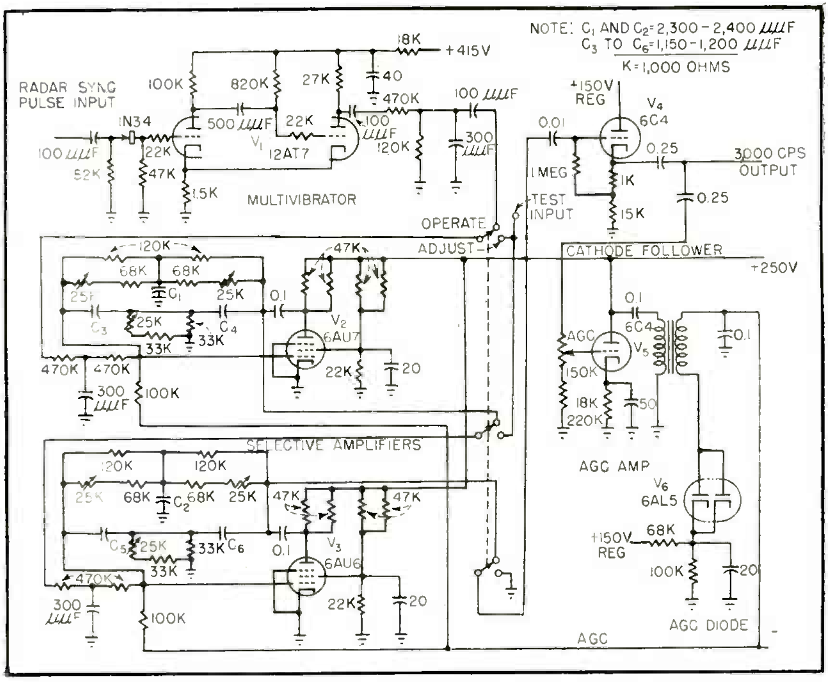


FIG. 2—Monostable multivibrator synchronized with parent radar generates 3,000-cps circular-sweep voltage. Selective amplifiers incorporate parallel-T networks to reject undesired components of multivibrator waveform

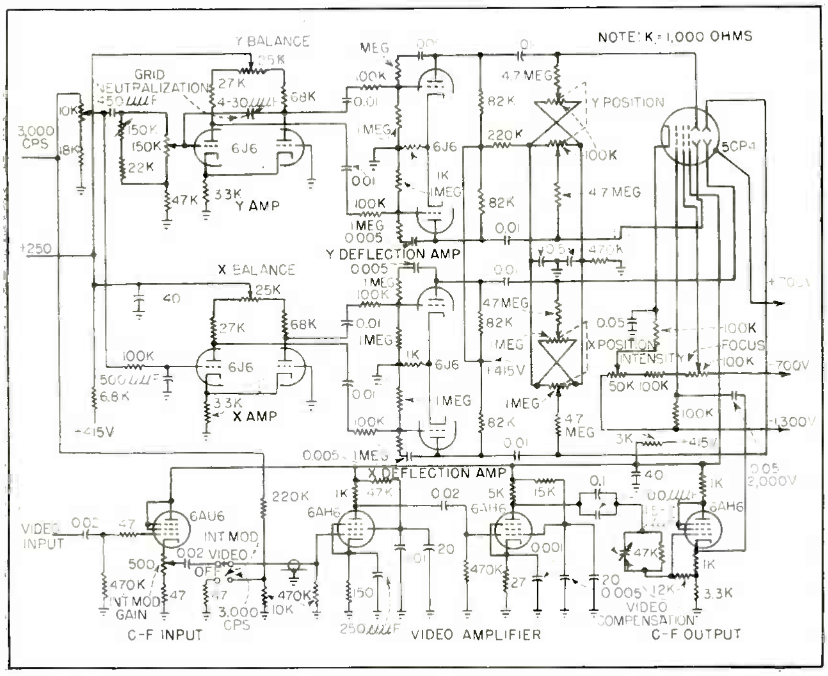


FIG. 3—Grid-circuit networks of X and Y-channel paraphase amplifiers produce circular sweep by respectively retarding and advancing 3,000-cps sweep voltage 45 deg

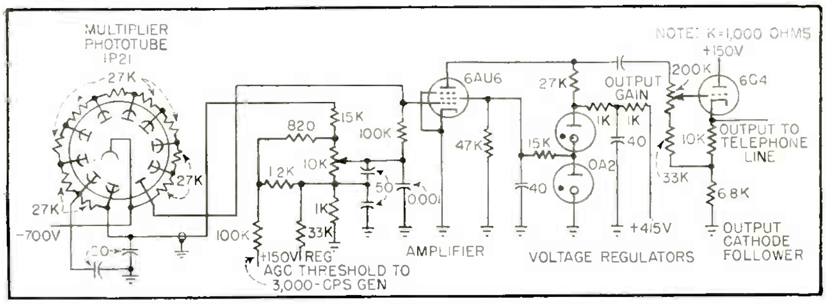


FIG. 4—Test oscilloscope chassis is modified to incorporate multiplier-phototube amplifier and output cathode follower

law. Almost all pulse echoes from a given target are integrated on the screen. The scanner rotates at 30 rps, sampling the radar picture once per beamwidth of the parent radar. The scanning slit of the scanner is adjusted so that 150 elements are resolved in range.

The output of the phototube is used to drive the remote ppi display. The remote ppi operates in synchronism with the parent radar antenna at 10 rpm. Thus it moves through 2 deg for every rotation of the scanner. A signal-adapter unit at the remote end of the telephone relay link furnishes proper inputs to the ppi console. The video is fed into the adapter unit. This video drives the intensity grid of the ppi tube directly.

The main bang picked up by the scanner from the circle generator appears at the beginning of each video train received at the adapter unit. This main bang is used to sync a tv-type sweep generator which provides the sweep on the ppi tube. This main bang is periodic, and its length and amplitude are characteristic, so that it is not difficult to sync on it.

PPI Yoke Drive

The remaining input to the ppi console is to the yoke-drive motor. This is also taken from the remote video information. The radar antenna-drive motor and the scanner motor are synchronous and operate from the same power line so that an integral relationship exists between the speed of the antenna and the speed of the scanner.

The number of pulse trains per second received at the remote end is always equal to the number of scans per second performed by the scanner. Thus the main bang can be differentiated and used to sync a multivibrator running at nearly 30 cycles per second. The output of this circuit passes to a frequency doubler and is smoothed by filtering. The final output drives a 60-cycle synchronous motor. Thus the remote ppi tube yoke is driven in synchronism with the radar antenna.

Since the scanner rotates at 30 rps, the bandwidth required to resolve the targets that it sees may be

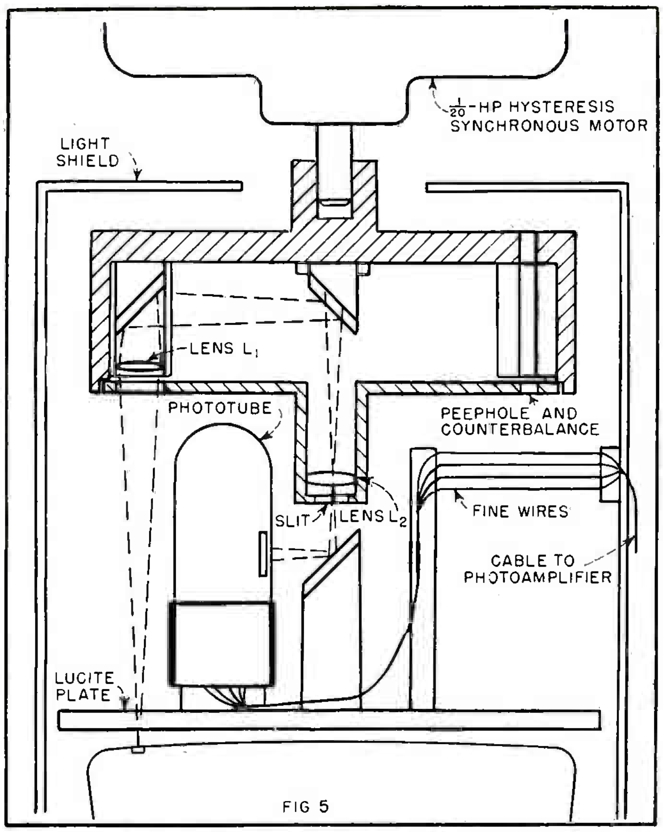
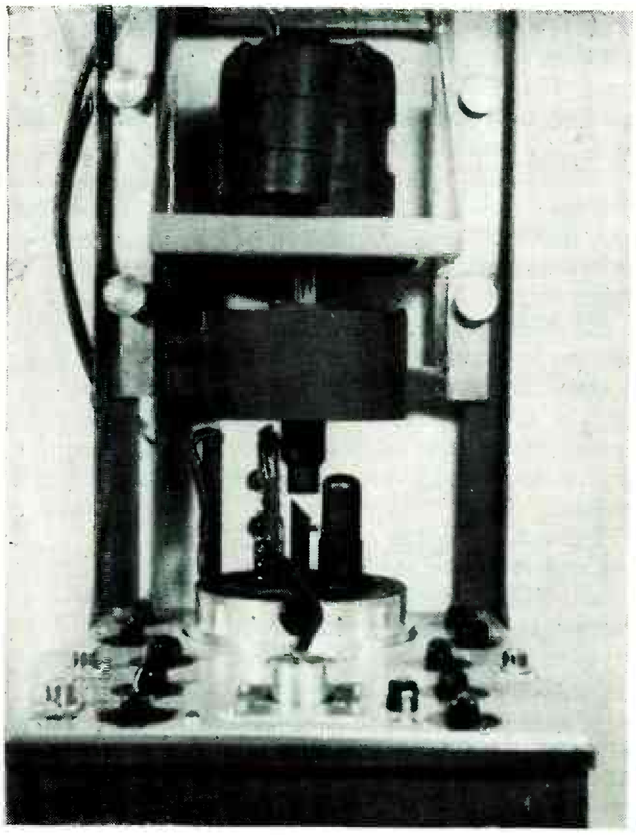


FIG. 5—Optical system of rotating scanner furnishes an output unaffected by small phase changes in circular sweep voltage. Integral relationship exists between scanning rate and radar-antenna rotation rate



Rotating scanner samples data displayed on the circular trace on the cathode-ray tube face. The phototube converts visual information into electrical energy for transmission to the remote control center

found directly by reference to the number of resolvable elements in range which it is desired to detect. In the usual case, some 150 elements are considered adequate. On the 30-mile range with the present equipment, this corresponds to a range resolution of 0.2 mile. The bandwidth required for a reasonable signal-to-noise ratio is thus 150 × 30/2 or about 2.3 kilocycles. Since a radar with 0.2 mile range resolution must have a minimum bandwidth of 250 kilocycles and in practice has from one to two megacycles, it is apparent that a great saving in bandwidth is accomplished.

Radar and Rafax Bandwidth

The large discrepancy between radar bandwidth and Rafax bandwidth is accounted for by the method of operation of radar. To resolve targets at range separations of 0.2 mile using a form of energy which propagates at the speed of light requires a system capable of responding to changes in two microseconds. Some portion of the system must be capable of discriminating between events which are two microseconds apart, and a minimum bandwidth for such discrimination is about 250 kilocycles.

Bandwidth Requirements

If the radar set is regarded as a device for determining the presence or absence of targets in discrete blocks of space, the theoretical minimum bandwidth can be found from the modified Hartley law, $C = b \log_2 (s + n)/n$, where s and n are in the same units, b is bandwidth in cycles and C is the capacity of the channel in bits per-second.

If the region of 30 miles radius surrounding a radar set were broken up into elemental (projected) areas, whose extension in azimuth is equal to the beamwidth of the radar (2 deg for this case) and whose extension in range is equal to its range resolution (0.2 mile), then the radar must perform yes-or-no decisions on the presence of targets in 180 × 150 = 27,000 small space elements during each rotation of the antenna. If the antenna rotates in 6 seconds, then 4,500 decisions per second are required.

Assuming a signal-to-noise ratio of 3; ($\log_2 (3 + 1)/1 = 2$). Thus $b = C/2$. Then to make 4,500 decisions or to acquire 4,500 bits of information per second requires a bandwidth of 2,250 cycles. Since the actual bandwidth of the radar set is more than 100 times as great as this theoretical requirement, it is apparent that it is the method of accumulation of the data and not the rate which demands such wideband systems in radar.

Circuit Details

A sync pulse from the parent radar actuates the circle generator and starts the circle on the face of the Rafax oscilloscope. The circle is produced by applying sine and cosine excitation voltages to the

X and Y deflection amplifiers.[1]

Figure 2 shows the sine wave generator that supplies deflection voltages to the oscilloscope. The radar sync pulse input triggers V_1, a monostable multivibrator having a period of about 150 microseconds. Two selective amplifiers, V_2 and V_3 pass the 3,000-cps component of the multivibrator waveform to the output cathode follower, V_4. Each of the selective amplifiers incorporates an R-C, parallel-T network in its grid-plate circuit. At the desired frequency, these networks present practically infinite impedence to the normally-heavy inverse feedback.

Figure 3 shows the scope deflection and intensity modulation circuits. The phase-shift network feeding the Y-channel paraphase amplifier shifts the 3,000-cps signal 45 deg ahead while the R-C network in the grid circuit of the X-channel paraphase amplifier retards the signal 45 deg. These amplifiers supply circular-sweep voltage to their respective push-pull deflection amplifiers. The intensity modulation circuit includes two stages of video amplification, and input and output cathode followers.

The scanner and the radar antenna are driven by synchronous motors, thus the speed of the scanner is synchronized with that of the antenna. The light from the scope face passes through a slit to the phototube whose output is amplified by the circuit shown in Fig. 4.

Optical System

The design of the scanner is shown in Fig. 5. Light from the scope face passes through a Lucite plate to the lens L_1, thence to two 45-deg mirrors to assume a coaxial orientation with the scanner shaft, and is brought to a focus on the slit. A third 45-deg mirror bends the light beam so that it falls on the phototube. Lens L_2 is in such a position that it focuses the plane of lens L_1 on the photocathode. Lens L_1 acts as an evenly illuminated source which is focused on the phototube. Any eccentricity in the circle on the crt will not result in movement of the spot of light on the photocathode. The phototube is removed from the path of the circle so that phase stability in the circle is unnecessary. Any amount of phase shift can be tolerated by this system. The only requirement is that the rate of phase shift remain less than about 2 deg (the radar beamwidth) per scanner rotation, that is, less than about 60-deg per second.

Magnification of the optical system up to lens L_2 is approximately unity. Lens L_2 has a short focal length (1 inch) so that a ½-inch circle of light at the plane of lens L_1 becomes a ⅛-inch circle on the phototube.

Motions of the spot of light on the crt result in no motion of the image at the phototube. However, modulations of the light intensity on the phototube can result if such motions are of sufficient magnitude to move the circle of light off lens L_2.

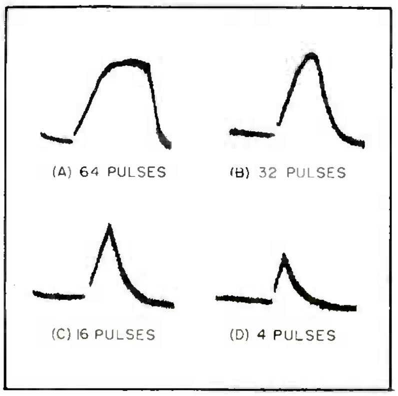


FIG. 6—Integration properties of P1 phosphor; 32 pulses may be integrated before saturation is reached

In general, maximum deviations of the c-r trace from a true circle are no more than ± ⅛ inch. Drifting of the spot by ⅛ inch will not move the spot of light off L_2.

Integration and Storage Properties

The system depends for its operation on the integration and storage effects in the phosphor. If this is not a good integrator, some small signals may be seen on the original ppi picture but not on the Rafax picture. If the phosphor is a good integrator, but decays in less than the time of illumination of the target, then, although integration takes place, signals may be lost.

A test of the properties of several phosphors was made at M.I.T.[2] Measurements of integration properties, and decay properties of the P1, P4, and P7 phosphors showed that the P4 and P7 were unsatisfactory.

Figure 6 shows the integration properties of the P1 phosphor for different numbers of radar pulses. The number of pulses corresponds to the illumination time of a radar target. For example, if the radar prf is 1,000 pulses per second and the target is illuminated for 1/30 second, approximately 32 echo pulses may be expected. If the phosphor is to give the integrated effect of all the pulses received from that target, it should integrate linearly over 32 pulses.

Figure 6 indicates that the P1 phosphor has integrated up to 32 pulses before saturation becomes serious. The integration effect is a function of the level of the individual pulses. Figure 6 shows the case where separate pulses were relatively small, corresponding to weak signals from a distant target. It is in just such cases that good integration is important if weak signals are not to be lost.

Figure 6 also shows the decay of the signal after the initial build up. It is desirable for the signal to decay to about 50 percent in the time corresponding to target illumination time. Since illumination time is a function of the radar set itself, no fixed value can be specified. However, if the radar constants assumed in this report are chosen, the P1 phosphor decays too fast. Its decay time is about 10 milliseconds, whereas a 30-millisecond decay time would be more desirable.

The original Rafax bandwidth compressor was conceived by W. N. Brown, Jr. Other Haller, Raymond and Brown, Inc. employees contributing to the development of Rafax in its present form are, in addition to the author, S. P. Detwiler, P. J. Freed, R. V. Higdon and A. G. Schilling.

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(1) S. P. Detwiler, "Maintenance Manual for Rafax Bandwidth Compressor," Haller, Raymond and Brown Technical Memorandum 36-M-2, Apr. 1952.
(2) J. V. Harrington, "Tests of Rafax Scanner," Project Lincoln, M. I. T., March 1952.

Simplified
I-F Amplifier Design

Three-step method makes use of three special charts that enable designer to choose circuit constants rapidly and to compare various combinations of parameters for obtaining optimum design. Typical examples are worked to illustrate use of charts

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INTERMEDIATE-FREQUENCY amplifier design by mathematical means is time consuming and the operations involved are quite cumbersome. Through the use of three charts given here, the process can be reduced to three or four simple steps for the complete design of a synchronously-tuned i-f amplifier system using the double-tuned transformer configuration shown in Fig. 1.

The chart in Fig. 2 is a family of curves showing the relation between shape factor of the selectivity curve of an i-f system to the coefficient of coupling of the double-tuned transformer used in this system. Shape factor *SF* of the i-f system will be taken as the ratio of the system bandwidth at −60 db to that at −6 db. This factor is independent of the Q of the primary and secondary of the transformer and is only a function of the coupling of a double-tuned circuit and the number of such circuits cascaded. Thus, once the shape factor of any system is specified the number of tuned circuits and coupling necessary is immediately found from Fig. 2.

The following equation was used in plotting this family of curves.

$$SF = \left[\frac{(p-1) \pm \sqrt{(p+1)^2\,(10^3)^{2/m} - 4p}}{(p-1) \pm \sqrt{(p+1)^2\,(2)^{2/m} - 4p}}\right]$$

where m is the number of double-tuned transformers and p is the square of the coupling coefficient k normalized to critical coupling k_c.

Figure 3 is a family of curves showing the relation between the bandwidth factor X versus the coefficient of coupling.

The expression for X is

$$X = \frac{2\,Q\,\Delta f}{f_0} = \frac{Q\,BW}{f_0} = \left[(p-1) \pm \sqrt{(p+1)^2\left(\frac{E_0}{E}\right)^2 - 4p}\,\right]^{\frac{1}{2}}$$

where $Q = Q_1 = Q_2$.

Figure 4 shows the relation between the normalized gain of a band-pass amplifier incorporating a double-tuned circuit versus coupling. The expression used in plotting this curve is

$$\frac{A}{A_0} = \frac{2\,k\,Q}{1 + k^2 Q^2}$$

where A_o = gain at $kQ = 1$ (critical coupling).

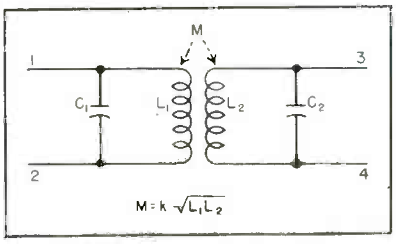

FIG. 1—Basic i-f transformer design considered in simplified design system

Symbol Summary

Definitions of transformer constants employed in this article are as follows:

L_1 = primary inductance in henrys
L_2 = secondary inductance in henrys
C_1 = primary capacitance in farads
C_2 = secondary capacitance in farads
Q_1 = Q of primary = $\omega L_1/r_1$
Q_2 = Q of secondary = $\omega L_2/r_2$
r_1 = resistance of primary winding
r_2 = resistance of secondary winding
$p^{1/2}$ = k/k_c = coefficient of coupling
SF = shape factor of selectivity curve
X = $2Q\Delta f/f_0 = Q\,BW/f_0$
A_0 = gain at f_0
E_p/E_0 = peak to valley ratio
f_0 = center frequency

The curve shown in Fig. 4 is also useful in determining peak-to-valley ratios of any system when the coupling coefficient is greater than unity. Above $k/k_c = 1$, the curve is a measure of the peak-to-valley ratio and the db (right hand) ordinate should be used. For example if $k/k_c = 2$, the peak-to-valley ratio for one transformer from the db scale is − 2 db. This means the response at the center frequency, which corresponds to the valley, is 2 db below the response at the peaks of the selectivity curve. Now, if n

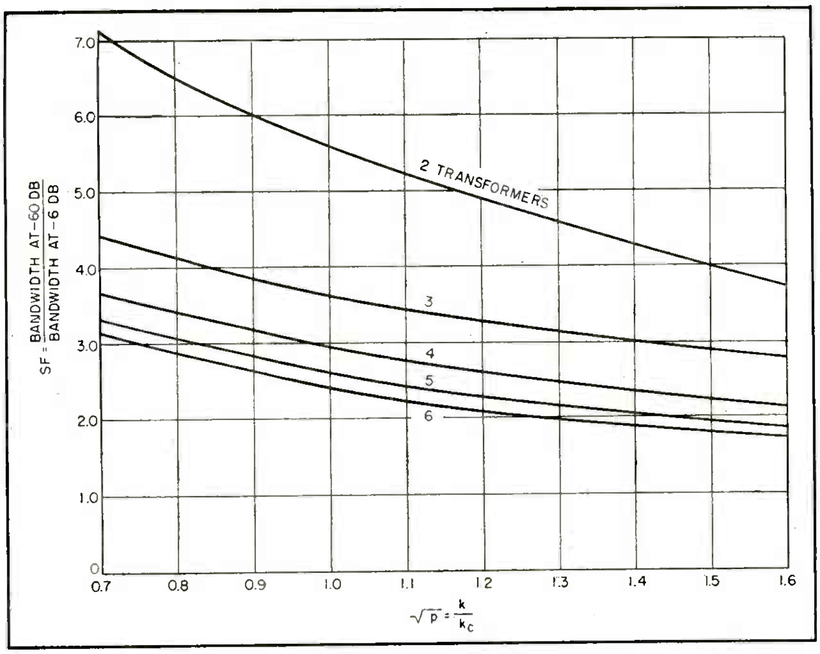

FIG. 2—Curves for determining coupling from specified shape factor. The number of stages is one less than the number of transformers, and the shape factor SF is independent of Q and center frequency

transformers are used the overall peak-to-valley ratio will be n times -2 or $-2n$ db.

Design Procedure

A complete i-f system design is as follows:

The i-f frequency is chosen using these factors as its basis:

Image Rejection—that is whether or not the r-f circuits have enough selectivity to reject the image frequency which is equal to the r-f frequency plus or minus two times the i-f frequency.

Rejection of r-f circuit to i-f. The i-f frequency must be chosen below the lowest r-f frequency covered by the receiver so that with the Q's obtainable in the r-f section, together with any traps that may be incorporated, the i-f rejection will be at least 60 db down.

The i-f frequency must also be chosen low enough in frequency so that the bandwidth requirement at 6 db (for example narrow band) can be met using the proper number of tuned circuits having a reasonable value of Q. The number of tuned circuits to be employed is determined by the shape factor specification. Now having determined the i-f frequency, proceed as follows to complete the design of the i-f system:

From Fig. 2 choose the number of transformers that will be necessary to meet the shape factor specification, having initially established the amount of coupling to be employed. As an aid in determining the proper coefficient of coupling to use refer to Fig. 4.

From Fig. 3 determine X. For example, if five transformers are required (obtained from previous step), at the value of k/k_c chosen, pick off the value of X from the 1.2-db curve, since the bandwidth at -1.2 and -12 db for one transformer would be the overall i-f bandwidth BW at -6 and -60 db respectively.

From the value of X, the required Q of the transformer can be computed as follows:

$$Q = \frac{Xf_0}{BW}$$

which equals Q_1 and Q_2. The term BW is the -6 db bandwidth. Having initially specified a certain gain per stage, the constants of the transformer are:

$$L = \frac{2A_0}{g_m \omega_0 Q}\left[\frac{1+p}{2\sqrt{p}}\right]$$

where $L = L_1 = L_2$, and A_o = desired gain at f_o.

If $\sqrt{p}$ is approximately 1 (critical coupling)

$$L \approx \frac{2A_0}{g_m \omega_0 Q}$$

and

$$C = \frac{1}{\omega_0^2 L}$$

where $C = C_1 = C_2$.

Practical Examples

Three examples are presented to illustrate the chart method.

Example 1. Design an amplifier with an overall selectivity curve of 100 kc at -6 db and 300 kc at -60 db at $f_o = 4.3$ mc. Use a gain of 90 db with 6AK5 pentodes.

Step 1. From Fig. 2 proceed horizontally along $SF = 3$. It can be seen that there are four curves of this family that intersect this line. They are the 6-transformer line at $\sqrt{p} = 0.75$, the 5 line at $\sqrt{p} = 0.825$, the 4 line at $\sqrt{p} = 0.975$ and the 3 line at $\sqrt{p} = 1.400$.

The choice of any one of the above curves is a matter of judgment and is based on the gain and peak-to-valley ratio considerations. From Fig. 4 it can be seen that if six transformers are used, there will be approximately a 0.5-db loss per stage as compared to the four transformer choice. If three are used an overcoupled condition is realized, and from Fig. 4 the peak-to-valley ratio per transformer will be approximately 0.5 db, which may or may not be desirable. Four transformers will be chosen here since with three stages (1 less than the number of transformers) the overall gain specification can be met using a 6AK5 and a reasonably high value of fixed tuning capacitance to reduce any effects of detuning due to variations in input capacitance (Miller effect) resulting from any avc action. Therefore the desired value of $\sqrt{p}$ is 0.975, and the required number of transformers is four.

Step 2. Since four transformers are to be used the selectivity of one of these transformers at -1.5 and -15 db (Fig. 3) will be the overall selectivity of the i-f system. Locate the intersection of a line drawn vertically at $\sqrt{p} = 0.975$ with the -1.5 and -15 db lines. These points give $X_{-1.5}$ db and X_{-15} db. It is only necessary to use one of these factors, say $X_{-1.5}$ db for the Q determination.

$$Q = \frac{X_{-1.5} f_0}{BW}$$

$$= \frac{1.1 \times 4.3 \times 10^6}{100 \times 10^3} \approx 47$$

Step 3. A gain of 30 db per stage is desired with a 6AK5.

Therefore $L = \frac{2A_0}{g_m \omega_0 Q}$

since $\sqrt{p} \approx 1$.

If $A_0 = 30$ db or 31.6, $g_m = 5{,}000$ μmhos, $\omega_0 = 2\pi \times 4.3 \times 10^6 = 27 \times 10^6$, and $Q = 47$, then $L = 10$ μh and C = 137 μμf.

Example 2. Design an amplifier with an overall selectivity of 8 kc at − 6 db and 24 kc at − 60 db at a frequency of 1,255 kc using type 5702 pentodes. An overall gain of 80 db is desired.

Step 1. Considering the curves that intersect the $SF = 3$ line (Fig. 2), five transformers (four stages) will be used and the desired value of $\sqrt{p}$ is 0.825.

Step 2. From Fig. 3 and at intersection of $\sqrt{p} = 0.825$ and the − 1.2-db line, $X = 0.85$ and Q is found to be 89.

Step 3. The constants of the transformer can be computed from the following data: $A_0 = 10$, $g_m = 4{,}000$ μmhos, $\omega_0 = 7.88 \times 10^6$, and $Q = 89$; L = 13 μh and C = 1,240 μμf.

Example 3. Design an i-f system using 1AD4 pentodes to have a gain of 80 db and a bandwidth of 4 kc at − 6 db and 10 kc at − 60 db being centered at 455 kc.

Step 1. From Fig. 2 it can be seen that the 6, 5 and 4 transformer lines intersect the $SF = 2$ line at $\sqrt{p} = 0.95$, 1.05 and 1.29 respectively. Suppose the 4-transformer line is chosen since space limitations in the equipment permit only three amplifier stages.

Step 2. Proceed to Fig. 3 and locate intersection of line drawn from $\sqrt{p} = 1.29$ and the − 1.5-db line. (The −1.5-db line is chosen here since this corresponds to the overall − 6-db point of the system.) This occurs at $X = 1.6$. Thus $Q = 182$.

Step 3. The constants of the transformer are

$$L = \frac{2A_0}{g_m \omega_0 Q}$$

and if $A_0 = 22$, $g_m = 2{,}000$ μmhos, $\omega_0 = 2\pi \times 0.455 \times 10^6 = 2.85 \times 10^6$, and $Q = 182$; then $L = 42.5$ μh and $C = 2{,}870$ μμf. The overall peak-to-valley ratio can be found from Fig. 4; $E_p/E_0 = 0.25$ db per transformer and the overall $E_p/E_0 = 4 \times 0.25 = 1$ db.

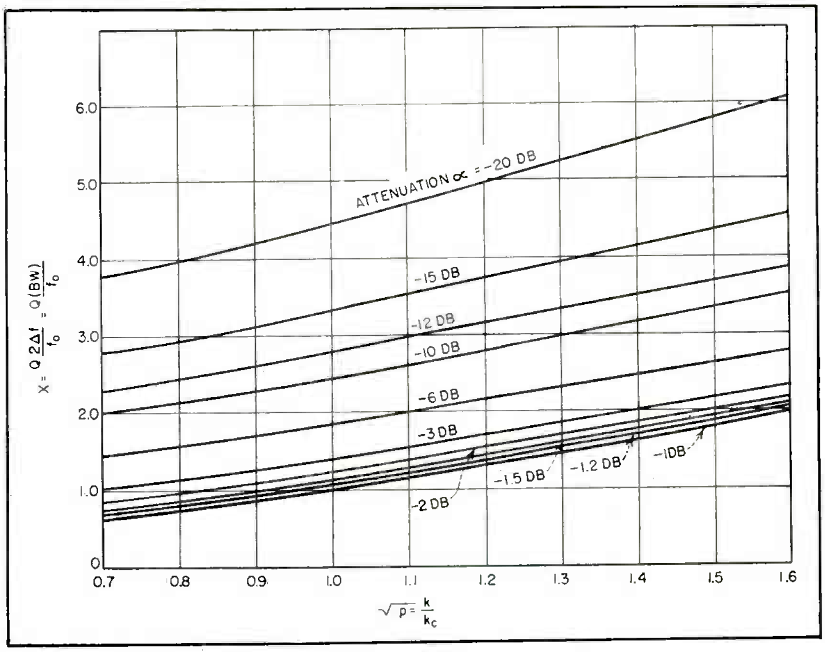

FIG. 3—Chart shows relation between bandwidth factor X and coupling for various degrees of attenuation

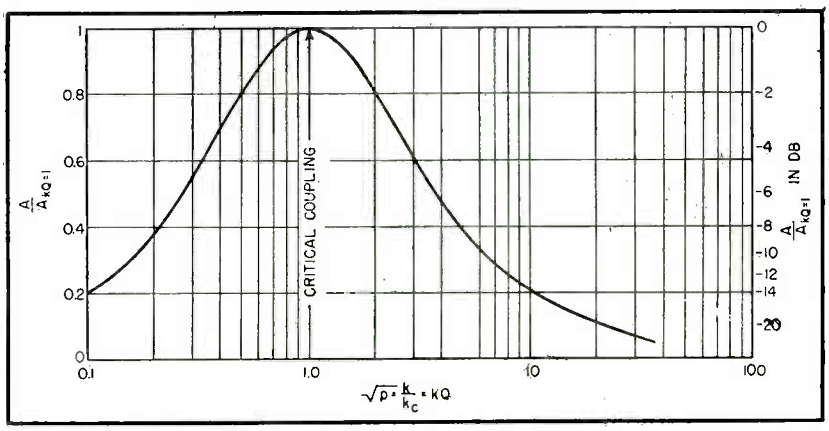

FIG. 4—Normalized gain of double-tuned circuit versus coupling up to critical coupling. Beyond critical, the curve is a measure of peak-to-valley ratio. For example, for *kQ* of 2, the peak-to-valley ratio is 0.8 or 2 db

Other Considerations

Practically speaking, one would choose the nearest RMA value of capacitance. The above constants were computed on the assumption that the high side of the input and output were respectively terminal 1 and 3 of Fig. 1. If a smaller value of capacitance and larger value of L were desired, certain modifications of the transformer must be made. That is, if C is reduced by a factor of 10 and L is increased by the same factor, the gain of each stage will automatically increase 10 times and a condition of instability may arise. In such instances a tap is placed on either the primary or secondary or both to compensate for the increase in impedance of the transformer. For Example 3, L would be increased to 425 μh and C decreased to 287 μμf. One way of compensating for the increased stage gain would be to tap down on the secondary by a factor equal to 1/10 to restore the gain of 22.

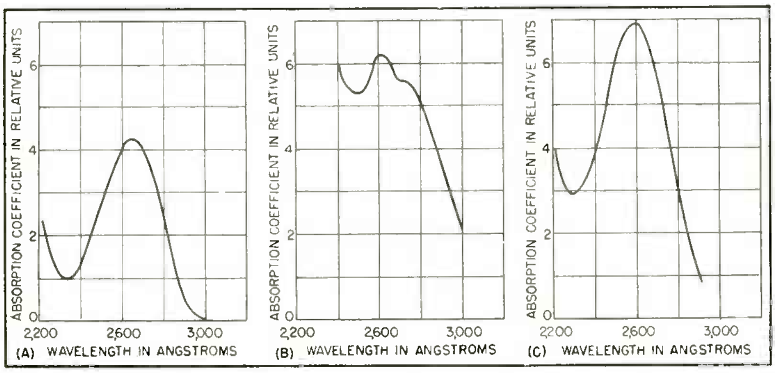

FIG. 1—Ultraviolet absorption curves for thymine (A), liver cytoplasm (B) and yeast nucleic acid (C)

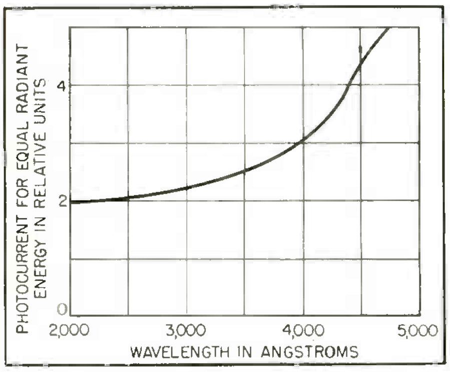

FIG. 2—Typical spectral response curve of ultraviolet-sensitive Vidicon

Ultraviolet Television Microscopy

Thin sections of biological tissue are observed directly under ultraviolet illumination by use of an ultraviolet-sensitive television microscope camera. Specimen is illuminated successively with radiation of three different wavelengths

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STUDY of biological materials under the microscope depends upon a differential absorption of light in the various parts of the cells or tissue being studied. In thin sections, most material of this type is practically colorless and some artificial means of increasing the contrast between different materials is necessary.

In some instances, selective staining of the specimen to introduce color contrast can be used to advantage. The phase-contrast microscope introduces another factor, that of time of transmission of the light through the specimen, to introduce artificially contrast which did not exist in the usual absorption sense.

The use of the television microscope has provided another means of contrast enhancement, that of gamma control which provides the same contrast enhancement in a direct-viewing instrument as can be obtained by photomicrography.

Another means of securing greater contrast in biological materials is by the utilization of illumination covering a much wider range of wavelengths, particularly in the ultraviolet. Thus materials which may appear completely colorless to visible light may exhibit highly selective absorption in regions of the ultraviolet.

Several published absorption curves for biological materials are shown in Fig. 1. All of the materials shown have very little absorption at wavelengths longer than 3,000 A but they exhibit peaks of absorption at various points from 2,800 A down to 2,200 A or lower, below which it is difficult to measure accurately with present equipment. Of particular interest is the high absorption of nucleic acid typified by the curve for yeast nuclei in Fig. 1.

Visible Image Techniques

Since the region of the spectrum of greatest interest lies beyond the range of sensitivity of the eye, some method of transformation must be employed to make ultraviolet microscopy useful. One direct method consists of the projection of the ultraviolet image by means of a quartz or reflective objective onto a fluorescent screen, the visible image resulting then being viewed directly or by an ocular. This method suffers from lack of both sensitivity and resolution.

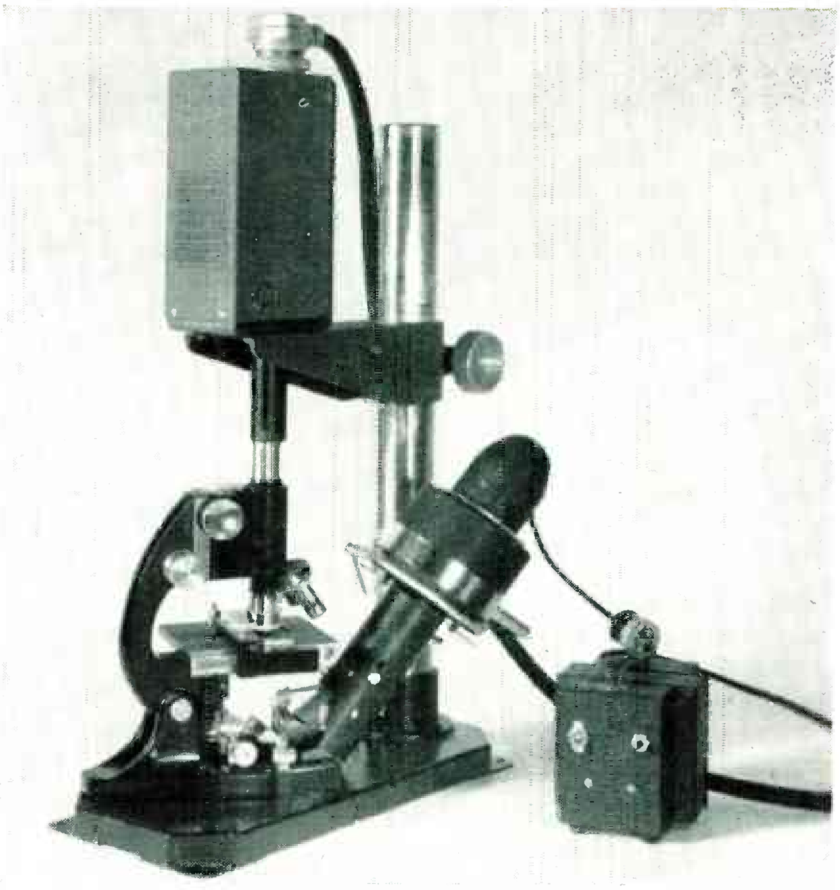
A more satisfactory method as regards sensitivity and resolution makes use of ultraviolet-sensitive photographic film exposed directly to the invisible image. This method gives satisfactory results but requires a time delay for processing the film.

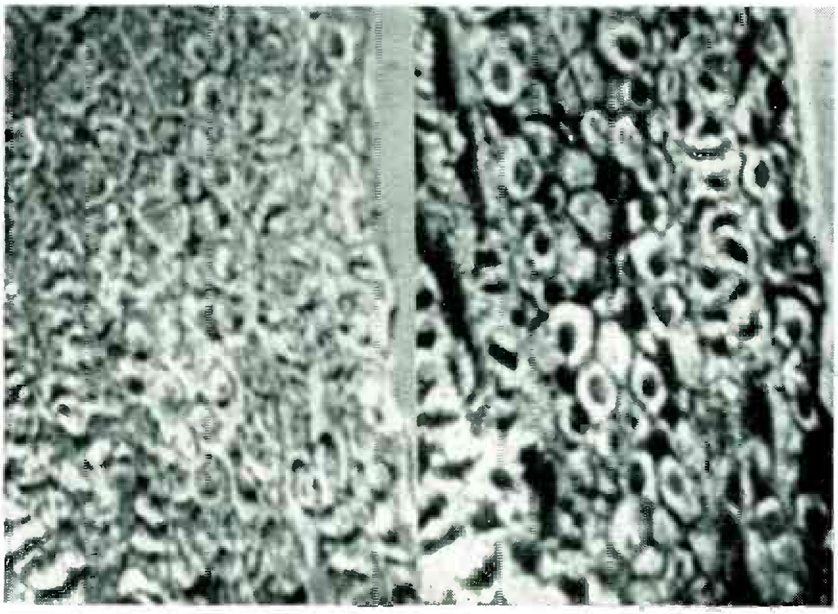
Television techniques offer a direct method of observation of microscopic specimens with ultraviolet illumination. The television microscope[1] can be equipped with an ultraviolet-sensitive Vidicon enabling it to respond to illumination down to 2,500 A or beyond. This permits the direct observation of biological or even living tissue within the limits of the killing power of the radiation.

The color response of a typical Vidicon[2,3] in the ultraviolet region is shown in Fig. 2. A television microscope camera and ultraviolet illuminator are shown in the photograph.

The illuminator consists of a mercury-vapor lamp with a quartz prism and optics and an inclined mirror to project a spectrum on a slit below the condensing lens of the microscope. This arrangement forms a crude monochromator. By sweeping the spectrum over the slit, the desired wavelength can be selected. Either quartz or reflective optics must be used throughout.

The second photograph shows two views of identical object fields taken from the television screen. The specimen is an unstained section of kidney tissue. The left half of the slide was exposed at 4,000 A while the right half was exposed at 2,537 A. The cell nuclei in the right half are plainly visible as black dots due to the high absorption of the nucleic acids within.


Vidicon camera mounted on microscope and ultraviolet illuminator


Unstained tissue section under the television microscope. Left half was illuminated at 4,000 A and the right half at 2,537 A

Obtaining Color Contrast

The different absorption of materials at different wavelengths could be said to indicate that the material has "color" in the ultraviolet region, using the word "color" loosely. This introduces another interesting possibility which was orignally proposed by Brumberg[4] and later by Land[5] and others. This consists of the assignment of three visible wavelengths of light to represent three wavelengths in the ultraviolet. By exposing three photographic films to the three ultraviolet wavelengths and then reproducing them in the three visible colors, a color micrograph would be obtained. The micrograph would not be a true color photograph of the specimen, but would be representative and would contain color contrasts and shadings corresponding to the ultraviolet absorption characteristics of the original material.

Use of the television microscope in this connection offers some interesting possibilities. In connection with the ultraviolet television microscope, it was pointed out that by sweeping the spectrum over a slit at the substage condenser, different wavelengths may be selected. If a three-segment rotating mirror is substituted for the plane mirror in the illuminator, the three parallel segments may be mounted at different elevations so that the specimen may be illuminated successively with radiation of three different wavelengths as the mirror rotates. A diagram of the optical system arranged in this manner is shown in Fig. 3.

Method Used

Functioning of the system depends on the fact that the refractive power of the collimator and telescope lenses of the illuminator vary in the same manner as the deflection produced by the prism. Hence the exit slit A may be so placed that radiation of different wavelengths is focused on it when the mirror M is given different displacements Δd parallel to itself. Position of the exit slit A relative to the telescope lens B is not fixed uniquely by this requirement.

Both the glancing angle χ at which the principal rays meet the mirror M and the variation of Δd with wavelength are fully determined by the refractive indices, vertex angle and focal lengths of the optical components.

Assume, specifically, that the vertex angle of the prism is 60 deg and the prism, collimator lens and telescope lens are all of the same material with median refractive index n. Then the glancing angle χ for the principal ray of the corresponding wavelength and the mirror displacement for a change in wavelength corresponding to a change in index Δn are given by the formulas

$$\tan \chi = \frac{\sqrt{4 - n^2}}{n - 1}$$

$$\Delta d = -F \frac{\Delta n}{n - 1} \sqrt{\frac{5 - 2n}{4 - n^2}}$$

Here F is the focal length of the collimator and telescope lenses for the median wavelength.

The magnitudes demanded by these formulas are entirely reasonable. For example, for crystalline quartz components cut perpendicular to the optic axis and for a lens focal length of 4.5 inches, the following values are obtained:

λ in A	2,537	3,130	4,358
n	1.5980	1.5737	1.5540
χ	65 deg, 4.5 min		
Δd, in.	-0.210	0	0.170

The two 120-deg mirror sectors selecting 2,537 and 3,130 A radiation are thus raised by 0.38 and 0.17 inch, respectively, with respect to the remaining sector, for 4,358-A radiation. Empirical masking of the individual sectors is employed to equalize the picture signal level for the three wavelengths.

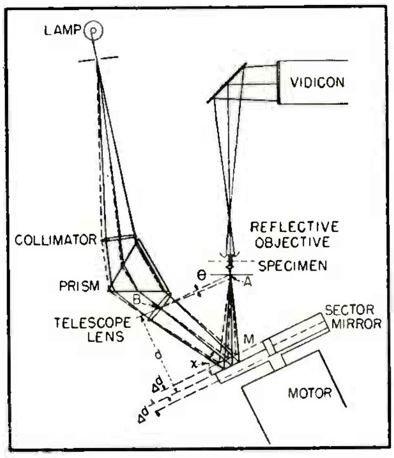


FIG. 3—Optical geometry of three-"color" ultraviolet microscope

Color Pictures

If the rotation of the mirror is synchronized at one-third the field frequency of the television system, successive fields will contain the information for the three ultraviolet pictures. If this information is then displayed on a color television receiver in which the tricolor kinescope is keyed to correspond with the rotation of the mirror, a color picture representative of the three "color" ultraviolet micrograph will be obtained.

The three-wavelength illuminator has a three-segment rotating mirror which selects the different ultraviolet wavelengths in synchronism with the field rate of the television system. Because of the storage properties of the Vidicon target, it is necessary that the illumination be on the target only for a short interval during the vertical blanking time. This is accomplished by applying a short high-intensity pulse to the light source, a mercury-vapor lamp, at the proper time in the scanning cycle. The charge laid down on the target as a result is then removed, without any color dilution, during the next scanning interval.

This equipment is still in a highly experimental stage but it has been operated successfully in the laboratory. The Vidicon was designed for operation at 30 frames per second, which is satisfactory for black-and-white pictures. In the color system described, however, very serious color flicker is observed at this frame frequency. There is hope that the speed of response of the Vidicon may be improved beyond that required for black-and-white operation. This would then permit a higher rate of color alternation and improved performance. Color separation is adequate and illustrates plainly the value of an integral representation in the picture of the selective absorption characteristics of the material through a wide range of ultraviolet wavelengths.

The authors acknowledge the contribution of James Hillier and Edward Ramberg to this program. They also thank J. M. Morgan and J. E. Dilley, who are responsible for the pulsing and keying circuit design,, and A. D. Cope who carried out development of the ultraviolet Vidicons.

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Chart Speeds Design of Feedback Amplifiers

Feedback ratio is found from values of normalized gain, both with and without feedback, for change in an amplifier parameter. Method is used to check conventional feedback ratio measurements and to design amplifiers with desired gain-stability characteristics

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COMMON PRACTICE has been to measure the amount of feedback in an amplifier by the feedback ratio, that is, the ratio, at the design center, of the amplifier gain with feedback to that without feedback.[1] While this method is extremely simple, it frequently leads to erroneous results.

Errors arise from many sources. Some errors are due to the fact that mere gain reduction by feedback may be complicated by reflected admittances introduced through interelectrode and stray capacitances not anticipated in design. It should be further noted that simple removal of feedback is never completely realized without disturbing the operating conditions of the rest of the amplifier.[2] In extreme cases it is possible to alter amplifier gain so drastically by disturbing design conditions that the gain change due to removal of feedback is obscured.

Under such circumstances it is obvious that gain ratio tests may not give a true indication of active feedback in an amplifier. Recourse must be made to determination of feedback through the effects of feedback on amplifier characteristics other than gain.

The effects of feedback depend in general upon the type of feedback used. While it is possible to apply feedback over several loops, some partially or wholly within others, feedback is very often applied over only one loop in a given amplifier and it is to such amplifiers that this paper applies. It is further assumed that all unstable elements such as vacuum tubes and varistors are included within the feedback loop.

Gain Stability Studies

Of the many alternative ways of observing the effects of feedback on a single-loop amplifier, the method of studying gain stability as affected by variations in amplifier parameters will be discussed.

Basically, a determination of amplifier gain stability is made for a certain change in a parameter both with and without feedback and a comparison made to determine the effect of the feedback. This approach is not altogether new[3] but it is believed that the present method offers several advantages in many cases, largely through the elimination of auxiliary graphical constructions and by the use of the concept of normalized gain.

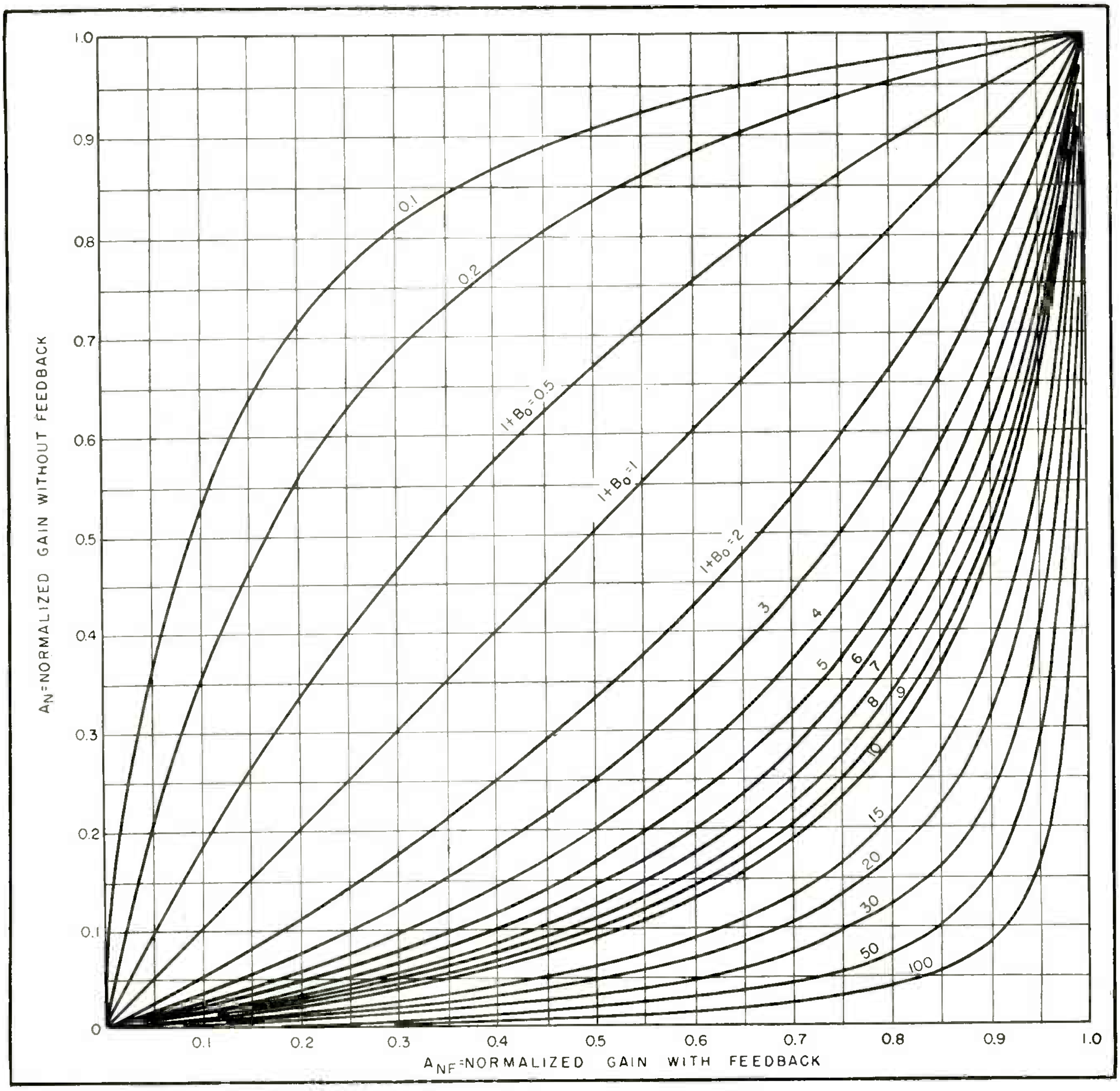
The amount of feedback found to be present in an amplifier at design center, by use of this method, will be denoted by $1 + B_0$, and will be that gain ratio that would be associated with the indicated stability change if design-center, gain-ratio measurements yielded a true value of active feedback. The design-center feed-back ratio found on a stability basis can be used as a check on the ratio

DESIGNING FOR GAIN STABILITY

An amplifier is to be designed for less than ten-percent loss of gain with feedback as compared to an anticipated loss of gain of 50 percent for a similar amplifier without feedback.

Enter the chart at an abcissa of 0.9 (normalized gain with feedback) and at an ordinate of 0.5 (normalized gain without feedback). Extend these coordinates until they intersect and read the value of feedback ratio from the curve through the point of intersection, interpolating in the case of intermediate values.

In this example, the intersection is approximately 9.0. Therefore, the feedback ratio of the proposed amplifier should be 9.0. If the amplifier is to have an operational gain of 100, a gain of 900 without feedback will be required



Amplifier feedback ratio at design center is plotted against normalized amplifier gain with, and without, feedback. Gain for a change in an amplifier parameter is normalized with respect to gain at design center

found by gain measurements, wherein a large discrepancy indicates either faulty technique in measurement or malfunctioning of equipment.

It is frequently found that the design-center feedback ratio, 1 + B_0, as determined by gain ratio, differs from that determined by a stability test. As an example, tests made on an r-f feedback amplifier indicated a gain ratio 1 + B_0 of 6.0 while stability tests indicated an active feedback ratio of only about 2.5. Subsequent tests revealed that an interstage transformer was improperly aligned. When the transformer was realigned, the discrepancy between gain and stability feedback ratios was reduced to less than 15 percent, indicating normal operation.

Graphical Determination

Use of the chart in the determination of active feedback can be seen by following an example from an actual r-f feedback amplifier. This amplifier was a 13-mc amplifier utilizing current feedback. The gain without feedback was 208 and the gain with feedback was 34.2, yielding a feedback ratio of 6.08 (15.7 db of feedback).

When the supply voltage was dropped from the design-center value of 300 volts to 80 volts, the gain with feedback was observed to drop to 0.9 of its initial value. Removing the feedback and repeating the same test showed that the gain without feedback dropped to 0.61 of its original value for the same change in supply voltage.

Entering the chart at the point $A_n = 0.61$, $A_{nf} = 0.9$, the value of the curve passing through this point is read, interpolating visually for intermediate values. In the example this value is approximately 6.0, indicating a close check of the gain-ratio measurement.

While the example was based on a supply voltage test, it should be apparent that the same principles could be applied to a heater voltage test. Any test is applicable as long as the parameters altered by the test will be wholly included in the feedback loop. For example, the plate load impedance may be shunted with a resistance in the case of a single-loop, single-stage, voltage-feedback amplifier but not in the case of a single-loop, single-stage, cathode-feedback amplifier. In the former case, the plate load impedance is wholly within the feedback loop while in the latter case the feedback is confined to the grid-cathode circuit. Restrictions on the types of tests permissible will depend in large part upon the particular circuit used. Care should be taken to avoid injury to components by prolonged subjection to abnormal operating conditions.

The chart can be used in amplifier design when gain stability is one of the design factors. An example is given in the editorial box on the preceding page.

Positive Feedback

The same procedures outlined above for amplifiers of one loop utilizing negative feedback can be applied equally well to amplifiers utilizing positive or regenerative feedback (feedback ratios less than unity). A few values of feedback ratio less than unity are shown on the graph as an indication of the trends. However, these few curves are not intended to cover the usable range.

It can be shown that it is possible simply to interchange the A_n and A_{nf} readings on the coordinates for positive-feedback determinations. For example, the $1 + B_0 = 20$ curve is that for $1 + B_0' = 0.05$, the prime indicating that A_n and A_{nf} are now the abcissa and ordinate respectively. This modification enables the determination of prevailing positive feedback or allows the design of regenerative amplifiers of given stability as in the previous cases for negative feedback.

Greater Precision

For more precision than is afforded by the graph, the equations in the box are recommended. Equation 5 is of particular value in computing the feedback ratios on a stability basis. The analysis in the box is based on the assumption that the feedback factor, $1/(1 - KA)$ in Eq. 1, retains a constant phase angle regardless of variations in A, the complex gain without feedback. This phase angle is further assumed to be some integral multiple of π so that only manipulations with real numbers are necessary. In general, small deviations of phase angle from integral multiples of π will not cause appreciable error. The analysis has been used with high-frequency amplifiers in the vicinity of 20 mc with considerable success, although in this range, phase shifts should be quite prevalent.

Another assumption tacitly made is that the feedback path contains only elements whose parameters do not vary as a function of amplifier gain or as a function of the parameter varied during the stability tests. This arises from the assumption that the feedback factor, K, in the analysis is truly a constant. Thus, should the feedback path contain elements such as vacuum tubes, it is imperative that the operating conditions of such elements be maintained, by separate power supplys and biases if need be, throughout the stability tests. If the feedback elements were allowed to vary, the gain with feedback would not bear the assumed relation to the gain without feedback.

BASIC THEORY

From conventional feedback amplier theory

$$A_f = \frac{A}{1 - KA} \qquad (1)$$

where K is a constant, at a given frequency, denoting the portion of the output that is fed back, and

A = gain without feedback
A_f = gain with feedback
A_n = normalized gain without feedback
A_{nf} = normalized gain with feedback

The additional subscript, zero, is used to denote design-center values. Thus, A_{f0} represents gain with feedback at design center.

Equation 1 may be rewritten

$$A_f = \frac{A}{1 + B_0 A_n} \qquad (2)$$

where

$B = - KA$
$B_0 = - KA_0$
$A_n = A/A_0$

Using the concept of normalized gain

$$A_{nf} = \frac{A_n}{1 + B_0 A_n} (1 + B_0) \qquad (3)$$

where

$A_{nf} = A_f/A_{f0}$

Equation 3 may be rewritten

$$A_n = \frac{A_{nf}}{1 + B_0 (1 - A_{nf})} \qquad (4)$$

Equation 4 is plotted on the chart. However, a more precise determination of feedback is given by

$$B_0 = \frac{(A_{nf}/A_n) - 1}{1 - A_{nf}} \qquad (5)$$

It should be noted that the design-center feedback ratio is $1 + B_0$ rather than simply B_0 so that the feedback ratio is obtained by adding 1 to the B_0 of Eq. 5

Other Considerations

Care should be taken when making stability tests to assure that other extraneous effects do not vitiate the results. An example of such an effect is grid current flow at the reduced gain levels during the tests. Such current flow can cause limiter action within the amplifier and lead to inaccurate results. In general, forethought will avoid difficulties from such causes and the method presented may easily be used as a check upon the active, design-center, feedback ratio.

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Series-Resonant

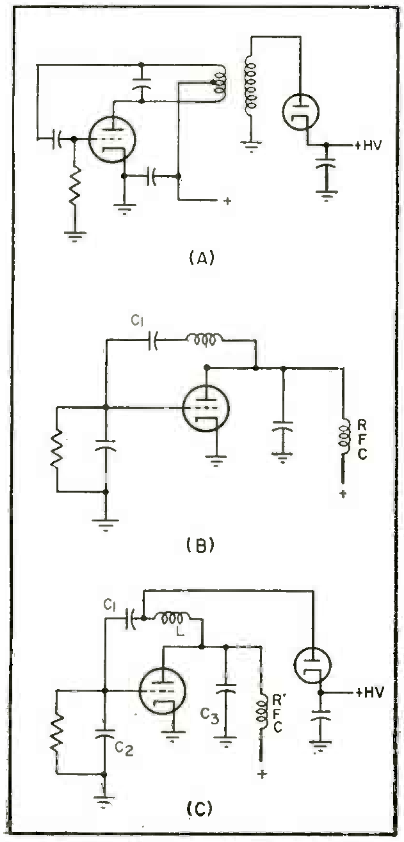

FIG. 1—Steps in deriving the series-resonant oscillator high-voltage supply described in the text

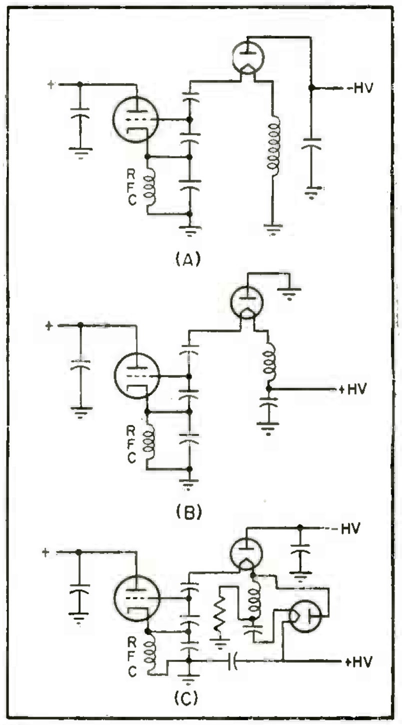

FIG. 2—Oscillator-rectifier circuits with provisions for rectifier filament supply

By **PETER G. SULZER**
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Washington, D. C.

OSCILLATOR-TYPE high-voltage supplies have been employed in oscilloscopes and television receivers to eliminate the bulky components required to produce rectified and filtered high voltages directly from the power frequency. Such a supply consists of an oscillator tube, a transformer, a rectifier and filter. The need for a special transformer has usually restricted use of the scheme to production equipments where a suitable transformer could be fabricated in quantity.

The circuits described here permit satisfactory results with conventional r-f choke coils of a type commonly available.

Rectifier limitations usually require that the oscillator operate at a low radio frequency. The use of either the Hartley oscillator, or the tuned-plate oscillator, will lead to circuits similar to that of Fig. 1A in which a center-tapped transformer is inductively coupled to a self-resonant high-voltage winding. The requirement for mutual inductance makes the design and construction of such a transformer difficult.

The Colpitts oscillator of Fig. 1B differs in that a simple coil may be employed. The low-reactance capacitor C_1 is inserted for the purpose of d-c blocking.

Figure 1C is a modification of the Colpitts circuit in which the reactance of C_1 is comparable to the reactance of L. One of the conditions for the oscillation of this circuit requires that the capacitive reactance of C_2 and C_3 in series equal the inductive reactance of C_1 and L in series. If the reactance of C_1 is much greater than that of C_2 or C_3, then C_1 and L are almost at resonance and the familiar series-resonant step-up is obtained for the plate of the rectifier tube.

Several different oscillator-rectifier connections may be employed as shown in Fig. 2, the choice depending upon the polarity and magnitude of the high voltage required.

Where the weight and magnetic field of the filament transformer must be avoided, it is convenient to to use the circulating tank current to heat the filament, as in the negative supply of Fig. 2A.

A positive voltage may be obtained as shown in Fig. 2B. Although the capacitor at the high-voltage terminal may be chosen to provide a low reactance at the oscillator frequency, an additional filter section may be required since a small r-f voltage is present across the capacitor.

Both polarities at full voltage may be obtained by using two rectifiers as shown in Fig. 2C.

Examples

Figure 3A is a 2.2-kv supply suitable for use in a small oscilloscope. The requirements for both power and space are relatively modest. The photograph permits comparison of this unit with the 60-cycle components originally intended for the same application.

Design of the oscillator and associated circuits is best carried out on a power basis. With a specified load voltage and current, the load power can be calculated. If the rectifier filament is to be heated by the circulating tank current, a value of inductance must be chosen to provide sufficient current at the desired output voltage. With a suitable coil selected, the power dissipated in the coil and rectifier filament can be computed and added to the load power. This permits selection of the oscillator tube, which then permits completion of the design. The following example will serve as an

High-Voltage Supply

By the use of a series-resonant voltage step-up, conventional r-f chokes may be used instead of a special oscillator coil. This type of supply eliminates bulky components usually required in circuits operating directly from the power frequency

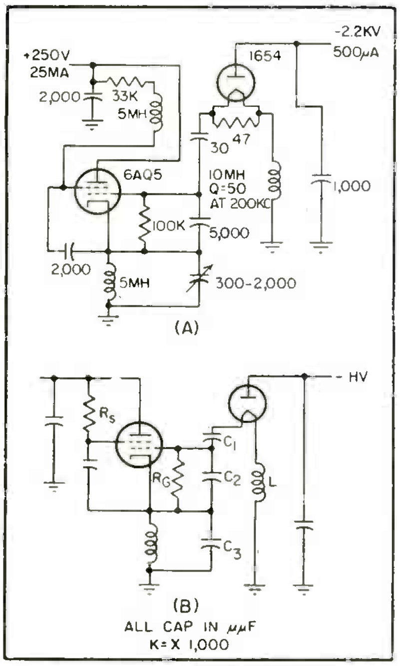
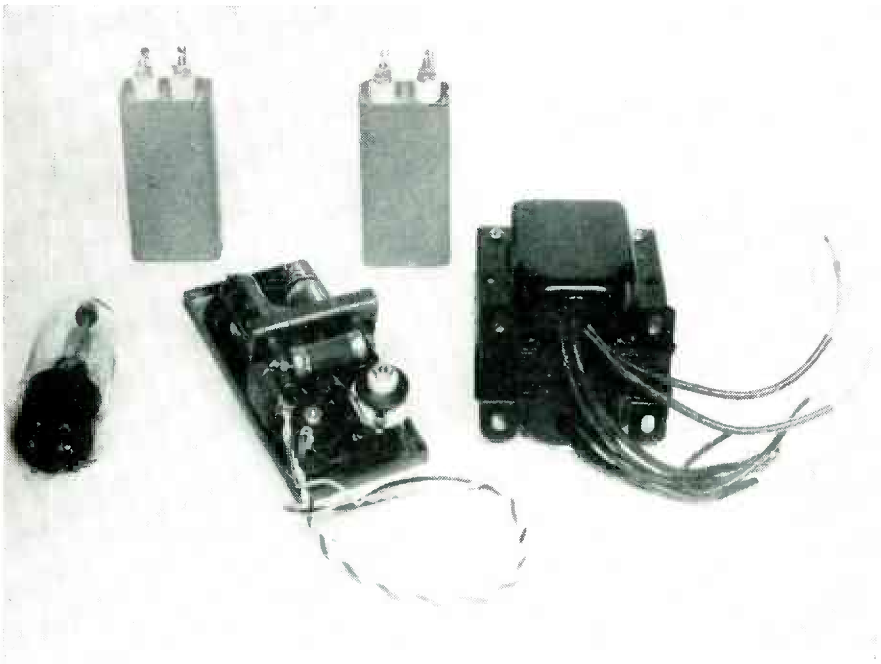


FIG. 3—Examples of series-resonant supplies



Compact 2.2-kv supply shown with 60-cycle components required for the same application

illustration of the method used:

A 4,000-volt, one-milliampere supply is required, using a type 1B3GT rectifier. Referring to Fig. 3B, approximately 3,000 volts rms will be required across the coil with a current of 0.2 amp for the rectifier filament. If the operating frequency is 400 kc, an inductance of 6 millihenrys will provide the required 15,000 ohms reactance. Assuming resonance, C_1 equals 27 μμf. The choke coil selected has a measured Q of 50 at 300 kc, which corresponds to an equivalent series resistance of 300 ohms. The power dissipated in the coil is $(0.2)^2 \times 300$, or 12 watts. The total power, neglecting capacitor losses, is approximately 16 watts. This is easily supplied by a type 6L6 tube with a 400-volt plate supply and a 250-volt screen supply. Referring to the type 807 class-C characteristics, which apply to the 6L6, $R_s = 20{,}000$ ohms and $R_g = 15{,}000$ ohms, while the peak r-f grid voltage appearing across C_2 is 65 volts. Thus, C_2 must have a reactance of

$$\frac{65 \times 0.707}{0.2}$$

or 230 ohms and a capacitance of 1,700 μμf is indicated.

To determine C_3 it is necessary to make an assumption concerning the plate-voltage drop in the oscillator tube at maximum plate current. Measurements have shown this to be roughly 20 percent of the plate-supply voltage, with the result that the rms voltage across C_3 is roughly ½ the plate supply voltage or 200 volts. Since the tube is supplying 16 watts to the tank circuit plus load, the impedance presented to the oscillator cathode should be $\frac{(200)^2}{16} = 2{,}500$ ohms. The equivalent series resistance of the loaded tank circuit is

$$300 \times \frac{16}{12}$$

or 400 ohms. This must be transformed to 2,500 ohms. For this impedance transformation, $X_{c3} \approx R_1 \frac{R}{R_1 - R}$, where R_1 is the impedance desired and R is the equivalent series resistance, 400 ohms. Substituting, $X_c \approx 1{,}000$ ohms or $C \approx 400$ μμf.

Operation of the power supply was found to be successful and an output of 4,000 volts at one ma was obtained with an input of 400 volts at 65 ma. This indicates an oscillator plate efficiency of 65 percent and an overall efficiency of 15 percent. If a coil with a Q of 100 had been available, the overall efficiency would have increased to approximately 25 percent.

Nomograph Aids Filter Designers

Convenient nomograph aids design of power-supply filters. Percent ripple at output can be determined for various filters, including choke and capacitor input L-C filters and R-C types. Nomograph applies equally to full-wave and half-wave power supplies

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PERCENTAGE RIPPLE for filters used with single-phase rectifiers operating from 60-cps sources can be easily and accurately determined with the accompanying nomograph.

Ripple factor is defined as the ratio of rms value of all a-c components of voltage to the d-c or average value of voltage. Generally, more than one frequency component is present in ripple, but a good approximation is obtained by considering only the lowest frequency component, especially when more than one filter section is employed.

The ripple factor of the voltage across the input of a capacitor-input filter is approximately

$$\frac{1}{\pi f R_L C_1}$$

where R_L is the d-c load resistance, C_1 the input capacitor and f the fundamental frequency.

On the chart, percentage ripple across the first capacitor is found by drawing a line connecting rectifier output voltage on scale *A* with rectifier output current on *B*. This line intersects *C* at the value of R_L. A line connecting R_L with the value of the input capacitor on *F* gives percentage ripple on *E*.

A second filter section consisting of a series inductance L_2, followed by a shunt capacitance C_2, reduces percentage ripple by the factor

$$\frac{1}{(2\pi f)^2 L_2 C_2 - 1}$$

where again f is the fundamental frequency of ripple. Within the range of L_2 and C_2 covered by the chart, $(2\pi f)^2 L_2 C_2$ is considerably greater than 1 so the ripple reduction factor is approximately

$$\frac{1}{(2\pi f)^2 L_2 C_2}$$

Ripple reduction factor of the second filter section is found on scale *I* by drawing a line connecting the value of L_2 on J with the value of C_2 on *H*. Ripple appearing across C_2 is obtained by multiplying the ripple across C_1 by the ripple reduction factor. This is accomplished by connecting these values on scales *E* and *I* with a straight line, giving the answer on *G*.

R-C Filters

The chart also provides for computation of ripple reduction resulting from a second filter section consisting of a series resistance followed by a shunt capacitance. In this case filter resistance is entered on *K* in place of the inductance which was entered on *J* as described above. The relation here states that the ripple reduction factor of the R-C filter is approximately

$$\frac{1}{2\pi f C_2 R}$$

Ripple across C_1 is multiplied by this factor.

These procedures apply to either half-wave or full-wave rectifiers using scale markings labelled half-wave or full-wave. The two sets of markings account for different fundamental ripple frequencies.

Usually choke-input filters are designed so that the input choke has greater than critical inductance. Critical inductance is the minimum inductance that will provide uninterrupted current flow, and for 60-cps full-wave rectifiers, is equal to $R_L/1{,}132$. If the input choke has greater than critical inductance, the fundamental component of ripple at the rectifier output has an rms value 0.471 times the d-c component of rectifier output voltage. Thus percentage ripple at this point is approximately 47.1 percent.

Input choke L_1 and the shunt capacitor C_1 reduce this ripple by a factor $1/(2\pi f)^2 L_1 C_1$ giving the percentage ripple across C_1

$$\frac{47.1}{(2\pi f)^2 L_1 C_1}$$

This is found on the chart by drawing a line between L_1 on scale *D* and the C_1 on *F*. Percentage ripple across C_1 is found at the intersection of this line on *E*. Further ripple reduction resulting from an additional L-C or R-C section is found in the manner described for the capacitor-input filter.

Examples illustrating use of the chart are given in Fig. 1, 2 and 3.

These show analysis of performance of proposed filters with specific values of circuit components. Any component value could have been considered an

(Continued on page 160)

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(Shown enlarged twice)

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The CINCH sub-miniature socket insures positive electrical contact, holds tubes securely in place, permits easy maintenance and replacement, yields maximum insulation resistance and minimum high frequency loss. And provides manufacturers of electrical controls, transmitters, receivers, transceivers, airbourne equipment, etc., and hearing aids . . . a labor saving chassis installation which serves terminal board functions while permitting designers to obtain maximum space afforded by the standard flat base tubes. For mounting perpendicular tubes, retainer rings and saddles are available, when socket cannot be staked. Available in quantities because CINCH's extensive and modern molding facilities for mica filled low loss bakelite. Contacts silver plated beryllium copper. For the Standard subminiature socket in quantity, quickly,

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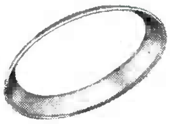
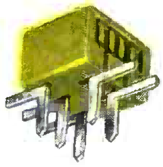


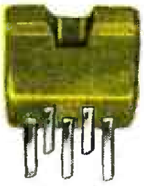
(Above) Small button subminar 8 pin with saddle shown enlarged twice.

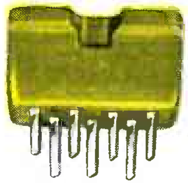
Sub-miniature (above right, shown enlarged twice) for Small button Sub-minar 8 pin base T3 tubes mounted perpendicular to chassis.

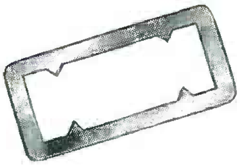


Five pin stem type (above) for mounting tubes parallel to chassis and for printed circuits.

Five, six and seven pin stem type for tubes vertically mounted. (below)







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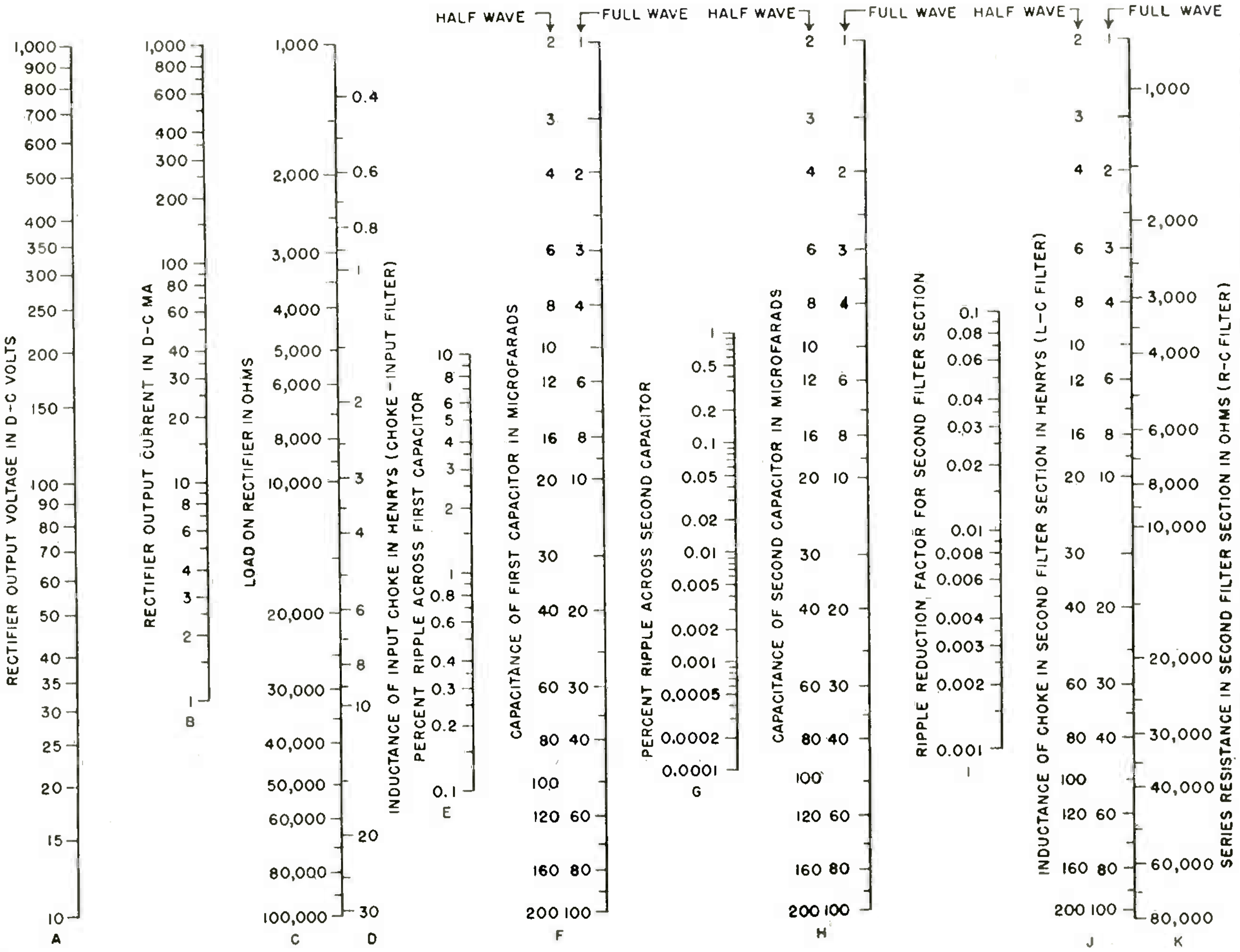

Basic filter design equations are combined in convenient form in this single nomograph

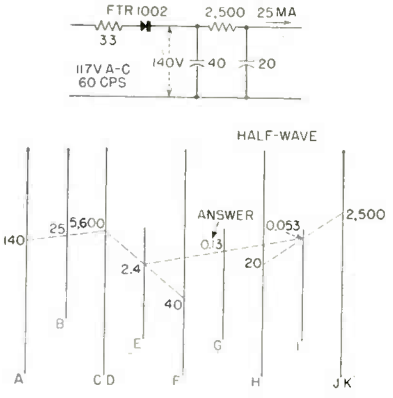

FIG. 1—Solution for half-wave selenium-rectifier supply using an R-C filter

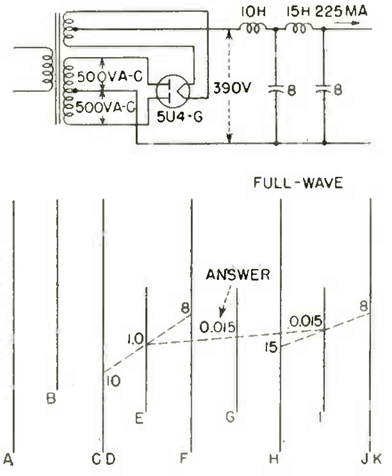

FIG. 2—Full-wave power supply using an L-C filter with capacitor input

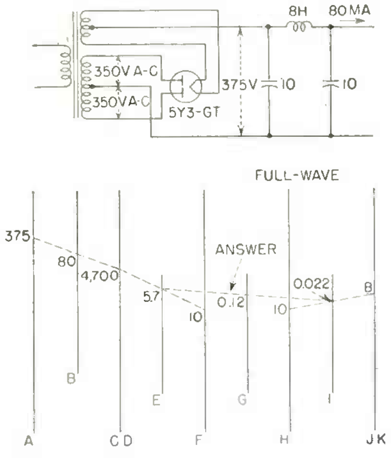

FIG. 3—Solution for full-wave supply using a choke-input filter

unknown to be determined for specified filter performance. However, design procedure is usually to analyze various possible filter circuits made up of available components. The chart provides a means for estimating the ripple for various filter circuits.

The chart is applicable only where power-line frequency is 60 cps. To predict the performance of a filter at some other frequency, f', the values of capacitances and inductances should be multiplied by the factor $f'/60$ before entering these values on the chart.

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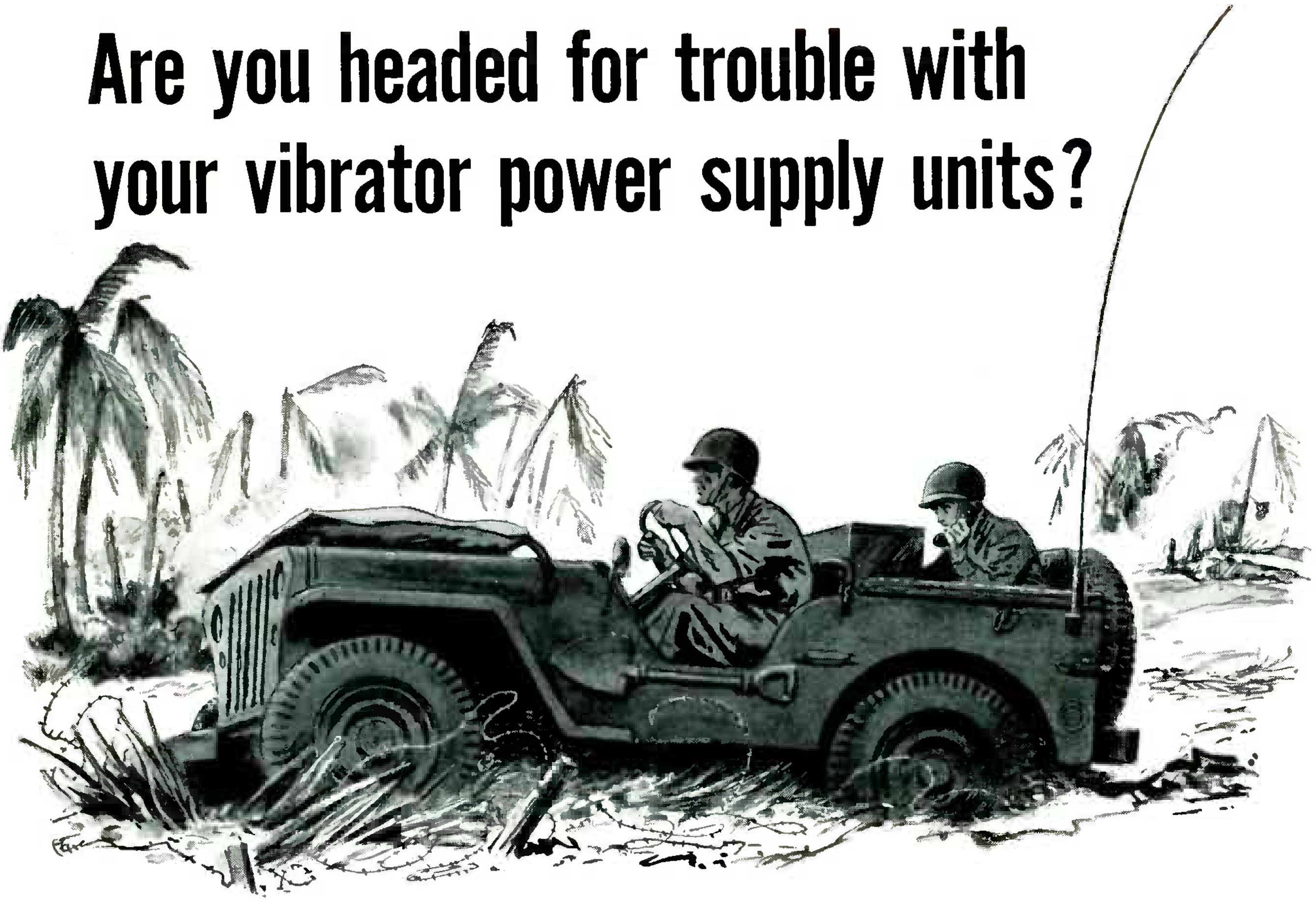

Specification of vibrator frequency, voltage and size is no guarantee that your power supply unit will do its job right . . . permit your mobile radio equipment to operate properly.

To get long, trouble-free performance, the power circuit must be designed so that the characteristics of the vibrator are in balance with the transformer and buffer capacitor.

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ELECTRONS AT WORK

Including INDUSTRIAL CONTROL

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OTHER DEPARTMENTS
featured in this issue:

Double-Phase-Shift Wide-Deviation F-M Oscillator

By Philip S. Wessels
Electronic Scientist
Federal Communications Commission
Laboratory Division
Laurel, Maryland

When an amplifier is incorporated in a closed loop it is assumed that it will oscillate if there exists a frequency where the gain is greater than one and the phase shift is some integral multiple of 2π radians. When the gain criteria is satisfied over a broad frequency range the factor determining the frequency of oscillations will be the total phase shift around the closed loop. If this phase shift can be controlled by any one of numerous methods, the frequency may also be controlled.

The oscillator described in this article may be considered as being composed of six phase-shift elements. The two grid-plate phase shifts are assumed constant and each equal to 180 deg, giving the required 360 deg for oscillations to develop. The other phase shifts can be divided into two groups, variable and fixed.

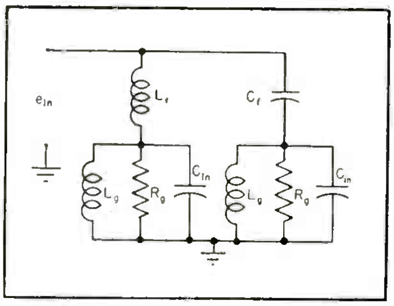

FIG. 1—Grid circuit of the oscillator

The fixed phase shifts take place in the two tuned-plate circuits and may be determined by well-known rules, one of which follows. When the frequency of the applied voltage of a tuned circuit deviates from the resonant frequency by an amount that is $1/2Q$ of the resonant frequency, the gain will be reduced to 70.7 percent of the maximum gain and the phase angle will be changed from zero to 45 deg. It will be shown that this is just the maximum phase shift obtainable in one of the variable phase shifters in the grid circuits of each stage.

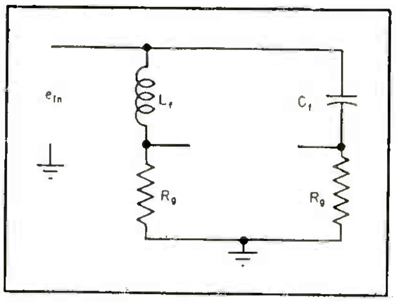

FIG. 2—Modified form of circuit given in Fig. 1

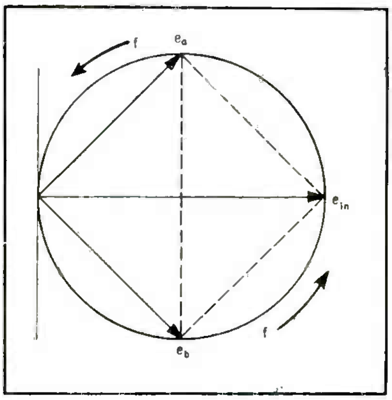

FIG. 3—Phase-shift circle diagram

Although there are two tuned-plate circuits, which doubles the total phase shift for one circuit, there are also two variable phase shifters. The total deviation from the center frequency possible in this f-m oscillator will be equal to $1/2Q$ of the center frequency. It might be mentioned at this point that if a circuit were employed which had a constant 180-deg phase shift over the entire bandwidth of the oscillator, the second set of tubes and associated circuits could be eliminated entirely with no loss in total deviation.

The variable phase-shift elements, consisting of R_g, L_g, C_g and the four vacuum tubes have some interesting properties that are discussed in the following paragraphs.

The grid circuit, as simplified in Fig. 1, has the property of presenting a pure resistance at any frequency if $R_{g1}^2 = R_{g2}^2 = L/C$. Each

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Modulation Fidelity ±0.5 db
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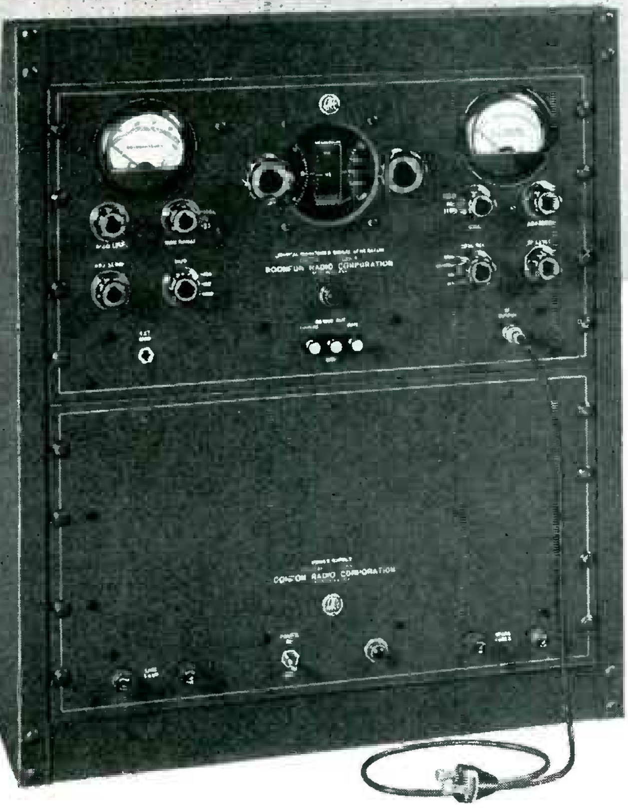
Negligible Spurious FM



The Type 211-A Signal Generator was designed by Boonton Radio Corporation in cooperation with the CAA and leading manufacturers of aircraft navigation and landing receivers. It was designed for specific application to the calibration of these receivers to the high accuracy characteristics required. The CAA system requiring these receivers guides aircraft from one location to another and assists in landing under marginal weather conditions. The Signal Generator is also useful in testing accurately tuned communications receivers.

SPECIFICATIONS

FREQUENCY RANGE: 88 to 140 mc. in one Range. Vernier Dial marked to 10 Kc. division. Accuracy ± 0.25%.

R. F. OUTPUT: 0.1 to 200,000 microvolts. Output resistance looking into output terminals 26.5 ohms.

AMPLITUDE MODULATION: AM 0-30% and 0-100% with internal or external oscillator. Distortion below 5% at 95% modulation.

INTERNAL AUDIO OSCILLATOR: 400 and 1000 cps.

MODULATION AMPLIFIER: Uniform response within ± 0.1 db 90 to 150 cps. and 9.5 to 10.5 Kc. within ± 0.5 db 30 cps. to 11 Kc.

PHASE DISTORTION: Up to 60% modulation less than 0.25 degrees at 30 cps and 10 degrees at 11 Kc.

SPURIOUS FM: Less than 1 Kc. at 60% FM.

CRYSTAL CALIBRATING FREQUENCIES: 110.100 and 114.900 mc. ± 0.0035%. Calibrations can be made at these and other frequencies by slipping dial vs condenser shaft position.

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Glide Slope Test Set *Type 212-A*

Frequency Range 329-335 mc.

The 212-A Glide Slope Test Set when used with the 211-A Signal Generator provides RF output between 329 and 335 mc. for testing aircraft landing receivers. Three crystal controlled frequencies are provided for I.F. amplifiers of the receiver.

The 212-A consists of a unity gain radio frequency converter (Univerter) which adds 200 mc. to the input frequency from the 211-A and a crystal controlled I.F. Signal Generator.

SPECIFICATIONS

RF SECTION

FREQUENCY RANGE: 329 to 335 mcs.

OUTPUT FREQUENCY: Equals input frequency plus 200,000 mcs. ± 0.005%.

OUTPUT LEVEL: Equal to input ± 1db over frequency range. Maximum input 0.1 volt (0.05 volt modulated to 100%).

OUTPUT IMPEDANCE: 53 ohms unbalanced.

ENVELOPE DISTORTION: Less than 5% for 0.05 volt signal modulated 95%.

IF SECTION

OUTPUT FREQUENCIES: 20.700 mc. ± 0.0035%; 20.400 mc. ± 0.005%; 21.000 mc. ± 0.005%.

OUTPUT LEVEL: 1 to 100,000 microvolts across 53 ohms unbalanced.

MODULATION: AM up to 30% using internal or external source.

PRICE: $875.00 FOB Boonton, N. J.

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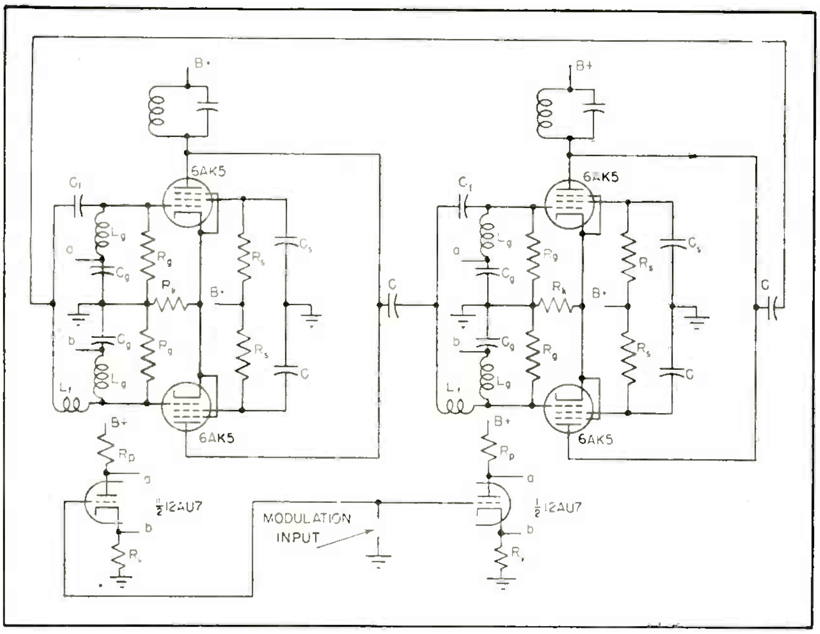
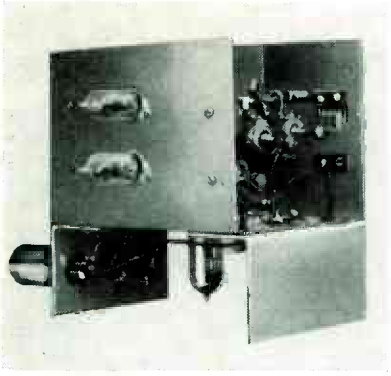


FIG. 4—Complete circuit diagram of the oscillator



Chassis view of the oscillator. The 12AU7 used to supply the two balanced inputs from a single unbalanced supply is inverted and on the bottom of the chassis

branch of the circuit has an impedance of $R + j\omega L$ and $R + j\omega C$. The parallel impedance of both branches is given by

$$\frac{(R + j\omega L)\ (R + 1/j\omega C)}{(R + j\omega L) + (R + 1/j\omega C)}$$

When $R^2 = L/C$ is substituted into this, the equation reduces to R. It follows that the plate load of the previous stage would always see a constant resistance R. Since the circuit had to be modified as shown in Fig. 2 to cancel out the effects of the tube input capacitance, the plate load does not strictly see a constant resistance R.

Since the maximum deviation is proportional to $1/2Q$, R_g is necessarily low so that the tuned parallel circuit made up of L_g, R_g and C_{in} has a very low Q and is thus quite broad.

At the center frequency, the circuit is designed so that $R_g = \omega L = 1/\omega C$. The phase shift with respect to e_{in} in Fig. 1 between parallel-branch midpoints and ground is +45 and −45 deg respectively. This is shown in the circle diagram of Fig. 3. Actually, these angles will vary from 45 deg as the frequency deviates. This may be represented by rotating the diameter formed by the ends of the vectors e_a and e_b about the center of the circle diagram. This effect will be ignored in this analysis since the shift is not great.

The two tubes in a single phase shifter may be regarded as a vector adder. The input of the lower and upper tube is represented by the vectors e_a and e_b, respectively, of Fig. 3. The output current of a vector adder will be the vector sum of e_a and e_b, each multiplied by the g_m of its respective grid. This is true by virtue of the fact that the two plates of a single adder are tied together.

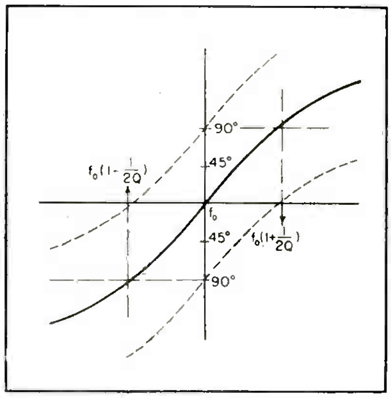


FIG. 5—Operating limits of the oscillator

If the magnitude of $g_m e_a$ is increased and that of $g_m e_b$ is decreased, there will be a positive phase shift resulting in a decrease in the operating frequency of the oscillator. If the four sets of points a and b in Fig. 4 are fed from a signal source with a balanced output correctly phased, the frequency will deviate approximately proportional to its amplitude.

Figure 5 shows the operating limits of this oscillator. The solid line represents the phase shift versus frequency experienced in the two tuned-plate circuits while the dotted line represents the maximum phase shift possible in the two phase shifters.

Figure 4 shows the circuit diagram of the model developed by the author at the FCC Laboratory. Deviations as high as ±5 mc with a center frequency of 60 mc were experienced in this experimental unit.

Titanium-Dioxide Rectifiers

A NEW TYPE of metal-oxide rectifier developed by the National Bureau of Standards is composed of a layer of semiconducting titanium dioxide, a sheet of titanium metal and a counterelectrode of some other conducting material.

Figure 1 shows a laboratory test sample of the rectifier. The rectifier plate has been processed to show the titanium metal (light corner), the dioxide coating (center portion) and the electroplated silver counterelectrode (dark corner).

Two processes have been devised to form the oxide layer for the rectifiers which withstand reverse voltages of about 20 volts per plate and have satisfactory properties at elevated temperatures. The first process involves heating the titanium metal first in oxygen gas and then in hydrogen gas. The second and improved version of the first

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A 10-turn unit, approximately 1¾" diameter with 12 to 14 times the resolution of single-turn units of same diameter. Very versatile—low in price—wide range of applications.*

MODEL C:

Similar to Model A, but 3 turns of resistance winding instead of 10.*

MODELS B, D, & E:

Larger-diameter (3 5/16") designs. B has 15 turns—D, 25 turns—E, 40 turns, for applications requiring extreme ranges of adjustment and highest possible resolution.*

ultra-precision

MODELS AN, BN, & CN:

Similar to Models A, B & C in size and performance but feature precision ball-bearings and extra-close tolerances throughout. Have approximately twice the linearity accuracy of equivalent standard Helipots—are ideal servo units.*

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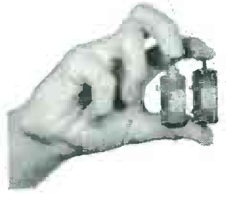

MODELS AJ, AJS, AJSP:

Tiny multi-turn Helipots the diameter of a penny, weight 1 oz. All have 18.5" slide wire for high resolution (1/6550—50 K unit). AJ has threaded bushings, sleeve bearings . . . AJS, servo mountings, sleeve bearings . . . AJSP, servo mountings, ball bearings. Many other features.*

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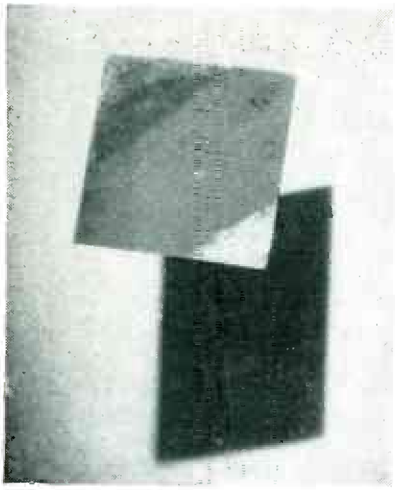

FIG. 1—Laboratory test sample of the titanium-dioxide rectifier. The plate is made of ½-inch squares of commercial titanium metal sheet 0.020-inch thick

consists in heating the titanium metal in steam at elevated temperatures. This process produces the semiconducting oxide layer on the metallic titanium in one step.

The most satisfactory films are formed by heating similar titanium plates in steam at 600 C for about three hours. The counterelectrodes are then electroplated in the same manner to form a finished unit.

Electron Flow

The rectifiers bear a physical resemblance to the copper-oxide type, but the direction of easy flow of current is opposite in the two types. In the titanium-dioxide rectifier, the electrons flow from the titanium base metal to the counterelectrode. The conduction in the metal oxides is also different. In cuprous oxide the charge carriers are holes or electron vacancies in the lattice while in titanium dioxide the charge carriers are free electrons.

Radome Fabrication Techniques

FABRICATION OF RADOMES, the optically-opaque, electrically-transparent blisters that cover airborne-radar antennas permitting rapid rotation of the dishes while preserving the plane's aerodynamic characteristics, has become an interesting and unique technology.

Outstanding achievement of the art are the radomes on the navy's flying combat-information-center, a modified Lockheed Constellation. Both upper and lower domes are built in sections of glass-honeycomb construction. The upper dome measures 8-feet high by 4-feet wide by 12-feet long. The lower dome measures 4-feet deep by 8-feet wide by 12-feet long.

Lay-up of impregnated cloth. The brush is used to aid in smoothing out the cloth and removing air bubbles

The oldest type of radome construction, and one still used for most smaller domes, is the solid glass-laminate. Layers of glass cloth from 3 to 15 mils in thickness are cut in segments providing a plane development of the three-dimensional surface of the dome. These segments are impregnated with polyethal resins. The segments are laid in a female mold of the radome and the entire mold is evacuated. The radome is then fixed in shape by curing at 250 F. Solid glass-laminate construction has the disadvantage of being heavy.

Sandwich Construction

Light weight is combined with strength in the glass-honeycomb sandwich-type of radome construction. Here glass cloth having a hexagonal honeycomb weave is impregnated with resin and the radome is constructed as in the case of the solid laminate. Inner and outer skins of glass cloth are provided for smoothness.

For fabrication of radomes to exacting tolerance, a glass-matte construction is used. Glass matte consists of chopped-up glass fibres. This material is resin-impregnated and formed between matched male and female molds. This type of construction is light in weight and can be worked to closer tolerance, ± 10 mils, than the honeycomb sandwich.

Foam Sandwich

A peculiar problem arises in radome manufacture when specifications call for a dome to be built to exacting tolerance and with tapering walls to provide proper electrical characteristics for the radar antenna. This is especially necessary in the case of airborne fire-control radar. The technique used here is called the foam sandwich. Matched male and female molds are used as well as preformed inner and outer skins of glass cloth. An alkyd foaming-resin, isocynate foam, is allowed to foam up between the inner and outer skins. The foam sandwich dome not only can be built to exact tolerance using tapered

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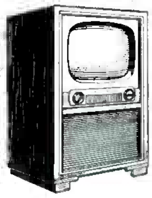

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walls but is the lightest of all radomes. Most large radomes are of the sandwich type, generally constructed in sections and spliced or bolted together.

Recently, the Navy has devised a means for patching radomes. The domes are frequently damaged either through careless handling or by impact of small stones during landing. All major overhaul and repair activities are now equipped to patch large radomes. In this process, plaster molds are first made to preserve the shape of the damaged radome. The damaged portions are then cut away and replaced by material similar to that of the original dome. The resin-impregnated glass cloth or honeycomb is then cured and the dome is painted and restored to service.—J.M.C.

Low-Cost Vertical-Scan Transformer

By SEYMOUR CUKER*
Chief Engineer
Gem Radio and Television Corp.
Jersey City, New Jersey

THIS PAPER describes the operation and design of a low-cost vertical sweep circuit. The r-f type blocking-oscillator transformer described affords all the advantages of the iron-core blocking-oscillator transformer, as well as additional advantages.

A simple schematic is shown in Fig. 1 to aid in detailing the functions of the vertical blocking oscillator in a television receiver. When the circuit is energized, the abrupt change in plate current which occurs induces high-frequency voltage into the grid circuit. Since the grid winding is self-resonant and is very tightly coupled to the plate winding, the oscillations build up very rapidly. The flow of grid current rapidly charges C_g far beyond cutoff. At the same time, the large flow of plate current rapidly discharges C, thus reducing the instantaneous plate voltage.

With the plate voltage greatly reduced and with the relatively fixed high grid bias, developed when the plate voltage was much higher, the

---

* Work done by the author while in the employ of CBS Columbia, Inc.

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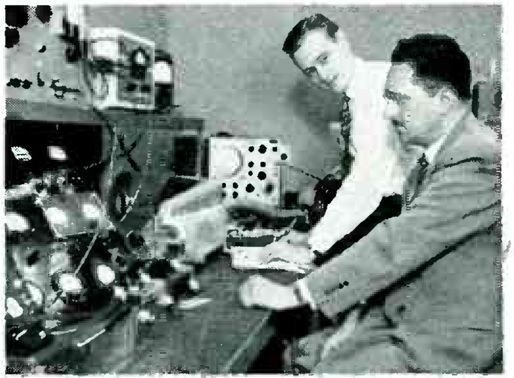
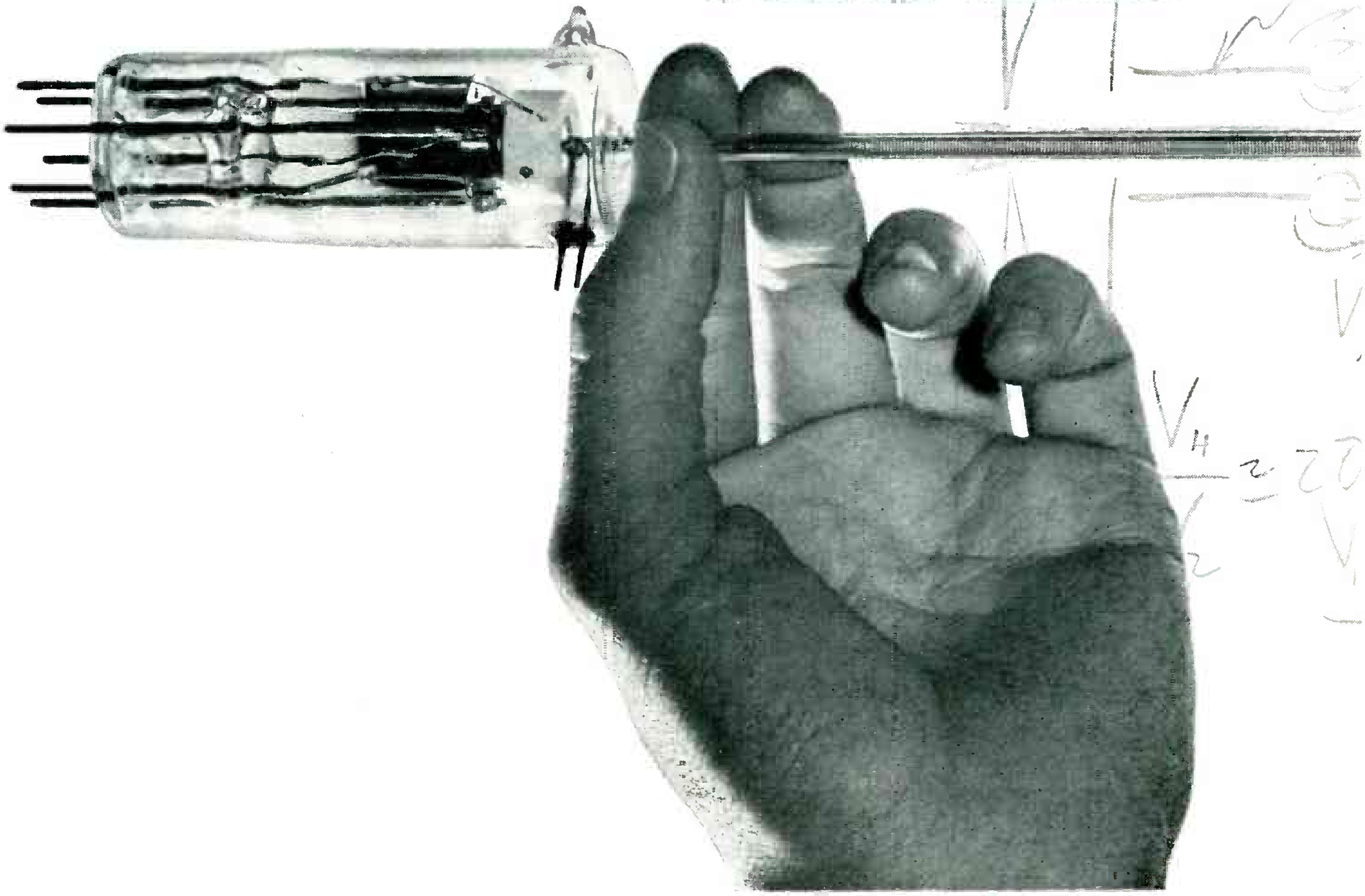
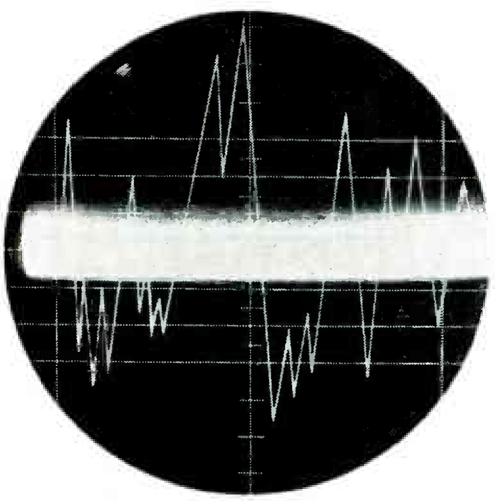
Reducing **noise** in radar...

Measuring the noise figure of an experimental traveling-wave tube are Dr. A. V. Haeff (right) head of the Electron Tube Laboratories at Hughes, and Dr. Dean Watkins (left) one of his co-workers.



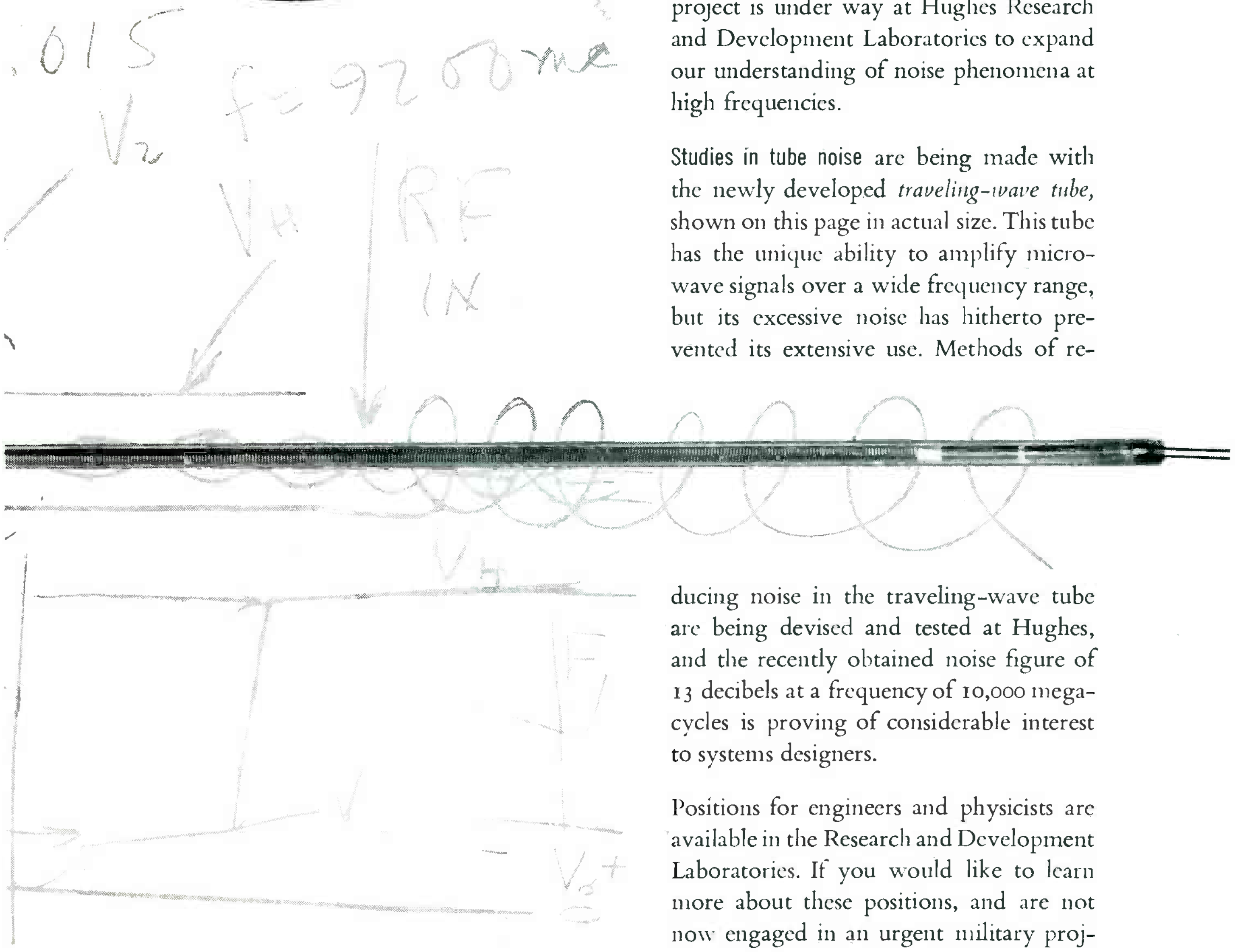




In the operation of a radar system, the amount of energy reflected from small targets is very minute. The over-all sensitivity and range of radar depend equally upon effectively generating and transmitting considerable power at microwave frequencies—and upon effectively receiving and amplifying very weak echo signals.

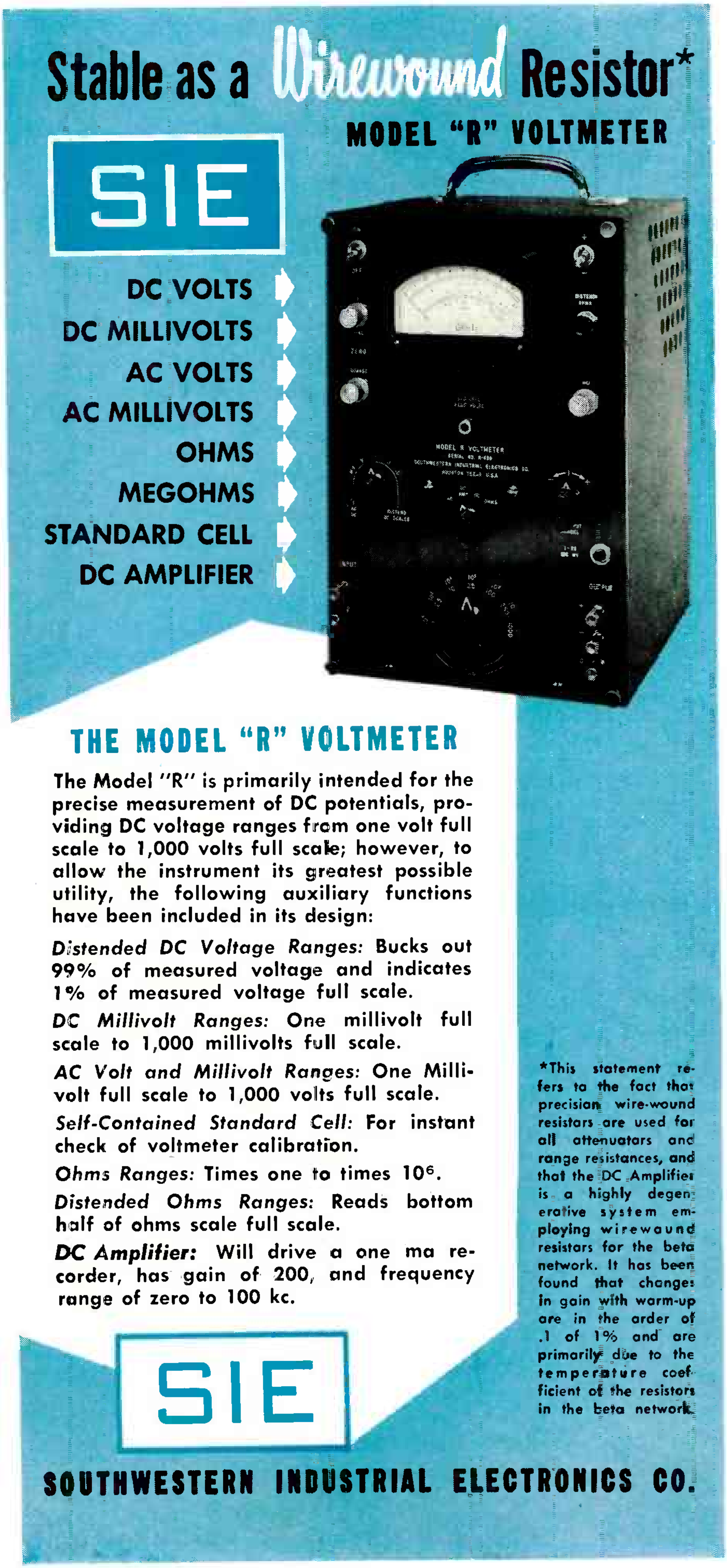
An important limitation in receiver sensitivity is imposed by noise that is created within the receiving tubes—and caused by random motion of electrons. Because the reduction of tube noise could make available improved techniques to the designer of many types of microwave systems, a project is under way at Hughes Research and Development Laboratories to expand our understanding of noise phenomena at high frequencies.

Studies in tube noise are being made with the newly developed *traveling-wave tube,* shown on this page in actual size. This tube has the unique ability to amplify microwave signals over a wide frequency range, but its excessive noise has hitherto prevented its extensive use. Methods of reducing noise in the traveling-wave tube are being devised and tested at Hughes, and the recently obtained noise figure of 13 decibels at a frequency of 10,000 megacycles is proving of considerable interest to systems designers.



Positions for engineers and physicists are available in the Research and Development Laboratories. If you would like to learn more about these positions, and are not now engaged in an urgent military project, write to:

Hughes Research and Development Laboratories
Engineering Personnel Department
Los Angeles County
Culver City, California



Stable as a Wirewound Resistor*

MODEL "R" VOLTMETER

SIE

DC VOLTS
DC MILLIVOLTS
AC VOLTS
AC MILLIVOLTS
OHMS
MEGOHMS
STANDARD CELL
DC AMPLIFIER

THE MODEL "R" VOLTMETER

The Model "R" is primarily intended for the precise measurement of DC potentials, providing DC voltage ranges from one volt full scale to 1,000 volts full scale; however, to allow the instrument its greatest possible utility, the following auxiliary functions have been included in its design:

Distended DC Voltage Ranges: Bucks out 99% of measured voltage and indicates 1% of measured voltage full scale.

DC Millivolt Ranges: One millivolt full scale to 1,000 millivolts full scale.

AC Volt and Millivolt Ranges: One Millivolt full scale to 1,000 volts full scale.

Self-Contained Standard Cell: For instant check of voltmeter calibration.

Ohms Ranges: Times one to times 10⁶.

Distended Ohms Ranges: Reads bottom half of ohms scale full scale.

DC Amplifier: Will drive a one ma recorder, has gain of 200, and frequency range of zero to 100 kc.

*This statement refers to the fact that precision wire-wound resistors are used for all attenuators and range resistances, and that the DC Amplifier is a highly degenerative system employing wirewound resistors for the beta network. It has been found that changes in gain with warm-up are in the order of .1 of 1% and are primarily due to the temperature coefficient of the resistors in the beta network.

SIE

SOUTHWESTERN INDUSTRIAL ELECTRONICS CO.

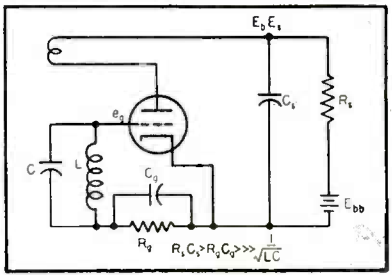


FIG. 1—Simplified schematic of the vertical blocking oscillator

oscillator ceases and decays exponentially to zero. After a period determined by R_gC_g, the grid bias ascends from cutoff, the oscillations build up and the cycle of events repeats.

It was mentioned that during the oscillatory phase, the voltage across C_s decreases rapidly to a very low value. In the next phase, when the tube is cut off, C_s commences to charge through R_s toward E_{bb}, thus producing a sweep voltage. This is illustrated in Fig. 2 and 3.

Design Concepts

An important design concept is the connection between the rated tube current and the required sweep voltage. It will be shown that the constants of the blocking-oscillator transformer do not appear in this relationship.

The total charge withdrawn from the capacitor C_s during oscillation is

$$-\Delta Q_s = \int_{T-\delta}^{T} i_b dt, \text{ but}$$

$$i_b = C_s \frac{de_s}{dt}$$

$$\text{therefore } -\Delta Q_s = \int_{E_B + E_s/2}^{E_B - E_s/2} C_s de_s$$

$$= -C_sS_s$$

where δ and T are defined in Fig. 3.

The conservation of charge applies to any cycle. The change in charge over one cycle may be equated to zero, or since the charge added is

$$\Delta Q_s = I_b(T - \delta)$$

$$\text{then } I_b = \frac{C_sE_s}{T - \delta} \approx f_{\text{sweep}} C_s E_s$$

The equation for I_b does not contain any of the transformer constants directly but does contain the sweep frequency and the sweep

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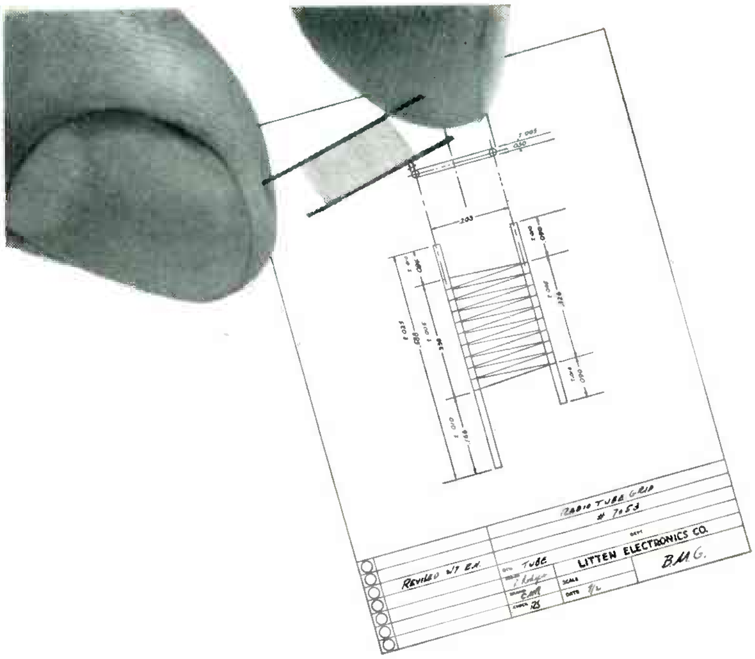

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In your area there's an engineer with wide experience in both aspects of optical gaging technique. It will cost you nothing to discuss with him the details pertinent to your own particular requirements. To get in touch with him, write Eastman Kodak Company, Industrial Optical Sales Division, Rochester 4, N. Y.

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Optical Gaging

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JAN R-93 or MIL R93A SPECS.

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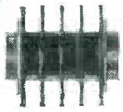

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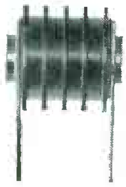
(non-hygroscopic) prevent distorted windings, breaking of seal, breakdown of dielectric.

HIGH-STABILITY RESISTANCE WIRES
—pure, carefully selected, pretested alloys.



PRECISION WINDING
—uniformly wound, mechanically tied under scientifically controlled conditions.

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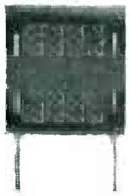

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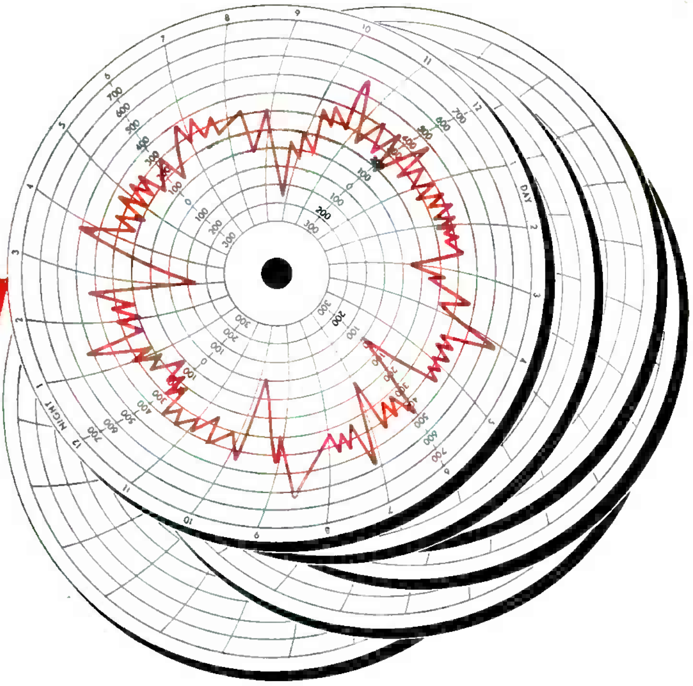

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Will your present high temperature insulation meet these tests? Can it be twisted and bent to withstand operational and assembly stresses — without cracking, crazing or loss of dielectric strength, or flexibility? Will it remain unchanged after *continuous* operation from –90°F. to 400°F. . . . or 15 minutes at 600°F., 4 hours at 500°F., 96 hours at 450°F.?

BH "1151" will! Its remarkable flexibility and dielectric strength is built into its base materials. BH "1151" combines two great inorganic materials — Fiberglas and Silicone Rubber. The result is electrical tubing and sleeving with remarkable long life — with flexibility for the life of the insulation.

BH "1151" will not support fungus growth — offers excellent chemical resistance. Meets *all* applicable Class H NEMA specifications.

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capacitance. Since these are generally constants, the charging current I_b is directly proportional to the peak to peak sweep voltage E_s.

If a linear retrace is assumed and on this basis the tube rating is determined, during oscillation the discharge current flowing through the tube is

$$i_b = \frac{C_sE_s}{\delta} = \left(\frac{T}{\delta}\right)\frac{C_sE_s}{T}$$

$$\left(\frac{T}{\delta}\right) \approx 60,\ T = \frac{1}{60}\ \text{sec},$$

$$C_s = 0.05 \times 10^{-6}f,\ E_s = 60\text{v}$$

$$\text{therefore } i_b = \frac{0.05 \times 10^{-6} \times 60}{1/60} \times 60$$

$$= 10.8 \text{ ma}$$

(approximate rating for 6SN7 or 12AU7)

This shows that even though the power requirement is negligible, the tube should be capable of delivering about 10 ma during oscillation.

It has been shown that the transformer constants do not enter explicitly in determining the sweep voltage. However, the efficiency of the oscillator as measured by the ratio $E_s/2E_b$ is related to the transformer constants. It is well known that conventional transformers are designed to have near unity coefficient of coupling, an optimum turns ratio (about 2 to 1) and a high winding inductance.

The difference between a more efficient (low E_b) and a less efficient (high E_b) transformer design is found in the shape of the retrace. The more efficient oscillator builds up to saturation more rapidly than the less efficient one and, in a given time will discharge capacitor C_s to a lower value, resulting in a lower E_b.

One might speculate that a cheaper transformer than the con-

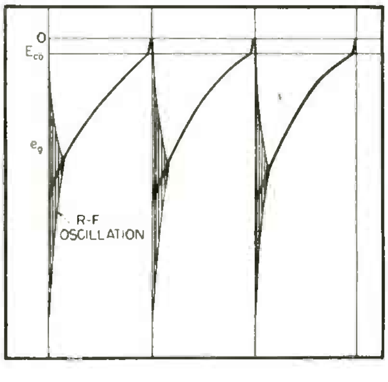

FIG. 2—Oscillatory phase voltage waveforms

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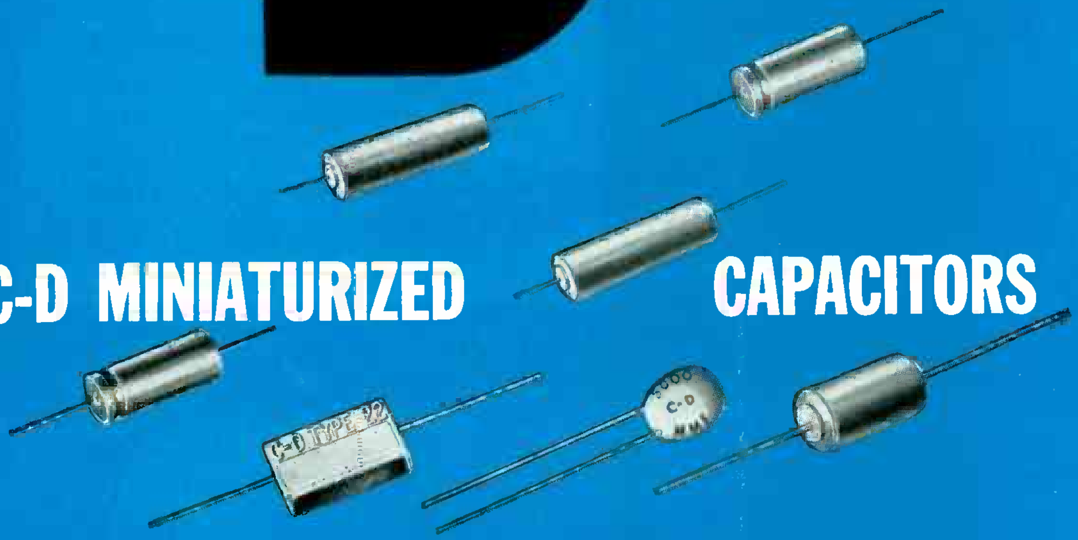

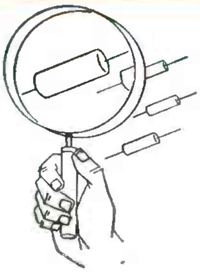

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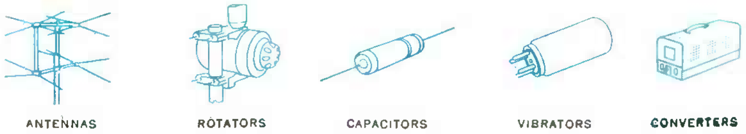

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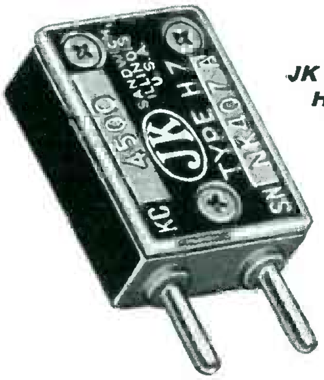
keeping communications ON THE BEAM



JK STABILIZED H-7 CRYSTAL

CRYSTALS FOR THE CRITICAL

The H-7 crystal is in common use with two-way police radio systems. Frequency range: 3 to 20 mc. Water and dust-proof, it is pressure mounted, has stainless steel electrodes. Just one of many JK crystals made to serve EVERY crystal need!

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Monitors any four frequencies anywhere between 25 mc and 175 mc, checking both frequency deviation and amount of modulation. Keeps the "beam" on allocation; guarantees more solid coverage, too!

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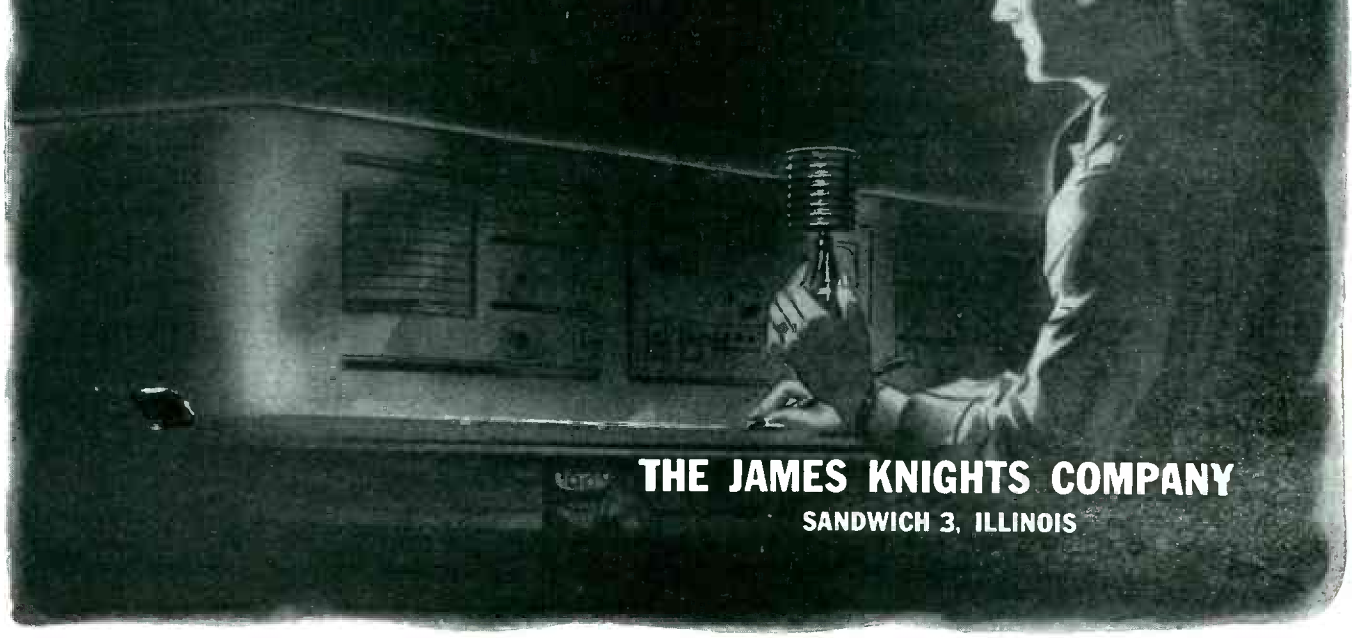
In a split second your police station and the farthest cruising prowl car can respond as one man! Such "safety at your doorstep" is possible only through compactly efficient two-way radio. JK crystals and monitors are in constant use to keep police radio frequencies reliably "on the beam."



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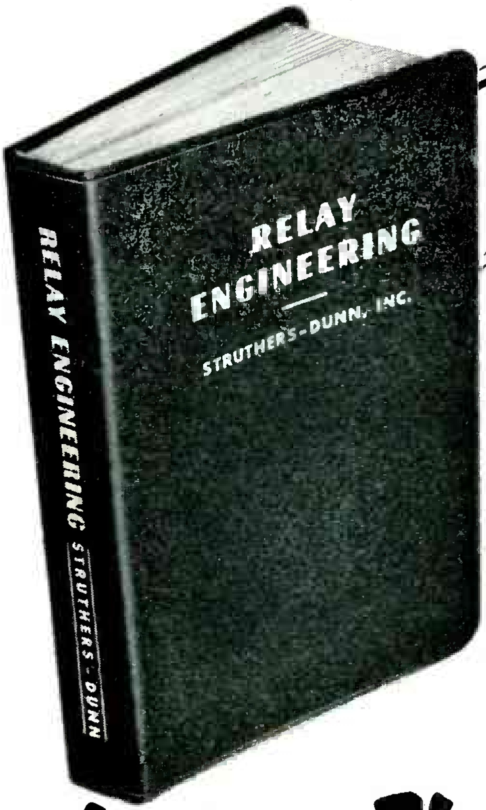

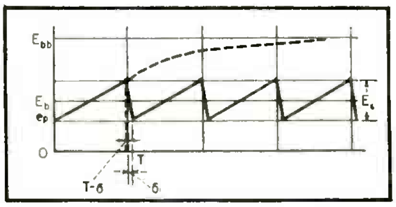

FIG. 3—Sweep voltage waveforms

ventional blocking-oscillator type can be developed for one-mc operation. Several problems are raised by operating at this high frequency: oscillator harmonics injected into the sound i-f, oscillator harmonics injected into the video i-f and oscillator frequency injected into local broadcast receivers.

The first of these problems is completely solved by proper dressing and separation of the oscillator tank circuit from the first video i-f tank circuit. The strength of harmonics at r-f carrier frequency is negligible so that placement with respect to the antenna is uncritical.

The sound i-f in an intercarrier set is in the region of a much lower and stronger harmonic of the oscillator tank. The best solution to this problem is to choose the tank frequency so that no integral harmonic occurs near 4.5 mc. The third problem is solved only by making the tank frequency above the broadcast band.

Apparently, the choice of frequency is limited to 1.9 mc. This frequency is above the broadcast band and has harmonics at 3.8 mc and 5.7 mc which are out of the pass band at 4.5 mc. The first sig-

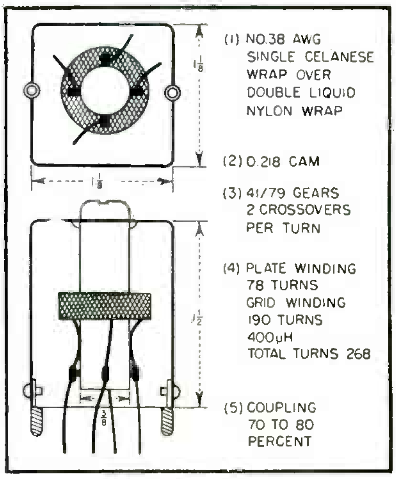

FIG. 4—The r-f blocking oscillator transformer

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self-bonding Polyethylene, for resistance to corrosion and chemicals.

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	10^6 cycles	0.0004
Dielectric constant	60 cycles	2.32
	1000 cycles	2.34
	10^6 cycles	2.13

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Ozone	Excellent
Oxygen	Excellent
Acids	Excellent
Alkalies	Excellent
Moisture vapor transmission	Negligible
Castor Oil	Good
Commercial Hydraulic Fluids	Excellent
Aging qualities	Excellent
Operating temperature	197°F to —67°F
Application temperatures	150°F to —67°F

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SUPERIOR AGING

EXCELLENT CONFORMABILITY

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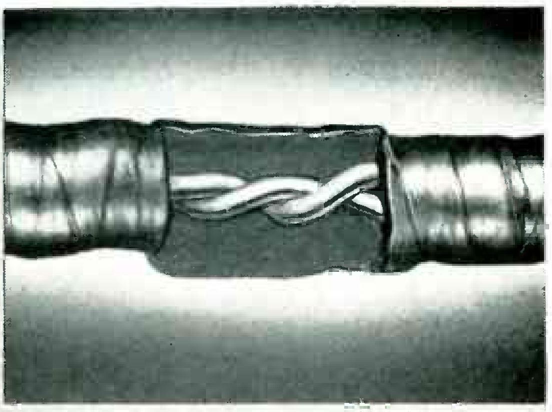

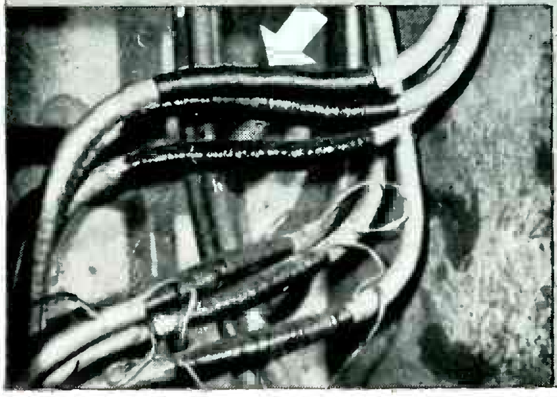

BI-PRENE INSULATION CHARACTERISTICS

Physical Tests on Press Cured Slabs 10°/310°F

Tensile	1980 p.s.i.
Elongation	400%
200% Modulus	1030 p.s.i.
Ozone	6 hours to cut

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80°C Oxygen Bomb for 14 days
67.4% of original elongation
62.6% of original Tensile

Air Bomb at 26°F for 30 Days at 80 p.s.i.

160% of original elongation
66% of original Tensile

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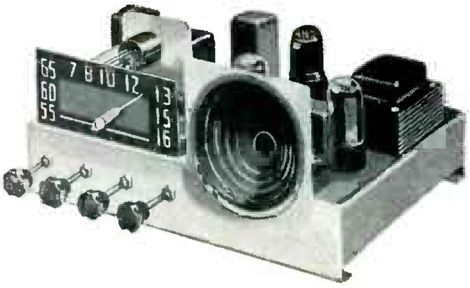

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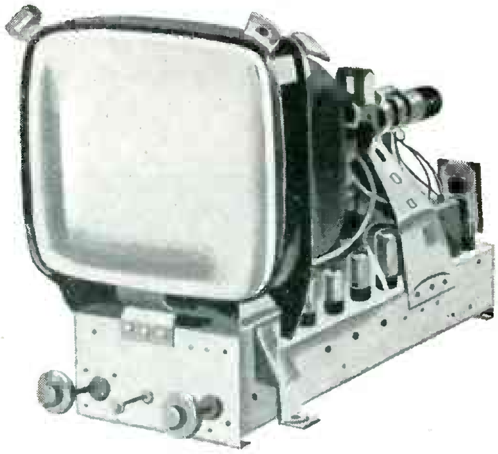

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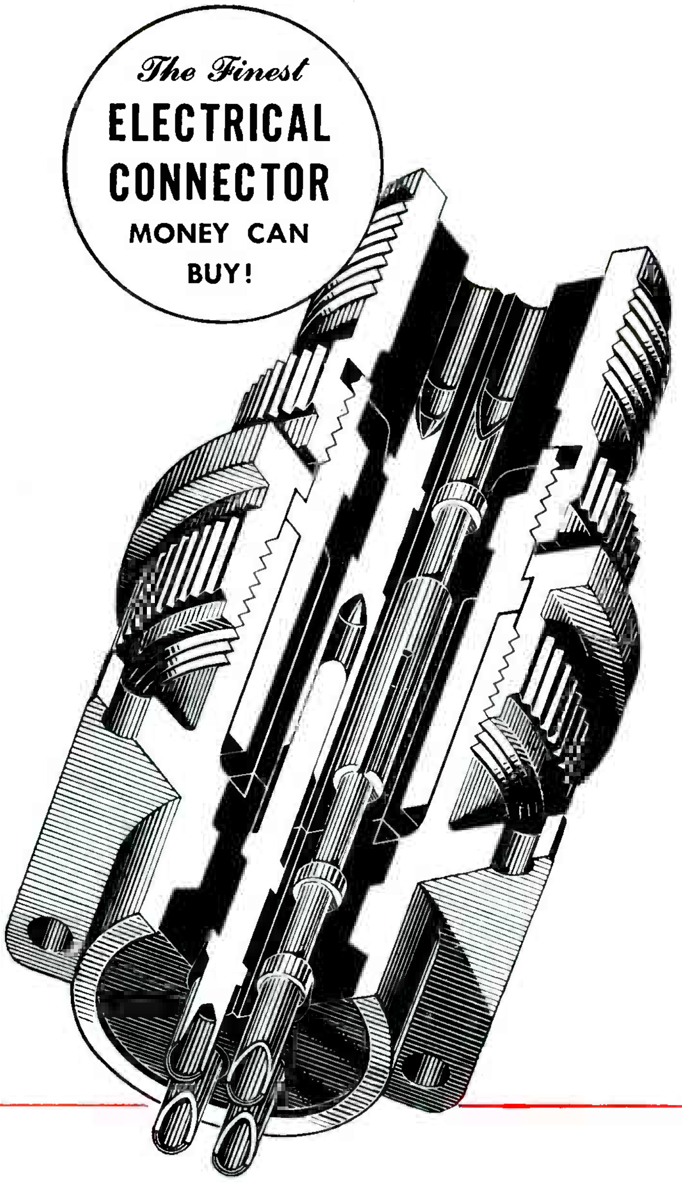

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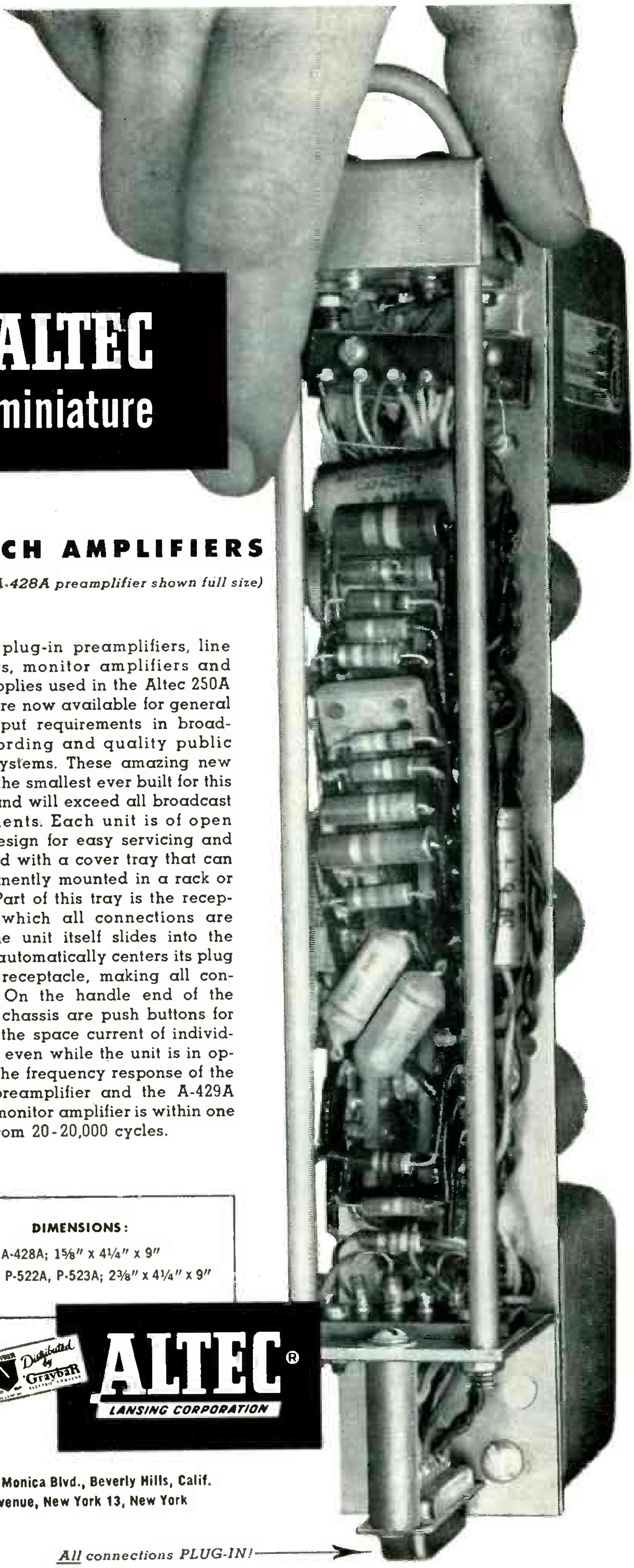

nificant harmonic in the i-f band pass is the twelfth harmonic, a very weak one.

The next question which comes to mind is how to maintain the 1.9 mc without excessive deviation in production. Capacitance measurements indicated a variation of ± ten percent in total tank capacitance with variation in lead dress. With a design center frequency of 1.9 mc, the extremes are 1.8 mc and 2.0 mc.

Physically, the commercial r-f blocking-oscillator transformer is entirely different in appearance from its conventional iron-core counterpart. It has a resonant frequency of 1.9 mc and most nearly resembles a broadcast oscillator coil. The turns ratio of the grid-to-plate winding is about 2.5 to 1 for maximum sawtooth output. There is no iron core and the copper used is much less than that in the iron-core type. A shield serves the two purposes of mounting the transformer and completely shielding it so that 1.9-mc harmonics do not get into the vertical.

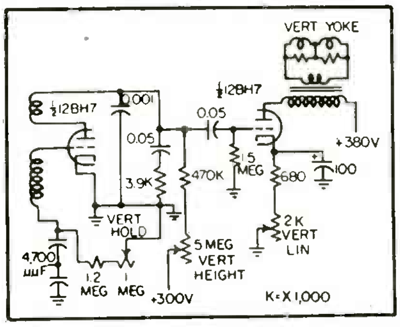

FIG. 5—Schematic of the blocking oscillator. The 0.001-μf bypass capacitor is necessary only when the peaking resistor is used

It was found that when the r-f type blocking oscillator was used, a spike existed on the trailing edge of the vertical sync pulse at the video detector. This was traced to harmonic radiation from the vertical oscillator tube into the first i-f tube. These tubes are about 1½ inches apart. The spike was found to be inconsequential since it occurred after the vertical sync leading edge and during the blanking period. Most manufacturers keep their vertical sweep circuit and the first i-f amplifier much further apart so that they would probably not have

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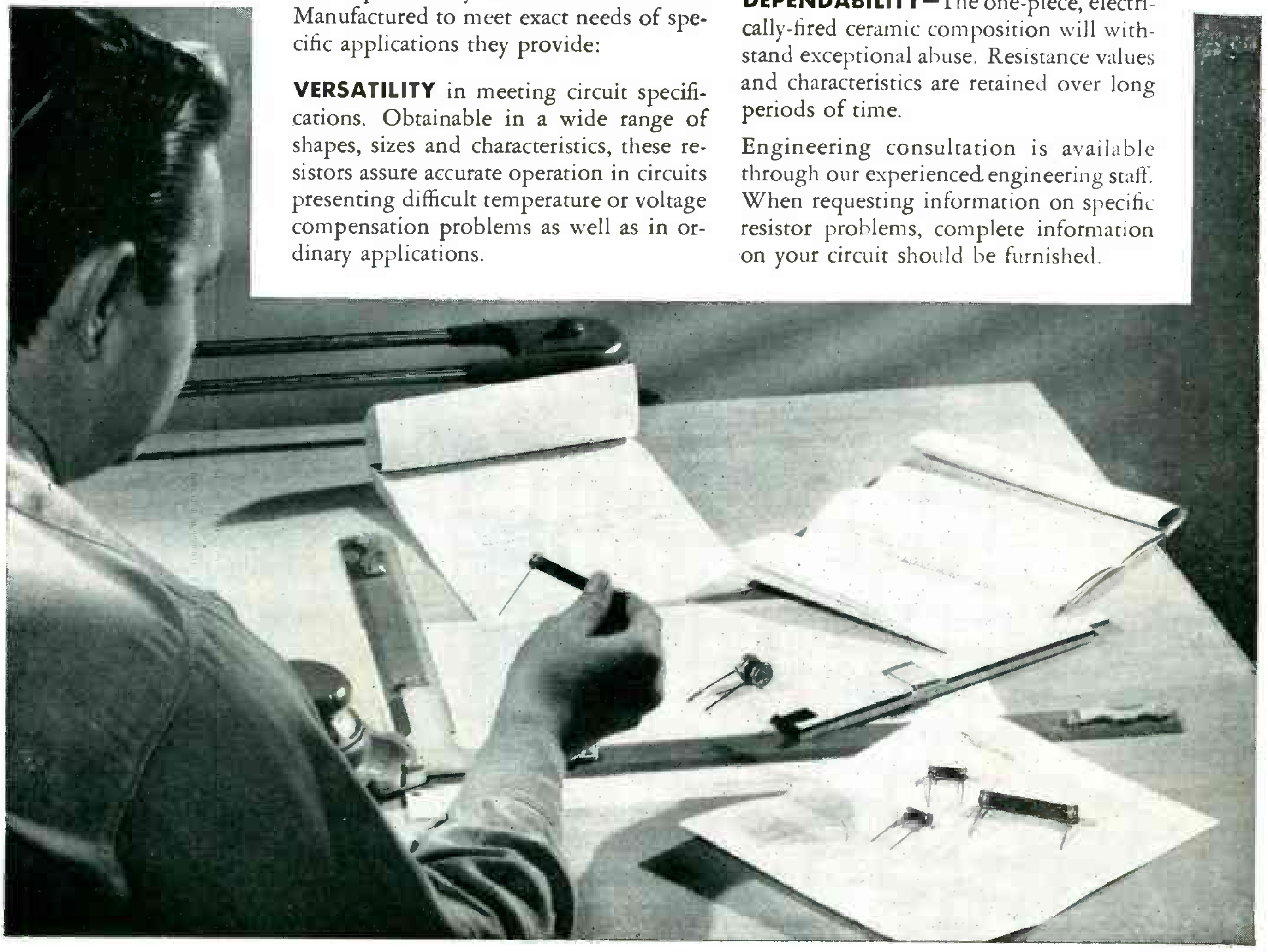

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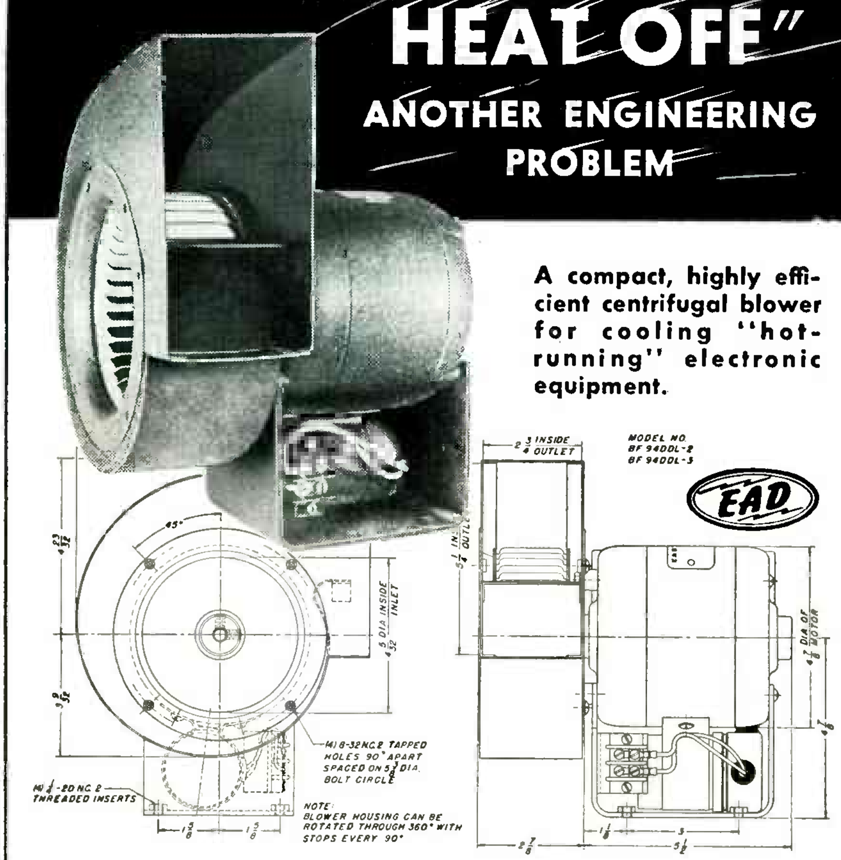

a spike in the video.

The problem of interlace is a difficult one in practice. It is known that only odd harmonics of 30 cps can destroy interlace. The horizontal sweep frequency is the 525th harmonic of 30 cps and is therefore most likely to spoil interlace. Although horizontal frequency voltage can enter at several places, the most susceptible place is the grid circuit of the vertical oscillator. The iron-core transformer has a grid inductance of ten henrys, a plate inductance of one henry and self resonance at a high audio frequency. It is extremely susceptible to 15,750 cps pickup. On the other hand, the grid inductance of the r-f type oscillator is 400 μh and represents 40 ohms reactance at 15,750 cps. At this level, there is no pickup of horizontal frequency.

A schematic diagram and a data sheet for the design of the air-core vertical blocking oscillator transformer are included in Fig. 4 and 5. The circuit values are identical with those for the iron-core type.

In summation, the advantages of the r-f type blocking-oscillator transformer are that it is less expensive, much less susceptible to horizontal transients which prevent proper interlace and that much less critical material is required.

The author acknowledges contributions of Ed Stanwyck in aiding the transformer design and of Stanley Seitz in field testing the transformer.

Simple Millisecond Meter

By Ronald C. Walker

Caversham, Reading, England

Relays of the telephone type are extremely useful in electronic circuits and it is frequently necessary to know their response time in operation and release and the period of contact closure and opening. The measuring equipment usually used for such investigations, though lacking nothing in accuracy is frequently expensive, elaborate and not always easily obtainable.

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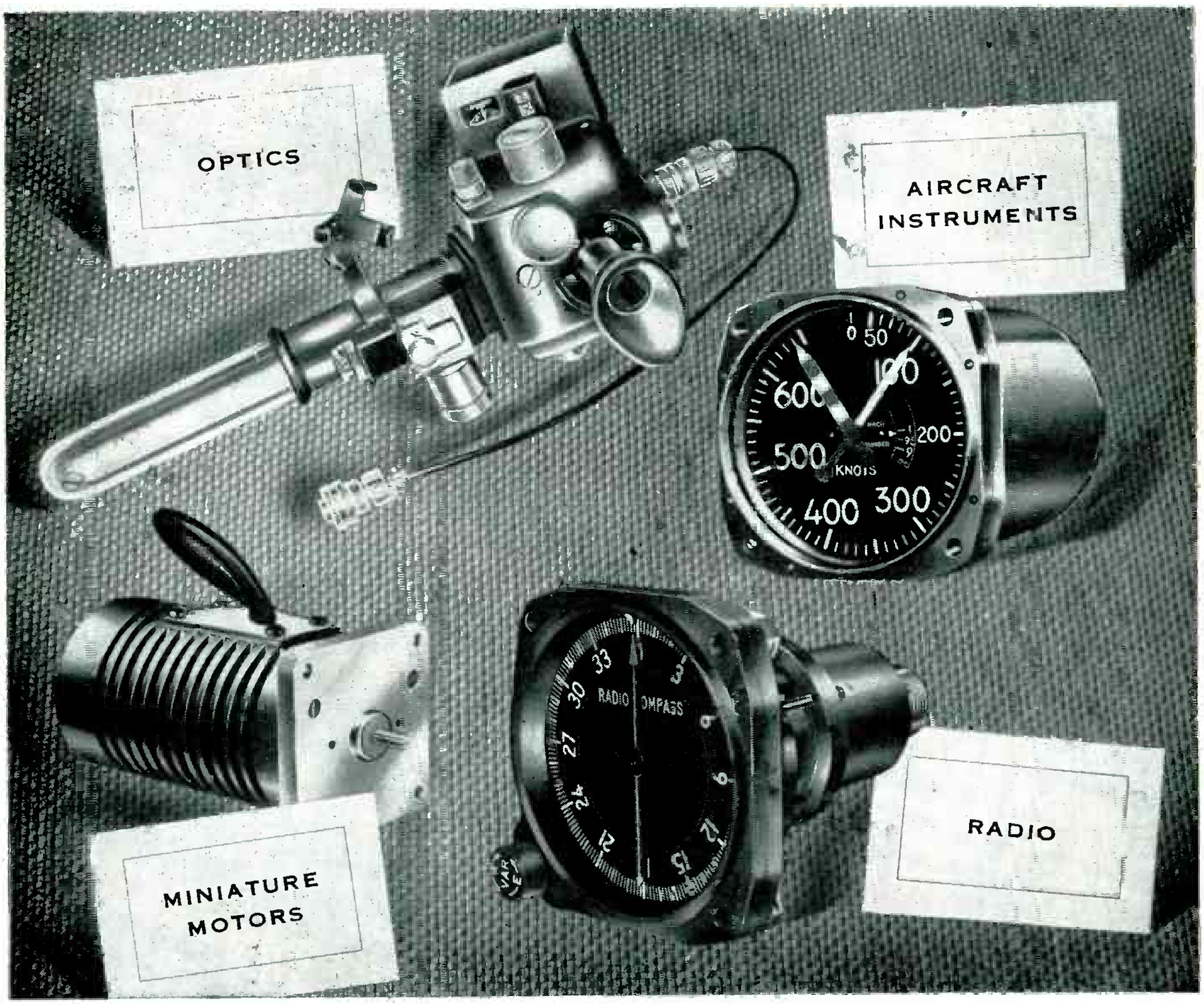

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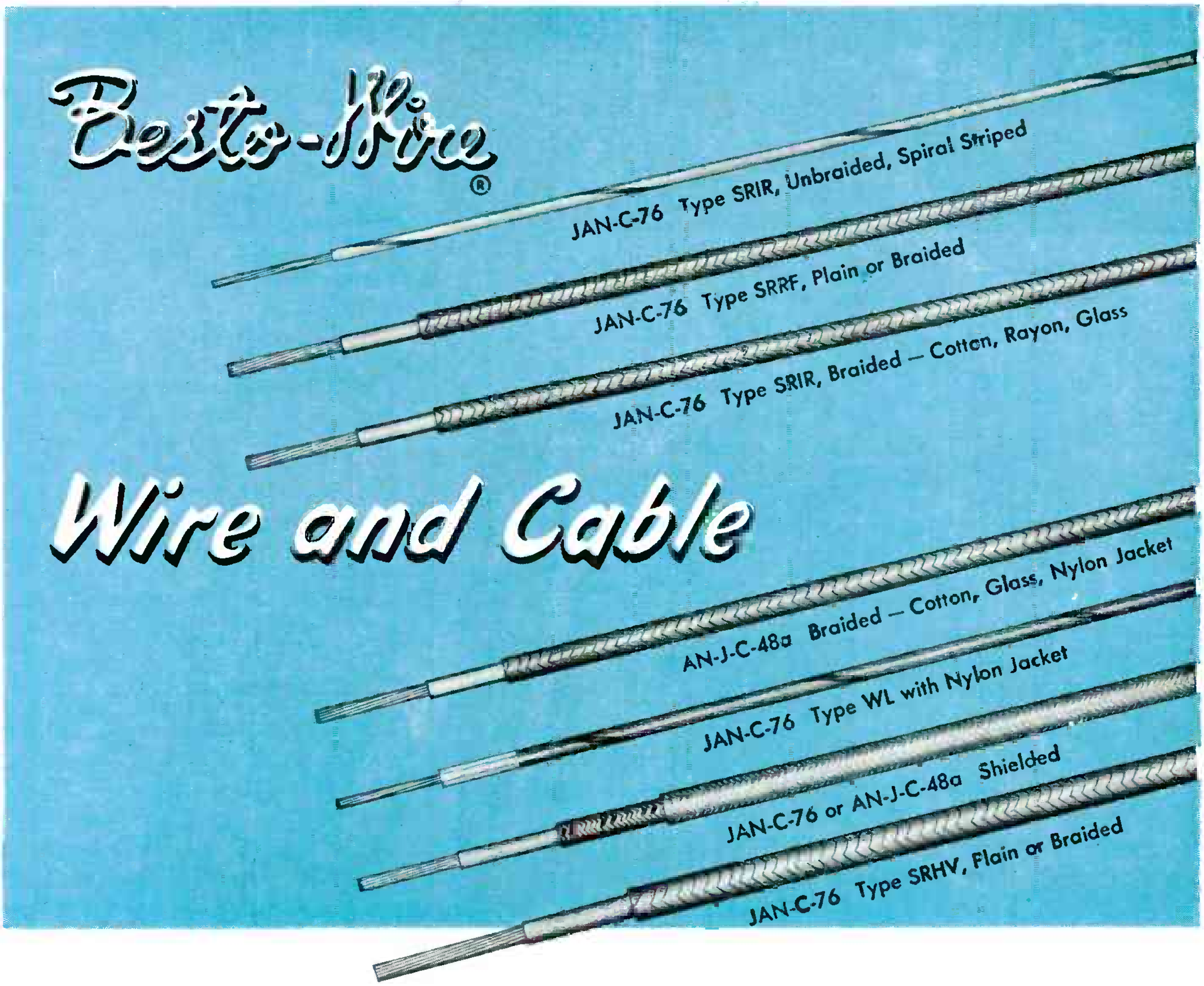

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preciated that to measure times down to this limit requires only simple gear to insure good accuracy provided certain precautions are observed. The apparatus here described utilizes the principle of measuring the electrostatic charge lost by a capacitor during the short time to be recorded.

Two high-speed relays of the electromagnetic type are required with a response time of less than one millisecond and small compared with the shortest period to be measured. The capacitor and the potentiometer by means of which the charge loss is restored must both be high-grade instruments. All the wiring of the circuit should be short and the various leads should not be bunched together. Apart from these precautions no special skill is required in operating the circuit which is shown in Fig. 1.

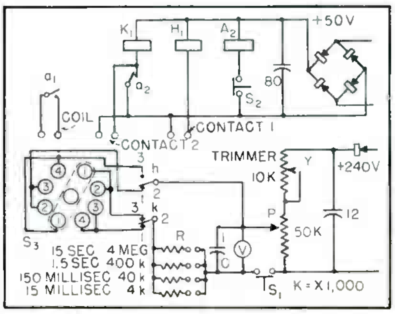

FIG. 1—Schematic diagram of relay test circuit

Capacitor *C* is charged to a fixed potential indicated by the electrostatic voltmeter *V*. During the short period to be measured, the terminals of the capacitor *C* are connected by a discharge resistance *R*. The loss in charge is subsequently restored by adjusting the position of potentiometer *P* which is calibrated in milliseconds until the original reading of the instrument *V* is indicated.

Resistor *R* consists of a plug switch enabling the discharge resistance to be altered so as to cover one of several ranges in time, 0–15, 0–150 milliseconds and 0–1.5, 0–15.0 seconds. Switch S_3 is a double-ended stud switch with four positions numbered as shown enabling time periods of different nature to be measured. H_1 and K_1 are high-

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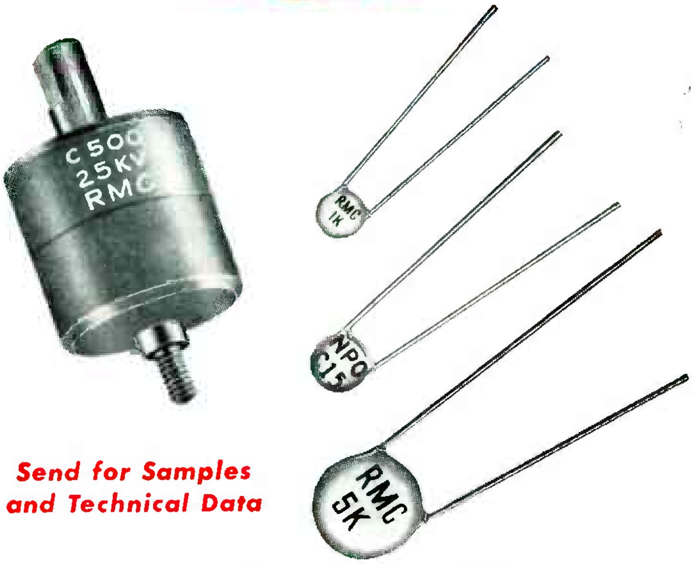

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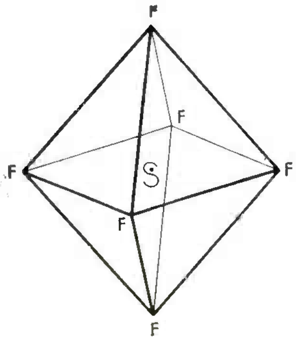

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speed relays having contacts h and k respectively.

Relay A_2 is a standard telephone relay carrying contacts a_1 and a_2 which must make and break simultaneously. Switch S_1 is a press-to-close reset switch and S_2 is a push-pull switch which may rest in either position, the pulled condition closing the contacts.

The instrument is designed for line operation and the rectifiers included produce the direct voltage for charging the capacitor and operating the three relays as and when required.

Before making any measurements, the line supply voltage tapping should be checked. The reset switch S_1 is then pressed and the needle of V swings to its reference point which can be conveniently near the center of its scale. If the needle does not align exactly with the reference point, the trimmer Y can be adjusted to make it do so.

On releasing S_1, the needle of V should remain steady. If it does not, there is some leakage and either a wrong connection has been made or the push-pull switch S_2 needs reversing. Measurements cannot be made until the reading of V remains steady when S_1 is released.

To measure the duration of a contact closure, connect contact to CONTACT 1 terminals, switch S_3 in position 4, switch S_2 in either position. To measure the duration of contact opening, connect contact to CONTACT 1 terminals, switch S_3 in position 4, switch S_2 in either position.

To measure the pick-up time of a relay, connect coil in series with its supply to COIL contacts. Connect make contact to CONTACT 1. Switch S_3 to position 2. Press reset switch S_1. Use switch S_2 to energize relay under test.

To measure pick-up lag of a relay, connect and proceed as in previous test but with switch S_3 in position 1. To measure release time of a relay, connect as in previous test but with S_3 in position 4. Press reset switch S_1 with push-pull switch S_2 pulled. Push S_2 to release relay under test.

To measure release lag of a relay, connect as for pick-up test, but with

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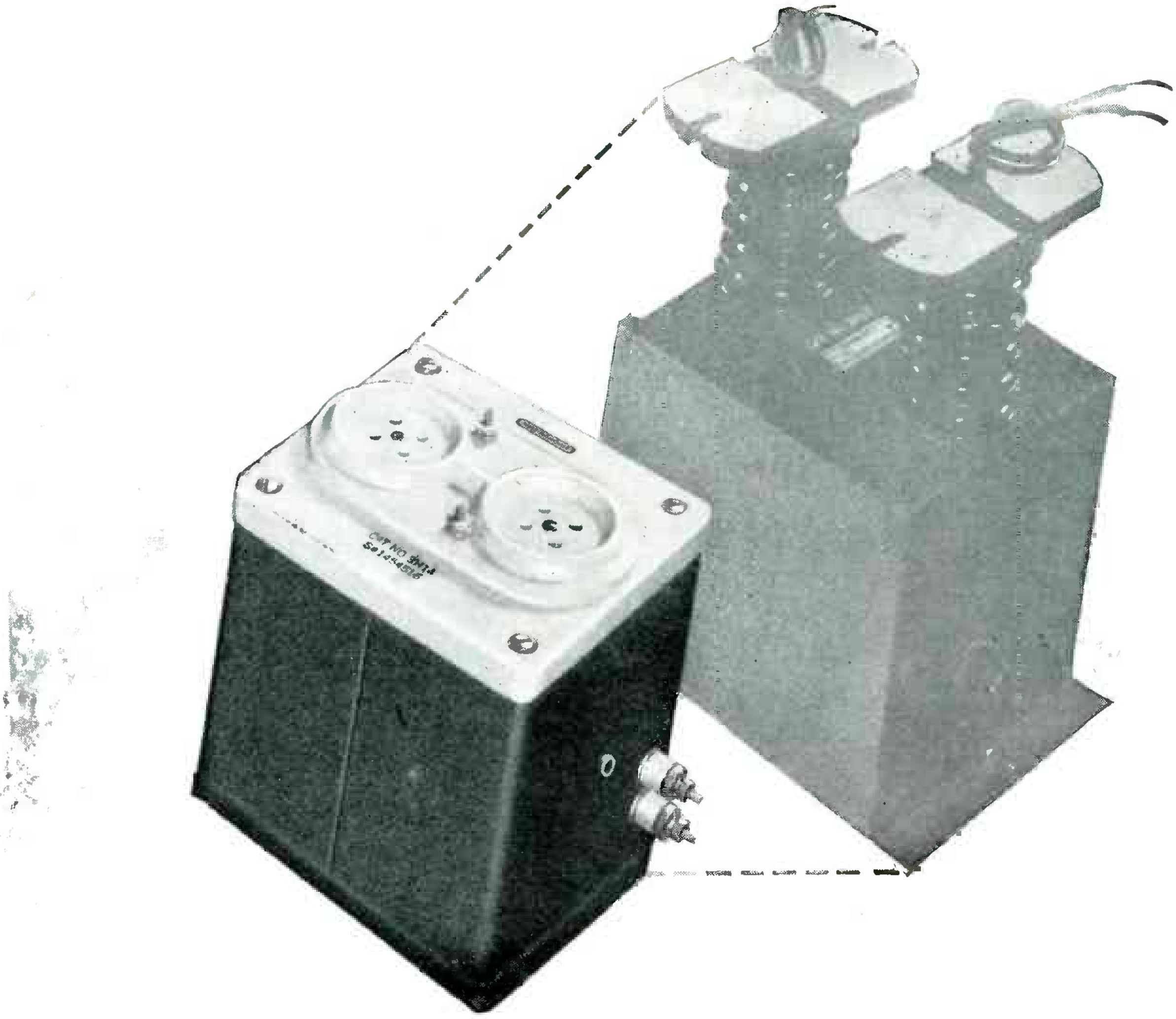

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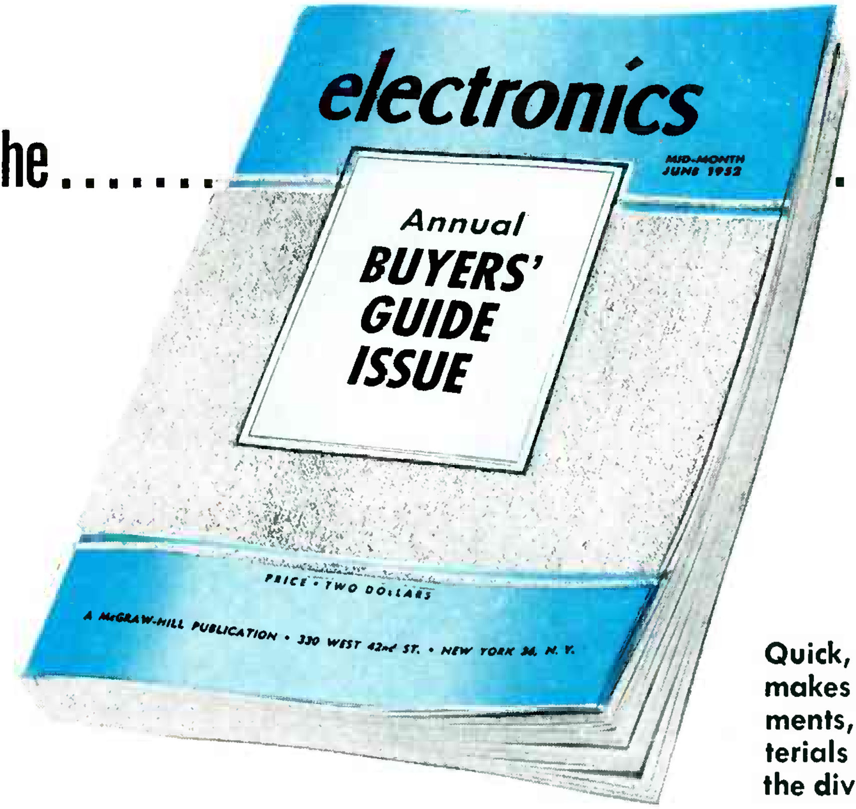

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S_3 in position 3. To measure time between break of one contact and make of another, connect break contact to CONTACT 1 and make contact to CONTACT 2. Switch S_3 in position 3. Push-pull switch S_2 in pushed position.

To measure the duration between make of one contact and break of another, connect as for previous test, with S_3 in position 1. To measure the duration of overlap of a make and break contact, repeat test just described.

Multiple-Unit Control System

By F. P. McKNIGHT

Senior Research Engineer
Electronics Division
Speer Carbon Company
St. Marys, Pa.

A DEVICE is often needed to operate controls at a number of similar points in a machine in response to some measured condition. For example, one might wish to operate several heat-control relays to maintain a controlled temperature in several sections of a single machine or in several similar machines operating independently.

On these applications it would often be economical to use a single measuring instrument to operate all of the controls, saving duplication of the measuring equipment. One solution of this problem is the system described. In this system a single measuring instrument is made to scan periodically all of the control points and operate the controls in response to the measurement obtained. In this particular application the instrument was a pyrometer measuring the temperature of a number of thermocouples but it could just as well be controlled by other properties measured with a multipoint recorder such as voltage, current, pressure and flow.

Basic Circuit

The basic circuit is shown in Fig. 1. In this circuit, there is a relay with a coil designed to operate at approximately half of the line voltage. This relay operates in series with a resistor R_1 or R_2 in response to signals from the

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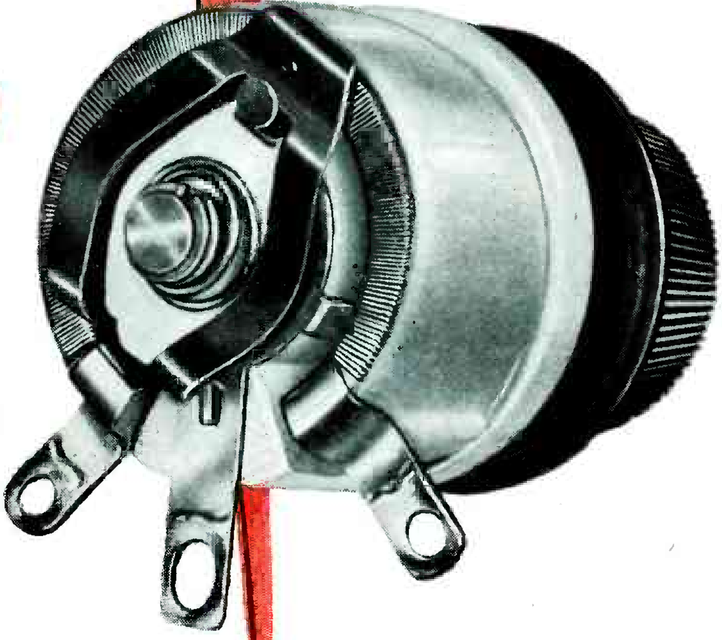

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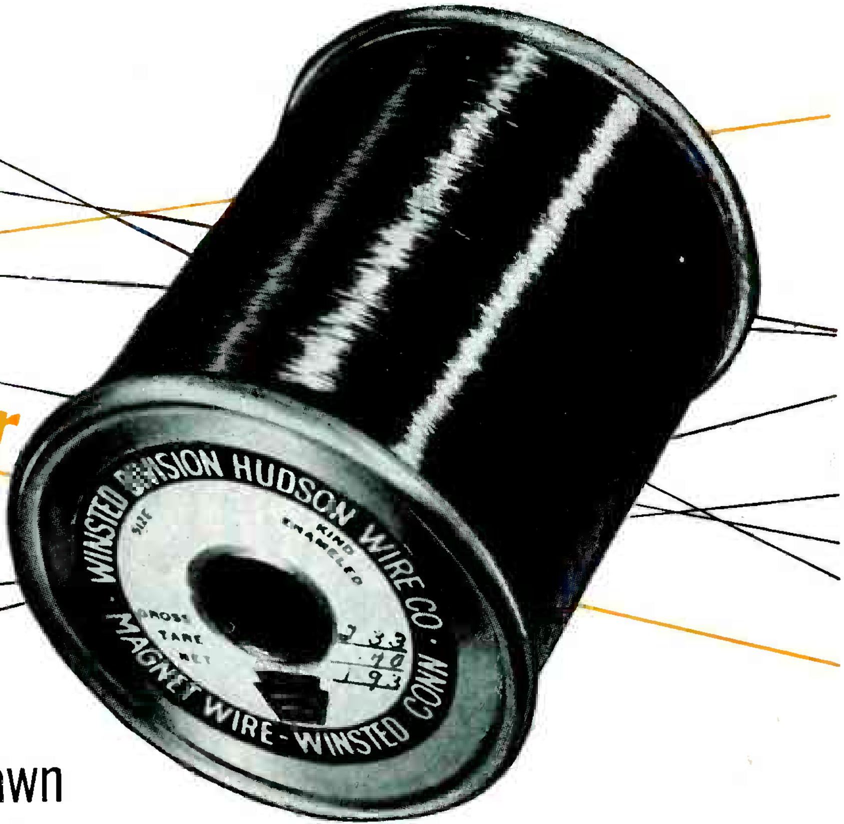

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(Winsted Division)

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Copper Aluminum Iron Copper-clad Steel	Instrument Tubing Litz Multiplied and Twisted	Plain and Heavy Enamel Formvar EZsol (Liquid Nylon) Cement-coated Enamel

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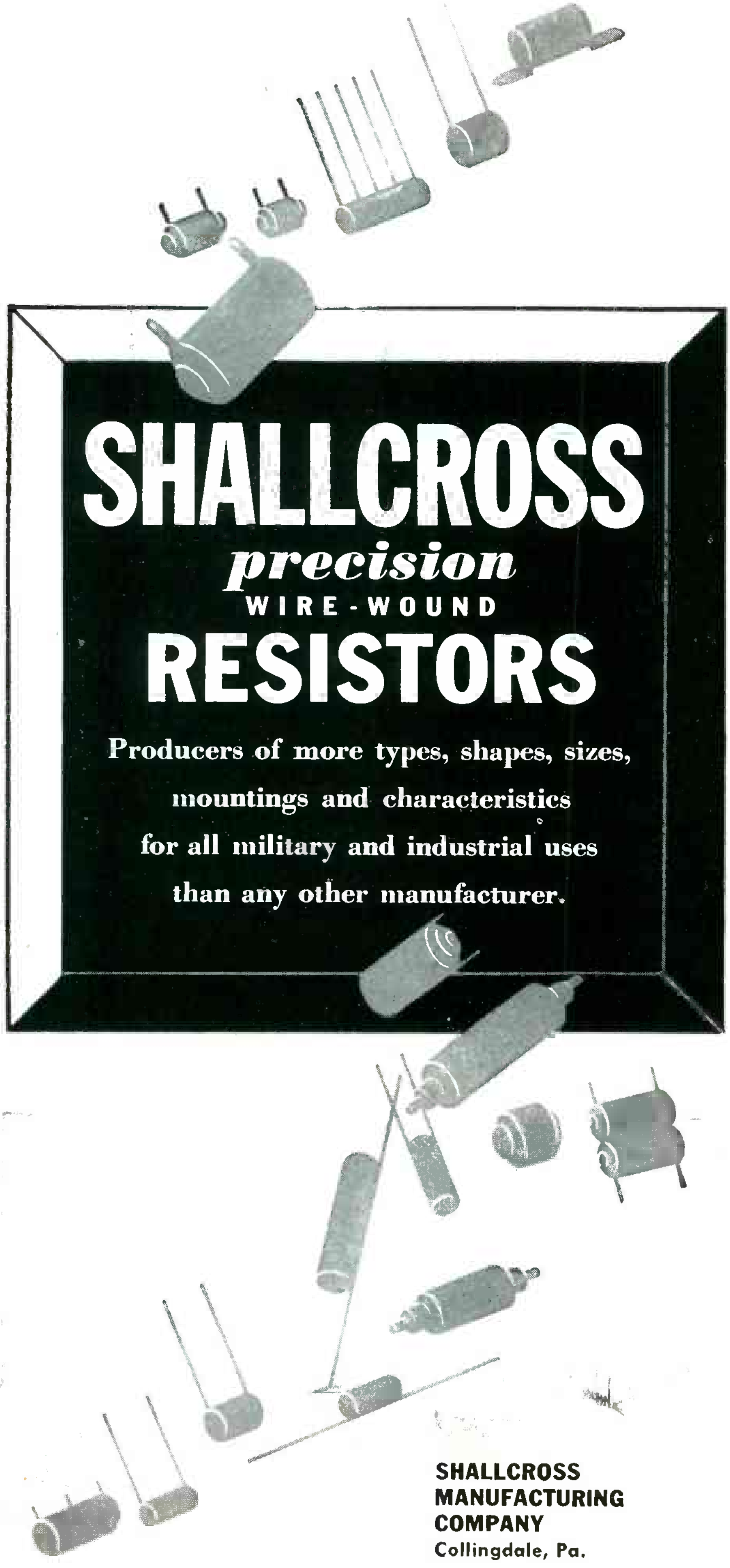


control switch S. The operation may be illustrated as follows.

Assume that the current supply has been turned off and is now turned on with switch S open. In this case, all circuits are open and the relay is open. As switch S is closed to position 2, voltage is applied to the relay coil through resistor R_2 causing the relay to close. When the relay closes, holding contact C_1 is closed, and the relay remains closed even when switch S is opened. If switch S is closed in position 1, the relay coil is short-circuited, causing the relay to open. Once the relay is open, control switch S may be opened and the relay will remain in an open position.

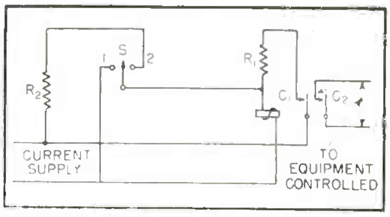


FIG. 1—Basic circuit of the multiple-unit control

This is a basic system which will respond to signals from a control switch and which will hold its position until a different signal is received.

Complete Circuit

The complete circuit is shown in Fig. 2. It differs from the basic circuit chiefly in that a nonshorting scanning switch has been added, geared to the thermocouple switch on the multipoint recorder so that they rotate together. Here a relay has been used for each of the six points being controlled. The operation of the circuit may be explained by an illustration.

Suppose that the current supply has been off and all relays are open. The controller is turned on, the scanning switch S_S, rotates to position 1 and pauses. At the same time the instrument is connected to the thermocouple in position 1 and comes to balance at a point below the control temperature closing the control switch S_T in the low position.

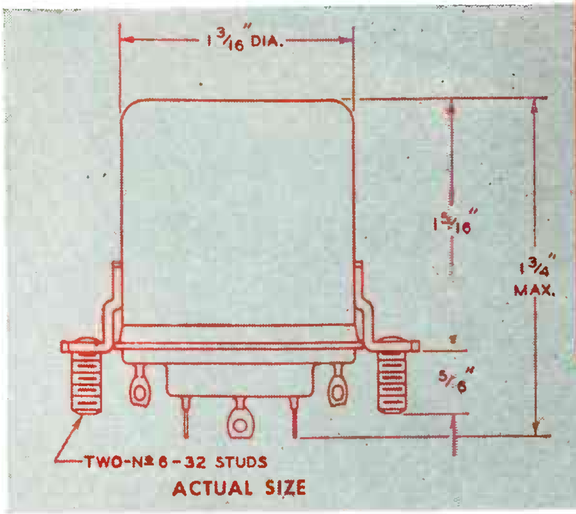
When sufficient time has lapsed

Miniaturized DC Relay

for military aircraft applications

IMPORTANT FEATURES

- **Designed to meet U. S. Air Force Relay Specification MIL-R-5757**
- **Palladium Contacts . . . Six-pole, double-throw design**
- **Moisture-free-gas-filled . . . Hermetically sealed**



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RCA-203W1 DC RELAY

. . . Specifically produced for military requirements by the Electronic Components activity of the RCA Tube Department.

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Built to operate under severe service conditions, and in any mounting position, the RCA-203W1 will provide longevity of service under extremes of temperature, humidity, shock, vibration and voltage variations. Because it is hermetically sealed in a steel envelope which is evacuated and filled with moisture-free gas, the coil and contacts are impervious to dust, moisture, and corrosion.

Its 6-pole, double-throw construction features palladium contacts rated to handle 2 amperes with a resistive load at 26.5 volts dc and 1 ampere with an inductive load at the same voltage. Contacts are arranged in a break-before-make sequence.

A technical bulletin covering ratings, dimensions, terminal connections, operating information, and descriptive data on shock, vibration, and life tests, is yours for the asking. Just write RCA, Commercial Engineering, Section IR42, Harrison, N. J. . . . or contact the nearest RCA field office.

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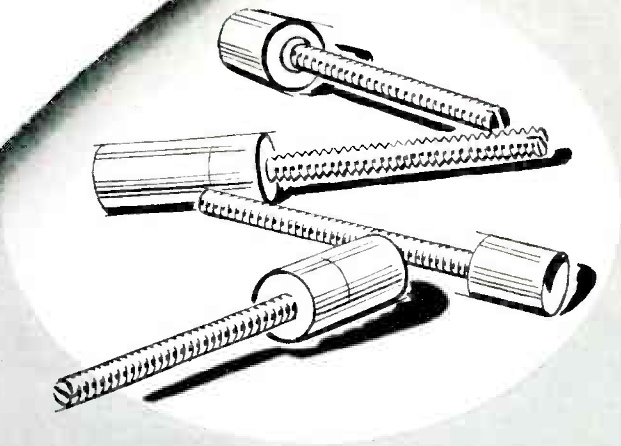

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- Linear Frequency Calibration, Accuracy — 2%
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- Calibrated Tuning Meter

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for the instrument to come to balance, the momentary switch S_M is closed for almost one second, applying power to relay one causing it to close. This relay in turn applies power to the heating system to raise its temperature.

Once closed, the relay is held in a closed position by its holding contact and the instrument proceeds to check each of the other five temperatures and set their controls accordingly.

Returning to thermocouple 1, the temperature may still be too low causing the action to be repeated, with no effect on the control relay because it is already closed, or it may have risen above the control point. If the temperature is above the control point, the control switch S_T will be closed in the high position.

When the momentary switch S_M is closed, the relay coil will be short-circuited, the relay will open and remain open until the controller closes it at some later time.

The momentary switch in the circuit serves three purposes. It prevents false operation of the relays when changing from a point at one temperature to a point at a different temperature. It keeps the scanning switch from carrying current while it is moving and prevents it from breaking a circuit carrying current. Its contacts take all the wear, preventing repairs to the other, more expensive switches.

Experience has shown that this

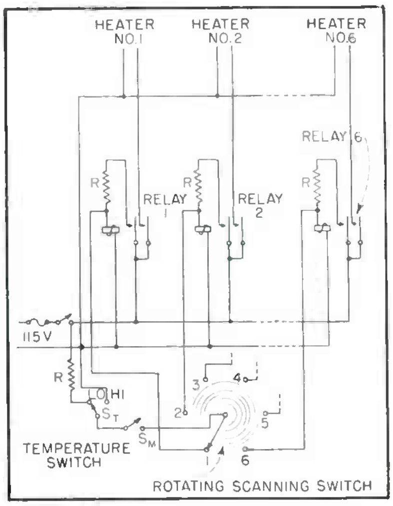
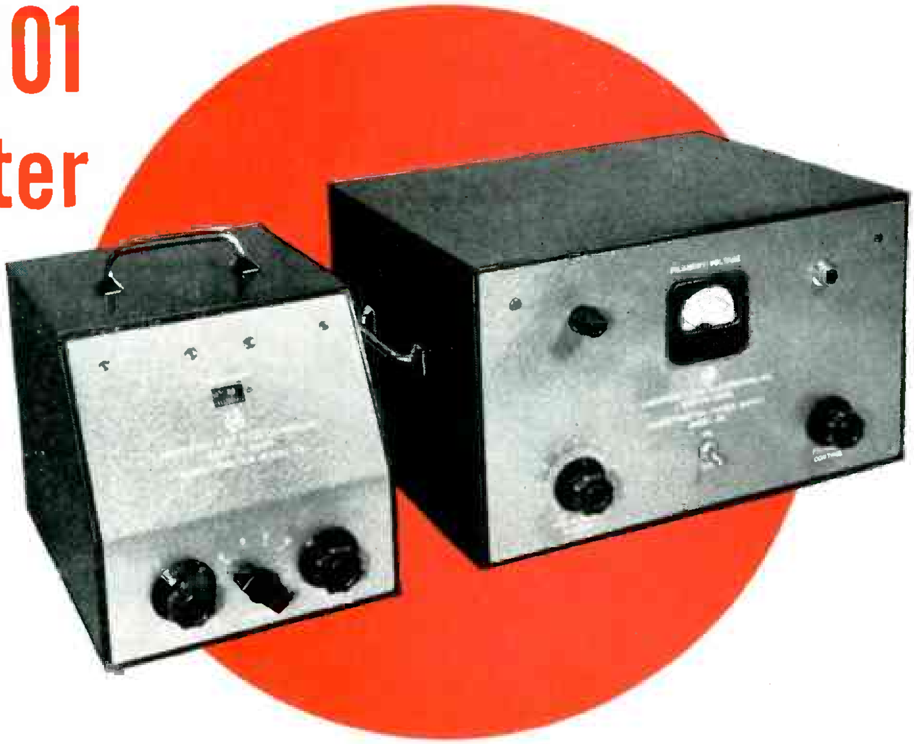


FIG. 2—Complete circuit of the device

New Model 101 Magnetometer



accurately measures magnetic field strength using the principle of nuclear resonance

The Magnetometer translates the problem of the measurement of magnetic field strength to the much more accurately solved one of the measurement of a radio frequency. An oscillatory magnetic field is provided by means of a coil surrounding a sample which permits measurement of proton resonance and the nuclear resonance of lithium (Li^7). The coil is part of an oscillator which is so designed that its level of oscillation drops with an increase in circuit losses, such as may be introduced by nuclear resonance in the sample material. Means are provided to make this resonance easily viewed on an oscilloscope.

The nuclear resonance effect is very small and requires a magnetic field homogeneity of at least one part in 500 for proton resonance and one part in 5000 for lithium over the dimension of the sample, to be readily detected. Due to its very high available accuracy, limited only by the accuracy of the frequency measuring equipment, the Magnetometer has many applications in the fields of research, instruction and control.

SPECIFICATIONS

Range of Magnetic Field Strength

Proton resonance: 300-8000 gauss
Lithium resonance: 7000-25000 gauss

Frequency to Field Ratio

Protons: 4257.76 ± 0.10 ∿/ gauss
Lithium (Li^7): 1654.61 ± 0.10 ∿/ gauss

Modulation Sweep Width Range

1.6 to 16 gauss

Power Requirements

115 volts, 60 cycles, 30 watts

Frequency Range

Probe 1: 1.18 to 2.84 mc   Probe 2: 2.61 to 6.25 mc
Probe 3: 5.6 to 13.5 mc   Probe 4: 13 to 34 mc

Area of Sample Material

Probe 1: 0.5 sq. cm.   Probe 2: 0.3 sq. cm.
Probes 3 and 4: 0.32 sq. cm.

Size of Probe and Cable

Cable: 18" long   Probe: ¾" Diam. ⅝" W.

Size of Units

Oscillator Cabinet: 7 9/32" W x 9 7/16" D x 7⅝" H
Power Supply Cabinet: 13½" W x 10⅜" D x 8⅜" H

Price—$725 F. O. B. Boston, Mass.

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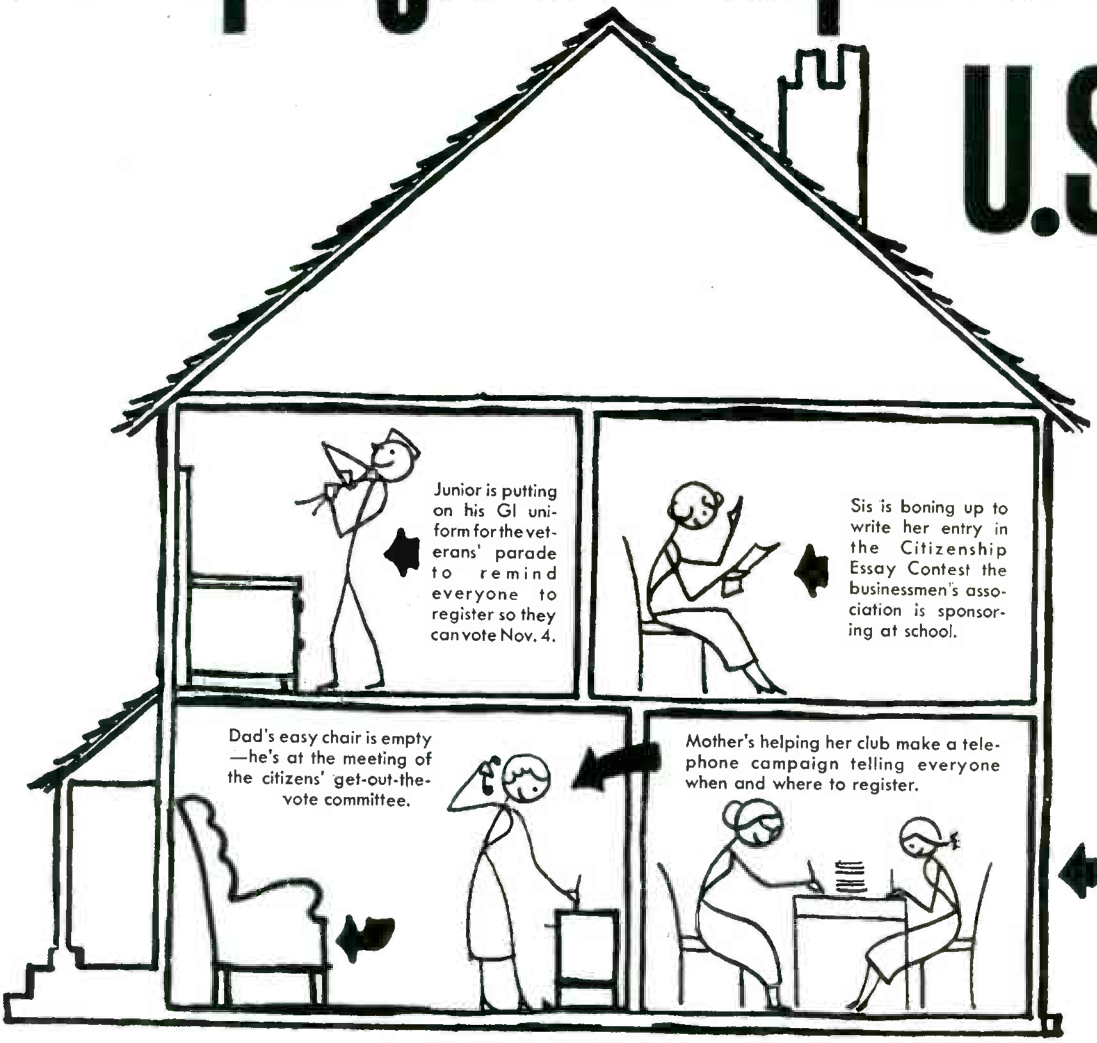

Grandma's sending registration reminders to all the church members. Even little Sis is helping—rubber-stamping messages on the cards.

The Family Vote

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THE BIG-CITY VOTE...
THE LABOR VOTE...
OR ANY PARTY VOTE...

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YOU know you're going to vote your own sweet way when you get behind that voting booth curtain—that where you live or work hasn't got a blankety-bloc thing to do with how you'll vote. You'll vote for what you believe to be in the best interests of your family—your kids—and your kids' kids.

So YOU know that this year—as always—it will be the FAMILY vote that really decides things. And families are working as never before to make sure every American votes. Right now in millions of American families, everyone from Little Sis to Grandma is pitching in to remind every eligible American to register to make sure of the opportunity to vote. And then they'll tackle the job of getting out the vote of every member of America's 44,000,000 families. They're the biggest "bloc" in America—they ARE America!

If your family is already working at the job—congratulations! If you aren't, talk it over at supper tonight, and pitch in tomorrow.

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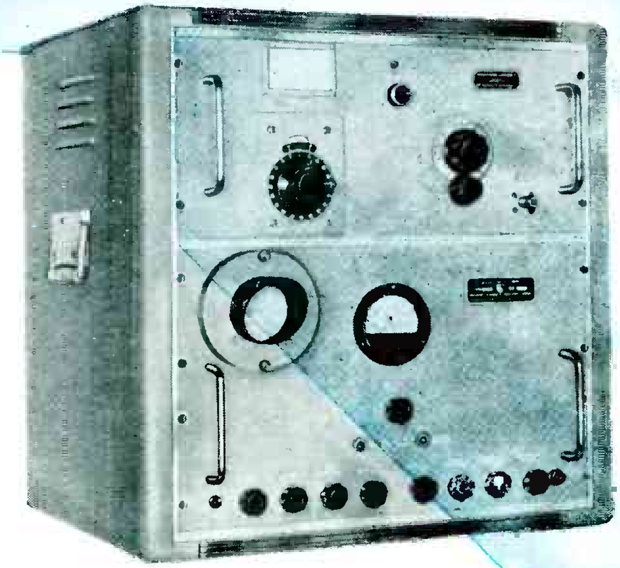

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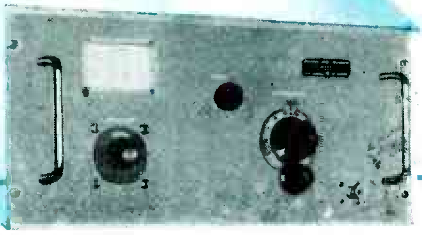

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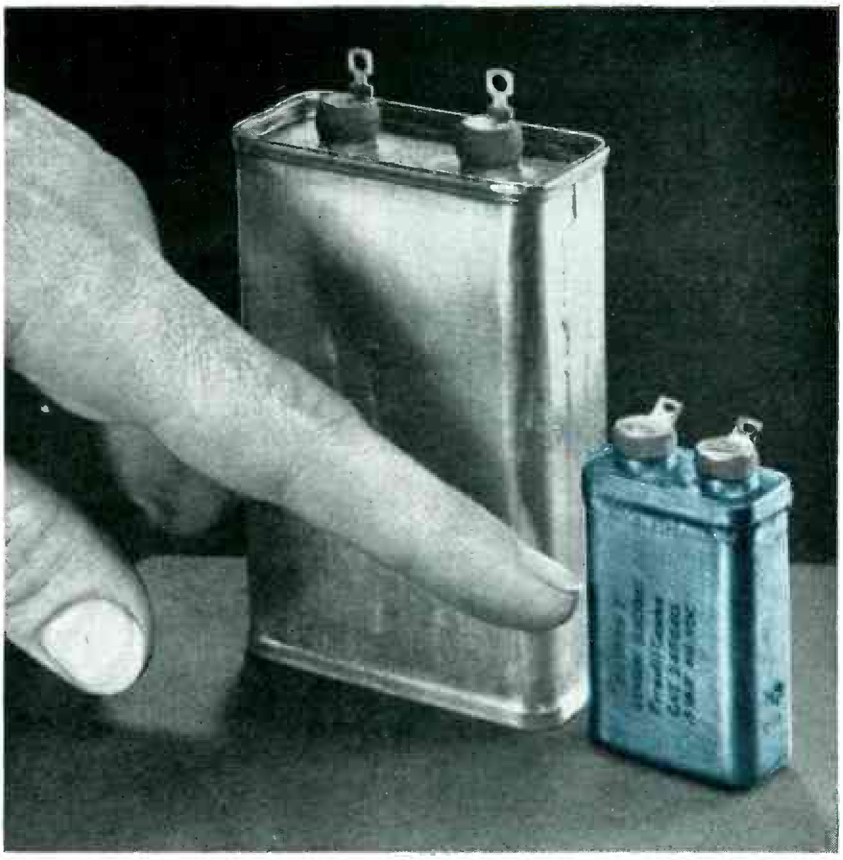
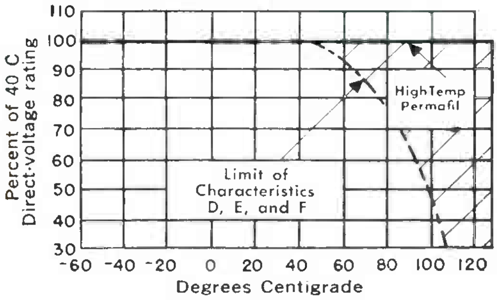


G-E Permafil d-c capacitors designed to operate in high ambients—up to 125 C—without derating

Why you gain by using Permafil capacitors for high-temperature operation



Comparison of operating voltages for JAN-C-25 characteristics D (vegetable oil), E (mineral oil), and F (synthetic insulating liquids) with Permafil impregnated capacitors—crosshatched area reveals advantages of Permafil over other impregnants in the high-temperature range above 40 C.

For ambient temperatures above 40 C, most liquid-filled paper-dielectric capacitors require considerable derating. This increases both space and weight requirements.

G-E Permafil capacitors, however, operate in high ambients—*up to 125 C*—for 10,000 hours, at full rated voltage. They average about 1/5 the size and weight of liquid-filled capacitors that will operate at 125 C—a saving of 80%. They're suitable for all blocking, by-pass, filtering, and many coupling and timing applications.

Permafil capacitors stand up in elevated temperatures because the paper dielectric is impregnated with a *solid* plastic compound that retains its electrical stability at *both* high and low temperatures. And since the impregnant is a solid, it can't leak. With proper derating or where short life characteristics are permissible, Permafil capacitors can be used in temperatures as high as 150 C. They can also be used in high altitudes and where extreme cold is encountered. Other characteristics include high insulation resistance and comparatively constant capacitance with temperature changes.

G-E Permafil capacitors can be obtained in case styles CP53 and CP61, as covered by specification JAN-C-25—in ratings of .05 to 1.0 muf, 400 volts DC. They are housed in metallic containers and hermetically sealed with G-E long-life all-silicone bushings.

For full information on Permafil capacitors, see your local G-E representative. Or write Section 407-310. Ask for Bulletin GEC-811. *General Electric Company, Schenectady 5, New York.*

GENERAL ELECTRIC

407-310

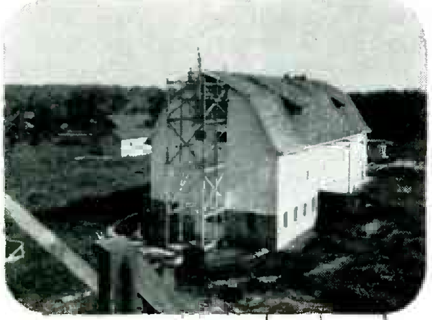
ANDREW

antenna research, development facilities

The 420-acre ANDREW Research Center, including a mile-long testing range, is devoted entirely to antenna research and development. In addition to the many Andrew standard models which have been developed here, several research and design problems have been undertaken on both prime and sub-contracts. The use of these facilities can be of material assistance in the design and manufacture of systems, associated equipment or in the development of custom antenna equipment.

The testing range utilizes this platform and various towers for antenna field testing. Recently, a full-scale model of the Empire State Building's conical upper section was built on the platform for testing television transmitting antennas. The ANDREW "Skew" antenna developed from the tests is now in use on the Empire State Building.

At this large, well equipped Center, a wide range of equipment and set-ups are available, both indoors and out. Antenna problems are solved by antenna specialists—equipment and experience cover 50 KCS to 20,000 MCS—these enable ANDREW to accept a wide range of antenna development and engineering responsibilities.



The large indoor laboratory has provisions for handling large equipment and is equipped with complete machine shop and metal working facilities. Testing is done in the upper portion of the building where the all-wood construction and elimination of metallic surfaces permit undistorted operation of the test set-up.

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rounding of the 100-kc square-wave would occur.

Certain limitations were placed on modifications in the circuit. First, the overall gain of the amplifier had to be kept as high as originally or higher. Second, the B supply and filament supply-current requirements could not be increased. In addition, wiring and layout had to be noncritical. Finally, peaking coils were not desirable because of the number of adjustments required.

The usual techniques employed to improve the bandwidth of resistance-coupled amplifiers are to (1) reduce distributed and wiring capacitances to a minimum, (2) use tubes having low internal capacitances, (3) use very low plate load resistors, (4) where gain is a factor, employ tubes having high mutual conductance, (5) use series and shunt peaking coils to resonate existing distributed capacitances, and (6) introduce sufficient degeneration to broaden overall bandwidth, even at the expense of some gain.

Unfortunately, the limitations placed on circuit modification prevented the use of these techniques. An examination of the circuit layout and wiring indicated that distributed capacitances were already at a practical minimum within the limitations of a noncritical layout.

Techniques (3) and (6) were not permitted because of the loss of overall gain. Technique (5) had previously been ruled out as one of the limitations.

A check on tube characteristics

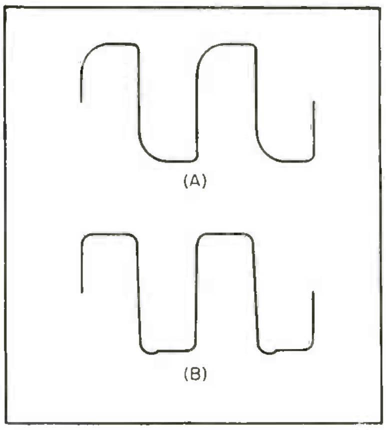

FIG. 2—Amplifier response to a 100-kc square wave (A) and response after circuit modification described in test (B)

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CM-15-C-020-M	2	500	.50	CM-15-E-820-J	82	500	.45
CM-15-C-030-M	3	500	.50	CM-15-E-910-J	91	500	.45
CM-15-C-050-K	5	500	.40	CM-15-E-101-J	100	500	.45
CM-15-C-100-J	10	500	.40	CM-15-E-111-J	110	500	.45
CM-15-C-120-J	12	500	.40	CM-15-E-121-J	120	500	.45
CM-15-C-150-J	16	500	.40	CM-15-E-131-J	130	500	.45
CM-15-C-180-J	18	500	.40	CM-15-E-151-J	150	500	.45
CM-15-C-200-J	20	500	.40	CM-15-E-161-J	160	500	.50
CM-15-C-220-J	22	500	.40	CM-15-E-181-J	180	500	.50
CM-15-E-240-J	24	500	.40	CM-15-E-201-J	200	500	.50
CM-15-E-270-J	27	500	.40	CM-15-E-221-J	220	500	.55
CM-15-E-300-J	30	500	.40	CM-15-E-241-J	240	500	.55
CM-15-E-330-J	33	500	.40	CM-15-E-251-J	250	500	.55
CM-15-E-360-J	36	500	.40	CM-15-E-271-J	270	500	.60
CM-15-E-390-J	39	500	.40	CM-15-E-301-J	300	500	.60
CM-15-E-430-J	43	500	.40	CM-15-E-331-J	330	500	.65
CM-15-E-470-J	47	500	.40	CM-15-E-361-J	360	500	.70
CM-15-E-500-J	50	500	.40	CM-15-E-391-J	390	500	.70
CM-15-E-510-J	51	500	.40	CM-15-E-431-J	430	300	.75
CM-15-E-560-J	56	500	.40	CM-15-E-471-J	470	300	.80
CM-15-E-620-J	62	500	.40	CM-15-E-501-J	500	300	.80
CM-15-E-680-J	68	500	.40	CM-15-E-511-J	510	300	.80

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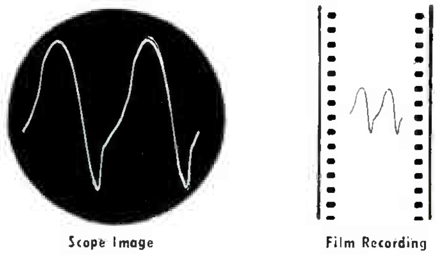
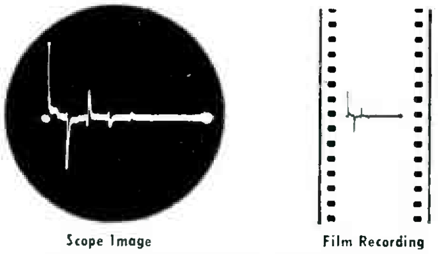
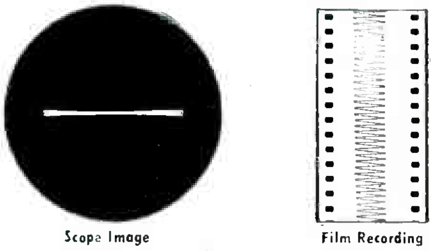


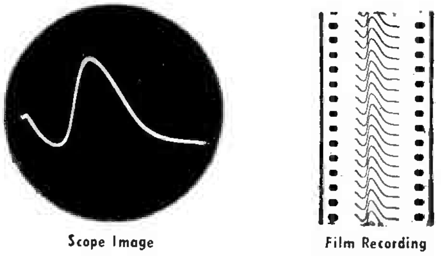
1. Single-frame photography of stationary patterns using a continuously running sweep.



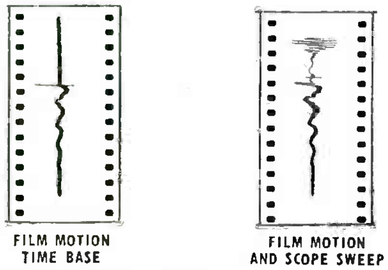
2. Single-frame photography of single transients using a single sweep.



3. Continuous-motion photography employing film motion as a time base.



4. Continuous-motion photography employing oscilloscope sweep as a time base.



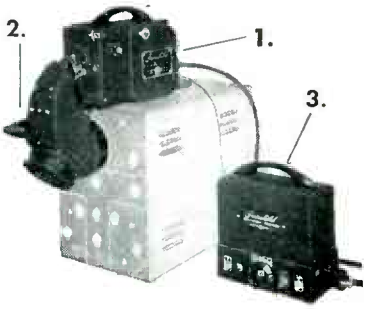
5. Continuous-motion photography employing combination of film motion and oscilloscope sweep as a time base.

Fairchild Oscillo-Record Cameras are now available *from stock* for immediate shipment. With these units you can make *permanent* photographic records of oscilloscope traces, thereby eliminating possible errors in making hand sketches from memory. In time-saving and convenience alone, these cameras will pay for themselves many times over.

FAIRCHILD OSCILLO-RECORD CAMERA IS UNUSUALLY VERSATILE

Users of the Fairchild Oscillo-Record Camera like its versatility. Designed for both still and continuous-motion photography on 35-mm film, it records non-recurring phenomena that are too rapid for visual study, others that are so slow that continuity is lost, and the occasions where very high-speed transients are combined with very slow-speed phenomena. For some idea of the types of jobs this instrument can do, study the examples at the left. Each solves a particular problem. Oscillo-Record camera users especially like its:

- **CONTINUOUSLY VARIABLE SPEED CONTROL** — 1 in/min. to 3600 in/min.
- **TOP OF SCOPE MOUNTING** that leaves controls easily accessible.
- **PROVISION FOR 3 FILM LENGTHS**—100, 400 or 1,000 feet.



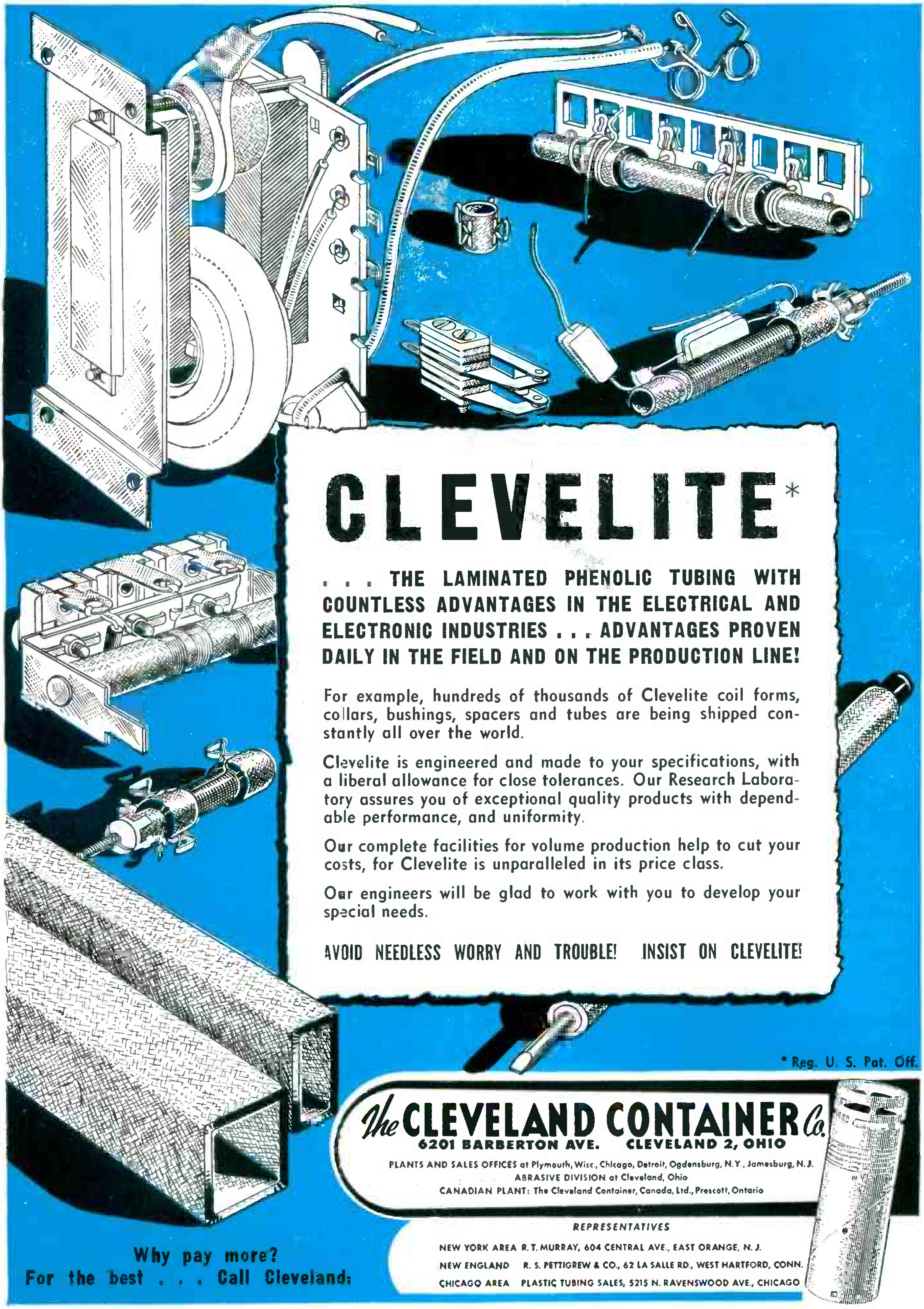
1. Camera, 2. periscope, 3. electronic speed control. Accessories include 400- and 1,000-ft. film magazines, magazine adaptor and motor, universal mount for camera and periscope, binocular split-beam viewer.

FAIRCHILD TAKE-UP CASSETTE FOR SHORT RUNS

Where only a few pictures are required for quick development and study, a small Take-up Cassette is available as an accessory. The convenience afforded by this unit results in the saving of considerable time in handling short runs and reduces film wastage to a minimum. It is easily attached to the top of the camera by means of an adapter. A built-in knife permits short lengths of exposed film (up to 10 feet) to be cut off and removed with the cassette for developing.

Complete information about applications and operation of both the Fairchild Oscillo-Record Camera and the Fairchild-Polaroid Oscilloscope Camera is available. Write today to *Fairchild Camera and Instrument Corporation, 88-06 Van Wyck Boulevard, Jamaica 1, New York, Department 120-18A2.*

FAIRCHILD
OSCILLOSCOPE RECORDING CAMERAS



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ruled out techniques (2) and (4), for tubes other than those already used having higher mutual conductance and/or lower internal capacitances were found to require greater B or filament currents, or both.

The circuit modifications shown dotted in Fig. 1 were tried. The results were quite satisfactory, as shown by the 100-kc square-wave response of the modified circuit Fig. 2B.

The principle used, though not new, is seldom applied to resistance-coupled amplifiers. Basically, capacitor C_a acts to couple a small amount of energy from the output of V_2 to the input of the preceding stage. Since C_a is kept small in value, only the higher frequency signals are affected. Resistor R_a acts to provide damping and thus to reduce any tendency towards oscillation and excessive peaking.

By adjusting C_a it is possible to actually place a slight 5 or 10 percent overshoot on the leading edge of the square-wave. The net effect is similar to that obtained when adjusting a peaking coil.

Components C_a and R_a together act to provide regeneration at the higher frequencies, boosting the gain of this section of the amplifier sufficiently to make up, in part, for the loss of highs in the rest of the circuit.

A further improvement in overall response was obtained by applying the same technique to the push-pull output stage, where the greatest high-frequency loss occurred. Cross-feed capacitors C_b and C_c provided the necessary in-phase feedback signal at higher frequencies.

A mathematical investigation of this technique has not been made, but the experimental results were so satisfactory it is felt that others in the field may be interested in investigating the technique further.

Tape Duplicating Equipment

THE GROWING BUSINESS of duplicating magnetic tapes has led to many interesting techniques. The method of duplication described is the work of the Audio-Video Recording Company, Inc., a sister company to A-V

LABORATORY ELECTROMAGNET

LARGE VOLUMES of homogeneous magnetic field are provided for experimental work by the Model V-4012 (12-in. pole diameter) Varian Electromagnet. A few applications are: nuclear- and paramagnetic-resonance work, Zeeman studies, and beam deflection. Pole caps are readily changed for high- or low-field operation.

EXTREMELY RIGID CURRENT REGULATION (1 part in 10^5 for 10 per cent line voltage change) is attained with the Varian Model V-2100 Magnet Power Supply—specifically designed to energize these magnets. Other features of the Model V-2100 include negligible long-time drift and circuitry for injection of: (a) field sweeping voltages, and (b) nuclear-resonance field regulating voltages.

VACUUM-IMPREGNATED and sealed magnet coils are insulated against high voltage to ground. Surge protection is included. A variety of series and parallel connection possibilities permits a wide choice of voltage-current combinations. Geometric changes are minimized by full-yoke construction. The magnet mounts on a base which brings the pole axis approximately to waist height.

GUARANTEED HOMOGENEITY is accomplished by accurate parallelism of carefully-ground air gap surfaces. Nuclear-resonance field-measuring techniques are employed to confirm the guaranteed performance of each magnet: That with conventional 12-in. diameter pole caps and standard 1¾-in. air gap the Model V-4012 magnet field will be uniform to 1 part in 50,000 over a volume not less than 1 cu. in.

Special field configurations can be provided where required.

TYPICAL GAP FIELDS

Air Gap, In.	Diameter of Pole at Air Gap, in.	Pole Arrangement	Magnet Input, kw	Field, Gauss
5¼	12	Pole caps removed	4	7,000
1¾	12	Standard pole caps	4	13,500
½	1⅝	Soft iron tapered pole caps with ⅛-in. axial hole, for Zeeman observation.	4	31,000
¼	1		4	37,500

YOUR CORRESPONDENCE is invited concerning this magnet and power supply as well as other models including an 8-in. pole-diameter electromagnet and large laboratory permanent magnets. Varian Associates also is active in both the research and manufacturing branches of the nuclear-resonance field.

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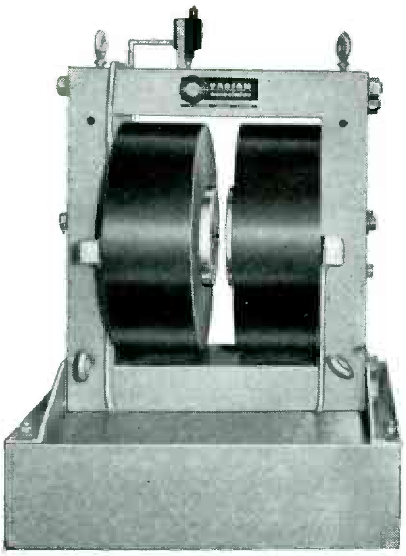

UNIFORM FIELDS

homogeneity
guaranteed
1 part in 50,000

HIGH FIELDS

40,000 gauss, max.

low
power requirements

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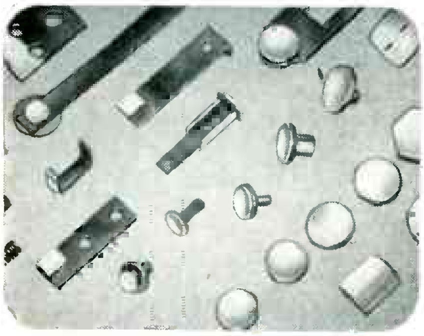
Give Higher Performance, Reduce Costs, Conserve Scarce Metals

General Plate Composite Metals, made by metallurgically bonding one metal to another, are available in strip, sheets, bars, tubing or wire in various sizes and thicknesses. Silver, gold, platinum on base metals give solid precious metal performance at a fraction of the cost of solid precious metal. The precious metal provides specific performance requirements such as electrical conductivity and corrosion resistance while the base metal provides workability, strength, and solderability.

Composite base metals available in variety of combinations to provide properties not possible with a solid metal. Typical General Plate clad metal combinations are copper on Monel; copper, brass, aluminum, Monel, nickel on steel; steel, copper, silver on aluminum. Special combinations include titanium on steel, molybdenum on cupro nickel, calcium on nickel, copper and silver on magnesium, etc.

General Plate manufactures all grades of silver solder, solder filled wire, solder clad base metal, etc., with various melting ranges for all applications. General Plate Engineers will gladly help you with your problems.

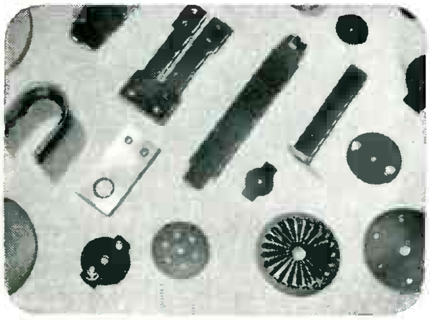


COMPOSITE CONTACTS

General Plate can supply all types of fabricated composite contacts, buttons, rivets, contact assemblies made to customer's specifications. These contacts give high electrical conductivity at reduced costs.

COMPOSITE BASE METALS

Available in practically any combination of precious to precious, precious to base or base to base metals. Combinations for electronics include aluminum clad iron, nickel clad iron for anode materials.



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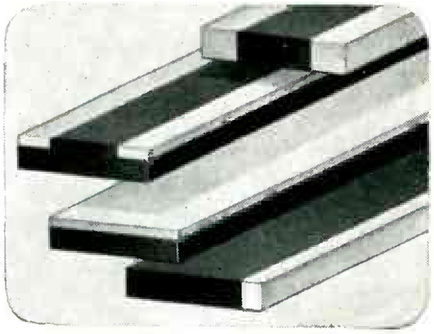
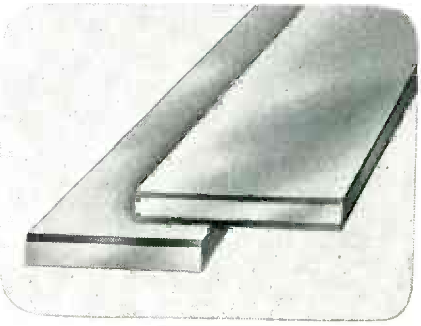
These thermostat metals are manufactured in a wide variety of types, each with a different reaction to temperature. Precision parts fabricated to exact specifications.



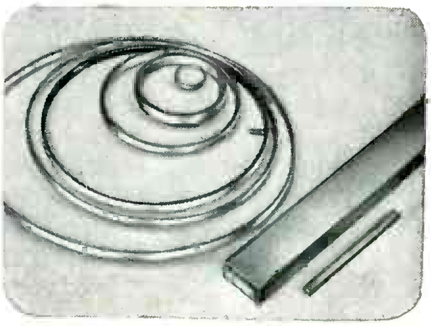
COMPOSITE PRECIOUS METALS

Precious metals and alloys bonded to base metals available in following types — overlay, single and double edgelay, single and double inlay, toplay, ready for you to fabricate.



ALCUPLATE

Copper clad aluminum for cooling fins, terminals, etc., light weight, excellent conductivity. Copper provides ideal surface for soft soldering.



WAVE GUIDE and COLLECTOR RINGS

RECTANGULAR WAVE GUIDES. Solid silver, silver lined brass or aluminum. Sizes to government specifications.
COLLECTOR RINGS. Solid silver or silver on base metal. All sizes.

* * * * * *

General Plate Products

- **ALFER, ALNIFER, NIFER** — Aluminum and Nickel clad Steel for anode plates.
- **ALCUPLATE** — Copper clad Aluminum for terminals, heat transfer sections, electronic component cases.
- **ALSIPLATE** — Silver clad Aluminum for lightweight conductors, capacitors, etc.
- **BRONCO** — Phosphor Bronze clad Copper for high conductivity springs.
- **#720 MANGANESE, AGE HARDENABLE, ALLOY** — Corrosion resistant spring material for diaphragms, springs, finger stock, etc.
- **PLATINUM** — Sheet, wire, tubing, parts of all types. Complete assay and refining facilities for platinum metals.
- **BONDWICH** — Solder clad brazing shim for carbide tipped tools.
- **THIN GAUGE METALS** — Beryllium copper, nickel, pure beryllium, Haynes Stellite alloys, etc.
- **WAVE GUIDE TUBING and COLLECTOR RINGS** — Full range of sizes to exact specifications.
- **COMPOSITE CONTACTS and CONTACT METALS** — High electrical conductivity, increased strength and wearing qualities at reduced cost.
- **TRUFLEX THERMOSTAT METAL** — Sheet, strip, formed elements and assemblies produced to specification.

WRITE FOR TECHNICAL BULLETINS

GENERAL PLATE ***Division of Metals & Controls Corporation***
FOREST ST., ATTLEBORO, MASSACHUSETTS

THE Erie TUBULAR TRIMMER STYLE 535...

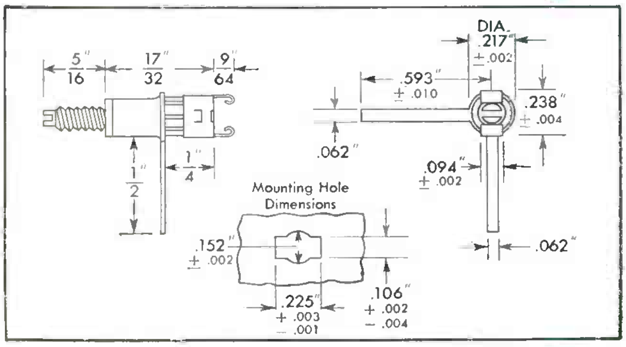
A "Natural" for Miniaturization and Low Inductance in UHF Circuits

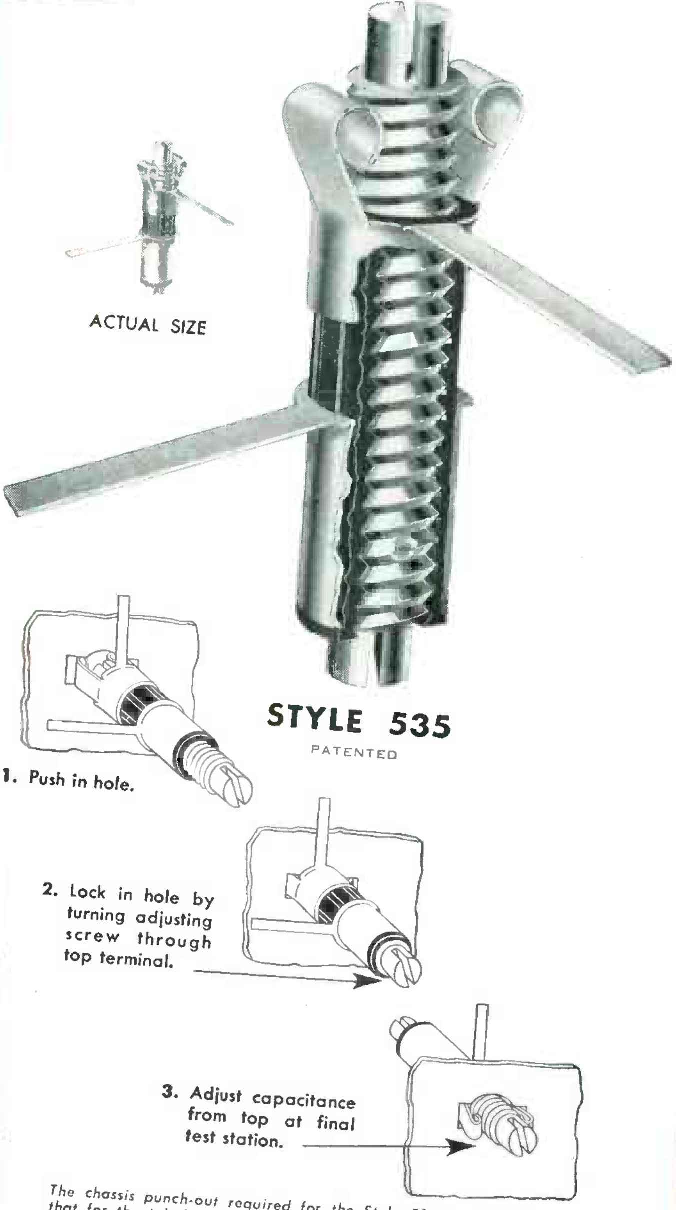
THE ERIE Style 535 Tubular Trimmer combines economical price, compact size, and easy mounting, with features for UHF operation. Capacitance range is 0.7 to 3.0 MMF. When mounted it extends only 17/32" from the underside of the chassis. It is 7/32" in diameter, and high terminal is conveniently available to tube socket terminals at a level 1/4" from the underside of the chassis.

Design simplicity results in very low inductance, and uniform, straight-line, and noiseless adjustment. It can be mounted close to associated circuit elements, and the ribbon type leads help to minimize inductance in UHF circuits.

The Style 535 Trimmer as shown at the right, is unique in requiring work from only one side of the chassis when mounting. Ground terminal is provided for soldering to chassis when desired.

Write for descriptive literature and samples.





1. Push in hole.
2. Lock in hole by turning adjusting screw through top terminal.
3. Adjust capacitance from top at final test station.

The chassis punch-out required for the Style 535 is identical to that for the tubular ceramic trimmers that are in general usage.

TRADE **ERIE** MARK
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Electronics Division

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Setup of the five master duplicators

Tape Libraries in New York.

The system makes use of the Ampex extended-range magnetic tape recorder which records and plays back signals as high as 100,000 cycles. Operating at a multiple speed, the entire audio spectrum can be rapidly re-recorded from one tape to the other without attenuating either the bass or treble ends.

A tape transport mechanism is used for the playing of the original tape but with the standard magnetic head housing modified for the installation. The head contains no erase or record heads but it does contain two separate playback heads. These are staggered vertically so that both tracks of a dual-track tape can be played back simultaneously.

The circuitry consists of dual playback amplifiers, one for each track. Output of each playback channel terminates at line level in an audio rack. Separate gain controls are provided for each playback channel to insure a matched balance between the two levels. Across the output terminals of these gain controls are meter multipliers and vu meters for gain setting. Outputs of the playback controls are terminated in channel buses across which are bridge-multiplied the inputs to the duplicators.

At present, five master tape duplicators are used. No erase head is provided but bias current is generated for the two separate record heads that are staggered vertically,

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...NOW AVAILABLE IN QUANTITY IN OVER 1000 STANDARD SIZES

STANDARD TEST

All 12 mil cores are tested for core loss (true watts) and exciting volt-amperes (apparent watts) at 60 cycles. 4 mil cores are tested at 400 cycles. Following table gives maximum test values. Average values are approximately 20% less than maximum.

	12 Mil—60 Cycle @ 15000 gauss	4 Mil—400 Cycle @ 10000 gauss
Core Loss (TW)	0.95 x lbs.	4.4 x lbs.
Exciting Volt-Amps (AW)	1.75 x lbs. + 6.25A*	5.0 x lbs. + 16.6A*

* A = Gross Area of core face in Sq. In.

All 2 mil cores are tested for pulse permeability by using a 2 microsecond pulse width at 400 P. P. S. and maximum flux density of 10000 gauss. The minimum permeability will be 500

All 1 mil cores are tested for pulse permeability by using a 0.25 microsecond pulse width at 4000 P. P. S. and maximum flux density of 3000 gauss. The minimum permeability will be 175.

Moloney HiperCore Electronic Cores now available in quantity to manufacturers of electronic equipment whose product is manufactured for ultimate use by U. S. Government. Produced in lamination thickness from 1 mil to 12 mil and in standard widths from ¼".

Better transformer performance is assured when HiperCore Electronic Cores are used because these wound cores have greater flux carrying capacity and lower losses than other types of cores of comparable sizes. The overall result, in addition to better performance, is a lighter, smaller core. Because HiperCores are wound cores, they permit accelerated production through savings in assembly time.

Rigid core production control permits these cores to test well within industry tolerances. Typical test requirements for various types are listed in the panel above. Special tests for specific operating conditions will be made if desired.

ME52-22

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for simultaneous dual-track playback in the master machine. The head housing also contains a dual-track playback head for monitoring purposes.

The electronic chassis contains dual record amplifiers fed independently to each of the two staggered heads. Dual playback head amplifiers are also contained on the chassis. Dual-track tapes are produced rapidly by recording both tracks simultaneously, resulting in a saving in labor-time costs by as much as one-half.

Simple Phase-Angle Measurement Technique

By JOHN A. RUDISILL, JR.
Assistant Test Engineer
Radio Shops
Western Electric Company
Burlington, N. C.

PHASE-ANGLE MEASUREMENTS may be made by the use of a method that eliminates the inaccuracies involved in measuring the axes of an ellipse. No measurements of the ellipse are necessary. The two waves need not be pure sine waves. The vertical and horizontal displacements need not be equal. No calibrated phase shifter is necessary. All parts are easily obtainable and all results are obtained by the measurement of resistance, capacitance, and frequency and simple circuit calculations.

The accuracy of measuring these quantities need not be great for most applications and only one quantity need be measured for mass-production tests. Most any laboratory with an occasion to measure phase differences has equipment to measure these basic quantities.

Figure 1 shows a basic circuit for measuring phase differences. In most applications it is desirable to select C_1 equal to C_2. This condition is not necessary but makes calculations easier. For C_1 equal to C_2, a workable value for R_1 is five or ten times R_2. The capacitors should be selected for the particular application so that the effect of the phase-shifting network on the reference and the signal is negligible for the measured phase angle.

Assuming that C_1 is approxi-

A DOUBLE FEATURE

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SHAKEPROOF ENGINEERING REDUCES ELECTRIC MOTOR ASSEMBLY COSTS!

Two outstanding Shakeproof developments, pre-assembly and thread-cutting action, are combined in the fastening shown here to save a costly production operation and improve performance at the same time!

1. The exclusive Shakeproof thread-cutting slot in the point of the screw actually *cuts* a thread as the screw is driven, completely eliminating the need for separate tapping.
2. Once the screw is driven, the *pre-assembled* SHAKEPROOF Lock Washer holds the field laminations tight against the loosening effect of high frequency vibration.

Shakeproof fastening engineering can be the key to outstanding cost reductions in almost any assembly . . . call a Shakeproof engineer today and see what *you* can save!

SHAKEPROOF inc., Division of Illinois Tool Works, Elgin, Illinois
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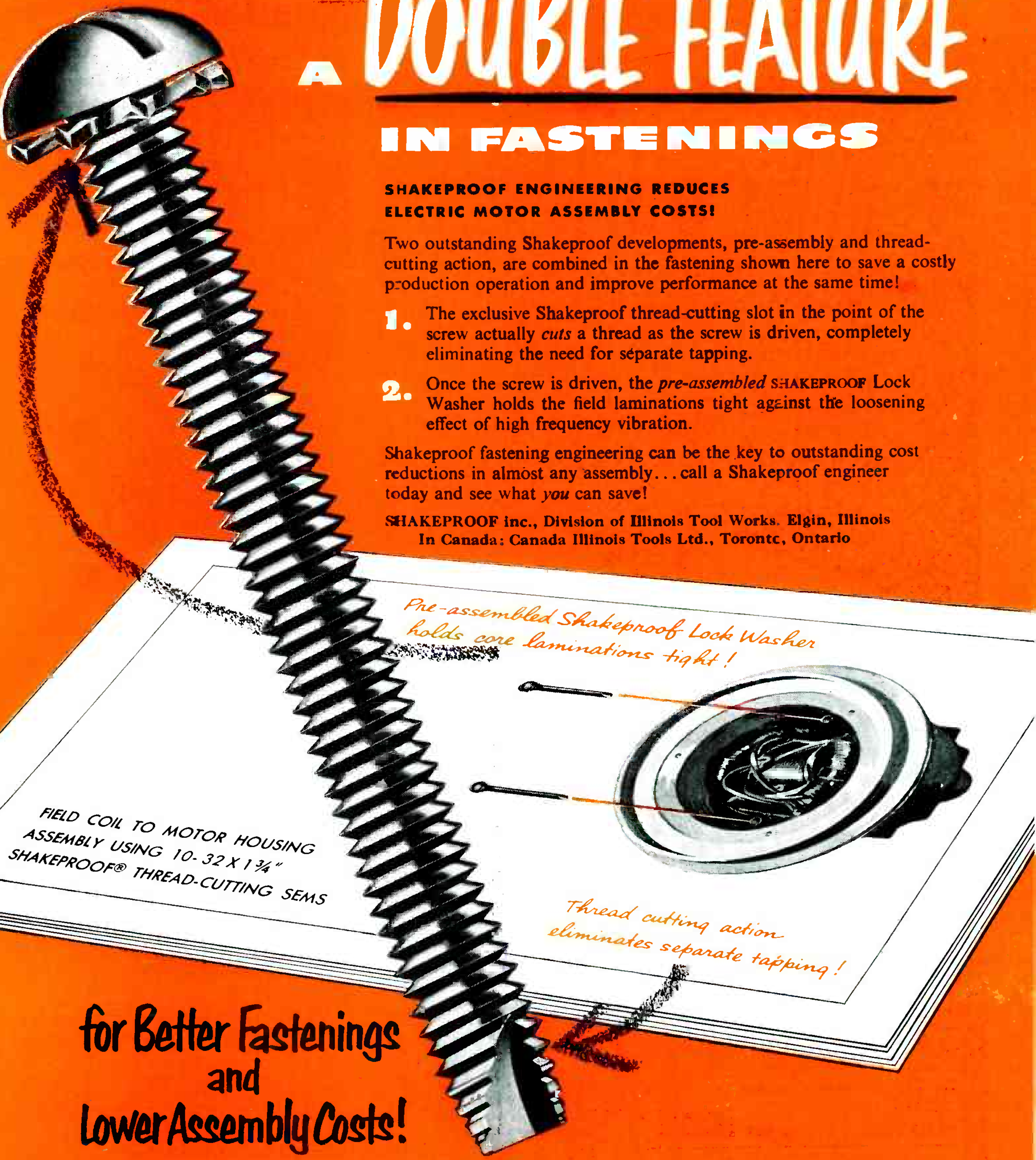

Pre-assembled Shakeproof Lock Washer holds core laminations tight!

Thread cutting action eliminates separate tapping!

FIELD COIL TO MOTOR HOUSING ASSEMBLY USING 10-32 X 1¾" SHAKEPROOF® THREAD-CUTTING SEMS

for Better Fastenings and Lower Assembly Costs!

SHAKEPROOF inc.

"Fastening Headquarters"
T.M. REG. U.S. PAT. OFF.

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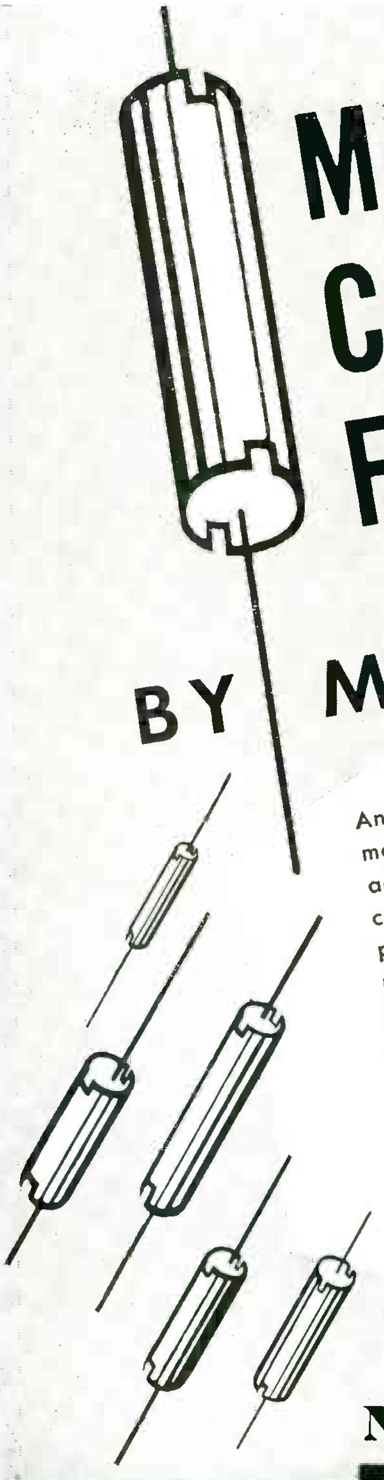

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SIG. C. SPEC.
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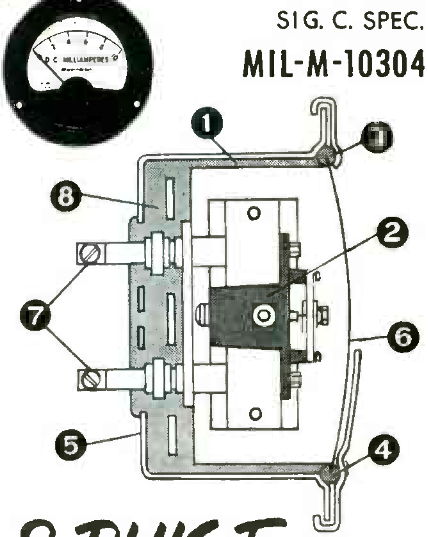

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❷ Meter movement supported by die-cast frame for greater strength and increased accuracy.

❸ Observation window rubber grommeted and sealed to rubber lining of case—providing hermetical seal of high dielectric materials.

❹ Non-rigid mounting of observation window with rubber grommet increases resistance to shock.

❺ Each meter designed and built by SUN to highest quality and precision standards.

EXTRA INSTALLATION ADVANTAGES

❻ Slight convexity of observation window reduces chance of accidental breakage during installation or shipment.

❼ Terminals side-tapped and provided with tined binding screws to facilitate wiring with or without wire lugs or by pressure, soldering or both.

❽ Breakage or damage in wiring is reduced through non-rigid mounting of terminals and use of flexible interior conductors.

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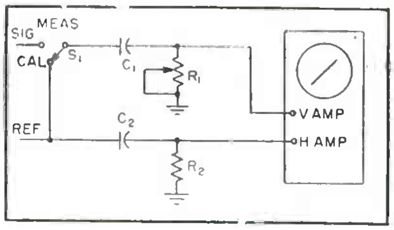

FIG. 1—Basic circuit for measuring phase differences

mately equal to C_2 and that R_1 is ten times R_2, the method of measurement is as follows if accuracy is desired. Measure and record the values of C_1, C_2, and R_2. Put S_1 on CAL and adjust R_1 for a closed elliptical pattern on the oscilloscope. A straight line is not specified because distortion may be present in the waves. Measure and record the value of R_{1a}. Put S_1 on MEAS and readjust R_1 for a closed elliptical pattern. Measure and record the value of R_{1b}. Measure and record the frequency of the incoming waves. Calculate X_{C1} and X_{C2} by the formula $X_C = 1/2\pi fC$.

The angles shown in Fig. 2 may be found by $\theta_{1b} = \arctan X_{C1}/R_{1b}$ and $\theta_2 = \arctan X_{C2}/R_2$. The phase difference between the two signals is the difference between θ_2 and θ_{1b} as shown in Fig. 2 as θ_d. Corrections for phase shift in the oscilloscope amplifiers may be made by calculating $\theta_{1a} = \arctan X_{C1}/R_{1a}$ and adding or subtracting the difference between θ_{1a} and θ_2 to θ_d.

Accurate results may be obtained by the use of this method because resistance, capacitance and frequency (the only variables) may be measured to close tolerances. If a potentiometer is not available for R_1, C_1 or C_2 may be made variable. For a specified frequency, R_1 or C may be calibrated directly in phase differences. The calibration consists only of accurately determining the values of R, C and the frequency.

This method is useful in adjusting phase-compensating networks in servo amplifiers so that there is zero phase shift between the input and output signals. In this application, calculation of the phase angle is unnecessary. Resistor R_1 is set for a closed elliptical pattern on the oscilloscope with S_1 on CAL. The servo amplifier phase shift is ad-

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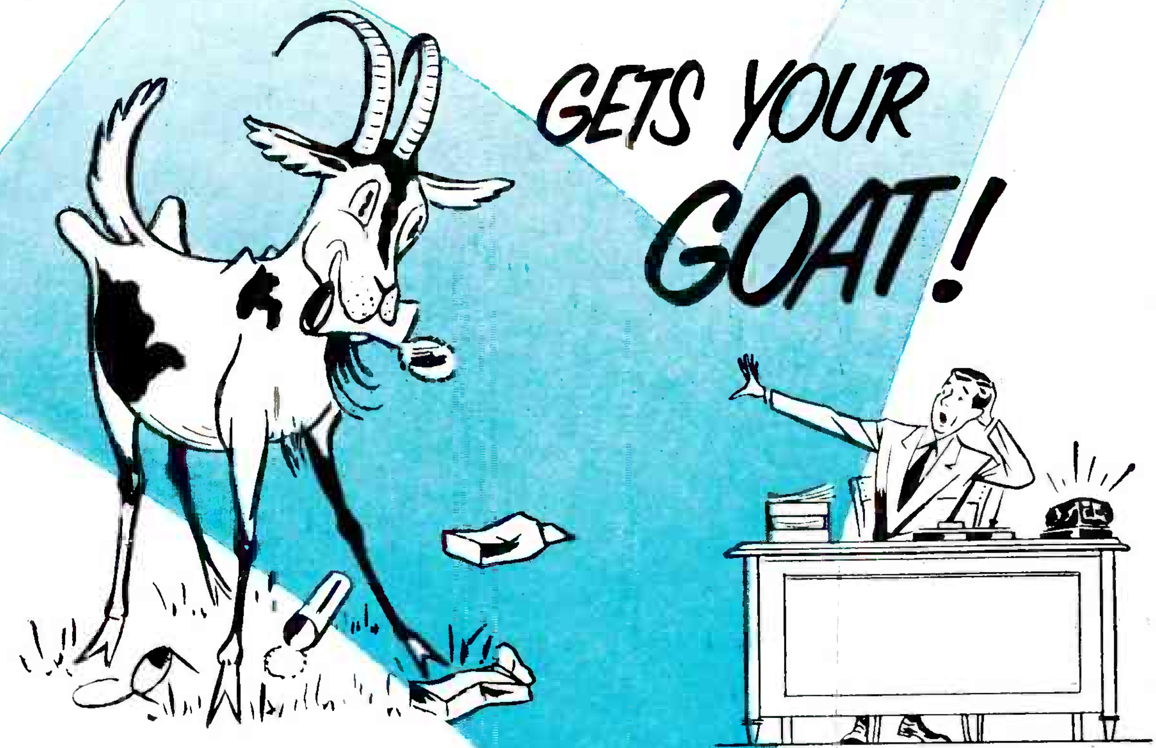

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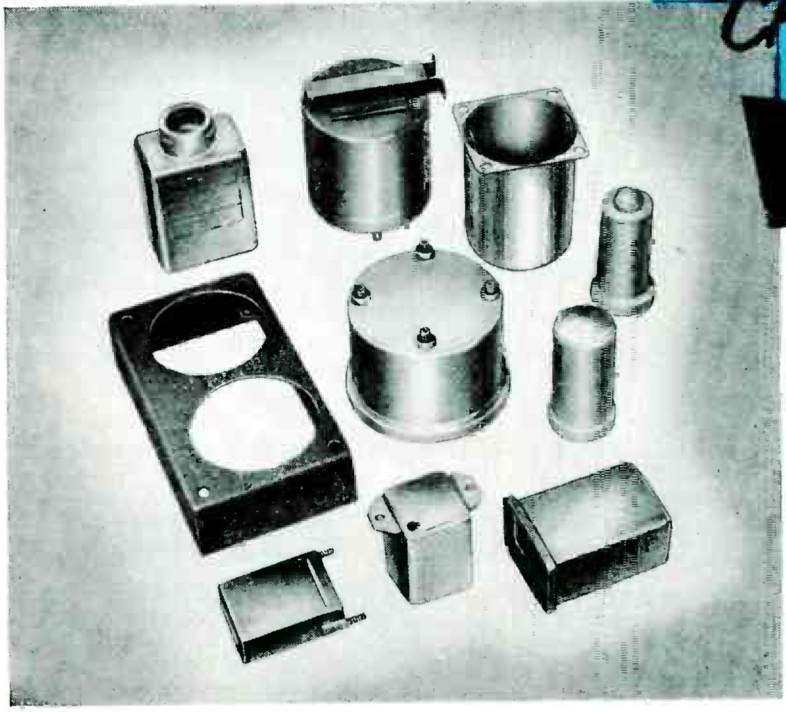

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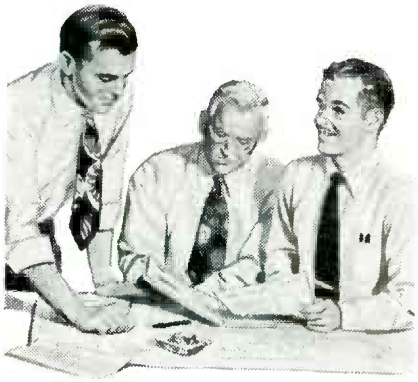

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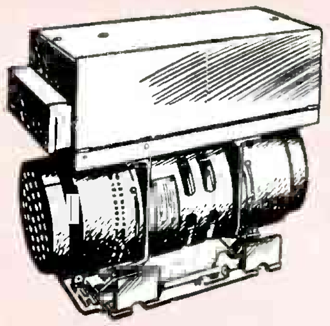

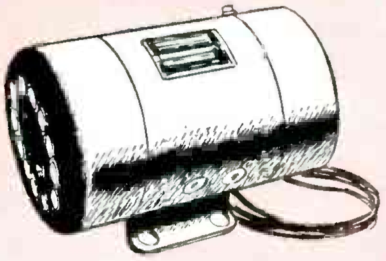

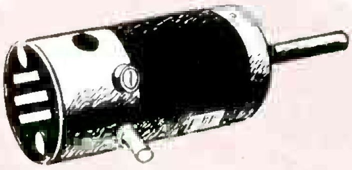

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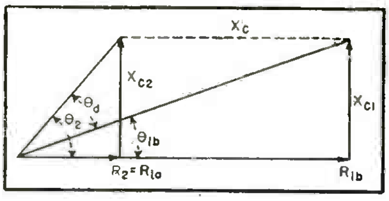

FIG. 2—Figure for determining phase angles

justed with S_1 on MEAS for the same closed elliptical pattern. If a specified phase difference is required for the amplifier, it is easily accomplished by adjusting R_1 for a closed elliptical pattern and then adding or subtracting from C_1, C_2, R_1 or R_2 a sufficient value to give the same closed pattern on MEAS with the phase difference required. For 400-cycle servo systems, workable values for the phase shift circuit are: C_1, C_2 = 0.25 μfd, R_2 = 20,000 ohms, and R_1 = 200,000 ohms.

If the resistance and capacitance values are properly chosen for a particular application, small values of noise or distortion of the wave shapes will have a negligible effect on the measurement of the phase angle. If extremely accurate results are necessary, a wave analyzer may be used to find the relative amplitudes of the harmonics so that the proper correction may be made to give the accuracy desired.

The accuracy of the measurement of phase difference by this method is limited only by the accuracy of measuring basic electrical quantities and the effect of the phase-shift circuit on the phase of the incoming signals, an effect which is small but may be calculated in most applications.

Pre-Cured Tape Resistor

ADHESIVE-TAPE resistors announced in 1951 (ELECTRONICS, Sept. 1951, p 236) required baking the supporting base material to cure the resistors after they were pressed in place. The National Bureau of Standards is now making a precured wire-lead version of the tape resistor which requires no heat curing after placement in the circuit.

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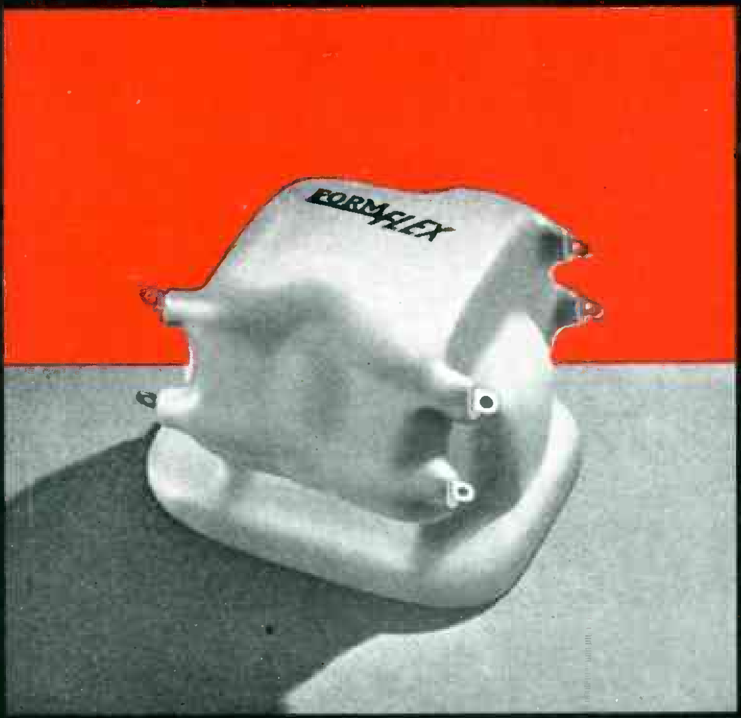

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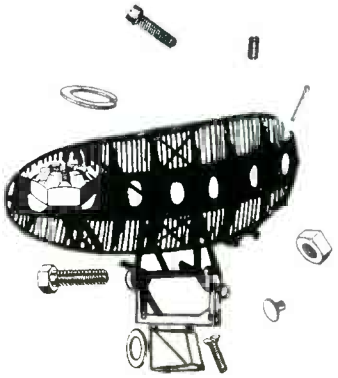

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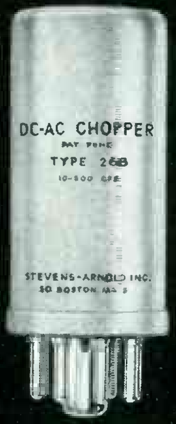

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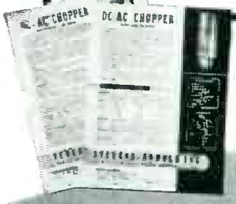

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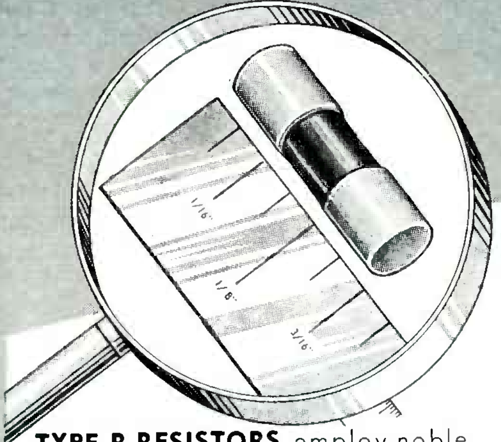

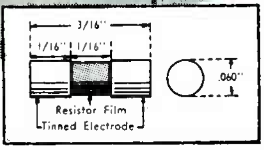

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Terminals: Tinned sections 1/16 inch long
Film Length: Type R-063 — 1/16 inch
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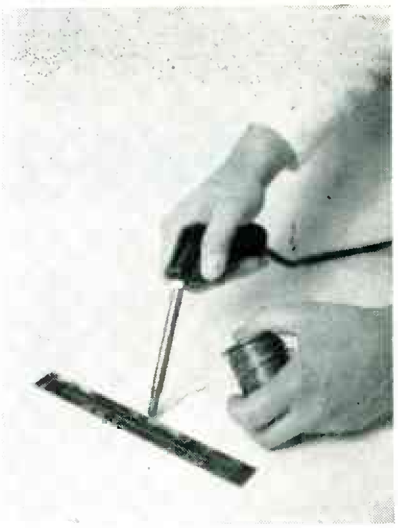

A tape resistor being soldered into place in a printed circuit

pressing uncured resistor tape against both sides of suitable wire or metal-ribbon leads. The leads are sandwiched between two pieces of resistor tape. The units are then given the usual heat cure to bond the resistor tape to the leads. The resistors may be soldered or spot-welded into the circuit.

Leads for the pre-cured tape resistor are made from ribbon of thin silver or silver-plated copper. Over-all length of the resistor is 1½ in.

Leads extend ½ in. beyond the resistor proper. Thickness is about 0.012 to 0.015 in.

Low-Frequency Modulator for Receiver Testing

By Charles R. Ammerman and Robert L. Riddle

*Ass't Professors of Electrical Engineering
The Pennsylvania State College
State College, Pa.*

THE INSTRUMENT herein described was constructed to provide a laboratory source of slowly fading r-f signals.

It was desired to check the speed of response of several recording field-intensity meters and conventional modulation of signal generators at frequencies in the range of 1/10 to 10 cycles was not feasible. It was therefore decided to utilize a

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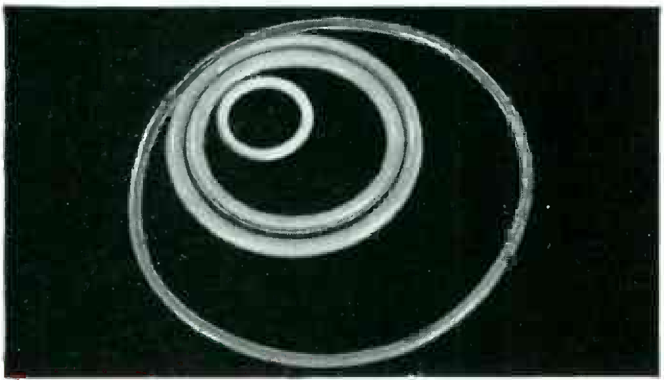
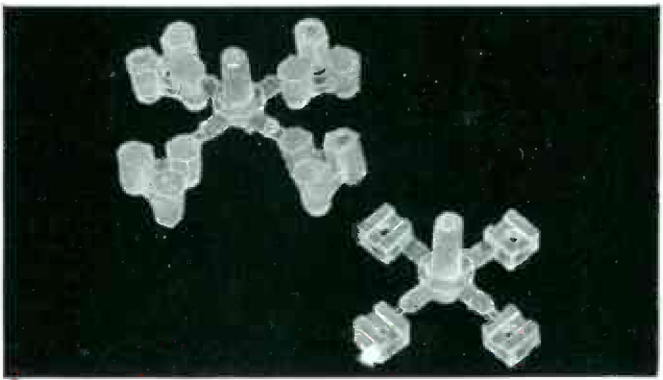
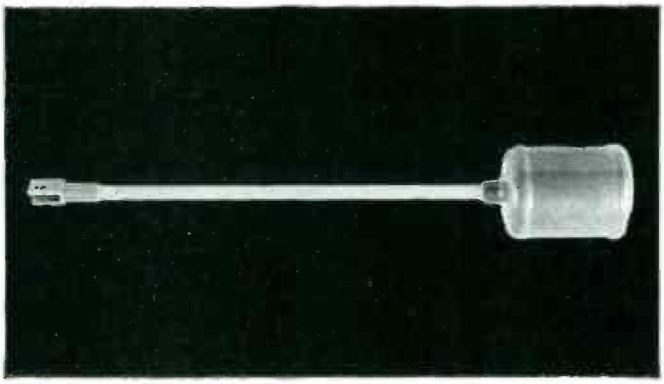


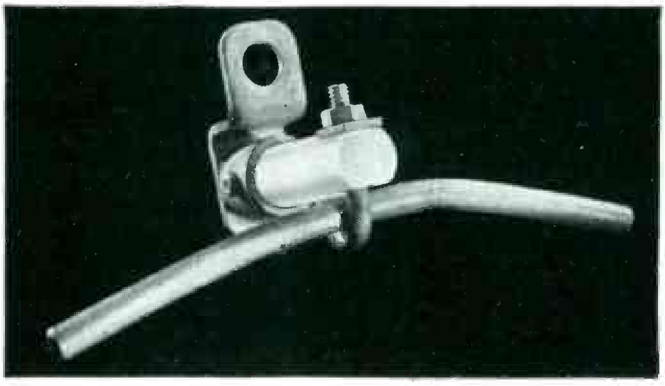
1. These "O" Rings are unusual because Kel-F is molded over a resilient core to provide high corrosion resistance in applications requiring either static or dynamic seals. Kel-F's chemical inertness, its high temperature properties and ready moldability combine to meet the specs for these small but extremely vital pump and compressor parts.



2. A Kel-F exclusive among fluorocarbon-type materials... production molding *by injection*. Indicative of hundreds of similar parts, these components are shown here complete with sprue and runners. Such Kel-F pieces have myriad uses where high dielectric strength, zero water absorption, corrosion resistance and high temperatures are involved.



3. This metal float would be safe even in aqua regia because a dispersion of Kel-F has been applied over its entire outer surface. Kel-F dispersion-coated parts — such as this liquid level gauge float — are currently solving many equipment problems involving corrosives. Kel-F dispersions are available in two basic formulas.



4. When dielectric and mechanical strength must be combined, as in this UHF aerial support, Kel-F extruded and molded rod is a natural specification. In addition to having excellent characteristics in both dielectric and mechanical categories, Kel-F retains those properties over an extreme temperature range of some 700 degrees—from minus 320F to 390F.

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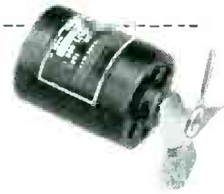

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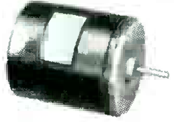

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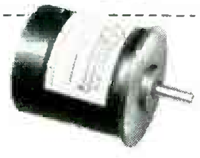
400 cycle, 60 cycle, single and poly phase, 2 to 8 pole. Frame diameters: 1.45″, 1.75″, 2″, 2½″ & 3-5/16″. *Output torque range: ½ in. oz. to 50 in. oz.*



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400 cycle, 60 cycle, hysteresis and reluctance types. Single and poly phase: 2, 4 and 6 pole. Frame diameters: 1.45″, 1.75″, 2″, 2½″, 3-5/16″. *Output torque range: .01 in. oz. to 10 in. oz.*

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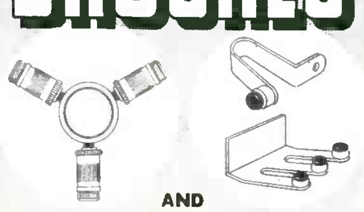
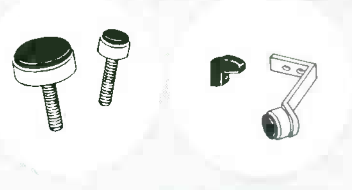


AND

CONTACTS



. . . for applications requiring low electrical noise, low and constant contact drop, high current density and minimum wear.

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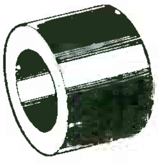

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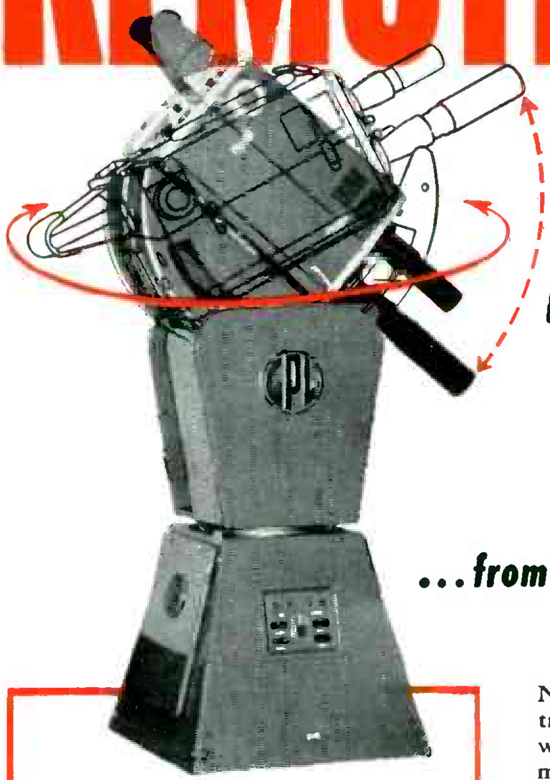
Again GPL *Leads the field with* FULL
REMOTE CONTROL



TV's OUTSTANDING CAMERA CHAIN

provides **PAN**
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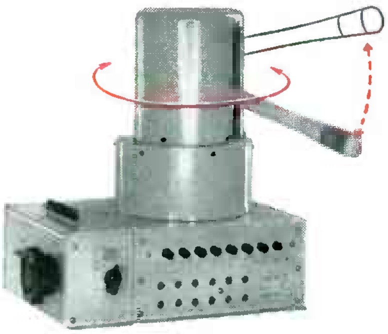
LENS change
IRIS adjustment

...from 1000 feet away...



Now, with the GPL Remote Control Pedestal, your cameraman can work at full efficiency a fifth of a mile from his camera . . . make any lens or focus adjustment instantly . . . control pan and tilt with a pan handle that works as if it were physically attached to the camera . . . or, at the touch of a button, swing the camera to any of six pre-set positions, with lens and focus automatically correct. As with all GPL camera chains, the CCU operator has full control of iris setting to assure finest picture reproduction.

This remote control makes possible the location of cameras where they could never be placed before—for better coverage in auditoriums, at sports events, in the center of "round-table" discussions. For military or industrial use it offers outstanding advantages.

Use Remote Control Now— or install it later

All GPL cameras are adaptable to the new remote control pedestal, yet there is no cost premium. Equip your studios now with TV's finest camera chain, add remote control at any time later on. Before you make any camera investment, be sure to investigate GPL—the industry's leading line, in quality . . . in design.

Compare

THESE CAMERA FEATURES WITH ANYTHING ON THE MARKET TODAY

- Three Compact Units
- Equal Flexibility in Studio or Field
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- Right or Left Hand Focus Knobs
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for specifications and complete details on GPL cameras and GPL remote control.

General Precision Laboratory GPL
INCORPORATED
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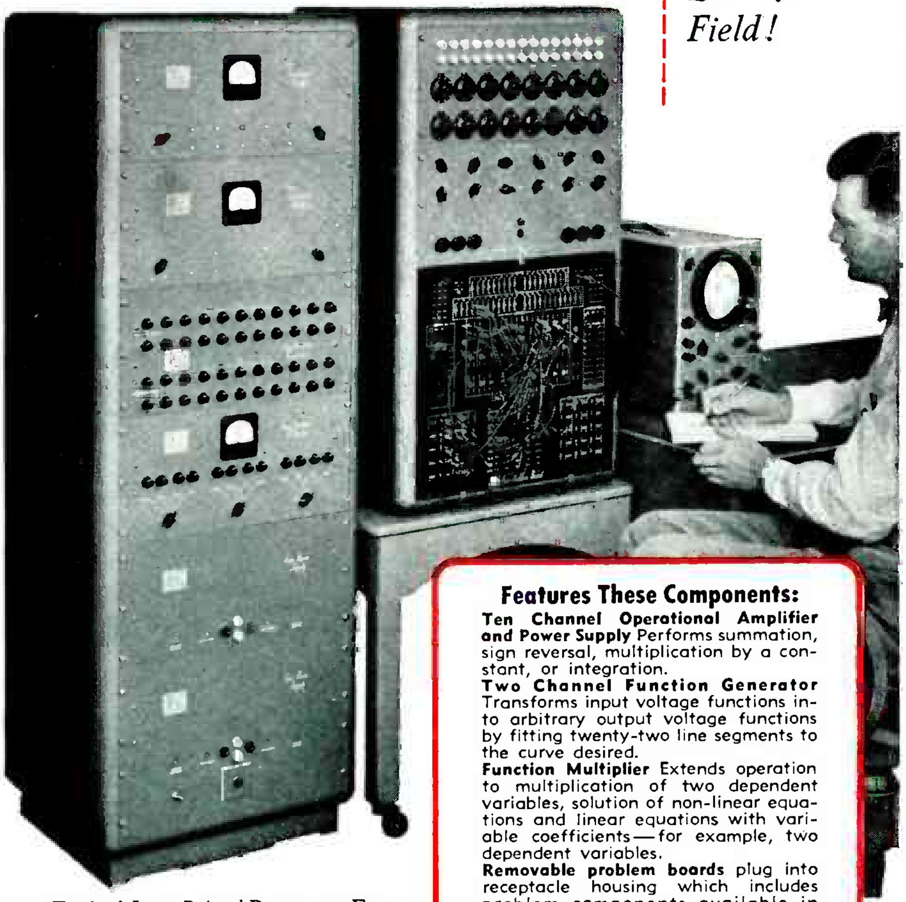

Announcing: the Beckman EASE COMPUTER

Lowest Priced Computer in the Quality Field!

Features These Components:
Ten Channel Operational Amplifier and Power Supply Performs summation, sign reversal, multiplication by a constant, or integration.
Two Channel Function Generator Transforms input voltage functions into arbitrary output voltage functions by fitting twenty-two line segments to the curve desired.
Function Multiplier Extends operation to multiplication of two dependent variables, solution of non-linear equations and linear equations with variable coefficients—for example, two dependent variables.
Removable problem boards plug into receptacle housing which includes problem components available in standard or custom arrangements.
Basic 10-channel amplifier and power supply unit, the heart of any analog computer, can be purchased for little more than $1,000. Additional 10-channel units and other special components offered at correspondingly low prices.

Typical Low Priced BECKMAN EASE COMPUTER *Installation showing 20-channel operational amplifier and power supply, 2-channel function generator, 3-channel function multiplier, typical variable component and over-voltage panel, 30-channel problem board.*

The New EASE Computer, manufactured by Beckman Instruments, Inc., is specifically designed to meet the growing demand for an Analog Computer which is low in cost and yet flexible enough to be successfully utilized by design engineers in every industrial, military, research and educational group working on problems of dynamics.

EASE* Computers are already effecting tremendous savings of time and money in a number of varied applications. A leading manufacturer of jet aircraft is using the Beckman EASE Computer as a flight simulator to prove design still on the drawing board. Several engineering and research organizations have found the computer indispensable in the study of guided missiles. And the Automatic Factory of Tomorrow may soon become a reality as universities throughout the country study the problem of "fully automatic control" with the aid of such computers.

By far the lowest priced quality instrument in the field, the Beckman EASE Computer is the ideal equipment for use as an equation solver, simulator or tester. The unitized design employing compact rack-mounted components permits the user to select a custom computer which meets his particular requirements.

Write for detailed literature which describes the EASE *Computer and its applications in greater detail. Ask for Data File 17-59.*

**Electronic Analog Simulating Equipment*

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resonant circuit with variable tuning, connected in the line from signal generator to receiver so that it would act as a variable attenuator as the tuning varied up and down the side of the resonance curve.

As the carrier frequency of interest was approximately 100 mc, a coaxial resonator was chosen. Tuning is accomplished by two means, the first being a screwdriver-adjustable trimmer for main tuning and the second a butterfly capacitor using a single rotor plate which is driven by a motor. The motor used is a small 24-v d-c motor with speed reduction gearing. The rated shaft speed is 250 rpm. Power at variable voltage is supplied by a Variac and a 250-ma selenium rectifier.

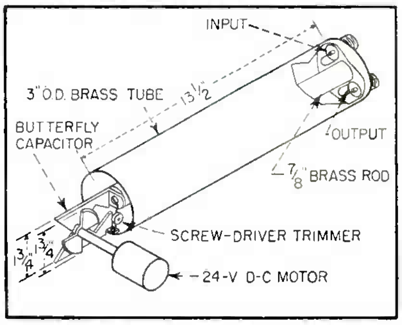


Fig. 1—Low-frequency modulator for receiver testing

Figure 1 shows the physical construction of this model. None of the dimensions is critical. The degree of modulation depends upon the amount of variation of capacitance and for that reason minimum spacing is desired in the motor-driven capacitor.

Input and output are connected to wire loops, in a radial plane, situated at the closed end of the resonator. No special attention was given to these couplers, which were simply made a convenient size, about ⅜ in. by ¾ in. In this application neither the impedance match nor insertion loss (about 40 db) seemed important since the signal generator had enough power. A resistance T pad giving 18-db attenuation in a 50-ohm line was used between the signal generator and resonator to minimize any frequency modulation that might be

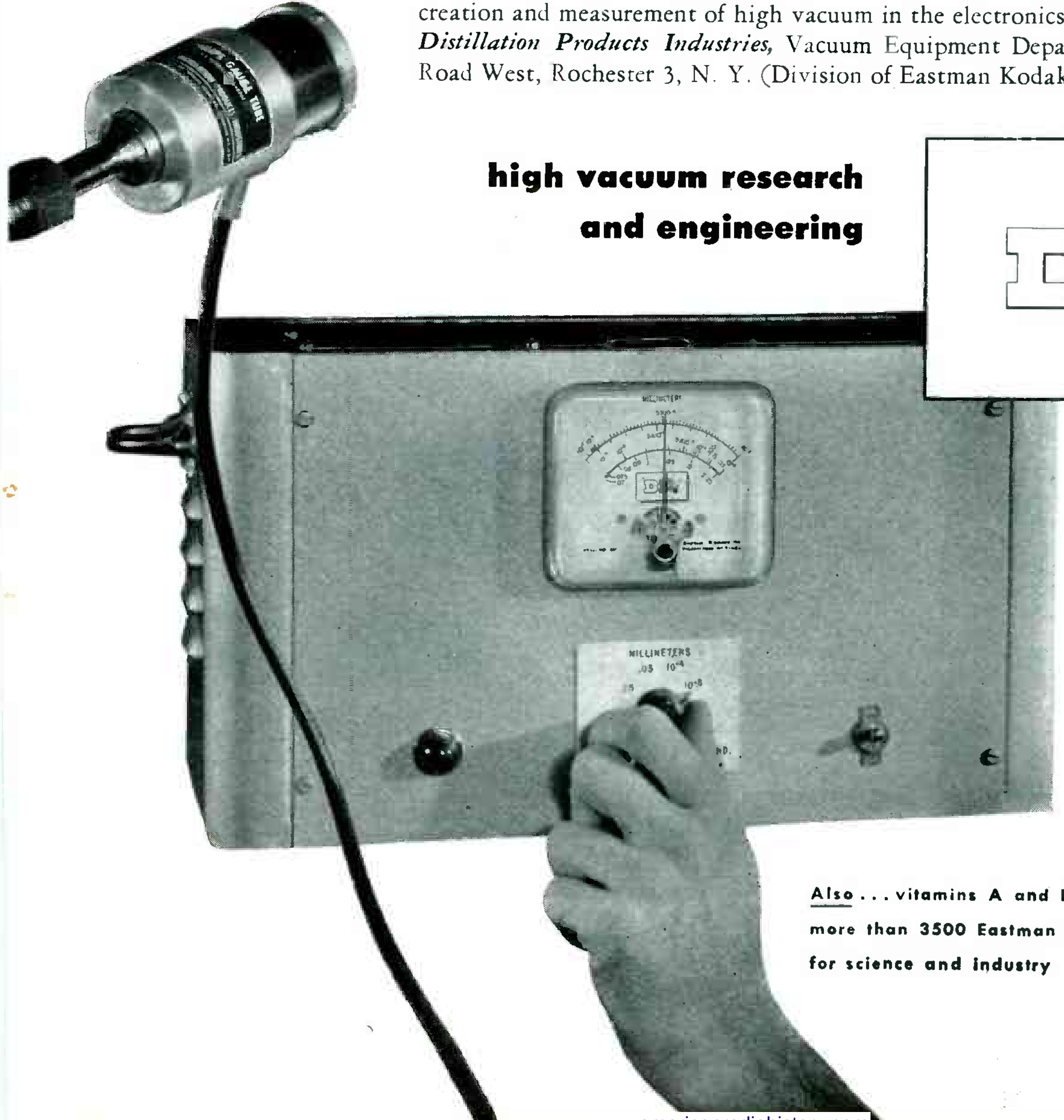
This new Vacuum Gauge

covers a range of 5,000,000:1 on a single meter from a single pickup

It's the DPi Philips Gauge, Type PHG-09, a remarkable new instrument developed by DPi high vacuum research. Here are the basic facts about it:

- A single meter covers the entire range from 0.50 mm to 10^{-7}mm Hg.
- A single all-metal pickup tube handles this range. It works on the glow discharge principle. Permanent magnets provide a field which lengthens the electron paths into tight spirals that give high ionization per electron, with a cascade effect.
- Having no filament to burn out, the tube can be operated at full atmosphere without damage, and the circuit is insensitive to fluctuations in the line voltage.
- With the magnets external to the ionization chamber, there is no problem of outgassing them or removing stray iron particles.
- Self cleaning, the tube at the higher pressures in the low sensitivity range automatically rids itself of deposited film because polarity is reversed.

This new Philips gauge is now being used in DPi exhaust machinery where close control of pressure is required. For information on this or any equipment for the creation and measurement of high vacuum in the electronics industry, write to *Distillation Products Industries,* Vacuum Equipment Department, 727 Ridge Road West, Rochester 3, N. Y. (Division of Eastman Kodak Company).



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DPi

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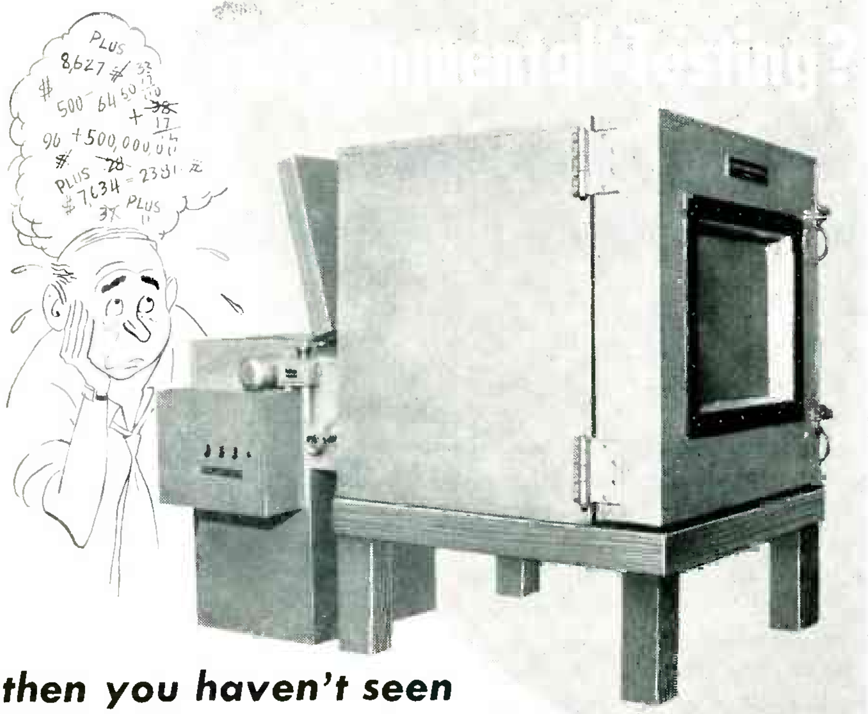
more than 3500 Eastman Organic Chemicals
for science and industry

no room in your budget for



then you haven't seen

the Tenney SERVO UNIT and COMPANION TEST CHAMBER

Accurate environmental testing, for a wide variety of controlled atmospheric tests, is within the reach of *all* industrial budgets. The cost is well under $2,000 for the majority of industrial needs.

The Tenney Servo Unit, a portable air-conditioning system, provides broad variations of heat, cold, and/or humidity for aging and weathering test programs. Air is circulated at the rate of 40 cu. ft. per min., capable of absorbing 1700 B. T. U. per hour at − 100°F., or of delivering 5000 B. T. U. heating effect at a maximum temperature of + 185°F. Relative humidity can be maintained from ambient to 95% in a temperature range of ambient to + 180°F. in 40 cu. ft. of recirculated air. Low temperature operation requires 10 lb. of dry ice per hour at − 180°F., ¾lb. per hour static.

SPECIFICATIONS

Model	Size	Wgt.	Dry Ice Capacity	Total Temp. Range	Electric Req'mts.
TSU-50	17"x17"x31"	165 lb.	50-70 lb.	− 100°F. to + 200°F.	2 kw.
TSU-150	21"x25"x33"	200 lb.	150 lb.	− 100°F. to + 200°F.	2 kw.

The Tenney Companion Test Chamber provides an efficient test work-space when attached to the Tenney Servo Unit either horizontally or vertically, by a simple, sturdy device. (Servo is easily detached for use with other enclosures or tests.) Ruggedly constructed and fully insulated, this chamber is built in three sizes of work space, stainless-steel lined: 3 cu. ft. (18" x 18" x 18"), 8 cu. ft. (24" x 24" x 24"), and 27 cu. ft. (36" x 36" x 36"). Forged brass hardware is provided. Complete vaporproofing is achieved by special gaskets. Optional equipment includes multi-paned viewing window in door, electrical connector panel, turning shafts, coaxial cable, utility ports, and high-voltage terminals.

For further information and prices write:

Tenney
ENGINEERING, INCORPORATED
Dept. A, 26 Avenue B, Newark 5, N. J. 8584

Los Angeles Representative: GEORGE THORSON & CO. Chicago Representative: SPARTON ENGINEERING CO.

Engineers and Manufacturers of Automatic Environmental Test Equipment

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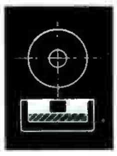
Sapphire... Glass...

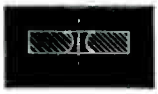
PRECISION Jewel Bearings

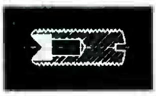
by Bird



At your service, for all small bearing problems, the Bird Company engineering staff designs accurate sapphire and glass jewel bearings used in the world's most famous aircraft, electrical and timing instruments; weather and all types of recorders; and fine indicating apparatus.

Close tolerances, accuracy, and long life qualify Bird Jewel Bearings to insure quality in your finest instruments. Quotations on request for jewels made to specifications for your individual requirements.





The engineering staff of the Bird Company is at your service for all small-bearing problems.

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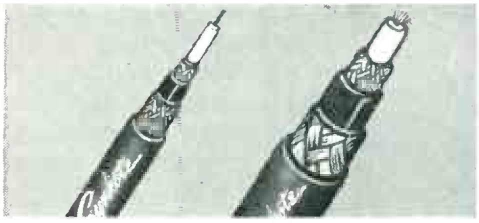
New Radiation-proof Coaxial Cables Give Proven Performance in Community TV Systems

RESIDENTS of mountain areas enjoy watching TV as much as anybody else — when they can receive a clear picture. Since most mountain towns are situated in valleys, however, the surrounding mountain ridges usually prohibit direct reception, and some form of "community antenna system" must usually be installed.

One of the world's largest manufacturers and installers of community systems is Jerrold Electronics Corporation of Philadelphia. In a Pennsylvania mountain installation, Jerrold field engineers discovered that ordinary coaxial cable (RG-11/U and RG-59/U) simply was not adequate. Picture quality was far from satisfactory. And the necessarily long lines called for cable with tensile strength greater than was then available.

To help solve the two problems, Plastoid engineers were called in, and succeeded in developing SYNKOTE coax cables that gave exceptional signal strength and clarity even in the most difficult terrain.



RG-59/U—double shield and jacket. Code: PP-3398. Put up in 1,000′ reels.

RG-11/U—double shield and jacket. Code: PP-3512. Put up in 1,000′ reels.

These new SYNKOTE coaxials (RG-11/U and RG-59/U) are *double*-shielded and *double* jacketed. The tensile strength is exceedingly high; and the cables are tough, rugged, and absolutely *radiation-proof* under normal conditions.

Today, Jerrold Electronics is one of many such companies that rely with confidence on SYNKOTE cable. Having run a number of tests both in their labs and also in actual installations, Jerrold enthusiastically reports that SYNKOTE double jacketed, double shielded coaxial cables are "absolutely radiation proof", and "definitely the answer for Community Antenna Systems".

CABLE PROBLEM BOTHERING YOU?

Plastoid's engineering staff will gladly work with you in developing wire and cable to fit your needs. Write, call, or mail the coupon!

Synkote®

DEPENDABLE
Coaxial Cable
"Made by the mile — tested by the inch"

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☐ Send samples and technical data on your double-shield, double-jacket coax cables (PP-3398 and PP-3512).

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caused by variations in loading.

Using this device, response to fast fading was readily measured. To obtain maximum modulation index, the screw-driver tuning should be set so that the line is in resonance when the motor tuning capacitor is at maximum or minimum. If the motor tunes the circuit through resonance, a double frequency component will result.

Modulation index may be reduced by setting the screw-driver trimmer farther from resonance. It should be noted that one revolution of the motor causes two fading cycles. Frequency was measured by counting the number of cycles drawn on a unit length of the recorder chart.

Work on this device was carried out under contract with the National Bureau of Standards. The help of Donald Brumbaugh in constructing the model is acknowledged.

Neon Diode Couples Control Circuit

CASCADED POWER SUPPLIES and special biasing voltages are eliminated by use of a neon diode to connect the plate circuit of a controlling multivibrator directly to the grid circuit of a controlled power tube.

A schematic diagram of the circuit is shown in Fig. 1. The load and limiting resistor for D_2 is R_6. This resistor also serves as the grid input resistor for the controlled vacuum tube V_2. When the right-hand plate of V_1 is drawing cur-

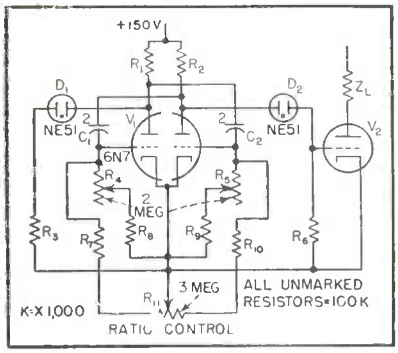
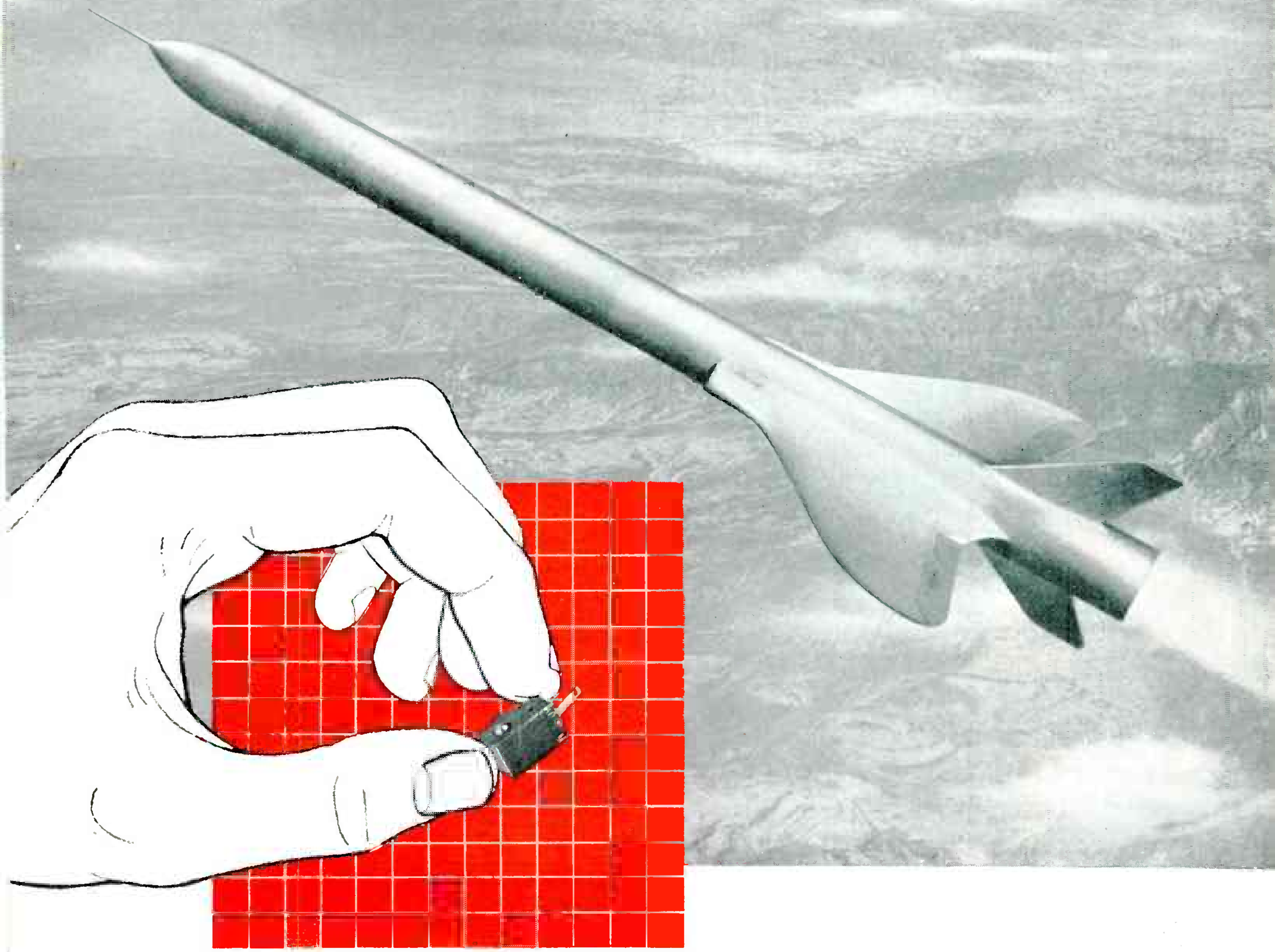


FIG. 1—Schematic diagram of control circuit



LOOKING FOR TROUBLE

This is an aircraft scale model in free flight. Its flight characteristics are being accurately tested — the information being picked up by a subminiature potentiometer which is smaller than your thumbnail!

Developed by Bendix-Pacific to measure wing deflection, this potentiometer has proved an important factor for the Douglas Aircraft Company in making practical free flight testing of scale models — a program which has substantially reduced the cost and time of obtaining precise aerodynamic information.

This company's leadership in airborne electronics is attested by the great number of Bendix-Pacific electronic units efficiently serving vital functions in present-day aircraft and guided missiles. Bendix-Pacific standard telemetering assemblies, radar equipment, radio-control systems and electronic servo components are recognized for their advanced design, ultra-compactness and reliability.

Your company, too, can profit from the many years of diversified experience built into every piece of electronic equipment bearing the Bendix-Pacific nameplate.

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Hermetic sealing meets all MIL-T-27 specs. Steel base cover is deep-seal soldered into case. Terminals hermetically sealed. Ceramic bushings. Stud-mounted unit.

there's nothing tougher than CHICAGO'S "Sealed-in-Steel" construction

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Free "New Equipment" Catalog

Get the full details on CHICAGO'S *New Equipment Line*—covering "Sealed-in-Steel" transformers for every modern circuit application. Write for your Free copy of this valuable catalog today, or get it from your distributor.

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In view of this, Driver-Harris is particularly gratified to have Resistance Products state: "Reflecting our experience with Driver-Harris alloys is our large use of Karma wire. Currently, we are employing Karma for numerous critical applications where utmost stability, together with high resistivity and low temperature coefficient of resistance, is requisite. *Consistently excellent results* are being obtained. We have, in fact, used Karma with outstanding success ever since its introduction several years ago. It is our belief the development of this alloy constitutes a major forward step."

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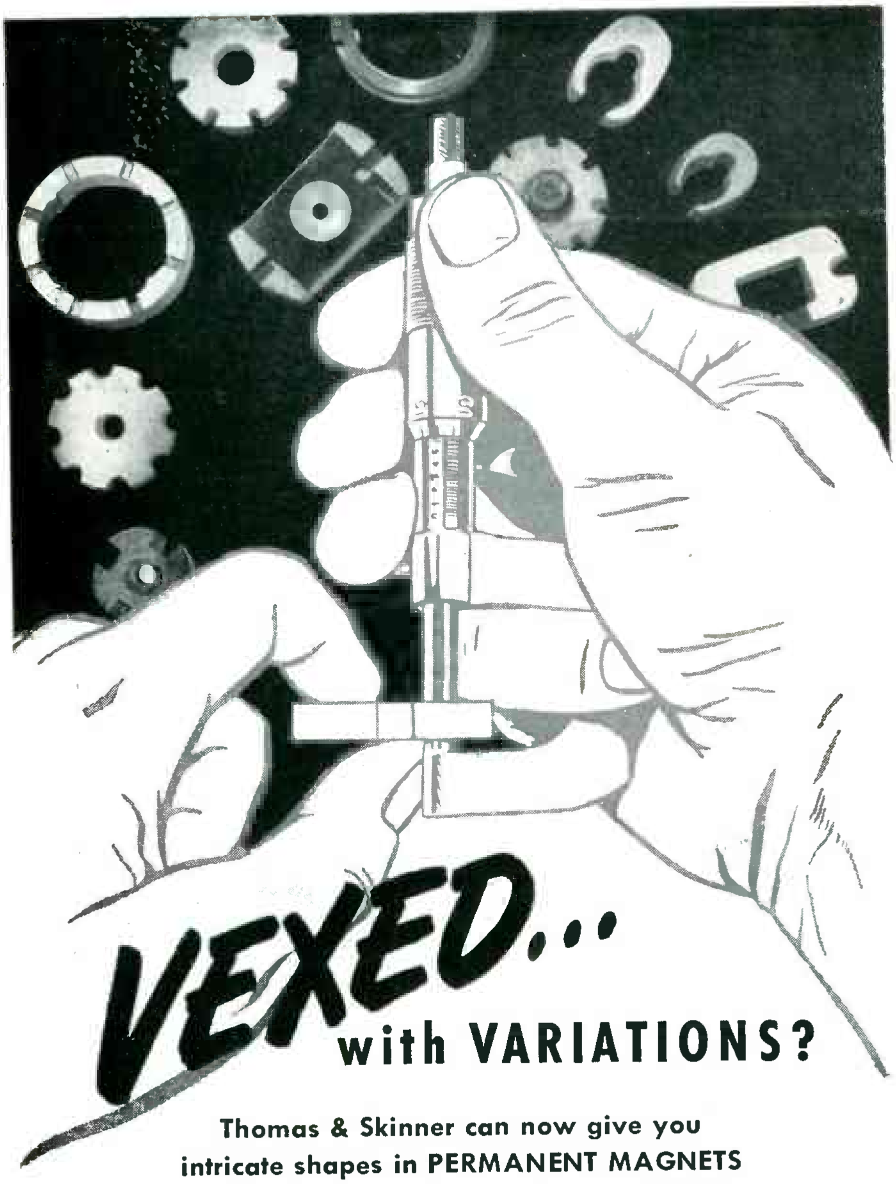

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Thomas & Skinner can now give you intricate shapes in PERMANENT MAGNETS with tolerances often as close as ±.005″
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Now your engineers can specify the intricate casting shapes—with sharply defined relief—which in the past have been too difficult or too expensive to produce. Through radically new techniques, Thomas & Skinner permanent magnets are cast with such close precision that little or no grinding and finishing is required for dimensional accuracy.

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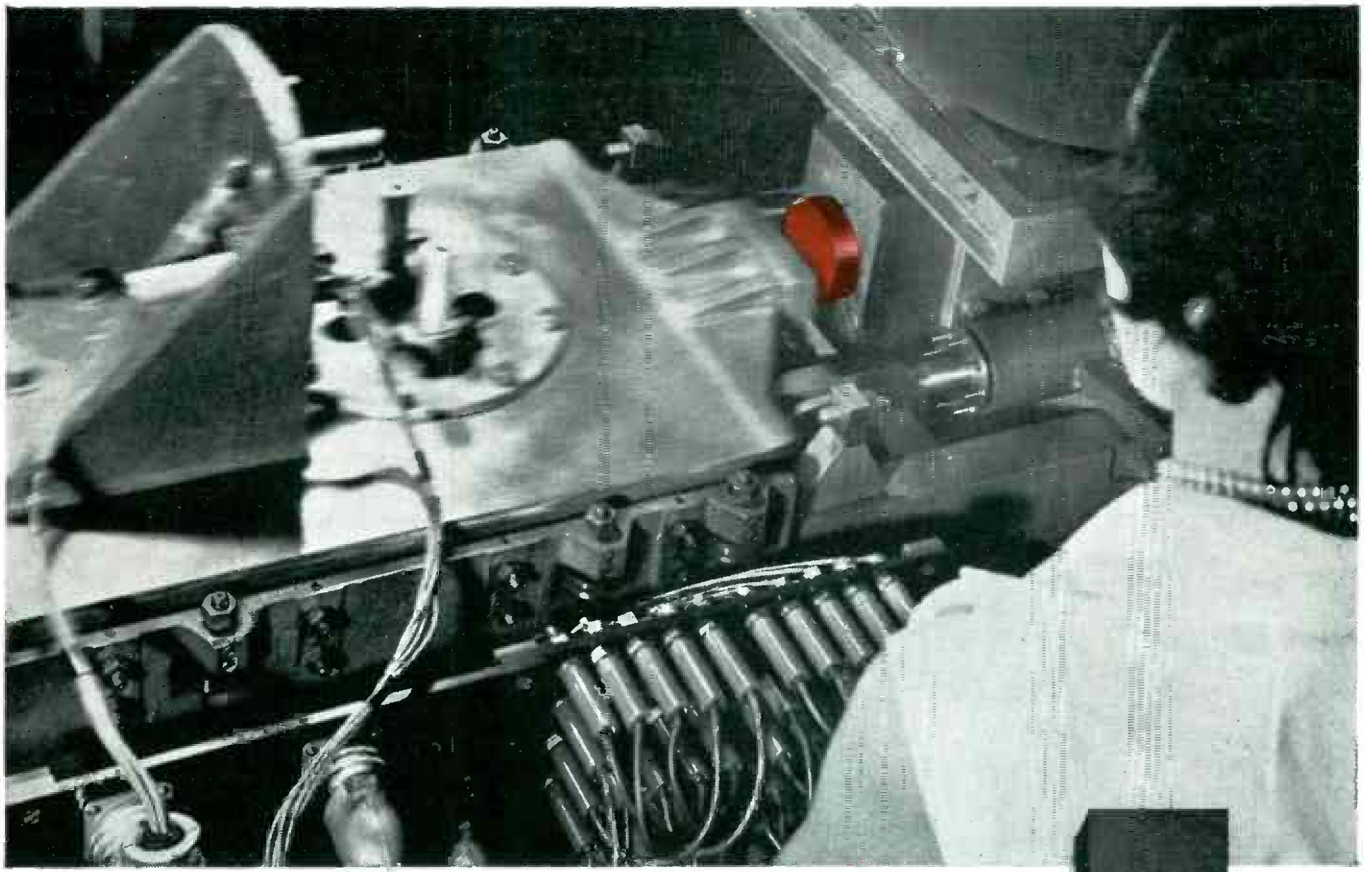
THE MAN WE MEAN IS A COMPOSITE of the editorial staff of this magazine. For, obviously, no one individual could ever accomplish such a vast business news job. It's the result of many qualified men of diversified and specialized talents.

AND, THERE'S ANOTHER SIDE TO THIS "COMPOSITE MAN," another complete news service which complements the editorial section of this magazine — the advertising pages. It's been said that in a business publication the editorial pages tell "how they do it" — "they" being all the industry's front line of innovators and improvers—and the advertising pages tell "with what." Each issue unfolds an industrial exposition before you — giving a ready panorama of up-to-date tools, materials, equipment.

SUCH A "MAN" IS ON YOUR PAYROLL. Be sure to "listen" regularly and carefully to the practical business information he gathers.

McGRAW-HILL FOR BUSINESS

McGRAW-HILL PUBLICATIONS



Four Tung-Sol Electron Tubes receive a terrific jolt as the heavy steel battering ram smashes against the movable table on which they are mounted. With an acceleration up to one thousand times the pull of gravity, this testing machine can give tubes a wicked beating.

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The ruggedized feature embodied in Tung-Sol Tubes for radio, TV and special industrial applications means top performance, longer and more efficient service life, plus lowest maintenance. So, for whatever purpose you use electron tubes, you'll find greater satisfaction with Tung-Sol Tubes and Tung-Sol Service.

Write for sales or engineering information, or for the name of the Tung-Sol distributor nearest you.

TUNG-SOL ELECTRIC INC., Newark 4, N. J.
Sales Offices: Atlanta · Chicago · Culver City
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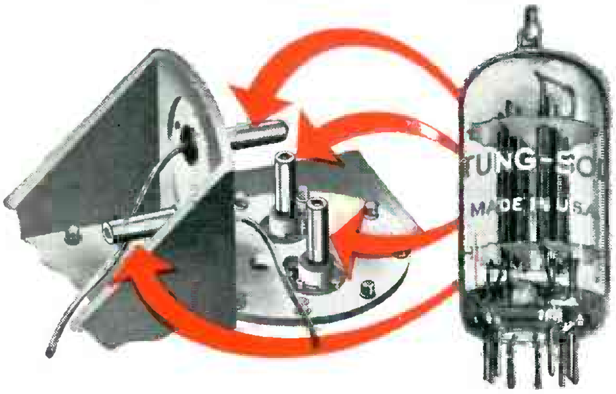

The four tubes are mounted in different positions to determine stability in all directions. Each tube is wired to a control panel where any electrical damage is recorded by indicator lights.

TUNG-SOL ELECTRON TUBES

RUGGEDIZED for Rugged Service

Tung-Sol makes All-Glass Sealed Beam Lamps, Miniature Lamps, Signal Flashers, Picture Tubes, Radio, TV and Special Purpose Electron Tubes.

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Magnet wire cannot be judged by externals. Hidden manufacturing variables quickly show up in the winding room . . . on the test rack . . . or out in the field.

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company's standard cameras are provided with remote control of iris from the camera control unit.

A simplified remote-control device for lens change and focus is available already in normal studio or field operation but with the new system, all camera functions are centered at the control point for remote operation.

The improved system used in the remote-control pan and tilt pedestal is similar to that used for focus control. For example, when the tilt handle is moved, a potentiometer is also moved. The potentiometer has about 200 volts across it at 60 cycles. The wiper picks off a portion of this voltage, representing an error voltage when compared with an answering potentiometer on the tilt head of the pedestal, and feeds it to an amplifier containing push-pull 6L6's. The output is transformer-coupled to a servo suitably geared to drive the tilt section of the pedestal. The pan arrangement is similar.

Maximum pan to right, of new pan-and-tilt pedestal. Total pan is 250 deg

The unit may be shifted instantly to any of six preset positions by pushing a button at the control station. This allows the six positions to be predetermined before a telecast and then selected instantly at appropriate times during the actual program.

Rate control of pan and tilt is

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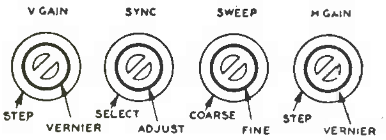
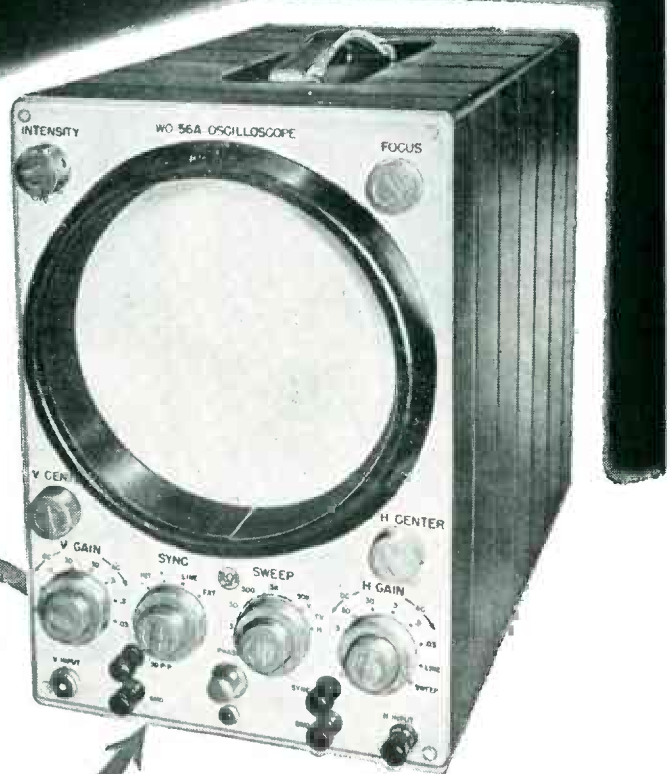
The 7" TV scope for professionals

RCA WO-56A

DUAL CONTROLS FOR "COARSE" AND "FINE" ADJUSTMENTS



No hunting or fumbling for controls when adjusting Vertical Amplifier Gain, Sweep Frequency, Sync Injection, and Horizontal Amplifier Gain.



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$217.50

Suggested User Price

Complete with direct probe, 10-megohm low-capacitance probe, and ground cable.

FEATURING—

- Giant, 7-inch cathode-ray tube.
- Direct-coupled, 3-stage, push-pull, vertical and horizontal amplifiers.
- Frequency-compensated and voltage calibrated attenuators on both amplifiers.
- A set of matched probes and cables. Panel-source of 3 volts peak-to-peak calibrating voltage.
- Identical vertical and horizontal amplifiers with equal phase-shift characteristics.
- Retractable light shield for convenience and visibility.
- New *green* graph screen with finely ruled calibrations.
- Magnetic metal shield enclosing CR tube to minimize hum-pickup from stray fields.

SPECIFICATIONS—

- Deflection Sensitivity: 10 rms millivolts per inch.
- Frequency Response: Flat within -2 db from dc to 500 kc; within -6 db at 1 Mc useful response beyond 2 Mc.
- Input Resistance and Capacitance: 10 megohms and 9.5 uuf with low-capacitance probe.
- Square-Wave Response: Zero tilt and overshoot using dc input position. Less than 2% tilt and overshoot using ac input position.
- Linear Sweep: 3 to 30,000 cps with fast retrace.
- Trace Expansion: 3 times screen diameter in vertical and horizontal axis, with 3 times centering control.
- Size 13⅜" h, 9" w, 16⅜" d. Weight only 31 pounds (approx.).

ADVANCED SWEEP FACILITIES—

- Preset fixed sweep positions for vertical and horizontal television waveforms.
- Positive and negative syncing for easy lock-in of upright or inverted pulse waveforms.
- 60-cycle phase-controlled sweep and synchronizing.

Built for laboratory, factory, or shop use, the WO-56A combines the advantages of high-sensitivity and wide-frequency range in a *very small* instrument with a *large* cathode-ray tube.

Designed with the user in mind, this new 'scope can be depended upon to provide sharp, bright, large, and accurate pictures of minute voltage waveforms over the entire useful surface of the CRT screen.

The direct-coupled amplifiers are provided with ac positions so that measurements can be made with or without the effects of any dc component.

Square-wave reproduction is excellent, whether the application is low-frequency TV sweep-alignment or observation of high-frequency steep-fronted sync and deflection waveforms.

The excellent linearity and fast retrace of the sweep or time base are functions of the Potter-type oscillator and the undistorted reproduction of the sawtooth by the wide-band horizontal amplifier. The preset fixed positions provide rapid switching between vertical and horizontal waveforms in TV circuits.

Truly, the WO-56A is a most useful and practical instrument for everyday work in the fields of television, radio, ultra-sonics, audio, and a wide array of industrial applications.

For details, see your **RCA Distributor**, or write RCA, Commercial Engineering, Section IX42, Harrison, N. J.

RADIO CORPORATION of AMERICA

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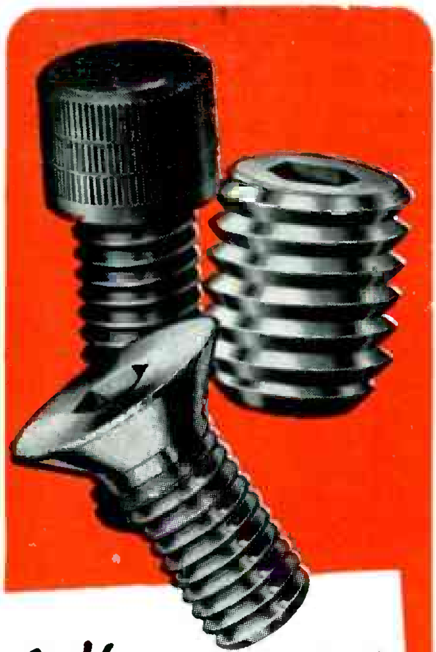

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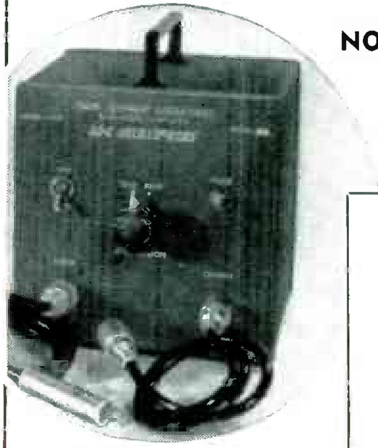

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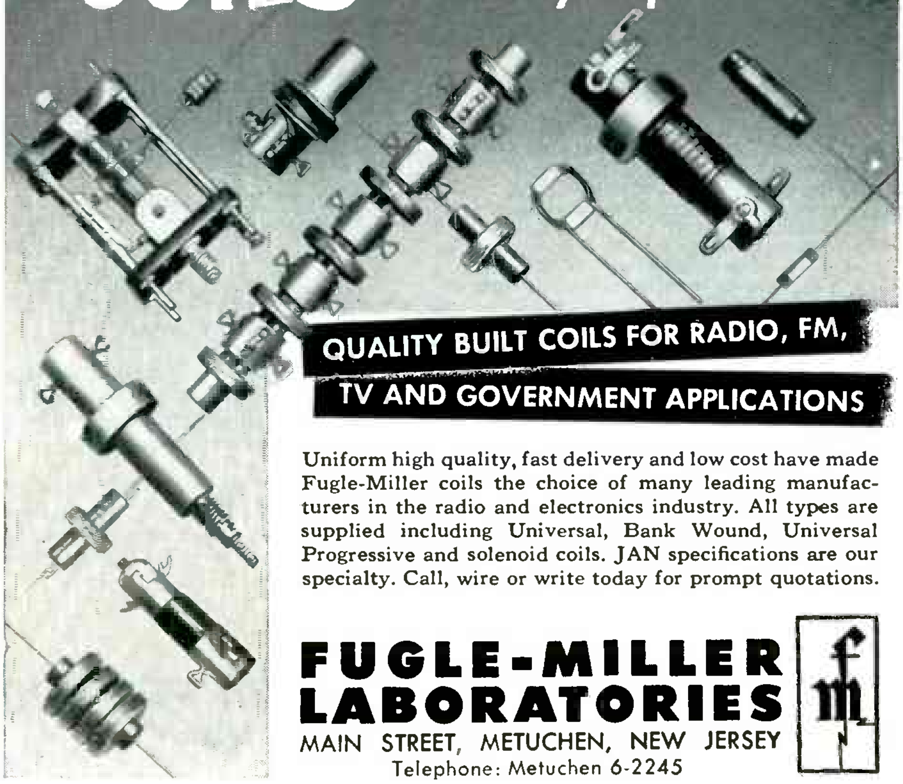

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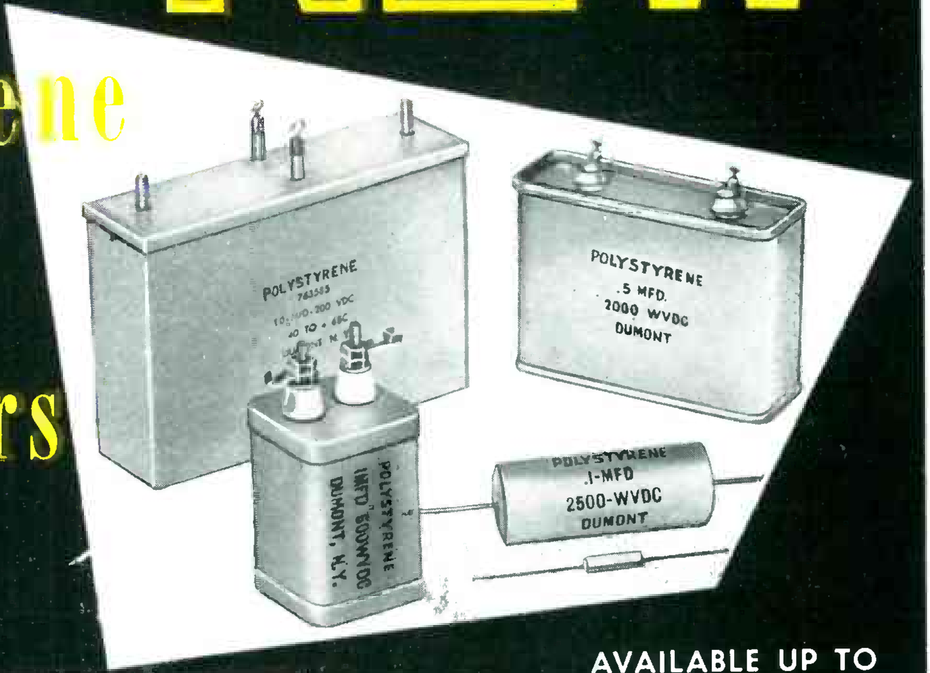

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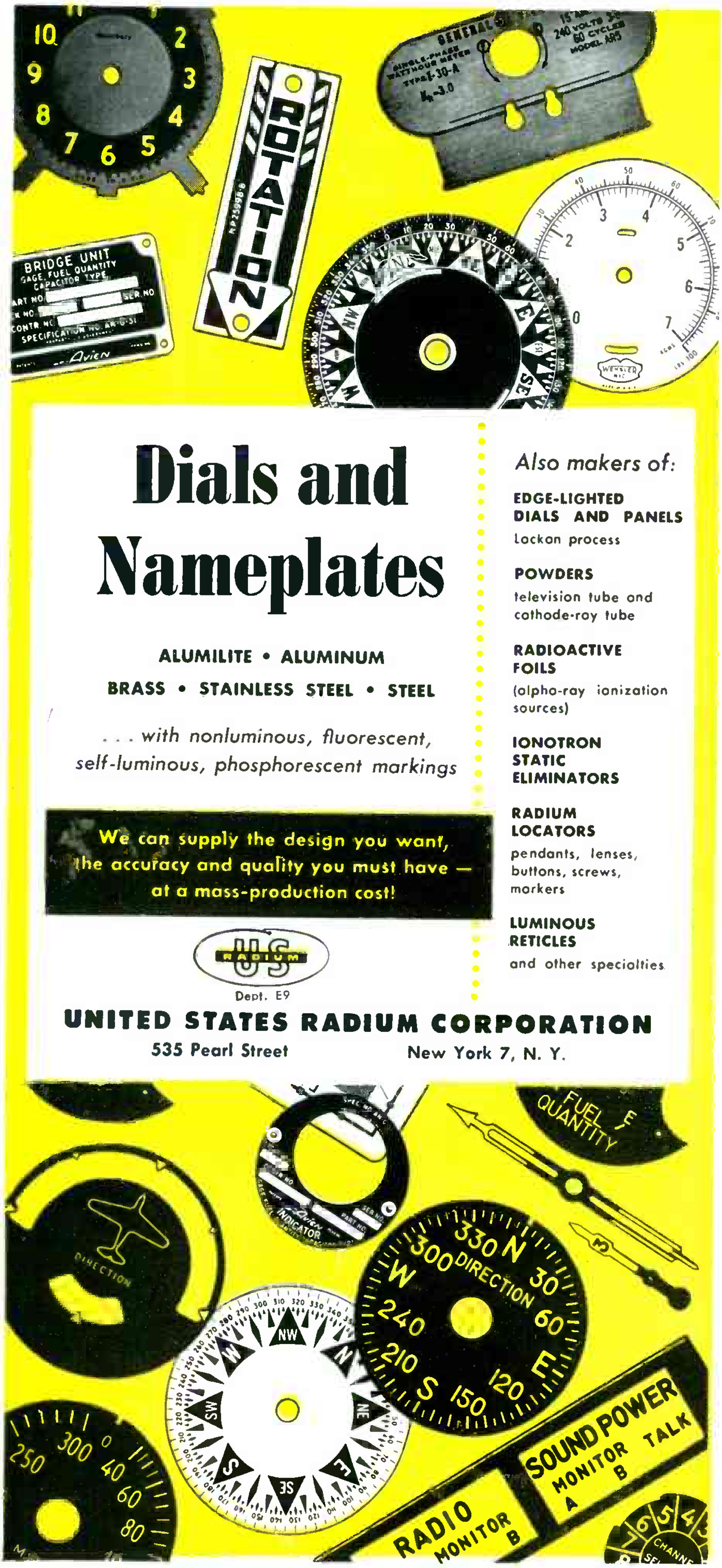

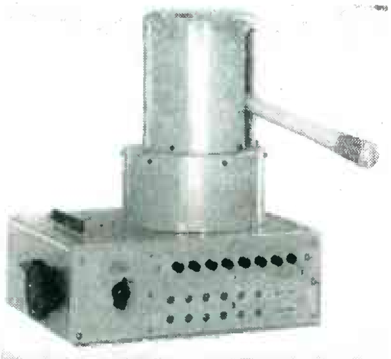

Remote-control box showing buttons and screw-driver adjustments for six preset positions. With this unit, operator controls pan and tilt, lens selection and focus. Iris control is from camera control unit

provided by simply disabling the answering or null-seeking potentiometers. Constantly increased control voltage results in increased rate of movement.

One of the first projected uses for the camera system is for round-table discussions. The unit may be installed with the pedestal on the floor and the camera projecting through an opening in the center of the table. Use of the six preset positions would make it possible to switch to any one of six speakers instantly.

Synthetic and Integrated Mica

INTEGRATED MICA is being made in two forms by the Integrated Mica Corp. of Woodmere, N. Y. One of these is made by splitting up ordinary mica waste into flakes less than four microns in thickness. If the surfaces of the flakes are not marred, the flakes can be made to hold together to form a solid sheet without using a binder.

Synthetic mica has also been made in sheets as much as fifty feet long. Synthetic mica may be treated in the same manner as natural mica and has the additional advantage of being reactive to heat. When heat and pressure are applied, the mica sinters and a strong porous sheet can be obtained. If the temperature is carried to the melting point, the mica recrystallizes and a transparent sheet can be made.

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Production Techniques

Edited by JOHN MARKUS

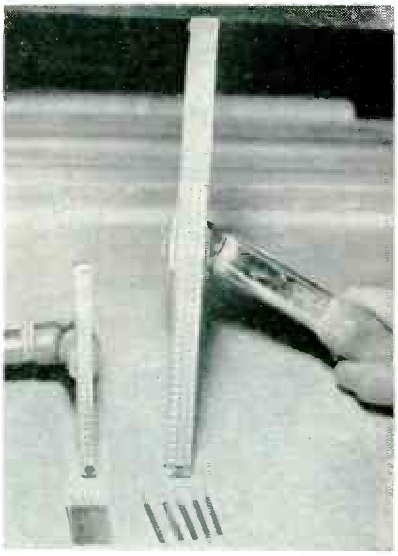
OTHER DEPARTMENTS

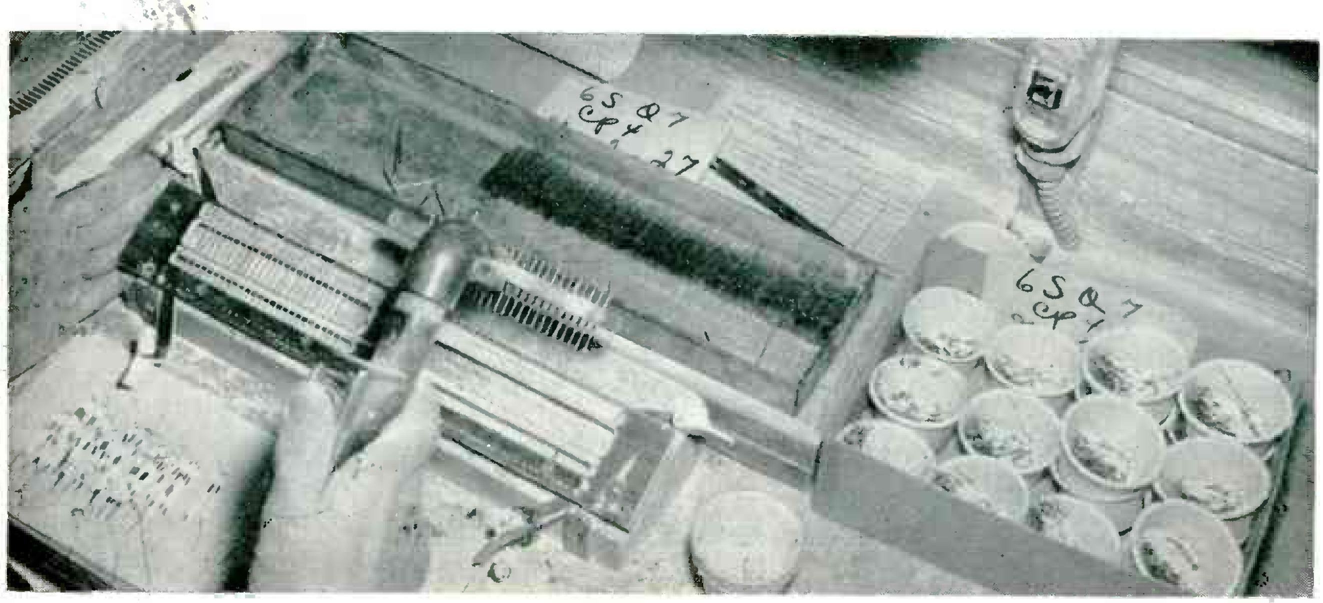
featured in this issue:

Vacuum Lifter for Cathode Sleeves

RACKS for supporting and masking the cathode sleeves of tubes during spraying of an electron-emitting oxide coating are loaded with specially designed vacuum lifters in the Emporium, Pa. plant of Sylvania Electric Products Inc. With this technique, up to 25 sleeves at a time can be picked up from a tray and loaded in the grooves of the rack in one operation. An entire 50-sleeve rack can thus be loaded almost as fast as it formerly took to put in two sleeves manually with tweezers.

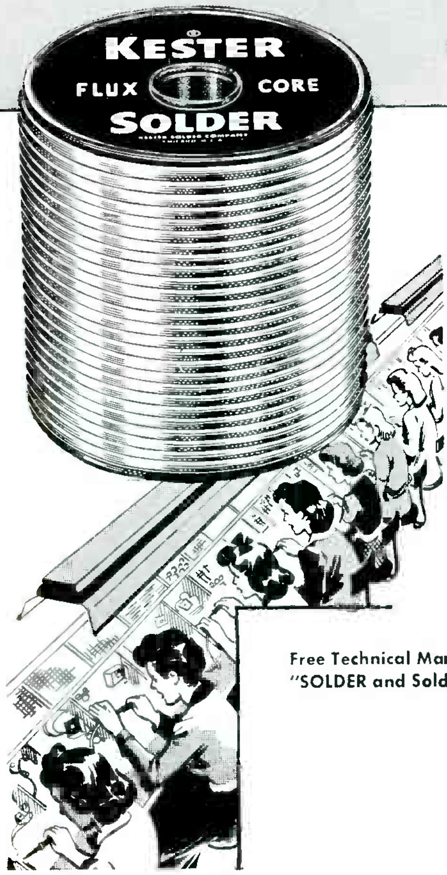
A different size and design of lifter is needed for each size of sleeve. Each lifter has grooves spaced the same distance apart as the grooves in the spraying racks. Bottoms of grooves are round for round sleeves, and have a saw-tooth shape for flat sleeves. Two holes in each groove run into the vacuum chamber of the lifting head, to provide the suction needed for holding a sleeve. A Micro Switch on the handle of each lifter controls a GE solenoid with 1-inch throw, located under the bench and used to operate an ordinary gate valve in the vacuum line for obtaining vacuum when needed. Threads were machined off the valve so it moves in and out with the plunger of the


Two types of vacuum lifters, and samples of cathode sleeves they handle



Transferring uncoated cathode sleeves from metal tray to spray rack with vacuum lifter. Unloading of sprayed racks is done here also, and finished cathodes are placed in paper cups as at right. Cups can be reused about ten times before replacement

SO SIMPLE...



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This exclusive Kester feature may be had in eight Flux-Core Solders including the widely accepted "44" Resin, "Resin-Five" and Plastic Rosin, also diameters ranging from nine-thousandths (.009") to one-quarter inch (.250"), and any alloy.

Kester, the "engineered" Flux-Core Solder, meets all applicable Government and Federal Specifications.

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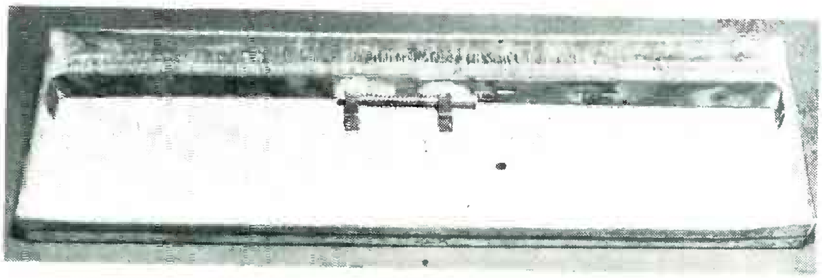
solenoid, giving vacuum control at low cost.

Uncoated sleeves are held in position in the tray with a spring-loaded steel partition to maintain alignment as required for picking them up in quantity with the vacuum lifter. The partition permits using one size of handling tray for different lengths of sleeves.



Spring-loaded partition used to hold uncoated cathodes in tray

Adding Machine Speeds Inspection of Cathodes

Using adding machine to get weight of oxide coating during sampling inspection of sprayed cathodes

In SAMPLING inspection of sprayed cathode sleeves for tubes. time is saved and errors minimized by punching out scale readings on an adding machine.

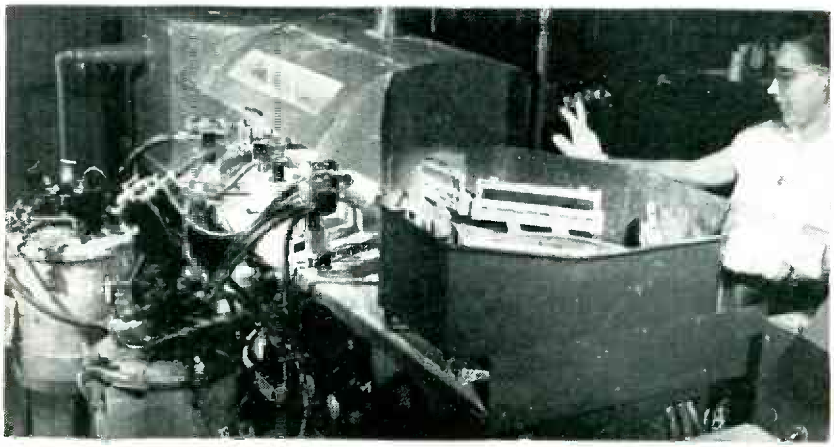
The operator removes one coated cathode at random from a spray rack after spraying, holds the cathode over an electric heater for a few seconds to drive off surplus moisture, checks the diameter with a micrometer, then weighs the cathode with a Roller-Smith precision balance and punches the weight value. Next, she scrapes off the coating with tweezers, weighs the bare sleeve, punches this value, punches the subtract button to get the difference, and records this as a check on spraying. The technique is cutting inspection costs in Sylvania's Emporium plant.

Cathode Spray Machine Uses Endless Track and Automatic Spray Guns

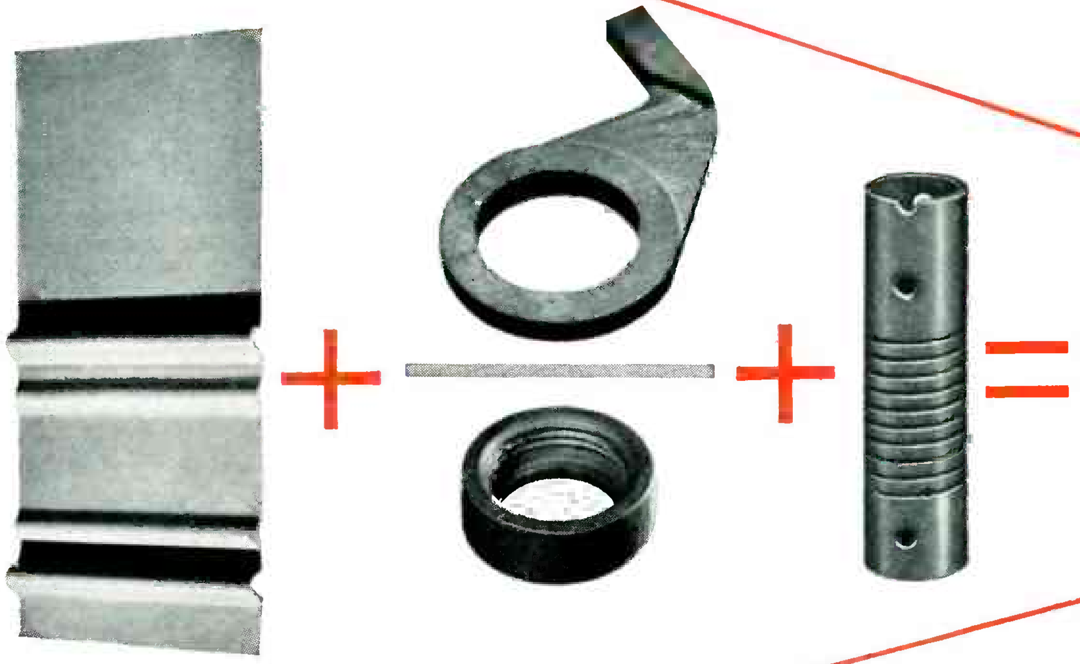
CATHODE sleeves, mounted in racks containing from 25 to 50 sleeves depending on their size, receive the required thickness of emissive oxide coating automatically in a machine somewhat resembling a model railroad. Racks filled with cathode sleeves are loaded into fixtures mounted on a motor-driven endless chain. These travel through the machine and past the spray guns at about the same speed as a toy train.

Stationary spray guns working in pairs are aimed at about 45 deg to the line and 90 deg to each other to give proper coverage of the cathodes as they go to the far end of the machine in one direction and then back again on the other track to expose the other side of each sleeve to the sprays. Duplicate spray facilities are provided, so that either of two different compounds can be sprayed without cleaning out tank and guns.

To conserve chemicals, valves for



Complete automatic cathode spraying machine, with hand of operator on control panel



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Take advantage of LAMICOID's "custom-built" personality. Investigate the advantages it offers *your* product. LAMICOID can be supplied in standard sheets, rods and tubes or fabricated into parts to your specifications. Our 58 years of experience in developing and producing electrical insulating materials is at your service. Send your blueprints and specifications today for a prompt quotation.

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the guns are so positioned that the sprays are on only when a rack of sleeves is in the path. Calrod heating elements inside the hood provide baking simultaneously with spraying. A control knob on the pushbutton control panel can be set for a choice of from 1 to 5 round-trip passes through the sprays, depending on the thickness of coating desired. The machine is used in the Emporium, Pa. plant of Sylvania Electric Products Inc., where it replaces slow and costly hand spraying with a single gun.

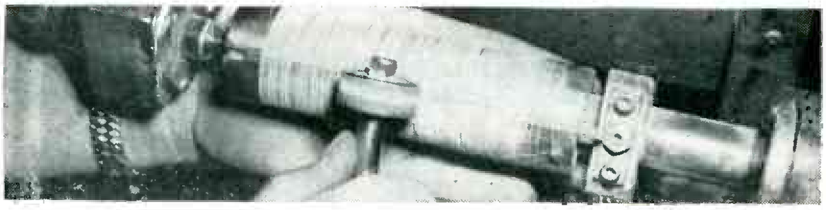

Closeup of loading end of spraying machine, showing how racks of cathode sleeves set into holders which somewhat resemble the cars of a model railroad

High-Speed Technique for Winding Tube Heaters

USE of a special metal mandrel in a lathe-like machine makes it possible to crease and cut 200 heaters at a time in the Emporium, Pa. plant of Sylvania Electric Products Inc.

The oxide-insulated wire is first wound on a mandrel whose circumference is equal to the total length required for each tube. This mandrel has projecting longitudinal insets at the desired locations for folds and a wider flat protecting inset or anvil at the cutoff line.

To crease the wire so it can later be folded back and forth accurately, a rubber roller is run over each of the thin longitudinal insets. Next, a steel roller is run over the cutoff anvil to remove the aluminum-oxide insulation from the ends of the heater, and the loosened powder is


Using steel roller, resembling roller-skate wheel mounted on shaft, to crush insulation over flat cutoff anvil in mandrel


Creasing heater wire by running rubber roller over projecting insert in mandrel


Cutting heaters apart by running steel disk in slot of cutoff anvil

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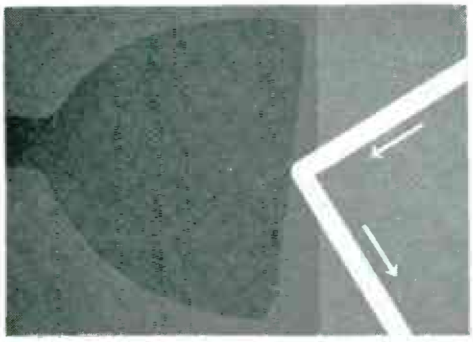
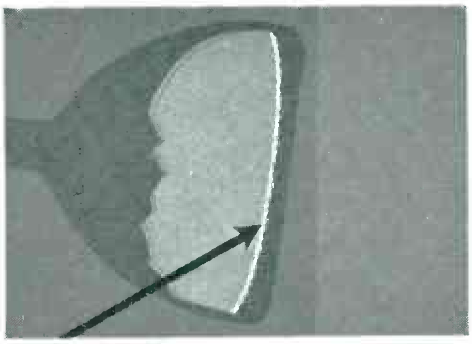
G-E CYLINDRICAL-FACE TUBES BANISH GLARE, WHILE *PRESERVING PICTURE DETAIL!*

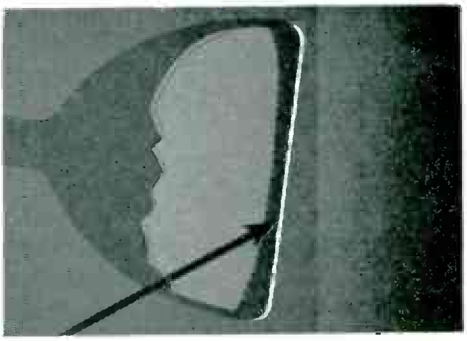
Now available, a picture tube with a vertically straight face! Spherically convex tubes, when tilted, cannot deflect all light down and away.



ROOM LIGHTING IS DEFLECTED DOWN! Light from ceiling lamps, table lamps, or windows is bent to the floor. Here a G-E Cylindrical is shown from the side in normal tilted mounting position. No light beams reach the viewer's eyes.



INTERNAL REFLECTIONS ARE REDUCED! The inner, or screen face of a G-E Cylindrical is stippled. Stippling wards off reflections, yet permits a picture surface which is fine-grained and uniform. The image has highest quality and rich contrast.



FOCUS AND DETAIL MAINTAINED! Tube's outer face is smooth and polished. Consequently, there are no glass-surface irregularities to refract and magnify . . . as can be the case with etched-face tubes. Viewers see the image in sharpest focus.

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Tube Department, General Electric Company, Schenectady 5, N. Y.

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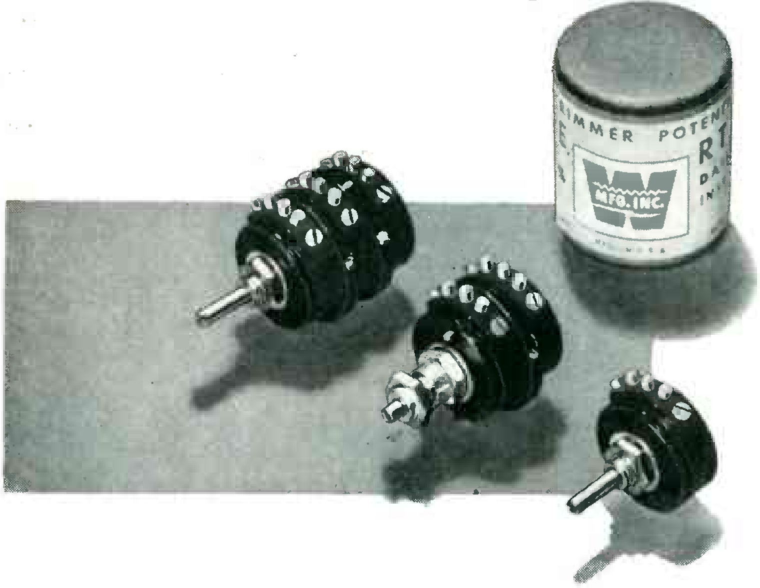

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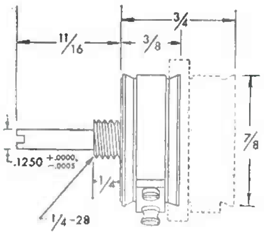

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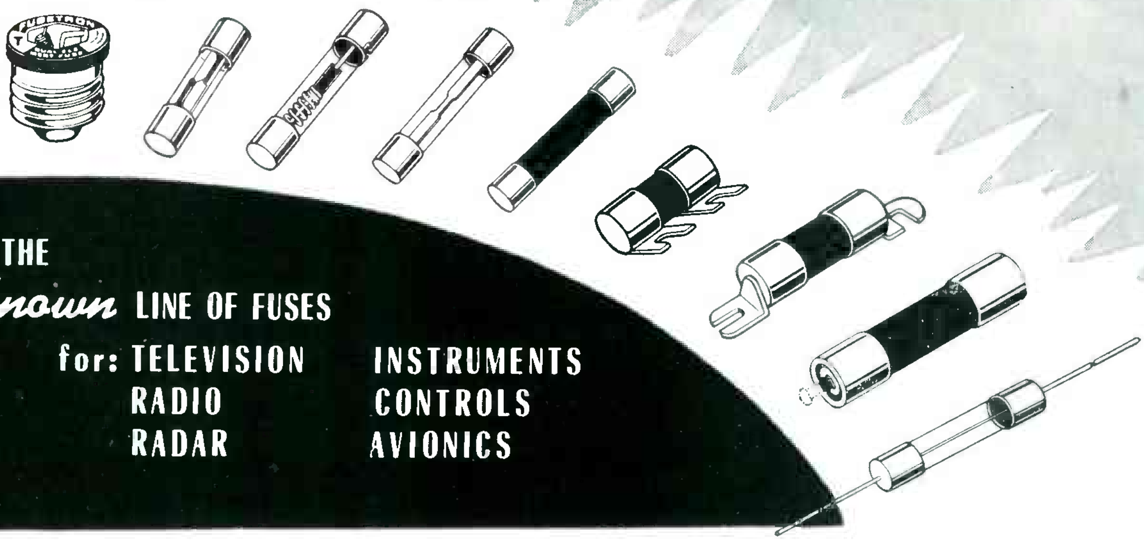

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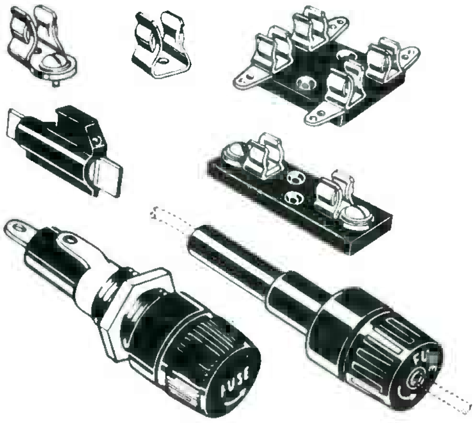

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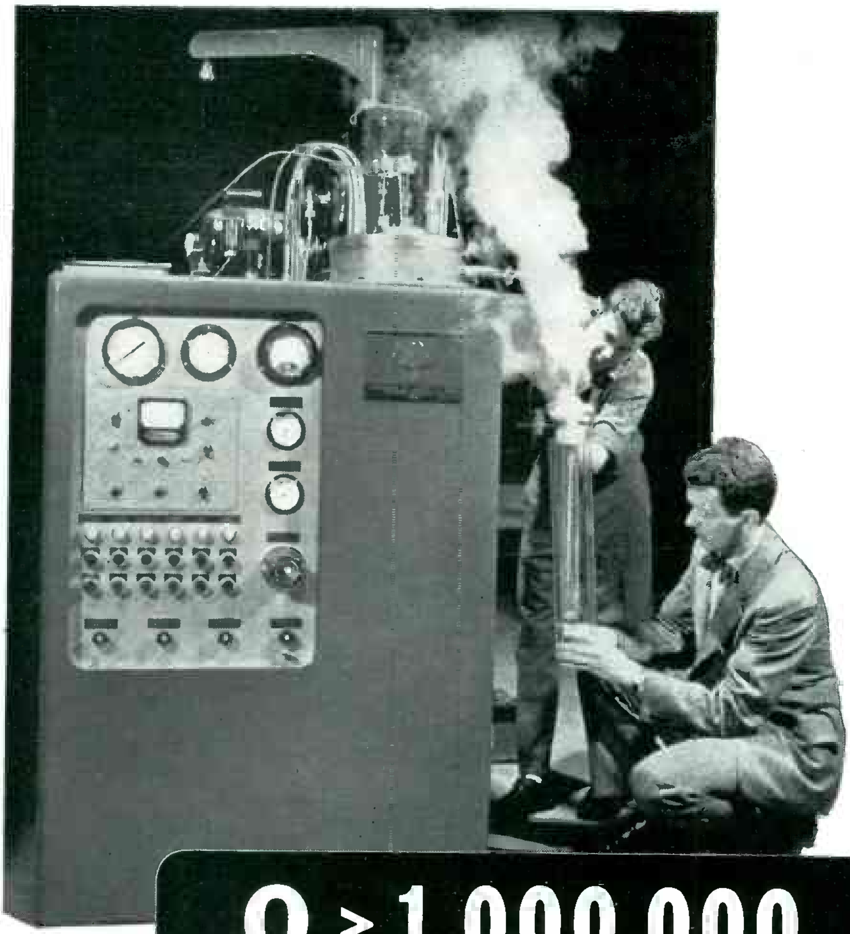

brushed off with a toothbrush to expose bare wire for connections.

As the last step, a cutting wheel is run across the winding in a groove in the cutoff anvil, and the individual turns are caught by the operator as they drop off. These are folded by other operators, for subsequent insertion in cathode sleeves of tubes.

Mandrels are easily changed by moving back the tailstock and loosening a few screws on the headstock. An odd number of legs for series heaters is just as easy to produce as an even number, since creasing anvils can be placed anywhere on the mandrel when it is being made in the tool shop.

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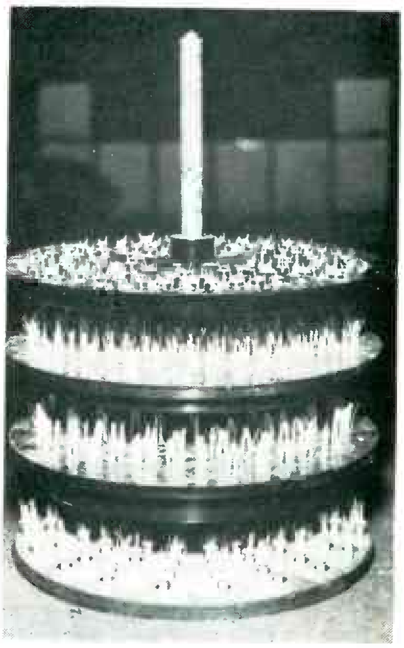

Three different examples of molded plastic trays, with a metal-plywood tray below. Each hole contains a single heater wire, insulated with aluminum oxide and then folded by hand ready for insertion in the cathode sleeve of a tube

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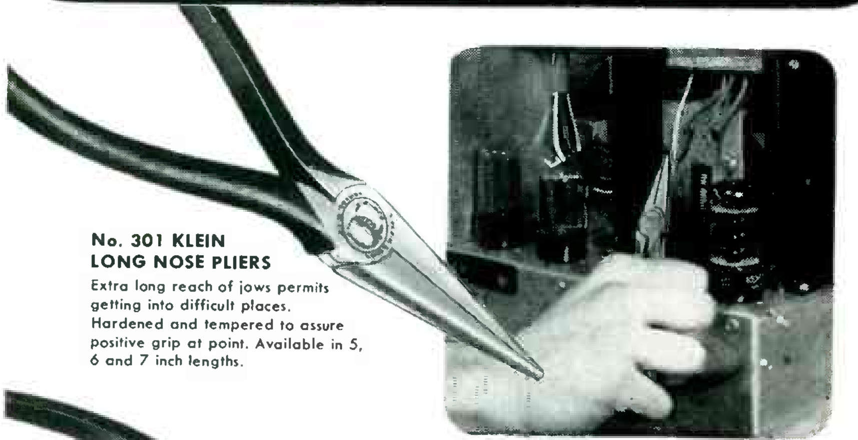

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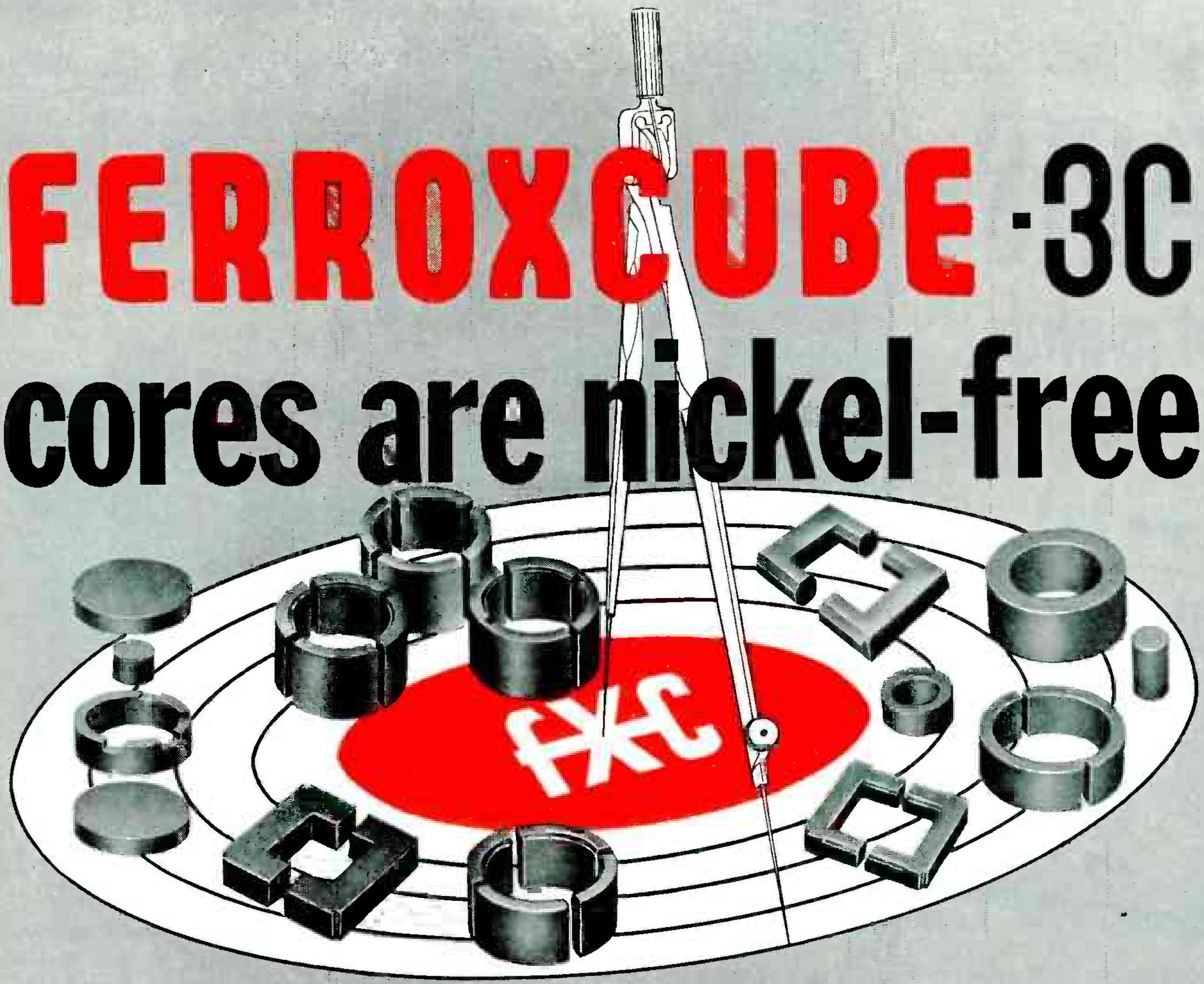

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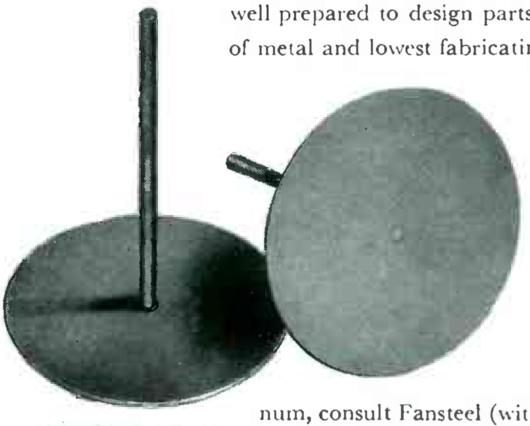

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22501C

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they are stacked on a vertical shaft.

Also shown is an earlier tray design cut from plywood, with metal inserts serving as cups for individual heaters. The inserts, shaped much like large tubular rivets, are a press fit in holes drilled in the plywood.

Coax Shield Cutter

Insertng metal sleeve between flared-out shield and dielectric of coax

SHIELDING braid for 72-ohm coaxial cable is trimmed off quickly at the desired point with a sliding knife, after first inserting a metal sleeve between the braid and the inner dielectric material, in a technique developed by the Television Receiver Division of Allen B. DuMont Labs., Inc., East Paterson, N. J. The outer plastic covering is removed conventionally with a sharp knife and ends of the braided shield wire are spread out a bit to facilitate insertion of the metal-sleeve anvil.

The cutting knife, with a wood handle at one end, is hinged to a

Pulling knife forward to cut shielding braid

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* Approved by U.S.A.F.
Spec. MIL-R-5757A

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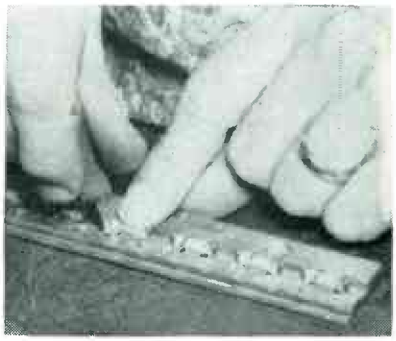
sliding fixture so the blade can move only in a vertical plane. The blade is lifted, the coax inserted and positioned, and the knife is pulled forward and down with slight pressure to roll and cut the shield. The inserted metal sleeve prevents damage to the dielectric during cutting.

Lead-Preforming Tool

Cutting leads precisely to length, using edge of holding fixture as guide

A TWO-PRONGED tool resembling a phone jack speeds bending of hooks for joints in shortened leads of resistors and ceramic capacitors in RCA's government plant in Camden, N. J.

To cut the leads precisely to correct length, the components are placed nine at a time in a holding fixture machined from quarter-inch sheet aluminum. The bodies of the parts fit into a rectangular groove machined in the aluminum strip, and the leads project at right angles in shallow cross-grooves leading to hook-forming holes. All lead lengths projecting beyond the alum-



Bending hook in lead by rotating two-pronged tool. Precise forming is required so parts will fit in limited space inside housing of plug-in i-f amplifier stage for AN/PRC-10 portable military radio

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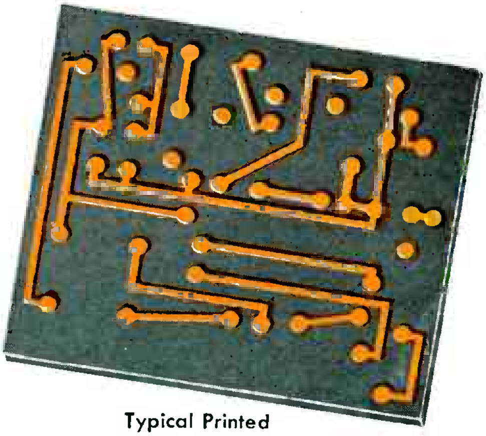

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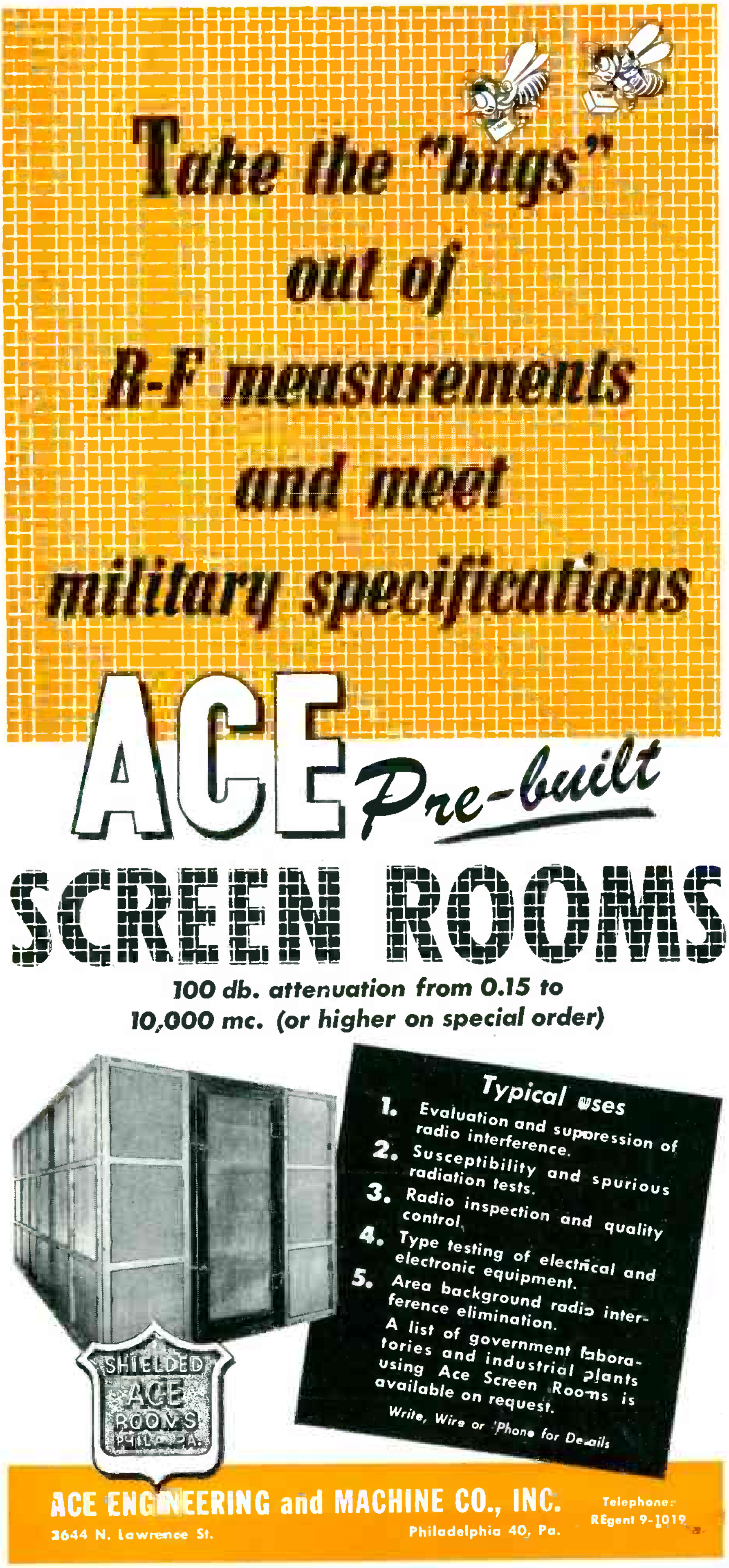

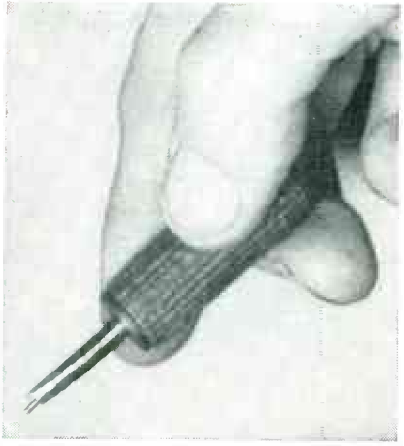

Closeup of tool for bending hooks in leads

inum strip are quickly cut off with side-cutting pliers.

For bending a hook, the longer of the two prongs of the tool is inserted in the hook-forming hole of a lead. With the shorter prong on the other side of the lead, so that the prongs straddle the lead, the tool is rotated 180 degrees to form a perfect hook.

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Induction soldering setup, with fume-drawing duct over single-turn water-cooled work coil. Rectangular mandrel with solder preforms is on table, behind C clamps

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LITERATURE AVAILABLE—Bulletin GEA-5524 gives testing directions. GET-2350 is a complete reference manual of application information on G-E selenium rectifiers. Write Section H461-25, General Electric Company, Schenectady 5, New York.

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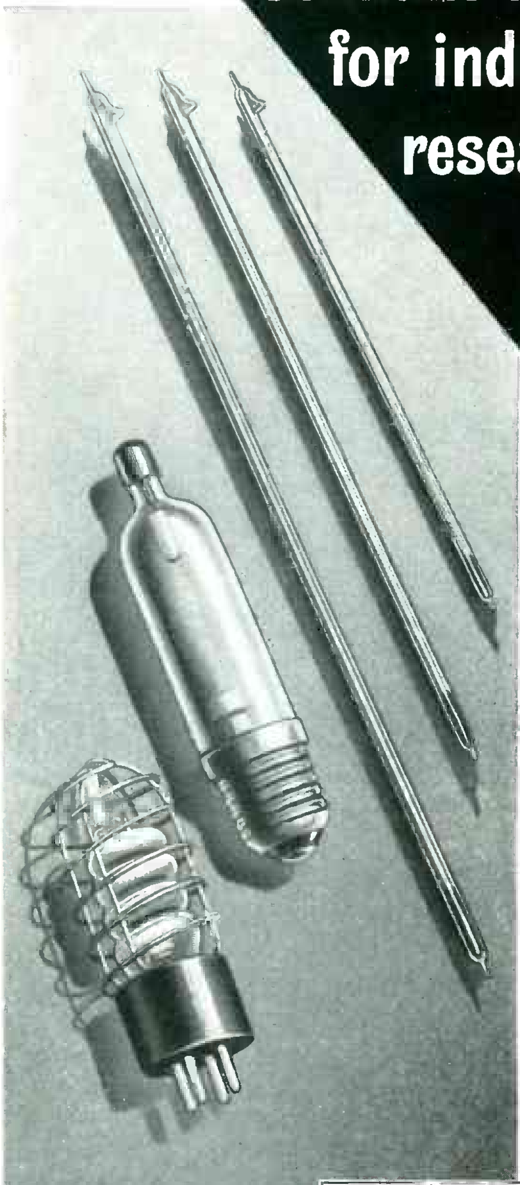

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*Provisional data.

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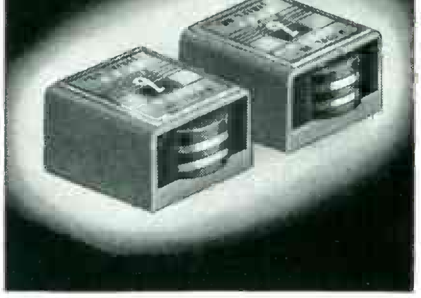
4 Channel Recording on ¼″ Tape



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Model BK-1502N Record/Reproduce Heads, like all other Brush Magnetic Recording Components, are the products of Brush engineering leadership and Brush skills in precision production.

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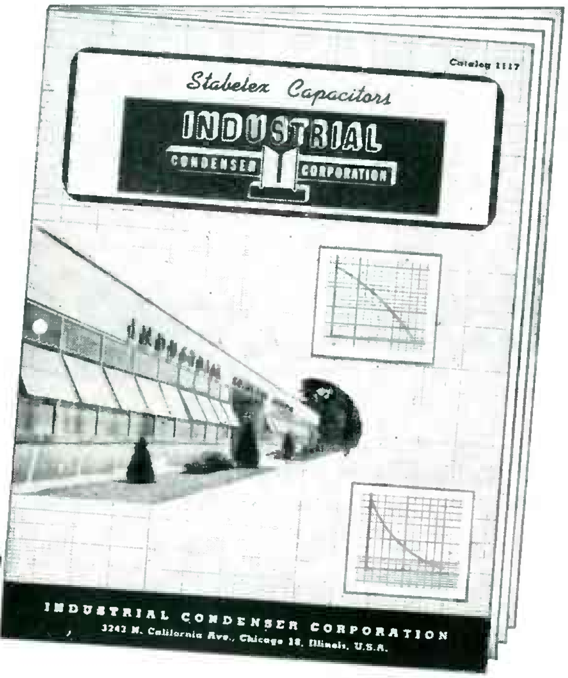

Catalog 1117

Stabelex Capacitors

INDUSTRIAL CONDENSER CORPORATION

INDUSTRIAL CONDENSER CORPORATION
3243 N. California Ave., Chicago 18, Illinois, U.S.A.

Curve #1111 illustrates the low dielectric absorption of Stabelex "D" and also makes a comparison with mica and paper capacitors. The absorption of mica and paper capacitors may be considerably higher, depending on the impregnating materials and design. The dielectric absorption of Stabelex "D" is never more than 1/25th that of the best commercially available Mica capacitors or 1/35th that of Paper capacitors.

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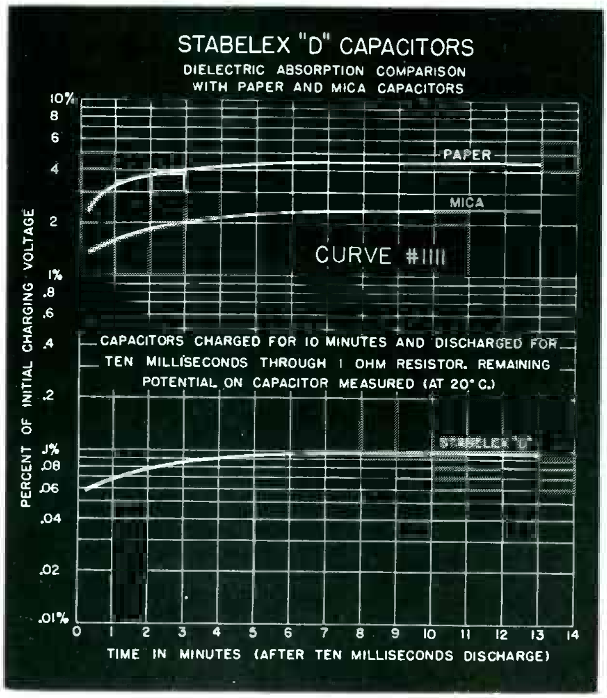
After a long period of research, Industrial Condenser Corporation now offers to industry for the first time the first of their family of Stabelex capacitors, stabelex "D", which has been produced for special applications for some time.

Complete information performance curves, characteristics, and suggested applications of the various types now available will be found in this catalog.



INDUSTRIAL CONDENSER CORPORATION

3244 N. California Avenue
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Please send me my FREE copy of your new Catalog 1117 on Stabelex "D" Capacitors.

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It might be pleasant to order a low resistance component with gold band tolerance and receive a snappy little blonde. But if your production line is waiting and your schedule is tight, better place your parts orders with MILO—where you get it right, and quickly, too.

For some mistakes have less happy consequences. And the day is long gone when just any old part would do. Complicated filtering and multi-purpose circuits call for critical values and dependable material.

This indicates components from the well-known manufacturers. You will find more of them at MILO—more available from stock, more quickly requisitioned when in temporary short supply. And handled by an alert, informed staff to assure accuracy and speed in fulfilling your requirements.

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system provides enough draft to pull fumes away from the work area almost instantly.

A four-position work table indexes each time it is lowered and raised by a foot pedal, so as to bring another unit up into the work coil. The rectangular solder preforms are wound on a rectangular mandrel in a lathe, then cut lengthwise along the mandrel to give single-turn loops of solder. The technique is used in the Clifton, N. J. plant of Federal Telephone and Radio Corp.

Stacking Cathodes

UNCOATED cathode sleeves for tubes have a welded tab at one end. To stack these cathodes so the tabs are all at the same end of a tray for further processing, Sylvania Electric Products Inc. uses a combination of a Syntron bowl feed and a Mead rotary work feeder.

After tabbing, cathodes are dumped into the bowl of the motor-driven feeder. This shoots the cathodes, one or two at a time, across rubber rollers so spaced that only those coming with untabbed end first can drop down between the rollers to the output chute. If a cathode comes with the projecting tab end first, the tab touches the

Two rubber rollers driven by small electric motor can be seen at left of bowl feed. Cathodes drop into glass cups on table actuated by air cylinder at lower right

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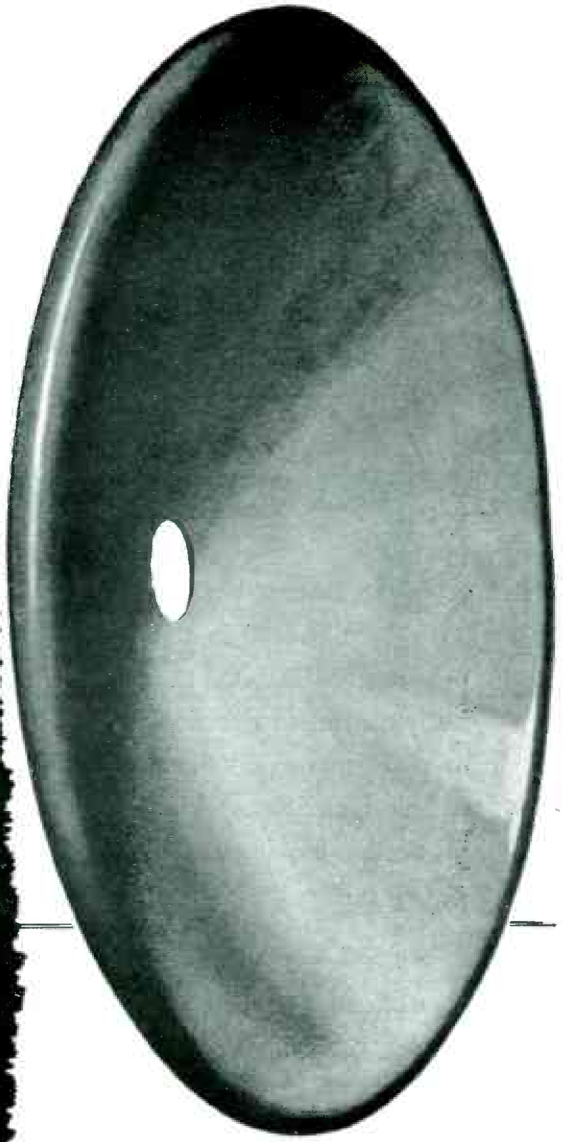
your choice of over 50 "dishes"



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Ward Leonard Electric Co.'s compact new unit for industrial chrome plating of cutting tools, gauges, etc., within the shop is a miniature powerhouse. It embodies all the necessary electric controls, and power in DC form is delivered across the bath by a full wave, metallic selenium rectifier.

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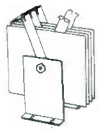
Because Chromaster's performance depends on component quality, rectifier choice of Ward Leonard engineers is SELETRON — famous for ruggedness and dependability . . . for its "Safe Center" contact construction and decreased bulk . . . for its high standard of quality control.

Wherever rectification is the key to your new or established products, it will pay to investigate SELETRON. Available in a large range of sizes for radio, TV and industrial electronic circuits from a few mils up to thousands of amps.

SELETRON application engineers will be glad to assist you in selection of the right rectifier for that job on the board. Drop us a line today!



A SELETRON Selenium Rectifier, Model H1C2N2B Full Wave Center Tap, helps Ward Leonard's A-20 Chromaster maintain accurate chrome deposits from .00005" to several thousandths.

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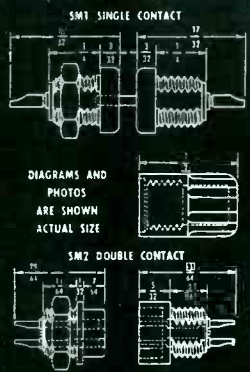
SUB-MINIATURE CONNECTORS*

...may help you solve your toughest space problems!



AVAILABLE IMMEDIATELY FOR EXPERIMENTAL & PROTOTYPE REQUIREMENTS

PHYSICAL AND ELECTRICAL DATA

Code No.	Number of Contacts	Weight (Oz.)			Solder Cup Hole Dia. (In.)	D. C. Volts Breakdown† (Engaged)			
						Sea Level Normal Humidity		60,000 Ft. Altitude	
		Plug	Recep-tacle	Hood		Between Contacts	Contacts to Ground	Between Contacts	Contacts to Ground
SM 1	1	.04	.02	.02	.043	....	5400	....	1750
SM 2	2	.02	.02	.02	.022	1600	2600	800	1100

†Connector mounted in 1/16" panel.

MONOBLOC★ CONSTRUCTION *eliminates unnecessary creepage paths, moisture and dust pockets . . . and provides stronger molded parts.*

MOLDED MELAMINE BODIES *(In accordance with MIL-P14), mineral filled, are fungus-proof and provide mechanical strength as well as high arc and dielectric resistance.*

CONTACTS PRECISION MACHINED: *Pins from brass bar (QQ-B611) and sockets from spring temper phosphor bronze bar (QQ-B746a). They are gold plated over silver for consistent low contact resistance, reduction of corrosion and aid in soldering.*

POLARIZATION: *Body design of the "SM2" permits engagement in one position only.*

RACK & PANEL MOUNTING: *Either plug or receptacle may be panel mounted with a 1/4-28 cadmium plated brass nut. A melamine cable hood protects soldered wires.*

*WIRE OR WRITE FOR CATALOG
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West Coast Branch: 1729 WILSHIRE BOULEVARD,
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GLENBROOK, CONN., U.S.A.

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second roller and bridges the gap before the center of gravity of the cathode reaches the fulcrum of the first roller. As a result, the tab rides across and goes back into the bowl for recirculation and another try.

Properly aligned cathodes drop down the chute into cups on the air-operated rotary table, on which are 24 cups. An associated air-actuated timer is adjusted to step the feeder to the next cup after about 20 cathodes have dropped in. The operator lifts out filled cups and transfers the cathodes to a metal tray, then replaces the cup.

Twinlead Stripper

A COMBINATION air and hand-operated tool punches out the web at the end of a length of twinlead and strips the insulation from the end of each lead at the CBS-Columbia television receiver plant in Brooklyn, N. Y.

The operator inserts the twinlead in the bend of the machine until it hits a stop, then steps on a foot valve in the compressed air line to lower the punching die. A small mirror is mounted on a stand behind the machine to show the operator whether the twinlead has hit the stop properly. The punched-out web drops into a pan under the stripper. Jaws alongside the punching die cut and hold the remaining insulation on the leads at the desired distance from their ends

Twinlead stripping setup

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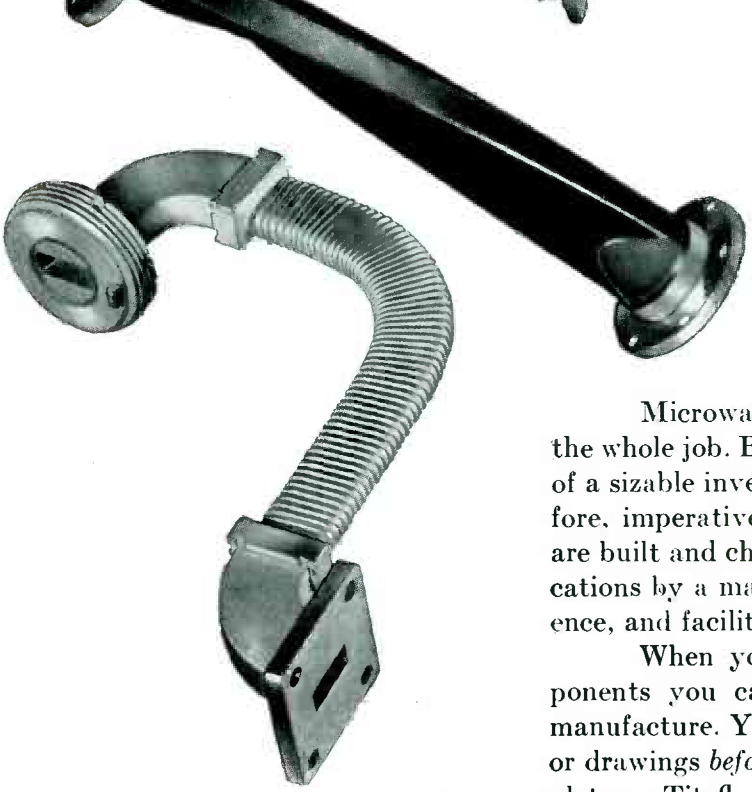
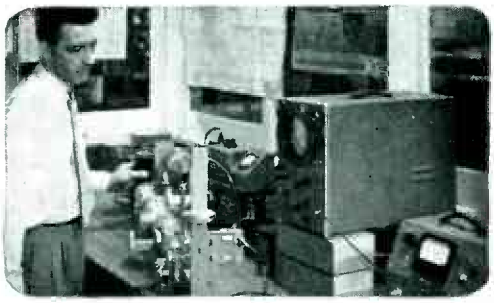
How to Get Microwave Components You Can Trust





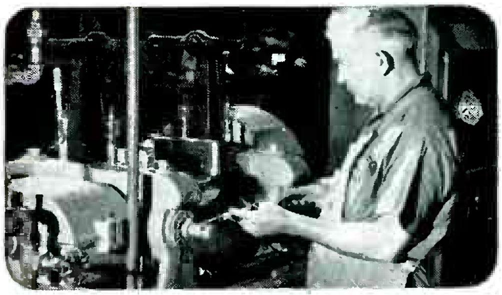
Philco Xb Band Rigid Components receiving swept-frequency discrimination tests.

Microwave components are not costly in relation to the whole job. But they can make or break the performance of a sizable investment once they are installed. It is, therefore, imperative to see that your microwave components are built and checked precisely to your drawings or specifications by a manufacturer who has the knowledge, experience, and facilities to meet these requirements.

When you specify Titeflex Waveguides and components you can be confident of top craftsmanship in manufacture. You can be sure Titeflex will meet your specs or drawings *before* shipment. Only testing facilities as complete as Titeflex maintains could give you this assurance.

Titeflex inspection often saves you the time and cost of duplicate inspection. It is the final step in the production of custom-engineered, precision-manufactured microwave components.

Titeflex engineering and production facilities are available to help you solve your Microwave problems from original design to final production.



Milling the rubber-like compound which is subsequently molded over Titeflex flexible waveguides to protect them.

Have you this catalog of Titeflex microwave components? Use coupon in sending for your free copy.

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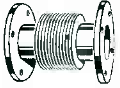

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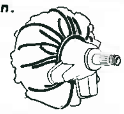

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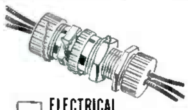
☐ IGNITION SHIELDING



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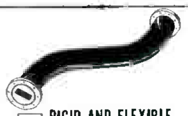

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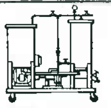

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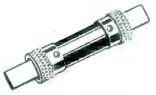

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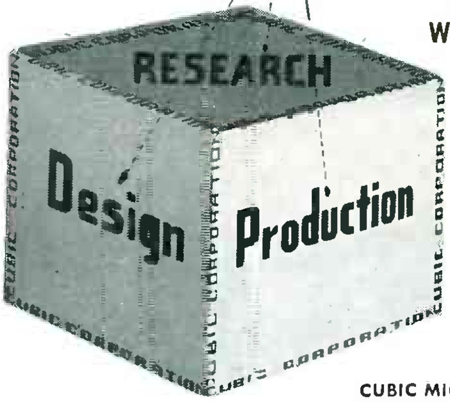
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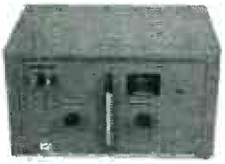

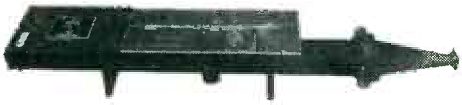

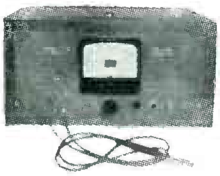

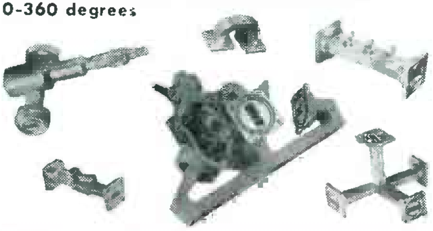

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A compact, complete, hermetically sealed frequency standard, presenting these features:—

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Also, manufacturers of frequency standards, multi-frequency standards, chart-recording chronographs, firing-cycle timers, the Watch-Master Watch Rate Recorder and other high-precision frequency and timing instruments, controlled by our tuning-fork oscillators.

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Gear this frequency standard to your designs and help solve climatic, space and weight problems in JAN-ized-MIL equipment

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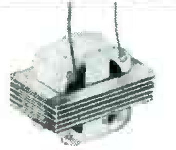
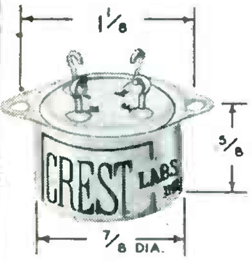


Open Frame Construction

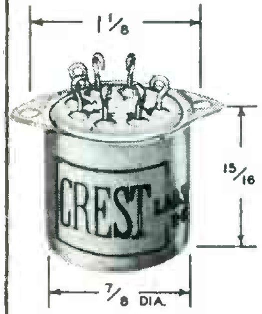


MICRO-MINIATURE • FOR HEARING AIDS SUB-MINIATURE TRANSMITTERS AND RECEIVERS

Providing the ultimate in miniaturization, these Micro-miniature transformers are the tiniest commercial units available. They are available either hermetically-sealed or in open frame construction. Open frame transformers are double Expoxy Resin impregnated for structural strength and are completely sealed against climatic conditions. Secure tie points for the three-inch color-coded flexible leads permit leads to be used for mechanical mounting. Maximum frequency range at O-DB level is obtained by use of Mu Metal core.

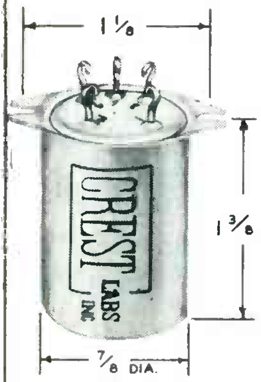
SUB-MINIATURE • FOR MINIATURE AMPLIFIERS HEARING AIDS AND AIRBORNE EQUIPMENT

Originally these Sub-miniature units were designed to meet the requirements of hearing-aid manufacturers, however, because of demands for ruggedized military type applications, these units are now available from stock in hermetically sealed containers. Mu Metal laminations coupled with unique winding methods permit full frequency range at O-DB level. Open frame units have flexible three-inch color-coded leads and are double Resin impregnated to provide thorough protection from adverse climatic conditions.



MINIATURE • FOR AMPLIFIERS TRANSMITTERS AND TRANSITOR CIRCUITRY

These units were developed to meet the demands of the growing miniaturization program. Despite their small size they are designed to work at an O-DB level with full frequency response. All units are customarily supplied in hermetically sealed cans; although open frame units may be obtained on order. Upon request for quantities over one hundred, unwanted taps will be omitted at no extra charge.



MIL TYPES

Miniature, sub-miniature and micro-miniature units may be built to particular family specifications required, and given the necessary tests as described in the test procedures for MIL-T-27. These items may be obtained as listed below:

FAMILIES — Power, Audio, Pulse and Reactor

CASES — AF, AG, AH, AJ, and YY cans under 2½" high

TERMINALS — Designed to withstand 5 lb. pull tests of MIL-T-27

Terminals are available in steatite compression types of pyrex glass sealed headers.

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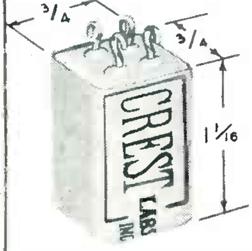


CREST LABORATORIES, INC.

Whitehall Building Far Rockaway, N. Y.

---

while the operator pulls out the twinlead with the hand-operated gripping tool mounted on the front of the fixture. This last operation strips the insulation from the wires.

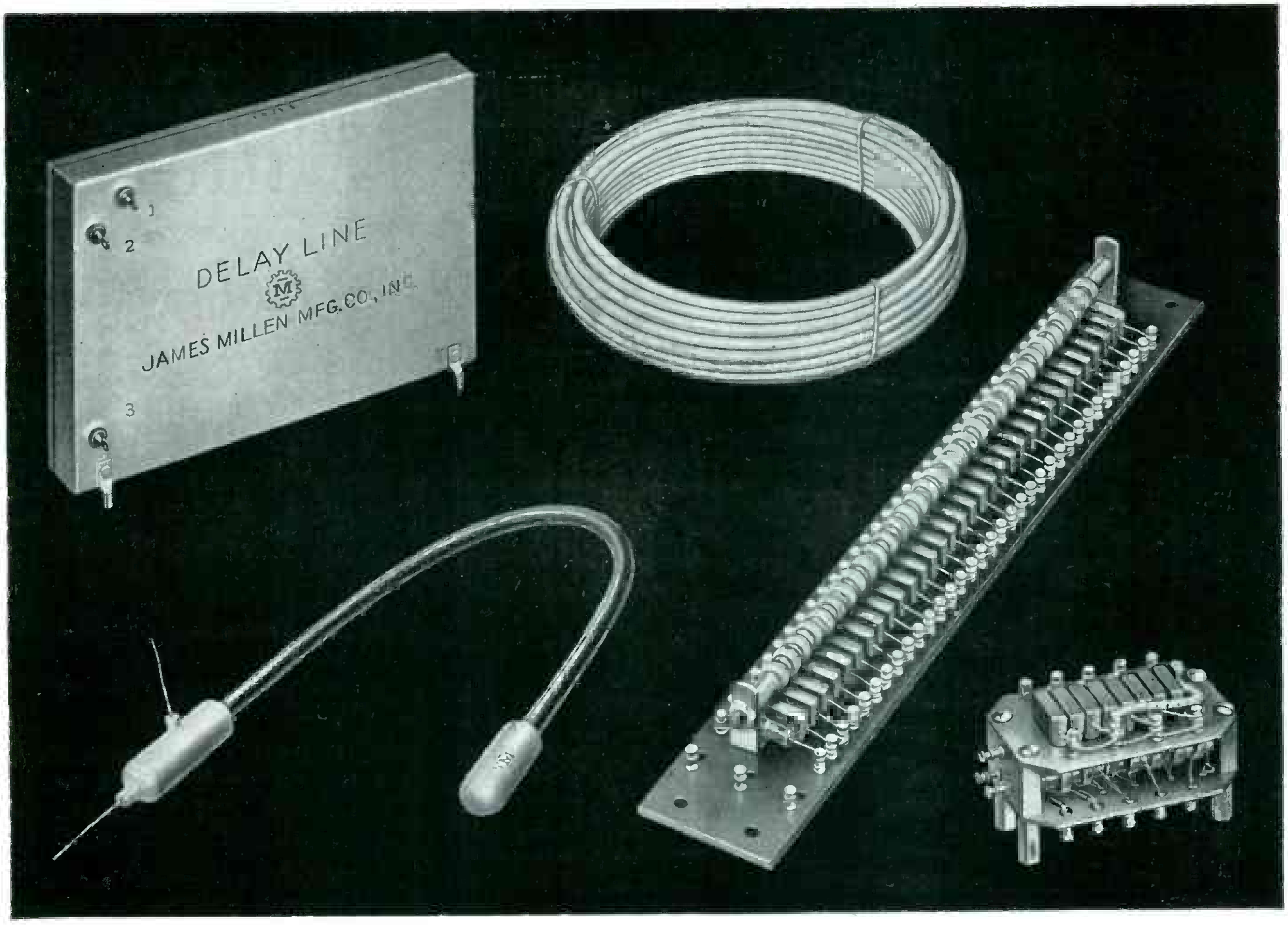
Welding Small Parts

Magnifier attached to fluorescent lamp aids welding of small electrodes for subminiature tubes

A 5-POWER magnifier supported conveniently near the eye of the operator by stiff wire is used to aid in hooking filament leads to connectors prior to welding, and also for inspecting the weld afterward, at the Emporium, Pa. plant of Sylvania Electric Products Inc.

A copper disk set into an insulating plastic washer forms the anvil of a capacitor-discharge spot welder for welding contact tabs to the ends of a coiled heater for tubes. The heater with loosely attached tabs is placed on the anvil with tweezers and welded by pressing over each tab in turn a pointed

Setup for welding extremely small tabs to coiled heaters of tubes



"Designed for Application"

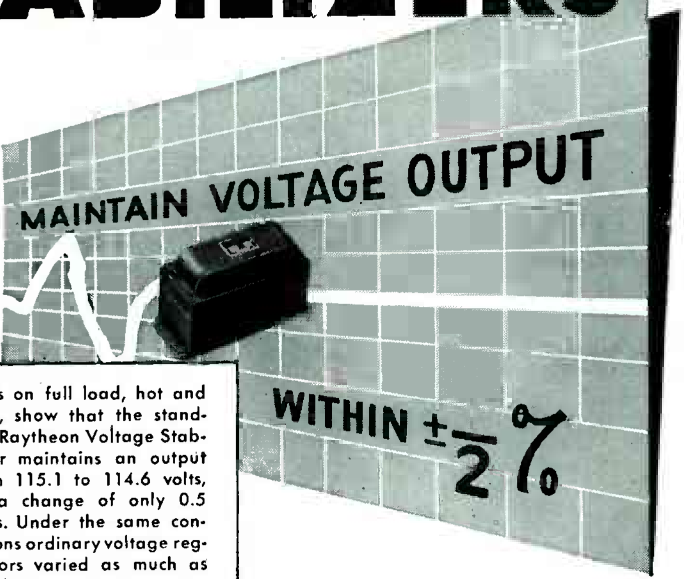
Delay Lines and Networks

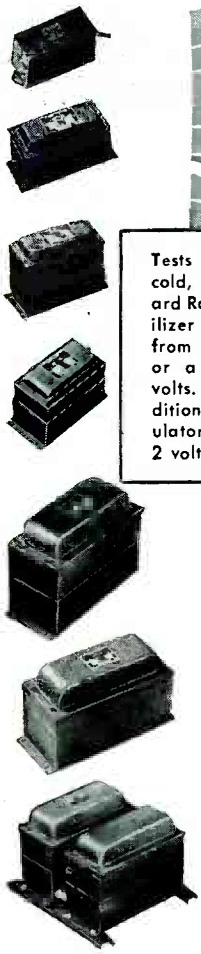
The James Millen Mfg. Co., Inc. has been producing continuous delay lines and lump constant delay networks since the origination of the demand for these components in pulse formation and other circuits requiring time delay. The most modern of these is the distributed constant delay line designed to comply with the most stringent electrical and mechanical requirements for military, commercial and laboratory equipment. Millen distributed constant line is available as bulk line for laboratory use and in either flexible or metallic hermetically sealed units adjusted to exact time delay for use in production equipment. Lump constant delay networks may be preferred for some specialized applications and can be furnished in open or hermetically sealed construction. The above illustrates several typical lines of both types. Our engineers are available to assist you in your delay line problems.

JAMES MILLEN MFG. CO., INC.
MAIN OFFICE AND FACTORY
MALDEN, MASSACHUSETTS, U. S. A.

RAYTHEON

VOLTAGE STABILIZERS





Tests on full load, hot and cold, show that the standard Raytheon Voltage Stabilizer maintains an output from 115.1 to 114.6 volts, or a change of only 0.5 volts. Under the same conditions ordinary voltage regulators varied as much as 2 volts.

Compare the performance of Raytheon magnetic Voltage Stabilizers with any other make. You'll find at least ten good reasons why they guarantee better, more reliable operation of any electrical or electronic equipment. All models are compact, light in weight and ruggedly built with no moving parts to wear out.

Raytheon Voltage Stabilizers rated from 15 to 2000 watts are carried in stock by 125 parts distributors strategically located from coast to coast. Custom-engineered units, ranging from 5 to 10,000 watts are also available for military or commercial applications.

Write for complete information and performance data.

TESTS PROVE 10 POINTS OF RAYTHEON SUPERIORITY

1. Deliver accurate AC voltage within ±½%
2. Stabilize output with more precision
3. Regulate better at full load
4. Hold up better under overload
5. Better no-load to full-load regulation
6. Accept wider input voltage range
7. Less voltage change as units heat up
8. Less change in output as frequencies fluctuate
9. Smaller, lighter, more compact, no moving parts
10. Cost less to operate

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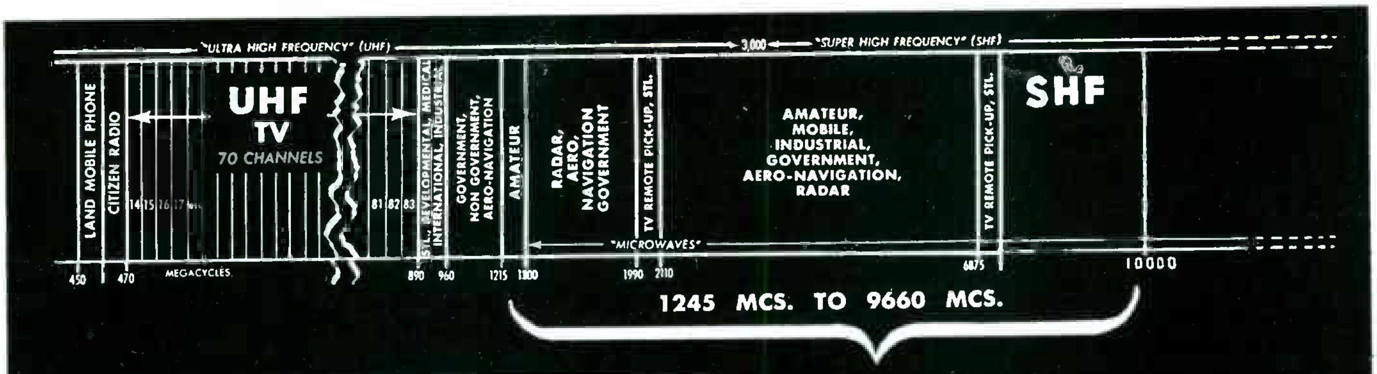

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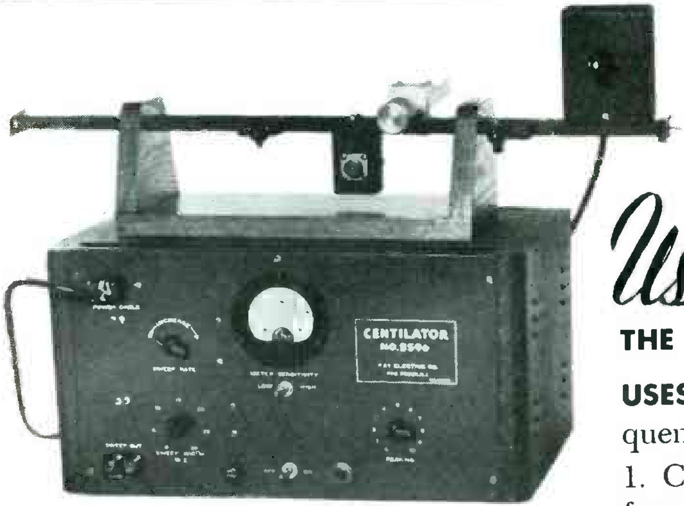

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CENTILATOR SPECIFICATIONS

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6274	6250 to 7425	5976	RG-50/U	UG-344/U	110	50	121-A	450.00
4249	4240 to 4910	2K22	50 ohm coax	Type N	115	35	122-A	450.00
3439	3400 to 3960	2K29	50 ohm coax	Type N	106	40	123-A	495.00
1214	1245 to 1460	5981	50 ohm coax	Type N	134	5	124-A	595.00

*Formerly called the Mega-X.

**Prices listed are domestic, F.O.B. Factory.

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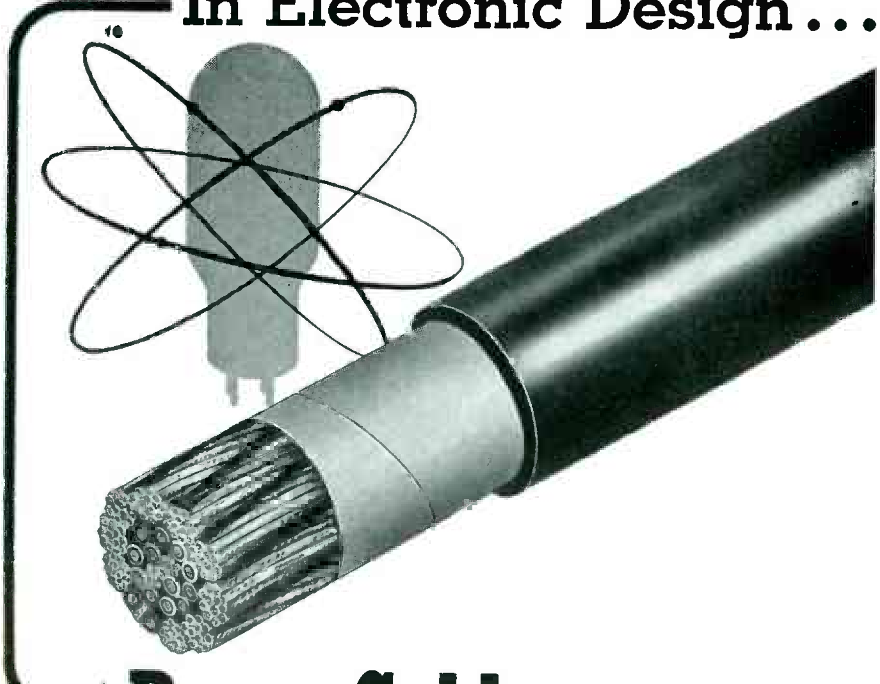

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copper rod serving as the other electrode of the welder. A foot pedal operates the welder. Heaters are kept in a molded plastic tray before and after welding, to prevent contamination.

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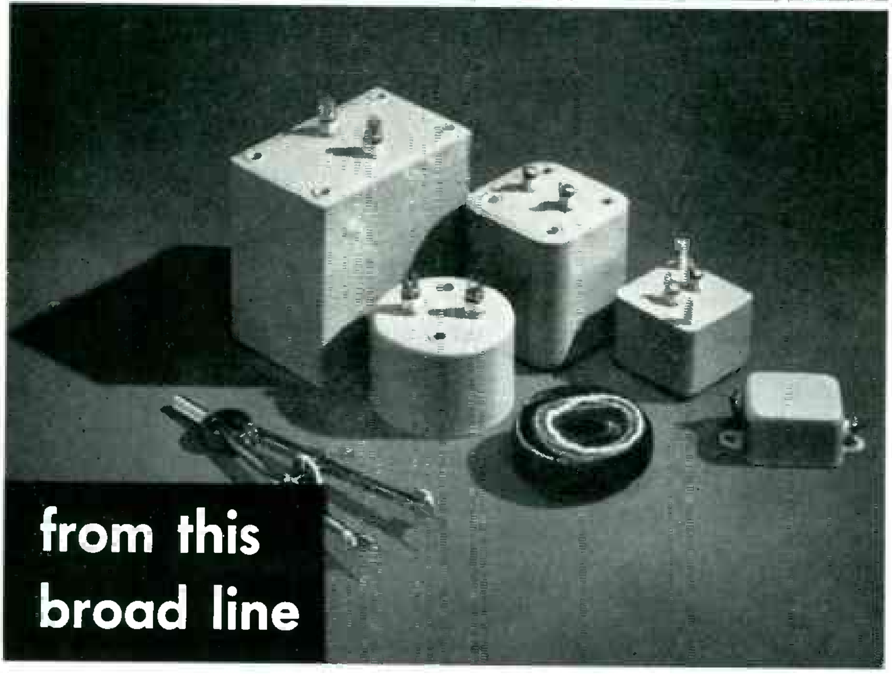

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LENKURT INDUCTORS are made by Lenkurt Electric Company—*largest independent manufacturer of telephone toll-transmission equipment*—also producers of variable inductors, quality filters, decade inductors, and molded iron-powder parts.

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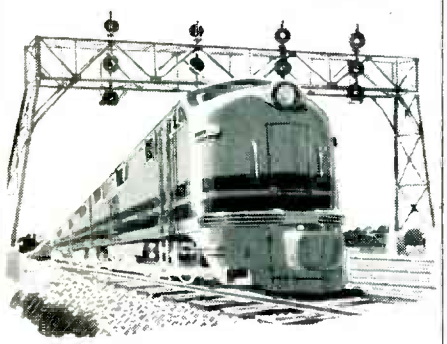
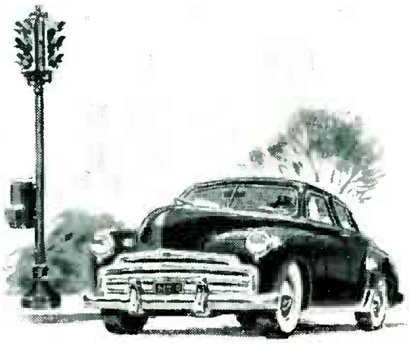


Railroad safety rests heavily on the accuracy of train signaling devices.

Aircraft beacons mark the way for night-flying aircraft. Dependability is essential.

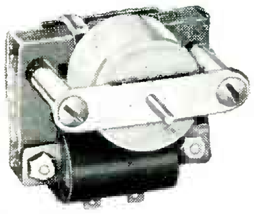


Traffic signals at busy intersections operate constantly. The timing motor must have long life.

Modern safety devices for high-speed transportation help assure safe arrival of loved ones who travel. And Telechron synchronous timing motors play a big part in making these safety devices reliable.

Because of design and the reservoir of specially compounded oil, all moving parts are continuously lubricated. The rotor shaft itself literally floats on a film of oil, and the entire mechanism turns quietly and with minimum friction. Even under the wide extremes in temperature and humidity common in the transportation field, Telechron motors — with their superior lubrication — have demonstrated consistent, year-in, year-out dependability.

Investigate the extra advantages of quality Telechron motors for your new product designs. They're available in a wide range of sizes and characteristics. For complete details, write for catalog IS-120. Telechron Department, General Electric Company, 49 Homer Ave., Ashland, Mass.



Type B3 Motor. A medium-duty motor for such applications as switches, combination recording and controlling mechanisms, and various types of control equipment.

Type C-5X Motor. A high-torque motor for operation in heavy-duty applications involving timing, switching, and controlling. Sturdy gear train construction. Reversible.

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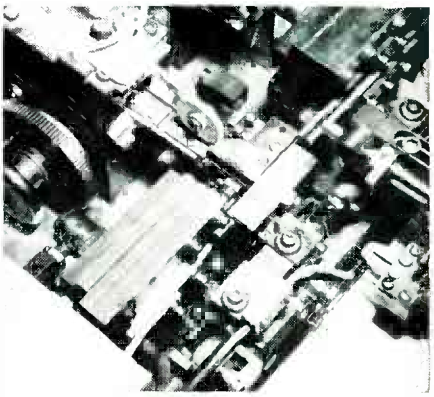

Automatic filament-tabbing machine. Jaws at right have moved to left to ease tension on finished filament while shear moves in to cut the welded tab. A split-second later, the jaws will move to the right and release, dropping the finished filament onto the cardboard square at the lower right

narrow nickel ribbon, both on spools.

The sequence of operation is such that the nickel ribbon is first cut to the length of two tabs, formed into a V, brought up around the filament wire and squeezed over it by clamping jaws. When these jaws retract under cam action, two pairs of welder jaws move in to weld each end of the tab to the wire. The tab is then cut into two pieces of unequal length by a shearing blade, the finished filament is pulled out and dropped over a sheet of cardboard, and the filament wire is advanced the exact length of one filament for repetition of the entire tabbing operation. The short tab for one end of one filament and the long tab for the other end of the next are thus applied in one operation in the Emporium, Pa. plant of Sylvania Electric Products Inc.

Inspecting With Ultraviolet

POWERFUL ultraviolet lamps are used at Utility Electronics to inspect for the completeness of fungi-proofing on military radio equipment.

Properly coated parts have a characteristic fluorescent glow under irradiation, so that areas skipped by the spray gun can be easily detected by visual inspection. The lamps are mounted in a shielding hood in such a way that they cannot shine directly on the

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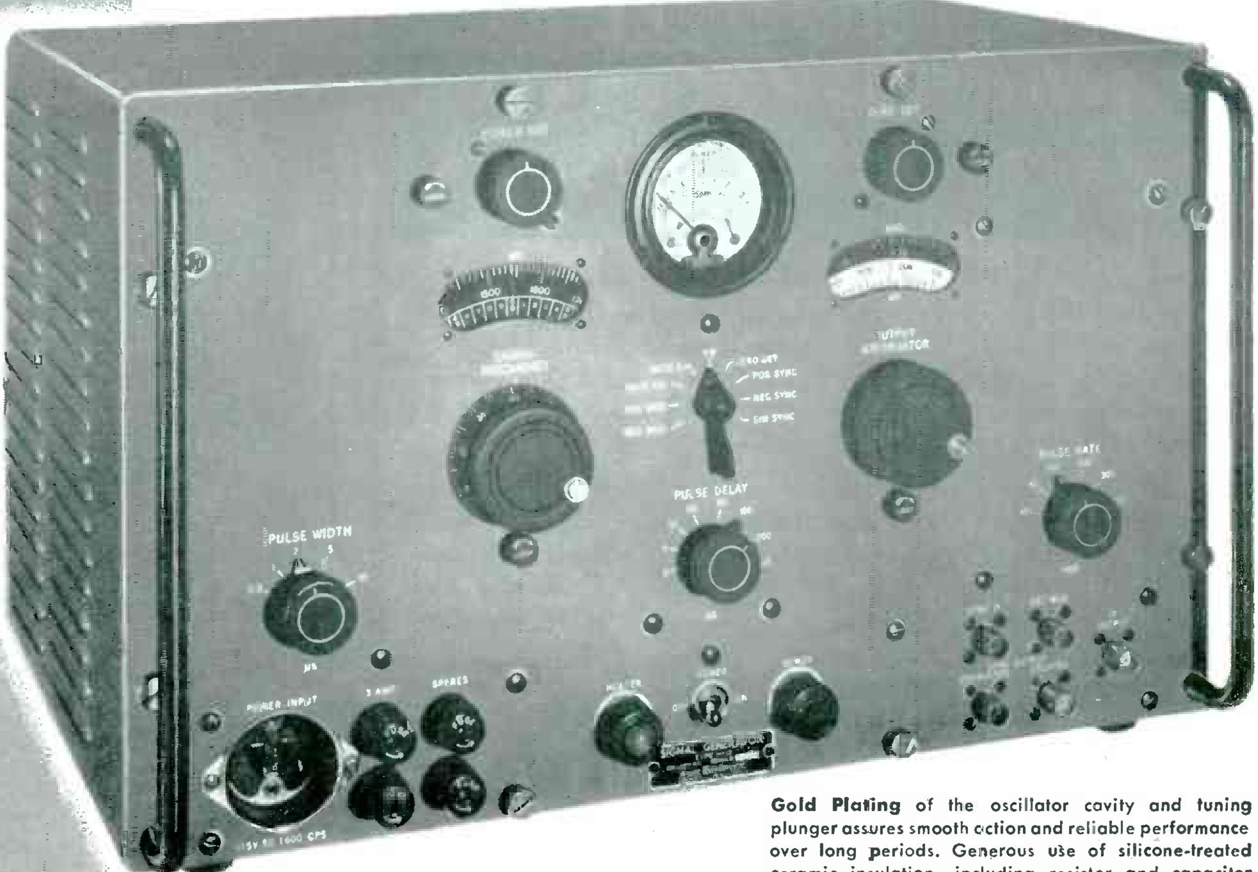

Gold Plating of the oscillator cavity and tuning plunger assures smooth action and reliable performance over long periods. Generous use of silicone-treated ceramic insulation, including resistor and capacitor terminal boards, and the use of sealed capacitors, transformers, and chokes, insures operation under conditions of high humidity for long periods.

The Type H-12

UHF SIGNAL GENERATOR

900-2100 Megacycles

This compact, self-contained unit, weighing only 43 lbs., provides an accurate source of CW or pulse amplitude-modulated RF. A well-established design, the Type 12 has been in production since 1948. The power level is 0 to −120 dbm, continuously adjustable by a directly calibrated control accurate to ±2 dbm. The frequency range is controlled by a single dial directly calibrated to ±1%. Pulse modulation is provided by a self-contained pulse generator with controls for width, delay, and rate; or by synchronization with an external sine wave or pulse generator; or by direct amplification of externally supplied pulses.

Built to Navy specifications for research and production testing, the Type H-12 Signal Generator is equal to military TS-419/U. It is in production and available for delivery.

Price: $1,950 net, f.o.b. Boonton, N. J.

Type H-14 Signal Generator

(108 to 132 megacycles) for testing OMNI receivers on bench or ramp. Checks on: 24 OMNI courses, left-center-right on 90/150 cps localizer, left-center-right on phase localizer, Omni course sensitivity, operation of TO-FROM meter, operation of flag alarms.

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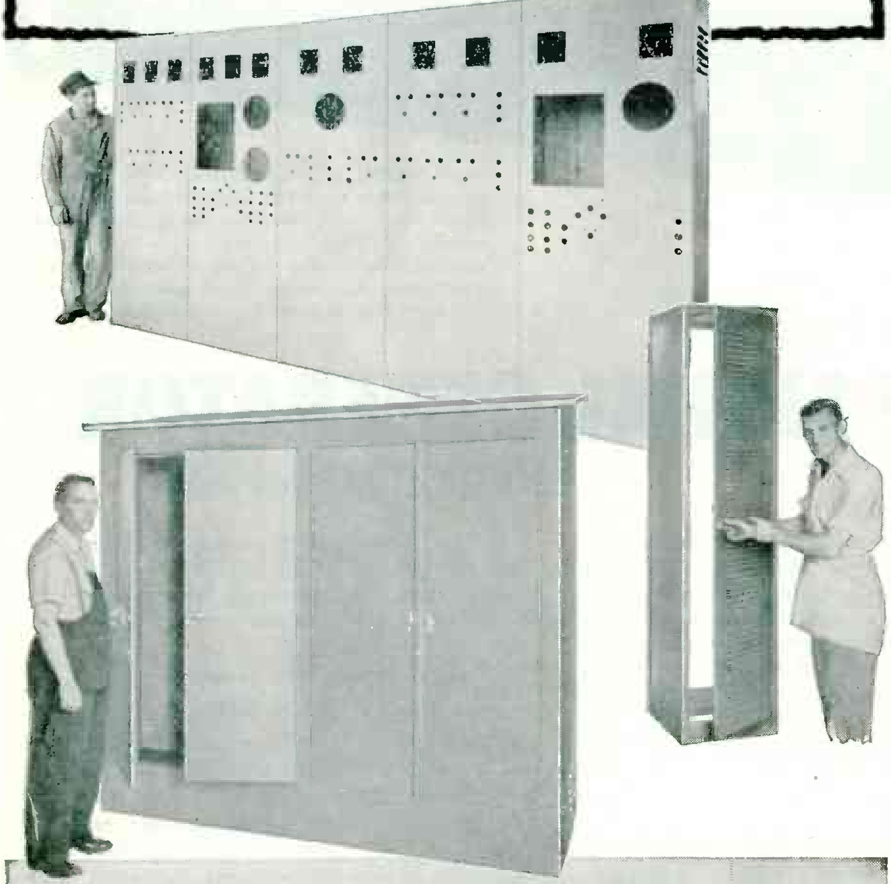

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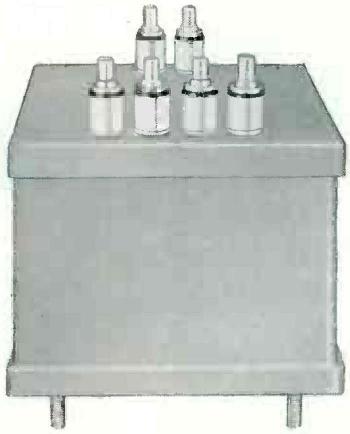

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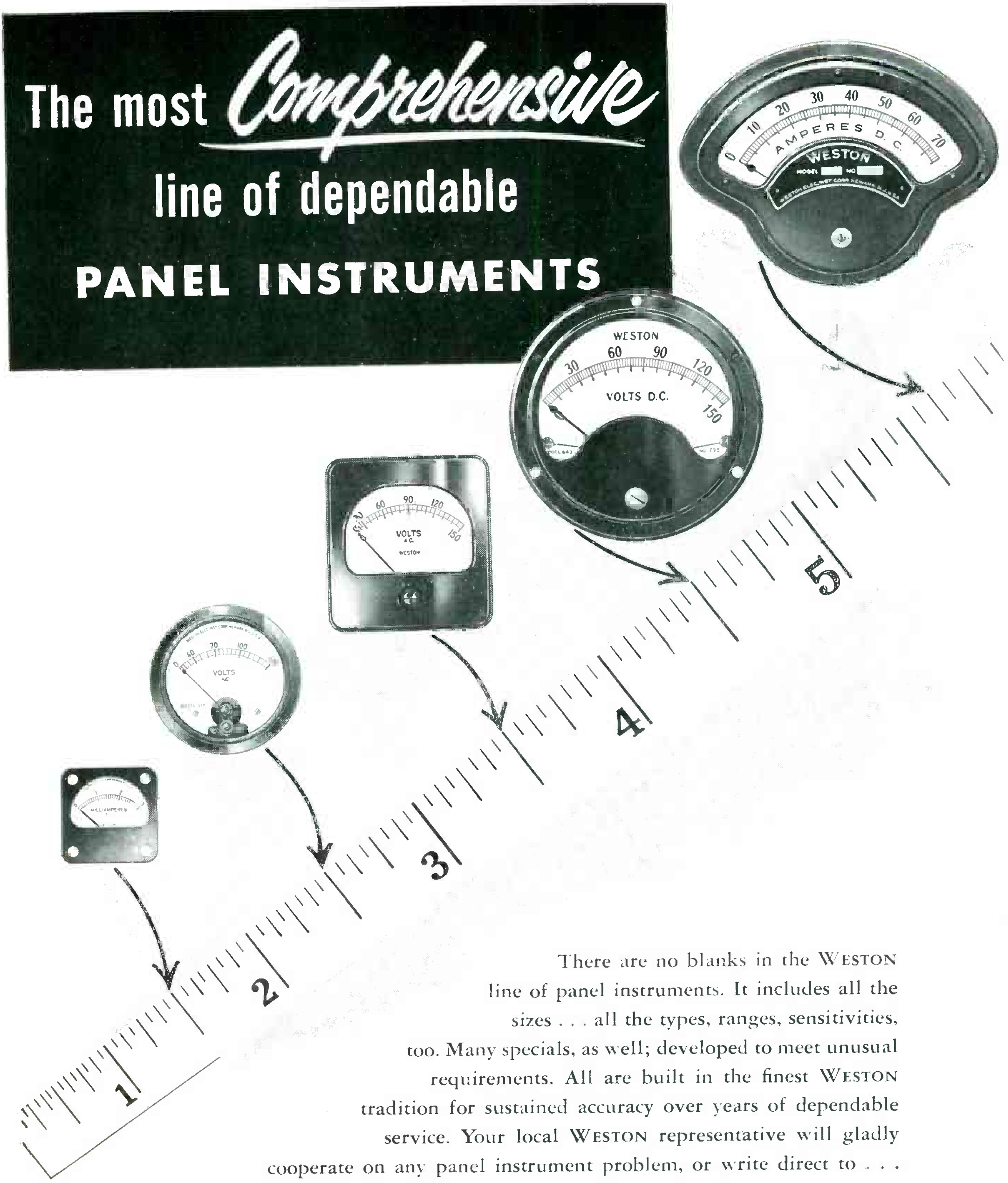

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Bond resistors are made to all standard tolerances and are wound in a wide range of alloys to meet requirements of varying resistance values. They are built to customer specifications and Bond facilities are available for making the following custom-built coils:

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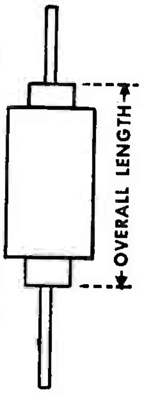
			MIN. OHMS	MAX. MEG OHMS	COMM.	JAN.	
1515	11/16	3/8	1.0	0.42	1/3	1/4	RB51
1516	1 1/16	3/8	1.0	0.85	1/2	1/4	RB51
1517	1 5/16	3/8	1.0	1.25	1.0		
201	1 1/16	7/16	1.0	1.15	3/4	1/4	RB51



Note: All Bond Resistors are impregnated to meet JAN-R-93 specifications.

BOND ELECTRONICS CORPORATION
60 SPRINGFIELD AVENUE, SPRINGFIELD, N. J.

eyes of the inspector.

A similar ultraviolet booth is used by Astron Corp., also in East Newark, N. J., to detect leaks in hermetically sealed capacitors. The impregnating wax used in the units glows with a yellow fluorescence under irradiation. Any wax coming out through a leak can thus be quickly spotted.

Multimeter Tester

In final testing of the Signal Corps TS 297-U multimeter at Utility Electronics in East Newark, N. J., a multi-pin fixture is used to plug into all panel jacks of the multimeter in one operation. The operator then flips switches one by one on the test panel, to connect a test circuit and meter to each range in turn for checking and calibration.

Making connections to all jacks of multimeter with one multi-prong fixture

With connect and disconnect time each simplified to one operation, the operator spends practically the entire day pushing bat-handle toggle switches. This caused sore fingers, hence some of the most-used switches are wrapped with wheel-like wads of adhesive tape for greater comfort.

Pin-Soldering Setup

A HIGH-SPEED setup for soldering electrode leads to the pins of tubes is used in the Emporium, Pa. plant of Sylvania Electric Products Inc. A metal mask over the solder pot has drilled holes for the pins and for the aligning key if soldering octal tubes. Height of the mask is such as to insure correct depth of immersion in the solder. The mask is easily lifted for removal of sludge

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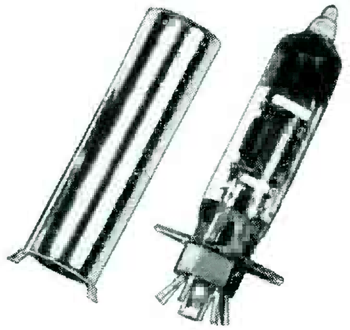
SYLVANIA TUBE SOCKETS

for Rugged Military Service

HIGH QUALITY SYLVANIA SOCKETS IMMEDIATELY AVAILABLE

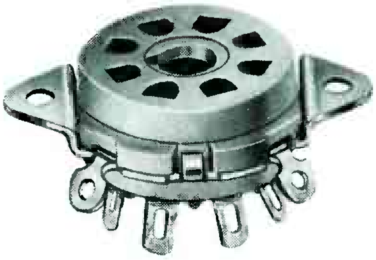
JAN OCTAL TUBE SOCKETS

Saddles of these sockets are nickel plated brass, either top or bottom mounted, with or without ground lugs. Body and contacts are of the same materials as the JAN miniature tube sockets. Contact tabs and saddle ground lugs are hot tin dipped.



JAN 7- AND 9-PIN MINIATURE TUBE SOCKETS

These sockets are available in grade L-4B or better ceramic, or type MFE low loss plastic. The contacts are either phosphor bronze or beryllium copper, silver plated. Contacts and center shield tab are hot tin dipped. Nickel plated brass shields equipped with sturdy springs are available for all 7- and 9-pin sockets.



BUTTON TYPE SUBMINIATURE (T3) TUBE SOCKETS

These sockets are available for round 8-pin subminiature tube types. Insulation is type MFE low loss plastic and contacts are beryllium copper silver plated with gold flash covering. Contacts especially designed for positive connection and high pin retention even after many insertions. Sockets are of rugged construction for long life.

When you order Sylvania Tube Sockets you get the extra value of Sylvania's experience and know-how at no extra cost. Designed for maximum strength and optimum electrical properties, Sylvania Sockets assure high tube retention and tube pin contact even under severe vibration. Highest quality is guaranteed by Sylvania's own exacting quality control.

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Millions of Birtcher Tube Clamps are in use in all parts of the world. They're recommended for all types of tubes: glass or metal—chassis or sub-chassis mounted.

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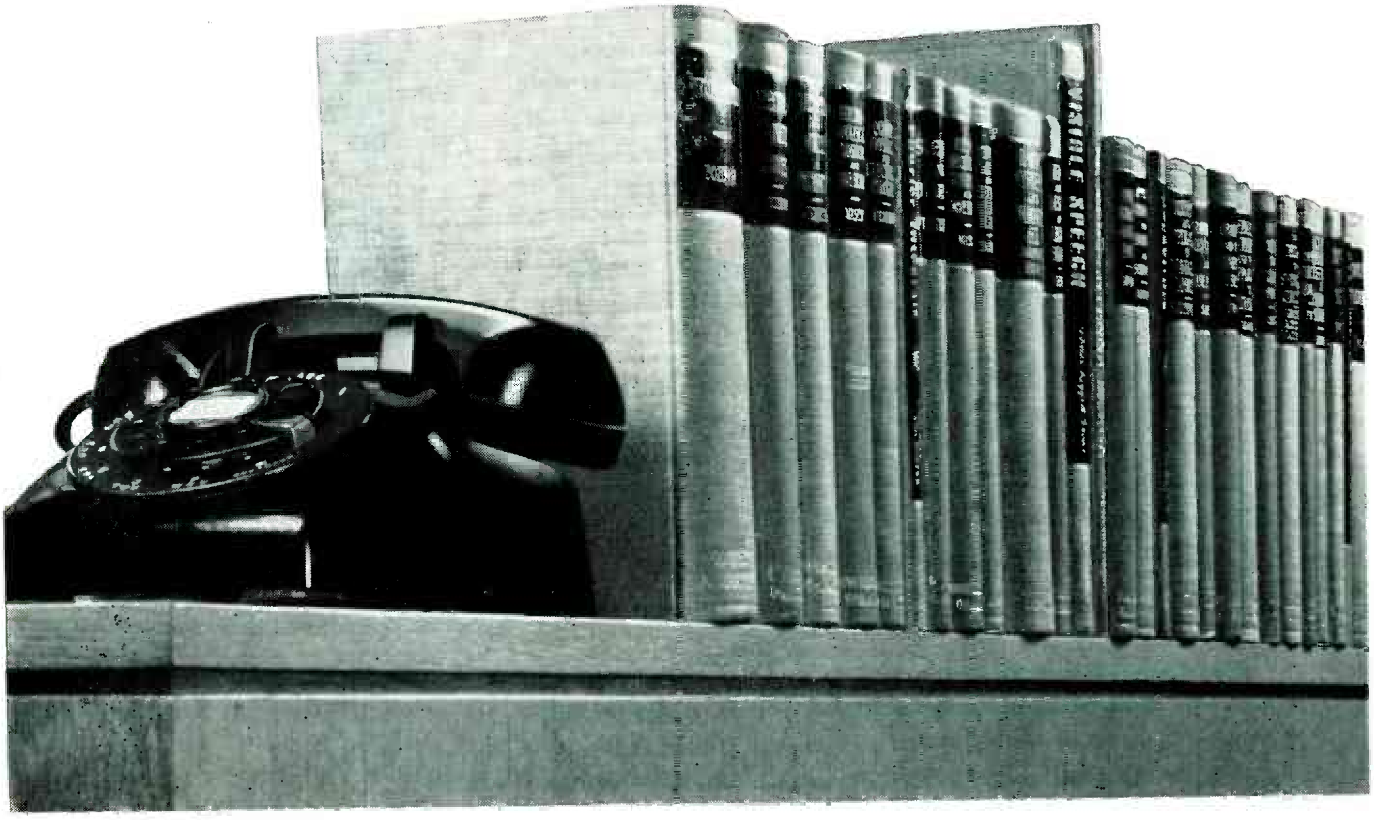

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List of Subjects: Speech and hearing, mathematics, transmission and switching circuits, networks and wave filters, quality control, transducers, servomechanisms, quartz crystals, capacitors, visible speech, earth conduction, radar, electron beams, microwaves, waveguides, traveling wave tubes, semiconductors, ferromagnetism.

In their work to improve your telephone service, Bell Laboratories make discoveries in many sciences. Much of this new knowledge is so basic that it contributes naturally to other fields. So Bell scientists and engineers publish their findings in professional magazines, and frequently they write books.

Most of these books are in the *Bell Telephone Laboratories Series*. Since the first volume was brought out in 1926, many of the books have become standards . . . classics in their fields. Twenty-eight have been published and several more are in the making. They embody the discoveries and experience of one of the world's great research institutions.

Bell scientists and engineers benefit greatly from the published findings of workers elsewhere; in return they make their own knowledge available to scientists and engineers all over the world.

BELL TELEPHONE LABORATORIES

Improving telephone service for America provides challenging opportunities for individual achievement and recognition in scientific and technical fields.

PATENT ATTORNEYS

An unusual situation has developed at Hughes. In the last few years, our Laboratories have grown to a population of more than three thousand men and women, who cover a wide range of research and development. New electronics products we have developed support a manufacturing organization of thousands of additional people.

And yet today our patent attorneys can be numbered on the fingers of two hands!

The explanation is, of course, that our growth has been very rapid and we have gotten a late start in trying to build an appropriately large patent department. The situation has not been made any easier for us by a current rapid expansion of our commercial, nonmilitary interests. As a result, however, we believe that the opportunities for patent attorneys are now unusually attractive at Hughes.

To keep abreast with the work being done in our Laboratories, our patent department must be greatly enlarged; this means that today's openings carry unusual potentialities for rapid advancement. On the other hand, the fact that the Research and Development organization to be served has already established itself as one of the largest and most productive electronics laboratories in the country provides a degree of security not usually associated with opportunities for rapid individual growth.

Inquiries should be addressed to:
Engineering Personnel Department

HUGHES

RESEARCH and DEVELOPMENT LABORATORIES

Culver City, Los Angeles County, California

Assurance is required that re-location of the applicant will not cause disruption of an urgent military project.

Soldering the 7 pins of type OB3 tubes. Gages for checking thickness of soldered pins are at lower left

from the solder surface and for adding solder.

After holding a tube in the solder long enough to bring the pins to proper temperature so solder flows inside each, the operator sets the tube on a projecting pipe in a water bath for cooling it. When the next tube is soldered, she removes the cooled tube with her left hand, presses it against a towel on the bench to sponge off excess water, then pushes the tube into a gage to check for adhering blobs or tears of solder. If within tolerance for pin dimensions, the tube is ready for test. If a pin has excessive solder the entire soldering operation is repeated, with the tube held a bit longer in the solder pot. For some tubes, the pins are pressed into a flux-saturated pad or dipped in liquid flux before being soldered.

Tube Assembly Setup

A WORK position that facilitates inspection and assembly of electrode structures for subminiature tubes is used at the Emporium, Pa. plant of Sylvania Electric Products Inc. A molded rubber mat with raised partitions covers the entire work position in front of the operator to keep small parts neatly separated and insure cleanliness of assembly work. Metal trays and molded plastic trays, each designed especially for transporting and storing a particular component part, are propped

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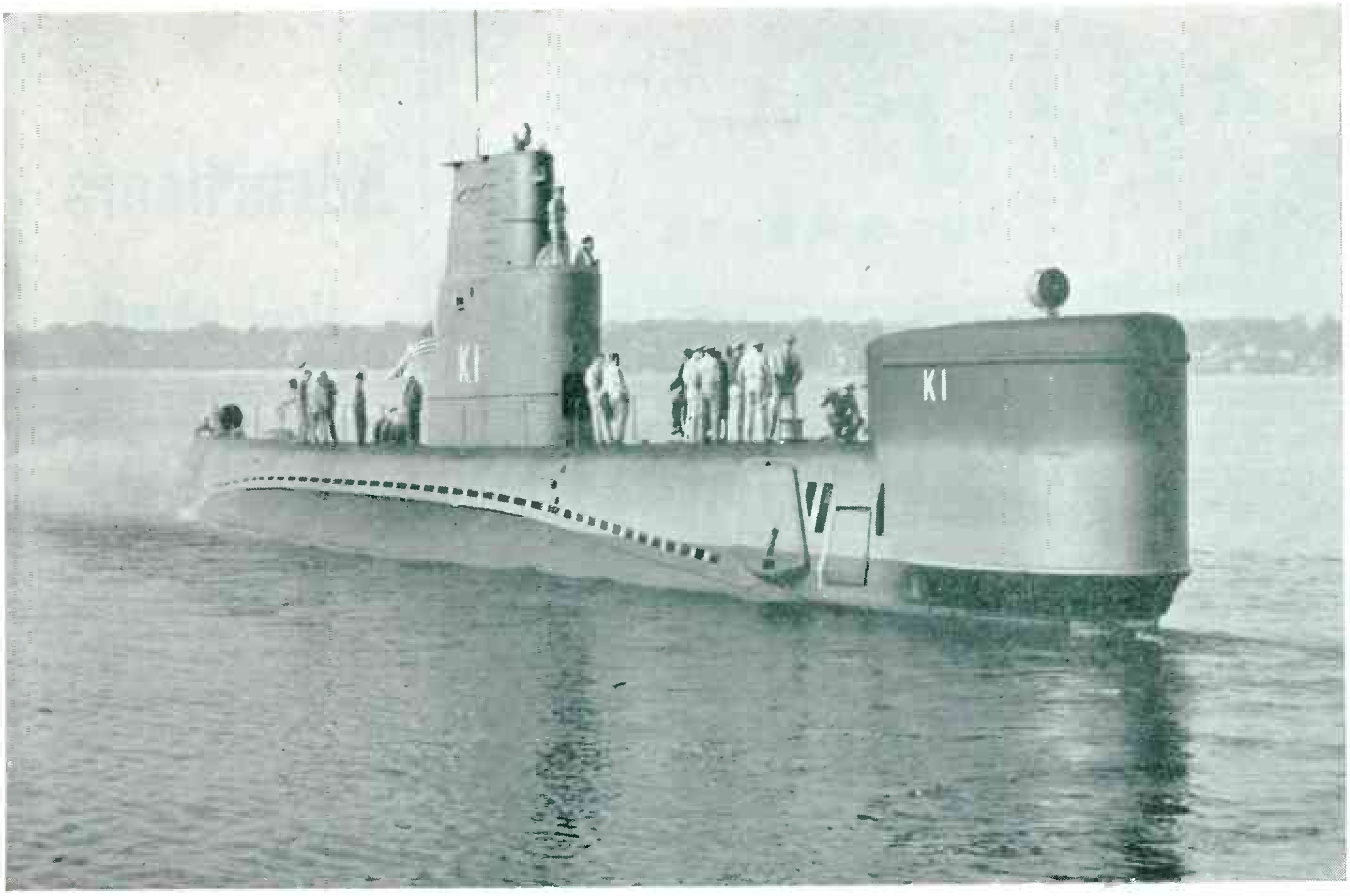

Official U. S. Navy Photo

going down...

but not out

Below periscope level, subs used to grope in the dark, little able to push an effective attack or to strike with accuracy at enemy vessels.

The dark depths were for hiding, not attacking.

Now sonar has changed this. Modern subs of the United States Navy, equipped with newly perfected under water detection devices can locate the enemy at great distances and press home attacks from below periscope depth.

Much of this change in submarine tactics can be traced to the electronic laboratories of the Edo Corporation where new types of sonar have been developed to make possible greater range and accuracy.

Edo has become not only a leader in the design and development of many new sonar devices but also is a major supplier of equipments which help make our Navy's fighting ships and subs the best equipped in the world.

EDO EQUIPS THE K-1

The United States Navy's newest submarine is the K-1 shown above,—a new hunter-killer submarine built by Electric Boat to seek out and destroy enemy submarines. Intricate electronic devices make this new vessel one of the deadliest vessels yet devised.

It is not surprising that much of the under water search and detection equipment of the K-1 was built by Edo where many great new advances in sonar are taking place. For here at Edo, the latest electronic developments are being put to use to increase the range and accuracy of many types of under water detection equipment.

Over a quarter of a century of experience in the aviation, marine, and electronic fields are behind the recent electronic developments which have established Edo as a leader in sonar development. If you haven't received your copy of the book describing Edo's first quarter of a century, write to Electronics Division, Edo Corporation, College Point, N. Y.

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plastic or braided type, conforming to Government Specification JAN-C-76, etc., for radio and instruments. Solid or flexible conductors, in a variety of sizes and colors.

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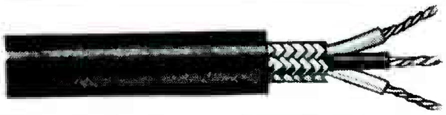
Underwriters Approved, for 80° C., 90° C. and 105° C. temperature requirements. Plastic Insulated, with or without braids.

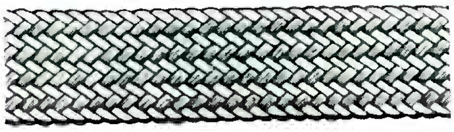


SHIELDED JACKETED MICROPHONE CABLE
Conductors: Multiple—2 to 7 or more conductors of stranded tinned copper. Insulation: extruded color-coded plastic. Closely braided tinned copper shield. Tough, durable jacket overall.

RF CIRCUIT HOOK-UP AND LEAD WIRE
for VHF and UHF, AM, FM and TV high frequency circuits. LENZ Low-Loss RF wire, solid or stranded tinned copper conductors, braided, with color-coded insulation, waxed impregnation.

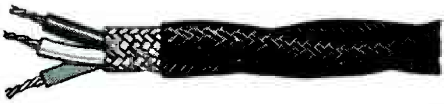
JACKETED MICROPHONE CABLE
Conductors: Extra-flexible tinned copper. Polythene insulation. Shield: #36 tinned copper, closely braided, with tough durable jacket overall. Capacity per foot: 29MMF.

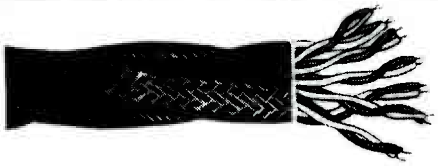
SHIELDED MULTIPLE CONDUCTOR CABLES
Conductors: Multiple—2 to 7 or more of flexible tinned copper. Insulation: extruded color-coded plastic. Closely braided tinned copper shield. For: Auto radio, indoor PA systems and sound recording equipment.



TINNED COPPER SHIELDING AND BONDING BRAIDS
Construction: #34 tinned copper braid, flattened to various widths. Bonding Braids conforming to Federal Spec. QQ-B-575 or Air Force Spec. 94-40229.

SHIELDED COTTON BRAIDED CABLES
Conductors: Multiple—2 to 7 or more of flexible tinned copper. Insulation: extruded color-coded plastic. Cable concentrically formed. Closely braided tinned copper shield plus brown overall cotton braid.





PA AND INTERCOMMUNICATION CABLE
Conductors: #22 stranded tinned copper. Insulation: textile or plastic insulated conductors. Cable formed of Twisted Pairs, color-coded. Cotton braid or plastic jacket overall. Furnished in 2, 5, 7, 13 and 25 paired, or to specific requirements.

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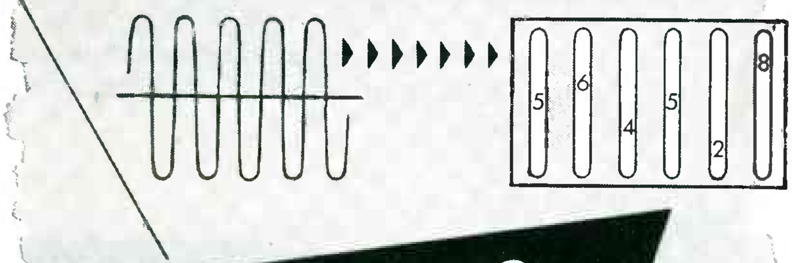
cords, cable and wire for radio ◆ p. a. ◆ test instruments ◆ component parts

*frequency measurement



DIRECT READING
to ± 1 cycle
...20 to
1,000,000
cps

FAST, ACCURATE, SIMPLE determination of unknown frequencies between 20 cycles and 1 megacycle is a routine operation with the Berkeley EPUT (Events-Per-Unit-Time) Meter. Result is displayed in direct reading digital form with accuracy of ± 1 cycle. Unit may be operated manually or recycled automatically. Convenient "test" switch provides complete check of the entire circuit in 2 seconds without additional test equipment. Thus the most inexperienced operator may at any time verify proper functioning of the EPUT.

SPECIFICATIONS

	MODEL 554	MODEL 558
RANGE	20-100,000 cps	20-1,000,000 cps
ACCURACY	± 1 cycle	± 1 cycle
TIME BASE	1 second	1 second
SHORT TERM STABILITY	Standard crystal—1 part in 10^5 Oven crystal—1 part in 10^6	Oven crystal—1 part in 10^6
INPUT (any wave form)	0.2-50 volts rms (pos.)	0.2-25 volts rms (pos. or neg.)
DISPLAY	Direct reading digital—variable 1-5 seconds	
DIMENSIONS	20¾" x 10½" x 15"	20¾" x 19" x 15"
PANEL	Standard rack 19" x 8¾"	Standard rack 19" x 17½"
PRICE	$775	$995

MODIFICATIONS: Standard modifications include 0.1, 1.0 and 10 second selective time base; automatic time base scanning over range of from 3-60 seconds; switch conversion to straight forward electronic counter; temperature-controlled crystal; remote indication. Special modifications can be made to meet particular requirements.

APPLICATIONS: As a production tool for mass checking of frequency sensitive elements by non-technical personnel—As a tool for rapidly and accurately checking crystals in production—As a general laboratory facility for frequency measurement and counting applications of all kinds.

For literature and data, please write for Bulletin 554

Berkeley Scientific
division of BECKMAN INSTRUMENTS INC.
2200 WRIGHT AVENUE • RICHMOND, CALIFORNIA

Assembly of top electrode structure for type 5905 tube. Magnet for handling degreased anodes is placed on lamp when not in use, at right of magnifying glass

at an angle within easy reach of the operator.

All parts are handled with tweezers or with a small permanent magnet as they are assembled on the pivoted bench-mounted holding fixture. Mica insulating spacers and degreased anodes come in Desicooler cans, furnished by Fisher Scientific Co., to minimize chances for contamination. Finished electrode structures are set on sheets of corrugated paper for transporting to the next work position. The size of the open corrugation is such that assemblies fit snugly in the grooves of the paper.

A 10-power magnifying glass is fastened to the overhead fluorescent lamp with soft but heavy wire so the lens will stay in any desired position. The glass is used for examining an assembly to see if grids are in line and none are bent.

Paper Cups for Cathodes

To PREVENT contamination of oxide-coated cathode sleeves of tubes after baking, the sleeves are transported to electrode assembly positions in small paper cups. Tweezers are used to pick out a cathode and insert it in the lower mica spacer of the tube.

Other small parts for the electrode structure are transported in metal or plastic trays having curvedbottom partitions to facili-

curved-bottom partitions to facili-

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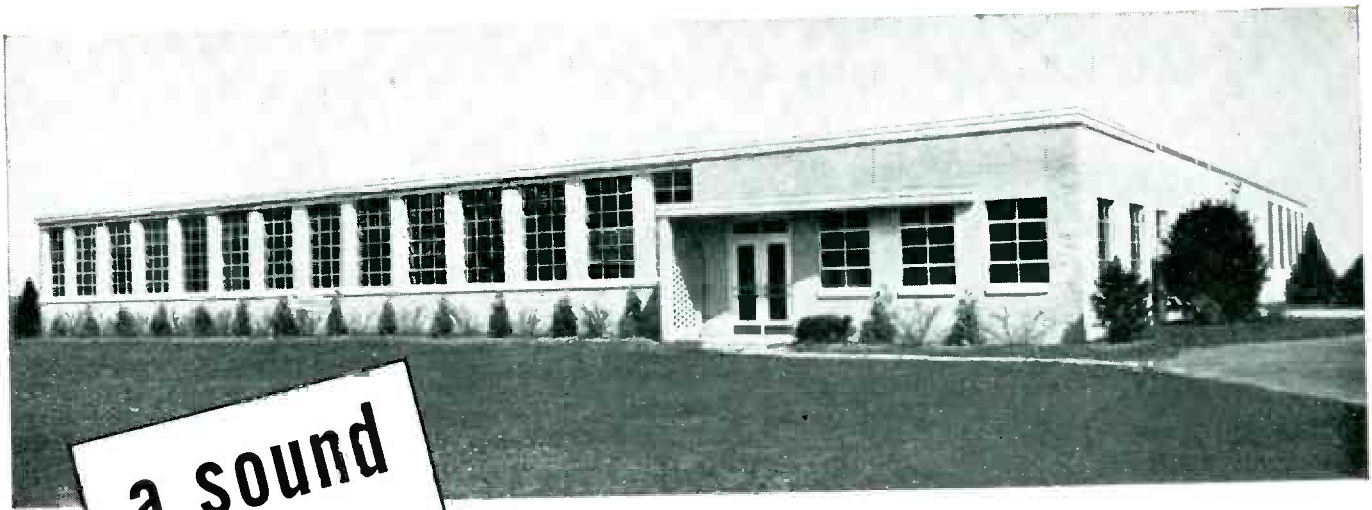

a sound move...

Dyna-Labs had its ear to the ground as long ago as 1946, the birth date of our business. Even then it was apparent that the demand for our newly developed earphones would soon strain our facilities to the limit. Today, in our own new "plant-in-the-country" location—with its one-floor operation, smoother departmental coordination, and vastly expanded facilities—we can serve our clients throughout the world better, faster, and more economically. Extensive provisions have been made, too, for the wide applications of the remarkable new Dyna-Labs Gaussmeter and Aviation Earphone Set illustrated below. We feel that it would be a sound move on your part to investigate the possibilities of these items in your business.

D-79 GAUSSMETER

First time ever—an instrument for all your magnetic measuring problems. Measures flux density, determines direction of flow, locates and measures stray fields, plots variations in strength, and checks production lots against a standard. Simple to operate, no ballistic readings, no jerking, no pulling. Supplied with protective carrying case.

D-47, D-69, D-90 HEARING AID EARPHONES

Dyna-Labs supplies almost 100% of the industry's outside purchases of hearing aid earphones. Illustrated in full scale are the sub-miniature, miniature and standard models, developed in our own laboratories, and accepted as the ultimate in modern design and performance.

D-98 AVIATION EARPHONE SET

This new development in radio earphones for commercial and private aircraft supplants the cumbersome, old-fashioned, "can" type headphones. It has been thoroughly tested under all ground and flight conditions, and has been approved by the CAA. Complete set weighs only 2½ ounces.

Exclusive Agents:
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Dyna-Labs INC.

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DEPENDABLE
1/8 MICRO-SECOND TIMING

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IN MEASURING:

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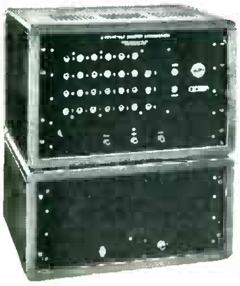
INSTRUMENT Potter COMPANY, INC.

8 MEGACYCLE COUNTER-CHRONOGRAPH



DIVIDES 1 SECOND INTO 8,000,000 PARTS

GREATER ACCURACY

The use of an 8 megacycle crystal time base provides the highest resolution of time measurement available in direct reading instruments.

COMPLETE DEPENDABILITY

To assure the highest degree of dependability, a straightforward 3-stage binary counter is used at the 8 megacycle frequency permitting the conservative use of decade counters at the lower frequencies.

DIRECT READING

Digital registration is used to indicate time from 1 microsecond to 1 second by means of 6 Potter decades. Fractional parts of a microsecond are read from a 3-stage binary counter which indicates in steps of 1/8 microsecond.

PROVED PERFORMANCE

Ten years of service in proving grounds and research centers give conclusive evidence that the simplified circuitry inherent in the Potter Counter-Chronographs provides the maximum reliability for critical timing applications.

WIDE APPLICATION

There is a Potter Counter-Chronograph made for your specific application. . . . High-speed digital recorders are available for permanent recording of measurements at rates up to 150 per second.

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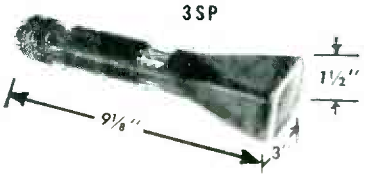
POTTER INSTRUMENT COMPANY
INCORPORATED
110 CUTTER MILL ROAD, GREAT NECK, NEW YORK

MANUFACTURERS OF
PREDETERMINED ELECTRONIC COUNTERS • FREQUENCY TIME COUNTERS • PRESET INTERVAL GENERATORS
HIGH SPEED PRINTING AND RECORDING, SHIFT REGISTERS, AND DATA HANDLING EQUIPMENT

SEE US AT BOOTH 1101 WEST COAST I. R. E. SHOW AND NATIONAL INSTRUMENT EXHIBIT, BOOTH 414, CLEVELAND

THE RAYONIC®
CATHODE RAY TUBES
BY WATERMAN

3SP



Since the introduction of Waterman RAYONIC 3MP1 Tube for miniaturized Oscilloscopes, Waterman has developed a rectangular Tube for multi-trace oscilloscopy. Identified as the Waterman RAYONIC 3SP, it is available in P1, P2, P7 and P11 screen phosphors. The face of the Tube is 1½" x 3" and the over-all length is 9⅛". Its unique design permits two 3SP Tubes to occupy the same space as a single 3" round tube, a feature which is utilized in the S-15-A TWIN-TUBE POCKETSCOPE. On a standard 19" relay rack, it is possible to mount up to ten 3SP tubes with sufficient clearances for rack requirements. Thus 3SP RAYONIC tube is ideal for multi-trace oscilloscopic work.

Maximum 2nd anode voltage 2750 volts . . . Satisfactory operation can be achieved at 600 volts . . . Vertical deflection factor 52 to 70 volts DC per inch per kilovolt . . . Horizontal deflection factor 73 to 99 volts DC per inch per kilovolt . . . Grid cut-off voltage 2.8 to 6.7% of 2nd anode potential . . . Focusing voltage 16.5 to 31% of 2nd anode voltage . . . Heater 6.3V at .6 amp . . . Twelve pin small shell duodecal base . . . Tube can be mounted in any position . . . 3SP1 JAN approved.

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WATERMAN PRODUCTS INCLUDE:
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The Bridgeport warehouses are designed to supply from stock limited quantities of sheet, rod, wire or tubing. It is the policy of the company to maintain adequate warehouse stocks at all times so that small orders can be filled without delay.

The fabricator is in a position to obtain promptly metal to fill orders for experimental work or to start production runs, while waiting for mill shipments.

Bridgeport warehouses make every effort to carry the variety of alloys, sizes and gages which fulfill the requirements of the locality they serve.

To take care of the maximum range of widths of strip metal, slitting service is available—not only to serve warehouse stocks, but also to make customers' stocks of non-ferrous strip metal more flexible.

Bridgeport's Warehouse Stocklist carries weight tables and a technical digest giving the properties of the most popular copper-base alloys. If you do not have a copy, ask your nearest Bridgeport office.

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Browning OSCILLOSYNCHROSCOPES ON-5A ON-5X
SYNCHROSCOPE P4-EX

Models ON-5A and ON-5X are designed as basic, highly flexible laboratory instruments for general pulse work. Their specifications include:

- High-gain vertical amplifiers.
- Triggered sweeps, from an external trigger or from the input to the vertical amplifier.
- Recurrent sweeps, at a repetition rate of 10 to 100,000 per second.
- Vertical input delay of 0.45 microsecond (ON-5X).

Model P4-EX is designed for applications requiring a triggered sweep, and where the signal levels met do not demand extremely high-gain amplification. Its many outstanding features include:

- Internal trigger, at a repetition rate of 50 to 5000 per second, easily synchronized with an external trigger if desired.
- Output trigger, with the same range of repetition rates, which can be continuously phased to lead or lag the sweep start by a maximum of 500 microseconds.

Detailed specifications and performance data available promptly on your request.

These new instruments represent a high level of precision design and versatility of application at remarkably low cost. Major features that are common to all three instruments include:

- Type 5UP cathode-ray tube, operating at an accelerating potential of 2600 volts. P1, P7 and P11 screens are available.
- Sweep writing rate continuously variable from 1.0 to 25,000 microseconds per inch.
- Sweep calibration in microseconds per horizontal scale division, accurate to plus or minus 10%.
- Vertical amplifier flat within 3 db from 5 cycles to 5 megacycles.
- Vertical calibration voltages, at accuracy of plus or minus 5% for Model P4-EX, and plus or minus 10% for Models ON-5A and ON-5X.
- Vertical amplifier input step attenuator.
- CRT cathode connection externally available, for application of blanking or marker pulses.

NET PRICES, F.O.B. Winchester, Massachusetts:
P4-EX . . . $465.00 ON-5A . . . $485.00 ON-5X . . . $535.00

Write today for **FREE BULLETINS** giving detailed specifications and performance data.

BL
BROWNING
Laboratories, Inc.
Winchester, Mass.
ENGINEERED FOR ENGINEERS

Assembling mount for type 6095 tube, a ruggedized version of the 6AQ5 pentode. Cathode sleeves are in paper cups. Holding fixture pivots forward or back, and top part rotates

tate picking out parts with tweezers. A simple holding fixture grips the mica spacer and stem leads on which the tube mount is assembled piece by piece in the Emporium plant of Sylvania Electric Products Inc.

Moth Balls for Silver

WHEN silver-plated components or contacts for electronic equipment are to be stored for several weeks or longer, they are liberally sprinkled with moth balls in the East Newark, N. J. plant of Utility Electronics, to prevent corrosion by normal sulphides in the atmosphere.

Tote Boxes

FIBER boxes with tapered sides, recessed bottoms and reinforced metal corners serve as low-cost safe-stacking tote boxes for finished tubes and parts at the Emporium plant of Sylvania Electric Products

Method of stacking tapered-side tote boxes

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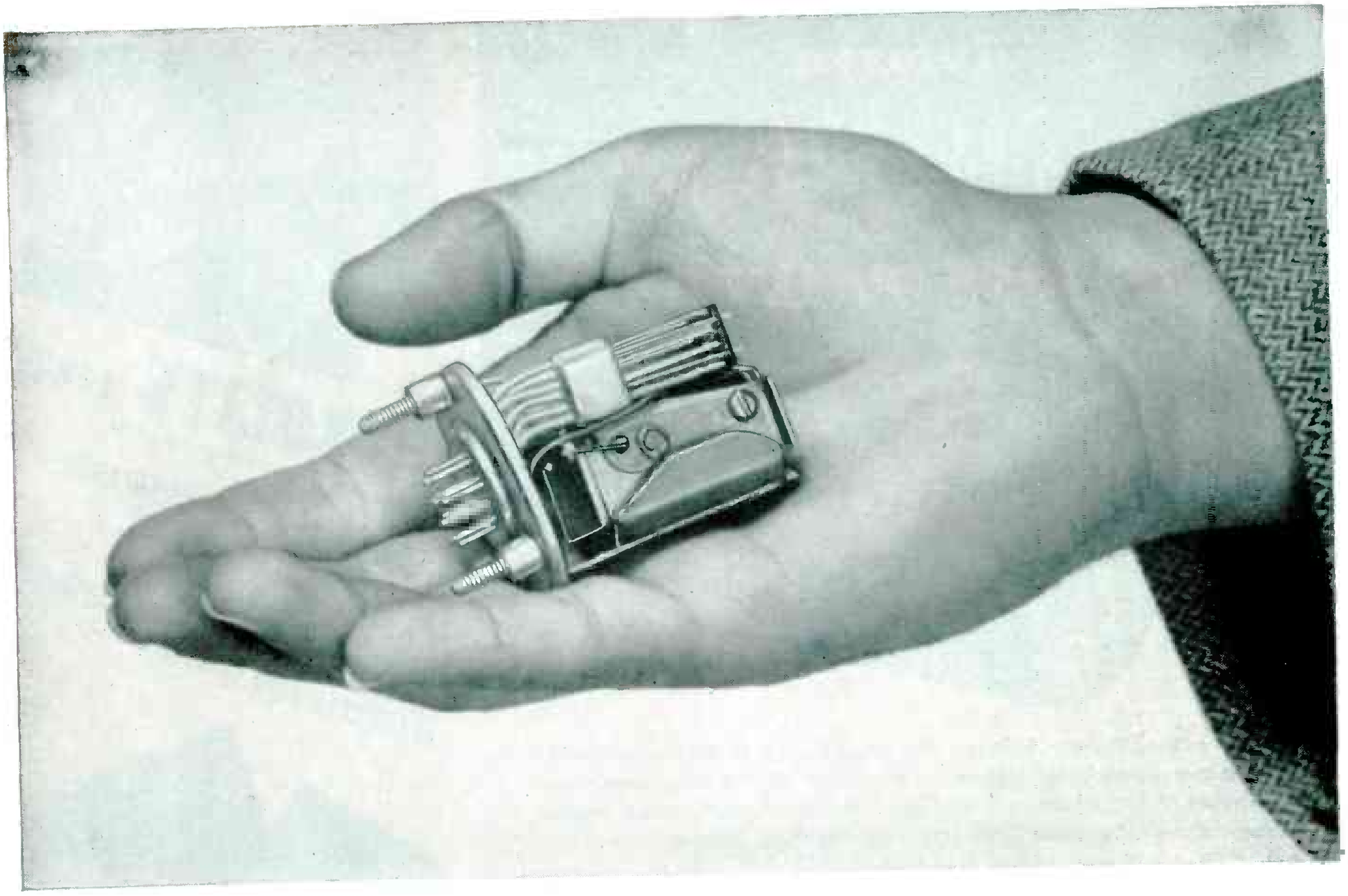


New G-E Relay Doubles Tip Pressure

Hermetically-sealed unit has larger magnet, no extra weight

Double the average tip pressure, 40-55 grams, is delivered by the larger magnet structure of the new G-E relay without exceeding Air Force-Navy specifications for size and weight.

The new relay, the first specifically designed for hermetic sealing, will withstand 50g operational shocks and instantaneous voltage surges up to 1500 volts rms *without failure.*

LONGER RELAY LIFE

The large magnet, polyester stack insulation, and silver-tipped contacts assure reliable, long-lived operation in aircraft, shipboard, portable land-based equipment and other systems which must meet Air Force-Navy specifications.

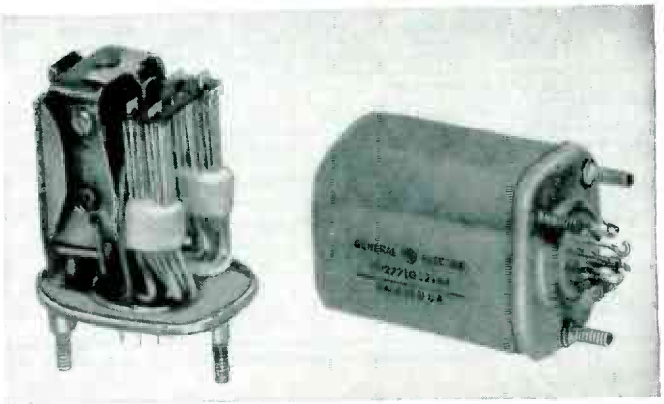
In every way, this new G-E relay is in a world of its own—sealed in a standard size enclosure against dirt, salt spray, high humidity, and widely varying air pressures.

RELIABLE SHIPMENT

This new device is now in full production and shipment can be made to meet your schedules.

Ask your nearest G-E office for more information, and send the attached coupon today. *General Electric Company, Schenectady 5, New York.*

GENERAL ELECTRIC



THE LARGER MAGNET is made possible by an exclusive G-E design which utilizes the relay housing for structural support, thus eliminating much of the weight of internal bracing.

General Electric Company
Section A730-41
Schenectady 5, New York

Gentlemen:

I would like __ copies of Bulletin GEA-5729 on hermetically-sealed relays for:

_____ reference only   _____ an immediate project

Name .... Title ....

Company ....

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Autosyn*

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Precision-Built by

ECLIPSE-PIONEER

For more than 18 years, Eclipse-Pioneer has been a leader in the development and production of high precision synchros for use in automatic control circuits of aircraft, marine and other industrial applications. Today, thanks to this long experience and specialization, Eclipse-Pioneer has available a complete line of standard (1.431" dia. X 1.631" lg.) and Pygmy (0.937" dia. X 1.278" lg.) Autosyn synchros of unmatched precision. Furthermore, current production quantities and techniques have reduced cost to a new low. For either present or future requirements, it will pay you to investigate Eclipse-Pioneer high precision at the new low cost.

*REG. TRADE MARK BENDIX AVIATION CORPORATION

AVERAGE ELECTRICAL CHARACTERISTICS—AY-200 SERIES**

	Type Number	Input Voltage Nominal Excitation	Input Current Milliamperes	Input Power Watts	Input Impedance Ohms	Stator Output Voltages Line to Line	Rotor Resistance (DC) Ohms	Stator Resistance (DC) Ohms	Maximum Error Spread Minutes
Transmitters	AY201-1	26V, 400~, 1 ph.	225	1.25	25+j115	11.8	9.5	3.5	15
	AY201-4	26V, 400~, 1 ph.	100	0.45	45+j225	11.8	16.0	6.7	20
Receivers	AY201-2	26V, 400~, 1 ph.	100	0.45	45+j225	11.8	16.0	6.7	45
Control Transformers	AY201-3	From Trans. Autosyn	Dependent Upon Circuit Design				42.0	10.8	15
	AY201-5	From Trans. Autosyn	Dependent Upon Circuit Design				250.0	63.0	15
Resolvers	AY221-3	26V, 400~, 1 ph.	60	0.35	108+j425	11.8	53.0	12.5	20
	AY241-5	1V, 30~, 1 ph.	3.7	—	240+j130	0.34	239.0	180.0	40
Differentials	AY231-3	From Trans. Autosyn	Dependent Upon Circuit Design				14.0	10.8	20

**Also includes High Frequency Resolvers designed for use up to 100KC (AY251-24)

AY-500 (PYGMY) SERIES

	Type Number	Input Voltage Nominal Excitation	Input Current Milliamperes	Input Power Watts	Input Impedance Ohms	Stator Output Voltages Line to Line	Rotor Resistance (DC) Ohms	Stator Resistance (DC) Ohms	Maximum Error Spread Minutes
Transmitters	AY503-4	26V, 400~, 1 ph.	235	2.2	45+j100	11.8	25.0	10.5	24
Receivers	AY503-2	26V, 400~, 1 ph.	235	2.2	45+j100	11.8	23.0	10.5	90
Control Transformers	AY503-3	From Trans. Autosyn	Dependent Upon Circuit Design				170.0	45.0	24
	AY503-5	From Trans. Autosyn	Dependent Upon Circuit Design				550.0	188.0	30
Resolvers	AY523-3	26V, 400~, 1 ph.	45	0.5	290+j490	11.8	210.0	42.0	30
	AY543-5	26V, 400~, 1 ph.	9	0.1	900+j2200	11.8	560.0	165.0	30
Differentials	AY533-3	From Trans. Autosyn	Dependent Upon Circuit Design				45.0	93.0	30

For detailed information, write to Dept. C.

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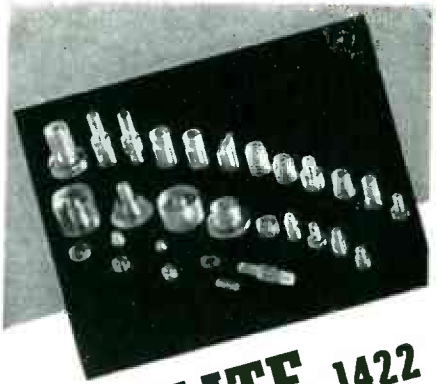
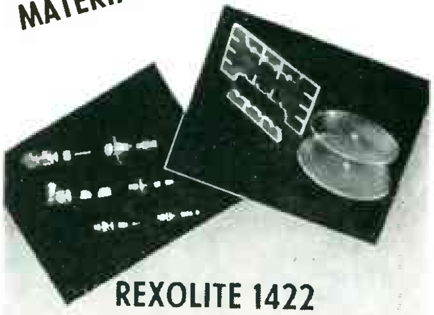
Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.



REXOLITE 1422

(FORMERLY G. E. TEXTOLITE 1422)

COMBINES EVERY DESIRABLE PHYSICAL, CHEMICAL, & ELECTRICAL PROPERTY IN ONE INSULATING MATERIAL FOR U. H. F.



REXOLITE 1422

- Specifically designed to meet the growing need for a U. H. F. insulating material thats low in cost.
- Meets JAN-P-77 and MIL-P-77A specifications.
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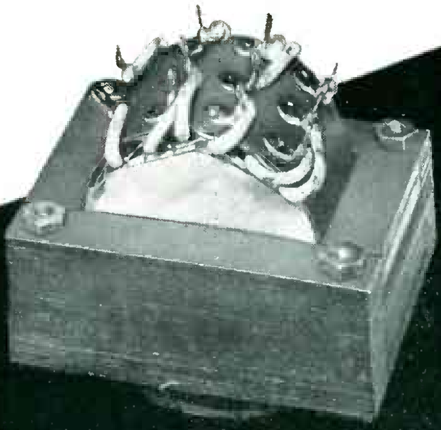

LEFT—Open view of a typical Keystone Aircraft Power Transformer to show construction. This particular unit was supplied hermetically sealed.

Aircraft Power TRANSFORMERS

The more rugged your transformer requirements—the more you need Keystone quality production. Unit shown is 400 Cycle, Single Phase aircraft power transformer. High voltage and Filament Supply. Every Keystone Transformer and every Keystone Magnetic Amplifier is custom-built. Open or hermetically sealed. Prices gladly quoted on request. Please send your prints and specifications by registered mail for safety.

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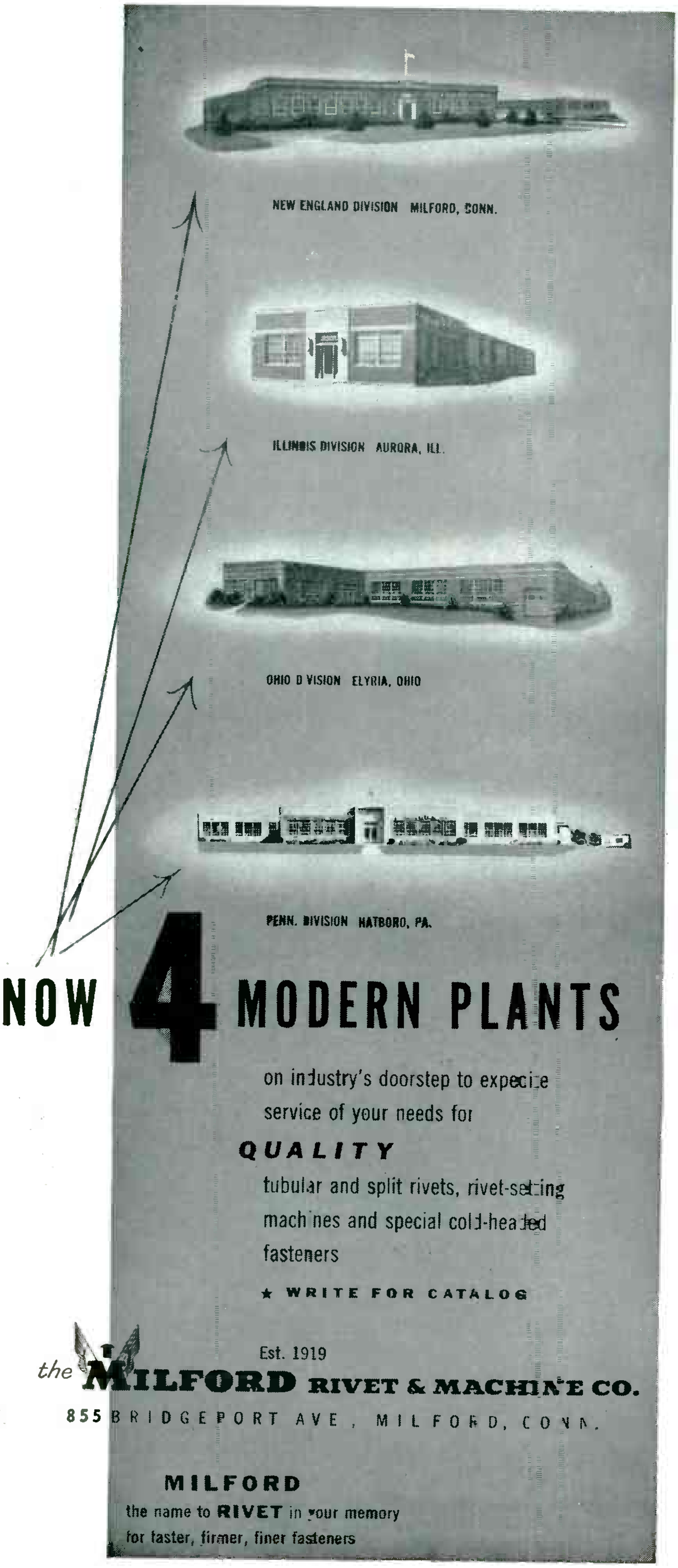

Inc. Assembly with tubular rivets gives strength at low cost. The boxes were built to Sylvania specifications in two different sizes by Grand Rapids Tote Box Co., Grandville, Mich.

Chassis Protector

Wood blocks on top of protective wood frame are turned to lock chassis in position. Open sides give access to parts

A SIMPLE open-sided wood frame is used to hold each completed military radio chassis after assembly at the Clifton, N. J. plant of Federal Telephone and Radio Corp., an IT&T associate. The frame protects chassis and components against damage or scratching during alignment and final operating tests.

Spraying Small Parts in Tumbling Cage

MICA spacers in batches of several thousand are each sprayed on both sides with a magnesium compound at a production rate of about 5 minutes per batch, by mounting the spray gun inside a rotating cylindrical screen-wire cage like a tumbling barrel and letting the spacers tumble through the spray. A 250-watt Sylvania infrared heat lamp, also inside the cage, bakes the compound simultaneously with spray-

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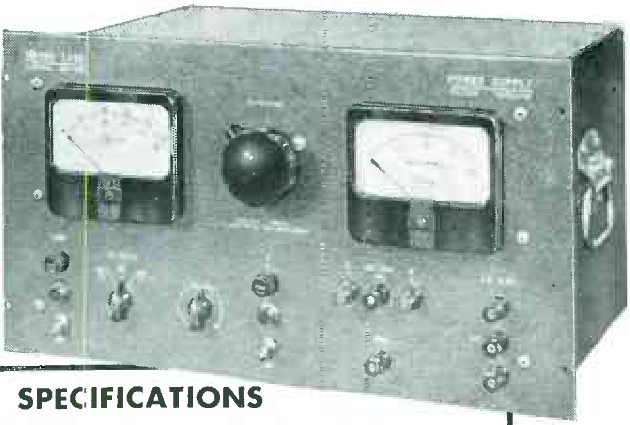

MODEL 815

DC POWER SUPPLY SPECIFICATIONS

REGULATION: ½% for both line (105-125 volts) and load variations.
REGULATION BIAS SUPPLIES: 10 millivolts for line 105-125 volts.
½% for load at 150 volts.
RIPPLE: 5 millivolts RMS

VOLTS	CURRENT	MODEL
100-325 0-150 Bias 6.3 AC.CT.*	0-150 Ma. 0-5 Ma. 10 Amp.	**131**
100-400 6.3 AC.CT	0-150 Ma. 10 Amp.	**141**
200-500 6.3 AC.CT.	0-200 Ma. 6 Amp.	**245**
0-300 0-150 Bias 6.3 AC.CT.	0-150 Ma. 0-5 Ma. 5 Amp.	**315**
0-500 6.3 AC.CT.	0-300 Ma. 10 Amp.	**500R**
#1 200-500 #2 200-500 #3 6.3 AC.CT. #4 6.3 AC.CT.	0-200 Ma. 0-200 Ma. 6 Amp. 6 Amp.	**510**
0-500 0-150 Bias 6.3 AC.CT.	0-300 Ma. 0-5 Ma. 10 Amp.	**615**
0-350	0-750 Ma.	**700**
0-350	0-1.50 Amp.	**710**
0-350	0-2.25 Amp.	**720**
0-350	0-3.00 Amp.	**730**
0-600	0-750 Ma.	**750**
0-600	0-1.50 Amp.	**760**
0-600	0-2.25 Amp.	**770**
0-600	0-3.00 Amp.	**780**
#1 0-600 #2 0-600 #3 6.3 AC.CT. #4 6.3 AC.CT.	0-200 Ma. 0-200 Ma. 10 Amp. 10 Amp.	**800**
0-600 0-150 Bias 6.3 AC.CT.	0-200 Ma. 0-5 Ma. 10 Amp.	**815**
0-1000 Ripple 10 mv. 6.3 AC.CT.	0-50 Ma. 10 Amp.	**1020**
0-1200 Ripple 10 mv. 6.3 AC.CT.	0-20 Ma. 10 Amp.	**1220**
200-1000 Ripple 20 mv.	0-500 Ma.	**1250**
0-1000 Ripple 20 mv.	0-500 Ma.	**1350**
100-400 Regulation 0.01% Ripple 1 Mv. 6.3 AC.CT.	0-150 Ma. 10 Amp.	**2000**
0-30 Ripple 0.1%	0-30 Amp.	**3030**
0-3 Regulation 5 Mv. Ripple 1 Mv.	0-100 Ma.	**3100**

*All AC Voltages are unregulated. All units are metered except Models 131, 315 and 3100
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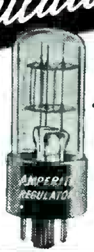

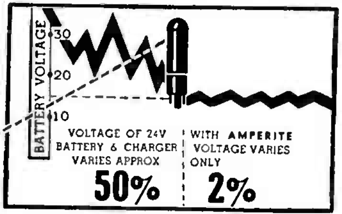

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RG-22B/U
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RG-24/U
RG-29/U
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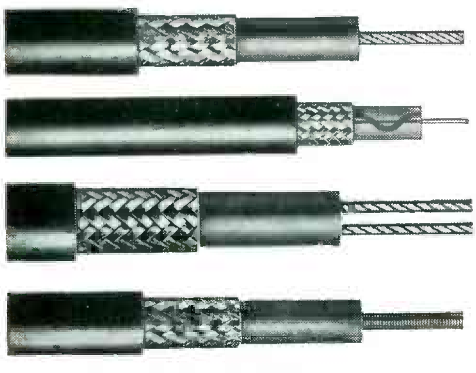

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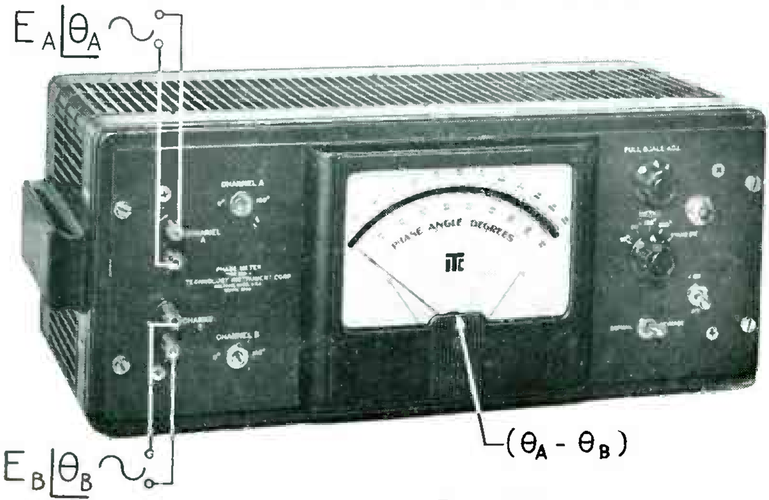

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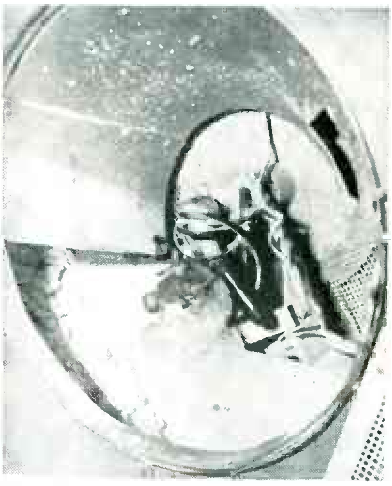
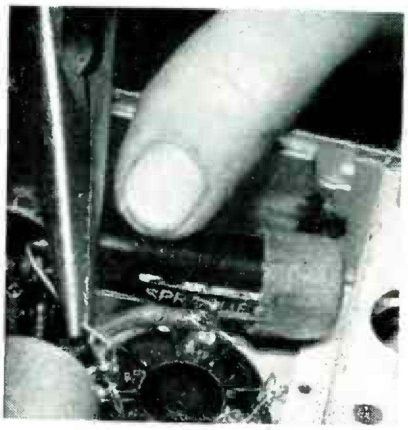


Use of spray gun and infrared lamp inside motor-driven squirrel cage to add insulating coating of magnesium compound to mica spacers for tubes

ing. The material cracks as it hardens, so that under a microscope the surface of the added insulating coating resembles that of a dried-out mudhole. This provides the desired increase in length of surface leakage paths.

Fiber Caps Prevent Shorts To Chassis

WHEN bare pigtail leads of capacitors are folded back along the component to reach a terminal close to the side in a crowded chassis, there is danger of the lead shorting to the chassis. This is particularly true in auto radios, where parts may shift due to vibration. Instead of insulating the lead with spaghetti as is conventionally done, time and money are saved in the Buffalo plant



Connecting capacitor lead to tube socket terminal in auto radio. Other lead is covered by fiber cap that prevents shorts to adjacent chassis walls

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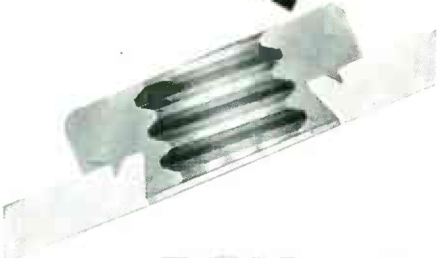

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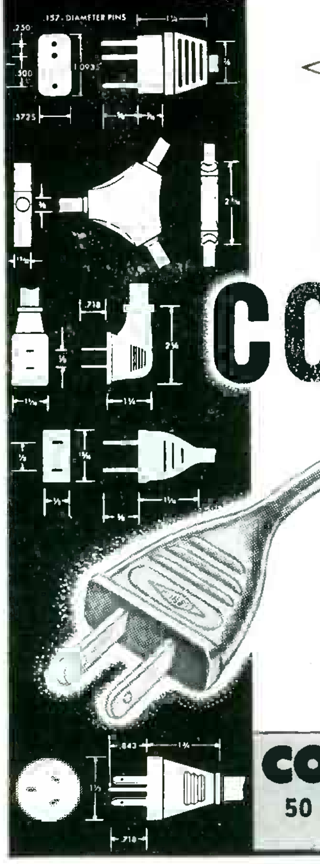

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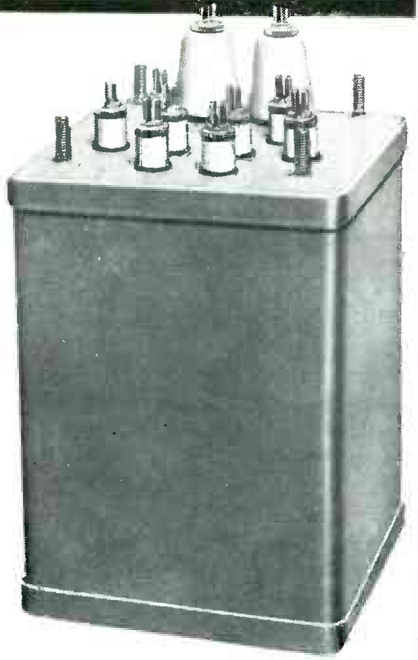
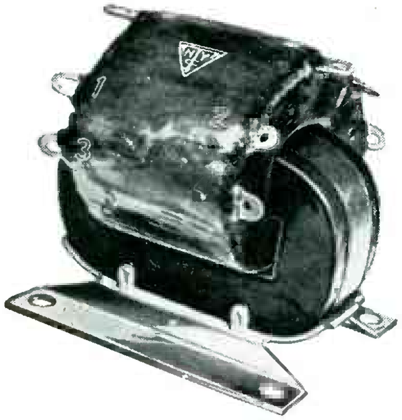




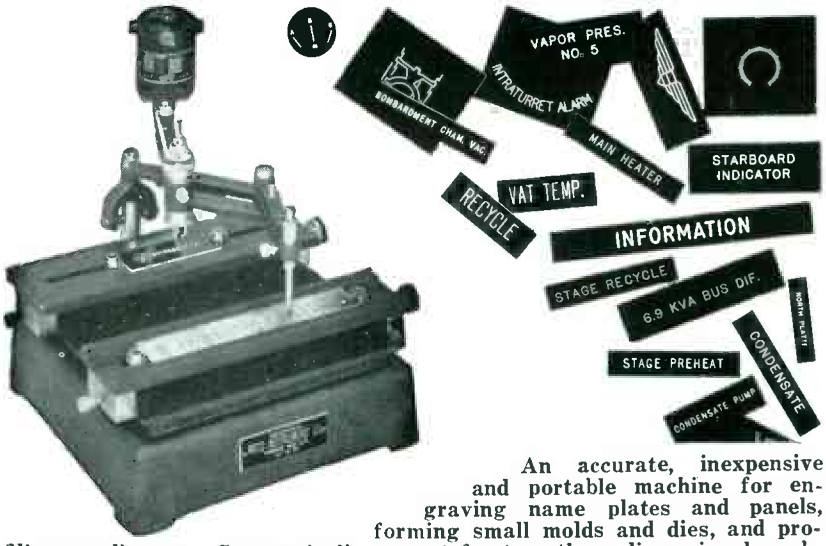
of Sylvania Electric Products Inc. by placing a fiber cap over the entire end of the part after the lead is bent back.

Stirring Chemicals

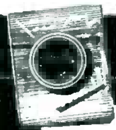
Mixing a batch of aluminum oxide solution

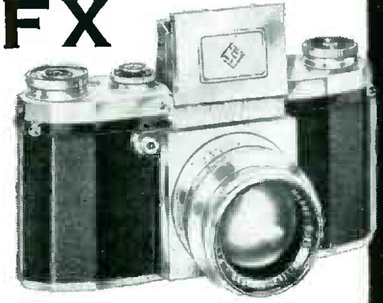
FRACTIONAL-HORSEPOWER motors insure thorough mixing of the aluminum-oxide solution for coating heater wire in the Emporium, Pa. plant of Sylvania Electric Products Inc. An ordinary Hamilton Beach malted-milk mixer is used for preliminary stirring when the chemical is prepared for use, and a small motor with two-blade fan is used to keep the solution agitated while wire passes through it in the Merkil Korff coating machine.

Method of using motor to prevent settling of aluminum oxide solution in coating machine. Small two-blade fan is positioned off-center to keep solution moving around bowl



VAPOR PRES. NO. 5
INTRATURRET ALARM
BOMBARDMENT CHAM. VAC.
MAIN HEATER
STARBOARD INDICATOR
VAT TEMP.
RECYCLE
INFORMATION
STAGE RECYCLE
6.9 KVA BUS DIF.
NORTH PLATTE
STAGE PREHEAT
CONDENSATE
CONDENSATE PUMP





NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

Recently Developed Test Instruments, New Materials and Components and Various Types of Power Supplies Are Included . . . Twenty-seven Trade Bulletins Reviewed Under *Literature* (p 368)

Phase Meter

ADVANCE ELECTRONICS CO., P. O. Box 394, Passaic, N. J. Type 404 phase meter is capable of giving direct accurate reading in degrees between two alternating voltages of any waveform, symmetrical or unsymmetrical, from 100 kc down to zero cps. It is based on a new circuit known as Advancetron that permits the comparison of phase difference between two alternating voltages at the exact instants when their waveforms intersect with the x-axis. As a result, the input voltages can be rectangular, exponential sawtooth, sinusoidal, or any symmetrical or unsymmetrical waveform. In addition, because only direct comparison between voltages takes place in the instrument, there is no limitation on the low end of the operating frequency.

Micrometer Frequency Meter

LAMPKIN LABORATORIES, INC., Bradenton, Fla. The new type 105-B micrometer frequency meter measures center-frequency deviation on any number of f-m or a-m transmitters, throughout a continuous range of frequencies, 0.1 mc to 175 mc. A stage of audio amplification and a function selector switch accomplish: (1) greatly increased sensitivity when measuring the frequency of vhf transmitters; (2) higher output for feeding into vhf receivers, for alignment purposes; and (3) a strong headphone signal when calibrating against the internal crystal standard, permitting settings to better than 1 part per million.

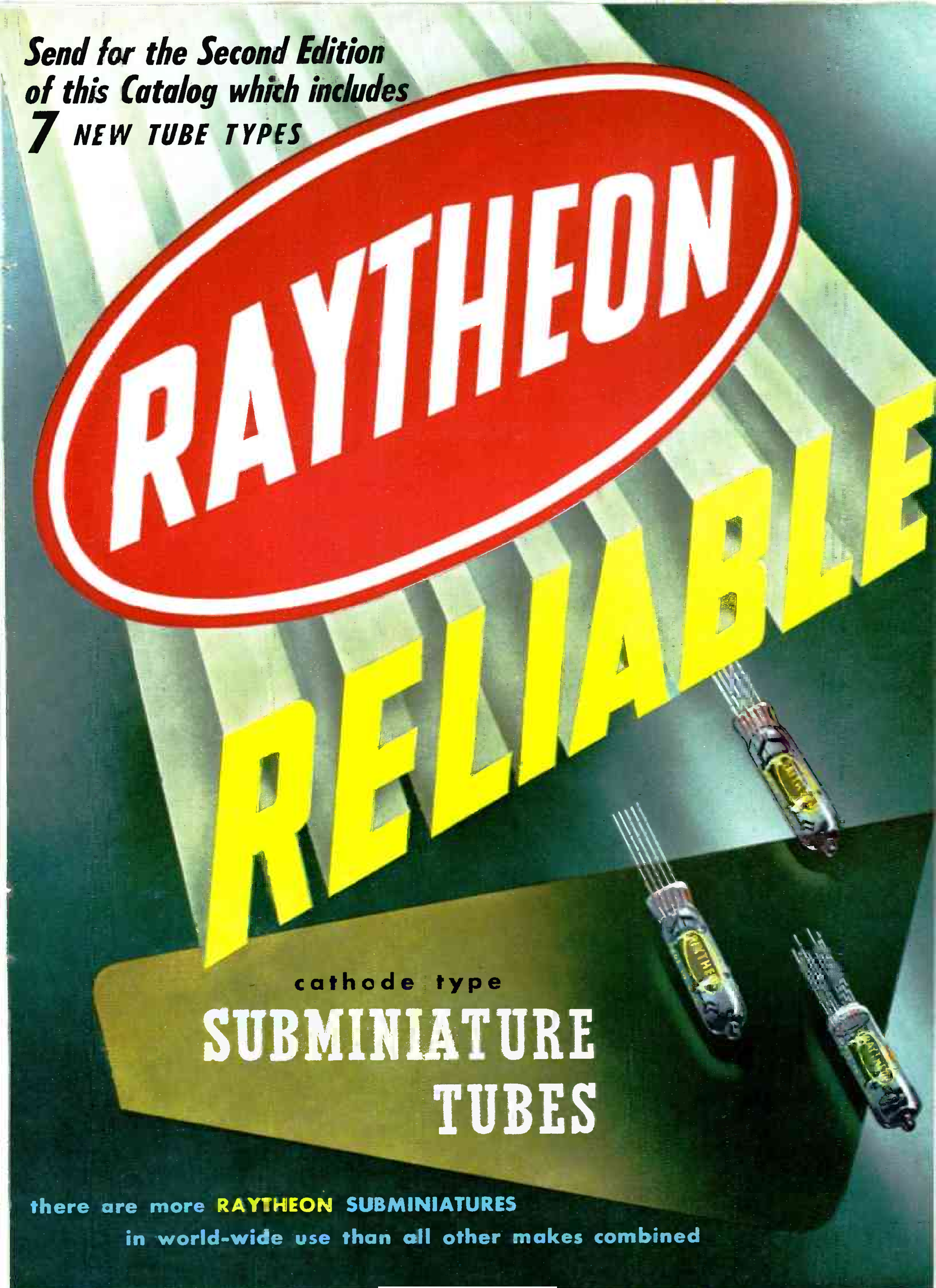
Contact-Making Instrument

WESTON ELECTRICAL INSTRUMENT CORP., 617 Frelinghuysen Ave., Newark 5, N. J. Model 1087 contact-making d-c instrument is of the new core magnet mechanism type. The contact circuit is electrically insulated from the moving coil circuit and is subjected to a dielectric test of 500 v a-c between these circuits, as well as between all circuits and the case. Contact rating is 6 v, 0.030 ampere d-c noninductive, maximum. The instrument serves the dual function of indication and control when used in conjunction with auxiliary equipment such as small power relays or electronic relay systems. Some of the suggested applications are: automatic testing of vacuum tubes; control of voltage or current levels of standby battery systems or in electroplating processes; indication and control of speed; or any one of the many functions that can be expressed in terms of voltage or current.

OTHER DEPARTMENTS featured in this issue:

Transformer Cores

WESTINGHOUSE ELECTRIC CORP., 401 Liberty Ave., Pittsburgh 30, Pa. Hipersil cores being manufactured for use in specialty and electronic transformers are now ribbed for added strength. Slightly corrugated before being wound into cores, the grain oriented steel strip lies on



RAYTHEON

RELIABLE
SUBMINIATURE TUBES
backed by
Thirteen Years of
SUBMINIATURE TUBE DESIGN AND PRODUCTION EXPERIENCE

All meeting military requirements for RELIABILITY based on field and production tests for

SHOCK • VIBRATION
FATIGUE • 5000 HOUR LIFE
CENTRIFUGAL ACCELERATION
HEATER CYCLE LIFE
HIGH TEMPERATURE LIFE
LEAD FATIGUE

Usable in the UHF region

Type	Description	Heater		Plate		Grid	Screen		Amp. Factor	Mut. Cond.
		Volts	Ma	Volts	Ma	Volts	Volts	Ma		
CK5702WA	RF Amplifier Pentode	6.3	200	120	7.5	$R_k = 200$ ohms	120	2.5	—	5000
CK5703WA	High Frequency Triode	6.3	200	120	9.0	$R_k = 200$ ohms	—	—	25	5000
CK5744WA	High Mu Triode	6.3	200	250	4.0	$R_k = 500$ ohms	—	—	70	4000
NEW CK5783WA	Voltage Reference		Operating voltage approximately 86 volts between 1.5 and 3.5 ma.							
CK5784WA	RF Mixer Pentode	6.3	200	120	5.2	−2	120	3.5	—	3200
NEW CK5787WA	Voltage Regulator		Operating voltage approximately 100 volts between 5 and 25 ma.							
NEW CK5829WA	Dual Diode	6.3	150		Max. Peak Inverse 360 volts. $I_o = 5.5$ ma. per plate					
NEW CK6021	Medium Mu Dual Triode	6.3	300	100	6.5	$R_k = 150$ ohms	—	—	35	5400
NEW CK6110	Dual Diode	6.3	150		Max. Peak Inverse 460 volts. $I_o = 4.4$ ma. per plate					
NEW CK6111	Medium Mu Dual Triode	6.3	300	100	8.5	$R_k = 220$ ohms	—	—	20	5000
NEW CK6112	High Mu Dual Triode	6.3	300	100	0.8	$R_k = 1500$ ohms	—	—	70	1800
CK6152	Low Mu Triode	6.3	200	200	12.5	$R_k = 680$ ohms	—	—	15.8	4000

Note: All dual section tube ratings (except heater) are for each section.

Write for Raytheon RELIABLE Subminiature Tubes Catalog E containing complete mechanical and electrical data on these tubes.

RAYTHEON MANUFACTURING COMPANY

RAYTHEON
Excellence in Electronics

Receiving Tube Division — for application information call

Newton, Mass. Bigelow 4-7500 • Chicago, Ill. NAtional 2-2770 • New York, N. Y. WHitehall 3-4980 • Los Angeles, Calif. Richmond 7-5524

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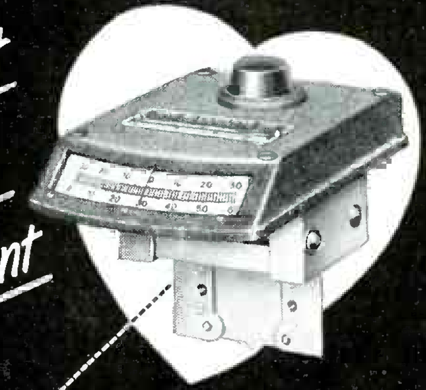
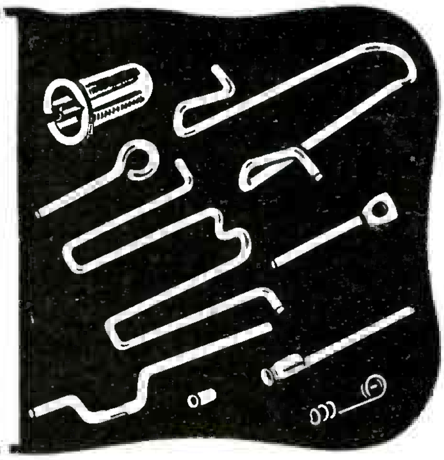
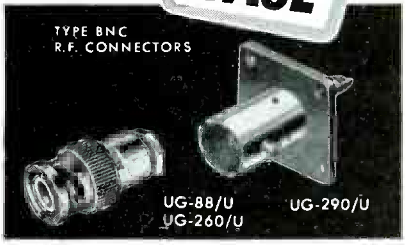
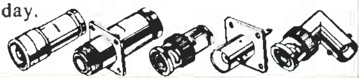
RELIABLE SUBMINIATURE AND MINIATURE TUBES • GERMANIUM DIODES AND TRANSISTORS • NUCLEONIC TUBES • MICROWAVE TUBES • RECEIVING AND PICTURE TUBES





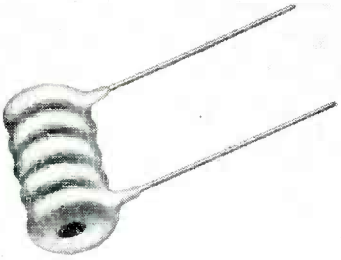

TYPE BNC
R.F. CONNECTORS
UG-88/U
UG-260/U
UG-290/U



itself in a compact and tightly integrated mass. The additional mechanical strength of the core afforded by the ribbed design maintains more perfect C sections both when the core is cut apart for assembling with the windings and during transformer operation. This assures that the etched surfaces remain in intimate contact resulting in a low-reluctance magnetic path and a low-loss butt joint. Cores of ribbed Hipersil have the same sizes and tolerances as superseded nonribbed cores.

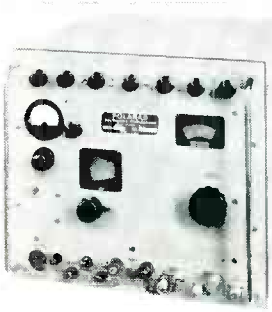
Range Calibrator

TEL-INSTRUMENT CO., 50 Paterson Ave., East Rutherford, N. J., has available the new type 2010 range calibrator, specifically designed for production testing and calibrating of radar receivers. It offers: crystal-controlled pulse rates of 200 to 2,000 pps, derived from a 327.80 kc marker crystal by the use of a binary divider system; Master-Slave operation permitting the use of a number of calibrators for multiposition test systems; narrow and stable 500-yard marker pulses; and a completely regulated power supply for operation from 105 to 125 v, 100 w 50-60 cycles.



High-Temperature Resistors

INSTRUMENT RESISTORS CO., Commerce Ave., Union, N. J., offers a complete line of precision resistors specifically designed for extreme high temperature applications. They function with dependability and long life where ambient temperatures in excess of 235 C are encountered. They also feature a low-temperature coefficient resulting in nearly constant ohmic value over a wide range—from —55 to +125 C the total percentage change in resistance is under 0.2 percent. Maximum resistances to 25,000 ohms and power ratings to 6 watts can be supplied. Standard tolerances are 1 percent; special to 0.1 percent. The units are built to exceed MIL-R93 specifications.

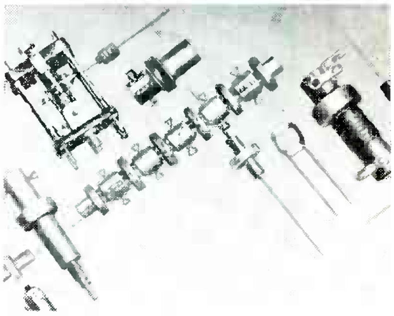


Signal Generator

POLARAD ELECTRONICS CORP., 100 Metropolitan Ave., Brooklyn, N. Y. Model MSG-4 microwave signal generator covers the frequency range from 7,000 to 10,750 mc. It is a continuously variable, direct reading instrument, utilizing single-dial control and noncontacting shorts on the klystron cavity. High stability assures accurate measurement of frequency and amplitude. Internal pulse and frequency modulation are available as well as delayed and undelayed sync signals.

H-V Power Supply

SPELLMAN TELEVISION CO., INC., 3029 Webster Ave., Bronx, N. Y., has introduced a high-voltage power supply unit that is especially popular for laboratory work. Model LAB-30 is a continuously variable 1 to 30 kv regulated d-c power supply with regulations of 0.5 percent of 1 ma. Up to 2 ma may be drawn from 20 kv down. The 16-tube unit is an r-f type consisting of a separate oscillator and buffer feeding the power oscillator into a doubler rectifier. Regulations are accomplished through feedback into a d-c amplifier plus simultaneous output control of the buffer. The unit is made in a rack model as well as a bench model.



Coils

FUGLE-MILLER LABORATORIES, Main St., Metuchen, N. J., has available coils for radio, f-m, tv and government applications to exact specifications. Included are precision-built r-f, i-f and tuning coils, discriminator transformers, choke coils, wire-wound resistors and solenoid coils. Windings can be universal, bank or universal progressive types. JAN specifications are featured.

TV Picture Tube

SYLVANIA ELECTRIC PRODUCTS INC., 1740 Broadway, New York, N. Y., has developed a new 27-in. rectang-

FULL DIMENSIONAL SOUND

Lifts "HI-FI" to a new HIGH

–thanks to the finest in modern sound recording methods and equipment

FDS

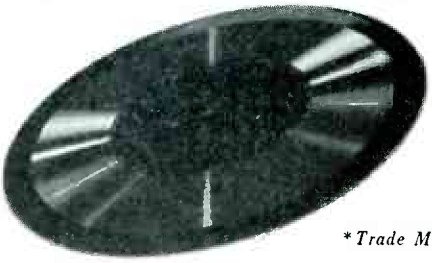
"FULL DIMENSIONAL SOUND" is an apt description of the tonal perspective that gives these fine records the true balance, depth and full tonal range of the original live performance.

To achieve these outstanding results, Capitol's sound recording methods and equipment include all of the latest technical advances in the audio field. Recording materials – both discs and tape – must measure up to the highest professional standards in every respect. And Capitol – like leading phonograph record manufacturers the country over – has found that Audiodiscs and Audiotape are the ideal combination for meeting these exacting requirements.

Remember – Audiodiscs and Audiotape are made *by* audio engineers, *for* audio engineers. Their consistent uniform quality is the result of more than a decade of experience by the only company in America devoted solely to the manufacture of fine sound recording media – both discs and tape.

...including
audiotape*
for the original sound

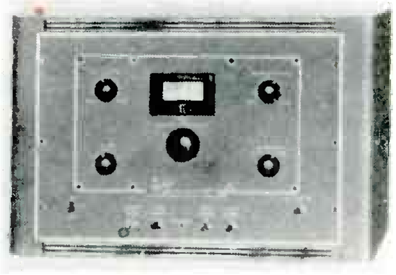
...and **audiodiscs***
for the master recording



**Trade Mark*

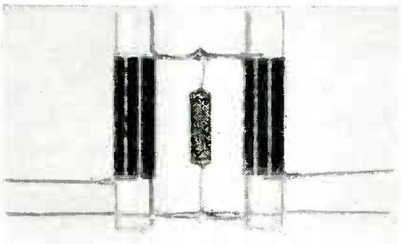
AUDIO DEVICES, Inc.
444 MADISON AVE., NEW YORK 22, N. Y.
Export Dept.: 13 East 40th St., New York 16, N. Y., Cables "ARLAB"

tube has neutral density gray-filter face plate to provide for glare reduction. It is a magnetically focused and deflected tube for use with an ion trap, and is supplied without an external conductive coating. By using a deflection angle of 90 deg, the overall length of the tube is only 22½ in. The recommended operating conditions include: anode—20,000 v; grid No. 2—300 v; ion trap field strength—45 gausses. Anode contact, base and base connections are conventional.



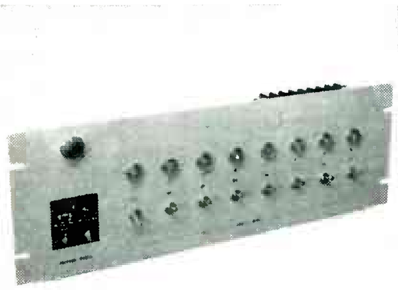
Fundamental Oscillator

POLYTECHNIC RESEARCH AND DEVELOPMENT CO., 55 Johnson St., Brooklyn, N. Y. Type 907 fundamental oscillator is continuously tunable over the frequency range of 35 to 900 mc. The unit features a tank circuit design that permits a 30 to 1 tuning range with an output voltage of not less than 1 v across 75 ohms at all frequencies. Other features include a video type blanking circuit which provides a true horizontal zero base line and provisions for the introduction of an external frequency marker. The r-f output power is coupled from the sweep generator by means of a waveguide beyond cut-off type attenuator. The attenuator permits continuous adjustment of the output voltage from 10 μv to 1 v at all frequencies.



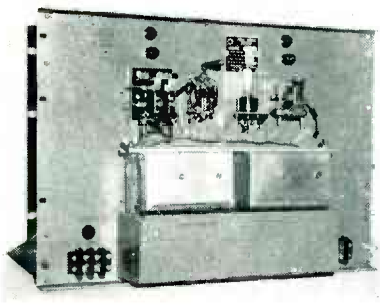
Delay Line Sections

THE DONALD M. MAY CO., 6055 Lankershim Blvd., North Hollywood, Calif., offers a new line of general purpose video and pulse delay line sections. The sections are of the lumped constant type constructed in the shape of a folded T to minimize space required and facilitate cascading. Sections in characteristic impedances of 50, 75 and 1,000 ohms are available in delays ranging from 0.001 μsec to as much as 1.0 μsec. Other impedances and delays are available on special order. The photograph shows a typical section with high-Q inductances wound of Formex insulated wire on polystyrene forms.



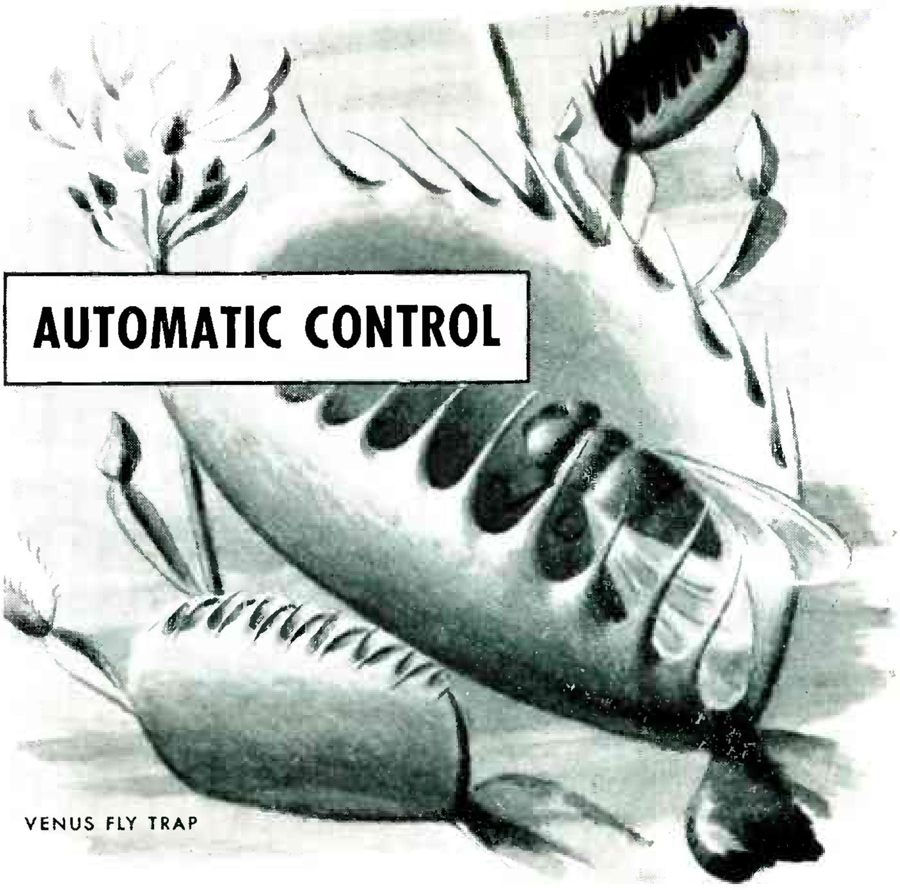
Power Control Panel

FEDERAL TELECOMMUNICATION LABORATORIES, INC., Nutley, N. J. Model FTL-71A power control panel provides facilities for the power control of as many as eight tv rack cabinets. Intended primarily for master control applications, the equipment may also be used as a power control unit for studio consoles. A total power-handling capacity of 100 amperes at 117 volts a-c, 50-60 cycles, is provided. The master switch is a circuit breaker type, with a capacity of 100 amperes.



Vibrator Converter

CORNELL-DUBILIER ELECTRIC CORP., Indianapolis, Ind. Model 3226 vi-



. . . AND SIGMA SENSITIVE RELAYS

Many control systems use relays to perform a switching function responding to electronically computed problem solutions. Sigma makes relays that will do a good job as slaves in such systems.

A Sigma specialty, however, is the design of relays to perform an integral part of the computation. Here are some of the ways that Sigma Sensitive Relays may be used in such a manner.

MEASUREMENT OF ONE VARIABLE

Sigma Sensitive Relays can measure the fluctuations in system variables (when the variables can be converted into changing voltage or current) and initiate proper response.

Example: In the control of boiler water salinity, Sigma Relays are used to measure changes in current flow between two electrodes. When salinity exceeds certain limits, the relay notes the resultant drop in electrical resistance and initiates corrective measures.

COMPARISON OF TWO VARIABLES

Sigma Sensitive Relays with two coils may be made to respond to the difference of two variables (expressed electrically), regardless of their magnitude.

Example: In the control of aircraft cabin temperature, Sigma Relays receive signals from a number of different temperature pickups and compute the required heat delivery to provide stable and constant temperature.

MODULATION — AMPLIFICATION

Sigma Sensitive Relays can be used to convert an electrical variable into a variation in width of continuously transmitted pulses of high power level.

Example: In servo systems a polarized relay is energized with a small AC signal and vibrates to close first one then another circuit. A separate DC signal controls closed-time ratio, thus total power ratio. A motor may thus be controlled as to speed and direction.

If you have a problem where a "discriminating" relay would help, be sure to let us know about it.

SIGMA

SIGMA INSTRUMENTS, INC.
62 PEARL ST., SO. BRAINTREE, BOSTON 85, MASS.

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GOAT Electronic Components

An example of GOAT engineering —THE TUBE SHIELD WITH BUILT-IN SPRING ACTION GRIP

Particularly suited for high vibration situations involving uhf tubes, the four spring-like lances of this shield expand with the tube without sacrificing full shielding efficiency.

This is only ONE of a wide variety of stock miniature and standard size GOAT shields.

A complete design service is available for those long-run, tough-spec custom jobs.

For a full description of tube shields, clips and other GOAT electronic components, send for GOAT catalog E52.

GOAT lanced tube shield G1702-2 and clip G1770

The Fred Goat Co., Inc.

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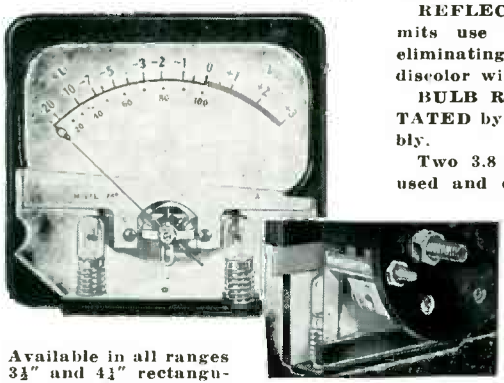
ILLUMINATED INSTRUMENTS

EXCELLENT LIGHT DISTRIBUTION affords **EASE IN READING, GLARE REDUCED** to a minimum by retaining **COMPACT DESIGN** of front case extension.

REFLECTED LIGHT PRINCIPLE permits use of standard **METAL DIALS** eliminating translucent materials that discolor with age and use.

BULB REPLACEMENT FACILITATED by removal of single lamp assembly.

Two 3.8 volt **STANDARD BULBS** are used and connected in series.



Available in all ranges $3\frac{1}{2}''$ and $4\frac{1}{2}''$ rectangular semi-flush models.

Cutaway views showing positions and connections of lamp assembly.

Write Dept. F-92 for complete details.

BURLINGTON INSTRUMENT COMPANY
BURLINGTON, IOWA

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There are a good many advertisers using this ELECTRONICS who should also be advertising in NUCLEONICS.

Particularly in instrumentation and laboratory equipment, there is a cross-over of use in the electronic and in the nuclear field.

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It is quite possible that you are doing an effective presentation of your products and abilities in this excellent issue, but are missing such presentation before one of the fastest growing fields in the country's history—the field of atomic energy.

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NUCLEONICS

ABC ABP

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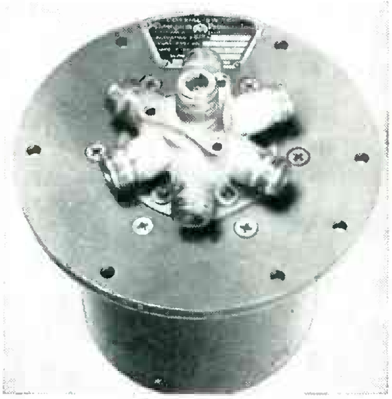
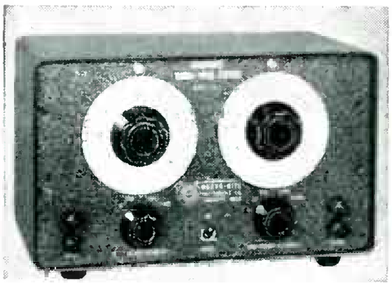
brator converter was designed to operate from a reserve battery source of 130 v d-c to supply up to 750 w of 115 v a-c 60-cycle power to microwave relay stations during commercial power failures. It will deliver full power output within 50 milliseconds of the time the power is applied. Use of the instrument permits the full cycle from commercial power to emergency power and back to commercial power when service is restored with no service interruption.



R-F Coax Switch

THOMPSON PRODUCTS, INC., 2196 Clarkwood Road, Cleveland 3, Ohio, has developed model CA-26 motor-actuated r-f coax switch. It is actuated by a 115-v 60-cycle a-c motor and has been designed to meet ground military performance specifications. At frequencies to 10,750 mc it has a maximum vswr of 1.5 and 0.2 db insertion loss; at 3,000 mc crosstalk is in excess of 55 db; power handling capabilities are 100 watts continuous c-w at 3,000 mc; actuation time is less than 1 second, with a minimum life of 50,000 cycles.



Band-Pass Filter

KROHN-HITE INSTRUMENT CO., 580 Massachusetts Ave., Cambridge 39,

ILLUSTRATING
ONE REASON WHY

You can't beat the system

WHEN IT'S A

SANBORN
Recording System

SANBORN records are *inkless* and *permanent.* They are produced by a *heated stylus ribbon* which melts the heat-responsive, plastic-coated surface of the recording paper (Sanborn Permapaper). The result is a clear, sharp tracing showing *fine* details of the phenomena being recorded. This is just *one* of many **SANBORN** advantages.

Learn MORE about SANBORN in a new, interesting, and pertly illustrated 16 page booklet, "7 Advantages of Sanborn Recorders for Industrial Users." Send for your copy today.

Please send me a copy of
"7 Advantages of Sanborn Recorders for Industrial Users."

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SANBORN CO. INDUSTRIAL DIVISION
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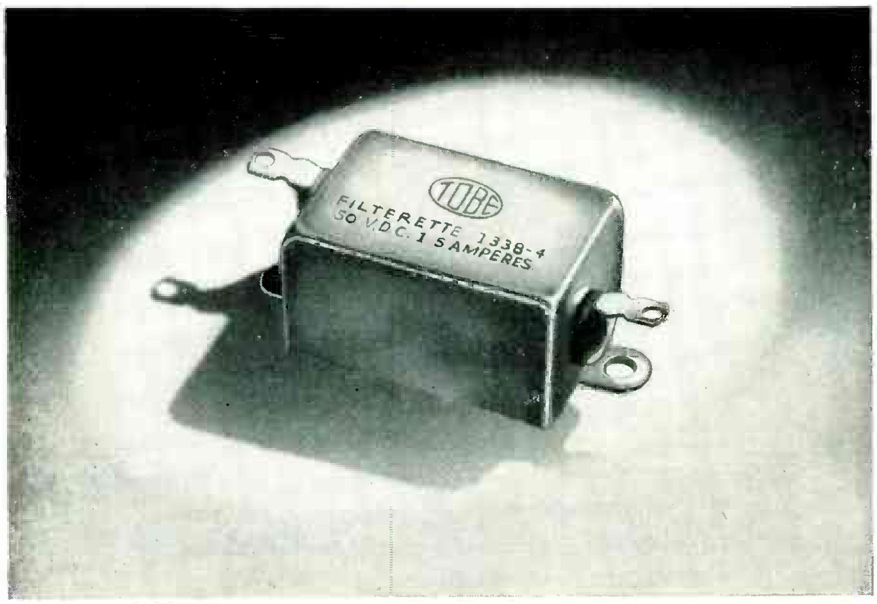


CAT. NO.	VOLTS DC	AMPERES	FREQUENCY (Mc)	ATTENUATION (at .15 Mc)	TERMINALS
1338	50	1.5	0.15-400	65 db.	Screw
1338-1	50	2.0	0.15-400	65 db.	Screw
1338-2	400	2.0	0.15-400	45 db.	Screw
1338-3	50	2.0	0.15-400	65 db.	Solder lug
1338-4	50	1.5	0.15-400	65 db.	Solder lug
1338-5	50	2.0	0.15-400	70 db.	Solder lug
1338-5A	50	2.0	0.15-400	72 db.	Solder lug
1338-6	50	2.0	0.15-400	65 db.	Shld. lead
1338-7	50	1.0	0.15-400	65 db.	Solder lug

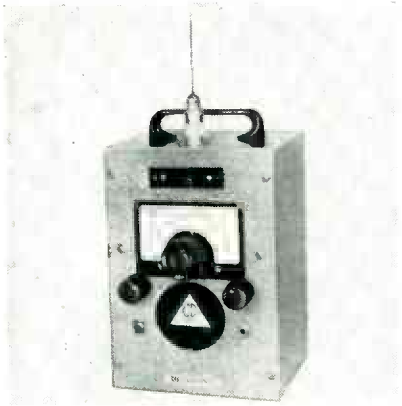
Mass. Model 310-A is an adjustable band-pass filter with unity pass gain and 24 db per octave slopes outside the pass band. A peaking factor is used to reduce the attenuation at the cutoff frequencies. Both the high and low cutoff frequencies are independently adjustable from 20 cps to 200 kc. This provides maximum flexibility of adjustment of both the band center frequency and the bandwidth. The unit is especially useful in the audio and ultrasonic frequency range for noise measurements, harmonic and frequency analysis, and for psychoacoustics and electromedical research. The instrument measures 12 in. × 7 in. × 8 in. overall.

Ignitron

National Electronics Inc., Geneva, Ill., has announced addition of a new class C ignitron to its line of industrial tubes. Designated as the NL-5552, it is a metal, water-cooled, mercury pool tube designed especially for welder control and similar a-c control applications. Its rating is approximately equivalent to a 600-ampere magnetic contactor. The tube utilizes an all-copper cooling system that provides exceptional cooling efficiency, permitting a 30-percent saving in water. The mercury-pool cathode permits the tube to handle extremely high currents on an intermittent basis.

Wattmeter

John Fluke Engineering Co., P.O. Box 755, Springdale, Conn. Model 102 VAW meter is an electronic low-power factor wattmeter covering the frequency range of 20 to 20,000 cps. Voltage ranges cover 1.5 to 600 v, and current ranges cover 0.0015 to 30 amperes giving full scale watt ranges of 2.25 mw to 18 kw at the unity power factor setting, and 225 μw to 1.8 kw at the 10-percent factor setting. Input impedance is one megohm and shunt drop is 45 mv. The meter is particularly applicable to transformer and other magnetic circuit power measurements.



Transmitter Receiver

DELTRONIC CO., 9010 Bellanca Ave., Los Angeles 45, Calif., has available a complete sending and receiving radio station weighing only 7 lb. It is self contained and can be plugged in on an ordinary 110-v receptacle. Range covers up to 40 miles. The CD 144 was designed to meet the urgent needs of civil defense but fits into many other uses of individuals and industry. It measures 6½ in. × 6 in. × 9½ in. and is equipped with a 19-in. whip antenna. The unit contains complete line isolated power supply and vibrator, a built-in noise limiter, and crystal controlled transmitter using the newest miniature tubes. Its two-meter band is calibrated for 143.8 to 148.1 mc.

TV Oscilloscope

TEKTRONIX, INC., P. O. Box 831, Portland 7, Oregon. Type 524-D oscilloscope has been designed to meet the needs of tv broadcasters in adjusting and maintaining tv transmitters and studio equipment. A variable sweep delay circuit pro-

SERVOTHERM PRODUCTS

BOLOMETER AND PREAMPLIFIER

Thermistor bolometers are FAST, sensitive INFRARED and HEAT detectors. Especially RUGGED for industrial, scientific, and military applications. PREAMPLIFIER provides NOISE-FREE initial amplification and mount.

THERMISTOR POWER SUPPLY

Provides voltages required by BOLOMETER bridge and PREAMPLIFIER. Regulated and filtered permitting THEORETICAL NOISE LIMITS of amplification, while operating from 60 CYCLE line.

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WIRE & CABLE

for ALL your ELECTRONIC wiring needs!

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  Solid Colors or Spiral Markings
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- **JAN-C-76 WL GLASS BRAID**
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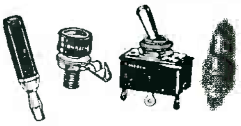
- **105° C. UL APPROVED THERMOPLASTIC**
  Hookup Wire



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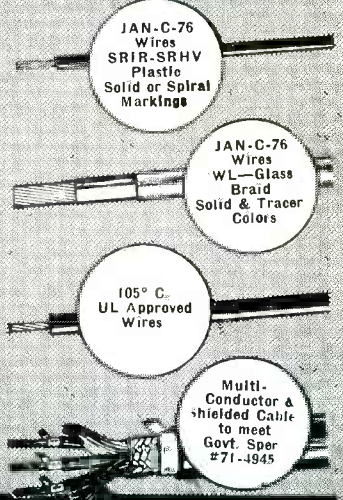
- Terminal Strips
- Insulated Hardware



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BIRNBACH RADIO CO., INC.
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There are a good many advertisers using this ELECTRONICS who should also be advertising in NUCLEONICS.

Particularly in instrumentation and laboratory equipment, there is a cross-over of use in the electronic and in the nuclear field.

But, there is very little cross-over in the subscriber lists of the two publications—a matter of a few percentage points.

It is quite possible that you are doing an effective presentation of your products and abilities in this excellent issue, but are missing such presentation before one of the fastest growing fields in the country's history—the field of atomic energy.

The sales representatives of ELECTRONICS are also the sales representatives of NUCLEONICS. They have much evidence pointing to the opportunities in this great NEW field. Ask them to show you what your potentials can be.

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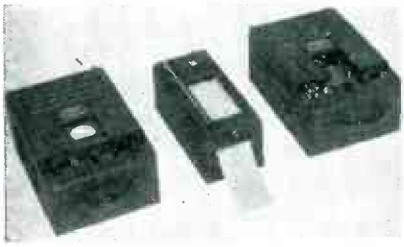
vides a zero to 25 millisecond delay. Delayed sweeps, triggered by any line sync pulse throughout the picture, are available through the entire sweep range of 0.01 sec per cm to 0.1 μsec per cm. Magnifications of three times and ten times are provided, permitting detailed examination of sync and equalizing pulses. An internal time mark generator modulates the trace brightness. More than 6 cm undistorted deflection is available on a flat faced crt. Accelerating potential is 4 kv.

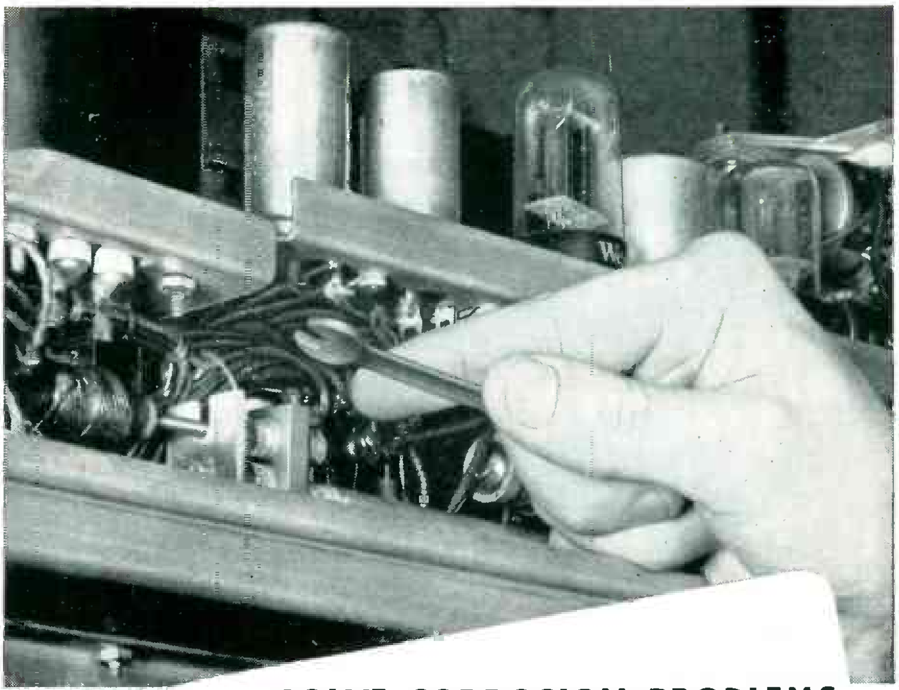
Embedded Selenium Rectifiers

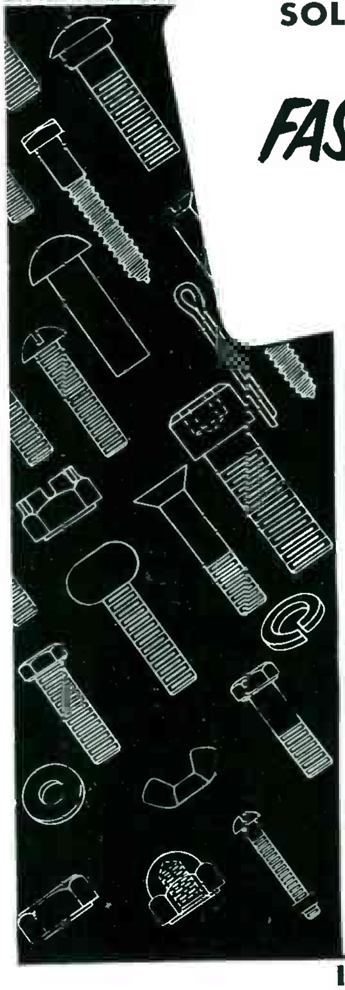
SARKES TARZIAN, INC., 415 N. College Ave., Bloomington, Ind., is currently producing embedded selenium rectifiers. Available in many sizes, these rectifiers are designed for use in military equipments and will meet all specifications on environmental conditions, shock, acceleration and high-altitude operation. The typical unit illustrated will deliver the same d-c power as a hermetically sealed-can enclosed rectifier that weighs 1.8 lb and measures 7¼ in. × 4¼ in. × 4¼ in. It will deliver 40 v d-c at 1 ampere under continuous operating conditions.



Welding Analyzer

THE BRUSH DEVELOPMENT CO., 3405 Perkins Ave., Cleveland 14,





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FASTENINGS by HARPER

Fastenings represent a vital part of any electronic equipment. And yet, fastenings represent an extremely small part of the cost. That's why so many electronic manufacturers demand the best fastenings procurable—Harper.

Over 7,000 different Harper Fastenings are available from stock—bolts, nuts, screws, washers, lock washers, rivets—of brass, naval bronze, silicon bronze, Monel, stainless steel and aluminum.

Harper offers electronic manufacturers these advantages: One source of supply, one order to write, one account to keep, one bill to pay. There is a Harper distributor near you with stocks to fill your order. Harper engineers and metallurgists will gladly assist you in the solution of any fastening problem you may face.

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Mail the coupon below for complete catalog of Harper Everlasting Fastenings. There is a Harper distributor near you with stocks to fill your requirements.

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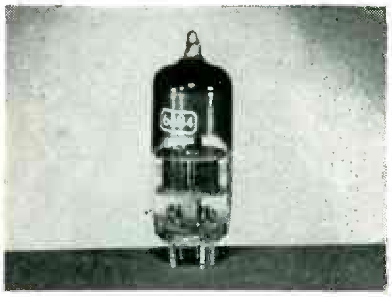
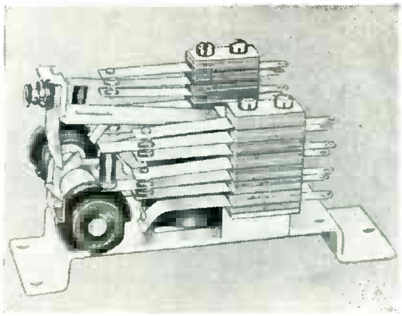
Ohio. Model BL-213 direct-writing welding analyzer records single-phase and three-phase resistance welding machine variables. Welding current and electrode force are measured and recorded simultaneously and show the important squeeze, weld, hold and off time intervals. It also records the small 180-cps component present in the three-phase welding machine current when ignitron rectifiers are used. The entire unit consists of a dual-channel oscillograph, a d-c amplifier and a universal amplifier.



UHF-VHF TV Receiver Tube

SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa. Type 6AN4 is a T-5½ miniature triode designed for use as a grounded-grid r-f amplifier or mixer in the uhf-vhf tv bands. It features high g_m and mu, internal shielding between plate and cathode leads, and double plate and grid connections for reduced lead inductance. In circuits designed for its use, a gain of 10 db, 10-mc bandwidth, and a noise figure of 15 db, can be obtained at 900 mc. In combined service, the tube minimizes the necessity of a special low-noise, pre-i-f amplifier, thus simplifying the switching from uhf to vhf.



Impulse Relay

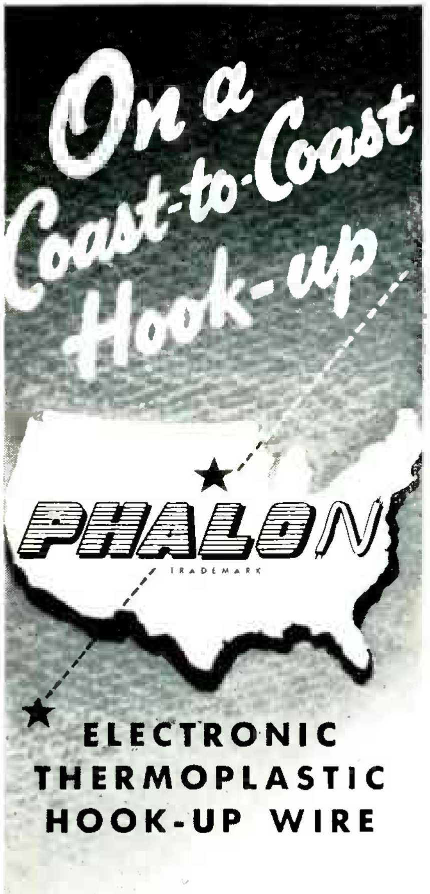
POTTER & BRUMFIELD, Princeton, Ind., offers a newly developed AP impulse (ratchet-type) relay that features a unique construction with an automatic stop which prevents slippage or overtravel of ratchet, and insures positive, precise action on each impulse, regardless of speed of operation. It is capable of high-speed operation with a contact transfer time as short as 20 milliseconds. Standard AP relays are available up to 230 v, either a-c or d-c and contact combinations up to 4-pole double throw. Contacts are $\frac{3}{16}$ in. diameter fine silver, rated at 5 amperes, 115 v. a-c noninductive load. The standard AP relay measures $2\frac{1}{8}$ in. wide x 4 in. long x $2\frac{1}{8}$ in. high.

Coil Transformers

STANDARD TRANSFORMER CORP., 3580 Elston Ave., Chicago, Ill., has announced two new line-to-voice coil transformers for 70.7-volt line audio distribution systems. Designed in accordance with RTMA specifications, the transformers, listed as part A-8102 and A-8103, are meant to operate into load impedances of 4, 8 or 16 ohms. The power taken from the line by each primary tap when the transformer is properly terminated in its rated load impedance shall fall in a series based on one watt and proceeding upward and downward in 3-db steps.

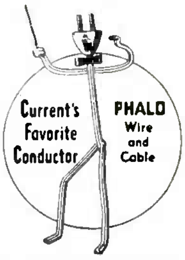
Gas Thyratron

RADIO CORP. OF AMERICA, Harrison, N. J., has announced type 6012 gas thyratron designed especially for motor-control and low-power inverter service in circuits operating at 60 cps. It is conservatively rated to withstand a maximum peak inverse anode voltage of 1,300 v, a maximum peak cathode current of 5 amperes, and a maximum average cathode current of 0.5 ampere. Operating features include a negative-control characteristic that is essentially independent of the ambient temperature over the range from − 75 to + 90 C, low preconduction currents, low control-grid-to-anode



There is no mistaking quality performance . . . and PHALON hook-up wires are proving their quality in top performances coast-to-coast.

Hook-up, lead or fixture wires . . . whatever your requirement, there is a PHALON wire just made for the job! Get strong, tough, easy stripping with PHALON hook-up wires.



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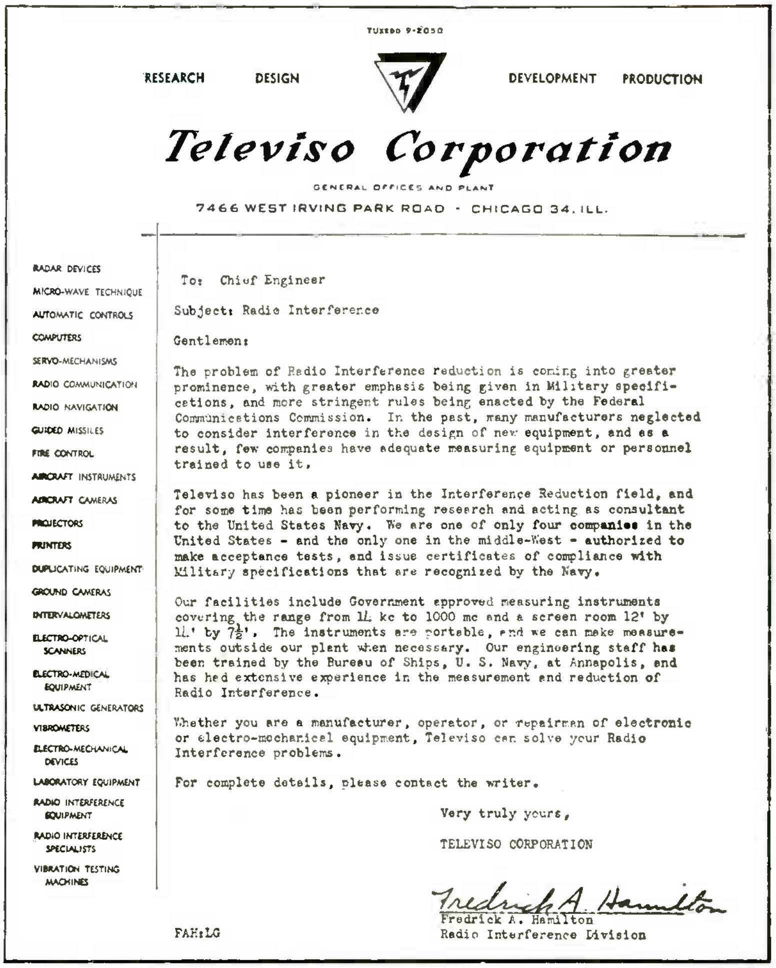

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To: Chief Engineer

Subject: Radio Interference

Gentlemen:

The problem of Radio Interference reduction is coming into greater prominence, with greater emphasis being given in Military specifications, and more stringent rules being enacted by the Federal Communications Commission. In the past, many manufacturers neglected to consider interference in the design of new equipment, and as a result, few companies have adequate measuring equipment or personnel trained to use it.

Televiso has been a pioneer in the Interference Reduction field, and for some time has been performing research and acting as consultant to the United States Navy. We are one of only four companies in the United States - and the only one in the middle-West - authorized to make acceptance tests, and issue certificates of compliance with Military specifications that are recognized by the Navy.

Our facilities include Government approved measuring instruments covering the range from 14 kc to 1000 mc and a screen room 12' by 14' by 7½'. The instruments are portable, and we can make measurements outside our plant when necessary. Our engineering staff has been trained by the Bureau of Ships, U. S. Navy, at Annapolis, and has had extensive experience in the measurement and reduction of Radio Interference.

Whether you are a manufacturer, operator, or repairman of electronic or electro-mechanical equipment, Televiso can solve your Radio Interference problems.

For complete details, please contact the writer.

Very truly yours,

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Fredrick A. Hamilton
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Radio Interference Division

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capacitance and low control-grid current. Maximum overall length is $4\frac{1}{4}$ in., and maximum diameter, $1\frac{3}{4}$ in.

Power Circuit Analyzer

INSTRUMENT LABORATORIES, 315 W. Walton St., Chicago 10, Ill. Model 247 power circuit analyzer, with ranges of 150-300-600 volts, 5-25-125 amperes and 0.6 to 60 kw, is invaluable in locating unbalanced loads; overloaded, underloaded or defective motors; low power factor; and excessive circuit voltage drop. It may be used on single-phase 2- and 3-wire, three-phase 3-wire, three-phase 4-wire networks or two-phase systems. It has shielded meters and an adjustable follow-up pointer.

Sealed Relays

POLYTRON ENGINEERING, 6659 Belair Road, Baltimore 6, Md. The PE5A series relays are designed for applications where size and sensitivity are of major importance. These relays are hermetically sealed in a metal envelope which is $1\frac{13}{16}$ in. long and $\frac{3}{4}$ in. in diameter using a standard 7-pin miniature plug-in base. It has an operating range from 6 to 150 v d-c or a-c; pull-in currents as low as 1 ma. Precious

The new S.S.WHITE 80X HIGH VOLTAGE RESISTOR

(½ Actual Size)

4 watts · 100 to 100,000 megohms

Developed for use as potential dividers in high voltage electrostatic generators, S.S.White 80X Resistors have many characteristics—particularly negative temperature and voltage coefficients—which make them suitable for other high voltage applications.

They are constructed of a mixture of conducting material and binder made by a process which assures adequate mechanical strength and durability. This material is non-hygroscopic and, therefore, moisture - resistant. The resistors are also coated with General Electric Dri-film which further protects them against humidity and also stabilizes the resistors.

WRITE FOR BULLETIN 4906

It gives complete information on S.S.White resistors. A free copy and price list will be sent on request. Send for a copy.

THE S.S.White INDUSTRIAL DIVISION
DENTAL MFG. CO.
Dept. R, 10 East 40th St.
NEW YORK 16, N. Y.

WESTERN DISTRICT OFFICE: Times Building, Long Beach, Calif.

SHOCKPROOF VACUUM TUBE RETAINERS

These retainers are used to secure Vacuum Tubes and to resist side motion of Vacuum Tubes used in radio equipment which is subject to shock and vibrations. These retainers meet the requirement of all JAN specifications. The insulated portion is made of a melamine base Fibre Glass Phenol which provides 300 volts insulation to ground and withstands a temperature of 350 F. The insulated plate can readily be fastened or released by hand.

Available for envelope types T7, T8, MT8, T9, T12, ST12, T12ZDI, ST14, S14, ST16, T5½, T6½, MT-IC, ST19, T14, ST128CT-9.

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NUCLEONICS

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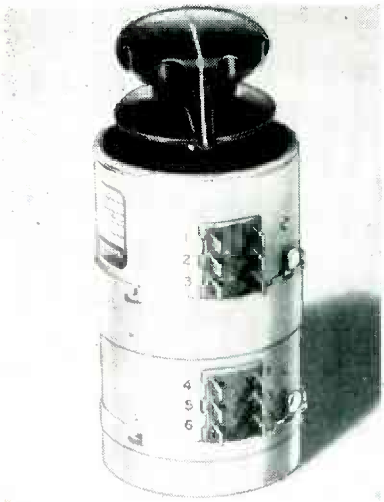
metal contacts rated up to 5 amperes inductive load are used. Numerous contact arrangements are available. It meets a wide variety of application requirements, including electronic control, counting and tube plate circuit loads.

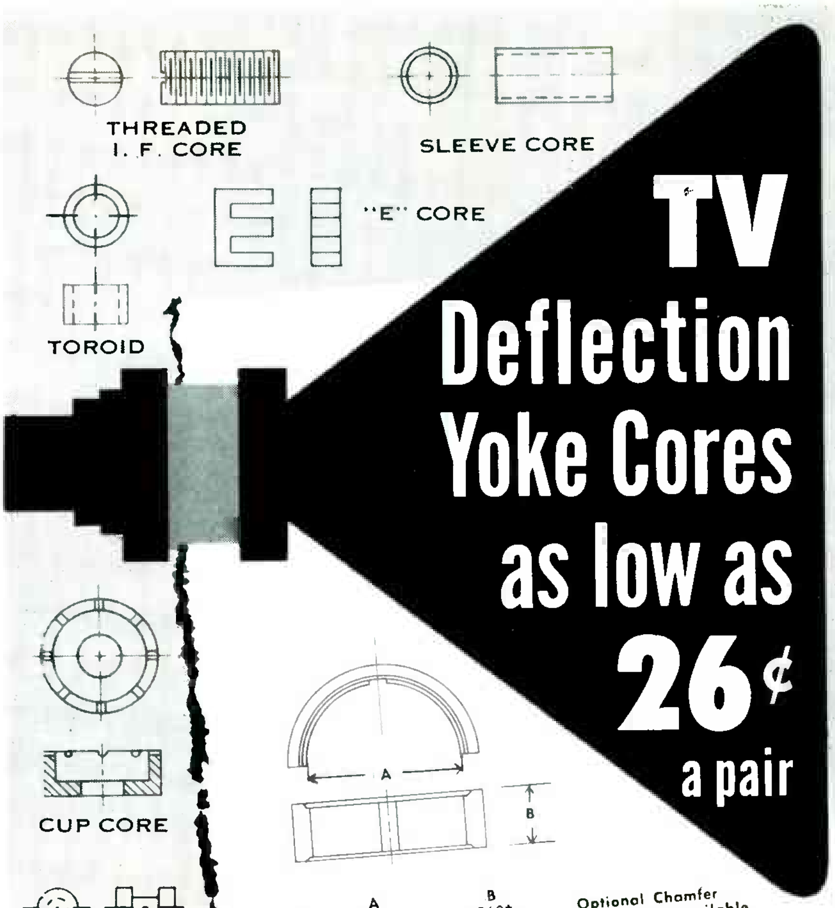
Half-Wave Vacuum Rectifier

Radio Corp. of America, Harrison, N. J. Type 12AX4-GT is a half-wave vacuum rectifier of the heater-cathode type designed primarily for use as a damper tube in horizontal deflection circuits of tv receivers utilizing series-heater strings. Designed with insulation between heater and cathode to withstand negative peak pulses between heater and cathode of as much as 4,000 v with a d-c component up to 900 v, the tube provides flexibility in choice of deflection circuits.



Program Line Equalizer

The Daven Co., 191 Central Ave., Newark 4, N. J., announces the type 286 program line equalizer consisting of a parallel network and calibrated step-type series control, which is designed to improve the frequency response of communications circuits. The parallel network is accurately tuned to the frequency of equalization. The calibrated attenuator connected in series with this network controls the degree of equalization. Four points of equalization, 5, 7.5, 10 and 12.5 kc, are readily available by selecting the proper terminals. The unit has



TV Deflection Yoke Cores as low as 26¢ a pair

	A	B	
DYC 1 :	1.850	.960*	
DYC 2 :	1.910	.960*	
DYC 3 :	2.054	.960*	← Optional Chamfer and groove available on this diameter

*Lengths vary upon individual requirements.

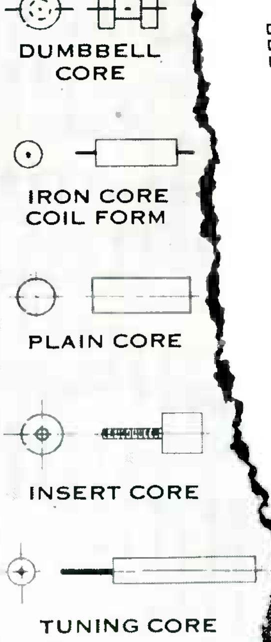
You can now get high permeability flake-iron deflection yoke cores for **only twenty-six** cents a pair. These deflection yoke cores are the results of our continuing powdered metal engineering research. You get a deflection yoke core produced from a combination of the latest powdered metal molding techniques, using an entirely new development of flake iron powder.

DEFLECTION YOKE CORE FEATURES

High Permeability — offers highest temperature stability to the deflection yoke coil as it directs the flow of electrons towards the face of the television tube.

Design and Manufacture—select one of our standard flake-iron deflection yoke cores for your needs. They are designed to meet the highest electronic and mechanical standards of deflection yoke coils. If one of our standard deflection yoke cores cannot meet your mechanical needs, we will submit samples and designs that will.

Cores Can Cost Less — daily we are proving the results of our engineering efforts by offering radio cores of higher permeability at lower cost. Write us your requirements for similar samples for material testing and specific costs.



For more detailed Threaded Core information—Write for Samples, designs and Specific Costs. Dept. E 952S. Technical Data Booklet "Engineered Radio Cores" No. E 952.

Radio Cores, Inc.

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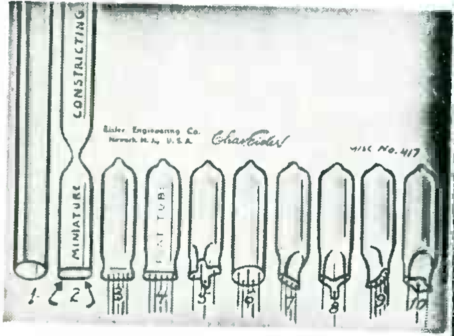

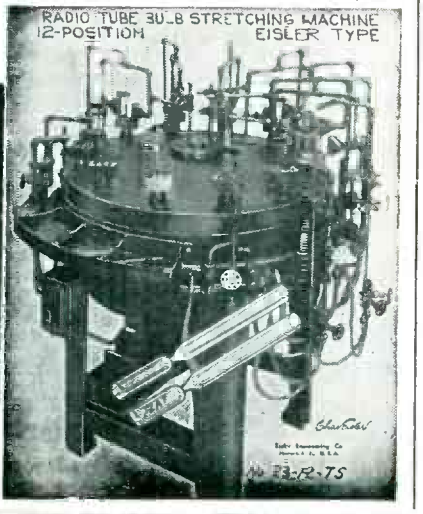

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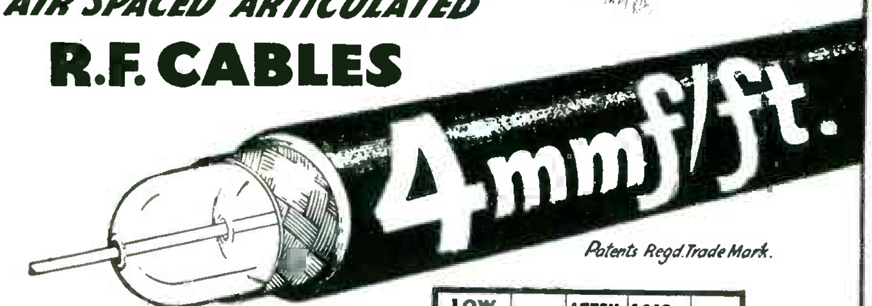
Only with CO-AX

AIR SPACED ARTICULATED

R.F. CABLES



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LOW ATTEN. *Types.*	IMPED. *Ohms.*	ATTEN. *db100ft. of 100Mcs.*	LOADG. *K.W.*	O.D."
A.1.	74	1.7	0.11	0.36
A 2	74	1.3	0.24	0.44
A 34	73	0.6	1.5	0.88

HIGH POWER FLEXIBLE

LOW CAPAC. *Types*	CAPAC. *mmf/ft.*	IMPED. *Ohms.*	ATTEN. *db100ft 100Mc/s.*	O.D."
C 1	7.3	150	2.5	0.36
PC 1	10.2	132	3.1	0.36
C 11	6.3	173	3.2	0.36
C 2	6.3	171	2.15	0.44
C 22	5.5	184	2.8	0.44
C 3	5.4	197	1.9	0.64
C 33	4.8	220	2.4	0.64
C 44	4.1	252	2.1	1.03

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VERY LOW CAPACITANCE

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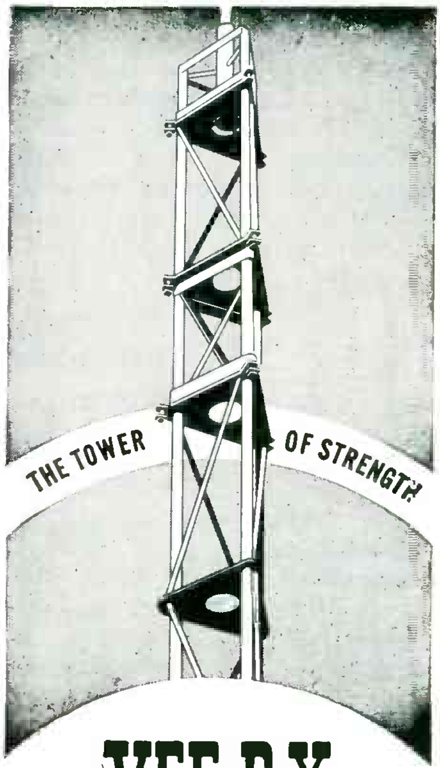
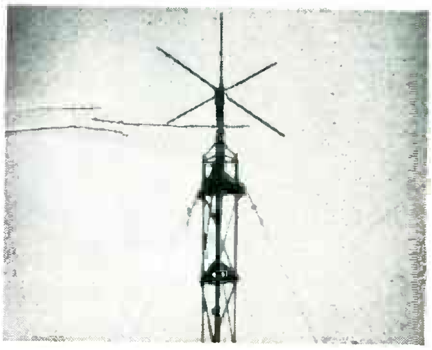
CABLES: TRANSRAD LONDON.



VEE-D-X

Sectional Tower

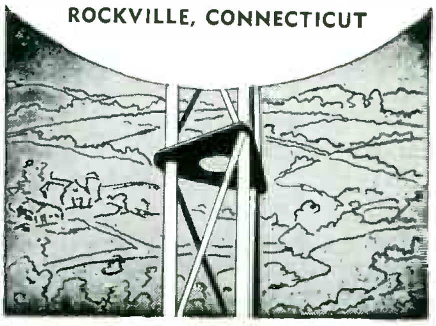
MOST ECONOMICAL FOR MICROWAVE • FM • TV COMMUNICATIONS • RADAR



Actual photograph of VEE-D-X Sectional Tower installation showing 152 MC ground-plane antenna suited for ground-to-plane, ship-to-shore, and mobile communications.

THE LaPOINTE-PLASCOMOLD CORP.

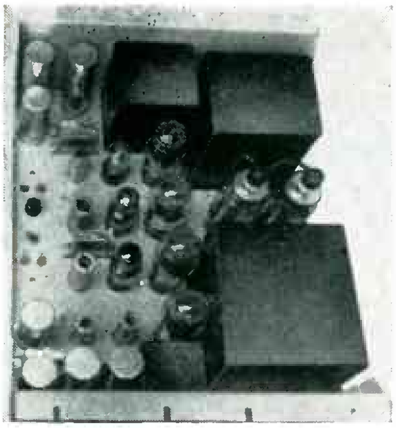
ROCKVILLE, CONNECTICUT



compact multichannel assemblies consisting of 1, 2, 3, or 4 equalizers and associated frequency selection switches mounted on a standard 5¼ in. × 19 in. relay rack-type panel.

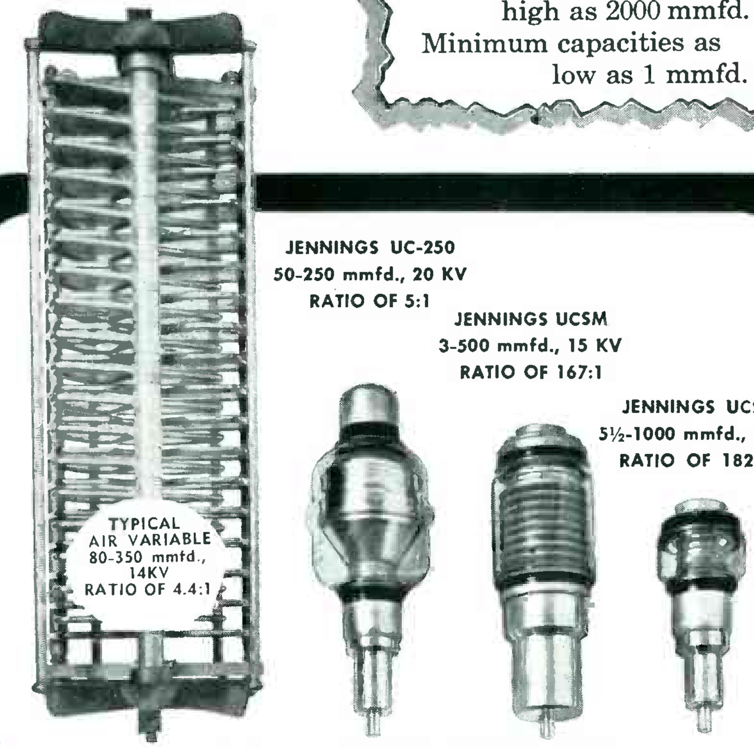
Marker Beacon Receiver

AIRCRAFT RADIO CORP., Boonton, N. J. Type R-20 marker beacon receiver weighs 2.6 lb complete with shock mounting. It obtains its high voltage from one of the aircraft dynamotors capable of supplying 3 ma at about 250 v d-c with no marker beacon signal to 11 ma for the duration of the marker signal. Capacitors and sensitive relays are sealed. Design and workmanship meet requirements for CAA type certification and all military operational specifications. The receiver provides both aural and visual indication of 75 mc signals.



Low-Voltage Power Supply

FEDERAL TELECOMMUNICATION LABORATORIES, INC., Nutley, N. J. The FTL-86A low-voltage power supply is a versatile unit intended primarily for tv studio equipment, but also useful where a source of several different regulated voltages is required. It provides six d-c voltages, including regulated, double regulated, and bias supplies at a combined maximum current up to 480 ma. Voltage sources are 435 v unregulated, 400 v unregulated, 250 v regulated, 150 v regulated, −150 v regulated, and an auxiliary negative bias or current source of 0 to 50 v. Source impedance in the positive regulated sections is approxi-



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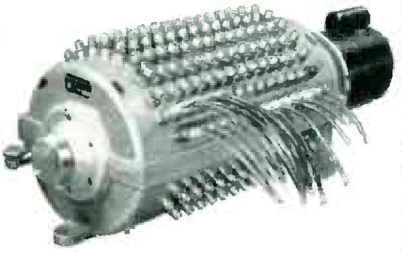

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In the past, the rapid development of modern automatic information-processing systems has been handicapped by the high cost and marginal reliability of the associated high-speed information-storage equipment.

Today, fully-engineered, operationally-proved ERA Magnetic Drum Storage Systems are available which provide the reliability, the large storage capacity, the economy in dollars and in space, and the high speed required for many applications.

Investigate the possibility of replacing storage relays, stepping switches, punched tape, or other bulky forms of storage with an ERA Magnetic Drum Storage System. ERA's experienced engineers will be pleased to assist you in the application of ERA Magnetic Drum Storage Equipment to your particular system requirements.

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Its control is anybody's job. But when it involves an intricate problem, the concern that may be depended upon to correctly solve it is the **A. W. Haydon Company**

Thoroughly experienced timing engineers assure prompt, accurate solutions to the most difficult of proposed applications.

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235 NORTH ELM STREET
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Design and Manufacture of Electrical Timing Devices

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Electro-Tech maintains one of the largest and most complete stocks in the country of electrical meters, instruments and industrial control equipment—representing over 250 top lines.

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Shunts (Electrical)
Meggers
Solenoid Valves
Pyrometers
Multimeters
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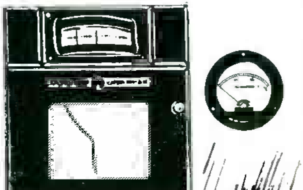
and Laboratory Standard Instruments



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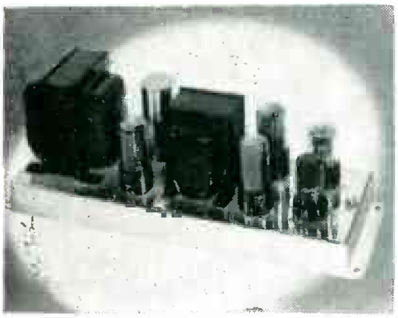

Audio Amplifier

THE RADIO CRAFTSMEN, INC., 4401 N. Ravenswood Ave., Chicago 40, Ill. The circuit of the type 400 high-fidelity audio amplifier features a direct-coupled, split-load triode phase inverter driving push-pull 6V6 power output tubes. Use of 13½-db inverse feedback around the entire amplifier results in a 4 to 1 output damping factor or an output internal impedance of 2 ohms at the 8-ohm tap. Power output is 10 watts ± 1 db, 15 to 20,000 cps. Total harmonic distortion is less than 1 percent at 10 watts output. Hum and noise level is 70 db below rated output.

Industial Thyratron

NATIONAL ELECTRONICS, INC., Geneva, Ill., has announced the NL-760 high-current industrial thyratron tube that carries 6.4-ampere d-c and 77-ampere peak ratings. It was designed for motor speed control, welding control and regulated rectifier applications. The tube is gas and mercury filled for quick-starting and constancy of char-

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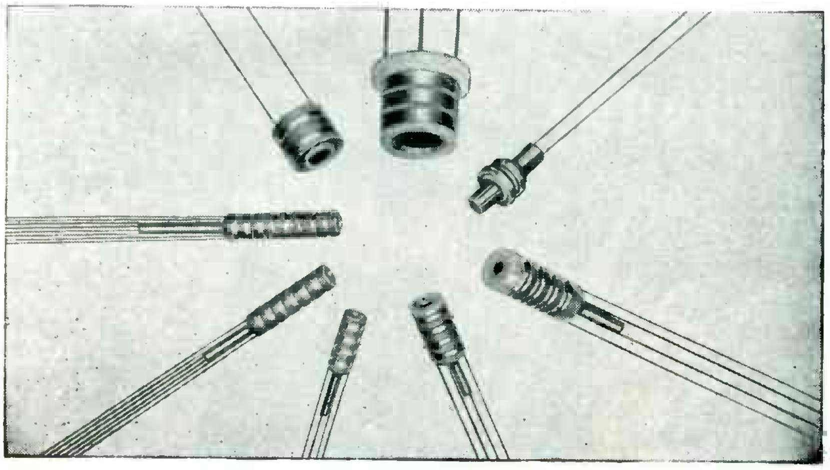
Commutators and other Electro-Mechanical Components

PRECISION MADE TO YOUR OWN SPECIFICATIONS



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Now is the time to install Lewis heating cable on those outside pipe lines that caused you trouble last winter. Nickel Chrome conductor with special insulation designed for 500°F operation.

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Send your electronic control, communications or appliance wiring specifications for a recommended solution by our engineers.

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Particularly in instrumentation and laboratory equipment, there is a cross-over of use in the electronic and in the nuclear field.

But, there is very little crossover in the subscriber lists of the two publications — a matter of a few percentage points.

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The sales representatives of ELECTRONICS are also the sales representatives of NUCLEONICS. They have much evidence pointing to the opportunities in this great NEW field. Ask them to show you what your potentials can be.

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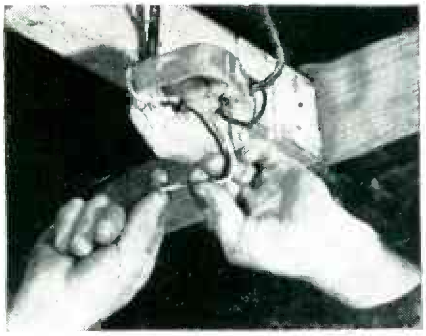
acteristics within wide temperature limits. Other rating details are: filament voltage, 2.5 v; filament current, 21 amperes; and peak inverse voltage, 1,250 v.

D-C Power Supply

John Fluke Engineering Co., P. O. Box 755, Springdale, Conn. Model 301A precision d-c power supply has an output voltage adjustable from 7.5 to 750 v at 0 to 500 ma. Regulation from zero to full load is within 40 parts per million. Regulation against line voltage changes of ± 10 percent (105 to 130 v) is ± 20 parts per million. For any output voltage setting, stability is within 100 parts per million per day under usual conditions. Auxiliary negative voltages of 350 and 700 v d-c at 0.5-percent regulation at 10 ma and, also, 6.3 v a-c ct at 10 amperes are provided.



Spring-Type Connector

Minnesota Mining and Mfg. Co., 900 Fauquier St., St. Paul 6, Minn., has introduced a new spring-type connector that can't shake loose and requires no tools, for making pigtail splices in electrical wiring. Designated the "Scotchlok" brand electrical spring connector, it is said to provide a tight permanent splice for single or multistrand wires up to gage 10 in more than 300 different combinations. The unique coil spring design allows the connector to expand while being applied, but provides a shake-resistant, tension grip on the wires once the splice has been made. The small diameter of the connector adds but a fraction of an inch to the diameter of the wires, making

Radio Frequency Insulators by JOHNSON

Steatite and porcelain insulators with a long history of user satisfaction. Dense molding and glazing insure fracture resistance together with low moisture absorption. Extended creepage paths of most types provide maximum voltage breakdown compatible with compact design. With proportionately large mounting faces, all types will handle substantial lateral stress. Heavily nickel plated brass hardware suitable for exposed applications.

STAND-OFF INSULATORS

STEATITE

Cat. No.	*Height	Hardware
135-20	1 9/16"	10-32
135-20J	1 9/16"	74 jack
135-22	1"	8-32
135-22J	1"	74 jack
135-24	⅝"	6-32
PORCELAIN		
135-60	4½"	1/4-20
135-62	2¾"	1/4-20
METAL BASE TYPES		
135-65	1⅜"	10-32
135-65J	1⅜"	74 jack
135-66	2¾"	1/4-20
135-66J	2¾"	76 jack
135-67	4½"	1/4-20
135-67J	4½"	76 jack
135-68	2"	10-32
135-68J	2"	74 jack
STEATITE CONE INSULATORS		
135-500	⅝"	6-32
135-501	1"	8-32
135-502	1½"	8-32
135-503	2"	10-32
135-504	3"	10-32
THRU-PANEL INSULATORS		
STEATITE		
135-40	1¼"	10-32
135-40J	1¼"	74 jack
135-42	⅞"	10-32
135-42J	⅞"	74 jack
135-44	⅝"	6-32
PORCELAIN		
135-45	1⅜"	10-32
135-45J	1⅜"	74 jack
135-46	2¾"	1/4-20
135-46J	2¾"	76 jack
135-47	4½"	1/4-20
135-47J	4½"	76 jack
135-48	2"	10-32
135-48J	2"	74 jack
LEAD-IN BUSHINGS		
STEATITE		
135-50	½"	6-32
135-51	13/16"	10-32
135-52	1⅛"	1/4-20
135-55	¼"	6-32
PORCELAIN		
135-53	1¾"	....
135-54	4"	....

Mounting flanges not included.
See 135-90 and 135-91 below.

BOWL INSULATORS

Electrical glass, 6 15/16" OD, 4⅜" high. Fittings include ½" stud, nuts and washers, corona shields, mounting flanges and gaskets.

SINGLE BOWL	TWO BOWLS
135-15-0 Bowl only	135-15-3 16" stud
135-15-1 10¼" stud	135-15-7 24" stud

MOUNTING FLANGES

Cat. No.	Cat. No.
135-90 for bushing No. 135-53	135-91 for bushing No. 135-54

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*Height above panel.

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ALLOY	650	2100° F	W-R	High-temp. Furnaces and Resistors
ALLOY 45	294	930° F	W-R	Precision Applications

† W—wire R—ribbon

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Whether the heat is literal (up to 2100F), or figurative in the sense that performance under difficult condition is a *must*, we have an alloy for almost any conceivable requirement. The above Table may suggest possible applications to your products.

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Complete Technical Data are available from Department 17.

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Whenever you WANT ONE

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$29.50 COMPLETE WITH SHIELDED LEADS

SIMPLE and EFFICIENT for T.V. ALIGNMENT

TESTS VIDEO AMPLIFIER LINEARITY and PICTURE TUBE PERFORMANCE

MODULATES YOUR T.V. SIGNAL GENERATOR FOR OVER-ALL TEST OF T.V. RECEIVER

HERE'S WHY YOU'LL LIKE IT . . .

- ★ Makes horizontal and vertical linearity, width, height and centering tests.
- ★ Checks relative gain of video stages; isolates defects in video amplifier.
- ★ Tests performance of kinescope directly.
- ★ Checks overall image reproduction when used to modulate TV signal generator.
- ★ Uses sync impulse of receiver to insure steady cross bar pattern.
- ★ No removal of chassis necessary; special leads connect to tube pins.

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Portable 12-channel Oscillograph Recorder

for applications requiring an instrument of minimum size and weight

Heiland
DENVER

Type A-500 12-channel

6-3/4" x 9-13/16" x 12-3/4"
33 lbs.

The Heiland A-500 Portable Oscillograph Recorder has been designed and developed for recording strains, pressures, accelerations, temperatures, etc. under conditions requiring an instrument of minimum size, light weight and extreme versatility. Incorporated in the "500" are many features found only in much larger instruments . . . simultaneous viewing and recording . . . four "quick change" paper speeds . . . easy loading and operation . . .

For complete information on the Heiland A-500 and the possible application of this instrument to your particular problem, write or wire . . .

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dependable instruments

Heiland
DENVER

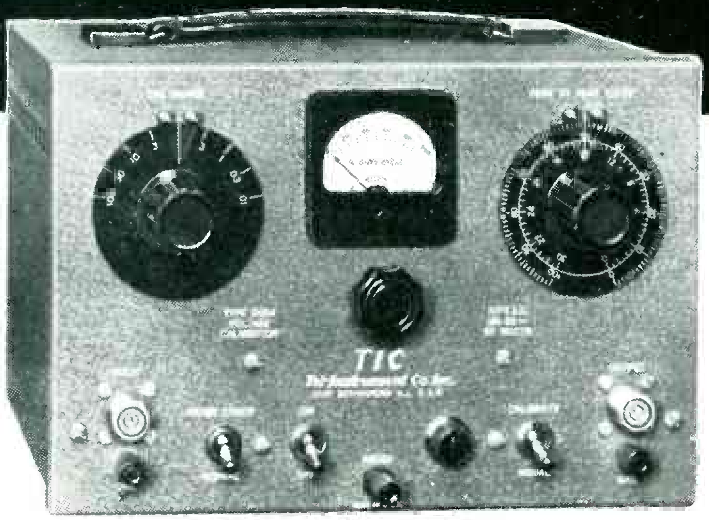
it valuable for joining wires in crowded junction boxes.

Mobile Radio

BENDIX RADIO DIVISION OF BENDIX AVIATION CORP., Baltimore 4, Md. The Command-Air series mobile communication equipment will operate in the vhf band and will be adaptable to all vhf mobile applications. The series features crystal-controlled, dual-channel operation in the 152 to 174 band. Units can be supplied with transmitter output of 10, 25, 30 or 60 w. Fixed stations of 250 w are also available. A new filter design provides for operation on the present channel spacing of 60 kc but will also allow for easy conversion to any one of the new proposed channel bandwidths.

Melting Pots

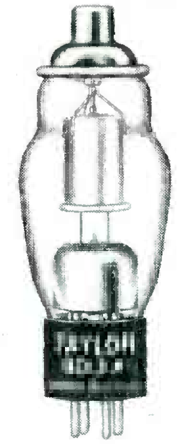
WAAGE ELECTRIC, INC., Kenilworth, N. J., announces a new line of rectangular melting pots that are finding wide usage in plastic melting, for dip coating and solder melting for printed circuit development. These pots have thermostatic temperature controls and are available in either cast iron or aluminum, depending on the temperature



range. Sizes run from 4 × 4 to 12 × 24 in. for operation at 110 or 220 v, a-c.

Slip-On Ion Trap

HEPPNER MFG. CO., Round Lake, Ill., has announced a slip-on ion trap of simplified construction that fully utilizes the maximum efficiency of the Alnico permanent magnet. Installation time of the model T-312 ion trap is 2 or 3 seconds. The smooth metal-to-glass contact permits easy adjustment. Weighing only 3/5 oz, the trap cannot harm the tube's neck. Gauss readings range from 25 to 60.



H-V Rectifier

TAYLOR TUBES, INC., 2312-18 W. Wabansia Ave., Chicago 47, Ill. Type 8013-A high-voltage rectifier tube is rated at 40 kv peak inverse or forward in air, 55 kv peak in oil, with an average current of 20 ma continuous in air and 30 ma continuous in oil, with an instantaneous peak current capacity of 450 ma. Of Nonex glass construction, the tube has a standard four-prong base and special oil-resistant silicone basing compound for oil-im-

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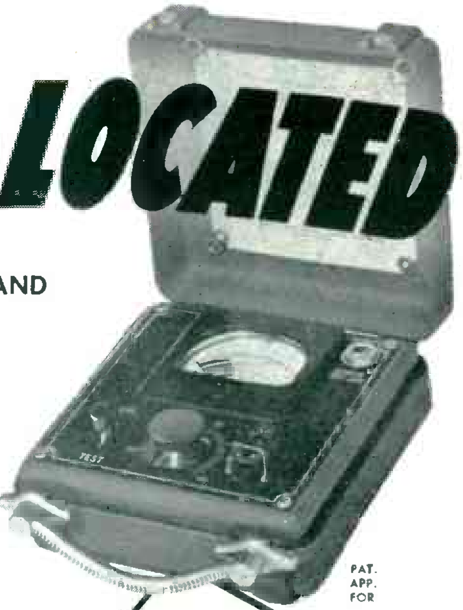

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MEASURE CONVERSION LOSS AND NOISE TEMPERATURE OF SILICON MIXER CRYSTALS

This portable self-contained instrument will indicate directly the conversion loss of all mixer crystals intended for use at or below 10,000 Mc. Above 10,000 Mc the readings are relative (crystals may be selected in the order of their quality). The instrument also indicates 30 Mc noise temperature. Conversion loss mean deviation ½ db; noise temperature mean deviation ½.

PRODUCTION TESTING
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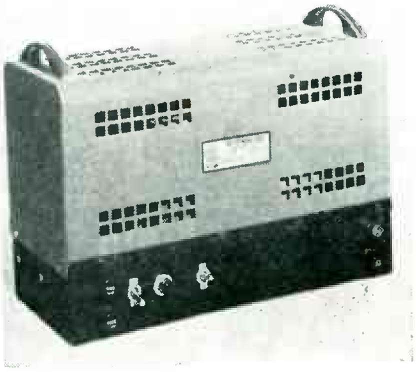
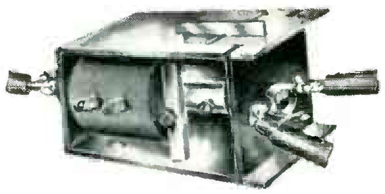
*Du Pont trademark for Polytetrafluoroethylene Enamel mersed operation. The 2.5-v filament is thoriated tungsten and operates at 5 amperes. If operated within ratings the tube has a life expectancy of over 5,000 hr. Physical dimensions are 6 in. in length and 2 in. in diameter.



A-C Regulator

AVION INSTRUMENT CORP., 299 State Highway No. 17, Paramus, N. J. Model 116 precision a-c voltage regulator is suitable for controlling voltage to analog computing setups and servo systems. It regulates line voltage to 0.01 percent and has a transient time constant of less than 0.01 second, meeting present needs for more rapid response to load changes. The unit may be used on either 60-cycle or 400-cycle lines. Power handling capacity is 100 volt amperes. Measuring 14 in. x 9¼ in. x 6 in., the regulator is of convenient size for general laboratory use.



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F. A. SCHERMA MFG. CO., INC. 424 Broome St., New York 13, N. Y. A unique design permits the making of a coaxial relay with minimum size and cost. Economy is effected by eliminating cable fittings and by minimizing wiring labor. The relay was originally designed for mobile radio service and is small, light and

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Also, conscientious testing of all materials with modern laboratory methods makes Precision Coil Bobbins 15 to 20% stronger—yet lighter in weight. Still another important feature is the greatly increased coil winding space of Precision Bobbins.

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Vector SOCKET-TURRETS

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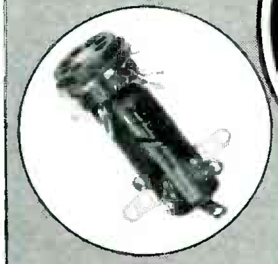

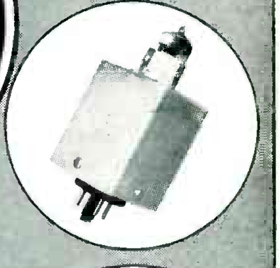

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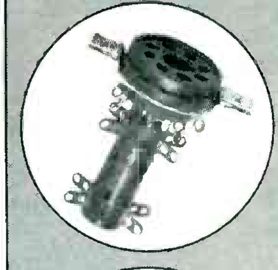
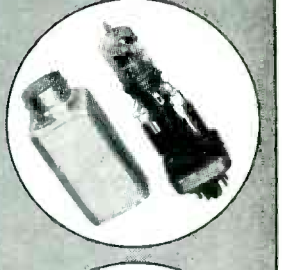
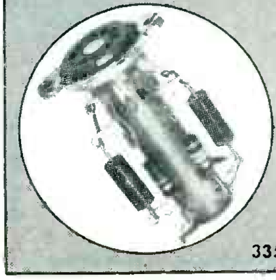
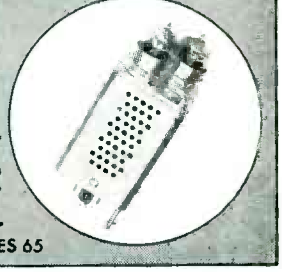
Unitize those tricky circuits for quick change or repair, compactness, top performance, ease and economy of fabrication. Hundreds of experimenters and designers have found the answer they have been looking for in the Socket-Turret Method of construction. New and improved models for the most exacting applications are now available. Let us tell you more about them. Send for catalog.









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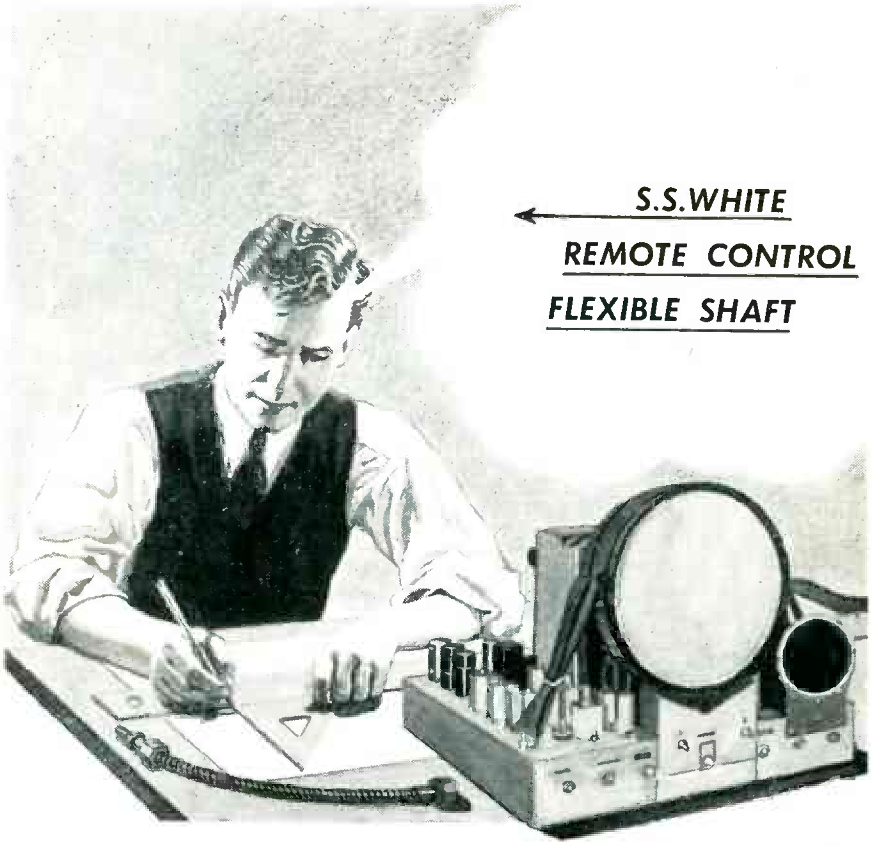

Shortcut to better remote control
—S.S.WHITE FLEXIBLE SHAFTS

S.S.White flexible shafts are the quick, easy and economical way to provide your equipment with smooth, sensitive control. By using these built-for-the-purpose mechanical elements to couple variable elements to their control knobs, you'll be able to meet every space, wiring, servicing and assembly requirement with ease. The shafts will operate around turns and can easily be run over, under, or around circuit components. Their special tension-wound construction gives them the sensitivity needed for practically any remote control application. Shafts can be supplied in any length you specify, ready for immediate coupling to the elements and their controls.

Our engineers are ready to cooperate with you in working out details of any application. Call them in today—their advice and assistance entails no obligation.

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It contains full facts and data on flexible shaft selection and application. Copy mailed free if you request it on your letterhead. No sales follow-up will be made.

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DENTAL MFG. CO.
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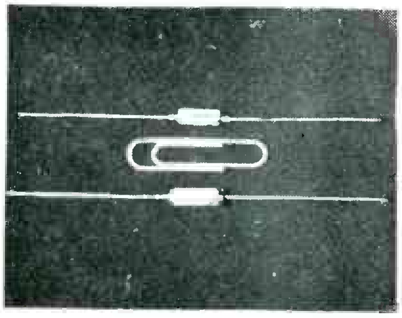
NEW YORK 16, N. Y.
Western District Office • Times Building, Long Beach, California

rugged. The heart of the relay is an iron tube that acts as both the magnetic core and the outer coaxial conductor (a nonmagnetic plating carries the r-f current). The relay can be furnished for operation from any d-c voltage, and can be operated from a-c through a small rectifier.



Tiny R-F Chokes

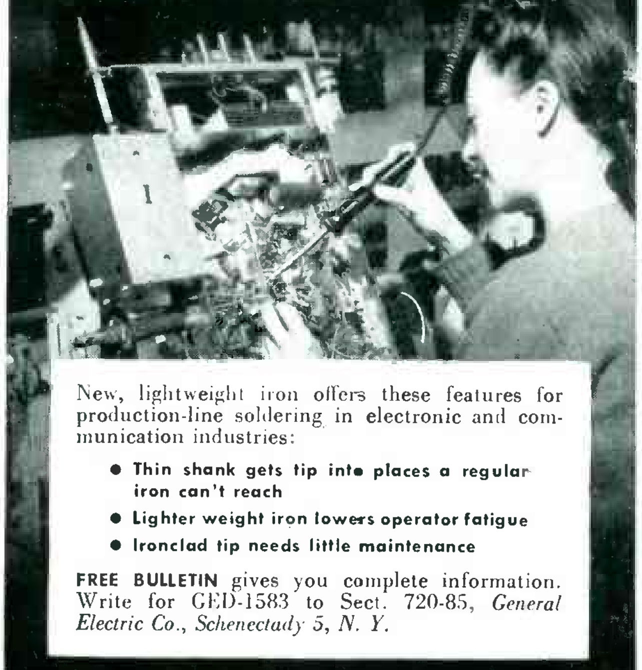
CONDOR RADIO MFG. CO., 116 N. Montezuma St., Prescott, Arizona, has announced a regular production line of tiny r-f chokes that range in inductance from 0.25 to 100 microhenrys. They are plainly marked and insulated for 500 volts.

Pulse Transformer

BERKSHIRE LABORATORIES, 506 Beaver Pond Road, Lincoln, Mass. Type PT-1 Labtrans pulse transformer was designed for use in the microsecond and fractional microsecond ranges. It is compact and convenient to use, being built in an octal tube base. Its windings comprise six sections, of which two pairs are connected in series and the other two sections are indi-

www.americanradiohistory.com

Speeds Soldering on Small Joints



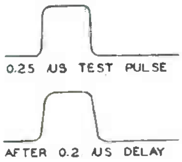
New, lightweight iron offers these features for production-line soldering in electronic and communication industries:

- **Thin shank gets tip into places a regular iron can't reach**
- **Lighter weight iron lowers operator fatigue**
- **Ironclad tip needs little maintenance**

FREE BULLETIN gives you complete information. Write for GED-1583 to Sect. 720-85, *General Electric Co., Schenectady 5, N. Y.*

GENERAL ELECTRIC

Type 506 *Miniature Continuously Variable Delay Line*



This unit is particularly suitable for incorporation in electronic instruments where continuously variable time delay is needed. By means of a novel mathematical method developed exclusively by our engineering staff, the amount of equalization in this line was made exactly equal to its correct optimum value. As a result, the transmission characteristics are far superior than those of any other commercially available delay line of distributed—or lumped-parameter type.

SPECIFICATIONS

TIME DELAY: Continuously variable from 0 to 0.225 microsecond.
RISE TIME: 0.0002 $\sqrt{t}$ microsecond, where t is the amount of delay in millimicrosecond.
CHARACTERISTIC IMPEDANCE: 190 ohms nominal.
ATTENUATION: The attenuation in db per 100 millimicrosecond delay is: essentially zero below 10 mc, 0.5 at 15 mc, 1 at 20 mc, and 1.8 at 30 mc.
SIZE: 1" deep, 4" long, 4" high. WEIGHT: 14 ounces.

ADVANCE ELECTRONICS CO., P. O. Box 394, Passaic, New Jersey

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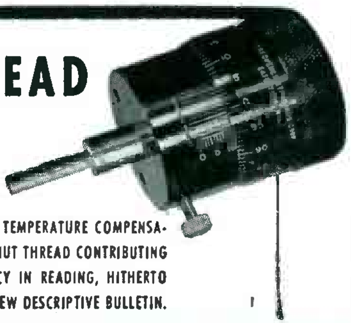
for the Electronics Industry



ENGINEERS USING FS MICROMETER HEADS FOR VARIOUS APPLICATIONS FIND THE TEMPERATURE COMPENSATION CONSTRUCTION AND AUTOMATIC COMPENSATION FOR WEAR OF SPINDLE AND NUT THREAD CONTRIBUTING FACTORS TO THE INSTRUMENT'S PRECISE ACCURACY . . . A DEGREE OF ACCURACY IN READING, HITHERTO UNATTAINABLE IN ANY MICROMETER HEAD. SEND TODAY FOR YOUR COPY OF THE NEW DESCRIPTIVE BULLETIN.

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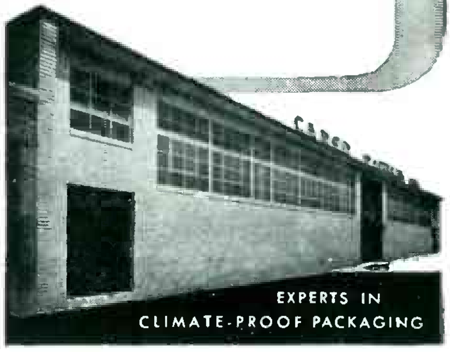

EXPERTS IN CLIMATE-PROOF PACKAGING

vidually connected to base pins. It is useful in blocking oscillators and other pulse circuits.

VTVM

MILLIVAC INSTRUMENT CORP., 444 Second St., Schenectady 6, N. Y. The MV-22A vtvm for a-c is a further development of the MV-12A meter recently announced. The older instrument has a frequency range of 20 cycles to 250 kc. The new meter has been extended to 6 mc. It has a six-stage amplifier with a novel a-c regulated power supply. The instrument measures voltages between 70 μv and 1,000 volts.

Solder Pot

DEE ELECTRIC CO., 1101 N. Paulina St., Chicago 22, Ill., has announced the model 85 solder pot for dip soldering large assemblies and printed-circuit units. It features high efficiency and long life ceramic embedded elements with adjustable thermostatic control of temperature. Inside dimensions of the pot are 12 in. long by 6 in. wide by $2\frac{1}{8}$ in. deep. The unit is for 110 v a-c and is rated at 900 w. Temperature

Measurements
Corporation

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111**

CRYSTAL CALIBRATOR

*For The Frequency Calibration
Of Equipment In The Range Of*

250 Kc. to 1000 Mc.

(To within .25 Mc.)

Frequency Accuracy: ±0.002%

The Model 111 provides a test signal of crystal-controlled frequency and has a self-contained detector of 2 microwatts sensitivity.

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Year after year — for over ten years — UNILECTRIC has produced millions of wiring systems, for more than 150 leading manufacturers of electric and electronic products. From controls to complex armed forces equipment, these wiring systems have consistently met the most exacting requirements and provided substantial savings to each customer.

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HERMETICALLY SEALED TERMINAL*

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See why over 1,000,000 are now in use by the biggest names in industry!

- 2000 volts, RMS-Corona Free
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TRANSFER SWITCH

Designed for radio frequencies where two circuits are required for remote control switching of two antennas with two receivers.

R. F. Range	0 to 10,500 mc.
VSWR	1.3/1 max.
Crosstalk	Greater than 60 db
Impedance	51.0 ohms
Operating Voltage	20-30 volts D.C.
Switching Time	0.1 seconds
Weight	1 lb. 8 oz.
Dimensions	2¾" Dia. x 4¾" H.

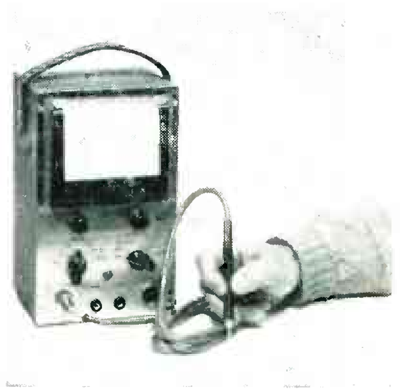
MODEL 2NRP1

For further information write to

General Communication Company

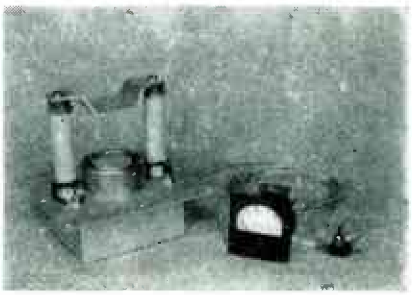
681 BEACON STREET, BOSTON 15, MASSACHUSETTS

range is 450 to 700 deg F, any point of which may be selected with the adjustable thermostat.



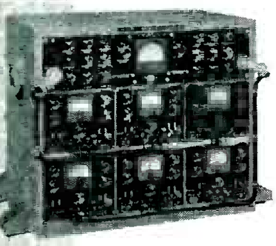
Test Leads

INSULINE CORP. OF AMERICA, 36-02 35th Ave., Long Island City, N. Y., has announced two new test leads designed to fit the REC vtvm and others equipped with screw-on microphone type connectors. The No. 316 contains an isolating resistor in its probe and is intended for d-c measurements; and the No. 317 is a straight-through lead for utility applications. Both are six feet long, are made of heavy, shielded wire and have insulated handles.



R-F Voltmeter

WESTINGHOUSE ELECTRIC CORP., Box 2099, Pittsburgh 30, Pa., has available a voltmeter that measures rms values of r-f voltages up to 10,000 v in dielectric heating loads. Use of the instrument will indicate to the operator of a dielectric heating apparatus the amount of heat that is being applied to the electrodes. The voltmeter consists of a capacitance voltage divider and a crystal rectifier unit, connected to an indicating instrument calibrated in kv. No external power is required for operation other than that



No more worries about
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The NEW and PHENOMENAL

HATHAWAY Type SC-16
OSCILLOGRAPH
with 6 elements is *flat from 0 to 200,000 cycles per second,* and its traces have a writing speed of *5 million inches per second.*

Fast transients and high-frequency phenomena now can be accurately recorded.

Several types of continuous-drive record magazines are available for 6-inch sensitized paper and film, and for 35-mm film. The magazine shown on the oscillograph at the left accommodates 100-foot rolls of record paper.

Drum-type magazines, both small and large, are valuable for short high-speed records. The large drum-type magazine at the left has a drum 3 feet in diameter and 6-inches wide. It can be driven at 3000 RPM for a *chart speed of 6000 inches per second* when high resolution is needed. It can be used to take one 10-foot record or a larger number of shorter records.

The ASC-10 6-element direct-coupled amplifier will drive the SC-16 oscillograph from potentials of millivolt level.

Useful for strain recording to 100 Kilocycles.

- **AUTOMATIC OPERATION** Initiate a transient with the oscillograph, or let the transient start the oscillograph.
- **QUICK-CHANGE TRANSMISSION** for wide range of record speeds.
- **PRECISION TIME LINES.**
- **Z-AXIS MODULATION** for timing to one-tenth millisecond.
- **QUICKLY-INTERCHANGEABLE LENS STAGES** for different record and trace widths.

Write for Bulletin 2G1-K for details.
Write for FREE copy of Hathaway Engineering News

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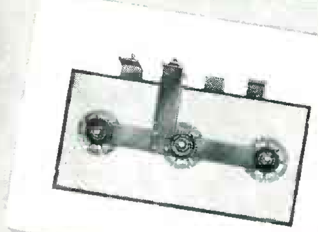
SYNTRON



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Made by a new vacuum process that insures a smooth, uniform selenium film, free from flaws and impurities, and permits the production of larger cells than have been practical heretofore.

Of proven dependability to withstand continuous heavy-duty service, they are available in one inch square to 12 by 16 inch cells, in standard stacks or for customer assembly.

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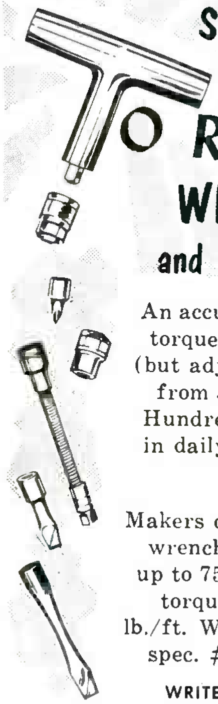

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An accurate, easy to use torque limit tool, preset (but adjustable) to limits from 5-100 lb./in. Hundreds of thousands in daily use.

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Makers of torque limit wrenches in capacities up to 750 lb./in., and torque meters to 4000 lb./ft. Wrenches meet spec. #MIL-H 4034A.

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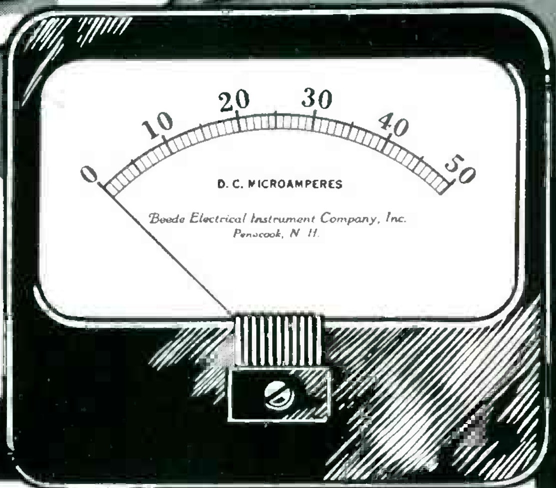


"accurate to the DOT"

The ORIGINAL BEEDE METERS have long been known for their high quality, durability, accuracy and advanced design. Specify ORIGINAL BEEDE METERS and be SURE.
Information or catalog on request

BEEDE ELECTRICAL INSTRUMENT CO., INC.
PENACOOK, N. H.

taken from the r-f voltage source. This will be less than 0.1 w.

Aircraft Hook-Up Wire

PLASTOID CORP., 42-61 24th St., Long Island City, N. Y., is producing Synkote AN hook-up wire, an improved 600-v aircraft wire conforming to military specifications MIL-W-5086. The new aircraft wire is superior to older types, with standing abrasion, corrosion, flame, fungus, gas, oil, moisture, antifreeze, salt water and the various extremes of temperature encountered at low and high altitude flight.

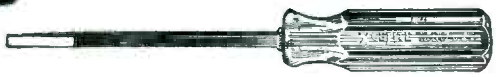
Literature

Sintered Magnets. The Indiana Steel Products Co., Valparaiso, Ind. Catalog No. 12 offers 24-hour-service on sintered permanent magnets. The catalog lists specifications for a range of magnets of special interest to makers of thermostats, meters, switches and other relatively small devices. It also describes in detail the magnetic and physical characteristics of these powdered metal magnets.

Oscillograph-Record Cameras. Allen B. DuMont Laboratories, Inc., 1,000 Main Ave., Clifton, N. J. A single-sheet bulletin describes and illustrates four new oscillograph-record cameras. It tells how photography augments the performance of a c-r oscillograph by perpetuating its presentation through permanent records. Included are the type 295 for more versatile single-transient recording; type 296 for thrift single-frame recording; type 297 for improved finished-print recording; and type 321 for simplified moving-film recording.

Wire-Wound Resistors. Shallcross Mfg. Co., Collingdale, Pa. Bulletin L-27 will acquaint users of precision wire-wound resistors with the significant differences between the new MIL-R-93A specifications and the old JAN-R-93 specifications which they supersede. Included are a cross-reference table contrasting MIL, JAN and the company's style numbers; bobbin sizes; maximum resistance avail-

XCELITE *Hand Tools*
PREFERRED BY THE EXPERTS



Do You Know the Advantages of XCELITE Beryllium Screwdrivers?

- Non-magnetic, non-sparking.
- Do not affect TV image during focalizer adjustment.
- More resistant to fatigue than steel!
- Do not require frequent regrinding as do plastic or fibre screwdrivers.

These hard, non-ferrous XCELITE Beryllium Screwdrivers come in 1/8, 3/16 and 1/4" diameters in varying lengths to suit every need. Widely used in TV applications as well as locations where explosive gases are present. Ask your dealer about XCELITE Beryllium screwdrivers with the man-size blue handle!

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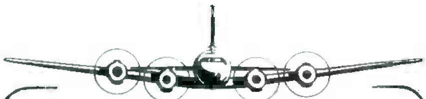
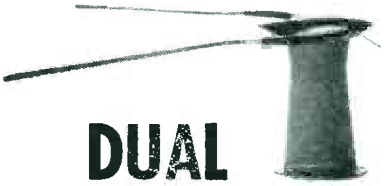
A Subsidiary of the RAY-O-VAC *Ray-O-Vac Company*
MADISON 10, WISCONSIN

Prize Horns for a PERFECT STEER!



Aircraft Radio Corporation's
A 13-B



DUAL ANTENNA

for all aircraft

The "ramshorn" contour of the A-13B Antenna affords improved signal reception via *two* broadbanded antennas. The horns are for use with VOR and runway localizer receivers, the bars for glide-path receivers. Both antennas terminate in BNC co-ax fittings UG-291/U. Their low head resistance provides freedom from icing and other structural problems. Already in wide use on transports of Pan American Airways, Eastern Air Lines and others, as well as Army, Navy, and Air Force (AN designation AS-580/ARN-30). This new antenna is designed for *all* aircraft, from helicopters to multi-engine transports. It is CAATC # 1R4-4. Available now. Write for full details today.

ARC **Dependable Electronic Equipment Since 1928**

Aircraft Radio Corporation
Boonton, New Jersey

able; and both MIL, JAN and commercial power ratings.

Resistors. Stackpole Carbon Co., St. Marys, Pa. A handy bulletin describes fixed composition resistors designed for JAN-R-11 uses. JAN types covered include RC10, RC20, RC21, RC30, RC31, RC41 and RC42. The bulletin is designed as a convenient guide and includes prices on the various fixed composition resistor types.

Welding Analyzer. The Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio. The model BL-213 welding analyzer, which graphically records welding current, electrode force and other variables in both single and three-phase resistance welding, is described in a recent single-sheet catalog.

TV Replacement Guide. Triad Transformer Mfg. Co., P. O. Box 17813, Los Angeles 34, Calif. Featuring replacement items for 77 different makes of radio and television receivers is catalog TV-52. The booklet contains a complete and separate listing of all replacement transformers together with specifications and prices. Typical cases and types are illustrated.

Rectifier Power Units. Opad-Green Co., 71 Warren St., New York, N. Y. Bulletin No. 118 describes 42 standard models of a new series of industrial power rectifiers. The units covered furnish 115 or 230 volts d-c and start at 125 watts load capacity. The new two-color bulletin includes tabular listings of ratings, dimensions and weights of the various models available.

Components. Ohmite Mfg. Co., 4876 W. Flournoy St., Chicago 44, Ill. Stock Catalog No. 24 illustrates and provides complete data, including sizes and prices, on the company's vitreous-enameled rheostats, composition potentiometers and resistors, wire-wound resistors, tap switches, r-f plate chokes and power line chokes.

Chopper Amplifier. Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio. A 2-page bulletin deals with the model 300 uni-

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bring your
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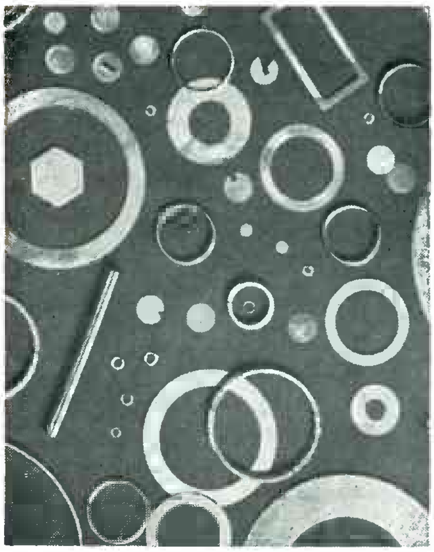

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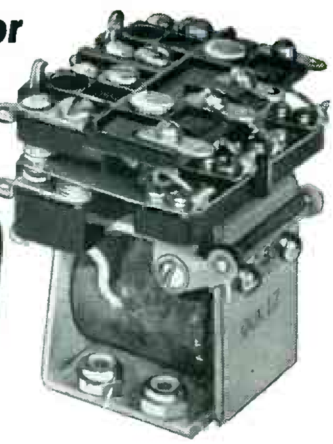
A Quality Relay for RUGGED DUTY!



AMRECON
TYPE: DO
A.C. or D.C.

WITH CONTACT ARRANGEMENTS OF 3- AND 4-POLE, DOUBLE THROW

Wherever severe shock and vibration are encountered, this rugged little relay can be relied upon to give *dependable* service. Originally designed for aircraft and mobile equipment, the versatile AMRECON Type DO is adaptable to many other uses where maximum protection against mechanical injury is required. Small in size ($2\frac{1}{4}$" high, $2\frac{1}{16}$" wide, $1\frac{13}{16}$" deep) it is available in contact arrangements of three and four-pole, double throw. Coils are normally rated at 3 watts d.c., or 6 watts, 60-cycle a.c.—for voltages up to 230 volts d.c., or 440 volts a.c. Contact rating: 10 amps—at 115 volts a.c. non-inductive, or 32 volts d.c. Weight: approximately six ounces.

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American Relay & Controls, Inc.
4911 W. Flournoy St., Chicago 44, Ill.

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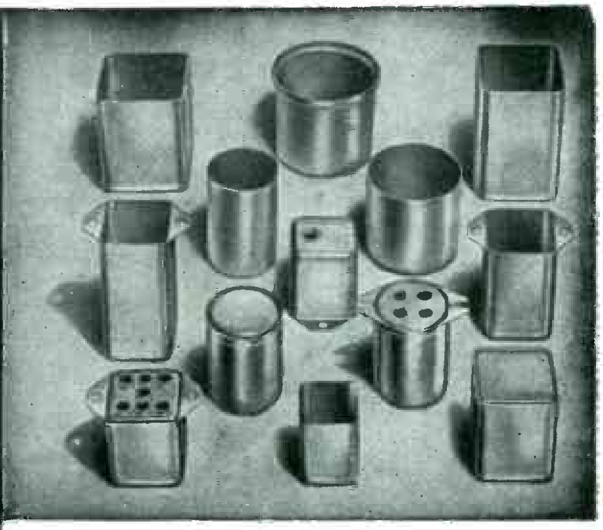

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hot tin dipped . . . fabricated terminal and vent holes . . . smooth, one-piece construction using cold rolled steel . . . draw depths up to $2\frac{1}{2}$" . . . inside fit covers for easy hermetic sealing in all sizes . . . available as stock sizes and as special fabrications.

OLYMPIC METAL PRODUCTS COMPANY, INC.
P. O. BOX 71A
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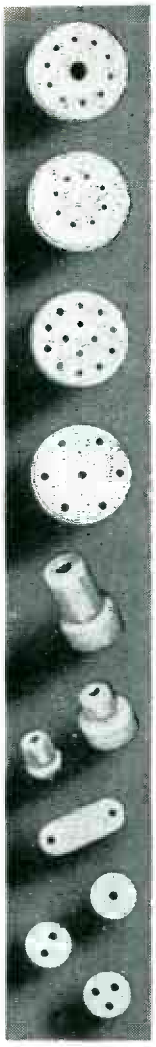
versal d-c chopper amplifier, an instrument with a maximum gain of 800,000, frequency response of 0 to 500 cps, input impedance of 1 megohm, noise and drift within 25 μv, or 2 percent of full scale. The bulletin includes complete specifications, and states that the new instrument will work with virtually all pen recorders, recording galvanometers and c-r oscilloscopes.

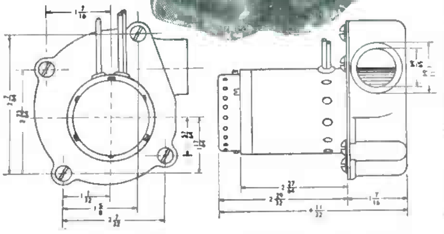
Insulating Varnishes. Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill., has released a 20-page catalog giving helpful information on varnish selection and use for users of electrical insulating varnishes, sealers, compounds and related materials. Varnish composition, types, functions, colors, processing and care are covered. Data on solvents are also included, as well as detailed descriptions of Pedigree and Dow Corning brands of electrical insulating varnishes for all types of applications.

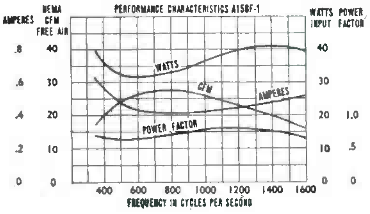
Instrumentation Literature. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa. Bulletin 100-A is an index of technical literature that consists of both a numerical listing and alphabetical cross index for specification sheets, instrumentation data sheets, catalogs and other literature.

Transformer Catalog. Triad Transformer Mfg. Co., P. O. Box 17813, Los Angeles 34, Calif. Catalog TR-52 lists more than 450 items with specifications and prices. Featured are hermetically sealed transformers designed to MIL-T-27 specifications, high quality audio transformers, 400-cycle power transformers, Trijet miniature transformers, toroids, general purpose transformers for radio and tv replacement, geophysical transformers and amplifier kits.

Band-Pass Filter. Krohn-Hite Instrument Co., 580 Massachusetts Ave., Cambridge 39, Mass., has available a descriptive pamphlet on the model 310-A band-pass filter. The instrument described is especially useful in the audio and ultrasonic frequency range for noise measurements, harmonic






PERFORMANCE CHARACTERISTICS A150F-1
AMPERES
NEMA CFM FREE AIR
WATTS INPUT
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WATTS
CFM
AMPERES
POWER FACTOR
1.0
.5
400
600
800
1000
1200
1400
1600
FREQUENCY IN CYCLES PER SECOND

and frequency analysis, and for psychoacoustics and electromedical research.

Laboratory Instrument. Saturn Electronics Co., 8237 Witkop Ave., Niagara Falls, N. Y. A 2-page bulletin illustrates and describes the model 102 sonic comparator that consists in an integral housing of all of the electronic elements required to determine the natural frequency of vibration of elastic bodies lying within the range of 100 to 10,000 cps to an accuracy of one percent. Information on operation, potential advantages and technical specifications is given.

Hard Rubber and Plastics. American Hard Rubber Co., 93 Worth St., New York 13, N. Y., has issued an 80-page handbook on hard rubber and plastics. Included are a description of hard rubber, its history, value and method of manufacture. Purpose of the handbook is to help answer the question "What materials should we use?" for parts and components manufacturers, and to help them design these articles to give all the qualities desired at least possible cost.

Chassis Catalog. California Chassis Co., 5410 Tweedy Blvd., South Gate, Calif., has reissued its 4-page catalog and insert. Included are a line of standard chassis items, relay racks, meter cabinets, ability cabinets, relay rack panels, chassis parts and accessories.

Low-Mu Triode. Lewis and Kaufman, Inc., 50 El Rancho Ave., Los Gatos, Calif., has issued a new data sheet describing the type 250TL low-mu triode. The data sheet illustrates the tube, provides outline details and dimensions, lists general electrical characteristics and gives constant-current curves. Typical operating parameters and maximum ratings are included for operation as a class-B a-f power amplifier and modulator and as a class-C r-f power amplifier and oscillator.

Converters. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa. Instrumentation data sheet

unicon
PLASTIC DIELECTRIC capacitors

Property	Poly-styrene	Poly-ethylene	Teflon	Synthetic D	Synthetic E
Capacity.......	.001 up	.001 up	.001 up	.01 up	.01 up
Voltage.......	100 up	2000 up	300 up	200 up	600 up
Power Factor...	.01%	.01%	.01%	0.5%	0.5%
I. R..........	10^6 meg/mf	10^4 meg/mf	10^6 meg/mf	10^6 meg/mf	10^4 meg/mf
Max. Op. Temp.	90°C	60°C	125°C	125°C	100°C
Soakage.......	.02%	.02%	.02%	1.0%	4.0%
Temp. Coef....	−100 ppm/°C	−500 ppm/°C	−100 ppm/°C	+500 ppm/°C	+500 ppm/°C
Bulk at lowest voltage given.	5 in^3/mf	36 in^3/mf	10 in^3/mf	1.2 in^3/mf	3.5 in^3/mf

Unicon Capacitors, with the characteristics shown above, give you an optimum solution to your capacitor problems. Unicon Capacitors are priced competitively, and delivery is excellent. Write for Catalog EE.

united condenser corp.

337 EAST 139TH STREET NEW YORK 54, N. Y.

Build YOUR OWN Heathkit TEST EQUIPMENT

Heathkits are completely engineered instruments supplied unassembled. Every kit goes together smoothly and easily. All drilling, punching, and painting has already been done for you.

It's easy and fun to build a Heathkit. All parts are furnished and are of highest quality for years of trouble-free, dependable operation.

Save money by constructing your own. All expensive wiring and assembly costs are completely eliminated.

Detailed construction manual shows clearly where each wire and part goes and tells exactly how to build the kit. Write for free catalog.

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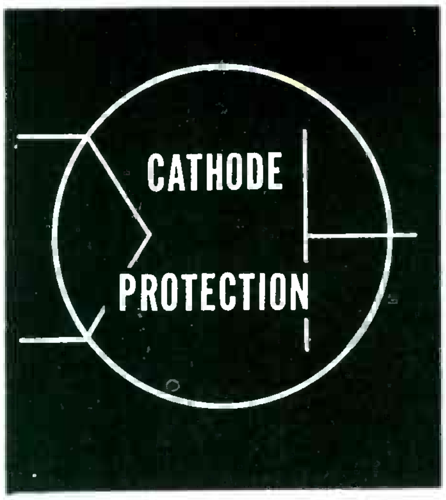
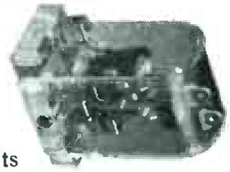
EXPORT AGENT
ROCKE INTERNATIONAL CORP.
13 E. 40th St.
NEW YORK CITY (16)

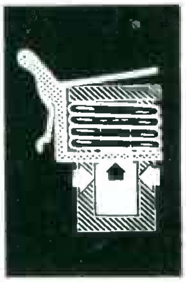


... with *Silic-O-Netic* TIME DELAY RELAYS

TIME DELAY is a basic requirement of many common electronic circuits. Thyratrons and gas filled rectifier tubes, particularly, must be protected to obtain any semblance of satisfactory life.

The facts are simple:
Time delay permits the tube to heat before the load is applied; otherwise a coating forms on the cathode which quickly destroys its effectiveness.





Operating principle is explained in Bulletin 5001A. Send for your copy.

HEINEMANN ***Silic-O-Netic*** Time Delay Relays have a unique combination of characteristics ideally suited to cathode protection. They are both low cost and fully dependable; small in size and lightweight. They are all metal, yet the time element is hermetically sealed . . . forever free of dirt and not subject to a fatigue factor. ***Silic-O-Netic*** Relays employ no thermal elements . . . thus they are not affected by the normal ambient temperature variations of electronic equipment.

don't use heat ...USE POWER

HEINEMANN
ELECTRIC COMPANY
97 Plum Street Trenton 2, N.J.

New "compact" scope

This ALL NEW precision oscilloscope is small, easily handled. Yet it out-performs instruments twice its size.

TYPE 315-D

Completely new design, both circuit and mechanical, permits TEKTRONIX to offer you this outstanding laboratory instrument in a small but accessible package. The Type 315-D weighs only 35 lbs. — measures 12 3/8" high, 8 5/8" wide, 18 1/4" deep. Electronic regulation of all dc voltages provides rigid stability over the supply voltage range of 105-125 volts, 50 to 800 cycles.

New—for the first time in a single instrument—calibrated time bases of 1 μsec to 50 sec. New 5x magnifier expands time base to right and left of center. Direct coupled trigger amplitude discriminator allows trigger phasing on complex waveforms. Direct coupled unblanking circuit insures constant beam current. Time base accuracy now independent of duty cycle.

New vertical amplifier design gives you greater stability, exceptional deflection linearity, high sensitivity. You can accurately read waveform voltages from the screen on nine calibrated ranges (0.02 to 100 v/division). Vertical amplifier rise-time 0.07 μsec. Bandwidth 5 mc.

New mechanical design gives you full accessibility even though the Type 315-D is extremely compact. Servicing is easily performed right in the instrument, or, if preferred, whole sections may be replaced with little effort.

Sensitivity
dc to 5 mc — 0.2 v/division
5 cycles to 5 mc — 0.02 v/division
(graticule marked in quarter-inch divisions)

Time Base
1 μsec to 50 sec — in 24 ranges — calibrated

Direct coupled unblanking
High definition three inch crt
5x Magnifier
Square wave voltage calibrator
Y-axis delay

TEKTRONIX Type 315-D — $785.00 f.o.b. Portland, Oregon

First display at the Western Electronic Show. Be sure to see and try the Type 315-D as well as the outstanding new Type 524-D Television scope.

TEKTRONIX, Inc.

P. O. Box 831A, Portland 7, Oregon **Cable: TEKTRONIX**

No. 10.20-5 describes the design, application and available types of Brown 60 cycle a-c and d-c converters. Electrical characteristics, applicability, wire diagrams, and photographs of the unit are included in the two-page bulletin.

R-F Equipment. The Daven Co., 191 Central Ave., Newark 4, N. J., has prepared a 10-page pamphlet covering the many types of r-f and video attenuators made by the company. Units such as variable attenuators, fixed attenuators, impedance matching networks, decade attenuator units, attenuation networks and components in the 10 mc (video) and 225 mc (r-f) range are completely detailed with pictures, descriptive copy and diagrams, as to types, specifications and impedances.

Powder-Iron Cores. Lenkurt Electric Co., 1113 County Road, San Carlos, Calif. Tuning cores, plain cores, bob cores, pot core assemblies and cup core assemblies are listed in bulletin IC-P8. Illustrations, drawings and dimensions of standard cores are included along with ordering in formation for both standard and special cores and core assemblies. Characteristics of commonly used powders are given, and typical performance data are presented for pot core assemblies made from three common powders to show how cores can be made to meet specific individual requirements.

Meter Matcher. Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio. A recent 2-page bulletin describes the model 105 meter matcher, a power frequency amplifier that relieves test circuits of supplying power to voltmeters or wattmeters; gives instrument voltage coils an effective full-scale range of 15 to 600 v; delivers 150 v rms into a 2,000 ohm resistive meter load; and adds less than 0.15 percent error to measurements.

Components Catalog. Switchcraft, Inc., 1328 N. Halsted St., Chicago 22, Ill. A new 16-page catalog of electronic components includes many additions to the present line as well as new items of special interest to the industry, such as

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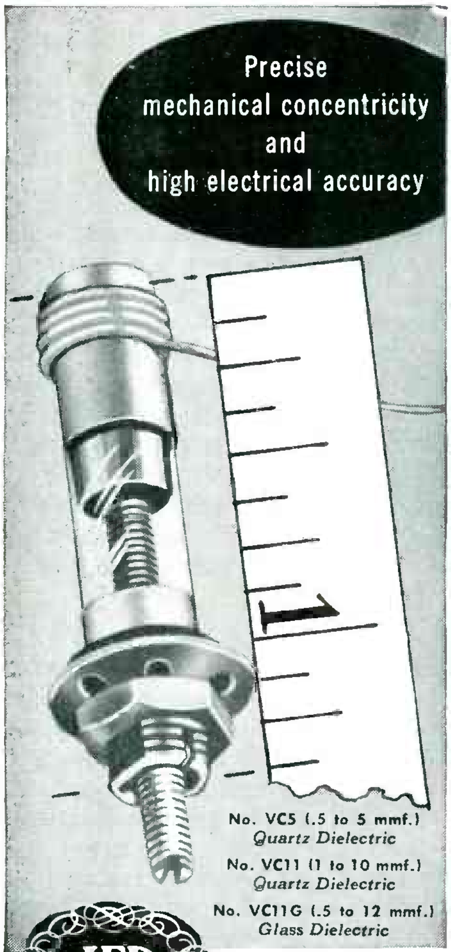

JFD

Piston type variable trimmer capacitors

Compare these Outstanding Features

- One-piece spring loaded piston and screw made of special invar alloy having extremely low temperature coefficient of expansion.
- Silver band fused to exterior of precision drawn quartz or glass tube serves as stationary electrode.
- Piston dimensional accuracy is held to close tolerance maintaining minimum air gap between piston and cylinder wall.
- Approximately zero temperature coefficient for quartz and ±50 P.P.M. per degree C. for glass units.
- "Q" rating of over 1000 at 1 mc.
- Dielectric strength equals 1000 volts DC at sea level pressure and 500 volts at 3.4 inches of mercury.
- 10,000 megohms insulation resistance minimum.
- Operating temperatures, −55 C. to +125 C. with glass dielectric. And −55 C. to +200 C. with quartz dielectric.
- Over 100 megohms moisture resistance after 24 hours exposure to 95% humidity at room temperature.

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NEW

the AUTOGRAF

a general purpose, wide range, portable, universal X=(f)Y graphic recorder

TYPICAL PLOTTING APPLICATIONS:

- Current/Voltage
- Lift/Drag
- Speed/Torque
- Magnetization
- Frequency response
- Analog computer output curves
- Temperature/Pressure
- Stress/Strain
- Transistor and Diode characteristics
- Magnetic amplifier, input/output
- Temperature/Activity
- X=(f)Y

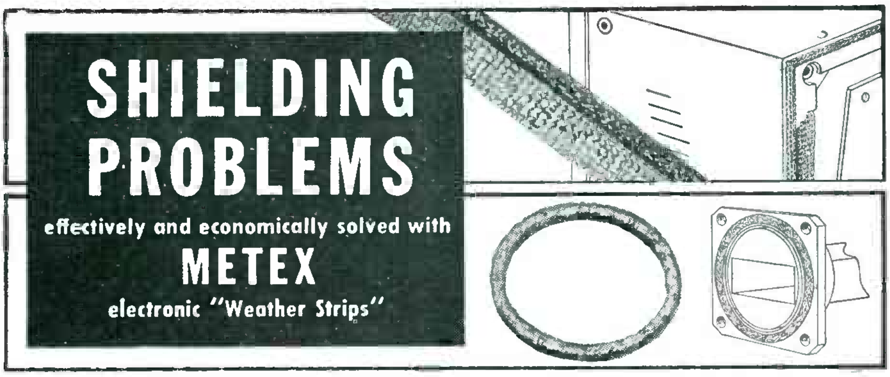
Now you can expedite your research, development, and test programs with the AUTOGRAF—a precision recorder that automatically plots curves showing relationship between a dependent and an independent variable. Through two rebalancing, servo-actuated recording axes, the AUTOGRAF draws cartesian coordinate graphs from any data that can be reduced to electrical form. You save the time it would ordinarily take to read meters, collate data, transfer data to grid, draw in curves...The AUTOGRAF does all this work for you, plotting the data simultaneously with occurrence of the phenomenon being studied. Too, the AUTOGRAF draws related curves in families as fast as input information can be altered. Without any additional steps, once a test is run, you have in hand a complete, accurate, pen-and-ink graph, drawn on a standard 8½"x11" sheet of paper, ready for study, file, notebook, or reproduction.

SPECIFICATIONS: — Two independent servo-actuated recording axes; input free of ground. • Recording speed, both axes, 1 second for full scale travel. • Scales: from 0-5 millivolts up to 0-100 volts, both axes. • Full-range zero set on either axis—plots data in any desired quadrant. • Sensitivity—200,000 ohms per volt, 5 microamperes drain for full scale. • Size and weight: 13" x 13" x 10"; 35 lbs. • Self-contained; operates from 115 volt 60 cycle line, 85 watts.

WRITE for complete details

MOSELEY

FRANCIS L. MOSELEY
1136 N. LAS PALMAS AVENUE
LOS ANGELES 38, CALIFORNIA



SHIELDING PROBLEMS

effectively and economically solved with

METEX

electronic "Weather Strips"

Resilient...Conductive...Compressible...Cohesive

From closures for cabinets to gaskets for waveguide couplings, Metex Electronic Shielding assures *lasting* metal-to-metal contact to prevent leakage, without the need for costly machining to secure precise surface-to-surface contacts. Metal wire — *knitted*, not woven or braided — gives Metex Electronic Strips and Gaskets that combination of conductivity and resiliency which makes them so effective and economical for shielding.

For a more detailed picture of the scope of utility of Metex Electronic Products, write for free copy of "Metex Electronic Weather Strips." Or outline your specific shielding problem—it will receive immediate attention.

METAL TEXTILE CORPORATION

KNITTERS OF WIRE MESH FOR MORE THAN A QUARTER CENTURY

METEX

641 East First Avenue Roselle, N. J.

adapters, shielded jacks, microphone connectors, lever switches and cable assemblies.

Components Brochure. Servomechanisms Inc., Post and Stewart Avenues, Westbury, Long Island, N. Y. A new 16-page illustrated brochure, MDA-200, describes the complete line of precision components for rapid and economical assembly of control systems instruments and analog computers for breadboard and semipermanent assembly. It features a greatly expanded line of new mechanical development apparatus components.

Amplifiers and Sound Systems. Don McGohan, Inc., 3700 West Roosevelt Rd., Chicago 24, Ill. A new catalog No. 200 describes and illustrates a complete line of eight amplifiers ranging in power from 7 w to 60 w, a 60-w amplifier booster, a mobile unit with regular or phono top, seven portable sound systems, sound projectors, microphones, and 3-speed record player and changer.

Industrial Phototubes. Mullard Ltd., Century House, Shaftesbury Ave., London WC 2, England. A revised and enlarged edition of a publication entitled "Photocells for Industrial Applications" has recently been issued. It contains notes on the principles of operation of both vacuum and gas-filled tubes together with characteristics, data an suggested applications.

Power Conversion Units. Syntron Co., 241 Lexington Ave., Homer City, Pa., has issued a new bulletin on its line of selenium rectifier power conversion units. The literature includes illustrations and specifications of the various models available according to capacity.

Motor Switch. Globe Industries, Inc., 125 Sunrise Pl., Dayton 7, Ohio. Bulletin 600 deals with the company's motor switch, a combination of the Moto-Mite motor, governor controlled if required, a small concentric gear reduction and a spdt switch mechanism. Chief features and dimensional diagrams are included.

- PREVENTS GASKET LEAKAGE
- LESS HANDLING
- ELIMINATES WASTE
- MORE USES

THIS IS NEWS! You can order this outstanding insulating material in sizes up to 60" x 72"—and save money, time and headaches.

If you have ever used large gaskets laminated from the old small sheets of TEFLON, you've been up against problems like blow-through and leakage. Because no cement known can bond TEFLON. And you have fretted about waste, if you've had to cut two 13" discs—because that meant using *two* of the old 24" x 24" sheets and throwing away the unused portions.

You pay no more per square inch for the new TEFLON size to get trouble-free gaskets, to get more cuttings per sheet. Where stripping is needed for punching, you now have a longer strip. That means less handling.

The large TEFLON sheets make wonderful covers for chemical table tops. No doubt you'll find many other uses for this remarkable material. Why not learn more about it? Write today for specifications and TEFLON Brochure #201.

ELECTRONIC MECHANICS INC.

101 CLIFTON BOULEVARD,
CLIFTON, NEW JERSEY

Phaostron RUGGEDIZED METERS

AVAILABLE ***NOW***

Built to meet Signal Corps specifications MIL-M-10304, JAN-I-6, MIL-M-6A & SCL-3069.

These meters are manufactured in standard 1½", 2½", 3½" and 4½" sizes.

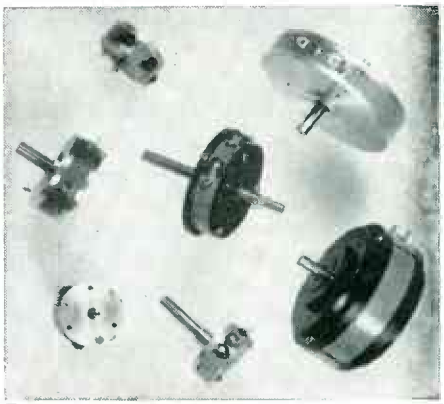
D.C. instruments available in microammeters, milliammeters, ammeters and voltmeters.

HERMETICALLY SEALED

LITERATURE ON REQUEST

ENVIRONMENT FREE ELECTRICAL EQUIPMENT by *Phaostron*

PHAOSTRON CO., 151 PASADENA AVE., SO. PASADENA, CAL.



PRECISION POTENTIOMETERS

Type RL-270: Wedding ring type . . . five sizes charted below. Gamewell Potentiometers are precision instruments in every respect. They feature close limits in electrical characteristics and mechanical construction, low electrical noise, low torque, and long life. All types operate at —55°C. to +55°C., 95% relative humidity at altitudes up to 50,000 ft. Non-linear windings are available.

CONDENSED SPECIFICATIONS	RL-272	RL-270	RL-271	RL-275	RL-277
Diameter (in.)	5	3	2	1⅝	1¼
Rating (watts)	12	6	3	2	1.5
Torque, max. (oz. in.)	1	1	1	½	½
Weight (oz.)	15	6	3	2	1
Mounting: 3 holes ⅛" deep	#8–32	#8–32	#8–32	#6–32	#4–40
Mounting circle diam. (in.)	3.250	1.750	1.250	1.000	1.000
Max. resistance (ohms) ± 10%	500,000	275,000	160,000	105,000	64,000
Min. resistance (ohms) ± 10%	460	250	150	105	80
Max. useful angle (deg.)	358±½	356±½	354±½	352±½	350±½
Max. resolution (%)	0.05	0.08	0.15	0.2	0.25
Min. resolution (%)	0.01	0.015	0.025	0.04	0.05
Linearity (%)	±0.10	±0.10	±0.15	±0.25	±0.30

Standard Shaft: single end, ¾" extension, specify if otherwise.
Double ended shaft special, specify diameter and length.
Multiple sections can be ganged, add ⅜" to the overall length for each additional section.
Terminals will be positioned on the circumference as required for taps and winding angle.
Expected life of all types over 1,000,000 cycles.

FOR COMPLETE DETAILS SEND FOR BULLETIN F-68-A

TRADE MARK GAMEWELL REG. U.S. PAT. OFF.

THE GAMEWELL COMPANY
NEWTON UPPER FALLS 64, MASSACHUSETTS

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PLANTS AND PEOPLE

Edited by WILLIAM P. O'BRIEN

Du Mont Personnel News

RECENT changes among the personnel of Allen B. Du Mont Laboratories, Inc. involve three engineers:

R. G. Scott has been named manager, sales engineering. He joined Du Mont in 1948 as a senior engineer working on the design and development of important picture-tube innovations, and later transferred to product engineering where he followed these developments through their initial mass-production stages. For the past two years he has been head of the Commercial Engineering Section of Cathode-Ray Tube Sales.

R. G. Scott

Morton G. Scheraga, formerly market research engineer for the Instrument Division, has been promoted to assistant technical sales manager of the division. He joined Du Mont in 1945 as a development engineer engaged in the design of television receivers. Prior to this he was successively a project engineer for the National Advisory Committee for Aeronautics, working on problems of electronic instrumentation, and a development engineer in nuclear instrumentation for the Carbide & Chemical Corp., Oak Ridge, Tenn.

M. G. Scheraga

Robert H. Dolbear was appointed to the post of sales engineer for the Instrument Division. He was formerly field service engineer for the electronic division of the Curtiss-Wright Corp. working on electronic flight simulators. Prior to that he was service engineer with Bendix Aviation Corp. and an engineer for Sperry Gyroscope.

CBS-Columbia Appointments

Two engineering appointments were recently announced by CBS-Columbia, Inc.

Alfred Shaffer has been named administrative engineer in the Government Contract Division. He was formerly with the Bendix Aviation Corp.

Leo Beiser was appointed assistant chief television engineer. Prior to his new advancement he was engaged in design and development of tv receivers on the company's engineering staff.

Breitwieser Advanced

P. R. MALLORY & CO., INC., Indianapolis, Ind., has promoted C. J. Breitwieser to director of engineering. He previously served the company as executive assistant to F. R. Hensel, vice-president in charge of engineering. In his new position, Dr. Breitwieser assumes direct responsibility for the company's central research laboratories and general engineering staff and functional direction of divisional engineering departments.

The promotion is part of a move by the Mallory Company to reorganize its engineering department, emphasizing long-range developments and basic research in the central organization and strengthening product development and engineering in its ten manufacturing divisions.

OTHER DEPARTMENTS
featured in this issue:

C. J. Breitwieser

Dr. Breitwieser joined Mallory in June 1951, following service with Consolidated Vultee Aircraft Corp., San Diego, Calif., as chief of electronics and head of the engineering laboratories.

Plant Expansions

EIGHT manufacturers recently reporting expanded facilities are as follows:

Galvanic Products Corp. of New York City has completed its new plant at Valley Stream, Long Island. The new building contains all of the equipment and facilities reubers.

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it's news!

EAI's Dataplotter . . .

An Electronic System That Converts Digital Data To An Analog Plot . . .

Here is a system that will save countless man-hours and costs, and will insure accurate and clear presentation of data.

This new Dataplotter, designed and developed by Electronic Associates Inc., will automatically plot a cartesian curve composed of incremental points or symbols from IBM card data at maximum machine reading speed.

It will accept data from other inputs — Magnetic tape, keyboards, digital computers, etc.

It will retain at all times the basic accuracy of the digital system.

Here's what the Dataplotter system consists of:

Variplotter Model 205G
Digital-to-analog converter, Model 417
Data input keyboard

For further information, clip out and mail the coupon below. No obligation.

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ELECTRONIC
ASSOCIATES
Incorporated

Electronic Associates Inc.
Long Branch
New Jersey

Gentlemen: Would you be kind enough to send me detailed information on your Dataplotter.

Name . . . .
Company . . . . Title . . . .
Address . . . .
City . . . . Zone . . . . State . . . .

quired for manufacturing selenium rectifiers, complete rectifier equipment and allied electronic components.

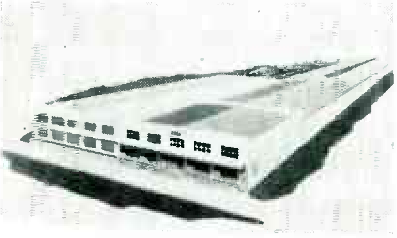
Resdel Engineering Corp., Los Angeles, Calif., designers of guided missile test equipment and radar systems, has added a larger building adjacent to its present one on Riverside Drive, L. A., to handle the extra work load resulting from a large Signal Corps contract.

Beckman Instruments, Inc., South Pasadena, Calif., manufacturers of scientific instruments, have opened a large new plant devoted exclusively to the manufacture of synchros and associated components—bringing the number of plants in the Beckman operations to a total of fifteen.

Packard-Bell Co. recently broke ground for the new $300,000 addition to the Los Angeles headquarters of the tv and radio manufacturing concern. The new building will be used primarily for manufacturing and will include a second floor of 7,500 sq ft which will be devoted to engineering facilities.

Robinson Aviation, Inc., Teterboro, N. J., has announced that its west coast engineering office at Burbank, Calif., has established an engineering laboratory with full test facilities for evaluating vibration control equipment used in the air frame and electronics industries.

Zero Mfg. Co., Burbank, Calif., is building a 7,500 sq ft addition to its main plant to provide more shearing facilities for electronic and metal parts and specialized aluminum cases.



Enlarged Zero plant

Illumitronic Engineering Co. recently built a new plant at 680 E. Taylor St., Sunnyvale, Calif. The company manufactures and develops electromechanical devices and processes.

A new jet engine laboratory is being established by the Aeronautical Division of Minneapolis-Honeywell Regulator Co. to speed development work on jet engine controls. The new facilities, which include a separate building for this work, will be equipped with a network of highly complex electronic computers, controllers and relays.

FIGHTING CANCER BY ELECTRONICS

Edward L. Ginzton (left), director of Stanford University's Microwave Laboratory, and Henry S. Kaplan (right), head of the radiology department at Stanford Hospital in San Francisco, have teamed up to fight cancer with one of science's newest weapons—the linear electron accelerator. Under their direction a six-million volt machine is being built to shoot x-rays at deep-seated cancer tissue. At this high intensity the rays will penetrate over-lying layers of healthy tissue without injuring them. The device will be compact and inexpensive enough to enable nearly every hospital in the country to own one

News From MIT

JEROME B. Weisner has been appointed director of the electronics research laboratory at the Massachusetts Institute of Technology. He succeeds Albert G. Hill, on leave of absence from the physics department, who has been named director of the Lincoln Laboratory, an electronic research project operated by MIT for the U. S. Department of Defense.

Dr. Weisner's career includes a term as chief engineer of the acoustical and record laboratory in the Library of Congress, a staff member of the MIT radiation laboratory in World War II, a year at the Los Alamos Laboratory and professorial posts at MIT.

RCA Promotes Veteran Engineer

EDWARD Stanko, veteran RCA engineer and pioneer in radio and television in the 1920's, has been appointed to the newly created post of manager of engineering, technical products division, RCA Service Co. Inc. In his new position he will direct specialized training of field personnel, preparation of technical information, and development of new and improved methods for installation and servicing of RCA technical products.

Air Force Appointee

HARRY Davis was recently named technical director of the laboratories at Rome Air Development Center, Rome, N. Y. In his new

Vibration Engineering that solves your problems

PROBLEM: To provide superior vibration control while simplifying suspension design

SOLUTION: The Isomode* Type 5 Mount that isolates all modes of motion

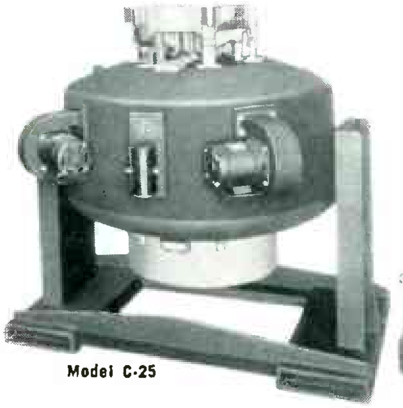
HOW to get optimum isolation into a product design? The answer is not always easy. But it was made much easier to find when Isomode Mounts were developed. They offer what's needed for outstanding results—namely, control of horizontal and rocking motions as well as vertical vibrations.

And here's why. Isomode Mounts have equal spring rates in all directions. They therefore absorb vibrations from all directions equally well. As a result, they can be mounted at any angle, permitting location of ideal suspension points and simplifying design.

In addition, Isomode Mounts have high load capacity in compact size, saving both space and weight. Large rubber volume for their size lends softness for good isolation, yet the mounts are stable, self snubbing and long lasting.

These mounts are an example of the kind of vibration engineering put to work for you at MB. Many companies have found it good practice to make MB their headquarters for vibration information. You will too—on vibration *isolation, control, testing, detection* or *measurement*. For more details on Isomode Mounts, be sure to write for Bulletin 410-5.

**Trade Mark Reg. U.S. Pat. Off.*



Model C-25

Model SD

A vibration exciter to meet your needs

Whether your shake testing requirements are of large order or small, there's an MB Shaker for the job. Model SD, for example, has rated force output of 10 pounds; while the C-25 provides 2500 pounds. Model also available for 10,000 pounds. So if you have to vibration test to MIL-E-5272, be sure to check up with MB. Bulletin No. 1-VE-5 gives technical data on MB Shakers. Write for it.

THE MB MANUFACTURING COMPANY, INC.
1060 STATE STREET, NEW HAVEN 11, CONN.

PRODUCTS AND EQUIPMENT TO CONTROL VIBRATION • TO MEASURE IT • TO REPRODUCE IT

LORD METER MOUNTS
PROTECT INSTRUMENTS
From Vibration and Shock . . .

Photos Courtesy The Massey-Harris Company.

Photo Below Courtesy Cummins Engine Company, Inc.

The Sure Way to "Design out" Vibration and Shock Damage.

Lord Meter Mountings are paying dividends to manufacturers and users of heavy duty industrial and farm tractors, lift trucks, stationary engines and many other industrial machines where shock and vibration are encountered.

The Lord Meter Mount assures the accurate performance designed into Hobbs Engine-Hour Meters when they are subjected to excessive vibration on farm tractors and stationary diesel engines. These meters are protected from the damaging effects of vibration and shock by the unique method of combining shear and rolling action of the rubber to absorb destructive forces. The outer ring is mounted to the panel and the inner ring holds the meter thus giving protection in multi-planes. The rubber between these rings does the work. We will be pleased to have the opportunity to help you in the application of Lord Meter Mountings.

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LORD BONDED RUBBER

HEADQUARTERS FOR VIBRATION CONTROL

H. Davis

duties he will direct the research and development ground electronics program, including communication, ground radar, navigation and guidance systems.

For the last five years Davis has been chief engineer of the Navigation Laboratory at Watson Laboratories, Red Bank, N. J. and at Rome, N. Y. He was responsible for a wide variety of systems developments in the field of navigation including base line guidance systems, long distance navigation aids, aircraft approach and landing equipment, data transmission gear, various types of transponders, traffic control equipment, automatic control systems and computer applications.

New Company Organized

FORMATION of the Mercury Electronic Co. in Red Bank, N. J., for the design, development and manufacture of electronic equipment, has been announced by Andrew Munchak, Jr., its founder. Mr. Munchak had been associated with Electronic Measurements Co., also of Red Bank, since 1940 when he founded the company.

Mercury's line of electronic devices includes static converters, regulated power supplies and specialized electronic equipment.

NYU Faculty Promotion

JAMES H. MULLIGAN, JR., has been appointed chairman of the department of electrical engineering, New York University.

Prior to joining the faculty in

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Advertisers:

How about the NUCLEAR field?

There are a good many advertisers using this ELECTRONICS who should also be advertising in NUCLEONICS.

Particularly in instrumentation and laboratory equipment, there is a cross-over of use in the electronic and in the nuclear field.

But, there is very little cross-over in the subscriber lists of the two publications — a matter of a few percentage points.

It is quite possible that you are doing an effective presentation of your products and abilities in this excellent issue, but are missing such presentation before one of the fastest growing fields in the country's history — the field of atomic energy.

The sales representatives of ELECTRONICS are also the sales representatives of NUCLEONICS. They have much evidence pointing to the opportunities in this great NEW field. Ask them to show you what your potentials can be.

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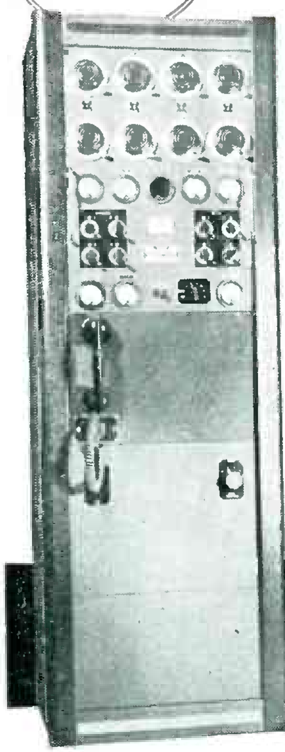
Multi-channel telegraph A1 or telephone A3



FROM GROUND TO AIR OR POINT TO POINT

STABLE

High stability (.003%) under normal operating conditions.

RUGGED

Components conservatively rated. Completely tropicalized.

Model 446 transmitter operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.5-13.5 Mcs (1 6-2.5 Mcs available) Operates on one frequency at a time; channeling time 2 seconds. Carrier power 350 watts. A1 or A3 AM Stability 003% using CR 7 (or HC-6U) crystals Operates in ambient 0° to + 45° C using mercury rectifiers; -35° to + 45° C using gas filled rectifiers. Power supply. 200 250 volts. 50/60 cycles. single phase. Conservatively rated. sturdily constructed. Complete technical data on request.

Here's the ideal general-purpose high-frequency transmitter! Model 446 . . . 4-channel, 6-frequency, medium power, high stability. Suitable for point-to-point or ground-to-air communication. Can be remotely located from operating position. Co-axial fitting to accept frequency shift signals.

Consultants, designers and manufacturers of standard or special electronic, meteorological and communications equipment.

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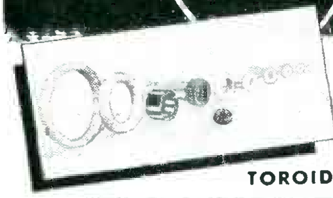
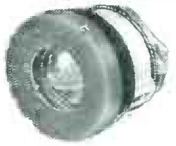
3090 Douglas Road, Miami 33, Florida

Boost Your Quality Standards with DX ELECTRONIC COMPONENTS



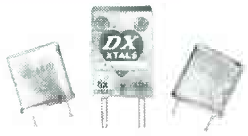
TOROID COILS

SPECIAL ASSEMBLIES



DEFLECTION YOKES

CRYSTALS



TOROID FILTERS . . . I. F. TRANSFORMERS . . . R. F. COILS . . . DISCRIMINATORS TRANSFORMERS . . . TV TUNERS . . . ION TRAPS . . . SPEAKERS

If you require exacting quality and dependable performance, let DX engineers figure with you on your next production run. Users of DX components enjoy exceptional freedom from field failures. This advantage can be yours at no extra cost. Write today.

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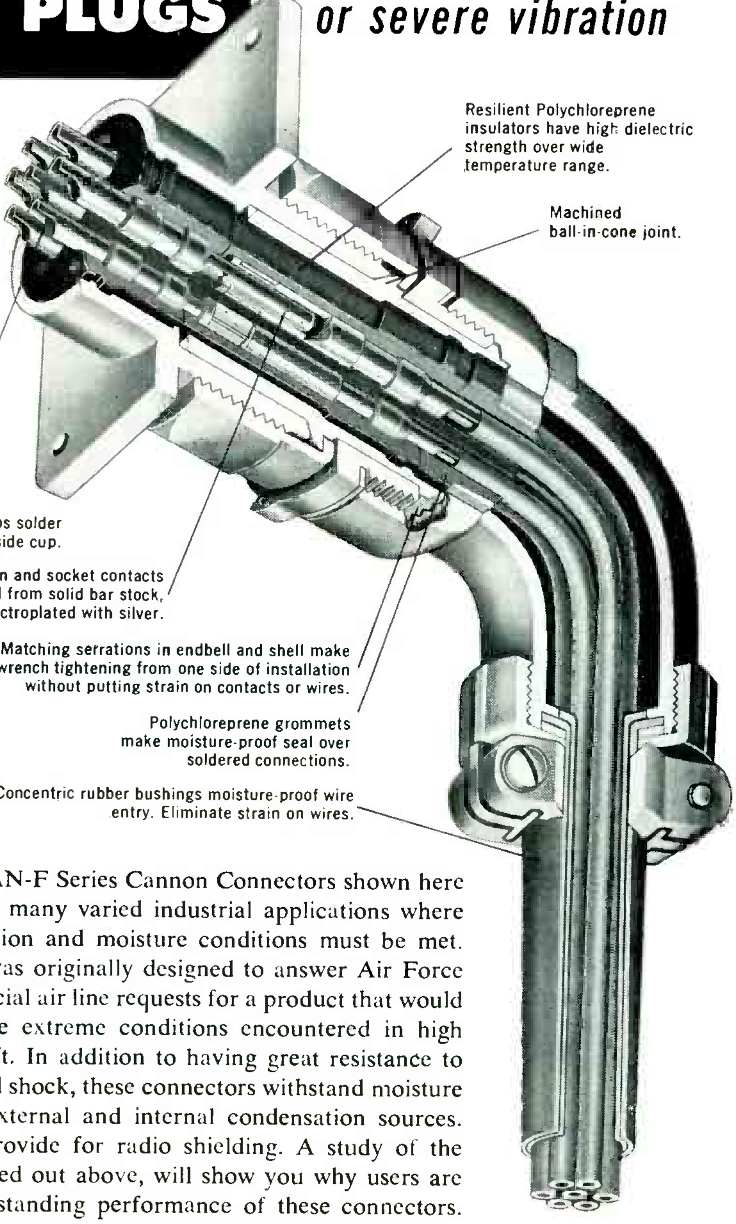
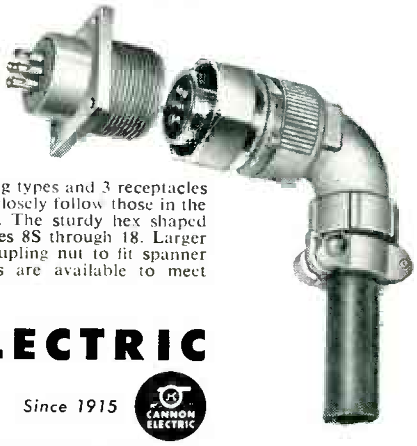
CANNON PLUGS *to withstand moisture or severe vibration*



AF and AN-F Series Cannon Connectors shown here are ideal for many varied industrial applications where severe vibration and moisture conditions must be met. This series was originally designed to answer Air Force and commercial air line requests for a product that would withstand the extreme conditions encountered in high speed aircraft. In addition to having great resistance to vibration and shock, these connectors withstand moisture from both external and internal condensation sources. They also provide for radio shielding. A study of the features, called out above, will show you why users are enjoying outstanding performance of these connectors. The machined ball-in-cone joint, while not obvious, plays an important part in providing radio shielding and improved vibration and moisture resistance. For engineering data request Cannon's AN Bulletin.



The Cannon AF Series consists of 2 plug types and 3 receptacles in 15 diameters. Contact arrangements closely follow those in the AN Series. Shells are cadmium plated. The sturdy hex shaped coupling nut shown here is used on sizes 8S through 18. Larger diameters have a strong spline type coupling nut to fit spanner wrenches. Knurled type coupling nuts are available to meet AN-F specification.

CANNON ELECTRIC

Since 1915

Factories in Los Angeles, Toronto, New Haven, Benton Harbor. Representatives in principal cities. Address inquiries to Cannon Electric Company, Dept. I-120, P.O. Box 75, Lincoln Heights Station, Los Angeles 31, Calif.

1949 he was chief engineer of the Television Transmitter Divsion, Allen B. DuMont Laboratories, and was active in the development of the first DuMont image orthicon field pickup equipment.

During World War II, Dr. Mulligan was a member of the Combined Research Group of the Naval Research Laboratory engaged in the development of radar identification equipment.

Presently he is chairman of the New York Section of IRE.

New Turner Co. V-P

BENNO Von Mayrhauser was recently appointed vice-president in charge of production at Turner Co., Cedar Rapids, Iowa. In his new position his time will be devoted to the expanding of product quality control and production methods.

B. Von Mayrhauser

Westinghouse Promotions

THREE top-rank engineering appointments at Westinghouse Electric Corp. have been noted lately.

J. H. Findlay has been named manager of power and special tube engineering for the Electronic Tube Division at Elmira, N. Y. He joined the company in 1933 as an x-ray tube engineer in the Lamp Division.

D. D. Knowles was recently appointed staff assistant to E. A. Lederer, manager of engineering for the Electronic Tube Division. Mr. Knowles, with Westinghouse since 1923, is holder of the John Scott Medal for meritorious inven-

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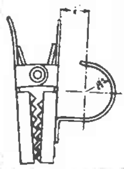
Style
No. 2906

CLOTHES CLIP

Sturdily constructed for maximum life. Finished in semi-gloss black enamel. Ribbed, firm-gripping clamping pads made of hard neoprene. Mounting plate enables clip to be attached to hard surface, such as a switch case. Hard drawn steel spring wire insures optimum spring action.



WITH MOUNTING HOOK FOR USE ON CORDSETS . . . This model utilizes a steel mounting hook which can be hooked directly on a cordset molded for this purpose.

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ON REQUEST.

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There are a good many advertisers using this ELECTRONICS who should also be advertising in NUCLEONICS.

Particularly in instrumentation and laboratory equipment, there is a cross-over of use in the electronic and in the nuclear field.

But, there is very little cross-over in the subscriber lists of the two publications — a matter of a few percentage points.

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The sales representatives of ELECTRONICS are also the sales representatives of NUCLEONICS. They have much evidence pointing to the opportunities in this great NEW field. Ask them to show you what your potentials can be.

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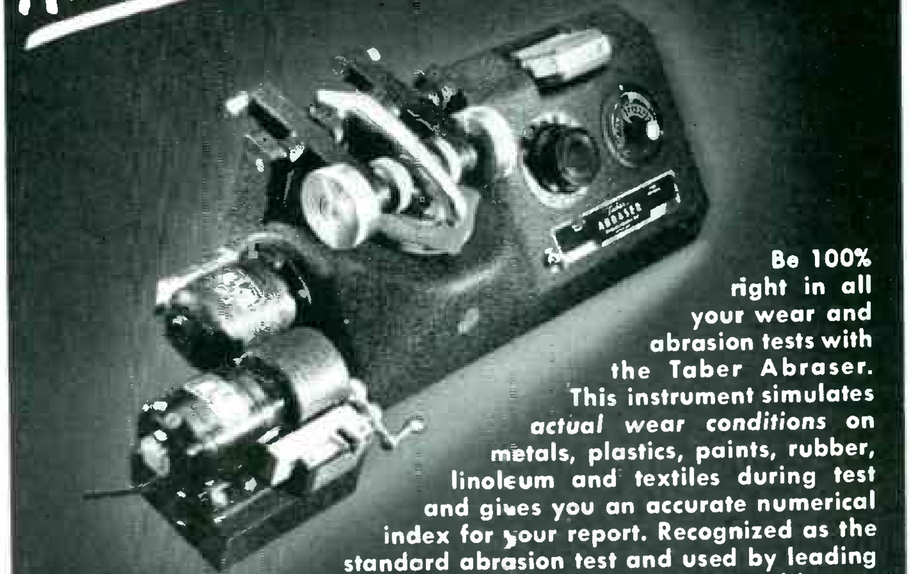
Abrasion Resistance TEST
for Metals, Ceramics, Rubber, Plastics & Textiles



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tions in gaseous conduction tubes. He has had more than 80 patents issued on electronic tubes, circuits and oil-burner controls.

S. C. Leyland, with the company in various engineering positions since 1925, was named manager of engineering for the Meter Division. In his new post he will be responsible for all products made at the division, including watthour meters, relays, instruments and auxiliary equipment.

Amperex Plant Completed

THE newly constructed plant of Amperex Electronic Corp. in Hicksville, L. I., N. Y. is now in full operation.

This modern structure houses executive and clerical departments, and contains elaborate research, engineering and production facilities for the design and manufacture of electronic tubes exclusively.

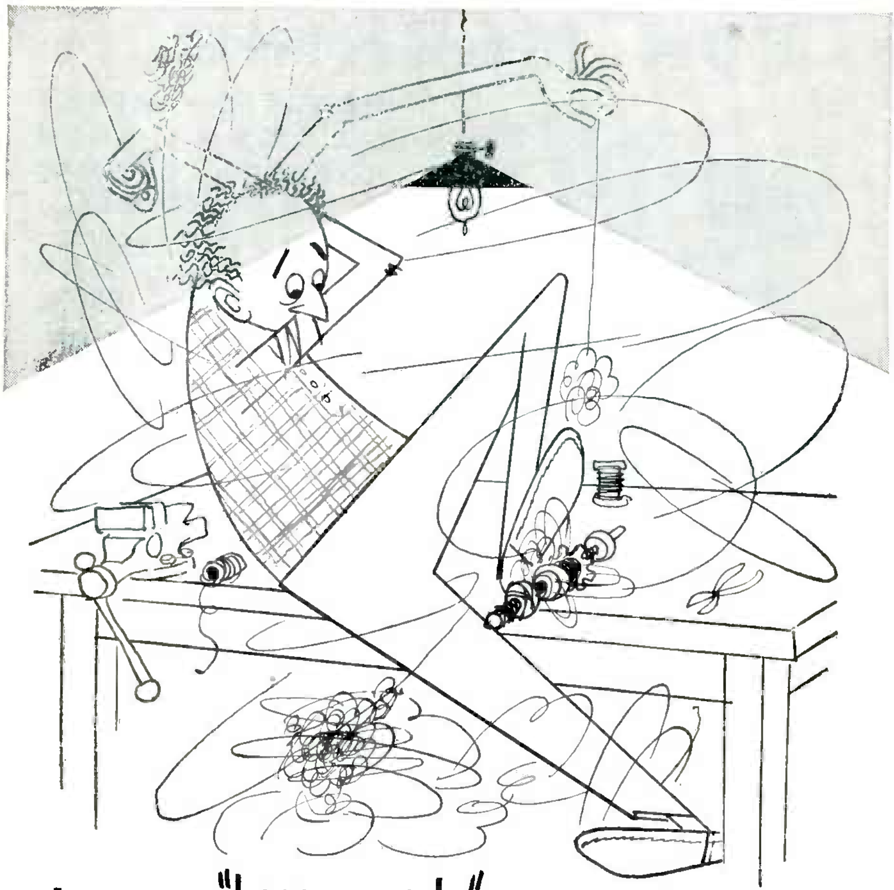

New Amperex plant

Syntron Opens Canadian Subsidiary

ORGANIZATION of a Canadian subsidiary, Syntron Ltd., with a manufacturing plant in Stoney Creek, Ontario, Canada, has been announced by Syntron Co. of Homer City, Pa. Selenium rectifiers will be the first item to go into production, although ultimately the company's entire line will be manufactured in the new plant. Production is expected to start sometime in the Fall of this year.

Nashua Gets Kaiser Plant

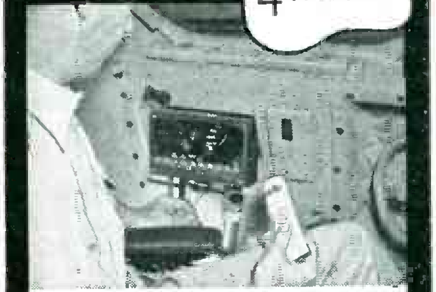
TEAMING up with Sanders Associates, an electronics engineering firm of Waltham, Mass., Henry Kaiser has entered the electronics field by opening up the Kaiser-Sanders Electronic Division in Nashua, N. H. Employment is to start at around 100 workers and



The Nonmelting Silicone Insulating and Waterproofing Compound that is stable from —70° to over 400° F.

Meets all Requirements of AN-C-128a

DOW CORNING 4 COMPOUND



Dow Corning 4 applied by brushing to AN connector receptacle of pilot's "jack box" prevents interference caused by moisture at this critical junction in aircraft communications system.

Dow Corning 4 applied by brushing to AN connector on V. H. F. Transmitter/Receiver excludes moisture without appreciable change in resistance across properly mated pin and socket connections.

Arrows show where Dow Corning 4 is used on variable inductance rollers in a Collins-Western Electric V. H. F. Transmitter/Receiver to lubricate, minimize resistance and reduce leakage losses.

Photos courtesy Braniff International Airways.

More water repellent than paraffin, Dow Corning 4 Silicone Compound is highly resistant to oxygen, ozone and deterioration caused by corona discharge.

Write Today! **for your copy of our new booklet on Dow Corning 4 Compound. Address Department BD.**

FIRST IN SILICONES

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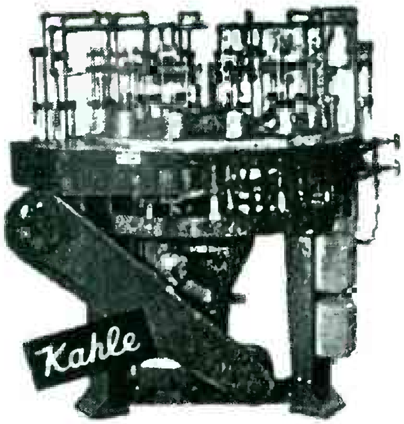
MIDLAND, MICHIGAN

Kahle

SPECIALISTS IN HIGH-SPEED

electron tube machinery

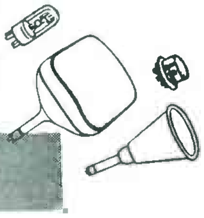
Kahle's 40 years of experience eliminate trial orders and experimental set-ups. Standard toolings for all tube manufacturing eventualities *already* have been tested and approved. This means that Kahle can assemble machines for everything from sub-miniature to largest TV picture tubes to your exact specifications . . . *at lower costs!*



#1384 12-HEAD BUTTON STEM MACHINE. FOR SUB-MINIATURE TUBES. Upper and lower molds on every head. Dual motor drive. Indexing and head rotation are by separate motors. For oblong, square, round buttons, etc.

Machinery for all types of electron tubes and related glass products.

Consultations invited. Write today for our new catalog with complete details.



Kahle

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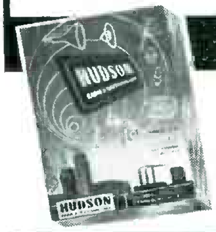

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HOW EDISON HELPED RCA BEAT the DOPPLER EFFECT

Edison Temperature Control in RCA Crystal Oven Maintains Oscillator Frequency to Accuracy of 0.00005%.

Equipment used in the monitoring of television transmitters employing the offset carrier system requires a degree of frequency accuracy and long term stability unheard of a short time ago. The most exacting requirements are imposed at the upper end of the newly assigned U.H.F. channel, where monitor accuracy must be held to 5 parts in ten million.

At this high order of accuracy, single checks against a stable reference source such as WWV are inadequate because the Doppler effect in transmissions reflected from the ionisphere causes variations amounting to 50% of the allowable monitor tolerance over a 24 hour period.

Engineers at the Radio Corporation of America found the solution in a new crystal oscillator so stable that readings can be taken over a relatively long period of time without recalibration. In this way accurate average frequency values can be obtained which cancel out the variations caused by the Doppler effect.

The heart of this oscillator is the new RCA VC-1-F crystal unit. Mounted in the TMV-129-P oven and temperature-controlled by an Edison sealed-in-glass thermostat, the oscillator maintains the required accuracy of 0.00005% for periods in excess of the 30 day minimum specified.

Let us send you, free, specifications on Edison sealed thermostats. Ask for bulletin No. E-3009. Edison thermostats feature stability measured in years; control within ± 0.1°F and capacity to 115 volts 8 amperes d.c. or 1000 watts.

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MANUFACTURERS OF
Electrical Resistance Bulbs
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YOU CAN ALWAYS RELY ON EDISON

is expected to reach several hundred very shortly. The new firm will turn out servomechanisms for guided missiles and other similar control equipment.

Caruthers Joins Lenkurt

ROBERT S. Caruthers has joined the Lenkurt Electric Co., San Carlos, Calif., manufacturers of telephone and telegraph carrier equipment, as chief systems engineer. In this capacity he will be responsible for working out design objectives of new carrier systems to meet future requirements of the communications industry.

He comes to Lenkurt after 23 years with the Bell Telephone Laboratories where he was engaged principally in the development of carrier telephone systems.

Transco Names Engineering Manager

FREDERICK G. Suffield has been appointed engineering manager of Transco Products, Inc., with headquarters at the Los Angeles, Calif., plant.

He has an engineering background of fifteen years, specializing in airborne search radar and related electronic units. Formerly with Westinghouse and until recently with the Houston Corp. which was acquired by RCA in 1950, he was chief engineer of the electronics division and manager of the engineering section handling design of military search radar systems.

Dedicate New Raytheon Unit

WITH the dedication of a new building on Seyon St., Waltham, Mass., Raytheon recently announced a $2 million transistor program for both research and development. Not only will uses of transistors be explored, but high-speed machinery to manufacture them automatically is also under consideration.

The company's experience with these devices includes the production of germanium photocells experimentally in 1929 and the supplying of point-contact transistors since 1948.

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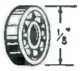
For ultra precision design



specify Micro, America's only fully ground miniature ball bearings

In just three years, sales of Micro bearings have soared 850% as more and more top-flight designers and engineers choose Micro for exacting designs. Only *grinding* can give you the ultra precision and trueness of dimension Micro offers — yet Micro bearings actually cost less than unground miniatures. 85 sizes and types in dimensions as small as ⅛" o.d. and in tolerance ranges of ABEC-5 and above.

Write for Technical Bulletin No. 50

New Hampshire MICRO Ball Bearings, Inc.

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SERIES

RACKS by PAR-METAL

18" Deep, 22" Wide

offer you the greatest dollar-for-dollar value in the industry today!

Because only in the ER-225 will you find these unique features:

- ✓ *Standard 43¼", 67¾", and 83½" heights.*
- ✓ *New ribbed design corner trims, with new quick FRONT detachable fastenings.*
- ✓ *The door is stamped from one piece of steel and reinforced — with formed, clean, smooth, double thick edges.*
- ✓ *"Multiracks" available with closed or open intermediate sides for rack-to-rack wiring.*
- ✓ *Streamlined modern design; beautiful finish.*

Planning an electronic product? Consult Par-Metal for

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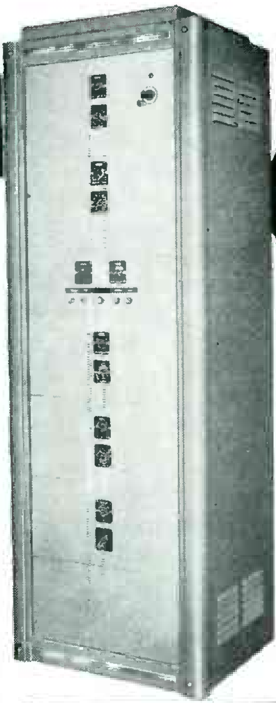
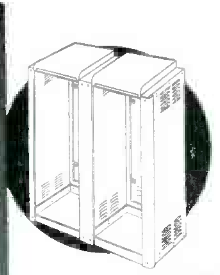
Remember, Par-Metal equipment is made by electronic specialists, not just a sheet metal shop.

Made by Electronic Specialists!





"MULTIRACKS"

These Racks may be assembled in multiple units as shown above..

SHELVES available.

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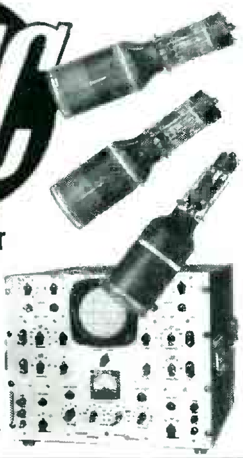

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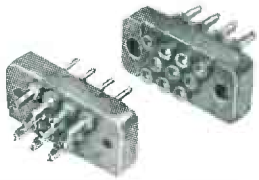

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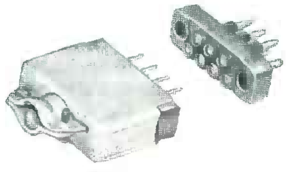

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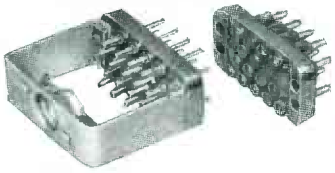

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NEW BOOKS

The Magnetron

By R. Latham, A. H. King and L. Rushforth. *Published by Chapman & Hall Ltd., London, England,* 1952, 142 *pages,* 18*s.*

THE PURPOSE of this monograph was stated by the authors to be two-fold. First, it was intended to explain the construction and properties of the microwave magnetron in a way that could be understood by readers not having a specialized knowledge of high-frequency fields. The second purpose was to provide more detailed information for those already familiar with magnetrons.

So far as the first objective is concerned, the result is admirable. The general approach is partly from the historical point of view in that many of the problems that confronted those responsible for tube and system development, especially during the late 30's and early 40's, are stated and an outline of the reasoning and results that followed are discussed. In following this plan the authors have produced a monograph that makes very enjoyable and instructive reading.

The second objective, that of providing detailed information, is satisfactory to a limited extent. The authors have obviously made no attempt at as complete a coverage of theory and practice as is given in Collins' "Microwave Magnetrons". This is not, however, to be taken as adverse criticism, for to have included more information would probably have resulted in burial of the basic principles, so nicely outlined, in a welter of detail.

The first twenty-three pages review briefly the requirements of a radar system, the production of very-high-frequency oscillations, and early magnetron development. The next hundred pages describe properties of the anode block, extraction of energy from the magnetron, electronic theory, cathode problems and construction, and tube manufacturing and testing. The three chapters on electronic theory are, in this reviewer's opinion, particularly interesting because of the logical manner in which threshold voltage, energy conversion and

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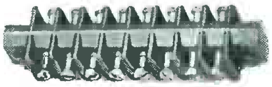

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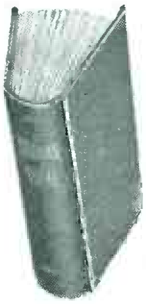

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mode stability are presented.

All three authors were active during the war on the magnetron research and development project sponsored by the British Government. Messrs. Latham and King are presently members of the Imperial College of Science and Technology and of Clifton College respectively; Mr. Rushforth is a member of the Research Laboratory of the British Thomson-Houston Company, Ltd.—GEORGE D. O'NEILL, *Sylvania Electric Products Inc.*

Electromagnetics

By ROBERT M. WHITMER, *Rensselaer Polytechnic Institute. Prentice-Hall, Inc., New York, 1952, 270 pages, $6.65.*

THIS book comprises a very excellently integrated and accurately written introduction to electromagnetic theory for undergraduate students of physics or electrical engineering. Integration stems from: consistent use of the field-theory point of view; compacting of mathematical manipulation through use of vector analysis; use, in general, of a single set of units (the internationally-recommended MKSA units in the preferred rationalized form); and emphasis on subject content and illustrative examples which are of common interest both to electrical engineers and to physicists. Accuracy stems from: careful statement of basic laws; detailed development of general theory therefrom; considered use of the recommendations encompassed in the 1950 report "The Teaching of Electricity and Magnetism at the College Level" of the Coulomb's Law Committee of the American Association of Physics Teachers; and, above all, to the writer's own well-evidenced grasp of basic electrical theory. In consequence, this text ranks among the best of those available for introductory study of electromagnetic theory.

The essential content comprises account of the basic theory of electrostatics (Chapters 1-5), magnetostatics and electromagnetism (Chapters 7, 8 and 9), brief chapters on d-c and a-c circuits (Chapters 6 and 10), an introduction to

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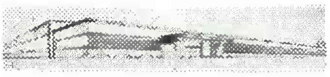

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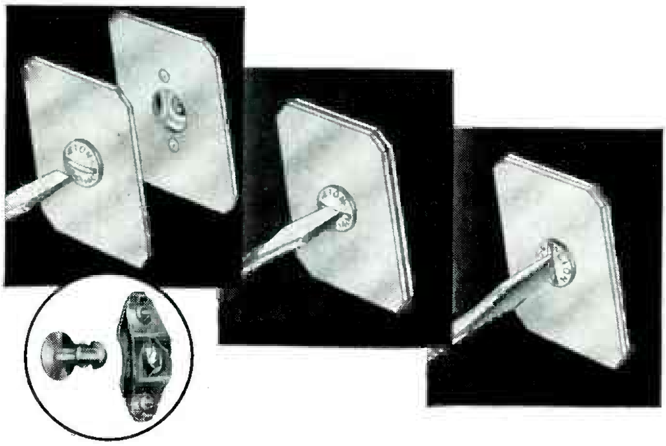

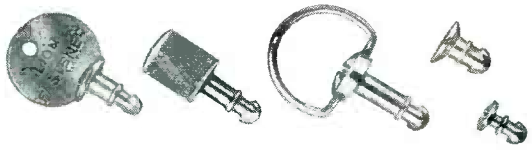

wave propagation based on use of Maxwell's scalar and vector potentials (Chapters 11, 12 and 13), a concluding Chapter 14 on the Hertzian vector, an appendix listing the principle identities in vector analysis used in the context, and a short list of recent pertinent texts for supplementary reading.

The typography, binding, line-drawings, and page layout are excellent, indicating the careful attention of the publishers to facilitating ease of use, reading and grasp of content by the student. The problem exercises are numerous, carefully phrased and so selected that solution of them by the student will both illustrate application of and familiarize him with all the principal points of theory.

Errors Noted

The text appears unusually free from typographical errors and from any considerable number of inaccuracies of statement. Illustrative of those which do occur, the reviewer noted: The phrase "work which must be expended" instead of the correct "work per unit of charge which must be expended" on page 13, third line from bottom; mislabeling of a vector in Fig. 1.4 as **F** instead of **E**; $\phi(\mathbf{r})$ instead of $\phi(r)$ in equation 5-10; omission of arrowheads on the radial lines of Fig. 2.8; omission of $\lim_{dS \to 0}$ before the right-hand member of equation 5.5, and use of *S* instead of the correct *s* on the integral of the following unnumbered equation; the usual semi-incorrect characterization on page 216 of the Poynting vector as "the flux of power per unit area" instead of the correct designation as a vector, the integral of whose normal component over a closed surface yields the flux of power through the surface; etc.

However, these inaccuracies are rather minor, can easily be corrected in a second printing, and, for the most part, are of such nature that they do not detract from the reviewer's estimate of the book as a most admirable text, well suited both to use as an under-

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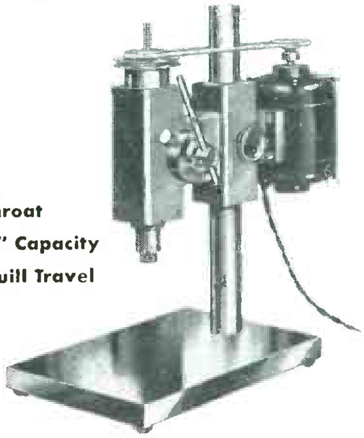

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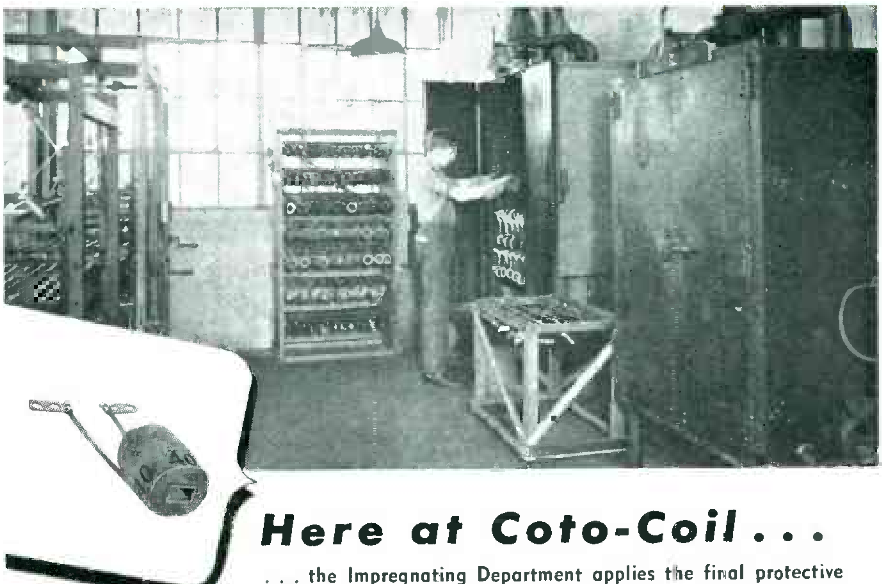

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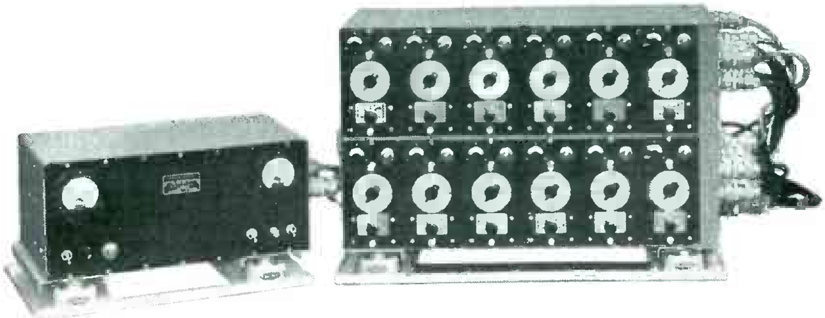

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graduate classroom text (as intended by the author) and to use by the practicing engineer who may seek an introductory text on electromagnetic theory for original self-study, or for refreshing earlier classroom study.—THOMAS J. HIGGINS, *Professor of Electrical Engineering, University of Wisconsin.*

Fundamentals of Electronics and Control

BY M. G. YOUNG AND H. S. BUECHE, *both at the University of Delaware. Harper & Brothers Publishers, New York*, 1952, 525 *pages*, $6.00.

THIS text is for an introductory course in electronics directed to students majoring in all branches of engineering. The broad purpose of the book is reflected in such features as a discussion of the phenomena in an ignitron in the chapter on electron theory, nearly a whole chapter on the thyratron, and about 40 pages (another whole chapter) on mercury-pool tubes, in addition to the usually presented material. The first half of the book is on properties of electronic devices—including such modern ones as nonlinear resistors, saturable-core reactors and transistors; the second half is on applications—amplifiers, oscillators, modulators, demodulators and rectifiers.

The treatment is straightforward description augmented by diagrams and illustrations. Circuit theory is introduced to enable the book to be used, if necessary, without a previous course on electrical fundamentals. Only the mathematics necessary for the descriptions is introduced, mostly algebra and differential calculus.

Electronic techniques have penetrated many fields. In describing dielectric phenomena and derating of capacitors due to heating, industrial uses of dielectric heating could have been mentioned. In describing mutual coupling and the operation of transformers, the design of applicators for induction heating could have been presented as an example. The use of the magnetron for r-f heating, such as in special food cookers, might have been mentioned.

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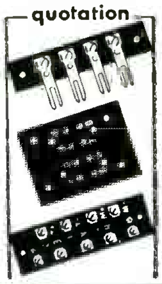

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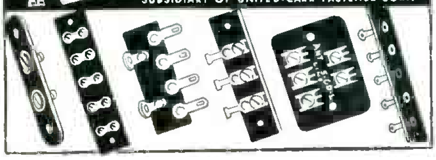

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DALE PRODUCTS, INC. Columbus, Nebraska out in the problems (with answers); the authors have recognized the commercial importance of the subject by referring to trade literature as well as to the more esoteric literature usually used for references. Thus the book constitutes a current resume of the art for nonelectronic engineers who find these techniques entering their special fields.—F. H. ROCKETT, *Airborne Instruments Laboratory, Mineola, New York.*

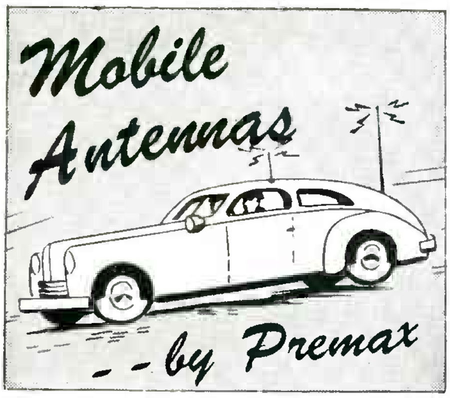
Application of the Electronic Valve in Radio Receivers and Amplifiers

BY DR. B. G. DAMMERS, J. HAANTJES, J. OTTE, AND H. VAN SUCHTELEN. *Book V, Philips' Technical Library, distributed in the U.S.A. and Canada by Elsevier Press Inc., 402 Lovett Boulevard, Houston 6, Texas, 450 pages*, $7.75, 1951.

THIS book is intended for radio technicians, engineers, students in technical universities and all who are interested in radio development. This review is concerned only with Book V of a series of seven books on "Electronic Valves". This volume consists of Chapters 6, 7, and 8 of "Application of the Electronic Valve in Radio Receivers and Amplifiers." The remaining chapters are the contents of books IV and VI.

Chapter 6, on audio-frequency amplification, covers various types of voltage amplifiers and phase inverters. A substantial portion of the chapter is devoted to factors affecting the frequency response. Another section considers the design of a-f transformers in some detail. The chapter concludes with a discussion of nonlinear distortion in voltage amplifiers.

Chapter 7 is devoted to power output stages in audio systems. Class A, Class AB and Class B amplifiers are analyzed in considerable detail. Considerable attention is given to design procedures to arrive at optimum operating conditions on a theoretical basis. The discussion is profusely illustrated with practical examples. In addition, the chapter contains a useful section on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the comparison of different types of operation for triodes and pentodes. A comprehensive treatment of the theoretical prediction and measurement of harmonic distortion in output stages is provided.

Chapter 8 reviews the various power supply design practices which are found in radio receivers. The material includes the design of filament supplies, rectifier circuits and circuits for regulating anode supply voltage.

The book includes within one volume information which has been pretty well scattered. The treatment is thorough and lucid. The value of the book is greatly reduced by an inadequate index. Moreover, this reviewer believes that the subject could have been covered in fewer pages with no loss of clarity and important material, missing in this volume, could then have been included. Thus, the Miller Effect is dismissed by a three-line footnote referring the reader to Book VI. The subject of control of distortion and fidelity by inverse feedback is also missing, although there appears to be a paragraph on this subject in Book VI (not yet available). Not a word could be found about automatic volume expanders and compressers. Such common techniques as self-biasing of driver tubes by grid rectification on signal peaks, and tone-compensated volume controls are not mentioned.

The symbols, some of the language, and tube types follow European practice; however, the American engineer will have little difficulty in adapting himself.

Book V is a useful addition to a technical library. — CHARLES J. HIRSCH. *Chief Engineer, Research Division, Hazeltine Corp.*

Television Servicing

BY MATTHEW MANDL. *The Macmillan Co., New York, 1952, 421 pages, $5.50.*

PREDICATED on a practical knowledge of radio circuits and test equipment, this volume presents television receiver fundamentals (41 pages) and troubleshooting procedures for the eight major sections of a tv receiver (239 pages). Remaining chapters round out the

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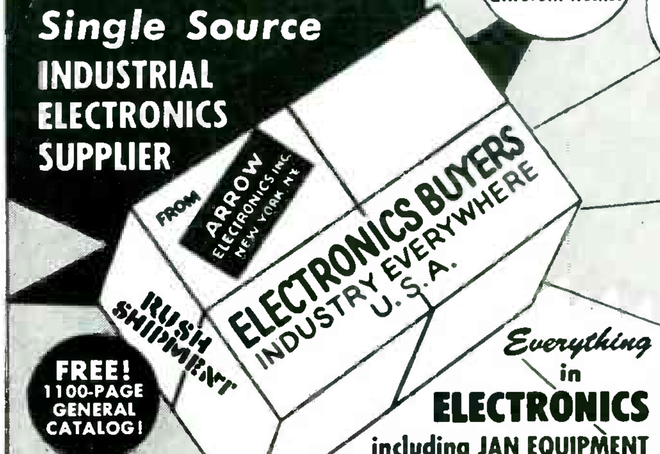

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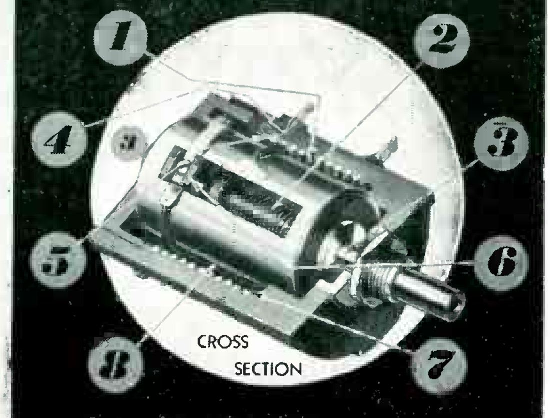

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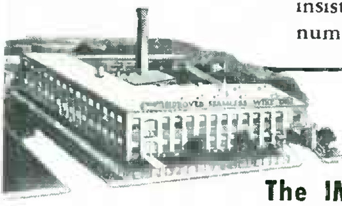

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coverage with chapters on projection television, uhf servicing factors, servicing of now-obsolete CBS color television receivers, and use of oscilloscopes, sweep generators and marker generators and calibrators.

In a field that is expanding as fast as television, no book can possibly be up-to-date as of the day of publication, because of today's unseeming delay of six to twelve months between receipt of a technical manuscript by a publisher and delivery of the finished book. Likewise, because of the complexity of the subject, no book can give complete coverage of even a particular branch of television such as servicing yet still remain a size that can comfortably be held in hand and marketed at a reasonable price.

In this instance, the author has done a highly commendable job on the topics selected for inclusion, by writing with conciseness and clarity. The publisher also deserves credit for pricing the book at 1.3 cents per page in times when other publishers in the technical field are hitting close to and even over the 2-cent mark.—J. M.

General Network Analysis

BY WILBUR R. LEPAGE AND SAMUEL SEELY. *McGraw-Hill Book Co., Inc., New York*, 1952, *1st Edition*, 505 *pages and index*, $8.00.

IN MANY ways this is a remarkably good book. Here in five hundred odd pages is developed in ordered array an introduction to modern network analysis. Starting with a discussion of the complex number representation of sinusoidal functions and Kirchhoff's Laws, the book proceeds to develop equations for all the basic circuit combinations. The principle of duality is early introduced and continuously stressed; both loop and junction analysis are fully developed, using determinant theory. Generalized network theorems and a thorough discussion of magnetic coupling follow.

With the introduction of generalized four-terminal networks the concepts and properties of matrices are introduced. At this point the first hint of advanced analysis is given in the form of a study of the general properties of the network

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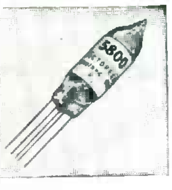

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Filament Current	10 ma

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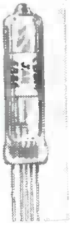
Filament Voltage	1.5 v
Plate Voltage	50 v
Average Cathode Current	500 μ a

TYPICAL OPERATION

Plate Voltage	+4.5 v
Accelerator Grid Voltage (g_1)	+3.4 v
Control Grid Voltage (g_2)	—3 v
Amplification Factor	1
Transconductance	15 μ mhos
Plate Current	12 μ a
Accelerator Grid Current	300 μ a
Control Grid Current	3 x 10^{-15} amp

5886 Pentode Electrometer



This subminiature electrometer pentode has very low filament current and high emission stability. Its structure is designed to reduce microphonics, an improvement of prime importance in portable equipment. The tube has a high ratio of transconductance to control grid current, a feature which makes it especially useful in single stage circuits in portable equipment.

CHARACTERISTICS

Filament Voltage	1.25 v
Filament Current	10 ma

MAXIMUM RATINGS

Filament Voltage	1.55 v
Plate Voltage	45 v
Average Cathode Current	500 μa

TYPICAL OPERATION (PENTODE)

Plate Voltage	+12 v
Accelerator Grid Voltage	+4.5 v
Control Grid Voltage	—2.0 v
Plate Current	6 μa
Control Grid Current	3 x 10^{-15} amp
Transconductance	14 μmhos

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Tolerance from Labeled Resistance	—1	+1%
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Voltage Coefficient**	—0	—.03%/v

* Higher resistance or closer tolerances are available on special request.

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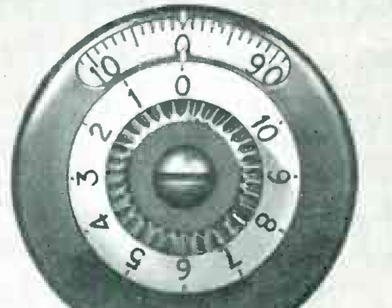

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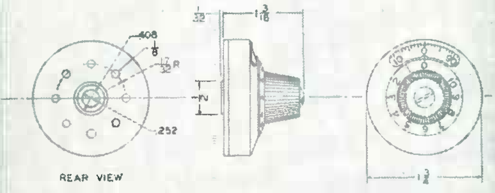

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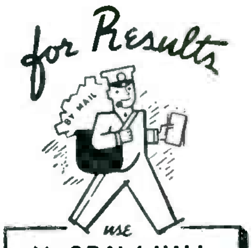

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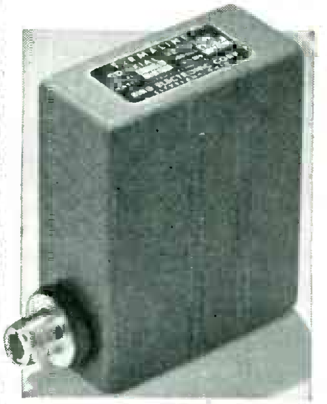


solution and the loci of the complex response functions of networks, including the effect of the locations of poles and zeros on the properties of the response function. The concept of a generalized complex frequency is here introduced and discussed.

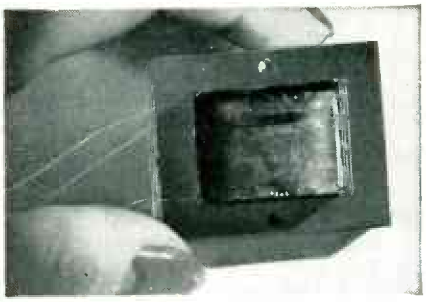
The development then returns to an elementary study of resonant circuits and nondissipative filters. Only here is a certain amount of synthesis introduced, giving design processes for constant-k, m-derived, and stagger-tuned filters. Polyphase systems and lines with distributed properties are also covered in an adequate but routine fashion. Thus, the first 340 pages of the book, with the possible exception of Chapter 6, might perhaps constitute a senior year course in alternating current circuit theory.

The rest of the book is given over to the first steps of modern analysis theory. A thorough discussion of impedance and admittance charts is given, with examples involving double-stub tuners and standing wave measurements. A chapter on the use of the Fourier Series follows. The last three chapters discuss transients in linear systems from the standpoint of the classical analysis of the differential equations, the Fourier integral and lastly by the use of operational calculus. These 145 pages, with Appendices A and B, might well comprise the beginning of a course for first year graduate students.

The various developments are clearly stated and illustrated. In fact, in general, they are a mite too elaborately drawn out for the type of material and supposed stage of sophistication of the students involved. The examples are divided into a routine practice group, and a group designed to stretch the imagination of the reader. In particular, it is pleasant to see that the student is allowed to set up his own equations from the physics of the problem as well as to solve them. Each new analysis tool is thoroughly studied and tested as it is introduced.

The typography is excellent and errors almost nonexistent.

What then could be wanting? There are a few minor flaws in expression or in particular stages of developments, mostly not worth mentioning. One which was mildly

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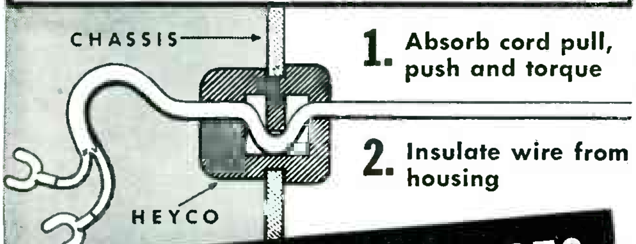

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annoying to this reviewer was a tendency to proliferate new technical words at the slightest excuse. Maybe the term copedance is justified as being frequently used, but there does not seem to be the slightest excuse for receptance. The effort to remember these words on the occasions of their infrequent use is surely greater than the effort required to pronounce the three extra syllables involved in the use of standard terminology. Such specialized vocabularies and notations can in the limit get so bad as to prevent the widespread use of an otherwise excellent book. Here they are merely a mild irritant.

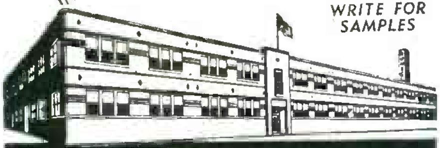
The real fault of the book, however, is that it isn't a book, in the sense of being an integrated entity. It starts at one point and ends at another point, for no visible reason. Even the authors recognize this: "It is realized, of course, that more material is contained in this book than can be covered in a single course of the usual extent. However, the diversity of the context makes possible a choice of topics which will satisfy a wide variety of course demands". This reviewer will not swallow this patent attempt to turn a fault into a virtue. It is part of the author's job to guide the teacher or student who wishes to use his book.

While this is a real fault it should not be allowed to obscure the point that here is a clear, unified introduction to modern circuit analysis. It is a welcome addition to the technical literature.—KNOX MCILWAINE, *Hazeltine Electronics Corporation.*

The Recording and Reproduction of Sound

BY OLIVER READ. *Howard W. Sams & Co., Inc., Indianapolis, Ind., Second Edition*, 1952, 790 *pages*, $7.95.

THOUGH presented as a second edition, this newest audio compendium contains over twice as many pages as the original volume and as such rates consideration as a new book. It now definitely meets the author's expressed goal of covering, in a single volume, the essential requirements for a complete understanding of all currently employed audio systems. The level of writing is semi-



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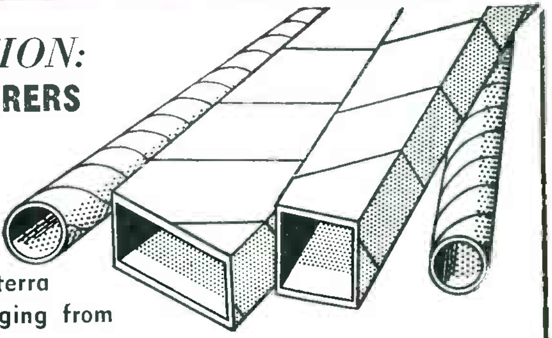

technical or nontechnical wherever possible, to emphasize the practical aspects of audio.

New chapters include: Disc Recorders; Microgroove Recording; Magnetic Film Recorders; Loudspeakers and Enclosures; Attenuators and Mixers; Preamp-Equalizers; Music Systems; PA Sound Systems; Acoustics; Tuners; Speech Input Systems; Record Manufacture. In addition, practically all of the older chapters have been expanded and several have been broken up into two or more individual chapters. Material on magnetic recording now fills over 100 pages, as compared to 30 pages in the first edition.

For anyone interested in audio as a hobby or career, this new edition is essential for both study and reference. Some may feel that a chapter or two on troubleshooting, repair and preventive maintenance of audio equipment should have been included for completeness, but that would unnecessarily increase the size and cost of the book since many practical books on radio servicing cover basic audio amplifier servicing. The greatly enlarged chapter on Audio Measurements adequately presents the specialized techniques for checking the performance of high-fidelity equipment.—J.M.

THUMBNAIL REVIEWS

F-M SIMPLIFIED. By Milton S. Kiver. D. Van Nostrand Co. Inc., New York, 1952, 2nd edition, 458 pages, $6.50. Revised and enlarged to bring up to date the explanations of the construction and operation of f-m radio receivers and transmitters. Practical and detailed troubleshooting procedures are included. Intended more for students, technicians and servicemen than for engineers.

SELLING TO INDUSTRY. By Bernard Lester. The Industrial Press, 148 Lafayette St., New York 13, N. Y., 1952, 255 pages, $3.50. Manual of practical ideas and suggestions for analyzing and improving methods used by engineers for selling technical products to industrial customers.

20 BASIC POINTS FOR TV RECEIVER SERVICE. By A. C. W. Saunders. Paul H. Wendel Pub. Co., Inc., Indianapolis, Ind., 1952, 44 pages, $1.00. For advanced television technicians, presenting basic circuit theory that can expedite tv troubleshooting. A good review for junior engineers engaged in design of television or radar equipment.

MAKE YOUR BUSINESS LETTERS MAKE FRIENDS. By James F. Bender. McGraw-Hill Book Co., New York, 1952, 250 pages, $3.50. Practical rules, examples of effective modern business-getting letters, letter-dictating tips, and progress-measuring quizzes. Golden Rule No. 3: "Good human relationships must be maintained in your own business circle in order to give your letters the ring of friendliness."

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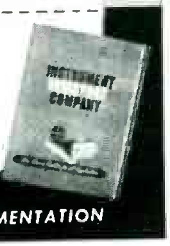

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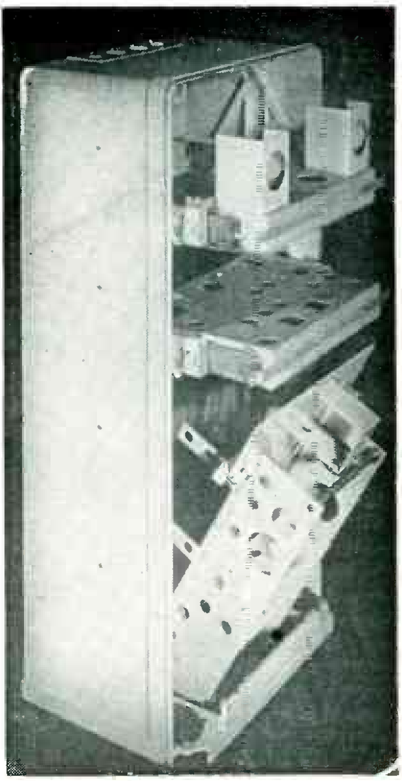

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BACKTALK

Feedback

DEAR SIRS:

I AM OBLIGED to Mr. Lawrence Fleming for his approval (ELECTRONICS, May 1952, p 366) of my vtvm, and sorry he is grieved that I did not refer to his, described in your April 1951 issue, p 181. This was because I did not see it, and if I had, it would not have occurred to me to cite it, since the only feature it seems to have in common with mine is the use of two-stage feedback. Voltmeters using this have been in commercial production in Britain for some years. The analogy between the absence of a reference in this case, and the sort of thing *Wireless World* has in mind, is therefore not very clear, nor is the precise significance of Mr. Fleming's summing-up.

M. G. SCROGGIE
Elstree Laboratory
Bromley, Kent, England

(Editor's Note: This all-in-fun (we hope) controversy all began when *Wireless World* mentioned the fact that an article had appeared in the American literature that was directly related to an article that had appeared in the British literature, but no reference had been cited. According to Larry Fleming, General Radio once made a version of this two-stage feedback circuit, but withdrew it because of poor stability with battery ageing. His circuit, on the other hand, has been in use at three test panels daily for over five years. A patent search failed to yield anything closer than the mentioned GR patent.)

Accurate Phase

DEAR SIRS:

I WAS very interested in an article in the *Electrons at Work* section of the March 1952 issue of ELECTRONICS entitled, "Accurate Phase Difference by Lissajous Figures" by Mr. John L. Glaser of Washington University. In this article Mr. Glaser attempts to increase the accuracy of measuring phase differences by calculations based on the lengths of the major and minor axes of a Lissajous pattern on an oscilloscope. The article leads one to believe that ratios of the two axes may easily be read and the phase difference be found to an accuracy of one percent.

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racy of reading the two axes to one percent would mean an accuracy in measuring the lengths of the axes to better than 1/20 of an inch. The trace on most oscilloscopes is almost as wide as this tolerance. This method leaves no allowance for harmonics in the waves or the inherent phase shift in the oscilloscope amplifiers. The accuracy of his method also hinges on equal amplitudes of the horizontal and vertical deflections. This requirement is difficult to attain to one percent on an oscilloscope. Combining these requirements with the drafting problem involved in measuring the ellipse, it is doubtful if an accuracy of five percent could be obtained with this method.

JOHN A. RUDISILL, JR.

Assistant Test Engineer
Western Electric Co.
Burlington, North Carolina

(Editor's Note: A brief description of John Rudisill's technique phase measuring appears in this month's *Electrons at Work* Department.)

OH! That Decimal Point

DEAR SIRS:

THE DOLLAR VALUE given for Eimac's uhf-tv klystron in your May 1952 issue (*Industry Report*, p 14), is high by a factor of just about 10. The tentative price is $2,500 and not $25,000.

W. W. EITEL

President
Eitel-McCullough, Inc.
San Bruno, California

(Editor's note: We sincerely hope that no prospective customers were discouraged by our misplaced decimal point.)

Translations

DEAR SIRS:

YOUR excellent job on the "Boundary-Displacement Magnetic Recording" article (ELECTRONICS, Apr. 1952, p 116, by H. L. Daniels) has received compliments from a number of the professional people we have had occasion to contact in the past weeks. One of the more unusual contacts which resulted from the article was an electronics manufacturer from Japan who visited us recently. In the course

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of his discussion with Mr. Daniels, author of the above mentioned article, this gentleman produced several sheets of paper filled with handwritten characters which were a Japanese translation of those portions of the article which were pertinent to his interests. As you can imagine, this proved to be quite a conversation piece for the fellows who had worked on the development.

W. K. DRAKE
Engineering Research Associates, Inc.
St. Paul, Minnesota

(Editor's Note: An appreciable amount of foreign language literature passes through this editorial office each month. Quite often we find articles abstracted or reprinted from ELECTRONICS in French, Italian, Spanish, Japanese and other languages. Whenever possible, we forward such translations to the authors of the original articles.)

Frequency-Shift Monitor

DEAR SIRS:

WHEN reading the note on a tuning indicator for frequency-shift receivers, (ELECTRONICS, Apr. 1952, p 234) it occurred to me that the principle of my "double-ended d-c restorer" (ELECTRONICS, Jul. 1949, p 162) could probably be adapted to monitoring receiver tuning. This circuit was devised for the purpose of obtaining telegraph signals free from bias (in the telegrapher's sense) at the output of an a-c coupled amplifier, and works by establishing a steady reference level in terms of the excursions of the signal in either direction, whereas an uncorrected a-c amplifier establishes a reference level which varies with the proportion of time for which the signal is on either side of zero.

As I am no longer working in the telegraph field I have not been able to test this adaptation of the idea, but the original idea as published was tested on telegraph signals. The advantages of such a scheme would be first that one could use a center-zero meter as an indicator, and second that one could readily apply the off-center signal to a servo device for correcting the receiver tuning.

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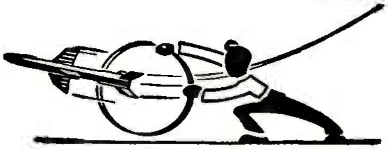

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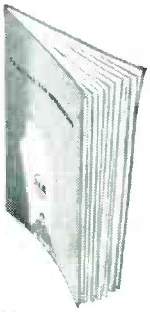
Help to Engineers



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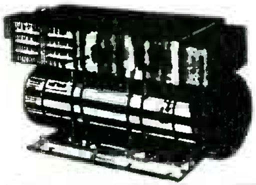

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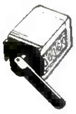

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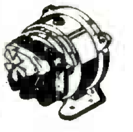

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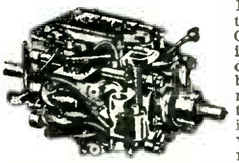

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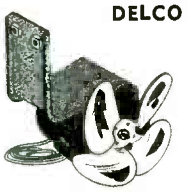

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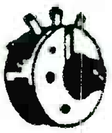

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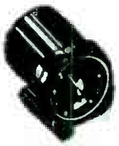
General Electric-Type 5BA10AJ52C; 27 volts, DC; .5 amps, 8 oz. inches torque; 145 RPM; shunt wound; 4 leads; reversible **$12.50 ea.**

SENSITIVE ALTIMETERS



Pioneer Sensitive altimeters, 0-35,000 ft. range . . . calibrated in 100's of feet. Barometric setting adjustment. No hook-up required...**$12.95 ea.**

PIONEER GYRO FLUX GATE AMPLIFIER

Type 12076-1-A, complete with tubes **$27.50 ea.**

MOTOR GENERATORS

G.E. Model 5LY77AB1, Input: 115 volts D.C.; 1½ H.P. motor; 13 amp; 3600 RPM; shunt contact regulated. Output: 115 Volts A.C. 60 cycles; KVA .06; shunt self excited. **$129.00 ea.**
MG-183, Input: 70 Volts DC, 5.4 amps., 1/3 H.P., 3500 RPM. Output: 50 Volts AC, 2.6 amps., 175 cycles, 3 phase, .225 KVA. **$79.00 ea.**

PIONEER AUTOSYNS

AY-1...... 26 Volt—400 Cycle..... **$6.95**
AY-5.......26 Volt—400 Cycle.......**$7.95**
AY27D **$25.50**
AY6—26 Volt—400 cyc.............**$4.95 ea.**
AY30D—26 Volt—400 cyc.........**$25.00 ea.**
AY14D **$14.00**
AY34 ....**$20.00**
AY20—26 Volt—400-cyc. ....**$12.50 ea.**

AC CONTROL MOTOR

Diehl Mfg. Co., FPE-25-7, 20 Volts, 2 phase, 1600 RPM, .85 amps............**$15.00 ea.**

SINE-COSINE GENERATORS

(Resolvers)

Diehl Type FJE-43-9 (Single Phase Rotor). Two stator windings 90° apart, provides two outputs equal to the sine and cosine of the angular rotor displacement. Input voltage 115 volts, 400 cycle..........**$25.00 ea.**
Diehl Type FPE-43-1 same as FJE-43-9 except it supplies maximum stator voltage of 220 volts with 115 volts applied to rotor ....**$25.00 ea.**

ALL EQUIPMENT FULLY GUARANTEED

Please enclose full amount with order
All prices net FOB Pasadena, Calif.
Prices subject to change without notice

C and H Sales Company

BOX 356-X EAST PASADENA STATION • PASADENA 8, CALIFORNIA

OUR GROWTH and PROGRESS

Authorized factory sales and service for Eclipse Pioneer, U. S. Gauge, Kollsman. C.A.A. approved repair station #3564. Contractors to U. S. Air Force.

Has kept pace with the rapid strides of the electronic and aviation industries. Our new plant in Great Neck, New York with new facilities and expert technical help now serves our armed forces, aircraft companies and airline transports, with precision instrument overhaul. Our stock of instruments is one of the largest in the east. A complete line of flight and navigation instruments and engine instruments on our shelves will keep your aircraft flying. We invite inquiries from air frame builders, maintenance shops, and private aircraft owners on our efficient overhaul service or emergency exchange.

INSTRUMENT ASSOCIATES

351 GREAT NECK ROAD, GREAT NECK, N. Y.
Telephone GReat Neck 4-1147

Write for Catalog NE100

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Western Union address:
WUX Great Neck, N. Y.

IMMEDIATE DELIVERY - - - FULLY GUARANTEED

A. C. SYNCHRONOUS MOTORS

110 Vt. 60 Cycle

HAYDON TYPE 1600, 1/240 RPM
HAYDON TYPE 1600, 1/60 RPM
HAYDON TYPE 1600, 4/5 RPM
HAYDON TYPE 1600, 1 RPM
HAYDON TYPE 1600, 1 1/5 RPM
TELECHRON TYPE B3, 2 RPM
TELECHRON TYPE BC, 60 RPM
HOLTZER CABOT, TYPE RBC 2505, 2 RPM, 60 oz. 1 in. torque.

SERVO MOTORS

CK1, PIONEER 2 ϕ, 400 CYCLE
10047-2-A, PIONEER 2 ϕ, 400 CYCLE, with 40:1 reduction gear.

D. C. MOTORS

BODINE NFHG-12, 27 VTS., governor controlled, constant speed 3600 RPM, 1/30 H.P.

DELCO TYPE 5068750, 27 VTS., 160 RPM, built in brake.

DUMORE, TYPE EIY2PB, 24 VTS., 5 AMP., .05 H.P., 200 RPM.

GENERAL ELECTRIC, TYPE 5BA10AJ18D 27 VTS., 110 RPM, 1 oz. 1 ft. torque.

GENERAL ELECTRIC, TYPE 5BA10AJ37C 27 VTS., 250 RPM, 8 oz., 1 in. torque.

BARBER COLMAN ACTUATOR TYPE AYLC 5091, 27 VTS. .7amp., 1 RPM, 500 in. lbs. torque.

WHITE ROGER ACTUATOR TYPE 6905, 12 VT., 1.3 amp. 1½ RPM, 75 in. lbs. torque.

ENGINE HOUR METER

JOHN W. HOBBS, MODEL MI-277 records time up to 1000 hours, and repeats, operates from 20 to 30 volts.

AMPLIDYNE AND MOTOR

AMPLIDYNE, GEN. ELEC. 5AM31NJ18A input 27 vts., at 44 amp. output 60 vts. at 8.8 amp., 530 watts.

MOTOR, GEN. ELEC. 5BA50LJ22, armature 60 vts. at 8.3 amp., field 27 vts. at 2.9 amp. ½ H.P., 4000 RPM.

INVERTERS

WINCHARGER CORP. PU 16/AP, MG750, input 24 vts. 60 amps. output 115 vts., 400 cycle, 6.5 amp., 1 phase.

HOLTZER CABOT, TYPE 149F, input 24 vts. at 36 amps., output 26 vts. at 250 V.A. and 115 vts. at 500 V.A., both 400 cycle, 1 phase.

PIONEER TYPE 12117, input 12 vts., output 26 vts. at 6 V.A., 400 cycle.

PIONEER TYPE 12117, input 24 vts., output 26 vts. at 6 V.A., 400 cycle.

WINCHARGER CORP., PU/7, MG2500 input 24 vts. at 160 amp., output 115 vts. at 21.6 amp., 400 cycle, 1 phase.

GENERAL ELECTRIC, TYPE 5D21NJ3A, input 24 vts. at 35 amps., output 115 vts. at 485 V.A., 400 cycle, 1 phase.

LELAND, PE 218, input 24 vts. at 90 amps. output 115 vts. at 1.5 K.V.A., 400 cycle, 1 phase.

LELAND, TYPE D.A. input 28 vts., at 12 amp. output 115 vts. at 115 V.A., 400 cycle, 3 phase.

PIONEER AUTOSYNS 400 CYCLE

TYPE AY1, AY5, AY14G, AY14D, AY20, AY27D, AY38D, AY54D.

PIONEER AUTOSYN POSITION.
INDICATORS & TRANSMITTERS.

TYPE 5907-17, single, Ind. dial graduated 0 to 360°, 26 vts., 400 cycle.

TYPE 6007-39, dual Ind., dial graduated 0 to 360°, 26 vts., 400 cycle.

TYPE 4550-2-A, Transmitter, 2:1 gear ratio 26 vts., 400 cycle.

VOLTAGE REGULATOR

LELAND ELEC. CO. TYPE B, CARBON PILE. Input 21 to 30 volts D.C. regulated output 18.25 vts. at 5 amp.

WESTERN ELEC. TYPE BC937B, input 110 to 120 volts 400 cycle. Output variation 0 to 7.2 ohms at 5 to 2.75 amps.

WESTERN ELEC. TRANSTAT, input 115 vts., 400 cycle output adjustable from 92 to 115 vts., rating .5 K.V.A.

AMERICAN TRANS. CO., Transtat input 115 vts., 400 cycle output 75 to 120 vts. or 0 to 45 volts, rating .72 K.V.A.

TACHOMETER GENERATOR & INDICATOR

GENERAL ELECTRIC, GEN. TYPE AN5531-1, Pad mounting 3 phase variable frequency output.

GENERAL ELECTRIC, GEN. TYPE AN5531-2, Screw mounting 3 phase variable frequency output.

GENERAL ELECTRIC, IND. 8DJ13AAA, works in conjunction with above generators, range 0 to 3500 RPM.

SYNCHROS

I F SPECIAL REPEATER 115 vt. 400 cycle.
2J1F1 GENERATOR, 115 vt. 400 cycle.
2J1F3 GENERATOR, 115 vt. 400 cycle.
2J1G1 CONTROL TRANSFORMER 57.5 vt. 400 cycle.
2J1H1 DIFFERENTIAL GEN. 57.5/57.5 vt. 400 cycle.
5G GENERATOR, 115 vt. 60 cycle.
5DG DIFFERENTIAL GEN. 90/90 vts. 60 cycle.
5HCT CONTROL TRAN. 90/55 vts. 60 cycle.
5CT CONTROL TRAN. 90/55 vts. 60 cycle.
5SDG DIFFERENTIAL GEN. 90/90 vts. 400 cycle.

D. C. ALNICO FIELD MOTOR

DIEHL TYPE FD6-23, 27 vts. 10,000 RPM.
DELCO TYPE 5072400, 27 vts. 10,000 RPM.

GENERAL ELECTRIC D. C. SELSYNS

8TJ9-PAB TRANSMITTER 24 VTS.
8TJ11- INDICATOR, dial 0 to 360°, 24 vts.

RECTIFIER POWER SUPPLY

HAMMETT ELECTRIC MFG. CO. MODEL SPS-130 Input voltage 208 or 230 volts, 60 cycle, 3 phase, 21 amps. Output 28 volts at 130 amps. continuous duty, 8 point tap switch, voltmeter ammeter, thermo reset all on front panel.

MISCELLANEOUS

PIONEER MAGNETIC AMPLIFIER ASSEMBLY Saturable reactor type, designed to supply variable voltage to a servo motor such as CK1, CK2, CK5 or 10047.

SPERRY A5 CONTROL UNIT, part No. 644836.

SPERRY A5 AZIMUTH FOLLOW-UP AMPLIFIER part No. 656030.

SPERRY A5 DIRECTIONAL GYRO, part No. 656029, 115 vt. 400 cycle, 3 phase.

SPERRY A5 PILOT DIRECTION INDICATOR, part No. 645262 contains AY 20.

ALLEN CALCULATOR, TYPE C1, TURN & BANK IND., part No. 21500, 28 vts. D. C.

TYPE C1, AUTO-PILOT FORMATION STICK, part No. G1080A3.

PIONEER GYRO FLUX GATE AMPLIFIER, type 12076-1-A, 115 vt. 400 cycle.

INSTRUMENT ASSOCIATES

351 GREAT NECK ROAD, GREAT NECK, N. Y.
Telephone GReat Neck 4-1147

Write for Catalog NE100

U. S. Export License-2140

Western Union address:
WUX Great Neck, N. Y.

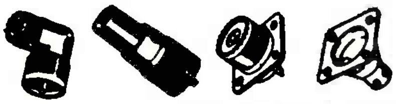
OIL FILLED CONDENSERS

MFD	VDC	Price	MFD	VDC	Price	MFD	VDC	Price	MFD	VDC	Price
2	400	$ .55	.1	1500	.59	1	6000	9.95	1	25KV	85.00
5-5	400	1.65	.5	1500	1.25	.1	7000R'd	1.79	.125	27KV	37.50
1	600	.55	3	1500	2.50	.1-.1	7000	5.95	.001	50KV	24.50
2	600	.69	4	1500	2.95	.1	7500	2.85	.025	50KV	42.50
2	600 R'd	.69	.1-.5	2000	.95	.5	7500	8.95	.2	50KV	85.00
2-2	600 R'd	1.65	.25	2000	1.50	1-1	7500	22.50	.25	50KV	95.00
3	600	.95	.3	2000	1.30	.075-.075	8KV	6.50	7.5	220VAC	1.95
4	600	1.65	1	2000	1.95	.5	10	16.50	1-3	330VAC	1.95
4	600R'd	1.65	3	2000	3.75	1	10KV	29.50	10	330VAC	3.95
5	600	1.75	12	2000	8.95	.1	12KV	8.95	12.75	330VAC	4.10
6	600	1.85	1	2500	2.75	1	15KV	37.50	15	330VAC	4.50
8	600R'd	1.85	1-1	2500	3.85	.045	16KV	4.70	5	440VAC	3.10
8-8	600	1.95	32	2500	15.80	.05	16KV	4.95	2.9	660VAC	3.50
4-4-4	600	2.50	.5	3000	2.40	.075	16KV	8.95	7	660VAC	4.25
4 x 3	600	2.50	1	3000	3.40	.25	20KV	19.95	8	660VAC	4 50
10	600	3.25	2	3000	4.50	1	20KV	54.00			
1	1000	.65	.03	4000	1.25						
2	1000	.90	3 x .2	4000	2.95						
2	1000R'd	.95	2	4000	6.95						
3.5-.5	1000	1.85	.1	5000	1.60						
4	1000	1.95	.2	5000	2.50						
6	1000	2.50	1	5000	4.88						
8	1000	3.25	2	5000	18.50						
1	1200	.85	5	5000	29.50						
1-1-1	1200	1.85	.01-.03	6000	1.65						

OILMITES

MFD	VDC	TYPE	Price
.02	600	OM-6002	$ .45
.05	600	OM-6005	.48
.1	600	OM-610	.51
.25	600	OM-625	.55
.5	600	OM-650	.60
1.0	600	OM-601	.85

COAXIAL CONNECTORS



83-1AC	$ .42	83-1RTY	$.65	83-22R	$ .68
83-1AP	.30	83-1SP	.50	83-22SP	.90
83-1F	1.20	83-1SPN	.56	83-22T	1.95
83-1H	.12	83-1T	1.30	83-168	.15
83-1HP	.25	83-2AP	1.95	83-185	.15
83-1J	.75	83-22AP	1.40	83-765	.24
83-1R	.40	83-22F	2.10	83-776	.85
		83-22J	1.50		

FULL LINE OF JAN APPROVED COAXIAL CONNECTORS
IN STOCK
UHF—N—PULSE—BN—BNC

UG-7/AP	$6.30	UG-23C/U	$1.90	UG-58A/U	$1.15	UG-106/U	$ .15	UG-191/AP	$.80	UG-262/U	$1.20
UG-12/U	.95	UG-24/U	1.30	UG-59A/U	2.25	UG-108/U	2.60	MX-195/U	.75	UG-273/U	2.25
UG-15/U	1.50	UG-25/U	1.35	UG-83/U	2.25	UG-109/U	2.60	UG-197/U	2.80	UG-274/U	2.75
UG-18/U	1.25	UG-27/U	1.30	UG-85/U	1.75	UG-146/U	2.55	UG-201/U	2.25	UG-275/U	5.50
UG-19/U	1.80	UG-27A/U	2.95	UG-86/U	2.50	CW-159/U	.60	UG-203/U	.85	UG-276/U	2.75
UG-21/U	.95	UG-28A/U	3.75	UG-87/U	1.60	UG-166/U	32.50	UG-206/U	1.80	UG-290/U	1.20
UG-21A/U	1.50	UG-29/U	1.55	UG-88/U	1.10	UG-167/U	5.85	UG-224/U	1.20	UG-291/U	1.35
UG-21B/U	1.35	UG-30/U	2.30	UG-89/U	1.35	UG-171/U	2.80	UG-236/U	3.85	UG-306/U	2.95
UG-22/U	1.35	UG-34/U	16.50	UG-90/U	1.60	UG-173/U	.40	UG-245/U	2.30	UG-414/U	3.25
UG-22B/U	1.65	UG-36/U	17.50	UG-98/U	1.85	UG-175/U	.15	UG-254/U	2.75	UG-625/U	1.35
UG-22C/U	1.65	UG-37/U	17.50	UG-102/U	.90	UG-176/U	.15	UG-255/U	2.45		
UG-23/U	1.20	UG-57/U	2.30	UG-103/U	.68	UG-177/U	.24	UG-260/U	1.20		
UG-23B/U	1.90	UG-58/U	.80	UG-104/U	1.40	UG-185/U	1.35	UG-261/U	1.20		

QUOTATIONS UPON REQUEST ON ANY CONNECTORS NOT LISTED HERE

M-358
M-359
M-359A
M-360
MC-277
MC-320
PL-258
PL-259
PL-259A
PL-274
PL-284
PL-293
PL-325
SO-239
SO-264
TM-201
93-C
93-M
49120
49121A
D-163950
D-166132
ES-685696-5
ES-689172-1

COAXIAL CABLE

Type	Price Per M Ft.	Type	Price Per M Ft.	Type	Price Per M Ft.	Type	Price Per M Ft.
RG-5/U	$140.00	RG-13/U	$216.00	RG-26/U	$475.00	RG-57/U	$325.00
RG-6/U	180.00	RG-17/U	650.00	RG-29/U	50.00	RG-58/U	60.00
RG-7/U	85.00	RG-18/U	900.00	RG-34/U	300.00	RG-58A/U	70.00
RG-8/U	100.00	RG-19/U	1250.00	RG-35/U	900.00	RG-59/U	60.00
RG-9/U	250.00	RG-20/U	1450.00	RG-54A/U	97.00	RG-62/U	75.00
RG-9A/U	275.00	RG-21/U	220.00	RG-55/U	110.00	RG-77/U	100.00
RG-10/U	240.00	RG-22/U	150.00				
RG-11/U	100.00	RG-22A/U	285.00				
RG-12/U	240.00	RG-24/U	675.00				

ADD 25% TO PRICES SHOWN FOR QUANTITIES UNDER 500 FT.

2 φ LOW INERTIA SERVO MOTORS

KOLLSMAN—45 Volt 60 cycle 4 watts 1500 RPM—new $22.50

PIONEER—10047-2-A 26 volt 400 cycle with 40:1 reduction gear $10.50

PIONEER—CK-14 115 volt 400 cycle—includes damping signal generator (antosyn) $47.50

HIGH VOLTAGE TRANSFORMERS

G.E.—Pri. 115V 60 cy. Sec. 6250V 80 MA—12.5 KV insulation $18.50

G.E.—Pri. 115V 60 cy. Sec. 6250/3850/2600V 56 MA 12.5 KV Insulation $18.50

ANTENNAS

AT-4/ARN-1	$8.25
AT-38A/APT (70 to 400MC)	13.70
AT-49/APR-4 (300 to 3300MC)	13.70
AN-65A (P/O SCR-521)	1.50
AN-66A (P/O SCR-521)	1.75
AIA-3CM conical scan	125.00
ASB Yagi—5 element 450 to 560MC	7.00
ASB Yagi—Double stacked 6 element	12.70
ASA Yagi—Double stacked 370 to 430MC	29.40

RELAYS

Sigma type 4AH—2000Ω 4 ma DC coil—SPDT contacts—hermetically sealed 5 pin plug-in base. $3.30

Sigma type 4R—8000Ω 1 ma DC coil—SPDT contacts—enclosed type 5 pin plug-in base $4.25

Stevens Arnold type 171 Millisec relay—900 ohm coil SPST NO contacts $5.50

Cutler-Hammer and Square D type B-7A contactor—24 VDC coil—SPST NO 200 Amp contacts ... $4.75

Price Bros. type 161-M—220 VAC contactor—SPST NO double bk 30A contacts $3.25

G.E. CR5181-1A6—115 V 60 cy. AC contactor—4PST 30 Amp contacts plus two auxiliary SPDT contacts $14.50

RBM—115 V 60 cy. AC coil—DPDT 3 amp Contacts $3.20

METERS

1 MA DC 3½" R Dejur Mod 310 (0-4KV scale)	$5.75
500 Microamps, DC—2½" round—Sun	4.30
1ma. DC Fan type—4" scale (rem. from equipt)	3.95
500 ma. DC 2½" R.—General Electric	2.95
2 amp. RF 2½" Sq.—Simpson	3.15
5 amp. AC 4½" R.—JBT	4.11
30 V DC 2½" R.—General Electric	3.95
3 amp. RF 3½" R.—Weston	6.00

CRYSTAL DIODES

1N21	$1.19	1N27	$1.79	1N41	$11.25
1N21A	1.69	1N31	8.10	1N42	18.75
1N21B	3.50	1N34	.66	1N43	1.55
1N22	1.09	1N34A	.95	1N45	.94
1N23	1.95	1N38	1.70	1N52	1.05
1N23A	3.25	1N39	6.25	1N55	3.15
1N23B	4.25	1N40	10.60	1N60	.55

TYPE "J" POTENTIOMETERS

Resis.	Shaft	Resis.	Shaft	Resis.	Shaft
60	SS	5K	1/4"	50K	3/8"
60	9/16"	5K	3/8"	50K	1/2"
100	SS	5K	1/2"	100K	SS
200	SS	10K	SS	150K	1/2"
250	1/8"	10K	3/8"	200K	3/8
500	SS	10K	1/2"	250K	SS
500	5/16"	15K	SS	250K	3/4"
500	1/2"	15K	1/2"	250K	3/8"
500	5/8"	20K	SS	500K	SS
650	1/2"	25K	SS	500K	1/4"
1K	SS	25K	1/4"	500K	7/16"
2K	3/8"	30K	1 1/8"	1Meg	SS
2500	SS	40K	SS	2.5 Meg	SS
4K	SS	50K	SS	5 Meg	SS
5K	SS	50K	1/4"		

$1.25 each

DUAL "JJ" POTS.—$2.95 ea.

50 SS	330 SS	2500 SS	2.5 meg SS
100 SS	500 SS	10K SS	5 meg SS
250 SS	1K SS	1 meg SS	1K/25K ⅜"

TRIPLE "JJJ" POTS.—$3.95 EA.

100K/100K/100K ⅜"   20K/150K/15K ⅜"

SOUND POWERED TELEPHONES

U. S. NAVY TYPE M HEAD AND CHEST SETS
U.S.I. A-260   W.E. D-173013
A.E. GL832BAO
ANY TYPE—$14.88 EACH

TS-10 Type Handsets $9.25

GENERATORS AND INVERTERS

Eclipse-Pioneer type 716-3A (Navy Model NEA-3A) Output-AC 115V 10.4A 800 to 1400cy. 1φ: DC 30

Eclipse-Pioneer type 1235-3. Output-30 Volts DC Volts 60 Amps. Brand new $38.50

15 Amps. Brand New-Original Packing $15.50

PE-218 Inverters-28 VDC to 115 VAC 400 cy 1500 VA. (New) $49.50

Pioneer Type 800-1B Inverter-28VDC to 120V 800 cy 7 amp AC (used) $22.65

G. E. Inverter-28 VDC to 120 VAC 800 cy 750 VA 1φ $39.50

ATR Inverter 6VDC to 110 VAC 60 cy 75W $22.95

PU-7/AP Inverter-28 VDC to 115 VAC 400 cy 2500 VA (used) $75.00

Eclipse-Pioneer type 12121A Inverter—Voltage and frequency regulated—24VDC 18 Amp input—AC output 115V 3φ 400 cy 250VA 0.7 PF — (New) $225.00

TEST EQUIPMENT

• Gen. Radio 475B Frequency Monitor	*$200.00
• Gen. Radio 681A Freq. Deviation Meter	*$87.50
• I-72K Signal Generator	$48.50
• C-D Quietone Filter Type IF-16 110/220V AC/DC 20 Amps.	*$9.00
• TS-143/CPN Oscilloscope	*$95.00
• Dumont 175A Oscilloscope	*$225.00
• Gen. Radio 757-P1 Power Supply	*$27.00
• I-130A Signal Generator	*$85.00
• A.W. Barber Labs. VM-25 VTVM	*$86.00
• TS-10A/APN Delay Line Test Set	$45.00
• TS-19/APQ-5 Calibrator	$75.00
• CWI-60AAG Range Calibrator for ASB, ASE, ASV and ASVC Radars	$39.95
• CRV-14AAS Phantom Antenna for Transmitters up to 400 MC	$11.75
• 3 CM Pickup Horn Antenna AT-48/UP	$9.95
• I-138A Signal Generator—10 cm	*$185.00
• BC-221 Frequency meter	*$125.00
• CW—60ABM Frequency Meter—10 CM	$97.50
• Weston Model 1 D.C. Milliameter 150/1500 MA with leather case	$75.00

All items New Except Where noted * (Exc. Used Condition.)

MISCELLANEOUS EQUIPMENT

I-82F Selsyn Indicator	$6.95
SCR-515 compl. w/dynamotor, control box	69.50
Amperex 1B98 Gamma Counter	9.87
Powerstat 1226—115/230V Input—0-270V out. @ 9 amp.	37.00
EIMAC 35T Ionization Gauge	5.95
R-7/APS-2 Receiver	49.50
R-78/APS-15 Receiver	49.50
FL-8 1020 cycle filter	2.95
RM-29 remote control unit	8.95
RM-14 remote control unit	8.95
RTA-1B 12/24 V dynamotor	40.00
BC-1206-CM2 Receiver	12.95
ASB-4 Radar equip. Complete	69.75
RCA AVR-15 Beacon Recvr	18.50
Navy DP-14 Direction Finder complete	385.00
CU-24/ART-13 Antenna Loading Cond	4.95
T-85/APT-5 300-1600 MC Transmitter	175.00
BC-1016 Tape Recorder	350.00
AN/APA-30	375.00
BC-910A Oscilloscope	147.50
BC-1068 Receiver	57.50
ATJ and ATK TV Block Equip	Quote
BC-348 Receiver	Quote
RTA-1B Transceiver	Quote
T-47/ART-13 Transmitter	Quote
Sperti 1S21 vacuum relay switch (P/O AN/ART-13)	9.50

PULSE TRANSFORMERS

UTAH 9262 9278 9280

G.E. K54J318
G.E. 68G-627
G.E. 68G828
G.E. 68G929G1
G.E. 80G13
G.E. K-2468B
G.E. K-2469A
G.E. K-2744B
AN/APN-9 (901756-501)
AN/APN-9 (901756-502)
AN/APN-9 (352-7250)
AN/APN-9 (352-7251)
Westinghouse 132-AW
Westinghouse 139DW2F
Westinghouse 166AW2F
Westinghouse 176AW2F

UTAH 9318 9340 9350

Westinghouse 187AW2F
Westinghouse 232-AW2
Westinghouse 232-BW-2
AN/APN-4 Block Osc.
Philco 352-7149
Philco 352-7150
Philco 352-7071
Philco 352-7178
Raytheon UX-7350
Raytheon UX-10066
W.E. D-161310
W.E. D-163247
W.E. D-163325
W.E. D-164661
W.E. KS-9563

AN/APA-23 RECORDER

Sweeps any receiver through its tuning range and permanently records frequency and time of received signals on paper chart. Power input—(motor) 27V DC 1.5A. and (recorder) 80/115V AC 60-2600 cy 135W.

Originally designed to record pulse or sinewave modulated signals received by AN-APR-1, AN/APR-2, AN/APR-4, AN/APR-5, BC-348, S-27, SX-28. BRAND NEW $147.50

SPRAGUE PULSE NETWORKS

7.5 E3-1-200-67P. 7.5 KV, "E" Circuit 1 Microsec. 200 PPS 67 ohms imped, 3 sections $4.30

7.5 E3-3-200-67P. 7.5 KV, "E" Circuit 3 Microsec. 200 PPS. 67 ohms imped, 3 sections $6.75

7.5 E4-16-60-67P. 7.5 KV, "E" Circuit 4 sections. 16 microsec, 60 PPS. 67 ohms imped $8.25

15 E4-.91-400-50P. 15 KV, "E" Circuit .91 microsec. 400 PPS. 50 ohms imped. 4 sections $16.50

15-A-1-400-50P. 15 KV, "A" Circuit, 1 microsec. 400 PPS. 50 ohms imped $37.50

LECTRONIC RESEARCH LABORATORIES

715-19 ARCH ST.   PHILA. 6, PA.
Telephones - MARKET 7-6771-2-3

GUARANTEED
BRAND
NEW

TUBE SPECIALS

STANDARD
BRANDS
ONLY

Receiving Tubes

OOA	$1.50
O1A	.67
OZ4	.74
OZ4A	.90
1A3	.71
1A5GT	.72
1A6	.72
1A7GT	.91
1AB5	.89
1B3GT	.99
1B4P	1.17
1C5GT	.85
1C6	.69
1C7G	.69
1D5GP	.69
1D7G	.69
1D8GT	.71
1E5GP	.71
1F4	.69
1F5G	.69
1F6	.71
1G4GT	.69
1G5G	.69
1G6GT	.69
1H4G	.89
1H5GT	.74
1H6G	.99
1H6GT	1.01
1J5G	.74
1J6G	.95
1L4	.69
1LA4	.87
1LA6	1.10
1LB4	1.01
1LC5	.81
1LC6	.93
1LD5	.93
1LE3	.93
1LH4	.82
1LN5	.91
1N5GT	.85
1N6G	.97
1P5GT	.69
1Q5GT	.99
1R4	.69
1R5	.89
1S4	.71
1S5	.81
1T4	.81
1T5GT	.71
1U4	.86
1U5	.81
1V	.69
1X2	1.09
2A3	1.28
2A5	.79
2A7	.89
2B7	.79
2E5	.94
2X2	.89
2X2A	1.85
3A4	.65
3A5	1.89
3A8GT	2.25
3B7	.57
3C6	1.15
3D6	.57
3LF4	.91
3Q4	.77
3Q5GT	.83
3S4	.77
3V4	.87
5AZ4	.69
5R4GY	1.59
5T4	1.91
5U4G	.69
5V4G	1.07
5W4	.82
5X4G	.87
5Y3GT	.59
5Y4G	.71
5Z3	.87
5Z4	1.11
6A4	1.35
6A6	1.17
6A7	1.05
6A8	1.08
6AB4	.99
6AB7	1.05
6AC5GT	1.19
6AC7	1.11
6AC7W	3.25
6AD6G	.98
6AD7G	1.31
6AE6G	.89
6AF6G	.89
6AG5	.87
6AG7	1.59
6AH6	1.39
6AJ5	2.50
6AK5	1.35
WE-6AK5	2.85
6AK5W	3.05
6AK6	.99
6AL5	.69
6AL5W	2.90
6AQ5	.89
6AQ6	.79
6AR5	.79
6AS5	.99
6AS6	3.30
6AS7G	4.53
6AT6	.63
6AU5GT	1.21
6AU6	.69
6AV6	.63
6B4G	1.60
6B5	1.20
6B7	.97
6B8	.99
6B8G	.85
6BA6	.72
6BA7	1.20
6BC5	.88
6BC7	1.10
6BD5GT	1.60
6BD6	.99
6BE6	.72
6BF5	1.10
6BF6	.83
6BG6G	1.92
6BH6	.99
6BJ6	.99
6BK7	1.60
6BL7GT	1.45
6BN6	1.59
6BQ6GT	1.26
6C4	.65
6C5	.75
6CB6	.89
6C6	.88
6C8G	.96
6CD6G	2.40
6D6	.88
6D8G	.83
6E5	1.10
6F5GT	.83
6F6	.99
6F6G	.99
6F7	.85
6F8G	.91
6G6G	1.06
6H6	.83
6H6GT	.83
6J5	.75
6J5G	.64
6J5GT	.64
6J6	1.09
6J7	.99
6J7GT	.79
6J8G	1.28
6K5GT	.99
6K6GT	.69
6K7	.83
6K7G	.88
6K8	1.22
6K8GT	.96
6L5G	1.06
6L6	1.87
6L6G	1.79
6L6GA	1.59
6L7	1.08
6L7G	.95
6N7	1.19
6N7GT	1.10
6P5GT	.96
6Q7	.99
6Q7G	.89
6R7	.99
6S4	.72
6S7	1.06
6S7G	.99
6SA7	.84
6SA7GT	.74
6SB7Y	1.05
6SC7	1.20
6SC7GT	1.05
6SD7GT	.94
6SF5	.83
6SF5GT	.80
6SF7	.69
6SG7	.91
6SH7	.89
6SH7GT	.89
6SJ7	.89
6SJ7GT	.89
6SK7	.89
6SK7GT	.89
6SL7GT	.96
6SN7GT	.89
6SN7WGT	2.30
6SQ7	.75
6SQ7GT	.75
6SR7	.81
6SS7	.99
6ST7	1.25
6T7G	1.09
6T8	1.11
6U5	1.19
6U7G	88
6V6	1.60
6V6G	.89
6V6GT	.79
6W4GT	.72
6W6GT	.99
6X4	.59
6X5GT	.59
6Y6G	.99
6ZY5G	.89
7A4	.79
7A5	.88
7A6	.83
7A7	.83
7A8	.83
7AD7	1.44
7AH7	1.08
7B4	.83
7B5	.83
7B6	.83
7B7	.83
7B8	.89
7C4	.69
7C5	.83
7C7	.83
7E5	1.20
7E6	.58
7E7	.83
7F7	.99
7F8	1.59
7G7	1.32
7H7	.83
7J7	1.32
7K7	1.32
7L7	.97
7N7	.97
7Q7	.83
7R7	.94
7S7	1.11
7V7	1.11
7W7	1.11
7Y4	.73
7Z4	.89
10	.45
12A	.65
12A6	.71
12A6GT	.69
12A7	1.16
12A8GT	.77
12AH7GT	1.32
12AL5	.89
12AT6	.59
12AT7	1.15
12AU6	.79
12AU7	.95
12AV6	.63
12AW6	1.20
12AX7	1.08
12BA6	.72
12BA7	.95
12BD6	.99
12BE6	.70
12C8	.77
12F5GT	.79
12H6	.69
12J5GT	.69
12K8	.83
12Q7GT	.67
12SA7	.89
12SA7GT	.89
12SF5	.79
12SF5GT	.79
12SF7	.79
12SG7	.99
12SH7	.73
12SJ7	.79
12SJ7GT	.89
12SK7	.81
12SL7GT	1.03
12SN7GT	.99
12SQ7GT	.79
12SR7	.89
12SR7GT	.89
12X3	1.19
12Z3	.89
14A4	.97
14A7	.97
14B6	.93
14B8	1.09
14C5	1.29
14C7	1.15
14E6	1.09
14E7	1.29
14F7	.93
14H7	.93
14J7	.93
14N7	.93
14R7	.93
14W7	.93
14X7	.93
19	.89
19T8	1.16
22	1.16
24A	.79
25A6	1.16
25L6GT	.89
25Z5	.99
26	.79
27	.69
28D7	1.75
30	.72
30 Spec	.48
31	.62
32	.99
32L7GT	.87
33	.99
34	.99
35/51	.79
35A5	.89
35B5	.87
35L6GT	.81
35W4	.55
35Y4	.81
35Z4GT	.69
35Z5GT	.59
36	.69
37	.69
38	.69
39/44	.59
41	.71
42	.89
43	.89
45	.89
45Z5GT	.79
46	.81
47	.99
48	1.60
49	1.19
50	1.41
50A5	.91
50B5	.88
50C5	.88
50L6GT	.79
50Y6GT	.92
53	.95
55	.99
BK55B	.40
L55B	.32
56	.69
57	.89
58	.89
59	1.24
70L7GT	.91
71A	.79
75	.89
76	.69
77	.69
78	.79
79	.89
80	.65
81	1.41
82	1.19
83	1.11
83V	1.45
84/6Z4	.79
85	.79
89Y	.55
117L7GT	1.89
117P7GT	1.89
117Z3	.74
117Z6GT	.97
FM-1000	1.59

Cathode Ray Tubes

2AP1	$9.75
2AP5	9.75
3AP1	10.25
3AP4	10.25
3BP1	7.95
3CP1	2.25
3DP1	4.85
3DP1A	6.75
3EP1	4.95
3FP7	4.95
3FP7A	6.95
3GP1	4.95
3HP7	4.91
4AP10	4.75
5AP1	5.95
5AP4	4.75
5BP1	5.75
5BP4	5.75
5CP1	4.95
5CP7	9.50
5FP7	4.95
5HP1	5.75
5HP4	5.75
5JP1	26.50
5JP2	26.50
5JP4	26.50
5LP1	19.75
5LP5	19.75
5MP1	10.65
7BP1	8.75
7BP7	7.95
7BP12	14.95
7BP14	14.95
7CP1	14.95
9GP7	12.85
9LP7	9.95
10BP4	18.50
10FP4	24.50
12DP7	16.50
12GP7	16.50
12HP7	16.50
902P1	9.95
905	4.45

Photo Cells

1P23	$4.10
1P24	1.27
918	1.65
919	1.95
923	1.35
927	1.85
931A	6.95
1645	1.95

Thyratrons & Ignitrons

OA4G	$1.32
EL-C1A	4.75
2A4G	1.25
2B4	2.10
2C33	4.95
2D21	1.55
3C23	9.95
3C31/EL-C1B	3.95
3C45	17.50
4C35	28.75
EL-C5B	9.95
5C22	53.45
C6A	6.75
C6J	9.95
FG-17/5557	5.25
FG-33	17.50
FG-41	122.50
FG-67	14.80
FG-81A	4.95
91	7.85
FG-95/5560	25.00
FG-104/5561	24.60
FG-105	19.50
FG-166	95.00
FG-172	39.50
FG-178	14.50
RX-233A	4.95
FG-235A/5552	94.50
FG-271/5551	62.50
393A	8.60
394A	4.77
GL-415/5550	39.50
KU-610	12.50
KU-623	39.50
KU-628	22.25
KU-634	39.50
WL-652/5551	62.50
WL-654/659	82.00
WL-672	22.00
WL-677	39.50
WL-681/5550	39.50
722A	3.75
884	1.85
885	1.90
1665	1.80
1904	14.80
2050	1.80
2051	1.15
5545	32.50

Transmitting & Special Purpose Tubes

OA2	$1.30
OA3	1.51
OB2	1.50
OB3	1.29
OC3	1.20
OD3	1.15
1B21A	2.85
1B22	3.25
1B23	9.95
1B24 (West)	12.95
1B24 (Sylv)	18.95
1B26	3.73
1B27	19.50
1B29	2.90
1B32	3.95
1B35	12.50
1B36	12.50
1B38	32.50
1B41	47.50
1B42	9.80
1B54	32.50
1H20	.88
1S21	9.50
1Z2	3.75
2B22	2.20
2C21	.75
2C22	.75
2C26	.49
2C26A	.49
2C34	.49
2C39	22.00
2C40	16.25
2C42	26.50
2C43	22.50
2C44	1.50
2C46	29.50
2C51	5.75
2E22	1.85
2E24	4.10
2J21A	9.95
2J22	9.95
2J26	26.50
2J27	24.50
2J31	39.50
2J32	42.50
2J33	39.50
2J34	39.50
2J36	85.00
2J37	13.70
2J38	17.50
2J39	49.50
2J40	39.50
2J41	175.00
2J48	27.50
2J49	65.00
2J50	39.50
2JB51	2.50
2J55	87.50
2J56	150.00
2J61	45.20
2K23	37.50
2K25	33.50
2K26	107.15
2K28	34.50
2K29	26.00
2K33	295.00
2K45	145.00
2K54	135.00
2K55	135.00
2X2A	1.85
3B22/EL-1C	2.95
3B23	4.75
3B24	5.25
3B24W	7.95
3B25	4.50
3B26	3.75
3B27	3.95
3C24	1.85
3C27	6.95
3D21	1.98
3D21A	2.25
3E29	14.50
3J31	95.00
4-125A	29.50
4A1	1.18
4B22/EL-5B	8.95
4B24	5.75
4B25/EL-6CF	8.95
4E27	17.25
4J36	150.00
4J38	120.00
4J50	375.00
4J52	400.00
5D21	26.50
5J23	24.50
5J29	18.50
6-8B	.85
6AN5	5.95
6AR6	3.35
6C21	29.50
6C24	52.50
6J4	7.95
7-7-11	1.19
10T1	.88
10Y	.45
13-4	.80
15E	2.35
15R	.95
REL-21	2.25
24G	1.85
HK-24	3.95
RK-25	3.82
FG-32/5558	6.75
RK-34	.49
35T	4.95
35T Ion gauge	5.95
35TG	4.95
REL-36	.78
RK-47	4.92
EF-50	.79
VT-52	.65
53A	5.60
RK-59	2.44
RK-60	1.95
VT-62(Br)	1.15
RK-63	22.50
VT-67	.48
RK-69	2.25
72	1.32
73	1.32
RK-75	3.50
VR-75/OA3	1.51
75T	5.80
VR-78	.64
VR-90/OB3	1.29
VT-98 (Br)	65.00
C100E	2.30
100R	2.90
100TH	10.25
WE-101D	1.65
WE-101F	3.62
WE-102F	2.85
VR-105/OC3	1.20
WE-113A	1.32
HY-114	.75
WE-117A	.95
F-123A	8.95
WE-124A	3.80
F-127A	22.50
VT-127A	3.60
AB-150	12.50
VR-150/OD3	1.15
FG-190	12.15
HF-200	16.50
203A	7.40
203B	6.33
204A	49.50
CE-206	3.15
211	.95
WE-211D	12.50
WE-211E	12.50
212E	42.50
WE-215A	.24
217C	8.95
221A	1.95
227A/5C27	4.60
WE-231D	2.25
232CH	240.00
WE-244A	5.20
WE-245A	2.35
WE-249B	3.50
WE-249C	3.50
250TH	22.50
250TL	22.50
WE-252A	5.65
WE-254A	5.90
WE-257A	3.77
WE-274A	5.50
274B	2.85
WE-275A	6.95
WE-283A	4.25
WE-285A	5.57
WE-286A	7.90
WE-294A	5.75
304TH	9.75
304TL	9.75
307A	5.50
WE-309A	6.45
WE-310A	7.50
WE-313C	4.15
316A	.89
327A	4.25
WE-331A	9.75
WE-343A	185.00
WE-346A	2.75
WE-350A	6.95
350B	4.95
WE-356B	5.45
361A	4.75
368A	6.95
371A	.95
371B	.95
388A	2.95
WE-399A	4.70
417A	16.95
434A	17.50
446	1.95
446A	1.95
446B	2.25
450TH	42.50
450TL	42.50
451	1.39
471A/1B21A	2.75
SS-501	12.50
503AX	1.65
506AX	1.47
507AX	1.47
527	12.25
530	17.20
531	8.25
532A	3.95
WL-533	65.00
559	2.20
561	3.50
HY615	.49
WL670A	8.70
700A	24.50
700B	24.50
700C	24.50
700D	24.50
702A	2.95
702B	4.25
703A	6.95
704A	.95
705A	2.75
706AY	45.00
706BY	45.00
706CY	45.00
706FY	45.00
706GY	45.00
707A	9.95
707B	22.50
708A	4.85
709A	4.87
710A	1.70
713A	1.45
714AY	6.95
715A	6.75
715B	12.75
715C	26.50
717A	1.47
718AY	45.00
718BY	45.00
720CY	75.00
720DY	75.00
721A	4.90
723A	9.95
723A/B	18.50
724A	3.22
724B	3.22
725A	8.95
726A	8.50
726B	45.00
730A	25.00
731A	2.45
WL-787	9.80
788Y	1.40
800	1.88
801A	.48
803	4.95
804	8.95
805	4.50
806	24.50
807	1.70
808	2.65
809	2.40
810	10.95
811	3.60
813	9.50
814	3.95
815	2.75
816	1.45
826	1.45
828	13.48
829	9.95
829A	14.50
829B	14.50
830B	3.95
832	7.95
832A	9.95
833A	45.00
836	3.50
837	1.85
838	3.25
841	.49
843	.59
845	5.75
845W	6.75
849	29.50
851	67.00
852	22.60
860	4.95
861	24.50
864	.39
865	1.28
866A	1.48
869B	45.00
872A	3.95
874	1.45
876	1.60
878	1.85
886	3.50
954	.39
955	.70
956	.49
957	.49
958A	.69
959	1.50
991	.45
1003	.90
CK-1005	.79
E-1148	.35
1201	1.20
1203	.69
1291	.69
1294	.69
1299	.69
1602	2.25
1613	1.20
1614	2.00
1616	1.07
1619	.39
1620	6.25
1622	2.30
1624	1.95
1625	.45
1626	.39
1629	.39
1630	.95
1631	1.38
1632	.75
1636	3.10
1638	.70
1641	1.95
1642	.75
1644	1.17
1655	1.90
1960	.70
5611	135.00
5651	3.05
5654	5.85
UX-6653	.65
7193	.75
8005	5.95
8011	.87
8012	2.60
8013	2.75
8013A	4.90
8016	1.05
8020	1.39
8025	6.95
9001	1.75
9002	1.50
9003	1.75
9004	.55
9005	1.95
9006	.35
189048	3.79
189049	3.79
199698	2.69

SYNCHROS

IMMEDIATE

DELIVERY FROM STOCK

GENERAL ELECTRIC
CONTROL INSTRUMENT
FORD INSTRUMENT
HENSCHEL

ARMA
BENDIX
KETAY
DIEHL

ARMY ORDNANCE—NAVY ORDNANCE—COMMERCIAL

AY-101D
1CT
1F
1G
1HG
1SF
5B
5CT

5D
5DG
5F
5G
5N
5SF
5SG
6CT

6DG
6G
7DG
7G
A
B
M
N

X
2J1F1
2J1G1
2J1H1
2J1M1
2J5A2
2J5D1
2J5HA1

2JD5E1
C-44968-6
C-56701
C-56776-1
C-69405-2
C-69406
C-69406-1
C-77610

C-78248
C-78249
C-78254
C-78410
C-78411
C-78414
C-78415
C-78670
C-79331

SYNCHRO CAPACITORS

SYNCHRO BLOWN FUSE INDICATORS

SYNCHRO BLOWN FUSE INDICATORS

Terms 20% cash with order, balance C. O. D. unless rated. All prices net F.O.B. our warehouse, Phila., Penna., subject to change without notice.

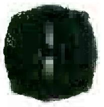
LECTRONIC RESEARCH LABORATORIES
715-19 ARCH ST.
PHILA. 6, PA.
Telephones - MARKET 7-6771-2-3

IMMEDIATE DELIVERY • LOW PRICES • FULLY GUARANTEED

BLOWER ASSEMBLY

Lear frame CO10, 5500 rpm motor with 3" Sirroco impeller. Motor 28 v. DC @ 1.2 Amps. Output 10 watts. Cont. duty. **Stock #SA-347 Price $9.75 each.**

Radio Compass Indicator

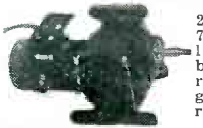


I-82F. Compass Indicator. 0-360°-5 in. dial, 26 v. 400 cy. 8-12 v. 60 cy. Ideal position indicator. Stock #SA-284.

Price $6.50 each

AIRCRAFT MOTOR

G. E. Type 5BA25AJ32A

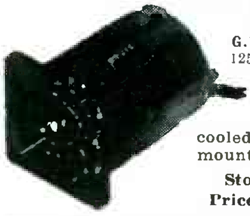


24 volts at 2.9 amps. 75 in/lb. torque. 3 lead shunt with brake. 1 minute rating. Double worm gear reduction. 4 rpm reversible.

Stock #SA-298 **Price $39.50 each.**

DIEHL PM MOTOR

Type FD6-31-1, 27.5 V. D.C. 10,000 rpm. Dual Shaft. Shaft ext. ⅝" ea. end. Diam. 0.120. Motor 1" Sq. x 2" Lg. Stock #SA-355. **Price $13.25 each.**



G. E. 1/10 HP DC Motor

G.E. Type 5BN58LA5

125 volts DC at 1.2 amps. 4000 rpm. Int. duty Internal fan cooled. 3½" sq. front mounting flange.

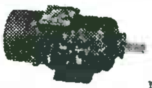
Stock #SA-312
Price $19.50 each.

60 CYCLE AMPLIDYNES

G.E. Types 5AM45DB15 and 5AM73AB95. Type 45DB15 input 115 v. 60 cy. at 5 amps. Output 250 volts DC at 0.6 amps. Stock #SA-147.

Type 73AB95 input 115 volts 60 cy. at 9 amps. Output 250 volts DC at 1.5 amps. Stock #SA-257.

PRICES ON REQUEST



DELCO CONSTANT SPEED MOTOR A-7155

1/30 hp. 27.5v d-c 3600 rpm. Cont. duty, 2½" diam. x 5⅓" lg. ⅞" shaft extension. 5/32" diam. 4 hole base mounting. Stock #SA-34. **Price $19.50 each.**

BLOWER ASSEMBLY

Delco 27 v. DC motor, 5400 rpm. 3" Sirroco impeller. Shunt motor, 4 in./oz. torque. Base Mtg. Stock #SA-352. **Price $9.75 each.**

INSTRUMENT INVERTER

Pioneer Type 12128-1B Post War Model. Input 27.5 volts DC at 1 amp. Output 26 volts 400 cy. Single phase. P.F. 0.4. 6.0 VA. Stock #SA-295. **Price $39.50 each.**

SYNCHRO CAPACITORS

Production quantity requirements of the following Synchro "Exciter" Capacitors are available for immediate delivery.

Type 6C—connected 20-20-20 mfd.
Type 1C—Mk. 12—connected .6x.6x.6 mfd.
Type 3C—Mk. 1—connected 10x10x10 mfd.
Type 4C—Mk. 14—connected 3x3x3 mfd.

Quantity Quotations on Request

BLOWER ASSEMBLY

WESTINGHOUSE FL BLOWER

115 v. 400 cy. 17 c.f.m. Includes capacitor. Stock #SA-144. **Price $14.50 ea.**

Pioneer Servo Motor

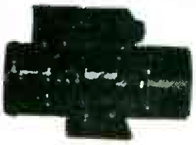
Type 10047-2A, 2 ϕ 400 cycle low inertia. 26 v fixed phase. 45 v. max. variable phase. Stock #SA-90. **Price $12.50 each.**

MOTOR GENERATOR SET

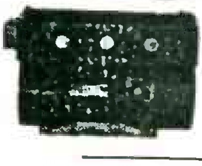
Navy Type CAJ-21989. For OBE-3 Underwater sound equipment. Mfd. by Holtzer Cabot. Motor—115 volts DC at 8.3 Amps. 0.75 hp. Generator—115 volts 60 cycles single phase, 4.0 Amps. 0.88 P.F. Self-excited. Cont. Duty. Stock #SA-505. **Price $195.00 each.**

INVERTERS

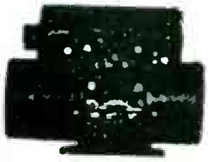
WinchargerPU-7/AP Input 28 VDC at 160 amps. Output 115 v. 400 cy. 1 ϕ at 2500 VA. Voltage and frequency, regulated. Cont. duty. Stock #SA-164.
Price $119.50 each.



G.E. 5AS131NJ3 (PE-118) Input 26 VDC at 100 amps. Output 115 v. 400 cy. 1 ϕ at 1500 VA. PF 0.8 W.E. Spec. KS-5601L1. Stock #SA-286. **Price $39.50 each.**



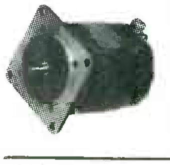
PE-218EInverters Russell Electric and Leland. Input 28 VDC at 92 amp. Output 115 v. 400 cycles at 1500 VA. PF 0.9. Stock #SA-112A. **Price $69.50 each.**



Pioneer 12130-4-B Input 28 VDC at 14 amps. Output 120 v. 400 cy. single phase at 1.15 amps. (140 VA.) Voltage and frequency regulated. Made 1949. Stock #SA-304. **Price $99.50 each.**

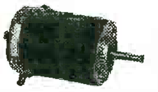
Leland SD-93—(10285)—Input 28 volts DC at 60 amps. Output 115 volts three phase 400 cycles at 750 va. 0.90 P.F. Second output voltage of 26 volts 400 cycles at 50 V.A. Voltage and frequency regulated. Designed for use with various autopilots. Stock #SA-209.

Price $99.50 each



DIEHL DC MOTOR

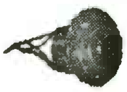
Type FDE-83-2. 24v @ 9.5 Amps. 1/6 hp. 6350 rpm. Cont. duty. Motor 4¼" diam. x 5" Lg. with 1" shaft ext. x ⅜" dia. front mtg. flange 4¼" Sq. Stock #SA-354. **Price $19.50 ea.**



DC MOTOR

John Oster Type A-16A-2B. 28 v. DC Shunt wound. 8000 rpm. 0.09 oz./in. torque. Large Qty. **Prices on request.**

PIONEER AUTOSYNS



Pioneer Bendix Types AY-1; AY-54; AY-14D; AY-14G and others.

Prices on request.

KOLLSMAN TELETORQUE

Kollsman Type 403 self synchronous units. (Synchro) 115 volt 60 cycle excitation. Use as either generator or repeater. Stock #SA-79.
Prices on request.

115 VOLT D-C MOTOR

G.E. Type SD. 1/20 hp. 4 lead shunt. Reversible. Double shaft extensions. Speed 1725 rpm. **Large Quantity.**

Special $19.50 each.

LEAR POSITIONING MOTOR

Model 156A. 115 watt 24 v. DC motor. 10,000 rpm. Int. duty. Reversible. Dual rt. angle output shaft. Release clutch. 7:1 reduction to output. 250:1 reduction to limit switches. **Stock #SA-343.**
Prices on request

MAGNETIC AMPLIFIER

Pioneer Type 12077

115 V. 400 cy. One Tube Servo Amplifier using saturable reactor type outlet transformer. Limited Quantity

SYNCHROS AND SELSYNS

Navy Types

A; M; 1SF; 5G; 5F; 5SDG; 5SG; 5SF; 5HSF 6DG; 7G, etc.

Army Types

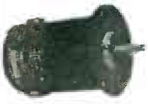
II; IV; V; VII; IX; XXI; XV; etc.

G.E. Types

2J6F2; 2JD5J2; 2J5A2; 2J5HA1; 2J1H1; 2J1F1; 2J1G1;2J1F3; 2JD5HB1; 2J5LA1. 2JD5C2, etc.

SERIES MOTOR

John Oster Type A-21D-7A



24 v. DC. 0.005 hp. .6 Amps. 11,000 rpm. Cont. duty. 1-½" diam. x 2-½" lg. Front flange mtg. Shaft 3/16 dia. x ⅝" ext. Stock #SA-353. **Price $8.75 each.**

WRITE FOR LISTING
Prices F.O.B. Paterson
Phone ARmory 4-3366

Servo-Tek products co.
4 Godwin Ave. Paterson, N. J.

SPECIALISTS IN FRACTIONAL HORSE POWER MOTOR SPEED CONTROL

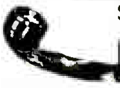
Reliance Specials

GEAR ASSORTMENT

100 small assorted gears. Most are stainless steel or brass. Experimenter's dream! ....Only $6.50

VERNIER DIAL or DRUM (From BC-221)

Dial—2⅝" dia. 0-100 in 360° Black with silver marks. Has thumblock. **DRUM**—0-50 in 180°. Black with silver marks .... either 85¢



SOUND POWER HANDSET

BRAND NEW

Includes 6 ft. cord.—Uses no batteries or external power source. $18.50 pr

AC LINE CORDS 6 ft. long with molded plug......16¢

BALL BEARINGS

Mfg. No.	ID	OD	Thick.	Price
MRC5028-1	5 1/2	6 1/2	1	$3.75
MRC7026-1	5 5/64	6 15/64	9/16	3.50
MRC7021 200	4 1/8	5 9/32	23/64	2.95
MRC106M2	1 17/64	2 7/16	25/64	1.75
MRC106M1	1 13/64	2 7/16	25/64	1.60
Federal LS11...	1 1/8	2 1/2	5/8	1.75
Norma S11R	1 1/8	2 1/8	5/8	1.70
Federal AS41...	1 1/16	1 1/2	9/32	1.50
Schatz	3/4	1 3/4	9/16	1.00
Norma 203S	5/8	1 9/16	7/16	.90
ND5202-C13M	1/2	1 3/8	1 3/8	1.00
ND 3200	25/64	15/32	11/32	.60
ND R6	3/8	7/8	7/32	.40
MRC39R1	11/32	1 1/32	5/16	.45
MRC38R3	8/16	55/64	13/32	.45

NEEDLE BEARINGS

TORRINGTON B108 ½" wide ⅝" 13'16"......30¢

Brand New Meters—Guaranteed

0-10 ma D.C. 3½"..$3.95 0-80 Amp. D.C. 2½"..$2.50
0-1 Ma. D.C. 3½" DeJur..(Scale Reads 0-4 KV)..$5.75

SELENIUM RECTIFIERS

Full Wave 200 MA 115V..........................$1.79
Half Wave 100 MA 115V.......................... .91

TIMING MOTOR

8 RPM 115V 60 cyc
E. Ingraham Co.

$1.79

400 CYCLE INVERTERS

Leeland Electric Co.

#10890 in: 20-28 V.D.C., 92 A. 8000 R.P.M. Out: 115V. 400 Cyc. 1 phase, 1500 V.A. 90 PF.................$24.95

3 AG FUSES

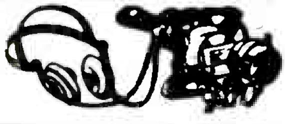
Amp.	Per 100	Amp.	Per 100	Amp.	Per 100
1/8	$4.00	3/4	$4.00	8	$3.00
3/8	4.00	1	3.00	10	3.00
1/2	4.00	4	3.00	15	3.00
		5	3.00		

3 AG FUSE HOLDERS (Finger) 25¢

DELAY NETWORK—ALL 1400Ω

T 114—Approx. 2.2 micro sec. delay.............. } 95¢
T 115 Similar to T 114 with tap brought out } each

Sound Powered
Chest Set RCA—
With 24 Ft. Cord
Per Pair
USED $17.60
NEW $26.40



POSTAGE STAMP MICAS

mmf	mmf	mmf	mmf	mmf	mmf	mmf	mfd	mfd
10	40	70	125	240	400	680	.0016	.004
20	43	75	135	250	430	800	.002	.006
22	47	80	150	270	470	820	.0027	.0065
23	50	82	160	300	500	910	.0033	.0068
24	51	90	175	330	510	.001	.0035	.0082
25	56	100	180	360	580	.0012	.0036	.01
33	60	110	200	370	600	.0013		
39	62	120	220	390	650	.0015		

Price Schedule

10 mmf to 820 mmf.................................... 5¢
.001 mmf to .0016.................................... 8¢
.002 mfd to .0082 mfd................................ 15¢
.01 mfd.. 28¢

SILVER MICAS

mmf	mmf	mmf	mmf	mmf	mmf	mfd	mfd	mfd
10	40	75	135	250	410	680	.0022	.0039
18	50	82	150	255	430	700	.0023	.004
22	51	100	155	260	470	.0011	.0024	.005
23	56	110	170	270	500	.0013	.0025	.0051
24	60	115	180	360	510	.0015	.0027	.0056
27	62	120	208	370	525	.0016	.0028	.006
30	66	125	225	390	560	.0018	.003	.0068
39	68	130	240	400	570	.002	.0033	.0082

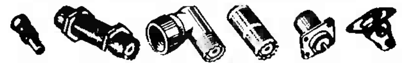
Price Schedule

10 mmf to 700 mfd .... 10¢
.0011 mfd to .002 mfd............................... 20¢
.0022 mfd to .0082 mfd.............................. 50¢

PULSE TRANSFORMERS

UTAH—9262 9278 9280 9340
WESTERN ELECTRIC—D166173 D161310
KS8696, KS9565, KS9800, KS9862, KS13161
GENERAL ELECTRIC—K2729A 80-G-5
JEFFERSON ELECTRIC—C-12A-1318
DINION COIL—TR 1048 TR1049
also 352-7250-2A; 352-7251-2A; T-1229621-60

COAXIAL CABLE CONNECTORS



15¢	$1.20	30¢	75¢	40¢	12¢
UG175/U	83-1F	83-1AP	83-1J	SO-239	HOOD

83-1AC	$0.42	UG-22/U	1.30	UG-106/U	.12
83-1AP	.30	UG-22A/U	1.60	UG-167/U	5.70
83-1F	1.20	UG-23/U	1.20	UG-175/U	.15
83-1H	.12	UG-23B/U	1.90	UG-176/U	.15
83-1HP	.25	UG-23G/U	1.90	UG-185/U	1.35
83-1J	.75	UG-24/U	1.30	UG-224/U	1.20
83-1R	.40	UG-25/U	1.35	UG-255/U	2.45
83-1RTY	.65	UG-27/U	1.30	UG-260/U	1.20
83-1SP	.50	UG-27B/U	3.45	UG-261/U	1.20
83-1SPN	.55	UG-28A/U	3.75	UG-274/U	2.75
83-1T	1.30	UG-30/U	2.30	UG-290/U	1.20
83-2AP	1.95	UG-57B/U	2.30	UG-306/U	2.95
83-2J	2.10	UG-58/U	.80	UG-499/U	1.25
83-2R	1.70	UG-58A/U	1.15	UG-625/U	1.35
83-22AP	1.40	UG-59A/U	2.25	CW-123A/U	.50
83-22R	.68	UG-85/U	1.75	M-358	1.30
83-22SP	.90	UG-87/U	1.60	M-359	.30
83-168	.15	UG-88/U	1.10	PL-258	.75
83-185	.15	UG-89/U	1.35	PL-259	.50
UG-13/U	1.70	UG-102/U	.90	PL-259A	.55
UG-21/U	.95	UG-103/U	.68	PL-274	1.20
UG-21B/U	1.35	UG-104/U	1.40	SO-239	.40

NEW COAXIAL CABLES

	Price per 1000 Ft.		Price per 1,000 Ft.
RG 5/U*	$140.00	RG 22A/U	$285.00
RG 6/U	180.00	RG 24	675.00
RG 7*	85.00	RG 26/U	475.00
RG 8*/U	100.00	RG 29*	50.00
RG 9*/U	250.00	RG 34/U	300.00
RG 9A/U	275.00	RG 35	900.00
RG 10	240.00	RG 41*/U	295.00
RG 11*/U	100.00	RG 54A/U	97.00
RG 12	240.00	RG 55*	110.00
RG 13*/U	216.00	RG 57*/U	325.00
RG 17	650.00	RG 58*	60.00
RG 18/U	900.00	RG 58A/U*	65.00
RG 19	1250.00	RG 59*	55.00
RG 20/U	1450.00	RG 62*	75.00
RG 21	220.00	RG 77*	100.00
RG 22/U*	150.00		

Add 25% for orders less than 500 feet.
* No minimum order—others 250' minimum.

UNIVERSAL JOINT ALUMINUM

¼" hole x ½" O.D.
1⅛" long **85¢**

SPAGHETTI SLEEVING assortment—90 feet.....$1.00

TYPE "J" POTENTIOMETERS

100 S.S.*	1,500 1/4S.S.	15K 1/4	200K S.S.*
150 S.S.	2,000 1/4	25K S.S.	250K 5/8
300 S.S.*	2,500 S.S.	70K S.S.	250K S.S.*
400 S.S.	3,000 3/8	80K S.S.	500K S.S.*
500 S.S.	4,000 3/8	100K 7/16	1Meg S.S.
1,000 3/8	5,000 3/4*	100K S.S.*	
1,000 S.S.	10K 5/8	200K 5/8	

***Split Locking Bushing** **$1.50 EACH**

TYPE "JJ" POTENTIOMETERS

Ohms	Shaft	Ohms	Shaft	Ohms	Shaft
1000	S.S.	30K-10K	3/8"†	1 Meg.	1/2"
10K	5/16"	3K-90K	1/4"	1 Meg.	S.S.
15K	S.S.			1 Meg.	S.S.

SD—Screw Driver
*—Split Locking Bushing—
†—With Switch

PRICE—$2.00 EACH

JONES BARRIER STRIPS

2—140Y	$.17	3—141W	.27	9—141Y	.71
3—140¾W	.21	4—141W	.33	12—141	.64
6—140	.28	5—141	.29	3—142	.24
10—140W	.59	5—141¾W	.41	2—150	.43
10—140¾W	.59	7—141¾W	.56	3—150	.60
3—141¾W	.27	8—141¾W	.64		

TIME DELAY RELAY

Raytheon CPX 24166
1 Min. Delay. 115 V., 60 Cycle

2½ second recycling time spring return • Micro-switch contact, 10A • Holds ON as long as power is applied • Fully Cased •

ONLY $6.50

AN CONNECTORS
IMMEDIATE SERVICE
PHONE! WIRE! WRITE! YOUR NEEDS

OIL FILLED CONDENSERS

MFD	V.D.C.	Price	MFD	V.D.C.	Price
5 2	50	$0.35	.1-.1	2,000	1.30
6	400	.85	.1-.5	2,000	1.65
3 x 3	400	1.00	3	2,000	3.75
4	500	.85	8	2,000	7.95
4-4	500	1.30	3	4,000	7.95
8	500	1.35	.01	5,000	.95
1	600	.45	.01-.03	6,000	1.40
.5-.5	600	.40	.03-.03	6,000	1.50
2	600	.80	1	6,000	9.95
4	600	1.63	.02-.02	7,000	1.55
8	600	2.05	.02-.03	7,000	1.60
10	600	2.95	.1	7,000	1.95
4 x 3	600	1.75	.1-.1	7,000	2.25
8-8	600	1.79	.1	7,500	2.25
1	800	.60	.3-.3	7,500	4.50
1	1,000	.75	.075-.075	8,000	1.85
2	1,000	.95	.15-.15	8,000	2.95
3	1,000	1.70	.25	20,000	19.95
4	1,000	2.25			
6	1,000	2.75			
8	1,000	3.25			
1	1,500	1.45			
.02	2,000	.65			
.25	3,000	2.25			
1	3,600	3.95			
3 x .2	4,000	2.50			
2	4,000	6.95			

6 mfd
6.000
V.D.C.
G.E.
$2.75

PRECISION RESISTORS—¼ WATT—30¢

2	10.48	12.32	14.98	62.54	147.5	705
2.5	10.84	13.02	15.8	79.81	220.4	2,193
3 5	11.25	13.52	16.37	105 8	301.8	3.500
5	11.74	13.89		123.8	366.6	
6.68				125	414.3	59,148

PRECISION RESISTORS—½ WATT—35¢

.25	11.1	75	400	6,500	16,000	36,000
.334	13.15	87	723.1	7,000	16.700	37.000
.444	13.3	97.8	855	7,300	17.000	45.000
.502	15	125	970	7.500	19.860	47.000
.557	25	178	1,500	8,000	20.150	50.000
.627	44.73	179.5	2,500	8.500	21.300	56,000
.76	45	180	2,850	8.800	25.000	59.000
1.00	46	200	3,995	10.000	26.667	59.905
1.01	52	210	4.000	12.000	30.000	68,000
1.53	55.1	235	4,285	14.825	32.700	79.012
2.04	61	240	4.451	15.000	32.888	100,000
3.25	65	260	5.714	15.750	33.000	180,000
5.26	66.6	270	5.900	15.755	33.300	
5.89	69	290		15.810	35.888	
		298.3				

PRECISION RESISTORS—1 WATT—45¢

.1	2 58	15	60	425	7.000	55.000
.11	2 6	18	80	1,530	8.250	56.000
.2	2.66	28	125	2.215	9.000	65.000
.31	3.1	30	250	2.250	10.000	68.000
.861	3.39	38	270	2.550	12.000	70.000
1.01	4.29	45.5	312	3.300	50,000	84.000
1.166	5.21	54.25	420	5.221		95,000
2.55						

PRECISION RESISTORS—1 WATT—60¢

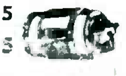
100,000	149.500	270.000	348.000	590.000
105,000	150.000	296.000	399.000	600.000
120,000	240,000	310.000	413.000	645.000
128.000	260,000	320,000	520.000	650.000
130.000			522.000	700.000
132.000				800.000

MEGOHM 1 WATT 1%—$1.50; 5%—60¢

PRECISION RESISTORS—2 WATT—75¢

4.385 5,000 6.000 10,000 19.917

DIFFERENTIAL Used $4.95
115 V., 60 Cyc.,
#C78249 **New $9.95**



3⅜" dia. x 5⅜" long
Used between two C7824's as a dampener. Can be converted to 3600 RPM Motor in 10 minutes. Conversion sheet supplied. (Converted)..........$5.50

Mounting Brackets — Bakelite for selsyns, and differentials shown above......................35¢ pair

OIL FILLED A.C. CONDENSERS

MFD	V.A.C.	Price	MFD	V.A.C.	Price
2	750	$0.69	15	440	6.25
8	660	7.50	4.4	375	2.15
6	660	5.95	25	330	7.50
5	660	5.45	20	330	6.75
4	660	4.95	4	330	2.25
3	660	4.45	3	330	1.45
2.9	660	4.35	1.75	330	.85
2	660	3.95	20	220	4.95
1	660	2.95	7.5	220	2.00

1N34 Crystal Diode ....79¢

300 Twin Lead..............02½ per ft. $18.95 per M.

Dynamotor DM 33A ....$3.75 ea.

Chokes: 30 Hy. 80MA @...$1.29: 6HY, 80 MA @...79¢

Power Tap Switch—OHMITE (#312-5 Taps) non-shorting 25A 150 V. A.C..........................$3.95

Timer—Industrial Timer Corp. 15 min. on 15 min. off continuous 115 V. A. C. Fully cased Plugs into octal socket $6.50

BC 221 FREQUENCY METER......................$85.00

Mike Connector Amphenol 80-81 Interchangeable with Amphenol 80-M cad plated............................25¢

2J1G1 SELSYNS $9.50
400 CYCLE BRAND NEW

Minimum Orders $3.......All orders f.o.b. PHILA, PA.

RELIANCE MERCHANDIZING CO.

Arch St. Cor. Croskey Phila. 3, Pa. Telephone RIttenhouse 6-4927

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2.5 KVA Diehl Elec. Co. 120DC to 120AC, 60 cy., 1 Ph., Complete with Magnetic Controller, 2 Field Rheos and full set spare parts including spare armatures for generator and motor. New..$295.00

2 KVA O'Keefe and Merritt. 115DC to 120AC, 50 cy., 1 Ph. Export Crated. New............$195.00

MOTOR GENERATOR, TYPE CGU-2
Unit of U. S. Navy TCK-7 Transmitter
Motor: 2 H.P., 230 V.D.C., 10 amps.
Generator: 1800V. D.C., 0.4 A, 500V. D.C., 0.35A. 115 V. D.C., 1.5A, 12 V. D.C., 2A. 3480 R.P.M. Self excited. Brand new including spare armature $365.00

INVERTERS

Onan M-G.-215H. Navy type PU/13. Input 115/230, 60 cy., 1 Ph. Output: 115, 480 cy., 1 Ph., 12Kw and 26V DC at 4 amps. New............$295.00

Leland Elec. Co. PE206A. Input: 28DC at 38 Amps. Output: 80V. 800 cy. 1 Ph., 485VA. New..$22.50

G.E. J8169172. Input: 28DC. Output: 115, 400 cy., 1 Ph. 1.5KVA. New......................$32.50

G.E. 5AS131551IA. Model 218J. Input: 28DC. Output: 115, 400 cy., 1 Ph., 1.5KVA. Regulated. New $89.50

Holtzer-Cabot M.G. 164. Input: 440, 3 Ph., 60 cy., Output: 70V, 146 cy. 3 Ph., 0.140KVA. New $67.50

Eicor. 32DC to 110AC, 60 cy., 1 Ph. at 2.4 Amps. New $39.50

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Navy type CAJO-211444. Input: 105 to 130DC. Output: either 26DC at 20 amps. or 13DC at 40 amps. Radio filtered and complete with line switch New $89.50

Type PE94CM. For SCR-522. Brand new in overseas cases $19.50

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Edison 5AM31NJ18A. Input: 27VDC, 44 Amps. 8300RPM. Output: 60VDC at 8.8 Amps., 530 Watts. New $22.50

SMALL D.C. MOTORS

G.E. 5BA50LJ2A. Armature 27VDC at 8.3 Amps. Field 60VDC at 2.3A. RPM 4000, H.P. 0.5. New $27.50

Oster E-7-5. 27.5DC. 1/20HP, 3600RPM. Shunt Wound. New $9.50

Dumore Co. type ELBG. 24VDC. 40-1 gear ratio. For type B-4 Intervalometer. New..........$8.50

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Westinghouse. Type FL. 115V. 400 cy., 6,700 RPM. Airflow 17C.F.M. New $9.50

E.A.D. Type J50-CW—60 cycle—NEW......$15.50

SYNCHROS

Ford Inst. Co. Synchro Differential Generator. Mod. 3 Type 5SDG. 90/90V. 400 cy., Ord. Dr. 173020. New $22.50

Armor. Synchro Differential Generator. Type 6DG. New $60.00

Electrolux, Torque Motor. Power Drives MK10 Bu. of Ord. Dr. No. 499500. New...............$6.50

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Spun Magnesium dishes 17½" dia. 4" deep. Mounting brackets for elevation and azimuth control on rear. 1½ x 1⅝" opening in center for dipole. Brand new, per pair $12.50

SOUND POWERED CHEST SETS

U. S. Instrument Co. No. A-260 Combination headset and chest microphone. Brand new, including 20 ft. of rubber covered cable.........$17.50 each

W.E. Laboratory Headsets—Type 316 B, 600 ohms at 1000 C.P.S.
Brand new—Price per set.........................$6.50

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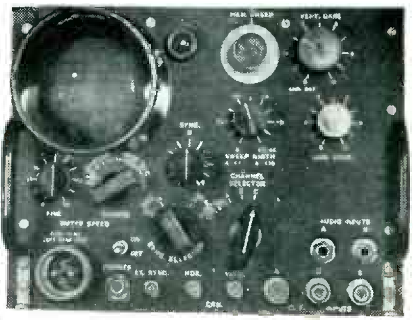
Struthers-Dunn 1BXX129, 110 A.C.	$2.60
Advance type 455C, SPDT, 115 A.C.	$1.95
Leach type 1154A, SPDT, 115 A.C.	$2.35
Leach type 1054, BSN 20-28V D.C.	$2.35
Clare Plug-in base No. 30FMX 115 A.C.	$3.50
G.E. Plug-in base Sensitive K27J853	$4.50
Western Electric D-163781 Plug-in	$10.00
Guardian Time Delay type B-9-SPDT	$2.95
Haydon Time Delay 17717 110V/60	$4.75

MODEL AN/APA-10 PANORAMIC ADAPTER



Provides 4 Types of Presentation:

(1) Panoramic (2) Aural
(3) Oscillographic (4) Oscilloscopic

Designed for use with receiving equipment AN/ARR-7, AN/ARR-5, AN/APR-4, SCR-587 or any receiver with I.F. of 455 kc. 5.2mc or 30mc.
With 21 tubes including 3" scope tube. Converted for operation on 115 V. 60 cycle source.
Price **$245.00**
Gov't Cost $1800.00.
AN/APA-10 80 Page Tech Manual..........$2.75

TEST EQUIPMENT

TS-127/U Lavoie Freq. Meter—375 to 725 MC.
TS-47APR Test Osc. 40-500MC.
TS-487/U Peak to Peak VTVM.
AN/APR-1 Receiving sets.
R111A/APR-5A Receiver—1000 to 6000 MC.
AN/APR-4 Tuning Units TN-17 (76-300 MC).
AN/APR-4 Tuning Units TN-18 (300-1000 MC).
AN/APR-4 Tuning Units TN-19 (950-2200 MC).
TU-58 Range "A" Tuning Units (110-370 MC).
AN/APA-10 Panoramic Adapters 115V/60 cycles.

Repair Parts for BC-348 (H, K, L, R only)

Also BC 224 Models F. K., Coils for ant., r.f., det., osc., I.F., c.w. osc., xtal filters, 4 gang cond., front panels, dial assemblies, vol. conts., etc. Write for complete list and free diagram.

HIGH QUALITY CRYSTAL UNITS

Western Electric—type CR-1A/AR in holders. ½" pin spacing. Ideal for net frequency operation. Available in quantities, 5910-6350-6370-6470-6510-6610-6670-6690-6940-7270-7350-7380-7390-7480-7580-9720. All fundamentals in KC. Good multipliers to higher frequencies ....$1.25 each

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Antenna-Trans-Rec. Unit ASG-1.
Radar Set SQ complete with spares.
Modulator type SO-11.
Pulse Timers CUZ-50AGD (SD-5 Radar).
Radar Crystal Units 98.35kc, Raytheon.
1N21B Sylvania Diodes.
Repeater Adapters CRM-50 AFO.
SO Series Accessory Control Panels.
SO Series Transmitter-Receiver unit.
CARD 23AEK Bearing Control Units for SO Series.
Auxiliary Rectifier.

RADAR ANTENNAS

Type SO-1 (10CM) assembly with reflector, waveguide nozzle, drive motor, etc. New.......$279.50

Type SO-3 (3 CM.) Surface Search type with reflector, drive motor, etc., but less plumbing. New in original cases $189.50

Type SO-13 (10CM.) Complete assembly with 24" dish, dipole, drive motor, gearing, etc. New $149.50

Also in stock — spare reflectors, nozzles, probes, right angle bends for SO-1 antennas.

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G.E. No. 6 RC89F16 for 54 cells 10 amps.
Mallory APS-20—In: 115/230/60/3. Out: 12/42V-65-130A.
Turret Trainer Supply. In: 220/60/3. Out: 28V-130A.
Complete specs. on request.

TERMS: Rated Concerns Net 30, FOB Bronxville, New York. All Merchandise Guaranteed. Prices Subject to Change

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AUTO. 400 cy. G.E. Cat. No. 80G184.
KVA .945S-.520P Volts 460/345/200/115. New $6.95

FILAMENT—400/2600 CPS. Input—0/75/80/85/105/115/125V. Output—5V3A/5V3A/5V6A/6.3V 0.5A. No. 7249010—New $3.95

PLATE WECO KS 9560 800 cy. Pri: 115V, Sec: 1350-0-1350 at .057A (2700 V. Total). Elecstat shlded. Wt. 2.3 lbs. New.....................$2.95

Plate, Thordarson #T46889. 1650 VA. Pri: 105-120V. 500 cy. 1 PH. Sec: 5600V. Center tapped. 1.5KV. insulation. Brand new $49.50

PLATE & FIL. WECO KS9555, 400 cy. Pri: 115V. Sec. #1: 930-0-930. Sec. #2: Three 6.3V windings $4.95

FILAMENT. 400/2400 cps. WECO KS9553. Pri: 115V. Sec: 8.2V1.25A/6.35V1.5A Elecstat shlded. Wt. 0.5 lbs. New............................$2.95

PLATE & FIL. 400/2600 cy Pri: 0/80/115V. Sec: #1=1200VDC at 1.5MA. Sec. #2=400 VDC at 130MA. Fil. Secs: 6.4V4.3A/6.35VO.8A (ins. 1500V)/5V2A/5V2A $4.95

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High Voltage Trans. Westinghouse Pri: 115. 60 cy. Sec: 15,000 C.T., 60 MA. Good for Hi-Pot test set up. C. T. ungrounded......................$39.50

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PULSE WECO KS-9563 Supplies voltage peaks of 3500 from 807 tube. Tested at 2000 Pulses/sec and 5000 peak. Wdg. 1-2=18 ohms. Wdg. 1.3=72 ohms. L of Wdg. 1.3=082H at 100 cps......$7.50

PULSE. WECO KS-161310. 50 KC to 4MC, 1¾" Dia. x 1⅞" high, 120 to 2350 ohms. New....$6.75

High Reactance Trans. G.E. type Y-3502A.—60 cy., Voltage 11200-135. Inductance H.V. Winding 135 Henries. Output: Peak Voltage 22.8KV. Cat. 8318065G1. New $89.50

RAYTHEON VOLTAGE REGULATORS

Adj. input taps 95-130V., 60 cy. 1 Ph. Output: 115V. 60 Watts. ½ of 1% Reg. Wt. 20 lbs. 6½" H x 8¼" L x 4⅝" W. Overload protected. Sturdily constructed. Tropicalized. Special $16.75

AMPLIFIERS

GE Servo type 2CV1C1 400 cycle
Constant Output Line RC-730C
Synchro Amplifiers for Radar
Intercommunication type BC-605

ANTENNAS

MR-162 Coast Guard 23½ ft. whips
AS-33 APT-2, AT-38A/APT, AS-62/APS-13
AS-125/APR for APR-5A
TDY RADAR JAMMER HORNS
PARABOLOIDS, MAGNESIUM DISHES 17½" dia.
SCR-623-A (part of RC-153-B Antenna)
CU 64/APT Antenna matching unit 50 ohm unbal. to 100 bal.

POTENTIOMETERS

W.E. KS-15138 Linear Sawtooth
W.E. KS-8732 for SCR547 Radar
W.E. KS-8801 Motor Driven

LINEAR SAWTOOTH POTENTIOMETER

W.E. KS-15138

Has continuous resistance winding to which 24 volts D.C. is fed to two fixed taps 180° apart. Two rotating brushes 180° apart take off linear sawtooth wave voltage at output. **Brand New...$5.50**

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Cathode Ray Shields for 3" tube	$3.75
Variac type Motor Controls 600 watt	$13.50
10 CM Waveguide 90° elbow	$20.00
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Shock Mounts U. S. Rubber #5150C	$.30
Commando Pole Jacks (Cook Elec. Co.)	$1.00
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Switch Arkless 16 sec. Rotary	$7.50
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Switch Micro R-RL2T	$.65
Switch Navy Rotary #647491	$17.50
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.25 Mfd., 15KV	$22.50
1 Mfd., 15KV	$44.50
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2 Mfd., 6.0KVA	$14.50

50 KV Capacitors also available various sizes. Write for list.

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ID-24/ARN-9	$12.50
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ID-60/APA-10 Panoramic Adapter converted for 60 cycle operation—complete with tubes and 80 page Tech. Manual	$245.00

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278A
304TL
368AS
3E29
534A
6C21
718BY
724B
725A
780A
803
811
826
832A
837

838
860
872A
874
1616
1619
1626
1629
8025
3BP1
5BP1
5BP4
5CP4
5FP4

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OIL FILLED CONDENSERS

.045 MFD 16,000 Volt Vitamin "Q". One Ceramic Insulated Screw Terminal 1¾" x 3½" x 4¾" High Can.

Stock No. 5399A. PRICE EACH **$4.95**

2x. 15mfd 8000 VDC Two Ceramic Ins. Terms. 1¾ x 3½ x 4¾ High Can.

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G.E. NO. 26F405 CERAMIC

Insulator Screw Terminals. 4" x 2¼" x 4⅛" high.

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AEVX' Type 4009. Ceramic insulator screw terminals.

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CERAMIC INSULATOR SCREW TERMINALS

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CERAMIC INSULATOR SCREW TERMINALS

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T-46 Chestset
BC-602 Control Boxes
BD-72 Switchboards
BD-67 Switchboards
J-5 Flameproof Keys
J-38 Keys
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Guardian BK-17A Relay
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MP-48A Mast Bases
DU-1 Direction Finder
RT-7/APN-1—With Access

PRICES ON REQUEST

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DM-35, DM-32 less base, PU-7/AP Motor Generator, PE-125AX

OSTER B9-2 12VDC 1.4A. 5600 RPM

OSTER C-2H-1A 27.5VDC 1/100 HP 7000 RPM

KOLLSMAN Type 775-01 MO-26

WESTINGHOUSE Type FL 115 Volt 400 Cycle Blower 6700 RPM

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2C6191/T3
2C6191A/3
2C619F/T2
2C6230/123
2C6230.3/124
2C6307/AK1
2C6386A/T14
2C6494A/C11
2C6530-653A/C10
2C653-653A/T5
2Z3625-66
2Z5731-337
2Z9600.3
2Z9604.16
2Z9608.36
2Z9611.115
2Z9611-289
2Z9612.52
2Z9613.14
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2Z9879
2Z9879-2
2Z9879-3
2Z9900-5
2Z9931B
2Z9944
2Z9984
3C106B
3C307-1

3C307-46
3C317.33
3C317-43
3C317-44
3C323-6C
3C323-14A
3C323-54B
3C323-122B
3C323-145B
3C324-4
3C324-40
3C343-2
3C344
3C344-9
3C362-8
3C375-15
3C549
3C573
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3C362-24
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3C4075
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Permoflux 10" PM Speaker with 2.15 oz. Magnet. Packed 18 to a carton.

Stock No. 5335A Price Each **$3.00**

Carton Lot $50.00

2 VOLT BATTERY

Signal Corps Type BB-54A 2 Volt 27 Ampere Hour Storage Battery. Non-Spillable Transparent Acid Proof Plastic Case has Built-in Ball Type Hydrometers. 3" x 4" x 5" High. Shipped Dry with Acid in Separate Container. Made by Willard.

Carton of 12 @ $1.60 Each

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ELECTRO-VOICE—602 DIFFERENTIAL DYNAMIC MICROPHONE

A close talking, noise-cancelling Speech Microphone. 150 Ohm Impedance Dynamic Unit comes complete with press-to-talk switch and 5 Ft. Shielded Four Conductor Cable. Brand New. Individually boxed.

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Stock No.	Cap.	Test Volts	Type No.	Price Each
5493A*	.01	1000	1445	.35¢
5494A	.02	1000	144T	.40¢
5495A	.006	1200	A2	.40¢
5496A	.001	1500	BE 15	.20¢
5493A	.004	2500	4	.30¢
5499A	.001	5000	F	.60¢
5600A	.0036	5000	A2	$1.00
5601A	.15	1000V	XS	1.90
5602A	.00007	2500V	3	.90¢
5603A	.00005	3000V	15L	1.00
5604A	.0001	5000V	F2L	1.00
5605A	.0008	5000V	F21	1.00
5606A	.000025	10.000	PL-34L	1.95
5607A**	.00015	10,000	PL-315	7.95

*Supplied with Meter Bracket
**D.C. Working Voltage
OTHER TYPES AND SIZES AVAILABLE

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Signal Corps Type J-38 Keys.

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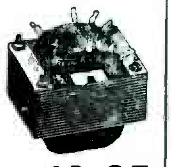
6.3 VOLT FILAMENT TRANSFORMERS

Primary 115 Volt 60 Cycle 1600 Insulation Three 6.4 Volt Secondaries

6.3 Volts @ 4.9 Amps.
6.3 Volts @ 4.5 Amps.
6.3 Volts @ 1.1 Amps.

Stock No.
5254A

Horizontal Half Shell Mounting. 2¼" x 2 13/16" Mounting Centers. 2 13/16" x 3⅜" Core Size. 2½" above Chassis. Solder Lug Terminals—All Terminals Marked.



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Open Account to rated or acceptable reference accounts. Others Pre-payment of 25% deposit with order, balance C.O.D. Price F.O.B. Chicago and subject to change without notice. Merchandise subject to prior sale.

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COMMUNICATIONS EQUIPMENT CO.

PULSE EQUIPMENT

MIT. MOD. 3 HARD TUBE PULSER. Output Pulse Power 144 KW (12 KV at 12 Amp.) Duty Ratio .001 max. Pulse duration: 5, 1.0, 2.0 microsec. Input voltage: 115 v 400 to 2400 cps. Uses: 1-715B, 4-829-B, 3-'72's, 1-'73. New $110.00

APQ-13 PULSE MODULATOR. Pulse Width .5 to 1.1 Micro Sec. Rep. rate 624 to 1348 Pps. Pk. Pwr. out 35 KW Energy 0.018 Joules $49.00

TPS-3 PULSE MODULATOR. Pk. power 50 amp. 24 KW (1200 KW pk): pulse rate 200 PPS. 1.5 microsec. pulse line impedance 50 ohms. Circuit series charging verson of DC Resonance type. Uses two 705-A's as rectifiers. 115 v. 400 cycle input. New with all tubes $49.50

APS-IC MODULATOR DECK. Complete, less tubes $75.00

PULSE NETWORKS

#755: 10KV, 2.2usec., 375 PPS, 50 ohms imp.... $27.50
#754: 10KV, 0.85usec., 750 PPS, 50 ohms imp... $27.50

15A—1-400-50: 15 KV, "A" CKT. 1 microsec. 400 PPS. 50 ohms imp. $37.50

G.E. #6E3-5-2000-50P2T, 6KV "E" circuit, 3 sections .5 microsecond, 2000 PPS 50 ohms impedance... $6.50

G.E. #3E (3-84-810) (8-2.24-405) 50P4T; 3KV "E" CKT Dual Unit; Unit 1, 3 sections. 0.84 Microsec. 810 PPS, 50 ohms imp.; Unit 2, 8 Sections, 2.24 microsec. 405 PPS. 50 ohms imp. $6.50

7.5E3-1-200-67P. 7.5 KV. "E" Circuit, 1 microsec 200 PPS, 67 ohms impedance 3 sections........ $7.50

7.5E4-16-60, 67P. 7.5 KV, "E" Circuit, 4 sections 16 microsec. 60 PPS. 67 ohms impedance........ $15.00

7.5E3-3-200-6FT, 7.5 KV, "E" Circuit, 3 microsec. 200 PPS, 6 ohms imp. 3 sections........ $12.50

DELAY LINES

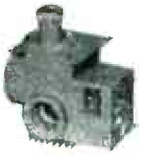
D-168184: .5 microsec. up to 2000 PPS 1800 ohm term $4.00

D-170499: 25/.50/.75 microsec. 8 KV 50 ohms imp. $16.50

D-165997: 1¼ microsec. $7.50

RCA 255686-502, 2.2μ sec. 1400 ohms........ $2.00

PULSE TRANFORMERS



U-10198 Pri: 4-5KV, 97A Pk Sec: 18KV, 26A, PRR-350-500 Cy. Duration 1.3 usec. $42.50

D-166173: Video. Ratio = 50:900 Ohms 10KC—2MC $12.50

G.E.K.-2745 As shown..... $39.50

G.E.K.-2744-A, 11.5 KV High voltage. 3.2 KV Low voltage @ 200 KW oper. (270 KW max.) 1 microsec. or 1/microsec. @ 600 PPS $39.50

W.E.-KS 9800 Input transformer. Winding ratio between terminals 3-5 and 1-2 is 1.1:1, and between terminals 6-7 and 1-2 is 2:1. Frequency range: 380-520 c.p.s. Permalloy core $6.00

W.E. D169271 Hi Volt input pulse Transformer.. $27.50

G.E. K2450A. Will receive 13KV, 4 micro-second pulse on pri. secondary delivers 14KV. Peak power out 100KW G. E. $34.50

G. E. K2748A. Pulse Input line to magnetron.... $36.00

Ray UX 7896—Pulse Output Pri. 5v, sec. 41v..... $7.50

Ray UX 8442—Pulse inversion—40v + 40v $7.50

Ray UX 7361 .... $5.00

PHILCO 352-7250, 352-7251, 352-7287.

UTAH 9332, 9278, 9341.

RAYTHEON: UX 8693, UX5986 .... $5 ea.

W.E.: D-166310, D-16638, KS 9800, KS9948

THERMISTORS VARISTORS

THERMISTORS		VARISTORS	
D167018	$1.50	D171812	$1.50
D167332	1.50	D172155	1.50
D167613	1.50	D167176	1.50
D166228	1.50	D168687	1.50
D164699	2.50	D167208E, D171858	1.50
D163903	1.95	308A, 3A, 27-B...	1.50
D166792	2.15	D168403	2.15

WANTED

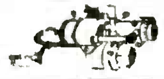
Any and all types of Radar and parts of Radar, also test sets or what have you to sell in surplus electronic parts.

MICROWAVE COMPONENTS

S BAND — 3" x 1½" WAVEGUIDE

CAVITY WAVEMETER, 2700–3400 MC. 3-Digit Counter Dial Mfg WE. Calib Chart $115.00

REACTION WAVEMETER, Mfg. G.E. 3000–3700 MC. Mic. Head $125.00



LHTR. LIGHTHOUSE ASSEMBLY, Part 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........ $49.50

BEACON LIGHTHOUSE cavity 10 cm. Mfg Bernat Rice, each .. $47.50

MAGNETRON TO WAVEGUIDE Coupler with 721A Duplexer Cavity, gold plated $45.00

RT-39/APG-5 10 cm. lighthouse RF head c/o Xmtr.-Recvr-TR cavity, compl recvr. & 30 MC IF strip using 6AK5 (2C40, 2C43, 1B27 lineup) w/Tubes.

721A TR BOX complete with tube and tuning plungers........ $12.50

McNALLY KLYSTRON CAVITIES for 707B or 2K28........ $4.00

TS 268 CRYSTAL CHECKER $50

F 29/SPR-2 FILTERS, type "N" input and output........ $12.50

WAVEGUIDE TO 7/8" RIGID COAX "DOORKNOB" ADAPTER CHOKE FLANGE, SILVER PLATED BROAD BAND........ $32.50

AN/APR5A 10 cm antenna equipment consisting of two 10 cm waveguide sections, each polarized, 45 degrees .... per set, $75.00

AS14A/AP-10 CM Pick up Dipole with "N" Cables........ $4.50

OAJ ECHO BOX, 10 CM, TUNABLE $22.50

HOMEDELL-TO-TYPE "N" Male Adapters. W.E. No. D167284... $2.75

I. F. AMP. STRIP: 30 MC, 120 d.b. gain. 2 MC Bandwidth uses 6AC7's—with video detector. Less tubes........ $24.50

POLYROD ANTENNA, AS31/APN-7in Lucite Ball. Type"N"feed. $22.50

ANTENNA, AT49A/APR: Broadband Conical, 300–3300 MC Type "N" Feed........ $12.50

"E" or "H" PLANE BENDS. 90 Deg. less flanges........ $7.50

RG 48/U WAVEGUIDE, 1-½" x 3" .... per ft., $4.65

⅞" RIGID COAX—⅛" I.C.

RIGHT ANGLE BEND, with flexible coax output pickup loop. $8.00

SHORT RIGHT ANGLE BEND, with pressurizing nipple........ $3.00

RIGID COAX to flex coax connector........ $3.50

STUB-SUPPORTED RIGID COAX, gold plated 5' lengths. Per length $5.00

RT. ANGLES for above........ $2.50

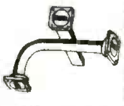
RT. ANGLE BEND 15" L. OA. $3.50

FLEXIBLE SECTION. 15" L. Male to female $4.25

7/8" RIGID COAX. BULKHEAD FEED-THRU. $14.00

X BAND — 1" x ½" WAVEGUIDE

CROSS-GUIDE COUPLER



MAIN SECTION, 7" LONG WITH 90 DEG. BEND (E-PLANE), 2-½" RADIUS. BROADBANDED. COUPLING FIGURE IS 20 DB. INDIVIDUALLY CALIBRATED $22.50

1" x 1/2" waveguide in 5' lengths, UG 39 flange to UG40 cover .... per length $7.50

Rotating joints supplied either with or without deck mounting. With UG40 flanges .... each, $17.50

2J42 Magnetron Pulse Modulator, 14kw max. rating 7kw min. Plate voltage pulsed 5 kv. 6.5 Amp .001 duty cycle. 2.5 usec pulse length max. filament 6.3V .5 Amp. Includes magnetron mtg. and blower. Requires 3C45 and 2-3B24 New........ $75.00

Bulkhead Feed-thru Assembly $15.00

Pressure Gauge Section 15 lb. gauge and press nipple........ $10.00

Pressure Gauge, 15 lbs $2.50

DUAL Oscillator-Beacon Mount. P/O APS 10 Radar for mounting two 723A/B klystron with crystal mts. matching slugs, shields $42.50

Dual Oscillator, Mount. (Back to back) with crystal mount, tunable termination attenuating slugs........ $18.50

Directional Coupler, UG-40/U Take off 20 db........ $17.50

2K25/723 AB Receiver local oscillator Klystron Mount. complete with crystal mount. Iris coupling and choke coupling to TR........ $22.50

TR-ATR Duplexor section for above........ $8.50

723AB Mixer Beacon dual Osc. Mnt. w/xtal holder $12.00

Waveguide Section 12" long choke to cover 45 deg. twist & 2 1/2" radius, 90 deg. bend........ $4.50

Twist 90 deg. 5" choke to cover w/pres nipple........ $6.50

Waveguide Sections 2 1/2 ft. long silver plated with choke flange.. $5.75

Rotary Joint choke to choke with deck mounting........ $17.50

3cm. mitered elbow "E" plane........ $12.00

UG 39 Flanges .... $ .85

90 degree elbows, "E" or "H" plane 2 1/2" radius........ $12.50

90 degree twist 6" long $8.00

45 degree twist $8.00

APS-4 Under Belly Assembly, less tubes and less covers........ $375.00

1¼" x ⅝" WAVEGUIDE

CG 98B/APQ 13 12" Flex. Sect. 1 1/4" x 5/8" OD........ $10.00

X Band Wave GD. 1 1/4" x 5/8" O.D. 1/16" wall aluminum per ft. 75c

Slug Tuner Attenuator W. E. guide. Gold plated........ $6.50

BI/Directional Coupler. Type "N" Takeoff 25 db. coupling........ $27.95

BI/Directional Coupler, UG-52. Takeoff 25 db. coupling........ $24.95

Waveguide-to-Type "N" Adaptor, Broadband........ $22.50

K BAND — ½" x ¼" WAVEGUIDE

APS-34 Rotating joint $49.50

Right Angle Bend E or H Plane, specify combination of couplings desired........ $12.00

45° Bend E or H Plane, choke to cover........ $12.00

Mitered Elbow, cover to cover........ $4.00

TR-ATR-Section. Choke to cover........ $4.00

Flexible Section 1" choke to choke........ $5.00

"S" Curve Choke to cover........ $4.50

Adapter, round to square cover........ $5.00

Feedback to Parabola Horn with pressurized window........ $27.50

90° twist $10.00

Immediate Delivery

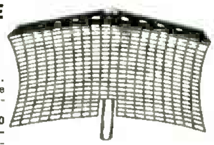
RADAR TRAINER

Bench set designed for training personnel in use of ASB radars, or any sets using "B" presentation. Simulates convoy, ship, land, sea return with adjustable amplitude, range, and azimuth. Brand new, in original cases, complete with all cables and instruction book. Prices and additional info on request

RADARS

● AN/APS-2	Airborne S Band Radar
AN/APS-3	Airborne 3CM Radar
AN/APS-4	3CM Airborne Radar
● RU/GF	Complete Airborne Xmtr-Revr $99.50
● SO-1	1CCM SEA Radar, 115VDC
● SN	1CCM Portable Radar, 115V, 60Cy.
● PP-4/APQ-2	DC Power Supply from 400 Cy. 65.00
● MK 10	10CM Gun Laying Radar
MK IV	800MC Gun Laying Radar
● SO-8	10CM Radar 115V DC
● CPN-8	10CM NAV. Beacon, Ground Sta.
● SG	10CM Heavy Duty Ship Radar
● SO-7	10CM Radar Truck Portable 115VAC
● AN/APN-4	Loran Set, Airborne
● AN/APN-3	Shoran, Xmtr only
● SE	10 cm Surface Search Radar
● RA-30	H.V.P. Power Supply
● AN/APN-7	Airborne Beacon, 10CM.
● BM or BG	IFF Sets, 115VAC

MICROWAVE ANTENNA EQUIPMENT



AS-31/APN-7: 10 cm. Polyrod in Lucite Ball. Type N Fitting Coax Feed $22.50

Relay System Parabolic Reflectors approx range 2000 to 6000 Mc. Dimensions 4 1/2' x 3'. New (As Shown) $100.00

Dipole for above........ $12.00

TDY "JAM" Radar rotating antenna, 10 cm. 30 deg. beam, 115 V AC drive New........ $150.00

10 CM Horn, Rectangular-to square-to circular RF assembly ending in horn, radiating circularly polarized beam. Waveguide input. Complete with flange........ $50.00

Parabolic Peel. Radiation pattern approx. 25 deg. in horizontal, 33 deg. in vertical planes........ $35.00

Cone Antenna. AS 125 APR. 1000–3200 mc. Stub supported with type "N" connector.... $14.50

140-600 mc Directional Antenna

140-310 mc cone and 300-600 mc cone, each consisting of 2 end fed half wave conical sections with enclosed matching stub for reactance changes with changing frequency.

New: complete with mast, guys, cables, carrying chest.... $49.50

30' SIGNAL CORPS RADIO MASTS

Complete set for erection of a full flat top antenna. Of rugged plymold construction telescoping into 3 ten-foot sections for easy stowage and transportation. A perfect set-up for getting out. Supplied complete: 2 complete masts, hardware, shipping crate. Shipping wt. approx. 300 lbs. Sig. Corps No. 2A283-223-A. New.. **$39.50 per set**

AS14A/AP, 10 CM pick up dipole assy. complete w/length of coax and "N" connectors........ $3.50

AS46A/APG-4 Yagi Antenna, 5 element array.. $22.50

30" Parabolic Reflector Spun Aluminum dish... $4.85

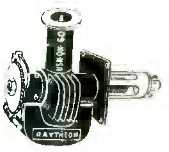
AT49A/APR—Broadband Conical, 300–3300 MC. Type N Feed........ $12.50

TEST SETS

● Signal Gen.	RCA 710A, 370-560 MC..... 350.00
● Signal Gen.	Type 605 CS, 9.5KC-50 MC 385.00
● Signal Gen.	20A Microvolter.... 175.00
● TS 10A	Altimeter Test Set 32.50
● TS 16/AP	Altimeter Test Set
● TS 36	Power Meter, 3 CM
● TS 47/APR	Test Osc. 50-3000 MC..... 325.00
● TS 56/AP	Slotted Line, 500 MC 325.00
● TS 127/UP	Wavemeter, 300-700 MC...... 72.50
● TS 69/AP	Wavemeter, 340-1000 MC..... 72.50

MAGNETRONS

Tube	Tube	Tube
2J27	2J49	720BY
2J31	2J61	725-A
2J21	700	730-A
2J22	706	QK 62
2J26	2J62	QK 61
2J32	3J31	QK 60
2J38	5J30	
2J39	718DY	



MAIL ORDERS PROMPTLY FILLED. ALL PRICES F.O.B. NEW YORK CITY. SEND M.O. OR CHECK. ONLY SHIPPING SENT C.O.D. RATED CONCERNS SEND P.O. ALL MDSE. SUBJECT TO PRIOR SALE, AND PRICES SUBJECT TO CHANGE WITHOUT NOTICE. PARCELS IN EXCESS OF 20 POUNDS WILL BE SHIPPED VIA CHEAPEST TRUCK & RAILEX.

131 Liberty St., New York 7, N. Y. Dept E Chas. Rosen Phone: Digby 9-4124

COMMUNICATIONS EQUIPMENT CO.

DYNAMOTORS

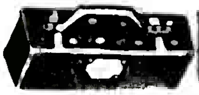
Type	Input Volts	Input Amps	Output Volts	Output Amps	Radio Set
PE86	28	1.25	250	.060	RC 36
DM416	14	6.2	330	.170	RU 19
DM33A	28	7	540	.250	BC 456
PE101C	13/26	12.6	400	.135	SCR 515
		6.3	800	.020	
BD AR 93	28	3.25	375	.150	
23350	27	1.75	285	.075	APN-1
ZA0515	12/24	4/2	500	.050	
B-19 pack	12	9.4	275	.110	MARK 11
			500	.050	
D-104	12		225	.100	
			440	.200	
DA-3A	28	10	300	.060	SCR 522
			150	.010	
			14.5	.5	
5053	28	1.4	250	.060	APN-1
PE73CM	28	19	1000	.350	BC 375
CW21AAX	13	12.6	400	.135	
	26	6.3	800	.020	
			9	1.12	
PE94	28	10	300	.200	SCR 522
			150	.101	
			14.5	.5	

INVERTERS

PE-218-H: Input: 25 28 vdc, 92 amp. Output: 115 v. 350 500 cy 1500 volt-amperes. New $44.50

PE-206: Input: 28 vdc, 38 amps. Output: 80 v 800-cy. 500 volt-amps. Dim: 13"x5 ½"x10 ½". New $22.50

LELAND No. 10536: IN: 28 VDC, 12A. OUT: 115V, 115VA, 400 CY 3 PHASE. EXC. COND $70.00



SELENIUM RECTIFIERS

RU/GF COIL SETS SINGLE BAND RCVR UNITS

BAND	FREQUENCY
L	400– 600 KC
C	545– 850 KC
D	850– 1330 KC
E	1330– 2040 KC
F	2040– 3000 KC
G	3000– 4525 KC
H	4000– 6000 KC
M	5200– 7700 KC
N	6000– 9050 KC
K	9050–13 375 KC

PRICE: $1.50 EACH

RCVR. DUAL BAND COILS

400-600 KC 6000-9050 KC
540-830 KC 5200-7700 KC
195-290 KC 290- 435 KC
540-830 KC 540- 830 KC

PRICE: $2.25 EACH

RU/GF XMTR COIL SETS

2000–2500 KC
3000–3675 KC
3675–4525 KC
6000-7350 KC
7350-9050 KC

PRICE: $1.79 each

ACCESSORIES

REMOTE TUNING BOX TYPE. CW-23012	$1.75
XMTR. CONTROL BOX, CW 23097	1.69
RCVR. SWITCH BOX, CW-23096A.	1.75
28V DYNAMOTOR & FILTER BOX FOR RU.	8.95

COMPLETE RU/GF SET, WITH ALL PLUGS MOUNTINGS XMTR RCVR., TUNING UNITS DYNAMOTOR; INSTRUCTION BOOK—READY TO GO—ALL BRAND, SPANKING NEW $97.50

F. W. BRIDGE

UP TO 18 VAC IN— UP TO 14 VDC OUT

2A	$2.50
4A	4.00
6A	6.00
10A	7.50
12A	9.00
24A	18.00

UP TO 36 VAC IN— UP TO 28 VDC OUT

1A	$3.00
2A	4.00
5A	10.00
10A	14.50
12A	18.00
24A	36.00

UP TO 54 VAC IN— UP TO 42 VDC OUT

2A	$6.50
4A	8.50

UP TO 120 VAC IN— UP TO 100 VDC OUT

2A	$11.00
10A	48.00
12A	60.00

Special Rectifiers On Request

Hi-Current Chokes

.1 HY—12 Amp—0.46 Ohms	$14.95
.01 HY—2.5 Amp—Cased	$2.25

LO-VOLT. XFMRS Primaries 115v, 60 Cycle

8v-1.5A	$0.98
16v–5A	3.75
20v/10A	3.95

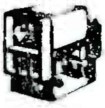
HI CAP. FILTER CONDENSERS

Cap.	WVDC	Price
2000	6	$1.85
500	200	2.00
1000	35	2.45
500	15	1.25

FILTER CHOKES

Stock	Description	Price
CH-917	10H/450 MA—10KV	$12.95
CH-366	20H/.3A	6.95
CH-322	.35H/350 MA—10 Ohms DCR	2.75
CH-141	Dual 7H/7[illegible] MA, 11H/60 MA 5KV DC Test	4.69
CH-119	8.5H/125 MA	2.79
CH-69-1	Dual: 12[illegible]H/1[illegible] MA	2.35
CH-8-28	2 x .5H/380 MA/25 Ohms	1.79
CH-776	1.28H/1[illegible]0 MA/[illegible]5 ohms	2.25
CH-344	1.5H/145MA/1200V Test	2.35
CH-43A	10HY/15MA—850 ohms DCR	1.75
CH-917	10H, 450MA, 10KV TEST	12.95
CH-366	20H/300MA	6.955
CH-999	15HY/15MA—400 ohms DCR	1.95
CH-511	6H/80MA 310 ohms DCR	2.45
CH3-501	2x5H/400MA	2.79
CH 188M	5HY 200MA	1.79
CH 303	300H/.02A, 2500V Test	1.69
CH 932	SWING 9-60H/.4-.05A, 10KV	7.95

BC 605 INTERCOM



INTERPHONE AMPLIFIER

Easily converted to an ideal inter-Communications set for office, home, or factory. Original New w/conversion Diagram $4.75

POWER TRANSFORMERS

Comb. Transformers—115V/50-60 cps Input

CT75B	600-0-600V/.6A, 2X5VCT/6.2A, 6.3VCT/3A, 6.3V/.3A	$12.95
CTJ5-2	600VCT/.2A, 5V/6A	5.95
CT-15A	550VCT .085A 6.3V/.6A, 6.3V/1.8A	2.85
CT-164	4200V.002A/12KV Test, 5VCT/3A/12KV Test, 6.3V/0.6A/5400V Test	12.95
CT-341	1050 10 MA.—625V @ 5 MA, 26V @ 4.5A 2x2.5V/3A, 6.3V @ 3A	16.95
CR-825	360VCT .340A 6.3VCT/3.6, 6.3VCT/3A	3.95
CT-626	1500V .160A 2.5/12, 30/.100	9.95
CT-071	110V .200A 33/.200, 5V/10, 2.5/10	4.95
CT-367	580VCT .050 A 5VCT/3A	2.25
CT-99A	2x110VCT .010 A 6.3V/1A, 2.5VCT/7A	3.25
CT-403	350VCT .026 A 5V/3A	2.75
CT-931	585VCT .086 A 5V/3A, 6.3V/6A	4.25
CT-610	1250 .002 A 2.5V/2.1A, 2.5V/1.75A	4.95
CT-456	390VCT 30 MA 6.3V/1.3A, 5V/3A	3.45
CT-160	800VCT 100 MA 6.3V/1.2A, 5V/3A	4.95
CT-931	585VCT 86 MA 5V/3A, 6.3V/6A	4.95
CT-442	525VCT 75 MA 5V/2A, 10VCT/2A, 50V/200 MA	3.85
CT-720	550-0-550V/250 MA 6.3V/1.8A	8.95
CT-43A	600-0-600V/.08A, 2.5VCT/6A, 6.3VCT/1A	6.49
CT7-501	650VCT/200 MA, 6.3V/8A, 6.3V/5A	6.49
CT-444	230-0-230V/.085A, 5V/3A, 6V/2.5A	3.49

Filament Transformers—115V/50-60 cps input

Item	Rating	Each
FT-674	8.1V/1.5A	$1.10
FT-157	4V/16A, 2.5V/1.75A	2.95
FT-101	6V/.25A	.79
FT-924	5.25V/21A, 2x7.75V/6.5A	14.95
FT-824	2x26V/2.5A, 16V/1A, 7.2V/7[illegible] [illegible] 4V/10A, 6.4V/2A	8.95
FT-463	6.3VCT/1A, 5VCT/3A, 5VCT/3A	5.49
FT-55-2	7.2V/21.5A, 6.5V/6.85A, 5V/6A, 5V/3A	8.95
FT-986	16V @ 4.5A or 12V @ 4.5A	3.75
FT-38A	6.3/2.5A, 2x2.5V/7A	4.1[illegible]
FT-A27	2.5V/2.5A, 7V/7A, TAP 2.5V/2.5A, 16KV TEST	[illegible]
FT-608	6.3V/3A/750V Test	1.79
FT-873	4.5V/.5A, 7V/7A	2.19
FT-899	2x5V @ 5A, 29KV Test	24.50

Plate Trans.—115V, 60 cps

Item	Rating	Price
PT-446	185V3.5A	$4.59
PT-699	300/150V/.05A, 300/150V/.05A	2.79
PT-302	120-0-120V/350 MA	4.69
PT-108	17,600V/144 MA	120.00
PT-671	62V/3.5A	7.95

Special Fil. Transformers—60 cps

Item	Pri. Volts	Secondaries	Price
STF-370	220/440	3x2.5V/5A, 3KV Test 2.5V/15A	$6.95
STF-11A	220V	2x40V/.05A, 2x5V/6A 12.6V/1A	4.49
STF-608	220V	24V/0.6A, 5V/3A, 6.3V/1A, 6.3V/1A	3.45
STF-968	230V	2.5V/6.5A	3.50
STF-631	230V	2x5V/27A, 2x5V/9A	17.59

Special Plate Transformers—60 cps

Item	Pri. Volts	Secondaries	Price
STP-613	230V	230/.05A, 230V/.05A	$1.79
STP-409	220/440V	136VCT/3.5A	5.69
STP-815	240/440, 3ph	1310V/.67A, 6KV Test	27.50
STP-129	230V	3850V/3.12KVA	42.59
STP-823	137V	222VCT/.3A	2.35
STP-08B	50V	2x750V/.001A	1.79
STP-622	210/220/230	5000V/1A	59.75
STP-945	210/220/230	550-0-550V/.3A	5.95

Special Comb. Transformers—60 cps

Item	Pri. Volts	Secondaries	Price
STC-16A	220V	260V/.03A, 100V/1A, 6.3V/4.2A	$4.69
STC-609	220V	220V/3A	6.95
STC-047	200V	700V/80 MA, 110V/80 MA, 24V/80 MA, 6.3V/.3A, 6.3V/1A, 5V/3A, 5V/5A, 2.5V/5A	6.95
SCT-607	220V	350-0-350V/.075A, 40VCT/1.A, 15/10/15V@100 MA	4.79

AUDIO TRANSFORMERS

AT201 50L6 output (4000 ohms) to V.C. (3 ohms)	$.40
AT SUB Subouncer. Multimatch, 200 ohms to 15 K ohm C.T. and 100 K ohm Grids	$.69
AT731 H.F. Plate (1500 ohm C.T.) to V.C. (16/4 ohms) 20-15KC	$3.29
AT501 HI-FI Special: PRI: 3000 ohms P-P/Sec: 4/16/12/50/200 ohms 60-10,000 CY. - 1 db 50W	$3.49
AT152 HI-FI Driver Pri: 10,000 ohms Sec: 40,000 ohms PP Grids 50-15 KC/1 db	$1.49
AT062 Output to H.S. or line PRI: 14,200 ohms SEC: 8000/600 ohms	$1.10
AT449 HI-FI Driver (5000 ohms) to P.P. output grids (4,000 ohms) 100-10,000 CY, 10 W 6V6 to PP 805's	$2.39
AT666 Intercon Input: Spkr (-4-8 ohms) to grid (250-000 ohms)	$0.69
AT415 Plate (18,000 ohms C.T.) to line (125 ohms) 175 w.—500-600 CY	$1.95
AT858 Plate (10,000 ohms C.T.) to line (125 ohms) 125130 ohms) HI-FI 50 W	$6.95
AT070 Mike-or-Line (250 ohms) to grid (250,000 ohms C.T.	$1.20
AT765 Mike-or-Line (600 ohms to grid (50,000 ohms C.T.	$0.69
AT-694 HI-FI Output: 3 Watts. 8500 Ohms P-P to V.C. (15 Ohms 15-15KC PM 1 db	$1.49
AT4-AI: Mike (35 ohms Carbon) to Line 600 ohm/200 ohm	$1.19
AT 649: Line (500 ohms to Grid (75K ohms)	$0.89
AT-448: Line(600 ohms) to V.C.(6 ohms) 17 d.b. Level	$1.19
AT 631: Mike-or-Line (200 ohms) To Single or P-P Grids (50K Ohms	$0 59
AT 718 Line (300 ohms) to Line (600/30 Ohm) Response 50-20KC P.M. 1 db	$0.49

SCOPE TRANSFORMERS

PRI: 115V. 60 Cy., Sec. 3000V5 MA, 6.4V/8.7A, 6.4V/.6A, 5V/3A, 360-0-360V/200 MA, 1.25V/.3A $3.95

400 CYCLE TRANSFORMERS

(All Primaries 115V, 400 Cycles)

Stock	Ratings	Price
352-7039	640VCT @ 250MA, 6.3V/.9A, 6.3V/6A, 5V/6A	$5.49
702724	9800/8600V @ 32MA	8.95
12033	4540V/250MA	17.50
KS9584	5000V/290MA, 5V/10A	22.50
52J652	13.500V/3.5MA	14.65
KS9607	734VCT/.177A, 1710VCT/.177A	6.79
352-7273	700VCT/350MA, 6.3V/0.9A, 6.3V/2.5A, 6.3V/.06A, 5V/6A	6.95
352-7070	2X2.5V/2.5A (2KV TEST) 6.3V/2.25A, 1200/1000/750V @ .005A	[illegible] 7.45
352-7196	1140V/1.25MA, 2.5V/1.75A, 2.5V/1.75A 5KV Test	3.95
352-7176	320VCT/50MA, 4.5V/3A, 6.3VCT/20A, 2X6.3VCT/6A	4.75
RA6400-1	2.5V/1.75A, 6.3V/2A—5KV Test	2.39
901692	13V/9A	2.49
901699-501	2.77V @ 4.25A	3.45
901698-501	900V/75MA, 100V/.04A	4.29
UX8855C	900VCT/.067A, 5V/3A	3.79
RA6405-1	800VCT/65MA, 5VCT/3A	3.69
T-48852	700VCT/80MA, 5V/3A, 6V/1.75A	4.28
352-7098	2500V/6MA 300 VCT, 135MA	5.[illegible]5
KS 9336	1100V/50MA TAPPED 625V 2.5V/5A	3.95
M-7474319	6.3V/2.7A, 6.3V/.66A, 6.3VCT/21A	4.25
KS 8984	27V/4.3A, 6.3[illegible]9A, 1.25V/.02A	2.95
52C080	526VCT 50MA, 6.3VCT/2A, 5VCT/2A	3.75
32332	450VCT/35MA, 6.4V/2.5A, 6.4V/.15A	3.85
68G631	1150-0-1150V	2.75
80G198	6VCT 00006 KVA	1.75
202133A	6.3V/9.1A 6.3VCT/6.5A, 2.5V/3.5A, 2.5V/3.5A	4.85
KS [illegible]45	592VCT/118MA, 6.3V/8.1A, 5V/2A	5.39
KS [illegible]85	6.4 [illegible]5A, 6.4V/3.8A, 6.4V/2.5A ALL CT	4.79
[illegible]G3[illegible]1	600V[illegible]/36MA	2.65
M-74[illegible]318	2100V/.027A	4.95
95[illegible]G-4[illegible]	2000V/.002A, 465V/.6A, 44V/10A, 6.3V/23.5A, 6.3V/1.8A, 5V/9A, 2X2.5V/1.75A	17.9
TRANSTAT	IN: 115V, 400 CY. OUT: 75-120V, 6.0 Amps	12.95

POWER INVERTERS

115 VDC—116 VAC

Rated 500W int. and 350W Contin. All Brand New. Famous Mfr. .... $75.00 each

SPECIALS

GIBSON GIRL, Emerg. Xmtr. 500 kc	$42.95
BC 306 ANTENNA TUNING UNIT, NEW	$6.95
R9/APN-4, New, With Tubes	$75.00
1D6/APN-4, New, With Tubes and Crystal	$75.00
A-62 Phantom Antenna	$8.50
2 Meter Choke, 1000 MA, 20-144	8/$1.00
Supersonic Crystal Head, M-1, 22-27KC HI-2	$27.45
Underwater Microphone, Model JR, Z=50	$24.50
Dynamic Mike & Headset Combo, B-19, New	$3.75
HS-30 Inserts, M-300	$3.50 per M
AN-ARC-4 VHF Trans-Rcvr	$75.00
IE 36 Test Set. New	$37.50
SCR 274 Test Set, 1-104	$12.25
Carbon Pile Reg., 18V-5V No. 35X025	
ART-13 Driver Trans. 6V6 to P-P 811's	$1.29
DM 34 Dynamotor, 14V In. 220V, 80 MA out	
Sens. Relay: 3.5MA. 13K ohms, 2PST, 2A	$1.29
Klixon Breaker: Thermal, 35A	.69
T-30 Carbon Mikes. New	.89
Tel. Tape. 3/8" x 8 1/2" Rolls	.23 ea. 5/$1.00
Tel. Tape. 4" Rolls	.12 ea. 10/$1.00
BC366 Interphone Jack Box	$ .79 ea.
AN-109-A Antenna	1.98 ea.
C-30/ARC-5 Control Box	2.35 ea.
EE-89A Telephone Repeater	12.50 ea.
EE-65-A Telephone Test Set	50.00 ea.
ID24/ARM-9 Cross Point Indicator	6.95 ea.
TU-8 Tuning Unit 6.2-7.7mc	4.95 ea.
BC496-A Dual Rcvr. Con'l box, 3-6 & 6-9, Imc.	1.75 ea.
AN/104-A Antenna, 150mc	1.49 ea.
BC704 Indicator, 5" CR Tube, New	22.50 ea.
BC929 Indicator, 3BPI, all tubes, New	29.50 ea.
Noise Filters, 100 AMP, G.E.	1.39 ea.
MC211 Right Angle Drives	.19 ea.
IF Transformers, 112 KC Double Slug Tune	.69 ea.
IF Transformers, 1600 KC Double Slug	.79 ea.
MD/7 Modulator for ARC/5, All tubes	7.95 ea.
ARC-5 Xmttr. Tuning Cond. No. 5032	1.49 ea.
ARC-5 Xmttr. M.O. Trimmer No. 4990	1.29 ea.
Buffer or Osc. Coil, 160 meters, 50W End-Link, 5 nr. STD. Socket, OEL-160	.79 ea.

BIRTCHER TUBE CLAMPS

926B-16 926C-15 926C-19
926B-18 926K-2 @ 22c ea.

Oscilloscope Recording Paper, E.K. Contrast 2, 35MM.—250' Rolls, Herm. Sealed $1.25

STEP-DOWN TRANSFORMERS

210-250V PRI—110-220V SEC

Watts	Price
250	$5.95
300	7.49
500	10.95
1000	19.95
1500	24.95

Mail Orders Promptly Filled. All Prices F.O.B. New York City. Send M.O. or Check. Only Shipping Sent C.O.D. Rated Concerns send P.O. All Mdse. Subject to Prior Sale, and Prices Subject to Change Without Notice. Parcels in Excess of 20 Pounds Will Be Shipped Via Cheapest Truck or Railex.

131 Liberty St., New York 7, N. Y. Dept [illegible] Chas. Rosen Phone: Digby 9-4124

ROTARY'S VAST INVENTORY KEEPS PRICES DOWN....

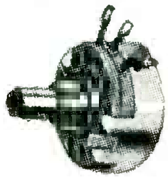
ROTARY ELECTRONIC SALES
GReat Neck 2-0902

POTENTIOMETERS $.95 each

SINGLE TYPE "J" AND "JL"—

100,000 Carbon Potentiometers available for Immediate Delivery.

Note: Lock Nuts Available for Type "JL" Potentiometers at 10¢ each.

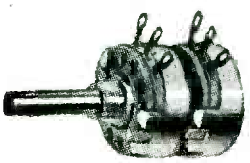


Explanotion of Tapers

U—Linear
A—Audio
B—Reverse Log

Explanation of Letters

L.B.—Locking Bushing
A.S.—Added Shaft
S.D.—Screw Driver Slot



OHMS	BUSHING	SHAFT	TAPER	OHMS	BUSHING	SHAFT	TAPER
50	½ LB	⅝	U	15,000	¼	¼ SD	A
50	⅜	¼ SD	U	20,000	½	⅛ SD	U
50	¼	⅛ SD	U	20,000	½ LB	⅛ SD	U
60	½	⅜	U	20,000	½ LB	½	U
100	½ LB	⅛ SD	U	20,000	½ LB	3	U
150	¼	7/16	U	25,000	½ LB	2 13/16 AS	U
150	½ LB	⅛ SD	U	25,000	½ LB	⅛ SD	U
300	¼	⅜	B	25,000	⅜	⅛ SD	U
350	½ LB	⅛ SD	U	30,000	¼	½	U
350	¼	⅛ SD	U	40,000	½ LB	⅛ SD	U
500	½ LB	½	U	50,000	¼	⅛ SD	U
500	¼	⅜	B	50,000	½ LB	⅛ SD	A
500	¼	1⅜	U	50,000	⅜	⅜	A
500	½ LB	⅛ SD	U	50,000	½ LB	⅛ SD	U
1,000	½ LB	⅛ SD	U	50,000	½ LB	2 13/16 AS	U
1,000	¼	⅛ SD	U	60,000	½ LB	⅛ SD	U
2,000	½ LB	⅛ SD	U	70,000	½ LB	⅛ SD	U
2,500	⅜	⅛ SD	U	100,000	¼	⅛ SD	U
2,500	¼	⅝	B	100,000	⅜	¼ SD	U
2,500	½ LB	⅛ SD	U	100,000	½ LB	⅛ SD	U
5,000	⅜	⅜ SD	A	150,000	½ LB	⅛ SD	U
6,000	⅜	7/16 SD	U	250,000	½	⅜	A
10,000	⅜	1⅞ SD	U	250,000	⅜	5⅝	A
10,000	½ LB	⅛ SD	U	250,000	⅜	½	A
10,000	½ LB	⅛ SD	A	250,000	¼	⅛ SD	A
10,000	⅜	⅜	U	350,000	½ LB	⅛ SD	A
10,000	⅜	⅜	B	1. Meg.	⅜	⅛ SD	U
10,000	½ LB	½	U	1. Meg.	¼	⅛ SD	U
10,000	⅜	5/16	U	2. Meg.	⅜	5⅝	A
15,000	¼	¼	U	3. Meg.	⅜	1 1/16	A

DUAL TYPE "JJ" — $2.50 each

OHMS	BUSHING	SHAFT	TAPER
200	½	½	U
500	¼	1½	U
500	½ LB	½	U
500	½ LB	½	U
500	¼	1½	U
600	¼	¼	U
600	⅜	⅛ SD	U
1,500	¼	¼ SD	U
2,000	½ LB	⅛ SD	U
3,000	¼	½ SD	U
20,000	¼	3/16 SD	U
25,000	⅜	⅜ SD	U
25,000	½ LB	⅛ SD	U
25,000	¼	½	U
25,000	⅜	⅛ SD	U
30,000	½ LB	⅛ SD	U
40,000	⅜	⅛ SD	U
100,000	½ LB	⅛ SD	U
200,000	⅜	1	U
250,000	¼	⅜	B
500,000	½ LB	⅜	A
500,000	½ LB	⅝	A
1. Meg.	½ LB	⅜ AS	U
1. Meg.	½ LB	⅛ SD	U
1. Meg.	¼	⅛ SD	U
1. Meg.	¼	⅜	U
2. Meg.	⅜	⅜ SD	U

SYLVANIA DIODES

Type	Price
IN 21	$ .95
IN 21A	1.25
IN 21B	2.95
IN 22	1.50
IN 23	1.95
IN 23A	2.25
IN 23B	3.75
IN 34	.95
IN 34A	.95

UG CONNECTORS

UG 12/U	1.00
UG 15/U	1.00
UG 21/U	1.00
UG 29/U	1.00
UG 88/U	1.00
UG 245/U	1.00
UG 260/U	1.00
UG 261/U	1.00
UG 262/U	1.00
UG 290/U	1.00
UG 291/U	1.00

CARBON RESISTORS

Type EB-½ Watt, GB-1 Watt, HB-2 Watts

½ WATT ± 10%

OHMS	OHMS	OHMS
10	2,200	82,000
22	2,700	100,000
24	3,000	120,000
27	3,300	150,000
33	3,900	180,000
39	4,700	220,000
47	5,000	270,000
82	5,600	330,000
100	6,800	470,000
120	8,200	560,000
150	10,000	680,000
220	12,000	1. Meg.
270	15,000	1.2 Meg.
330	18,000	1.5 Meg.
390	22,000	1.8 Meg.
470	27,000	2.2 Meg.
560	33,000	3.3 Meg.
680	39,000	4.7 Meg.
820	47,000	
1,000	56,000	
1,500	68,000	

½ WATT ± 5%

10	2,700	300,000
13	3,900	390,000
16	4,700	470,000

OHMS	OHMS	OHMS
22	5,100	620,000
24	7,500	680,000
27	8,200	1.2 Meg.
30	13,000	1.8 Meg.
47	15,000	2.7 Meg.
56	18,000	3. Meg.
68	22,000	3.3 Meg.
100	43,000	5. Meg.
220	47,000	6.8 Meg.
270	75,000	7.5 Meg.
330	100,000	16. Meg.
470	150,000	
1,000	160,000	
1,500	220,000	
1,800	270,000	

1 WATT ± 10%

330	33,000
470	39,000
680	120,000
1,500	270,000
3,300	470,000
3,900	820,000
4,700	1. Meg.
6,800	2.7 Meg.
10,000	4.7 Meg.
12,000	

1 WATT ± 5%

OHMS	OHMS	OHMS
22	1,500	360,000
24	2,000	430,000
43	2,200	470,000
47	3,000	560,000
62	7,500	750,000
100	15,000	1. Meg.
130	30,000	2.2 Meg.
150	62,000	3. Meg.
200	75,000	5.6 Meg.
330	100,000	12. Meg.
680	150,000	15. Meg.
820	240,000	

2 WATT ± 10%

22	470	12,000
47	680	56,000
56	1,000	150,000
82	1,800	390,000
100	2,700	1.2 Meg.
120	3,900	1.5 Meg.
220	4,700	2.7 Meg.
330	5,600	
390	6,800	

2 WATT ± 5%

OHMS	OHMS
10	5,600
13	7,500
39	10,000
56	15,000
82	18,000
120	22,000
270	27,000
470	39,000
680	56,000
1,500	62,000
1,800	130,000
2,700	180,000
4,300	1. Meg.
1.2 Meg.	11. Meg.
1.6 Meg.	12. Meg.
2.7 Meg.	13. Meg.
3. Meg.	15. Meg.
3.3 Meg.	16. Meg.
3.6 Meg.	18. Meg.
4.7 Meg.	20. Meg.
6.2 Meg.	22. Meg.
6.8 Meg.	
7.5 Meg.	
8.2 Meg.	
9.1 Meg.	
10. Meg.	

PRICE SCHEDULE

Wattage	Tol.	100-499 Per Type	500-999 Per Type	1000 & Up Per Type
½ Watt	10%	.04	.037	.035
½ Watt	5%	.08	.075	.07
1 Watt	10%	.06	.055	.05
1 Watt	5%	.12	.11	.10
2 Watt	10%	.10	.09	.09
2 Watt	5%	.24	.22	.20

ROTARY ELECTRONIC SALES

10 Grace Avenue, Great Neck, N.Y.

Call GReat Neck 2-0902

NEW YORK'S RADIO TUBE EXCHANGE

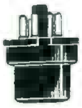


TYPE	PRICE
OA2	51.40
OA3	1.75
OB2	1.75
OC3	1.25
OD3	1.25
C1B	6.95
1B21A	2.75
1B22	3.95
1B23	9.95
1B24	17.95
1B26	2.95
1B27	19.50
1B32	4.10
1B38	33.00
1B42	19.95
1B51	9.95
1B56	49.95
1B60	69.95
1N21	1.35
1N21A	1.75
1N21B	4.25
1N22	1.75
1N23	2.00
1N23	2.00
1N23A	3.75
1N23B	6.00
1N27	5.00
1N43	2.50
2B22	1.95
2B26	3.75
2C34	.35
2C40	20.00
2C43	27.00
2C44	.90
2D21	1.75
2E22	3.75
2E30	2.75
2J21	17.95
2J22	17.95
2J26	27.75
2J27	29.95
2J31	29.95

TYPE	PRICE
2J32	69.95
2J36	105.00
2J38	17.95
2J40	35.00
2Y42	189.00
2J49	109.00
2J50	195.50
2J55	95.00
2J61	75.00
2J62	75.00
2K25	37.50
2K28	37.50
2K29	37.50
2K41	150.00
2K45	149.50
2V3G	2.10
3BP1	7.50
3B24	5.50
3B24W	7.50
EL3C	5.95
3C22	120.00
3C24	1.95
3C31	5.95
3DP1A	10.95
3DP1S2	12.00
3E29	15.50
3GP1	5.50
SN4	5.50
4A1	1.75
4A21	2.75
4B26	10.95
4C27	25.00
4C28	35.00
4E27	17.50
4J25	199.00
4J26	199.00
4J27	199.00
4J31	199.00
4J32	199.00
4J33	199.00
4J37	199.00
4J38	89.00
4J39	199.00

TYPE	PRICE
4J41	199.00
C5B	3.95
5BP1	6.95
5BP4	6.95
5CP1	6.95
5D21	27.50
5JP1	27.50
5JP2	19.50
5JP4	27.50
WE6AK5	2.50
6C21	29.50
C6A	12.50
C6J	10.95
7BP7	7.95
7DP4	10.00
12AP4	55.00
15E	1.95
15R	.95
NE16	.68
FG17	6.95
RX21	3.95
FG33	12.95
35T	4.95
45 Special	.35
RK39	2.95
HF50	1.75
VT52	.25
RK72	1.95
RK73	1.95
100TH	9.95
FG105	19.00
203A	8.95
211	.95
217C	18.00
242C	10.00
244A	12.95
249C	4.95
250TL	19.95
274A	3.00
274B	3.00
304TH	15.00
304TL	14.50
307A	4.95





TYPE	PRICE
310A	7.95
311A	7.95
312A	3.95
323A	25.00
327A	3.95
328A	9.95
350A	7.95
350B	5.95
357A	20.00
368AS	6.95
371B	2.95
385A	4.95
388A	2.95
394A	7.95
MX408U	.75
417A	27.95
434A	29.95
446A	1.95
446B	5.40
450TH	45.00
450TL	45.00
464A	9.95
471A	2.75
527	15.00
WL530	3.50
WL531	22.50
WL533	17.50
700A/D	25.00
701A	7.50
703A	6.95
705A	3.95
707A	17.95
707B	27.00
714AY	17.95
715A	7.95
715B	18.00
715C	25.00
717A	1.95
718AY/EY	48.50
719A	29.50
721A	3.95
722A	3.95
723A/B	17.95

TYPE	PRICE
724A	4.95
724B	6.95
725A	9.95
726A	18.00
726B	56.00
726C	69.00
728AY	27.00
801A	1.00
802	4.25
803	7.95
804	13.50
805	5.95
806	25.00
807	1.69
808	3.50
810	11.00
811A	3.15
813	9.95
814	3.95
815	3.50
816	1.45
829	12.95
829A	13.95
829B	15.95
830B	3.50
832	7.95
832A	9.95
833A	49.95
834	7.95
836	4.95
837	2.95
838	6.95
845	5.59
849	52.50
851	80.50
860	4.95
861	39.50
866A	1.79
869B	57.50
869BX	35.00
872A	3.95
878	1.95
884	1.95

TYPE	PRICE
885	1.75
889R	199.50
914	75.00
931A	6.95
954	.35
955	.55
956	.69
957	.29
958A	.69
991	.65
E1148	.35
1280	1.95
1611	1.95
1613	1.38
1616	2.95
1619	.89
1622	2.75
1624	2.00
1625	.45
1851	1.85
2050	1.85
2051	1.80
8012	4.25
8013	2.95
8013A	5.95
8019	1.75
8020	3.50
8025	6.95
PD8365	89.00
9001	1.75
9002	1.50
9003	1.75
9004	1.75
9005	1.90
9006	.35

Minimum Order

$25.00

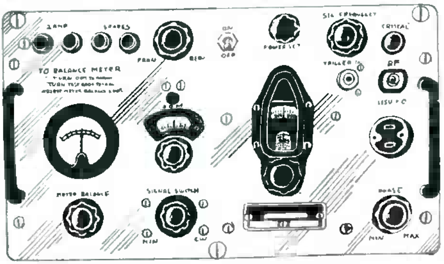
ATTENTION OIL COMPANY ENGINEERS SHIP SUPPLIERS USERS OF SHORAN WE HAVE FOR IMMEDIATE DELIVERY TESTED AND GUARANTEED PERFECT, NEW

4C28 SPECIAL PRICE $35.00

TS 148/UP

MICROWAVE TEST EQUIPMENT

NEW



TS 147/UP

TS148/UP SPECTRUM ANALYZER

TS147 also available

Field type X Band Spectrum Analyzer, Band 8430-9580 Megacycles

Will check Frequency and Operation of various X Band equipment such as Radar Magnetrons, Klystrons, TR Boxes. It will also measure pulse width, c-w spectrum width and Q of resonant cavities. Will also check frequency of signal generators in the X band. Can also be used as frequency modulated Signal Generator etc. Available new complete with all accessories, and carrying case.

Other test equipment, used checked out, surplus.

TSK1/SE K Band Spectrum Analyzer
TS3A/AP Frequency and power meter S Band
RF4A/AP Phantom Target S Band
TS10/APN Altimeter Test Set
TS12/AP VSWR Test Set for X Band
TS13/AP X Band Signal Generator
TS15/AP Flux Meter
TS16/AP Altimeter Test Set
TS33/AP X Band Power and Frequency Meter
TS34/AP Western El. Synchroscope
TS34A/AP Western El. Synchroscope
TS35/AP X Band Signal Generator
TS36/AP X Band Power Meter
TS47/APR 40-400 MC Signal Generator
TS69/AP Frequency Meter 400-1000 MC
TS100 Scope

Also available of new production
TS239A Synchroscope

TS102A/AP Range Calibrator
TS108 Power Load
TS110/AP S Band Echo Box
TS125/AP X Band Power Meter
TS126/AP Synchroscope
TS174/AP Signal Generator
TS175 Signal Generator
TS226 Power Meter
TS251 Range Calibrator APN9
TS270 S Band Echo Box

SURPLUS EQUIPMENT

APA10 Oscilloscope and panoramic receiver
APA38 Panoramic Receiver
APS 3 and APS 4 Radar
APR5A Microwave Receiver
APT2 Radar Jamming Transmitter
APT5 Radar Jamming Transmitter

MINIMUM ORDER
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SPECIAL

Wide Band S Band Signal Generator 2700/3400MC Using 2K41 or PD 8365 Klystron, Internal Cavity Attenuator, Precision individually calibrated Frequency measuring Cavity. CW or Pulse Modulated, externally or internally.

Large quantities of quartz crystals mounted and unmounted.
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400 CYCLE
HIGH FREQUENCY MG UNITS

LOUIS-ALLIS 3 UNIT MG SET. Consists of 5 HP motor operative at 220/440-3-60 directly coupled to alternator with output of 115 volts. 1 ph., 400 cyc. and with exciter unit all mounted on steel base.
Price ....$565.00.

AMERICAN 400 CYCLE SETS. A precision built motor generator set ideal for laboratory test work. Consists of 10 H.P. motor directly connected to alternator with output of 5 KVA, 120/208 Volts, three phase, 400 cycles. With electronic exciter—voltage regulator. Frequ. variation ±5%; Voltage variation ±1%; Total harmonic cont. 1.2%. PRICE........$1850.00

WINCHARGER PU-7/AP: Input 28 VDC. 160 Amps. Output: 115 VAC. single ph. 2500 V.A. 400 C.P.S. Frequency and voltage regulation built-in. Price....$87.00

ONAN 400 CYCLE MG SET. Motor: 220V. 3ϕ. 60 cy. V belted to self-excited alternator with output of 4 KVA, 115 Volts. single ph. 400 CPS. Mounted on base with voltage regulator connected. Components all brand new ....PRICE, $712.00

PE118 Units: Operate at 26 VDC. 100 Amp. Output: 115 VAC. 1ϕ. 400 CPS, 1500 VA. with filter system built-in ....PRICE, $29.50

BOGUE THREE PHASE MG SETS. Consists of Motor 10 H.P. operative at 220/440-3-60 Self exc. alternator with output of 120/208V. 3ϕ. 400 cyc. 5 KVA. Brand New ....PRICE, $1850.00
With Voltage Regulator........PRICE, $1950.00

5 KVA BRITISH MG SETS. Motor 7½ HP. 220-3-60 V belted to self exc. alternator with output of 115 Volts. 1ϕ 400 cycles ....PRICE, $975.00

WINCHARGER PU-10/AP INVERTER. Type MG750. Input: 28 volts, 60 amp. Output: 115 volts, 6.5 amp., 400 cyc., 1 ph. Brand new. Price........$69.50

PE109 INVERTERS. Input 13.5VDC 29A: Output 115V 400 cy. 1.53A 8000 RPM........$59.95

BTH 400 CYCLE M-G SETS. Consists of an alternator of 6 KVA with output of 115 volts. 1ϕ. 400 CPS. V belted drive to 10 HP. motor operative at 220/440-3-60. Excitation provided by dry disk rectifier. Complete with field rheostat. SPECIAL PRICE........$985.00

LOUIS ALLIS FREQUENCY CHANGER SETS. Pri: 25 H.P. 220/440-3-60: Sec. 15/10.8 K.W. 3300/2200 RPM. 306/220 Volts, 35/35 Amps. 2 ph. 500/360 C.P.S. Brand new. PRICE........$1250.00
We can supply these units for 400 cycle output and with transformers to supply 3 phase, wye output. Write for further information.

THREE PHASE 400 CYCLE SETS. Consist of motor operative at 220/440-3-60 V belted to self excited alternator made by Holtzer-Cabot with output of 500 VA. 115 VAC. 3ϕ. 400 cycles ....PRICE $295.00

G. E. INVERTER UNITS. Model 5AT121JJ2B: Input: 24 VDC. 55 amp. 8000 RPM. Output: 115 Volts. 3 phase. 400 CPS. 750 VA and secondary output of 26 volts, single phase, 400 CPS. 250 VA. With automatic voltage and frequency regulation, built in. Rebuilt and warranted equal to new. Similar to Model 153F.
SPECIAL PRICE........$97.50

400 CYCLE COMBINATION I AND 3 PHASE MOTOR GENERATOR. Consisting of 20 HP Synchronous 220/440V. Motor V belted to two self excited alternators. Generator I: Bogue 5 KVA 120/208 Volts. 3 Phase. 400 CPS with voltage regulator. Generator II: Onan 4 KVA. 115 Volts. single ph. 400 CPS with voltage regulator. Motor and both alternators and two voltage regulators are mounted on welded channel from base complete with motor starting compensator. SPECIAL PRICE $3175.00

WE CAN SUPPLY MOTOR-GENERATOR SETS TO ANY FREQUENCY SPECIFICATIONS AND FOR ANY APPLICATION CONSULT OUR ENGINEERING DEPARTMENT

WESTINGHOUSE 20 KVA 400 CYCLE SET. This unit consists of a synchronous motor of 30 H.P. 1200 RPM operative at 220-3-60 direct connected to self-excited alternator with output of 115 Volts, 3 phase, 400 CPS. (Can be reconnected for 120/208 output) Complete with compensator for motor starting.
SPECIAL PRICE $3750.00

HOLTZER-CABOT MG218. Compact 2 bearing units for low current 400 cycle output. Operative at 115 VDC. 2.3 amp. Output: 110 Volts, 1.0 amp. 1 ph. 400 CPS. Brand New. PRICE........$79.50

BENDIX-ECLIPSE 800 CYCLE AERO UNIT. Input: 24-28 VDC. 75 amps. Output 115 V. 10.5 Amp. 800 C.P.S. Complete filter system mounted thereon.
Price $22.50

INVERTER UNIT PE206A. Input: 27.5 VDC. 28 amp. Output: 80 Volts. single ph. 800 CPS. 500 VA.
Price $19.00

H.F. MOTOR GENERATOR. G.E. Model 5LY126A4. Motor: 115 VDC direct connected to Generator 24 32 VDC. 78 amps., and to alternator 120 VAC 720 cycles. 1 ph. KW-2¼........PRICE $245.00

BENDIX POWER MG SET. Consists of G.E. 2 HP. Rep-Ind. Motor, 115 volts, single phase, 60 cy. directly connected to Bendix alternator with output of 120 volts, 700 cyc., 600 watts and DC output of 14.5 volts, DC, 22 amp. Brand new. Price ....22 .00

50 K.V.A. 400≈ MG SETS

We have been fortunate in acquiring a quantity of **KATO 400 Cycle Alternators** that we have made up into motor generator sets and are thus enabled to offer these at a very attractive price. These sets consist of a 75 H.P. Motor operative at 220/440 Volts, 3 Phase, 60 Cycles, 1750 R.P.M. which are coupled directly to a self-excited alternator with output of 50 KVA, 120/208 Volts, 400 CPS, 3 Phase. These motor-generator sets are BRAND NEW and complete with compensator for motor starting and field rheostat for voltage output control. Voltage regulator can be supplied at $100.00, additional to price as quoted. We will be pleased to supply complete specifications relative to frequency and voltage variation and harmonic content.
SPECIALLY PRICED! $7450

ESCO DUAL FREQUENCY UNITS. Motor operates at 120 VDC. 10 amperes. Delivers 70 Volts at 120 Cycles or 200 Volts at 720 Cycles. Price........$95.00

CONTINENTAL DC/AC SET. Motor: 1.5 HP. 230 VDC. 3440 RPM. Output: 120 VAC. 6.6 amps., .8 KW 800 cyc., 1 ph., also output of 14 VDC, 4 amps., Model CG21637. Compact 2-bear. units. Completely rebuilt.
Price $89.00

ONAN 800 CYCLE MG UNIT. Employing 5 H.P. Motor operative at 220/440 Volts, 3ϕ, 60 Cy. V belted to self-exc. generator with output of 1.5 KVA. 115 Volts, single ph. 800 CPS, and secondary output of 500 Watts 28.5 VDC 17.5 amperes. PRICE........$289.00

BRITISH MADE 500 CYCLE MG SETS. Motor: 230 Volts, 3 PH—50 Cycles. Alternator: 5 K.W. 180 Volts, 27.8 Amp. 50 Cycles. Excitation—110 VDC. When used at 60 Cycle current, Output is 600 cycles, 220 Volts. Price $353.00

BURKE ALTERNATOR. 62.5 KVA. 220 Volts, 3 Ph. 180 Cycles, 1800 RPM, separately exc. at 125 VDC. 80% P.F. Type ACR-7. Complete with auxiliary exciter MG set and field rheostat. Ball bearings. Will deliver 400 cycles at 4000 RPM. Rebuilt. Price.....$1375.00

BRITISH DC/AC MG SETS. Input: 230 VDC. Output: 180 VAC, 1ϕ. 500 Cyc. 5 KVA..NEW. PRICE, $265.00

G.E. MG SET MODEL 5LY56AB5A. Motor: 1.1 HP. 250 VDC. 4 amp. Generator: 600 watts, 125 VAC. 4.8 amp., 500 cyc., 1 ph. Price........$89.50

NORMAND ELEC. CO. (BRITISH MFG.) MG UNIT. Motor: 220 VDC. 8.8 amp. 2 HP. 4200 RPM. directly connected to H. F. alternator with output of cyc. 1200 watts. Exc. 24 VDC. Price........$70.00

ESCO MG UNIT. Operative at 120 VDV. 25 Amp., 4 HP. Delivers 115 VAC, 1 ph., 1050 cyc., 2 KW. An exceptionally fine machine for laboratory use. Can be used with field rheostat for frequencies up to 2000 cycles.
Price $175.00

ELECTRIC SPECIALTY FREQUENCY CHANGERS. Type BFS52/BFRS354 Input: 230 Volts, 3 Ph. 60 cy. 3600 RPM. Output: 250 Volts, 20 Amps. single ph. 180 Cyc. 5000 VA. 3000 Watts. Brand New. Compact ball bearing units for operation of Hi-cycle equipment.
SPECIAL PRICE $160.00

WESTINGHOUSE 180 CYCLE ALTERNATORS. 750 V.A. Output: 110 Volts, 3 Phase, 180 C.P.S. 3000 R.P.M. Separately excited at 110 VDC. Price..$44.00
Also available with built-in exciter. Price......$78.00

GENERAL ELECTRIC HIGH FREQUENCY UNIT. Operating at 440-3-60 .75 amp. Output: 70 Volts, 3 ph. 148 cyc. 220 Watts. 1.8 amperes. An ideal unit for experimental work or for operation of equipment.
SPECIAL PRICE $34.50

HIGH FREQ. UNIT. Motor: 24 VDC 50 amp. Alternator: 17 VAC. 1300-1600 cyc. sep. exc. at 24 VDC. 1.25 BHP, 4000 RPM. Made in Canada by Electric Tamper & Equ........PRICE $49.00

WESTINGHOUSE HIGH FREQUENCY UNITS. Input: 115 Volts, D.C. 2.7 Amps. Output: 14.4 Volts. .139 Amp. 450-2550 Cycles. Frequency variation is obtained with built-in controller on end of unit. Price..$48.50

RLX DUAL GENERATORS. Flange mounted. Output: 500 Watts, 1300-2600 Cycles, also 12-14 VDC. 750 Watts. Price $25.50

ELECTRIC SPECIALTY HIGH FREQUENCY CONVERTER UNIT. Primary: 32 VDC, 16 amperes, 3000 R.P.M. Ball Bearings. Secondary: 350 volts, 1500 cycles. .75 amps. 275 V.A. Single Ph. Built-in frequency control. Specially Priced at........$30.00

[illegible] CONVERTER UNIT. Input: 115 VDC, 34 amps. Output: 140 volts, 1.2 amps., 350 cycles. Ball bearing. Complete with field rheostat for 400 cycle output. Price ....$79.50.

GREAT LAKES MF CONVERTER UNIT. Input: 220 volts, 3 phase, 60 cycles. Output: 120 volts, single phase, 420 cycles, 2 KW. Also 120 VDC, .35 amps.
Price ....$390.00.

HOLTZER-CABOT MF MG SET. Type MG160. Input: 220-3-60. Output: 110 volts, 3 phase, 460 cycles, 1 KW.
Price ....$425.00.

G.E. MG SET. Model 5LY104A1, Nema frame. Motor: 220/440-3-60. Output: 115 volts, single phase, 1050 cycles, 1 KVA. Also delivers 115 VDC, 17.4 amps.
Price ....$850.00.

LELAND MG SET. Motor: 5 HP, 220/440-3-60. Generator: 120/208-3-400, 3 KVA. Price........$960.00.

DIFFERENTIAL SELSYN SETS

These units consist of a G.E. 1/6 HP motor operative at 230 VDC with right angle gear reduction which with field rheostat supplied has output RPM between 650 and 27.5 RPM. Directly coupled to a differential Selsyn transmitter, Frame M224, 3 phase, 60 cycles, 4 pole. Each unit is supplied with a Selsyn receiver rated at .25 HP, 440 volts, 3 phase, 60 cycles, 4 pole. The set may be used for control of radar antennae or any other innumerable applications such as lathes, winding machines, etc. One of the finest values we have ever offered. Fully guaranteed. The entire equipment as above at a price of $165.00.
Price ....$265.00.

WESTINGHOUSE SPECIAL MOTORS

Type FBS, 4 pole, open round frame, reluctance type synchronous, sleeve bearings. Motors will operate over a range of 51 volts, 3 phase, 17 cycles, to 250 volts, 3 phase, 110 cycles. Pull-in torque of 9 oz. ft. Full load torque of 3 oz. ft. Weight 40 lbs. each. Price: **$16.90 each.** Blueprints of this unit will be supplied upon request.

LOW VOLTAGE EQUIPMENT

We are listing below but a few items from our very large stock of low voltage MG sets. Your inquiry is invited for any type of unit which you may desire. We have one of the largest stocks in the country.

ESCO LV MG SET. Brand new. Operative at 120 VDC. Output: 9 VDC, 225 amps. Price........$290.00.

CROCKER-WHEELER MG SET. Rebuilt, condition like new. Motor: 20 HP, 220-3-60. Generator: 12 volts, 1000 amps. Price........$1,250.

BOGUE LV MG SET. Motor: 10 HP, operative at 220/440-3-60. Generator: 15 VDC, 500 amps.
Price ....$575.00.

ESCO LV MG SET. Motor: 5 HP, 220/440-3-60. Generator: 20 VDC, 100 amps. Price........$295.00.

MASTER MG SET. Brand new. Motor: 15 HP. 220/440-3-60. Directly coupled to 2 generators: Output of 24 VDC, 208 amps. and 12 VDC, 416 amps. With built in exciter. Price........$900.00.

R&M MG UNIT. Operative at 110 VDC to deliver 32/40 VDC. Complete with field rheostat for output of 24/28 VDC. Rated at 40 watts but will deliver 200 watts for intermittent operation. Gearhead built into one end rotates external shaft at 225 RPM. An exceptional value at a price of........$13.75.

CENTURY MG UNIT. Consisting of a .75 HP motor operative at 115/230 volts, single phase, 60 cycles. Output: 27 VDC, 9.3 amps., 250 watts. Price......$85.00.

MASTER MG SET. Motor: 2 HP. 220/440-3-60. Generator: 28 VDC, 35.7 amps., 1 KW. Price....$265.00.

WESTINGHOUSE TRANSFORMERS. 550/220/440 Core and Coil type. 200 VA..$12.75; 500 VA..$18.85; 750 VA..$23.75; 1 KVA..$29.85.

CORNELL DUBILIER VIBRATOR TYPE INVERTER UNITS. Input: 105-125 VDC; Output: 115 VAC, 1ϕ. 60 cyc. 65 watts, with built-in relay which automatically starts unit with connected load. SPECIAL PRICE $9.90

BACH-SIMPSON ELECTRONIC INVERTER. DC input: 115 Volts. Output: 115 Volts. 1ϕ. 60 cyc. 24.5 watts, modified square wave, with built-in relay which automatically turns on inverter with connected load. Contains 8 50L6 GT Tubes. Brand New.
SPECIAL PRICE $12.95

MASTER GENERATORS. 12 Volts, D.C. 41.6 amp. 500 watts. Sep. exc. at 125 VDC. PRICE......$33.00

BURKE MOTOR GENERATOR DC/AC SETS. 2 Bearing, ball bearings. Motor: 115 VDC 74 amp. 9.4 H.P. Generator: 120 VAC. 48 amp. 3 ph. 60 cyc. 10 KVA. Complete with magnetic controller and field rheostat. SPECIAL PRICE $325.00

ALLIS CHALMERS DC/AC MG SETS. Brand new. 5 KVA: 115 VDC/115 VAC 1ϕ. 60 cyc. complete with controller, field rheostat and spare parts.
SPECIAL PRICE $490.00

ACME AIR-COOLED TRANSFORMER. Primary: 500 volts. Secondary: 14,840 volts with C.T., 3 phase, 60 CPS, 18.2 KVA, brand new. Price........$390.00

GARDNER DRY TRANSFORMER. 3.42 KVA, 230/115 to 5.7 volts, 600 amperes. Price........$48.75

BOGUE ELECTRIC AC/DC MG SET. Consists of 7.5 HP motor in center directly connected to 2 12 volt 160 amp. generators. Will deliver 24 volts at 160 amp. or 12 volts at 320 amp. Condition like new.
Price $375.00

BRITISH DC/AC MG UNITS. Operate at 100/110 VDC, 4 amps., 3000 RPM. Output: 230 VAC, .87 amp., 50 cyc. Wt: 132 lbs. Brand new. Price......$42.50
With field rheostat for 60 cyc. output. Price...$50.00

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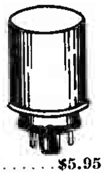
WE SPECIALIZE IN RELAYS

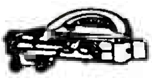
TREMENDOUS QUANTITIES IN STOCK!

SEALED RELAYS



Clare 5001; 24vdc; DPDT; 300 ohm; Octal Plug Base; #R678 $5.95
Struthers-Dunn 181CXC100; 12 vdc; 3As, 3Bs; #R679 $5.95
Sigma 73351; 16vdc; SPDT; 2000 ohm; 8 ma; #R682 $6.95
Allied SKHX; 24VDC; 3A, 3B; 425 ohm; #R913 $5.95
SIGMA Type 4AH; 2000 ohm; SPDT, 4 ma. pull in, 2.5 ma. hold, 5 prong plug-in. $3.95
SIGMA 71257; 6 voc. SPDT, 500 ohms. $4.95
SIGMA 949; 115V AC, SPST N.C. $4.95

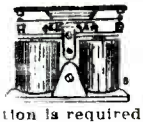
STEPPING SWITCHES



AUTOMATIC ELECTRIC TYPE 13 25 Position; Non-Bridging Wipers; Self Interrupter Springs; Norm. Oper Volts: 24 VDC; Max 30VDC; 0.6 Amps; 30 Ohm.

Two Levels; #R905 $15.95
Three Levels with two wipers; #R906 16.50
Six Levels with two wipers; #R908 17.75

DIFFERENTIALS



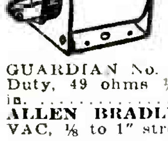
Dual 8000 ohm coils, Armature pivoted between poles, all contacts normally open. High-speed. Suitable for P.P. bridge or balanced circuits where differential action is required.

COOK 11710/613 DPDT, 6 ma., #R605 $5.95
Allied 803476 SPDT, 2.5 ma., #R418 $4.95
ALLIED DSX3 9500 ohm, 4 ma., 2A, 2B, #R941 $5.95

115V AC RELAYS

SIGMA 41FZS7; SPDT, 10,000 ohms #R909 $2.[illegible]
WARD LEONARD 104-662; DPDT, #R998 $3.50
PRICE ELECTRIC Type 1620; DPST N.O., 10 Amp. Contacts $2.95
RBM #42600; DPST N.O. 10 amp. Contacts $3.25

A.C. SOLENOIDS

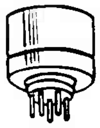


GUARDIAN No. 1: 24 VAC. 6 ohms ⅛ to ½" stroke, 6 oz.-in. #R 804 $1.95
GUARDIAN No. 4: 115 VAC, 133 ohms ⅛ to 1⅛" stroke, 14 oz.-in. #R 805 $3.95
GUARDIAN No. 4: 115 VAC, Intermittent Duty, 49 ohms ⅛" to 1⅛" Stroke, 2 lb.-in. $3.95
ALLEN BRADLEY BULLETIN 860. 110 VAC, ⅛ to 1" stroke, 2 lb-in pull; #R942 $3.50
WARD LEONARD N83 CONTACTOR; 110 VAC, Heavy Duty 5 double make contacts, 3 at 50 Amp, 2 at 30 Amp; 8 lb-in stroke; #R238 $10.95

110V 60 Cyc TIMING MOTORS

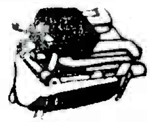
INGRAHAM 8 RPM Fully Enclosed $1.95
TELECHRON 3.6 RPM 2.50
GILBERT With Gear Train for 6 RPDay 1.95
GILBERT 60 RPM (1 RPS) 1.75
HAYDON 1600A; 1 RPM 2.25
HAYDON: 1 RPM, 24V AC 1.95

D.C. SENSITIVE RELAYS



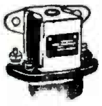
SIGMA Type 4AH; 2000 ohms; SPDT 4 ma. pull in, 2.5 ma. hold, 5 prong plug-in $3.95
Sigma 41FS7; 2 ma; **SPDT; 10,000 ohm**; @ #R914 2.95
Allied FID; 8 ma; 1A; 3000 ohm; #R916 1.50
RBM 23024; 6 ma.; 4PST n.o. (4As); 6500 ohm, #R802 2.95
RBM 23025 6 ma., SPDT, 8000 ohm, #R428 1.50
W.E. (Wheloek) KS9665 9 ma., 1A, 1B 1C, 2000 ohm, #R426 4.95
Kurman Midget 12 ma., SPDT, 1500 ohm. #R427 .98
Clare Type J (K102) 6 ma., SPDT, 3500 ohm, #R30 3.50
Cooke Type C 4 ma., 1A, 6500 ohm, #R596 3.50
Claire B11613 (K101) 2 ma., SPDT, 6500 ohm, #R588 4.95
Clare A8053 8 ma., 3A, 6500 ohm, #R408 3.95
RBM 452-1041; 4 ma., 12,000 ohm; DPDT; Telephone Type; #R685 4.95
POTTER-BROMFIELD Type LC; 5000 ohms. 5 ma. SPST N.O. #R230 1.50
POTTER-BROMFIELD Type LC; 2500 ohms, 9 ma. SPDT #684 1.50

MINIATURE RELAYS



23025 **RBM** 48VDC, SPDT, 8000 ohm, 6 ma #R428 $1.50
55251 **Telechron**, 24VDC, SPST n.o. (1A) 300 ohm, #R174 90¢
55310 **Price**, 24VDC SPST n.o. (1A) 300 ohm #R170 90¢
55342 **Telechron**, 24VDC. Makes 3 Breaks One (2As, 1C) 300 ohm, Anti-Capacity Arms, Low Loss Bakelite Insulation #R171 $1.25
55528 **G.E.** 12VDC, 6PST n.o. (6As), 150 ohm, #R426 $1.50
55589 **RBM**, 24VDC, DPST n.o. (2As). 300 ohm. #R245 $1.25
55836 **G.E.** 24VDC, SPDT. (2As), 250 ohm. #R402 ea. $1.25
55837 **G.E.** 24VDC. Double Make, 300 ohm. #R108G $1.00
55837 **RBM.** Same as #R108G, #R108R $1.25
55837 **Allied.** Same as #R108G. #R108 $1.50
23012-0 **RBM.** 24VDC, SPDT. 250 ohms. #R172 $1.25
7251 **ARC** 24VDC. SPDT, 300 ohm #R406 $1.25
7252 **ARC**, 24VDC, DPST, n.o. (2As) 300 ohm, Anti-Capacity Arms, Ceramic Insulations; #R354 $1.25
COOK 482; 24VDC; DPDT; 500 ohm #R918 $1.75
G.E. CR2791G11OF2 24VDC; DPDT; 300 ohm; #R919 $1.50
CLARE A20545; 8VDC; 1B; 45 ohm; #R920 $1.25
AUTOMATIC 754A; 12VDC; DPDT 6 Amp; 200 ohm; #R921 $1.75
AUTOMATIC 754; 6VDC; DPDT 6 Amp; 50 ohm; #R922 $1.75
POTTER BRUMFIELD KR11D; 6VDC; DPDT; 75 ohm; #R923 $1.95
SIGMA 41F; 6VDC; SPDT; 62 ohm; #R924 $1.75
SIGMA 41F; 12VDC; SPDT; 340 ohm; $R925 $1.95
CLARE 8045; DPDT, 300 ohms. 24V DC $1.50

D.C. SOLENOIDS



B5A ALLEN BRADLEY 24VDC SPST. 50A 100 ohms #R105 $1.95
B5A HART Cat. #692R4 SPST 50A, 150 ohms. #R105H 1.95
B5A SQUARE "D" 24VDC SPST 50 A 150 ohms #R25 2.25
B5A CUTLER HAMMER 24VDC, SPST 50A 100 ohms #R24 2.25
B4 AUTO LITE 24VDC. SPST 200A 90 ohms #R174 3.50
B8 CUTLER HAMMER 6041H139A, 24VDC, SPST 200A, 10 ohms #R130 3.95
B8 AUTO LITE SPEC #22424A, 24VDC, SPST 200A 6 ohms #R128 2.75
D1 ECLIPSE DIFA 53528, 24VDC SPST 200A 6 ohms #R126 2.95
CUTLER HAMMER 6041H36A, 12VDC, SPST 200A 17 ohms #R121 3.95
D1 CUTLER HAMMER D1-9432181, 24VDC, SPST 200A 50 ohms 3.95
LEACH 5020CSP, 12VDC, SPST 50A, 25 ohms #R125 1.95
LEACH 79733, 24VDC, Dble Make & Break 50A, and SPST n.o., 65 ohms #R131 2.50
G.E. 429896, Plastic Enclosed, 24VDC SPST 50A 150 ohms #R23 2.93
G.E. CR2792D116W2 Plastic Enclosed, 12VDC, SPST 100A, 30 Ohms #R23B. 5.50
EPCO S17D, 12VDC, SPST 30A, 35 ohms #R122 2.95
RBM BN5, 24VDC SPST 50A, 200 ohms #R224 1.95
G.E. CR2800384A3, 24VDC, SPST, 200A, 50 ohms #R59B 3.95
G.E. CR9522K 100A2, 24VDC, 2 switchettes, DPST n.c. & SPST n.c. long throw #R132 9.95
GUARDIAN 34585 Dual Latching 24VDC ea section: Double Make & Break & Alternate Double Make, Break, 100A contacts, 24 ohms #R223 8.75
G.E. M29J682-1 (No Contacts) 10-12VDC—Micalex Flipper Arm. Releases at 2VDC #R167 1.25
CUTLER - HAMMER 6041H158A 12 VDC, SPST n.o. 50A, 25 ohm #R428. 1.95

ALLIED RELAYS

Each

BO6D35 24VDC, DPDT, 240 ohm #RO4 $2.50
BO13D35 24VDC, SPST, double make, 240 ohm #RO6 1.25
BJ6D36 25VDC, DPDT, 255 ohm #R420 1.55
BJX-12 12 or 24VDC, SP DBLE break, 240 ohm CT #R226 1.25
55837 24VDC, Double make, 300 ohm #R108 1.50
BO1332 12VDC, 80 ohm Coil & Frame only (no contacts) #RC358 .40
BOVX3 1VDC, SPST, n.o., 1½ ohm #R35 1.50
BOY13D 20VDC, Double make & break 550 ohm #R360 1.95
AR 12VDC, SPST n.o., 75 ohm #R429 1.00
DIFFERENTIAL 803476 DUAL 8000 ohm 2.5 ma. coils, Armature pivoted between poles, all contacts normally open, SPDT 5A, contacts Hi-speed. Suitable for P. P., bridge or balanced circuits where differential action is required #R362 $4.95
5R1-2 27.5VDC, Double Make & Break, 150 ohms, 9000 Volts Hi-Pot Insulation #R418 $22.50
BJU (Electrical Latching) 6VDC, 4PDT, 16 ohm ea coil, dust-proof shield, 11 Pin Plug Base #R435 $6.95
FID: 3000 ohms 8 ma., SPST No.O. $1.50
FID: 40 ohms, 6V DC, SPST N.O. .98

TERMS:—All Prices F.O.B. Our Plant. Rated Firms Net 10 Days: All Others Remittance with Order. Orders Under $10 Remittance With Order, Plus Approximate Shipping Charges (overage will be returned.)

324 CANAL ST., N.Y.C., 13, N.Y. WAlker 5-9642

Universal general corp.

CONDENSERS

MICRO & TOG. SWS. – RELAYS – "J" POTS

OIL CONDENSER SP'LS

6 mfd.—150 V........$.35
Three term. dual 3 mfd. oil cond. complete with brackets, measuring 4¼"x1¾" x1". Ideal for audio crossover networks.

7 mfd.—600 V.......$1.65
Small, high quality oil cond. measuring 2⅛" x 3¾" x 1¾" complete with brackets.

7 mfd.—600 V.......$1.15
Brand new—Guaranteed. Dims. 4⅝ x 3¾ x ¾. Brackets..................$.15

10 mfd.—600 V.......$.98
Three term. bal. mntg. channel type. Dims. 3¾" x 3½" x 2". Two 5 mfd. sections rated 400 V at 72 deg. "C". 1800 V test. Meets commercial specs. for 600 V. operation up to 40 degs. "C". Ideal for filter or power factor application. Repeat sales prove this rugged high quality condenser to be of outstanding value. Carton of 24, weight 42 lbs. Large qua. available......$ .89

2 mfd.—1500 V.....$1.09
Avox #1509.

16 mfd.—600 V......$1.75
Dual 8 mfd. herm. sealed and packed. Type PT-SC-11 measuring 3¾" x 2⅝" x 2⅝". Stud. mtg. centers 2". Plugs into standard four prong socket. Quantity discount.

.2 mfd.—1000 V.......$.21
Standard 2 side term. bathtub cond. Same dimensions as .25 mfd, 600 V type. Exceptional value.

2 mfd.—600 V.........$.49
Dims. 2" D x 2⅝" Brack'ts.

JAN APPROVED

10mfd—1000V	4.55	8mfd—600V	2.25
8mfd—1500V	4.25	6mfd—600V	1.55
8mfd—1000V	3.25	4mfd—600V	1.75

Mfd	Volts	Price
.005–		
.005-.01	10KV	3.75
.01	10KV	4.25
.012	25KV	19.50
.02	20KV	15.90
.075–		
.075	7.5KV	3.95
.08	12 5KV	15.95
.1	1500V	.59
.1	2000V	.49
.1	2500V	1.20
.1	3000V	1.75
.1	7500V	1.95
.1	7500V	4.25
.1-.1	7500V	6.25
.1	10KV	8.95
.1	15KV	15.95
.15-.15	8000V	1.95
.2	10KV	10.95
.25	2000V	1.25
.25	3000	2.15
.25	6000V	1.75
.25	18KV	15.95
.25	20KV	19.95
.4	10KV	12.95
.5	1500V	1.02
.5	2000V	1.39
.5	3000V	2.69
.5	25KV	Quote
.5-.1	2000V	.89
.5-.5	600V	.69
1	400V	.45
1	500V	.59
1	1000V	.69
1	1500V	1.35
1	2000V	1.95
1	2500V	2.25
1	3000V	3.50
1	5000V	4.99
1	15KV	Quote
1	16KV	Quote
1	25KV	Quote
1-1	7500V	Quote
2	600V	.59-.79
2 TLAD	600V	.80
2	1000V	.85
2 TLA	1000V	1.29
2	1500V	1.65
2	2000V	2.80
2	2500V	3.39

Mfd	Volts	Price
2	3000V	4.69
2	4000V	5.69
2	5000V	10.95
2	12.500V	Quote
2-2	600V	1.25
3	600V	.59
3	4000V	7.95
3-3	150V	.29
3-3-3	400V	.75
3.75	1000V	1.59
4	400V	.85
4	600V	1.25
4	1000V	1.95
4	1500V	2.79
4	2000V	4.25
4	3000V	7.95
4	4000V	10.95
4-4	1000V	1.85
4-4-4	600V	2.40
5	330VAC	1.75
5	600	1.35
5	600V	2.49
5	1500V	2.89
5-1	400V	.89
6	600V	1.45
6	330 VAC	2.49
6	1000V	2.49
6	1500V	3.25
6	2000V	3.95
7	600V	1.45
7	800V	1.90
7	1000V	2.49
8	600V	1.35
8	600V	1.75–2.15
8	660 VAC	4.25
8	1000V	3.25
8	1500V	4.25
8	2000V	4.95
8-8	600V	1.75
10	600V	2.50
10	1000V	4.55
10	6000V	Quote
12	600V	2.40
12	1000V	4.95
14	1000V	5.25
15	1000V	5.25
17	25V	.69
24	1500V	8.50

DUAL "AB" POTS

OHMS	SHAFT	OHMS	SHAFT
1500	5/16"	20K	7/16"
1-5 meg	1/2"	1 meg	1/2"
		2 meg	1/8 S

COAX. CONNECTORS

83-1R	$.45	83-1SPN	$.39
83-1AP	.25	PL-177	.50

TRANS. MICA CONDS.

Mfd	Wvdc	Price
.00015	5000	1.75
.0002	15KV	Quote
.00025	1200	.35
.00025	5000	1.95
.001	2500	.48
.001	8000	3.65
.002	6000	3.50
.0024	5000	1.95
.003	6000	5.95
.01	600	.40

Mfd	Wvdc	Price
.01	1200	.55
.01	15KV	Quote
.0125	6000	5.50
.02	600	.27
.03	600	.49

Other types available.

MICA CONDENSERS

5, 6, 8, 10, 15, 25, 30, 34, 39, 50, 70, 75, 100, 140, 150, 185, 200, 230, 240, 250, 300, 350, 390, 400, 470, 500, 510, 600, 650, 700, 750, 1000, 1200, 1250, 1400, 1500, 2000, 2200, 2400, 3000, 3300, 3700, 3900, 4000, 4700, 5000, 5100, 6000, 6200, 6500, 7900, 7950, 7960, 8000, & 9100 mmfd.

PRICE SCHEDULE

5 to 750 mmfd	5¢
2000 to 5100 mmfd	11¢
1000 to 1500 mmfd	7¢
6000 to 8000 mmfd	12¢

Special Mica Kit—100 @ $3.50

SILVER MICA CONDENSERS

7, 24, 25, 33, 50, 60, 75, 95, 100, 120, 150, 170, 200, 270, 300, 330, 390, 400, 450, 500, 750, 800, 1000, 1400, 1450, 1700, & 2500 mmfd.

PRICE SCHEDULE

7 to 95 mmfd	8¢
1000 to 1700 mmfd	14¢
100 to 800 mmfd	9¢
2500 mmfd	16¢

Special S.Mica Kit—100 @ $6.50

CERAMICON CONDS.

10, 56 & 100 mmfd @	.05
1000 to 5000 mmfd @	.06
.01 400 V	

MOLDED PAPER CONDS.

.01 400 VType CN 35		15¢ ea.	$10.50per"C"
.01, .05, .06	400V.	4¢ ea.	$ 3.50per"C"
.004, .01, .03	600V.	5¢ ea.	$ 4.50per"C"
.1	1000V.	8¢ ea.	$ 7.50per"C"
.01	1000V.	15¢ ea.	$13.50per"C"

AIRCRAFT TOG. SWS.

Aircraft type-20A @ 24VDC-10A @ 125VAC-C-H

CH#	Govt. Spec.	Circuit
8201K4	B-5A	SPST On-Off
8211K5	B-6B	SPST Off-Mom. On
8208K4	B-7A	SPST On-Off-Mom. On
8210K5	B-1B	SPST On-On
8200K8	AN3022-1B	SPDT On-Off-On

Plush Mounted—Luminous Tip—Bat. Handle—Price—$.22 ea; $20/100; $170/1000.
To get 1000 qua. disc. you may combine types.

OTHER AIRCRAFT TYPES

Ch#	Circuit	Cur. @ 125VAC		Price
8871K-1	SPST	15A	Push but.—Type A2—On-Mom. Off	$.59 P.T.
8905K-514	SP-4Pos.	35A	@ 24VDC On-Off-Mom. On-Mom. On	.79 L.T.
8905K-526	SPST	5A	B-5A-1¼" Bat.	.32 L.T.
8905K-722	3PST	10A	Off-Mom. On	.79 L.T.
8911K-524	DPST	15A	Push But.-Off-Mom. On	.59 P.T.
8202 K-7	SPST	10A	2 Gang B-5A	.32 L.T.

10% Dis. in quas. of 100 or more per Type.

TOGGLE SWITCHES

CH#	Circuit	Price	AH & H	Circuit	Price
8800K4	SPDT	$.60	6A. 125V	DPST	$.42
8824K4	DPDT	.75	6A. 125V	DPDT	.50

RELAYS & CONTACTORS

Type	Volt	Ohms	Current	Action	Price
1027	12 Leach	67	8	DPDT	1.25
1077-BFW	24 Leach	160	¼ Cont.	DPDT	1.50
1220-DE	24 Leach	95	20	SPST-Double Break	1.25
1222-BF	24 Leach	160	10	SPST-Double Break	1.25
1227-B2A	24 Leach	140	25	SPST	1.25
1254M	24 Leach	160	10	2-SPST N.O.	1.25
7055	12 Leach	100	50	SPST N.O.	3.50
2791-B100-C3	24 GE	150		DPDT	.95
2791-B100-G3	24 GE			3PST N.O.	.95
9350-B7A	24 Sq. D	132	250	SPST N.O.	4.75
6041-H81A	24 CH	.65	100	SPST N.O.	2.95
6046-H1A-C1	24 CH	70	50	DPDT	9.95
6046-H1B-C1	24 CH	70	50	DPDT	9.95
6046-H2B-C2	24 CH	49	100	DPDT	11.95
B-9 Time Delay Guard.		500		SPDT	.95
106-612	115 WL		6	DPST	1.50
9340-975 Latching Relay	24 Sq. D	500		4 Pole	8.95

MICRO SWITCHES

Number	Actuator	Circuit	Term.	Price
WZR-31	Pin	SPST-N.C.	Screw	.49
WZR-31-M	MC2711 Plunger	SPST-N.C.	Screw	.69
M-WZ-RS13	Plunger	SPST-N.C.	Screw	.79
WZR-31	HO3-RE11	SPST-N.C.	Screw	1.95
WZ-2YST	Plunger	SPST N.O.	Screw	.89
WZRQ-41	Plunger	SPST N.C.	Screw	.89
YZR-31	T-Actuator-LH	SPST N.O.	Screw	.79
YZ7RDTC	Plunger	SPST N.O.	Screw	.69
YZ3RDT	Plunger	SPST N.O.	Screw	.69
YZ-2YST	Plunger	SPST N.O.	Screw	.95
YP3	Button	SPST N.O.	Solder	.49
BZRL2	Roller	SPDT	Solder	.95
BZ3RW2T	Roller	SPDT	Screw	1.05
MU-SW(15A 125V)	Lever	DPST N.O.	Solder	1.05

TYPE "AB" POTS

OHMS	Shaft	OHMS	Shaft
50	1/8 S	20000	1 1/4 & 1/8 LS
60	1/8 LS	25000	3/8 & 1/8 S
150	1/4 S	3000	1/8 S
300	3/8 S	40000	1/8 LS
500	3/8 & 1/8 S	50000	1/4 & 1/8 S
1000	1/8 S	50000	1/8 LS
1500	1/4 S	100000	1/2"
2000	1/8 LS & 3/8 S	150000	2 1/8
2500	1/8 S	200000	1/8 LS
3000	1/8 LS	250000	1/8 LS, 9/16 & 1/8 S
6000	1/4	300000	1/8 S (2 terms.)
5000	1/8 LS & 3/8	1 Meg.	1/8 S & 1/8 LS
10000	3/8 & 1 1/7		
10000	5/16		
15000	1/8 S		

CHOKES

5 Hen	2 amps	14 Hen .13 amps
2.6 Hen	.80 amps	15 Hen .50 amps
7 Hen	.57 amps	Thord'n T60650
8 Hen	.52 amps	Thord'n T19C45
12 Hen	.10 amps	Specially Priced

BATHTUB CONDS.

Mfd	Volts	Price	Mfd	Volts	Price
.01-.01	600	$.25	.25	600	.41
.02-.02	600	.25	.25	1000	.48
.04-.04	600	.25	.3	400	.15
.05	600	.20	.5	400	.37
.05-.05	600	.25	.5	600	.47
.08-.08	600	.25	.5	1000	.52
.1	600	.39	2x.5	600	.59
.1	1000	.42	1	200	.25
.1	1200	.45	1	300	.30
.1-.1	400	.29	1	400	.45
.1-.1	600	.39	1	600	.59
.1-.1	1000	.51	2	400	.60
3x.1	600	.40	2	600	.91
.2	1000	.21	4	100	.40
.25	300	.19			
.25	400	.30			

S.p. Bathtube Kit 15 @........ 1.00

CHANNEL CONDS.

Mfd	Volts	Price	Mfd	Volts	Price
2x.05	600	.30	.4	600	.30
.1	500	.28			
.1	600	.32	.5	400	.21
.1	2500	1.20			
2x.1	400	.34	.5	500	.43
2x.1	600	.40	.5-.1	600	.39
3x.1	400	.40	.5	600	.49
.25	600	.43	1	500	.58
2x.25	600	.48	1	600	.63

—SUPER SPECIALS—

Freq. Meter BC 906	$15.95
RAK-7 Rcvr & Pwr. Sup	40.00
BC-1080 Driver	50.00
Record Player & Amp	10.00
Blower, dual 230 V	3.00
Tunger Rect. (Hvy Duty)	12.00
Choke 165 MA, 5H. 160 ohms	.89
Octal Socket	.07
Pilot L. Assem. Grn & Blue	.25
Beachmaster PA Unit	75.00
Prec. WW-1 5400 ohms	.20
Prec. WW-3 32,888 ohms	.12
Prec. WW-3 35,888 ohms	.12

POWER SUPPLY

#CJP-20ABX for ASB 7/7A/7B equip. 800 cy. 115V. inp. 2.5/56.5/880/2000V. out. Contains 6AC7, 5T4 & 2X2, plus oil conds; chokes, resistors, connectors & switches. Parts alone, easily removed worth considerably more. Brand new. Individually boxed. Qua. discount.........................$6.75

WANTED

Condensers of all types in any quantity. Also other standard components. Top prices.

Write: **ART HANKINS, Owner**

MONMOUTH RADIO LABORATORIES

BOX 159 Long Branch 6-5192 OAKHURST, N. J.

Somebody—Somewhere,

can use the equipment you want to sell!

Reach that buyer quickly and economically thru the

"SEARCHLIGHT SECTION"

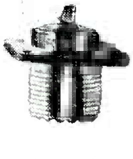
The meeting place of Used Equipment Buyers and Sellers

LIFE ELECTRONIC SALES

THE ONLY COMPLETE SOURCE OF UHF CONNECTORS UG CONNECTORS AN CONNECTORS


PL-259A

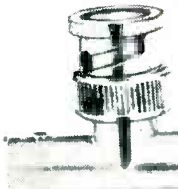

PL-259

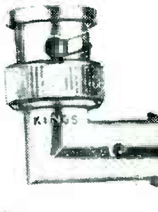

SO-239

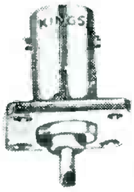
FROM STOCK

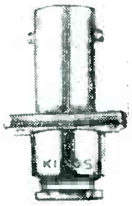
NO.	JAN NO.	DESCRIPTION	1-99	100 TO 999	1000 AND OVER
83-IR	SO 239	RECEPTACLE	$ .50	$ .45	$ .40
83-ISP	PL 259	PLUG	.55	.55	.50
83-168	UG 176/U	ADAPTER	.15	.12	.11
83-185	UG 175/U	ADAPTER	.15	.12	.11
83-ISPN	PL 259A	PLUG	.65	.60	.55
83-776	UG 203/U	PLUG	.65	.60	.55
83-IRTY	....	RECEPTACLE	.75	.65	.65
83-IH	UG 106/U	HOOD	.15	.14	.13
83-IHP	....	HOOD	.27	.24	.22
83-765	UG 177/U	HOOD	.24	.24	.24
83-IAC	....	CAP & CHAIN	.55	.50	.45
83-IBC	....	CAP & CHAIN	.35	.31	.30
83-IT	M 358	T CONNECTOR	1.50	1.40	1.40
83-IAP	M 359	ADAPTER	.35	.30	.28
83-IAP	M 359A	ADAPTER	.80	.75	.70
83-IJ	PL 258	JUNCTION	.75	.70	.65
83-IF	PL 274	FEED THRU	1.25	1.20	1.10
83-22SP	UG 102/U	TWIN PLUG	.90	.80	.75
83-22R	UG 103/U	RECEPTACLE	.90	.80	.75
83-22AP	UG 104/U	ADAPTER	1.40	1.25	1.10
83-22J	UG 105/U	JUNCTION	1.50	1.40	1.40
83-22T	UG 196/U	T CONNECTOR	1.65	1.50	1.50
83-22F	PL 275	FEED THRU	2.00	1.80	1.75
83-2SP	PL 295	PLUG	2.25	2.15	2.00
83-2R	SO 265	RECEPTACLE	1.65	1.55	1.50

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
UG 9/U	$ 1.95	UG 57/U	$ 2.30	CW 155/U	$ .63	UG 254 A/U	$ 3.50	UG 496/U	$ 3.50
UG 10/U	2.75	UG 57 B/U	1.85	UG 155/U	9.50	UG 255/U	2.85	UG 499/U	1.50
UG 11/U	2.25	UG 58/U	.80	UG 156/U	8.50	UG 256/U	15.50	UG 503/U	50.00
UG 12/U	1.55	UG 58 A/U	1.25	UG 157/U	8.50	UG 257/U	15.50	MX 504	.45
UG 13/U	2.25	UG 59/U	2.45	UG 158/U	47.50	UG 259/U	6.50	UG 505/U	50.00
UG 14/U	1.80	UG 59 A/U	2.15	CW 159/U	1.95	UG 260/U	1.20	UG 506/U	50.00
UG 15/U	1.25	UG 59B/U	2.75	UG 159 A/U	2.20	UG 260 A/U	1.40	UG 507/U	50.00
UG 16/U	2.75	UG 60/U	2.40	UG 160 A/U	2.20	UG 261/U	1.20	UG 526/U	3.75
UG 17/U	2.75	UG 60 A/U	2.25	UG 160 B/U	2.50	UG 262/U	1.20	UG 530/U	4.50
UG 18/U	1.75	UG 61/U	2.55	UG 166/U	47.50	UG 266/U	4.50	UG 531 U	5.15
UG 18 A/U	1.75	UG 61 A/U	2.40	UG 167/U	5.75	UG 269/U	3.75	UG 532-U	6.95
UG 18 B/U	1.75	UG 83/U	1.95	UG 167 A/U	5.75	UG 270/U	10.00	UG 533/U	10.00
UG 19/U	2.25	UG 85/U	2.00	UG 173/U	.38	UG 271/U	10.00	UG 535/U	4.95
UG 19 A/U	2.25	UG 86/U	2.80	UG 174/U	20.00	UG 272/U	25.00	UG 536/U	2.45
UG 19 B/U	1.95	UG 87/U	1.60	UG 180 A/U	10.00	UG 273/U	2.55	UG 541/U	3.95
UG 20/U	1.95	UG 88/U	1.10	UG 181 A/U	10.00	UG 274/U	3.95	MX 554/U	2.25
UG 20 A/U	1.90	UG 88 B/U	1.95	UG 182 A/U	10.00	UG 275/U	7.50	UG 557/U	5.50
UG 20 B/U	1.90	UG 89/U	1.35	UG 185/U	1.35	UG 276/U	7.50	MX 564/U	.55
UG 21/U	1.25	UG 90/U	1.60	UG 188/U	1.30	UG 279/U	3.95	UG 564/U	3.95
UG 21 A/U	1.95	UG 91/U	1.95	MX 195/U	1.00	UG 286/U	4.95	UG 565/U	3.95
UG 21 B/U	1.45	UG 91 A/U	1.70	UG 197/U	4.95	UG 287/U	7.75	UG 566/U	7.95
UG 21 C/U	1.75	UG 92/U	1.80	UG 201/U	2.75	UG 290/U	1.20	UG 567/U	6.95
UG 21 D/U	1.95	UG 92 A/U	2.25	UG 202/U	3.95	UG 291/U	1.25	UG 568/U	4.95
UG 22/U	1.65	UG 93/U	1.95	UG 204 A/U	3.50	UG 294/U	2.20	UG 569/U	2.95
UG 22 A/U	1.60	UG 93 A/U	2.25	UG 206/U	2.00	UG 299/U	7.75	UG 570/U	2.95
UG 22 B/U	1.50	UG 94/U	2.25	UG 207/U	25.00	UG 306/U	2.95	UG 571/U	6.95
UG 22 C/U	1.95	UG 94 A/U	1.60	UG 208/U	22.50	UG 309/U	3.75	UG 572/U	5.95
UG 23/U	1.65	UG 95/U	1.95	UG 212 A/U	3.50	UG 332/U	3.50	UG 573/U	7.25
UG 23 A/U	1.95	UG 95 A/U	2.00	UG 213 A/U	4.10	UG 333/U	5.50	UG 602/U	3.00
UG 23 B/U	1.75	UG 96/U	2.10	UG 215/U	5.50	UG 334/U	6.50	UG 603/U	3.00
UG 23 C/U	1.95	UG 96 A/U	1.95	UG 216/U	14.00	UG 335/U	3.75	UG 625/U	1.70
UG 27 A/U	3.75	UG 97/U	4.25	UG 217/U	7.50	UG 347/U	2.50	UG 627/U	7.25
UG 27 B/U	3.75	UG 97 A/U	3.95	UG 218/U	10.00	UG 348/U	1.50	UG 628/U	7.25
UG 27C/U	4.50	UG 98/U	2.50	UG 219/U	7.50	UG 349/U	3.50	UG 634/U	4.95
UG 28/U	3.95	UG 98 A/U	2.70	UG 220/U	10.00	UG 352/U	7.50	MX 913/U	.65
UG 28 A/U	3.95	UG 100/U	2.95	UG 222/U	43.75	UG 352A/U	9.00	UG 931/U	3.00
UG 28 B/U	4.50	UG 100 A/U	3.75	UG 223/U	6.50	MT 412	.95	UG 932/U	3.00
UG 29/U	1.00	UG 101/U	4.45	UG 224/U	1.20	UG 414/U	2.95	IPC Miniature Connector	
UG 29 A/U	1.90	UG 101 A/U	4.55	UG 231/U	2.70	UG 419/U	1.95		
UG 29 B/U	1.90	UG 107 A/U	4.50	UG 233/U	18.50	UG 421/U	3.25		
UG 30/U	2.50	UG 107 B/U	4.50	UG 234/U	18.50	UG 422/U	3.25		
UG 32/U	19.00	UG 108/U	2.90	UG 235/U	35.50	UG 423/U	5.80		
UG 33/U	19.00	UG 108 A/U	3.25	UG 236/U	12.00	UG 447/U	1.50	MC 10	.36
UG 34/U	19.00	UG 109/U	2.30	UG 237/U	25.00	UG 478/U	50.00	MC 20	.46
UG 35 A/U	19.00	UG 109 A/U	2.90	UG 241/U	3.45	UG 479/U	33.80	MC 30	.82
UG 36/U	19.00	UG 110/U	15.00	UG 242/U	3.95	UG 482/U	33.80	MC 40	.86
UG 37/U	19.00	UG 114/U	2.15	UG 243/U	4.50	UG 483/U	4.65	MC 50	.36
UG 37 A/U	19.00	UG 115/U	2.25	UG 244/U	4.00	UG 484/U	5.80	MC 60	.46
UG 38 A/U	22.00	UG 119 U/P	7.50	UG 245/U	2.50	UG 486/U	2.30	MC 70	.82
UG 39/U	1.75	CW 123 A/U	.55	UG 246/U	3.10	UG 487/U	6.50	MC 80	.86
UG 40/U	1.95	UG 131/U	10.00	UG 249/U	18.50	UG 491/U	2.25	MC 100	1.20
UG 45/U	5.00	UG 146/U	2.95	UG 250/U	18.50	UG 492/U	5.00	MC 110	1.12
UG 46/U	5.00	UG 148 A/U	7.85	UG 251/U	18.50	UG 493/U	7.25	MC 120	.36
UG 49/U	20.00	UG 149 A/U	5.25	UG 252/U	7.50	UG 494/U	4.75	MC 150	.75
UG 50/U	20.00	UG 154/U	9.50	UG 253/U	5.50	UG 495/U	7.50	MC 250	1.50









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NEW LISTING

Made from the finest Brazilian Quartz. Will provide a high degree of activity and frequency stability. All tested and marked by the manufacturer to a very close tolerance. In the frequencies outlined below the crystals itemized under the heading "From & To" are mostly in progressive frequencies between the limits shown (as for example: "From 3300 to 3377," are as follows: 3300KC, 3301KC, 3302KC—, 3377KC.) are of limited quantities in each frequency. Those listed singly are in quantities of 50 or more.

FT243

Prong centers ½", Prong dia. 3/32"

Price $1.15 ea. (25 for $25.00)

FROM	TO
1915	1995
2030	2065
2125	2155
2300	
2320	2390
2420	2490
2604	
2605	
2750	
2880	
2940	
3110	
3215	
3652	3689
3729	3799
3805	3823
4014	4100
4104	4150
4244	4290
4300	
4305	4397
4400	4480
4600	4690
4735	4799
4800	4898
4913	4941
5065	5092
5100	5195
5200	5295
5300	
5320	5397.5
5630	
5633 3	
5655 5	
5677 7	
5700	
5706 6	5775
5800	5892
5900	5975
6000	6075
6150	
6175	

FROM	TO
6100	6173.3
6200	
6250	
6275	
6206	6292
6300	6375
6400	6498
6500	
6506.6	6675
6700	6775
6800	6875
6815	
6830	
6900	6975
6978 75	
7228	7281
7325	7375
7458.75	
7425	7475
7500	7597
7606	7673.3
7625	
7650	
7675	
7700	
7725	
7728.8	
7750	
7751 25	
7773 75	
7775	
7716	784
7800	
7825	
7850	
7875	
7900	
7925	
7950	
7925	
7906	7968
8000	

FROM	TO
8025	
8050	
8075	
8100	8175
8200	8275
8300	8375
8385	
8400	8475
8500	8575
8600	8650
8786 25	
8808 75	
8876 25	
8921 25	
9135 0	
9254	9284
9342	9399
9405	9499
9500	
9516	9589
9608	9668
10075	
12608	12698
12700	12783
12800	12890
12902	12998
13004	13009
13010	13099
13100	13196
13213	13299
13302	13361
13400	13496
13500	13554
13636	13684
13702	13799
13837	13897
13903	13996
14038	14092
14110	14198
14281	14391

CR 1A/AR or FT241

Prong spacing ½", Prong dia ⅛"

Price 79¢ ea. 12 for $9.00

FROM (Frequencies in KC)	TO
2853	
3988	
4188	
4285	
4300	4374
4640	
4788	
5020	5090
5100	
5120	5180
5200	5295
5250	
5300	5396
5410	
5470	
5500	
5648	
5740	5780
5810	
5891	
5910	
5923	5960
6011	6080
6130	6195
6203	6275
6270	
6300	6375
6370	
6400	6499
6490	
6500	6590
6600	6685
6744	
6815	6877
6905	6980
7270	
7330	
7440	
7460	
7500	
7560	
7600	
7620	
7625	

FROM (Frequencies in KC)	TO
7650	
7738	
7740	
7750	
7760	
7770	
7775	
7778	
7780	
7790	
7800	
7810	
7825	
7830	
7850	
7851	7880
7900	
7910	
7925	
7930	
7940	
7950	
7970	
7975	
7990	
8000	
8001	
8002	
8008	8010
8007	
8012	
8010	8092
8205	8298
8308	
8300	8370
8407	
8412	
8405	8490
8506	8561
8645	
8630	8650
8985	
11677	

XL5 Dual

3 prongs ½" X 1 19/32" prong dia.

Price $1.95 ea.

2520 & 2698
2731 & 2891
2436 & 2276
3128 & 3153
2605 & 3153

XL5 Single

3 prongs ½" X 1 19/32" prong dia.

Price $1.35 ea.

FROM	TO
2200	2210
2300	2384
2410	2450
2561	
2600	2698
2704	2787
2802	2891
2916	
3117	3171
3154	
3325	3371
3435	
3857	

FT241A

SPECIAL TYPE WE.
Prong spacing 1" CTS.
Prong Size 3/32" dia.

These are in successive steps of .1 MC variation from 20.0 MC to 38MC.

Suitable for low frequency purposes (1/72 of Stated Values)

Price $1.15 ea.

UNASSEMBLED CRYSTALS

consists of quartz crystal plates made for FT243 holders. Furnished complete with holders, electrodes, springs and all hardware.

Price .29 ea.

Crystal plates available in the following frequencies:—

7533
7541
7550
7640
7650
7700
7750
7775
7800
7825
7850
7873
7950
8275
8325
8450
8475
8750

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"NEW" TRANSMITTER-RECEIVER AN/FRC-1

An extremely versatile transmitter-receiver with a very desirable frequency range from 1.5 mc to 12.5 mc (200-24 meters) Ideal for *Airport Traffic Control.*

Power Output. . . . . .150-250 watts
Transmission. . . . . . . .Phone, CW, MCW
Power Input. 90-120, 200-230v 50/60

COMPONENTS

1. TRANSMITTER
2. RECEIVER
3. MODULATOR
4. POWER SUPPLY
5. DELUXE CABINET
6. REMOTE CONTROL
7. CABLES
8. KEY AND MICROPHONE

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Leeds and Northrup-Test set #5430-A for both Varley and Murray loop. Used but in excellent working condition. Price . . . .$92.50 each

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G.E. Type SH 110 V. 60 cycle 1 PH 1/40 HP 1800 RPM, double end shaft, completely overhauled . . . . .Price $35.00 Other Synchronous Motors in stock. Send us your inquiries.

THREE SPEED MOTORS

3600-5000-10,000 RPM No Load. Governor controlled. Made by EMC 115 Volt .8 amp. AC and DC. Overall size 6" x 3¼, shaft ¼x1¾ long. . . . . .Price $7.50

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The Versatile Indicating Desicant size #8 mesh in 6 oz. bottles, 24 bottles to a case. In case lots $4.80 per case. Minimum order 6 bottles for. $1.50

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CORDAGE

CO-122 3 conductor each #22 AWG neoprene jacket 550' lengths

CO-127 single #14 AWG braided and tinned copper braid shield

MULTI-CONDUCTOR

2 conductor AWG 12
7 conductor AWG 14
14 conductor AWG 16
11 conductor shielded AWG 20
2 conductor AWG 18
7 conductor AWG 16
19 conductor AWG 16
6 conductor AWG 20
10 conductor AWG 16
22 conductor AWG 16
2 conductor shielded AWG 10

ARMOUR

DRIA-23 DHFA-100 FRIA-4

SINGLE CONDUCTOR AWG 10

shielded cable with terminal lug each end 100' and 150' lengths

WIRE

AWG 18 copperweld
AWG 29 tinned copper
Resistance wire AWG 32
AWG 22 with nylon core plastic insulation

LINEAR WIRE WOUND POTENTIOMETERS

10 Ohm	25 Watt	$.90	15000 Ohm	25 Watt	$1.70
15	25	.95	20000	25	2.00
20	25	.95	6	50	1.60
25	25	.95	150 /switch	50	2.15
50	25	.95	200 w/switch	50	2.15
100	25	.95	10000	50	2.95
200	25	1.20	15	75	2.95
350	25	1.20	.5 Meg 1" shaft	AB "J"	1.45
500	25	1.20	200.000 1/8 SD	AB "J"	1.40
1000	25	1.30	200 1/8 SD	AB "J"	1.40

SPECIALS

80-86 Crystal in Holder $2.50
Balloon with Hydrogen Generator $2.50
300 Feet Aerial Wire $2.00
Box Kite 17" x 17" x 36" $2.25

MICROWAVE TEST EQUIPMENT

10 CM echo box CABV 14ABA-1 of OBU-3, frequency range 2890 MC — 3170 MCS. Direct reading micrometer head. Ring prediction scale plus 9% to minus 9% Type "N" input. Resonance indicator meter. With accessories, spares and 10 CM directional coupler. Brand New

TUBES

2C34	$0.55	803	$3.75	CEQ-72	$1.15
2X2/879	.60	826	.95	CK-70	4.25
3B24	5.00	864	.40	CRP-72	1.15
3C24	1.75	931A	4.45	E1148	.35
7C4/1203A	.75	955	.40	HY-615	.20
10Y	.45	957	.40	RKR-72	1.15
15R	.70	CK1005	.50	RK-73	.60
30 Special	.45	CK1007	.90	5BP4	4.95
39/44	.30	1626	.40	5FP7	1.95
45 Special	.35	1629	.35	1J6G	.70
WE 203A	8.00	2051	1.15	1B3GT	.89
316A	.65	7193	.50	3A4	.65
WL-531	5.50	8011	1.50	5U4G	.57
713A	.95	9006	.40	6K6GT	.65
801A	.40	C5B	8.50	12A6	.65

HI VOLTAGE FILTER CHOKES

.4 HY 4.5 Amp DC 3 ohms 1230 RMS to ground. New.
.25 HY 4 Amp .5 ohm 20,000 Test. New.
1 HY 3.2 Amp DC 3.5 ohm GE69G459. New.
1.7-3 HY 2 Amp DC 34,000 VDC GE Y346A. New.

NAVY ENTERING TYPE INSULATOR

Porcelain flanged bowl with brass rod, fittings and aluminum shield. Dimensions 4⅜" high, 6-5/16" OD at base. Brand new $4.50

10 CM ROTATING ANTENNA

24" Parabola in turret 360° span at 12 RPM DC, motor control and reversing switch New

TIME DELAY SWITCHES

1 Minute 115 VAC 60 cycle Enc. in Waterproof Metal Case New $5.25
3 Micro Switches Contact at 40-41-42 Second Time Delay 110 VAC Motor New $4.50
Thermo Switch 50° to 300° F 115 VAC @ 6A 230 VAC @ 5A
Breaks Contact with Increase in Temperature New $1.35

CONTACTORS

DPST 115 VAC 60 cycle 15 Amp De-Ion Line Starter Westinghouse $6.95
DPST 115 VAC "AB" #700 $5.95

RELAYS

12 VDC DPST Allied Control Box 32	$1.25
24 VDC DPDT Allied Control BJ6D36	$1.45
24 VDC 3PDT 8 Amp	$1.50
110 VAC DPST 1 Amp Contacts Struthers Dunn CKA 1970	$3.65
115 VAC DPST Struthers Dunn CXA 2997	$3.65
220 VDC DPDT Struthers Dunn CK 2122	$4.50
230 V 50 cycle DPDT G.E. 12HGA11A2	$4.00

ROLLER INDUCTANCE COIL 0-15 MH WITH VERNIER ADJUSTMENT

Coil is wound on ceramic form 3⅛" long. Right angle drive gear with ⅝" shaft. Three position switch for vernier operation
New—Meissner—C-625

METERS

Portable 0-25 Amps AC Weston #433 Brand New $37.50
Switch Board Panel 0-100 Amps DC Weston #269 with 100 Amp Shunt Brand New $24.95

EQUIPMENT

Walkie-Talkies 2.3-4.6 MC
MN-26Y Bendix Compass Receiver
BC-733 Glide Path Receiver
DAB-3—Direction Finder
RDF Receiver Equipment 200-550 KC Fixed Tuned

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1.5	GENERAL ELECTRIC DW-52, 2½" rd metal case, black scale @	$3.50
2	WESTINGHOUSE RT-35, 3" square @	6.95
2.5	WESTINGHOUSE NT-35, 3½" round, S.C. type IS-111, Stock # 3F311 @	7.50
3	WESTON 425, 3½" rd. with external couple and leads @	9.50
4	GENERAL ELECTRIC DW-52, 2½" rd. @	4.95
6	GENERAL ELECTRIC DW-44, 2½" rd., black scale, S.C. type IS-182, Stock # 3F382 @	5.50
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0-1	WESTINGHOUSE NX-35, 3½" rd. AWS type MR34W001DCAA @	$6.00
0-3	SIMPSON 25, 3½" rd. @	8.70
0-10	SIMPSON 25, 3½" rd. @	8.70
0-15	SIMPSON 25, 3½" rd. @	8.70
0.25	SIMPSON 25, 3½" rd. @	8.70
0-30	GENERAL ELECTRIC DW-51, 2½" rd. metal case @	4.50

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0-3	SIMPSON 25, 3½" rd. @	$8.85
0-15	SIMPSON 25, 3½" rd. @	8.85
0-15	GRUEN, 2½" rd. @	4.50
0-30	WESTON 301, 3½" rd. @	9.50
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0-150	HOYT 17-L, 3½" rd. metal case @	4.50
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0-1	DEJUR 310, 3½" rd. 4 KV scale @	$4.95
5-0-5	WESTERN ELECTRIC, 3½" rd., concentric style @	$4.00
0-15	SIMPSON 26, 3½" rd., AWS type MR35W015DCMA @	6.00

A.C. AMMETERS

100	MAAC, WESTON 476, 3½" rd. @	$7.50
3	AMP, SIMPSON 55, 3½" rd. @	8.10
5	AMP, SIMPSON 55, 3½" rd. @	8.10
10	AMP, BURLINGTON 142, 4" surf. mtd. @	4.95
50	AMP, SIMPSON 55, 3½" rd. @	9.30
150	AMP, WESTINGHOUSE NA-35, 3½" rd., 5 amp mvt., use with external Current Transformer @	6.00
	CURRENT TRANSFORMER, 150/5, for above @	7.50

A.C. VOLTMETERS

3	SIMPSON 55, 3½" rd. @	$8.10
10	SIMPSON 55, 3½" rd. @	8.10
15	WESTINGHOUSE NA-35, 3½" rd., AWS type MR35W015ACVV @	5.50
50	SIMPSON 55, 3½" rd. @	8.10
150	SIMPSON 55, 3½" rd. @	9.60
300	SIMPSON 55, 3½" rd. @	9.60
300	TRIPLETT 232C, 2½" rd. metal @	6.00
500	SIMPSON 55, 3½" rd., with external resistor @	13.50

D.C. MICROAMMETERS

0-50	SIMPSON 25, 3½" rd. @	$11.85
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0-100	SIMPSON 25, 3½" rd. @	11.25
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Besides this unit we are presently making the TS-117, the TSX-4SE, TAA-16EA, TS-89, TS-102A/AP, TS-189, SG-8U, TS-268, AN-UPM-13, etc. Other equipment available from Weston Laboratories is partially listed below:

TS-1ARR
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TS-8A/U
TS-10A/APN-1
TS-11/AP
*TS-12
*TS-13
TS-14
TS-15B/AP
TS-16/APN
TS-18
TS-19
TS-23/AP
TS-25/TSM
TS-27/TSM
TS-32A/TRC-1
TS-33/AP
TS-34AP
TS-34A/A
TS-35/AP
TS-36/AP
TS-24/APM-3
TS-46/AP
TS-47/APR
TS-48
TS-51/APG-4
TS-55/AP
TS-60/U
TS-61/AP
TS-62/AP
TS-63/AP
TS-76/APM-3
TS-87/AP
TS-83/AP
TS-96/TPS-1
TS-98/AP
TS-100/AP
TS-101/AP
TS-102/AP
TS-108/AP
TS-110/AP
TS-111/CP
*TS-117/GP
TS-118/AP
*TS-125/AP
TS-127/U
TS-131/AP
TS-142/APG
TS-143/CPM-1
TS-144/TRC-6
TS-145
*TS-147/UP
*TS-148/UP
TS-153
TS-153(*)
TS-170/APN-5
TS-173/UR
TS-174/U
TS-175/U
TS-184/AP
TS-189/U
TS-192/CPM-4
TS-194/CPM-4
TS-197/CPM-4
TS-198/CPM-4
TS-203/AP
TS-204/AP
TS-205/AP
TS-210/MPM
TS-213/UP
TS-220/TSM
TS-226A
TS-233/TPN-2
TS-239A
TS-251
TS-253
TS-258
TS-270A/UP
TS-281/TRC-7
TS-285/GP
TS-294/U
TS-297/U
TS-301/U
TS-303A/G
TS-311/FSM-1
TS-323
TS-324/U
TS-328
TS-338
TS-359A/U
TS-363/U
TS-375
TS-377/U
TS-389/U
TS-421/U
TS-437
I-56
I-61B
I-83A
I-95/A
I-98/A
I-106/A
I-114
I-115
I-122
I-122-B
I-126
I-130A
I-134B
I-137A
I-139A
I-145
I-147
I-153A
I-167A
I-177
I-178
I-195A
I-198A
I-203/A
I-212
I-222/A
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I-225
I-233
IE-21/A
IE-36
IF-12/C
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IS-189
AN-PNS-1
BC-221(*)
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BC-438
BC-439
BC-838
BC-9
BC-949/A
BC-1060/A
BC-1066/A
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BC-221
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TS-11
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TS-19
TS-45
TS-51
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TS-143
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3,741	.003	⅞	⅜	7/16	3

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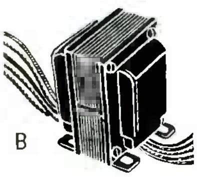

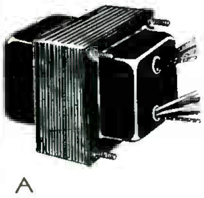

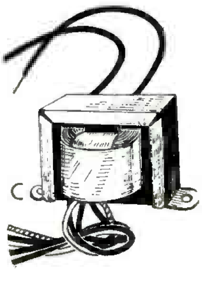

Type	Specifications	Figure	Mtg. Centers	Weight	H. W. D.	Stock No.	Your Cost
20 MA.	400VCT. 6.3V/3M, 6.3/1A	C	1⅝"x2⅜"	2½ lbs.	2¾"x3" x2⅜"	7934	$1.95
50 MA.	PRI. 110V./220V. SEC. 600V. CT 6.3V. 3A.	A	2¼"	2½ lbs.	3½"x3" x2½"	8006	2.00
50 MA	480V. CT 6.3V. CT 2A. 5.0V. 2A. Electrostatic Shield	A	2"x2½"	2¼ lbs.	2⅞"x2½"x3"	239	1.80
60 MA.	6.3 5A. 450V. CT	A	2"x2½"	2½ lbs.	2½"x2½"x3"	60737	1.85
90 MA.	550V. CT 6.3V. 3A.	A	2½"x2⅞" x 3⅜"	5 lbs.	3½"x2⅞"x3⅜"	61433	2.50
120 MA.	PRI. 110-220V. SEC. 550V. CT, 6.3V. 4A.	A	2¼"x2⅞"	5 lbs.	4¾"x3⅜"x2¾"	306836	2.95
120 MA	750V 125MA, 5.0V 2A, 6.3V. 4A, 6.3V 2A	A	2⅞"	7 lbs.	4½"x3" x3¾"	#1196	3.85
200 MA.	800V. CT 5.0V. 3A. 2.5V. 3A. 2.5V. 1.5A. 2.5V. 1.5A.	A	3"x3"	14 lbs.	5½"x4½"x3¾"	24526	3.95
250 MA.	750V. 6.3V. 9A. 5.0V. 3A.	A	3½"	11 lbs.	3⅞"x4⅞"x4⅝"	8396	5.95
305 MA.	768V. CT 5.0V. 6A. 6.3V. 6A. (Matched Pair) Plate & Filament	A	(P) 3¼"x4⅛" (F) 3"	10 lbs. 5 lbs.	5¼"x4½"x3¾" 3⅜"x3⅞"x3¼"	3039	5.75 (per pair)
PLATE	Sec. 768V/CT 305 MA.	A	3¼"x4⅛"	10 lbs.	5" x4⅝"x3¾"	3056	3.25
STANCOR STEPDOWN	500 WATTS 220 to 110V.—50-60 CY	F	3" x4"	15 lbs.	4⅝"x3⅞"x5¼"	P 6141	9.95
6.0V.	24 AMPS	B	3" x3¼"	8 lbs.	4½"x3¾"x5"	2546	5.95
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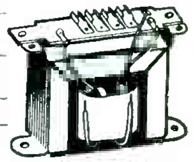
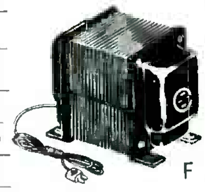
T. V. Vertical Output	10-1 Ratio	C	2⅞"	1 lb.	2" x2¼"x2"	T-116	1.50
6L6 Output	20 Watts P.P. To: 8 Ohms and 500 Ohms	D	3½"	2 lbs.	2½"x4" x2¼"	36434	1.50
6V6 Output	⅝"x⅝"	C	2⅜"	½ lb.	1½"x1½"x1⅞"	6003	.45
6V6 Output	20 Watts P.P.	D	3 5/16"	2 lbs.	2¾"x2½"x4"	198G7	.80
Auto-Vibrator	50 MA.	C	2 7/16"	½ lb.	2" x2½"x1⅞"	8415	.85
Auto-Vibrator	80 MA.	C	2⅜"	2 lbs.	2⅝"x3" x2⅛"	7682	1.25
Auto-Vibrator	120 MA.	E		2½ lbs.	3"x2¾" x2¼"	6133	1.45





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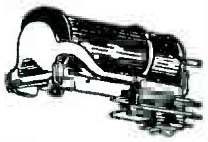

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2) 5800 ohms	3A	5 MA	2.50 ea.
3) 5800 ohms	2B-1C	5 MA	2.50 ea
4) 4850 ohms	1C	4 MA	2.50 ea
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6) 4850 ohms	1A	5 MA	2.00 ea.
7) 3300 ohms	(None)	ACTUATOR	1.50 ea.

All above Relays may be used for continuous duty operation on 110V, D.C.

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(A) Normally open set of contacts.
(B) Normally closed set of contacts.
(C) Single pole double throw set of contacts.
MA = Milliamps.

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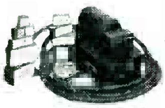

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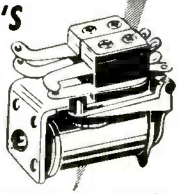

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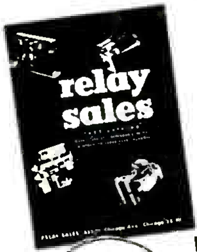

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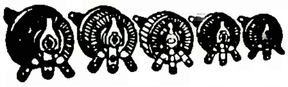

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.5	25	1.98	75	25	1.98	500	300	9.49
.5	50	2.81	75	75	3.90	585	150	6.59
.5	150	5.93	80	50	2.53	750	25	2.23
1	50	2.81	80	500	12.46	750	150	5.46
2	50	2.81	100	25	1.98	1000	25	2.53
2	100	4.68	100	50	2.53	1000	50	2.66
2	300	8.42	100	100	4.39	1200	225	7.20
3	100	4.67	125	25	2.23	1200	300	8.40
3	225	6.58	150	50	2.53	1250	50	2.66
4	225	6.60	175	25	2.23	1250	150	6.10
5	25	1.97	185	25	2.23	1500	25	2.53
5	50	2.53	200	25	2.23	1500	50	2.66
5	100	4.68	200	100	4.40	1600	50	2.66
6	25	2.23	200	150	5.04	1800	150	6.19
6	50	2.53	225	50	2.53	2000	25	2.53
6	75	3.90	250	25	2.23	2000	50	2.66
7	25	1.98	250	50	2.53	2250	150	6.24
7.5	75	3.95	300	50	2.53	2500	50	2.66
8	50	2.53	300	75	3.90	2500	100	4.68
10	25	2.23	300	100	4.40	2500	150	6.24
10	50	2.53	300	150	5.04	3000	25	2.66
10	100	4.37	350	25	2.25	3000	100	4.95
12	25	2.23	350	100	4.40	5000	25	2.66
12	50	2.53	370	25	2.23	5000	50	2.90
15	25	1.98	378	150	6.59	7500	50	2.90
15	75	3.90	400	25	2.23	7500	100	5.32
15	100	4.38	400	75	3.90	10000	50	2.99
20	50	2.53	500	25	2.23	10000	100	5.32
22	50	2.53	500	50	2.53	10000	100	5.51
25	25	2.23	500	75	3.95	15000	25	3.25
50	25	1.98	500	100	4.50	20000	150	8.75
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00015	5kv	.00015	10kv	.00015	20kv	.0006	35kv
0002	6kv	0002	10kv	.0004	20kv	.0025	25kv
.0008	6kv	.00025	12kv	.00045	15kv	.003	20kv
01	4kv	0003	10kv	.00047	20kv	0039	20kv
.032	2kv	000375	10kv	.0005	20kv	.0075	15kv
.04	1kv	.0004	5kv	.00095	5kv	.01	12kv
.051	1.5kv	.0005	10kv	.001	20kv	.03	8kv
.08	1.5kv	.00057	10kv	.0011	20kv	.056	5kv
.09	1.5kv	.00065	10kv	.00124	15kv		
		.001	10kv	.01	5kv		
				.015	3kv		
				.25	1.6kv		

C-D Type #56

.000155	30kv	.001	30kv
.0001	30kv	.03356	2 5kv
.000533	30kv	.007/15kv–70A/300kc	

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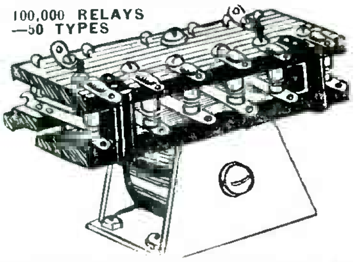

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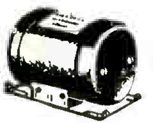
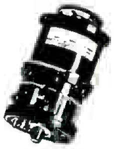

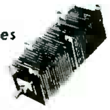

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6AQ5	.41	12BA6	.38
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6AV6	.37	19T8	.70
6AX4GT	.54	25BQ6GT	.77
6BA6	.38	25L6GT	.43
6BC5	.46	35B5	.41
6BD6	.41	35C5	.41
6BE6	.40	35L6GT	.45
6BG6G	1.21	35W4	.26
6BH6	.50	35Z5GT	.31
6BJ6	.41	50B5	.41
6BQ6GT	.77	50C5	.41
6C4	.32	50L6GT	.43
6CB6	.46	117Z3	.34
6CD6G	1.58		

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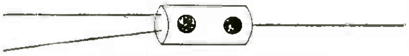

ACTUAL SIZE DCT-7

Operating power gain (db)	17
Power output (milliwatts)	25
Input imp. (ohms)	800
Output imp. (ohms)	24,000
Max collector (V.D.C.)	—45
Max emitter signal (V.D.C.)	+4
D. C. emitter current (ma)	0.4
Max collector current (ma D.C.)	2

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2 mfd	600 vdc	605	.89
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10 mfd	2000 vdc	TJU-20100	6.95
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1 mfd	3000 vdc	TJU-30010	3.50
0.1 mfd	4000 vdc	TJU-40001	2.50
0.5 mfd	4000 vdc	TJU-40005	3.45
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0.5 mfd	5000 vdc	26F405	3.95
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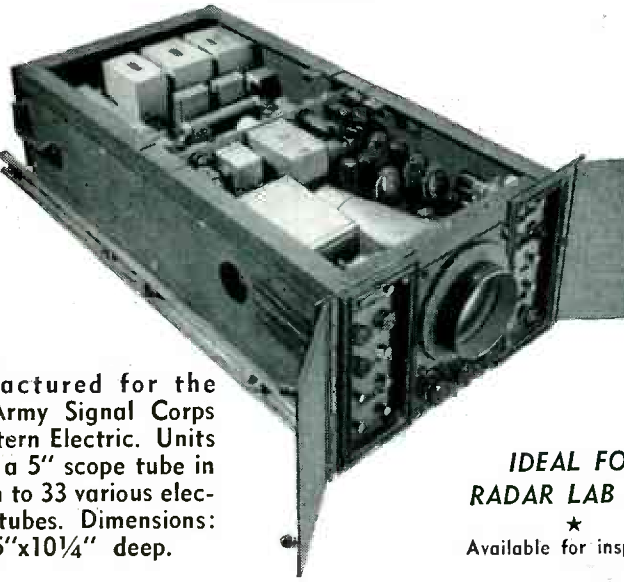

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6F6
6J6
6L6G

6SC7
6SN7GT
6T8
6W4GT
7A4/XXL
7A6
7B6
7C6

7F7
7Y4
12AT7
12AV7
12BA7
12BF6
12H6
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APS–4
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I–122
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TS3/AP
TS10A/APN
TS12/AP
TS16/APN
TS19/APQ

TS24A/ARR–2
TS27/TSM
TS34/AP
TS36/AP
TS–45A/APM–3
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TS62/AP
TS89
TS92
TS100/AP
TS111/CP
TS126
TS127/U
TS131

TS159
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Part #	Item
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565027	4–Pile Ceramic, Variable Cap.
K7890443	6–Pile Ceramic, Variable Cap.
564605	4 Centralab–Type 843–003 Cap Assembly

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R89
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AS-69/APT
ASB-5 Aircraft Radar
AT-49/APR-4 Aircraft Radar Antenna
ATD Aircraft Trans.
BEACHMASTER 250W. Sound System
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BC-221 Freq. Meter
BC-224 Rcvr.
BC-322 Transceiver
BC-443 Receiver
BC-604 FM Trans.
BC-611 Handy-Talky
BC-620 FM Trans-Rcvr.
BC-654 Trans-Rcvr.
BC-659 FM Trans-Rcvr.
BC-684 FM Trans.
BC-689 Transmitter
BC-701A Receiver
BC-733A Receiver
BC 745 Trans-Rcvr.
BC-969-T1 Receiver
BC-974-T2 Receiver
BC-797A VHF Trans.
BC-793B DF Rcvr., w/loop.
BC-1062A Range Unit
BC-1066A Receiver
BC-1068A VHF Rcvr.
BC-1149A Transmitter
BC-1236A Sig. Generator
BD-72 Switchboard
CRV-46136 Receiver
CRV-60028 Freq. Meter
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GO-9 Transmitter
GP-7 Transmitter
HLAS 500W. Sound System
I-148A Test Set
I-222A Sig. Generator
JEFF. TRAVIS 18W. Radiotelephone
J-70-A Junction Box
KY-3/APN-7 Coding Unit
LINK 1498 VHF Trans-Rcvr.
LRN-1A Loran Eqpt.
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QBE Underwater Sonic Eqpt.
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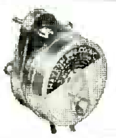

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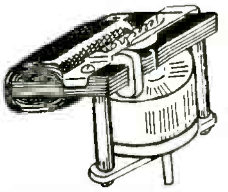

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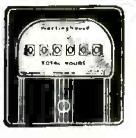

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Ledco's new, modern, U. S. Air Force approved standard laboratory with its highly skilled personnel has complete facilities for designing, calibrating, scaling and repairing panel meters, lab standards and special test equipment to your most exacting requirements.

Stock panel meters converted and rescaled to your specifications.

Let Us Know Your Requirements

Send for brochure of facilities on your company letterhead.

LEDCO, INC.
380 Great Neck Road
Great Neck, L. I., N. Y.
Phones: Great Neck 2-0081, 0082

Columbia

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★ NOTE!!! ALL PURCHASING AGENTS for export, industrial or military electronics! We have A-to-Z inventory of EVERYTHING IN RADIO. Write or contact us — especially for hard-to-get items. Remember: WE WILL NOT BE UNDERSOLD!

BC-639 VHF RECEIVER & RA-40 POWER SUPPLY

Variable freq. range of 100-156 MC. AM. 110 V. 60 cps. input. Checked out. Set of both items. $325.00

RADAR EQUIPMENT

ANTENNA AS-54-A/APQ-13. New.......P.U.R.
RT-39/APQ-5 TRANSMITTER-RECEIVER.P.U.R.
APR-1, APR-4, APR-5....................P.U.R.
ID-93/APG-13 .............................P.U.R.
APS-4, APS-13, RC-184 IFF. Complete....P.U.R.

HEADSETS & HANDSETS—Checked Out

HS-30. Used	$1.95	TS-13. New	$9.95
HS-23. New	4.95	HS-30. New	3.50
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SPECIAL OF THE MONTH:
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SCR-274N or ACR-5 (Medium or VHF frequency) Complete installation available P.U.R.
LORAN APN-4 Complete.................... 150.00
APN-1 ALTIMETER. Complete.......... 49.50

ARC-4
ARC-3
RTA-1B
ART-13
APT-9
SCR-269-G
BC-348
BC-733-D
R-89/ARN-5
BC-375
TA-2J24
TA-6
TA-12
ARR-5
ARR-7

SCR-625 MINE DETECTOR

NEW cond. .....$59.50 USED cond. $39.50

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BC-221
I-36
I-130A
I-222
LM
TS-10
TS-16
TS-34A
TS-46AP
TS-47APR
TS-124
TS-127
TS-170
TS-215/AP

BC-683 Frq. Meter.........................$150.00

IF YOU NEED IT—WE GOT IT!

WE STOCK COMPLETE LINE: Inverters, Motors, Meters, Dynamotors, Power Supplies. Also SCR-193, BC-312, BC-342, Halicrafter BC-610 Transmitter. 400 Watts. BD-71 & BD-72 Switchboard. Prices upon Request.

REMEMBER: WE ALSO BUY NEW AND USED RADIO GEAR. WE PAY TOP DOLLAR AND WILL BEAT ANY COMPETITIVE PRICE! WRITE US TO SELL ANYTHING IN RADIO.

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Frequency Measuring Components:
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General Radio 1109A Comparison Scope
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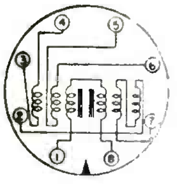
POLYSTYRENE ROD 1¾" DIAMETER X 4 13/32". TUBING 2" OD X 1¾" I.D. X 3½". ROD FITS TUBE. ALSO CAST LUCITE ROD 1¾" X 48". FRACTION OF MANUFACTURERS COST. LARGE QUANTITY. CONDITION PERFECT.

HOUSE BEAUTIFUL PLASTICS
DEPT. E9—742 W. 79TH
CHICAGO, 20

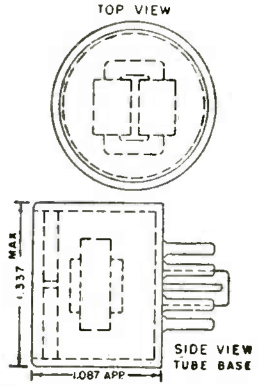
PULSE TRANSFORMERS

Tube base plug in type

Here are precision made, high quality compact pulse transformers wound on hypersill cores. They are built in octal bakelite tube bases and can be adapted to many uses. Kindly distribute this data to key personnel in your Electrical Engineering Department, to your Technical Library, to your Electronic Equipment Buyers and to any person who should have knowledge of this item.



TYPE UX 7350
EACH COIL - 50-T #36
MAX. DC RES. OHMS
1 & 8 = 4.02Ω
2 & 7 = 4.542Ω
3 & 4 = 2.357Ω
5 & 6 = 2.165Ω



OTHER DATA

- ★—Completely Impregnated and sealed.
- ★—Physically small, measuring only 1.377" dia. x 1.087" high.
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- ★—Schematic of winding sequence and connection pressed into disc covering top of tube base. Schematic designates socket connections.
- ★—The coils are wound on high-grade tested hypersil cores.
- ★—Used in some of the Navy's modern and highly accurate Radar and Direction Finding Equipment.
- ★—Standard types—Manufactured by Raytheon Manufacturing Company.
- ★ Quantities available—immediate delivery.

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- ★—Wherever Accurate Timing and Triggering are necessary.
- ★—Unexcelled in circuit applications for generating low power and low voltage pulses.
- ★—Can be used in circuits utilizing repetition rates from 0 to well over 1 MC and pulse widths ranging from .05 Microsecond up.

PRICE $4.50 EACH—Immediate Delivery

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EE-101-A 2-channel 1000/20 cycle carrier ringers.
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FMC 1 or 2 channels carrier telephone terminals, automatic regulation, duplex signaling each channel. Carrier frequencies above 35 KC. Ideal for adding channels above type "C".
Complete engineering and installation services offered.

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5..10..50 microamperes
THERMOCOUPLE MILLIAMMETERS
1, 5..5..10 milliamperes
THERMOCOUPLE VOLTMETERS
5 to 500 volts

Available in multiple range combinations

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Attn: Industrial Purchasing Agents . . .

Our new Radio Master Catalogue is available to you at no charge upon receipt of your request on your letterhead. We are National Distributors of General Electric, Sylvania, Ohmite, Amphenol, Sprague, Aerovox, Sangamo, Stancor, Merit, A. H. & H., Simpson and many others. All telegrams, cablegrams, and inquiries acknowledged and promptly answered.

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WESTINGHOUSE

1P1
1P8
1P13
1P26
1P29
132 AW
132 BW2
132 DW
133 AW
145 EW2
145 EWP
166 AW
175 AW
301445

UTAH

X 124 T-2
X 124 T-3
X 143 T-3
X 146 T-1
X 154 T-1
9280
9289
9318
92870

GENERAL ELECTRIC

68G813
68G894
68G979
80G13
80G58
80G59
K199T1
K2449
K2460
K2478
K2728
K24350

RAYTHEON

UX 7361-A
UX 7307
UX 7350

Tubes

OA2
OA3/VR-75
OA4
OB2
OB3/VR-90
OC3/VR-105
OD3/VR-150
1B22
1B23
1B24
1B26
1B32
1B35
1B36
1C21
1P23
1P28
1P40
1P42
2AP1
2AP1-A
2AP5
2B21
2B22
2C25
2C26
2C33
2C34
2C39
2C40
2C43
2C44
2C46
2C51
2C53
2D21
2E22
2E24
2E26
2E30
2E36
2J22
2J26
2J27
2J31
2J32
2J34
2J37
2J38
2J49
2J50
2J54
2J54-B
2J55
2J61
2J62
2K22
2K23
2K25
2K28
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2K33
2K34
2K43
2K44
2T4C
2V3-G
2X2
2X2A
3AP1-A
3AP1
3B7
3B22
3B23
3B24
3B25
3B26
3BP1
3C22
3C23
3C24
3C25
3C31
3C37
3C45
3CP1
3D21-A
EL-3C/4B24
3E29
3EP1
3FP7
3GP1
3JP1
3LF4
4-65A
4-125A/4D21
4B25
4C22
4D32
4E27
4J32
4J37
4J38
5BP1
5BP4
5C21
5CP7
5D21
5C22
5CP1
5CP7
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5J29
5JP1
5JP2
5LP5
5LP7-A
5UP1
5W4
6AC7
6AG5
6AJ6
6AK5
6AN5
6C4
6C21
6H6
6J6
6K7
6SG7
7BF7
7BP7
7C4/1203A
7JP4
9JP1
10
10E
10Y
12GP7
15E
15R
FG-17
TUF-20
RX21
CE-25
25-T
RK-34
35-T
REL-36
RK-38/100TH
RK-47/814
QK-60
QK-61
RX-61
RK-63
HY-65
RK-65/5D23
CEQ-72
CRP-72
CRP-75
HY-75
VR-75
FG-81A
VR-90
C-100E
100TH
FG-104
FG-105
VR-105
HY-114B
C-120
121A
VR-150
FG-172
FG-178
211/4621
227-A
RX-233A/2C33
249C
250R
250TH
250TL
267-B
271-A
274-B
304TH
304TL
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396A/2C51
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732AB
801A
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SD-917
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R-4410
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A-5640
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CK-5703
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6146/8008
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8025
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9003
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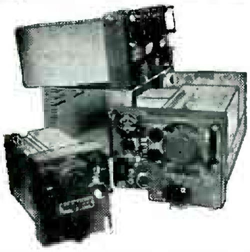
9006
38222/3B23
189048/4B28

Type G Mica's

.001	75KV	.000375	10KV
		.00025	10KV
.001	50KV	.0002	10KV
		.005	10KV
.001	35KV	.02	10KV
.002	30KV	.002	8KV
.0025	25KV	.00012	7KV
		.003	7KV
.00025	20KV		
.00015	20KV	.00025	6KV
.0005	20KV	.00024	6KV
.0003	20KV	.0006	6KV
.0002	20KV	.004	6KV
.002	15KV	.0015	5KV
.01	15KV	.006	5KV
		.01	5KV
.008	12KV		
		.0008	3KV
		.02	3KV
		.09	1.5KV

ALL OUR PRICES ARE IN LINE WITH THE EXISTING MARKET

Write—Phone—Telegraph **ELECTRONICS INC.** *92 Broad Street, Babson Park, Mass.* **WE 5-5210-1**



AN/APR-4 LABORATORY RECEIVERS

Complete with all five Tuning Units, covering the range 38 to 4,000 Mc.; wideband discone and other antennas, wavetraps, mobile accessories, 100 page technical manual, etc. Versatile, accurate, compact—the aristocrat of lab receivers in this range. Write for data sheet and quotations.

For the limited budget, we can supply AN/APR-1 Receivers (a predecessor to the APR-4), or even the earlier SCR-587; or individual Tuning Units covering the desired frequencies, for use as a converter feeding your own 30Mc. I. F. strip or receiver tuned to 30 Mc.

SOME SPECIAL ITEMS IN OUR STOCK: 723A/B Tubes, $12.00 postpaid . . . GL-446A Tubes (interchangeable with 2C40), $.75 each in lots of ten, postpaid . . . APR-5A Receivers (1,000-6,230Mc.) . . APA-10 Panadapters . . . G-R 804, Ferris 16C, Measurements 78B, etc. Signal Generators . . . BC-433 ADF Receivers, new . . . ARR-5, ARR-7, BC-348 etc. Receivers . . . BC-221, TS-323, etc. Frequency Meters . . . BC-1016 Code Recorders . . . BC-303B A-N Beacon Transmitters . . . RBL-3 Receivers (16-630Kc.) . . . TS-13, TS-14, etc. Microwave Units . . . APS-2 R-F Heads (new) . . . Northern Radio Oscillator-RF Bridge-Detector Equipment . . . Sonar Generator & 60-cycle Power Supply (17-27Kc, 600 Watts) . . . G-R 815-50 Cycle Standard Fork set . . . ARN-7, APN-1, ARR-1 Spares . . . ARC-1, ARC-3, ART-13, etc. . . .

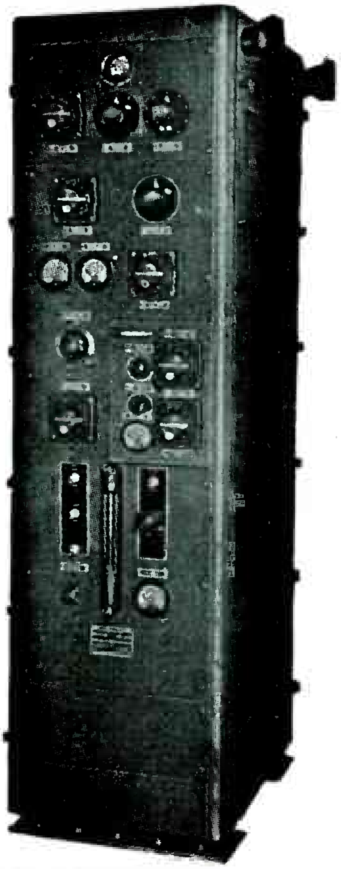
Buy from us with confidence—Army-Navy Standards are rigidly maintained. When any irregularities exist, you will be advised in detail. Write for quotations and data on your needs; place your name on our mailing list. We also have production line items—Power Supplies to 800 Amps at 12 to 28 volts DC, and 0-15,000 VDC 500MA. from 60 cycle line, etc.

We will buy any Electronic Material at top prices.
SCHOOLS—We will obtain anything you can use and exchange for your useless surplus.

ENGINEERING ASSOCIATES
434 E. Patterson Road Dayton 9, Ohio

R.C.A. Model MI-8167 TRANSMITTERS

Point-to-point communications



Freq. Range: 2000 to 20,000 Kcs.
Output: 350 Watts C.W. 250 Watts Radio telephone
Input: 190 to 250 Volts AC 50/60 cps.
Size: 60" high, 17" wide, 27" deep.
Tubes: 807s, 813s, 805s, 866s.

Crystal Oscillator unit built-in, fully shielded and stable. All self contained including antenna network. Master Oscillator unit (available) fits in place of Xtal unit. Speech amplifier is only external unit and has 110/220 v. AC input, four stages, high gain. Total net weight, 625 lbs.

Complete! New! From Stock! Quantities!
Prices on Request.

COMMUNICATION DEVICES CO.
INCORPORATED
2331 Twelfth Ave. N. Y. 27, N. Y.

WANTED

(Additional Wanted Ads on page 417)

WANTED TO PURCHASE

USED GE X-RAY MACHINE

For Use In Quartz Crystal Orientation. Call Lexington 2-5194 or Write

ELECTRONICS CRYSTAL CORP.
1134 BROADWAY N. Y. 10, N. Y.

WANTED

BD110 Telephone Switchboards, BD100 Telegraph Switchboards, BD90 Power Boards, EE101 V-F Ringers, BE72 Cabinets, FM19 Frames, RA43, REC30, KS5988, RA87, RA37, RA91 Rectifiers, BD101 Test Boards, SB6 Switchboards. Type CF1A, CF3A, CF2B Carrier Equipments. Any condition and quantity.

W-4212, Electronics
330 W. 42 St., New York 36, N. Y.

WE BUY

All kinds of surplus electronic equipment and components.

ELECTRONICRAFT, Inc.
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BRonxville 2-0044

WANTED

- AN/TRC-1 Equipments.
- T14 Transmitters.
- R19 Receivers.
- TS32 Test Oscillators.

Any condition or quantity

W-3858, Electronics
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ELECTRONIC EQUIPMENT WANTED!

Sell to → → → Arrow SALES INC.

We want to buy all types of new and used surplus electronics equipment. Use coupon to tell us what you have. We are the largest purchasers of such equipment. WRITE TODAY!

Use following numbers to indicate conditions: N-1, brand new; N-2, used, like new; N-3, used.

ITEM	CONDITION	PRICE WANTED

To: ARROW SALES, INC., 7460 Varna Ave., N. Hollywood, Calif.

Name ....

Address ....

SEE ARROW SALES, INC. AD ON PAGE 451

CONDENSERS

IMMEDIATE DELIVERY—FRESH STOCK

MFD.	VOLTAGE	TYPE	PRICE
.01	1000 DC	24F174	.49
.01	4000 AC	26F789	2.95
.02	1000 DC	27F285	1.25
.02	400 DC	23F274	.39
.02	10 KVDC	24714	9.50
.045	16 KVDC	D-4495	9.95
.05	600 DC	S. T.	.29
.05	1000 DC	23F328	.49
.05-.05	600 DC	S. T.	.49
.05-.05	600 DC	22F797	.69
.06	25 KVDC	26F585	17.50
.1	400 DC	481379	.45
.1	500 DC	K7876543	.49
.1	600 DC	22F415	.59
.1	1000 DC	27F287	.65
.1	1500 DC	P70B1EH104K	.69
.1	3500 DC	K5204513	2.95
.1	7500 DC	25F405	3.95
.1	10 KVDC	23F430	9.95
.1	12 KVDC	26F68	9.95
.1-.1	230 AC	Z11860	.49
.1-.1	600 DC	22F805	.85
.1-.1	600 DC	27F291	.85
.1-.1-.1	400 DC	NCP9193	.79
.1-.1-.1	400 DC	CA-255	.79
.1-.1-.1	600 DC	6111G	.85
.1-.1-.1	600 DC	371425	.85
.15	440 AC	5213288	.70
.15	4000 DC	400015	2.95
.15-.15	6000 DC	26F435	5.25
.15	8000 DC	Ldg. Mfgr.	6.95
.19	2500 DC	28F201	2.35
.2	440 AC	Ldg. Mfg.	.69
.2	1000 DC	23F316	.72
.2	10 KVDC	26F433	10.95
.2-.2-.2	4000 DC	10345	4.95
.25	250 AC	26F822	.69
.25	330 AC	9CE1A147	.72
.25	400 DC	DA4025	.49
.25	460 AC	26F876	.79
.25	600 DC	22F611	.69
.25	1000 DC	62B1FG254K	.89
.25	1000 DC	27F255	.85
.25	1000 DC	26F467	.85
.25	1000 AC	481129	1.45
.25	2000 DC	TJU200025	1.45
.25	3000 DC	5511P	3.45
.25	3500 DC	25F637	4.95
.25	4000 DC	26F767	5.95
.25	6000 DC	25F659	7.95
.25-.25	400 DC	22F640	.79
.25-.25	600 DC	6022G	.79
.25-.25	600 DC	51R4FF254L	.99
.25-.25	600 DC	K7102019P1	.79
.3	2000 DC	25F932	1.45
.3-.3	1000 AC	21F560	1.95
.31	2000 AC	21F480	2.50
.36-.36	800 AC	25F888	1.65
.366-.127-.055	330 AC	25F683	.95
.375	250 AC	26F937	.79
.38-.38	800 AC	21F707	1.65
.4	500 AC	21F720	.79
.4-.4	800 AC	21F588	1.70
.4	1400 AC	25F934	1.70
.42	800 AC	21F331	.85
.44-.44	880 AC	21F484	1.70
.45	120 DC	Ldg. Mfg.	.65
.45-.45	800 AC	21F569	1.95
.46	1750 AC	21F573	1.95
.5	200 DC	Ldg. Mfg.	.62
.5	330 AC	25F572	.79
.5	400 DC	C59589	.69
.5	400 DC	Ldg. Mfg.	.69
.5	600 DC	22F612	.79
.5	600 DC	Ldg. Mfg.	.79
.5	600 DC	Ldg. Mfg.	.79
.5	600 DC	65R144504K	.95
.5	1000 DC	23F331	.89
.5	1000 DC	10050G	.89
.5	1500 DC	481294	.95
.5	1500 DC	21F628	.95
.5	2000 DC	26F698	1.95
.5	3000 DC	30003	3.95
.5	4000 DC	28F128	6.95
.5	5000 DC	50005	7.95
.5-.1	400 DC	481769	.70
.5-.5	300 DC	23F280	.82
.5-.5	400 DC	Top Term.	.89
.5-.5	600 DC	23F498	.92
.5-.5	600 DC	23F487	.92
.5-.5	3000 DC	25F526	4.95
.5-.5-.5	600 DC	22F437	1.25
.58	1000 AC	21F476	1.65
.6	200 AC	28F120	.95
.6-.6-.6	100 AC	22F7142	1.25
.635	1300 AC	21F386	1.65
.656	900 AC	25F891	1.65
.666	800 AC	21F333	1.35
.67	170 AC	26F663	.95
.7	1300 AC	21F475	1.50
.7-.7	800 AC	21F321	1.95
.7-.7	800 AC	21F718	1.95
.75	330 AC	9CE1A148	.95
.75	400 DC	28F168	.89
.8	120 AC	21F603	.89
.86	660 AC	21F336	.95
1.0	100 DC	54B1EB105K	1.25
1.0	500 DC	23F303	.95
1.0	500 DC	9CD6A4	.95
1.0	440 AC	9CE1A320	1.05
1.0	600 DC	62B1BF105K	1.15
1.0	600 DC	Bathtub	.89
1.0	600 DC	Ldg. Mfg.	1.05
1.0	1000 DC	Ldg. Mfg.	1.15
1.0	1150 AC	21F641	1.75

MFD.	VOLTAGE	TYPE	PRICE
1.0	1500 DC	15010	1.85
1.0	2000 DC	23F70	2.95
1.0	4000 DC	40010	8.95
1.0-1.0	600 DC	Bathtub	1.25
1.0-1.0	600 DC	23F569	1.65
1-1-3-5	150 DC	Ldg. Mfg.	.95
1.05	800 AC	21F592	1.25
1.1	200 AC	25F450	1.25
1.1	440 AC	26F853	1.30
1.1	720 AC	21F477	1.65
1.25	125 AC	26F594	1.45
1.25	125 AC	28F192	1.45
1.25	660 AC	21F713	1.65
1.26	440 AC	21F338	1.45
1.26-.25	1000 AC	21F850	.95
1.26-3.0	1000 AC	21F714	.95
1.35	125 AC	28F238	1.49
1.45	750 AC	Ldg. Mfg.	1.55
1.45-2.8	850 AC	Ldg. Mfg.	1.55
1.5	330 AC	25F483	1.55
1.5	660 AC	21F651	1.75
1.58-0.3	800 AC	21F671	.95
1.66	850 AC	21F697	1.75
1.75	150 AC	28F159	1.55
1.75	330 AC	21F174	1.75
1.75	660 AC	21F631	1.95
2.0	120 AC	1A931	1.45
2.0	220 AC	21F169	1.65
2.0	330 AC	Ldg. Mfg.	1.70
2.0	400 DC	Bathtub	1.45
2.0	600 DC	Ldg. Mfg.	1.70
2.0	600 DC	22F999	1.70
2.0	250 AC	25F150	1.68
2.0	660 AC	25F993	1.85
2.0	800 AC	21F835	1.90
2.0	1000 DC	Ldg. Mfg.	2.95
2.0	1500 DC	Ldg. Mfg.	3.95
2.0	2000 DC	20020	5.50
2.0	2500 DC	Ldg. Mfg.	6.45
2.0	3000 DC	Ldg. Mfg.	7.95
2.0	4000 DC	22F985	14.95
2.0	5000 DC	23F50	15.95
2.0	6000 DC	60020	27.50
2.0-.5-.3	200 DC	355	.95
2.2	750 AC	21F563	1.75
2.25	330 AC	21F479	1.85
2.25	600 DC	Ldg. Mfg.	1.85
2.25	1600 AC	21F667	4.50
2.5	330 AC	Ldg. Mfg.	2.35
2.6	440 AC	21F744	2.35
2.6-0.4	440 AC	21F676	1.75
2.7	230 AC	Ldg. Mfg.	2.45
2.75	330 AC	25F983	2.50
2.75	385 AC	49F16	2.60
3.0	330 AC	Ldg. Mfg.	2.75
3.0	600 DC	F6030	2.25
3.0	1000 DC	Ldg. Mfg.	2.75
3.0-.05	600 DC	22F632	1.65
3.25	330 AC	25F378	3.15
3.26	230 AC	21F696	2.75
3.5	330 AC	21F567	3.45
3.5	660 AC	25F971	3.95
3.7	230 AC	49F9	3.45
3.7	230 AC	21F705	3.45
3.75	330 AC	Ldg. Mfg.	3.50
3.75	1000 DC	6037	3.75
3.9	230 DC	Ldg. Mfg.	3.50
4.0	100 DC	23F548	1.95
4.0	330 AC	Ldg. Mfg.	3.65
4.0	400 DC	Oil Filled	2.50
4.0	500 DC	Oil Filled	2.65
4.0	600 DC	26F106	2.75
4.0	600 DC	70B1FF405V	3.45
4.0	600 DC	481249	2.75
4.0	660 AC	21F665	3.95
4.0	1000 DC	Oil Filled	3.75
4.0	2000 DC	22F195	15.95
4.0	4000 DC	70E1EM405K	27.50
4.0-4.0	1000 DC	4223	4.50
4.5	230 AC	21F703	3.95
4.5	330 AC	21F691	4.25
4.65	230 AC	21F365	3.95
5.0	220 AC	21F134	4.35
5.0	330 AC	9CE1A306	4.35
5.5	230 AC	21F702	4.40
5.75	330 AC	26F100	4.50
5.0	440 AC	21F420	4.75
6.0	330 AC	3060	4.85
6.0	600 DC	5060	4.85
6.5	330 AC	Ldg. Mfg.	4.95
7.0	230 AC	21F300	4.95
7.5	330 AC	9CE1A309	4.95
8.0	660 AC	6080	5.25
8.0	1000 DC	Oil Filled	4.95
9.5	330 AC	26F273	4.95
10.0	50 AC	26F412	2.75
10.0	330 AC	Oil Filled	5.95
10.0	440 AC	25F501	5.95
10.0	600 DC	Ldg. Mfg.	5.95
10.0	1000 DC	10100G	7.95
10.0	1500 DC	23F152	8.95
10.0	1500 DC	70B1FH106K	8.95
12.0	750 AC	25F268	8.95
12.0	1000 AC	25F234	8.95
14.5	275 AC	25F500	7.50
15.0	330 AC	Ldg. Mfg.	9.50
20.0	220 AC	21F299	9.50
25.0	25 DC	Bathtub	.95
25.0	50 DC	Bathtub	1.45
30.0	90 AC	Ldg. Mfg.	2.65
30.0	400 DC	26F702	9.95
42.0	600 DC	25F673	17.50
46.2	330 AC	26F413	24.50
50.0	330 AC	KS8545	27.50
50-50-50	90 AC	MK4 MOD2	29.95

HIGH VOLTAGE CAPACITORS

#18F269 rated dual 60 Mfd @ 3000 VDC	$65.00
#PFD-40244G Paper rated 7.0 Mfd @ 4000 VDC	$42.50
#19F210 rated 0.1 Mfd @ 6000 VDC, max amps 204	$37.50
#7520, Oil, rated Dual 1.0 Mfd 7500 VDC	$27.50
#14F338 rated 4.5 Mfd @ 7500 VDC	$79.50
#2C-2181 Paper rated Dual 0.5 Mfd @ 9000 VDC	$32.50
Inerteen type FL rated 1.0 Mfd @ 10,000 VDC	$37.50
#26F68 rated 0.1 Mfd @ 12,000 VDC	$9.95
#A7548, oil filled, rated Dual 0.25 Mfd @ 8000 VDC	$14.50
#TK120065-1 Paper rated 0.65 Mfd @ 12,500 VDC	$19.95
#15020, rated 0.25 Mfd @ 15,000 VDC	$19.50
#20020 rated 0.25 Mfd @ 20,000 VDC	$27.50
#TK20002-2 Paper rated 0.25 Mfd @ 20,000 VDC	$27.50
#TK20005 Paper rated 0.5 Mfd @ 20,000 VDC	$45.00
#14F22 rated 1.0 Mfd @ 20000 VDC	$72.50
#20020 rated 2.0 Mfd @ 20000 VDC	$129.50
#14F103 rated 0.5 Mfd @ 25,000 VDC	$57.50
#TK25050 Paper rated 0.5 Mfd @ 25,000 VDC	$57.50
Inerteen type FP rated 0.5 Mfd @ 25,000 VDC	$57.50
#14F88 rated 0.75 Mfd @ 25,000 VDC	$72.50
#14F59 rated 1.0 Mfd @ 25,000 VDC	$82.50
#A6734 rated 1.0 Mfd @ 25,000 VDC	$82.50
#14F112 rated 0.001 Mfd @ 50,000 VDC	$42.00
#14F98 rated 0.025/0.025 Mfd @ 50,000 VDC	$59.50
#14F127 rated 0.025 Mfd @ 50,000 VDC	$45.00
#14F97 rated 0.25 Mfd. @ 50,000 VDC.	$79.50

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INDEX SEARCHLIGHT

September, 1952

This index is published as a convenience to the readers.

SEARCHLIGHT SECTION
(Classified Advertising)
H. E. Hilty, Mgr.

ADVERTISERS INDEX

TO THE ADVERTISERS

September, 1952

Care is taken to make it accurate but ELECTRONICS assumes no responsibility for errors or omissions.

ELECTRONIC SURPLUS

RELAYS

Auto Elec, R45H, 6500 Ohm. 2MA. SPST. NO..$1.45
Auto Elec. R45, 6500 Ohm, 2MA, SPST, NC. & SPST, NO Simul....$1.95
Guardian G39327, 6VAC, SPDT & SPST — NO Simul. $1.95
Struthers-Dunn ADBT8, 6VAC, DPST. 30A..$2.95
Edison Thermal 18480S, 6V AC-DC, SPST-NC..$1.95
Allied FX-31A, 6VDC, SPDT, 2A....$2.25
Allied POX-86, 6VDC. 4PDT. 15A....$4.95
RBM #59B84712, 6VDC, SPST-NO. 5A....$1.95
RBM #5608-10, 6VDC, SPST, double break..$1.45
Allied BO9D29. 6VDC. 3PDT. 15A....$3.95
G.M. #12700, 6VDC. SPST-NO. 200MA....$1.95
Struthers-Dunn 8XAX100. 18VAC, SPDT, 8A..$2.95
Auto Elec, R45P, 24VAC, SPST-NC & SPST-NO $1.95
Auto Elec, R-30, 20-30VDC, 3PST-NO & DPDT $2.95
Clare #35EC, 12-24VDC, DPST-NO&SPST-NC $1.75
G.E. CR2791-B108C20, 12-24VDC, DPDT, 10A.$1.75
G.M. #13020, 18-24VDC. DPST-NO & SPST-NC $1.75
Leach 1054ARW, 22-30VDC, DPDT & SPST-NO. 15A $2.25
Henry #1010 Min., 24VDC. SPST-NC....$1.35
Allied BO13D35, 24VDC, SPST-NO, double break. 15A $2.35
Allied ES691526. Min. 24VDC. DPDT, 3A....$1.35
Allied 452-11272. 24VDC, SPDT. 3A....$1.65
G.E. CR2791-G10F2, 24VDC, DPDT, 5A....$1.95
G.E. 55836. 24VDC, DPST. 6A. Min....$1.95
G.M. #13013. 24VDC, SPDT, double break, 15A $1.95
G.E. 3GTR72F4, 24VDC, SPST. double break, 300A $4.95
G.E. CR2791-D101F3, 24VDC, DPDT, 10A....$2.25
Allied BO14D35, 24VDC, SPST-NC, double break. 15A $2.95
G.E. E55837, 24VDC, SPST-NO, double break. 2A $1.95
Sperry E1A20248, 24VDC, DPST-NO, 2A....$1.75
Leach 1222DED, 24VDC, SPDT, 8A....$1.95
G.E. CR2791-B100F3, 24VDC, DPDT, 15A....$2.25
G.E. #55251, 24VDC. SPST-NO. 6A, Min....$1.75
Leach #1074, 24VDC, DPST-NO, 15A. Ceramic $3.25
Allied BO15D35, 24VDC, SPDT, double break, 15A $2.95
Allied BO6D35, 24VDC, DPDT. 10A....$2.25
Allied BN18D33. 24VDC, 6PDT, 10A....$5.25
Allen Bradley X95545, Type B6B, 24VDC, SPST-NO double break, 200A $2.95
Allen-Bradley X89309. Type B6B, 24VDC, SPST-NO double make/break, 200A $3.95
Allied BOX48, 24VDC, SPST, double break....$2.95
Price Bros. #311. 28-32VDC, DPDT, rotary..$2.95
Square D. Class 8990, ARO-30, 110VAC 60 cy, 3 PST, double make NO double break, 15A....$9.95
Cramer Type Tec, Adjustable timer, 115VAC, 0-5 min....$12.50
W-L Type NS3, 115VAC, 60cy., 3PST-NO & SPST-NC, 15A $9.95
Westinghouse #1162956. 115V, 60cy, DPDT, 10A $9.95
Struthers-Dunn 1BXX54. 115VAC, 60cy, DPST-NO. 6A $3.95
W-L #4566297, 115VAC 60cy. DPST-NO. 25A..$7.50
Allied BOHX-P4. 115VAC 60cy, DPDT, 10A....$5.25
Edison Type 501, 115VAC-DC, SPST-NO. Thermal, 5 sec. $1.95
Edison Type 501, 115VAC-DC, SPST-NO, Thermal, 45 sec. $1.95
Struthers-Dunn TD474A, Thermal, 115V, 60cy, SPDT, 30 sec. $2.95
Struthers-Dunn Thermal, PVA3, 115V, 60cy, SPST-NO, 1 min....$2.95

PULSE NETWORKS AND TRANSFORMERS

Sprague #7.5-E4-16-60-67-P, 7.5V, "E" Circuit, 4 sections, 16 Microsec. 60 PPS, 67 Ohms Imped.$7.95
Sprague #7.5-E3-3-200-67-P, 7.5KV, "E" Circuit, 3 Microsec. 200 PPS, 67 Ohms Imped, 3 sections $6.75
Sprague #8-E5-1-1000-50P. 8KV, "E" Circuit, 1 Microsec. 1000 PPS, 50 Ohms Imped. 5 sections $22.50
Sprague #10-E3-0.5-2000-50P. 10KV. "E" Circuit. 3 sections, 0.5 Microsec. 2000 PPS, 50 Ohms Imped $29.95
Sprague #15-A-1-400-50P. 15KV, "A" Circuit, 1 section, 1 Microsec. 400 PPS. 50 Ohms Imped...$37.50
Sprague #15-E4-0.91-400-50P. 15KV, "E" Circuit, 4 sections, 0.91 Microsec. 400 PPS, 50 Ohms Imped $19.95
Fast #15-E5-1.33-700-50P2T, 15KV, "E" Circuit, 5 sections, 1.33 Microsec. 700 PPS, 50 Ohms Imped. $29.50
W.E. #D-163330 Network Assy, 3 retard coils & 3 cond in oil filled rect. case, 330 Ohms. 1 Microsec. $22.50
Raytheon Pulse Trans. Type WX-5137. Pri: 4KV. 1 Mu. Sec., Sec: 16KV 16A....$9.75
Raytheon Pulse Inversion Trans. Type UX-8442 —40V +40V $6.75

ELAPSED TIME METERS

Mfd. by R. W. Cramer Co. Type RT-2H. 0-10,000 hours by tenths. 115 Volts 60 cy....$11.50
Mfd. by G.E. Model 8KTYD33, 0-10,000 hrs. by tenths. 115V., 60 cy, 3" sq....$14.95
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Size	I.D.	Color	Type	Per 100′	Per M′
	.0156″	Greent	Var. Cam.	$1.75	$11.00
	.0156	Black	Extr. Plas.	.75	5.40
20	.034	Black	Var. Cam.	1.75	13.50
20	.034	Yellow	Tri. Sat. Glass	3.75	32.50
20	.034	Brown	Tri. Sat. Glass	3.75	32.50
14	.072	Black	Var. Cam.	2.10	17.50
12	.089	Black	Sat. Glass	1.10	7.00
12	.089	Orange	Extr. Glass	4.75	42.50
12	.089	Orange	Var. Cam.	2.20	18.00
12	.089	Black	Var. Cam.	2.20	18.00
11	.101	Black	Extr. Plas.	1.10	7.00
11	.101	Black	Var. Cam.	2.55	21.50
11	.101	Black	Sat. Glass	5.00	46.00
11	.101	Yellow	Sat. Glass	5.00	46.00
11	.101	Yellow	Dbl. Sat. Glass	7.50	60.00
10	.112	Black	Var. Cam.	2.75	23.50
9	.124	Black	Var. Cam.	3.00	26.00
8	.141	Black	Var. Cam.	3.15	27.50
8	.141	Black	Extr. Plas.	1.40	10.00
8	.141	Clear	Extr. Plas.	1.40	10.00
8	.141	Yellow	Cel. Extr.	3.15	27.50
7	.158	Black	Var. Cam.	3.45	30.50
6	.178	Black	Sat. Glass	6.15	57.50
6	.178	Clear	Extr. Plas.	1.65	12.50
6	.178	Orange	Var. Cam.	3.80	34.00
6	.178	White	Extr. Plas.	1.65	12.50
6	.178	Black	Var. Cam.	3.80	34.00
5	.198	Black	Var. Cam.	4.10	37.00
5	.198	Black	Extr. Plas.	1.85	14.50
5	.198	White	Extr. Plas.	1.85	14.50
4	.224	Clear	Extr. Plas.	2.00	16.00
4	.224	Black	Sat. Glass	7.00	64.00
3	.249	Black	Extr. Plas.	2.25	18.50
3	.249	Black	Tri. Sat. V.C.	5.25	48.50
3	.249	White	Extr. Plas.	2.25	18.50
3	.249	Black	Sat. Glass	6.55	61.50
2	.278	Clear	Extr. Plas.	2.65	22.50
2	.278	Black	Var. Cam.	5.15	47.50
1	.299	Clear	Extr. Plas.	3.00	26.00
5/16″	.3125	Clear	Extr. Plas.	3.10	27.08
5/16″	.3125	Black	Neo. Hose	10.00	......
0	.347	Yellow	Var. Cam.	6.60	62.00
0	.347	Black	Var. Cam.	6.60	62.00
3/8″	.375	Black	Dbl. Sat. V.C.	8.90	81.00
3/8″	.375	Black	Extr. Plas.	3.60	32.00
3/8″	.375	Yellow	Var. Cam.	8.00	76.00
3/8″	.375	Black	Sat. Glass	8.90	85.00
3/8″	.375	Black	Var. Cam.	3.60	32.00
7/16″	.438	Black	Extr. Plas.	4.00	36.00
7/16″	.438	White	Extr. Plas.	4.00	36.00
15/32″	.469	Clear	Extr. Plas.	4.50	41.00
1/2″	.500	Black	Extr. Plas.	5.00	46.00
5/3″	.625	Clear	Extr. Plas.	6.85	64.00
11/16″	.688	Black	Extr. Plas.	8.75	Quote. on req.
3/4″	.750	Clear	Extr. Plas.	9.50	
13/16″	.813	Clear	Extr. Plas.	10.00	
7/8″	.875	Black	Extr. Plas.	12.50	
7/8″	.875	Clear	Extr. Plas.	12.50	
1″	1.000	Clear	Extr. Plas.	15.00	
1″	1.000	Black	Extr. Plas.	15.00	
1-1/8″	1.125	Black	Extr. Plas.	17.50	
1-1/8″	1.125	Clear	Extr. Plas.	17.50	
1-1/4″	1.250	Black	Extr. Plas.	20.00	

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G. E. Cat. #79G365. Pri: 203.5V; Sec: 6.5VCT @ 250A. 50/60cy. 2.46KVA. Wt: 130 lbs. 9¼"x7¼" x9-¾" $39.50
G. E. Cat. #7479972. Pri: 230/208V, 50/60cy; Sec: 2450/2320/2210V @ 1.162/1.222/1.29A. 2.85KVA 49.50
G. E. Cat. #7471997. Pri: 215/430V, 50/60cy; Sec: 5VCT @ 30A. 8KV ins....$22.50
G. E. Cat. #7479971. Pri: 230/208V, 50/60cy: Sec: 1365/1300/1235V @ 0.539/0.555/0.595A. 0.735KVA $29.50
G. E. Cat. #7479965. Pri: 230V, 50/60cy, 3 ph: Sec: 16.4/8.2V @ 60A 1KVA....$27.50
G. E. Cat. #7475695. Pri: 115V, 50/60cy: Sec: 3530/3720/3910V 1.31KVA. 2.5KV ins....$47.50

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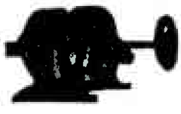
Adams Electric Thermag, 120VAC 60cy. 15 Amperes. SPST $4.95
Adams Electric Thermag, 120VAC 60cy. 20 Amperes. SPST $5.25
Westinghouse #4127F, 125VAC 60cy, 20 Amperes. SPST (LN) $4.95
Adams Electric Thermag, 120VAC 60cy. 25 Amperes. SPST $5.95
Heineman #0322, 230VAC 60cy, 25 Amperes Curve A, DPST $8.75
Heineman #0111, 115VAC 60cy, 30 Amperes Curve 2. SPST $7.75
G.E. Type AF-1, 230VAC 60cy, 35 Amperes DPST $9.95
G.E. Type AF-1, 230VAC 60cy, 50 Amperes DPST $12.50
Heineman #0322, 115VAC 60cy, 50 Amperes Curve

Amertran "TRANSTATS"



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2½ Amps.	......	......	......	13.00
4 Amps.	3.75	6.75	8.75	......
5 Amps.	4.95	7.95	12.95	27.00
6 Amps.	5.50	9.00	14.00	36.00
10 Amps.	6.75	12.00	20.00	45.00
12 Amps.	8.50	16.00	25.50	52.50
20 Amps.	13.25	24.00	36.00	90.00
24 Amps.	16.00	31.00	39.50	93.00
30 Amps.	18.50	36.00	......	......
36 Amps.	25.50	45.00	......	......

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PRI: 115 V., 60 cycles In.
SEC: 9, 12, 18, 24, and 36 volts
4 Amps......$ 8.75
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24 Amps...... 35.75

Made to our specs. for continuous, heavy-duty use

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  - 12 Amps.—.01 hy.—.1 ohm $14.95
  - 24 Amps.—.004 hy.—.025 ohm...........$29.95

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OB2	1.10	6AK6	.90	373-A(WE)	5.00
OZ4	.59	6AN5	1.75	374-A(WE)	4.00
1AE4	1.10	6B8	.65	387-A(WE)	2.50
1B3GT	.83	6BG6-G	1.60	400-A(WE)	2.50
1B22	2.00	6C4	.45	401-A(WE)	3.50
1B23	8.00	6F6-M	.88	403-B(WE)	7.50
1L4	.69	6F8-G	.88	407-A(WE)	5.00
1L21	4.00	6G6-G	.95	408-A(WE)	2.75
1N21-B	3.45	6J5	.49	GL-559	1.00
1N23-A	2.45	6J6	.59	KU-676	25.00
1N23-B	3.70	6J7	.75	715-C	20.00
1N31	5.50	6K7	.70	717-A	.98
1N34	.64	6L5-G	.49	803	3.50
1N34-A	.85	6L6-G	1.19	805	2.50
1N44/400-B	1.21	6L7	.98	807	1.59
1N45/400-C	1.39	6S7	.98	829	9.95
1N54	.89	6SD7	.79	832	6.95
2C39	29.95	6SG7	.88	837	1.45
2C43(G.E.)	15.95	6SK7-GT	.60	838	2.25
2C52	5.50	6SL7-GT	.60	860	3.95
2D21	1.35	6SN7-GT	.65	861	22.50
2E24	2.75	6V6-GT	.60	866-A	1.55
2E30	2.15	6X5-GT	.45	872-A(G.E.)	3.50
2K45	85.00	6Y6-G	.95	1616	.74
3B28	7.50	7C30	85.00	1619	.30
3B29	12.00	7H7	.80	1622 (6L6M)	1.95
3BP1	5.75	12A6	.65	1625	.40
3BP11	10.00	12C8	.79	1629	.30
3C27	7.50	12AH7-GT	1.10	1631	1.50
3C33	9.95	12AU7	.69	1632	.70
3E29	10.95	12SF5	.70	2050	1.45
3Q5	.99	12SG7	.87	2051	1.19
4C35	26.50	12SH7	.65	5516	5.95
4X150A	37.50	12SJ7	.65	5608-A	3.95
5BP1	3.50	12SR7	.70	5654	2.00
5BP4	4.00	FG-105	19.50	5910	.75
5CP1	3.00	211	.70	8020	.98
5FP7	1.95	274-A(WE)	3.50	9001	1.35
5U4-G	.59	274-B(WE)	2.25	9002	.80
5X4-G	.85	276-F and G	15.00	9003	1.10
5Y3-GT	.45	304-TH	7.75	9004	.39
5Z3	.85	304-TL	8.00	9006	.39
6AB7	.95	310-A(WE)	5.95	C6L/5528	15.00
6AC7	.98	311-A(WE)	6.50	F-123-A	6.95
6AG7	1.45	350-B(WE)	4.95	RK-72	.75
6AJ5	1.90	359-A(WE)	4.00	RK-73	.75

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R·H·S

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Set of 83-1SP Coax-Connectors for Above	1.35
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0A3/VR75	$1.04
0B3/VR90	1.19
0C3/VR105	1.19
0D3/VR150	.95
1B22	2.15
1B23	9.75
1B24	9.75
1B26	2.35
1B27	14.95
1B29	2.45
1B32	3.75
1B36	19.95
1B38	28.75
1B42	4.75
1N21 xtal	.75
1N21A "	1.59
1N21B "	3.25
1N22 "	1.19
1N23 "	1.25
1N23A "	2.39
1N23B "	3.69
1N26 "	6.95
1N27 "	1.59
1N34A "	.97
1P21	37.50
1P23	3.95
1P24	1.79
1P36	2.69
1S21	6.85
2AP1	10.95
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2C22/7193	.29
2C26A	.18
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2C39	32.50
2C40	8.49
2C43	14.95
2C44	1.19
2C46	7.95
2C51	6.95
2D21	1.35
2E22	1.92
2E24	4.65
2E26	3.15
2E30	2.15
2J21A	8.95
2J22	7.75
2J26	24.50
2J27	24.50
2J30	87.50
2J31	27.50
2J32	27.50
2J33	27.50
2J34	27.50
2J36	110.00
2J37	11.95
2J38	11.95
2J39	44.50
2J40	39.50
2J46	39.50
2J48	24.50
2J49	34.50
2J50	21.50
2J54B	32.50
2J55	97.50
2J61	44.50
2J62	47.50
2K25/723AB	28.75
2K28	32.50
2K29	21.75
2K33A	310.00
3AP1	9.95
3B22/EL1C	2.59
3B23/RK22	4.69
3B24	5.25
3B24W	7.95
3B25	4.39
3B26	3.59
3B27	3.75
3B28	8.39
3BP1	5.95
3C22	124.50
3C23	10.95
3C24/24G	1.75
3C27	7.95
3C31/C1B	2.75
3C45	16.95
3CP1	1.95
3CP1S1	1.95
3DP1	4.45
3DP1A	6.95
3DP1-S2A	8.95
3D21A	1.65
3E29	13.95
3FP7	1.65
3GP1	4.39
3HP7	3.45
4-65A	19.95
4-125A	29.95
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4AP10	4.45
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4B26/2000	8.95
4B28	4.95
4B32	9.69
4C27/CV92	22.95
4C35	27.50
4E27/257B	14.95
5AP1	3.45
5AP4	3.45
5BP1	4.45
5BP4	4.45
5CP1	4.59
5CP7	11.75
5C22	65.00
5D21	24.25
5FP7	1.85
5GP1	4.85
5JP1	24.45
5JP2	22.50

5JP4	$24.45
5J23	12.25
5J29	12.25
5J30	49.50
5J32	99.50
5LP1	22.50
5NP1	5.50
6AN5	3.75
6AS6	2.75
6AS7	4.45
6C21	22.25
6F4	6.25
6J4	7.55
7BP7	6.55
7DP4	14.50
9GP7	13.75
9JP1	13.75
9LP1	14.95
9LP7	4.95
10BP4	17.45
10Y	.39
12DP7	14.75
12GP7	14.75
12HP7	14.75
12LP4	20.95
15E	1.35
15R	.69
19T8	.99
23D4	.45
28D7	2.25
30 special	.45
35TG	3.25
45 special	.32
53A	5.95
75TL	6.25
100R	.89
100TH	7.95
121A	2.39
203A	8.45
204A	69.50
211	.69
212E	49.50
215A	.15
217C	8.49
227A/5C27	4.59
249C	3.69
250R	9.45
250TH	21.95
250TL	17.95
262B	3.95
274A	5.50
274B	2.95
276A	9.75
293A	2.69
294A	3.95
300B	9.95
304TH	8.95
304TL	8.95
305A	34.95
307A/RK75	4.45
310A	5.95
316A	.65
323A/B	23.95
327A/5C37	4.75
328A	8.95
331A	11.95
350A	6.45
350B	3.95
368AS	7.50
371A	.95
371B	.69
388A	1.45
393A	7.95
394A	3.95
417A	8.75
434A	27.50
446A	1.15
446B	3.75
450TH	38.75
450TL	43.95
471A/1B21	2.45
527	12.45
559	1.35
562	97.50
575A	13.45
701A	5.75
702A	3.25
703A	5.25
704A	.95
705A	1.95
706BY	35.00
706CY	35.00
706FY	39.50
706GY	39.50
707B	13.95
708A	4.45
709A	3.45
710A/8011	.89
713	.95
714AY	4.95
715A	6.39
715B	8.75
715C	22.50
717A	.98
721A	2.45
722A	2.35
723A	9.50
723A/B	19.95
724B	3.25
725A	6.75
726A	18.95
726B	49.50
730A	29.50
750TL	89.50
800	1.75
801A	.25
802	3.95
803	3.75
804	11.75
805	3.75
806	24.95
807	1.59
808	2.69

809	$1.69
810	9.95
811	2.85
812	2.75
813	7.75
814	2.69
815	2.35
816	1.05
826	.69
828	9.95
829	10.95
829B	12.95
830B	2.75
832	8.95
832A	9.45
833A	42.50
836A	3.49
837	1.45
838	2.25
841	.45
843	.27
845	4.25
849	27.50
851	47.50
852	27.50
860	3.95
861	22.50
864	.27
865	.98
866A	1.35
866JR	1.29
869B	35.00
872A	2.95
874	1.19
876	.27
878	1.59
884	1.75
885	1.39
902A	9.95
905	3.25
908	9.95
918	1.45
919	2.79
922	1.25
923	.95
927	1.10
930	1.20
931A	4.50
954	.25
955	.35
956	.35
957	.39
958	.39
959	3.95
991/NE16	.35
1603	4.95
1613	.79
1614	2.49
1616	.69
1619	.24
1622	2.45
1624	1.45
1625	.35
1626	.35
1629	.25
1630	.75
1631	1.75
1632	.72
1633	.69
1634	.69
1636	2.75
1638	.45
1641/RK60	2.25
1644	.89
1654	2.89
1655	1.50
1665	1.25
1851	1.55
1960	.65
1961	4.95
2050	1.45
2051	1.18
5670	6.95
8005	6.75
8008	5.95
8011	1.59
8012	2.65
8013	2.59
8014	28.75
8020	.98
8025	5.45
9001	1.50
9002	.98
9003	1.65
9004	.35
9005	1.45
9006	.27
C1JA	9.95
C5B	8.95
C6A	7.45
C6J	6.39
C100D	1.49
CK502AX	2.49
CK503AX	2.95
CK505AX	1.98
CK506AX	2.25
CK507AX	2.25
CK512AX	2.95
CK517AX	7.45
CK1005	.48
CK1006	3.25
E1148	.35
EF50	.69
F123A	7.75
F127A	27.50
F128A	89.50
F606	37.50
F660	47.50
FG17	4.89
FG27A	4.95
FG32	8.95
FG57	14.95
FG81A	3.49

FG105	$17.95
FG146	8.95
FG172	33.50
FG451	4.95
FG562	97.50
GL434A	29.95
GL502A	1.79
HF100	8.95
HF300	22.45
HY114B	.69
HY115	.69
HY615	.19
KC4	37.50
KU610	6.75
ML101	47.50
REL21	1.95
RK48A	4.59
RK59	1.35
RK60/1641	2.25
RK65	26.50
RK72	.48
RK73	.48
RX21A	2.49
RX120	12.95
TZ40	3.75
V70D	6.95
VR78	.48
VR91	.95
VR92	.25
VT127A	2.45
VT158	13.95
VU29	2.49
VU111	1.19
VX33	3.95
VX41	6.95
WL468	19.95
WL530	12.75
WL531	5.95
WL532	2.45
WL578	1.29
WL616	34.50
WL619	18.95
WL607	27.50
ZB3200	145.00
0A2	.95
0A4G	1.15
0B2	1.39
0Z4	.59
01A	.65
1A3	.70
1A4P	.75
1A5GT	.58
1A6	.65
1A7GT	.85
1AB5	.69
1B3/8016	.82
1B4P	.79
1B5/25S	.82
1B7GT	.85
1C5GT	.75
1C6	.69
1C7G	.69
1D5GP	.65
1D7G	.65
1D8GT	.65
1E5GT	.69
1E7G	.95
1F4	.65
1F5G	.65
1G4	.65
1G6GT	.65
1H4G	.62
1H5GT	.72
1H6GT	.75
1J6	.75
1L4	.67
1L4A	.85
1LA6	.95
1LB4	.98
1LC5	.75
1LC6	.91
1LD5	.90
1LE3	.79
1LG5	.79
1LH4	.87
1LN5	.75
1N5GT	.75
1P5GT	.69
1Q5GT	.68
1R4	.69
1R5	.65
1S4	.69
1S5	.65
1T4	.65
1T5GT	.68
1U4	.67
1V	.65
1X2	.96
2A3	1.10
2A4G	.85
2A5	.45
2A6	.45
2A7	.45
2B7	.40
2V3G	1.05
2X2	.59
2X2A	1.55
3A4	.65
3A5	.85
3B7/1291	.42
3D6/1299	.43
3LF4	.89
3Q4	.63
3Q5GT	.79
3S4	.74
3V4	.74
5R4GY	1.95
5T4	1.32
5U4G	.69
5V4G	.98
5W4	.79
5X4G	.75
5Y3GT	.45

5Y4G	$0.67
5Z3	.85
5Z4	.85
6A3	.95
6A4LA	.95
6A6	.82
6A7	.89
6A8GT	.95
6AB7	.98
6AC5GT	1.05
6AC7	.95
6AD7GT	1.29
6AE6G	.79
6AF6G	.85
6AG5	.82
6AG7	1.45
6AH6	1.29
6AJ5	1.95
6AK5	1.30
6AK6	1.09
6AL5	.59
6AQ5	.57
6AQ6	.85
6AR5	1.25
6AT6	.65
6AU5	1.19
6AU6	.65
6AV6	.55
6B4G	1.25
6B7	.95
6B8G	.75
6BA6	.65
6BC5	.75
6BE6	.65
6BF6	.72
6BG6G	1.59
6BH6	.95
6BJ6	.95
6BQ6	1.25
6C4	.55
6C5	.60
6C6	.59
6C8G	.85
6CB6	.72
6D6	.72
6D8	.85
6E5	.79
6F6	.85
6F7	.85
6F8G	.87
6G6G	.95
6H6	.65
6H6GT	.65
6J5	.75
6J5GT	.55
6J6	.95
6J7	.95
6J7G	.60
6K6GT	.65
6K7	.79
6K8	.85
6L5G	.75
6L6	2.25
6L6G	1.50
6L6GA	1.50
6L7	.85
6L7G	.85
6N7GT	.85
6Q7GT	.85
6R7	.79
6S7G	.85
6S8GT	.92
6SA7GT	.65
6SC7	.95
6SD7GT	.85
6SF5	.77
6SF5GT	.77
6SF7	.75
6SG7	.75
6SH7	.65
6SJ7	.75
6SK7GT	.72
6SL7GT	.75
6SN7GT	.75
6SQ7	.65
6SR7GT	.68
6SS7	.80
6ST7	.98
6SU7GTY	2.75
6SV7	.98
6T7G	.85
6T8	1.05
6U5G	.89
6U6GT	.85
6U7G	.55
6V6	1.39
6V6GT	.65
6W4	.65
6W7G	.85
6X4	.65
6X5GT	.65
6Y6G	.95
6Y7G	.75
6ZY5G	.65
7A4/XX1	.75
7A5	.75
7A6	.75
7A7	.75
7A8	.75
7AG7	1.00
7B4	.75
7B5	.75
7B6	.75
7B7	.75
7C4	.75
7C5	.75
7C6	.80
7C7	.75
7E5	.65
7E6	.55
7E7	.75
7F7	.75
7H7	.75

7K7	$1.10
7L7	.85
7N7	.85
7Q7	.75
7R7	.85
7S7	.95
7V7	.89
7W7	.95
7X7	.99
7Y4	.59
7Z4	.65
12A	.59
12A6	.65
12A7	.90
12A8GT	.69
12AH7GT	1.19
12AL5	.85
12AT6	.55
12AT7	1.10
12AU6	.75
12AU7	.88
12AV6	.65
12BA6	.69
12BE6	.69
12C8	.69
12F5GT	.65
12H6	.69
12J5GT	.50
12J7GT	.75
12K7GT	.65
12K8	.72
12Q7	.65
12SA7GT	.79
12SC7	.85
12SF5	.75
12SF7	.52
12SG7	.85
12SH7GT	.68
12SJ7GT	.65
12SK7GT	.80
12SL7GT	.75
12SN7GT	.85
12SQ7GT	.72
12SR7	.72
12Z3	.75
14A4	.89
14A7	.85
14B6	.75
14F7	.82
14F8	.85
14H7	.85
14J7	.85
14N7	.89
14Q7	.75
14R7	.82
19BG6G	1.85
25L6GT	.65
25Z5	.65
25Z6GT	.68
26	.47
27	.30
30	.25
31	.55
32	.47
32L7GT	.78
33	.57
34	.65
35/51	.60
35A5	.68
35B5	.75
35C5	.67
35L6GT	.65
35W4	.53
35Y4	.65
35Z3	.69
35Z4	.60
35Z5	.52
36	.64
37	.59
38	.52
39/44	.25
41	.69
42	.65
43	.65
45	.75
45Z3	.53
45Z5	.69
46	.75
47	.79
48	1.25
49	.75
50A5	.89
50B5	.75
50C5	.67
50L6GT	.65
50Y6	.72
53	.69
56	.55
57	.62
58	.65
59	.85
70L7GT	1.35
71A	.55
75	.82
76	.55
77	.55
78	.75
80	.65
82	.85
83	1.10
83V	.92
84/6Z4	.75
85	.69
89	.25
117L7/M7	1.29
117NS	1.29
117P7	1.29
117Z3	.65
117Z6	.89

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0-40 Volts D.C.	2.95
0-.5 Amp R.F.	2.95
0-5 Ma	$2.95
0-500 Microamp.	4.95
0-100 Ma (0-300 scale)	$2.95

RADAR—COMMUNICATIONS AND TEST EQUIPMENT

FLUXMETER

Portable Gauss Meter with range of 500-4000 Gauss. Used to test Magnatron and other magnets. Probe has a gap of 1¼". Complete. Brand New $32.50

TS-34/AP SYNCROSCOPE AND OSCILLOSCOPE. Used to test and service airborne and ground radars. Complete in portable carrying case with all probes, cables and accessories. Input 110v 60-2600 cyc. Excellent.

TS-16 Altimeter Test Set. Used to check various altimeters or as an accurate wavemeter. New $29.95

TS-61/AP S-band Echo Box. Using meter provided, it is possible to maximize the XMTR adjustment and determine relative power output. Complete with probe and cable. Very good condition. .$140.00

TS-13/AP Xa band signal generator, wave meter, wattmeter. Precision lab microwave. Test set will provide either pulsed or CW output in Xa band. Input 115v 60-800 cyc.

TS-226/AP used to measure peak power output of any xmitter in the range of 200-1000 mcs. Has provision for oscilloscopic signal observation and built in calibration. Part of AN/APM-29.

TS-69/AP freq. meter covering range of 400-1000 mcs. complete with calibration charts, antenna & crank. In metal carrying case. Excellent........ $72.50

TS-170/ARN-5 XTAL controlled test ocs. with the following freq. ranges: 332.6, 333.8, 335.0 depending on XTAL in use. This set is used to align glide path receivers. Batteries and antenna are self contained. Excellent condition.

TS-89/AP Voltage Divider. 1:10 and 1:100 ratios. Wide band for true pulse shape. Output to scope.

TS-10/APN Altimeter Test Set. Good condition. Complete with cables and dummy antenna $35.00

TS-12/AP V.S.W.R. Test Set for X-band. Complete with amplifier. slotted line. termination, adaptors, etc. In 2 carrying cases. Excellent.

TS-45/APM-3 X-band signal generator. 8400-9600 mcs. pulsed & CW output. Used to check APS4 and similar sets.

TS-36/AP X-band Power Meter. Consists of power measuring circuit. Horn antenna, co-ax to wave guide adaptor, connecting cable and probe. Will measure either absolute or relative power. Nominal band of usefulness is approx. 8.5-9.7 KMC.

TS-3/AP S-band Frequency and Power Meter. Portable. Battery operated. Complete with all cables.

TS-33/AP X-band Frequency Meter. 8500-9600 mcs. Contains crystal detector and indicating meter. Output to scope will indicate pulse wave shape.

TS-62/AP X-band Echo Box. 8400-9600 mcs. tuned and untuned input. Will indicate resonance on meter. Complete with pick up antenna and cable.

IE-19 TEST SET. V.H.F. portable equipment covering 100-156 mcs. Used to test SCR-522. ARC-1, ARC-3, etc. Complete with signal generator. field strength meter and accessories. In carrying case. Excellent.

BC-221 PRECISION FREQ. METER. Covers 150kc-20,000kc. Can be supplied with or without modulation. Portable. Complete with calibration book and crystal. Excellent.

S-BAND SIGNAL GENERATOR. Laboratory test set using 707 Klystron in McNally Cavity. Has precision attenuator and wave meter. Complete with cables. Mfg'r. Western Electric. Input 110v 60-2600 cyc. $400.00

CW-60/ABM WAVEMETER in portable carrying case with calib. charts and cables. New $97.50

OTHER TEST SETS

TS-278/AP
TS-102/AP
TS-47/APR
TS-184/AP
TS-268/UP
1-130
TS-189/U
TS-110/AP
TS-164/AR
TS-19/APQ-5
TS-98/AP
TBN-3EV Thermister Bridge
LM
IE-36
TS-59/APN
TS-23/APN
TS-18/AP

AN/TPS-3 PORTABLE RADAR

Lightweight Portable Search Radar for detection of aircraft. in the frequency range of 600 MCS. power input: 115v 400 cyc. 1330 watts, 28V DC 400W. Complete installation.

SO-13 S-BAND MARINE RADAR

Compact Sea Search Radar for small vessels. P.P.I. indication is provided. Complete in original cases with complete sets of spares. Excellent condition. 28V DC input.

We maintain a completely equipped reconditioning shop and development laboratoy. All equipment is reconditioned and checked out to original specs. Our laboratory facilities, technical and production know-how and thirty thousand feet of space is available for electronic subcontracts.

AN/APS-15A RADAR

High resolution X-band Navigation and Blind Bombing Radar. Can be used for high or low altitude blind bombing. precision navigation and to home on X-band ground beacons. Can also be used for ground installations. Available with or without the flux gate gyro stabilizing system. Presentation is a 5" P.P.I. a 3" A scope and a 5" remote P.P.I. Power input is 28v and 110v 400 cyc. Weight is approx. 375 lbs. installed. Electrical characteristics are as follows: freq. X-band, power output approx. 40 KW, range 5, 30, 50 and 100 mile search and beacon. Antenna beam width 4°. Supplied from stock, reconditioned and checked out.

SCR-718A, AM C HIGH ALTITUDE ALTIMETER. A complete equipment for installation in aircraft to determine height above terrain. The range of SCR-718A. AM is 0-5000 ft. SCR-718B, C is 0-50,000 ft. Power input 115v 400-2600 Cyc.

MOBILE POWER PLANT

(Gas Driven)

Output: 220v—3kw—60 Cyc. One phase. Excellent condition, checked out.

SCR-555 DIRECTION FINDER

Freq. range 18—65 mcs. Complete installations available including the quonset hut. Bearing indication is aural-null or left-right bearing on a meter type indicator. Power input is 12v. Weight of complete installation, approx. 2500 lbs.

AN/UPN 1 & 2 PORTABLE RADAR BEACONS

S-band beacons that can be interrogated by any S-band radar in a 45 mile range and will answer with a coded reply which can be changed as desired. The UPN-1 is battery operated. The UPN-2 is 110v 60-2600 cyc. Weight is approx. 65 lbs. complete.

APR-1 MICROWAVE RECEIVER

We can supply from stock AN/APR-1 receivers and 3 tuning units to cover the freq. range of 38-1000 mcs. These receivers are almost identical to the APR-4 equipment and the tuning units are directly interchangeable. These sets have outputs for a panadaptor and pulse analyzer which can be supplied at additional cost.

AN/APS-4 RADAR

Airborne X-band search and attack radar housed in a plastic bomb assembly that can be jettisoned at will. Presentation is a 3" B-scope. Range 3-75 miles. Freq. approx. 9375 MC. Supplied complete with all amplifiers, indicators, junction box: input 115v 800-2600 Cyc. and 28v DC.

AN/APS-2 RADAR

Airborne S-band search bombing and surveying radar using 5" PPI and 3" A scope. This equipment is an ideal low cost radar for commercial or military aircraft. Using UPN-1 or 2 S-band portable beacons, very accurate mileage measurements can be made to over 45 miles between the APS-2 and the beacon. Provides a very rapid surveying method. Charac. as follows: range 5, 20, 50, 100 miles; 360° PPI sweep; freq. approx. 2900 Mcs.; power input 28v and 115v 400-2600 Cyc. Complete, checked out ready for installation.

AN/APS-3 Airborne X-band Search and Homing radar. Complete. Contains RF head, modulator, synchronizer, control boxes, plugs. antenna, etc. 115v 400 cyc.

SQ 10 CM PORTABLE RADAR. This set is a very compact search radar. Complete installation available. New in carrying cases. Tech. data as follows: Power input: 90-130v cy cyc.; pulse rate: 800 cyc.; range: 3, 15, 45 miles; pulse width: 1 microsec.; 300 yds. min. range, all ranges; I.F.F. Synch, output available; accuracy — 5°; power output 1 KW; beam width: 8° horiz. 15° vert.; presentation: A, B, P.P.I.

AN/ARC-1 TRANS/REC.

Provides Radio-Telephone Communication between Aircraft or Aircraft and Ground. Complete with Shock Mount and Control Box. Input: 28V DC. Excellent condition. Available in either 10 or 20 Crystal Controlled Channels 100-156 MCS. checked out.

SCR-269/G Automatic Radio Compass. Freq. range 200-1750KC. Complete with BC-433-G receiver, BC-434, LP-21, 1-81, 1-82, BK22, etc. Very good condition $129.95

TCS Marine Radio Telephone and Telegraph Xmitting and Receiving Equipment. Freq. range 1500 12000KC. Consists of xmitter, receiver, antenna loading coil, remote control box, power unit, cables, etc. Power input is 12 or 32v DC. We can supply an 110v AC power supply for stationary use at additional cost. Excellent condition.

SCR-536 Xmitter-Receiver (handy talkie). Freq. range 3885-5500KC. Complete with coils, tubes, crystals. Very good condition. Pair........ $185.00

AN/APA-10 Panoramic Adaptor for use with any receiver with following IF's: 455KC. 5 mcs. 30 mcs. Unit will give panoramic presentation (1 mc wide for 455KC input) (100KC for 5MC input) (2MC for 30 mcs input). Power input 115v 400 cyc. but can be changed with the addition of a proper power transformer. Excellent condition $175.00

10 CM R.F. package, 2700 mcs. Consists of BC-1007 modulator and BC-1091 RF head. Power output approx. 40 KW. Complete with tubes...... $125.00

AN/CRT-3 Victory Girl. Dual frequency emergency lifeboat xmitter. Complete with xmitter, kite hydrogen generator, eto. New in knapsack. C.A.A. approved.

AN/APR-5 Radar Search Receiver. Freq. range 1900-3100 mcs. Will detect signals up to 10,000 mcs. with reduced sensitivity. Contains oscillator and mixer cavity, IF strip, power supply. Input 60-2600 cyc. 115v. Excellent condition.

T-50 Radiotelegraph Transmitter complete with power supply and all accessories with spares. Portable. New in cases $275.00

AN/APT-5 300-1500 mcs. xmitter cavity oscillator using 3C22 lighthouse tube. Power output 30 watts. Noise modulated. Excellent condition. Complete with all tubes $169.50

PE-104 Vibrapack for SCR-284. Overseas packed in original cartons with spare vibrator. Large quantity available. New.

SCR-522 VHF Airborne Command Equipment. Freq. range 100-156 mcs. in 4 channels receiver and transmitter. Crystal controlled. Complete equipment. Consists of trans/rec control box BC-602, dynamotor PE-94, AN104A antenna, plugs, etc. Power input with PE-94 in 28v. We can supply PE-98 dynamotor for 12v input at additional cost.

HEADSETS - MICROPHONES

HS-18 Headset	8000 ohm	PL-54 Plug	$2.95
HS-23 Headset	8000 ohm	PL-54 Plug	4.95
HS-30 Headset	200 ohm		2.95
HS-33 Headset	600 ohm	PL-354 Plug	4.95
HS-38 Headset	600 ohm	PL-354 Plug	2.95
T-30 Throat Microphone		PL-291 Plug	.95
T-17 Throat Microphone		PL-68 Plug	4.75

MISCELLANEOUS

Sound powered chest and headsets MI-2454-B type O, mfg. RCA. Brand new. Pair	$ 29.95
R-57/ARN-5 receiver	29.50
AS-32/APX-1 antenna	2.50
AN-CRC-7 V.H.F. Handi-Talkies 112MC CRYS Controlled	
RA-62 power supply for SCR-522	165.00
RA-34 power supply for BC-375	250.00
BC-1206 beacon rec. 200-400KC 28v in. exce.	14.95
MN/26-Y compass receiver. Excellent	24.95
EC-1016 tape recorder. Complete. New	
BC-733D receiver w/tube	29.95
C-3 Navy snooperscope in carrying case. Uses flashlight batteries	425.00
BC-1284 lighthouse tube preamplifier	69.95
AN/ARC-4 2 meter trans/rec	22.50
AN/APA-17 radar direction finding antenna, back to back parabola; freq. range 300-1000 mcs, horizontally and vertically polarized	59.00
BC-996 interphone amplifier	9.95
RL-42 motor antenna reel	6.95
30 MC I.F. strips using 6AK5	24.95
RD-7/APA-23 recorder for APR	135.00
AS-27/ARN-5 antenna. Excellent	4.95
ARA-500-1500 KC receiver	24.95
ID-80/APA-17 indicator. Excellent	129.95
R-28/ARC-5 100-156 mc. receiver	34.95
BC-639 receiver. New	
RM-29 remote control. New	17.95
BC-455 6-9 mc receiver	13.95
BC-454 3-6 mc receiver	14.95
BC-800 xmitter/receiver	39.95
BC-950 100-156 mc xmitter	49.50
RA-300 FM exciter (mfg. Tempco). New	32.50
FL-8 filter	3.95
FL-5 filter. Less cables. Fair	2.65
3C-16-D GSAP gun camera computers with all access. In carrying case. Excel	19.95
AT-2A/APN-2 antenna. Fair	4.95

We have a large stock of TS-34A/AP spares.

SEE OUR TUBE AD OPPOSITE PAGE

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New fall catalog now available

CABLE: HAMSHACK NEWYORK

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Prices subject to change without notice F.O.B., NYC minimum order $10.00. 20% deposit required. All merchandise guaranteed.

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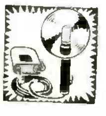
189 GREENWICH STREET . NEW YORK, N. Y.



NEW THRIFT-LITE LIFETIME PHOTO-FLASH

Not a kit. Incl Pwr pok, Life gtd Lamp. Rflctr & 15' cord 1/1000 Sec flash every 7 Sec True daylite color. Usable all cameras oner 115VAC w/lite Type AC40. $39.69

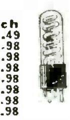
Complete Outfit for AC & Battery opr. Incl AC40 & BP25 portopak & all accssrs for KODAK & COMPUR shutters. $53.98

Write for Complete "THRIFTLITE" Data Boosterpacks. Ext lites. Units for Focal plane shutters & accessories.

AD15 Intensifier, Doubles Light Output of Basic Unit. $15.69

AC-45F 115V/60cy Flash Unit. Features Selective Time Delay. Up to 30 Millisecond Complete W/Lifetime Flash Bulb. $49.40

TAB "SUN-FLASH" LAMPS



"Tab" No.	Replaces	W-Sec. Max.	Each
U10	GE FT114	100	$8.49
No. 1	AMGLO 5804X	100	9.98
238T	GE FT 210	200	9.98
53GT	GE FT 403	500	15.98
VA	SYLV. 4330	200	9.98
23MT	FT 214	250	10.98
22ST	FT 110	200	10.98
353GTQ	FT 503	5000	54.98

PHOTO FLASH PWR SUPP KIT

1800VDC/35MA. Using Doubler Crkt. Transformer, Rectifier, Socket, Condensers, Resistors, Diagram. W/Flash Tube V4X4/X400. Rated 200–300 Watt Sec. $31.98

PHOTOFLASH CAPACITORS

2x.36MFD Total 72MFD Per Unit. 30 Units 21.6MFD 1800VDC/36.8 W Sec $5.95

30 Units 21.6MFD/3000VDC 64 8 W. Sec. 7.95

Save on Replacements. Write for Details

15MFD/330VAC/1500VDC Intermittent. $3.98

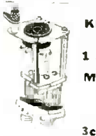
25MFD/330VAC/1500VDC Intermittent. 6.49

16MFD/600VAC/2800VDC Intermittent. 6.95

16MFD/660VAC/3000VDC Intermittent. 7.95

Sunflash Tubes Operating Data Sheets. .25

MICROWAVE



Klystron Mtg Assy (723 AB) & Coupling to 2 Type "N" Co-Ax Fittings. $9.98

1 Microsecond Delay Line, Millen. $2.95

Microwave Lighthouse Assy—P/O RT39 Apg & 15, osc and Tr Cavities. Type N Coupling. Uses 2C43, 2C40, 1B27. Tunes 24–2700 MC Less Tubes. $29.95

3cm T-Sect. Waveguide & Atten Output. Thermal Comp & Pwr Meas Thermistors Xtal Diode Detector Mtg & C'ling $18.95

Less Xtl Mtg. & Thermistor $13.95

3CM X-Band Wave Meter 9285-9465MC $29.95

PULSE TRANSFORMERS

7.5 KV Pulse, Pri 4KV. 50-1000 ohm imped. Permalloy Core. WEco. $14.98

Pulse Blocking Osc. 3 wndgs. Video Interstate, 1:1 ratio, 32 mh wndgs, H'Sld, HiVins, GE. $1.98

Pulse Blocking Osc. 3 wndgs, 1:1:1 ratio, 1 mh wndgs GE H'Sld, HiVins. $2.98

Pulse Blocking Osc. Video Interstage, 3 windgs, 1:1:1 ratio, 4.3 mh windgs, GE, H'Sld, HiVins, 1, Micro Second rise time. $2.98

PULSE SHAPING Xfmr Raytheon UX12819, 1 MU Sec. 2000 CY. $9.95

UTAH 9340 P/O CP-5A/APS15. $9.00

400 CYC XFMRS

3140, 3030, 2920, 2810V/35 Ma. $4.98

1233vct/350Ma, 1140vct/70 Ma. 5.98

788V/200Ma, 210V/15Ma, 5V/2A 4.95

6.3V/7A, 6.7V/.9A 6.3V/.3A 3.98

6.3V/4.65A, 6.3V/.3A 3.49

6.3V/1.25A, 6.3V/1.25A 1.98

6.3V/3A, 5V/2A 2.98

6.3V/1A $1.95; 6.3V/.6A 1.49

FREED 5V/10A 4.95

WEco 5V/4A 2.98

FREED 2.5vct/10A csd 4.95

Mfgrs Tell Us Your Needs. Give Mfgrs and Sig Corps Stock Numbers

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500V for Crt 6.3V/.6A, 2.5V/1.75 csd Hvins 4/BC412 replmnt $7.98

1320V&375VCT/110ma, 5V/3A, 2.5V/3.25A; 6.3V/2.75A Hsld Hvins 9.98

1000VCT/200MA, 18V/.55A, 6.3V/5A, 5V/6A 6.98; 2 for 12.98

1000VCT/45MA, 795vct/80ma, 360vct/55ma, 3x5V/3A, 6.3vct/1A, 6.3vct/.3A csd Hvins can be used 2x rating Raytheon Hypersil Core 4.98

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840VCT/110MA, 530vct/21ma, 2x5V/3A, 6.3vct/1A, 6.3vct/.3A 4.98

770VCT/85MA, 5/2A, 6.3V3.5A, Throd 3.98

750VCT/200MA, 6.3V/5A, 5V/4amp 5.95

700VCT/120MA, 2x6.3V/3A, 6.3V/1A 3.98

600VCT/100MA, Tapped 350vct, 6.3V/3A, 2.5V/3A Isolation Windg 115V/.45A 3.25

550VCT/150MADC, 5V/3A, 6.3V/5A 3.49

500VCT/60MA, 6.3V/4A Hsld 2.98

450VCT/200MA, 6.3V/3A, 5V/3A 3.95

FILAMENT TRANSFORMERS

6.3vct/4A (gud 6.5A) H'Sld HVins $2.69

6.3vct/1A $1.98; **6.3v/.6A** 1.98

2.5v/2A 2 for 1.49; **7.5vct/12A 15Kvins** 10.98

24v/6a csd 4.98; **24v/1.25** csd 1.98

2.5vct/10Amp 5 Kvins 3.59; **2x12V/2A** 3.89

5V/2A, 6V/3A 2.25; **6V/6A** 2.95

5V/60A 13.98; **5V/115A** 16.95

PLATE TRANSFORMERS

750VCT/650MA W/500V TAP Hmsld $9.95

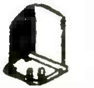
1100VCT/212MA PRI. 115 or 230V Csd 6.50

15000V AS V'dblr **WE. SIG 3H5629/7500V /35MA** 19.95

3000V/10MA Csd WE 161913 Hvins 8.95

5500VCT/650MA USN Wstghs Csd 69.95

FILTER CHOKES



Dual 30 Hy/60ma Csd $ .98

15Hy/40ma AC/DC sets.3 for .98

12Hy/80ma/H'Sld/3KVins 2.25

10Hy/125ma/UTC/Csd/H'Sld/1KVins 1.69

50Hy/125ma/Csd/H'Sld 2.89

Dual/12Hy/150ma/2KVins 2.98

12Hy/300ma/5KVins 4.95

20Hy/300ma or 15Hy/400ma/12KVins 8.95

13.5Hy 1A/17KVins/Raytheon 55.00

10HY 200ma Hmsld Jefferson 2.95

8 HY 225ma Thordason 3.50

CIRCUIT BREAKERS

Heinmann Magn Bkrs, **Amps:** 0 22, 2, 3, 5, 7, 9, 12, 15, 20, 30, 35, 40, 80, 180 **Each $1.69 10 for $15.98**

Sq. D & CH Toggle Sw Brkrs. **Amps:** 5, 10, 15, 20, 25 **98c** **10 for $8.98**

Klixon Thermal Push Button Brkrs **Amps;** 5, 10, 15, 20, 25, 30 **89c.** **10 for $7.98**

STORAGE BATTERIES

36 Volt WILLARD Mini-BRAND NEW; 5 oz Designed Portable Equip Models **98c; 4 for $3**

2V/20AH Willard PLUS 2V. Vibrator 2.89

6V/6AH Willd NT6/BB214U 1.98

6V/40AH Willard 6.98

Battery Acid, (R-Exp) 1 pt 59c; 2 pts .98

Hydrometer 1.06 to 1.24 Sp Grav 1.98

Spec Grav Ind & More. Thermom .98

866A KIT AND XFORMER

2 Tubes, Sckts, xmfr 115v 60cyc Inpt, outpt 2.5vct, 10A/Hvinsul $6.98

"T.A.B." THAT'S A BUY

UHF ANTENNA

UHF ANTENNA 12"/30CM AT5/ARR1 Usable Citzn & Ham Band Ins. Coax Term Silv Pl Cont Gask & H'ware Mobile Mtg. **39c; 4 for $1.00**

PL259 for above. .65

TV CONICAL ANTENNA Sturdy Prefab Incl. 8 elements & 100 ft. Copper Twinex Cross Bar & Hdware, Brand New. $6.95

MICROWAVE ANT AS125/APR. 1000 to 3400Mc w/UG58U Term In Built HiPass Fltr Flange Mtg Incl. H'Ware. $5.98

SECTIONAL ANTENNAS

MS 49-52, 12¼ Ft. $1.69

MS 49-53, 16 Ft. 2.49

BASE. MP22, **3.98;** MP47, **3.75;** MP48. **3.98**

TUBE CLAMPS

926B-5, 926B-16, 926B, 929-1 930-19, 926B-19, 926A-10. **Each 25c; 5 for $1.00**

"TABS" TUBE SPECIALS

BROKEN KEYS- ELECTRICALLY PERFECT

1B3GT, 6H6, 6K6GT, 6SN7GT 12SN7GT. **Each 50c; 5 for $2.00**

6BG6G, 6BQ6GT, 12SG7, 19BG6 6LBG, 6L6GA. **Each 79c; 3 for $2.00**

RHEOSTATS

2 ohm 50W Model J. $2.59

15 ohm 25W w/knob. 1.98

60 ohm 50W w/knob 2.69

200 ohm 25W Model D. 1.98

250 ohm 25W. **ea. 1.39; 4 for 5.00**

300 ohm 200W Model P. 5.49

350, 500, 5000 ohm Slotted shaft 25 W. **3 for 2.00**

1000 ohm 25W Model J. 2.19

Infrared Snooperscope

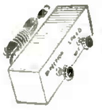
Image-Converter Tube HiSensitivity simplified design 2" dia. Willemite screen—Resolution up to 350 line/in. Complete data & tube, ea. **$4.98; 2 for $9.49**

SNOOPERSCOPE PWR SUPPLY

1800VDC/35MA, Using Doubler Crkt. Transformer, Rectifiers, Sockets, Resistors, Capacitors and Diagram. $6.98

DIODE PROBE TUBE

Unexcelled for **No-Loss VHF** testing. Ultra-sensitive subminiature-envelope. App 1¼x⅜". Element and probt at tip. Low pwr. htr **Brand New,** w/data VR92 **25c; 5 for $1.**



Selenium Power Supply

0 to 12 VDC/2 A op. Variable DC supply, uncased and completely built—inpt. 115v/60 cy. Usable LAB supply, filament D. C. plating, battery charging, model railroad, includes voltage or sped control and center off reversing sw. Ideal for two "HO" locomotives. $10.95 **2 for $20.00**

SELENIUM RECTIFIERS

We specialize in Rectifiers and Power supplies to your specifications. Immediate delivery.

Current (cont.)	18/14 Volts	26/18 Volts	36/28 Volts	54/40 Volts	130/100 Volts
2AMP	2.20		3.60	6.50	10.50
4AMP	3.75		6.75	8.75	
5AMP	4.95		7.95	12.95	27.00
10AMP	6.75	9.98	12.00	20.00	45.00
12AMP	8.50		16.00	25.50	52.50
20AMP	13.25	16.20	24.00	36.00	90.00
24AMP	16.00		31.00	39.50	98.00
30AMP	18.50	24.30	36.00		
36AMP	25.50		45.00		

C. T. Rect 100 Amp 10-0-10V $44.95

Full Wave Selen Rect & Trans. with Ageing Taps, in Kit form. All 115V/60cy inputs

up to 16VDC at 12 amps $23.98

up to 28VDC at 12 amps 31.98

up to 28VDC at 48 amps 149.50

up to *20VDC at 6 amps 12.98

*This 6 amp supply has no ageing taps.

RECTIFIER XFMRS

18.8–19.2—20.4—21.4 Volts/12Amp $14.98

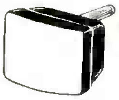
31—32—34—36 Volts/12Amp 2 Kvins 16.98

18–12—9—CT—9—12–18V/4Amp 8.75

18—12—9—CT—9 12 18V/12Amp 16.75

36VCT—24V—18V/24Amp 35.75

ONE YEAR GTD PICTURE TUBES



10 inch Round $14.95

12 inch Round 17.95

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19 inch Round 28.50

20 inch Rectangular 29.95

21 inch Rectangular 30.45

24 inch Metal 67.00

Your old pict. tube is worth money. write for trade-in-allowance on RMA coded and dated tubes with one year guarantee. Ship your defective picture tubes prepaid only.

When ordering metal tube, defective metal tube is required.

END EQUIPMENT BUYS

SCR595 IFF, Less Tubes, As Is 3.98

BC602 Cont Box for 522, As Is 1.29

BC605 Amp. Less Tubes, As Is 3.98

BC906 Freq. Mtr. exc. cond 29.95

I-222A Signal Generator 129.50

I-222A Sig Gen As Is 79.50

BC221 Sig Gen. Exc. Cond 125.00

SCR522A Less/Xtals w/Tubes 69.95

ANTENNA Relay BC442-A, Meter, Thrml Couple 50 mmf vac Cndsr Complt 5.95

TG5 Kexer, New $5.98

R4/ARR2 Revr w/Tubes & Dyna 21.95

BC733D Revr Less Tubes As Is 19.98

RM29 Control Unit BRAND NEW 12.98

I-108 Range Calibrator. Metal Case 29.98

I-198 Sig Gen. Good Cond, Less Tubes 14.95

TUBES

"TAB" TESTED & GUARANTEED

PRICES SUBJECT TO CHANGE
WRITE FOR COMPLETE TUBE LISTING

OA2	.98	**3C45**	17.98	**6SB7Y**	1.19	**F127A**	19.98	**801A**	.4
DA3/VR75	1.23	**3D6/1299**	.69	**6SC7**	1.39	**VT127A**	3.90	**803**	3.8
OR2	1.37	**3D21A**	3.98	**6SD7GT**	.99	**CV148**	4.98	**805**	3.90
OB3/VR90	1.09	**3D22**	13.95	**6SF5**	.89	**VT158**	14.49	**807**	1.65
OC3/VR105	1.19	**3D23**	4.90	**6SF7**	.89	**FG166**	49.00	**808**	2.98
OD3/VR150	.98	**3E29**	14.95	**6SG7**	1.39	**FG172**	31.50	**809**	2.43
1B3/8016	.81	**4-125A**	29.95	**6SH7**	.99	**250TH**	22.25	**810**	9.95
1B21/471A	2.85	**4-250A**	40.95	**6SJ7**	.89	**250TL**	18.50	**811**	2.90
1B22	2.20	**4-1000A**	108.50	**6SK7GT**	.89	**304TH**	8.90	**812**	2.70
1B23	9.90	**4C35**	27.25	**6SL7GT**	.89	**304TL**	8.90	**813**	12.49
1B24	17.49	**EL5BHD**	16.98	**6SN7GT**	.79	**388A**	1.49	**814**	3.45
1B26	2.45	**5C21/C6J**	6.95	**6SN7WGT**	2.25	**417A**	8.95	**815**	2.98
1B27	14.98	**5C22**	49.95	**6SQ7GT**	.79	**417A/5842**	18.50	**816/866Jr**	1.07
1B32/532A	3.90	**5C30/C5B**	3.95	**6SR7**	.69	**GL434A**	29.95	**826**	.95
1B35	10.98	**5D21**	27.45	**6SS7**	1.12	**446A**	1.05	**829**	11.49
1B37	16.98	**5D23/RK65**	36.50	**6ST7**	1.33	**446B**	3.89	**829B**	12.45
1B38	29.95	**5J29**	12.40	**6SU7GTY**	3.37	**450TH**	44.00	**832**	7.65
1B40	4.95	**5R4GY**	1.80	**6V6**	2.25	**450TL**	$7.00	**832A**	9.65
1B41	49.95	**5R4WGY**	1.75	**6V6GT**	.57	**450/HF200**	15.95	**833A**	39 45
1B42	18.00	**6AG5**	.79	**6W4GT**	.57	**WL468**	13.95	**834**	5.95
1B46	1.98	**6AG7**	1.99	**12AH7GT**	1.45	**GL471A**	2.69	**836**	4.75
1B53	49.95	**6AH5G**	1.49	**12AK5**	1.98	**CK501X**	1.26	**837**	1 15
1B56	38.50	**6AH6**	1.89	**12AK5W**	2.98	**CK501AX**	1.26	**849**	29.45
1B58	350.00	**6AJ5**	1.40	**12AL5**	.83	**GL502A**	1.79	**860**	1.90
1B60	69.75	**6AK5**	.74	**12AT6**	.53	**CK502AX**	1.79	**861**	3.95
1B63	50.00	**6AK5W**	2.98	**12AT7**	.72	**CK503AX**	1.79	**865**	1.29
1B63A	75.00	**6AK6**	1.05	**12AV6**	.72	**CK505AX**	1.79	**866A**	1.50
2C39	33.98	**6AL5**	.54	**12AU7**	.57	**CK506AX**	1.79	**869**	36.95
2C40	9.98	**6AL7GT**	1.29	**12AV6**	.53	**RH507**	9.98	**872A**	3.29
2C40 JAN	19.90	**6AN5**	2.90	**12AV7**	.98	**CK509AX**	1.26	**460/HF200**	15.95
2C43	26.75	**6AQ5**	.55	**12AW6**	1.79	**CK512AX**	3.15	**CK1005**	.85
2C43/464A	9.49	**6AQ5W**	3.98	**12AX4GT**	1.20	**CK522AX**	2.49	**CK1027**	3.35
2C44	1.20	**6AQ6**	.81	**12AX7**	.79	**CK525AX**	3.15	**CK1023**	9.98
2C50	3.69	**6AQ7GT**	1.29	**12AY7**	2.95	**CK526AX**	3.95	**CK1089**	2.98
2C51	6.45	**6AR5**	.79	**12AZ7**	1.49	**CK528AX**	2.39	**CK1090**	2.98
2C52	5.98	**6AR6**	2.98	**12BA6**	.79	**CK529AX**	2.98	**CK5672**	2.29
2E31	1.49	**6AS5**	.79	**12BA7**	.79	**GL530**	22.00	**CK5678**	2.45
2E36	2.19	**6AS6**	2.65	**12BD6**	1.23	**CK531DX**	1.98	**5687**	5.75
2E41	2.39	**6AS7G**	4.35	**12BE6**	.63	**531**	6.98	**CK5702**	7.45
2E43	1.39	**6AT6**	.63	**12BF6**	.85	**CK532DX**	1.98	**CK5703**	.98
2G21	2.39	**6AU5GT**	1.49	**12BH7**	1.29	**WL532**	3.98	**Xtal Diodes**	
2J31	29.75	**6AU6**	.59	**12BY7**	1.35	**CK533AX**	1.39	**1N21A**	1.55
2J31A	79.95	**6AV5GT**	1.29	**12BZ7**	1.25	**CK534AX**	.89	**1N21B**	3.00
2J32	59.95	**6AV6**	.59	**12SG7**	1.05	**CK536AX**	.89	**1N21C**	21.50
2J33	39.39	**6AW6**	1.89	**FG17**	3.95	**CK537AX**	4.98	**1N22**	1.25
2J34	38.50	**6B4G**	1.59	**19T8**	1.09	**CK538DX**	.89	**1N23**	1.35
2J36	120.00	**6BA6**	.63	**19V8**	1.62	**CK539DX**	1.98	**1N23A**	2.35
2J37	12.70	**6BA7**	1.27	**RK20A**	8.95	**CK541DX**	1.98	**1N23B**	3.49
2J38	17.75	**6BC5**	.63	**24G/3C24**	1.90	**CK542DX**	.98	**1N25**	4.98
2J39	49.50	**6BC7**	1.23	**25BQ6GT**	1.19	**CK543DX**	.98	**1N26**	8.75
2J42	250.00	**6BD5GT**	1.65	**25L6GT**	.69	**CK544DX**	.98	**1N27**	1.55
2J48	28.50	**6BD6**	.83	**25Z5**	.79	**CK546DX**	1.98	**1N29**	3.50
2J49	39.45	**6BE6**	.59	**25Z6GT**	.99	**CK547DX**	1.98	**1N32**	23.75
2J50	27.50	**6BF5**	.98	**FG27A**	8.70	**CK571AX/**		**1N34**	.64
2J52	249.50	**6BF6**	1.49	**HV27**	10.95	**5886**	4.98	**1N34A**	.98
2J55	85.00	**6BF7**	2.55	**RK28A**	4.89	**CK573/AX**		**1N35**	1.65
2J56	199.50	**6BG6G**	1.39	**28D7**	1.39	**6029**	4.45	**1N38**	1.43
2J61	49.95	**6BG7**	1.98	**FG32/5558**	13.85	**WL579**	10.49	**1N39**	4.15
2J62	49.45	**6BH6**	.63	**35Z5GT**	.59	**WL579B**	12.98	**1N40**	9.98
2K25	39.95	**6BJ6**	.69	**RK39**	2.89	**KU627**	18.00	**1N43**	1.69
2K25/723AB	39.00	**6BK7**	2.15	**RK48**	6.85	**WL652**	65.00	**1N44**	1.21
2K28	32.00	**6BL7GT**	1.45	**RK49**	7.50	**WL676**	39.95	**1N45**	1.39
2K29	23.95	**6BN6**	1.49	**50L6GT**	.69	**WL686**	35.00	**1N46**	.69
2K33	300.00	**6BN7**	1.69	**80**	.69	**707A**	7.90	**1N47**	5.49
2K35	398.00	**6BQ6GT**	1.20	**81**	1.69	**707B**	17.49	**1N48**	.59
2K39	100.00	**6BQ7**	2.15	**FG81A**	3.90	**715A**	6.45	**1N51**	.45
2K42	145.00	**6BY5G**	1.45	**82**	1.19	**715B**	8.90	**1N52**	1.85
2K43	135.00	**6C21**	29.45	**82V**	1.39	**715C**	29.85	**1N54**	.89
2K46	360.00	**6CB6**	.69	**83**	1.45	**717A**	1.49	**1N55**	2.35
2K47	460.00	**6CD6G**	1.69	**83V**	1.79	**718BY**	48.45	**1N56**	.89
2K48	118.00	**6D4**	2.70	**84/6Z4**	.99	**718CY**	48 45	**1N57**	.89
3B22	2.70	**C6J/5C21**	6.95	**FG95/5560**	24.85	**719A**	49.95	**1N58**	1.19
3B23/RK22	4.95	**6J4**	7.65	**FG98**	19.95	**721A**	2.49	**1N60**	.60
3B24	5.40	**6J5GT**	.59	**100TH**	8.89	**722A/287**	2.45	**1N61**	2.10
3B25	4.50	**6J6**	.57	**FG104**	37.98	**723A**	11.95	**1N63/K63**	2.49
3B26	3.70	**6K4A**	6.45	**FG105**	18.98	**723A/B**	25.00	**1N64**	.69
3B28	7.90	**6L6**	2.09	**117L/M7GT**	1.59	**724A**	3.95	**1N67**	1.95
3C22	125.00	**6L6G**	1.69	**117N7GT**	1.79	**724B**	3.45	**1N69**	1.98
3C23	12.45	**6L6GA**	1.69	**117P7GT**	1.39	**725A**	8.90	**K34**	1.39
3C31/C1B	3.45	**6L6GAY**	2.29	**117Z6GT**	1.19	**726A**	8.45	**CK705**	.77
3C33	14.98	**6SA7GT**	.89	**117Z7GT**	1.49	**726B**	59.95	**CK706**	.54
3C34/HK24	5.49	**6SA7GTY**	3.37	**F123A**	7.90	**726C**	69.95	**CK707**	1.80

OIL CAPACITORS

Mfd.	Each
50 vdc	
.4	.49
150wvdc	
1-1-3-5	.69
250wvdc	
2x 25	.35
300wvdc	
1.2	.39
400wvdc	
.1	.49
.5	.59
1	.69
4	1.69
6	2.29
8	2.49
10	2.89
2x.1	.75
2x.5	.94
3x 1	.91
3x.25	.99
600wvdc	
.034	3.69
.1	.52
.2	.69
.25	.61
.5	.65
1	.75
2	.92
3	1.08
4	1.89
5	1.98
6	2.69
7	2.89
10	3.29
2x 1	.79
2x.25	.98
2x 5	.98
2x1	1.19
2x2	1.39
2x8	3.49
3x 05	.89
3x 22	.98
3x 25	1.09
700wvdc	
4	1.98
800wvdc	
.1	.69

Mfd.	Each
1000wvdc	
.45	79
1	.90
2	1.69
5	2.98
15	4 98
1400wvdc	
.25	1.29
.5	1.39
1500wvdc	
.5	1.49
.75	1.69
1	1.79
5	3.49
6	3.98
2000wvdc	
1	1.49
2x 1	1.75
1	1.89
2	2.98
3	.52
8	9.49
2500wvdc	
.25	2.29
3000wvdc	
1	2.49
5	2.98
2	4.49
3	6.98
4	7.98
4000wvdc	
2	8.98
5000wvdc	
.2	4.49
2	10.98
4	19.98
7000wvdc	
.002	1.69
.0075	1.98
1	4.98
7500wvdc	
.03	2.98
.05	3.49
10000wvdc	
.03	3.49
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Mfd.	Each
12500wvdc	
2	95.00
15000wvdc	
.0016	9.98
25000wvdc	
.00025	7.49
1	95.00
AC RATED	
220vac/600dc	
3	.69
4	.89
5	1.29
225vac/630dc	
3 3	.79
230vac/630dc	
5	1.29
330vac/1000dc	
1 25	.79
1 5	.89
1 75	.98
2	.33
2 5	1.09
2.8	1.15
3	1.19
4	1.29
5	1.49
12	3.49
15	3.98
25	6.49
40	9.98
405vac/1200dc	
.15	1.29
600vac/1800dc	
16	6.98
660vac/2000dc	
5	4.49
6	4.98
10	6.98
16	7.98

2MFD/330VAC/1000VDC CD" Rd Can **3 for $1.00; 10 for $3.00**

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.0025	12	20	8	28.95
.001	30	30	3	110.00
.0012	20	16	3	35.00
.002	20	22	3	40.00

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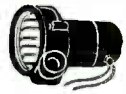

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200 KDD Fafnir	25/64	1 11/64	22/64	1.00
S12/12R Norma	1 24/64	2 32/64	27/64	1.89
305 Norma	63/64	2 28/64	42/64	1.80
6304 SKF	50/64	2 3/64	38/64	1.45

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1000 ohm Type J ⅛" Flatted Shaft 1.19

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7K ohm Type J ⅛" Slotted Shaft .98

25K ohm Type J ⅛" Slotted Shaft .98

50K ohm Type J ⅜" Flatted Shaft 1.19

100K ohm Type J ¼" Flatted Shaft 1.19

1 meg Type J ⅛" Slotted Shaft .98

1 meg Type JJJ (Triple) 1⅜" Shaft 3.69

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CORD same as above **8 ft $1.29; 12 ft** 1.49

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CORD RG11U 5 foot lengths per **ft** .18

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RG59U Cable per **ft .08;** **100 ft $5.98**

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INPT 6VDC/27.5A Oupt 590VDC/150MA Carter Mag Motor 29.95

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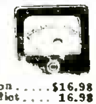

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PRODUCTS OF WORLD-FAMOUS

DAVEN

CREATIVE-ENGINEERING

TYPE T-330

DAVEN ATTENUATORS

Exclusive Features:

1. **"Knee-Action" Blade**
   - Tamper proof
   - Uniform contact pressure and low contact resistance over the life of every unit.
   - Each rotor blade individually supported to give positive contact in operation under all types of conditions.
2. **Brass Case of 2-Piece Construction**
   - Greatly reduces clearance space required for removal of cover in rear of unit.
3. **"Lock-Tite" Dust Cover**
   - Held by positive, bayonet-type lock which prevents cover from falling off under stress of vibration.
4. **Enclosed Roller-Type Detent Mechanism**
   - For extra long life and positive indexing.
   - Addition of detent does not increase depth of unit.
5. **Low-Loss Molded Terminal Board**
   - For high resistance to leakage.
6. **Rigidly Supported Resistor Strips**
   - With air insulation.

YEARS AHEAD, CREATIVE-ENGINEERING has always characterized Daven's efforts in the production of electronic components and equipment.

The unit illustrated above is only one in a complete line of Daven's world-famous attenuators. Because this Company has pioneered and created so many worth-while improvements in units of this type, you can do no better than to specify Daven Attenuators.

Daven's skilled staff of specialist-engineers is at your "beck and call" to help with your problems in the selection of the right attenuators for the equipment you are designing.

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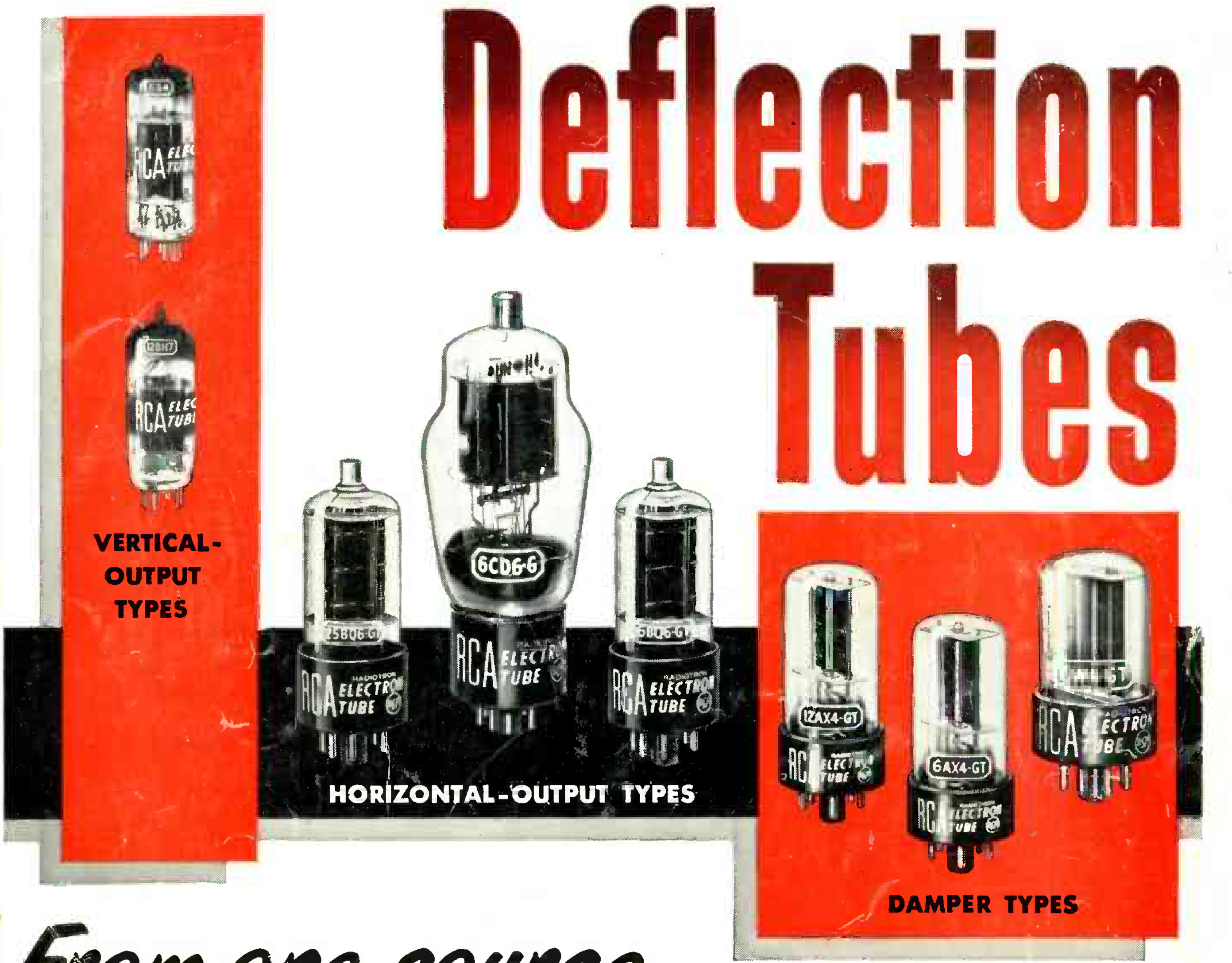
GREATLY EXPANDED PRODUCTION FACILITIES ENABLE DAVEN TO MAKE DELIVERY FROM STOCK ON A LARGE NUMBER OF STANDARD ATTENUATOR TYPES.

VISIT DAVEN'S BOOTH 329 AT THE CLEVELAND INSTRUMENTS SHOW — SEPTEMBER 8 TO 12

Deflection Tubes



From one source...

8 types to fill your deflection-system needs

RCA now offers these eight volume-type, deflection-system tubes having performance range to take care of most circuit requirements efficiently and economically.

Vertical-Output Tubes: The RCA-6S4 is a miniature medium-mu triode for circuits operating from the boosted B-voltage supply and is capable of supplying ample deflection for kinescopes having diagonal-deflection angles up to 70 degrees and operating at voltages up to 18 kilovolts. The RCA-12BH7 is a miniature twin triode used in similar circuits having more modest deflection-voltage requirements and permits the economy of using one triode unit as the vertical oscillator.

Horizontal-Output Tubes: The RCA-6BQ6-GT beam power tube is capable of fulfilling most requirements for horizontal deflection and high voltage in receivers having B voltages in the order of 230-300 volts. RCA-25BQ6-GT, the same as the 6BQ6-GT except for its 25-volt, 0.3-ampere heater, is for use in receivers having series heater strings. The huskier RCA-6CD6-G has the reserve power desired in deluxe receivers operating at high voltages up to 18 kilovolts.

Damper Tubes: The RCA-6W4-GT has the high perveance needed for efficient operation and good linearity in horizontal-deflection circuits. The RCA-6AX4-GT features higher heater-cathode voltage ratings so that a separate heater supply is not required. RCA-12AX4-GT, identical with the 6AX4-GT except for its 12.6-volt, 0.6-ampere heater, is for use in receivers having series heater strings.

Application Notes: Application Notes covering "Design Considerations for Minimizing Ripple and Interference Effects in Horizontal-Deflection Circuits," and "Horizontal-Deflection-Output and High-Voltage Transformer RCA-230T1 for 18-Kilovolt Kinescope Operation" are yours for the asking. For your copies—and data on these RCA tubes for deflection systems—write RCA, Commercial Engineering, Section IR-42, Harrison, N.J.

For additional information on using these RCA tubes in your circuits contact the nearest RCA Field Office.

FIELD OFFICES: (East) Humboldt 5-3900, 415 S. 5th Street, Harrison, N. J. **(Midwest)** Whitehall 4-2900, 589 E. Illinois Street, Chicago, Illinois. **(West)** Madison 9-3671, 420 S. San Pedro Street, Los Angeles, California.

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