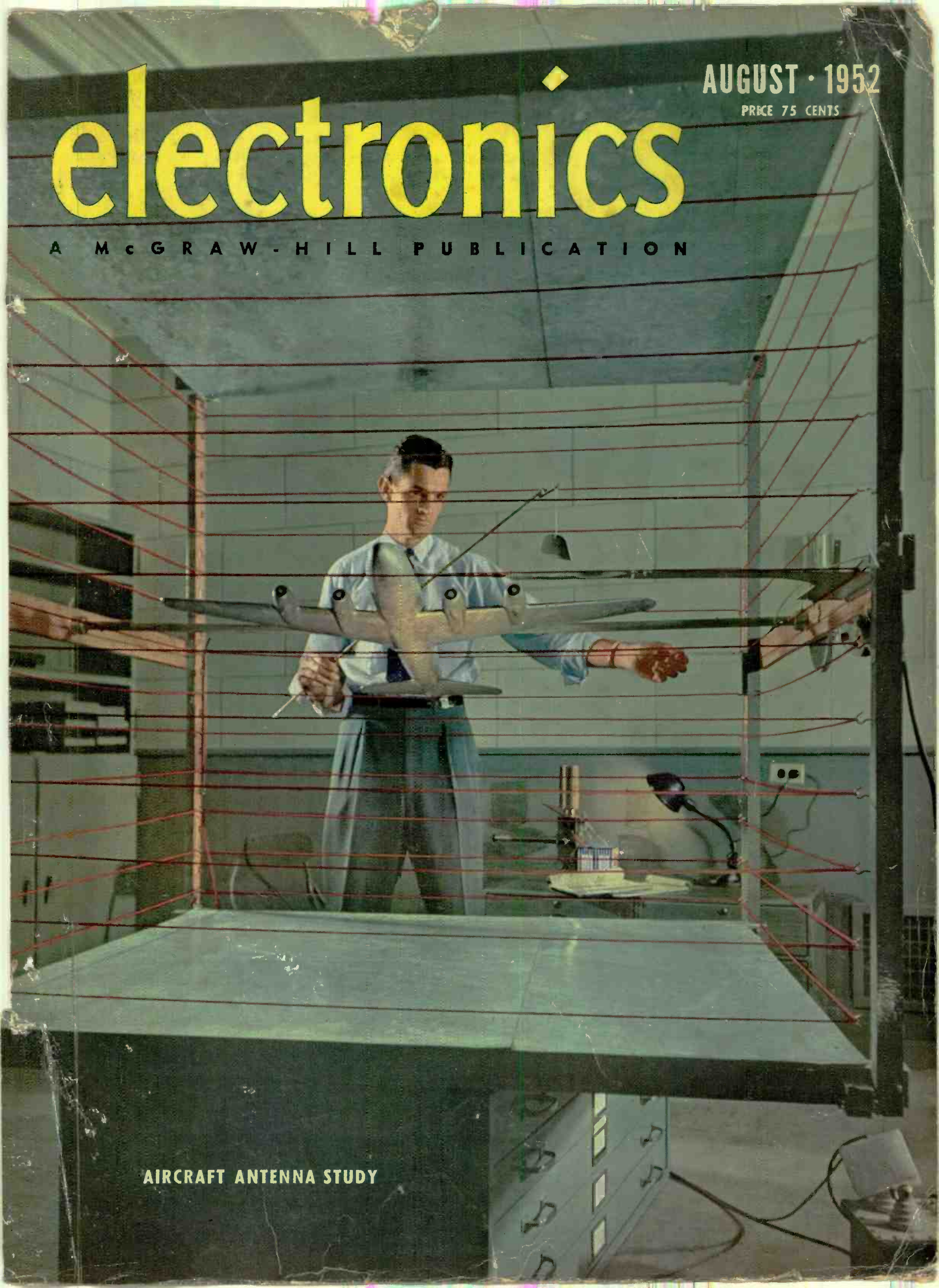
electronics

AUGUST · 1952

PRICE 75 CENTS

A McGRAW-HILL PUBLICATION



AIRCRAFT ANTENNA STUDY

for Stock Hermetically Sealed Components

For over fifteen years UTC has been the largest supplier of transformer components for military applications, to customer specifications. Listed below are a number of types, to latest military specifications, which are now catalogued as UTC stock items.

RCOF CASE

Length 1 25/64
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-0 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.

United Transformer Corp.

150 VARICK STREET • NEW YORK 13, N. Y.

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

electronics

AUGUST • 1952

A McGRAW-HILL PUBLICATION

AIRCRAFT ANTENNA STUDY — Electrostatic technique employs large parallel plates and potential-dividing wires to establish uniform field around model at Stanford Research Institute (see p 156)....................COVER

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Member ABC and ABP

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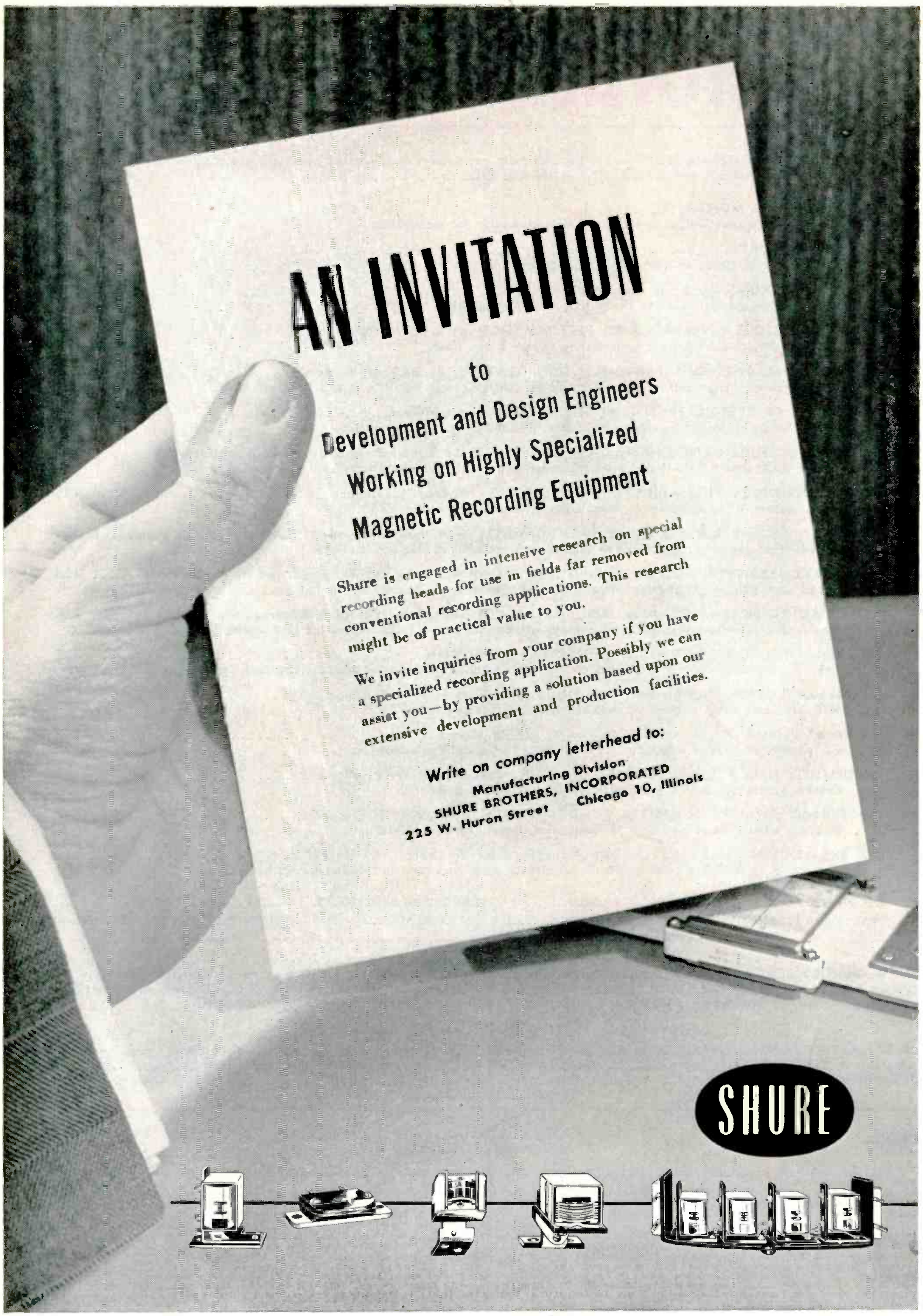
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SHURE

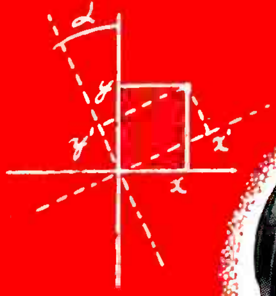
MUIRHEAD MAGSLIP RESOLVER NO. 2

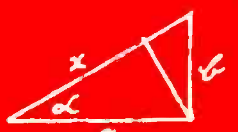
Given R & θ find h & r

$$h = R \sin\theta$$
$$r = R \cos\theta$$

Change of Axes.

$$x' = x \cos\alpha + y \sin\alpha$$
$$y' = y \cos\alpha - x \sin\alpha$$



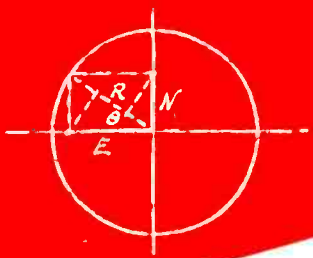


$$x = \cancel{\sqrt{a^2 + b^2}}$$

$$x = a \cos\alpha + b \sin\alpha$$

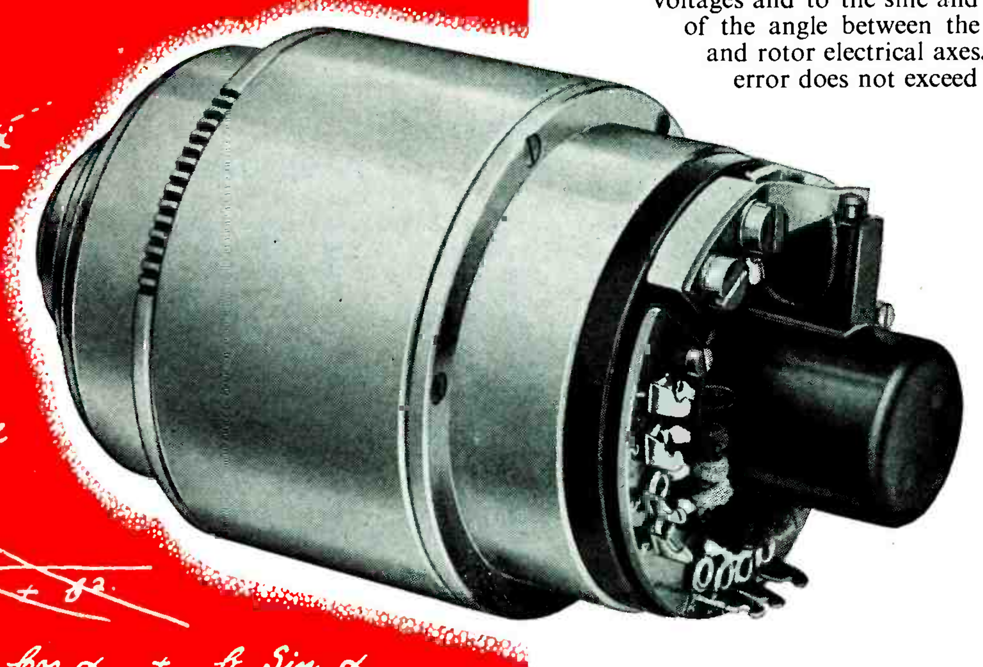
Given N, E determine R & θ

$$R = E \cos\theta + N \sin\theta$$
$$\text{Zero} = E \sin\theta + N \cos\theta$$



THE RESOLVER No. 2 is a special type of Magslip used for the solution of trigonometrical problems, such as the conversion of polar to Cartesian coordinates.

Each stator phase is energized in accordance with an applied computing voltage. No power is taken from this source, energization being obtained by means of an amplifier and a second (feedback) stator winding. The rotor voltages are proportional to the exciting voltages and to the sine and cosine of the angle between the stator and rotor electrical axes. The error does not exceed 0.1%.



MAIL THIS COUPON FOR DETAILS

Please mail Bulletin B-690 fully describing MUIRHEAD MAGSLIP RESOLVERS

NAME________________________________

POSITION________________________________

COMPANY ________________________________

ADDRESS________________________________

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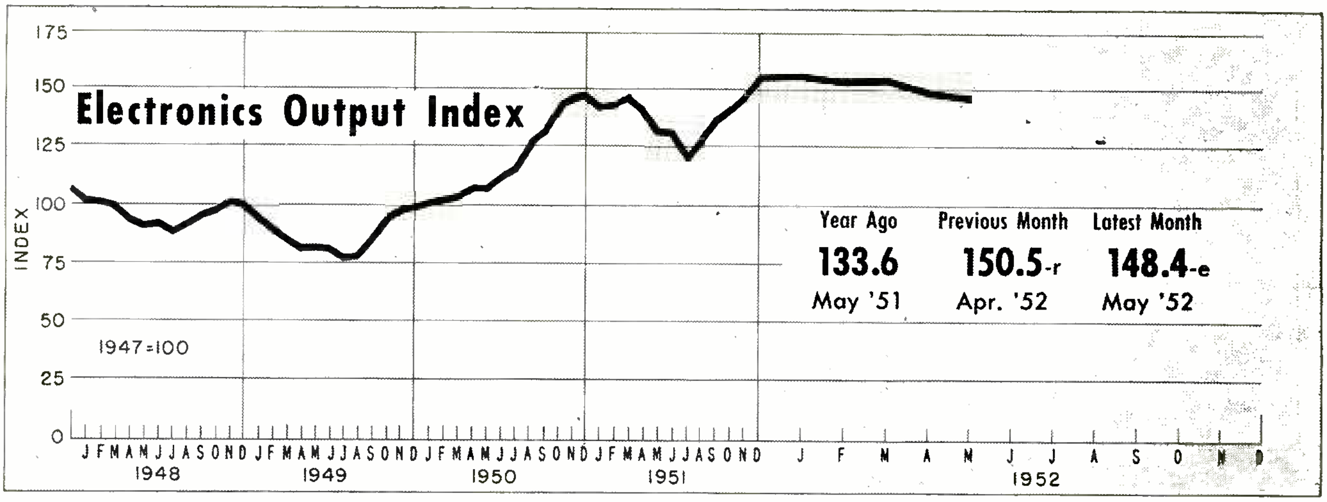
ELECTRONICS 75

MUIRHEAD & CO. LTD. BECKENHAM · KENT · ENGLAND

PRECISION ELECTRICAL INSTRUMENT MAKERS



FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RTMA)	Year Ago May '51	Previous Month Apr. '52	Latest Month May '52
Television sets	339,132	322,878	309,375-p
Home Radio sets	581,557	462,167	404,515-p
Portable sets	164,171	110,529	128,351-p
Auto sets	603,534	275,250	215,478-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)	May '51	Apr. '52	May '52
Receiv. tubes, total units	34,074,356	26,247,258	23,636,484
Receiving tubes, new sets	23,768,898	15,334,092	15,807,449
Rec. tubes, replacement	8,113,122	6,095,641	4,178,292
Receiving tubes gov't.	261,353	3,257,119	2,433,605
Receiving tubes, export.	1,930,983	1,560,406	1,217,138
Picture tubes, to mfrs.	229,250	270,781	247,724

BROADCAST STATIONS

(Source: FCC)	June '51	May '52	June '52
TV Stations on Air	107	108	108
TV Stns CPs—not on air	2	0	0
TV Stns—Applications	415	541	716
AM Stations on Air	2,281	2,352	2,355
AM Stns CPs—not on air	104	66	65
AM Stns—Applications	270	323	323
FM Stations on Air	699	630	629
FM Stns CPs—not on air	10	17	19
FM Stns—Applications	10	10	9

NETWORK BILLINGS

(Source: Pub. Info. Bureau)	May '51	Apr. '52	May '52
AM/FM—ABS	$2,991,227	$3,244,146	$3,323,092
AM/FM—CBS	$6,745,098	$4,943,400	$4,989,424
AM/FM—MBS	$1,510,818	$1,677,748	$1,820,521
AM/FM—NBC	$5,329,752	$4,078,593	$3,861,882
TV—ABC	$1,385,901	$1,686,583	$1,501,148
TV—CBS	$3,066,249	$5,641,831	$5,602,634
TV—DuMont	$622,646	$738,926	$775,063
TV—NBC	$4,946,338	$6,946,751	$6,822,982

TV AUDIENCE

(Source: NBC Research Dept.)	Year Ago June '51	Previous Month May '52	Latest Month June '52
Sets in Use—total	12,769,300	17,290,800	17,627,300
Sets in Use—netw'k conn.	10,821,000	16,352,300	16,656,500
Sets in Use—New York	2,390,000	2,970,000	3,005,000
Sets in Use—Los Angeles	933,000	1,185,000	1,200,000
Sets in Use—Chicago	930,000	1,155,000	1,160,000

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	May '51	Apr. '52	May '52
Aeronautical	33,462	32,147	32,852
Marine	29,258	35,116	35,476
Police, fire, etc.	8,970	10,787	10,965
Industrial	9,145	12,766	13,056
Land Transportation	4,197	4,886	4,966
Amateur	91,558	108,648	110,931
Citizens Radio	527	971	1,175
Disaster	2	31	65
Experimental	476	349	357
Common carrier	818	942	770

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Apr. '51	Mar. '52	Apr. '52
Prod. workers, electronic	261,500	273,300-r	268,300-p
Prod. wkrs., radio, etc.	171,100	170,900-r	168,000-p
Av. wkly. earnings, elect.	$60.60	$64.86-r	$63.75-p
Av. wkly. earnings, radio	$56.74	$60.72-r	$59.47-p
Av. weekly hours, elect.	41.0	41.0	40.3-p
Av. weekly hours, radio	40.1	40.4	39.7-p

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	June '51	May '52	June '52
Radio—TV & Electronics	226.5	281.8	288.9
Radio Broadcasters	211.9	273.9	276.7

INDUSTRIAL EQUIPMENT ORDERS

Quarterly Figures

(Source: NEMA)	Year Ago 1st '51	Previous Quarter 4th '51	Latest Quarter 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

FCC Grants 18 New TV Construction Permits

Denver's KFEL breaks tape for new applicants with tests on channel 2 July 19

FOUR LEAN YEARS for would-be telecasters came to an end Friday, July 11, as the FCC granted 18 construction permits; 13 in the uhf band.

Thirteen construction permits were granted in group A priority areas, currently receiving service from cities 40 miles or more distant; while five CP's were issued for priority B areas now receiving local service. FCC recently acquired a $300,000 appropriation.

Otherwise, 64 contested applications were designated for hearing while 25 applications were dismissed either because the application had remained unamended since the lifting of the freeze or because the application was incomplete or otherwise defective.

During the meeting, applications were considered strictly in order of the FCC's city-by-city priority list.

New applications continue to deluge the Commission. During the week ending July 12 there were 84 new applications filed. Total filings now are approaching 600 of which nearly 200 are for uhf assignments. KFEL began tests in July, and KVOD will follow by mid August.

▶**New TV CP's —**

GROUP A

City	Channel	Licensee
Denver, Colo.	2	Eugene P. O'Fallon Inc. (KFEL)
	9	Colorado TV Corp. (KVOD)
	26	Empire Coil Co. (WXEL, Cleveland)
Portland, Ore.	27	Empire Coil Co. (WXEL)
Springfield-Holyoke, Mass.	55	Hampton-Hampshire Corp. (WHYN)
	61	Springfield TV Broadcasting Co.
Youngstown, Ohio	73	Vindicator Pub. Co. (WFMJ)
	27	WKBN Broadcasting Corp.
Flint, Mich.	28	Trans-America TV Corp.
Spokane, Wash.	4	KXLY-TV Co.
	6	KHQ Inc.
Austin, Texas	7	Texas Broadcasting Co. (KTBC)
	18	Capital City TV Co.

GROUP B

City	Channel	Licensee
Bridgeport, Conn.	43	Southern Conn. and Long Island TV Co. (WICC)
New Britain, Conn.	30	New Britain Broadcasting Co. (WKNB)
New Bedford, Mass.	28	E. Anthony and Sons (WNBH)
York, Pa.	49	Helm Coal Co. (WNOW)
	43	Susquehanna Broadcasting Co. (WSBA)

Backlog Nears $5-Billion Mark

Electronics industry reports over half its equipment output earmarked for defense

OFFICE OF NAVAL MATERIAL figures gathered for the Department of Defense reveal a January 1, 1952 backlog of undelivered electronic equipment orders totaling $4,972,-100,000, of which $824,100,000

'Going Up' Via Atomic Electronics

Experimental radioactive elevator buttons which control leveling to within 0.05 of an inch are checked with a Geiger counter. When an elevator is signalled, the buttons, located at each floor, pass energy through 0.005-inch slits in their lead cases to a modified counter on the car and trigger electronic control mechanisms. Automatic timing equipment (right) is located at the top of the elevator shaft represents subcontracts.

There has been some backlog reduction since that date.

Military production will take an estimated 53.3-percent bite out of this year's electronic-equipment output. Last year's production, military and civilian, totaled $3,818,200,000.

▶ **Survey**—The survey upon which the above figures are based covered 409 manufacturers, of which 278 were 'small', with less than 500 employees. Component and piece-part makers were not included.

Small companies reported proportionally more military business than did large firms. Percentage wise, small companies outstripped large firms 65.2 to 52.2.

Subcontracts for military equipment comprised 16 percent of large-company backlog, while that of small concerns is approximately 23.3 percent.

Sixty-eight companies said all their business was now military; 28 reported no military business. Applications for certificates of necessity have been filed by 132 companies.

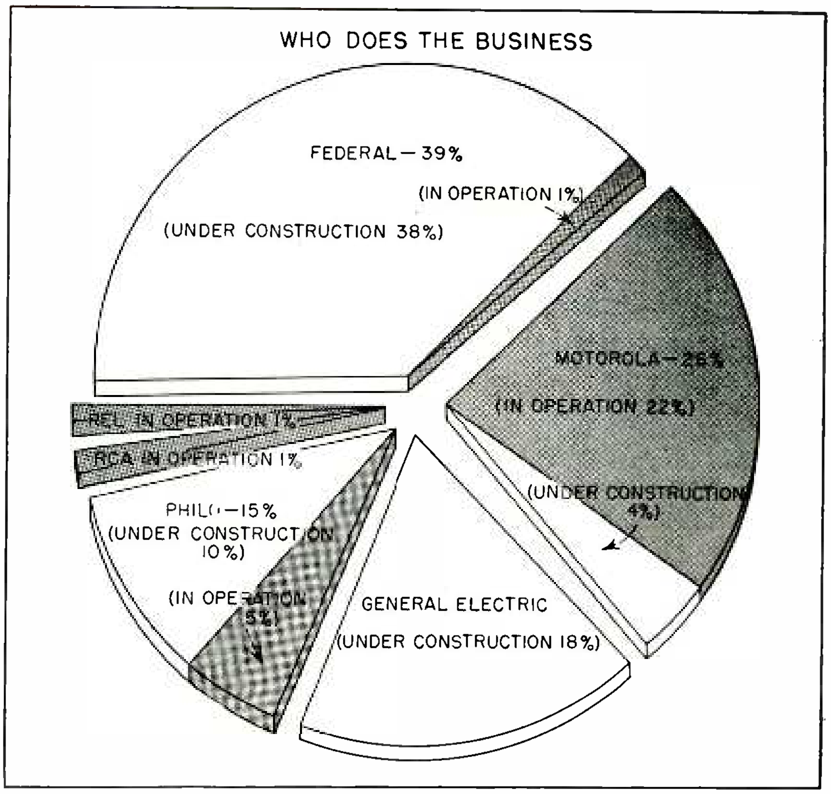
New ILS Transmitters

IMPROVED glide slope transmitters are replacing the old war surplus transmitters in CAA's Instrument Landing System (ILS) as rapidly as they can be manufactured.

The new transmitters will go into 98 domestic airports now using ILS and about 75 additional ones where ILS is scheduled. Installed in duplicate for standby service, they will increase the usable range of the glide slope from 10 to 30 miles.

An improved monitoring system is being installed with the new transmitters. Independent receivers continuously sample the output of the transmitter. If it changes in path width, path angle, or signal level, red lights flash and bells ring in the control tower. The traffic controller can then immediately switch to the standby transmitter.

Cost of the new electronic equipment is approximately $7,500 for each location.



Six companies slice $12 million melon, as . . .

Pipeline Microwave Blooms

Potential market is barely scratched as microwave links gird nation

MICROWAVE RADIO RELAY, furnishing communications along gas and oil pipelines, represents a capital outlay of nearly $12 million. Microwave today links 3,074 miles of oil and natural gas pipeline. An additional 7,140 miles are approaching completion.

Two systems, Mid-Valley and Texas-Illinois, each extending nearly 1,000 miles, are in daily operation. Four systems now under construction will also stretch 1,000 miles or more. These include the 1,840-mile Transcontinental Gas system, Michigan-Wisconsin, Texas-Eastern, and Trunkline Gas.

▶ **Potential Market**—Microwave systems provide communications for less than four percent of all operating gas and oil pipelines. There are 161,151 miles of oil pipeline, the American Petroleum institute reports, while there are 117,000 miles of natural gas pipeline, according to an American Gas Association estimate.

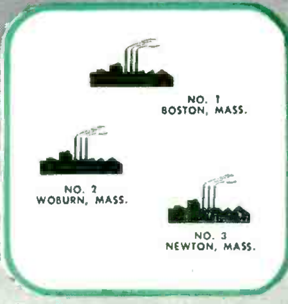
The chart shows how six manufacturers of complete microwave packages have so far served the pipeline market. Federal Telephone and Radio leads in total orders but few Federal pipeline microwave systems are in operation. Motorola, second in total business, leads in systems in operation.

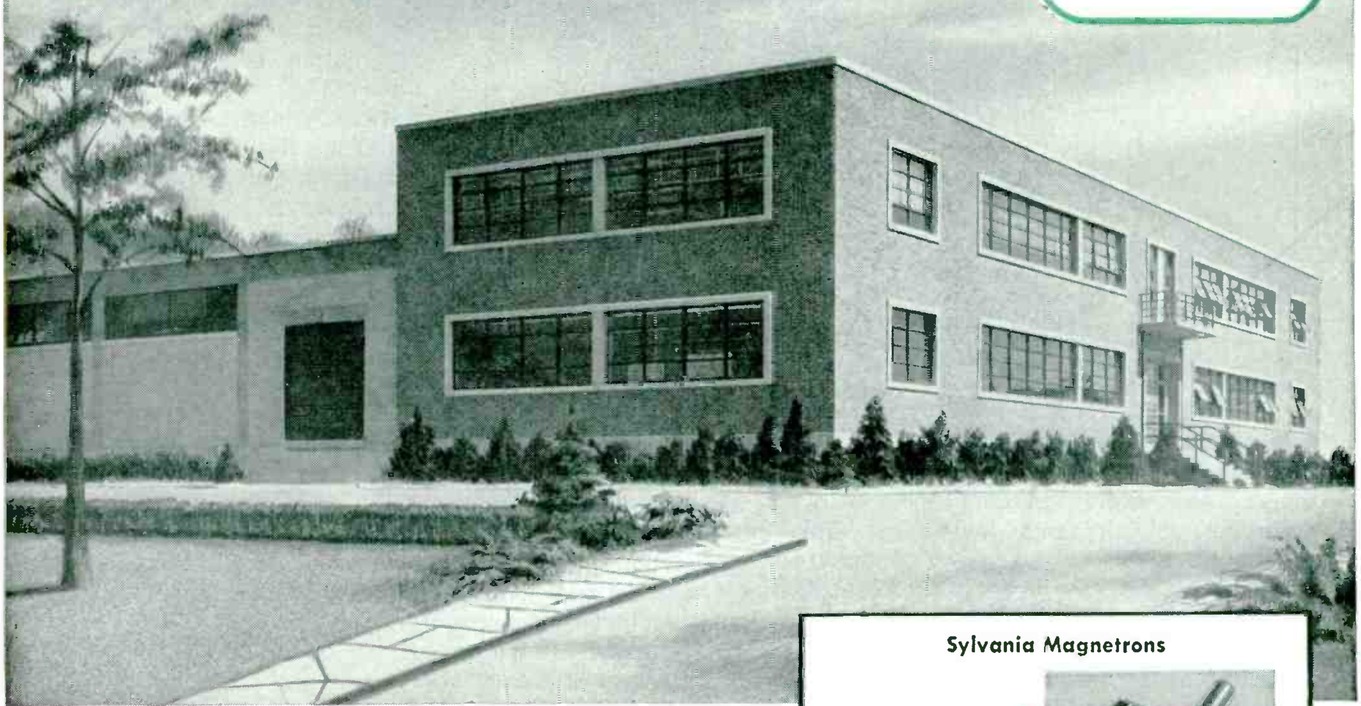
Slow starters, aware of the vast potential market in this field, may be holding back to benefit from the often costly experiences of microwave pathfinders.

▶ **Economic Features** — Pipeline communications experts, after carefully eyeing long-distance telephone tolls, conclude that any right-of-way company that requires four or more private lines may well consider installing private communications facilities. Initial cost of a microwave system, $800 to $1,500 per mile, roughly equals that of

(Continued on page 8)

STILL ANOTHER SYLVANIA ELECTRONIC TUBE PLANT





Second new plant in New England area to produce magnetrons and special purpose tubes

Again Sylvania prepares for new advances in electronics production with the announcement of plans for a third Electronics Division plant.

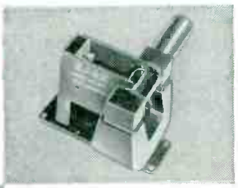
Located at Newton, Massachusetts, this up-to-the-minute manufacturing unit will include in-line-exhaust equipment devoted to manufacture of Sylvania Magnetrons for microwave radar equipment use.

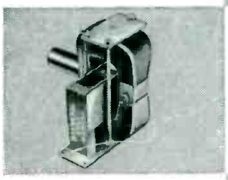
This new plant represents one more step in Sylvania's long-range program of providing high quality electronic tubes for military and commercial use where top performance is needed.

For information on Sylvania tubes for use from 1000 mc. up, write for Microwave Package H-4 which includes catalog material on Sylvania Magnetrons, TR and ATR Tubes, Hydrogen Thyratrons, Microwave Crystals, Rocket Tubes and Tunable Klystrons. Write Dept. E-2608, Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.

Sylvania Magnetrons

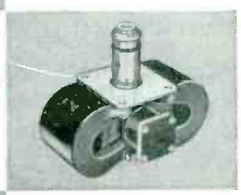
Type 2J42—A low-power fixed-frequency X-band type

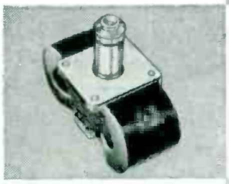




Type 6027—Similar to 2J42 with higher power output

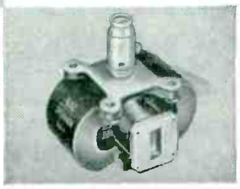
Type 4J50—High-power X-band magnetron





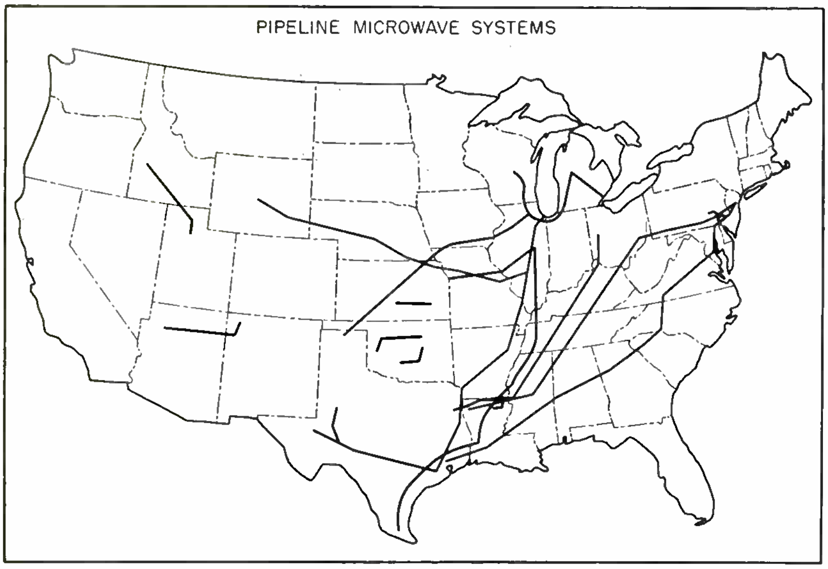
Type 4J78—High-power X-band magnetron

Type 4J52—Low power X-band magnetron



SYLVANIA

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



10,214 miles of pipeline microwave relay girds nation

a wire line. Microwave, however, does not require easements as does a pole line, it uses less hard-to-get copper, and avoids maintenance headaches arising from ice and windstorm.

Potential microwave users in the pipeline clan have been concerned because of the Bell System's policy regarding interconnection of telephone company facilities and private communications systems. Latest word is that Bell will generally permit interconnection with telephone-company-owned PBX's for calls along the right-of-way. Toll and exchange connection, however, will not be provided.

This means that the private microwave user will not have to supply an extra telephone for every desk to carry on company business along the right-of-way. However, an oil man in Chicago still cannot legally call up the little woman in Houston, using the oil company's microwave system to save long-distance toll.

Electronic Clerks: Fact or Fancy?

Computer-type business machines are fast and accurate, but high cost discourages large-scale use

ELECTRONIC computers can readily be taught to solve extremely complicated mathematical problems, but no really simple method has yet been devised for teaching these machines the simple concepts of reading and writing.

As a result, they have become widely accepted in scientific laboratories, where the math problems are complex and the amount of information involved is small, but in business offices, where the situation is the reverse, electronic computers have yet to prove their worth in all but the most special cases.

▶ **What's New**—Many companies are currently engaged in developing tube devices for doing clerical work that now occupies the time of 16 percent of the country's working population.

Electronic Computer Corp., of Brooklyn, is nearing completion of a 1,000-tube machine to service a weekly magazine subscription list. It prints 750,000 up-to-date labels for mailing and makes an average of 20,000 corrections in stored information each week.

Potter Instruments will soon unveil a random-access memory device which, in conjunction with the already introduced 5,000-wpm typewriter (ELECTRONICS, May 1952) and a new input keyboard, will provide a completely automatic electronic business machine of extraordinary flexibility and capacity.

▶ **Looking Ahead** — Drawing boards are full, but offices are still unfortunately void of electronic business machines. At present government agencies are the only quantity buyers, but large mail-order houses, insurance companies, banks and publishing houses are catching on fast.

Most research is being directed toward improved memory and input and output devices. The almost universally-used IBM card has limitations. Magnetic tapes are capable of storing large amounts of information, but with present-day techniques it is difficult and time consuming to jump from one end of a long tape to the other.

With the cost of human labor constantly rising, and companies like Remington Rand, IBM and Burroughs constantly working to reduce the cost of electronic office machines, a fairly optimistic prediction for the future can be made. When the breakeven point is reached, the electron tube should be as commonplace in the business office as the filing cabinet is today.

Londoners View Gaite Parisienne

Different picture standards fail to impede international television

INTERNATIONAL TELEVISION became a reality this month when British and French viewers witnessed a week-long series of bilingual programs originating in Paris between July 8 and 14. Although cross-channel television was first tried in August 1950, this latest test marks the first time two national systems have been completely interconnected.

A similar international hook-up is planned to carry next year's coronation ceremonies from London. At this time the network may also include Holland, West Germany, Belgium and Italy.

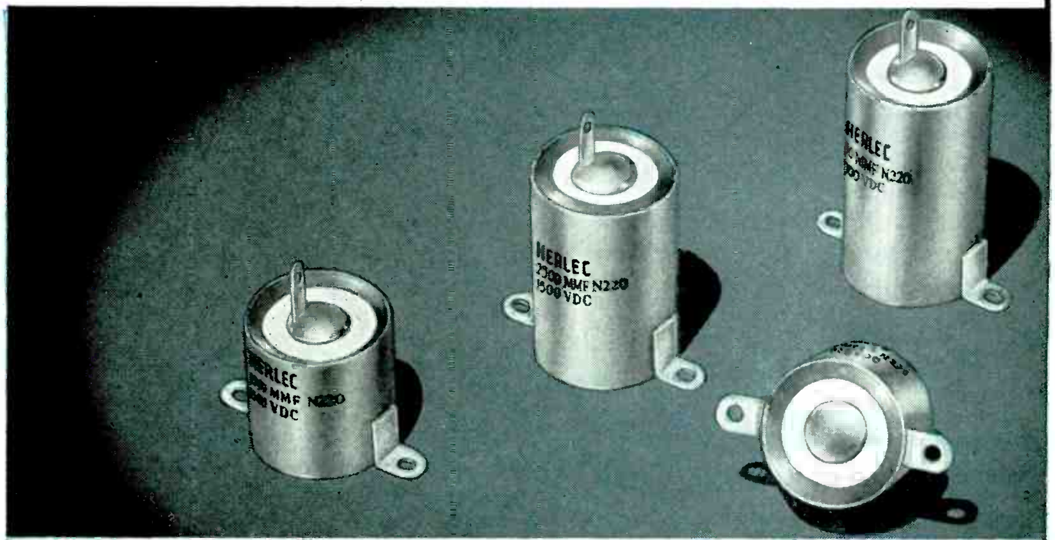
▶ **Technical Problems**—Converting the French 819-line picture to the British 405-line picture posed a

(Continued on page 10)

9 standard terminal designs fit every mounting need

20,000-Volt Molded Ceramic Capacitors

Molded in moisture resistant, non-flammable thermosetting plastic, these new Sprague Type 700C Ceramic Capacitors offer exceptional reliability and economy as filters for TV receivers and C-R instrument high-voltage supplies. Standard capacitance is 500 mmf. and the units are conservatively rated for operation at 20,000 volts d-c. Write on letterhead for Engineering Bulletin 606.



Extended Capacitance Ranges for Precision Circuitry

These new Sprague-Herlec Precision Tubular Ceramic Capacitors make it possible to control the capacitance tolerance of exacting 500, 1000 and 1500 V. d-c precision circuits within ±1%. Temperature coefficient tolerances may be reduced to as little as ±1.0 parts in a million!

A logical development of the design first popularized in Sprague-Herlec cup ceramics, they greatly extend the capacitance range available to designers. "Q" and capacitance stability are high and the units have excellent retrace characteristics. Hermetically sealed in metal tubes, they operate over the range from −55°C. to +85°C. Bulletin 607 sent on letterhead request to Sprague Electric Company, 35 Marshall St., North Adams, Mass. or to the wholly owned Sprague subsidiary, The Herlec Corp., 422 N. 5th St., Milwaukee 3, Wis.

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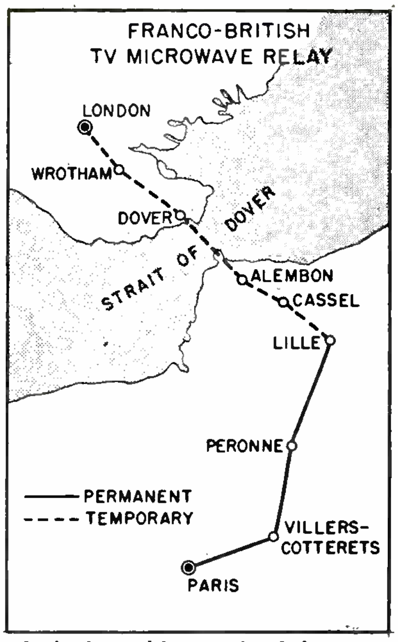


technical problem solved by scanning, with a 405-line camera, the picture on an 819-line receiver.

The receiver incorporates, for this purpose, a picture tube having a long-persistence phosphor. The same system can be used when interconnecting systems using either the American 525-line picture or the 625-line picture favored in several European countries. London viewers report picture quality compared favorably with regular BBC remotes.

▶ **Microwave Relay** — The map shows the Paris-London microwave radio relay. Temporary links connected London with the permanent Paris-Lille installation. Conversion of television signals to British standards was accomplished at Cassel.

The Franco-British test renewed speculation concerning trans-Atlantic television. Suggested schemes envision a radio-relay system using either a chain of high-flying planes or of shore stations located in the Faroe Islands, Iceland, Greenland, Baffin Land and Labrador. Either system, however, would cost upwards of $50 million.

High-Frequency Transistors Coming

Developmental point-contact type opens new fields of application

IN THE SHORT TIME since the discovery of transistor action, many technical advances have been made.

The so-called 'junction' type quickly followed the point-contact type. Probably second in importance only to the announcement of the junction transistor is the recent news that point-contact transistors can be made to oscillate at frequencies in the 100 to 200-megacycle band.

▶ **Significance**—Early transistors had been publicized as capable of oscillating at 50 megacycles. With operation extended well above 50 megacycles, the transistor is now able to keep company with the tube in new areas of application.

According to B. N. Slade, transistor engineer of the RCA Tube Department in Harrison, N. J., there is a definite correlation between spacing of the contact points of a transistor and frequency response. In general, the closer the spacing, the higher the frequency. Less widely realized, however, is the fact that frequency response as well as stability of a transistor is determined largely by resistivity of the germanium.

Different combinations of spacing and resistivity enable engineers to design transistors with a wide range of operational characteristics. One combination recently resulted in a transistor oscillating stably at 225 megacycles.

Study Army's Use Of Electronics In Korea

A GROUP of prominent industrialists and scientists has just completed a three-weeks tour of Korea studying problems involved in the Army's utilization of electronics. Their report is expected to give industry and government a better idea of how more effective electronic equipment, of maximum reliability, can be built for battlefield use.

U.S. Lifts Controls On Engineer Salaries

THE NATION'S 400,000 engineers employed in a professional capacity are among millions of workers brought out from under wage and salary controls by amendments to the Defense Production Act effective July 1.

The Salary Stabilization Board has issued an interpretation, defining 'professional engineer'. Qualifications include holding a college degree or license to practice.

▶ **Non-engineers**—SSB warns that technicians, no matter how highly skilled, advisers on sales promotion, business methods and operations are not to be considered engineers. Nor are persons simply designated as engineers, such as stationary, maintenance, sales, management or administrative engineers. Physicists, chemist, mathematicians and others in scientific fields are not classified as professional engineers either, even though their work may be closely related to engineering.

Set Manufacturers Eye Growing Hi-Fi Market

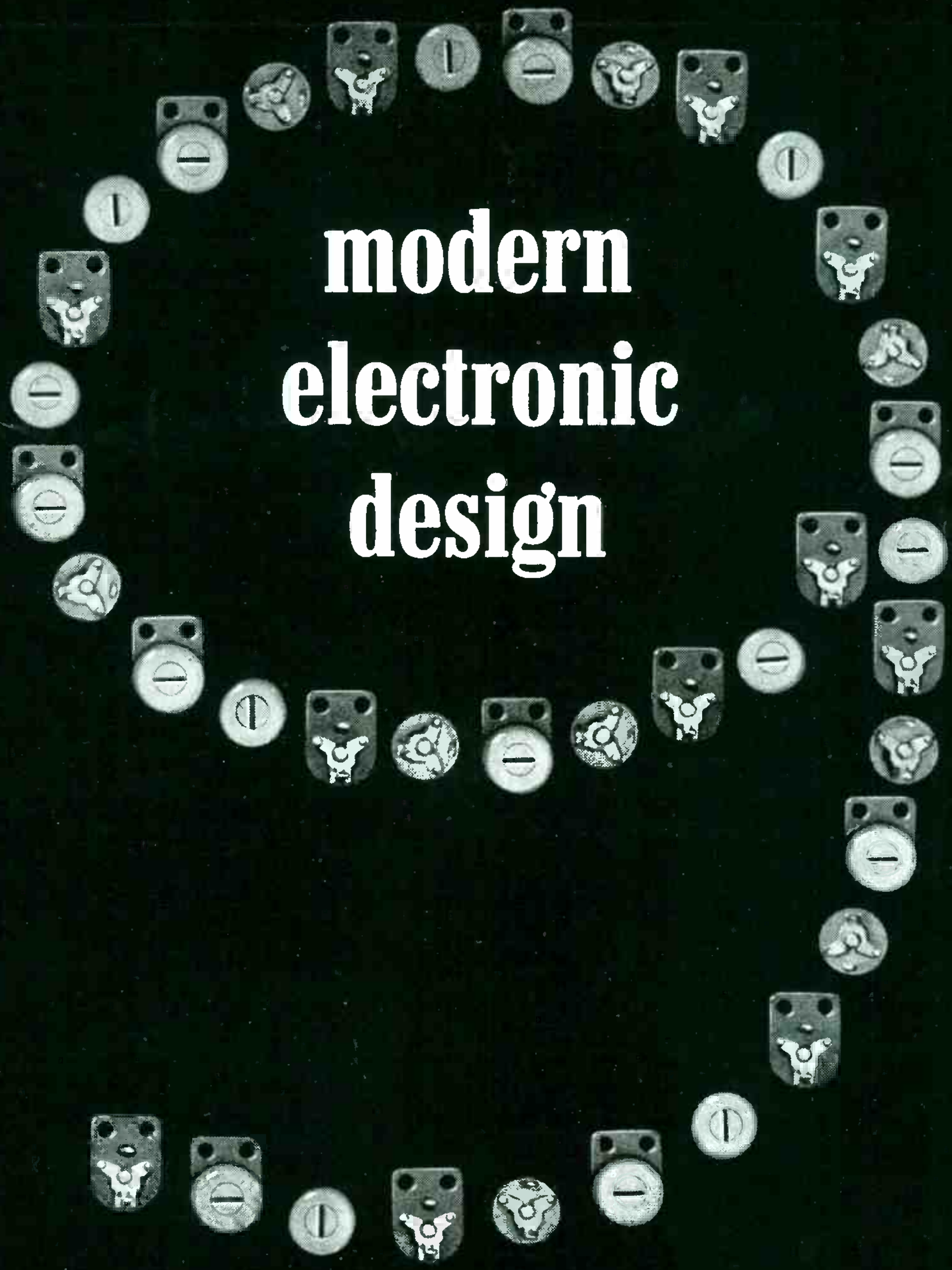
Increasing public demand attracts more radio companies; some continue wary

INCREASED INTEREST of Stromberg-Carlson, Hallicrafters and Pilot in the high-fidelity field is causing other manufacturers to take a closer look at the market. It is reported that General Electric will also introduce a new line of hi-fi equipment this year.

▶ **High Interest**—Companies pushing for highly specialized hi-fi business list several reasons for their action. Stromberg-Carlson says that current public interest is 'tremendous.' New York dealers report annual sales increases of 60

(Continued on page 14)

There are 9 features of Ceramic Trimmers essential to –



modern
electronic
design

and only CENTRALAB has all 9

FOR PROOF, SEE NEXT TWO PAGES

9 good reasons

Miniature Ceramic Trimmers

Check these Centralab Miniature Ceramic Trimmer advantages:

SMALLEST TRIMMERS — the smallest yet produced by Centralab. That means the smallest size available — *anywhere*.

MOISTURE-RESISTANT ceramic body for complete imperviousness to moisture. Holds moisture absorbtion to 0.007% or less.

MORE RUGGED — unmatched ability to withstand temperatures normally encountered in electrical apparatus.

PHENOLIC MOLDED CASE insulates unit electrically — protects working parts from damage. Seals out dust, dirt, moisture.

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WIDE RANGE OF CAPACITY — from 2.5-7 mmf to 8-50 mmf.

SMOOTH LINEAR TRIMMING provides easy adjustment and precise alignment when balancing sensitive circuits.

EXCELLENT ELECTRICAL CHARACTERISTICS — Voltage rating 500 vdcw and 1000 vdct. Power factor 0.2% at 1 megacycle.

ACCEPTED FOR MILITARY APPLICATION — meet applicable portions of JAN-C-81.

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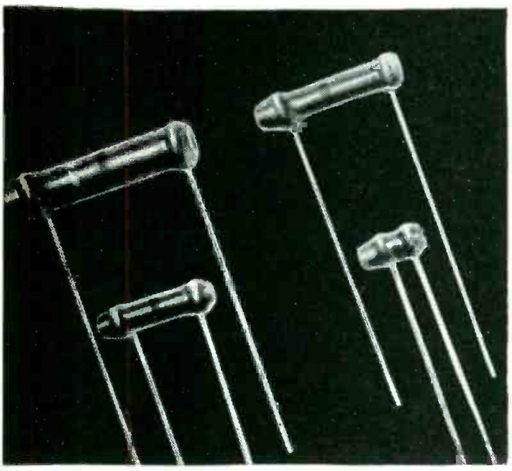
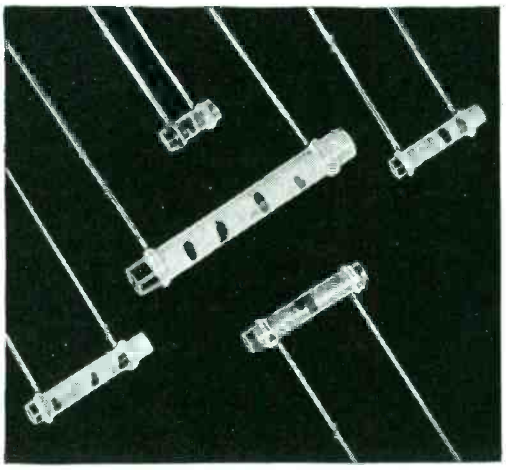
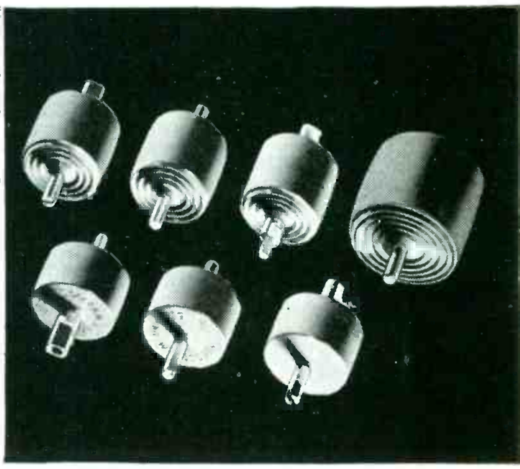


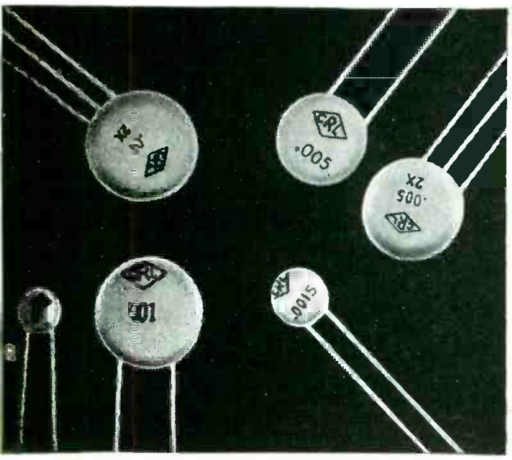
BC HI-KAP TUBULAR CERAMIC CAPACITORS available from 1 mmf to 10,000 mmf. Ideal for use in r.f. by-pass and audio-coupling applications. For details, write for Bulletin 42-3.



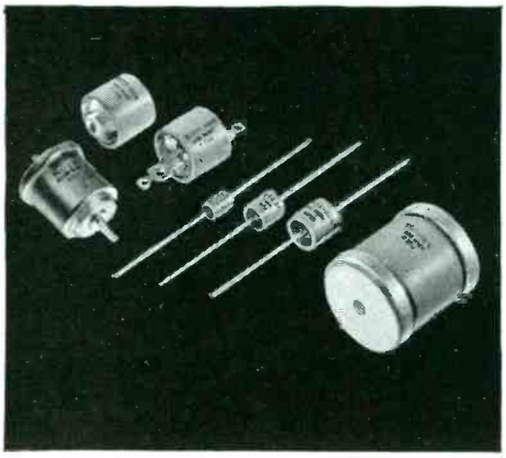
TUBULAR CERAMIC CAPACITORS — Type TCZ show no capacitance change over wide temperature range. Type TCN special ceramic body varies capacitance with temperature. Write for Bulletin 42-18.



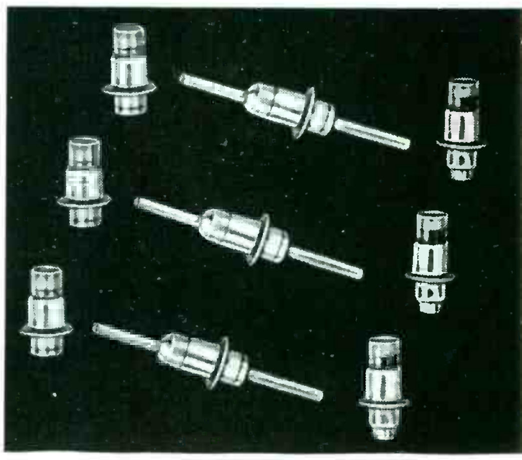
TV HI-VO-KAPS are the standard high-voltage capacitors for the TV industry. Capacitance: 500 mmf, 10 KV, 20 KV and 30 KV D. C. working. Write for 42-10R.



CERAMIC DISC HI-KAP CAPACITORS hold thickness to a minimum. Make possible very high capacity in extremely small size. Used in HF by-pass and coupling. For details, write for Bulletin 42-4R.



HIGH VOLTAGE CERAMIC CAPACITORS. Capacitance: 5 to 500 mmf, 5KV to 40 KV D.C. working. Ideal for portable or mobile equipment and high-voltage, high-frequency gear. Bulletin 42-102.



EYELET-MOUNTED FEED-THROUGH CERAMIC CAPACITORS—smallest made... widest range obtainable with general temperature-compensating characteristics. 10 to 3000 mmf, 500 vdcw. Bulletin EP-15.

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☐ EP-16 ☐ 42-3 ☐ 42-18 ☐ 42-10R ☐ 42-4R ☐ 42-102 ☐ EP-15

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percent in the past two years and dealers elsewhere report demand for 'custom' sound equipment outrunning their ability to make immediate delivery.

Hallicrafters noted the growing demand for hi-fi last year when they found that their shortwave receivers were being used as hi-fi system components. As a result, a full line of high-fidelity amplifiers was introduced at the recent Audio Fair in Chicago.

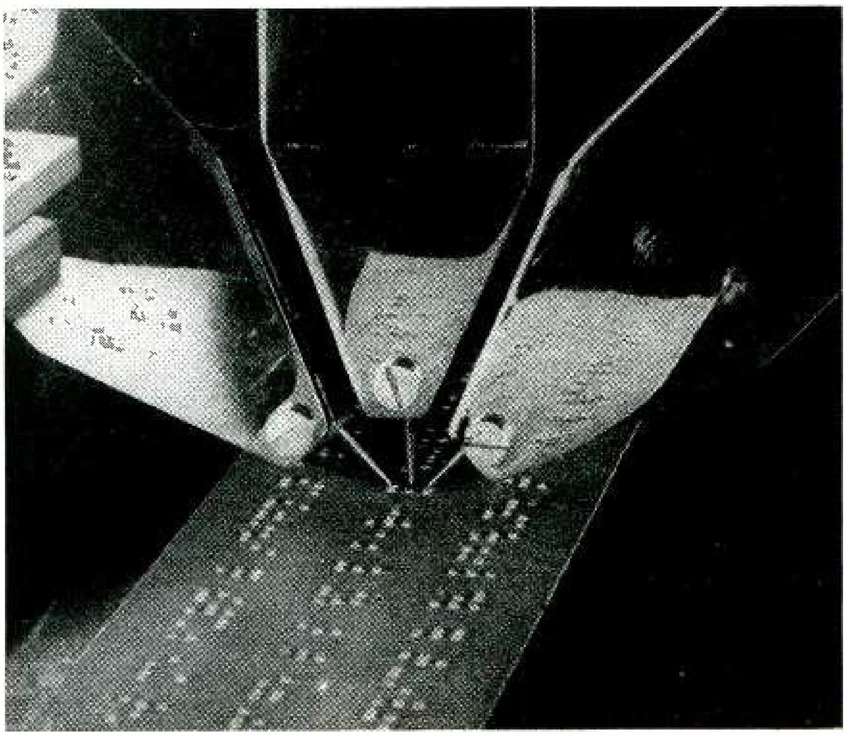
Pilot, too, found public demand growing and is now selling a line of amplifiers, tuners and pre-amplifiers on a national basis.

▶ **Market Potential**—It has been estimated that there are now about 500,000 hi-fi enthusiasts in the U. S. Manufacturers say that most of them are located around the so called 'cultural centers' of the country, such as New York, Chicago and Los Angeles. As much as 25 percent of the total 1951 national sales volume of about $14 million was probably done in the New York area. Total national sales volume this year is expected to reach at least $15 million.

▶ **Future Outlook**—Some proponents feel that hi-fi systems will eventually replace standard radio combinations, which continue to lose ground to television. They say that television combinations cannot meet the needs of the growing number of fidelity-conscious people and still remain competitive in price.

Even RTMA recently noted the tendency of manufacturers to order larger and heavier loud speakers. They also predict that before long the hi-fi market will become a more important market factor.

But many manufacturers are still wary. Some remember the unprofitable experience of standard-set manufacturers who entered and soon left the field a few years ago.



Tiny Antennas Read Dot Braille

Duplicating machine demonstrated in London senses words dotted in Brailled sheet and makes corresponding holes in tape that then serves as a stencil. Printer that uses solid plastic ink then readily creates new copies for the blind. Dots shift phase of 30-mc signal emitted by tiny antennas. Phasitron tube in each sensing head detects shifts and sends appropriate signals to perforator

Industry Proposes New Spare-Parts Code

Urges military to delegate spare-parts selection power to contractors

OUTCOME of current confabs between industrial and military leaders over procurement of spare parts for concurrent delivery with electronic equipment may be appointment of a joint military-industry committee to prepare uniform spare-parts policies for the three services.

▶ **Industry's Gripe**—Concerned over the collective black-eye handed the industry by equipment malfunctioning due to lack of spare parts, industry representatives generally indict the military for impeding concurrent delivery through contract red tape.

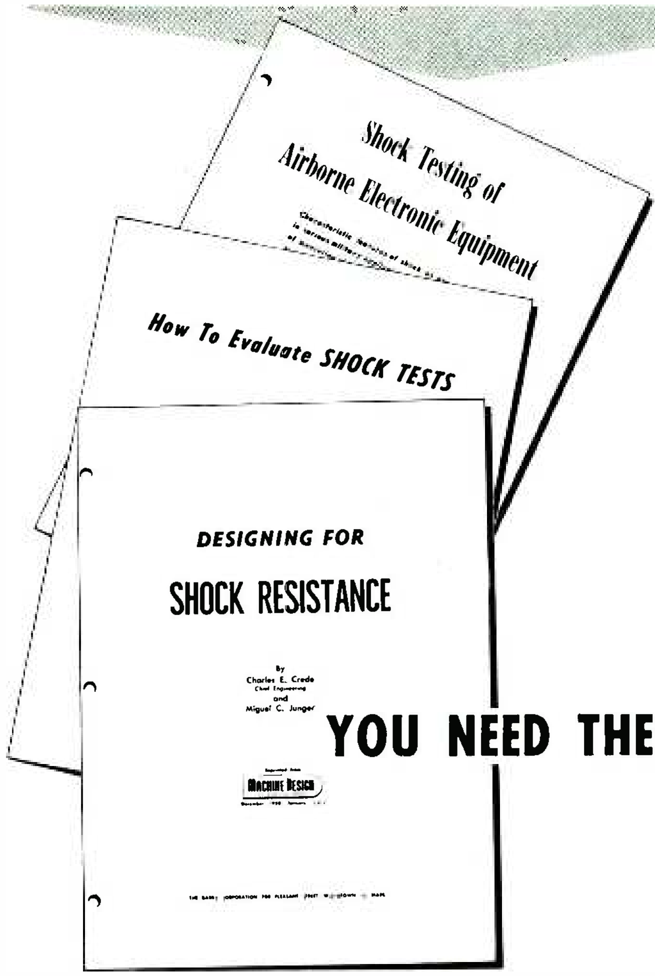
Industry men suggest five alternate spare-parts procurement plans:

- *Precontract selection by government*—In repeat-production contracts, the parts required would be spelled-out specifically in the original contract.
- *Selection of equipment spares by contractor*—In first-run contracts, the contractor would supply with the equipment those parts peculiar to it. Stock spares, designated by the government, would be furnished later.
- *Selection of all spares by contractor*—Where all spares must be delivered with the equipment, the contractor would take full responsibility for choosing and procuring the needed parts.
- *Selection of all spares by government*—This method, similar to that now in use, would be used only with the understanding that concurrent delivery of equipment and spare parts is not promised.

Industry representatives have stipulated that the proposed spare-parts regulations provide for government review when the contractor has power of initial selection, subject, however, to compensation of the contractor following either a

(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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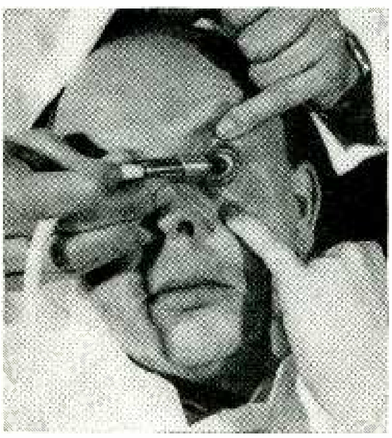
change-order or partial contract termination.

Industry men further urge that design changes in spares be negotiated simultaneously with equipment design changes, that spare-parts paperwork be greatly simplified in the interests of economy and efficiency and that the proposed regulations be devoid of contractual aspects.

▶ **Military reaction**—Some Pentagon brass take a dim view of industry's proposals, feeling that contractors might seize upon the proposed ground-rule changes to pad contracts and furnish spare parts derived from sweeping-up the floor.

Industry has attempted to allay these fears by pointing out the integrity and technical competence of known electronic equipment manufacturers.

Since military departments maintain substantial stocks of standard component parts and have adequate means to determine useage rates, a possible solution to a deadlock might be to exclude standard parts from provisioning chores and permit the contractor to select those spare parts peculiar to the equipment.



Eye-Size X-Ray Tube

Used for irradiating a transplanted cornea, this 4.5 by 1.4-cm X-ray tube developed by Philips is said to be the smallest ever made. Gold coating inside the beryllium window is the anode and layer in which X-rays are generated by a variable 25-kw generator. The tube may be useful industrially for checking defects in very light metals

Navy Receivers Fail Tropics Test

Jungle moisture and fungus affect components even when specially treated

REPORT on a four-year study of Navy communications receivers in a tropical jungle indicates that none of the equipment studied is capable of giving prolonged, dependable service under tropical conditions. Navy scientists found no evidence to indicate that use of fungicidal varnish either prolonged the life or increased the reliability of treated equipment.

Eighteen receivers were tested by the Office of Naval Research at the laboratory's tropical exposure station in Panama. Eight receivers were uncoated while the other ten were treated with moisture and fungus-proofing varnish.

Only two of the eighteen receivers survived forty-four months of exposure without requiring component replacement, complete realignment, or both. Excluding vacuum tubes, power units, resistors, potentiometers, and mica capacitors were the principal sources of trouble.

▶ **Design Recommendations** — Significant recommendations include the elimination of fungus-susceptible materials such as natural-fiber cable lacings, cotton insulation, cellulosic plastics, and vinyls containing susceptible plasticizers; development of flexible glass-to-plastic bonding cements or non-welling plastics for meter cases and tube sockets.

Because ferrous parts rust severely, particularly on areas where condensed moisture can accumulate, such parts should be thoroughly protected. Conventional pigmented finishes, in addition to cadmium plating or other surface treatment, are recommended.

TV Tube Trend Still Far From Stable

Status of tv tube production not affected by expected expansion in cobalt output

NEW cobalt recovery process developed by Chemical Construction Corporation, which promises to expand cobalt supplies in the near future, will have little immediate effect in determining trends in picture-tube focus methods.

According to major tube manufacturers, even with present short cobalt supplies magnetic-focus tube production still leads electrostatic output by about 3 to 1.

▶ **Conservation**—At the beginning of the Korean War, tube manufacturers stepped up conservation methods for critical metals and started production of electrostatic-focus tubes saving about 5 ounces of Alnico-5 on each tv set made. (ELECTRONICS, April, 1951, p 85) But shortages due to expected increases in defense production have not materialized to the extent anticipated. This, coupled with the general decrease in tv sales during the past year, has made conservation less urgent.

Other factors too, have conditioned the expected trend to electrostatic focus. As one tube manufacturer put it, "We are in a buyer's market now and have to produce what our customers want. Right now, most of them want magnetic-focus tubes."

▶ **Opinion**—Of six leading tv-set producers, four use magnetic focus almost exclusively in their new receivers. They indicate that one of the reasons for the continued use of the magnetic-focus tube, is that they are more familiar with it and prefer it as long as adequate materials are available.

Most tube and set manufacturers

(Continued on page 18)

think that the present status of magnetic and electrostatic-focus tube production is not likely to remain stable. A wholesale shift to electrostatic focus could take place almost overnight if increased conservation were necessary or if further technical and competitive developments take place. Until such factors develop, the magnetic-focus picture tube will predominate.

Potentiometer Makers Plan Standardization

GROWING precision potentiometer industry is developing a standardization program to facilitate quantity production of such components.

First steps are directed toward standardizing physical dimensions and mechanical accuracies where it is felt that selections can now be made to satisfy 70 to 80 percent of the users. Plans for standardizing terminology and definitions which will permit all manufacturers and users to converse on a common basis are also in progress.

Groups representing the military and other users are at work on the program but completion is not expected for several months.

What's Behind the Figures—TV Audience

Sixth of a series outlining background of statistics printed in "Figures of the Month"

THE SIXTH listing on the monthly statistics page (p 4), under the heading *TV Audience* is a count of television receivers actually in use, as compiled by the Sales Planning and Research staff of the NBC TV Network. The figures represent the receiver count as of the first of the month indicated at the top of each column.

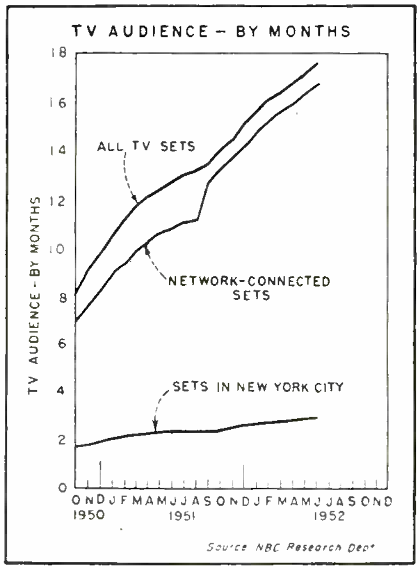
The accompanying chart, which shows the trend of the tv audience from October 1950 to the present, shows a steady increase in the total count, despite the limitation imposed by the freeze on new tv stations.

The number of sets served by stations having network connections has paralleled the total count, with a notable sharp increase between August and September of 1951. This coincided with the opening of the transcontinental microwave relay, which added nearly two million receivers to the network.

▶ **Saturation**—One evidence of saturation is the set count in New York City, now three million strong. Early in 1951 sets in use in this city were increasing at the rate of nearly 100,000 per month. After the summer doldrums, the rate picked up again to about 80,000 per month at the end of 1951, but is now only 40,000 per month.

An interesting comparison is that between Chicago and Los Angeles. Chicago and its suburbs, with a population roughly 50 percent greater than Los Angeles and suburbs, has fewer tv sets than Los Angeles (1,160,000 vs 1,200,000 in June, 1952.

This may possibly be explained by the greater choice of programs in Los Angeles, which has seven outlets to Chicago's four.



As of June there were 94,000 sets estimated in use in Canada and Mexico not tallied in the NBC totals. These included 55,000 sets in Canada served by Buffalo, 36,000 in Canada served by Detroit, and 2,500 in Matamoros, Mexico.

How Good Is Russian Radar?

Indications are that the Soviets possess quantities of effective equipment

AN Associated Press dispatch datelined Seoul, April 6, listed UN air losses in the Korean campaign as 622 exclusive of naval aircraft. Of this total, 490 planes were lost to ground fire.

World War II air losses due to ground fire seldom exceeded three percent of total losses. Although the entire increase cannot be definitely credited to assistance from Soviet radar equipment neither can the 80 percent loss to ground-fire be attribtuted solely to North Korean and Chinese marksmanship.

▶ **Four Design Sources** — Soviet electronic equipment obviously derives from four sources: (1) native Russian developments, (2) study of British and American equipment prototypes furnished under the lend-lease program, (3) developments based upon captured German equipment and the work of German scientists captured by Russian forces, and finally, (4) purchase of commercially available equipment adaptable to military use.

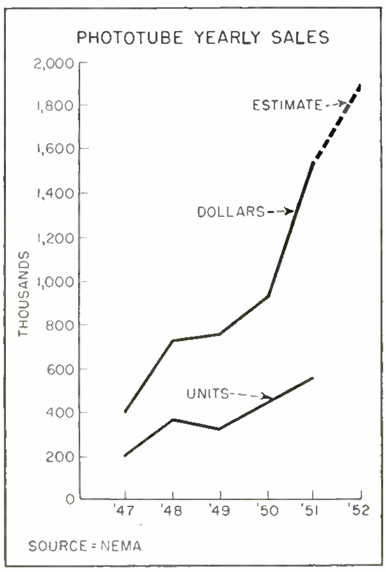
A study of Russian technical

(Continued on page 20)

books and magazine indicates that the technology of both radar and television are well understood by Soviet scientists. In fact, characteristically, they claim to have developed the art some 50 years ago. Photographs showing tv factory interiors are indistinguishable from those of our own factories. It is no stretch of credibility to presume these production lines are perhaps paralleled by others turning out electronic-warfare devices. Specifically, Russian technical literature deals at length with magnetrons, acorn tubes and other high-frequency components that provide the building blocks for microwave ranging equipment.

▶ **Ape Anglo-American** — Russian radar engineering texts carefully avoid reference to operational Soviet equipment or to electronic equipment of Russian design. Discussion is confined mainly to British and American equipment.

Early-warning and land-warfare equipment described is of the early British type, while naval radar follows American pattern.



Phototube Sales Rise

PHOTOTUBE dollar sales volume has tripled since World War II and is expected to reach $1.9 million by the end of this year.

Equipment manufacturers were the leading customers during the first quarter of 1952.

Instruction-Manual Writing Is Big Business

Four percent of the cost of new electronic equipment goes in to the preparation of manuals

WRITING technical instruction books for the armed services is big business. Just how big, military people aren't saying, but men who should know guesstimate that 4 percent of the total cost of new military electronic equipment is represented by preparation cost of the operating and servicing manual to accompany the equipment.

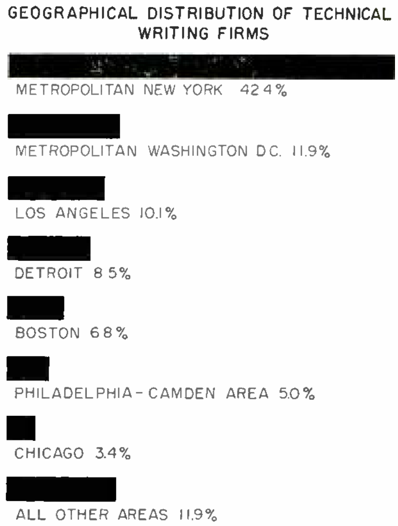
Material procurement contracts let by all three services generally require the manufacturer to be responsible in some degree for preparation of manuals. At present, most prime contractors do their own technical writing. This is because contracts placed during the initial phase of rearmament went chiefly to large manufacturers maintaining their own writers. However, even the big boys find it necessary to call in outside talent for illustrating and art-layout chores.

▶ **Preparation Costs** — Per page costs for military manual preparation run between $70 and $125. Costs vary considerably with the complexity of the equipment, the availability of necessary technical data, and with engineering changes made during production. The latter factor is especially important since contracts often contain a continuing requirement for manual revision to reflect the latest equipment design changes.

One rule of thumb for estimating manual preparation cost is to allow $100 for each electron tube in the equipment.

▶ **Writing Services**—A survey of 58 technical writing services experienced in government work reveals that large, well-established concerns handle most of the business, although there is plenty of incidental work to sustain a multitude of small firms.

About one-third of the writing firms listed in Dun and Bradstreet



entered the field during the last war. Many top men in the newer concerns got their start with one outfit that during World War II established technical writing as a full-time business. Most of the larger firms have some well-established peacetime stock-in-trade. Publishers, printers, advertising men and consulting engineers have invaded the field. Recently two of the largest electronic manufacturing firms have begun to accept outside work for their technical writing departments.

Personnelwise, the largest writing firms employ from 100 to 250 men, while most smaller outfits a staff of under 25.

Geographically, the metropolitan New York area encompasses the bulk of the technical-writing business. Several Detroit firms, long engaged in writing for the automotive industry, have recently turned their talents to the electronics field.

▶ **Navy**—The three-way split in Navy electronics procurement carries over to technical instruction books. The bulk of land-based and sea-going electronic equipment is procured by the Bureau of Ships. The Bureau of Aeronautics takes care of airborne electronic equipment, while certain special equipment such as fire-control radar

(Continued on page 22)

DAVEN Electronic Voltmeter Type 170-A

Vastly Improved with 3 important, new features

1. Input stages of the amplifier are shock mounted to reduce microphonics.

2. The amplifier is completely shielded to prevent hum pick-up.

3. The power supply is completely shielded to prevent hum radiation in adjacent equipment.

Write for completely detailed catalog data.

THE DAVEN CO.
191 CENTRAL AVENUE
NEWARK 4, NEW JERSEY

The New Daven Electronic Voltmeter, Type 170-A

is a superior, portable instrument, ideal for general laboratory and production use. It is built with typical Daven precision to measure accurately A.C. sinusoidal voltages over a frequency range from 10 to 250,000 cycles and a voltage range from .001 to 100 volts.

- Large, easy-to-read, illuminated, meter scale on which all readings may be made.
- Accuracy ± 2% over entire frequency range.
- Output jack and separate volume control for using Voltmeter as wide-range, high-gain amplifier.
- Construction permits readings independent of normal power line variations.
- Meter scale has both voltage and decibel ranges.

★ LIMITED NUMBER AVAILABLE FROM STOCK

comes under the Bureau of Ordnance.

Since every naval vessel must be largely self-sufficient at sea, the Bureau of Ships requires that a single all-inclusive instruction manual accompany each item of equipment. The manufacturer of the gear is responsible not only for preparation of the book but for printing and distribution as well.

Four handbooks are required for each piece of airborne equipment, namely: operator's handbook, servicing handbook, overhaul handbook and illustrated parts breakdown. Since these books are distributed to activities and squadrons according to technical requirements, a complete set of books is not needed for each equipment. The Bureau of Aeronautics, therefore, requires only that the manufacturer furnish reproducible copy and takes care of printing and distribution itself.

The Bureau of Ordnance has no hard-and-fast rule concerning instruction book procurement. Generally, in the case of fire-control radar, the manufacturer furnishes an instruction-book manuscript for each equipment prototype. Bureau officials, however, see definite advantages in having the instruction book prepared by a "third party" not too intimately involved in the equipment's technology.

▶**Air Force**—The Air Material Command at Wright-Patterson Air Force Base is generally responsible for buying and contract approval. However, under a decentralized procurement policy, each air-district headquarters is responsible for procurement of equipment and books from manufacturers located within the district.

In general, the Air Force policy regarding instruction books is similar to that of the navy's air arm.

▶**Signal Corps**—Most army electronic equipment comes under Signal Corps auspices. The Signal Corps Publication Agency, Fort Monmouth, N. J., has 245 men engaged in technical writing. The Army prefers to have the manufacturer furnish reproducible copy from which a technical manual may be prepared.

In certain instances, a manufacturer's instruction book finds interim use as a technical manual. However, when an equipment manual is destined for field or training use it is usually rewritten, printed and distributed by the Signal Corps.

TV Export Volume Increasing

Monthly shipments of tv sets increase in first quarter. More new markets expected this year

DESPITE technical difficulties and foreign trade restrictions, some U. S. inventory-burdened tv producers are finding a profitable and growing market abroad, especially in countries of the Western Hemisphere.

Indicative of the growth of foreign tv sales is the fact that this year U. S. tv sets exported rose from 3,650 in January to 7,377 in March for a quarterly total of 16,107 sets worth $3,053,598.

Leading markets for sets, according to Department of Commerce figures, are Cuba, Mexico, Brazil and Argentina.

▶**Export Problems**—Exports are not accomplished without difficulty. Manufacturers have found that countries such as Mexico, Argentina and Brazil increase import restrictions as their own manufacturing facilities develop. Now, the only countries in the Western Hemisphere where complete U. S. tv receivers are accepted without restriction are Cuba and Canada.

The solution for most U. S. tv manufacturers is the establishment of assembly plants in foreign countries, although even this is not being permitted by some governments.

▶**Potential Markets**—By the end of 1952 it is expected that at least five new areas operating with U. S. standards will be active markets. Station operation is expected in the capital of the Dominican Republic in August and Caracas, Venezuela plans to have its station operating in November. In addition to Montreal and Toronto, which expect to be telecasting on a regular schedule by September, Hawaii is another market using U. S. tv standards that plans to have a station in operation this year.

With these new markets opening this year and others in such countries as Peru, Uruguay, Columbia, Puerto Rico, Chile and Guatemala expected in the near future, the outlook for tv receiver marketing abroad is promising.

British Firm Announces 'Junior GCA' Radar

AN INEXPENSIVE ground-control-approach radar system will soon be available to medium-size airfields for around $28,000. The new equipment uses ppi scan, has a range of 15 to 20 miles. Takeoffs and landings at the rate of one every two minutes have been achieved under instrument conditions, using an early model of the equipment.

Flexibility is such that fast jet aircraft can be slipped past slow-flying transports while on their final approaches. According to manufacturer A. C. Cossor, airplanes can be tracked easily to within ½ mile of touchdown, and weather minimums of 200 ft and ½-mile visibility are considered safe.

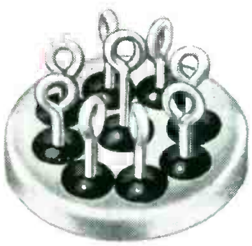
Dry-Disk Rectifiers Invade New Markets

COPPER-OXIDE and selenium rectifiers, once considered useful only at power-line frequency, are being used at higher and higher frequencies.

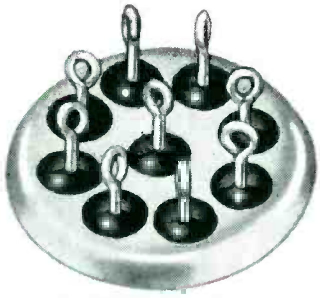
Applications are mostly in the audio and low radio-frequency ranges, up to 50 kilocycles. At least one manufacturer, however, has

(Continued on page 24)

4-900 Series
1000 V (RMS)



Disc size $\frac{11}{16}$ D
Available 2 to 9 electrodes.
Electrode treatment L only.



5-900 Series
1500 V (RMS)
Disc size $\frac{61}{64}$ D
Available 2 to 9 electrodes.
Electrode treatment L only.

7-700 Series
2000 V (RMS)

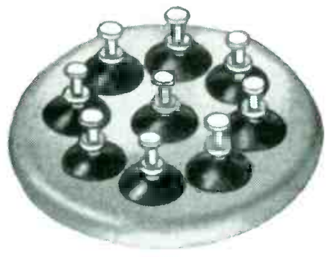
Disc size $\frac{61}{64}$ D
Available 2 to 7 electrodes.
Electrode treatments TH, FP, HT and L.

Meet the FUSITE FAMILY *of* MULTIPLE TERMINALS

Glass to Steel for a True Fused Hermetic Seal

Protect Sensitive Electrical Components from

- DIRT
- MOISTURE
- FUMES
- CHANGING PRESSURES



7-900 Series
2000 V (RMS)
Disc size 1 $\frac{15}{64}$ D
Available 2 to 9 electrodes.
Electrode treatments TH, FP, HT, and L.

7-1300 Series **2000 V (RMS)**
Disc size 1 $\frac{15}{64}$ D
Available 10 to 13 electrodes.
Electrode treatments TH and HT.

7-2300 Series **2000 V (RMS)**
Disc size 1 $\frac{5}{8}$ D
Available 11 to 23 electrodes.
Electrode treatments TH and HT.

GENERAL SPECIFICATIONS

materials -- C.R. steel disc and steel electrodes. Interfused with glass.

finish -- fused electro tin plate.

voltage test -- see individual terminal.

pressure test -- 12 pounds gauge.

insulation test -- 10,000 megohms after sclt water immersion.

sudden thermal shock test -- dry ice to boiling water.

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

Key to Electrode Treatment Available on These Terminals

SEE US AT BOOTH 1018 WESTERN ELECTRONIC SHOW, LONG BEACH, CALIF.
AUGUST 27-28-29

Write FOR CATALOG of Complete Line and Engineering Details -- Dept. B

THE FUSITE CORPORATION
6028 FERNVIEW AVENUE - CINCINNATI 13, OHIO

ised dry disks as high as 10 megacycles, as detectors in communications equipment. The disadvantage of low output at that frequency is more than offset by reliability under extreme vibration.

▶ **Other Applications**—In one electronic dictating machine, selenium works well in an automatic-volume-control circuit used to minimize 'blasting.' Germanium diodes formerly used varied greatly in reverse resistance with change of temperature. Selenium enjoys considerably less drift with heating. Further advantage of this characteristic is taken by another company, using selenium rectifiers as detectors in aircraft beacon radio receivers subject to extremes of temperature as well as vibration.

Instrument manufacturers are rediscovering the stability of copper-oxide rectifiers and are using them in audio, volume level and db meters, where maintenance of calibration is an important factor.

Industrial TV Aids Landing Aircraft

INDUSTRIAL TELEVISION may find widespread application as an air-safety aid if experiments at Washington National Airport prove successful.

Used to observe landings during bad weather, a tv camera located at the runway threshold picks up the plane as it drops out of the overcast, permitting control-tower personnel to determine the pilot's slant-height visibility. Similarly, runway surface visibility may be determined.

Taking up where airport-surveillance radar and ground-control-approach systems leave off, landing t-v is the final link in all-electronic air navigation.

▶ **Results Being Checked**—The airport experiment is jointly sponsored by the U. S. Weather Bureau and the Air Navigation Development Board. Television slant-height information is being correlated with visual observations and photoelectric measurements of the air's optical density.

Televising a foul-weather landing from runway threshold at Washington National Airport

The tv system is operated by WTTG engineers, using a DuMont camera chain and remote truck with a 5,700-mc radio link to monitors located on the weather observation deck and in the control tower. Operational installations would probably use coaxial cable links.

Evaluation of the experiment so far indicates that the system is comparable to visual observation with perhaps a 10-percent safety factor. In its present form the system is not useful at night.

Electronics Industry Wages Average $1.36

Hourly earnings range from $1.19 for solderers to $2.13 for tool-and-die makers

RADIO, television and radar production workers average $1.36 an hour, according to the latest industry wage study (November) made by the Bureau of Labor Statistics in Washington.

▶ **Job Categories** — Tool-and-die makers earn the top average hourly wage of $2.13, solderers the lowest of $1.19. About one-fourth of the jobs fall within the "skilled" category and pay average wages of $1.80 or more an hour for class-A machine-tool operators, maintenance electricians and machinists, machine-tool set-up men, and class-A testers and welders.

Two-fifths of the workers are in more routine jobs, such as class-C assemblers, inspectors, wirers, coil winders, solderers and janitors. Their average hourly earnings are below $1.30.

More than 38,000 routine assemblers, the largest single block of workers, average $1.20 an hour. Class-C wirers, next largest job classification with 9,000 workers, average $1.21.

▶ **Regional Rates**—New England averages are below national averages for all job groups. Hourly earnings for all production workers there average $1.16. The Great Lakes and Pacific regions are well above New England job rates.

Most of the plants studied were on a 40-hour-a-week work schedule. Typically, six or seven paid holidays a year are granted. Most plants give a week's paid vacation after one year's service and more than two-fifths of the workers get two weeks after three years.

Tube Market Over One Billion

ONE out of every fifteen tv sets now in use will need a new picture tube by the end of this year, according to GE.

About 1,100,000 picture tubes worth $44,000,000 and 110,000,000 receiving tubes worth $220,000,000 will be sold for television and radio replacement purposes in 1952.

More than 950,000,000 receiving tubes are now operating in tv receivers and home and car radios. This total is expected to pass the one billion mark within the next few weeks.

Cash Awards for Educational TV

AS AN INCENTIVE to establishment of noncommercial educational tv stations, Ben Abrams, president of Emerson Radio and Phonograph Corp., has announced a grant of

(Continued on page 26)

$100,000. Equal sums of $10,000 will go to each of the first ten such stations to get a test pattern on the air. State universities and municipally operated stations will not be eligible for the awards.

At the same time, Mr. Abrams proposed the formation of a cooperative organization that would include educators, industrialists, artists and public leaders to further the cause of educational tv. He set as his goal a $5 million fund to help fill the 242 channels allocated by FCC for schools and colleges.

Home Radio-TV Outlook Healthy for Decade

Serviceman requirements may double; parts business triple by end of 1961

KEEPING UP with America's home radio and television needs will take a steadily increasing segment of the electronics industry's personnel and equipment—at least for the next ten years, according to Sylvania's Fred Mansfield.

Statistical analyses predict almost 50 million sets in use by the end of 1961—an increase of three times over today's figure. Radio sets in use will increase from the present 59 million to around 62 million during the same period.

▶ **Service and Parts**—To build, sell, install and maintain this increasing number of sets, more men and companies are expected to enter the field, while those already involved will expand their efforts.

One serviceman can service 780 radio homes or 125 television homes, according to Mansfield, or he can install 250 television sets. Accordingly, in ten years there would be a need for more than twice as many servicemen if service requirements remained essentially as they are today.

In 1952 the radio-tv parts business is estimated at $500 million. In the next four years this figure may double, and by the end of 1961 parts business could pass the $1.5 billion mark.

MEETINGS

AUG. 11-21: Congress of U.R.-S.I. Sydney, Australia.
AUG. 12-15: 1952 APCO Conference, Hotel Whitcomb, San Francisco, Calif.
AUG. 15-16: Emporium Section, IRE, Annual Summer Seminar, Emporium, Pa.
AUG. 10-22: AIEE Pacific General Meeting, Phoenix, Ariz.
AUG. 26-30: Australian IRE Radio Engineering Convention, Sydney, Australia.
AUG. 27-29: Western Electronic Show and Conference, Municipal Auditorium, Long Beach, Calif.
AUG. 27-SEPT. 6: British National Radio Show, Earls Court, London.
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. 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. 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. 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.
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.
JAN. 14-16, 1953: Joint AIEE-IRE Conference on High Frequency Measurement, Washington, D. C.

Business Briefs

▶ **Signal Corps Aviation Center** recently set up at Fort Monmouth, N. J. to work closely with the Electronic Warfare Center and Signal Corps Engineering Labs in this section, will study and develop the use of microwave and vhf radio relay in helicopters and the use of television, communications and navigational equipment in aircraft.

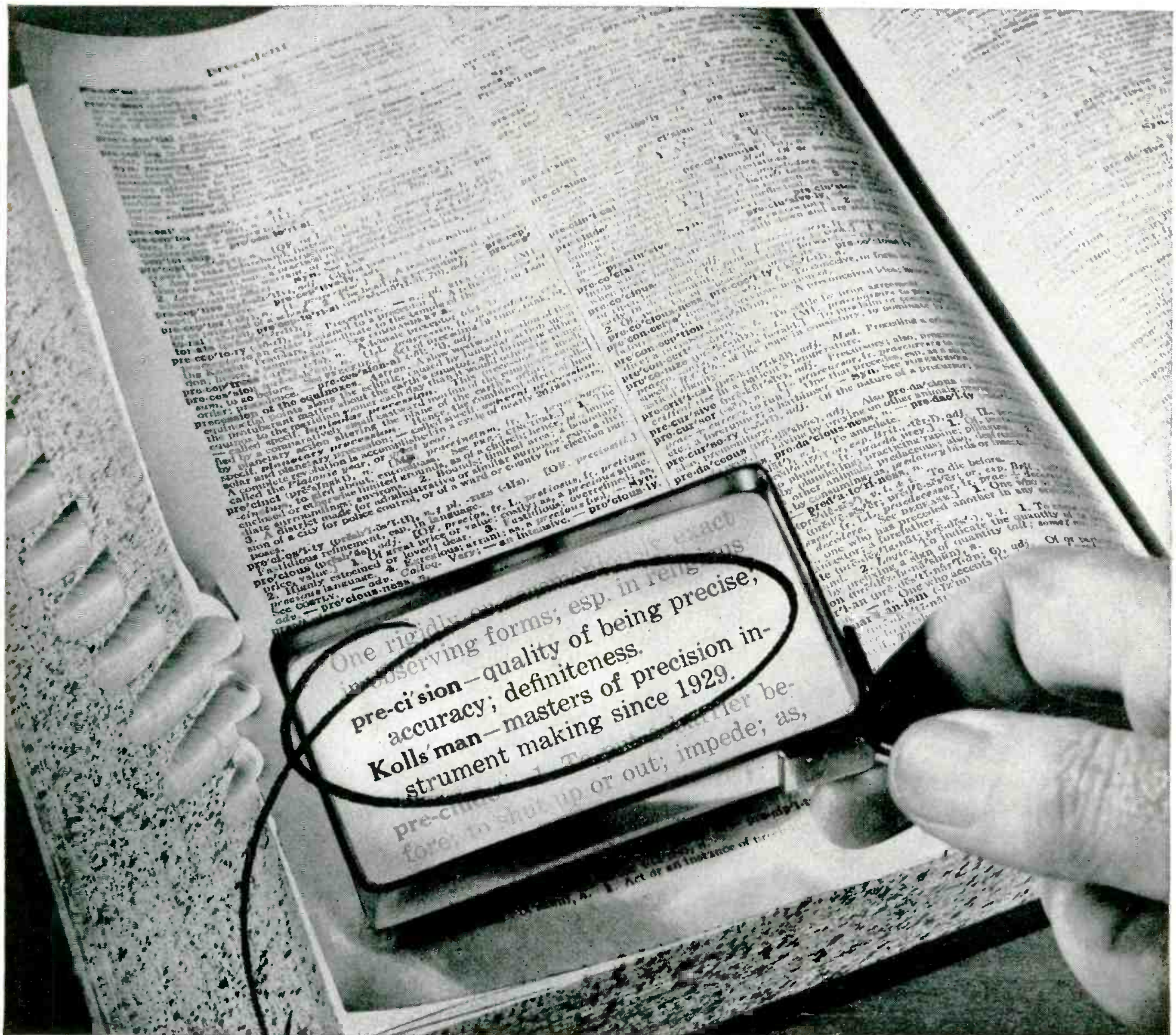
▶ **Since** the outbreak of the Korean incident, the production of military electronics equipment has increased seven times, according to John R. Steelman, defense mobilizer; 95 percent of the items currently being produced were put into production since the opening of hostilities in June 1950.

▶ **Gun-Type** high-frequency heater is being used experimentally for glueing wallboard to building studs, eliminating the conventional nails.

▶ **Proposals** from contractors for simplifying the design of electronic equipment are being sought by the Electronics Design and Development Division of the Bureau of Ships.

▶ **West German** Radio and Television Exhibition in Duesseldorf has been postponed until Feb. 8, 1953 because the North-West German Broadcasting Company does not expect to be telecasting regularly until that time. However, the German Radio Industry will exhibit at the German Industrial Fair, in Berlin, August 22 to 31, 1952.


JK
PRODUCTS
keeping communications ON THE BEAM
JK STABILIZED
H-17 CRYSTAL
CRYSTALS FOR THE CRITICAL
The small, compact H-17 is designated as a military type crystal for its use in mobile units common to the military. Frequency range: 200 kc to 100 mc. Hermetically sealed holders; wire-mounted, silver-plated crystals.
the JK
FD-12
FREQUENCY AND MONITOR MODULATION
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!
"High Gear" Response to High Power Maintenance!
Dawn or dusk, it doesn't matter. These heroes of the high wires arrive to stop power trouble before it starts. Their "nose for disaster" is in the service truck, in the mobile radio unit which often relies on JK crystals and monitors to keep their assigned radio frequency on the beam!
THE JAMES KNIGHTS COMPANY
SANDWICH 3, ILLINOIS



Synonyms

THE KOLLSMAN INSTRUMENT CORPORATION—designers, developers and manufacturers of precise, dependable instruments in the fields of:

Aircraft Instruments and Controls • • Miniature AC Motors for Indicating and Remote Control Applications • • Optical Parts and Optical Devices • • Radio Communications and Navigation Equipment

While current facilities of our laboratories and plants are geared to production for National Defense, the planning divisions of Kollsman are ever active. And versatile Kollsman research engineers stand ready to assist America's scientists in the solution of instrumentation and control problems.

KOLLSMAN INSTRUMENT CORPORATION

ELMHURST, NEW YORK GLENDALE, CALIFORNIA

SUBSIDIARY OF *Standard* COIL PRODUCTS CO. INC.

Carbofilm® RESISTORS

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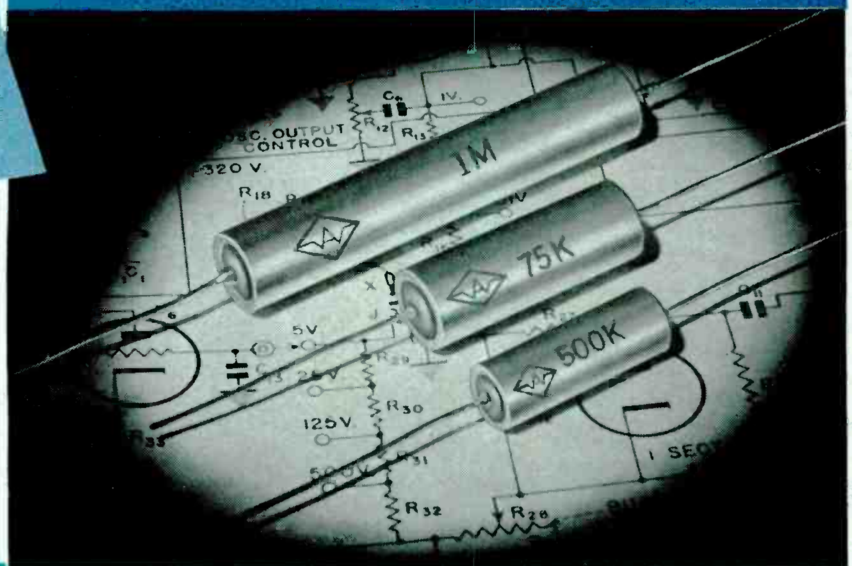
HERMETICALLY SEALED

TOUGH FOR ROUGH GOING!



SPECIFICATIONS

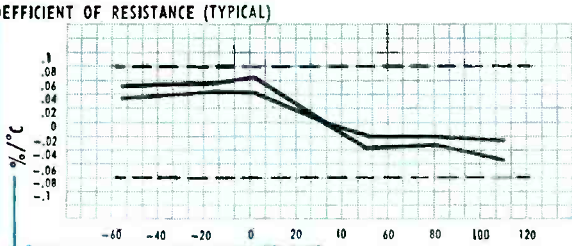
1. **Hermetically sealed.** Metal case. Vitrified ceramic end seals, pigtail leads. Thoroughly protected — mechanically, electrically, climatically.
2. **Temperature Coefficient** not exceeding .0003 ohm per ohm per °C. over temperature range of −40°C. to +60°C. up to 15 megohms. Not exceeding .0005 ohm per ohm per °C. up to 100 megohms.
3. **Voltage Coefficient** so extremely low that for most applications it can be discarded.
4. **Overloads** up to 200% of rated voltage, without showing permanent change in resistance.
5. **Accuracy:** guaranteed tolerance of plus/minus 1% at 25°C. (77°F.).
6. **Aging Changes** negligible. Average change in resistance for self-aging, approximately 0.2% in a year.
7. **Noise:** Silver-to-silver contacts and welded leads to cap insure very high stability and correspondingly low noise levels.
8. **In Four Sizes:** Two ½ watt, 1 watt and 2 watt. Cased or uncased.
9. **Meet the MIL Specifications.**

Wilkor, the first licensee under Western Electric patents to produce carbon deposited precision resistors, takes another step forward. Wilkor now offers hermetically-sealed Carbofilm Resistors, the first fully-protected precision resistors available on a production basis.

Primarily intended for circuits calling for the accuracy and stability of wire-wound resistors, yet with the compactness of carbon or composition-element resistors. Excellent for measuring-instrument applications; in test and lab equipment; in oscillography and other critical electronic circuits; in electronic computers and allied techniques; and now, in the encased, hermetically-sealed construction, particularly in applications where resistance values must be critically maintained over long service life, regardless of climatic conditions.

TEMPERATURE COEFFICIENT OF RESISTANCE (TYPICAL)

TYPE CPH-1
Temperature Coefficient of Resistance curves typical of samples (5M, 100V.)



Literature on request. Let us collaborate in your precision-resistor requirements.

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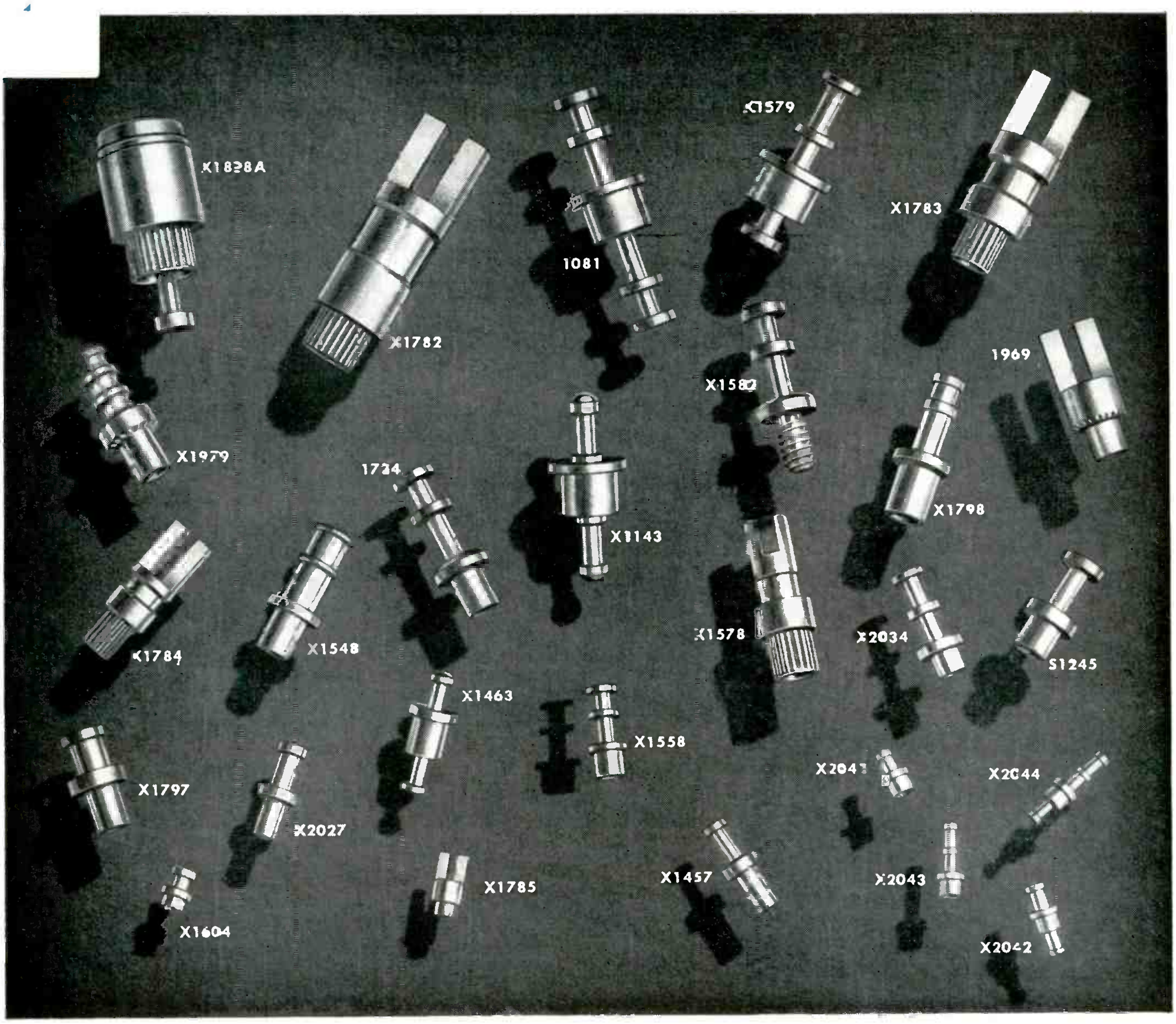


Everything you need in standard terminal lugs
. . . or *made to your own specifications!*

C.T.C. has exactly the types and sizes of terminal lugs you want . . . or will quickly make them to your specifications in any production quantity. Very likely you'll find what you're looking for in the broad C.T.C. line of standard terminals. There are 28 different types, each available in varied shank lengths.

C.T.C. standard terminals are of silver plated brass, coated with water dip lacquer to keep them chemically clean for soldering.

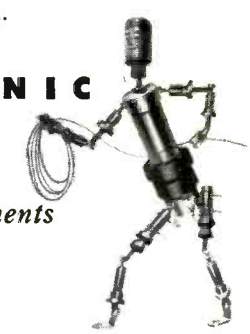
In addition, combination screw and solder terminals are available in 3 sizes, and a complete line of phenolic or ceramic terminals can be furnished.

All materials, processes and finishes meet applicable government specifications. Finishes include hot tinned, electro-tin, cadmium plate or gold plate on special order. In the event standard terminals don't meet your needs, C.T.C. offers a special consulting service to solve your solder terminal problems without extra cost or obligation.

For all specifications and prices, write to Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. West Coast Manufacturers contact: E. V. Roberts, 5068 West Washington Blvd., Los Angeles 16 and 988 Market Street, San Francisco, California.

CAMBRIDGE THERMIONIC CORPORATION

custom or standard . . . the guaranteed components



See our listing in Electronics Buyers' Guide

TUNG-SOL®

6AX4 GT

damper diode

for transformerless receivers

for "direct drive" deflection circuits

see other side for additional information

HERMETIC SEALING FOR EVERY REQUIREMENT

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.

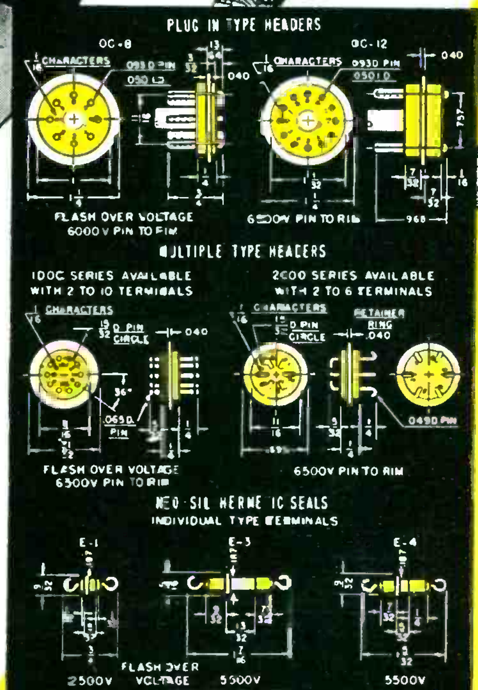
NEO-SIL ROTARY WATERSEAL PANEL ASSEMBLIES — These units have an excellent five year customer history on gas filled pressurized components. They are available for 1/4″ shafts and for potentiometers and switch bushings.

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.



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 300 Volts d-c

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

Dielectric Constant and Dissipation Factor

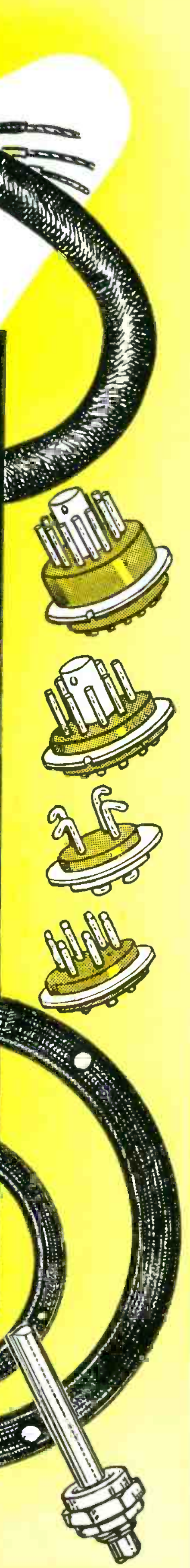
Dielectric Constant	*Dissipation Factor*	*Loss Factor*
	@ 60 cycles per second	
9.22	.056	5.32
	@ 1 megacycle per second	
6.17	.0455	.28
	@ 50 megacycles per second	
5.35	0.20	1.1

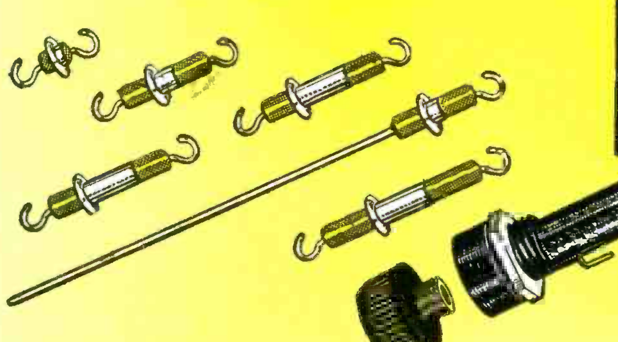
Dielectric Strength at 60 cycles
Volts per mil — 370

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.





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

NEO-SIL CORPORATION

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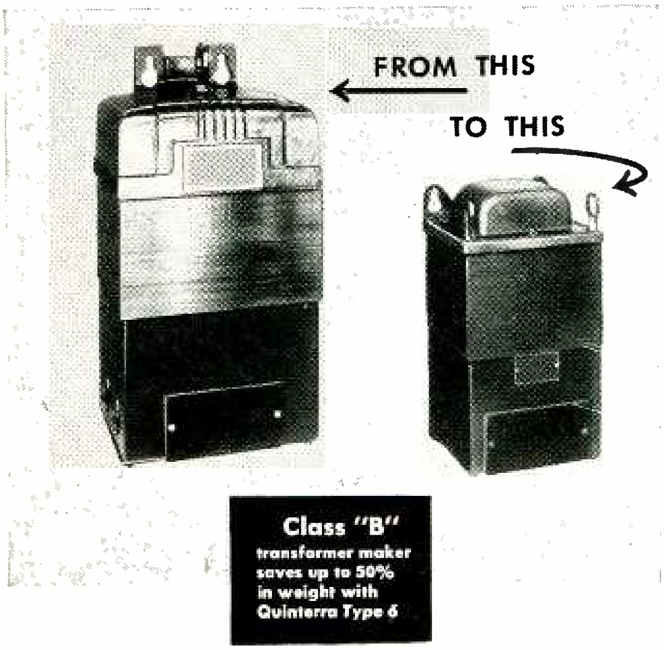
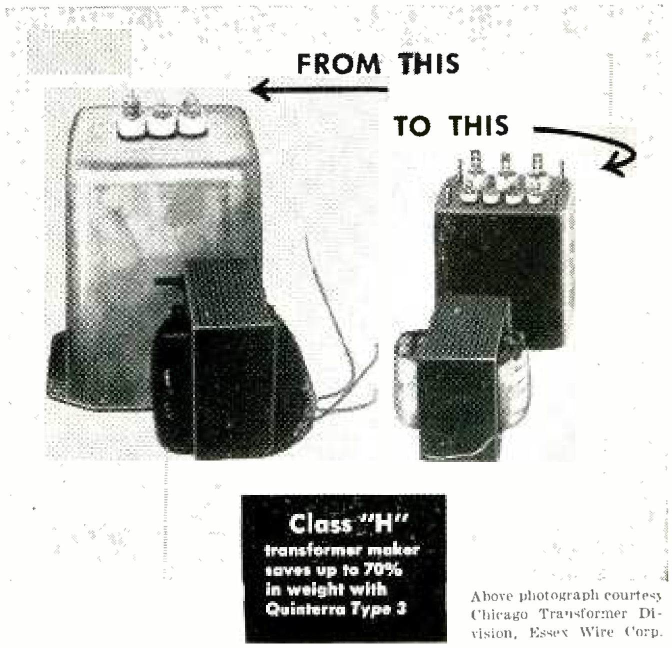
6319 North Clark St., Chicago 26, Ill.

Quinterra BRINGS SUBSTANTIAL SAVINGS to Class "B" and Class "H" transformer makers...





Above photograph courtesy Chicago Transformer Division, Essex Wire Corp.

. . . each using a <u>different</u> <u>type</u> Quinterra® to meet his needs

THE two "before and after" photographs above do more than show what manufacturers can do when they employ Quinterra as layer insulation. They also demonstrate that the manufacturer is not limited to one type of this thin, flexible, purified asbestos insulation. Any one of several types will help him conserve materials, gain greater safety, raise overload limits, decrease rejects, lessen production costs, and lengthen service life.

For Class "B" operations, he can choose Type 6 . . . the twin-ply Quinterra treated with polyvinyl acetate. It retains its dielectric strength of about 300 VPM at temperatures above the Class "B" maximum of 130 C. Strongest of the Quinterras, it is made by combining and calendering two layers together into a dense, smooth-surfaced sheet. Its excellent tensile and bursting strengths enable assemblers to reach favorable production rates. And it also provides a large square foot per dollar coverage*.

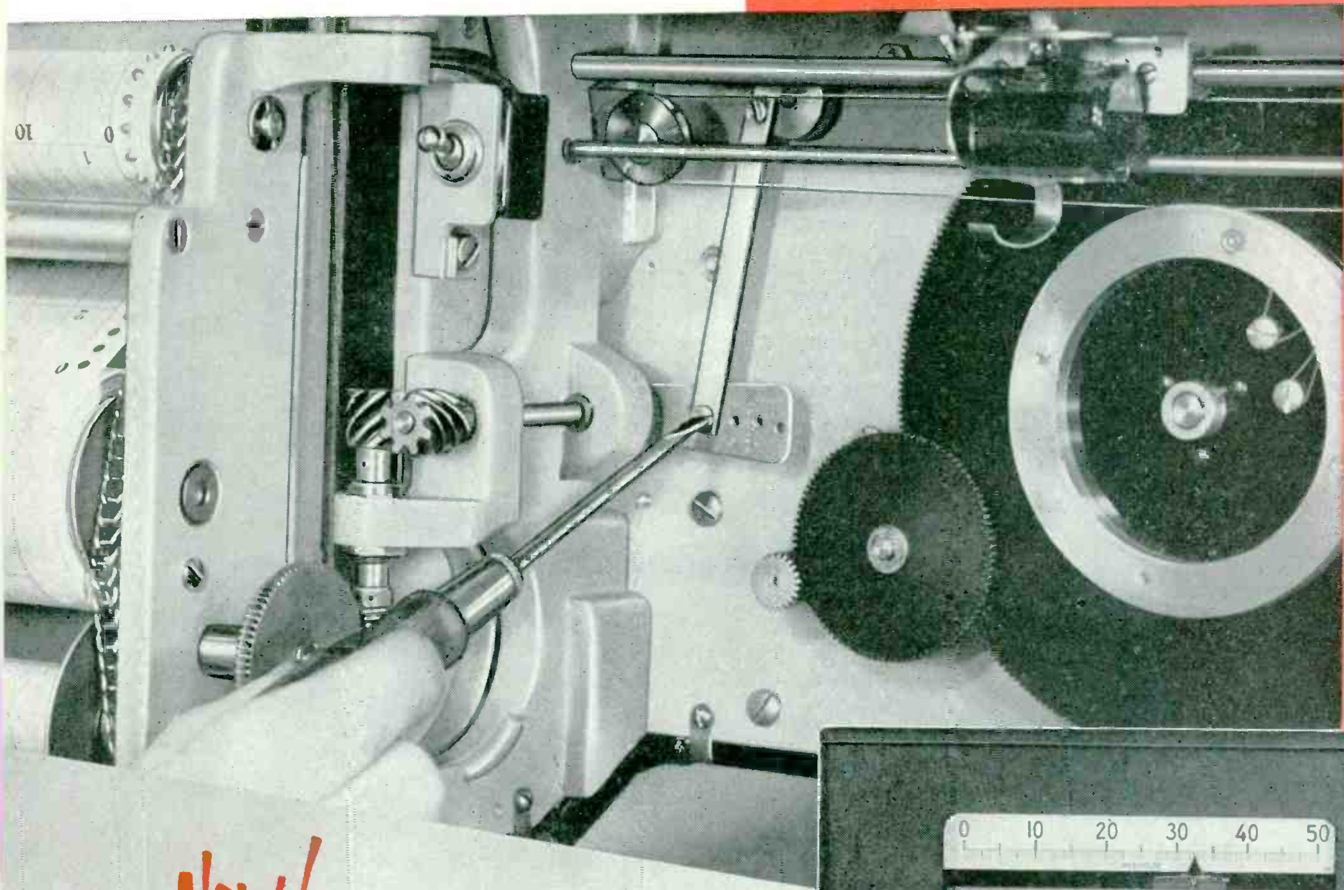
For Class "H" operations or for high processing and ambient temperatures, the manufacturer can choose single-ply silicone-treated Quinterra Type 3. Its dielectric strength of about 300 VPM is retained under continuous exposure to temperatures higher than 180 C, the Class "H" maximum. It also has good moisture-resistance, flexibility, and adequate physical strength for many applications.

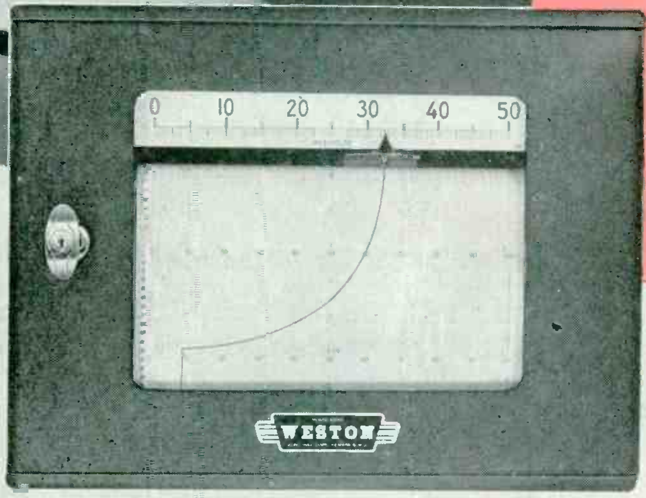
Each of these Quinterras is made of the same highly purified asbestos base sheet that has the inherent dielectric . . . and has a hole-free, closed structure. They differ only in the saturant used and in the number of plies. For further information and samples of Quinterra, write to Johns-Manville, Box 60, New York 16, N. Y. No cost or obligation.

*Also true of its companion product, Quinterra Type 5, which is preferable for applications where maximum mechanical strength is not required.

JOHNS-MANVILLE JM PRODUCTS **Johns-Manville ELECTRICAL INSULATIONS**

You change chart speeds *this simple way*





New! simplified... Recording Potentiometer by WESTON

Maybe you seldom change chart speeds . . . while other users frequently do. But should the need arise, isn't it best to have a *flexible* instrument . . . one quickly adaptable for any requirement that comes along?

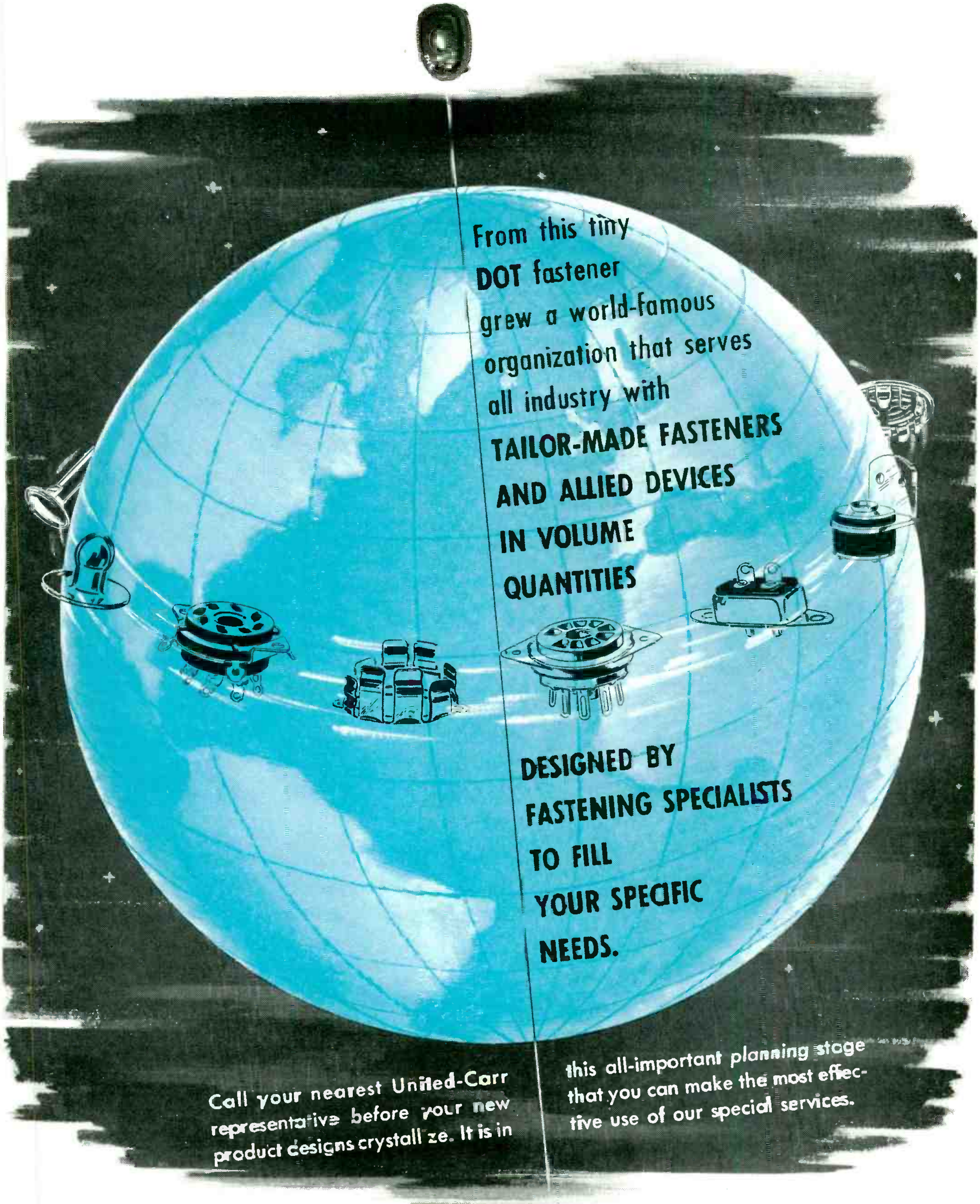
As shown above, the change is simple and quick with the new WESTON Recording Potentiometer. No multiplicity of gears involved . . . no complicated gear changes to make. This speed linkage permits quick selection of 5 different speeds by simple screwdriver adjustment. And these speeds can be doubled or quadrupled by quickly changing only two gears.

This is just one of a dozen features that make this the simplest, most flexible recorder ever offered. Changing ranges, installing charts, removing amplifier . . . all are just as simple and quick! Combined, they cut maintenance 'way down. And for accuracy and dependability . . . they're assured by the name the instrument bears.

For full details, ask your local WESTON Representative, or write . . . WESTON Electrical Instrument Corporation, 617 Frelinghuysen Ave., Newark 5, N. J. . . . *manufacturers of Weston and Tag Instruments.*

WESTON TAG

9130 **WESTON** *Instruments* INDICATE — RECORD — CONTROL



UNITED-CARR DOT FASTENERS

UNITED-CARR FASTENER CORP., CAMBRIDGE 42, MASS.

TAILOR-MADE IN VOLUME QUANTITIES

Snug Fitting ALL-WEATHER JACKET FOR OUTDOOR BUSSES

NATVAR 400
EXTRUDED PLASTIC TUBING

USED TO INSULATE AND PROTECT DELTA STAR METAL-ENCLOSED BUSSES FOR THE DEPT. OF WATER & POWER, CITY OF LOS ANGELES

These 15 KV. 2000 Ampere busses were built for outdoor service where space was limited. Therefore to meet this requirement, each conductor of 3" I.P.S (3½" O.D.) hard-drawn copper tubing was covered with a smooth, tight sleeve of Natvar 400 tubing. 3" I.D Natvar tubing having a ⅛" wall thickness was immersed in a dilating solution before it was slipped over the conductor. The result is a snug fitting, uniform insulating jacket, that increases the insulation to adequately protect the bus from phase to phase short circuits in the event of heavy voltage surges, and at the same time safeguards life against accidental contact with the high operating potential.

Delta Star Electric Company, Chicago, manufacturers of high voltage switching equipment, build many types of metal-enclosed busses of their own design, and also manufacture several types to meet customer's own specifications.

Their close attention to details in designing, in selection of materials, in assembling, and in testing before shipment has paid off in reducing costs of installation, and in dependable performance after installation.

In the metal-enclosed busses built by Delta Star for the Department of Water & Power, City of Los Angeles, Natvar 400 extruded plastic tubing was used to insulate and protect the bus tubes because it is easy to dilate and apply, and because when it shrinks, it provides a snug jacket with uniformly good electrical and physical properties.

Natvar 400 tubing, tape, and other Natvar flexible electrical insulating materials are consistently uniform, no matter when or where purchased. They are available either from your wholesaler's stocks or direct from our own.

Natvar

Natvar Products

- Varnished cambric—straight cut and bias
- Varnished cable tape
- Varnished canvas
- Varnished duck
- Varnished silk
- Varnished special rayon
- Varnished Fiberglas cloth
- Silicone coated Fiberglas
- Varnished papers
- Slot insulation
- Varnished tubing and sleeving
- Varnished identification markers
- Lacquered tubing and sleeving
- Extruded plastic tubing and tape
- Extruded plastic identification markers

Ask for Catalog No. 22

NATVAR CORPORATION

FORMERLY THE NATIONAL VARNISHED PRODUCTS CORPORATION

TELEPHONE RAHWAY 7-8800 · CABLE ADDRESS NATVAR: RAHWAY, N. J.

201 RANDOLPH AVENUE • WOODBRIDGE, NEW JERSEY

REALLY *New!*

COMPLETE
miniature
FREQUENCY STANDARD

ACTUAL SIZE

A compact, complete, hermetically sealed frequency standard, presenting these features:—

1. JAN-ized construction throughout.
2. SPACE-SAVING, 1½" dia. x 4½" high.
3. WEIGHT, approximately 10 ounces.
4. AVAILABLE in 400 and 500 cycles.
5. ACCURACY — .002% (15° to 35°C).
6. SHOCK-MOUNTED on Silicone rubber.
7. POWER REQUIRED — 6 Volts, 3 amps. 70 to 200 V. at 1 to 5 ma.

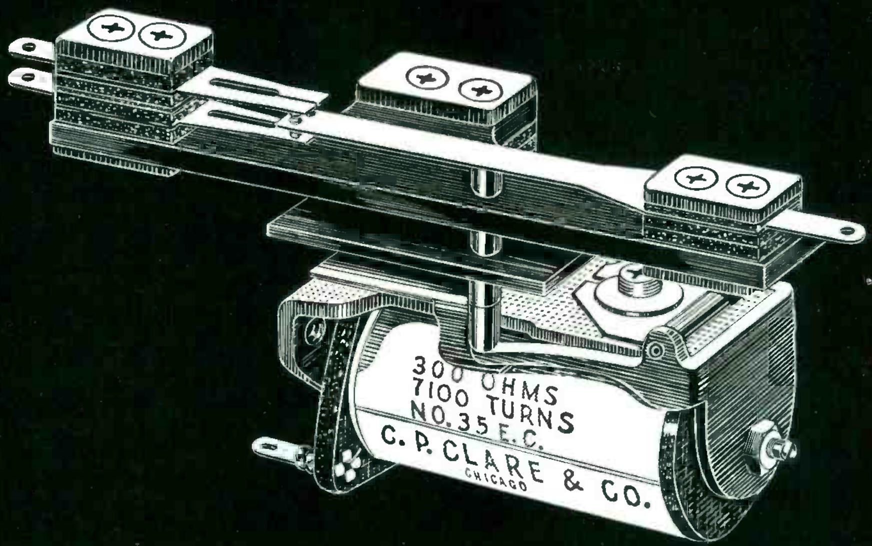
WRITE FOR DESCRIPTIVE LITERATURE, SPECIFYING "TYPE 2007"

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.

Engineers!
Gear this frequency standard to your designs and help solve climatic, space and weight problems in JAN-ized-MIL equipment

American Time Products, Inc.
580 Fifth Avenue **New York 36, N. Y.**

MANUFACTURING UNDER PATENTS OF THE WESTERN ELECTRIC COMPANY



"WE WANT A RELAY THAT..."

That's the signal for ACTION at CLARE!

Almost simultaneously CLARE received requests not long ago from one of the world's largest manufacturers of radio and television equipment and from a nationwide broadcasting system. They presented similar but not identical problems.

Both involved relays for switching circuits carrying video frequencies present in the output of television cameras—frequencies ranging from almost zero to several million cycles. The capacitance between one contact spring and another, as well as between the contact springs and the frame of the relay must be extremely low. Available relays were too large and cumbersome—a typical relay extant at that time occupied 17 cubic inches—their operate, release and transfer times were too slow, and they were full of contact bounce. These customers were familiar with the versatility of the CLARE Type J Relay. They asked us to try to adapt it for switching high-frequency currents. The Type J Video Relay was the result of intelligent cooperation between CLARE and the customers' engineers. It has negligible contact bounce and is otherwise superior to previous designs; and it occupies only about 7 cubic inches. It proved to be ideally suited to the needs of both customers, and it is now in high demand.

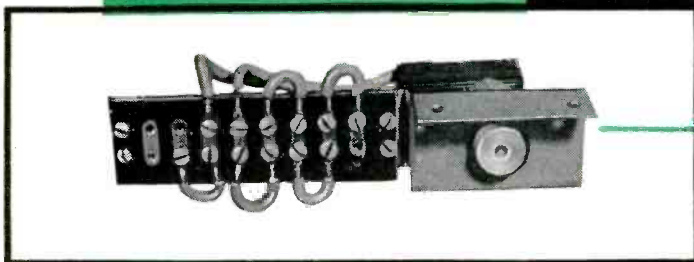
Bringing relay problems to CLARE by leading manufacturers has resulted in many outstanding relay developments. You, too, can save time, money and often needless experiment by contacting the nearest CLARE sales engineer. Call him today or write: C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable Address: CLARELAY.

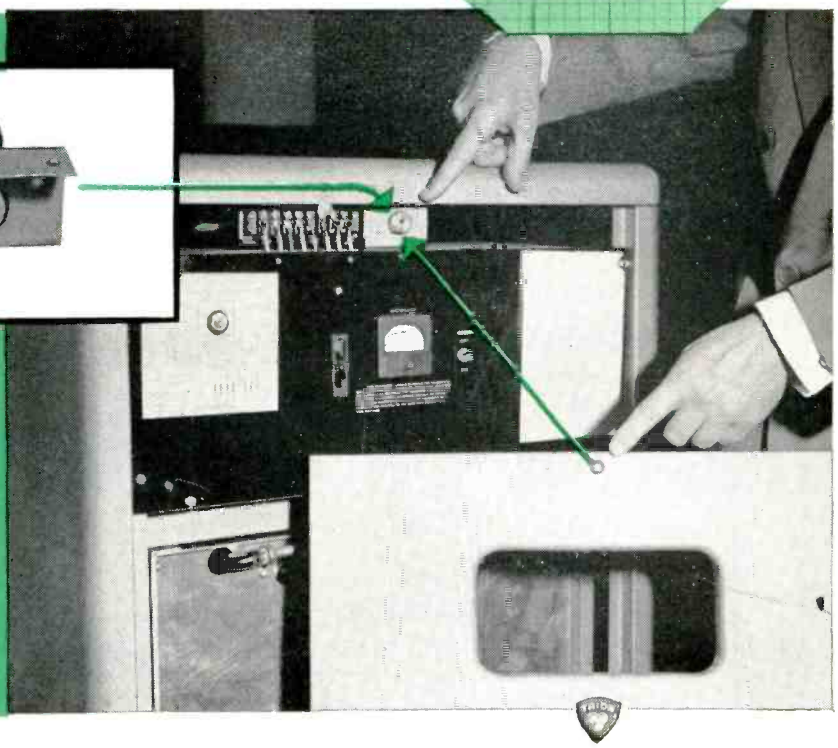
CLARE RELAYS

First in the Industrial Field

High voltage areas of TRION Electric Air Filters are protected by MICRO Precision Switches

Let a MICRO SWITCH engineer show you how you can use **MICRO Precision Switches "as a principle of good design."**





Close-up of safety screw and safety switch assembly which actuates MICRO precision switch when screw is removed from safety door of Trion "Standard Package" Electric Air Filter. Small photo shows location of MICRO panel mounting switch located at rear of terminal board assembly.

Every Trion Electric Air Filter made by Trion, Inc. uses a MICRO precision switch to break primary circuits before access to high voltage areas is possible. Thus the complete safety of maintenance, operation and other personnel is assured.

Access is impossible while the equipment is in operation. As the machine screw which holds the door is unscrewed, it releases the switch plunger and interrupts the power supply to the filter.

MICRO units were selected by Trion engineers because their operating position and operating travel can be held to very close tolerances . . . tolerances that cannot vary even after years of continuous use. "Our choice of MICRO has proved very successful," says George F. Landgraf, vice president in charge of engineering.

This use of MICRO precision switches by Trion engineers as an integral component of equipment which must give dependable, unfailing, trouble-free service is typical of the confidence design engineers place in the faithful performance of these precise, snap-action switches.

The MICRO line consists of a wide variety . . . over 5000 in all . . . of different types, characteristics, housings, mountings and actuators. MICRO field engineers, fully experienced in precision switching problems, will be glad to help you choose the switch best fitted to meet your designs. Call the nearest MICRO branch office for cooperation on YOUR switching problem.

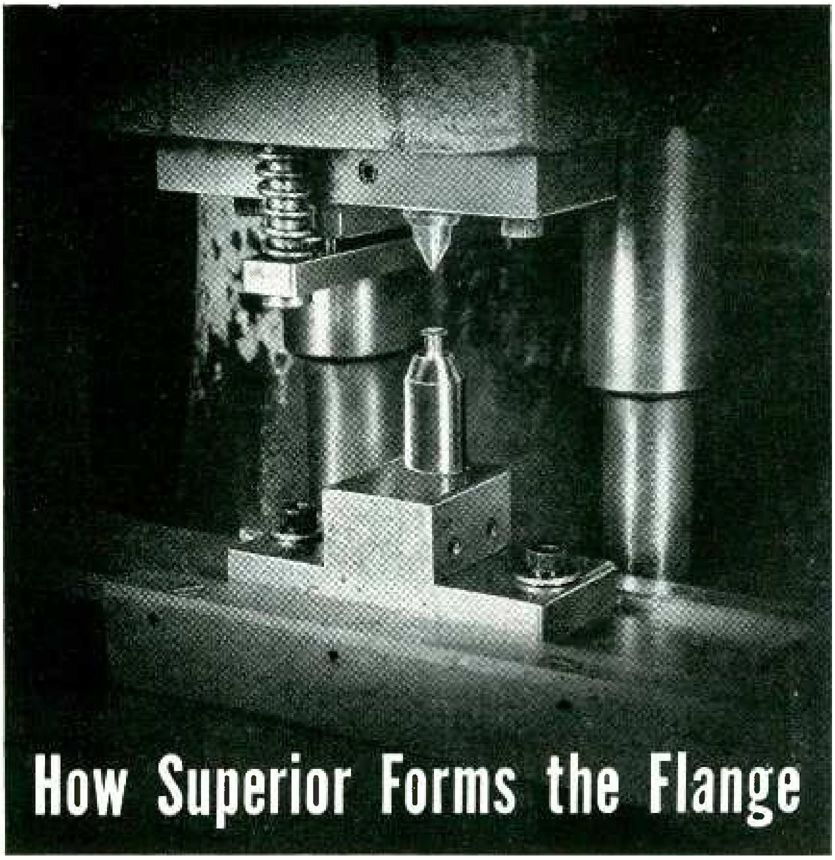
MICRO MS SWITCH

FREEPORT, ILLINOIS

H HONEYWELL

MICRO Snap-Action Switches
Honeywell Mercury Switches

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY



How Superior Forms the Flange

to give you better tube performance

● What do you expect when you order a tubular part with a flare or flange at one or both ends?

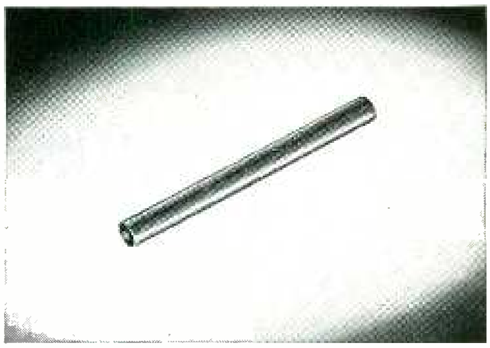
Certainly you expect that the over-all dimensions of the part will be within certain close tolerances. You expect that the flange or flare will be the only distortion in the tube. You want the flange dimensions and the flare angle to be within the limits established in your specification. You must be assured that the worked areas will be free from cracks, pits and breaks. You probably hope that the working has not set up unrelieved stresses to result in premature failure of the part.

When Superior supplies the part, you get all you expect, want and hope for.

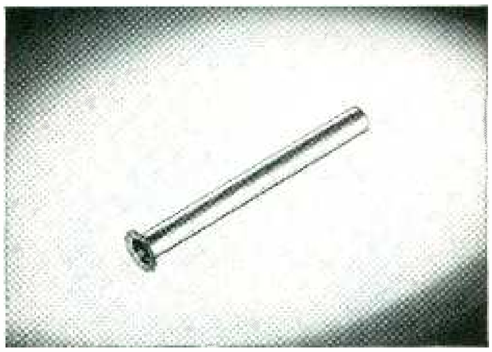
This isn't a matter for boasting. The ability to deliver flared and flanged parts to meet these basic requirements is just a part of our job, made possible by our long experience and extensive, highly-developed equipment for performing just such operations.

The rest of our job is in the field of advice, research and development assistance and careful problem analysis to make sure that you have the right metal or alloy for your purpose.

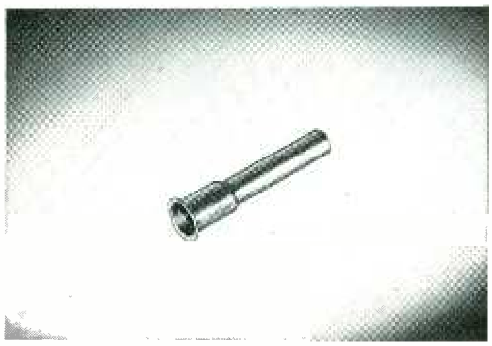
If you are a manufacturer or experimenter in electronics and have need for a tubular part, whether it be a simple cut and tumbled tube, a flared or flanged part, rolled or bent, machined at either or both ends or drilled in one or more places, tell us about it. We can probably help you and we're always glad to do so. Write Superior Tube Company, 2500 Germantown Ave., Norristown, Penna.



Cut and Annealed. Extensive cutting equipment, hand cutting jigs, electronically controlled annealers and other equipment, much of it developed within our own organization, results in high speed, precision production of parts.



Flanging. Automatic flaring and flanging machines are combined in Superior's Electronics Division with carefully trained production and inspection personnel who know how to do a job right and take the time to be sure.



Expanded. Here is a part almost ready for delivery. Simple as it looks, it may well have been the subject of a score of operations and at every stage the prime consideration has been the *quality* of the finished part.

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, sublimation rate of the nickel base; also future trends of cathode materials are evaluated.

Superior
THE BIG NAME IN SMALL TUBING

All analyses .010" to ⅝" O.D.
Certain analyses (.035" max. wall) Up to 1⅞" O.D.

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

MILITARY dehydrators

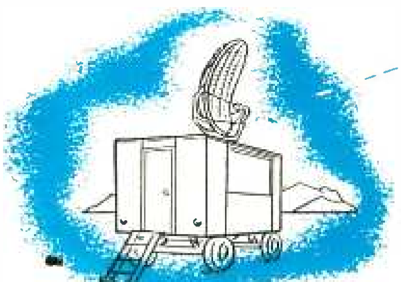
FOR AIR, LAND AND

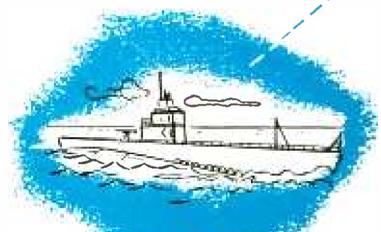
TYPICAL APPLICATIONS IN WHICH CP DEHYDRATORS PROVIDE YEAR 'ROUND TROUBLE-FREE AUTOMATIC SERVICE:

- 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

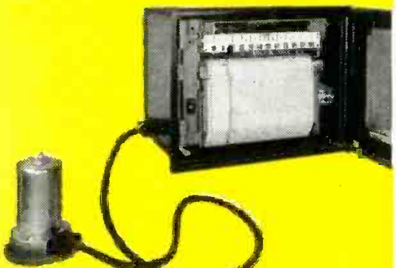
CP dehydrators are readily adaptable to the critical requirements of the Armed Forces. Standardized parts permit rapid assembly of equipments suitable for practically any specialized need at minimum cost and without prolonged delay. Over a decade of CP experience in dehydrator design and manufacture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

COMMUNICATION PRODUCTS COMPANY • Inc

MARLBORO, NEW JERSEY
Telephone: FReehold 8-1880

DIPOLE ANTENNAS, SWITCHES, Q-MAX LACQUER AND CEMENT

Instruments



BROWN ELECTROMETER

For measuring and recording currents as low as 10^{-15} amperes. High accuracy provided through use of a null balance servo system and a-c amplifiers which eliminate drift common to d-c amplifiers. Used to measure and record minute currents in ionization chambers and wherever currents as low as a billionth of a microampere are encountered. The only such system that incorporates a recorder as an integral part of the circuit.

Electrical Characteristics

Full Scale Current Ranges Available: 10^{-13} amperes with 10^{11} ohm resistor, and selector switch adjustment for full scale or 10^{-12} or 10^{-11} amperes. Using other resistors, full scale current changes up to 10^{-7} amperes can be supplied with selector switch adjustment up to 10^{-5} amperes.

Input Resistor: 10^{11} ohms for most sensitive current measurement. (Also supplied in values down to 10^{5} ohms.)

System Accuracy: Approximately 1 per cent of scale.

Zero Drift: Should not exceed 0.3 millivolt per day.

System Noise: Approximately 5 microvolts.

Instrument Speed of Response: Available for either 24, 12, or 4½ seconds full scale.

Maximum Speed of Response Using 4½ Second Instrument Speed: 5 seconds for 90 per cent of change, with preamplifier located at source.

Power Supply: 115 volts, 60 cycles. Also dry cell supplied in instrument.

Power Requirements: 65 watts.

For further information, send for Data Sheet No. 10.0-4.

FUNCTION PLOTTER

Can be advantageously employed wherever there is occasion to depict graphically one variable as a function of another. It imparts speed, accuracy and efficiency to the plotting of curves.

Special Instruments

BROWN EXTENDED RANGE PRECISION INDICATOR

Ideal for facilitating the measurement of a variable where it changes throughout a wide range, and where precise evaluation and good readability are vital factors. Incorporating extended scale with automatic range changing operation, the instrument can be supplied with from two to five ranges, calibrated in emf or the specific quantity under measurement (*i.e.*, pounds or tons of force or thrust, millivoltage, temperature, etc.).

For further information, send for Data Sheet No. 10.0-3.

DUPLEX TWO PEN RECORDER

Provides simultaneous measurements of practically any combination of two independent variables (voltage, current, temperature, pressure, etc.) on a single chart thereby facilitating comparisons of the two variables. Has two separate measuring systems with associated pens. Pens are entirely independent, and traverse the full eleven inches of chart width without interfering with each other. Both measuring circuits are standardized simultaneously by means of a push button. Actuation and range of the circuits may be the same or totally different.

For further information, send for Data Sheet No. 10.0-6.

NARROW SPAN RECORDERS

New narrow span potentiometer circuit makes possible precise measurement of spans as low as 100 microvolts. Instruments embodying this new circuit (recorders and precision indicators) are available as self-contained units requiring no pre-amplifier unit. The instruments find ready use wherever accurate measurement of d-c potentials of the order of microvolts is required. Potentials as low as one microvolt can be precisely determined. Can be calibrated in terms of temperature, emf, etc.

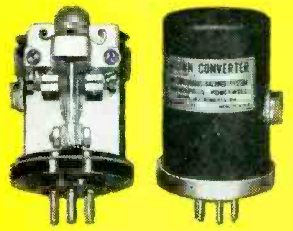
For further information, send for Data Sheet No. 10.0-8.

NEW *ElectroniK* HIGH SPEED RECORDER

Ideal for accurately measuring and recording rapidly changing variables often found in research, engineering analyses and other technical investigations. Develops a pen speed sufficiently high to traverse its 11-inch graduated chart in one second. Full scale signals which vary as rapidly as 20 cycles per minute can be accurately recorded. Signals with a peak-to-peak amplitude of 10% of scale can be reproduced at variations up to 180 cycles per minute.

For further information, send for Data Sheet No. 10.0-7.

Components



BROWN CONVERTERS

May be used with any system requiring the conversion of low power d-c signals, of the order of 100 microvolts, to 60 or 400 cycle alternating voltages. Output is *unaffected* by atmospheric pressure changes. Special material in reed assembly reduces pick-up of strays and transients to negligible proportion. Particularly useful in applications requiring error voltage measurements or null detection.

Electrical Characteristics of 400 cycle Converters

Driving Coil Requirements: 18 volts, 94 milliamperes, 400 cycles—10 per cent.

Contact Rating: SPDT switching. Nominal rating—6 volts to one microvolt. 1.0 milliampere; maximum power 100 microwatts.

Switching Action: Each contact closed 55 per cent of each cycle. Contacts closed simultaneously 5 per cent of the time, twice each cycle.

Symmetry: Within 5 per cent.

Load Characteristics: Resistive or inductive.

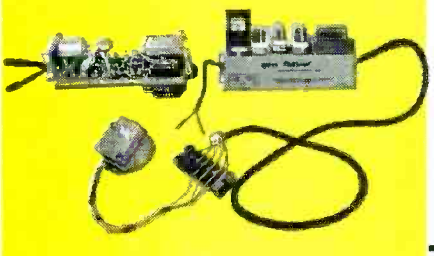
Shielding: Shell and coil shield, both grounded through pin No. 2.

Vibration Resistance: Output voltage will vary less than 2 per cent, with rates of vibration from 0 to 10 g (gravity).

Phase Shift: Output voltage differs from that of driving voltage by 45 to 50 degrees.

Stray Pick-up: Electrostatic—$2x10^{-10}$ volts per ohm of input circuit impedance. Electromagnetic—$2X10^{-5}$ volts, constant to $2X10^{-6}$ volts.

For further information, send for Data Sheet No. 10.20-1.



BROWN SERVO AMPLIFIER SYSTEM

Comprises a converter (if the signal to be detected or measured is d-c); amplifier; and balancing motor. Ideal for null detection and correction of error signals. General characteristics are:

Amplifier No.	*Input Impedance Ohms	Sensitivity, Volts	Over-All Voltage Gain	60-Cycle Output Current	60-Cycle Output Voltage
351921	400	2×10^{-6}	10^6	0-12	0-154
354547	7000	0.5×10^{-6}	4×10^6	0-12	0-154

*The amount of resistance in series with the input necessary to reduce the output voltage by one-half with the input voltage maintained constant.
For further information, send for Data Sheet No. 10.20-3.

• An amplifier with added stage of amplification and greatly increased sensitivity is also available. It produces motor drive from signals as low as 0.05 microvolt. Special features eliminate spurious signals resulting from thermal potentials and stray a-c pick-up.
For further information, send for Data Sheet No. 10.20-4.

BROWN 60-CYCLE BALANCING MOTOR

Totally enclosed and self-lubricated, ideal where positive positioning is required. Designed to have a tapered curve of speed versus voltage and, at the same time, maintain high torque at low speeds.

	27 RPM MOTOR	54 RPM MOTOR	162 RPM MOTOR
MAXIMUM TORQUE	Approx. 85 inch-ounces	Approx. 43 inch-ounces	Approx. 19 inch-ounces
MAXIMUM POWER	Approx. 6300 inch-ozs. per minute at approx. 17-18 rpm.	Approx. 67— inch-ozs. per minute at approx. 30-32 rpm.	Approx. 8150 inch-ozs. per minute at approx. 100 rpm.
POWER REQUIREMENTS	Line field—approx. 9.5 Watts. Amplifier field—approx. 4 Watts. Total power—approx. 13.5 Watts		

For further information, send for Data Sheet No. 10.20-2.

and components

for a variety of applications

These products are representative of the thousands of modifications of the *ElectroniK* Potentiometer and the great numbers of Brown Electronic Components which are being utilized as precision measuring devices and as integral elements of various analytical systems. Perhaps *your* research program can benefit from such specialized instrumentation . . . your inquiry is invited. MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division,* 4428 Wayne Ave., Philadelphia 44, Pa.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

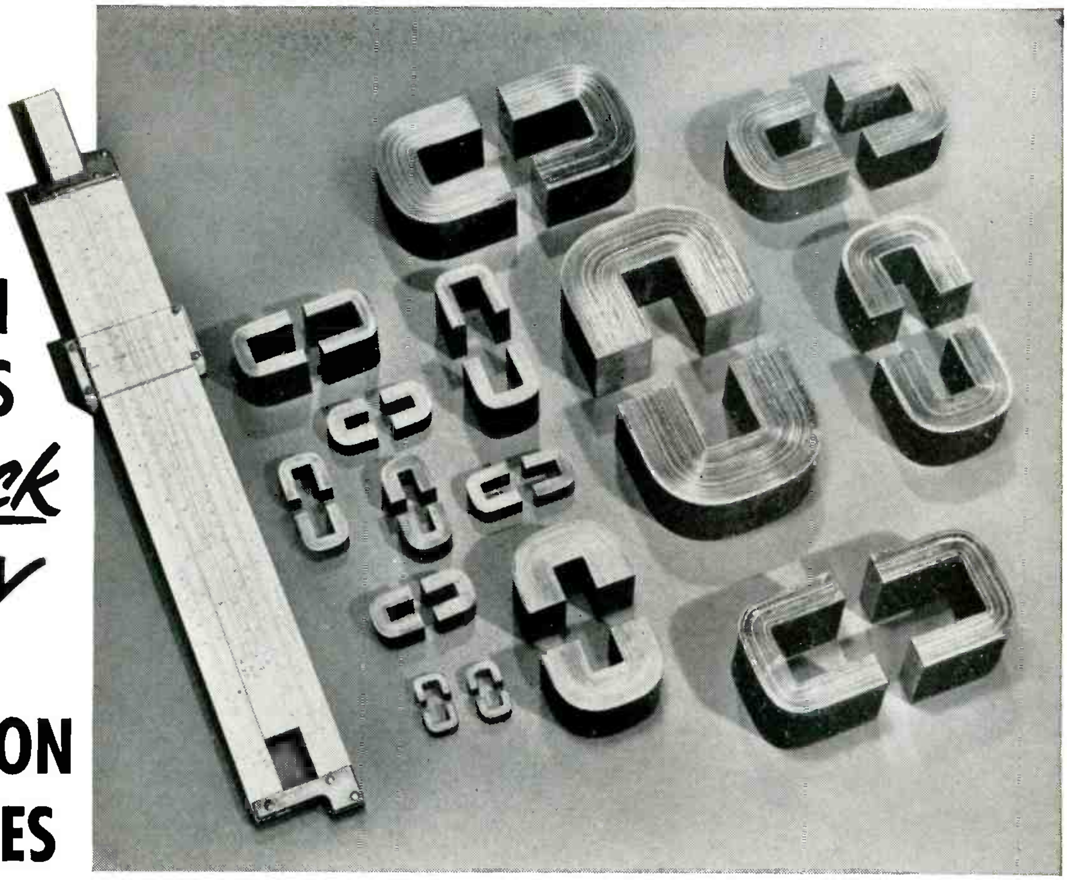
H
HONEYWELL

First in Controls

• *Important Reference Data*

Write, today, for a copy of Research Bulletin No. 15-14 . . . "Instruments Accelerate Research".

SILECTRON "C" CORES *for quick delivery* IN PRODUCTION QUANTITIES



... wound from strip as thin as 0.00025"

Quality-Tested and Proved

- ★ Arnold "C" Cores are made to highly exacting standards of quality and uniformity. Physical dimensions are held to close tolerances, and each core is tested as follows:
- ★ 29-gauge Silectron cut cores are tested for watt loss and excitation volt-amperes at 60 cycles, at a peak flux density of 15 kg.
- ★ 4-mil cores are tested for watt loss and excitation volt-amperes at 400 cycles, at a peak flux density of 15 kg.
- ★ 2-mil cores are tested for pulse permeability at 2 microseconds, 400 pulses per second, at a peak flux density of 10 kg.
- ★ 1-mil cores are tested for pulse permeability at 0.25 microseconds, 1000 pulses per second, at a peak flux density of 2500 gauss.
- ★ ½ and ¼-mil core tests by special arrangement with the customer.

Now available—"C" Cores made from Silectron (oriented silicon steel) thin-gauge strip to the highest standards of quality.

Arnold is now producing these cores in a full range of sizes wound from ¼, ½, 1, 2 and 4-mil strip, also 29-gauge strip, with the entire output scheduled for end use by the U. S. Government. The oriented silicon steel strip from which they are wound is made to a tolerance of plus nothing and minus mill tolerance, to assure designers and users of the lowest core losses and the highest quality in the respective gauges. Butt joints are accurately made to a high standard of precision, and careful processing of these joints eliminates short-circuiting of the laminations.

Cores with "RIBBED CONSTRUCTION"* can be supplied where desirable.

Ultra thin-gauge oriented silicon steel strip for Arnold "C" Cores is rolled in our own plant on our new micro-gauge 20-high Sendzimir cold-rolling mill. For the cores in current production, standard tests are conducted as noted in the box at left—and special electrical tests may be made to meet specific operating conditions.

● **We invite your inquiries.**

*Manufactured under license arrangements with Westinghouse Electric Corp.

W&D 4211

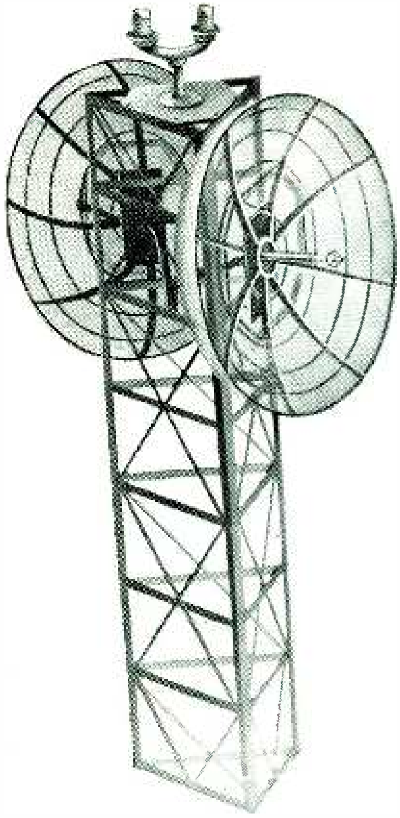
THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

BETTER FOR RADIO RELAY

—Because it's Simpler!



Federal PTM
(PULSE TIME MODULATION)
MICROWAVE

Streamlined Circuitry and Fewer Tubes Provide Greater Economy and Dependability!

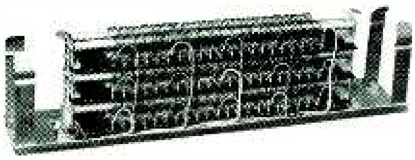
SIMPLICITY... that's the basis for the greater efficiency, reliability and economy of maintenance of Federal Pulse Time Modulation Microwave... for radio relay systems of any size, type or length... over any terrain.

Through *simpler* equipment—requiring *fewer* tubes—Federal PTM successfully meets all needs of telephone, teleprinter, telemetering, remote and supervisory control, VHF mobile radio and other services... for complete, simultaneous, dependable, all-weather voice and signal facilities.

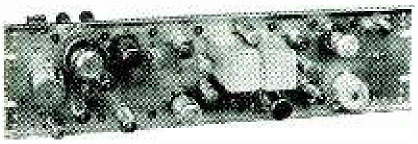
Get the facts about Federal PTM's system-wide superiority and proved performance . . . about Federal's more than 20 years of experience in microwave engineering, planning and installation. Write today to Dept. H-713.

FOR Pipelines, Utilities, Railroads, Telephony, Aviation, Highways...

Federal PTM Delay Line —"Heart of the System"

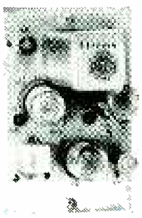


Remarkably compact and efficient... *has no tubes.* Maintains absolute synchronization between channels... provides non-shifting channel selection... eliminates crosstalk.

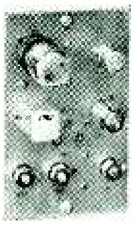


Federal PTM Pulse Generator

Supplies synchronizing pulse to delay line for simple, automatic channel synchronization, eliminating elaborate individual channel tuning provisions. Uses *fewer* tubes... greatly increases system dependability.



Simplest in the Field!

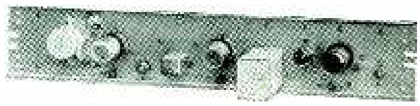


Federal PTM Modulator and Demodulator

Outstanding for minimum-tube design and interchangeability. Plug-connected for ready maintenance... greater economy in stocking of spare parts.

HERE are some of the Federal PTM multiplex elements that demonstrate the Simplicity of Design that makes Microwave by Federal—

"Microwave at its BEST"



Federal PTM Pulse Restorer

A valuable insurance factor in longer systems. Automatically cuts in and converts repeater into temporary terminal if adjacent repeater fails... maintains communication over remainder of system.

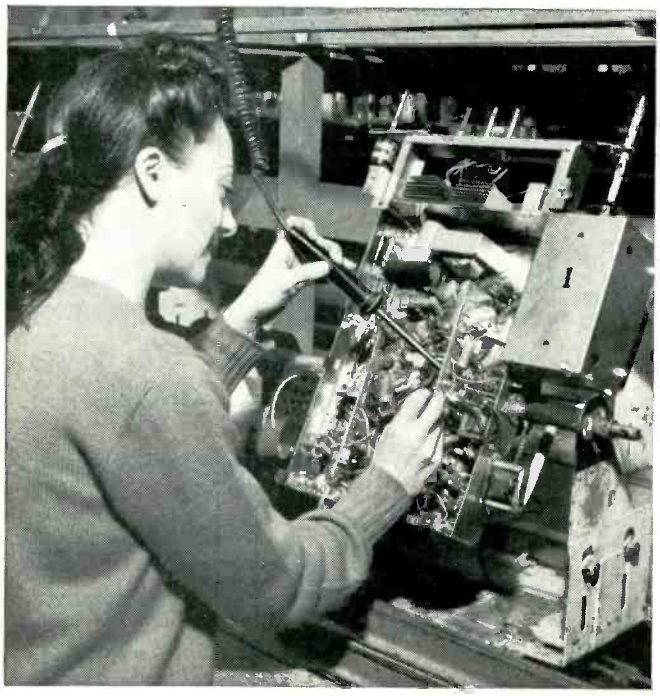
MICROWAVE MOVIE: Be sure to see Federal's new 16 mm. sound-color motion picture *"Modern Communications With Microwave."* Prints shipped without charge for company or organization showings. Write to: Film Distributing Dept.

Federal Telephone and Radio Corporation

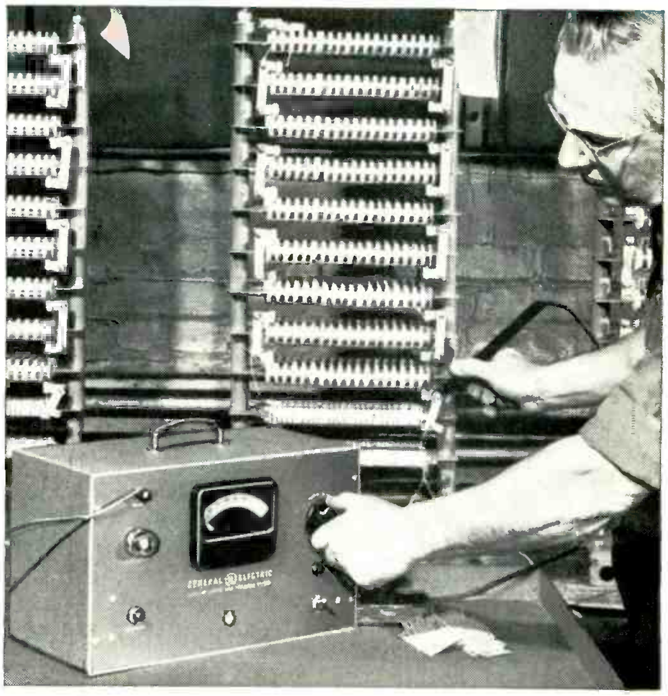
WIRE AND RADIO TRANSMISSION SYSTEMS DIVISION
100 KINGSLAND ROAD, CLIFTON, NEW JERSEY

In Canada: Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., N.Y.

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

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.

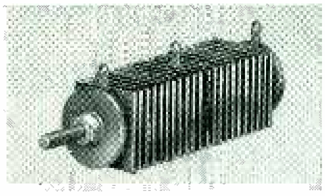
2. Less back leakage—for higher efficiency as well as higher output.

3. Cooler operation—the result of the above characteristics—since there is less heat to dissipate, less ventilation is needed.

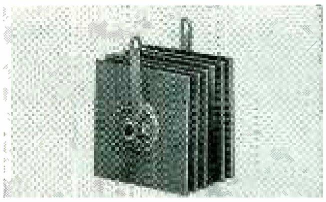
4. Slower aging—which extends expected life at rated output to over 60,000 hours.

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

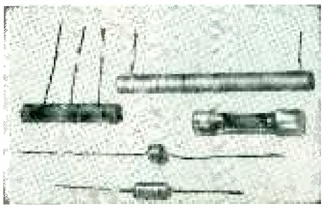
For a complete refresher on rectifier fundamentals, circuits, and applications, send for the new 28-page G-E booklet prepared to aid the design engineer. Check Bulletin GET-2350.



Standard stack construction



Tube-mounted construction



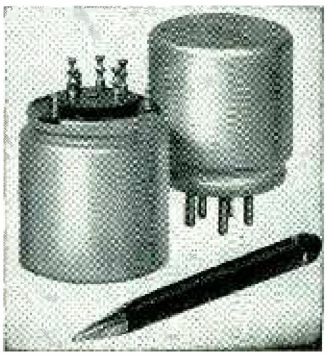
Miniature cell assemblies

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 C667-21
Schenectady 5, New York

Please send me the following bulletins:

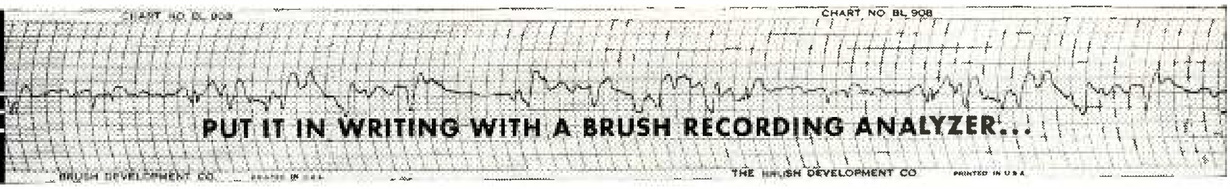
Indicate: √ for reference only
X for planning an immediate project

☐ GEC-700 High-Potential Tester
☐ GEC-809 Paper-Dielectric Capacitors
☐ GEC-834 Current-Sensitive D-C Relays
☐ GED-1583 Lightweight Soldering Iron
☐ GET-2350 Selenium Rectifiers

Name____________________

Company____________________

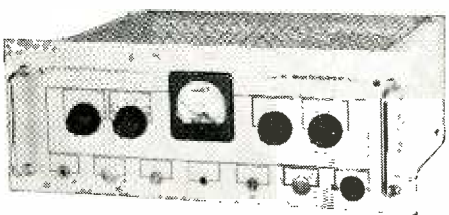
City______________ State______



Checks dialing on Micro-wave and Carrier Current Equipment

● Brush Recording Analyzers save plotting and testing time in applications everywhere. Here, at a substation of the Bonneville Power Administration, a Brush direct-coupled dual channel amplifier and dual-channel oscillograph record dialing pulses for a maintenance check. The test immediately indicates any dialing troubles in the system, and their nature. The Brush equipment is also used to check relay operation, and has been found essential to keeping the micro-wave system "on the air". Duplicate Brush equipment is used to service communication facilities in each Bonneville maintenance area.

MEASURES ELECTRICAL VARIABLES . . . CHART AVAILABLE INSTANTANEOUSLY



Brush Direct-Coupled Amplifier for Rack Mounting, Model BL-962.

This high gain, low-drift D-C amplifier is designed for mounting in a standard 19-inch rack. Other Brush amplifiers and oscillographs are being designed for rack mounting. When used in conjunction with Brush direct-writing oscillographs, amplifier can be used to make recordings of many types of phenomena which previously required complicated intermediate equipment. Voltage gain gives one chart millimeter deflection per millivolt input. Frequency response is essentially linear from D-C to 100 cycles per second. (Bulletin F-698)

Direct-writing Two-Channel Magnetic Oscillograph Model BL-202

The Brush Magnetic Oscillograph, used with the proper Brush Amplifier, makes a direct chart recording of voltage or current, or of physical phenomena such as strain, pressure, acceleration, torque, force, temperature, displacement and vibration. Either direct inking or electric stylus models available. Gearshift provides chart speeds of 5, 25, and 125 mm per second. An auxiliary chart drive is available for speeds of 50, 250, and 1250 mm per hour. Accessory equipment provides event markers where an accurate time base is required, or where it is desirable to correlate events. Photo shows two-channel model for recording of two phenomena simultaneously.

For Bulletin 618 describing these instruments write The Brush Development Co., Dept. K-33, 3405 Perkins Avenue, Cleveland 14, Ohio. Representatives located throughout the U. S. In Canada: A. C. Wickman Limited, Toronto.

THE Brush DEVELOPMENT COMPANY

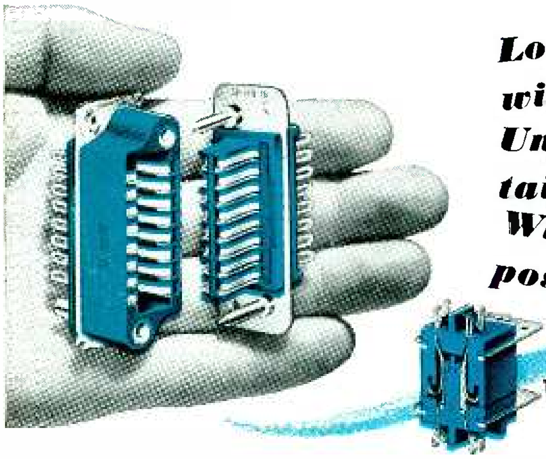
BRUSH

Piezoelectric Crystals and Ceramics
Magnetic Recording
Acoustic Devices
Ultrasonics
Industrial & Research Instruments

ANNOUNCING

AMPHENOL

BLUE RIBBON CONNECTORS



Low insertion and extraction force with high individual contact pressure

Unique spring contact construction maintains positive contact under vibration

Wiping action insures positive contact at all times

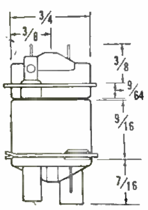
TYPICAL CROSS SECTION

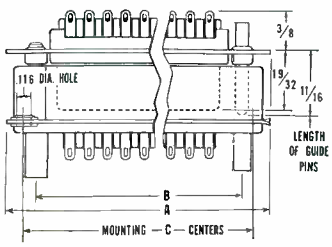
VOLTAGE RATING 5 AMPS { 600 VOLTS D. C. AT SEA LEVEL / 150 VOLTS D. C. AT 60,000 FEET ALTITUDE

RACK and PANEL TYPE

These new compact and lightweight connectors have been designed by Amphenol's Engineering Department to meet the demand for connectors that are easily mated even when out of sight. They provide quick disconnect, with low insertion and withdrawal requirements, for electronic sub-assemblies.

The rugged construction features high quality dielectric, silver base plated contacts with gold plated finish and stainless steel mounting plates. Plug contacts are supported their full length on the tough dielectric. The unique spring contact construction is self-cleaning and maintains full contact at *all* times! This same contact design makes it impossible to overstress or fatigue the spring members. The contact terminals are designed to accommodate up to No. 16 stranded conductors.





CONTACTS

26-159 } 26-190 }	16	24	32
"A"	2.437	3.118	3.798
"B"	1.842	2.522	3.202
"C"	2.024	2.704	3.384

These new Blue Ribbon Connectors are available in 8, 16, 24 and 32 contact sizes. Circuit switching or re-routing is easily done by proper wiring between contacts and plug-in member.

AMPHENOL 1-501 BLUE DIELECTRIC

This new dielectric, used in the Blue Ribbon Connectors, has been developed by Amphenol to meet the demand for a new and better dielectric. It easily meets the requirements of the Army-Navy Specifications and is far superior to melamine.

This diallyl phthalate resin-based compound combines nearly perfect dimensional stability with high insulation resistance, a lifetime shrinkage of less than 0.3% and an arc resistance exceeding 135 seconds on the standard ASTM test.

SPECIAL PURPOSE CONNECTORS

The Amphenol Blue Ribbon principle of low insertion and withdrawal force can be adapted to many special types and purposes. Pictured is a hermetically sealed plug with an adapted 16 contact receptacle. Special round configurations with and without keying shells are available. Mounting plates are available for special applications such as small complete circuit enclosures. The Amphenol Engineering Department offers consulting service in the designing of special purpose Blue Ribbon Connectors.

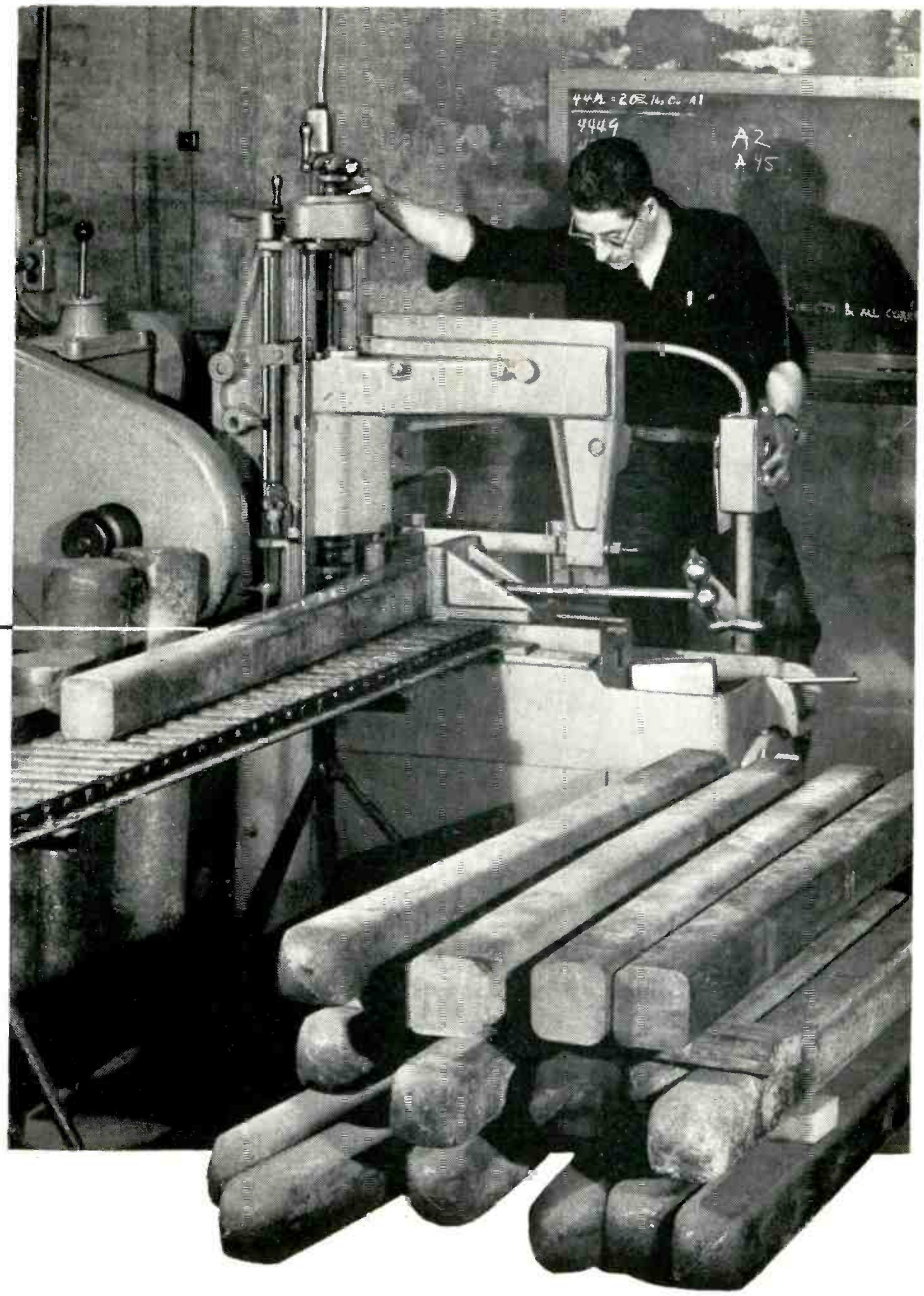
AMPHENOL

Write Dept. 13B for a copy of the four page Blue Ribbon Bulletin.

AMERICAN PHENOLIC CORPORATION

1830 SOUTH 54th AVENUE • CHICAGO 50, ILLINOIS

Serving up TONS of Vacuum Melted Metals



Preparing samples of vacuum melted metals for analysis.

PRODUCTION on vacuum melted metals that was formerly measured in pounds can now be measured in tons. Vacuum Metals' new expanded facilities are capable of producing 5 tons per day of Gas Free High Purity metals and alloys.

Vacuum melting techniques provide metals of higher purity . . . and alloys held to closer composition tolerances than ever before achieved commercially.

The unusual physical, chemical and electrical properties of these metals have proved of particular value for applications such as electronic and electrical parts, magnetic materials, bearing materials, diaphragms, instrument components, and Atomic Energy projects.

Metals now being vacuum melted include copper, nickel, iron, and molybdenum. Further information will be furnished gladly on request.

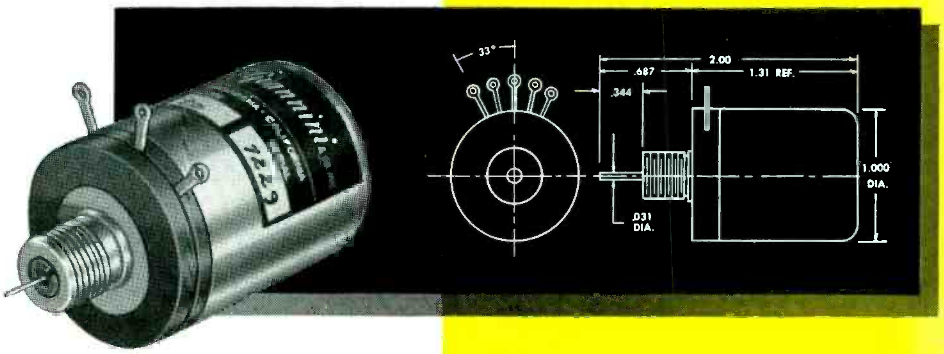
HIGH PURITY METALS
HIGH VACUUM CASTING
SPECIAL ALLOYS
GF (Gas Free) METALS

VACUUM METALS CORPORATION
Subsidiary of National Research Corporation
70 MEMORIAL DRIVE, CAMBRIDGE 42, MASSACHUSETTS

MICROTORQUE*

Jewel Bearing

LOW TORQUE POTENTIOMETER



Features

JEWEL BEARINGS

Jewel bearing construction offers watch-like precision, a high degree of shock resistance, and unusually low friction coefficient.

PLATINUM WINDINGS

The non-corrosive characteristic of platinum allows a light brush pressure to maintain efficient contact. This, in turn, virtually eliminates brush friction. Platinum, too, prolongs instrument life and assures dependability. One of the outstanding features that make the Microtorque* a truly low torque instrument-quality potentiometer.

SPECIFICATIONS

LINEARITY: ± 0.5% of total resistance.

MAXIMUM OPERATING SPEED: 100 rpm.

ACCELERATION: Will withstand 50G steady state acceleration in best axis.

VIBRATION: Will withstand 0.06" double amplitude sinusoidal vibration from 10 to 55 cps in best axis.

AMBIENT TEMPERATURE: Will function mechanically from −54° C. to + 71° C.

MOMENT OF INERTIA: 2 x 10−4oz-in.2 (approx.)

TEMPERATURE COEFFICIENT OF RESISTANCE: .0006/° C. Max.

A Simple Solution to Remote Indicating

The Giannini Microtorque* is an extremely low torque, instrument-quality potentiometer with an electrical output proportional to the angular position of the shaft. Its compact, light-weight, rugged and dust-proof construction means flexibility in applications. It may be directly connected to altimeters, temperature and pressure instruments; used in automatic flight equipment or in industrial laboratory installations where remote indication is required.

The Microtorque* is designed to have an extremely low starting torque and a negligible operating torque. The low mass of the moving parts makes the Microtorque* useful in those applications where an extremely low moment of inertia is essential. The Microtorque* is a proven instrument with proven performance.

Following Microtorques* are available from stock in quantities of six or less:

RES. OHMS	STARTING TORQUE IN-OZ	TURNS OF WIRE TYPE 2	TURNS OF WIRE TYPE 9	CURRENT**	PRICE***
250	.006	350	450	57	$45.00
1,000	.004	500	650	28	[illegible]
2,000	.004	700	750	20	$40.00
[illegible]	.003	900	1200	14	$40.00
10,000	.003	1,000	1300	10	$40.00
25,000	.003	1,000	1300	7	$45.00

**Must be de-rated for ambient temperature over 60° C.

***Prices apply to quantities of six or less. For quotation on larger quantities or specialtypes, please write.

Above Microtorques* are available in the following two types:
Type 2: 270° + 10° − 0° Electrical Rotation, Mechanical Rotation. Limited by internal stops.

Type 9: 354° Min. Electrical Rotation, Mechanical Rotation. Continuous. Brush does not short ends of coil.

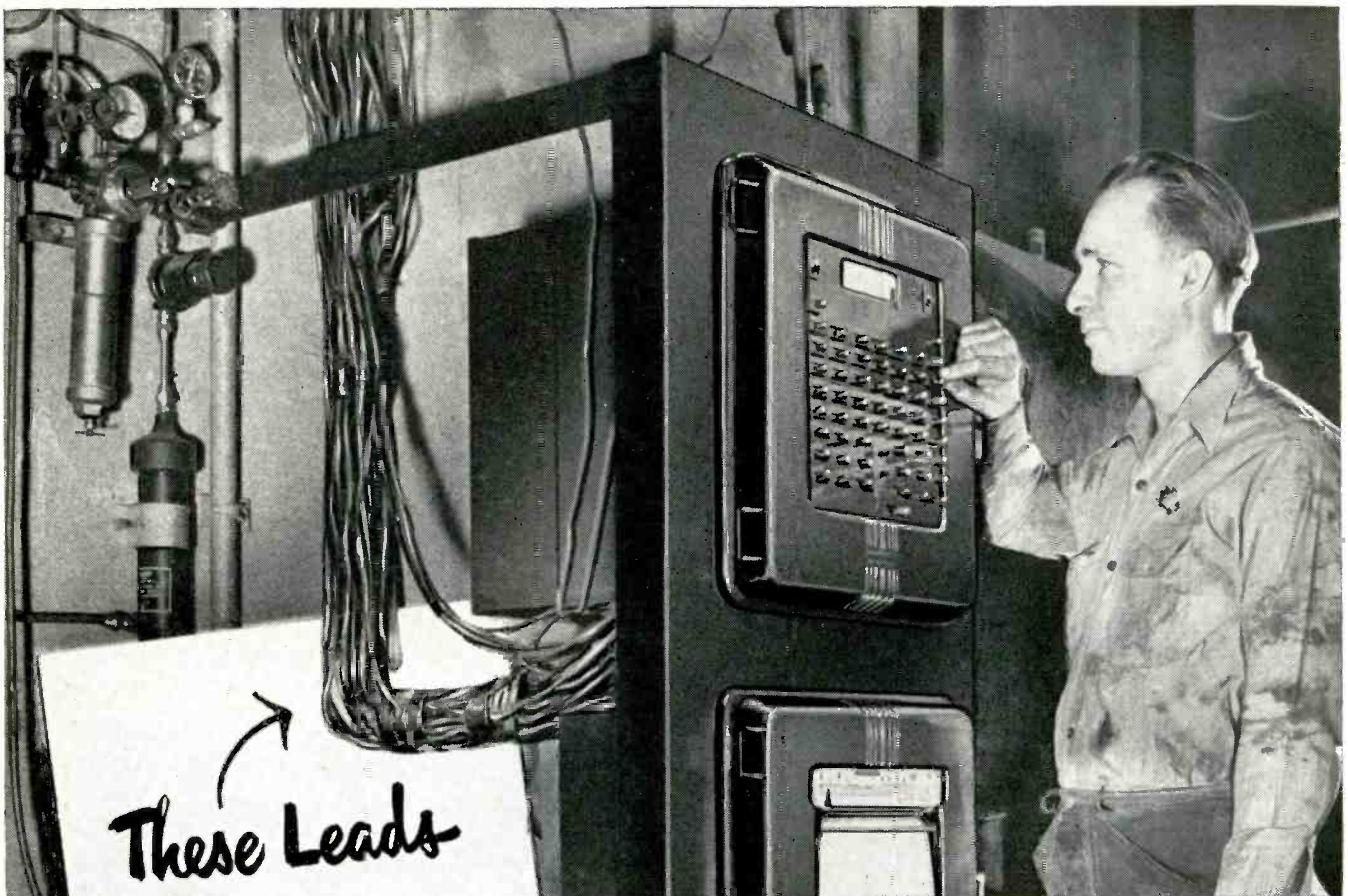
Giannini also produces potentiometers of various types, including non-linear functions, and tapped windings.

For information on this and other fine instruments write Dept. P. G. 1

Giannini INSTRUMENT-QUALITY **POTENTIOMETERS**

*MICROTORQUE—*T.M. REG. 1952

G. M. GIANNINI & CO., INC. PASADENA 1, CALIF. EAST ORANGE, NEW JERSEY



The scientist or test engineer who has a Speedomax Model G Electronic Indicator at his disposal is ready to save himself a lot of time and energy in running tests at as many as 126 different locations.

A flick of the finger connects the desired sensing element to the Indicator . . . the instrument's calibrated drum whirls to the reading . . . the drum stops dead still. The entire operation takes only 4½ seconds for consecutive readings at opposite ends of the scale. Minimum time for close-together points is only a fraction of a second. Logging speed depends only on the operator.

MANY CALIBRATIONS AVAILABLE

The condition most frequently measured with these Indicators is temperature, with stress and strain a close second. However, many other quantities suggest themselves, since the Indicator can show the output of any sensing element which provides a calibratable d-c signal.

The maximum of 126 points per Indicator is for measurement of thermocouples connected to toggle switches on the instrument. Using rotary or push button switches, the totals become 96 and 48 respectively. Push buttons are normally supplied with interlocks to assure one-at-a-time operation, but when desired the interlocks can be disconnected so that several switches may be closed simultaneously, causing the instrument to give the average of those points.

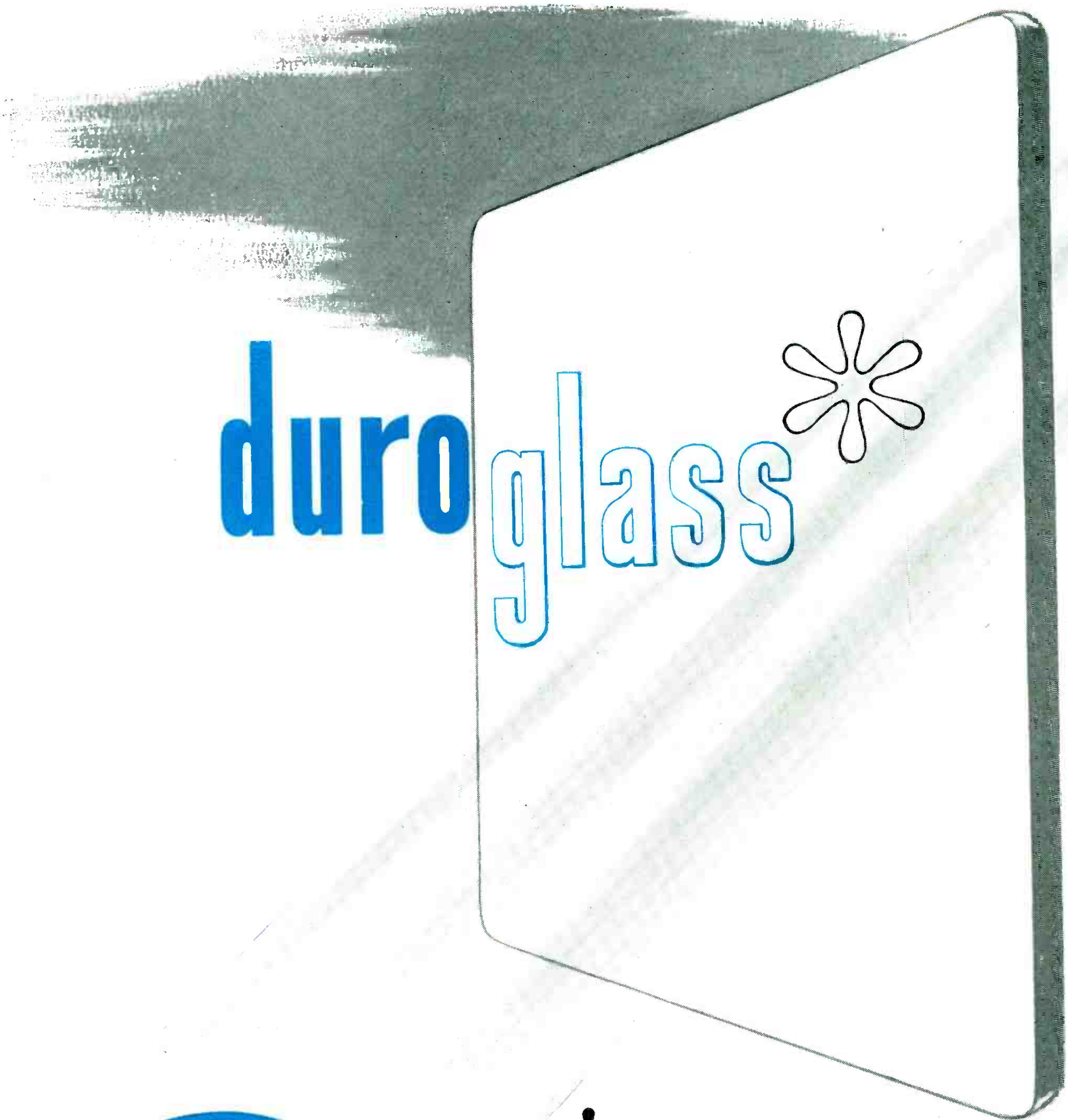
As many as 96 Thermohm electrical resistance thermometers may be connected to the Indicator, using either toggle or rotary switches. The number of points for load cells and other non-temperature-sensing elements depends on their requirements, but the Indicator can accommodate more points than any other self-contained Indicator available today.

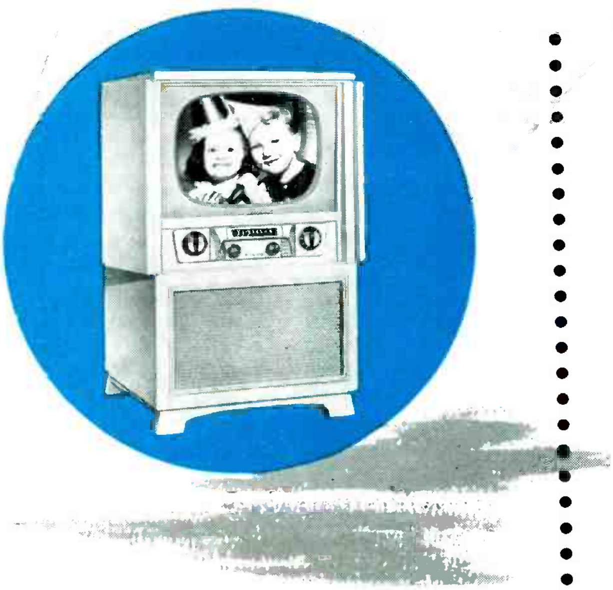
The equipment is described in our Catalog ND46(1). Whether or not you require this information at present, we will be glad to send a copy for reference. Address our nearest office, or 4979 Stenton Ave., Philadelphia 44, Pa.

LEEDS & NORTHRUP CO.

instruments • automatic controls • furnaces

Jrl. Ad ND46-420(1)





*duroglass is fully tempered to meet underwriters requirements for television implosion plates . . . available in $^{7}/_{32}$" or $^{1}/_{4}$" thickness, formed or flat.

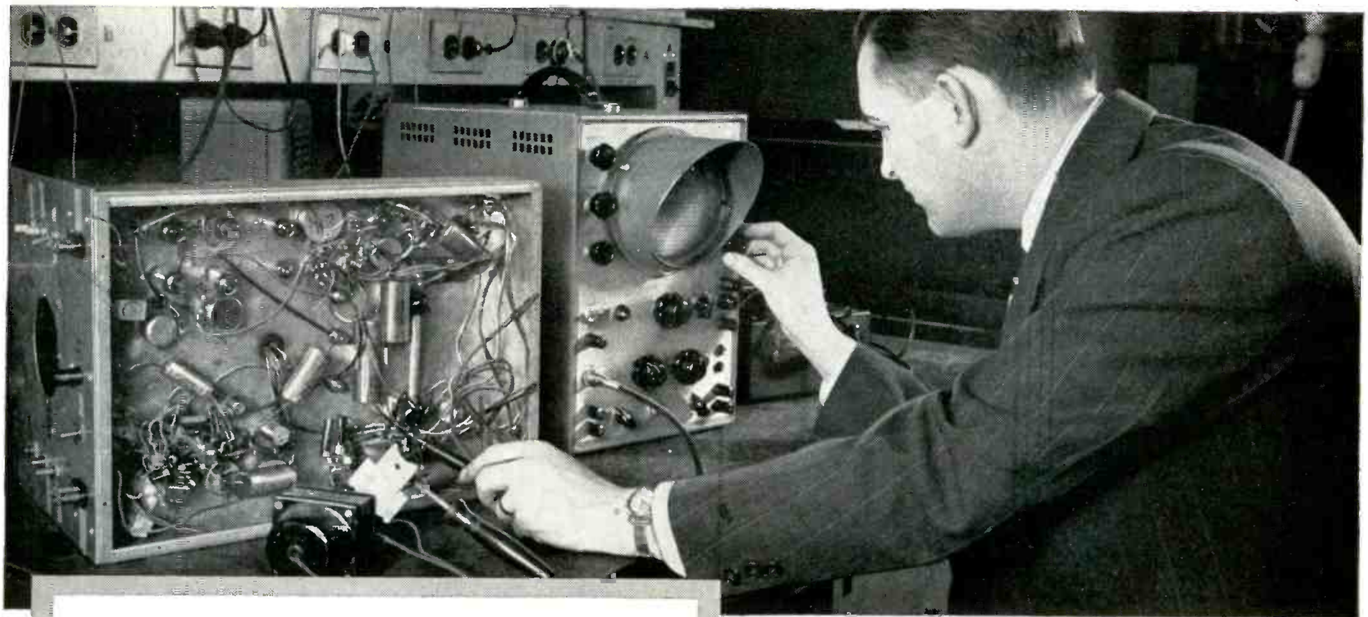
There is no finer *tempered glass* for implosion plate use.

We invite your inquiries.

chicago dial company

2919 S. LaSalle Street · Chicago 16, Illinois

Fabricators of precision glass parts for industry



SPECIFICATIONS—MODEL ST-2B

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.)

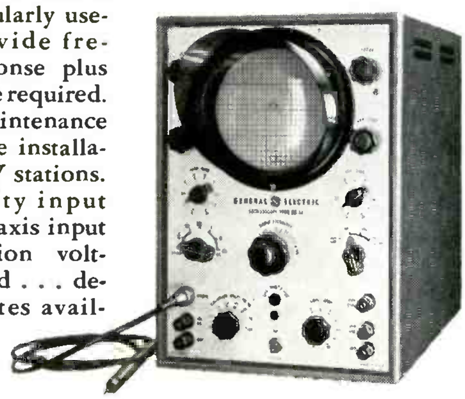
PRECISION THAT

Reliable General Electric Instruments Offer Extreme Versatility in Lab and Industrial Applications

STABILITY is the keynote of the ST-2B all-purpose scope, shown in the picture above. Designed to permit a choice of short, medium or long persistence CR tubes, the unit incorporates identical direct coupled vertical and horizontal amplifiers. Filaments and screens on the first amplifier stages are regulated. Vertical selector switch allows choice of probe, calibration, AC or DC inputs.

Across the board against 4 conventional scopes, the General Electric ST-2B tests superior in 11 different characteristics.

Type ST-2C—A 5-inch scope particularly useful where wide frequency response plus portability are required. Ideal for maintenance of microwave installations and TV stations. Low capacity input probe . . . Z-axis input . . . calibration voltages provided . . . deflection plates available... hard tube sweep.

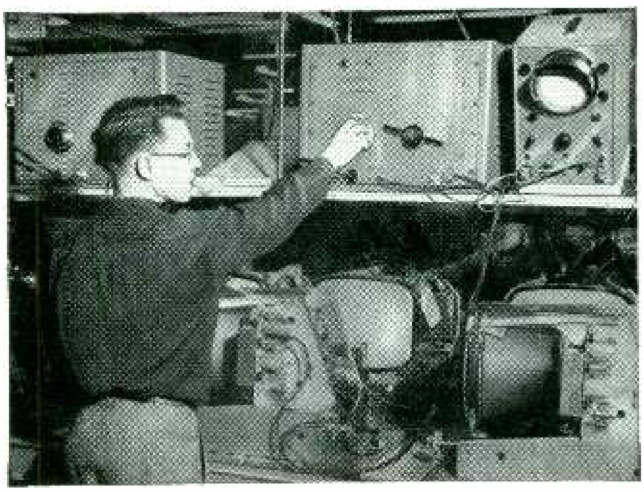


Type ST-2A—For general purpose use in laboratories. Excellent wide frequency response for TV receiver circuit work and industrial testing. Special features include a DC vertical amplifier to adapt the equipment to a wide range of applications. Deflection pattern can be expanded to several times the diameter of 5-inch tube.

Germanium Diode Checker Type ST-12A —A new G-E instrument for use in laboratories, quality control groups, service shops —wherever there is need for checking the static characteristics of diodes. *Specifications* —POWER REQUIREMENTS: 105-125 volts, 50/60 cycle, approximately 10 watts. FORWARD RANGES: Current—0.3, 1.2, 6 and 12 milliamperes full scale. Voltage—.3 and 1.2 volts full scale. INVERSE RANGES: Current —60, 120, 300 and 1200 microamperes full scale. Voltage—3, 12 and 120 volts full scale.

Other applications: general resistance checker (10 ohms to 6 megohms) . . . accurately-metered power supply . . . forming electrolytic capacitors and checking DC leakage current.

LABORATORY EQUIPMENT PAYS BIG DIVIDENDS



TV Channel Sweep Generator Type ST-11A —Covers all 12 VHF television channels and is designed primarily for TV receiver production line testing. Simple to operate: one front-panel control selects the sweep range and markers simultaneously. On-off switch and side-band control switch are also on the front panel. Separate crystal for each TV channel . . . picture and audio carrier markers available simultaneously.

This instrument combines the characteristics of General Electric's ST-4A Variable Permeability Sweep Generator and ST-5A Crystal Controlled Marker Generator.

CHECK OFF THE *FREE* BULLETINS THAT YOU NEED

- ☐ Type ST-2A Scope Bulletin X52-127
- ☐ Type ST-2B Scope Bulletin ECL-4
- ☐ Type ST-2C Scope Bulletin X52-147
- ☐ Type ST-11A Channel Sweep Bulletin ECL-1
- ☐ Type ST-12A Diode Checker Bulletin ECL-3
- ☐ Type ST-4A Sweep Generator Bulletin X52-014
- ☐ Type ST-5A Marker Generator Bulletin X52-128

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Electronics Park, Syracuse, New York
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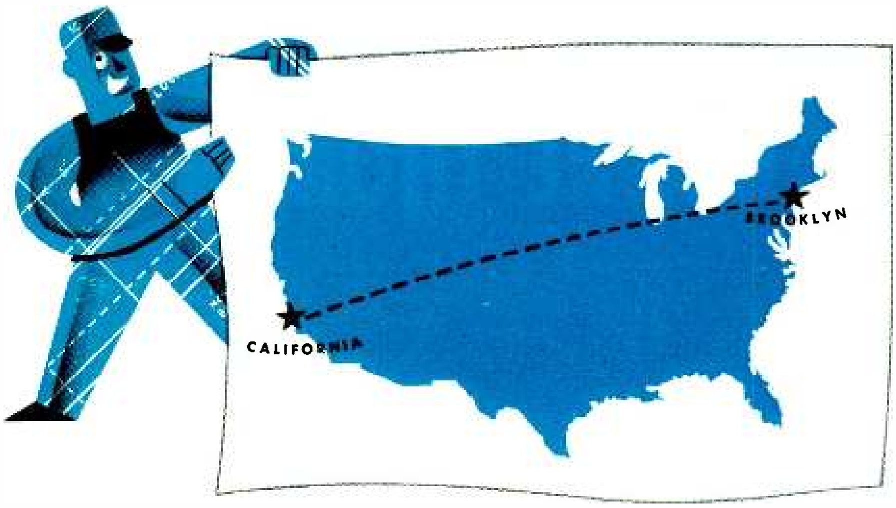


Why California comes to Brooklyn for sheet metal fabrication

West Coast electronic manufacturers reach 3000 miles across the country for Karp-fabricated cabinets because:

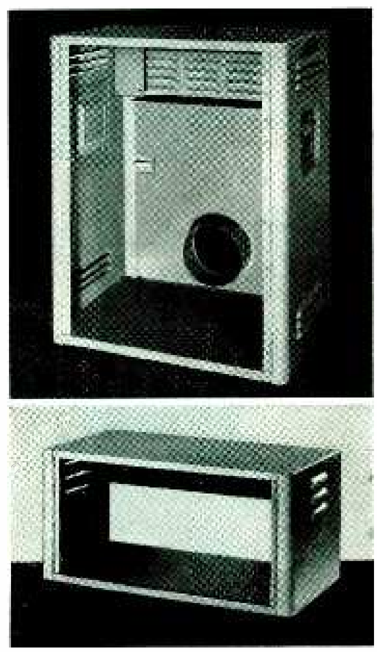
. . . ***they know*** Karp's experience with leaders—both large and small—of the electronic industry qualifies Karp to solve their problems in the design stage . . . economically, quickly, practically.

. . . ***they know*** they can often draw upon Karp's thousands of existing dies . . . to eliminate the need for much costly tooling.

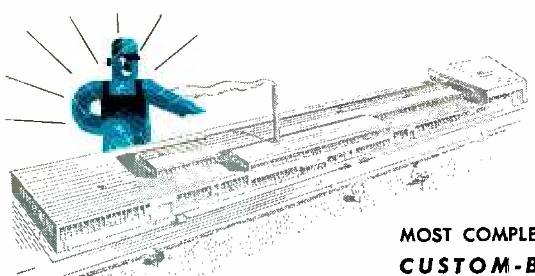
. . . ***and most of all,*** they know that when their cabinets leave the Karp plant, all dimensions are correct . . . every hole is drilled clean and positioned accurately . . . the finish is perfect.

If you would like to learn how Karp methods can be applied to your problems, write for complete details. Or, if you are on the West Coast, August 27-29, be sure to visit our booth (No. 423) at the Western Electronic Show, Long Beach, California.

Karp Metal Products Co., Inc., 215 63rd Street, Brooklyn 20, N. Y.



Rugged yet attractive . . . This cabinet for *Applied Electronics'* 10-watt radiotelephone (bottom) had to be rugged enough for small boat usage, yet attractive enough to sell. The top cabinet, specially designed for one of *Hewlett-Packard's* Electronic Frequency counters, is low cost yet distinctive. And among other leading West Coast electronic manufacturers, *Packard-Bell* is a regular user of cabinets built by Karp.



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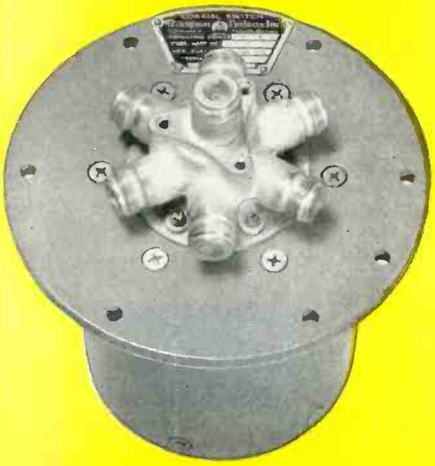
THEY'RE NEW... AND THEY'RE THOMPSON TOO!

COAXIAL SWITCHES

designed, engineered, manufactured ...

by Thompson



Model CA-26, 1P6T, 115 volt, 60 cycle, AC motor-actuated Coaxial Switch for use with RG-9/U cable.

Model CA-36, 1P3T manually-actuated RG-17/U Coaxial Switch with electrical and mechanical interlock.

Model CA-31, 2P2T Sensing or Lobing Switch, 115 volt, 380-1000 cycle AC motor actuator. Switching speed, 15—35 Rev/sec. For use with RG-58/U cable.

EVERY INCREASE in the scope and tempo of electronics creates new and stringent demands. Keeping abreast through development and manufacture of a reliable line of special-purpose electronic equipment is the business of Thompson experimental laboratories and manufacturing plants.

Like many other Thompson electronic developments, the three new coaxial switches illustrated were designed, engineered and manufactured to meet the rigid requirements of modern microwave components and accessories. Complete technical information is, of course, available upon request.

Whatever your problems may be—in coaxial switches, antennae, specialized test equipment or wave guide and coaxial components and accessories—Thompson's experience-proved research, development and production facilities at both Cleveland and Columbus, Ohio are at your service.

Thompson Products, Inc.

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Aid or Trade?
A CRISIS AHEAD

A crisis in the foreign trade relations of the United States is in the offing. It is a crisis caused by:

1. Efforts of producers in friendly nations to earn more dollars by increasing exports to the United States, and
2. Efforts of industries in the United States which would be hurt by competition from these imports to keep them out.

This crisis is a threat to the effectiveness of American leadership in the crucial effort to build the nations of the free world into a strong and unified group. It is the purpose of this editorial to advocate a constructive approach to the difficult situation that is developing.

Background of the Crisis

Most countries in the free world—with American aid—have managed to push their outputs well above prewar levels. As they have done so, they have been urged by our highest government officials to increase their exports to us. Sales in our market enable these countries to earn dollars which they use in turn to buy the products of America's farms and factories. Thus, as they become self-supporting, the need of American aid is reduced.

But as these efforts to export more to the United States have promised increasing success, competitive American producers have become increasingly alarmed about what that success might do to them. Consequently, they are seeking more protection—by appeals to the U. S. Tariff Commission to recommend higher import duties and by appeals to Congress for new laws to discourage imports.

Our Friends Protest

A year ago Congress answered one of these appeals by imposing a quota on imports of dairy products. Now, among many other legislative proposals being strenuously pressed is a move to extend the scope of "Buy American" legislation. A year ago the U. S. Tariff Commission had only four petitions for increased import duties on its docket. Since then fourteen more petitions have been filed and others are definitely on the way.

Faced by these mounting efforts to block the sale of their products in the American market, no less than eleven friendly nations, including Great Britain, France, Italy, Canada, the Netherlands, Switzerland and Denmark, have filed protests with our State Department. Through many of the protests runs one refrain. Although stated in diplomatic language, it might be correctly paraphrased to say: *"In* *sending us aid you have made it very clear that you want us to get on a self-supporting basis at the earliest possible moment. But, when we begin to make headway in that direction by trying to sell you more of the things we are equipped to produce, you start closing your market to us."* The threat of European resentment against the United States being stirred up by this argument is obviously great.

At the same time there exist grounds for special resentment in the United States against certain prospective imports of European manufactured goods – those of machine tools, for example. In part these will be produced with machinery that has been sent to Europe as part of our economic aid program. With absolutely no diplomatic language involved, the argument, which will be extended much farther than the facts would justify, will run: "*We gave those people the equipment that they now use to cut our throats!*" This line of argument will find response among workers as well as employers in industries faced by more competition from imports. Labor, too, is keen for protection against more foreign competition.

Aid or Trade?

As between continuing direct economic aid to Europe or accepting the imports that would make those countries self-supporting, some would prefer to continue the aid program. They argue that the tax machinery of the federal government can spread the burden of aid broadly, while we have no comparable machinery that can cushion the shock to individual industries, firms and communities that may result from stepped-up imports of competitive products.

As we see it, this position is untenable. It would make rubbish of our Atlantic Charter promise ". . . to further the enjoyment by all States, great or small, victor or vanquished, of access, on equal terms, to the trade and to the raw materials of the world which are needed for their economic prosperity." It would be an admission that, for all our profession of faith in competition and our opposition to European cartels, we really don't believe in competition.

U. S. Self-Interest

The people of this country have invested billions of dollars and seven years of hard work in the attempt to put our allies on a self-supporting basis. If we keep their goods out by raising trade barriers, we are directly defeating our own purposes.

Also, in moving to protect some groups of American producers we should be hurting others. For many American producers the export market, which this year will take about $14 billion of civilian goods, spells the difference between operating at capacity and closing down 25% of their facilities. When we discourage imports we cut off dollar earnings by other nations which are spent here to keep some of our factories and farms going.

At the same time, it must be recognized that certain American industries and their capacity to maintain employment will be hurt by increased imports. Hence it becomes critically important for the United States to formulate a national program designed to help these industries and communities take up the shock.

There is no neat and simple prescription by which this can be done, but several possibilities have been suggested. One on which there is general agreement is that tariff reductions should be gradual. To cushion their impact, the government might well give preference on defense orders to industries and areas adversely affected by an increased volume of imports. Direct assistance to workers and companies in shifting to different lines of business may be worth consideration.

These are by no means all the possibilities. They may not even be the best. But they do serve to suggest the necessity for flexibility and imagination in dealing with the growing crisis in trade relations. *Our ingenuity in developing new ideas to meet this crisis may well be a decisive factor in our effort to weld the free nations into a strong and durable alliance.*

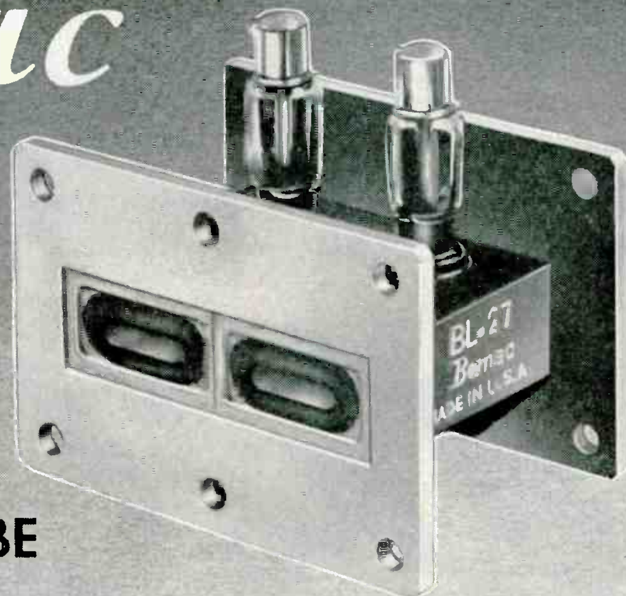
McGraw-Hill Publishing Company, Inc.

Bomac

Announces

The BL27

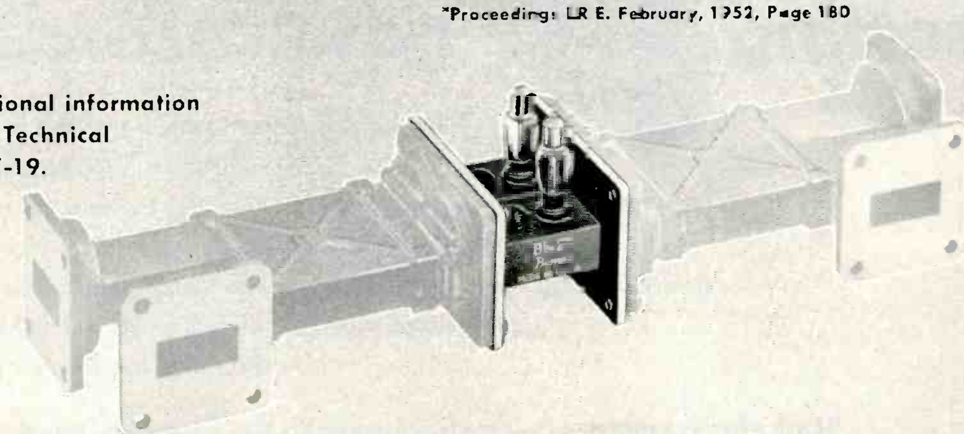
A DUAL TR TUBE



Each section of the BL27 is electrically similar to Type 1B63A. The two sections have a common wave guide wall and a common gas fill. Used with short-slot hybrids,* the BL27 provides a highly compact duplexer of utmost simplicity, with excellent performance over the band of 8500-9600 mc. with respect to both transmission and reception characteristics.

*Proceedings I.R E. February, 1952, Page 180

For additional information write for Technical Bulletin T-19.



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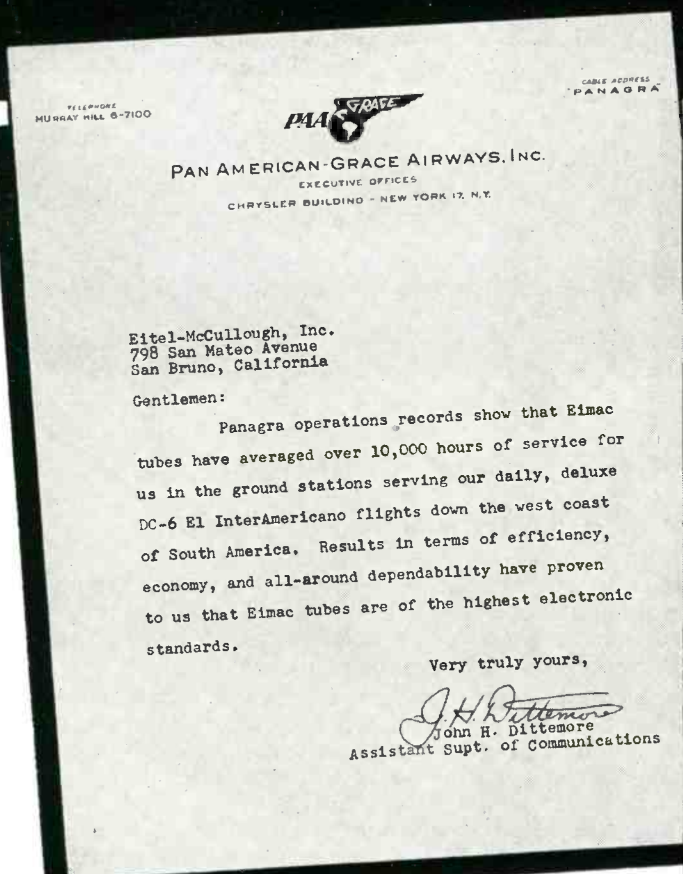
Operations Records Show...

... Eimac tubes are of the highest electronic standards



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Very truly yours,

J. H. Dittemore
John H. Dittemore
Assistant Supt. of Communications

Pan American-Grace Airways, Inc., pioneer South American airline has served the west coast countries for 24 years. Find as Panagra has found — that to employ Eimac tubes is to employ the best.

Follow the Leaders to Eimac TUBES

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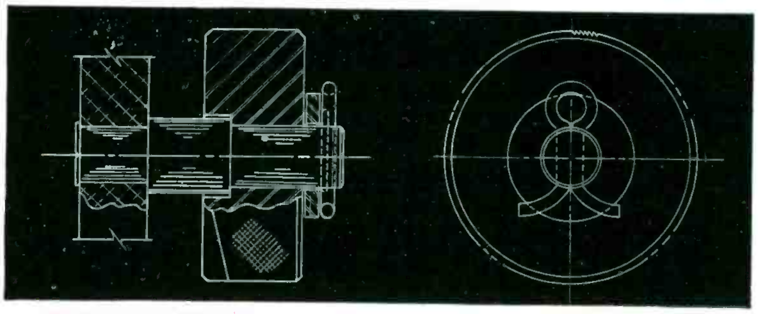
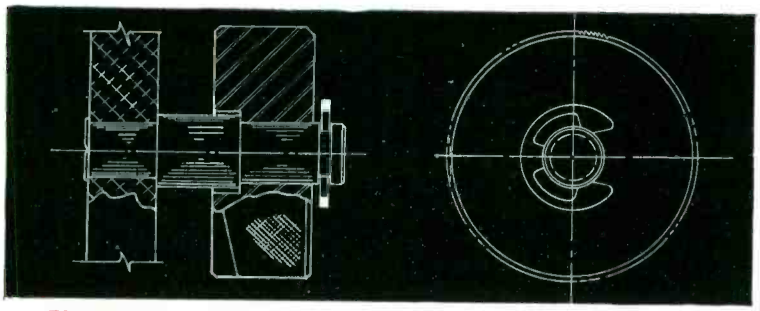
Export Agents: Frazar & Hansen, 301 Clay St., San Francisco, California

322

WALDES TRUARC RINGS REPLACE COTTER PINS...
SAVE 44% IN LABOR AND ASSEMBLY COSTS



COTTER PIN WAY: Flint wheel shaft in lighter assembly requires cotter pin, washer. Difficulty in drilling perfect hole causes rejects. Assembly is slow, costly.



TRUARC WAY: Waldes Truarc "E" ring fits into groove in shaft; locks assembly securely for life. Groove is quickly, easily cut...assembly is simple, speedy.

Brown & Bigelow, St. Paul, Minn., saved *$6.95 per thousand units* by incorporating Truarc Rings in the design for the REDI-FLAME compressed gas desk lighter! In spite of greater initial cost of Truarc Rings as against cotter pins, they were able to cut machining and assembly costs drastically—for an overall savings of 44%!

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

Waldes Truarc Rings are precision-engineered...quick and easy to assemble and disassemble. They can be used over and over again.

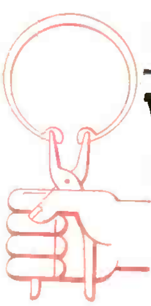
Find out what Truarc Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

COMPARATIVE COSTS

Cotter Pin Way	$ Per M	Truarc Way	$ Per M
Material		*Material*	
Shaft	.48	Shaft	.35
Cotter pin	.46	Truarc ring	8.68
Washer	1.50		
	2.44		9.03
Labor		*Labor*	
Shaft	10.22	Shaft	2.27
Washer	.72		
Assembly	9.28	Assembly	4.41
	20.22		6.68
TOTAL	$22.66	TOTAL	$15.71

TOTAL SAVINGS WITH TRUARC RINGS: $6.95 or 44%

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



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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. E084

- ☐ 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.

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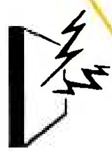
TEFLON is

a trademark of E. I. DuPont Co. for polytetrafluoroethylene. It is supplied by C-D-F in tapes and sheets, both plain and fibre glass cloth supported.

HEAT RESISTANT
Teflon may be used continuously at 200°C. (392°F.); or for short periods at 250°C. (482°F.). Meets A.I.E.E. Standards for Class H electrical insulation.

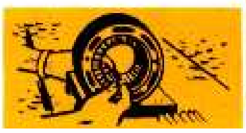
MOISTURE RESISTANT
Teflon products have practically zero water absorption and are unaffected by fungus, humidity and temperature changes. It remains pliable at −87.5°C. (−100°F.).



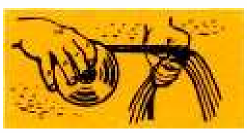
ARC RESISTANT
Teflon will not carbonize, but rather will vaporize. When the arc is extinguished, full insulation is restored.

CHEMICAL RESISTANT
Teflon is the most inert of all commercial thermoplastics and is not affected by any known solvent.

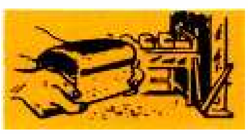
THAT'S WHY C-D-F TEFLON TAPES AND SHEETS CAN OFFER THESE BIG ADVANTAGES



FOR LINING SLOTS C-D-F sheets of fibre glass cloth supported Teflon can be cold-formed into easily loaded slot liners. Teflon is naturally slippery smooth, with plenty of "snap back." High in dielectric strength, liners are rated Class H insulation.



FOR WRAPPING CABLES C-D-F Teflon tapes are tough, strong, and stretchable. Teflon can be supplied unsupported, or combined with fibre glass fabrics in a variety of widths and thicknesses. It is suitable for winding around sharp bends or odd shapes.



FOR CHEMICAL AND MECHANICAL USES
Remember, Teflon is non-adhesive and chemically inert. Bakers, food packagers, and pump manufacturers use it. For applications requiring extreme electrical insulation stability, high temperature or resistance to corrosion, C-D-F unsupported and fibre glass cloth supported products can do a job for you.

C-D-F's work with Teflon is really rolling! New applications are being developed daily in our laboratories by specialists who are devoting their entire time to improving and developing new Teflon products. Start talking Teflon with the man from C-D-F (sales offices in principal cities)—he's a good man to know!

CDF

Continental-Diamond Fibre Company

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TYPE 252, JAN-R-19, Type RA20

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

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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.

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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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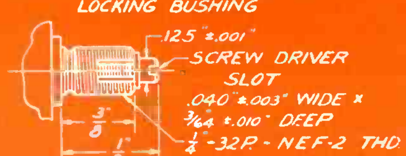
SHAFT TYPES AVAILABLE ON STOCK CONTROLS

CTS SHAFT TYPE LT-2

LOCKING BUSHING



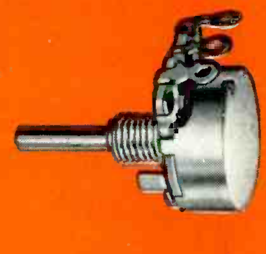
MOUNTING HARDWARE ASSEMBLED
MOUNTING NUT 3/8 HEX × 3/32
LOCK NUT 3/8 HEX × 1/8
LOCK WASHER #1914A

CTS SHAFT TYPE RE

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

TYPE 65

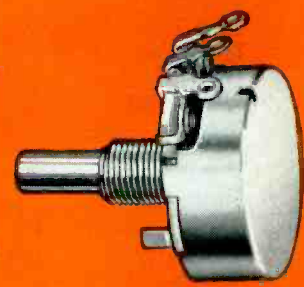
½ watt 70° C, ¾" diameter miniaturized variable composition resistor.



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

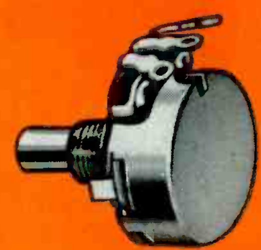
2 watt 70°C, 1⅛" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94. Attached Switch can be supplied.



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.



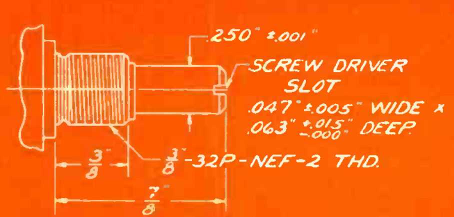
Resistance	RV2, JAN Shaft Type SD CTS Part	JAN-R-94 TYPE	CTS Part Non-JAN Locking Bushing CTS Shaft Type LT-1
100±10%	A5876	RV2ATSD101A	A5922
250±10%	A5877	RV2ATSD251A	A5923
500±10%	A5878	RV2ATSD501A	A5924
1000±10%	A5879	RV2ATSD102A	A5925
2500±10%	A5880	RV2ATSD252A	A5926
5000±10%	A5881	RV2ATSD502A	A5927
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.

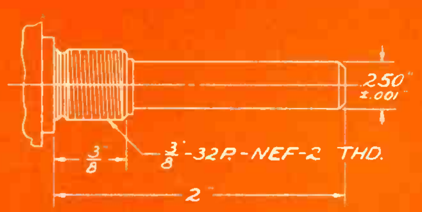
Resistance	RV3, JAN Shaft Type SD CTS Part	JAN-R-94 TYPE	CTS Part Non-JAN Locking Bushing CTS Shaft Type LT-1
100±10%	A5861	RV3ATSD101A	A5907
250±10%	A5862	RV3ATSD251A	A5908
500±10%	A5863	RV3ATSD501A	A5909
1000±10%	A5864	RV3ATSD102A	A5910
2500±10%	A5865	RV3ATSD252A	A5911
5000±10%	A5866	RV3ATSD502A	A5912
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



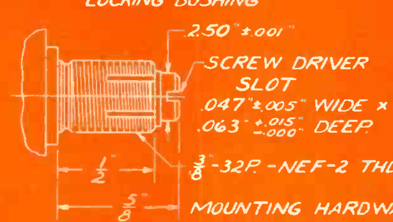
MOUNTING HARDWARE ASSEMBLED
MOUNTING NUT 9/16 HEX. × 3/32
LOCK WASHER #1920A

JAN SHAFT TYPE RJ

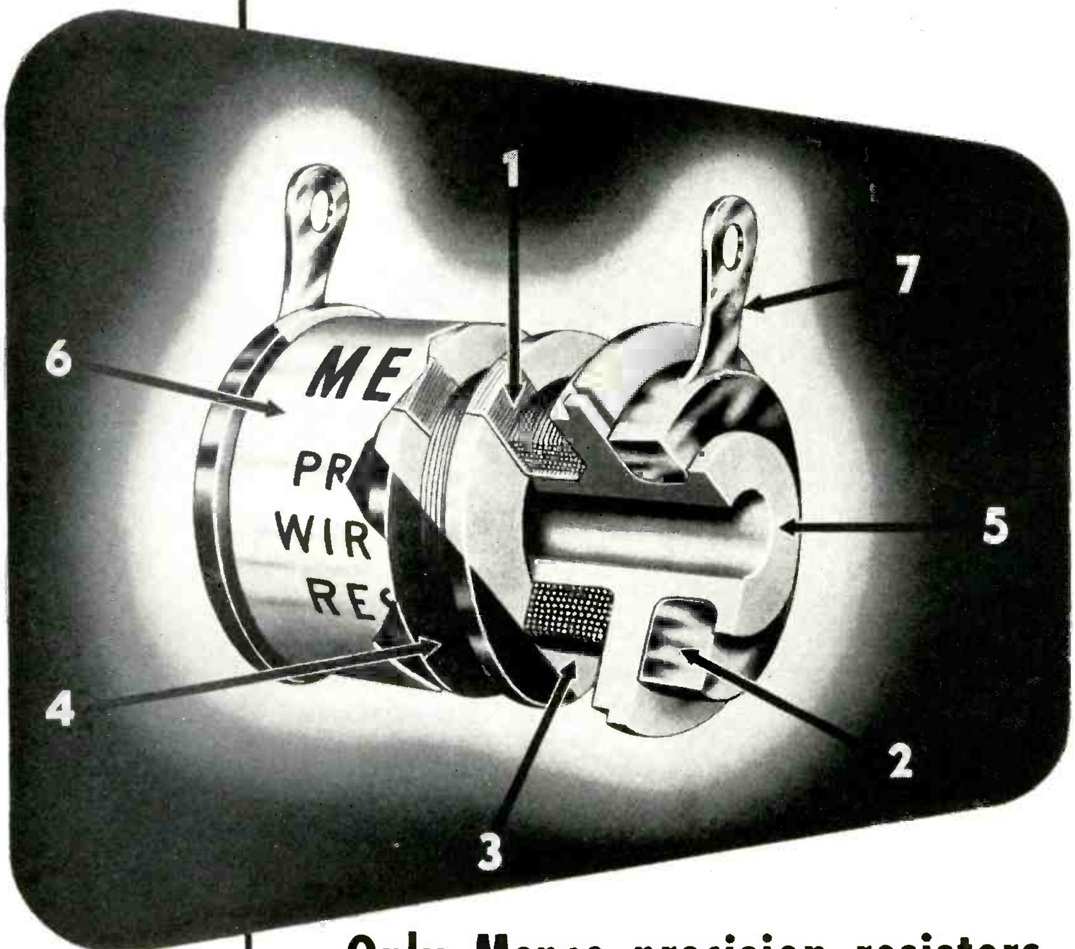


MOUNTING HARDWARE ASSEMBLED
MOUNTING NUT 9/16 HEX. × 3/32
LOCK WASHER #1920A

CTS SHAFT TYPE LT-1
LOCKING BUSHING



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



Only Mepco precision resistors give you *all* seven features

1. Crossover wire insulated from each winding by 2000v. insulation *(patented)*.
2. Special metal molded connecting feature, which bonds end of winding and terminal in a non-corrosive and mechanically secure manner—no solder or flux used.
3. Reversed and balanced PI-windings for low inductance, with use of only the finest resistance alloys.
4. Impregnated with approved fungus, moisture and salt waterproofing compounds.
5. JAN approved non-hydroscopic steatite bobbin, specially treated prior to winding in order to provide additional protection for fine enameled wire.
6. Protective fungi resistant acetate label.
7. Rigid hot solder coated brass terminals for easier soldering.

MEPCO

MEPCO INC., MORRISTOWN, NEW JERSEY

Slow leaks can be expensive

HOW SLOW?

10 years   20 years   30 years

Leak Detector Model 24-101A *detects, locates* and *measures* any leak down to the almost unbelievably minute range where it would require 31 years for one cubic centimeter of gas to escape.

HOW EXPENSIVE?

If you are working with critical processes or equipment such as hermetically sealed instruments or glass-to-metal seals required in television camera tube assembly, then you know very slow leaks can be costly. In many of these low-volume, low-pressure applications this mass spectrometer type leak detector is the only instrument sensitive enough for the job.

This instrument is also ideal for less critical work—checking industrial vacuum equipment, high pressure cylinders, compressors moving on an assembly line, valves, welded and soldered joints. Write for Bulletin CEC 1801.

Consolidated Engineering
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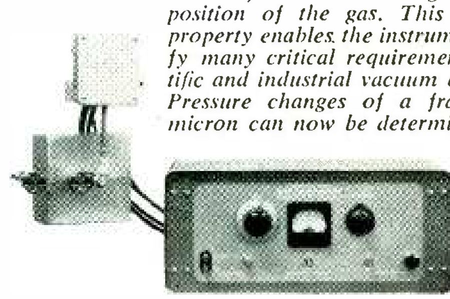
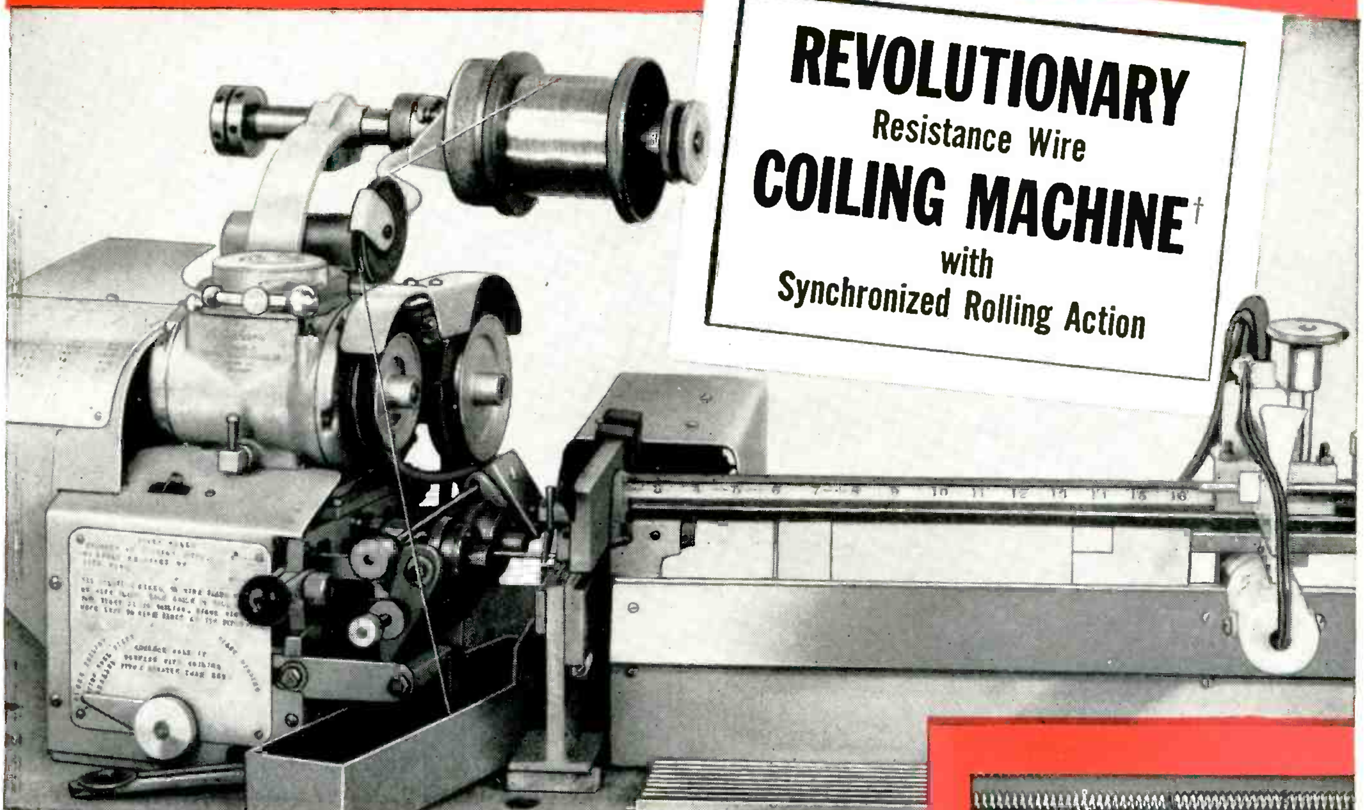
MICROMANOMETER, MODEL 23-105 *provides precise absolute pressure measurements in the micron range (0.1 to 150 microns) without knowledge of the composition of the gas. This remarkable property enables the instrument to satisfy many critical requirements in scientific and industrial vacuum applications. Pressure changes of a fraction of a micron can now be determined.*



DRIVER-HARRIS ANNOUNCES . . .



REVOLUTIONARY Resistance Wire COILING MACHINE† with Synchronized Rolling Action

As producers of the world famous "Nichrome"* and other outstanding electric heating and resistance alloys, Driver-Harris engineers are interested in obtaining application results commensurate with the exceptional advantages their alloys afford. Therefore they have developed a new coiling machine which eliminates wire coiling faults—especially coil irregularity due to work-hardened areas produced during coil formation.

This new machine is the result of knowledge accumulated during forty years of close association with wire coiling problems. Its revolutionary principle of operation—*the synchronized rolling action of all coiling parts*—results in vastly improved performance over that of any other type machine.

Product of long study and a thorough knowledge of the requirements of the industry, this Driver-Harris unit—

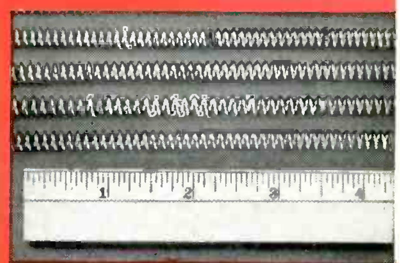
(1) handles the full range of resistance wire coiling normally required, close or open winding (and can be adapted for twin wire coiling);

(2) cuts coil ends clean on all sizes, close or open wound;

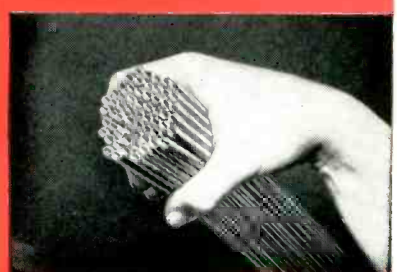
(3) maintains resistance accuracy of cut coils at all times by photo-electric control (variation not exceeding ± 1%);

(4) affords the lowest operational and maintenance costs of any comparable coiling machine.

Standard Model coils #20 to #36 B&S gauge wire. Units for other gauges built to order. Send for illustrated Bulletin C-52, giving full information.



Note even spacing between turns of stretched coils.



Coil ends lie *flat*. No burring or twisting of wire.

*T.M. Reg. U.S. Pat. Off.
†Patent Pending

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

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HARRISON, NEW JERSEY

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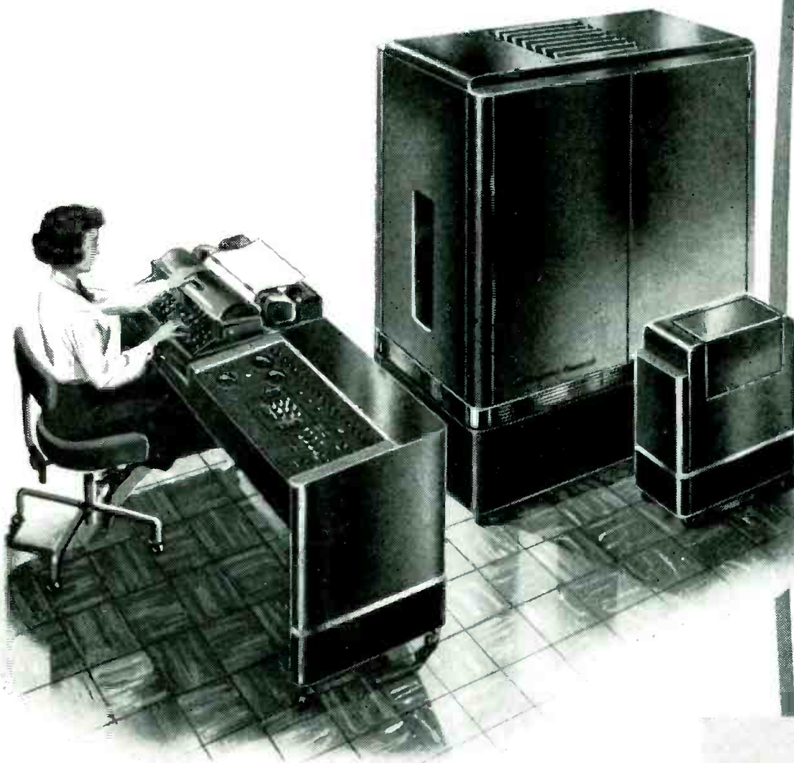
THE NEW

Cadac 102-A

a small, low-cost, electronic digital general purpose computer with 4 important new features



Radically new circuit techniques used in the CADAC 102-A make possible a small, extremely reliable, digital general purpose computer capable of solving any problem that can be put into numerical form. It uses a conventional three-address command with one instruction and three addresses per word, and has a full set of commands—including addition, subtraction, multiplication, division, shift, compare, over-flow, extract, print decimal, print octal, block search, tape read, tape write, card punch, and card read—available for use by the programmer. It is mounted on casters for mobility, and requires no special floor or ceiling installation for either power or ventilation.

The CADAC 102, predecessor of the 102-A recently delivered to the Air Force, has been operated for more than 170 hours over a three month period, with only three machine failures.

We would be happy to send you complete, detailed information and prices on the CADAC 102-A. Simply write to the Director of Applications:

THESE 4 New Features increase its usefulness to the engineer

100,000 word auxiliary magnetic tape memory

A block search magnetic tape auxiliary memory can be used with the CADAC 102-A. This unit is automatically accessible for reading from and writing on magnetic tape which stores 100,000 words. A multiplicity of these magnetic tape units can be coupled to the CADAC 102-A if more than 100,000 words of auxiliary storage is desired. Two commands—"read from" and "write on"—are available to the programmer for auxiliary storage use. A third command "block search" may be used to start a tape unit searching for a specific address on the tape. While searching proceeds, the computer can carry out other commands.

Computer can be filled automatically

A Flexowriter electric typewriter can be used for automatic read in and read out. Standard programs and problems can be stored on paper tape.

Decimal filling and printing

The new input-output number system of the CADAC 102-A enables it to accept and print decimal digits, with programmed conversion to and from binary numbers. The octal number system can still be used for filling and printing if desired.

IBM punched card input-output

Number and command information can be read into the CADAC 102-A from IBM punched cards. Output from the computer can operate an IBM card punch. Both of these operations are automatic upon command of the computer.

NEW LEASING PLAN NOW AVAILABLE

The CADAC 102-A can be purchased outright, or leased with the option to buy any time during the first two years. A complete parts and service warranty, including both preventive and special maintenance will be included with lease if desired.

CRC **Computer Research** CORPORATION OF CALIFORNIA

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ADLAKE RELAYS AT WORK

One of a series of advertisements on specific ADLAKE applications

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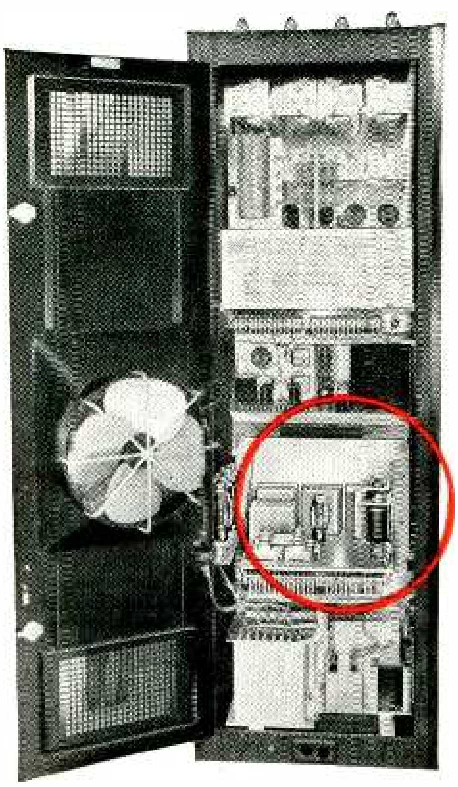
AEROCOM TRANSMITTERS USE

Adlake RELAYS



Model 446, 350 Watt, 4 channel, 6 frequency transmitter (A1, A3), manufactured by Aerocom. Frequency range from 2.5 to 24 Mcs. Stability .003% using CR-18/U crystals. Operates on any stable voltage from 200 to 250 volts, 50/60 cycles, single phase. This transmitter uses three ADLAKE Relays.

When the "ceiling is zero"—when fog, rain or sleet pulls visibility down and runs flying risks up—then aeronautical transmitters must not fail. Their reliability under all conditions makes ADLAKE Mercury Relays the choice of Aerocom, leading electronic manufacturer of 3090 Douglas Road, Miami 33, Florida.

ADLAKE Relays are designed and built to meet the most exacting requirements. Their mercury-to-mercury contact prevents burning, pitting and sticking, and their sturdy construction armors them against outside vibration or impact. And most important of all they require no maintenance, for they are hermetically sealed against dust, dirt and moisture.

Get the full story on the part ADLAKE Relays can play in your business! Write The Adams & Westlake Company, 1107 N. Michigan, Elkhart, Indiana. No obligation, of course.

EVERY ADLAKE RELAY GIVES YOU THESE ADVANTAGES:

HERMETICALLY SEALED—dust, dirt, moisture, oxidation and temperature changes can't interfere with operation.

MERCURY-TO-MERCURY CONTACT—prevents burning, pitting and sticking.

SILENT AND CHATTERLESS   ABSOLUTELY SAFE   REQUIRES NO MAINTENANCE

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Adlake 95th year of serving the transportation and building industries

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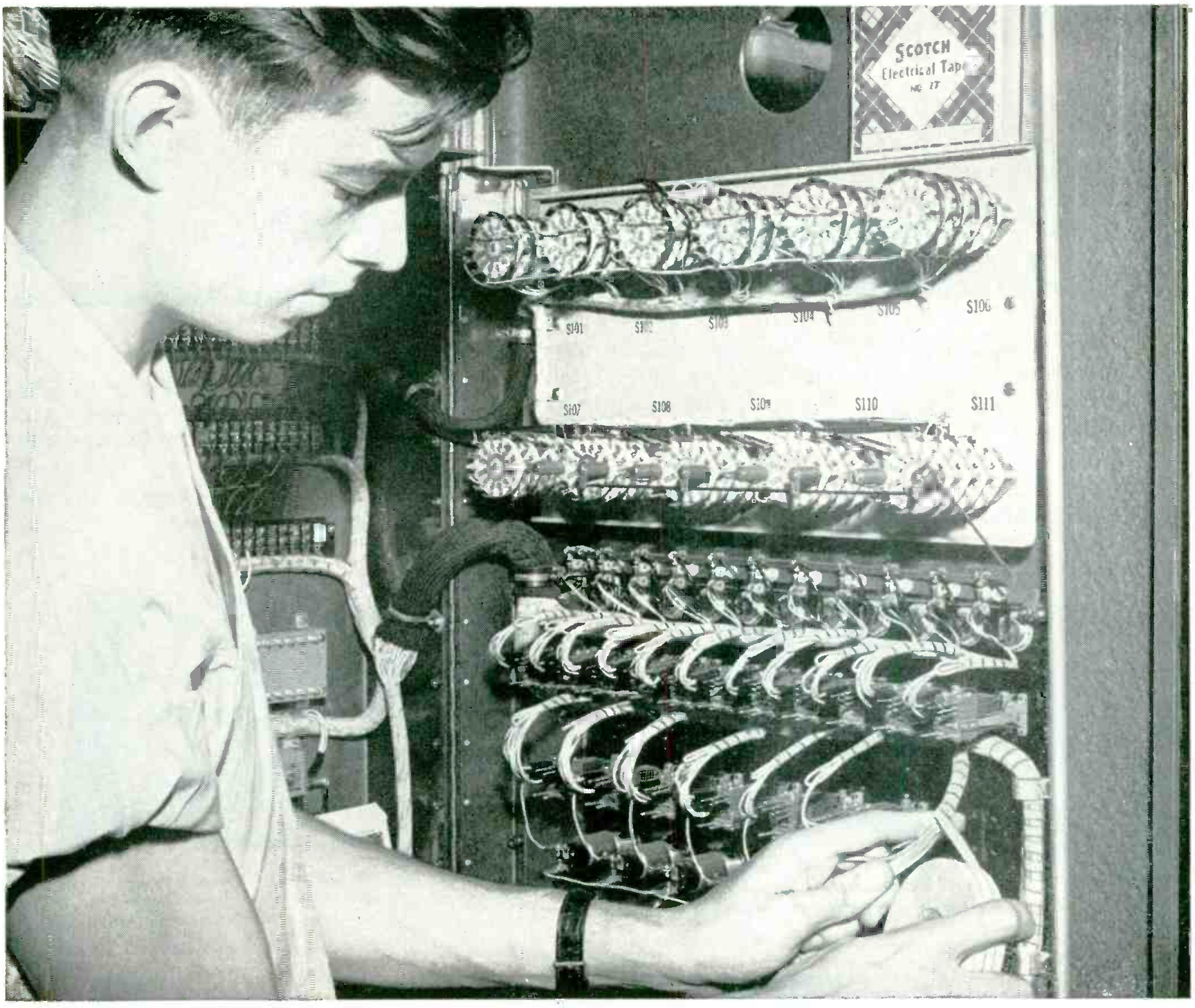
Manufacturers of ADLAKE Hermetically Sealed Mercury Relays



Fungus-resistant plastic tape harnesses wiring on this D.O.

Insulation rot is no problem on this Defense Order at The Austin Company's Special Devices Division, New York, N. Y. "Scotch" Electrical Tape No. 20 meets all military specifications for this special harnessing job—doesn't cause "cold flow" of the plastic jacketed wires like ordinary harnessing materials. And this tough plastic tape resists oil, moisture and acids, too.

Dozens of different "Scotch" Electrical Tapes are now available to help *you* meet D.O. specifications, or to solve practically any insulating or harnessing problem. There are tapes with thermosetting adhesives, high temperature tapes and films; tapes for high frequency insulation—you name it!

For complete information write Minnesota Mining & Mfg. Co., Dept ES-82, St. Paul 6, Minn. Do it today!

CUT 90% OF RADIO AND TV SET SOLDERING WITH

Cut costs! Use Sylvania stamped circuits and dipped solder sockets in your radio and television sets. Eliminate expensive hand-wiring . . . the danger of wrong connections and cold soldering joints.

Sylvania engineers are ready to develop stamped circuits for your TV Tuners and TV IF Amplifiers. Or prepare loop antennas for your radios . . . completely prefabricated panels with stamped wiring, and special sockets and terminals for hot dip soldering for all your electronic equipment. Sylvania socket terminals and components are electrically connected to the circuit in *one single soldering operation!*

For complete details write to: Sylvania Electric Products Inc., Dept. A-1008, Warren, Pa.

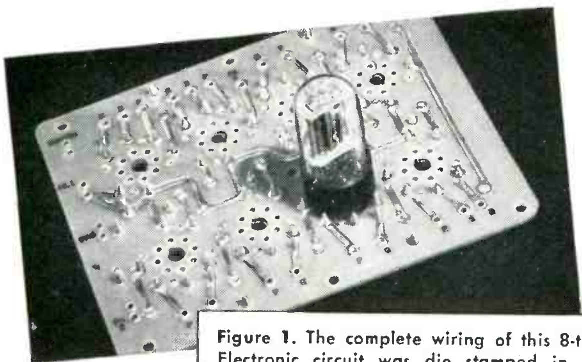


Figure 1. The complete wiring of this 8-tube Electronic circuit was die stamped in one operation. Its 90 connections soldered in another.

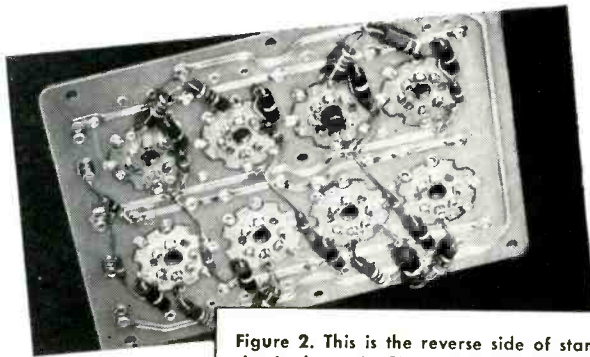


Figure 2. This is the reverse side of stamped circuit shown in figure 1. Both sides of the circuit were stamped in one operation.

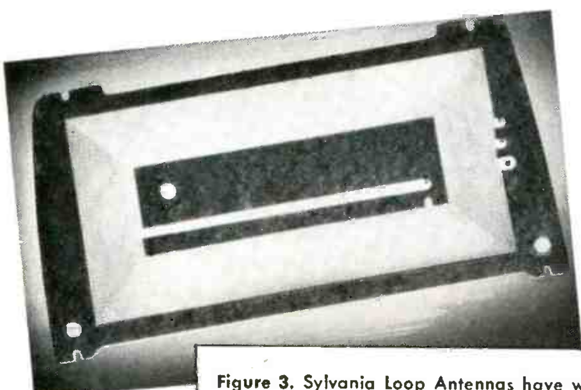


Figure 3. Sylvania Loop Antennas have wide acceptance and are surprisingly low in cost. They assure better reception.

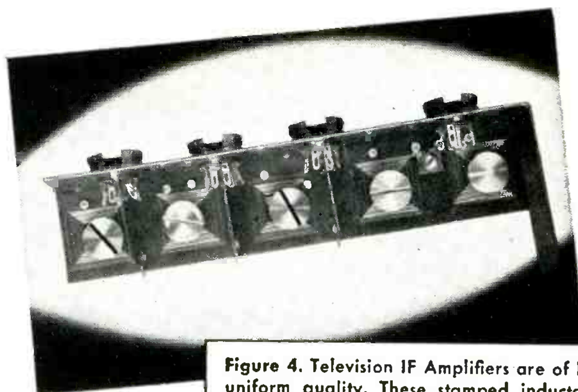


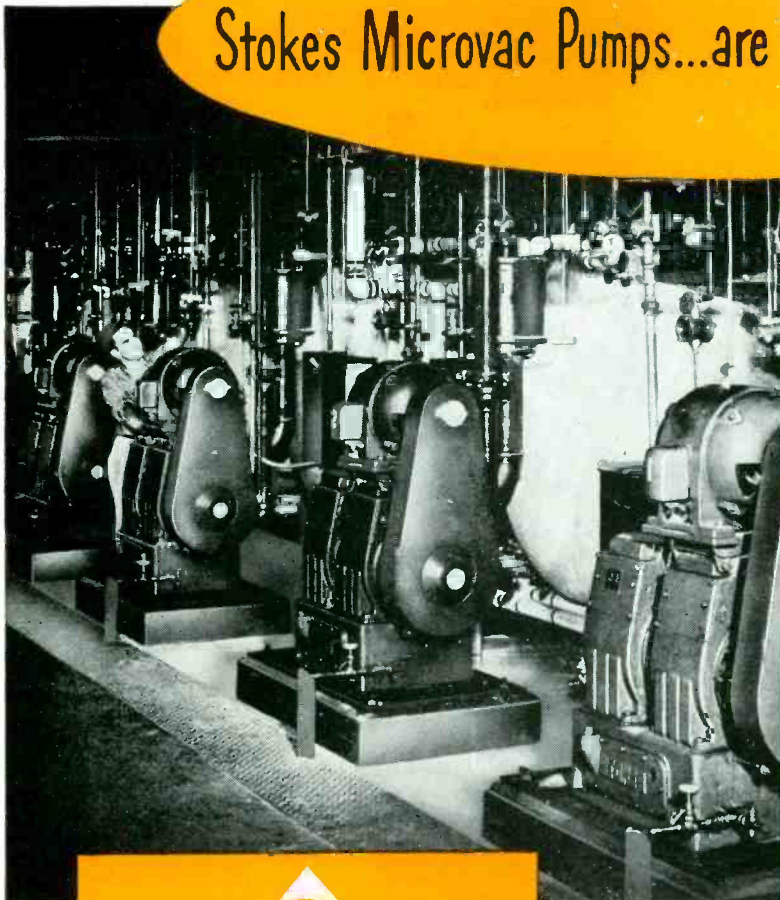
Figure 4. Television IF Amplifiers are of high, uniform quality. These stamped inductances have no variation with heat change, and have a relatively high "Q".

SYLVANIA

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

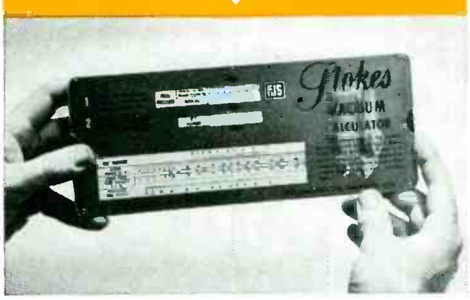
RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC PRODUCTS; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS

Stokes Microvac Pumps...are basic to Vacuum Processing



Typical installation of Stokes Vacuum Pumps.

Send for new Vacuum Calculator for rapid slide-rule calculations. Includes standard ABCD log scale. Also send for Catalog 700, "Stokes Microvac Pumps for High Vacuum" with copious reference material.



High volumetric and mechanical efficiency make these famous pumps economical and reliable units in any vacuum system.

Capacities of Stokes Microvac Pumps run from 15 to 500 cfm . . . pressures to 10 microns absolute. Power consumption is low and the top-mounted motor contributes to compact design requiring minimum floor space.

Lubrication of the four moving parts (including the exhaust valve of corrosion-resistant Teflon) is fully automatic. There are no stuffing-boxes or grease-fittings, and no packing.

Parts are precision-finished, standard and interchangeable. Freedom from wear assures years of trouble-proof service.

Stokes is the only manufacturer of equipment for complete vacuum systems, including Microvac mechanical pumps, oil diffusion pumps, McLeod Gages and Vacuum Valves.

Consult with Stokes on the application of vacuum to rotary exhaust machines, house vacuum systems, vacuum impregnation, vacuum furnaces, vacuum metallizing, and to other purposes for which vacuum deserves exploration.

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Plastics Molding Presses,

Industrial Tabletting

and Powder Metal Presses,

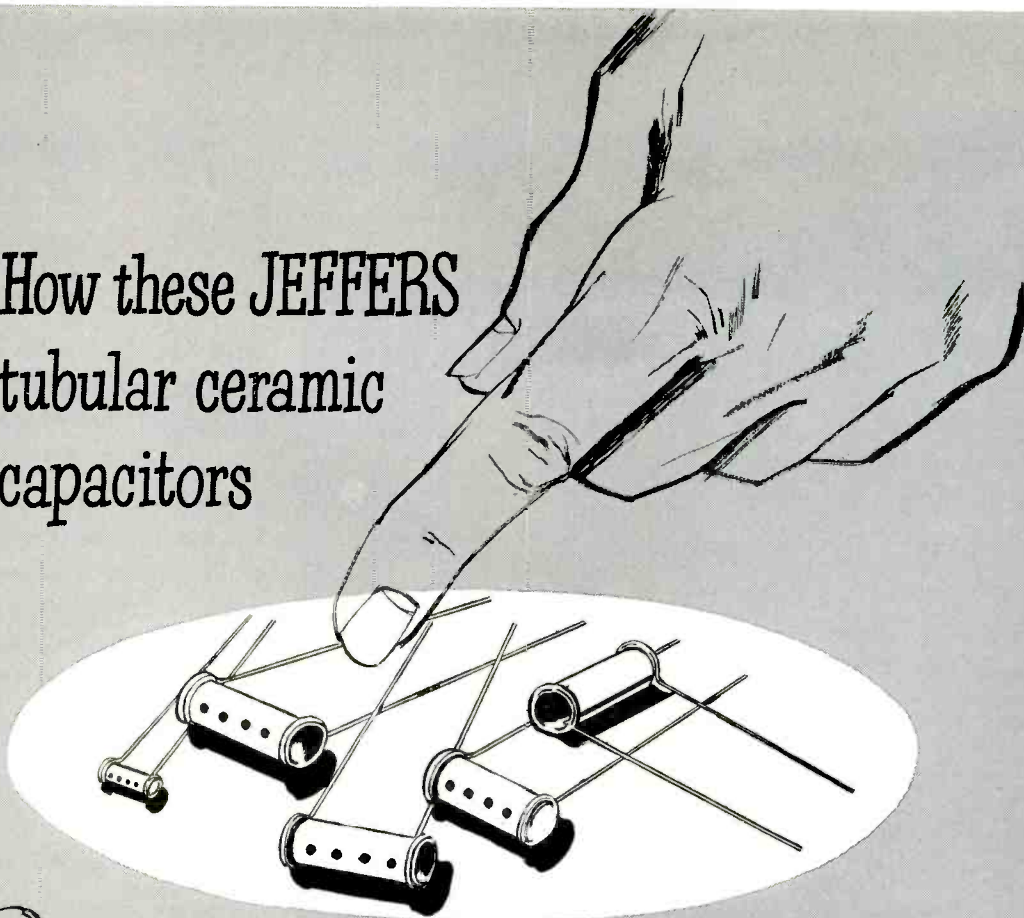
Pharmaceutical Equipment,

Vacuum Processing Equipment,

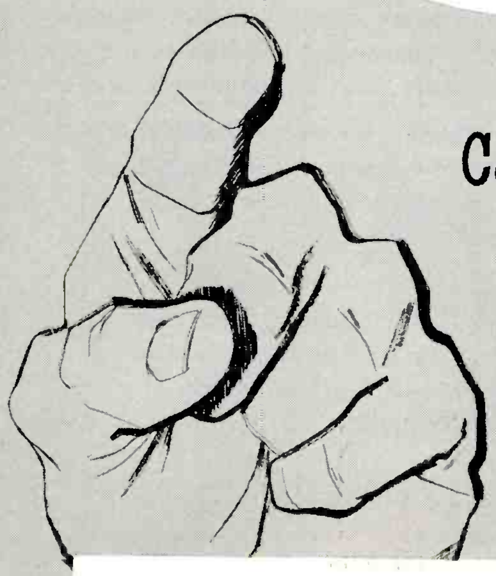
High Vacuum Pumps and Gages,

Special Machinery

F. J. STOKES MACHINE COMPANY, 5547 TABOR ROAD, PHILADELPHIA 20, PA.



How these JEFFERS tubular ceramic capacitors



can help you!

Need reliable tubular ceramic capacitors that will deliver the circuit characteristics you want . . . every time?

If you do, investigate Jeffers capacitors. Hundreds of users have found they can count on these units to give the maximum in efficient performance.

Reason? Their dependability results from unusual care in production. At Jeffers every step of manufacture is conducted in our own plant. Jeffers ceramic experts mix and make their own ceramic materials . . . fire it in their own kilns. Other Jeffers specialists see that molding, testing and inspecting is carried out according to precise specifications.

Couple this care in manufacture with Jeffers well-known ability in electronic design and you can easily see why Jeffers tubular ceramic capacitors are commonly called "best of their line."

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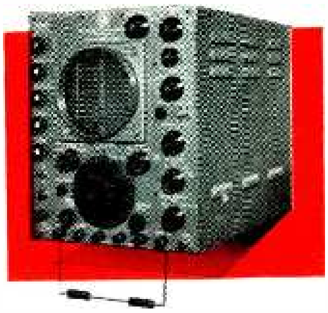
MODEL 401 OSCILLOSCOPE

—a high gain, wide band, versatile, general purpose instrument for precise, quantitative studies of pulse waveforms, transients and other high or low speed electrical phenomena.

For complete information Ask for Bulletin O52



MODEL 101 MAGNETOMETER

Accurately measures magnetic field strength using the principle of nuclear resonance.

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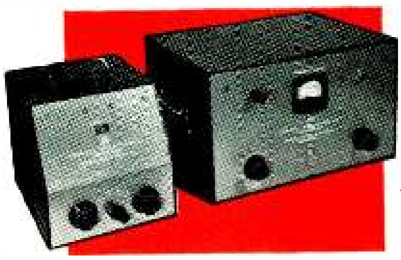


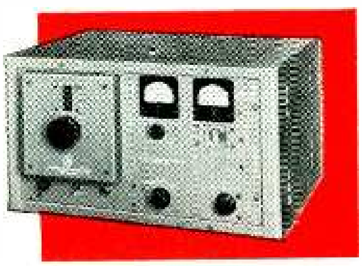
MERCURY DELAY LINES

Used for storage of information, comparison of two sets of information, correlations and sequential timing devices, they are the smallest, most compact lines available.

For complete information Ask for Bulletin MDL51

MODEL 802 STABLE MICROWAVE OSCILLATOR

Provides a highly stable source of microwave signals, suitable for use as a laboratory standard. Features a direct reading frequency dial, sine wave modulation input and self-contained power supply.



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Albuquerque 3-1998

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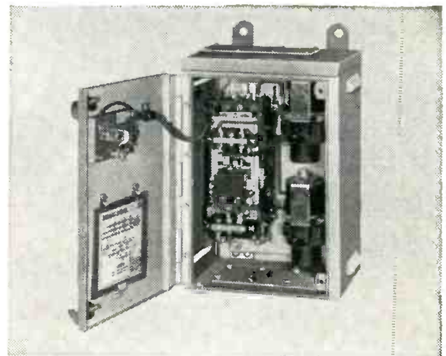
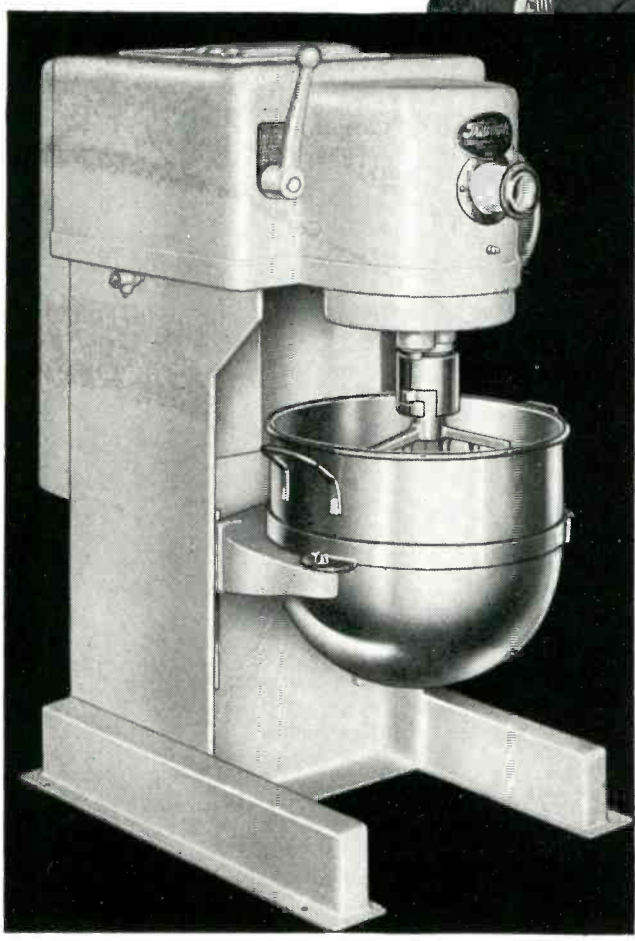
The Triumph Manufacturing Co.

"Galley duty in the Navy requires a motor control as rugged as the machine"

say Sheldon B. Storer (right) and Samuel T. Bryant (left), Sheldon Storer & Associates, Cincinnati, Ohio, representatives, Ward Leonard Electric Company.





This Triumph vertical "kitchen" machine is used by the Navy for everything from mixing dough to cutting French-fried potatoes, grinding coffee, sharpening cutlery.

Such machines are operated by a wide variety of people wherever naval vessels or installations are found and it is essential to keep them in operation with a minimum of down-time.

In order to meet exacting Navy standards, Triumph consulted Ward Leonard for a motor control. Because of their long experience and excellent record in the production and development of Navy controls of many types, Triumph was assured that Ward Leonard could supply them with sturdy, trouble-free equipment which would match the construction of their ruggedly built machines.

The Ward Leonard controllers used by Triumph vary depending on whether the power supply is a-c or d-c. For d-c applications they are Ward Leonard, Bulletin 4556, across-the-line starters, magnetic type, continuous duty, semi-automatic operation with overload and low voltage protection, drip-proof enclosure and spraytight pushbutton station; Bulletin 4651 is the equivalent for a-c applications.

Complete operating and maintenance instruction books were supplied the Navy as a result of the team work of William Leuze, chief engineer of Triumph, and Samuel Bryant of Ward Leonard.

Ward Leonard field engineers are always ready to work with you to solve your electrical control problems. When your production demands exact engineering, quality manufacturing, prompt, efficient handling and shipping, call on Ward Leonard.

WARD LEONARD

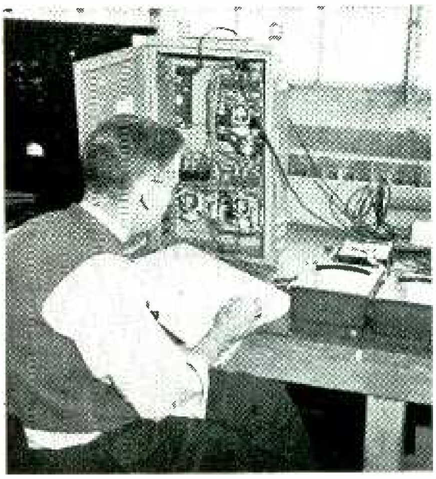
WARD LEONARD ELECTRIC COMPANY

MOUNT VERNON, NEW YORK

Result-Engineered Controls Since 1892

TO INSURE HIGH METAL QUALITY, Frank DePaola, chemist, studies samples microscopically for grain and crystal structure.

MAGNETIC OVERLOAD RELAYS are tested for tripping time by Anthony J. Bellitto before they are installed on motor control panels.



AN A-C MOTOR CONTROLLER undergoes a careful wiring check by Donald A. Parsons of Ward Leonard's Test Department.

COMPONENTS OF A-C SOLENOID STARTERS are being assembled in Ward Leonard's plant in Mount Vernon, New York.

From PT Boats to Battle Wagons — Ward Leonard Designs Controls to Meet Exacting Specifications

At sea, electrical controls or components must meet exacting service conditions involving mechanical shock, vibration, salt spray, plus pitch and roll.

The Ward Leonard control line includes devices designed especially for Navy, Coast Guard and Marine use, as well as the well-known industrial control line. For example, Ward Leonard makes pushbutton stations for the Navy and Marine applications, and a comprehensive line of commercial pushbutton stations. This holds true for a great variety of components.

Ward Leonard frequently builds special control items which involve contactors, starters, rheostats, relays, resistors, and other major electric components.

Ward Leonard controls are of unit construction. Each component is manufactured and tested independently. These components are then combined and mounted to suit customer's exact requirements.

Consult Ward Leonard on the extreme flexibility and adaptability of Ward Leonard controls and components to meet your special needs.

DISTRICT OFFICES AND REPRESENTATIVES

Atlanta 5, Georgia	C. B. Rogers and Associates
Baltimore 18, Md.	Durling Electric Co.
Charlotte 1, N. C.	James L. Highsmith & Co.
Chicago 4, Illinois	Ward Leonard Electric Co.
Cincinnati 2, Ohio	Sheldon Storer and Assoc.
Cleveland 14, Ohio	The Ambos-Jones Co.
Corpus Christi, Texas	Brance-Krachy Co., Inc.
Denver 2, Colorado	Mark G. Mueller
Detroit 21, Michigan	Jesse W. Eakins Co.
Hartford 6, Conn.	Ward Leonard Electric Co.
Houston 1, Texas	Brance-Krachy Co., Inc.
Kansas City 2, Mo.	Maury E. Bettis Co.
Knoxville, Tennessee	John G. Pettyjohn
Los Angeles 13, Calif.	Ward Leonard Electric Co.
Memphis 3, Tenn.	E. E. Torkell
Minneapolis 5, Minn.	Marvin H. Kirkeby
Newark 2, N. J.	Ward Leonard Electric Co.
New Orleans 13, La.	Electron Engineering Co.
Philadephia 2, Pa.	Ward Leonard Electric Co.
Pittsburgh 16, Pa.	W. A. Bittner
Roanoke, Virginia	Lynn H. Morris
Rochester 7, N. Y.	Ward Leonard Electric Co.
St. Louis 10, Mo.	Ward Leonard Electric Co.
Salt Lake City 1, Utah	Leonard M. Slusser
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San Francisco 3, Calif.	L. F. Church Co.
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Winnipeg, Man.	D. M. Fraser, Ltd.

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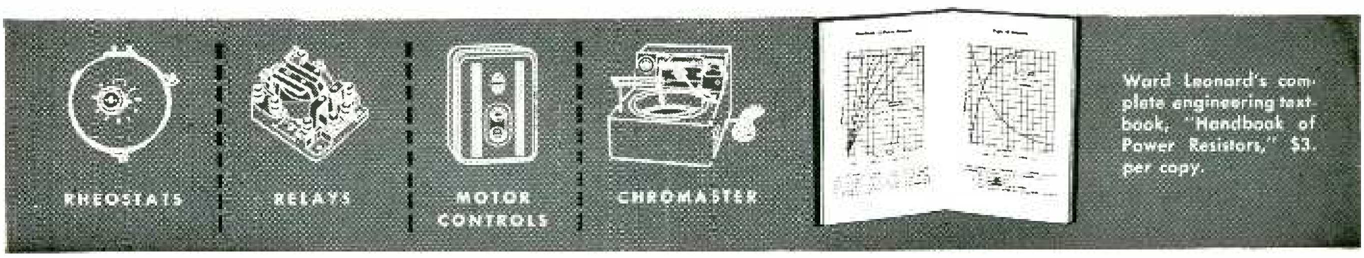


Important News For

ELECTRONIC EQUIPMENT MANUFACTURERS

General Electric offers you Expanded Application Engineering Service

HERE'S a way to improve the design of your radio-phonograph products and beat rising costs—without increasing your overhead.

The extensive research and engineering facilities of Electronics Park are yours to call upon for consultation or help in the following fields:

CARTRIDGES AND STYLI—G-E single and dual units, diamond or sapphire*-tipped for every recording or broadcast application, can be suited to your product requirements. The startlingly different G-E "Golden Treasure" cartridge, now in quantity production, features a dual wide-range diamond and sapphire stylus that reproduces an exceptional tone range of 30 to 15,000 cycles. Stylus pressure for *all* types of records is low—only 6 to 8 grams.

LOUDSPEAKERS—Choose from 19 G-E types sized from 4 to 12 inches. These include 6 sizes of round speakers, plus a special 6 x 9 oval for auto radio use. Remember too, that *the G-E 1201 and 1203 are the only high fidelity speakers commercially available in production quantities at moderate prices.* Of course, all G-E speakers have Alnico 5 magnets and the aluminum voice coil.

Our application engineers are prepared to discuss with your designers ways in which G. E. can be of service to you. Just phone or wire us. Meanwhile, check the coupon below for latest catalogs listing audio components.

**Some sapphires are synthetic.*

GENERAL ELECTRIC

General Electric Company, Section 482
Electronics Park, Syracuse, New York

Please send me the General Electric catalogs or bulletins checked.

☐ Phono Accessory Catalog ☐ Loudspeaker Catalog ☐ New Wide-Range Stylus Bulletin

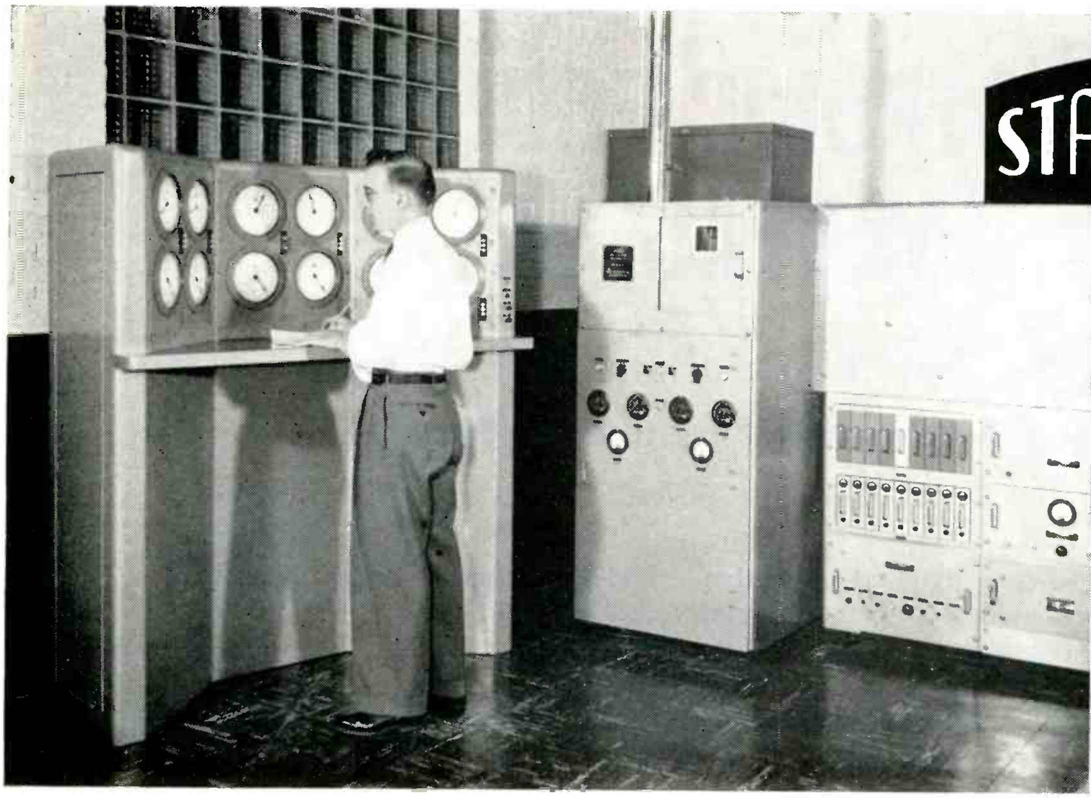
NAME..

COMPANY OR TITLE..

ADDRESS..

CITY.............................STATE....................

Time and Time Again...



STANDARD

SINCE 1884

The Direct Reader shown was made by Baird Associates and includes Precision Timers by Standard.

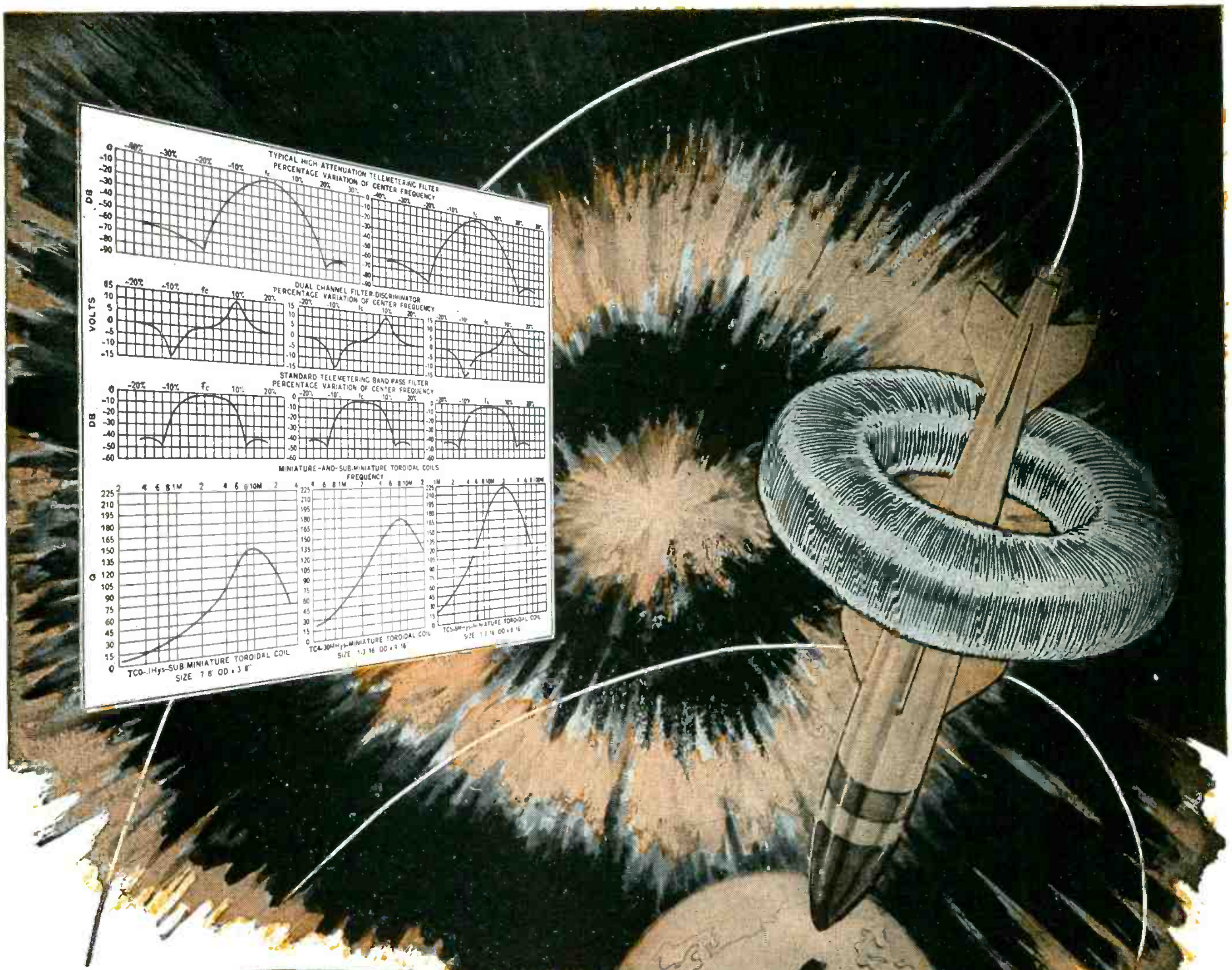
STANDARD ELECTRIC TIME Helps Attain High Degree of Quality Control at AMERICAN BRASS

SPLITTING the split second is often essential . . . Hours, days are cut to a mere 300 seconds at The American Brass Company, Waterbury, Conn. . . . where this Direct Reading Spectrometer completely analyzes an electric furnace charge of molten metal before it is even poured.

THE STANDARD ELECTRIC TIME COMPANY

97 LOGAN STREET • SPRINGFIELD 2, MASSACHUSETTS

PRECISION TIMERS • CHRONO-TACHOMETERS • LABORATORY PANELS • PIPELINE NETWORK ANALYZERS



On Target!

THE TERM "GUIDED MISSILE" TO THE UNINITIATED USUALLY INDICATES AN AIRBORNE PILOTLESS PLANE DEVICE. HOWEVER, TO THE WELL INFORMED, THIS CONNOTES MANY OTHER POSSIBLE FORMS OF MISSILES; SOME OF WHICH ARE PHYSICAL REALITIES AND SOME DRAWING BOARD PROJECTS.

NOT ALL OF THESE "CONTROLLED FLIGHT" DEVICES HAVE SPECIFIC USES AS ATTACK MISSILES. MANY ARE VALUABLE RESEARCH AIDS IN THE ANALYSIS OF THE BEHAVIOUR OF AIRCRAFT UNDER EXTREME OPERATING CONDITIONS. (TELEMETERING).

THE ENGINEERS WHO DESIGN THE CONTROL APPARATUS FOR MISSILES KNOW THAT IN ORDER TO ANTICIPATE THEIR EXACT BEHAVIOUR EVERY TIME AND THE SELECTIVE CIRCUITS AND FILTERS USED MUST BE UP TO THE HIGH STANDARDS OF PERFORMANCE FOR WHICH BURNELL'S TOROIDS AND FILTERS ARE SO WELL KNOWN.

THE NATURAL RESULT OF THIS REPUTATION IS THAT MANY THOUSANDS OF OUR PRODUCTS ARE IN SOME WAY PLAYING THEIR PART IN KEEPING THE MILITARY ELECTRONIC PROGRAM "ON TARGET."

EXCLUSIVE MANUFACTURERS OF COMMUNICATIONS NETWORK COMPONENTS

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

TDAF

TWO IMPROVED TYPES of Synchronous Motor Driven TIME DELAY TIMERS for Industrial Applications

Time Delay Timers are designed for application on circuit controls where a time delay is required between the closing of one circuit and the predetermined closing or opening of another.

Series TDAF and Series TDAB Time Delay Timers are built to stand abuse, and afford the dependable, consistent operation which modern industrial applications demand.

These timers are designed to handle time cycles up to 3 hours. They employ an external, magnetically-operated clutch that not only assures exceptional accuracy but permits *instantaneous,* automatic reset. Thus these timers are ideal for use where rapid recycling is necessary.

TDAB

OUTSTANDING FEATURES

Automatic, Instant Reset—As soon as the clutch is disengaged, an internal spring brings the actuating arm back to its reset position in a fraction of a second.

Time Setting Adjustment—Adjustment is accomplished by simply moving the black-button pointer to the time cycle required. Quick, easy, accurate.

Dial—Dials of both series have large, easily read numerals.

SERIES TDAF TIMERS

for panel mounting. Terminal strip for electrical connections located at back. 115 volt and 220 volt, A.C.—25, 50, and 60 cycles. (For time ranges, see chart.)

SERIES TDAB TIMERS

for surface mounting. Terminal strip for electrical connections located at front, below dial. If required, can be supplied in steel housing, as illustrated—eight knockouts for easy hook-up. 115 volt and 220 volt, A.C.—25, 50 and 60 cycles. (For time ranges, see chart.)

TDAB (in case)

TIME RANGES—Series TDAF and Series TDAB Timers

DIAL CALIBRATION	MAXIMUM TIME CYCLE
1/10 Second	5 Seconds
1/4 Second	15 Seconds
1/2 Second	30 Seconds
1 Second	60 Seconds
2 Seconds	3 Minutes
5 Seconds	5 Minutes
15 Seconds	15 Minutes
30 Seconds	30 Minutes
60 Seconds	60 Minutes
2 Minutes	3 Hours

For complete technical data request bulletin 39

MANUFACTURERS OF THESE AND OTHER TIMERS AND CONTROLS FOR INDUSTRY—Cam Timers • Manual Set Timers • Tandem Automatic Recycling Timers • Instantaneous Reset Timers • Running Time Meters

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION
115 EDISON PLACE, NEWARK 5, N. J.

When it comes to making a *Real Saving* in space...

Stackpole cup cores with their self-shielding characteristic can be mounted close to the chassis or any other metal part for maximum results in extremely close quarters. In some instances, the high Q circuits made possible through their use permit reduction in the number of tubes needed.

Standard types include numerous shapes and sizes, each available in a wide range of permeability possibilities. Highly specialized types to meet the most critical specifications can be engineered and produced from a broad background of experience in this exacting field.

Electronic Components Division

STACKPOLE CARBON COMPANY

St. Marys, Pa.

STACKPOLE *Cup Cores*

Other Stackpole core types include:

ALL STANDARD MOLDED IRON CORE TYPES, SIDE-MOLDED, CHOKE COIL CORES, SLEEVE TYPES, THREADED TYPES and COIL FORMS . . . also Stackpole CERAMAG® CORES (FERRITES).

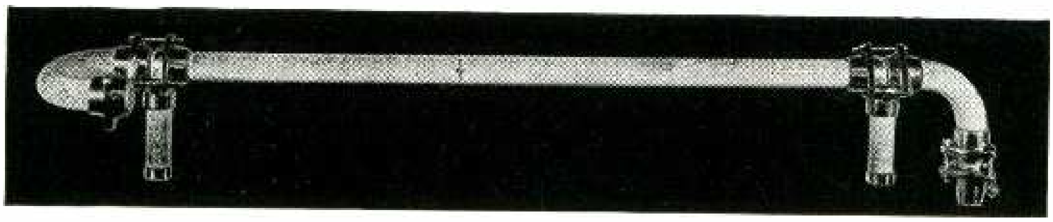
Write for Electronic Components Catalog RC-8

for INSULATING WATER SYSTEMS

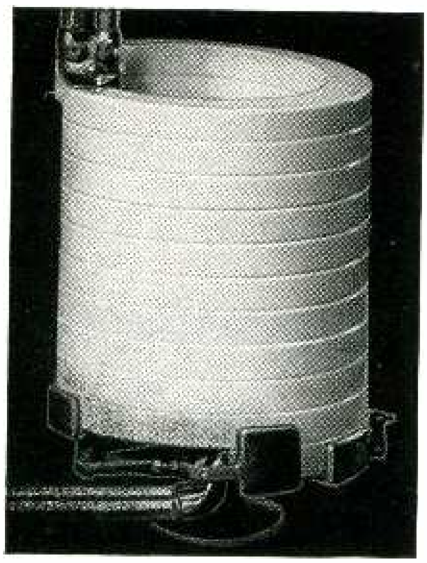
for cooling High-Power Electron Tubes

For insulating the water system for water-cooled tubes, use of Lapp porcelain obviates troubles arising from water contamination and conductivity, sludging, and electrolytic attack of fittings.

Lapp porcelain, in pipe, coils and fittings is a completely vitrified, non-porous ceramic, non-deteriorating and chemically inert. It assures permanent cleanness and high resistance of cooling water, eliminates need for frequent inspection, changing of water or failure of the water system, provides positive cooling for long tube life.



LAPP PORCELAIN PIPE Inside pipe diameters of ¾, 1, 1¼, 1½, 2 and 3″. Available in straight pipe up to 60″ lengths, 90° and 180° elbows, and fittings. All connections are swivel-type. Stand off insulators attach directly to bolts which hold pipe sections together. Metal fittings are bronze, polished heavy chrome plated.



LAPP PORCELAIN WATER COILS

Twin hole coils with inside pipe diameters ¼, ¾, 1″. Single hole coils with inside pipe diameters ⅜, 1¼, 1½″. Provide for flow of cooling water from 2 to 90 gal. per min. Coils provided with cast aluminum mounting bases, fittings, and three-foot sections of lead pipe for attachment to coil terminals.

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

Lapp

SORENSEN *electronically*

REGULATES AND CONTROLS

FREQUENCY

LOW VOLTAGE DC HIGH CURRENT

HIGH VOLTAGE DC LOW CURRENT

AC LINE

Model 2000S

SORENSEN ISOTRONIC AC LINE REGULATORS ARE YOUR BEST CHOICE FOR PERFORMANCE PLUS ECONOMY

The man who uses instruments likes Sorensen AC Line Regulators because of regulation accuracy, clean waveform, insensitivity to frequency fluctuation, load range.

The man who maintains instruments likes Sorensen AC Line Regulators because of circuit simplicity, conservatively rated tubes (only 3 in all), built-in ability to deliver trouble-free performance for months on end.

The man who pays for instruments likes Sorensen AC Line Regulators because of reasonable price and the fact that there are no extras for installation and special wiring.

The man who designs instruments likes Sorensen AC Line Regulators because they are ideal for incorporation as reliable components.

ELECTRICAL SPECIFICATIONS

Models available (numbers indicate VA capacities)		
	Input	95-130 VAC, 1ϕ, 50-60~; 190-260 VAC in "-2S" models
	Output	115 VAC ±5%; 230 VAC in "-2S" models
150S 250S 500S (-2S also) 1000S (-2S also) 2000S 3000S (-2S also) 5000S (-2S also) 10000S (-2S also) 15000-2S	Regulation accuracy	±0.1% against line or load
	Distortion	2% - 3% maximum
	P. F. range	Down to 0.7
	Load range	0 to full load
	Miscellaneous	Models 150S, 250S, 500S, 1000S, 5000S, 10000S, and 15000-2S are self-contained. Cabinets available for others.
1001	Regulation accuracy 0.01%, load range 0 - 1000 VA, output 115 VAC ±5%, other characteristics similar to those given above.	

OTHER SORENSEN ISOTRONIC PRODUCTS INCLUDE:

NOBATRONS (low-voltage, high-current DC Supplies)

B-NOBATRONS (high-voltage, low-current DC Supplies)

NOBATRON-RANGERS (full-range-variable DC Supplies)

FREQUENCY CHANGERS

SATURABLE CORE REACTORS

VARIABLE AUTO-TRANSFORMERS

* ISOTRONIC=Regulation and control of voltage, current, power, and frequency by electronic means.

SPECIFY SORENSEN

For Complete Information Write

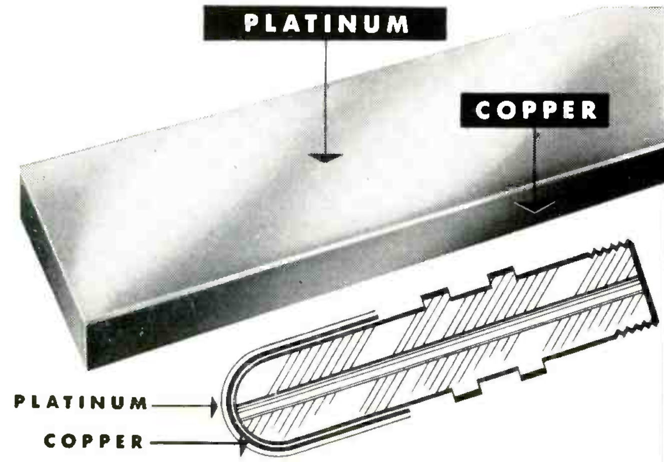
SORENSEN & COMPANY, INC.
375 Fairfield Avenue Stamford, Conn.

PROBLEMS:

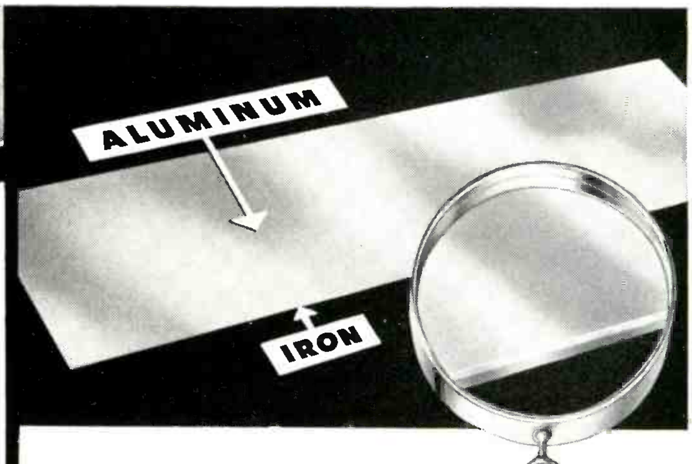
Reduce Costs, Replace Scarce Metals, Get Higher Performance, Simplify Brazing

GENERAL PLATE

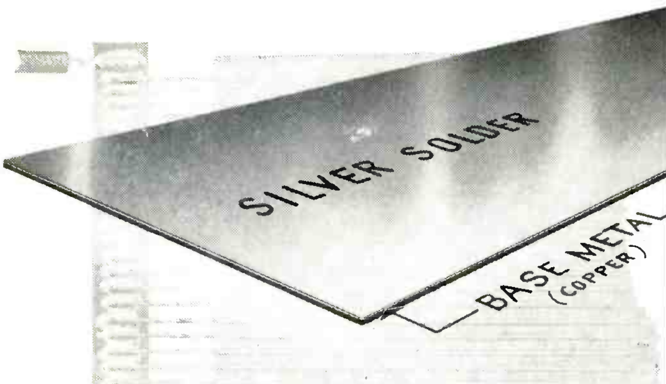
Provided Solutions with Composite Metals



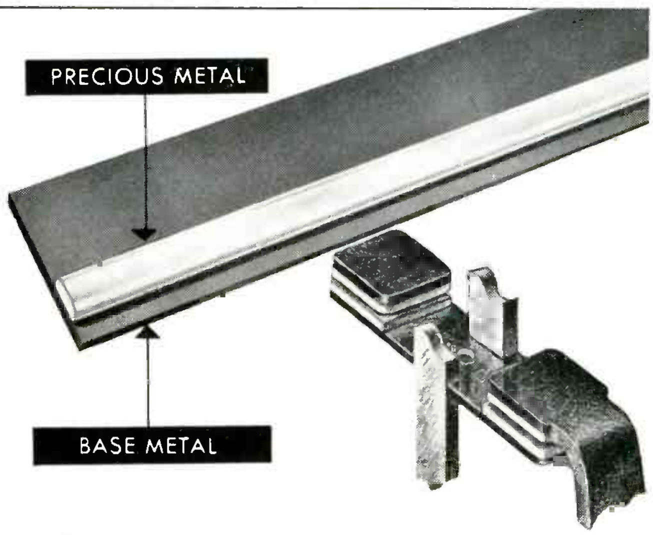
General Plate reduced high platinum cost in an electrode with platinum clad to copper.



General Plate replaced critical nickle in radio tube parts with ALFER®.



General Plate "Solder-Clad" metal simplified contact brazing of multiple leads from a screen.



General Plate provided higher performance and longer wearing qualities in contact assemblies with TOP-LAY.

Manufacturers of many products ranging from circuit breakers, radio tubes, temperature controls, electrical terminal conductors to carbide tipped tools have found the solution to their problems with General Plate Composite Metals.

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

General Plate products include... precious metals clad to base metals, base metals clad to base metals, silver solders, composite contacts, buttons and rivets, Truflex® thermostat metals, Alcuplate®, platinum fabrication and refining, #720 manganese age-hardenable-alloy. Write for information.

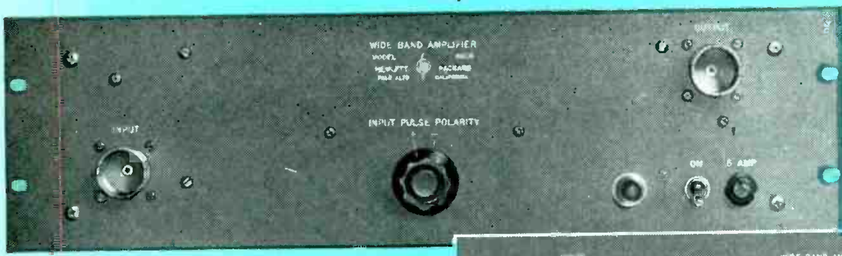
Have You a Composite Metal Problem?
General Plate can solve it for you

GENERAL PLATE

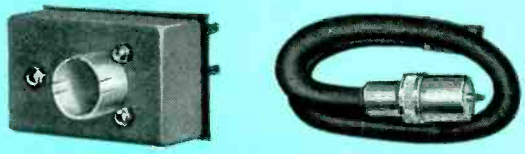
Division of Metals & Controls Corporation

38 FOREST STREET, ATTLEBORO, MASS.

COMPLETE, WIDE-BAND INSTRUMENTATION FOR DISTORTION-FREE, FAST-PULSE MEASUREMENT!



New -hp- 460B Fast-Pulse Amplifier



-hp- 46A Connectors and Accessories

-hp- 460A Wide-Band Amplifier

SPECIFICATIONS

–hp– 460B FAST PULSE AMPLIFIER

FREQUENCY RESPONSE: Closely matches Gaussian curve. Hf 3 db point is approx. 140 mc. Lf 3 db point is approx. 50 kc into 200-ohm load.
MAXIMUM OUTPUT VOLTAGE: High bias, approx. 125 v. negative open circuit. Normal bias (linear amplification) approx. 8 v. peak into 200-ohm load or 16 v. peak open circuit, pos. or neg. pulses.
GAIN: Approx. 15 db into 200-ohm load.
INPUT IMPEDANCE: Approx. 200 ohms.
RISE TIME: Approx. 0.0026 μsec.
DELAY: Approx. 0.016 μsec.
DUTY CYCLE: 0.10 max. for 125 v. output pulse.
LINEARITY PULSE OPERATION: See Figure 1.
MOUNTING: Relay rack. 5¼" x 19". 6" deep.
POWER SUPPLY: 115 v. 50/60 cps. 35 watts.
PRICE: $225.00 f.o.b. factory.

–hp– 460A WIDE-BAND AMPLIFIER

(Specifications same as Model 460B except:)
MAXIMUM OUTPUT VOLTAGE: Approx. 8 v. peak open circuit; 4.75 v. peak into 200-ohm load.
GAIN: Approx. 20 db with 200-ohm load.
DELAY: Approx. 0.012 μsec.
PRICE: $185.00 f.o.b. factory.

–hp– 46A ACCESSORIES

–hp– **46A-16A PATCH CORD** – 200-ohms, 2' long. $18.50.
–hp– **46A-16B PATCH CORD** – 200-ohms, 6' long. $25.50.
–hp– **46A-95A PANEL JACK**—For 200-ohm cables, low capacitance. 1⅛" dia. $7.50.
–hp– **46A-95B CABLE PLUG**—For 200-ohm cables, low capacitance. $7.50.
–hp– **812-52 CABLE**—200-ohm cable in lengths to specification. Per foot $1.75.
–hp– **46A-95C 50-OHM ADAPTOR** – Type N connector for coupling 50-ohm line into –hp– amplifiers. $15.00.
–hp– **46A-95D ADAPTOR**—Bayonet sleeve for connecting –hp– 410A VTVM to output of 460A/B amplifiers. $15.00.
–hp– **46A-95E CONNECTOR SLEEVE**—Joins two 46A-95B CABLE PLUGS. $7.50.
–hp– **46A-95F ADAPTOR**—For connecting to 5XP CRT. $10.00.
–hp– **46A-95G ADAPTOR**—For connecting to Tektronix type 511 oscilloscope. $12.50.
Data subject to change without notice.

UP TO 90 DB GAIN IN CASCADE! AMPLIFIES MILLI-MICROSECOND PULSES! RISE TIME .0026 μSEC! 125-VOLT OPEN-CIRCUIT OUTPUT! GIVES OVER 100 MC BANDWIDTH TO YOUR STANDARD OSCILLOSCOPE!

Here at last is complete instrumentation for true amplification of fast pulses at high power levels sufficient to operate scalers or counting meters, cathode ray tubes, or to give more than 100 mc band-width to your present oscilloscope. New *–hp–* 460B Fast-Pulse Amplifiers, in cascade with *–hp–* 460A Wide-Band Amplifiers, amplify up to 125 volts, open circuit (limited duty cycle). This permits full deflection of 5XP cathode ray tubes, or 2-inch deflection of 5CP tubes. Ultra-short rise time of 0.0026 μsec, combined with zero overshoot, insures distortion-free amplification of pulses faster than 0.01 μsec.

New *–hp–* 460B Amplifier, cascaded with *–hp–* 460A provides linear amplification of 16 volts peak output and pulse amplification of 125 volts output (slight non-linearity). This combination provides maximum usefulness in fast-pulse study for nuclear radiation work, television or VHF research; for increasing frequency range of your oscilloscope, or general wide-band laboratory amplification. In addition to the above instrumentation, *–hp–* also offers series 46A accessories—a complete set of 200 ohm cables, adapters and fittings for inter-connecting amplifiers or patching to oscilloscopes.

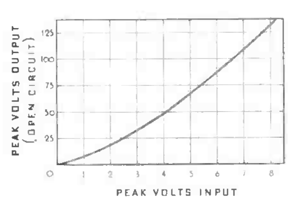


Fig. 1: Linearity of -hp- 460B Fast-Pulse Amplifier

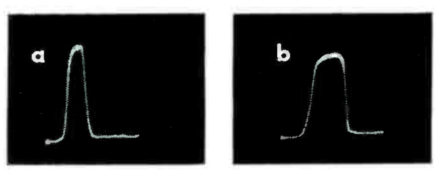


Fig. 2: (a) 0.01 μsec pulse through -hp- 460B Amplifier (b) 0.02 μsec pulse through 3 amplifiers in cascade

Get complete details. Write direct or see your -hp- sales representative.

HEWLETT-PACKARD COMPANY
2177A Page Mill Road • Palo Alto, California, U.S.A.
Sales Representatives in all principal cities
Export: Frazar & Hansen, Ltd., San Francisco, New York, Los Angeles

HEWLETT-PACKARD hp INSTRUMENTS

MALLORY electrolytic capacitors

JAN C-62 types

For use in military electronic equipment, Mallory manufactures a line of electrolytic capacitors which will meet the requirements of Specification JAN C-62. Included in the Mallory line is the full selection of standard case styles, ratings and characteristics required under the specification.

Into these military-type capacitors go the same engineering know-how and production craftsmanship which have made Mallory capacitors the standard of quality in the radio and television industry.

Look to Mallory for all your capacitor needs . . . whether for military or for civilian applications.

New Folder Outlines JAN Capacitor Types

A new folder, available on request, condenses the information on type designations of all electrolytic capacitors covered by JAN C-62, to convenient, easy-to-read chart form. It's an ideal reference for everyone who specifies or uses electrolytic capacitors. Write to Mallory for your copy today.

P.R. MALLORY & CO. Inc.
MALLORY

SERVING INDUSTRY WITH THESE PRODUCTS:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Dry Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

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

CROSS TALK

▶ **TREND** . . . Continued sluggishness of government orders is causing many manufacturers to reexamine their civilian-market prospects. Recent easing of material restrictions permits increased production. It may be, therefore, that moving merchandise rather than building it will be the major problem for the balance of the year.

One way to move merchandise is to increase sales pressure. Another is to bring merchandise within the reach of more people by simplifying design and thus reducing price. And there are signs that the second method is being widely considered along with the first, which puts the engineer right in the driver's seat along with the salesman.

Commercial radar units stripped down to bare essentials have been announced. Computers that won't put out the cat but will perform a few important functions are coming along. In the test-equipment field, particularly, examples of simplified design have been seen in many a back room.

▶ **WORDS** . . . Wiring may be printed, etched, stamped or deposited in a variety of ways. Component parts used in conjunction with such wiring may be similarly fabricated or may be of conventional construction. Combinations of wiring and parts are frequently called printed circuits, and this phrase obviously leaves much to be desired in the way of precise description.

Wiring alone can be readily identified by using the proper adjective telling how it is made, or the whole new group of machine-made wiring boards, panels or chassis could be classified as "mechanized" wiring. But when parts as well as wires are involved the phrase "mechanized circuits" falls short of ideal. For one thing, conventional wiring or cabling and parts can be combined by mechanical means, solder dipping or other automatic assembly methods. For another, some embedment processes are mechanized circuits in a sense.

What should we call printed circuits when they are not actually printed?

▶ **COLOR** . . . Several engineers engaged in a high-echelon study of television recently had their eyes tested and turned out to be color blind. This brings up a number of questions that will have to be answered before polychrome pictures progress much farther.

Will men designing transmitters and receivers have to take tests similar to those given railroad engineers? Will factory people on final test periodically sort out bits of colored yarn and pretty beads? Will thousands of servicemen suddenly find themselves occupationally handicapped because they don't know mauve from magenta? And what about the consumer whose specs are not color corrected?

We're going to rush right out and get a checkup. We need new cheaters because of the increasing demands of our own occupation anyway.

▶ **WEDDING** . . . Motor-generator sets scarcely classify as electronic devices but when they are used to heat metals by induction then they are at least a bridesmaid.

The link is very close indeed in experimental units now being designed for the machine-tool industry. Here m-g sets turning out 9,600-cycle power are first used to preheat parts and then tube-powered generators delivering 200-kilocycle power finish up the job.

In this application it is hard to tell which is the bridesmaid and which is the bride, a not uncommon condition in our field since electronics works so closely with so many other things.

▶ **ACHIEVEMENT** . . . Transistors have definitely arrived. If anyone needs any proof it is afforded by the fact that the little germanium jiggers were recently mentioned by *Chris Welkin, Planeteer*, nationally syndicated comic-strip scientist.

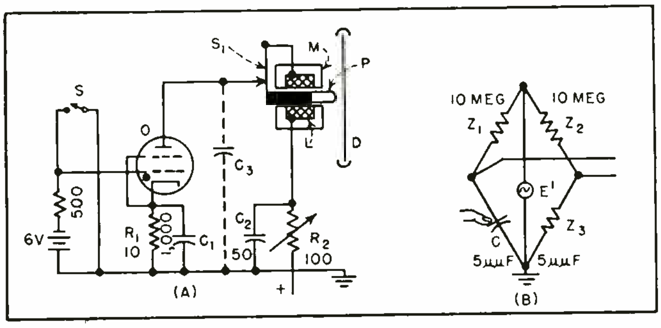


FIG. 1—Simple circuit diagram for thyratron-controlled electromagnetic system (A) and grid control via hand-capacitance bridge (B)

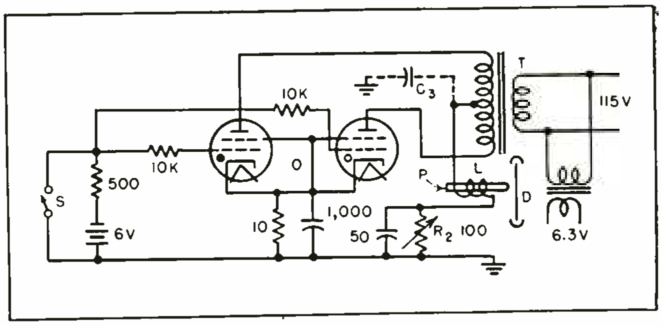


FIG. 2—Practical direct a-c type thyratron circuit free from mechanical contacts. Thyratrons are connected in push-pull arrangement

Electronic Drums

Tube-timed drums can develop much higher beat rates, with beats having more abrupt acoustical wavefronts than can be generated conventionally. Volleys of beats can be repeated indefinitely with precision and without change in quality

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Two ways of using a solenoid-actuated plunger to obtain drum beats have been developed.* One system uses contacts on a plunger with a single thyratron. The other uses a pair of thyratrons without plunger contacts. A coder can repeat a volley of drum hits.

Several techniques are possible for the input circuits. With the system shown in Fig. 1A, the performer uses one, two or three fingers to operate a feather-light contact spring *S* to generate voltage pulses. The pulses operate the output stage *O* driving the electromagnetic system *LMP*. Finger operation, although effortless in terms of the driving power of the spring contact *S*, is just as tiresome in the long run as the conventional, manual drum-stick operation.

Figure 1B shows a hand-capacitance bridge $CZ_1Z_2Z_3E'$ used to eliminate the work represented by the driving power of the spring. Moving one or more fingers in the air causes unbalance of the bridge and a pulse output to be improved by pulse-shaping networks.

While 60-cycle operation of the bridge is possible with the impedances Z_1Z_2 resistive and Z_3 capacitive, better results have been obtained with 400-cycle operation and phase compensation.

Pulse Forming

The main problem in electronic operation of a drum lies in the forming of proper pulse-power output and the utilization of this output under high-efficiency conditions in an oscillating electromechanical system of required transient response. This response should be characterized by short rise and decay time and freedom from jitter, overshoot and multiple hits.

There are two reasons for multiple hits on single pulses generated via the switch *S*. One consists of undesirable transient response and the other of power-supply pulsations when a-c or poorly filtered d-c is used.

The first experimental model built consisted of a class-C, push-pull beam-tube circuit, which was discarded because of insufficient output. The second model at first utilized one thyratron tube (2050 or 2D21) in the circuit shown in Fig. 1 and yielded good efficiency and sufficient output. In the accompanying photograph, the electromagnetic moving system can be seen on top of the drum (it may be mounted inside the drum) and the electronic circuit chassis on the bottom of the U-shaped wooden rack, serving as support and transport case.

The electromechanical system in Fig. 1A consists of a solenoid *L* surrounded by a bell-shaped laminated iron yoke *M* of about two inches axial length, inside which a plunger or laminated slug *P*, moves axially. The design is similar to that of a hypothetical field-coil-operated electrodynamic loudspeaker in which the center, cylindrical core would be free to move back and forth in axial direction, sliding in the concentric air gaps of the ends of the cylindrical core.

* U. S. Patent Appl. Nr. 191,550.

Operator playing the electronic drum. The electromagnetic system is mounted above the drum diaphragm

The black part of the slug in Fig. 1A is laminated iron, the white part is a brass extension carrying the glove-skin-covered button that hits the diaphragm or drum skin D. The stroke is approximately ½ inch. The slug P is spring-loaded away from the drum skin D and just prior to the hit it breaks the contact S_1, thus discontinuing the thyratron plate current.

Since the cathode potential restoration is determined by the time constants R_1C_1, R_2C_2 and that of the moving system with the capacitor C_3, and since the contact S is only closed a few hundredths of a second, the thyratron will not fire again when the slug approaches its rest position away from the drum skin. The design should be such that one complete cycle of operation has a period shorter than the interval between two sequential pulses on the thyratron tube grid. Actually, the circuit elements R_1C_1, C_2, C_3 are included to show various ways to influence the transient performance.

To be useful, the electromagnetic system must have rather unconventional characteristics, particularly in view of the fact that the power level approaches or exceeds one kilowatt. The proper solution in obtaining precise operation lies basically in the adaptation of negative-feedback principles and essentially in the use of a servo-type loop. Simple circuits in accordance with this principle were tried on the first hard vacuum-tube model but were not found equally applicable to the thyratron model.

Damping Systems

Good results have been obtained by applying nonlinear mechanical damping to the moving system. With electromagnetic transducers, one method consists of sidewise spring loading of the moving slug with the spring loading released by the magnetic field. In the ON stroke, the slug rides free in the well-oiled airgaps, while in the OFF stroke, the slug rides with high friction. It stops dead against the rubber cushion catching the slug at the end of the OFF stroke.

By use of such methods, it was possible to excite the magnet forcefully almost during the entire ON stroke. The limit is set by the heat dissipation in the coil L, causing it to burn out. Coil resistances from 10 to 100 ohms were tried.

Due to the high peak power required by the unit, the power-supply problem is somewhat difficult. Since portable instruments are of interest, power supplies utilizing such sources will have to be designed.

Improved Version

A new circuit, Fig. 2, was developed to cut in half the uncertainty of the starting time. With this circuit, one of the two push-pull plate-connected tubes will fire each 120th second. Since unfiltered a-c is used, heavy and expensive power-supply components are eliminated. The entire power supply may consist of a line transformer T. In both this and the previous circuit, volume is controlled by a series resistor R_2 of a few hundred ohms in the electromagnet lead.

One of the most important features of the circuit in Fig. 2 is that the switch in series with the electromagnetic system has been eliminated. The unfiltered a-c used extinguishes the thyratrons repeatedly. This circuit has been used with satisfactory results but the accoustical power delivered by the drum was too high for comfortable listening in a living room.

For still larger outputs, needed to operate large bass drums in concert and dance halls, heavier types of thyratrons may be inserted and a heavier line transformer used. The power drawn from the line may then exceed that comfortably handled by a 15-amp house fuse.

One of the recorders, or coders, used in the development work described, consists essentially of a motor-driven drum with spokes which close a switch momentarily during rotation. When used as a signal generator in laboratory experiments, this device produced and repeated endlessly a volley of drum hits.

More reliable recorders may be built in form of magnetic wheels or rings or may utilize reels of magnetic tape. The simplest arrangement is to use a conventional tape recorder, followed by proper pulse-shaping circuits.

New Transistors Give

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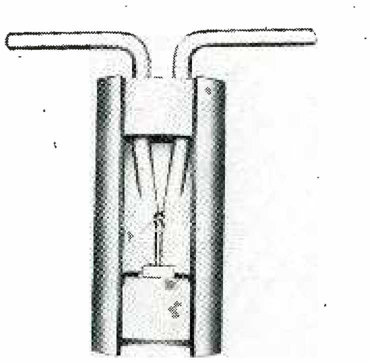
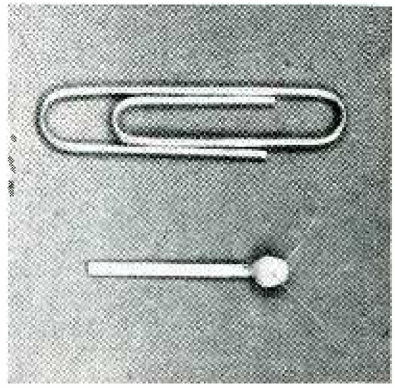


FIG. 1—Type-A cartridge structure used in earliest transistors



The M1689 bead-type point-contact transistor, progress in miniaturization

Reproducibility, reliability and designability have been major obstacles in the progress of transistor development. During the past two years, measurable progress has been made in reducing these three limitations through improved understanding, new processes and better germanium materials.

The point-contact cartridge-type transistor is shown in a cutaway view in Fig. 1. This general construction was used for all early transistors. The characteristics of a particular transistor, called the type A[1], will be used as a reference for measuring results obtainable now with new types under current development.

Table I—Reproducibility of Point-Contact Linear Characteristics

Element	Range (Sept 1949)	Range (Sept 1951)
a	4 to 1	±20%
r_c	7 to 1	±30%
r_e	3 to 1	±20%
r_b	7 to 1	±25%

Table II—Characteristics of M1729 Point-Contact Compared to M1752 Junction

Type	M 1729	M 1752
r_e	120	25
r_b	75	250
r_c	15,000	5×10^6
a	2.5	0.95

Physical operation of a type-A point-contact transistor is illustrated in Fig. 2. Two rectifying metal electrodes press down upon the surface of a small die of n-type germanium; one electrode is labelled E for emitter the other C for collector. A large-area ohmic contact to the underside of the die of germanium is the base electrode B.

Rectifying properties of the emitter and collector electrodes are obtained as a result of the p-n barrier, shown by dotted lines in Fig. 2, existing at the interface between the small p-type inserts under each point and the n-type bulk material. When the collector is biased in the back direction with a moderately large negative voltage, the collector barrier has relatively high impedance. A small amount of reverse current in the form of electrons flows from the collector to the base as shown by the small black circles.

If the emitter is biased in the forward direction with a few tenths of a volt positive, a current of holes (small open circles) is injected from the emitter region into the n-type material. Under the influence of the field set up originally by the initial collector electron current, the holes are swept along to the collector. This action adds a controlled increment of collector current. Because the holes have positive charges, they can lower the potential barrier to electron flow from collector to base and allow several electrons to flow in the collector circuit for every hole entering the collector barrier region.

The ratio of change in collector current to change in emitter current for a fixed collector voltage is the current gain α. Alpha may be greater than unity in point-contact transistors. Voltage amplification is obtained also because the collector current flows through a high impedance when the emitter current is injected through a low impedance.

The point-contact transistor has been miniaturized to contain only its bare essentials. Several of the current development types are made in the bead form.

Junction Type

The n-p-n junction transistor is shown in Fig. 3. A thin layer of p-type germanium is formed in the center of a bar of single-crystal n-type germanium.

Ohmic nonrectifying contacts are fastened to the three regions as shown. The essential behavior of point-contact and junction-type transistors is similar in many simple respects except for change in conductivity type from p-n-p in the point-contact to n-p-n in the junction type.

If the collector junction is biased in the reverse direction, Fig. 4, so that electrode C is biased positively

Improved Performance

Better manufacturing processes and germanium materials have provided greater reliability and reproducibility and improved frequency response. Higher power output and better noise figure for high-sensitivity applications are properties of new types

with respect to electrode *B*, only a small residual back current of holes and electrons will diffuse across the collector barrier as indicated. This reverse current is very much smaller and relatively independent of the collector voltage because the reverse impedance of such bulk carriers is so many times higher than that of the barriers produced near the surface in point-contact transistors.

If the emitter barrier is biased in the forward direction (a few tenths of a volt negative with respect to the base), a relatively large forward current of electrons diffuses from the electron-rich *n*-type emitter body across the reduced emitter barrier into the base region. Practically all of the injected emitter current can diffuse to the collector barrier if the base region is adequately thin so that the injected electrons do not recombine in the *p*-type base region, either in bulk or on the surface.

The injected emitter current is swept through the collector barrier field and collected as an increment of controlled collector current. Very high voltage amplification will result since the electrons are injected through the low forward impedance and collected through the high reverse impedance of bulk-type *p-n* barriers.

No current gain is possible in the simple bulk structure described and the maximum attainable value of alpha is unity. Because the bulk barriers are so much better rectifiers than the point-surface barriers, the ratio of collector reverse impedance to emitter forward impedance is many times greater. This greater ratio offsets the point-contact higher alpha and the junction unit may have much larger gain per stage.[1,2,3]

Linear Characteristics

In describing reproducibility of transistor characteristics for small-signal linear applications, statistical averages and ranges for the open-circuit impedances are given. Such a state of control does exist for most transistors under current development. However, such was not the case for old type-A units so that ranges for commensurate fractions of the total family are given for the old units.

A generalized 4-pole network representing the transistor is shown in Fig. 5. Here the input terminals are emitter-base and the output terminals are collector-base. The pair of linear equations shown represent the linear relations between the incremental emitter and collector voltages and currents over a sufficiently small region of the static characteristics.[1] The open-circuit driving point and transfer impedances of the transistor are the coefficients of the equations. Any one of a large number of equivalent circuits serve to represent the equations. The T circuit shown in Fig. 6 is perhaps the most useful configuration. In this circuit r_e represents the a-c forward impedance of the emitter barrier, r_c the a-c reverse impedance of the collector barrier, r_b the feedback impedance of the bulk germanium common to both, and *a* is the circuit current gain representing carrier collection and multiplication if any.

The circuit current gain *a* turns out to be very nearly equal to the current multiplication factor α of the collector barrier, mentioned previously. Average values for the different elements are given in Fig. 6.

Table I gives the ranges of these parameters for the type A as of September 1949 and the control limits for the same characteristics for new point-contact transistors now under development. The ranges for September 1949 are taken about the average values shown in Fig. 6 for the type-A transistor. The later control limits apply to many different types of point-contact tran-

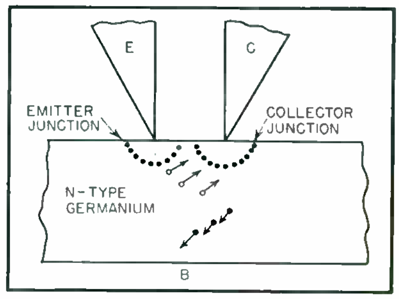


FIG. 2—Schematic diagram of a point-contact transistor

Table III—Reliability Status

	Sept 1949	Sept 1951
Average Life	>10,000 hours	>70,000 hours
Equivalent Temperature Coefficient of r_c	−1% per deg C	−¼% per deg C
Shock	?	>20,000 g
Vibration	?	20–5,000 cps negligible to 100 g

sistors so that the present average values of these equivalent circuit elements depend upon the type of transistor considered.

Table II shows the average values of the characteristics of the M1729 point-contact video-amplifier transistor, bearing the closest resemblance to the older type-A transistor. For contrast, typical figures for the M1752 junction transistor currently in the developmental stage are shown.

Transistors in the grounded-base connection may be short-circuit unstable if $a > 1$ and r_b is too large because r_b appears as a positive feedback element.[1] The circuit user of type-A units in 1949 had approximately a 50-percent chance of obtaining a short-circuit unstable unit from a large family of type-A units. The M1729 transistor presently under development has all members of its family unconditionally stable.

Large-Signal Characteristics

In switching and computing applications and other large-signal uses, the transistor characteristics must be controlled over a broad range of variables from cutoff to saturation.

One characteristic common to practically all of the transistor pulse-handling circuits examined to date is the ability of the transistor by virtue of its current gain to present various types of two-state negative resistance characteristics at any one or all of its pairs of terminals.

Reliability and Life

Table III is a comparison of reliability for transistors in 1949 and 1951. These estimates are based on extrapolation of survival curves assuming that a known survival law will continue to hold. For the test, the transistors were operated as class-A amplifiers and failure was considered to be the time when the class-A gain had fallen three db or more below its starting value.

For the 1949 figures, the type-A units had been in operation for about 4,000 hours and extrapolation predicted a half-life in excess of 10,000 hours. For the 1951 figures, actual running time was approximately 20,000 hours, giving a more reliable estimate somewhat in excess of 70,000 hours. The units under development now, made with new materials and processes, should be superior in life but it is too early to extrapolate the data.

Temperature Effects

The collector impedance r_c and the current gain α of the transistor are the most sensitive elements to temperature variations. The other elements are much less sensitive over the range from -40 C to $+80$ C.

The r_c of early type-A transistors fell off to about 20 to 30 percent of its room temperature value when the temperature was raised to $+80$ C. Over the same temperature range, alpha increased from 20 to 30 percent. This variation in r_c has been reduced by a factor of about four for most current point-contact types. Variations in the current gain remain about what they were in the older types.

In such linear applications as the grounded-base amplifier, the gain will stay essentially constant within a db or two from -40 C to $+80$ C. The d-c collector current for fixed emitter current and collector voltage will change at about the same rate as r_c (factor of four) in pulse applications. Similar improvements have been made for switching transistors.

It is believed that reliable operation in switching functions, at the present time, may be obtained at temperatures as high as $+70$ C in most applications and as high as $+80$ C in others.

Temperature variation effects in junction transistors are not yet well established. It seems there will be smaller variations in such parameters as alpha and r_c than in the point-contact type. Variations in the direct current, especially I_{co} (collector current at zero emitter current) are of the order of ten percent per degree C. However, I_{co} is usually much less than the operating value of I_c.

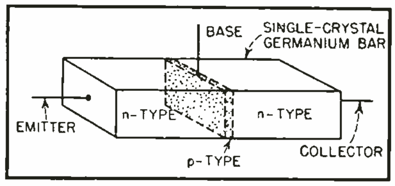


FIG. 3—Components of the n-p-n Junction transistor

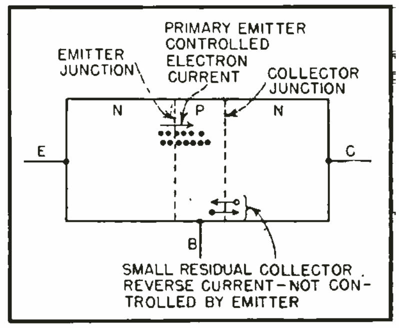


FIG. 4—Schematic diagram of a junction transistor

Table IV—Miniaturization in Space and Power Drain

	Type A Sept 1949	Sept 1951	New Types
Volume	$\frac{1}{50}$ in³	$\frac{1}{2,000}$ in³	Point M1689
		$\frac{1}{500}$ in³	Junction M1752
Min collector voltage for class-A	30 v	2 v	Point M1768, M1734
		0.2 v	Junction M1752
Min collector power for class-A	50 mw	2 mw	Point M1768
		10 μw	Junction M1752
Class-A efficiency	20%	35%	Point M1768, M1729
		49%	Junction M1752

The cartridge-type transistor, see Table IV, has a volume of 1/50 cubic inch. The M1689 bead-type point-contact transistor under current development occupies only about 1/2,000 cubic inch. The M1752 junction bead transistor has a volume of about 1/500 cubic inch which may be reduced to the volume of the bead-type point-contact transistor if necessary. Further size reduction must come about in the passive components of circuits. This seems feasible because of low voltages, low power drain and lower equipment temperatures associated with transistor circuitry.

Advances have been made in the past two years in reducing the collector voltage and power required for practical operation. In 1949, the minimum collector voltage for which the small-signal class-A gain was still within three to six db of its full value was about 30 volts. Today, the M1768 and M1734 point-contact transitors perform well with collector voltages as low as two to six volts even at relatively high frequencies.

The M1752 junction transistor, at collector voltages as low as 0.2 to 1.0 volt, can deliver useful gains. Under these conditions, the minimum collector power may be as low as two to ten mw for point-contact and 10 to 100 μw for junction types in typical operation.

Efficiencies for class-A operation have been raised to 30 to 35 percent for point-contact and 49 percent out of a possible 50 percent for junction transistors. Efficiencies for class-B and class-C are correspondingly close to their theoretical limiting values.

Performance

Table V compares the progress made in several important performance figures of merit by development of several point-contact and junction types during the past two years. Reference is made to the type-A transistor as of September 1949.

Laboratory models of point-contact transistors for some switching and transmission applications now have useful values of current gain as high as 50. The single-stage gain of point-contact types M1768 and M1729 for straight transmission applications has been increased to 20 to 24 db and for the M1752 junction-type, the single-stage gain may be as high as 45 to 50 db.

Table V—Performance Progress

	Type A Sept 1949	Sept 1951	New Types
Current gain α	5 x	50 x	Point, Junction
Single-stage class-A gain	18 db	22 db 45 db	Point M1729, M1768 Junction M1752
Noise at 1,000 cps	60 db	45 db 10 db	Point M1768 Junction M1752
Frequency response f_c	5 mc	7–10 mc 20–50 mc	Point M1729 Point M1734
Class-A power output	0.5 w	2 w	Junction
Switching characteristics	none	good	Point M1698, M1689, M1734
Feedback resistance r_b	250 ohms	70 ohms	Point M1729
$\frac{\text{Light}}{\text{Dark}}$ photocurrent ratio	2 to 1	20 to 1	Junction M1740

Point-contact devices have been improved to have noise figures of about 40 to 45 db for high-sensitivity low-noise applications. The M1752 junction transistor has noise figures in the 10 to 20 db range. Noise figures are taken at 1,000 cycles and vary inversely with frequency.

Frequency response improvement has been obtained so that for video amplifiers up to about 10 mc, the M1729 point-contact transistor has a gain of about 18 to 20 db per stage. The M1734 point-contact transistor is under development for high-frequency oscillators and microsecond pulse switching. This transistor has been used in 24-mc i-f amplifiers with a gain of 18 to 24 db per stage and bandwidth of several megacycles. These transistors work well as pulse generators and amplifiers of one-half microsecond pulses with collector voltage of six to eight volts and 12 to 20 mw collector power per stage. Amplitudes of four to five volts out of a total collector voltage of six volts and 0.01 to 0.02-μsec rise times are obtainable in the amplified pulses.

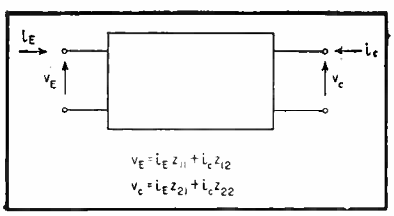


FIG. 5—General linear transistor

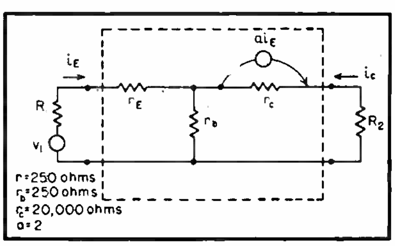


FIG. 6—Equivalent T circuit and type-A average element values

Class-A power output has been raised to two watts in junction transistors by increasing the thermal dissipation limits and this is not the upper limit.

Junction-type phototransistors[4] allow much greater output voltages for the same light flux than do point-contact-type phototransistors.[5]

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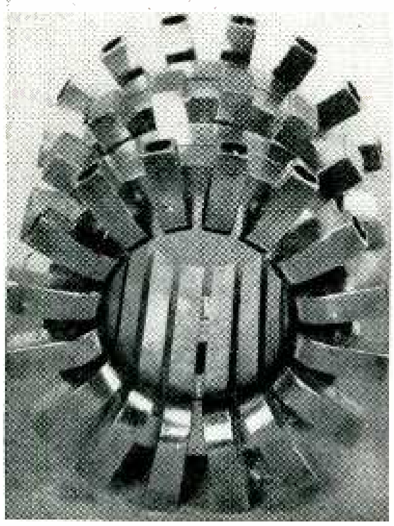


Water-cooled magnetron anode rated at 80 kw

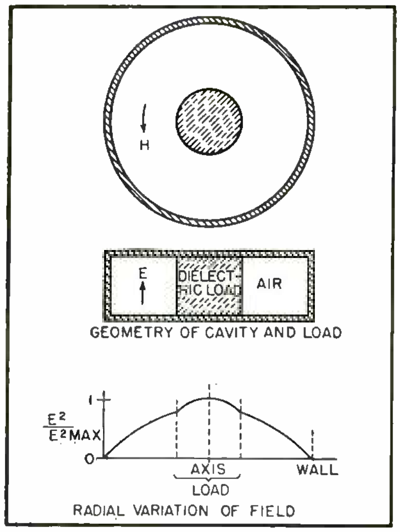
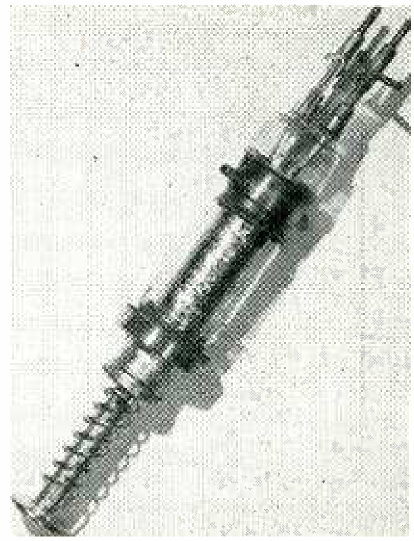


FIG. 1—Distribution of heating in a cylindrical resonant cavity



Pure-tungsten hot cathode with maximum heating power of 5 kw

Industrial Magnetrons for Dielectric Heating

Heating at microwave frequencies can be much faster than at lower frequencies and the bands at 915 mc and 2,450 mc minimize communications interference from leakage radiation. Magnetron oscillators, their control circuits and industrial applications of the tubes are discussed

By **RICHARD B. NELSON***

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MICROWAVE TUBE developments several years ago reached the stage where kilowatts of power were available at frequencies of 10^9 to 10^{10} cycles. It was soon evident that many heretofore difficult or impossible jobs of dielectric heating could be done easily at these microwave frequencies.

Fundamental to dielectric heating is the relationship

$$P = 2\pi f E^2 \epsilon'' \times 0.0885 \times 10^{-12} \qquad (1)$$

where P = power in watts per cc converted to heat in the dielectric, f = frequency of alternating electric field, E = rms field strength in volts per cm and ϵ'' = loss factor of the dielectric.

The rate of heating for any material is

$$\frac{dT}{dt} = \frac{P}{4.186C} = \frac{1}{C} 2\pi f E^2 \epsilon'' \times 0.0211 \times 10^{-12} \qquad (2)$$

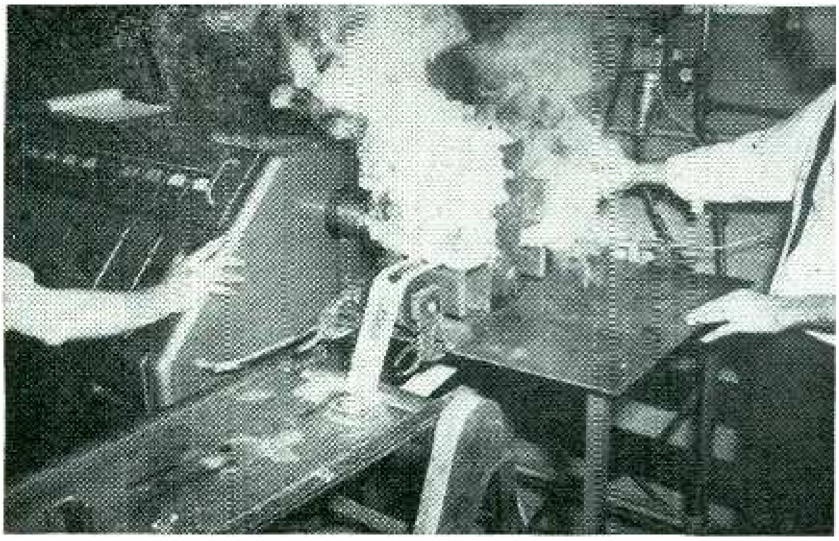
where dT/dt = time rate of temperature rise in degrees C per sec and C = specific heat of material.

To increase the rate of heating a given dielectric material, either the field strength or the frequency may be increased. The field strength is easy to control but it can be increased only to the limit imposed by arcing between the electrodes and the work. The field strength at which arcing occurs varies tremendously with different kinds of materials.

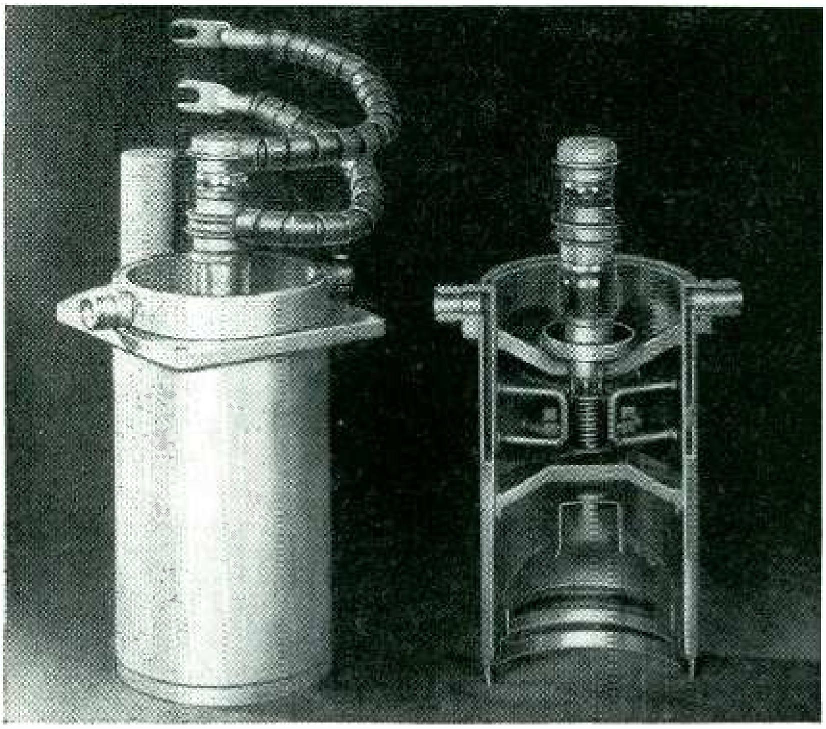
Choice of Frequency

Referring to Eq. 2, the rate of heating at constant voltage is proportional to frequency if the loss factor does not change. In most materials, the loss factor actually rises with frequency in the useful ranges. It would seem necessary only to go to a high enough frequency to heat any material rapidly with a voltage safely below the breakdown point. There are, how-

* Now with Varian Associates, San Carlos, California.



Experimental plastic preheater. Radiation through the entrance and exit holes in the cavity is reduced by quarter-wave chokes



Complete and cut-away views of a water-cooled 915-mc magnetron with plate dissipation rating of 3,000 watts

ever, limits on usable frequencies, imposed by economic and physical factors.

In the microwave region, it has been found extremely difficult to shield dielectric heating equipment to reduce radiation below the allowable FCC maximum.

Heating apparatus must be essentially confined to the frequency bands assigned for this service where large amounts of stray radiation are permitted. These bands are shown in the table.

Center frequency (mc)	Deviation allowance (mc)	Quarter wavelength in air (in.)
915	± 25	3.22
2,450	± 50	1.21
5,850	± 75	0.50
10,600	±100	0.28
18,000	±150	0.16

Standard grid-controlled vacuum tubes serve as efficient oscillators up to the order of 100 mc. Their wide use in communications has made them highly developed and cheap.

Throughout the range of 100 to 900 mc, vacuum-tube oscillators can be built to give as much power as is needed. These are specialized tubes in small production and they are expensive. In view of the lack of frequency assignments, it is doubtful if these frequencies will be used much for heating.

At 915 mc, a rugged magnetron oscillator is available to give 5-kw output. Experimental magnetrons have been built to produce 50 kw in this frequency range. At 2,450 mc, magnetrons are available from the Raytheon Manufacturing Company giving up to 2-kw output. At higher frequencies, tubes suitable for industrial use have not yet been put on the market. They can be made if a demand for them develops.

Uniformity of Heating

Most of the materials to be heated with microwaves are relatively low-loss dielectrics. This means that in the passage of an electromagnetic wave through the material, only a small part of the energy in the wave is absorbed per wavelength of travel. If it is desired to dissipate all the energy in the wave in a piece of dielectric no more than a few wavelengths long, the wave must be reflected back and forth through it many times. Interference of the reflected waves sets up a standing-wave field pattern with maxima and minima of field strength separated by one-quarter wavelength.

The standing-wave pattern imposes definite restrictions on the size of objects that may be heated uniformly at a given frequency. Consider the case of a cylindrical resonant cavity excited with the electric field parallel to the axis. The electric field strength is

$$E = E_{max} J_o (6.28\, r/\lambda) \quad (3)$$

where E_{max} = maximum field (on the axis), r = radial distance from the axis and λ = wavelength in the material with which the resonator is filled.

In Fig. 1 is plotted the variation in E^2 derived from this equation. The rate of heating, proportional to E^2, is greater than 90 percent of its maximum value inside a radius of 0.07 λ.

In a practical case, such as heating a plastic preform, the dielectric load is placed in the center of the cavity where the field is high and uniform. If the diameter of the cavity is adjusted for resonance, with a coaxial cylinder of dielectric, the field in the dielectric will be exactly the same as in a smaller cavity completely filled with dielectric.

For a plastic material of dielectric constant 4.0

$$\lambda = \lambda_0/\sqrt{4} = 0.5\lambda_0 \tag{4}$$

where λ_0 = wavelength in free space.

If the plastic cylinder has a diameter d such that its surface is heated 90 percent as much as its center

$$d = 2 \times 0.07 \times 0.5\ \lambda_0 \tag{5}$$

At 915 mc, λ_0 = 12.9 in. and d_{915} = 0.9 in. is the maximum diameter permitted.

This example illustrates the role of standing-wave patterns in selecting frequencies. Another effect becomes important for very lossy materials. Here the electromagnetic wave may lose its energy so rapidly in its first passage into the material that at the center of the load the fields are too weak to produce enough heat. For example, at 915 mc roast beef has a dielectric constant of 28 and a loss factor ε'' = 5.6. The attenuation constant α for the fields of a wave is given by

$$\frac{\pi}{\lambda_0}\ \frac{\epsilon''}{\sqrt{\epsilon'}} \tag{6}$$

where ε' = real part of dielectric constant. The power density in the wave is

$$E^2 = E_o^2\ e^{-2\alpha} \tag{7}$$

If the effective depth of penetration p of the wave is defined as that depth at which the power density has fallen to $1/\sqrt{e}$ or 0.61 of its initial surface value

$$p = \frac{1}{4\alpha} = \frac{\lambda_0\ \sqrt{\epsilon'}}{4\pi\ \epsilon''} = \frac{\lambda}{4\pi\ \epsilon'} \tag{8}$$

In roast beef, p = 0.97 in. effective penetration at 915 mc.

These examples indicate how, for any type of load, consideration of the wavelength in the material in relation to the size of the piece leads to the choice of frequency. Present applications use the 2,450-mc band and the 915-mc band. It appears that these will remain the most important in the microwave region, even when tubes become available for higher frequencies.

In the General Electric Company, microwave heating investigations and developments have been concentrated at 915 mc. Tube development was started in 1945 with a 5-kw magnetron oscillator operating at 1,040 mc. This tube was superseded by the type Z1492, operating at 915 mc. This tube requires a magnetic field of 1,400 gauss and has a plate dissipation rating with water cooling of 3,000 watts.

Construction of the 5-kw magnetron is shown in Fig. 2. The filament is a helix of pure tungsten wire, 0.400 in. in diameter. Surrounding it are 10 anodes on a 0.687-in. diameter circle, formed by U-shaped loops of $\frac{3}{16}$-in. copper tub-

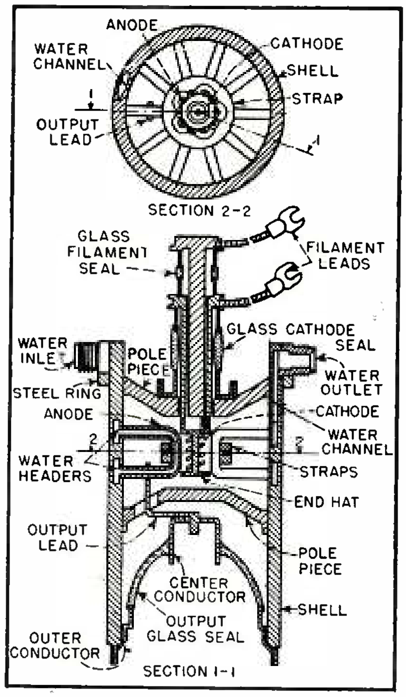


FIG. 2—Cross-sectional view of a 5-kw water-cooled magnetron

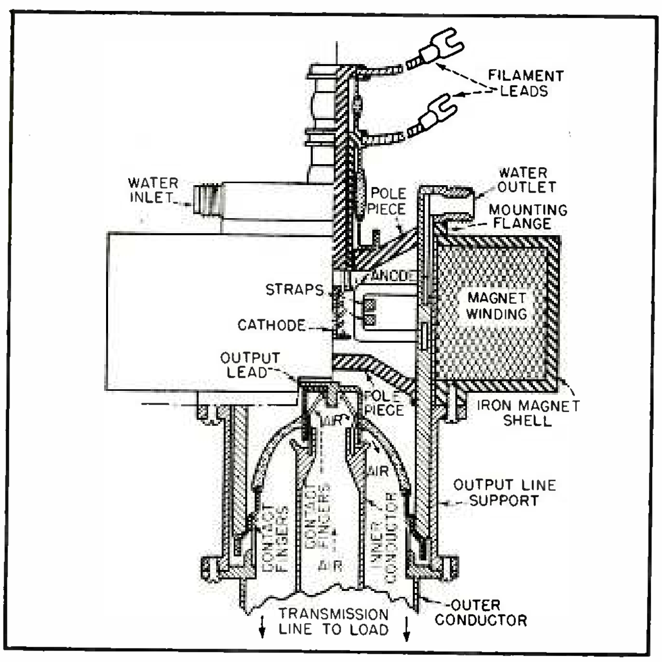


FIG. 3—Mountings and connections for the magnetron of Fig. 2

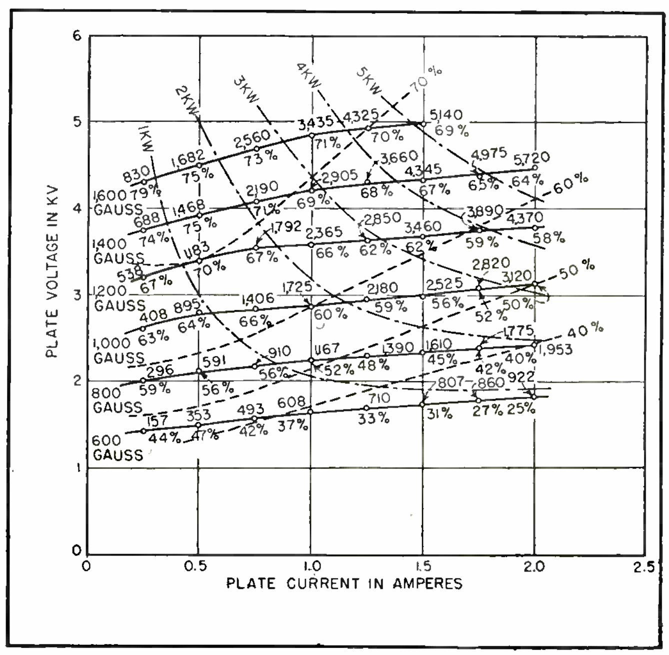


FIG. 4—Performance curves taken with transmission line matched to load

ing through which the cooling water flows. This method of removing heat from the anodes gives good dissipating ability and practically eliminates frequency drift from thermal expansion of the anode structure.

The ten resonant circuits of the oscillator are formed by the anode pipes themselves and the copper tube shell connecting them at their outer ends. At their inner ends, the anode pipes are connected alternately by copper straps into two sets of 5 anodes. The purpose of these straps is to increase the frequency separation between the resonant modes of the anode structure, so that the oscillation will always take place in the desired mode with alternate anodes 180 deg out of phase. The resonant circuits would be quite loosely coupled without the straps, with the resulting resonant frequencies differing by a few percent.

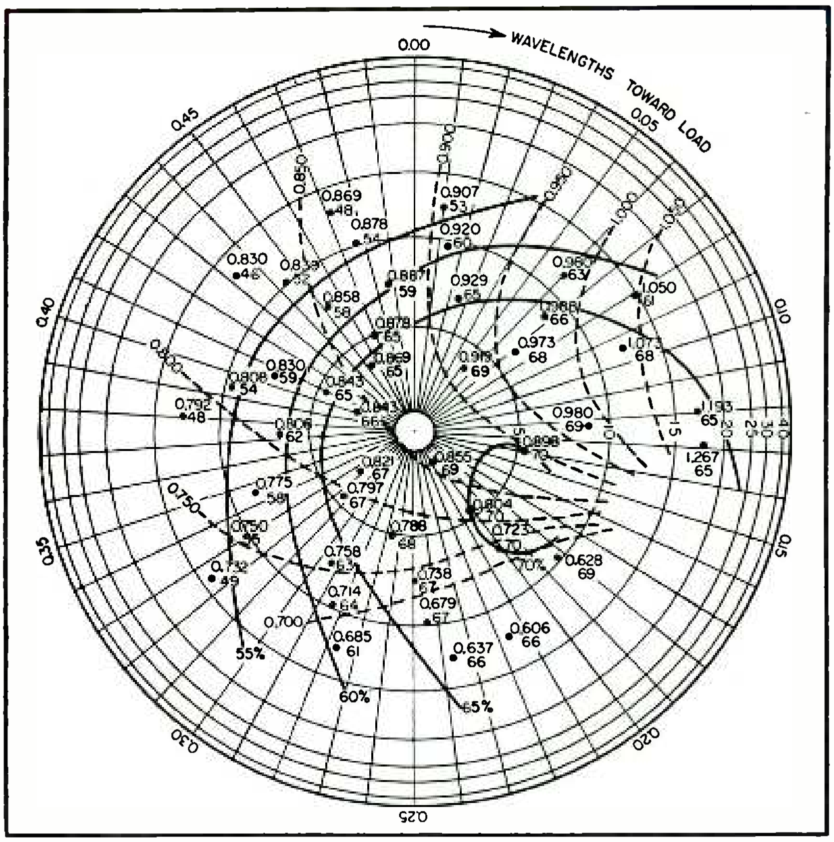


FIG. 5—Rieke diagram for a plate current of 1.0 amp and magnetic field of 1,200 gauss. Radial coordinate is the voltage reflection coefficient (scale marked in swr in db) and azimuthal coordinate is phase angle of reflection coefficient (scale marked in wavelengths displacement of standing wave minimum). Upper numbers are wavelength (add 29,000 cm), dotted lines are constant-wavelength contours, lower numbers are percent efficiency and solid lines are constant-efficiency contours

Coupling to Load

In the strapped structure, resonances of a laboratory tube were at 1,063 mc, 2,110 mc, 3,040 mc, 3,750 mc, and up. This extreme mode separation is not necessary but it has proven very desirable in dielectric heating. Where the load impedance may change wildly, it is nice to have insurance against oscillations jumping to another mode.

Referring again to Fig. 2, coupling of the anode tank circuits to the load is provided by a copper strap connected to one leg of one anode pipe and leading through the glass output seal to an external coaxial line. The point of attachment to the anode pipe is determined to give the proper loading of the oscillator when the transmission line is reflectionless.

The tube is mounted by sliding it inside its solenoidal electromagnet. As shown in Fig. 3, the magnet has an iron shell which carries the flux. Jumping a short gap formed by the copper tube shell, the flux enters the iron pole pieces inside the tube and provides the magnetic field parallel to the axis of anode and cathode. As the tube is plugged into its magnet, its output end makes contact with the inner and outer conductors of the transmission line. Air is blown in through the inner conductor to cool the glass seal, which itself undergoes dielectric heating.

Operating characteristics of a magnetron are best shown by two sets of curves. Figure 4 is a performance chart where contours of magnetic field, output power and efficiency are plotted on coordinates of plate voltage and current. This data is taken with the transmission line matched to the load.

Figure 5 is a Rieke diagram where for standard conditions of plate current and magnetic field, the efficiency and wavelength are plotted on coordinates of reflection coefficient of the load for waves going down the transmission line.

Electromagnet Control

The magnetron is essentially a diode, operated for convenience with its anode grounded. The plate power supply is between cathode and ground. It is advantageous to return the low-voltage end of this supply to ground through the electromagnet, so the magnet is effectively in series with the plate current of the magnetron. The reason for this is illustrated in Fig. 4. If the magnetic field is constant, a small change in plate voltage produces a large change in current and output power. The dotted curve in Fig. 6 shows this relation. Line-voltage fluctuations can cause serious output variations.

When the plate current flows through the electromagnet, an increase in plate voltage causes increased current to flow, raising the magnetic field in proportion. Referring to Fig. 4, the plate voltage is almost directly proportional to magnetic field. The resultant effect is that plate current becomes proportional to plate voltage. This ohmic characteristic gives much smaller variations of power with plate voltage, as shown by the solid curve in Fig. 6.

The series electromagnet also

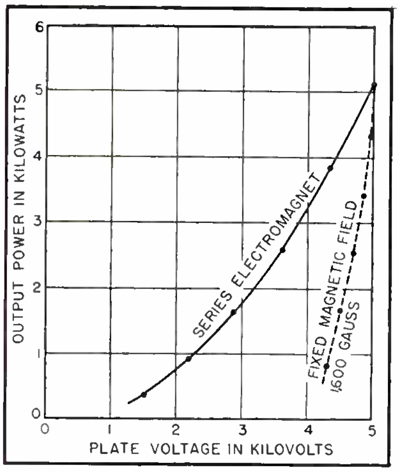


FIG. 6—Effect of plate voltage on output power

stabilizes the output power against variations in load impedance. In Fig. 7, power is plotted versus resistance of an ohmic load measured in terms of Z_o, the characteristic impedance of the transmission line which it terminates. The power curve with a series electromagnet is more constant than with a fixed magnetic field and either constant voltage or constant current from the plate supply. Judicious choice of regulation characteristic of the supply could help in this respect also.

One difficulty with the series electromagnet is that when the plate voltage is first applied, the field is zero. Under these conditions, the magnetron will not start in its proper mode, but will oscillate in a high-frequency electronic mode at a voltage too low for the proper mode to take over. The remedy for this trouble is to have a residual magnetic field present before the plate voltage is applied.

Figure 8 shows a rectifier circuit that supplies starting field by feeding current into the magnet in parallel with the plate current. As the plate current rises, the drop in the magnet exceeds the rectifier voltage and the rectifier stops feeding current.

The rectifier shown in Fig. 8 has other uses. It provides a surge path for the magnet current when the plate supply is cut off, avoiding excessive voltage rise due to the inductance of the magnet.

Also, with the variable a-c supply to the rectifier, it may be used as an output power control that is much cheaper than a plate power supply with continuously variable voltage. Leaving plate voltage fixed, the d-c output voltage of the rectifier is raised until it feeds shunt current into the magnet. This raises the magnetic field and reduces magnetron plate current. In this way, complete and continuous power control is obtained with a small Variac.

One very important piece of circuitry is a device for keeping the magnetron's filament at the proper temperature. The filament receives a considerable amount of energy from bombardment by electrons that get into the r-f field in the wrong phase and are accelerated, as in a cyclotron. Most of these electrons strike the cathode.

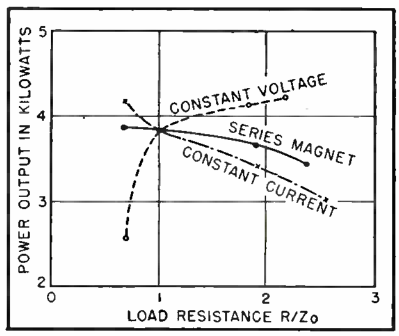


FIG. 7—Effect on output power of varying pure resistance loads

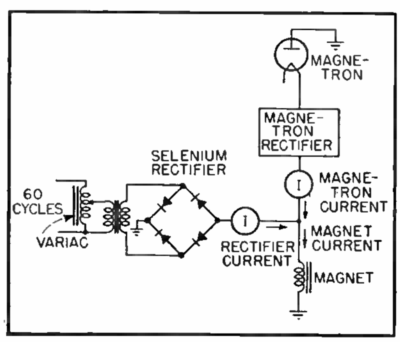


FIG. 8—Rectifier circuit supplying starting field for electromagnet

The back-heating power in a Z1492-type magnetron at 1,000 and 1,400 gauss is plotted as a function of output power in Fig. 9. This data was taken with a load matched to the output transmission line. The heating is also a complicated function of load impedance, getting worse for unloaded conditions. No device capable of anticipating its amount has been very satisfactory.

The Z1492 cathode, running normally at 560 watts, would have its life shortened by a factor of seven by the addition of 155 watts of back heating, so it is worth while to compensate for it.

A regulating circuit, shown in Fig. 10, compares the resistance of the filament with a reference resistor. As the filament temperature rises, its resistance increases. This generates an error signal in the servo circuit, which reduces the heating current.

The circuit as shown will compensate for three-fourths of the back-heating power in a Z1492 magnetron. More elaborate controllers with better regulation have been designed, but the circuit shown has the advantage of simplicity and of failing safe. If a tube loses conductivity, the magnetron filament becomes colder.

The Z1492 is designed to feed into a $3\frac{1}{8}$-in. coaxial transmission line of 53 ohms characteristic impedance. Lines with dielectric beads supporting the center conductor are not desirable, due to reflections from the beads and dielectric losses in them. Stub-supported lines, having an inner conductor $1\frac{1}{4}$ in. in diameter and an outer conductor with a 3.027-in. inside diameter, have been used satisfactorily.

Magnetron Application

Experimental work on dielectric heating at 915 mc has been carried on by several departments of the General Electric Company

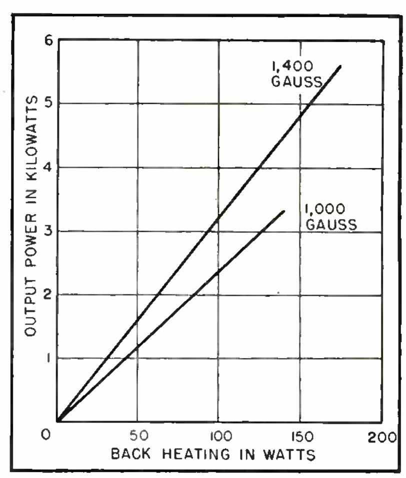


FIG. 9—Back heating of the cathode in a 5-kw magnetron with matched load

and by other organizations. To facilitate experiments, a number of 5-kw heater units have been built and sold. This heater unit contains a Z1492 magnetron, power supplies, filament temperature regulator, triple-stub r-f impedance matcher and directional couplers to read directly the power in the transmitted and reflected waves. In use, matching the external load to the oscillator is done by adjusting the two controls on the impedance matcher until the reflected power meter reads zero.

In microwave heating, even more than low-frequency heating, each job presents a new problem in coupling power to the load. One example which has been studied is the heating of precooked frozen dinners. A specialized unit was developed for this purpose by P. W. Morse and H. E. Revercomb and described by them in ELECTRONICS, October 1947. It contains a resonant cavity, inside which the food is rotated on a turntable to average out the standing-wave pattern.

Another example of coupling methods is in preheating of thermosetting plastics. Here the pieces are small and uniform but a very uniform temperature is required. One method which has been used is the resonant cavity shown in Fig. 11. The transmission line is coupled by an inductive loop to the cavity, which is tuned to resonance by moving one side. The plastic preform pellet is placed at the center of the cavity in the region of most uniform field. A support of nonlossy dielectric prevents burning at the points of contact with the metal walls. In this cavity, fed with 915-mc power, phenolic plastics can be preheated to a molding temperature of 190 C in one second.

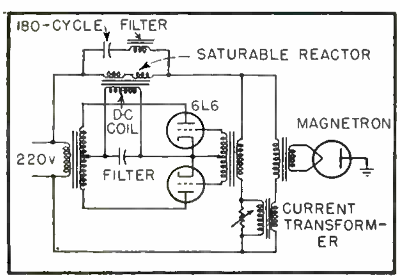


FIG. 10—Constant-temperature filament regulator circuit

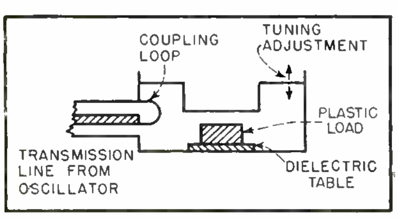


FIG. 11—Resonant cavity for heating plastic preforms

One of the photographs in this article shows an experimental plastic preheater. In this machine, preform pellets are fed through a resonant cavity on an endless belt, emerging at molding temperature. Quarter-wave chokes reduce radiation through the entrance and exit holes in the cavity.

High-Power Magnetron

Experimental magnetrons have been built to give up to 50-kw output at 1,000 mc. Fig. 12 shows a cut-open view of a tube which was developed as part of a Signal Corps contract. Similar tubes may be built to a degree of ruggedness and reliability suitable for industrial dielectric heating.

This magnetron operates at about 14 kv, with a magnetic field of 1,500 gauss. Plate efficiency is from 50 to 60 percent.

At the high-power level, it is desirable to use waveguides for transmission lines. The magnetron output is designed to couple directly into the waveguide by a quarter-wave antenna penetrating the guide. Surrounding the antenna is a ceramic dome, which forms the vacuum seal. The ceramic material, a high-alumina vitreous body known as Aluminite, will stand much higher powers than glass.

The anode structure, capable of dissipating 80 kw consists of 16 anodes 3½-in. long by ¼-in. wide, each carrying cooling water.

The limit on power in these c-w magnetrons is in the cathode, where back-heating is severe. Experiments were carried on with water-cooled cathodes coated with good secondary-emitting materials. With a secondary electron yield ratio of three to one, the back-bombarding electrons generate enough secondary emission to sustain oscillations. A small thermionic cathode is used as a starter.

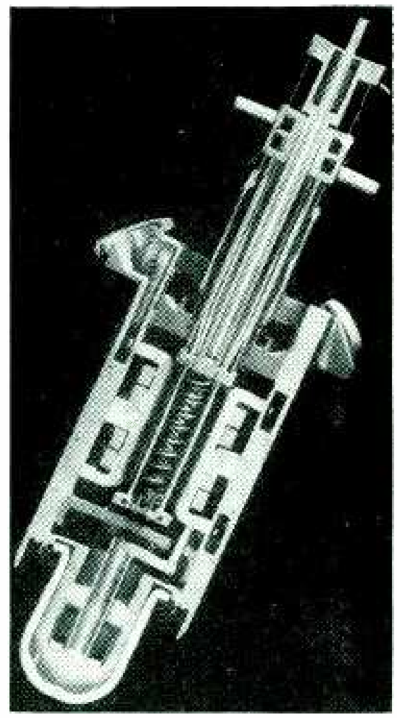


FIG. 12—Cut-away view of a 14-kv magnetron with magnetic field of 1,500 gauss

With these cathodes, power output of 50 kw was obtained, but the life was measured in tens of hours. The secondary emitting surfaces consisted of active metals such as magnesium and beryllium oxidized to a depth of a few hundred Angstroms. In operating the tube, residual gases are ionized by the high density of electrons between cathode and anode. These positive ions bombard the cathode, and are believed to sputter off the oxide layer, leaving a clean metal surface which has a low secondary yield.

Thermionic cathodes coated with thoria were tried, such as the one in the cut-open tube of Fig. 12. Powers around 30 kw were obtained, limited by cathode-to-anode breakdown. These cathodes should have very long life.

A husky pure-tungsten hot cathode required a heating power of 5 kw. With it, outputs of 35 kw were reached, limited by back heating of the cathode exceeding its total power requirement. The conclusion from these high-power tube tests is that a good 30-kw oscillator at 1,000 mc is now realizable.

Improving TV System

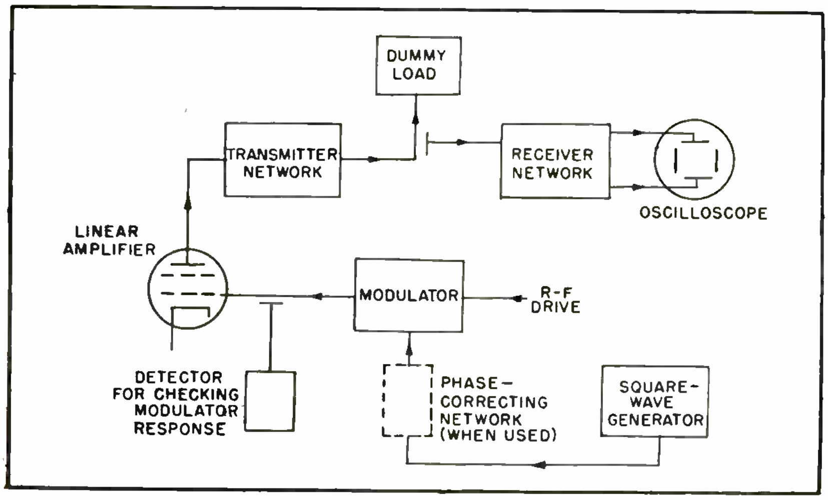


FIG. 1—Experimental system used to determine tv system characteristics

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IN STANDARDIZING the transient response of the various parts of the television broadcast system a difficulty arose concerning that of the carrier-frequency system linking the transmitter to the receiver. Doubt arose as to whether it was possible to obtain an acceptable transient response within the framework of the present broadcast transmission standards. Accordingly, an investigation was made of the system between the modulator in the transmitter and the final detector in the receiver.

Experimental System

To measure the transient responses of systems having a wide variety of characteristics, an experimental system was set up as shown in Fig. 1. A carrier-frequency signal is amplitude-modulated by a square wave and fed to a linear amplifier that raises the power level to about 100 watts. The signal goes through a passive, linear, minimum-phase-shift network representing the r-f circuits of the transmitter. A sample of the transmitter output is coupled through a similar kind of network representing the carrier-frequency circuits of the receiver and is then fed directly to the vertical deflection plates of a cathode-ray oscilloscope.

The system is carefully adjusted so that the envelope of the signal fed to the input of the transmitter network is a substantially undistorted square wave of very short rise time.

Any transient distortion introduced by the transmitter and receiver networks can then be assessed by observing the square-wave envelope of the signal displayed by the oscilloscope. Transient response of any specific system can be measured by adjusting the networks to have the desired transmission characteristics.

It has been shown that the transient response of any system is dependent upon its amplitude-frequency characteristic and its phase characteristic. However, in the carrier frequency circuits of nearly all practical television systems, the phase characteristic is uniquely determined by the amplitude-frequency characteristic, since simple minimum-phase-shift networks are used almost exclusively. This is also true in the experimental system. Hence as far as transient response is concerned, the experimental system will accurately simulate almost any practical system having the same amplitude-frequency response.

Standard System

Having established a method of measurement, it is appropriate to consider first the transient response of the system defined by the stand-

What The Author Found

- A television system that rigidly adheres to the present standard characteristics has so much inherent transient distortion that it can be considered unacceptable.
- Existing practical systems have transmission characteristics with a more gradual slope in the region of the carrier frequency. This results in improved transient response, but distortion is still objectionable. It cannot be substantially reduced by correction in the video circuits.
- Transient distortion can be largely eliminated by modifying the transmission characteristic to the step type described. By a suitable change in the present transmitter and receiver standards, compatibility with existing receivers could be obtained

Transient Response

Studies of existing standards indicate that a transmitter with characteristics only slightly different from those specified by FCC and RTMA will pass essentially undistorted square waves for any practical modulation factor when used with a receiver having a step-type amplitude characteristic

ards for television broadcasting. Figure 2 shows the transmission-amplitude characteristics for this system. The frequencies are shown relative to the carrier frequency so that the curves will apply to any channel and receiver intermediate frequency.

The overall system characteristic, shown in Fig. 2C, is obtained by combining the familiar standard characteristics for the transmitter (A) and receiver (B) as shown. It is noteworthy that the system response is determined primarily by the receiver.

However, when considering system response the individual transmitter and receiver characteristics are of no particular concern except as they affect the overall characteristic.

To measure the transient response of the standard system, the experimental system was adjusted to have an overall transmission amplitude characteristic as nearly as possible like that of Fig. 2C. The results are shown in Fig. 3. It is seen that except in the region of high-frequency cutoff the measured curve is everywhere within 5 percent of the standard shown by the dotted line. It was found that approaching any closer to the standard did not have any marked effect on the transient response.

When the carrier signal with square-wave modulation was fed into the system, the modulation factor was first adjusted so that the square wave represented abrupt transitions between the white and black levels of a standard television signal, that is, 12.5 percent and 75 percent respectively of the nominal sync peak level. This was called full modulation and corresponds to a modulation factor of 0.714. It is apparent that with this full modulation a given degree of square-wave distortion will be more noticeable in a received picture than it would be for lower modulation factors when the square wave represents transition between points closer together on the gray scale.

The output signal from the system as displayed by the oscilloscope is shown in Fig. 3B. For clarity only the shape of the envelope is shown. The actual display is, of course, a complete amplitude-modulated wave having an envelope of this shape. The output wave is

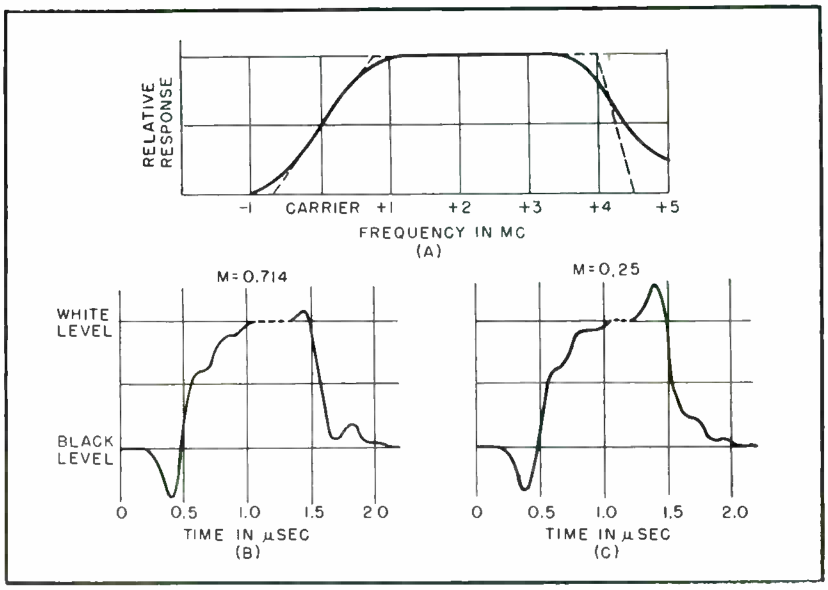

FIG. 3—Standard system ampliture characteristics (A) and output envelope waveforms for varying degrees of modulation (B) and (C)

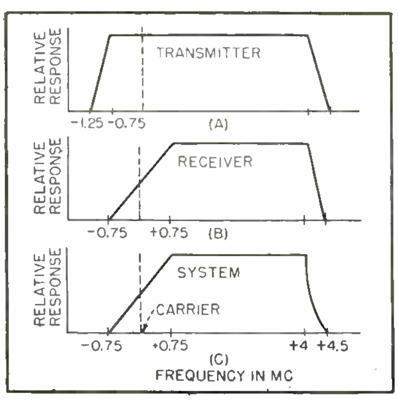

FIG. 2—Standard tv broadcast system transmission-amplitude characteristics

so distorted as to bear little resemblance to the input wave, which consisted essentially of abrupt transitions from black to white and from white to black.

One very noticeable effect is the marked difference in shape of the two transitions. This indicates a nonlinear type of distortion which it is practically impossible to correct inasmuch as it varies with the type of waveform being transmitted.

When the modulation factor is reduced to about 0.25 or lower, the nonlinear distortion is no longer present as shown by the waveform in Fig. 3C. The distortion remaining in this waveform could be corrected by means of phase-shifting networks in the video circuits of the system. However, it will be shown later that such phase correction would make the distortion at full modulation even worse.

Modified System

Distortion in the order of that shown in Fig. 3 is unavoidable with any system whose transmission amplitude characteristic is adjusted to conform to the standard. Since practical systems currently in use do not, in general, exhibit so much transient distortion it can only be assumed that they fortunately do not conform to the standard.

Figure 4 shows a characteristic in which the slope near the carrier has been reduced as much as possible while still maintaining adequate attenuation at the adjacent sound frequency of -1.5 mc. The slope is substantially less than that of the standard shown by the dotted line. This curve approximates that of an average receiver, which has been aligned to have a characteristic of the general standard form without going to great lengths to obtain rigid compliance with the standard.

The square-wave outputs obtained with this system are shown in Fig. 5. Waveforms (A) and (C) show that the transient distortion is appreciably reduced, but it can still be considered objectionable.

It was mentioned previously that the distortion present at low modulation can be corrected in the video circuits of the system. The addition of a suitable phase-shifting network in the modulator input does largely remove the distortion as shown by the waveform at (D). But at full modulation, the phase correction makes the distortion, if anything, somewhat worse as shown by the waveform at (B). The reason is that the phase correction tends to compensate for undershoot and smear that are not present in the white-to-black transition. This results in an extensive overshoot at the black level.

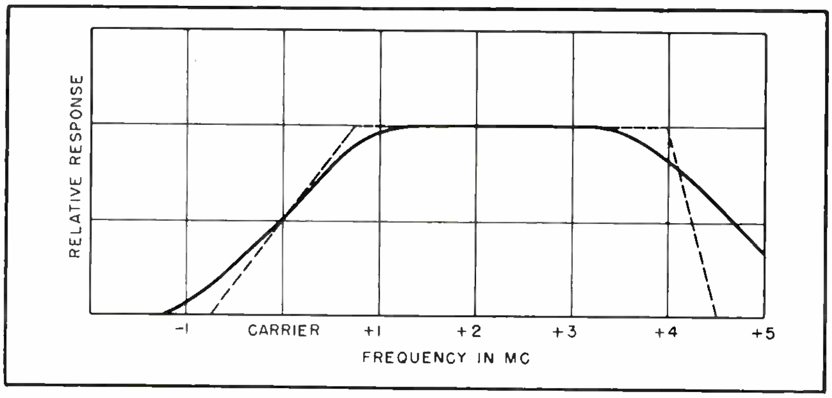

FIG. 4—Average system amplitude characteristics showing relative frequencies in megacycles

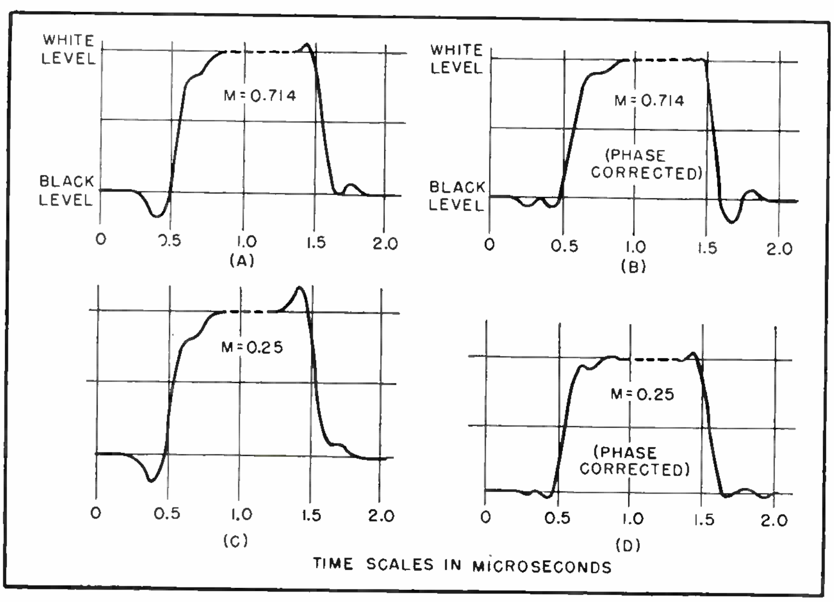

FIG. 5—Envelopes of resultant square waves for varying degrees of modulation (A) and (C) phase corrected (B) and (D)

Improved System

The results obtained so far indicate that objectionable transient distortion is unavoidable with a system of the general standard form. It would therefore seem worth-while to investigate the possibility of obtaining an improved transient response by making some major change in the system transmission characteristic.

The nonlinear type of distortion evident at full modulation is caused by the quadrature component produced when the relative amplitudes of the carrier and sidebands are changed asymmetrically. Distortion still present at low modulation results principally from nonlinearity of the phase characteristic, particularly in the region of the carrier frequency.

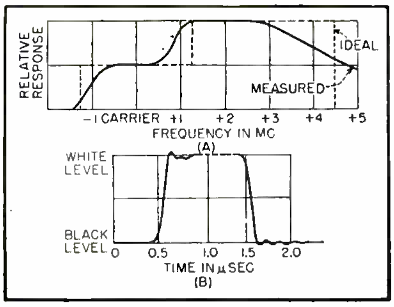

FIG. 6—Proposed step-type characteristic and resultant square-wave envelope obtained

Hence, the requirements for an improved transient response are a more linear phase characteristic and a transmission amplitude characteristic that is more nearly symmetrical about the carrier frequency.

These requirements are satisfied by the step type of transmission characteristic shown in Fig. 6. The ideal curve shown by the dotted line is symmetrical about the carrier from the lower edge of the channel up to +1.25 mc. Above this frequency the response necessarily increases two-fold to compensate for the loss of the lower sideband. Consideration of the general relationship between amplitude-frequency and phase characteristics indicates that this type of amplitude characteristic should also give a more linear phase characteristic than the standard.

When the experimental system is adjusted to have a transmission characteristic as close as possible to the ideal, the measured characteristic is as shown by the full line, and the output square wave is as shown at (B). The square wave is remarkably free from distortion. The quadrature component has been reduced to such an extent that the difference between the two transitions is less than 5 percent. The improvement in linearity of phase characteristic is so great that there is no detectable undershoot or smear. Furthermore, the waveform is substantially the same for any modulation factor up to the maximum of 0.714.

In order to obtain this improved transient response, it is necessary to keep the shape of the curve between the carrier and −1.25 mc the same as that between the carrier and +1.25 mc.

Practical System

It is rather difficult to do this in the r-f circuits of the system, but fortunately it is possible to obtain at least part of the desired shape by suitably modifying the response of the system video circuits. For instance, the two-fold increase in response above +1.25 mc could be obtained by including a suitable network in the video circuit of the receiver. The system r-f response would then be flat in the upper sideband region and the lower sideband response would be shaped to match that of the video network.

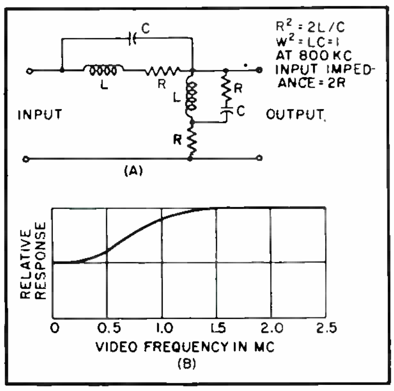

FIG. 7—Amplitude-correcting network for use at video-frequency level

Video Network

A suitable network for this purpose is shown in Fig. 7. This network has a constant resistive input impedance and could be used as the detector load or video amplifier load in a receiver.

The response shown at (B) has the desired two-fold increase at the higher frequencies. When the experimental system was suitably modified to include this network in the receiver output, the results shown in Fig. 8 were obtained.

The transmitter characteristic is flat over most of the passband but the lower sideband response is shaped to match the video network that has been included in the receiver.

The response of the carrier-frequency circuits of the receiver is also substantially flat, with the response maintained as far as possible into the lower sideband region; that is, down to about −1 mc. It then cuts off sharply to obtain about 45 db attenuation at the adjacent sound frequency. The overall square-wave response of the system (C) is again substantially free from distortion for any modulation factor up to the maximum of 0.714.

Similar to Standard

It will be noted that the transmitter characteristic differs very little from the present standard.

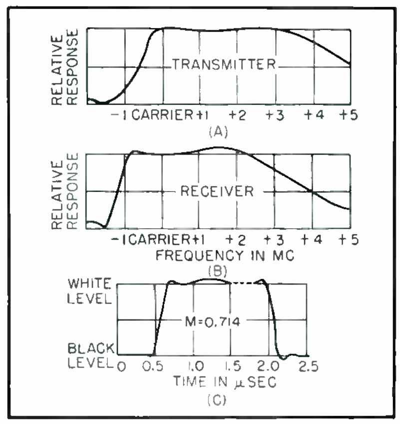

FIG. 8—Transmitter (A), receiver (B) and square-wave (C) characteristics of proposed system standards

The lower sideband response starts sloping off closer to the carrier but the actual amplitude-frequency response is still within the limits specified by the FCC and RTMA. Such a transmitter would then provide substantially the same service to present receivers as that from existing transmitters. However, by carefully controlling the transmitter lower sideband a considerably improved transient response could be obtained from receivers adjusted for this modified transmission characteristic.

Selective Erasure of

Methods of minimizing layer-to-layer transfer of signals in magnetic tape recordings during storage are analyzed. Best results are obtained by using weak erasing field during playback to suppress level of cross-talk without appreciably attenuating desired signal

IN MAGNETIC RECORDING, the tendency of one layer of tape to be magnetized by the field of the layer of tape against which it is wound has been studied empirically.[1,2,3] In two papers[4,5] dealing with theory and experiment, a method has been outlined for reducing the layer-to-layer transferred signal by a process of selective erasure. The present study is concerned with this process.

It has been shown[6] that the ease with which a recording can be erased is a function of the bias current used in recording it. The greater the bias current, the more difficult is the recording to erase. A signal which is recorded by layer-to-layer transfer is essentially a recording which has been made with zero bias current and might be expected to be easier to erase than the recorded material. With certain limitations, this is found to be the case.

Erasure Tests

Tests were made by recording reference signals on every sixth layer of a roll of freshly demagnetized tape. After various times of storage they were reproduced to get the level of the two layers adjacent to the recorded one. In tests of this type it is necessary to standardize carefully many factors that affect cross-talk, including bias level, use or absence of bias in unrecorded layers, time of wind (and rewind, if used), temperature, tape tension and other factors[1,4]. In reproducing, an erase head was arranged to provide variable fields from zero up to those which completely erased, so that the relative effects of weak erasure on recorded and unwanted signals could be measured.

It was found, as expected, that the unwanted cross-talk signals were more easily erased than the recorded signals. A small erase current (about 1/10 the normal one) would reduce cross-talk signals by 6 or 8 db without any effect on the recorded signal, or the cross-talk could be reduced 10 or 12 db while only reducing the recorded signal 1 db.

Effect of Frequency

These measurements were made on a single frequency but the problem for program material is more complex, because the ease of erasing signals with most heads varies with frequency. Furthermore, this dependence upon frequency is different for different head geometries. If the partial erasure is done by a recording head with a short gap, the field gradients near the gap are large, and short wavelengths are much more easily erased than long ones.

A typical erase head with longer gap produces a more uniform field through the thickness of the tape. A large air-core solenoid can be arranged to give a nearly perfectly uniform field if the tape is run through it. (Such solenoids are not practical for erasing recordings but can be arranged easily to give the fields necessary for selective erasure.) Since short wavelengths are not important in cross-talk but are important in recorded material, the best selective erasure head is one that gives most low-frequency erasure and least high-frequency erasure.

To test this, signals were recorded as above except that a high-frequency tone was also recorded. This tone was used to determine the frequency selectivity of the erasing process on recorded signals. After storing the recorded roll for 16 hours at 65 C, the tape was subjected to selective erasure fields of varying intensity from three sources: an Ampex recording head with 0.001-in. gap; an Ampex erase head with 0.020-in. gap; a 50-turn solenoid ½ in. long, ½ in. inside diameter and 1½ in. outside diameter, having a substantially uniform 60-cps field directed along the length of the tape. The results are summarized in Fig. 1.

It was found that for a given reduction of the printed signal, the 1-kc signal was reduced by about the same amount in all three cases. However, the high-frequency recorded signal was affected to a much greater extent and it was in this respect that the three methods differed markedly. The solenoid produced the least deterioration of the high-frequency signal, followed closely by the erase head, with the recording head running a very poor third. While the solenoid appears to be the most desirable means for selective erasure, practical considerations such as overheating, stray fields and cumbersome tape threading through the solenoid will probably prevent its widespread use.

The quantitative laboratory data in Fig. 1 are restricted to pure tones. They are also for particular heads and recording bias; results will vary somewhat for other experiments. As is often the case, the most satisfying proof of the

> **REDUCING CROSS-TALK**
>
> Avoid excessive peak record levels.
>
> Store reel in cool place, away from stray magnetic fields.
>
> Check recorder to make sure no stray fields affect tape in the supply or take-up positions.
>
> Rewind the recorded tape occasionally, especially during the first few months of storage.
>
> If necessary, use selective erasure to reduce cross-talk magnetization while reproducing

Magnetic Tape Cross-Talk

By ROBERT HERR and ROBERT A. von BEHREN

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usefulness of the technique is in tests of program material. In this sort of test, the following observations have been made.

The conditions for detectable cross-talk in actual program material are rather restrictive, so that it is rather infrequently encountered. Barring the occurrence of magnetic fields or high temperatures, printed signals are in the range of 50 to 60 db below the signal level even after a few years storage. This requires the complete absence of signal and a very low noise level in order to permit detection of the transfer. One procedure which aggravates the transfer effect is to commence a recording on a thoroughly erased tape in the middle of a loud program passage. Upon subsequent reproduction of this tape, the alert listener is almost certain to be forewarned of the impending affront to his eardrums. In these cases, selective erasure can be utilized to reduce the transfer to the point of insignificance if not inaudibility.

Effect of Rewinding

The effect of selective erasure upon the transferred signal is not permanent, inasmuch as a new transfer signal is started as soon as the tape is rewound. The print level will again rise as the tape is stored, but should the tape be unwound at any time, the cycle will be interrupted. For this reason tapes which are frequently replayed would be expected to give less trouble than those which are stored undisturbed. Subsequent erasures using the same device and the same field intensity will restore the transfer signal to approximately the same level as did the first erasure.

The program will suffer some deterioration during the first selective erasure, but the identical process can be repeated any number of times without resulting in any additional change in the program. Therefore, if the erase level is carefully monitored, it may be desirable to use selective erasure as a routine procedure whenever tapes are played back. In this case, the equalizers can be adjusted to restore the slight high-frequency loss in the process.

Practical Considerations

Unlike some conceivable methods for the control of layer-to-layer transfer, the selective erasure process is a very practical one. For example, in a conventional type of recorder, it is only necessary to arrange that the bias or erase supply is operated at a suitably reduced power instead of being turned off during the playback operation. Depending upon how generously designed the normal erase current is, the value used for selective erasure may be from $\frac{1}{10}$ to $\frac{1}{5}$ the normal current. The possible variations in switching technique to accomplish this are large in number but need not be complex. It is necessary that the high-frequency supply operate during reproduction, so the method is not applicable to some types of home recorders, as for example, those where the oscillator tube is used as the power output tube in reproduction. However, it is expected that this technique would never be required except for high-quality professional recordings. The use of selective erasure on any professional recorder would present no problem. Patents on the use of selective erasure have been applied for.

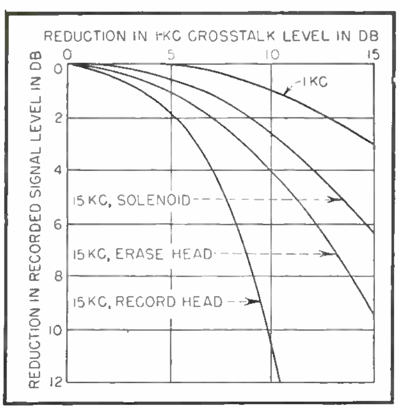

FIG. 1—Effect of selective erasure fields produced in three ways, when using 15-kc recorded signal. With 1-kc signals, all three erasing devices give the same results, represented by uppermost curve

One limitation to the application of this selective erasure is in the nature of the magnetic tape which is used. On some magnetic recording tapes, the recording becomes more difficult to erase with time of storage. On such tapes, selective erasure may only be effectively used for a short time after recording. Since serious levels of transfer generally occur only after considerable storage times, this means that the process is nearly worthless with such tapes. The data in this paper were taken with "Scotch" sound recording tape No. 111 and are typical of the results which can be obtained with this tape and comparable tapes and films made from the same magnetic oxide. The process is relatively useless with tapes made from other oxides by the Minnesota Mining and Manufacturing Co. Among other domestic and foreign tapes of different types a wide range of behavior from good to poor in this respect will be found.

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Nonsynchronous Pulse

Voice transmitters use one frequency simultaneously but no synchronizing pulse is necessary, although time-division multiplexing is used. Random samples from each transmitter are tagged for identification at proper receiver. System is applicable to rural telephony and moving-vehicle communication

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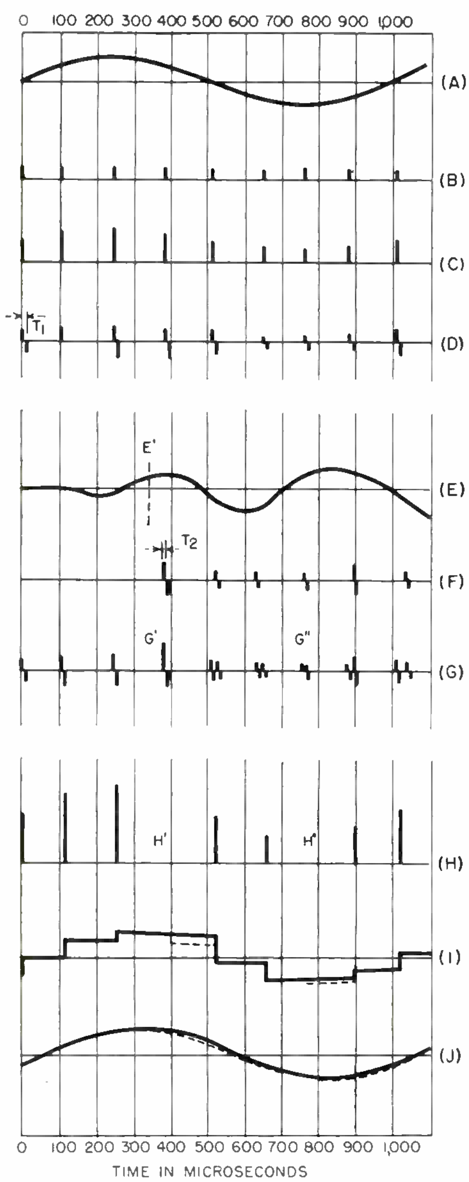


How It Works

Input wave form to transmitter 1 (A) is randomly sampled by pulses (B) to produce amplitude-modulated pulses (C). These pulses are paired by a delay line and made equal and opposite by a combining amplifier.

Modulated and coded pulse groups (D) are transmitted to a common medium.

Code delay T_1 tags sampling pulses originating in transmitter 1.

Input waveform to transmitter 2 (E) produces a similar set of modulated and coded pulse groups (F). However transmitter 2 is inactive due to lack of input until voice relay operates (E').

Code delay T_2 tags sampling pulses originating in transmitter 2.

Transmitter outputs (D and F) are superimposed on common medium as shown in (G).

Receiver recognizer selects pulse groups from transmitter 1 by their unique spacing (H). Anomalous pulse groups caused by interference between transmitter outputs (H' and H'') are rejected by all receivers.

Step wave (I) is obtained when amplitude-modulated pulses are integrated by the storage capacitor.

Low-pass filter reforms original audio wave (J). Some distortion is caused by missing pulses. Dashed lines show undistorted output

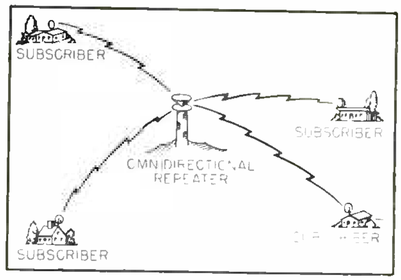


FIG. 1—Nonsynchronous pulse-multiplex may be applied in rural

Several independent speech transmitters using a time-division multiplex system that employs random sampling may transmit simultaneously over a single broadband carrier. From a sample of its input, each transmitter sends a group pulses into the common medium. This pulse group is coded at the transmitter so that it may be accepted by the proper receiver. Interferences between transmitters are reduced by sampling at irregular internals. No synchronizing pulse is required and the transmitters need not be interconnected.

A possible application of the system to rural telephony is shown in Fig. 1. It consists of a number of subscriber stations with directive antennas pointed at a central omnidirectional repeater. Each subscriber transmits on a common frequency. Subscriber transmitter powers are adjusted so that the repeater receives all signals at approximately the same level. The repeater amplifies the received sig-

Multiplex System

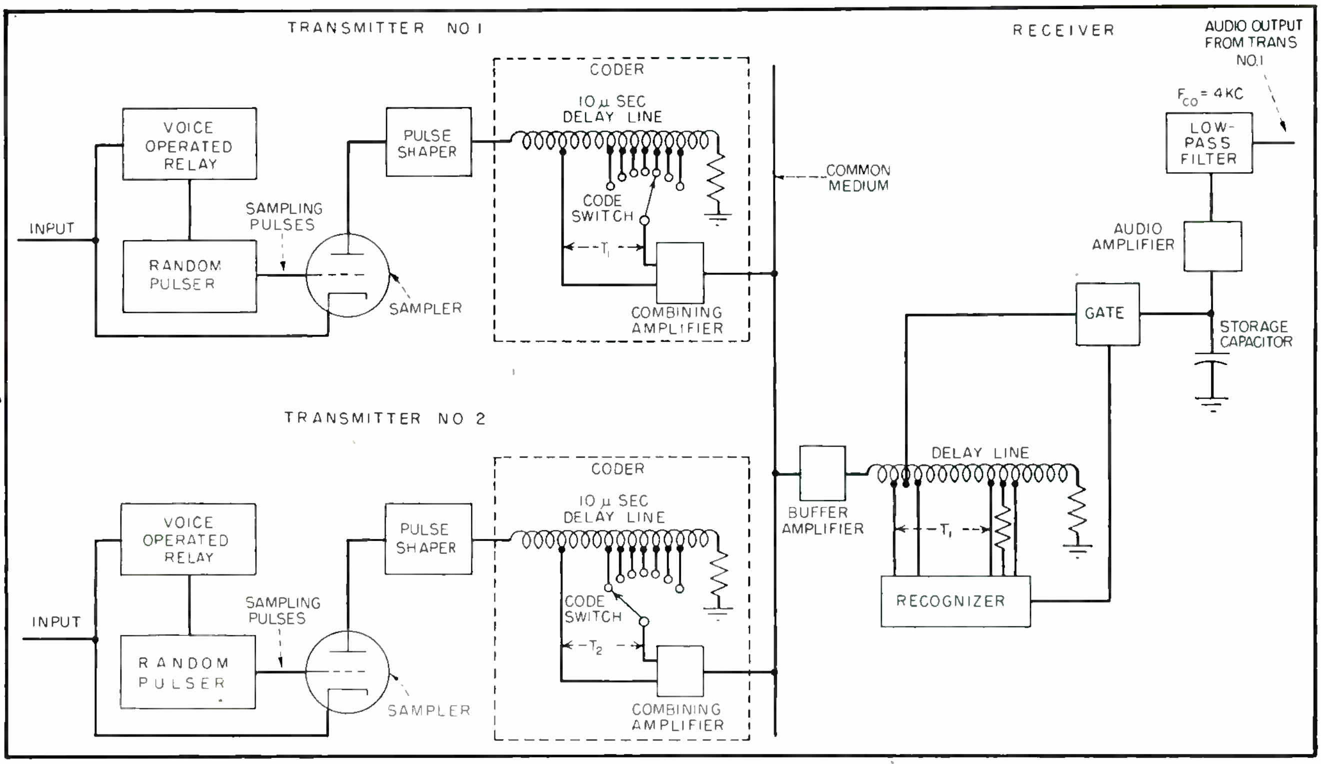


FIG. 2—System block diagram shows how receiver recognizer distinguishes between transmitter outputs by code delay introduced between pulse pairs

nal pulses, changes frequency and reradiates omnidirectionally.

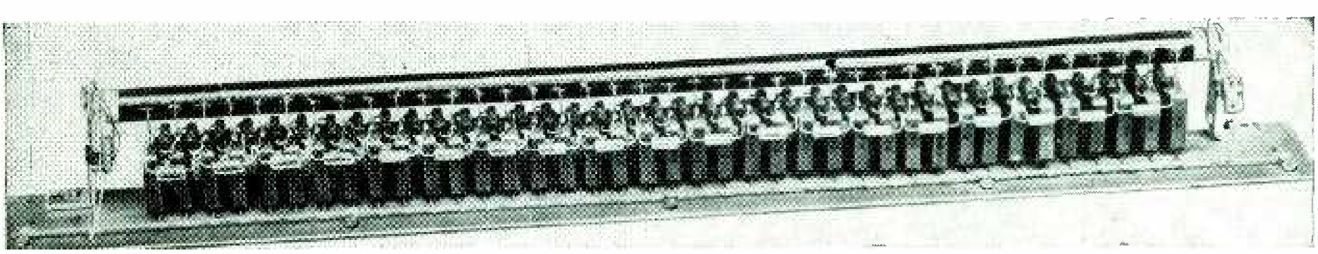
The system provides both for talking and automatic switching. Each subscriber is assigned a pulse-code group to which his transmitter and receiver will revert when the hook is down. When a certain party is dialed, the caller's transmitter emits pulse groups corresponding to the number dialed. When the called party answers, both parties talk using the pulse-code group of the called party.

The system may also be used for communication between moving vehicles and ships. Here synchronous time-division multiplex seems ruled out because of a number of paths of changing delay involved. Likewise, frequency-division multiplex may be difficult because of the excessive linearity requirements that it imposes on the repeaters.

Nonsynchronous System

Each transmitter consists of five major units as illustrated in Fig. 2. When the audio input is sufficient to operate the voice relay, the random pulser supplies a train of irregularly spaced enabling pulses to the grid of the sampler. Meanwhile, the audio input is applied to the sampler cathode. The output of the sampler, a train of irregularly spaced, amplitude-modulated pulses is passed through the pulse shaper to the coder. Here each sampling pulse is changed into two equal and opposite pulses separated by a constant delay as determined by the position of the code switch on a ten-microsecond delay line. This code delay identifies the pulse group as having originated in a particular transmitter after it is transmitted through the common medium.

At the receiving end, the recognizer continuously monitors the wave train from the common



Same delay line is used for both transmitter coder and receiver recognizer

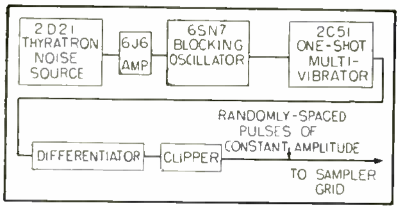


FIG. 3—Random pulser uses 2D21 thyratron as noise source for generating irregularly-spaced keying pulses

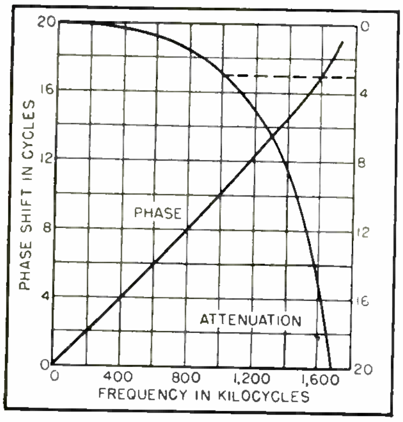


FIG. 4—Attenuation and phase characteristics of 10-microsecond delay line

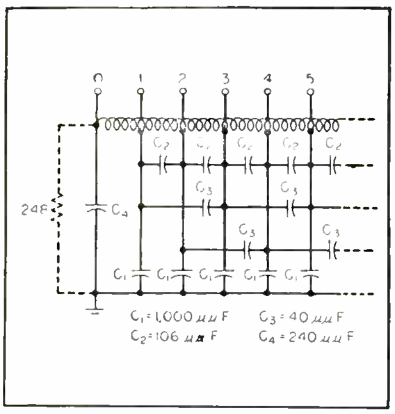


FIG. 5—Compensating capacitors help achieve phase-linearity in delay line

medium as it travels down the delay line. Each time a pulse group separated by the proper delay code appears, the receiver gate operates passing the information pulse to the storage capacitor. The storage capacitor holds its charge for each operation of the gate. The resulting step waveform is passed to the low-pass filter where the original audio waveform is reconstructed.

Random Pulser

The random pulser is shown in Fig. 3. It uses a 2D21 thyratron as noise source to permit generating randomly-spaced pulses. The noise is amplified by a 6J6 then fed to the grid of a blocking oscillator. Because the amplitude of the output of this stage varies considerably with repetition rate it is necessary to add a one-shot multivibrator that has a minimum of amplitude modulation in its output. After differentiating and clipping, randomly-spaced pulses of constant amplitude are available to the sampler grid.

Audio input is connected to the cathode of the sampler and also to a voice-operated relay through an amplifier. When there is no audio input the relay is released biasing the grid of the one-shot multivibrator beyond cutoff so that only during talk spurts are the random pulses sent to the sampler grid and thence to the common medium. This increases channel capacity by having the transmitter turned off during silent intervals in conversation.

Delay Line

The same delay line is used in both transmitter and receiver. As shown in the photograph, the line consists of a continuously wound solenoid approximately 20 inches long having a total delay of approximately 10 microseconds and a characteristic impedance of 248 ohms. Taps are located approximately ½ inch (¼ microsecond) apart. The attenuation and phase characteristics of the line are shown in Fig. 4. The line is about 3 db down at one megacycle with linear phase up to about 1.4 megacycles. To achieve the phase linearity shown in Fig. 4 it is necessary to use compensating capacitors in addition to the ordinary low-pass elements. As shown in Fig. 5 capacitors C_2 are bridged between adjacent taps and C_3 between alternate taps.

Pulse Shaper

Pulses delivered to the common medium must be shaped so as to be as nearly noninterfering as possible. Hairpin pulses with no preceding or succeeding overshoots or undershoots would be ideal but would require infinite bandwidth. Figure 6 shows the filtering used and the resulting pulse shapes. The sampler plate pulse A is about 0.4 microsecond long at the base. This pulse is fed to a two-section constant-resistance filter. The sections of this filter are tuned to resonate at 1.4 and 1.7 mc. The output of the filter *B* is a jagged wave due to the filter's transmitting frequencies beyond cutoff. By passing this wave through four sections of delay line these irregularities are smoothed out as shown at *C*. Further passage of the wave down the delay line results in additional overshoots and undershoots. The wave shape at the end of the line is shown at *D*.

Corresponding to the desirable pulse shown at *C*, the attenuation characteristic of the filter plus four sections of delay line is shown in Fig. 7. There is seen to be little deviation from the ideal Gaussian cutoff. The approximate bandwidth of the experimental system is about 0.5 megacycle corresponding to pulses about 2 microseconds long at the base.

Recognizer

The recognizer must enable the receiver gate only when the proper code is received. This is done as shown in Fig. 8 by sampling the voltage amplitudes at four points along the receiver delay line: *A*, *B*, *C* and *D*. The transmission delay between taps *A* and *C* or *B* and *D* must be the same as the interpulse spacing T_1 of the desired pulse pair. It is assumed that the desired wave (1) has traveled down the delay line (2) to the position shown by the correlation of (1) and (2). At this instant voltages could be measured

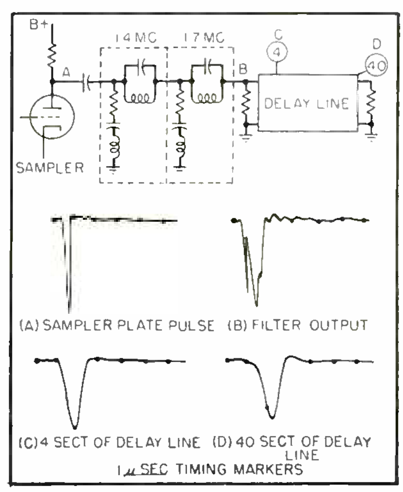


FIG. 6—Pulse shaper smooths pulses to forestall pulse interference

at taps *A*, *B*, *C* and *D*, corresponding to wave amplitudes *A*, *B*, *C* and *D* shown directly above. The voltages so measured may now be compared in bridge resistance networks. At the instant shown by the correlation of (1) and (2) the voltages are related as shown in Fig. 8B at the upper right.

If all four voltages are zero none of the diodes conducts and no pulses are fed to the grids of differential amplifier G_1. When zero voltage is fed into both inputs of this amplifier its output voltage will be zero as at a point *X* in the wave.

Point *X* satisfies the requirement that all four voltages are equal but we must also insure that they are not all zero, that is that some pulses are present. This is done by a fifth tap on the line that provides an enabling pulse to G_3 of the mixer. These voltages coincide on the grids of the mixer to produce a short pulse out of the recognizer to operate the gate.

Gate Circuit

The gate circuit is shown in simplified form in Fig. 9. A sample from a tap on the delay line is fed through a cathode follower to the gate input. The gate is of the double-diode type driven by transformer T_1 having balanced secondary windings and biased in the conventional manner. If the gate were driven directly from the recognizer output the gate operating pulses would vary in amplitude as shown at *A* owing to modulation and marginal conditions of interference. To avoid distortion, this pulse is regenerated by a one-shot multivibrator producing pulses of constant amplitude. This avoids noise from partial or marginal operations of the gate.

To avoid distortion the storage capacitor should fully charge and hold its charge indefinitely for each operation of the gate. Since the gate is operated for only ¼ microsecond and may be unoperated for 100 to 250 microseconds (allowing for randomness and a missed sample) a compromise value of *C* must be used. The larger values of *C* make the step wave flatter but cause a loss of high-frequency response. Smaller values cause the steps to slope more and increase distortion due to random sampling. A compromise value of 300 μμf was found most satisfactory. The need for a 10-megohm back resistance dictates the choice of 6AL5 diodes for the gate.

The response of the low-pass filter and the overall audio characteristic of the system is shown in Fig. 10. The difference in the curves results from incomplete charging of the storage capacitor.

Signal-to-Noise Ratio

The results of 1,000 cps signal-to-noise measurements at the output of the system are shown in Fig. 11

> **NO SYNC PULSES**
>
> Multiplexing, or putting a number of speech channels on a single broad-band carrier is accomplished by two general methods:
>
> (1) Frequency division, in which the band is divided into discrete frequency bands corresponding to the several intelligence channels.
>
> (2) Time division, in which the entire band is used for each channel with only one channel using it at any instant.
>
> In time-division systems such as pulse-amplitude modulation (pam), pulse-code modulation (pcm), and pulse-position modulation (ppm) speech channels are sampled at different times and pulses corresponding to these channels sent over the common medium and reformed into speech waves at the receiving end.
>
> Existing systems sample the speech channels at regular intervals and in the same order. This requires a synchronizing pulse and the speech transmitters must be interconnected.
>
> The system described makes use of random sampling. The speech channels are sampled at irregular intervals. No synchronizing pulses are needed and the transmitters need not be interconnected.

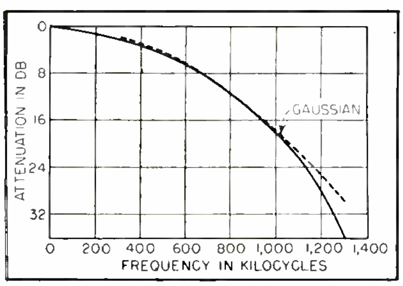


FIG. 7—Attenuation characteristics of pulse shaper

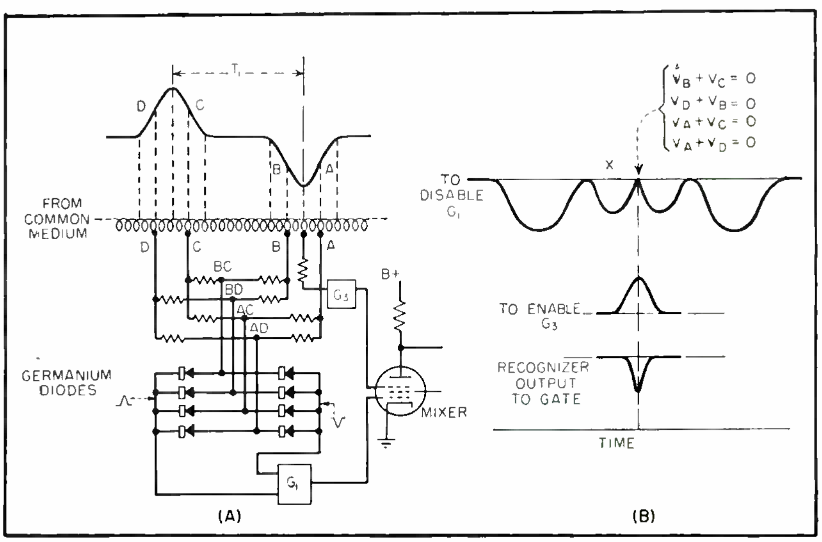


FIG. 8—Recognizer opens receiver gate only when pulse pairs separated by proper delay code are received. Pulse train is sampled at five points along delay line

in which noise plus distortion is plotted as a function of total output. Tests were made both with and without an interfering transmitter.

To obtain noise-plus-distortion readings, the 1,000-cycle signal was fed around the complete system from input to output with proper attenuation and phase shift to cancel the signal at the output.

Noise and distortion increase with the signal when both transmitters are operating. This behavior is to be expected when the effect of missing samples is considered. As shown in Fig. 11, maximum signal-to-background-noise ratio is about 42 db. However, maximum signal-to-noise plus distortion ratio at high levels is only about 20 db.

Interference Effects

A rough idea of the interfering effects of a number of transmitters is obtained by driving the interfering one at rates that are various multiples of 8 kc. Each simulated added transmitter degrades the signal-to-background-noise ratio by roughly 3 db. Thus with five simulated interfering transmitters this ratio drops from 42 db to about 30 db.

Listening tests were conducted in which each transmitter was fed from its own tape recorder while the receiver was arranged to accept signals from either one or the other. In general the operation of the second transmitter did not interfere with intelligibilty at normal talking levels although the transmission was judged to be below toll quality. The loss-of-sample distortion causes a certain rasping quality of speech. When more interfering transmitters are stimulated, distortion becomes progressively worse as expected. It appears that speech intelligibility would still be tolerable with between five and eight active interfering transmtters.

Features

The proposed system has a number of attractive features: the number of distinct assignments that can be made in a given channel is limited only by the video delay incorporated in receivers and transmitters; repeaters need not be linear to avoid crosstalk and for some forms of modulation nonlinear or even limiting repeaters can be used; and crosstalk is unintelligible noise proportional to signal amplitude.

Since each subscriber is assigned a specific number or pulse-code group to which his transmitter and receiver both automatically revert when the hook is down, the system provides inherently for both talking and automatic switching. However, among the several subscribers at distant exchanges, there need be one or more operators to provide communication between local exchanges.

The system has one outstanding disadvantage. It is not economical of channel capacity with respect to the number of simultaneous transmissions that it can handle as contrasted with the large amount of distinct and always available channel assignments than can be made with a synchronous system.

Conclusion

Experiments show that the quality of speech transmission is below toll system standards. In general, such a system might be useful where transmission of intelligence rather than high quality speech is of primary interest.

J. R. Pierce originally proposed and analyzed the principles of this system. In developing the system experimentally, the author was assisted by J. L. Wenger.

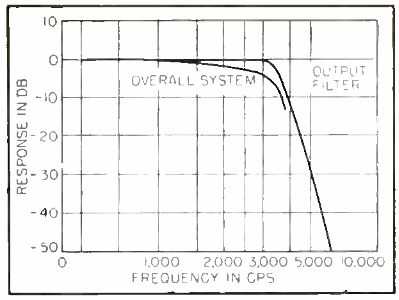


FIG. 10—Frequency response of output filter and overall system characteristic

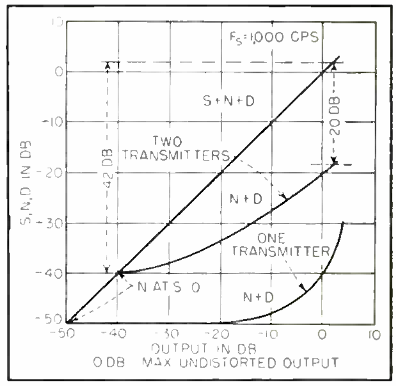


FIG. 11—Overall system signal-to-noise characteristics

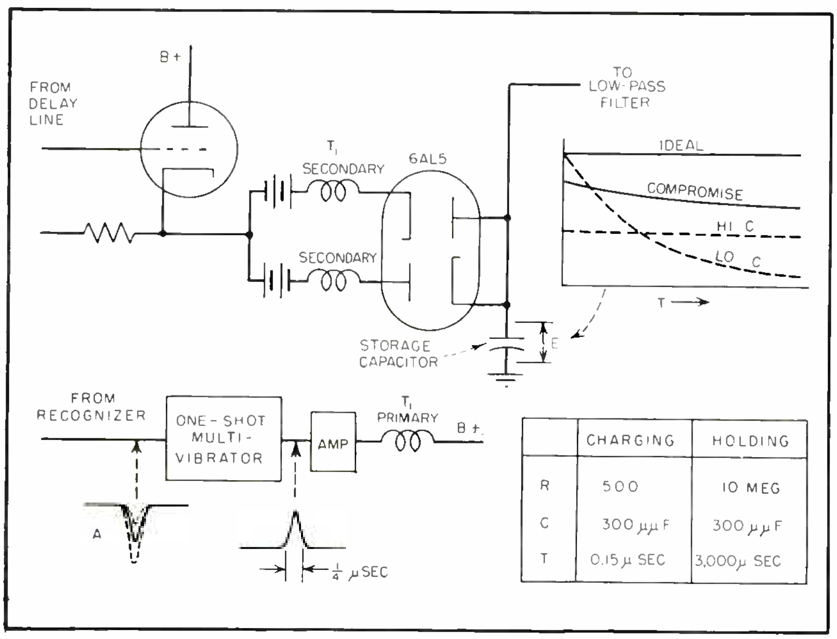


FIG. 9—Recognizer drives receiver gate through multivibrator and balanced transformer

Vibration Recorder Tests Army Packaging

In studies of shocks transmitted to a packaged article, nine accelerations are measured simultaneously and data recorded on magnetic tape that is played back slowly for chart recording. Pulse-width modulation system avoids distortion due to tape inhomogeneities

By J. A. SARGEANT and R. D. CAMPBELL

Engineer Research and Development Labs. Fort Belvoir, Va.

Reed Research, Inc. Washington, D. C.

Carefully controlled experiments to correlate cause and effect in damage to packaged articles are being conducted at the packaging development laboratory, Engineer Research and Development Laboratories, Fort Belvoir, Va. These experiments require the recording and analysis of forces transmitted to the contents of packages submitted to controlled shocks or vibrations. The forces are detected by electronic accelerometers located at various points of interest and their outputs remotely recorded for subsequent analysis.

Requirements for associated recording equipment are unusually stringent in an effort to reproduce faithfully data from several accelerometers and to have the records available for analysis in the shortest possible time following the experiment. The E.R.D.L. packaging branch assembled the specifications for recording equipment and turned the problem over to Reed Research Inc., Washington, D. C. for development and fabrication.

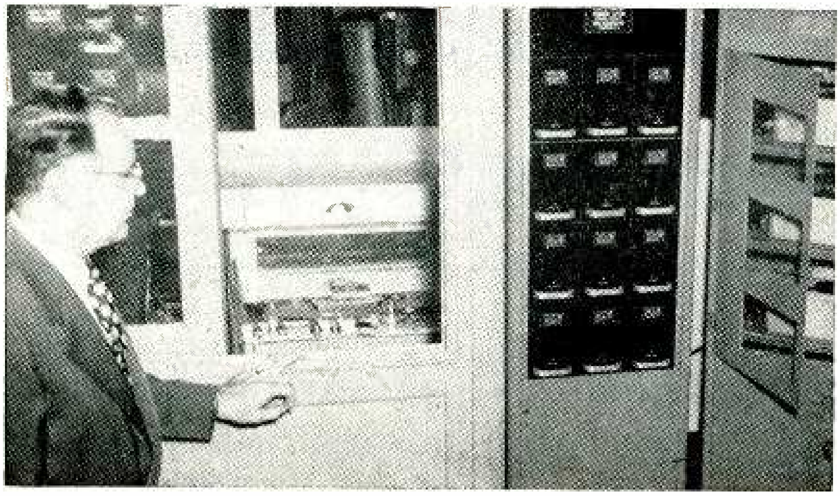
The shock and vibration recorder, shown in the photograph, simultaneously records nine accelerations and one set of timing signals. The frequency response of the data channels extends from 2 to 500 cps and full-scale acceleration is ± 80 g.

Figure 1 is a block diagram illustrating the operation of the equipment. Output data are recorded by direct-writing oscillographs, without recourse to photographic techniques. Since these oscillographs cannot record the desired frequency range directly, the data are first recorded on magnetic tape, which is then played back at one tenth its original speed; thus reducing all frequency components of the data to $\frac{1}{10}$ original frequency.

This feature effectively increases frequency response of the oscillograph tenfold and gives a corresponding increase in time scale on the chart paper. A ten-minute test on the acceleration table therefore requires an hour for recording. To achieve this time scale directly, however, would require a chart speed of 50 inches per second which is impractical for multiple-channel chart paper.

A precise method for magnetic-tape recording is necessary in order that the data be uncontaminated in the recording and playing back

Instrument container with accelerometers attached mounted for acceleration-table test. Table connects to vibration recorder housed in shelter, left



Vibration recorder shelter. From left to right, major components are: record modulator-amplifier; magnetic-tape recorder; playback demodulator-amplifier; and strip-chart recorder

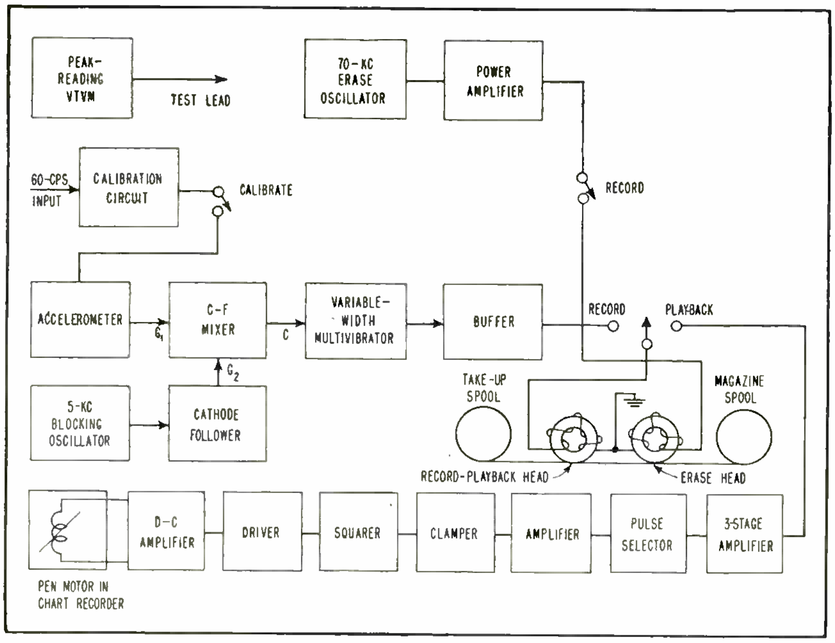


FIG. 1—Block diagram shows how system frequency response is extended using tape recorder to play back data at reduced speed

processes. This precision requirement excludes ordinary amplitude and frequency-modulation methods. The former is unsuccessful because of occasional clumps of particles in the tape coating whose ability to retain magnetism may be 20 to 50 percent below average. Frequency-modulation methods likewise introduce error since variation in tape speed appears, in magnified form, as a shift in the base line.

Pulse-Width Modulation

Pulse-width modulation is used. This technique consists of recording square waves whose period is constant but whose ratio of on to off time is varied by the signal. Thus, zero input is represented in Fig. 2A by a symmetrical square wave. Full-scale positive modulation, Fig. 2B, is represented by a square wave on 75 percent of the time and off 25 percent. Similarly, full-scale negative modulation is represented in Fig. 2C by a square wave on 25 percent of the time and off 75 percent. Figure 2D shows how demodulation restores the original a-m waveform.

The record modulator-amplifier circuit is shown schematically in Fig. 3. Intelligence is received from each of nine accelerometers in the form of an a-m voltage wave. Nine separate record modulator-amplifier channels convert this energy into a pulse-width modulated signal with a pulse repetition frequency of 5,000 pps.

Each modulation channel terminates in a separate record-playback head located in the control console. Tape speed while recording is 60 inches per second.

Magnetic-Tape Recording

The pwm signals are impressed upon magnetic tape as magnetized areas of alternate polarity. On playback, a different wave shape is obtained but the original square wave is capable of reconstruction by conventional circuitry. Similarly, variable amplitude of the recovered signal is of no importance. The tape is played back at 6 inches per second. Nine sparking stylii record the channel outputs on current-sensitive Teledeltos paper. Chart speed is variable from 0.5 to 5 inches per second.

It can be shown that variation in tape speed introduces only second-order errors. The reconstructed square wave is passed through a low-pass filter whose output is the average value of the square wave. This average value cannot depend upon tape speed as long as variations are slow compared with pulse-repetition frequency. It is evident that this average value must represent the original modulation.

The accelerometers are attached to significant points of the container to be tested. The accelerometer used here is a grounded-grid 5734 triode with movable anode. As acceleration increases, so does the plate-to-cathode voltage gradient causing a proportional increase in plate current. A signal is developed across the grid resistor of the cathode-follower mixer, shown in Fig. 3, wherein a voltage-rate-of-change of approximately 1.52 mv represents 1 g acceleration.

The pulse train from the 5-kc blocking oscillator is applied to the opposite grid of the twin-triode cathode follower. The output of the mixer is coupled to the input of the cathode-coupled multivibrator. Dwelling time of the multivibrator is adjusted by the zero-set potenti-

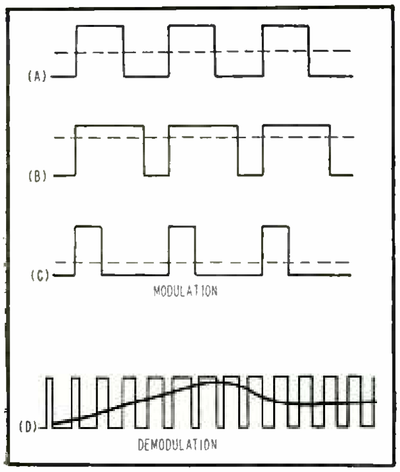


FIG. 2—Typical waveforms illustrate pulse-width modulation technique

ometer in the mixer grid circuit. The blocking oscillator pulse produces a positive output pulse from the multivibrator every 200 microseconds. In the absence of any input from the accelerometer, the output is a positive square wave of constant period. However, the signal from the accelerometer varies the bias on the multivibrator input grid and, correspondingly, the width of the output pulse.

Circuit Details

Figure 4 is a schematic of the playback-demodulator circuit. The input from the record-playback head is amplified by three class-A triode stages and applied to a double-diode pulse selector which selects only the tips of the pulses. The selected pulses are fed through a one-stage amplifier to a squaring tube, the output of which is a square wave having a movable leading edge and corresponding to the output waveform of the record multivibrator. This waveform is applied to a push-pull driver-demodulator stage wherein most of the 500-cps carrier component is removed

The two-stage frequency-compensated d-c amplifier provides low-frequency gain with an essentially flat response from d-c to above 50 cps. A cathode-follower output tube drives the stylus motor of the channel strip-chart recorder.

The linearity of the combined modulation and demodulation process is on the order of one percent. Frequency response extends well beyond 500 cps and square waves at 200 cps are quite recognizable on playback. The system resolves a square wave with a double overshoot two percent of maximum amplitude and a rise time of 0.7 millisecond. Signals due to tape noise have been reduced to about 50 spurious pulses per mile of tape. Throughout the remainder of the tape the signal to noise ratio is approximately 200 to 1.

In later models of this equipment, frequency response to 2,000 cps is achieved by using a recording tape speed of 60 inches per second and a playback speed of 3 inches per second. Data is reproduced faithfully on a strip-chart recorder whose response is only 100 cps.

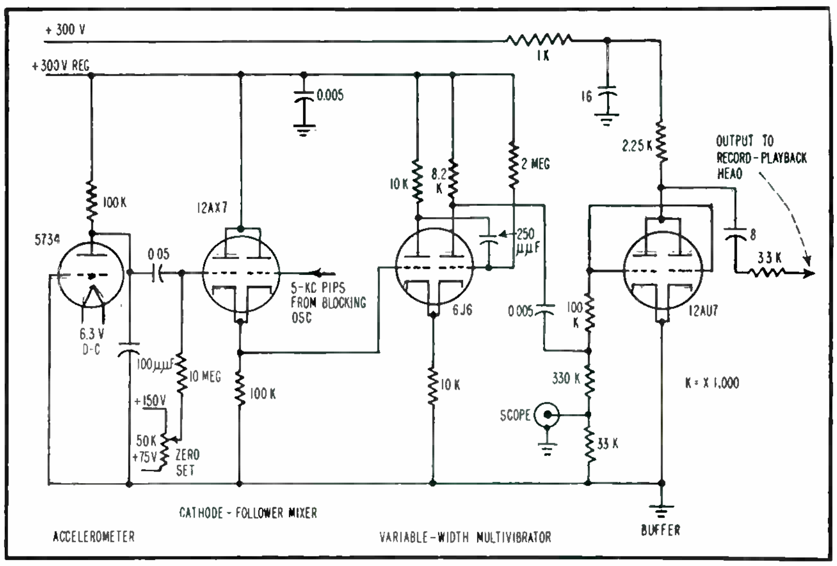


FIG. 3—Record modulator-amplifier converts a-m signal from electronic accelerometer to pulse-width modulated wave train for recording on magnetic tape

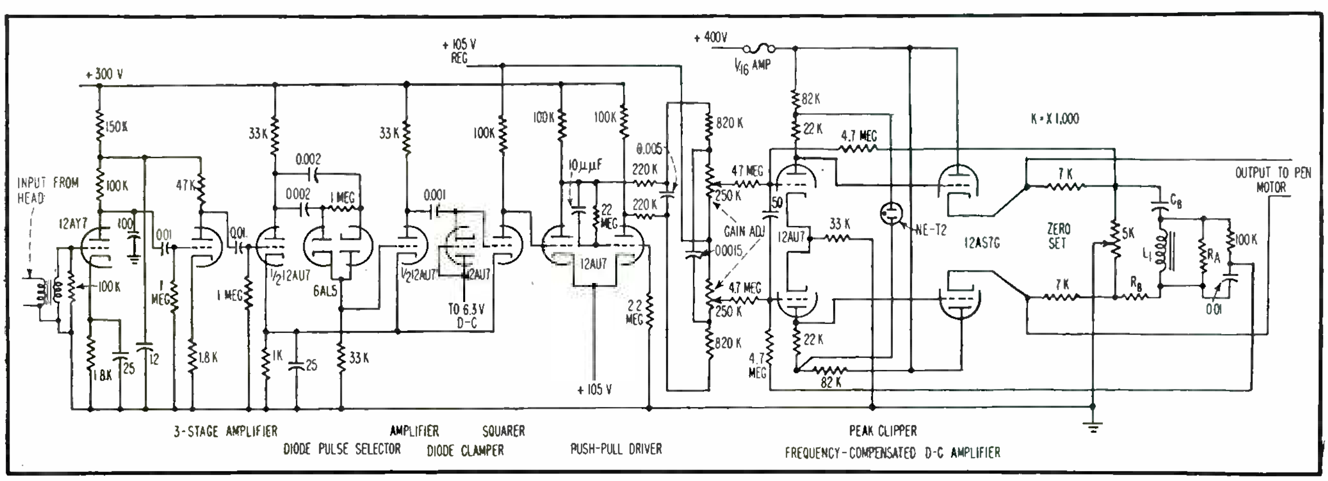
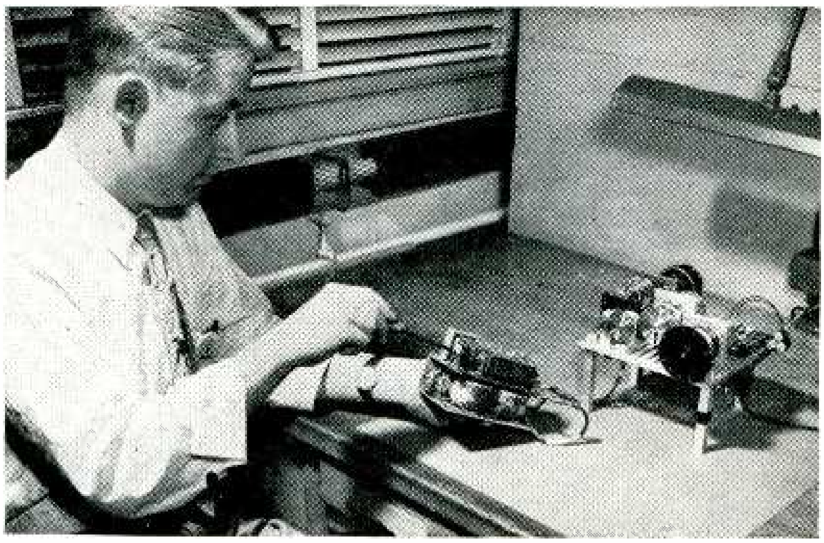


FIG. 4—Playback demodulator-amplifier restores accelerometer waveform for recording on strip chart. Tape recorder is slowed down to 1/10 record speed for playback

Half-Wave Magnetic

By CARROLL W. LUFCY, Program Leader; A. E. SCHMID, Project Leader; and P. W. BARNHART, Project Leader

Magnetics Division, U. S. Naval Ordnance Laboratory, White Oak, Maryland



Compact size of amplifier is evidence of half-wave circuit economy. Amplifier shown drives 5-watt servo motor

MAGNETIC AMPLIFIERS for instrument servo systems are currently undergoing considerable investigation. The recently perfected half-wave version shows promise for applications where a minimum speed of response, as well as reliability, long life, and ruggedness normally associated with magnetic amplifiers, are important.

At first it was thought that the output of the half-wave circuit would be unsuitable for driving the two-phase motors generally used in servo systems. This was disproved experimentally; a typical two-phase induction motor will produce at least half torque on a half-wave circuit, and much more if capacitors are used across the motor windings to tune them to the fundamental frequency.

The basic circuit found most useful for this application is shown in Fig. 1. The bridge configuration eliminates the need for a center-tapped return on the transformer secondary. As shown, two sets of windings appear on a single core, so that one stage requires but one pair of cores.

Either X_1 and X_2 or X_3 and X_4 could be removed from the circuit. However, all four rectifiers are included to eliminate completely any possibility for circulating currents in any leg or section of the bridge.

Flux Level Setting

One distinct advantage of the half-wave circuit arrangement is that during the half cycle when the power winding circuit is inactive, it has negligible effect on the control windings, thus permitting setting of flux levels with relative ease during these half cycles by the reference windings connected across the a-c line. The control winding need only furnish the incremental power required to override the reference winding and shift the flux along the magnetization curve. For materials exhibiting rectangular hysteresis loops, this power is quite small.

The bridge power windings are active only when the a-c line polarity is such that point X is positive. During this half cycle the flux in both cores is carried up the BH curve to saturation. At the end of this half cycle a large percentage of residual flux remains. During the succeeding half cycle, when no current flows in the power windings, the zero signal operating flux level is set as determined by the values of R_1 and R_2. Each core may be set independently to ensure balance. The use of separate reference windings, rather than using shunted rectifiers and allowing reverse current to flow through the power windings, permits higher gains.

In this circuit no response-improving resistance is needed in the control circuit since transients cannot exist over a complete operating cycle. When amplifiers are cascaded, the output of one is connected directly to the input of the next with no passive elements required.

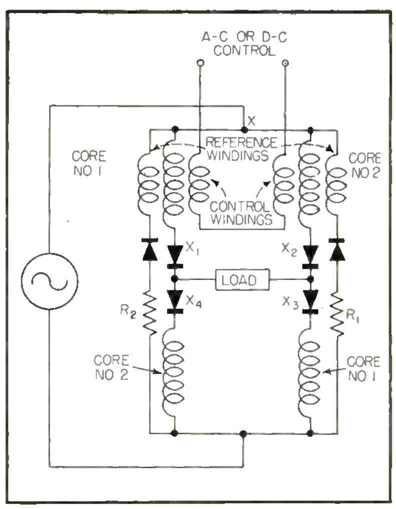


FIG. 1—Basic circuit shows use of bridge configuration to eliminate need for center tap transformer

This article is based on a paper delivered at the Summer General Meeting of the AIEE. The conference paper will appear in the *AIEE Transactions.*

Servo Amplifier

Circuit has possibilities for application in automatic feedback controls where reliability of operation and extreme ruggedness are important. Complete details of economical half-wave 60-cps and 400-cps magnetic servo amplifiers are given

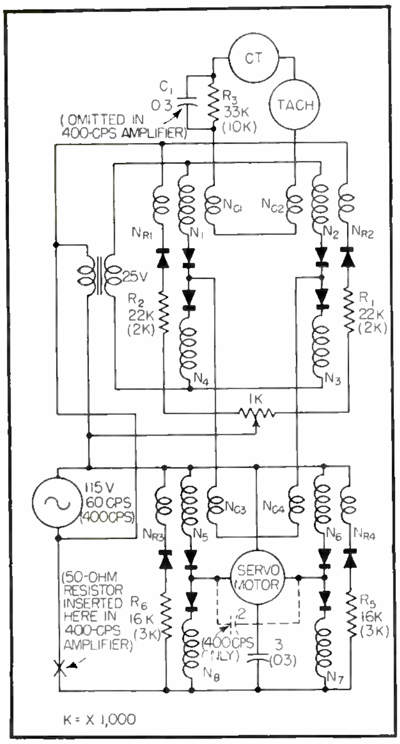


FIG. 2—Complete circuit showing parts values for 60-cps and 400-cps (in parentheses) two-stage magnetic servo amplifiers

The circuit has been used in both 60- and 400-cycle applications to obtain performance superior to that obtainable with conventional full-wave circuitry. The over-all time response of a two-stage amplifier is 1½ cycle (1 cycle for the first stage, and one half for each succeeding stage). In comparison to conventional full-wave circuitry, the number of parts required is about half, with resultant savings in cost, size and weight.

Cores and Windings

Figure 2 shows the complete circuit with values for 60-cycle operation and 400-cycle operation in parentheses. The resistance R_3 in series with the input circuit ensures a certain minimum input impedance, which is desirable where synchro components are used for error detection in a servo system. The capacitor C_1 around the input resistor of the 60-cps amplifier adjusts the phase to obtain slightly better performance.

The cores used are all tape-wound toroids made of 50-percent iron, 50-percent nickel grain-oriented material having a very rectangular hysteresis loop. Each core bears two power windings, a reference winding and a control winding. Core and winding specifications for a two-stage amplifier are shown in Table I.

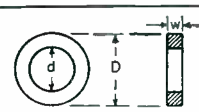
The 60-cps amplifier was designed to operate a Ford Instrument Company 5-watt low-inertia servo motor, presenting an impedance of about 250 ohms to the amplifier. The 400-cycle amplifier operated a U. S. Navy, Bureau of Ordnance MK 16 Mod O servo motor with an impedance of 365 ohms.

The two amplifiers described were tested on typical closed-loop servo systems. Stabilization was provided by a tachometer generator mechanically linked to the motors, the tachometer signal being fed back as an error signal.

Highest available slewing rates are 550 and 1,000 deg per sec for the 60- and 400-cycle versions respectively. Voltage gains are 12 (60-cycle) and 20 (400-cycle), while respective static errors amount to less than 0.1 and 0.01 degrees. Following rate for the 60-cycle system is 1 deg per 60 deg per sec, while that for the 400-cycle servo is 1 deg per 200 deg per sec.

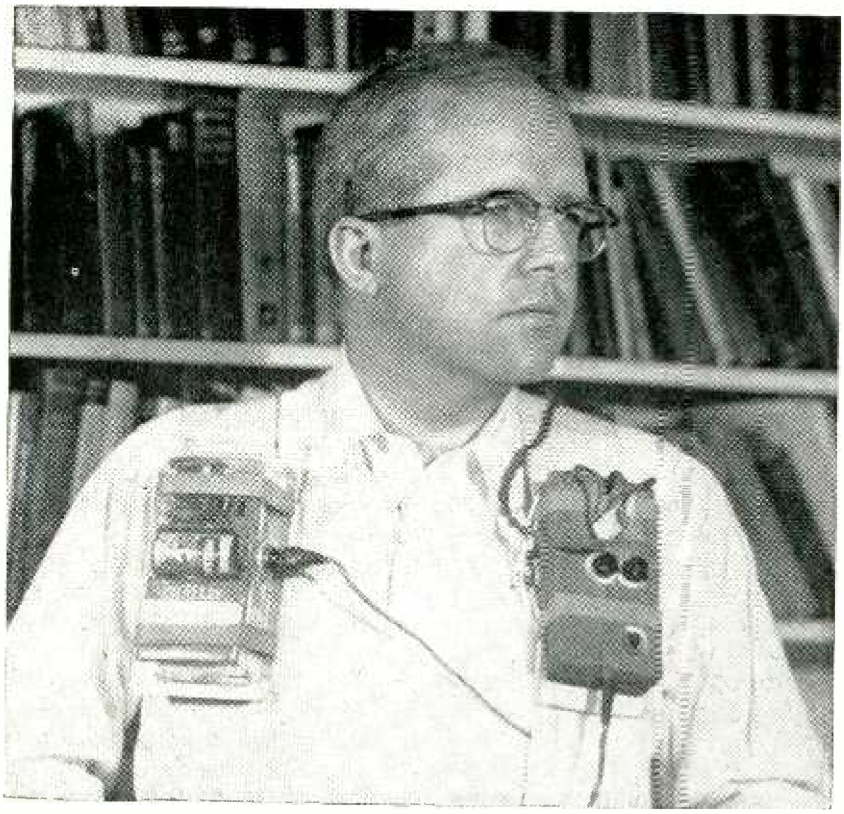
Table I—Core and Coil Data for 60-cps and 400-cps Magnetic Servo Amplifiers

Core Material: Orthonol (50% Ni 50% Fe alloy, grain oriented, dry hydrogen anneal)



	60 Cycles				400 Cycles			
	Input		Output		Input		Output	
Core Dimensions								
d (inches)	1.00		1.25		1.00		1.25	
D (inches)	1.25		1.75		1.25		1.75	
W (inches)	0.25		1.00		0.25		0.375	
Tape Thickness (inches)	0.002		0.002		0.002		0.002	
Winding Data								
	Turns	Wire Size	Turns	Wire Size	Turns	Wire Size	Turns	Wire Size
Power	2,000	33	1,500	30	500	28	850	29
Reference	500	36	500	34	50	31	50	31
Control	100	36	25	28	300	36	10	22

Radioelectroencephalograph



Subject wearing complete two-unit radioelectroencephalograph (REEG), with voltage amplifier on left shoulder and transparent plastic-encased transmitter on right shoulder. The three leads coming from top of amplifier go to electrodes on scalp

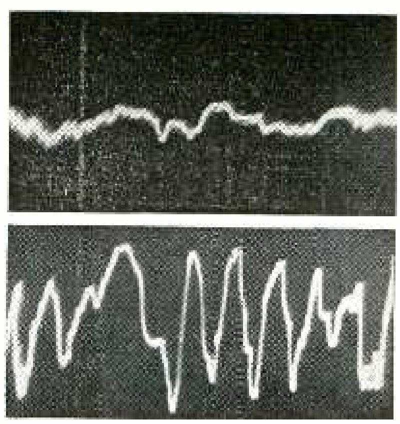
THE ELECTROENCEPHALOGRAPH (abbreviated EEG) is a clinical instrument for amplifying and recording the low-frequency alternating potentials which appear at points on the surface of the animal scalp as a result of electrical activity in the underlying cortical mass. These so-called brain-waves vary irregularly in frequency and amplitude in the range from about 6 to 50 cycles per second and from about 10 to 100 μv respectively. The subject usually reclines quietly in a shielded room and leads from various scalp regions are switched, in turn, to the amplifier input. The electric leads prevent the subject from engaging in such normal activity as walking around while the record is being made. The researcher is therefore somewhat limited in the scope of his possible investigations.

The present instrument is the result of an attempt to remove the restrictions imposed by wires between subject and equipment. The feasibility of utilizing radio broadcasting and of making the amplifying and transmitting equipment portable has already been shown and the instrument has been given the name radioelectroencephalograph (abbreviated REEG). The present REEG is an improved model from the standpoint of performance, portability and comfort. It can also be used as a radioelectrocardiograph (abbreviated RECG) for remote observation of heart potentials, as well as for the remote recording of pulse rates.

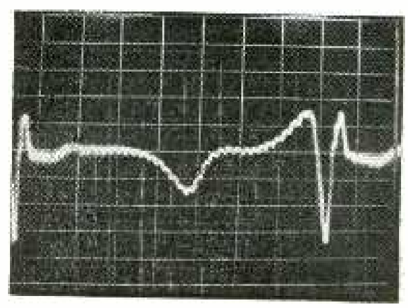
In the study of muscle action other than heart, the unit operates as a radioelectromyograph (abbreviated REMG). For exclusive use as an RECG or REMG, the electronics of the instrument can be simplified with consequent additional reduction in size and weight and with improved performance.

Portable Section

The portable section of the REEG consists of an electrode system, a high-gain voltage amplifier in one rectangular case, and a modulator stage, f-m oscillator, antenna system and power supply in another case. The two cases fit conveniently into suitcoat pockets or pockets of the usual laboratory jacket. These units can also be fastened directly to the body under the clothing with paper masking tape, or clipped or pinned to the clothing at points most suited to the



Examples of brain-wave patterns obtained from REEG system, for walking subject with eyes open (low-amplitude pattern) and with eyes closed (high-amplitude pattern)



Example of heart-potential pattern obtained with equipment connected as radioelectrocardiograph (RECG), with center electrode at sterno-xiphoid junction on chest and other electrodes two inches to right and left. This location gives minimum interference from signals generated by working muscles. Timing voltage and plastic grid overlay are superimposed on pattern

for Medical Research

Patient carries portable f-m transmitter while walking or exercising, for broadcasting brain waves, heart potentials, muscle potentials or pulse rate to receiver and cathode-ray viewer in laboratory. Used for clinical and laboratory research

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particular physical activity of the subject at the time.

Separation of the amplifier from the r-f section results in better performance and enables the weight to be reduced because the transmitter does not require shielding or shock mounting. Radiation directly from the tank circuit of the r-f section enables the antenna to be dispensed with at short ranges, with consequent greater stability of operation while the subject is active. The amplifier case is therefore of stainless steel and the oscillator case of transparent plastic, molded to fit interior components.

Electrode System

Electrode leads should be kept physically symmetrical with the center ground lead insofar as possible, to help equalize the amplitudes of unwanted signals appearing at the amplifier input.

For humans, flattened drops of solder 5 to 7 mm in diameter form the electrodes proper. Three are needed, as the amplifier is push-pull with the middle connection grounded. A drop of commercial EEG paste is applied to the skin at the point of application and rubbed briefly with the flat side of the electrode. The electrodes are held in place by collodion, or any other standard method can be used.

The leads from the electrodes are light-weight, flexible shielded wire described commercially as grid wire. The conductor is multiple-strand fine copper, rubber and/or fabric insulated, surrounded by metal braid and an outside protective covering. The leads terminate in small male pinjacks. The shield of the center lead is connected electrically to the center conductor at the electrode end and all three shields are connected electrically at the pinjacks.

Amplifier

The amplifier circuit, shown in Fig. 1, is a high-gain RC-coupled voltage amplifier with push-pull input and single-ended output. The light steel chassis is floated in carefully shaped sponge rubber inside a light stainless steel case with snap-on cover. The exterior of the shell is covered with flock to minimize artifacts caused by the subject touching the case, as well as for appearance.

The frequency range for a REEG or RECG amplifier needs to extend as close to zero as possible. Brain waves are principally in the range

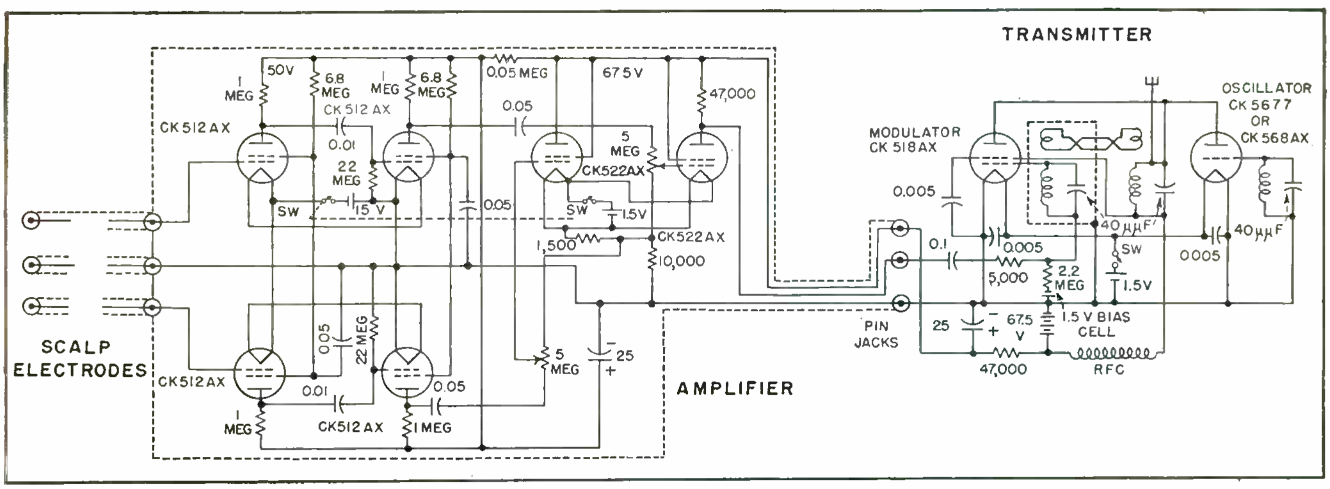


FIG. 1—Portable voltage amplifier and transmitter of radioelectroencephalograph, in two housings having total weight of only 2.6 lb

from about 6 to 50 cps, but some applications require a greater range.

A push-pull amplifier with two gain controls gives better rejection of stray 60-cps in-phase signals and those generated by motion through the earth's magnetic field.

The output stage is somewhat unconventional; it performs the functions of cancelling in-phase signals, adding some gain and providing single-ended output. One CK522AX operates as a triode and controls the IR drop in the common 1,500-ohm cathode resistor of the stage in response to the signal at the output of one side of the second voltage gain stage of the amplifier. The other side of the second gain stage feeds the grid of the CK522AX which is operated as a pentode.

The overall response of the entire REEG from amplifier input to observing system, including the radio link, is shown in Fig. 2 for three different input conditions. With each of these successively larger inputs, the gain was reduced to approximately that used in actual practice.

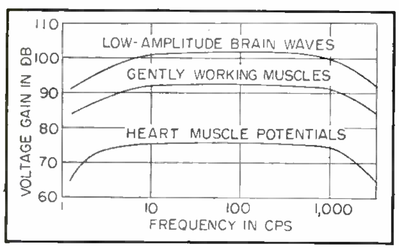


FIG. 2—Overall frequency response curves for three different gain settings of the REEG

The modulator and r-f stages with interstage shielding are mounted on a brass chassis in a formed plastic case. The low power requirements permit the use of subminiature tubes for modulator and oscillator. The modulator is a CK518 operating as a variable reactance in parallel with the plate of a single CK5677 tuned-plate tuned-grid r-f oscillator with 90° phase shift accomplished by a tuned circuit at the grid of the reactance tube, loosely coupled to the oscillator tank. The reactance grid tank is tuned by coil spacing. A carrier frequency of about 104 mc minimizes signal variations at the receiver arising from any standing-wave patterns in the laboratory, and allows the use of small components. Small frequency adjustments are made by bending the tank coils to change the ratio of the diameter to length and thereby change the inductance.

A single 1.5-volt flashlight cell operates the filaments of both tubes in parallel. One 67.5-volt cell supplies B power for both tubes and, with suitable decoupling, power for the amplifier through a lead between the two units. More than four hours of continuous duty and considerably more with intermittent duty is possible with this small power supply, which is readily replaced when needed. As the B battery voltage drops, r-f oscillation ceases before the amplifier is affected; this avoids recording signals which might be faulty as a result of decreasing amplifier performance.

For most uses, the transmitter antenna system consists of nothing more than the plate tank of the CK568AX. An antenna is indicated in the circuit of Fig. 1 to indicate radiation from this unit, but no wire projects from the tank.

Reception is adequate with this method to a range of about 50 feet, which is sufficient for most purposes. An antenna wire sewn in the sleeve or coat can be coupled to the oscillator for greater range, but with the disadvantage that the subject cannot be as active physically without introducing extraneous signals.

Receiver Section

The receiving antenna is a 300-ohm folded dipole tuned to the carrier frequency. It may be used near the receiver, placed in another room with the subject, or mounted outside a window for following out-of-door exercises.

The receiver circuit, given in Fig. 3, is a conventional f-m unit through the r-f and i-f stages but with modified discriminator and audio stages. In use, the r-f stage is tuned to the transmitter carrier. The transmitter has fixed tuning. Two 6AG5 pentodes form a double conversion system in which the 6C4 triode oscillator operates at one-half signal frequency minus 5.35 mc to provide a 10.7-mc i-f signal. Two 6BA6 pentodes furnish the i-f gain to drive the 6AL5 ratio de-

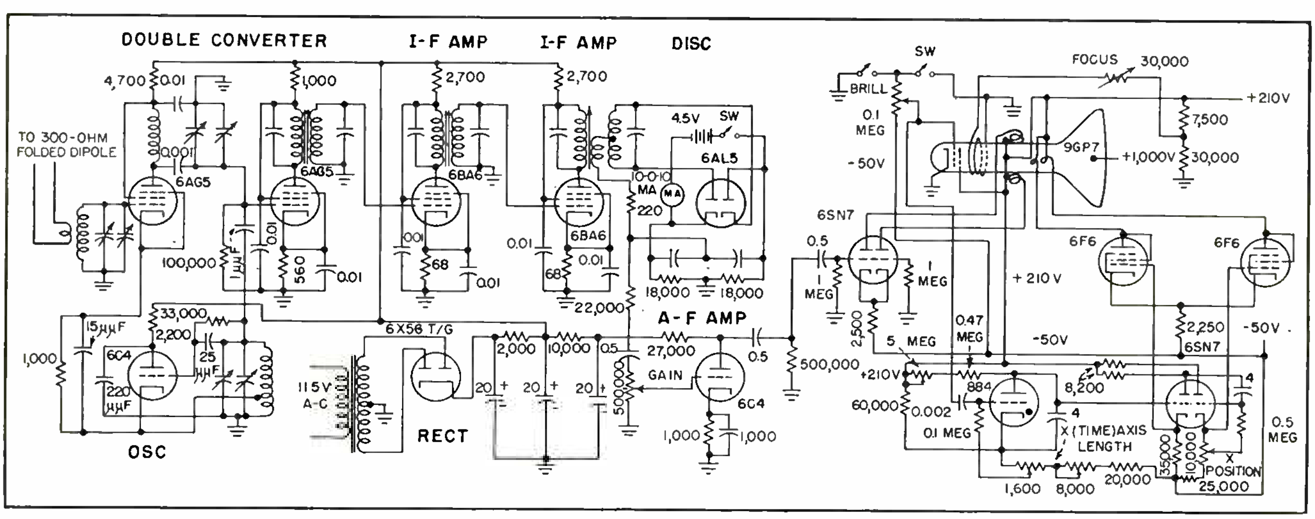
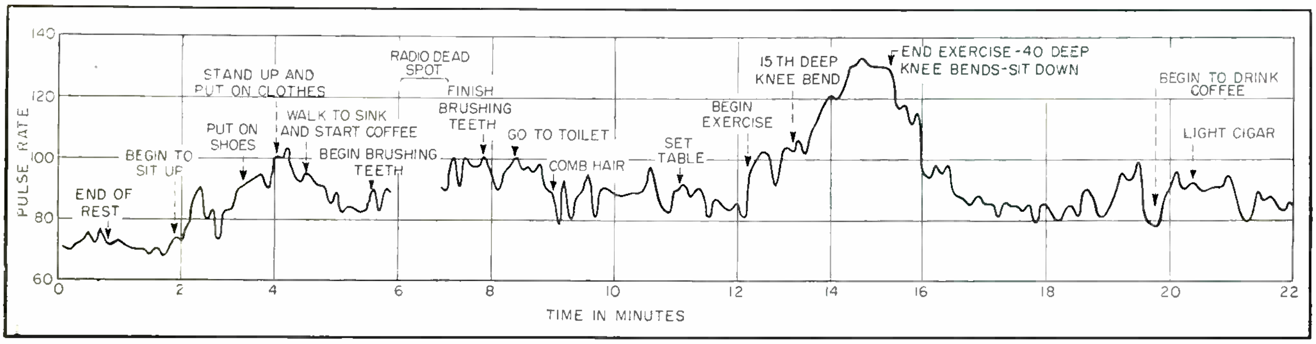


FIG. 3—Receiving and observing system of the REEG. The a-f amplifier delivers a signal output of several volts to the viewing section at the right, using a special long-persistence cathode-ray oscilloscope with a plate camera



Pulse rate changes during normal human activity, as calculated and plotted from curves obtained with RECG equipment. Subject shows good recovery time back to his normal from the 130 rate arising from exercise

tector, with limiting. This in turn drives a 6C4 triode having adjustable gain, with circuit elements chosen to give the desired a-f response.

Amplitude modulation by the portable transmitter itself has been satisfactorily minimized; however, some amplitude modulation can exist at the receiving antenna due to a shifting standing wave pattern as the subject moves about a room. This type of amplitude modulation falls within the frequency response of some of the signals being studied and below the frequency at which a normally sized capacitor in the ratio detector circuit can control amplitude fluctuations. In addition, large changes in signal strength at the receiving antenna can occur due to the relatively large changes in transmission distances involved in practice.

Ranges used can be anywhere from one foot to over 100 feet or about two orders of magnitude. The signal over such range differences will vary in an even greater ratio, hence some form of limiting action is needed. This has been achieved by the simple substitution of a 4½-volt dry battery in the position of the usual 10-μf capacitor in the discriminator circuit. Limiting action is shown in Fig. 4, which also shows the additional advantage of rapid falling off of output signal at too-low values of received signal. This is an advantage because the observer can then tell when the subject is in a dead spot, being aided in this by the large increase in receiver noise, with the result that the record will not be misinterpreted as an abnormally low-amplitude brain wave.

The type 9GP7 cathode-ray tube of the REEG receiver has a magnetic sweep and long-persistence screen. An x-axis linear sweep, adjustable from about 0.5 to 30 cps, enables brain waves and cardiograms to be observed conveniently, and also contains a single-sweep feature. The long-persistence screen permits studying a single trace for at least a minute in a semidarkened room or photographing it after it has been inspected, thus saving film when recording unpredictable patterns. Since the slowly moving spot on the 9GP7 screen covers such a small area per second, the tube is operated at only 1,000 v which is ⅐th its rated voltage. This low anode voltage also has the advantage that less magnetic deflection power is required.

Viewer and Recorder

A grid overlay on the face of the c-r tube provides reference lines for time on the x-axis and voltage amplitude on the y-axis. The grid lines are illuminated so that they are recordable by photography but without illuminating the screen where they would otherwise produce an undesirable glow. This is accomplished by forming a 6 × 6 × ¼-in. piece of plastic to the curved surface of the c-r tube, scribing lines on the back surface and partially filling them with white paint, then completing the filling with black paint. Light is introduced into the plastic by flashlight lamps inserted into frosted holes at the lower edge. Edges of the clear plastic are painted black.

RECG's can be utilized to provide a record of heart pulse rates where the pulse rate alone and not the form of the RECG is of interest. To convert the RECG signals to a

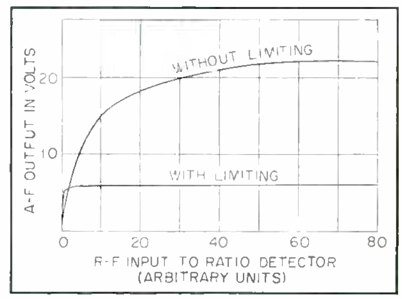


FIG. 4—Action of dry-battery limiter stage of receiver

form suitable for pulse recording the signal is differentiated and amplified, then rectified, with a 1N34 diode to give a simple positive wide peak which actuates a pen on a moving-chart recorder.

This work was financed, as a public service, by the Holter Research Foundation, a non-profit Montana corporation. The authors are also indebted to Professor J. A. Gengerelli of the University of California at Los Angeles for his many valuable suggestions during the course of the present development.

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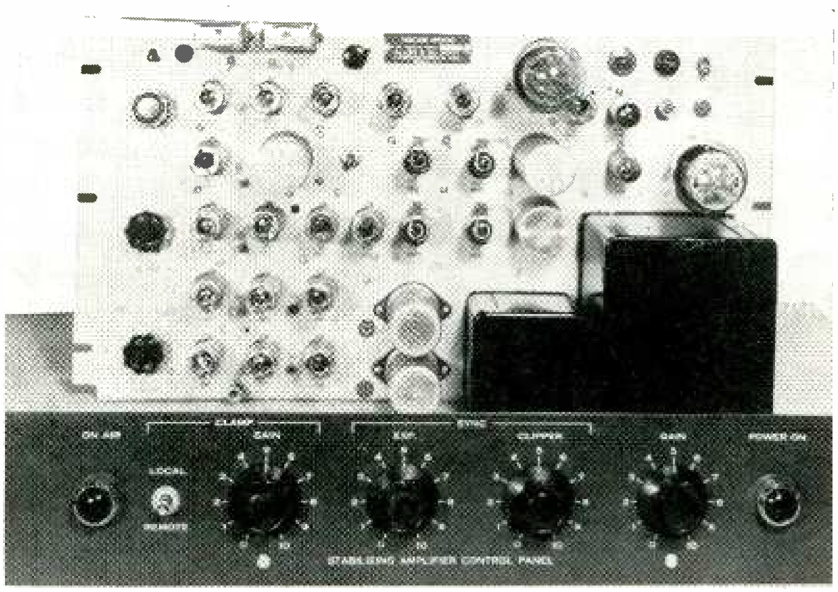
Regenerating Composite Video Signals

Hum, d-c surge, poor low-frequency content and sync compression on incoming television signals from network or remote pickup must be standardized before local broadcast transmission. Stabilizing amplifier under control of local operator corrects single faults or combinations of several



The stabilizing amplifier is rack mounted with a remote control panel for quick adjustment by operator

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TECHNICAL personnel in television stations are often faced with the problem of having to use drastically deteriorated, nonstandard composite video signals from a network or remote pickup. These signals may contain noise, hum, or spikes and video in the sync region. The sync portion may be compressed, the high or low-frequency content may be poor or sync pulses may even be missing. A means must be provided to improve this deteriorated signal in order that the transmitter output be compatible with FCC requirements.

A so-called stabilizing amplifier has been developed that regenerates such degraded signals. As shown in Fig. 1, the equipment comprises two main channels; the video amplifier and the sync amplifier. This unit is a device for expanding the sync portion of a composite video signal and clamping during the sync back porch interval. Such clamping will restore low-frequency response and eliminate low-frequency transients despite any sync-tip modulation.

The degree of sync expansion is sufficient to provide standard output with as little as 17 percent sync on the input signal. Percentage of sync content in the output signal is adjustable. For varying composite video inputs, the unit will maintain a constant sync level in the output.

Functional Arrangement

The video channel (upper half of drawing) has two stages of amplification and a cathode follower whose grid is clamped. This signal is then clipped and amplified in the next stage where either local or remote sync may be added through the sync insertion tube. The next stage is a cathode follower that drives two identical output stages to give one signal for the transmitter or network and one for monitoring purposes.

The sync channel (lower half of Fig. 1) has one stage of amplification followed by a sync separator and two additional stages of amplification. At this point, part of the signal feeds the sync insertion tube.

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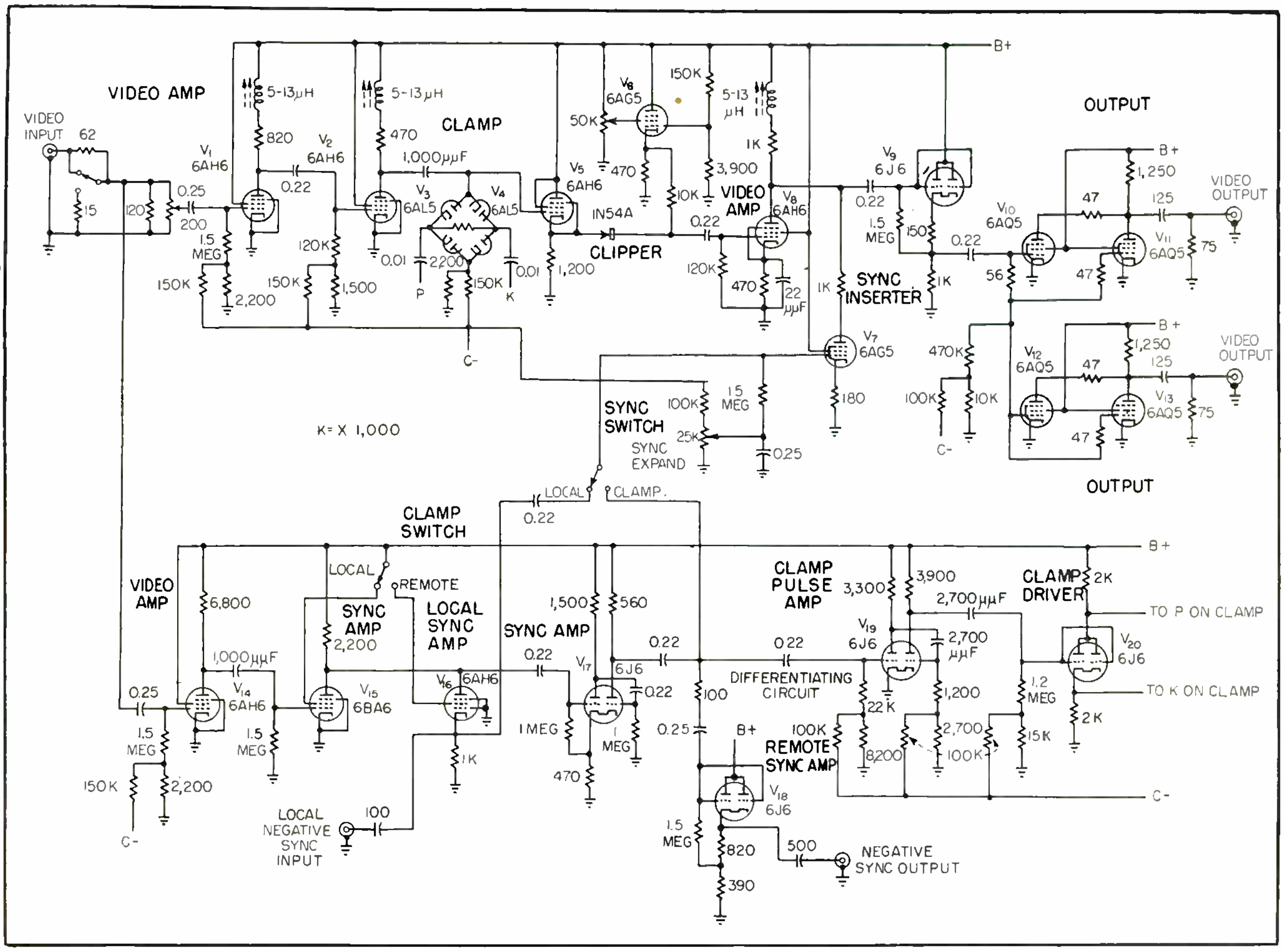

FIG. 1—Simplified schematic diagram of television video stabilizing amplifier

Another portion feeds a cathode follower to provide a negative remote composite sync signal for use in synchronizing local and remote equipment. The third portion feeds a differentiating circuit coupled to a selective stage that amplifies only the part of the differentiated signal corresponding to the trailing edge of the sync pulses. This signal drives another amplifier whose output is two clamp drive pulses of equal amplitude but opposite polarity.

Circuit Details

The simplified schematic of the stabilizing amplifier shows that the input is terminated in 75 ohms for use with coaxial cable. A 5-to-1 attenuation switch and a potentiometer constitute the gain control for the video channel. The sync channel input depends only on the position of the attenuation switch.

The first two tubes in the video channel V_1 and V_2 are shunt-peaked video amplifiers. The grid of the next tube, V_5, a 6AH6 triode-connected pentode, is clamped during the back porch of the sync by a 4-diode bridge clamp. This action is shown in more detail in Fig. 2A. Clamping is necessary to keep the blanking or black level constant so that the sync-clipping level adjusted in the next stage will remain constant regardless of the video content of the signal.

The black negative composite video signal that appears at the cathode of V_5 is fed through a series negative clipper circuit detailed in Fig. 2B. A 1N54A germanium diode is employed as the variable level clipper. The adjustable bias for the diode is supplied from the cathode resistor on V_6, a 6AG5 whose cathode current is adjusted by means of screen-voltage variation.

This method of biasing presents a low d-c source impedance that prevents the bias from changing with varying signal amplitude. The amplitude of the signal at this point is large enough to minimize the effect of the crystal nonlinearity at small positive voltages. Therefore, there is at most a 2 percent loss of setup. The clipped signal is fed to V_8, a 6AH6 shunt-peaked video amplifier that also employs some cathode peaking, indicated in Fig. 2C.

Table I—Sync Switch and Clamp Switch Combinations

Sync Switch	Clamp Switch	Sync Inserted	Clamp Drive
(1) Local	Local	Local	Local
(2) Local	Remote	Local	Remote
(3) Clamp	Local	Local	Local
(4) Clamp	Remote	Remote	Remote

Regenerated-Sync Insertion

The plate load of this tube is common to the sync-insertion amplifier V_7, a 6AG5. The sync-expand potentiometer provides a variable

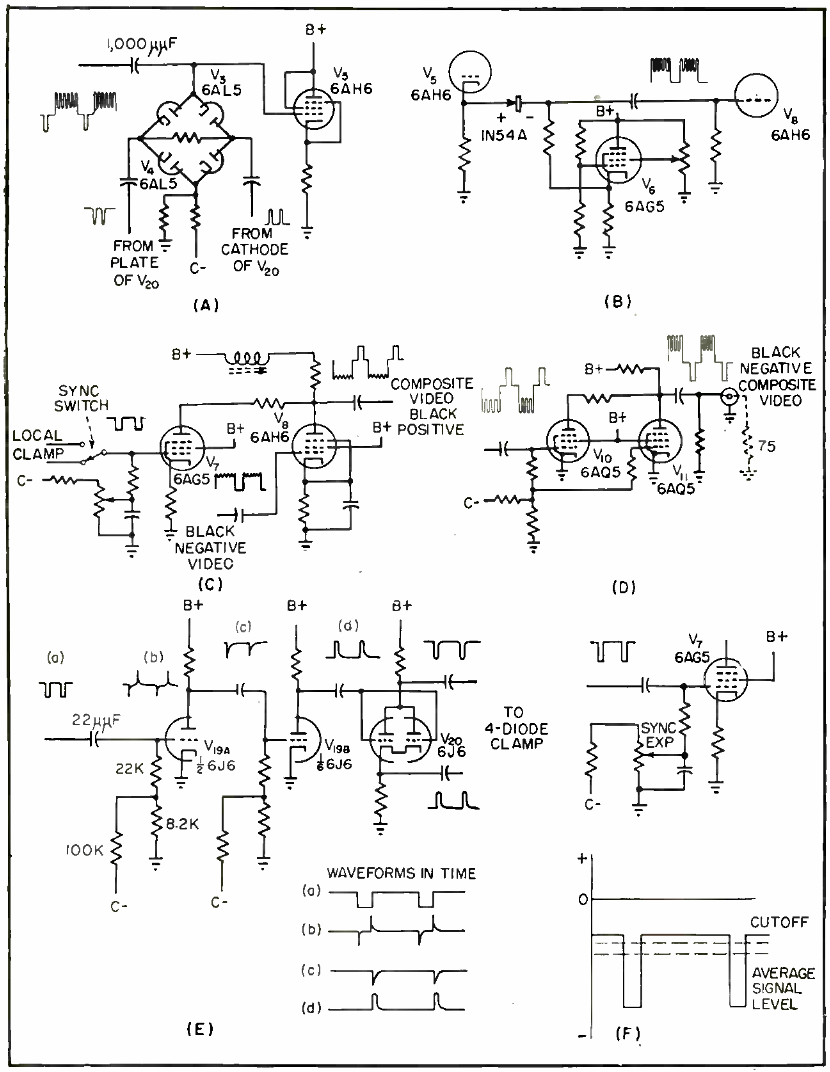

FIG. 2—Individual circuit elements of Fig. 1 discussed in text

bias to control the amount of sync signal above the cutoff point on the grid of V_7. The rise time of this sync is excellent because only a small portion of the sync is used to obtain the required amplitude at the plate of V_7. Therefore, on the plate of V_8 will appear a composite black positive video signal whose video amplitude is adjusted by the video-channel gain control and whose sync amplitude is adjusted by the sync-expand control described above. Each is independent of the other.

This composite signal is applied to the grid of a cathode follower that drives two output stages, one of which is shown at Fig. 2D. It consists of two 6AQ5's connected in parallel whose plates are a-c coupled to a source termination of 75 ohms. Each of these output stages furnishes a standard RTMA 1.4-volt composite black negative video signal across a 75-ohm termination.

The first tube in the sync channel, V_{14}, a 6AH6 pentode, amplifies and inverts the composite black negative video input signal. The second tube, V_{15}, a 6BA6 pentode, is grid leak biased. On account of the grid d-c restoring action and the large sync-positive signal amplitude appearing at its grid, this tube compresses and clips the video or negative portion of the signal. The gain characteristic of the tube is controlled by variation of its screen voltage.

The third tube, V_{17}, is a 6J6 dual-triode connected as a two-stage voltage amplifier. These tubes are overdriven as a result of the large grid-signal amplitude and therefore clip the positive and negative peaks of the input signal. The output signal is pure composite negative sync. A portion of this signal is fed to a 6J6 cathode follower, V_{18}, whose negative composite-sync output is used for synchronization of local and remote equipment.

A second portion is available for sync insertion in the video channel through the sync switch. A third portion is differentiated by the R-C grid-coupling network that feeds the next tube, V_{19}, a clamp-pulse amplifier. This is shown in Fig. 2E. The tube is a 6J6 dual triode whose first half, V_{19A}, is biased so that it only amplifies the positive portion of the differentiated sync pulses. These positive signals correspond to the trailing edges of the sync pulses.

The second half of V_{19B} amplifies these pulses and feeds them to the clamp-drive tube, V_{20}, a parallel-connected 6J6. Equal plate and cathode-load resistors furnish clamp-drive pulses from the plate and cathode of equal amplitude but opposite polarity.

Operational Combinations

By placing the clamp switch in the local position, V_{15} is disabled and V_{16} energized. Thus, local sync may be used to drive the clamp and also to feed the sync insertion tube V_7. There are four combinations of the sync and clamp switches. Of the four possible combinations, there are only three that are different as indicated in Table I. With these three combinations, however, much signal improvement results.

Types of Degradation

There are several faults possible with an incoming network or remote signal. These faults may appear individually or in combinations. Some of the more common shown in Fig. 3 are hum, d-c surge, poor low-frequency content, and sync compression. The action of the clamp in the video channel will overcome the first three difficulties despite any sync-tip modulation because the clamping occurs during the back-porch interval. The signal may now have the sync portion removed by clipping at the desired level.

As explained previously, either remote or local sync may now be inserted to any desired degree, thus overcoming sync-compression difficulties with the remote-input signal. If it has been chosen to add local sync, it is necessary that the local and remote sync signals be synchronized. This is accomplished by sync-co-ordinating equipment driven with the negative remote composite sync signal available from this unit.

Through use of long lines and microwave links the incoming network signal has often lost most of its setup. This too may be improved by adding local negative mixed blanking at the sync input terminal instead of local sync. This type of operation also requires synchronization of local and remote equipment.

The control formerly used for sync expansion may now be used to vary the setup. Output signal from the unit would be a black negative video signal with variable setup but without sync. Used in this manner, the unit would be operating as a remote sync stripper and local sync could be added in some subsequent piece of equipment such as mixer-line amplifier or switching gear.

Other signal conditions which may be improved with this unit are: video in the sync region, noisy signal, poor sync rise time, and missing sync pulses. The video in the sync region may be removed by the clipping circuit, and local or remote sync can be added in the sync insertion stage.

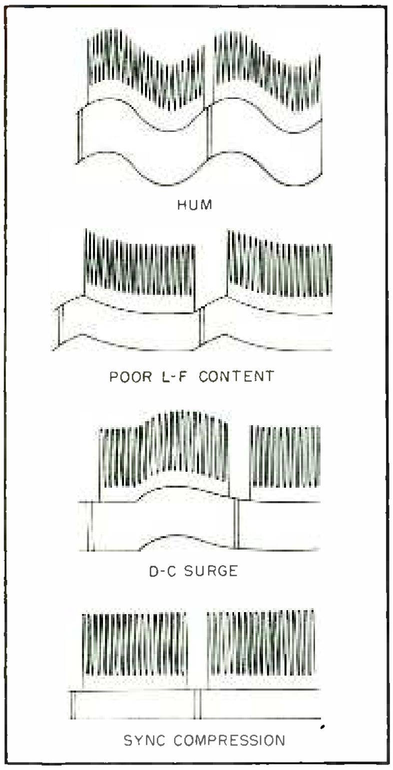

FIG. 3—Some common types of incoming video distortion

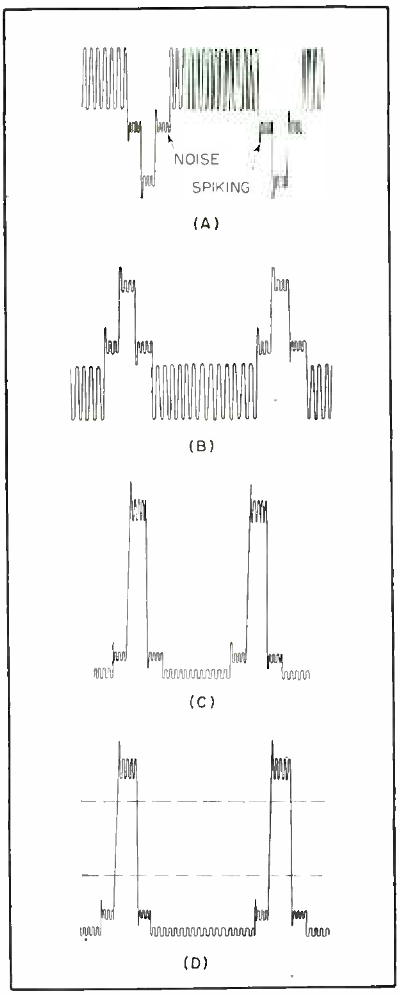

FIG. 4—Operation of sync-channel cleanup of spiking

For a noisy signal or one with spiking extending into the sync region, the operation of the unit would be similar to that described. Original sync would be clipped and standard RTMA sync pulses added. An explanation of the operation of the sync channel in the presence of noise or spiking is shown in Fig. 4. Signal A is the input signal applied to the grid of V_{14}. That shown at B is the amplified inverted signal appearing at the grid of V_{15}. As mentioned before, the grid-leak bias and the d-c restoring action of the V_{15} grid-cathode circuit tends to keep the sync tips near ground potential regardless of signal modulation and biases the tube near or beyond cutoff.

The resulting signal on the plate of V_{15} and the grid of V_{17} is shown in Fig. 4C. This signal amplitude is large enough to overdrive V_{17} and thus its output is clipped in the manner shown by the dotted lines in D. The final result is a clean composite sync signal with improved rise time and no modulation. This unit will operate well with signal-to-noise ratios as low as 5-to-1, or sync to video ratio of 17 percent.

Signals containing sync with poor rise time are improved in much the same manner. The amplification and clipping improve the rise time of the pulse. In addition, when the sync is added to the video, it is done as shown in Fig. 2F. The average signal level is moved in relation to cutoff by the bias or sync-expand control. Only 25 to 30 percent of the signal is necessary to give the proper amplitude at the plate for addition to the video signal. This greatly increases the rise time of the output sync. Sync output rise times as low as 0.05 microsecond have been measured with inputs of the order of 0.50 microsecond.

Loss of Remote Sync

When the remote sync generator functions erratically in such a manner that there are missing sync pulses or sporadic sync breakdown, it becomes necessary if not imperative to add local sync. For clamp operation and synchronization of local and remote equipment, a few missing sync pulses do not cause a serious situation. It is possible then to clamp and synchronize with the remote sync pulses and insert local sync for the output signal.

The frequency response of the video amplifier in this unit is down 1 db at 7.5 mc and down 6 db at 10 mc. The inputs are 0.5 to 2.0 volts peak-to-peak composite black negative video into 75 ohms and 3.5 to 8.0 volts peak-to-peak negative sync or blanking into 75 ohms. Outputs are two standard RTMA 1.4-volt peak-to-peak black negative composite video signals across 75 ohms, and 1.5 volts of negative remote sync across 75 ohms or 10 volts unterminated.

Bridge Oscillator

High frequency stability and good output waveshape are provided by R-L oscillator. Tunes linearly over the range from 1,000 to 500,000 cycles by means of a simple frequency control and a vernier

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BRIDGE-TYPE oscillators are simple in design, capable of almost pure sinusoidal output and able to cover wide frequency ranges. Such units have been designed to generate frequencies which cover the audio, ultrasonic and low radio-frequency spectra with excellent waveform and stability of output frequency and amplitude[1]. Components required for the construction of such units are inexpensive and easily obtained and need not be of particular tolerance.

Basically, a bridge oscillator is a broad-band amplifier whose input and output terminals are the terminals of a frequency-selective bridge network.

The function of the bridge network is to compare a degenerative and a regenerative alternating voltage on the basis of frequency selection, allowing regeneration only at the frequency for which the bridge is balanced. All other frequencies are attenuated. The types of bridges to be used in conventional units have been discussed extensively elsewhere.[2,3]

One of the basic problems of most oscillators is the fact that the frequency dial is nonlinear and often is compressed at particular sections of the scale. When it is necessary for the frequency dial to be linear, specially constructed variable capacitors are required.

In the bridge described herein all the features of typical bridge oscillators are retained, together with a unique characteristic which allows the choice of practically any tuning curve, one of which is perfectly linear. The controls are two in number; one varies the frequency rapidly, while the other is a linear vernier at any point in the range.

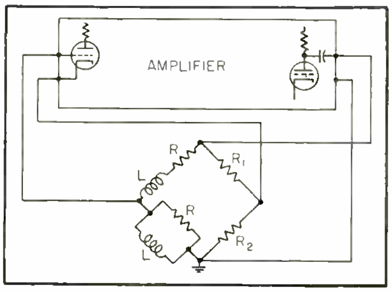


FIG. 1—Basic schematic of oscillator

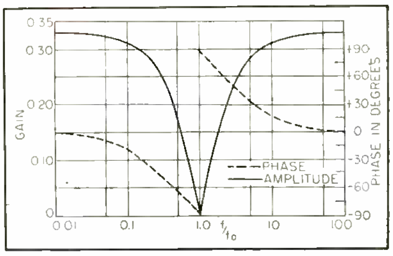


FIG. 2—Phase and amplitude characteristics

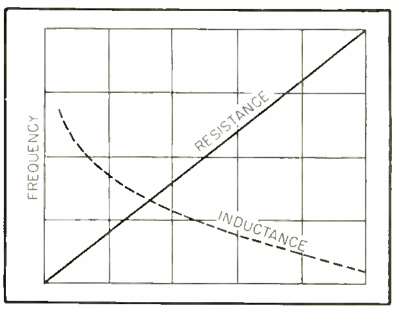


FIG. 3—Tuning characteristic of the oscillator

The diagram of Fig. 1 shows the basic configuration of the R-L type oscillator. The frequency-dependent components are confined to the positive feedback loop.

Oscillation takes place when the regenerative voltage is equal to or slightly greater than the degenerative voltage and the phase relations are correct. The phase and amplitude characteristics of the bridge are plotted in Fig. 2. These characteristics compare favorably with other bridge oscillators. Greater selectivity is obtainable with certain bridge-network equivalents but at the expense of more involved controls and with no possibility of simple linearity.

If losses in the two bridge inductances are considered, assuming the inductances are operated well below their resonant frequencies and are therefore substantially independent of frequency, the bridge relationships may be written

$$\omega^2 = \frac{R^2 - r^2}{L^2} \text{ and } \frac{R_2}{R_1} = \frac{R}{2\,(R + r)} \quad (1)$$

where r is the resistance of inductance L considered as a series resistance.

$$\omega^2 = \frac{R^2}{L^2} - \frac{r^2}{L^2} = \omega_0^2 - \frac{\omega^2}{Q^2}$$

where $Q^2 = \dfrac{\omega^2 L^2}{r^2}$

$$\omega/\omega_0 = \frac{1}{(1 + 1/Q^2)^{\frac{1}{2}}}$$

Therefore, when $Q = 10$, $\omega/\omega_0 = 0.995$.

The oscillator will operate in accordance with Eq. 1 to at least 0.5 percent as indicated as long as the Q's of the inductors used are equal or greater than 10. Such inductors are easily attainable in practice without special expedients.

Equation 1 indicates the novel characteristic of this type of bridge oscillator and may be termed the oscillator law. Consideration of this statement shows that frequency is linear with resistance, as shown in Fig. 3, in those cases where the values of the resistance in the two arms are the same. One

Has Linear Tuning

result is a vernier type of oscillator, simple and accurate with no involved calibration necessary.

Figure 4 shows a schematic diagram for such a unit in which a dual-inductance switch controls the frequency ranges. The dual linear potentiometers or decade boxes control variations within each range which are entirely linear.

The two fixed matched resistors R_0 employed in the arms of the bridge are used to fix the lower limit of frequency. With accurate inductors and potentiometers or decade resistance boxes, the unit is capable of a high degree of accuracy. No calibration curve is needed. The unit is checked against any single external standard frequency within its range of operation. The linear law then establishes all other generated frequencies.

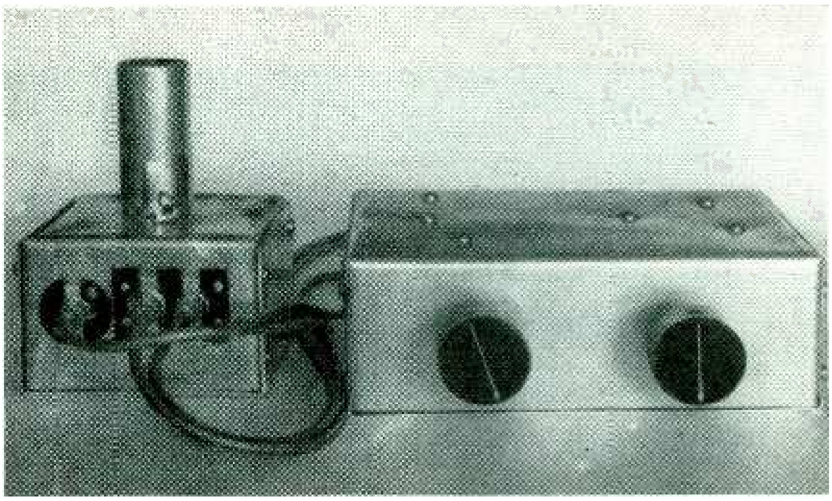
It is sometimes desirable to have the oscillator tune in a nonlinear manner, but which follows some arbitrary curve. In such a case, the expression which governs the action of the oscillator is given as

$$\omega = \left[\frac{R_3\,R_4}{L_1\,L_2}\right]^{\frac{1}{2}} \text{ to at least } \tfrac{1}{2} \text{ percent}$$

$$\text{if } Q_1 \text{ and } Q_2 \geq 10$$

also

$$\frac{R_2}{R_1} = \frac{L_2\,R_4}{L_1\,(R_3 + r_1) + L_2\,(R_4 + r_2)}$$



Typical oscillator construction. Tuning unit and amplifier have separate chassis

The same bridge circuit as shown may still be used, but the resistors will no longer be the same. Either one fixed and one variable resistor may be used, or two resistors of unequal values may be varied to control the frequency. Further variations of the linearity are possible by fixing either of the inductances and varying the other, or by varying unequal inductances or at an unequal rate.

The oscillator is economical and simple to construct and adjust. Values for R and L are not given, since they are a function of the frequency desired, and may be computed easily from the basic relationships. The unit shown in the photograph covered the range from 1,000 to 500,000 cycles. The dual inductive range used was 500 to 20 mh. The dual potentiometer was 50,000 ohms.

A three-watt lamp R_2 is used as a means of amplitude control but the unit seems to have negligible amplitude variation without this expedient. A frequency stability better than 0.01 percent was obtained without any precautions. In a ten-hour continuous run at ten kc, the drift was better than 10 cps. At output levels of the order of 10 volts or lower, the output is very nearly a pure sine wave. At higher outputs, between 10 and 150 volts, the waveform is distorted in accordance with the particular characteristics of the amplifier used.

The only precautions observed in the construction of the oscillator were that of shielding the amplifier and the tuning unit. In general, it is only necessary that the inductors be shielded from each other.

Several methods of varying the inductors were tried and step-switching and slug-tuning methods were successful. There are a number of linear potentiometers on the market with a variety of tolerances.

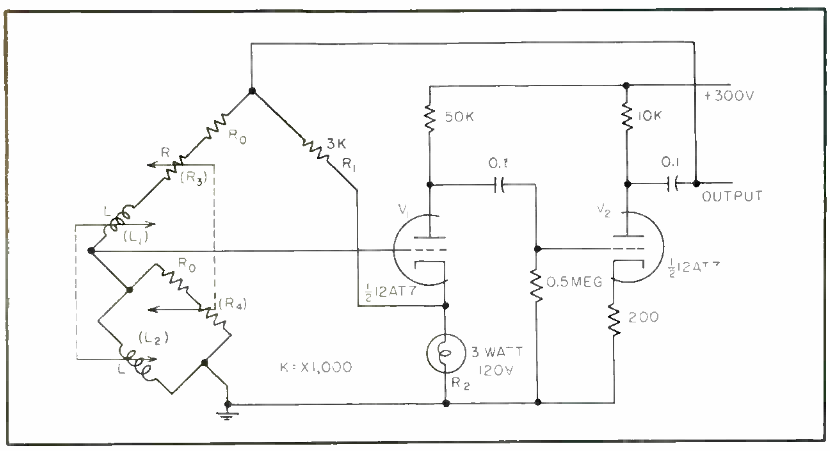


FIG. 4—Schematic diagram of R-L oscillator. For linear case $R_3 = R_4 = R$ and $L_1 = L_2 = L$

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(3) "Waveforms", MIT Radiation Series, McGraw-Hill Book Co., 19, ch

Gated Amplifier

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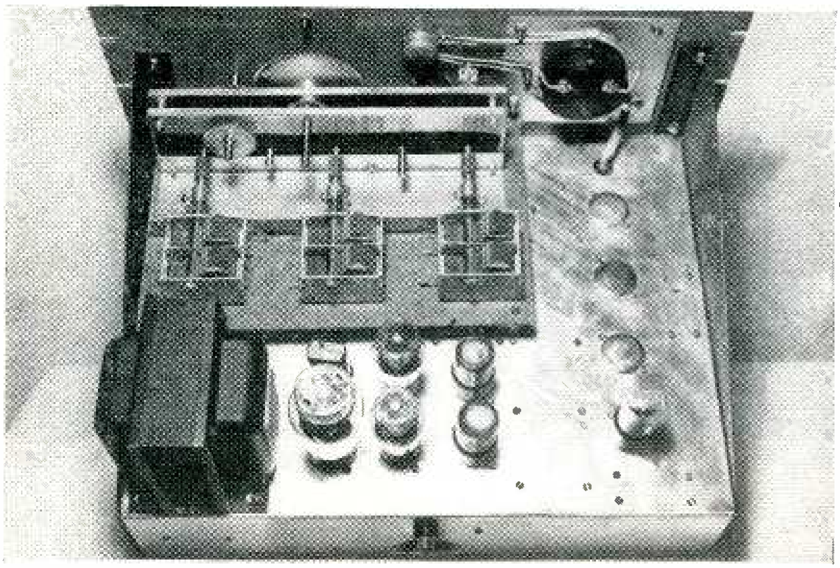


Rear view shows use of broadcast-type variable capacitors for setting frequency

MANY METHODS of wave analysis have been devised. Most of these possess one or more of the following disadvantages: the equipment required is quite elaborate and expensive; the frequency and amplitude of low-frequency components are not determined accurately; the frequency range is limited; the impedance offered by the instrument is not constant; tuning is not sharp resulting from low-Q circuits; the equipment is not readily portable.

A research program was launched to investigate the possibility of using a gated amplifier as a method of wave analysis which possesses none of the above mentioned disadvantages. The successful result of this investigation is the analyzer described herein.

Theory Review

If a sine wave is applied to the input of a gated amplifier and if the input wave and the gate are in phase, the output will have the form indicated in Fig. 1A.

The output meter will read the average value of this function. However, if their frequencies are very slightly different, their relative phase will be slowly changing. In this case, shortly after the time of Fig. 1A, the output will be of the form shown in Fig. 1B.

Again the meter reads the average of this waveform; the average here being somewhat less than that of Fig. 1A. Still later, the waveform will be as shown in Fig. 1C.

The meter reading has dropped to zero which is the average of this waveform. Some time later, the waveform will be as shown in Fig. 1D.

The meter now reads a maximum in the opposite direction from the direction of Fig. 1A.

As the phase changes, the meter reading varies from a maximum in one direction to a maximum in the opposite direction and back again. The frequency of this movement is equal to the difference between the gate frequency and the input frequency. However, because the meter has a certain amount of inertia, it is able to respond only if the difference frequency is of the order of a few cycles per second.

With this arrangement it would seem that a nonsinusidal wave could be analyzed by varying the frequency of the gate and noting the frequency at which beats occur. The appearance of beats should indicate the presence of a frequency component in the complex wave equal to the gate frequency with amplitude proportional to the amplitude of the beats.

Figure 2 shows a block diagram of the analyzer.

The circuit consists of three parts: a gating pulse generator, an input attenuator and amplifier, and an amplifier which is turned alternately on and off (gated) by the square wave.

The circuit used for generating the gating pulse for the amplifier is a square-wave generator. Most of the square-wave generators investigated for this purpose were far more elaborate than was desired. Various forms of multivibrators were tried. The circuit finally chosen was a symmetrical multivibrator with zero grid return as described by Terman.

The multivibrator uses resistance capacitance elements for tuning. As shown in Fig. 3, its frequency varies inversely with values of C and R. Because variable capacitors such as are used in radio receivers have a capacitance ratio slightly larger than 10 to 1, and because of their availability, standard two-gang capacitors of about 500-$\mu\mu$f maximum capacitance for each section are used as the frequency control. A range-changing switch changes R values in such a manner as to obtain frequency multiplying factors of 2, 10, 100, 1,000, and 10,000. The frequency for any setting of the two controls is then the product of the dial reading and the multiplying switch reading.

Complete Circuit

Referring to Fig. 3, V_1 and V_2, together with their associated circuits, constitute a symmetrical multivibrator. The variable capacitors provide a means of attaining a variable-frequency square wave, while a

Wave Analyzer

Direct-reading instrument quantitatively determines components of complex waveforms in the audio-frequency range. Accuracy is good, especially at low audio frequencies, and distortion introduced by instrument is less than one percent .

choice of resistors make possible several ranges of frequency. The plate resistors were chosen as small as possible to improve the square waveform and yet retain sufficient amplitude (60 volts peak to peak) to utilize the square wave as a gate.

This square wave is fed to the grid of a cathode follower V_3, whose function is to isolate the multivibrator from the circuits which follow. The gain here is approximately unity.

The output square wave from the cathode of V_3 is coupled to the SQUARE WAVE terminals, in the event it is desired to use the instrument as a square-wave generator, and to the grid of V_4. This grid is biased at 45 volts positive. The tube is alternately switched on and off by the square wave. Because V_4, V_5 and V_6 have a common cathode resistor, the potential on the cathodes of V_5 and V_6 is high when V_4 is conducting and low when V_4 is cut off.

The grids of V_5 and V_6 are biased at 50 volts positive potential. When V_4 is conducting, the cathodes of V_5 and V_6 are 75 volts positive, giving these tubes a negative grid-cathode potential of 25 volts which cuts them off. When V_4 is cut off, the cathodes of V_5 and V_6 are 57 volts

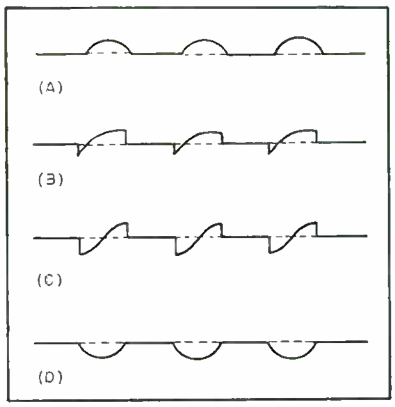


FIG. 1—Curves show output of gated amplifier for sinewave input at various phase angles

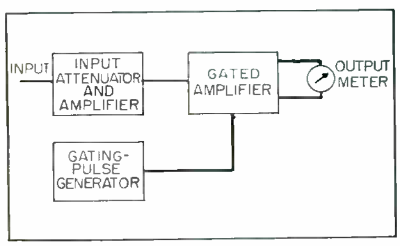


FIG. 2—Block diagram of stages in the wave analyzer

positive, giving them a net negative bias of 7 volts which allows them to conduct.

The gating action of V_4 causes the plate voltages of V_5 and V_6 to rise and fall together between 280 and 200 volts when conducting. Under these conditions, the reading of meter M_1 is zero.

Cathode follower V_7 isolates the meter tubes from the input. Its cathode resistor is chosen to give 7 volts bias with a gain of about 0.8, allowing a peak-to-peak swing on the input of about 17 volts.

The input attenuator is a conventional potential divider presenting a constant impedance of one and a half megohms, thereby minimizing loading effects upon the signal voltage source.

The output of V_7 is fed to the grid of V_6, which is alternately conducting and nonconducting.

If the input frequency coincides with the frequency of the gate, and if their phase difference is zero, the waveform on the plate of V_6 appears as in Fig. 4A. At the same time, the waveform on the plate of V_5 is that of Fig. 4B because V_5 and V_6 have a common cathode resistor;

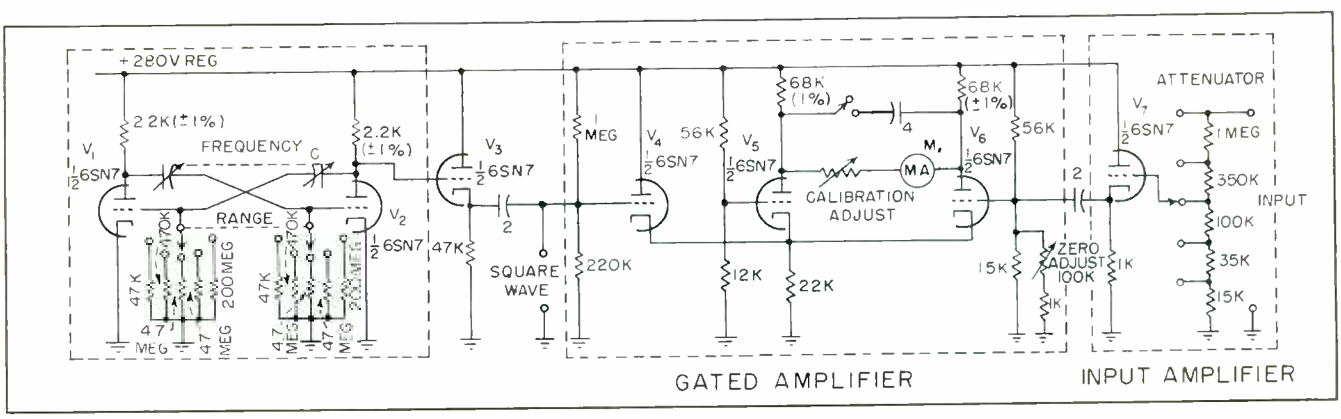


FIG 3—Complete circuit, less power supply. The multivibrator range switch provides frequency-multiplying factors of 2, 10, 100, 1,000 and 10,000. Auxiliary terminals are provided for using the square wave output of the multivibrator separately

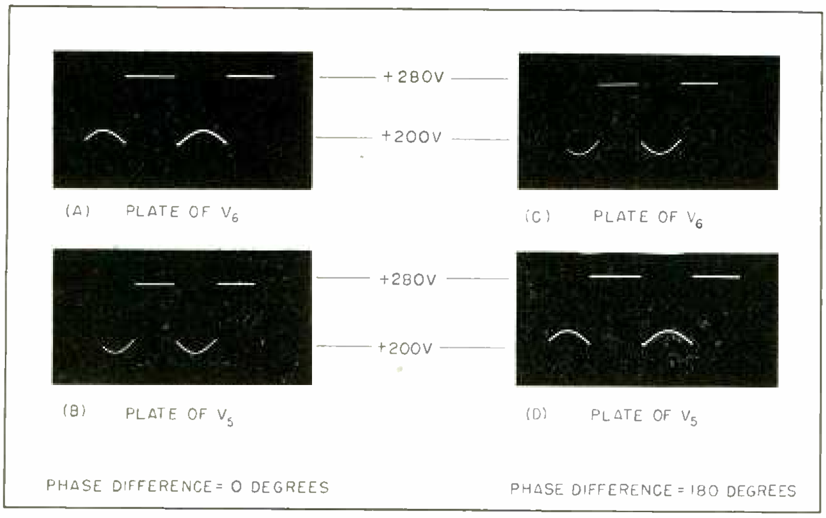


FIG. 4—Oscillograms show waveforms on plates of meter tubes

and the voltage between the plates of tubes V_5 and V_6 results in pulses of current through M_1 which reads the average d-c voltage difference. This reading is proportional to the amplitude of that component of the input signal whose frequency coincides with the gate frequency.

If the phase difference is 180 degrees, the voltage waveforms are as pictured in 4C and 4D and the meter reads a maximum in the opposite direction. The slow changing of the phase difference results in the modulation of the meter by the difference frequency.

Any steady deflection present in the meter with no input, may be balanced out by the ZERO ADJUST potentiometer.

Stability

The frequency of the multivibrator is a function of the mu of V_1 and V_2 so these tubes must be matched. Symmetry of the square wave was achieved by inserting a milliammeter in the plate circuit of each tube and adjusting the value of the grid resistors until the two meters read the same value of average plate current for each tube, indicating that off-times are equal.

A regulated power supply must be used because the frequency of the multivibrator is a function of its plate voltage.

Calibration

The dial is calibrated in cycles per second. Frequency calibration curves need be used only if great accuracy in reading the frequency is desired.

The meter M_1 is calibrated in volts by using an input of known frequency and amplitude, and adjusting the potentiometer (CALIBRATION ADJUST) in series with the meter.

At frequencies below 25 cps, operation was improved by shunting the meter with a 4-μf capacitor. This capacitor filters out the gate frequency which appears at low frequencies.

Performance

To check performance, signals of 3-volts amplitude and various frequencies were applied to the input. The meter reading was flat from 10 to about 30,000 cps. Above 30,000 cps, tuning is so sharp that amplitude measurements are very difficult. Below 10 cps, amplitude readings decrease sharply.

For frequencies of 10, 60, 400, 1,000 and 10,000 cps, various voltages from 0.1 volt to 300 volts were applied to the input. The meter reading was linear and correct over this range provided the proper attenuation was applied to prevent meter deflections of over 30 units. Deflections above 30 ma draw too much current from the plates of V_5 and V_6, resulting in loss of gain and nonlinear meter deflections.

The wave shape of the gating pulse was observed on the cathode of V_3 at frequencies ranging from 2 to 100,000 cps. The wave shape was excellent up to frequencies of about 10,000 cps. At this point, the corners of the square wave began to round off. However, the square wave is able to operate effectively as a gate, even though rounded, because its amplitude is larger than is necessary to switch the meter tubes.

Amplitude readings for the various components should be taken with a beat frequency of about 1 cps. An amplitude reading taken with zero beat frequency will be in error because the reading of the output meter is a function of the relative phase of the gate frequency and the particular component frequency being studied as well as be-

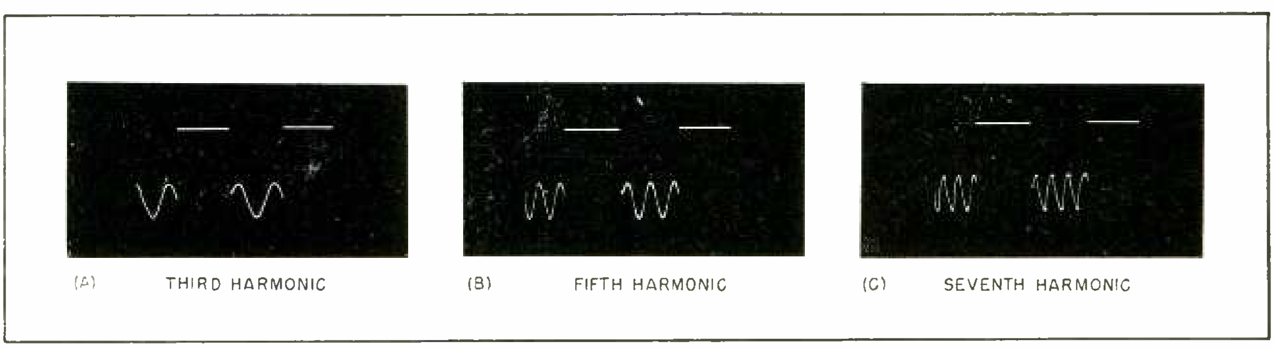


FIG. 5—Oscillograms of meter tube plate waveforms for odd harmonics

ing a function of that component's amplitude.

Operation

Suppose a sine wave with a frequency of 600 cps is applied to the input. The operator begins to search, starting at the high frequency end of the spectrum. The meter reading is zero until the gate frequency approaches, within a few cps, the frequency of the sine wave. Further searching will reduce the difference frequency to 1 cps. The meter reading varies from a maximum in one direction to a maximum in the other direction as the phase of the gate and the input vary from zero to 180 degrees. Figure 4A shows the waveform present at the plate V_6 when the two frequencies are equal with zero phase difference.

As the operator continues to search the remaining lower portion of the frequency spectrum, a reading is obtained at 200 cps, although 600 cps is being applied to the input. This reading is one-third that of the reading obtained at 600 cps. Figure 5A shows the waveform present at the plate of V_6 when the gate frequency is one-third that of the input frequency with zero phase difference. Under these conditions, the meter should and does give an average d-c reading of one-third the value obtained previously.

Figures 5B and 5C show that similar readings will be obtained at gate frequencies which are one-fifth and one-seventh that of the input with amplitudes correspondingly decreased. Figures 6A, 6B and 6C show that the even harmonics of the gate frequency result in an average d-c reading of zero. Herein lies the peculiarity of the instrument. It does pass the odd harmonics, although at increasingly decreased amplitudes (Fig. 7).

For a complex wave composed of frequencies such that the lowest frequency present is higher than one-third of the highest frequency present, the instrument, within the limits of its frequency and sensitivity ranges, analyzes the wave completely and accurately, determining the frequency and amplitude of each component. Such a wave might be one composed of these frequencies: 1,200, 1,150, 1,000, 875, 600 and 483 cps. Another example might be a wave made up of frequency components of 11,180, 9,350, 5,000 and 4,019 cps.

To examine a wave composed of the following frequencies and amplitudes: 1,000 cps at 10 volts, 2,000 cps at 5 volts and 3,000 cps at 3 volts, the operator begins at the high-frequency end. At a dial setting of 3,000 cps the meter reads 3 volts. At 2,000, it reads 5 volts. But at 1,000, it reads 11 volts—all 10 volts of the fundamental plus one-third of the 3 volts of the third harmonic. However, an operator with some experience and technique is able to analyze a complex wave quite adequately.

Future work might be done on the design of an additional circuit which would eliminate the odd harmonics.

The fact that the input to the meter tube cannot exceed about five volts rms naturally limits the sensitivity of the instrument. For all attenuator positions, frequency components whose strength is about 1 percent of the strongest component present can be detected and measured.

Frequencies as close together as 5 cps can be separated and their amplitudes measured.

Distortion introduced by the instrument including intermodulation distortion is under 1 percent.

The writer wishes to express his indebtedness to Professor Frank Walz and Mr. David Stacy, Research Physicist, both of the staff of the University of Colorado Physics Department.

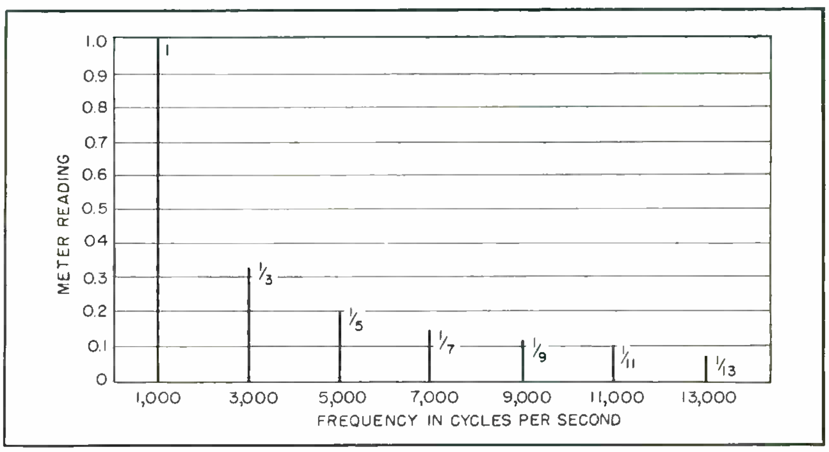


FIG. 7—Chart shows analyzer readings for 1,000-cps square-wave input

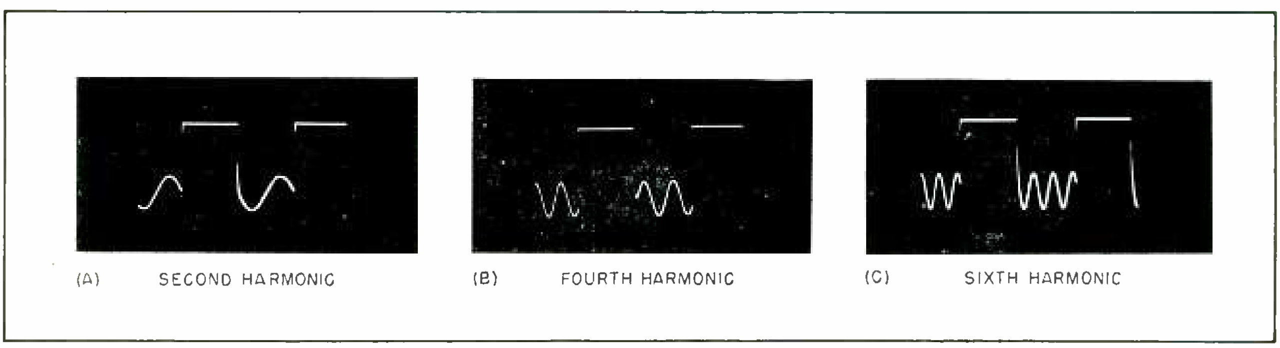
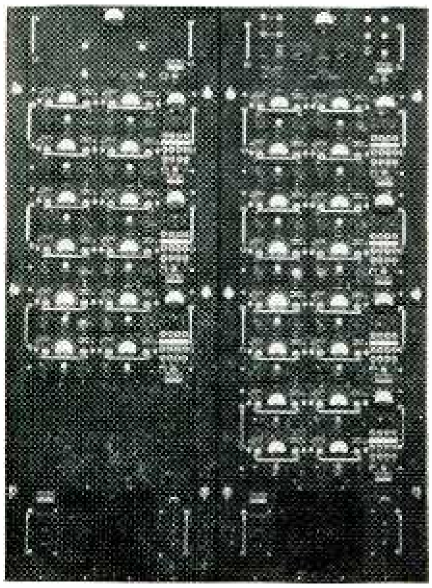


FIG. 6—Oscillograms of meter tube plate waveforms for even harmonics

Decommutating

Automatic decommutator separates up to 27 intelligence channels which are time-division multiplexed using pulse-amplitude modulation on a single f-m/f-m subcarrier. All common telemetering commutation rates may be accomodated. System conserves bandwidth and increases intelligence-handling capacity



27-channel automatic decommutator for pulse-amplitude modulated telemetry

Four-channel separator incorporates four basic information gates and common power supply

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INCREASED INTELLIGENCE-HANDLING capacity and bandwidth economy are achieved in f-m/f-m telemetry by time-division multiplexing one or more of the individual f-m subcarriers. Figure 1 illustrates a typical subcarrier waveform for commutation systems that employ pulse-amplitude modulation of the individual intelligence channels. The commutation rates listed in Table I have been established by the Research and Development Board committee on guided missiles and are compatible with conventional electronic separation techniques.

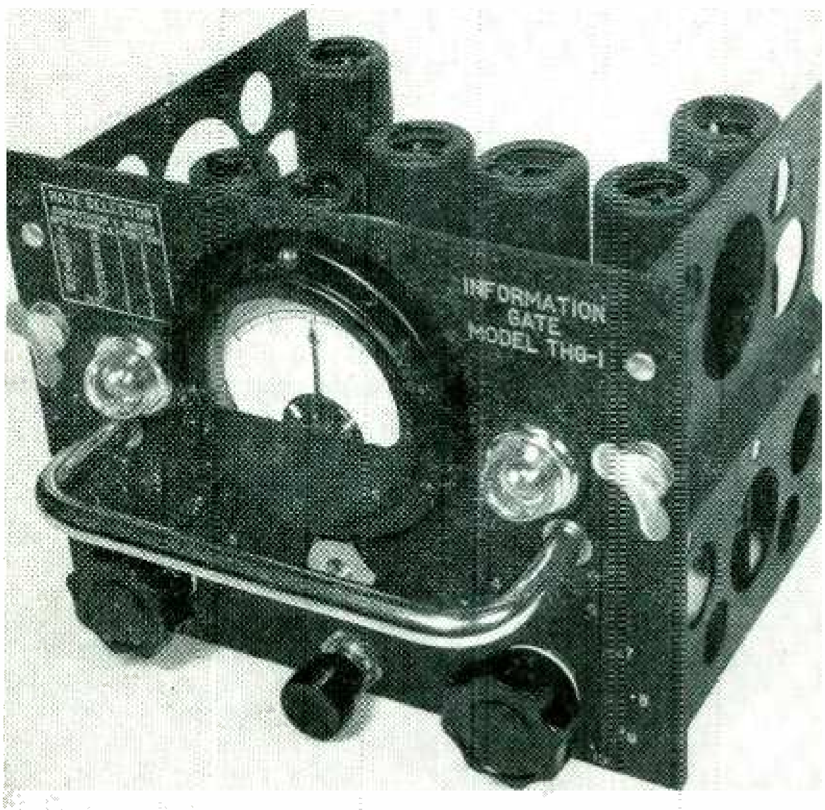
The Bendix THC-1 electronic decommutator shown in the photograph, is designed to handle the two commutator configurations and several rates, which are finding continually wider application. Front-panel switches permit rapid adjustment to either a system employing 15 intelligence channels at commutator speeds of 5, 10 or 25 revolutions per second, or 27 intelligence channels at 2.5, 5 or 10 revolutions per second.

The decommutator simplifies data reduction since each intelligence channel, after separation and conversion, may be recorded on a separate oscillograph trace as an essentially continuous indication. Presentation of the individual channels on panel meters provides a valuable simultaneous indication of measured phenomena. A typical input signal with corresponding decommutated output signals is shown in Fig. 2.

The input signal to the decommutator is the output from a subcarrier discriminator in a standard f-m/f-m telemetering receiving station. The discriminator serves to demodulate the frequency-modulated subcarrier and produce an output signal proportional to, and of the same form as, the signal that was employed to modulate the subcarrier oscillator in the airborne telemeter. The waveform is essentially as shown in Fig. 1 except that the keyed subcarrier frequencies have been converted to changes in direct-current level.

Figure 3 presents a functional

Pulse Telemetry



Information gate is basic building block of electronic decommutator

block diagram of decommutator operation. The unseparated information pulse train is applied through a balanced low-pass filter to the input of a balanced, direct-coupled information amplifier. Circuitry of the d-c amplifier is conventional. Two amplifier stages drive a cathode-follower output. Heavy inverse feedback is utilized from the output to the cathodes of the input stage, insuring amplifier stability and reducing the effective output impedance to approximately twenty ohms. The information amplifier feeds twenty-eight paralleled information gates.

Several factors dictated the use of balanced circuitry in the information channels of the decommutator rather than single-ended circuitry requiring fewer components. First, nearly all discriminators employed for subcarrier demodulation use balanced-output circuitry. Conversion to single-ended operation would reduce long-time stability by permitting variations of average current in the discriminator output tubes to appear as a system error. Second, the trend toward programs of longer duration made the inherent stability of push-pull amplifiers a desirable feature for the decommutator itself. Third, much of the control and recording equipment available to military facilities at present employs balanced circuitry.

Information Gates

Information gates are normally closed, and are opened by triggering pulses from associated counter stages. These triggering pulses are coincident in time with the leading edge of the information pulses. Therefore, information gates are opened, in sequence, to receive the same channel information pulse each frame. The gate-input circuit consists of a pair of 6AL5 diodes connected back-to-back to minimize contact potential and also to pass signals of either polarity. A simplified gate schematic is shown in Fig. 4.

During the gate-closed period, the diodes are cut off due to the voltage developed across the diode-load resistors by current flow through the bias tubes. During the gate-open period, the bias tubes are prevented from conducting by the control tube, and information is passed through the diodes to storage circuits.

The storage circuits cause the output to be maintained at a level proportional to the information-pulse amplitude until the gate is again opened by the same channel-opening pulse in the next frame. Nominal output of each information gate is ± 5 milliamperes into a 330-ohm load for band-edge-to-band-edge deflection of the subcarrier oscillator. A high-impedance, single-ended output is also provided from each gate. Linear output simplifies data reduction.

The storage circuit consists of a capacitor in the grid circuit of a specially designed cathode follower that meets the requirements of long time-constant and stability under essentially open-grid operating conditions. Gates are closed before the termination of the information pulse by a triggering voltage developed in the control unit, insuring that gate output is clamped at nearly peak value of the information pulse.

Counter Circuitry

The problem of channel-synchronizing or counter circuitry, was coupled closely with system flexi-

Table I—RDB Standard Commutation Rates

Number of Channels to be Commutated	Commutation Rate Cycles per Sec	Samples per Second (Including Synchronization)
15	5	90
15	10	180
15	25	450
27	2.5	75
27	5	150
27	10	300

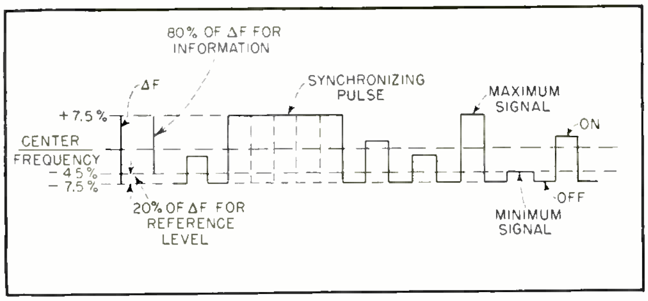


FIG. 1—Research and Development Board standard wave-forms for pulse-amplitude modulation of an f-m subcarrier. Maximum signal represents 7.5-percent deviation from subcarrier center frequency

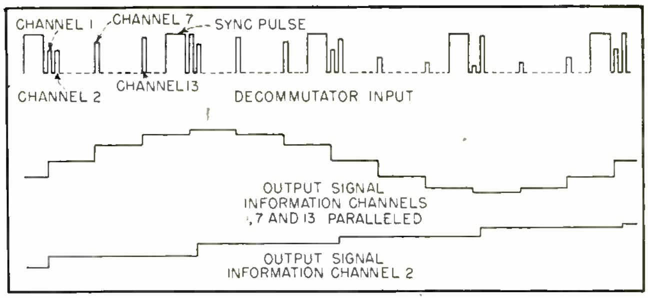


FIG. 2—Typical decommutator waveforms illustrate action of storage circuit. Output signal from information channel 2 shows original intelligence-carrying waveform reconstructed from sample pulses

bility. A tumble open-loop counter, consisting of a series of Eccles-Jordan trigger circuits, each providing sequential trigger pulses, was chosen. This type of counter has the advantage of expansion to any number of stages without the use of feedback or complex matrices.

Four such stages are included in each four-channel separator assembly and these groups of four counters are interconnected by isolating amplifiers. All counter stages are reset at the end of each information frame, or commutator revolution, by a master synchronization pulse. The choice of a tumble counter also simplified cabinet wiring since each counter stage is close to its associated information gate. The choice of four channels per separator unit was indicated by the divisibility of most commutator configurations by four, resulting usually in a spare channel in the decommutator.

In the decommutator control unit, positive-going information pulses at the output of the filter are applied to the control amplifier. Series diode limiters equalize pulse amplitudes, and a unique negative-feedback loop clamps the base line of the information wavetrain to a reference voltage. Output of the final stage of the amplifier, an Eccles-Jordan trigger circuit, is coincident with the original information pulse train, and is used to actuate the remaining control circuits.

Stepping-Pulse Generator

The stepping-pulse generator consists of a univibrator that delivers output spikes coincident with the leading edge of each information pulse. This positive pulse is transferred through an isolating cathode follower to an amplifier in each separator unit in use. Amplified and inverted, the pulse is then applied as common drive to the counter string, serving to synchronize information channels. Output trigger pulses from individual counter stages are fed through cathode followers and act to open the associated information gates. Up to seven of these cathode followers can be connected in parallel, by external patch cords, to trigger a single information gate, thereby increasing the frequency-response capability of an individual channel. The six bypassed information gates are inoperative under this condition.

Gate—Closing Pulses

Gate-closing pulses are generated by a univibrator used as a delay circuit. It is forced into its unstable position by the leading edge of the control-amplifier output pulses. Upon return to the stable state, its positive output is differentiated and applied to all gates, serving to close the single open gate. The delay period is chosen by switching timing capacitors.

Forced reset of the counter is utilized to insure that the decommutator is synchronized with the airborne equipment at the beginning of every frame. A pulse-selector circuit transforms the master synchronization pulse, which is five times the width of an individual information pulse, into an inverted sawtooth. This waveform is then differentiated and amplified. The resultant reset pulse, coincident with the trailing edge of the master pulse, is applied to all reset grids of the counter.

Reliability of the decommutation equipment is increased by the pulse synthesizer, which injects a substitute pulse to the stepping-pulse generator to replace a missing information pulse, and thereby maintains decommutator synchronization with the airborne commutator. Output of the synthesizer is gated so that with all information pulses present, no synthetic pulses are supplied to the equipment. If it were not for the synthesizer, all channels following a missing pulse would be recorded on the wrong receiving channel because the counter would not have been stepped one count for the missing pulse. The synthesizer consists of a voltage-controlled multivibrator, a combination phase-comparator and gating circuit, and a gate that is normally closed to prevent signal output. Up to five consecutive pulses may be replaced accurately by the synthesizer. Replacement of a much larger number is possible if the airborne commutator has speed stability and freedom from jitter.

System Layout

Standardization and operating convenience were achieved by dividing the equipment into a number of plug-in assemblies. Input filters, amplifiers, control and synchronization circuitry are included in the THS-1 decommutator control unit. This unit also contains the master rate-control switch and system-test circuitry.

Trigger pulses for control of individual information gates are generated in a number of THK-1 four-channel separator units. Each separator unit provides plug-in mounting for four information gates. A self-contained, regulated power supply furnishes power required by the separator and the four information gates. The number of four-channel units employed with any individual system is dictated by the system channel requirements.

Separating the trigger circuitry from the information gates simplified the technical problems of multiple opening of an individual gate within each frame, or commutator revolution. This feature provides an excellent means for monitoring a function that cannot be placed on a separate subcarrier channel but requires higher frequency response than is available with one sample per revolution. Separation of the trigger stages from the gates also simplifies the problem of bringing the trigger signals out to a patch bay on the four-channel separator. The trigger signals may be cross connected by patch cords between units with up to seven trigger signals being fed to a single gate.

Design Features

Removal of pulse circuitry from each individual information gate, and the use of several integral power supplies are a new approach to the problem of system flexibility. The design engineer who must anticipate expanding program requirements can acquire, in the beginning, a 15-channel system, expand the equipment after a few months to the 27-channel system and eventually procure a system that may have in excess of 40 channels. The new configuration eliminates the need for power supplies with inconveniently high capacity. Units are plugged into a standard cabinet for the 15-channel system. Addition of a standard cabinet and units expands the system up to 32 channels, and more cabinets and units may be added if larger systems are adopted.

Four THG-1 information gates shown in the photograph plug into each separator. The configuration provides one spare for either the 15 or 27-channel system. The spare is maintained in operating condition with heaters on. Panel meters on the gates provide an indication proportional to the measured function.

Other units are the dual regulated power supply, which furnishes power for the decommutator control unit, and centrifugal blower units for cooling. The quiet operation afforded by the centrifugal blowers enables the system operator to perform normally the many functions during an operation without a distracting high ambient noise level that can contribute to mistakes.

Test Circuitry

Test condition for the equipment is obtained upon the removal of input signal. With no signal applied to the decommutator, the pulse synthesizer supplies stepping pulses to the counter, but does not actuate the gate-closing generator nor the reset circuit. Counter outputs both open and close the information gates. The constant operation of circuits such as the counter stages and the information-gate control tubes helps prevent cathode deterioration, a common trouble with counter-type circuitry.

Under test conditions, two additional counters, normally inoperative with signal input, complete the counter chain. The output of the second of these counters is used to reset the counter every counter cycle. With the equipment in this condition, the power supplies and information amplifier may be adjusted, and the information gates balanced. The only operating adjustments consist of setting output levels and recorder calibration.

Test cathode followers are included in the control unit, with input and output-circuit jacks available on the front panel. Strategically chosen test points are available on two ten-position test switches for oscilloscope observation. Provisions are included to mix waveforms, thus permitting pulse phase comparisons with single-beam oscilloscopes.

Tests indicate that the decommutation equipment should introduce an error of less than 1 percent. The frequency response is normally considered to be approximately one fifth the frame rate, (rps of the commutator). The response can be increased to almost one half the frame rate by employing integration filters and slight circuit modification, but such response is seldom required for commutated functions.

Coordination of layout and mechanical design was contributed by C. P. Wiggins and R. A. Hanson. R. E. Cunningham solved the difficult pulse and timing-circuit problems.

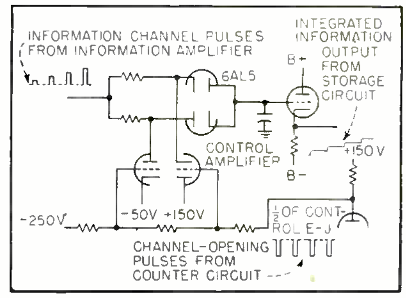


FIG. 4—Information gate is opened by sequencing pulse. Storage circuit holds information during off time

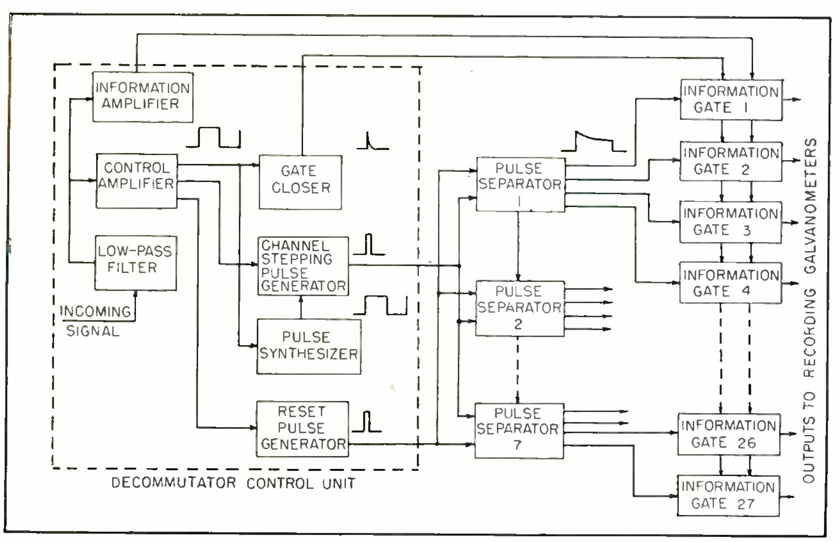


FIG. 3—Block diagram of electronic decommutator for 27 channels. Counter circuits supply sequencing trigger pulses to information gates

Electronic Analog

Application of electronic analog computers to systems study and analysis is described. Author shows derivation of electronic analog for processes of summation, integration and differentiation. Solution is shown for a typical closed-loop system

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Any systems study or analysis resolves itself into the problem of obtaining the response equation of the system and then solving the equation for the particular set of circumstances involved.

The prime use of the electronic analog computer is to obtain this solution of the response equation. The analogy involved is a mathematical one wherein an electronic analog is set up to perform the actual mathematical operations indicated by the solution to the equation.

The heart of the electronic analog computer is a d-c amplifier with specified characteristics. The design of such amplifiers and the difficulties encountered therein have been the subject of many articles which are readily available for reference. Since the performance of the amplifier in an electronic analog computer is of a particular type that can be obtained through the familiar methods of amplifier technique, the design of such an amplifier will not be discussed herein. It will suffice to discuss only the requirements of the amplifier insofar as they affect its operation as a computing mechanism.

Primarily the amplifier must have sufficiently flat frequency response to cover the range of frequencies encountered in the functions which result in the solution to the equation. The second requirement is that there can be no flow of current in the input stage to the amplifier. Perhaps the most important requirement of the amplifier is that it have a high gain in the frequency range in which it is used. The direct result of low gain in the amplifier is error in the solution. The minimum gain that can be tolerated is dependent upon the accuracy requirement of the solution to the system under investigation.

Basic Computer Element

Figure 1A is a functional diagram of a d-c amplifier used to form the basic element in the analog computer. It is from this element that all operations are performed. The element is formed by using a d-c amplifier with a gain of K and a feedback impedance Z_2. The input signal to be operated upon is introduced through a series impedance Z_1.

Figure 1B is an equivalent circuit from which the following voltage equations are obtained:

$$e_i = I_1 Z_1 + e_1 \quad (1)$$

$$e_1 = I_2 Z_2 + e_o \quad (2)$$

$$e_1 = \frac{e_o}{K} \quad (3)$$

Solving Eq. 1 for the current:

$$I_1 = \frac{1}{Z_1}\left[e_i - e_1\right] \quad (4)$$

Recalling the requirement that the input stage of the amplifier draw no current, it is seen that I_1 must equal I_2. Substituting Eq. 4 for I_2 and Eq. 3 for e_1 in Eq. 2 the following results:

$$\frac{e_o}{K} = \frac{Z_2}{Z_1}\left[e_i - \frac{e_o}{K}\right] + e_o \quad (5)$$

Rearranging terms in Eq. 5:

$$e_o\left[\frac{Z_2}{Z_1 K} + \frac{1}{K} - 1\right] = \frac{Z_2}{Z_1} e_i \quad (6)$$

If the amplifier has the required gain, the term involving K will be very much smaller than unity. Hence Eq. 6 can be reduced.

$$e_o = -\frac{Z_2}{Z_1} e_i \quad (7)$$

Equation 7 is the characteristic expression for the output as a function of the input to the computer element. By proper choice of the input and feedback impedances, the element can be made to perform the required mathematical operations in the solution of linear differential equations. The expression is independent of the gain of the amplifier as long as those terms involving the gain are very much less than one. Examination of Eq. 6 will show that for these terms to disappear from the characteristic equation, the value of K must be very large. Experience has shown that as long as the gain of

BACKGROUND

Electronic analog computers were born of necessity to fill man's need for a machine to do the mathematics involved in certain scientific investigations. They currently find widest application in making systems studies and analysis of servomechanisms and related equipment.

This article summarizes the fundamental operating principles involved for readers who are not presently engaged in computer design or operation

Computer Fundamentals

the amplifier is over 10,000 the error introduced is negligible as compared with normal instrumentation errors.

Summation

Figure 2A shows the method of using the basic element to obtain the sum of several quantities. For this purpose, the input and feedback impedances are pure resistance. An analysis of this circuit will result in the following expression for the output:

$$e_o = -Z_2\left[\frac{e_1}{Z_{11}} + \frac{e_2}{Z_{12}} + \frac{e_3}{Z_{13}} \dots + \frac{e_n}{Z_{1n}}\right] \qquad (8)$$

In some instances, it may be desired to subtract one or more quantities in the same operation that is used to obtain a sum. In this case, it is necessary to insert an additional summing circuit to change the sign of those quantities to be subtracted. If the feedback and input resistances are of equal magnitude, the output will differ from the input only in sign.

Integration

The quadrature method of solving differential equations where the variables are separable involves direct integration; hence, the most used element in the electronic analog computer is the one used for integration. Figure 2B shows the integrating element of the analog computer in which the input impedance is pure resistance and the feedback impedance is capacitive. By applying Eq. 7 to this circuit, the following expression for the output is obtained:

$$e_o = -\frac{1}{j\omega RC}\, e_i \qquad (9)$$

To show that this expression represents the integral of the input to the computing element, it is necessary to digress from the present topic and discuss operational methods used in systems analyses.

In the solution of linear differential equations with constant coefficients, the method using LaPlace transforms reduces mathematical complexity. Here, an operator p replaces the differential equation by an algebraic one involving p. In using this method, an integral in the differential equation will appear as a term involving $1/p$ in the algebraic equation. In this algebraic equation, the operator p can be replaced by $j\omega$ to obtain the steady state condition for sinusoidal excitation.

Consider the voltage drop across a capacitor C which has a current i flowing through it. Then

$$E_c = \frac{1}{C}\int i\, dt \qquad (10)$$

Putting Eq. 10 into LaPlace transform form:

$$E_c\,(p) = \frac{1}{pC}\, I\,(p) \qquad (11)$$

Now, replacing p by $j\omega$ we find that the voltage takes the form

$$E_c\,(j\omega) = \frac{1}{j\omega\, C}\, I\,(j\omega) = -\,jX_c I \qquad (12)$$

Neglecting any mathematical rigor, it will be sufficient to say that the appearance of the term $1/j\omega$ indicates that an integration has been performed. Applying this to Eq. 9, we find the output of the integrating element:

$$e_o = -\frac{1}{RC}\int e_i\, dt \qquad (13)$$

In any operation involving integration, the need for representing the constant of integration becomes evident. Since the constant of integration is the initial value of the variable in the analog computer, it is established by placing an initial charge on the capacitor such that a voltage equal to the initial value, in phase and in magnitude, appears at the output of the integrating element prior to the application of the input. Figure 2B illustrates this process wherein capacitor C has been initially charged with a voltage E_o such

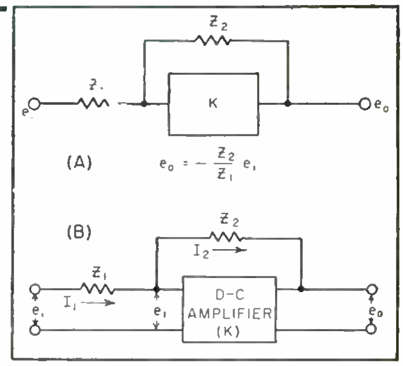

FIG. 1—Basic analog computer element consists of an input impedance, a d-c amplifier and some form of feedback loop

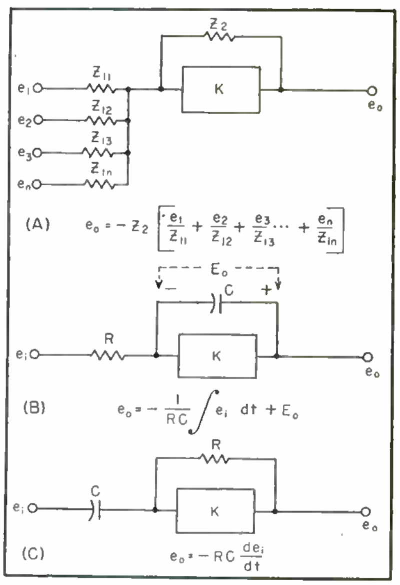

FIG. 2—Fundamental processes in analog computing are (A) summation, (B) integration and (C) differentiation

that an initial voltage E_o appears at the output of the element. In this case, the response equation for the element results.

$$e_o = -\frac{1}{RC}\int e_i\, dt + E_o \qquad (14)$$

Differentiation

Figure 2C shows the computing element used as a differentiating circuit. In this case the input impedance is a capacitor and the feedback impedance is a resistance. Applying Eq. 7 we find the response of this element:

$$e_o = -\,j\omega RC\, e_i \qquad (15)$$

In a manner similar to that used

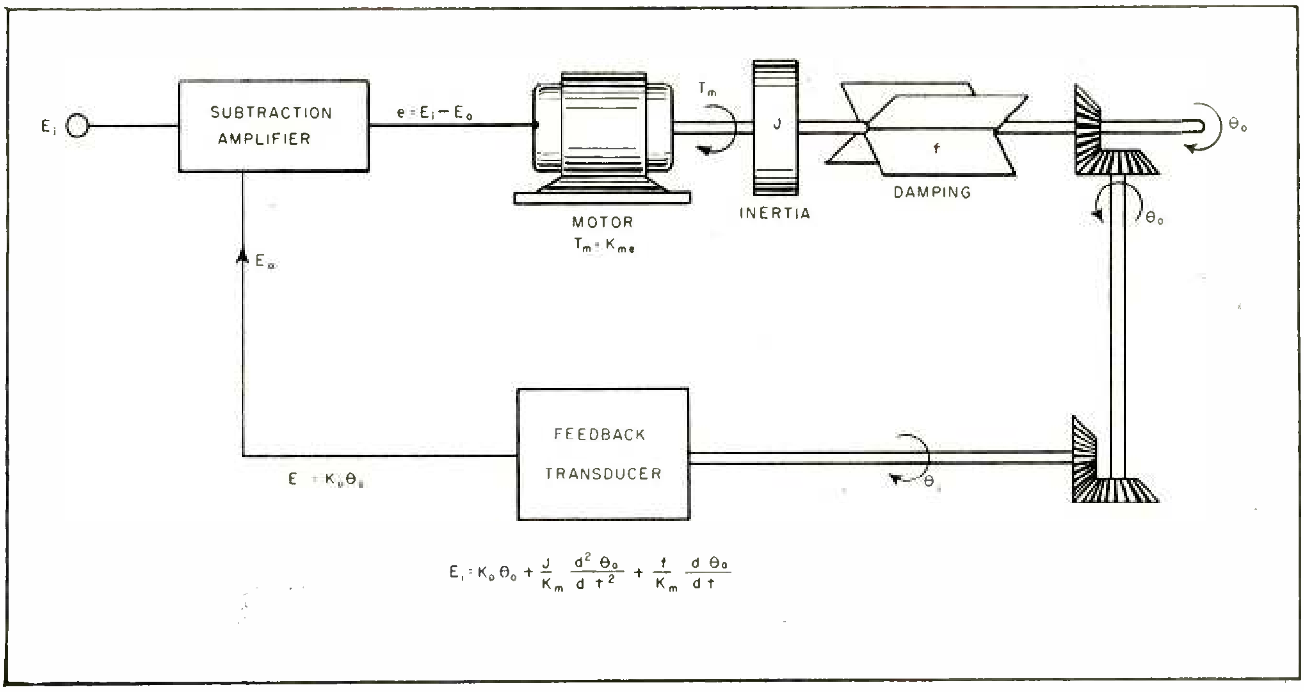

FIG. 3—Closed-loop servo system and its differential equation

in the case of integration, it can be shown that the appearance of $j\omega$ indicates that differentiation has been performed. Hence Eq. 15 reduces to

$$e_o = -RC\frac{de_i}{dt} \qquad (16)$$

In many cases of systems analysis differentiation is required in order that the analog perform in accordance with the components used in the actual system. An example of this is the process of error rate damping used in certain closed-loop systems. In this case, a particular transducer is required to respond to a signal which is proportional to the rate of change of an error between the input and output. An electronic analog of such a system would involve the use of a differentiating element in the synthesis of the error-rate transducer. Another important use of the differentiating element is the case of compensating networks which are used to improve the phase characteristics of systems. Such networks often involve a p term in their transfer function which requires a differentiating element in the analog.

General Characteristic

With the basic element so far described, it is possible to set up an analog of systems whose response can be described by a linear differential equation whose coefficients are independent of the variables in the system. In addition to the basic computing elements, there are generally certain other elements required. In many cases it is desired to place limits on the magnitude that certain variables may assume. For this purpose limiters, generally of the diode type, are provided whereby the voltage at any point in the analog may be limited to the desired value.

In systems analysis, the response of the system to prescribed forms of excitation is often desired. When this input is sinusoidal, the problem of excitation is easily answered by the use of oscillators to obtain the forcing functions. For more complex types of forcing functions, it is necessary to generate the prescribed form. A method that is commonly used, if the mathematical form of the function is known, is one which sets up a differential equation whose solution is the required forcing function. This equation is then set up on a portion of the computer and the solution used as the required forcing function. For example, it is often required to excite the system by a signal whose magnitude varies directly with time, the so-called ramp function. To obtain this, an equation is set up on the computers, the solution to which provides a linear magnitude-time variation with a slope of A. The solution of this equation is the function $y = At$.

The electronic analog computer has been extended to include certain nonlinear operations such as multiplication of variables. These extensions require the use of mechanisms which will multiply and divide. In most cases, these operations are performed by servo-type mechanisms of a mechanical nature rather than electronic circuits. As in any mechanical system, the speed of computation is no longer negligible; hence, the frequencies at which these elements may be used are greatly limited. The subject of servo-type computers will not be dealt with here.

Closed-Loop System

Figure 3 is a diagram of a hypothetical closed-loop system which illustrates very clearly how the electronic analog computer facilitates the study of such a system. In this system, it is desired to displace the angular position of a motor by a voltage system. Aside from the inherent inertia of the motor

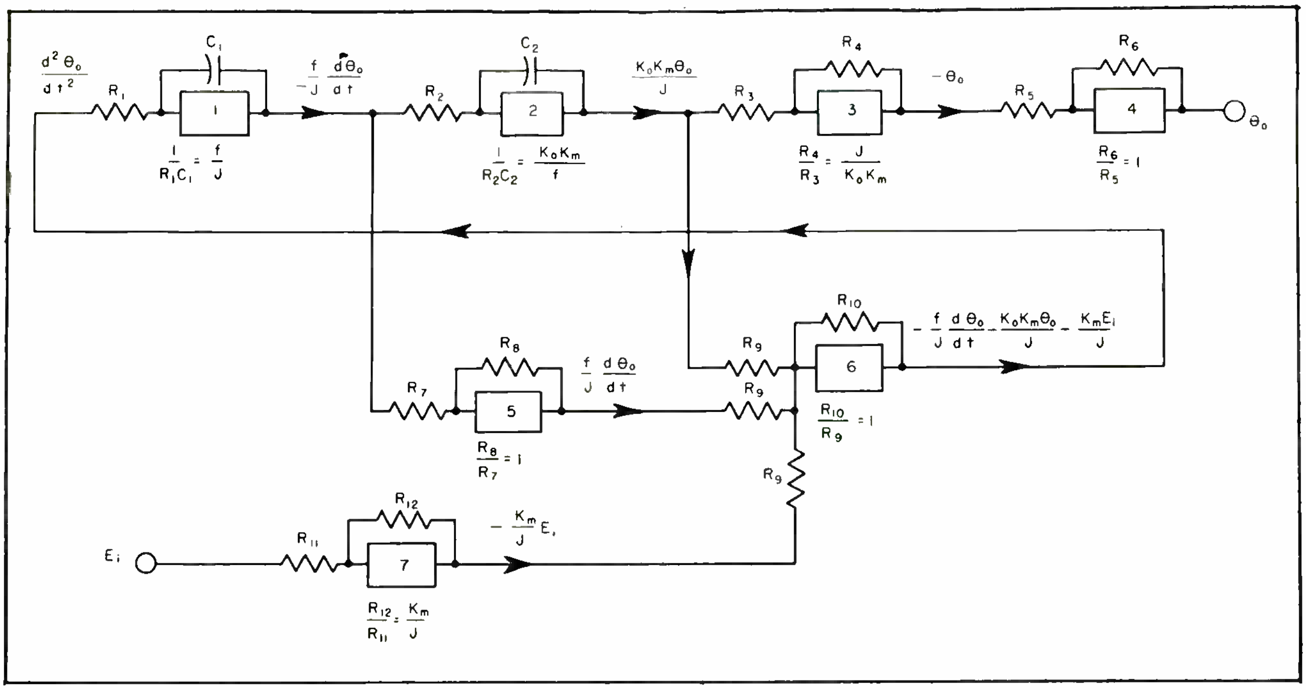

FIG. 4—Electronic analog solution of closed-loop system shown in Fig. 3

and the damping in the system, the components which make up the entire system are those which tend to minimize the magnitude and time-lag errors in the system. In order that the output displacement θ_o be directly proportional to the magnitude of the input voltage E_i, the output is compared with the input through the feedback transducer. This transducer converts the angular output to a proportional voltage which is compared with the input voltage in the subtraction amplifier. If at any time, the output differs from the input, an error signal e will drive the motor until such time as the output is equal to the input and the error signal is reduced to zero.

The response of the system is given by the following differential equation:

$$E_i = K_o \theta_o + \frac{J}{K_m} \frac{d^2\theta_o}{dt^2} + \frac{f}{K_m} \frac{d\theta_o}{dt} \quad (17)$$

In order that the performance of the system may be studied, it is necessary to solve this equation, in which case the output will appear as a function of time for various types of input signals. To apply the electronic analog computer to the solution of this equation, it is necessary to rearrange the equation by equating the highest order derivative in the equation to the remaining terms:

$$\frac{d^2\theta_o}{dt^2} = \frac{K_m}{J} E_i - \frac{K_m K_o}{J} \theta_o - \frac{f}{J} \frac{d\theta_o}{dt} \quad (18)$$

Starting with the highest order derivative, which is the second derivative in this example, the equation is set up on the computer by successive integration of the highest-order derivative. Figure 4 shows the analog solution for the example system and represents the solution for Eq. 18. In amplifiers 1 and 2, the second derivative has been integrated to obtain the first derivative and the variable output of the system. The magnitudes of the impedances in the individual integrating elements have been chosen so that the variables have been multiplied by the constants required by Eq. 18. Having integrated successively to obtain the variable, it is only necessary to combine the required terms with the input signal to satisfy the original equation.

In Fig. 4, this is done in amplifier 6; since the output of amplifier 6 now represents the entire right-hand portion of Eq. 18, it is used to form the input to the first integrating element.

The entire analog has now been set up and the output θ_o may be studied by applying the required input signals at the point shown in Fig. 4. In order that θ_o appear with a positive sign and in its true magnitude, amplifiers 3 and 4 have been added. In obtaining quantitative results, it is necessary to adjust the scale factors used throughout the systems, as set up on the computer, in such a manner that the desired quantities are of sufficient magnitude to be measured without excessive instrumentation error. Another important consideration in establishing the scale factors is the capabilities of the d-c amplifiers. Adjustment in scale factors may be required in order that the amplifiers are not overloaded since such overloading will result in considerable error.

Conclusion

While the electronic analog computer is a very important time saving instrument, it is not capable of doing the entire job. The system must be studied and its response equation obtained before the computer will be of any service. As in the case of all man-made devices, it does not experiment nor does it think. It is merely a tool in the hands of the user.

Air Breakdown Chart for Radar Pulses

Chart gives approximate breakdown voltage between conductors in air in the three major frequency ranges that are related to the mean free path of electrons in air. Chief use is design of high-voltage pulse circuit components for radar installations

By HAROLD A. WHEELER
Wheeler Laboratories
Great Neck, N. Y.

Use of high-power pulses in radar depends on the dielectric strength of air. The design of equipment to handle these pulses should be based on estimates of the breakdown voltage in the air gaps between conductors. The various configurations of the conductor contours make such estimates difficult, but a few simple rules and the accompanying chart are a great help.

The primary purpose of the chart is to show the variation of breakdown voltage with frequency. Breakdown by an alternating voltage is an effect of cumulative ionization by collision during successive cycles of alternation. At high frequencies, such that the electrons and ions oscillate in the field without reaching the electrodes, the free charges accumulate until the ionization and recombination rates reach equilibrium.

At low frequencies, such that the electrons and ions would oscillate further than the distance between electrodes, the free charges are partially collected during each cycle and hence do not accumulate. Consequently the breakdown gradient is greater at lower frequencies. Likewise, the breakdown gradient is greater in smaller distances, which also facilitate the clean-up. These effects are summarized by the three curves on the chart.

The transition between the medium-frequency and high-frequency curves occurs at certain frequencies and pressures, as indicated for a few cases that have been tested. At high frequencies the gradient is constant (2.9 kv per mm at one atmosphere pressure).

Transition Frequencies

If the distance is of the order of 1,000 times the mean free path of electrons in the air, this transition between middle and lower curves occurs at frequencies of the order of 100 mc, as shown on the chart. This relation is independent of the pressure, although the value of the mean free path is inversely proportional to the pressure. In other words, the product of pressure times distance is proportional to the ratio of distance over mean free path. This is the reason why a single family of curves is valid over a great range of pressure and distance.

The transition between the upper and middle curves (not shown) occurs at frequencies about 1/100th as great, since the velocity of ions is less than that of electrons in about this ratio, and their mean free path is nearly the same.

In either case, the transition occurs at a value of pressure-times-distance which is inversely proportional to the frequency.

Uniform Gradient

The simplest case for computation and formulation is a uniform voltage gradient between parallel plane conductors. Ordinary configurations have a peak gradient greater than the average, so the maximum gradient may be taken as a criterion of breakdown over a certain distance. This is valid at high frequencies; at lower frequencies the correct criterion is somewhere between the maximum and the average gradient, usually closer to the maximum.

A uniform gradient causes no corona, just a well-defined spark. A maximum gradient much greater than the average gradient causes corona below the sparking voltage, which expedites the final breakdown when the voltage is increased to that point. At high frequencies, it is even possible to have a breakdown (ball of fire) in a limited space separated from the electrodes.

At low frequencies, there can be no spark in a gas at a voltage less than a certain value (about 0.3 kv in air), because the electrons are collected before they can gather sufficient momentum. At high frequencies, this rule fails because most of the elec-

(Continued on p 150)

Air Breakdown Chart for Radar Pulses (continued)

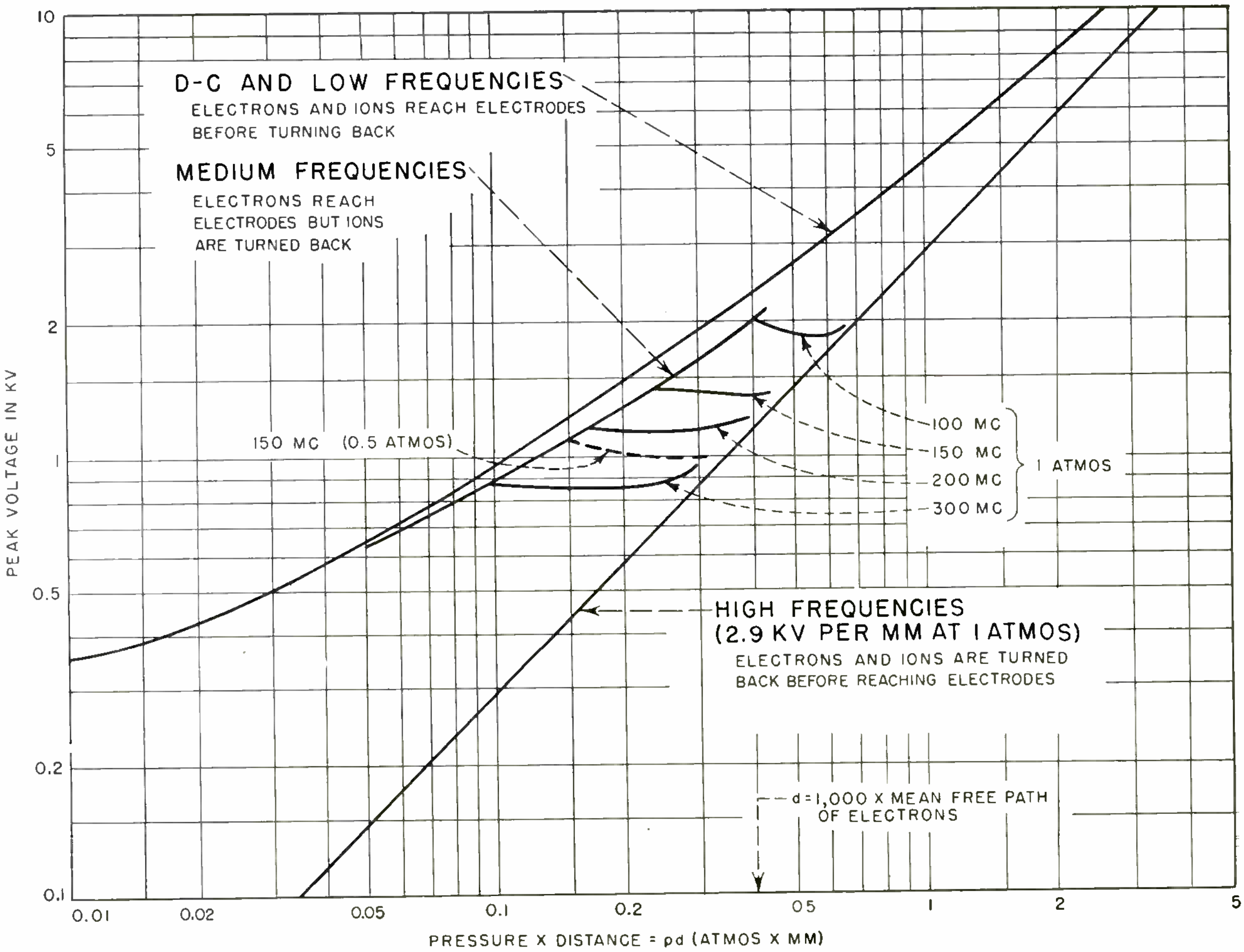

Chart giving breakdown voltage in air between parallel planes. For atmospheric pressure, horizontal scale represents distance in millimeters between the plane electrodes

trons oscillate without reaching an electrode.

Experimental Basis

The chart is based on a steady alternating voltage (unmodulated c-w). Short pulses of direct voltage (of the order of one microsecond) occurring at much longer intervals (of the order of one millisecond) stop before equilibrium is reached, so their breakdown voltage is naturally somewhat greater than that of a steady direct voltage, the highest curve on the chart. Such short pulses of high-frequency voltage have been presumed to show a similar tendency relative to the lowest curve, and there is some experimental evidence to this effect.

The chart is valid at lower pressures, provided that the distance is many times the mean free path of electrons, which is true over the range plotted.

In general, there is a scarcity of reliable experimental evidence either to support or to contradict these curves. It is expected that they will be verified under controlled conditions by providing some continuous supply of electrons. This supply may come from corona or other localized discharge, ultra-violet rays, x-rays or gamma rays, but hardly from thermal agitation at ambient temperatures common in electronics equipment (usually under 100C). Therefore a somewhat higher breakdown voltage may be fairly certain if such sources are precluded by design. This is especially true of short pulses such as mentioned above. However, cosmic rays arrive about once per hour per square millimeter, and cannot be stopped by reasonable shielding.

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ELECTRONS AT WORK

Including INDUSTRIAL CONTROL

Edited by RONALD K. JURGEN

OTHER DEPARTMENTS featured in this issue:

Wire Distribution of TV and Sound Signals

By H. J. Barton-Chapple
London, England

Relaying of sound signals to homes in Great Britain has been a major development over the past 25 years and there are presently more than a million subscribers to the service. Most of the operating companies distribute the programs at audio frequencies and provide two, three or four programs.

Since the signal is conveyed from the BBC studio to the listener entirely by wire, there is no interference. Quality of reproduction is superior to that obtained from the most expensive wireless set, while the weekly charge for the service is about 30 cents at the present rate of exchange.

In 1946, when the BBC again started its high-definition tv service in London, the resources of Broadcast Relay Service Ltd. (Rediffusion) became manifest by the provision of a vision service to supplement its sound service. Initially, this was confined to blocks of flats where a single antenna, suitably sited in the best position on the roof, fed the received signals to a wide-band amplifier having an approximately uniform gain of 55 db. Bandwidth was three mc either side of the Alexandra Palace tv station frequency of 45 mc working on 405-line definition, 25 pictures per second with double sideband. From an output matching pad, semi air-spaced polythene insulated coaxial cables linked up any flat to the system through junction boxes, incorporating 40 or 20-db loss pads.

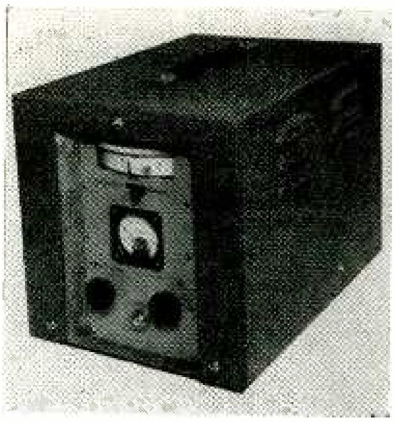
Television sound signals at audio frequency are passed to this control room for monitoring and redistribution over the feeders

Signal Level

The system was designed so that the input voltage to any receiver along the cable did not exceed 7.5 mv and was never less than 0.75 mv. The tenants' own standard tv receivers were used or, alternatively, Rediffusion supplied them for an all-in weekly rental which included free maintenance. Using a high-quality coaxial cable, the attenuation from the feeder itself plus the receiver insertion loss limited the length to approximately 450 yards.

With an average block of flats, it was found that each feeder could provide a wired tv service at carrier frequency to between 40 and 50 flats and, although there was no practical limit to the actual number of feeders installed, it was preferable not to feed more than five coaxial cables from each wide-band amplifier.

The present BBC tv plan in Great



For testing the performance of feeders on vision carrier frequencies, an automatic sweeping signal generator is used

Britain is limited to the provision of a single program for the whole population. The five main high-powered tv transmitting stations use carriers of 45 mc (double sideband), 51.75, 56.75, 61.75 and 66.75 mc (asymmetric sideband) with the sound carrier in each case 3.5-mc lower. It is necessary to convert these carriers to a standard i-f so that identical amplifiers and receivers can be used throughout the wired towns and also to increase substantially the length of cable used before signal attenuation necessitates insertion of a repeater.

Intermediate Frequency

At present, certain technical considerations make it preferable to use an intermediate carrier frequency of the order of 9 to 12 mc and the subscriber to the system is given the choice of one vision program with its accompanying sound plus three other sound programs, all the sound signals distributed being at audio frequency. The scheme is capable of having a second vision channel added later.

Transmission

As mentioned earlier, there is a widespread sound relay service operating in Great Britain and the natural method for a vision relay on the score of convenience and economy is to devise a method that can be combined with the existing audio network technique. Star quad cables, polythene insulated, are employed for modern relay feeders but, at the high frequencies necessary for the vision signal, the characteristics of this cable are subject to wide variations. These variations may be reduced by metallic screening by lapping helically a thin copper or aluminum tape over the cable before finally sheathing it with polythene. Without this screen stabilizer, the attenuation due to rain and dirt may vary by as much as 100 percent. Using two star quad cables, one screened and one unscreened, it is possible to relay four audio programs with the vision program intermediate carrier superimposed on one pair in the screened cable.

The antenna is sited in an area of low interference level and, by using tall masts and suitable directional arrays of high gain, a good signal-to-noise ratio is secured. When the antenna is located in a fringe area, the signal received by the antenna is fed into a wideband low-noise preamplifier.

Reception

A master vision receiver accepts the antenna or preamplified signal and, after amplification, converts it to the required distribution frequency and shapes it to standard asymmetric characteristics. The sound signal can be derived at the same site by direct reception or by line if more convenient but, in any case, it is made available at the central distribution station for monitoring and general retransmission at audio frequency. The vision signal is fed to the same point over low-loss screened coaxial cable.

Where the field strength of a tv signal is quite unsatisfactory, a station some miles away from the relay area can be used and a microwave link employed to retransmit the desired programs to the central station, which will then house the master vision receiver for conversion and amplification.

Subscriber's Equipment

The vision side of the subscriber's apparatus consists of a trf unit suitable for the carrier frequency employed and covering the necessary bandwidth. The sensitivity is approximately 0.5 mv and following this unit are the usual detector, video amplifier, scanning circuits and power supplies.

As mentioned earlier, the sound is transmitted at audio frequency and fed through to the loudspeaker at a level suitable for direct operation. This speaker is integral with the cabinet housing the vision chassis. A sound volume control is provided together with a program selector switch, giving the subscriber a choice of three separate audio programs or the combined vision and sound program. This last named program is fed over one pair of the screened star quad cable, a filter separating the h-f and audio signals.

Tick-Tack-Toe Computer

By E. M. McCormick
West Riverside, Calif.

This paper shows how a certain matrix of manually-operated switches alone is sufficient to solve the logical problem of playing the game of tick-tack-toe. Having a machine capable of playing this child's game is not in itself necessarily useful but some of the concepts in its design may be applicable to more useful devices.

Basically, as shown in Fig. 1, this special-purpose logical computer consists of 18 lights (nine "X's" and nine "O's") in the display, a filament transformer voltage source to operate the pilot lamps in the display and between these two the switch matrix which operates the lights. The switches in this network not only indicate what has been played but also decide in a logical manner what the machine response should be.

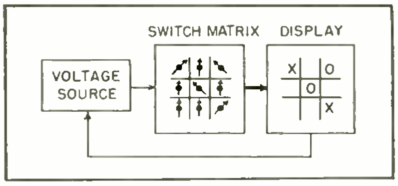


FIG. 1—Basic block diagram of the tick-tack-toe machine

There are nine main switches in this device. Each corresponds to one of the nine possible places one

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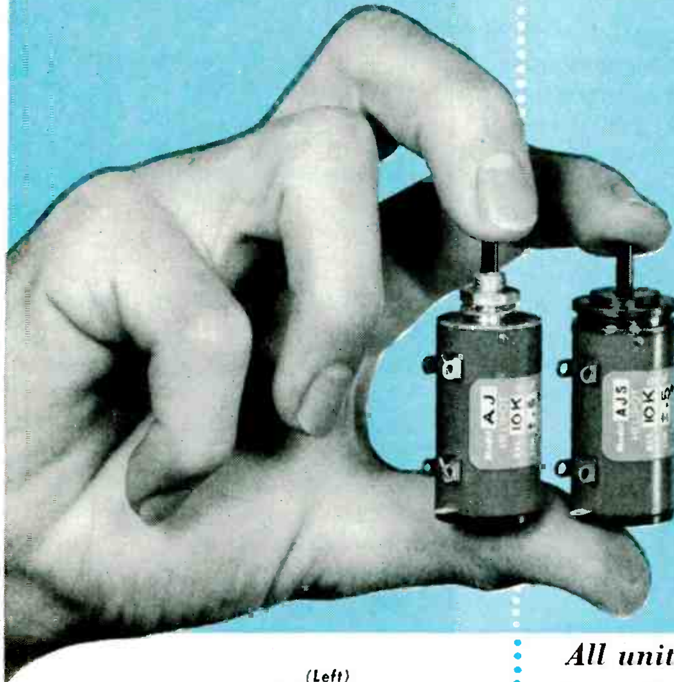

(Left) *Model AJ* *Bushing Mounting*

(Right) *Model AJS* *Servo Mounting*

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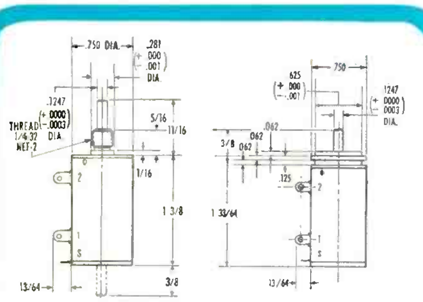

AJ **AJS**

CONDENSED SPECIFICATIONS

Number of turns	10
Power rating	2 watts
Coil length	18"
Mechanical rotation	3600° + 12° −0°
Electrical rotation	3600° + 12° −0°
Resistance ranges	100 ohms to 50,000 ohms
Resistance tolerance	± 5.0%
Linearity tolerances:	
All values	± 0.5% (standard)
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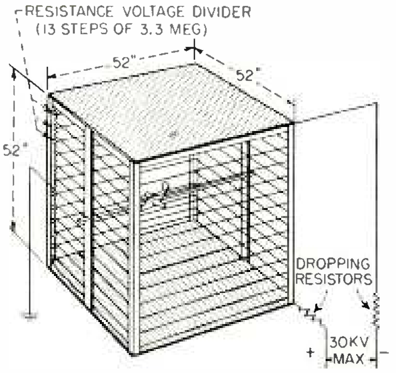


A UNIFORM electrostatic field is produced between the plates of a large parallel-plate capacitor made in the form of a cube shown in the cover photograph and the accompanying drawing. Fringing field effects are prevented in this Stanford Research Institute system by means of the wires shown. Each wire is made to assume the potential it would have if the capacitor plates were infinitely large by connecting it to an appropriate point on a resistance voltage divider.

Although the field configuration outside the cube is quite complex, the internal field is uniform except for localized distortions near the individual wires. An insulating shaft of laminated plastic passes through the field as shown to support the aircraft model under test.

Values of the equivalent area of an antenna, measured using electrostatic techniques, may be used to determine the low-frequency radiation pattern, receiving sensitivity and radiation resistance of the antenna. Antenna capacitance must be evaluated separately.

---

can play. A switch thrown to the left will cause an "O" to appear in that place in the display indicating that the machine has played there. A switch turned to the right produces an "X" to record the machine opponent's play. A switch in the normal (center) position indicates that neither player occupies that spot.

Playing Procedure

The person playing the machine starts by turning the switch corresponding to his desired first play to the right. An "X" appears at that place in the display.

After a few seconds an "O" appears in the area where the machine desires to play. It is then necessary

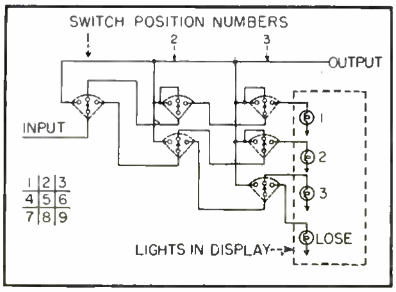


FIG. 2—Details of one of the eight sections of the defensive circuit

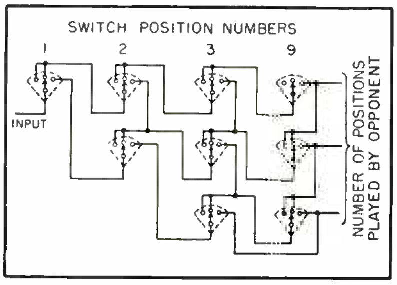


FIG. 3—Switching arrangements for the counter circuit

to manually throw the switch corresponding to that area to the left to record this move. If this is not done, the next play of the opponent would cause the machine not only to forget its last play but also to be confused and forget whose turn it is to play. The only means the machine has for knowing what or when to play is on the basis of the position of the nine switches.

After recording the machine response, the opponent plays again and the process is repeated until the game has reached some logical conclusion.

The machine's operation is errorless. If the person playing the machine knows as much about the game as the machine, all games will

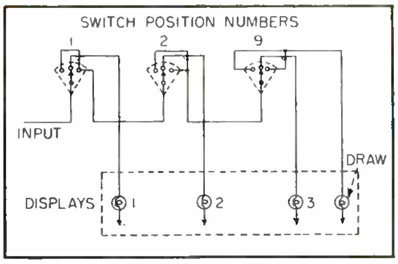


FIG. 4—Details for the "any number" circuit

be draws. If the machine's opponent makes an error, the machine will take the advantage to win. As a concession to human nature, a few errors in the machine response have been deliberately wired into the circuit and are optionally available by throwing a switch from INVINCIBLE to VULNERABLE. Knowing these weaknesses one can beat the machine.

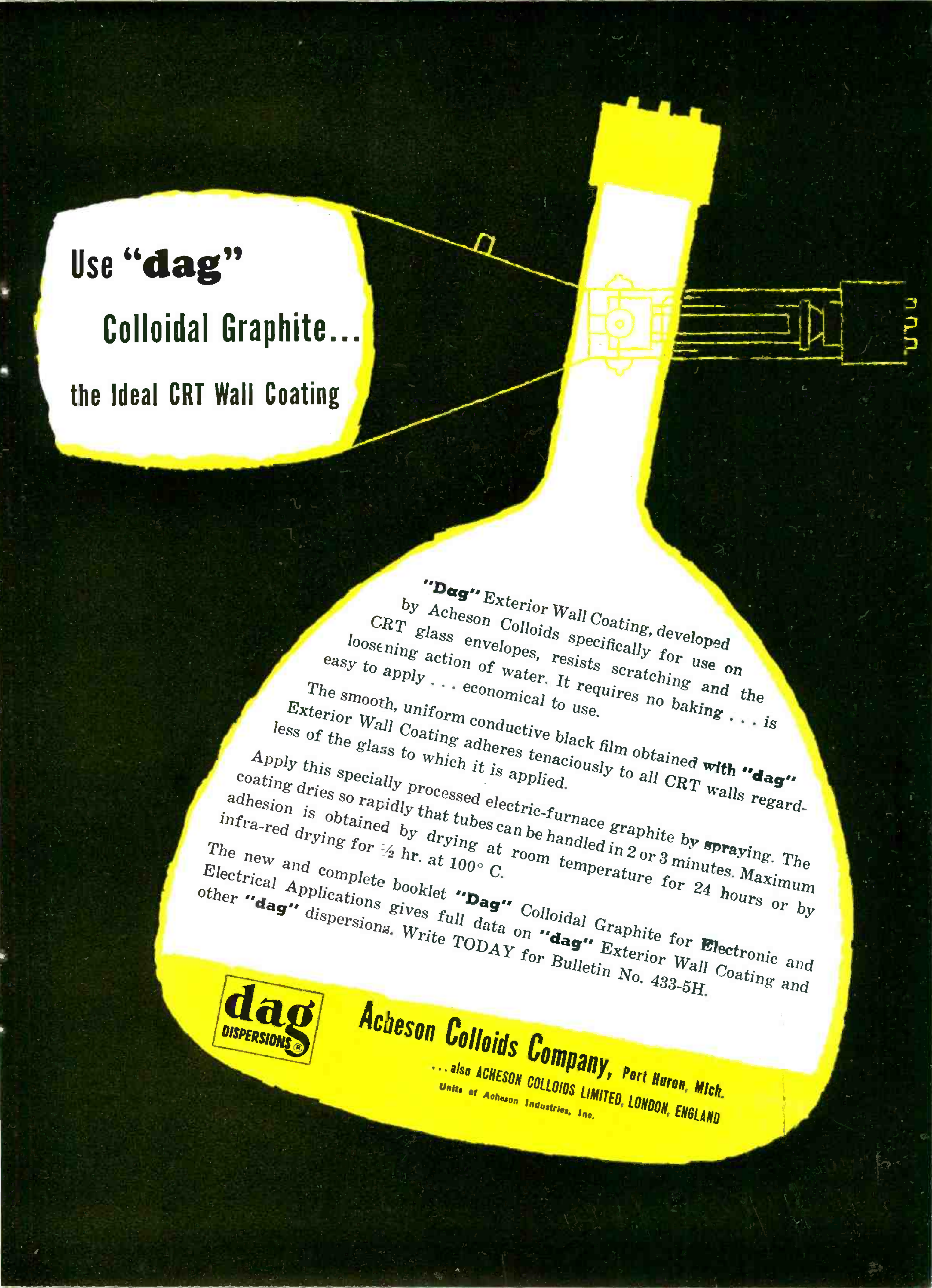
In its present form, the device can indicate only one response each time it plays. It will always play the same game for a given set of opponent plays.

There is an average of 30 individual three-position switches on the nine main switches or 270 individual switches in the network.

Detailed Circuits

The inhibitor circuit is merely an extension of the principle of the commonly used two-way switch. Here, however, the output voltage is on or off depending on whether an odd or even number of the nine main switches have been operated. It determines when it is the machine's turn to play.

The offensive and defensive circuits are quite similar and the basic arrangement of each is indicated by analyzing the defensive circuit. This is shown in Fig. 2. This circuit determines for each of the eight possible combinations whether two of the three have been played by the opponent and whether the third is not occupied. If both conditions are met, then the voltage applied to the input is diverted to operate the lamp which indicates the correct response. For example, if switches corresponding to spaces 1 and 2 are turned to the right and switch 3 is in the unplayed position, the input voltage is applied to the lamp which produces the "O" in the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space corresponding to 3.

If both of these conditions are not met the voltage is diverted directly to the input of the next of the eight defensive circuits. Any position being occupied by the machine is sufficient to do this. If all three switches are turned to the right, then the machine has lost.

The counter circuit is shown in Fig. 3. Here the input voltage is available at one of the three outputs depending on the number of the main switches which are to the right, that is, are played by the opponent. Unoccupied or machine-occupied positions are not counted.

The "any number" circuit is shown in Fig. 4. Note that the draw light is operated only after all nine positions are occupied.

The special instruction part of

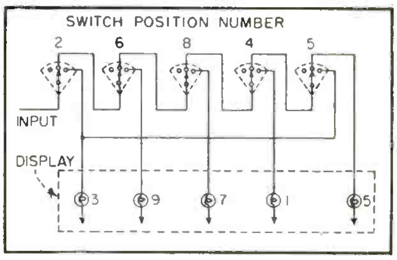
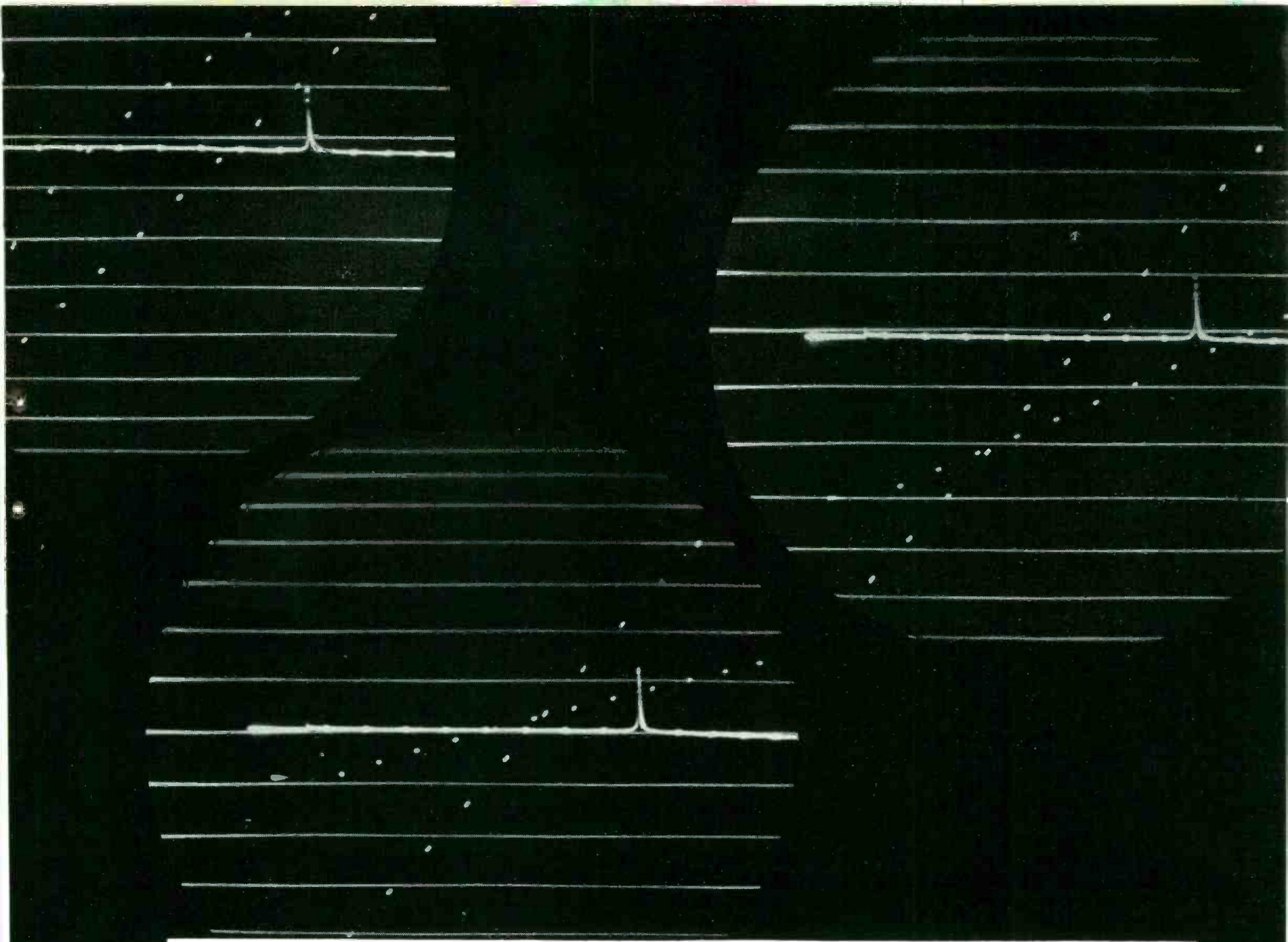


FIG. 5—Portion of special instruction section of switch matrix

the network is illustrated by the circuit which determines the machine's response to the opponent's first play when the machine is playing second. This is given in Fig. 5. Note that if the opponent's play has been 2 then the response is 3; if 6 then 9; if 8 then 7; if 4 then 1; if 5 then 3; but if none of these then the response is 5. If the first opponent play was 1, 3, 7, or 9 (that is, any of the corner positions) then the response by default is 5.

Delay

Since the only information required by the computer is the position of the nine main switches, the response is available as soon as the opponent's play is recorded. However, again as a concession to human nature, the response is purposely delayed by a delay circuit. This is merely for effect. Humans do not like to play a machine



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A peak power of 21,000 KVA creates the magnetic field in the cosmotron now being tested at Brookhaven National Laboratory. Protons whirl through the field of a giant doughnut-shaped magnet, over 60 feet in diameter. At every point of the protons' path along the circular quadrants and at all times during the second while the magnetic field is rising to its top value, the configuration of this field must be held within certain limits, or the protons will collide with the walls and be lost.

This monster magnet is built of laminations of ½″ steel sheets, 8 feet high, 12 in a 5.7-ton bundle, 288 bundles in all. Each bundle had to be carefully matched to its neighbors to give the utmost overall uniformity of magnetic parameters.

Photography provided a practical solution to the matching problem. The magnetic phenomena of each block were displayed on a cathode-ray oscillograph and photographed with a Kodak 35 camera. Five months and 8,000 oscillograms later (the shutter didn't fail once), a complete set of photographs like those seen here of the characteristics of each block made it possible to determine the position of each one in the magnet ring, to insure the most satisfactory magnetic field.

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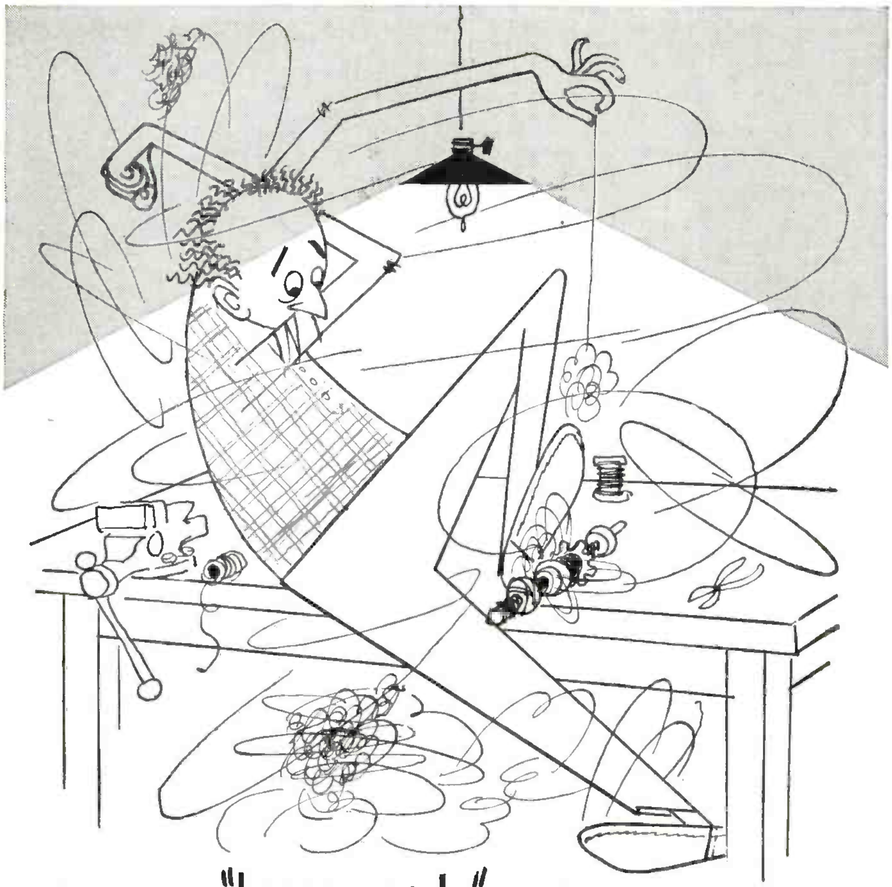

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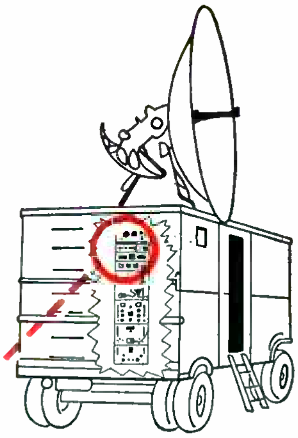
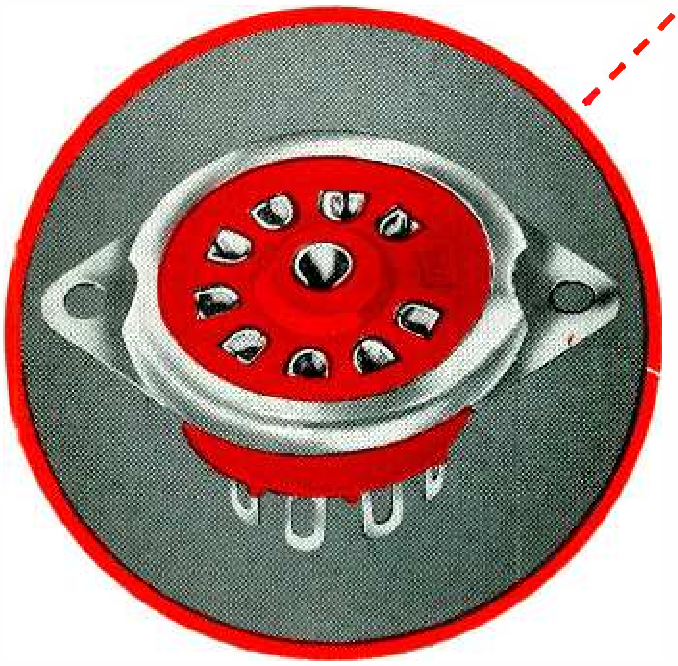


High frequency tube socket of Du Pont "TEFLON"



Tube socket manufactured by the United States Gasket Co., Camden, N. J.

retains dielectric properties in high or low ambient temperatures ... maintains frequency stability

Engineers designing a tube socket for high frequency installation needed an insulating material that would meet the conditions imposed by high or low ambient temperatures and frequency stability. The only material to fill the bill was Du Pont "Teflon"* tetrafluoroethylene resin. It makes possible a socket that meets TRMA and JAN specifications.

"Teflon" has a loss factor of less than 0.0005 and a dielectric constant of 2.0 from 60 cycles to 30,000 megacycles. These properties remain stable for long periods of service in temperatures ranging from — 110°F. to 500°F., and are not affected by extreme humidities, corrosive atmospheres or fungi.

"Teflon" does not carbonize under an arc discharge. It is noninflammable and under ASTM tests has a water-absorption rating of 0.0%.

Tough, resilient "Teflon" withstands vibration and shock. And it is chemically inert . . . has absolutely no reaction with oil, organic or inorganic acids, alkalis and solvents.

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which indicates its answer immediately, when they require time to think about a play.

The cost of the parts in this device was about $30.

Producing Barium-Titanate Transducers

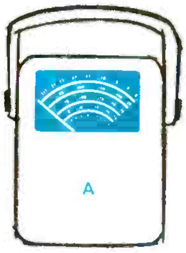
BARIUM-TITANATE TRANSDUCERS for ultrasonic-ranging equipment may replace both piezoelectric materials such as quartz, rochelle salts, and synthetic crystals and critical magnetostrictive materials such as nickel and Permalloy.

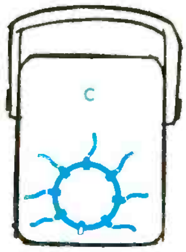
Scientists at Naval Air Development Center, Johnsville, Pa., are now investigating application of barium-titanate transducers to airborne underwater-sound gear. The material is especially useful since transducer elements can be formed in any desired shape to produce custom-made radiation patterns. This is a welcome contrast to the problems presented in growing and cutting piezoelectric crystal transducers.

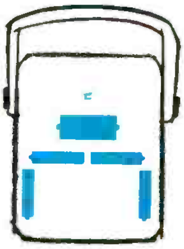
It is anticipated that barium-titanate transducers will also find application in phonograph pick-ups, microphones, speakers, dielectric amplifiers, capacitor dielectrics and possibly as frequency-determining elements. In contrast to scarce magnetostrictive materials, barium titanate is mined in quantity in Canada. The raw powder, finely ground but containing some ferrous impurities is available at about 20 cents a pound.

Manufacture

In the manufacture of barium-titanate transducers, the raw powder is first sifted through an 80-mesh screen and a small amount of lead titanate added to improve final transducer characteristics. Water is added together with an electrolyte to act as a deflocculant, preventing formation of lumps due to static charge. The wet mixture is ball-milled to a fine consistancy. A magnetic filter is used to remove ferrous impurities introduced in powder-grinding processes. The mixture is evacuated to prevent formation of air bubbles. Slip castings are made using desired molds. When forms are extruded, the mix-







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ranges

20,000 Ohms per Volt DC,
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Output: 2.5, 10, 50, 250, 1000
Milliamperes, DC: 10, 100, 500
Microamperes, DC: 100
Amperes, DC: 10
Decibels (5 ranges): —12 to +55 DB
Ohms: 0-2000 (12 ohms center), 0-200,000 (1200 ohms center), 0-20 megohms (120,000 ohms center)

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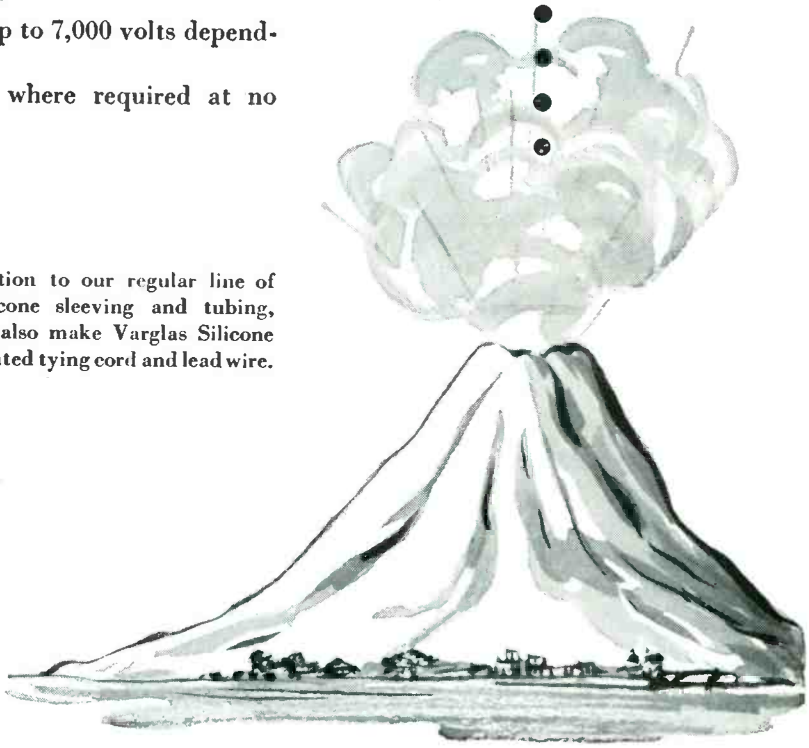

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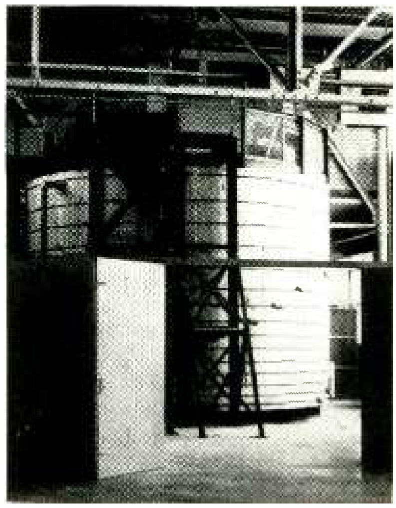
VARFLEX *Sales Co., Inc.*

308 N. Jay St., Rome, N. Y.

ing process is somewhat different.

The hollow-cylinder forms are fired in electric furnaces at 2,600 to 2,700 F. After firing, electrodes are formed on the inner and outer surfaces of the hollow cylinder. The cylinder ends are masked and the ceramic tube dipped in a mixture of finely ground silver and bismuth in an acetone vehicle. The cylinder is again fired, this time at 1,500 F to fix the electrode coatings.

After the metallic electrodes are fired on, leads are attached and the ceramic cylinder is now a capacitor having a dielectric constant of 1,300 to 1,500 and a plate-to-plate d-c resistance of 50 to 100 kilomegohms. For transducer applications, the tube must now be polarized to make it behave in a piezoelectric manner.



White-cedar sonar test tank at NADC is used in calibration of barium-titanate transducers

During polarization, crystals are formed in which the central titanium atom is displaced. To accomplish this, the barium-titanate cylinder is immersed in a dielectric bath, usually mineral oil, and the temperature is raised above the curing point. This is the temperature at which the cubical crystals form. Above this temperature, the barium-titanate crystals assume a hexagonal form. Curing point for the barium-lead titanate mixture is 135 C while for pure barium titanate it is 119 C.

A d-c voltage stress of 65,000 volts per inch thickness is applied

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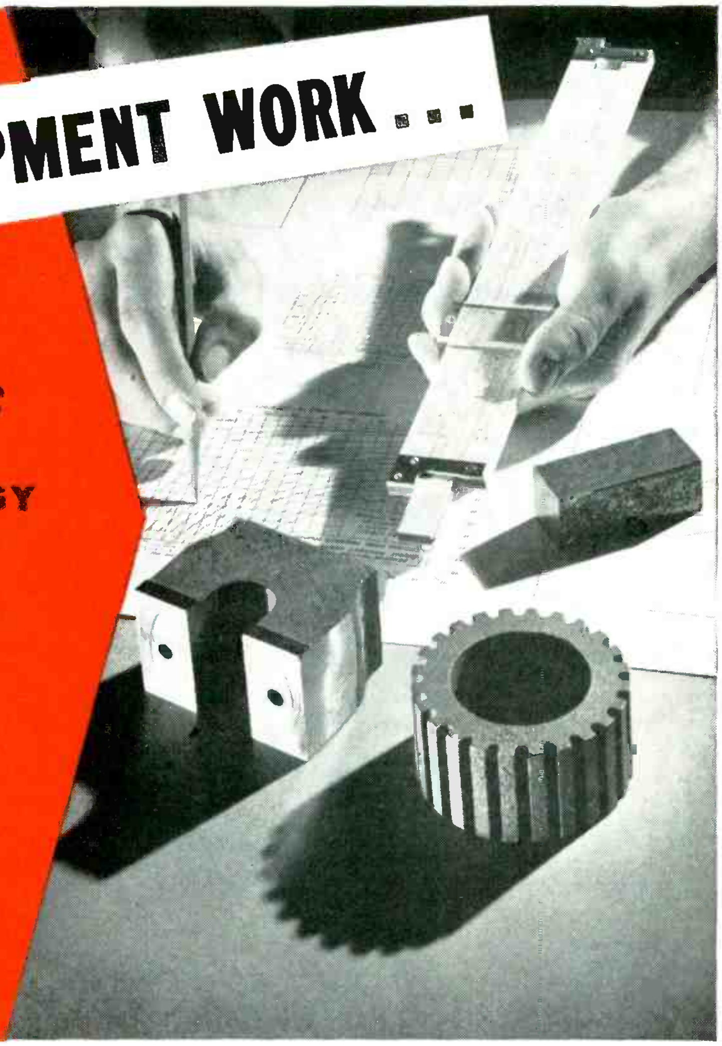

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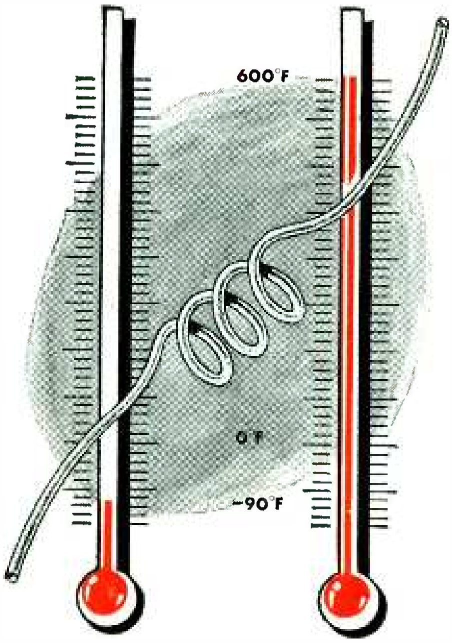

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BH "1151" is the electrical insulation you are looking for if you want low to high temperature flexibility—protection from heat aging — protection against vibration failure.

BH "1151" is available in colors; in coils, 36 inch lengths, or cut to individual specifications. Send for production testing samples and data sheet now.

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*BH Non-Fraying Fiberglas Sleevings are made by an exclusive Bentley, Harris process (U. S. Pat. No. 2393530). "Fiberglas" is Reg. TM of Owens-Corning Fiberglas Corp.

between the electrodes and the temperature is allowed to fall below the curing point. Cubical crystals form as though the high-voltage stress were the normal state of affairs. The voltage is then slowly removed and the hollow cylinder of barium titanate behaves as a piezoelectric transducer with a Q of 200. Ceramic casting and extruding techniques present the only limitations as to the size and shape of transducers that can be manufactured in this manner. Hollow cylinders up to 15 inches in length present no problem.

Calibration

At NADC, barium-titanate transducers used in underwater sound applications are carefully calibrated to determine the effect of frequency and orientation on their radiation patterns. To accomplish this, a white-cedar test tank, 20 feet in diameter and 14 feet high has been constructed as well as a special sonar test set.

The test set consists of a transmitter of 50 watts peak pulse power, a specially gated receiver and an indicator which provides a continuous measurement of pulse amplitude. The frequency range of the equipment is ± one db from 2 to 100 kc. A linear range of sound power measurement may be obtained over 35 db. Pulse repetition frequency is variable from 0.8 to 80 pps. Both pulse width and receiver gate delay are independantly variable from 0.001 to 0.1 second.

It is possible with this test set to examine and measure only the portion of the received pulse that interests the experimenter. Thus the only variables influencing transducer calibration measurements are frequency and orientation. Indicator output is independant of pulse rise time and transients, reverberations and transmitter pulse feedback. The indicator depends upon capacitors charging through a diode and will hold its reading until cleared, indication is 2 db down one minute after a single pulse.

Selective indication is achieved by a variable-length receiver-gating pulse initiated by a variable-length multivibrator pulse which is in turn initiated by the out-going trans-

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Our Blue Ribbon Resistor—designed in 1939—was the *first* flat or strip resistor in the field. And now, though there are others of similar type, the Hardwick, Hindle Blue Ribbon still holds first place—and *is still winning "blue ribbons,"* and such comments as quoted above.

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The aluminum thru-bar, in contact with the internal surface of the ceramic core, distributes the heat more uniformly along its entire length—than conventional tubular resistors.

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2. Reduction in space behind the panel or mounting surface.

3. Sturdy but simple mounting, either single or stacked.

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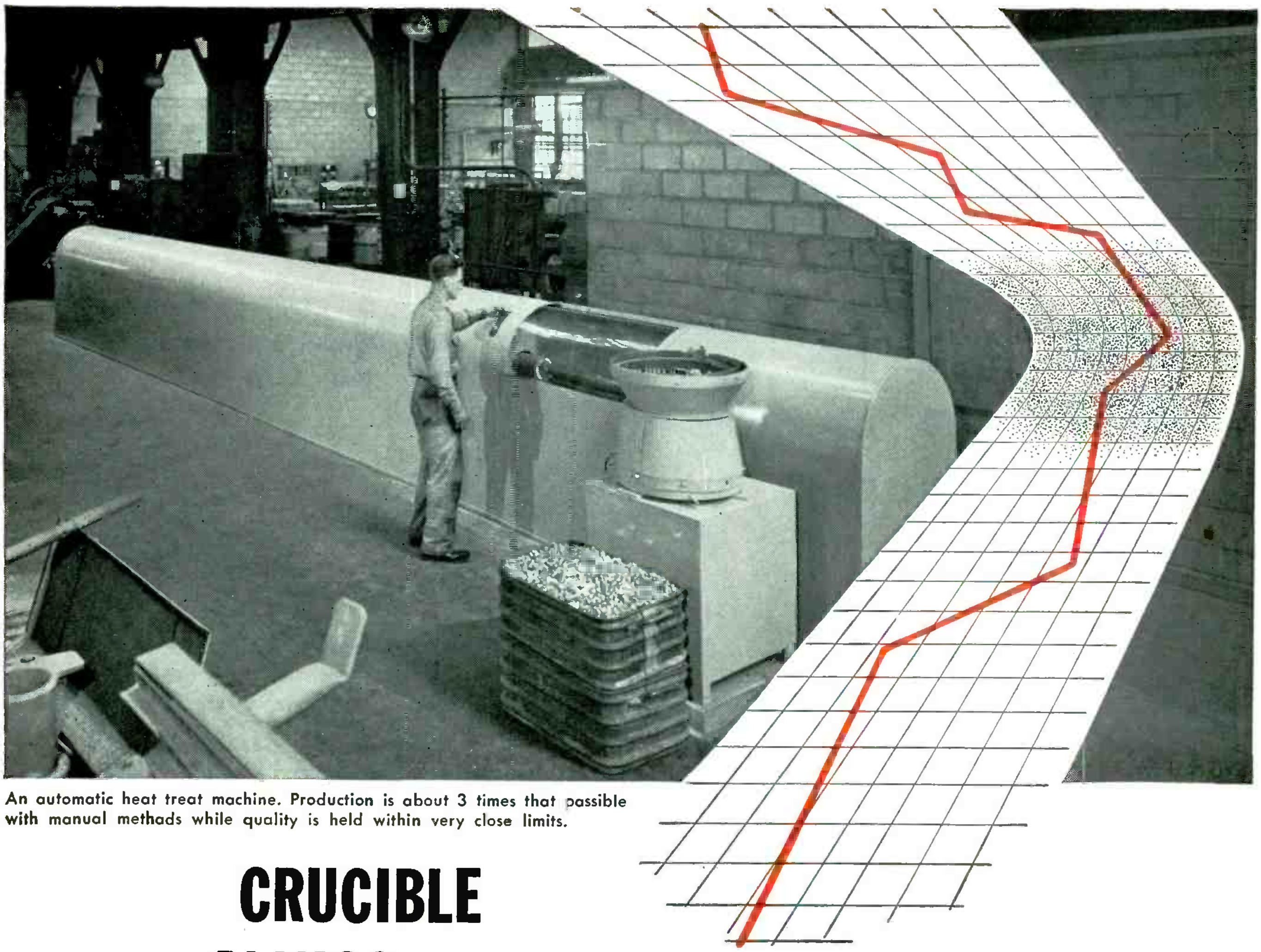

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Alnico magnets have been getting smaller and lighter, thanks to production techniques in use at Crucible. Automatic machinery cuts the possibility of human error to a minimum, so rejections are low. This helps to maintain stable price levels in the face of rising material and labor costs. At the same time, Crucible's rigid inspection standards and attention to quality have developed a magnet with the *highest gap flux per unit weight of any on the market.*

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Data-Displaying Cathode-Ray Tube

By Joseph T. McNaney
Senior Electronics Engineer
Electronics and Guidance Section
Consolidated Vultee Aircraft Corp.
San Diego, California

Special types of cathode ray tubes known as charactrons are designed and constructed to meet many needs of important military and industrial communication applications. Currently, they are being developed for several computer read-out applications.

The main difference between these special tubes and the conventional crt is the use of a beam-forming matrix located between the electron gun and fluorescent screen, Fig. 1. The matrix contains character-shaped openings through which the electron beam is directed. When the beam is changed in cross-section to the shape of a predetermined character, it is deflected toward a desired point on the screen from which the character may be read or photographed. The matrix character arrangements shown in Fig. 2 lend themselves to tubes used in analog data converters. The arrangement shown in Fig. 3 is more useful for message-receiving applications.

The tubes use electrostatic deflection plates for selection of char-

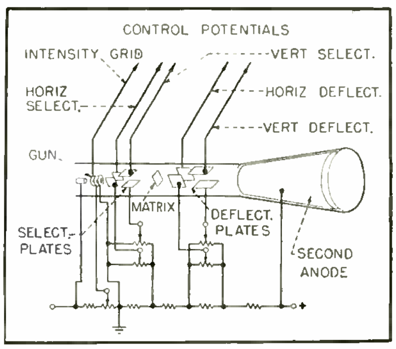
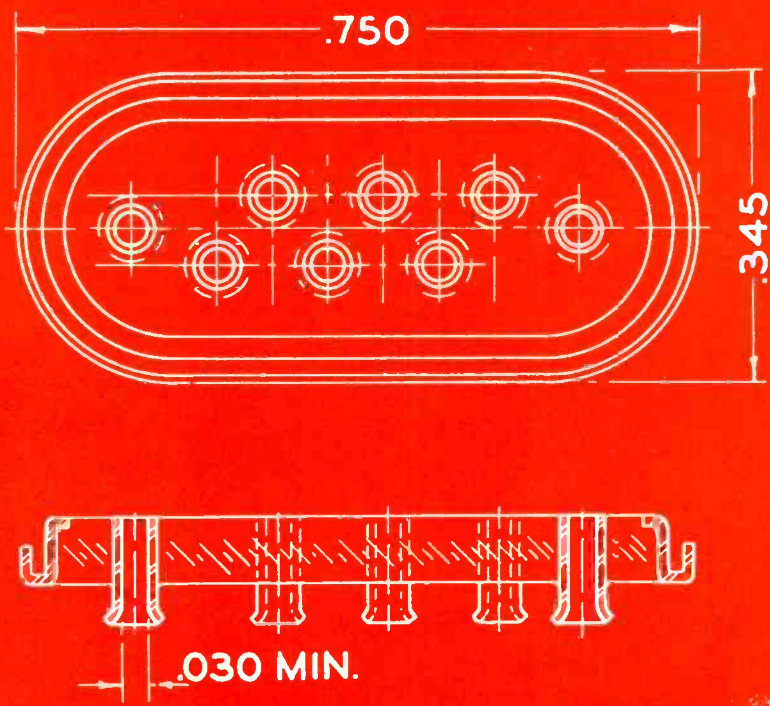


FIG. 1—Schematic-mechanical drawing of the special cathode ray tube

SUB
SUB
SUB

Part 1011 — .570
Part 1012 — .765
Part 1228 — 1.516

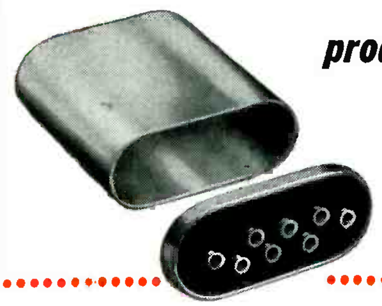
Ceramic-metal part shown with tubulations is also available with pins.



SUB
SUB

SUB-miniature HERMETICALLY SEALED RELAY ENCLOSURE

produced in 10 DAYS from modified EXISTING TOOLS.



Hermetic was called upon to develop a sub-miniature relay enclosure in a matter of weeks and came up with a solution in exactly 10 working days, by utilizing existing tooling and modifying one of its standard parts. This points up the unusually wide range of Hermetic's production and its ability to adapt it to particular problems, no matter how difficult. Naturally, the customer was saved a considerable amount of time and money and was able to meet a deadline with ease.

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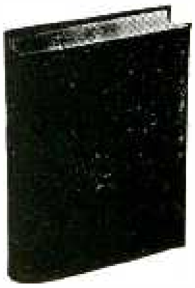

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16 CHAPTERS COVER

- amplifiers
- antennas
- audio
- cathode-ray tubes
- components
- electronic music
- filters
- measurements
- microwaves
- oscillators
- power supplies
- propagation
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- receivers
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Full coverage of electronic music

A helpful feature is the chapter on Electronic Music, a relatively new branch of electronics that is growing rapidly more important today. Compiled here are 10 articles giving information on both commercial and custom-built electronic organs.

Much of the material in the audio section supplements the basic articles on electronic music, since the audio amplifier is an essential part of every electronic organ.

Radar and television circuit developments are treated and explained in each appropriate chapter, rather than being grouped in a separate chapter.

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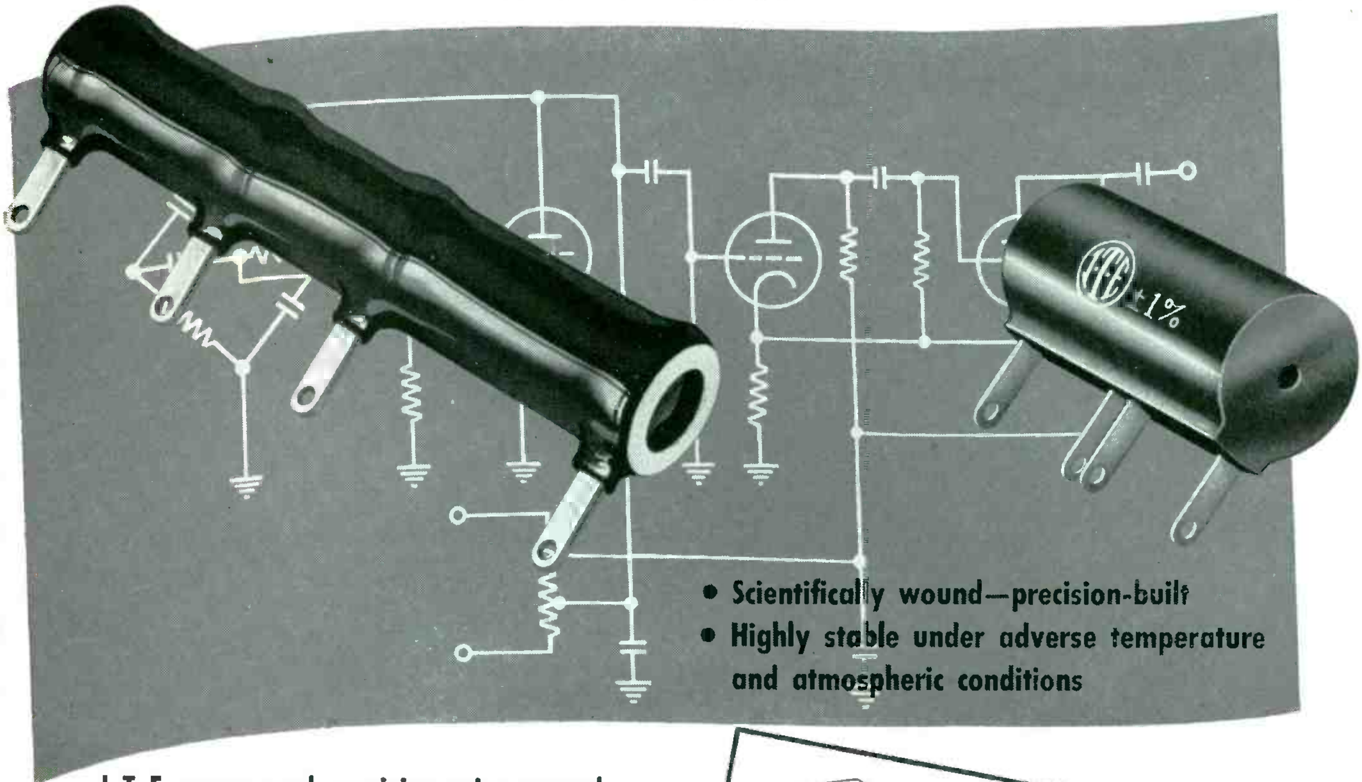

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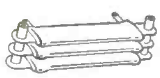

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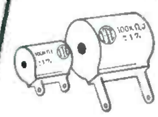

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acters in the matrix and either electrostatic or electromagnetic systems for placement of character presentations on the screen of the tube. Message characters may be selected from the matrix and oriented on the screen as visual intelligence by using the proper sequence of applied deflection voltages. Messages may be printed on the screen at a rate of 10,000 characters per second.

Operation

To operate the tube, the focusing voltage is adjusted so that the electron beam produces a comparatively large spot of light instead of the usual highly focused spot. Diameter of the beam at the matrix is just large enough to cover an opening in the matrix. By adjustment of the accelerating voltage, effective beyond the matrix position in the tube, an electron microscope effect is produced to cast an enlarged shadow of the matrix opening on the screen.

The application of the tube and the type of control signal to be used determine the particular order in which the characters are laid out in the matrix. Referring again to

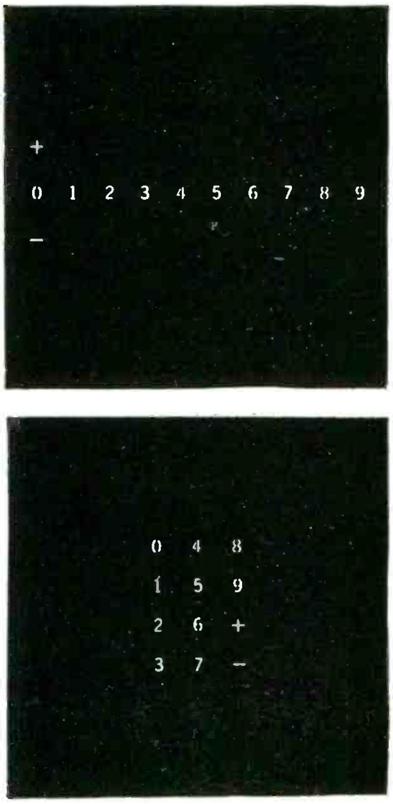
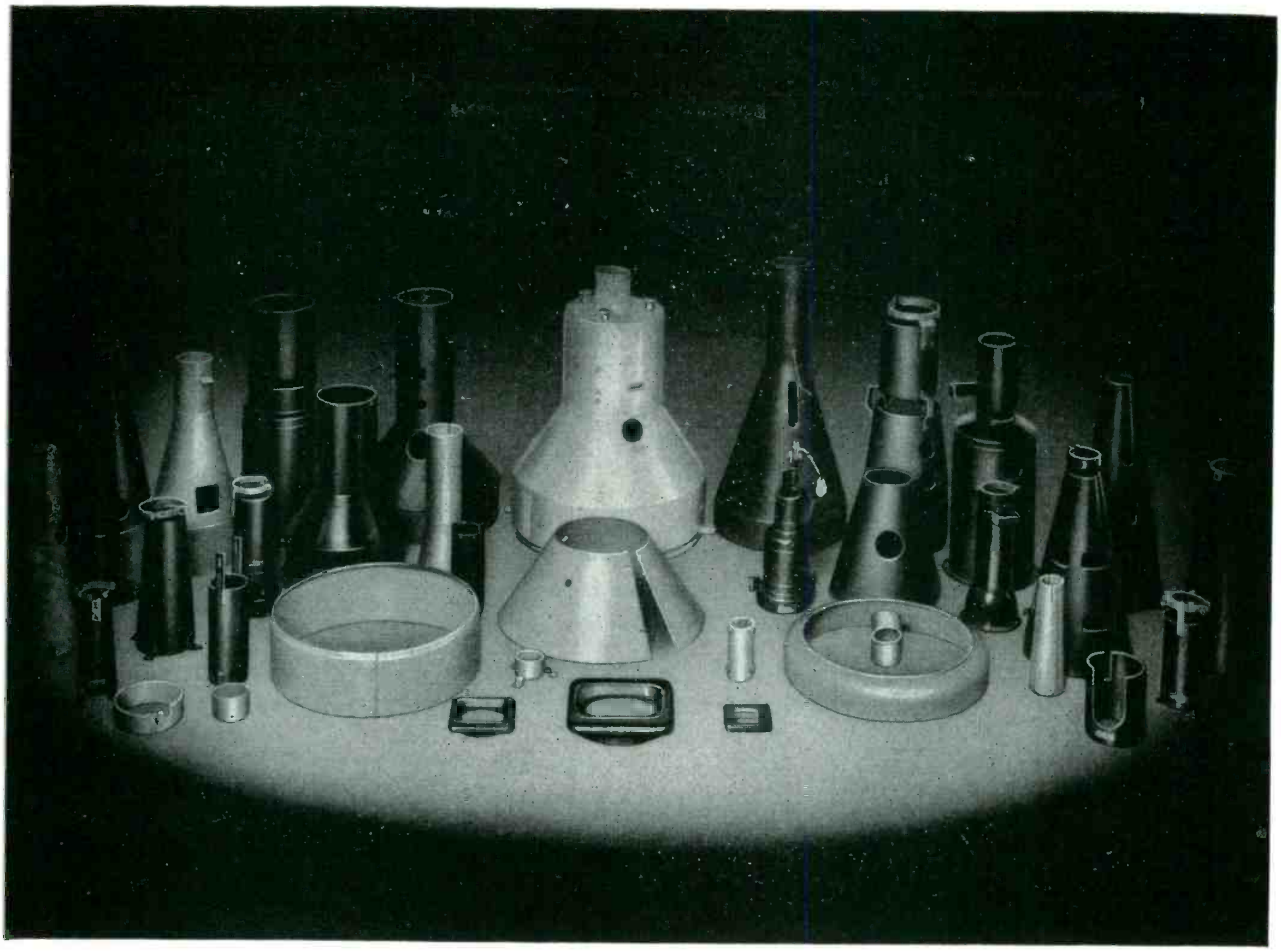


FIG. 2—Two possible matrix layouts for use in analog data converters



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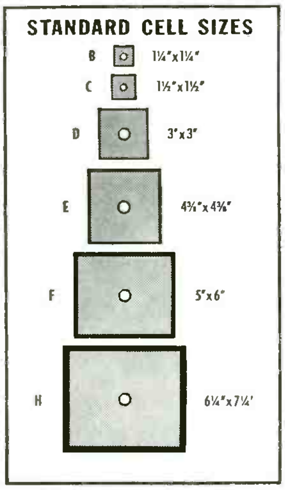

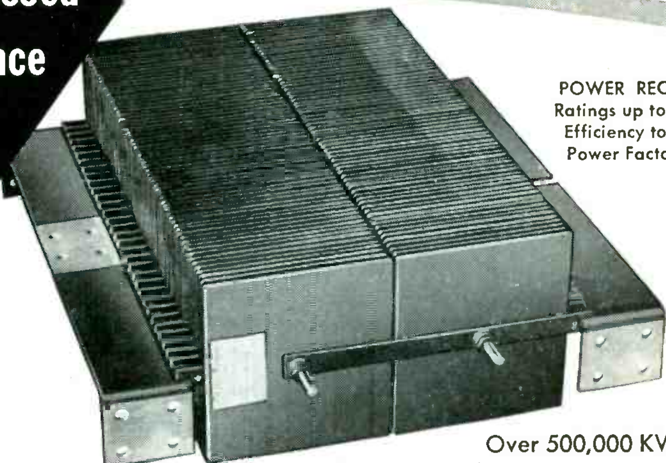

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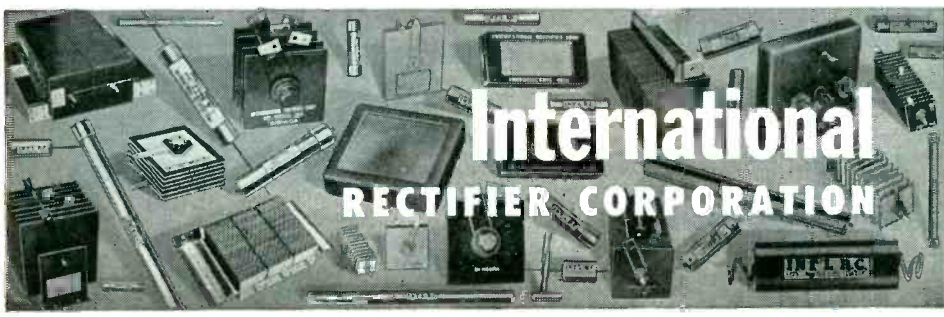

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Tube under test with electronic circuits designed for use in a high-speed printer

Fig. 3, this layout lends itself to message receivers employing a five or six-digit binary code signal. The order of potentials necessary to deflect an electron beam over the matrix area is given by the scale of voltages shown. For example, the selection of letter "C" requires a vertical voltage of 10 volts and a horizontal voltage of 60 volts.

In the process of writing a message on the screen of the tube, essentially three separate deflections of the electron beam occur. The first deflection selects a character, the second compensates for the different positions of the characters in the matrix and the third directs the beam to a desired spot on the screen.

Printing arrangements set up for the tube involve a process of transferring the messages on the screen of the tube to ordinary paper by means of a dry printing process such as Xerography. Time required

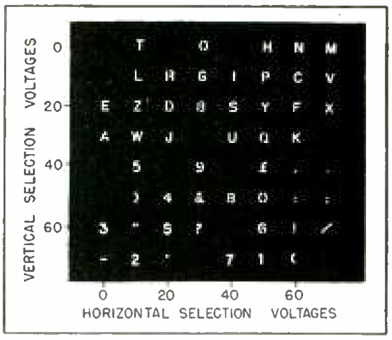

FIG. 3—Matrix layout for use in a message receiver

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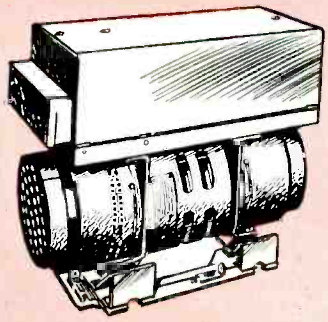

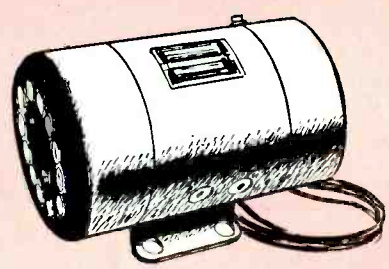

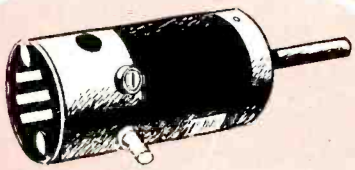

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for conversion of codes into printer characters may be less than 100 microseconds per character.

Electronics Measures Human Respiration

ELECTRONICS MEASUREMENT of human respiration is accomplished by the polyneumograph shown in block diagram form in Fig. 1. Developed by the staff of the University of Washington's psychology department in connection with the Air Force arctic-aeromedical research project, the device provides a written record both of instantaneous air flow as well as expired volume of air integrated over periods of one minute. Provision is also made for sampling and chemically analyzing the expired gases.

Expired air is carried through a unidirectional mask and heat exchanger to a laminer-flow, screen orifice. An increasing rate of flow through this flowmeter results in a pressure drop which is measured by the pressure transducer. This device consists of a balanced capacitance bridge composed of two moveable diaphragms and three fixed plates. This arrangement effectively balances out accelerational effects in gas flow.

Output of the 3,000-cps oscillator is applied to the capacitance bridge and hence to a linear, diode-bridge demodulator. A portion of the oscillator output is tapped off

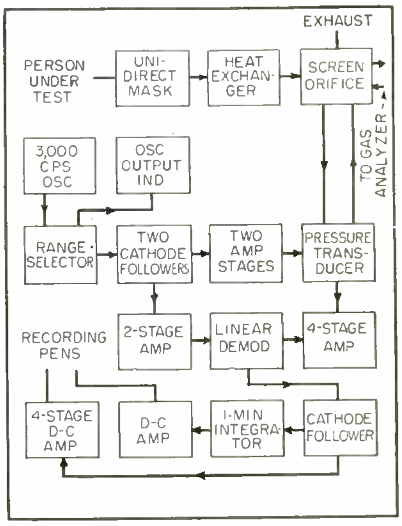

FIG. 1—Block diagram of the polyneumograph

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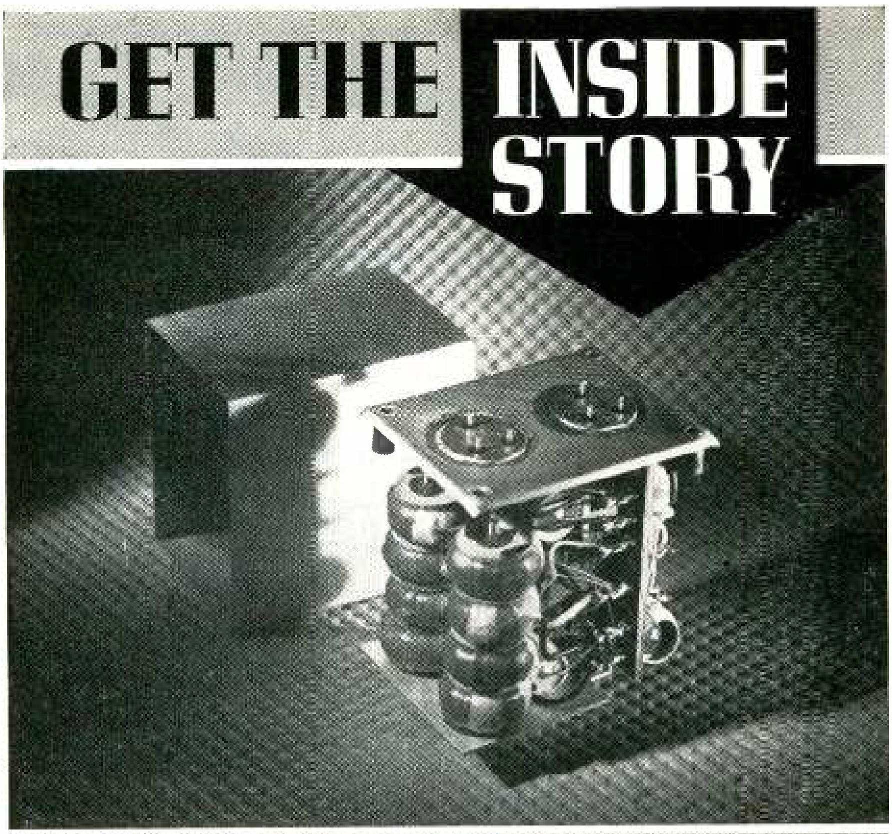

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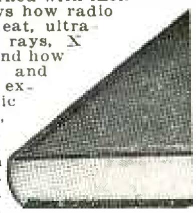

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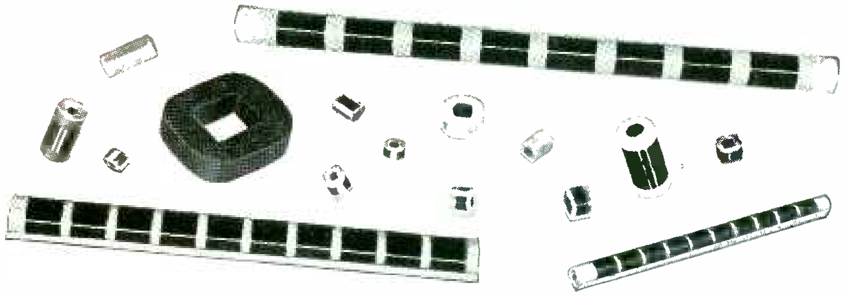

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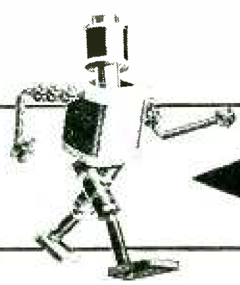

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the output cathode follower and also applied to the demodulator. Detector output is likewise taken off a cathode follower. In the tidal-flow recording channel, this voltage is applied to a four-stage, direct-coupled, d-c amplifier and hence to a recording potentiometer.

The one-minute integrating circuit resembles the tidal-flow circuit except for the long-time-constant, R-C integrating network which sums up the tidal rate of flow over successive one-minute intervals.

For further details see "Electronic Polyneumograph" by A. C. Young and others, published by the Air Material Command, Wright-Patterson A.F.B..

Economical TV Linearity Test Generator

By Frank J. Burris
San Francisco, Calif.

No direct metallic connection to the receiver under test is required with the television linearity test generator described herein. Output lead connections from the tester are placed close to the i-f tubes of the receiver when making adjustments. This procedure is possible because the output test oscillator is modulated for both the horizontal and vertical bar patterns on the i-f band. The fundamental covers frequencies from 20 to 27 mc and the second harmonic is suitable for receivers in the 40-mc i-f band.

A dpdt switch is incorporated in the tester for selection of either the horizontal or vertical pattern. No variable control of the output of the device is required since the gain may be conveniently controlled in the receiver or by the placement of the pickup lead.

Other features of the instrument include stable operation, ease of adjustment and low cost. Even if all the components are procured new, the total cost should not exceed ten dollars.

Referring to the schematic diagram of Fig. 1, the bar generator is composed primarily of a Hartley shunt-fed oscillator consisting of V_1 operating through the cathode-tapped coil L_1 or L_2, depending upon the position of S_2. For horizontal patterns, it has been found advantageous to use at least 12 or 13 bars.

To obtain the horizontal effect, the bar generator must oscillate at a stiffly blocked frequency of about 13 × 60 or 780 cps. Unless the oscillator is well blocked, the bar edges will present a sine-wave diffusion shading characteristic instead of the clear and sharp narrow lines which are more desirable. The blocking action requires that the grid of V_1 must be heavily discharged on each pulse so that the plate current will remain at zero for considerable time out of each cycle. Use of heavy feedback and a large coupling capacitor allows this action.

Since L_2 may be one of the cheapest models of a-f push-pull output transformers, the one-to-one feedback ratio of the primary section can be adjusted through the size of the grid-coupling capacitor and gridleak to vary the number of pattern bars. The voice-coil secondary may be disregarded unless a source of audio signal is needed for other test purposes. In general, the larger the coupling capacitor or the greater the value of gridleak, the fewer the number of horizontal bars.

The bar generator must have good stability because when testing a receiver by this means, both the receiver vertical and horizontal sync circuits receive their timing control from the bar generator. This applies to most linearity generators. A voltage-regulator tube V_3 is placed in shunt with the plate-current supply to the generator to keep the oscillator stable.

The vertical bar section of the

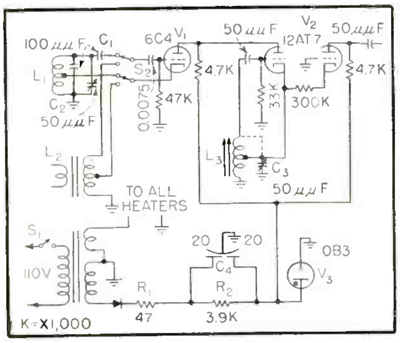
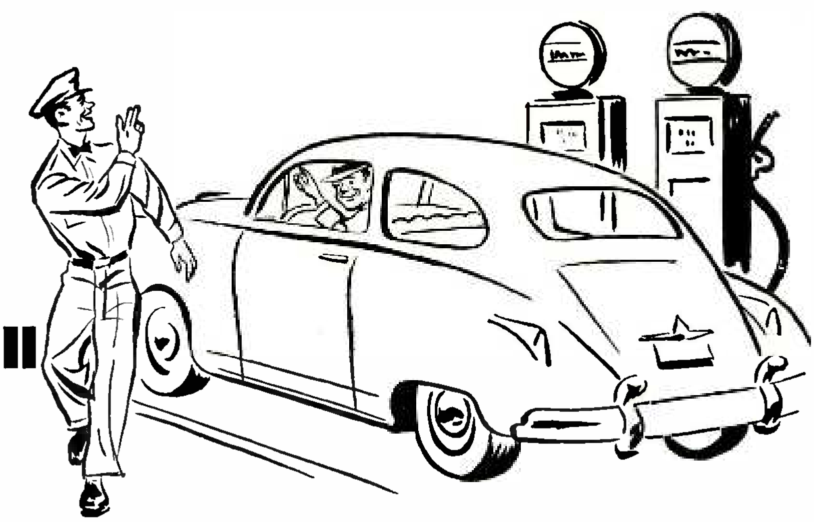


FIG. 1—Schematic diagram of the linearity test generator for tv adjustment

"SEE YOU AT THE POLLS!"

"SEE YOU AT THE POLLS!"

"SEE YOU AT THE POLLS!"



Nobody knows for sure how it started—this line about "See you at the Polls!" we're hearing all over these days.

Best explanation seems to be that it came from that state candidate out west. . . . His opponent in a debate got all riled up and challenged him to fight it out in the alley.

But he said—"I'll settle this the AMERICAN way—I'll see you at the polls!" And the audience picked up the chant.

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"SEE YOU AT THE POLLS!"

"SEE YOU AT THE POLLS!"

ELECTRONICS

generator utilizes the same Hartley-oscillator principle with the same tube V_1, gridleak and plate load as formerly. By means of S_2, the tank circuit L_1 may be inserted into the oscillator. This speeds up the oscillator to allow about 19 vertical bars over the raster. In this case the oscillator frequency will be about 19 × 30 × 525/1,000 or 299.25 kc. A tank circuit suitable for this frequency, with ample blocking interval, may consist of a center-tapped inductance coil of 400 turns of No. 32 plain enamelled wire, wound on a wooden bobbin 1⅛ in. in diameter and ½-in. long together with a 100-μμf fixed capacitor in shunt with a 50-μμf variable.

Bearing in mind what was stated previously concerning oscillator stability and its effect upon pattern design, it become apparent that the vertical bar-pattern generator must be stable to even a higher degree. For the purpose of closely adjusting the oscillator, the shaft of C_2, or the knob of the tuning slug if such a type coil is used, is extended through the panel for ease of adjustment.

With the addition of the simple power supply, the generator might be considered available for duty at this point by taking a tap off the oscillator output of V_1 directly to the video amplifier input of the receiver. Extended facility may be realized by adding an output oscillator circuit consisting of the dual triode V_2 which functions as another shunt-fed Hartley oscillator at i-f, cross-bar modulated and isolated from the the load by means of the grounded-grid cathode-coupled section of V_2.

For the oscillator portion of V_2, the tank circuit consists of 20 turns of No. 32 plain enamelled wire, wound on one of the 5/16-in. slug-tuned forms such as found in conventional tv intermediate amplifier transformers. If the tuning capacitor C_3 of 50 μμf is not used in the circuit and the tuning range is covered by means of the slug only, the slug control should be extended through the panel for ease of adjustment to the i-f of the receiver.

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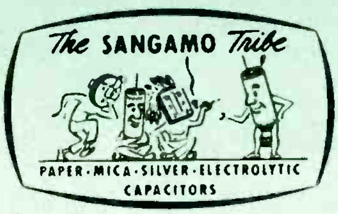

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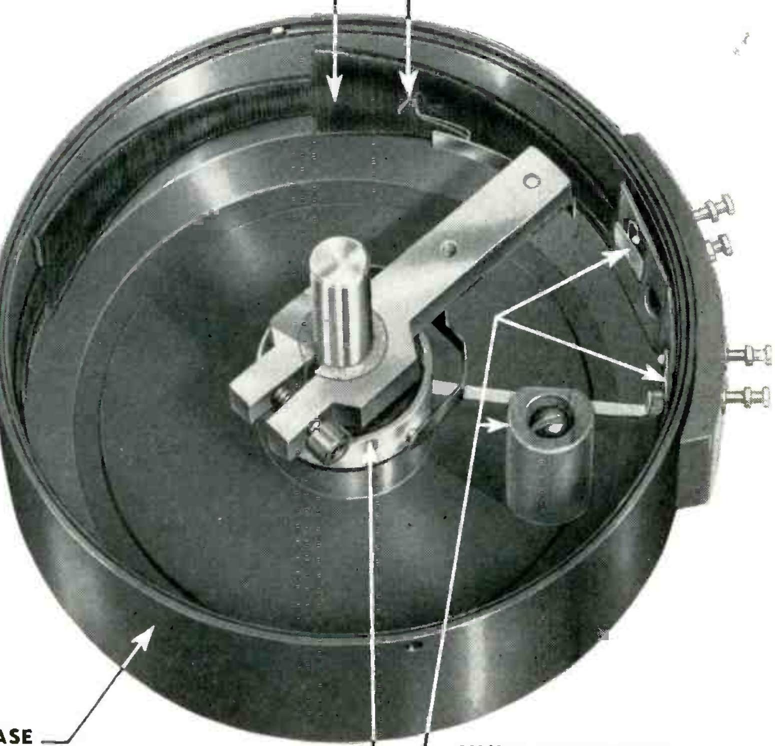

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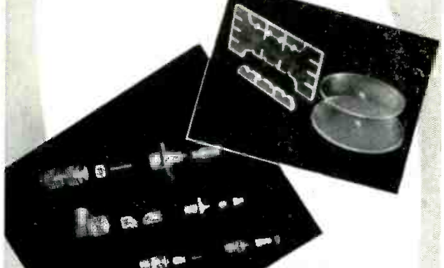

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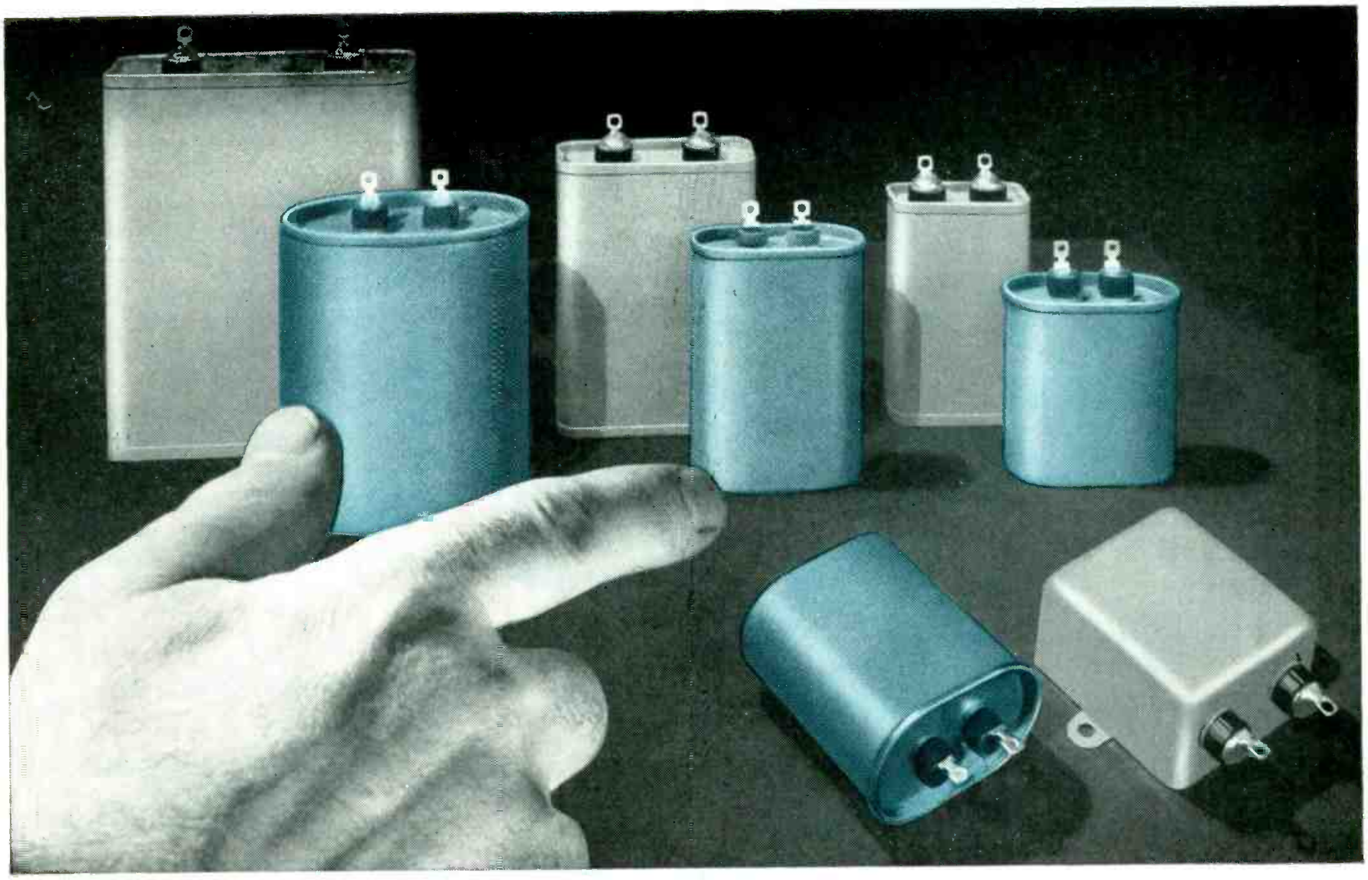

Photographic comparison of the new G-E Drawn-oval capacitors (in color) and the conventional units they replace, showing savings in size.

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arrangement also allows a quick receiver i-f checkup since the bars may be brought out at maximum intensity at the optimum of any particular frequency adjustment. The oscillator tank circuit should be adjusted to cover a fundamental range of about 19 to 27 mc. The second harmonic of the lower frequency will accommodate the receivers having 40-mc i-f bands.

The fourth and final element of the instrument consists of the power supply comprising a midget power transformer, a 65-ma selenium rectifier with protective resistor R_1 and the filter consisting of R_2 and the dual capacitor C_4.

Two-Tube Square-Law Detector

BY DAVID M. GOODMAN

Engineering Research Division
New York University
New York, New York

THE PROBLEM of measurement is acute in the field of electronics. One fundamental problem which has existed for many years is the measurement of nonsinusoidal waveforms.

The only description of a nonsinusoidal waveform that is entirely correct would be an instantaneous plot of amplitude versus time. In the case of a recurrent waveform the problem is simplified to the extent that the graph need only represent one cycle of the wave. In the case of a nonperiodic waveform the development of an instantaneous picture can only be used under very limited circumstances. For general application, such a picture is quite unsatisfactory from a practical viewpoint.

To overcome this difficulty the concept of root-mean-square values was adopted which equates the heating power in an a-c circuit to that in a d-c circuit. This concept has its difficulties too, in that the averaging period over which the wave is investigated has a considerable bearing on the indication.

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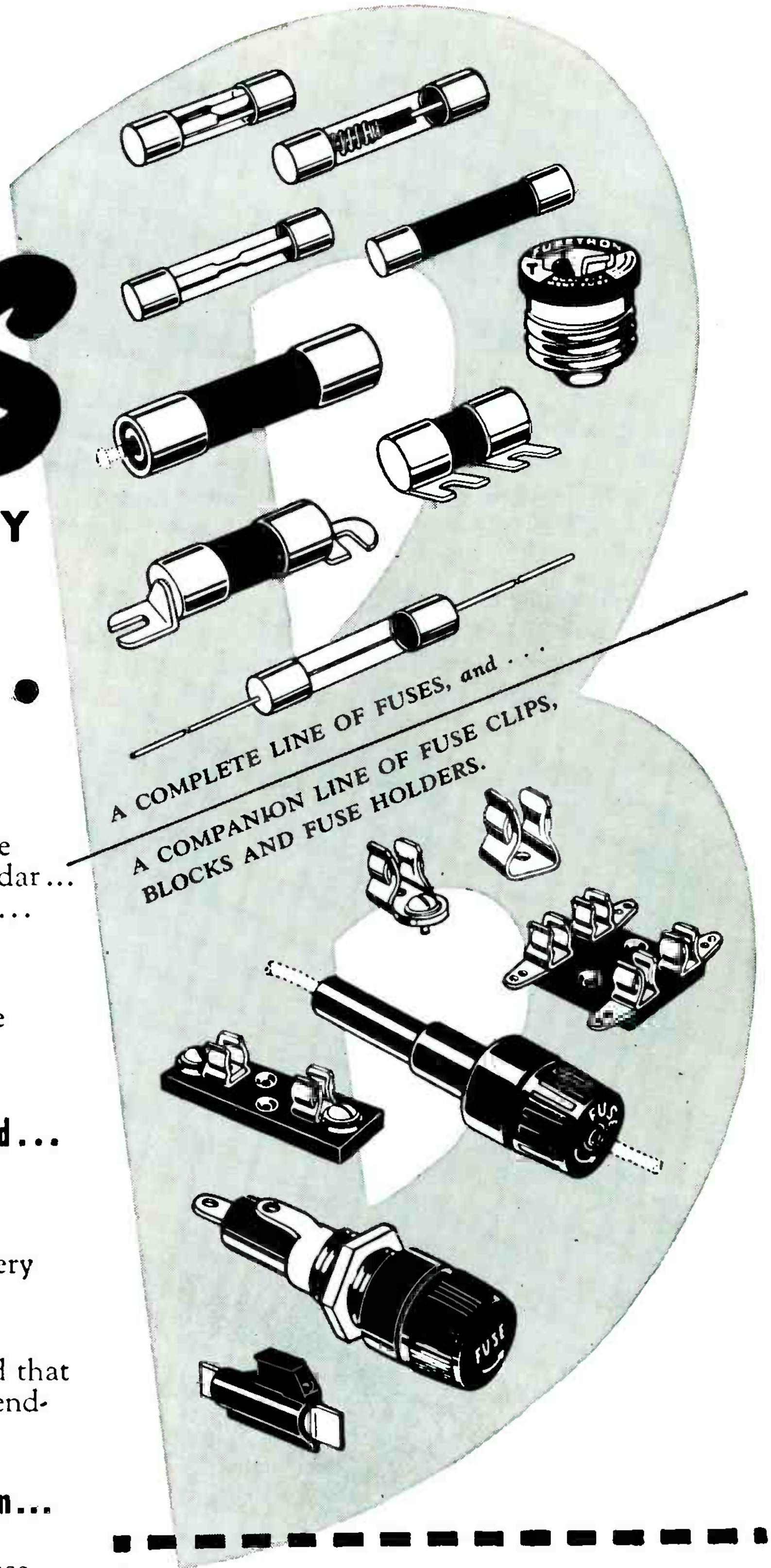

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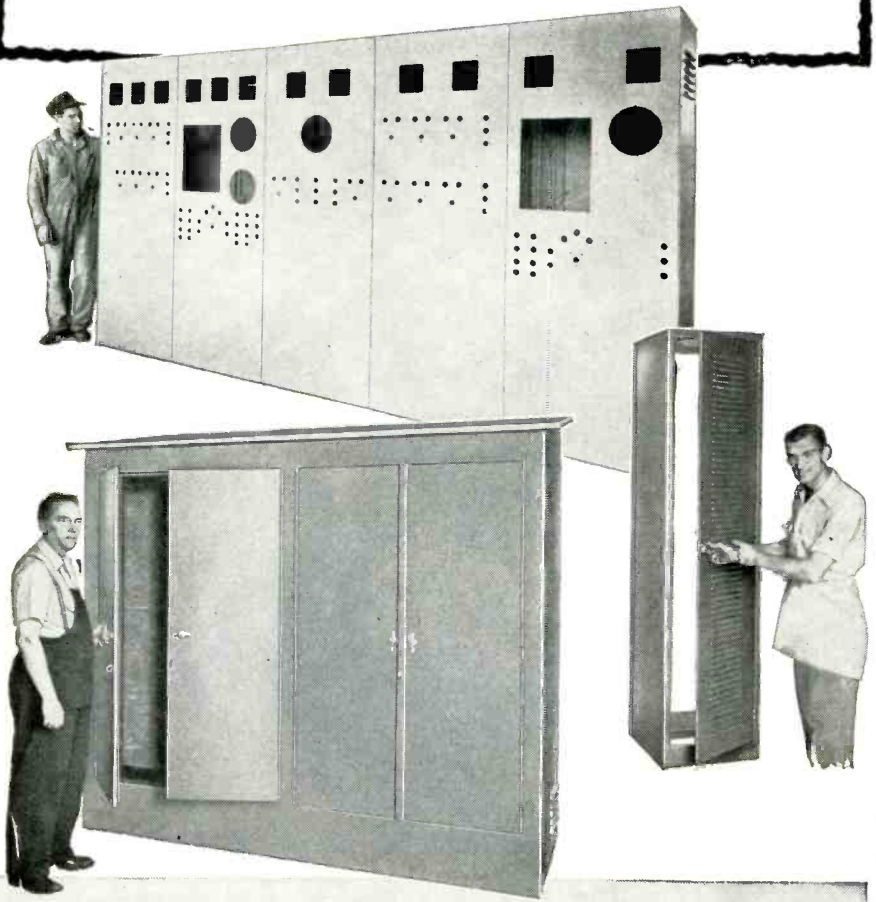

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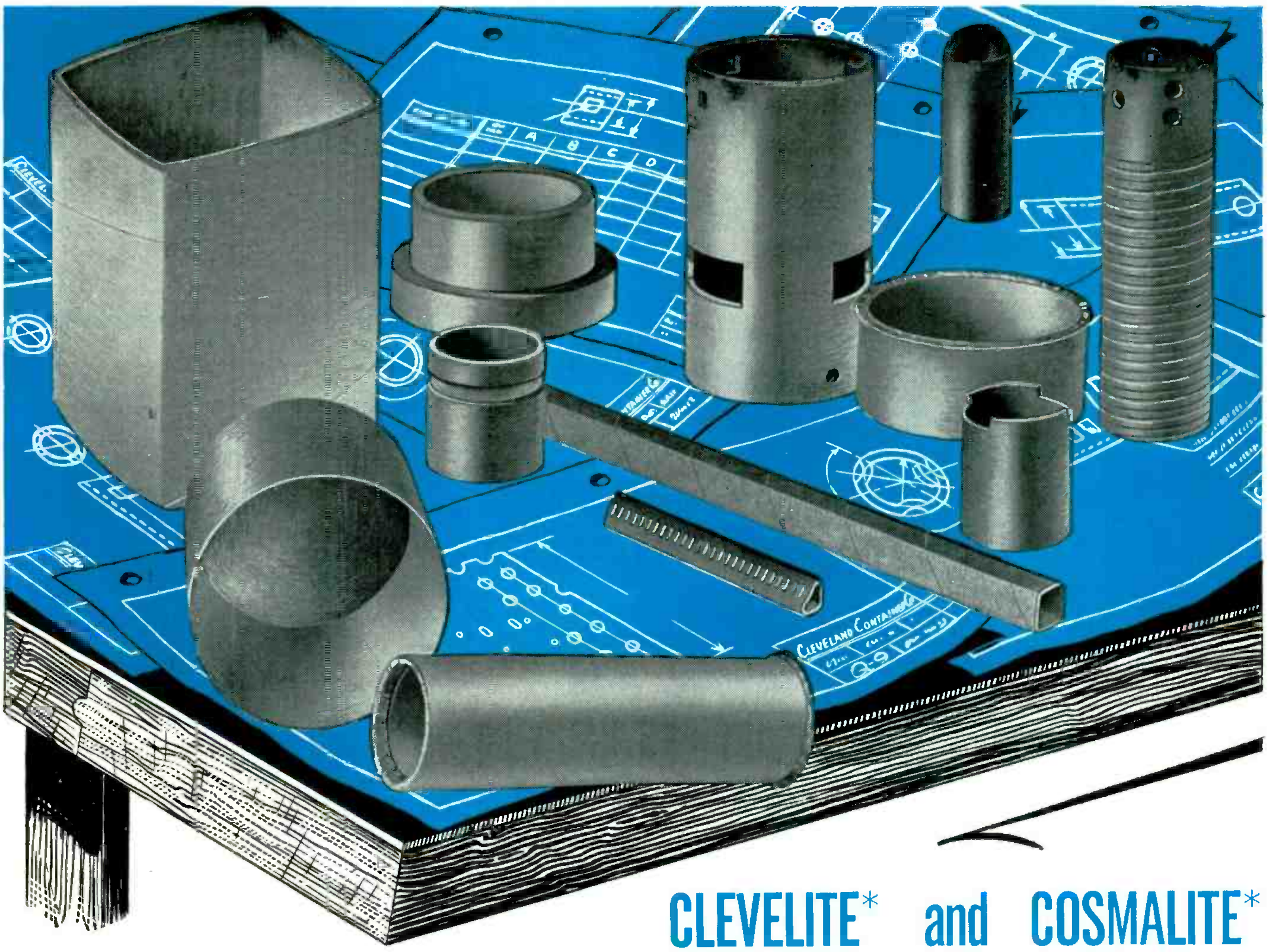

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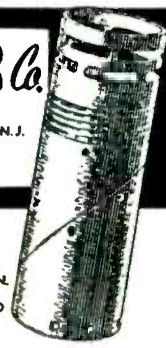

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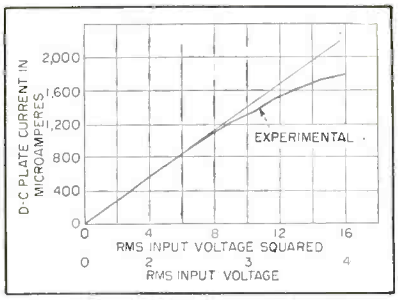

FIG. 1—Characteristic of the square-law detector

tials and by suitable choice of screen degeneration, it has been possible to develop a square-law detector with a useful operating range of nine volts peak-to-peak in the grid circuit of a 6AH6 vacuum tube. A brief description of the theory follows.

By definition

$$g_m = \frac{\delta i_p}{\delta e_g}$$

Then

$$i_p = \int_0^{e_g} g_m \, de_g + i_{po}$$

which expresses the plate current of a vacuum tube as a function of the transconductance and applied signal about an operating point i_{po}.

If over the operating range then

$$g_m = g_{mo} + ke_g$$

$$i_p = g_{mo}\, e_{ao} + \frac{ke_g^2}{2} + i_{po}.$$

For an input

$$e_g = A \sin \omega t$$

$$i_p = g_{mo} A \sin \omega t + \frac{k A^2}{4} + \frac{k A^2}{4} \sin 2\omega t + i_{po}.$$

For a multiple signal input

$$e_g = \sum_{i=1}^{n} Ai \sin \omega_i t$$

the plate current is

$$i_p = g_{mo} \sum_{i=1}^{n} Ai \sin \omega_i t + \frac{k}{4} \sum_{i=1}^{n} Ai^2 + \frac{k}{4} \sum_{i=1}^{n} \sin 2\,\omega_i t + \frac{k}{2} \sum_{i \mp j = 1}^{n} (Ai \sin \omega_i t + Aj \sin \omega_j t) + i_{po}$$

This last equation requires interpretation. The first, or repeat term, represents the fundamental cur-

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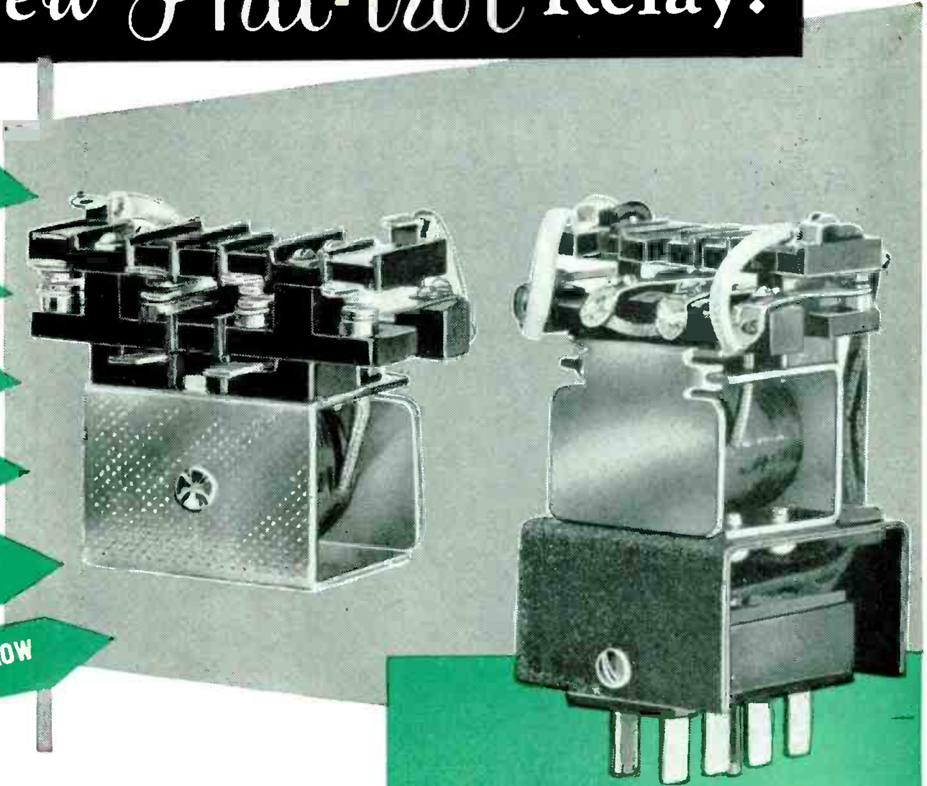

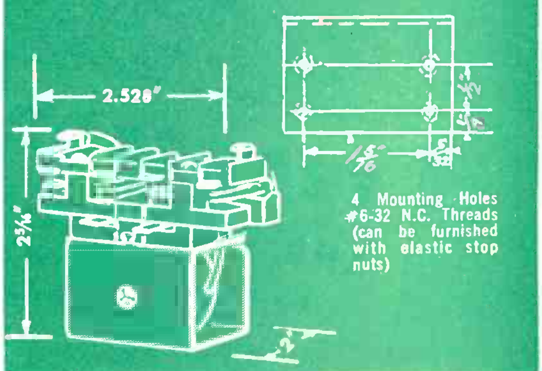

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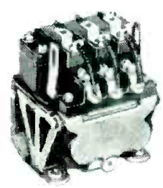

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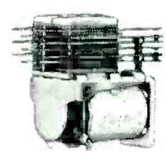

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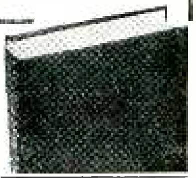

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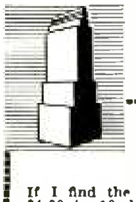

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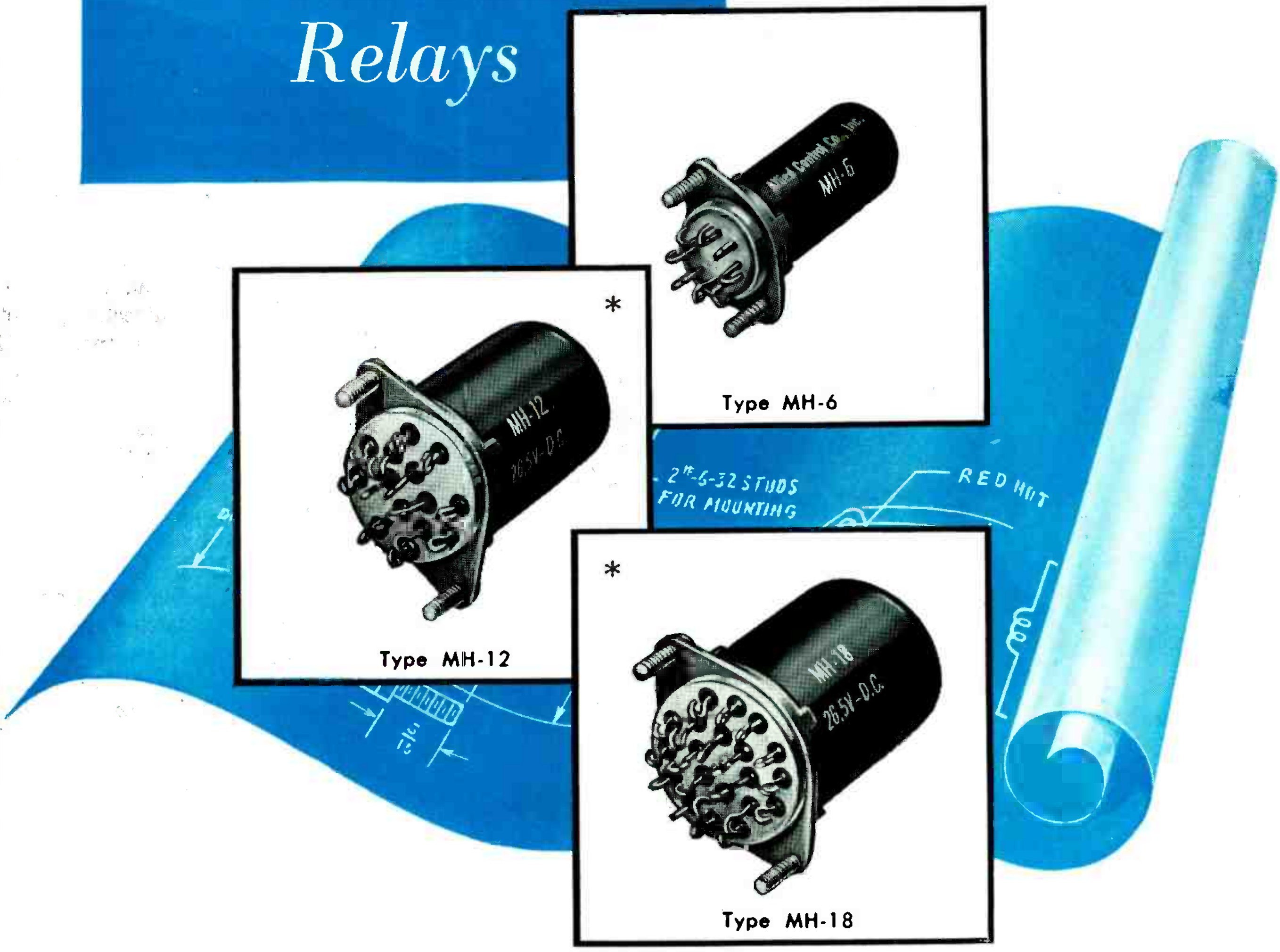

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rent components which are normally used in signal amplification. The third term represents the second-harmonic distortion generated from each signal component. The fifth term i_{po} represents the d-c operating point. The second and fourth terms, in which we are interested, will be explained.

The second term is a direct current proportional to the summation of the square of the individual voltage inputs. A nonsinusoidal wave shape expressed in terms of its Fourier components has a root-mean-square value

$$E_{rms} = \frac{1}{\sqrt{2}} \sqrt{A_1^2 + A_2^2 + \ldots A_n^2}$$

The change in d-c plate current in a tube operating under the conditions specified is directly proportional to E_{rms}^2. A properly calibrated meter will indicate a d-c plate-current change proportional to the square of the rms input voltage. This calibration can also be in terms of power if the impedance level of the circuit is known. The fourth term in the equation represents the product of the individual input waves and by trigonometric expansion yields sideband frequencies equal to the sum and difference of all the input terms. It is this property of a square-law detector which makes it ideally suitable for modulation and demodulation purposes.

The experimental results are plotted in Fig. 1. The circuit from which this data was obtained is shown in Fig. 2. The measurements were made at audio frequencies since, except for input loading, the applied frequency has no effect on the readings. The extent of the linearity, and hence the error as a function of magnitude of the ap-

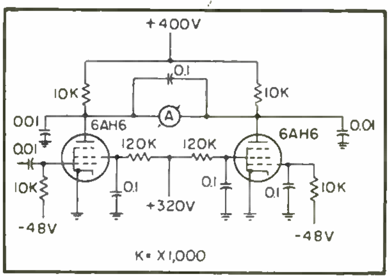
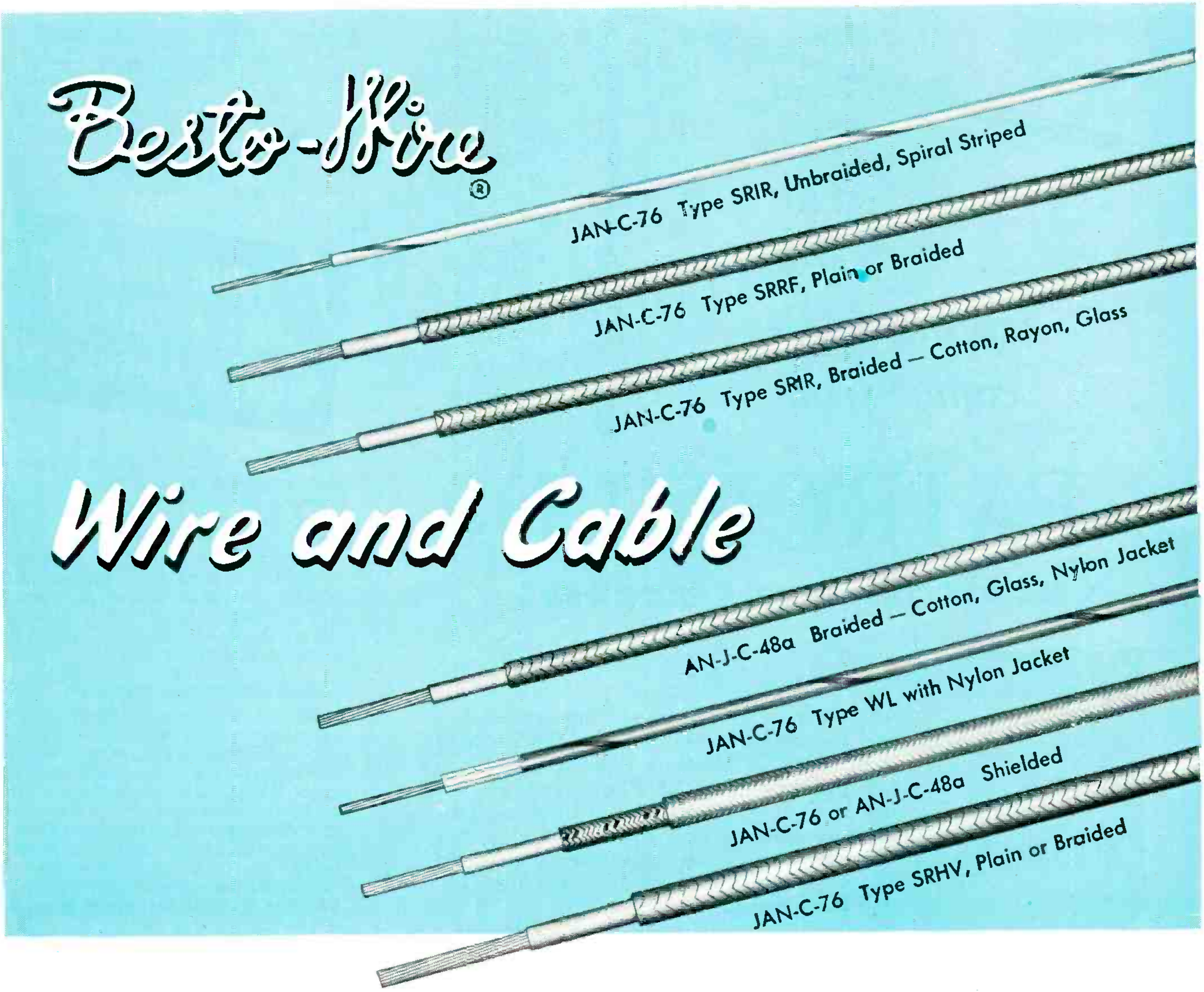


FIG. 2—Test circuit for obtaining the square-law characteristic



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plied signal, is apparent from Fig. 1 in the case of a single sine-wave signal.

In the case of a nonsinusoidal signal, the error will be a function of the peak-to-rms ratio as well as the wave shape of the applied signal. The dynamic range is limited by the maximum permissable error on the high side and by the circuit sensitivity on the low end of the scale. The sensitivity in turn is governed by the random d-c plate current drift present in the circuit.

Results obtained in this experiment indicate that a full-scale voltage sensitivity of 0.85 volt would be a suitable compromise requiring only occasional zero-set adjustment. This would allow for the instrument to average signals with a peak-to-rms ratio of 15 db with a maximum error of —10 percent.

Three interesting points remain to be considered. First, the two-tube circuit was required to balance out a large portion of the direct current drift. This was done at the expense of decreased sensitivity inasmuch as only one-half the plate-current change of the active stage is passed through the d-c meter.

It is also necessary to operate the stage at fixed bias. It would therefore be appropriate to use cathode bias whose value would be maintained constant through the use of a d-c feedback amplifier. This would essentially double the sensitivity of the circuit and at the same time afford a means of controlling the response time of the power meter. This modified circuit would have a sensitivity of approximately 0.5 volt and would accurately average 20-db peaks.

Experimental results indicate that the grid can be driven positive with no serious permanent effect. However, it was noticed and it is natural to expect as a result of the grid-heating effects, that a positive grid signal would tend to increase the d-c plate-current drifts. This can be remedied by clipping at the input grid at approximately the zero bias level through appropriate use of crystal diodes.

Because of the simplicity of the input circuit it is possible to broadband the circuit over a considerable

frequency range. Actually this last point is of considerable consequence inasmuch as an extended bandwidth is necessary in any system which is required to pass signals with a large peak-to-rms ratio.

In summarizing, it should be mentioned that the underlying theory behind this development is not new. Circuit applications of this theory in the past have suffered shortcomings of one form or another. With the advent of high-transconductance tubes, the chances for satisfactory circuit performance have steadily improved. Here described is a pair of 6AH6's which can be used in a single-ended circuit to provide square-law operation over a nine-volt swing in the grid region. This is especially important in the measurement of noise spectrums, speech signals and multiplexed circuits.

Precision Raster Sweep Oscillograph

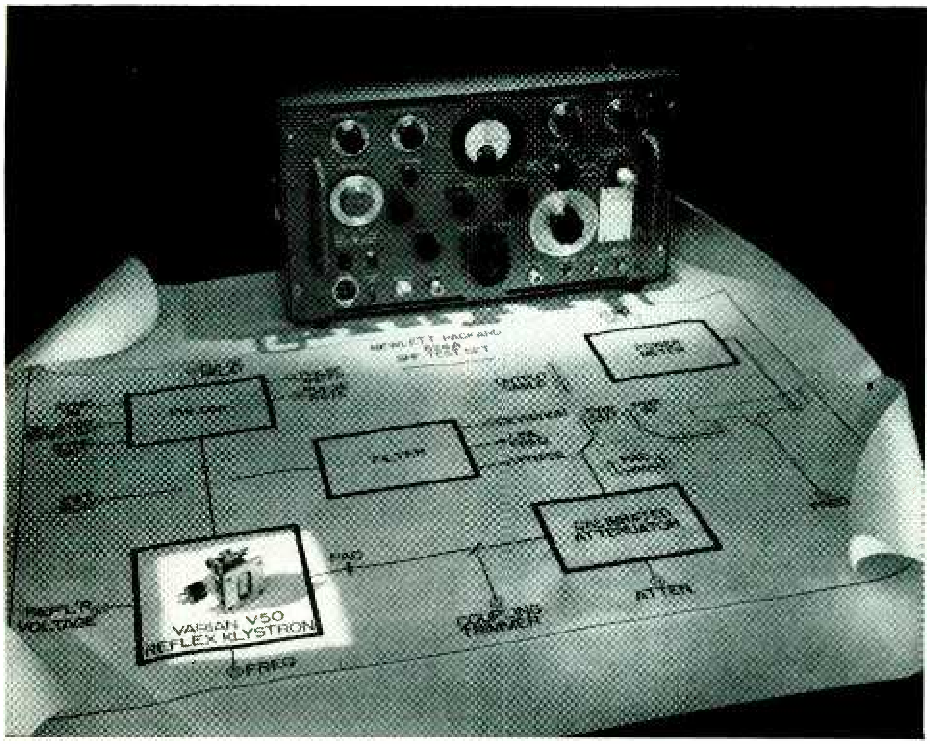
By H. B. Steinhauser

Instrument Division
Allen B. DuMont Laboratories, Inc.
Clifton, New Jersey

This paper describes a raster sweep oscillograph designed specifically to reproduce transient electronic information in such form as to allow the time-voltage variations to be analyzed with precision. Its applications embrace measurements of rise time, length, decay time and spacing transient pulses. Any time interval which can be represented by two successive transient pulses may be measured with a high degree of accuracy.

A raster sweep oscillograph differs from the conventional single trace oscillograph in that a large number of successive horizontal traces are displayed on the screen like lines on a sheet of ruled paper. Figure 1 illustrates the raster obtained with this instrument.

To produce the raster, sawtooth deflection voltages are required for both the horizontal and vertical axis. To enable measurements to be made, a source of sharp accurate marks is also needed. These marks are applied to the grid of the



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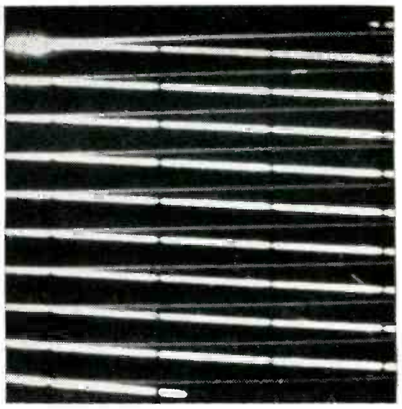

FIG. 1—Raster obtained with the instrument

cathode-ray tube and appear as blanking spots on the trace. The incoming video signals are applied to the Y-axis and produce vertical deflection as in a conventional oscillograph.

If the horizontal sweep generator is allowed to run continuously, the horizontal sweeps are visible on the screen only during the interval when the trace is brightened by an intensity gate generated by the vertical sweep generator. Horizontal sweep speeds of five and ten μsec are available and the number of horizontal sweeps in a raster may be adjusted from 10 to 30 permitting measurements up to 300 μsec. The marker frequency is switched when the sweep speed is switched so that five marks are always displayed on each horizontal sweep.

The vertical sweep may be initiated in several ways: internally with repetition rates of approximately 50 and one cps, manually by means of a push button on the front panel, or externally by means of a suitable pulse. Repetitive and manual triggering are generally used only for setting up and making adjustments.

The equipment is usually triggered by an external pulse and a photograph taken of the single-shot display. To obtain reading accuracy commensurate with the measuring accuracy, the photo negative may be enlarged to two or three feet in width by projection on a screen.

Figure 2 is a simplified block diagram of the equipment. A one-mc temperature-regulated crystal, ac-

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curate to ± 0.0025 percent, is used to control both the frequency of the markers and the repetition rate of the horizontal sweep generator. The output of the crystal oscillator is fed directly through a shaper tube to the marker generator for producing marks at one μsec intervals. Marks at two-μsec intervals are obtained by dividing the crystal output to 500 kc before feeding it to the shaper and marker generator.

The marker generator consists of a ten-mc shock-excited oscillator driven by the sawtooth output from the shaper tube. A resistance across the tuned circuit is adjusted to damp out the shocked oscillations after the first half cycle. Each time the oscillator is shocked into oscillation an output is obtained consisting of one-half cycle of a ten-mc sine wave with a width of 0.05 μsec. The marker amplifier increases the amplitude and inverts the marks to obtain the proper polarity for application to the crt grid. The problem of mixing the marks and the intensity gate is avoided by applying the marks to the grid and the intensity gate to the cathode of the crt.

The one-mc crystal-oscillator output is divided down to 200 kc for initiating the five-μsec horizontal sweep and divided down to 100 kc for initiating the ten-μsec horizontal sweep. The horizontal sweep is generated in a modified bootstrap circuit. Linearity is maintained

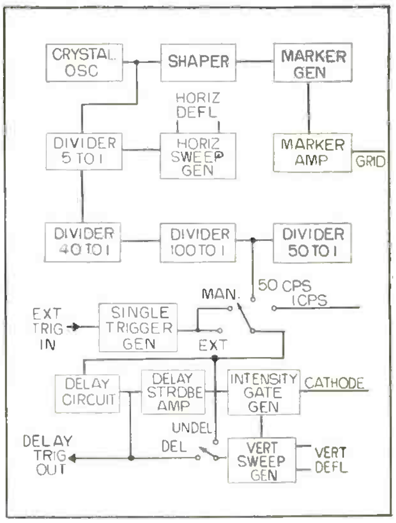


FIG. 2—Simplified block diagram of the sweep oscillograph

RCA UHF-TV SWEEP GENERATORS

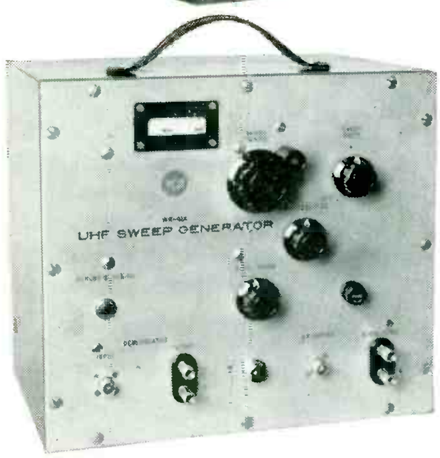
for design and production applications

RCA WR-40A UHF Sweep-Marker Generator

NOW—for the UHF development and design laboratory—the new RCA WR-40A combines sweep generator, marker, and calibrator facilities in one compact, practical unit. Its versatility is unmatched for testing UHF-TV tuners, converters, receivers, antennas, and transmission lines in the 470-870-Mc band.

CHECK THIS LIST of Important Features:

- ✓ Center frequency of sweep oscillator is variable from 470 Mc to 890 Mc. Operates on fundamental frequencies without harmonics or beat notes.
- ✓ Full 45-Mc sweep width available throughout the entire UHF band. "On" or "Off" blanking is included.
- ✓ Sweep generator output impedance is 50 ohms—output voltage across a 50-ohm resistive load is 0.5 volt. External pads to match 75-ohm and 300-ohm inputs are supplied.
- ✓ Amplitude variation of sweep oscillator does not exceed 0.1 db/Mc.
- ✓ Marker oscillator, controllable in amplitude, employs a hand-calibrated dial and operates on fundamental frequency throughout the UHF band.
- ✓ Crystal calibrator provides 1-Mc and 10-Mc check points throughout entire UHF band.
- ✓ Marker amplitudes from hand-calibrated variable oscillator and crystal calibrator remain constant over entire oscilloscope pattern.



RCA WR-41A UHF Sweep Generator

The WR-41A provides a quick, economical means of factory-testing UHF equipment with high accuracy. The instrument incorporates the same high-quality sweep oscillator as used in the WR-40A. Since this unit is designed primarily for production-line use, it employs four semi-fixed absorption-type markers. These are built inside the case, to prevent alteration of their adjustment during normal use.

For complete technical details and prices on the WR-40A and WR-41A UHF Sweep Generators, write RCA, Commercial Engineering, Section HR 42, Harrison, N. J.

TMK. ®

RADIO CORPORATION of AMERICA

TEST EQUIPMENT ***HARRISON, N. J.***

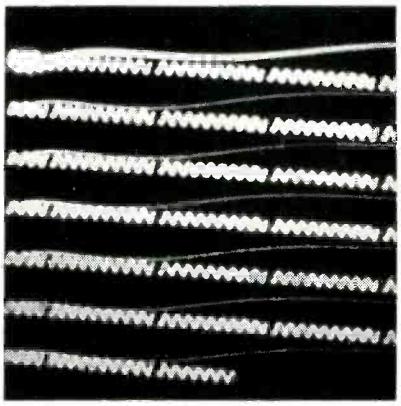


FIG. 3—Raster of Fig. 1 with ten-mc modulation applied

better than one percent between marks and retrace time is only four percent of the sweep cycle.

It is necessary when using repetitive vertical sweeping to have the vertical sweep synchronized with the horizontal to avoid vertical movement or jitter of the raster. This synchronization is achieved by further dividing down the crystal-oscillator frequency to approximately 50 and one cps and using it for triggering the vertical-sweep generator.

Frequency division is obtained in large steps of approximately 40 to 1 and 100 to 1. The exact division ratio is unimportant so long as the vertical-sweep generator is locked in at some integral submultiple of the horizontal sweep rate. The vertical-sweep generator is a bootstrap circuit. A vertical-sweep amplitude control serves to vary the spacing between horizontal sweeps from 0.1 to 0.3 inch.

For single-shot operation, a thyratron pulse generator is used which may be triggered either manually by a push button located on the front panel or externally by a pulse fed in through the external trigger jack. When the thyratron is fired it generates a single pulse which in turn triggers the vertical sweep generator to give a single vertical sweep. By using a thyratron in this circuit an automatic lockout is obtained, since once the thyratron has fired it cannot be fired again until it has been reset by depressing a reset button on the front panel.

A variable-delay circuit has been included to allow the insertion of

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FREEDSEAL TREATMENT
No. 1020B MEGOHMMETER
FILTERS
No. 1180 A.C. SUPPLY
NO. 1040 VOLTMETER
VOLTAGE RANGES: .001 volts to 100 volts in five ranges (.01, .1, 1, 10, and 100 volts full scale).
ACCURACY: 2% on full scale on all five ranges, on sinusoidal voltages.
FREQUENCY RANGES: 10 to 200,000 cycles, .1 db. variation from 20 cycles to 150,000 cycles; .50 db. variation from 10 cycles to 200,000 cycles.
INPUT IMPEDANCE: Equivalent to 500,000 ohm resistance in parallel with a 15 MMF. condenser.
STABILITY: Effect of variation in line voltage from 100 volts to 125 volts is 1%. Effect in changes of tubes is less than .5%.
METER: 4" suppressed zero 1 MA meter protected against overloads.
POWER SUPPLY: The instrument is entirely self-contained and operates on 100-125 volts, 50-60 cycles. Total consumption, 40 Watts.
DIMENSIONS: 4⅞" High, 5⅝" Wide, 9⅞" Long.
WEIGHT: 12 pounds.
No. 1110A INCREMENTAL INDUCTANCE BRIDGE
No. 1170 D.C. SUPPLY
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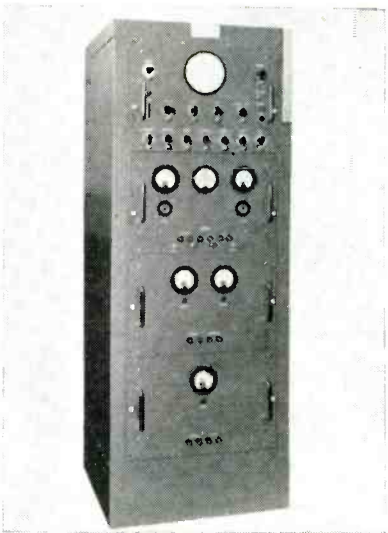
up to 150 μsec of delay between the vertical sweep trigger and the vertical sweep. This permits the entire raster to be delayed after the initiating trigger. A panel switch permits selection of the delayed or undelayed raster. An intensified strobe which occurs at the end of the delay period is displayed on the undelayed raster and enables the setting of the delay to be read. This strobe is obtained by taking the trigger from the delay amplifier, sharpening and amplifying it, and applying it to the cathode of the crt. The delayed trigger is also made available at a coaxial jack for external use.

External video signals are fed in via a coaxial jack through a cathode-follower isolation stage and coupled to one of the vertical deflection plates. Since a short video pulse might possibly be lost in the retrace period of the horizontal sweep, provision has been made for also feeding the signals to the vertical axis through a one-μsec delay cable and a phase-inverter isolation stage. This produces an inverted pulse exactly one μsec after the original. Since the delayed video signals are inverted they may be easily identified.

During development of the instrument it was necessary to make frequent checks on the linearity and retrace time of the horizontal sweep. This was done by applying a ten-mc signal of approximate sine-wave shape to one of the verti-



External view of the complete equipment

cal deflection plates through a small coupling capacitor.

The ten-mc test signal was obtained by frequency multiplication from the crystal oscillator so that the pattern would be synchronized with and remain stationary on the horizontal trace.

Figure 3 is a photograph of the raster shown in Fig. 1 but with the ten-mc modulation applied. By counting the modulation cycles it may be determined that the forward-going part of each horizontal sweep is 4.8 μsec long while the retrace is 0.2 μsec. The linearity is checked by measuring and comparing the spacings between adjacent cycles of modulation across the sweep. For perfect linearity, the spacing should be the same between any two adjacent cycles anywhere on the sweep.

Credit is due Arthur Mahren for his valuable contributions to the circuit development of this instrument.

Improving Electronic System Reliability

By W. Wagenseil

Associate Head
Production Design Department
Radar Laboratories
Hughes Aircraft Company
Culver City, Calif.

Examination of over 200,000 failure reports on equipment in the field showed that there was no outstanding cause of failure. It was decided to establish a parts application section, staffed with competent engineers selected to become specialists in the various components. These engineers study parts specifications at the time the systems are designed.

As a direct result of the establishment of the parts application section, the following examples have proven worthwhile as reminders to circuit and equipment designers.

The insulation resistance of any capacitor is a function of the voltage across the capacitor. The capacitance of high-K ceramic capacitors is a function of the voltage impressed across them. Below ten volts applied voltage, inserted-tab-construction capacitors should not be used since they may open. A resistance may build up between

the tab and the foil which will not break down at applied voltages of less than ten volts.

A careful examination and study should be made of any d-c paper capacitors which have alternating currents applied across them since the voltage derating of a d-c capacitor is a function of the frequency of the a-c applied.

During shipping or storage, parts may be subjected to rather low temperatures. Certain wax-impregnated capacitors are permanently damaged after such treatment. Metallized capacitors should not be used in high-impedance circuits because when they short through a paper pin hole or impurity, there may not be enough current to burn out the shorts. Metallized paper capacitors should not be used in pulse-sensitive circuits where sparking inside the capacitor may generate false pulses.

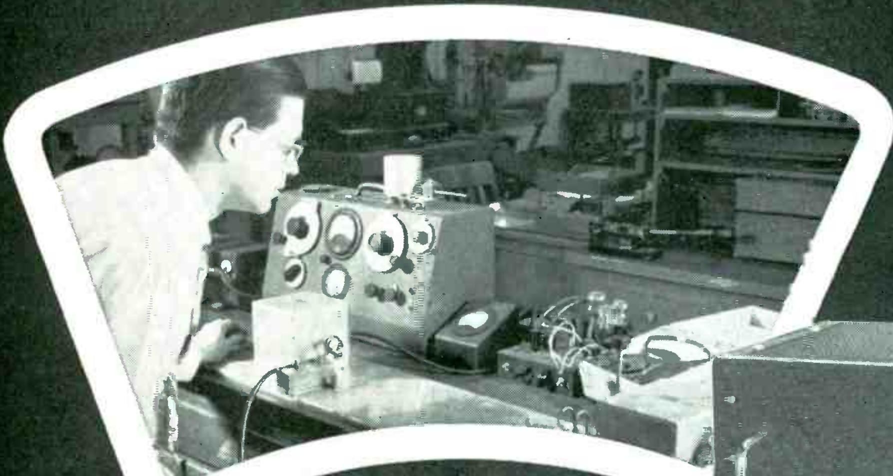
The difference in temperature coefficients between different values of deposited carbon resistors is so great that they are nearly useless for precision voltage-divider circuits used in military gear subject to large temperature variations.

Hermetic Sealing

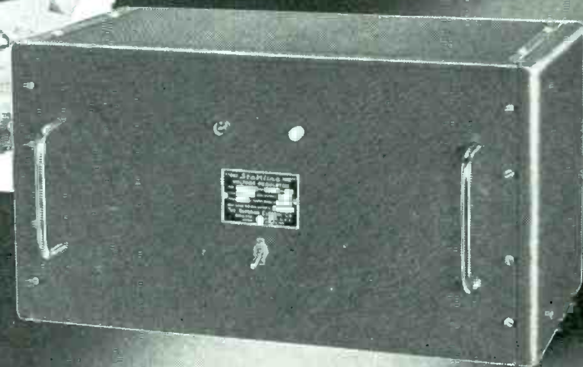
Parts that are not completely hermetically sealed might best be left open since tests show that changes in humidity, temperature and altitude may cause moisture to collect in such parts. The more commonly used potentiometers are subject to this difficulty.

Circuits must be designed to accept the full JAN tube limits. It is not difficult to obtain a JAN tube which operates within limits narrower than those specified. But when the equipment gets in production, a different manufacturer may provide the tube. This factor may result in the circuit not operating because the second manufacturer's limits are different from those which the first manufacturer selected. Both limits are within the range specified by JAN specifications.

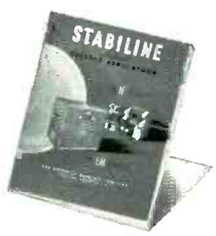
When a 385-volt capacitor is needed, it is not necessary to specify a 600-volt capacitor designed to be operated at 900 volts. The parts application engineer can give this



CABINET TYPE IE5101



RACK TYPE IE5101R



assurance because he has tested and approved vendor's products against purchase specifications.

All the characteristics of parts are not necessarily controlled. This is one of the things that engineers seems to forget most rapidly. They assume that all characteristics are controlled.

Present-day systems are so interdependent and complicated that there is a tremendous temptation to design with a soldering iron. The designer trys to make his system operate and prefers to forget details. The parts specialist remembers the details and looks for the unexpected things that prevent production systems from operating in the same manner as breadboard systems.

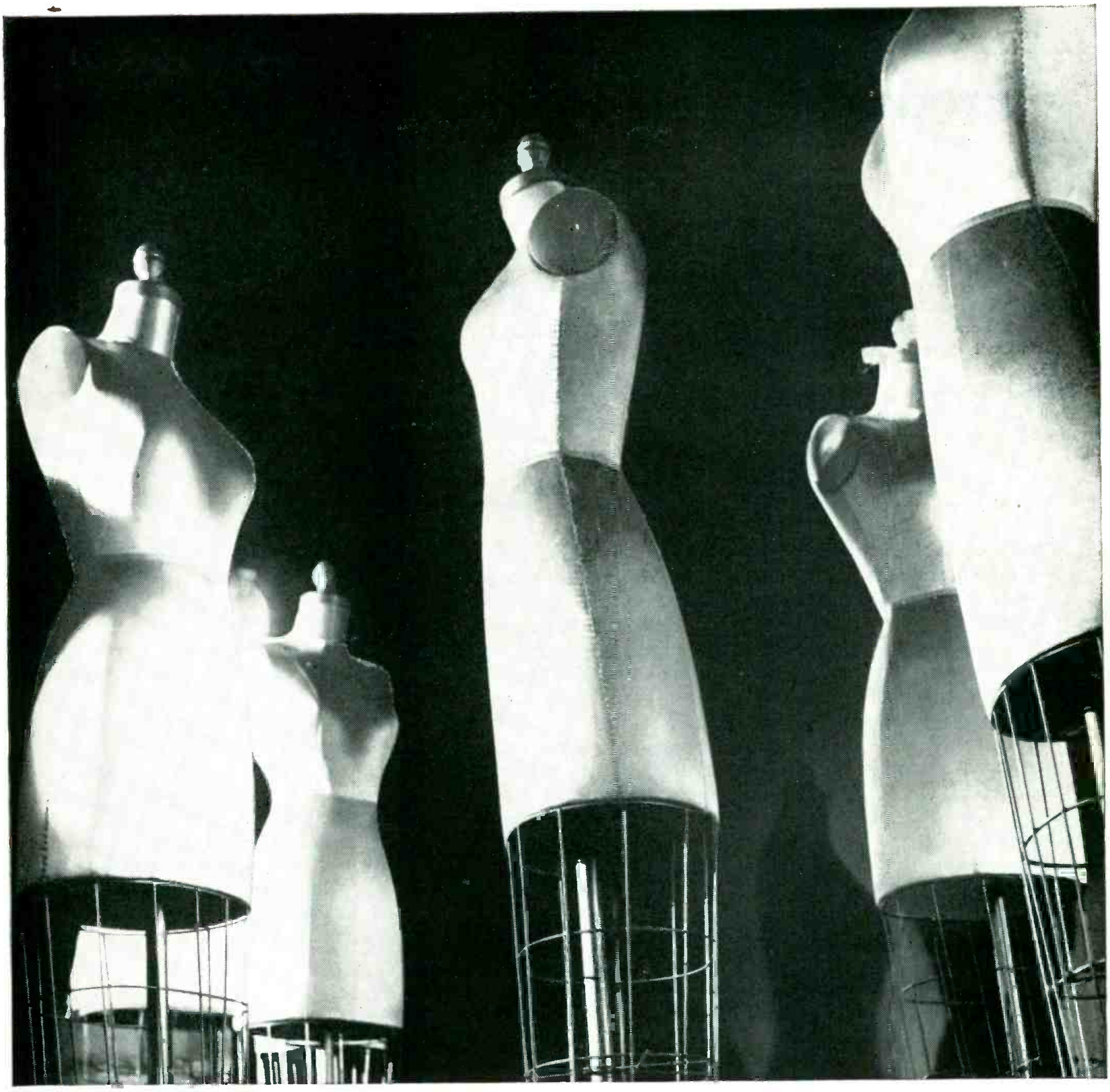
Fast Cueing of Tape Programs

By John B. Ledbetter

Engineer WKRC-TV
Cincinnati, Ohio

Many times the writer has found it convenient or necessary to record two or more separate programs back-to-back on a single 30-minute reel. This often happens when the tape recorder is used on several successive spot or special-events shows. In many cases, one of these programs (often the last one the reel) will be scheduled for immediate use, with the others out of order or rescheduled for later playback.

Normally, it would be necessary to run all or part of each reel in order to cue in at the desired spot, or dub each program onto separate reels. All this trouble can be avoided simply by numbering a small tab of paper and attaching with a very small piece of Scotch tape at the point where each program starts and ends. This can be done at the time each show is recorded. The cueing of each show then resolves itself into throwing the recorder switch to FAST FORWARD and stopping at the proper tab. This consumes only a fraction of the usual set-up time and has meant the difference between immediate playback or complete rescheduling.



Production Techniques

Edited by JOHN MARKUS

OTHER DEPARTMENTS featured in this issue:

Locking Adapter for Subminiature Tubes

TESTING of subminiature tubes is greatly simplified if their thin flexible leads are temporarily attached to a standard plug-in tube base. Since some of the premium subminiatures are given extremely high vibration tests, heat runs and severe electrical tests, firm connections to the leads are essential. So important is this requirement that before development of the locking adapter, leads of each miniature tube were inserted in the pins of an empty octal base and soldered for test purposes, then unsoldered after completion of tests.

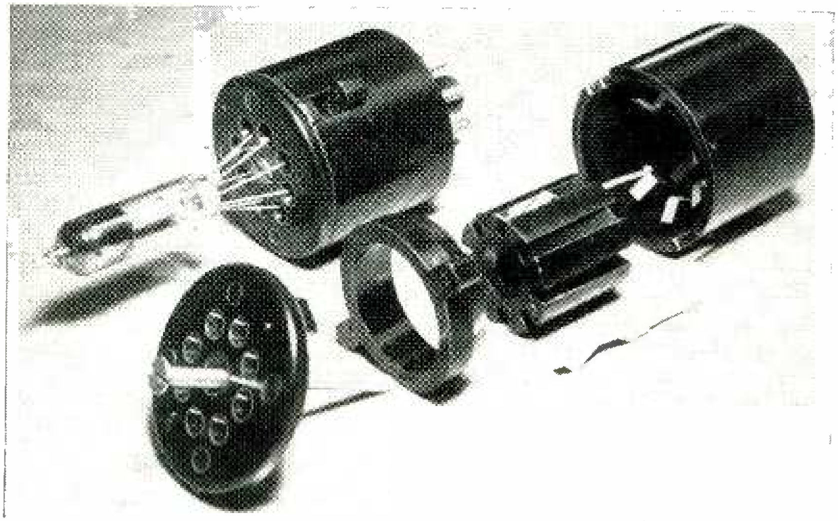
The locking adaptor, developed by engineers of Sylvania Electric Products Inc., solves the problem so perfectly that the adapter has been placed in mass production for use in all of this firm's plants and is available to other manufacturers.

The adapter is made up of five molded plastic parts, eight phosphor bronze contact clips and one machine screw. The base is a standard octal base, made from a revised mold having cutouts for the tabs of the molded plastic locking ring. A cylindrical core which fits inside the base has longitudinal slots located directly over the base pins, into which go the eight contact clips. These are preformed to give a press fit into the tube base pins. This is tight enough to eliminate need for soldering but the base pins are dipped in solder anyway to round off the ends for smoother insertion in sockets.

The locking ring moves up and down over bends in the contact strips. When moved down toward the base, it presses the strips firmly against the tube leads, to give a tight grip and good electrical connection.

Holes in the cover plate are coned outward to facilitate inserting the tube leads in the adapter. With practice, an operator can fan out the leads of a subminiature and get them into the right holes almost as fast as if plugging in an ordinary tube.

A molded raised dot on the cover plate identifies the space between pins 1 and 8, and the plate itself is molded with different widths of positioning lugs.



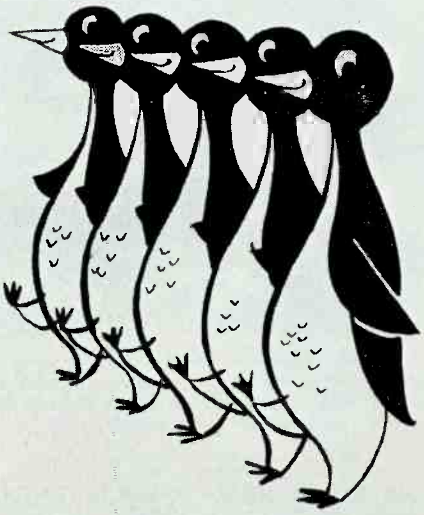
Component parts of locking adapter. In background is an assembled adapter with subminiature tube locked in position

Stripping Enameled Wire

TO REMOVE enamel insulation cleanly from leads of magnetic amplifier coils without nicking or otherwise weakening the fine copper wire, Keystone Products Co. in Union City, N. J. uses a special wire stripper with rotating wire brushes, made for the purpose by Newark Brush Co. of Kenilworth, N. J.

The brushes are mounted one above the other and belt-driven by a $\frac{1}{3}$-hp motor; the distance between the brushes is adjustable to accommodate different sizes of wire, by turning a knob that raises or lowers the entire upper brush assembly.

The wire coil leads to be stripped are inserted all at once in the opening located just between the brushes. One slow movement in and out cleans all the leads of the



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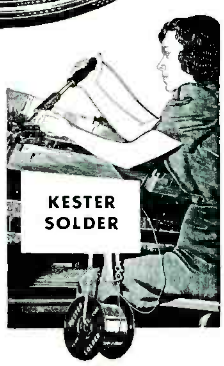

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All leads of this magnetic amplifier coil are cleanly stripped of enamel when inserted in the opening. Wire brushes pull the enamel away from the operator; this direction of rotation also serves to pull in flexible fine-wire leads so they get stripped for the desired length

coil simultaneously. A fan blade, also belt-driven by the motor, creates a vacuum to pull the enamel dust into a collecting drawer provided for the purpose under the machine. Edges of the drawer are temporarily taped to prevent leakage of the fine dust.

Magnetic Parts-Lifter

TUBE anodes emerging from a baking oven are picked up and loaded into tote boxes with a Multilift Magnetic Separator, made by Multifinish Mfg. Co., Detroit, Mich. In the lifting position, a permanent magnet in the tool attracts the parts. Pulling up an inner handle moves an internal shunt between the magnet poles, reducing the external magnetic field sufficiently so the parts drop off into the box.

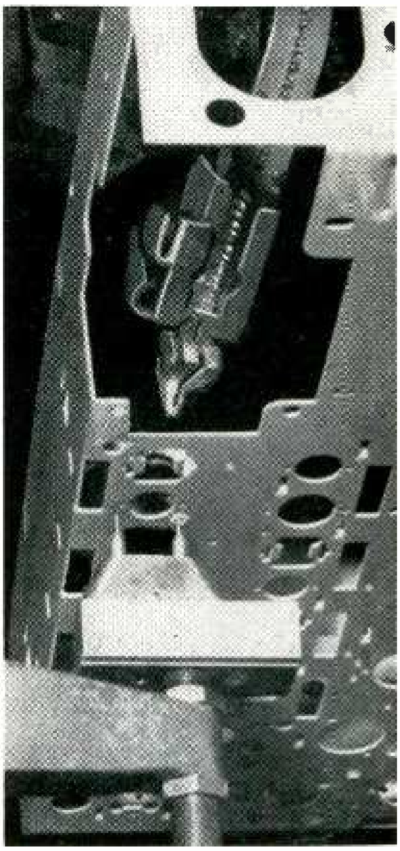
The lifter is used for this purpose in the Emporium, Pa. plant of Sylvania Electric Products Inc. because the parts are too hot to touch after emerging from the 1,700 F oven. Even if parts were cool enough, touching with gloved or bare hands could introduce grease or dirt that neutralized the degreasing and baking operation. The lifter insures cleanliness and permits using a much shorter conveyor for cooling.

Lifting hot anodes from moving woven-wire conveyor which runs through baking oven

Double-Anvil Riveter for Miniature Sockets

THROUGH use of a sliding double anvil on a single riveting machine, miniature sockets can be riveted to a television chassis just as fast and just as well as with a more costly dual-machine arrangement.

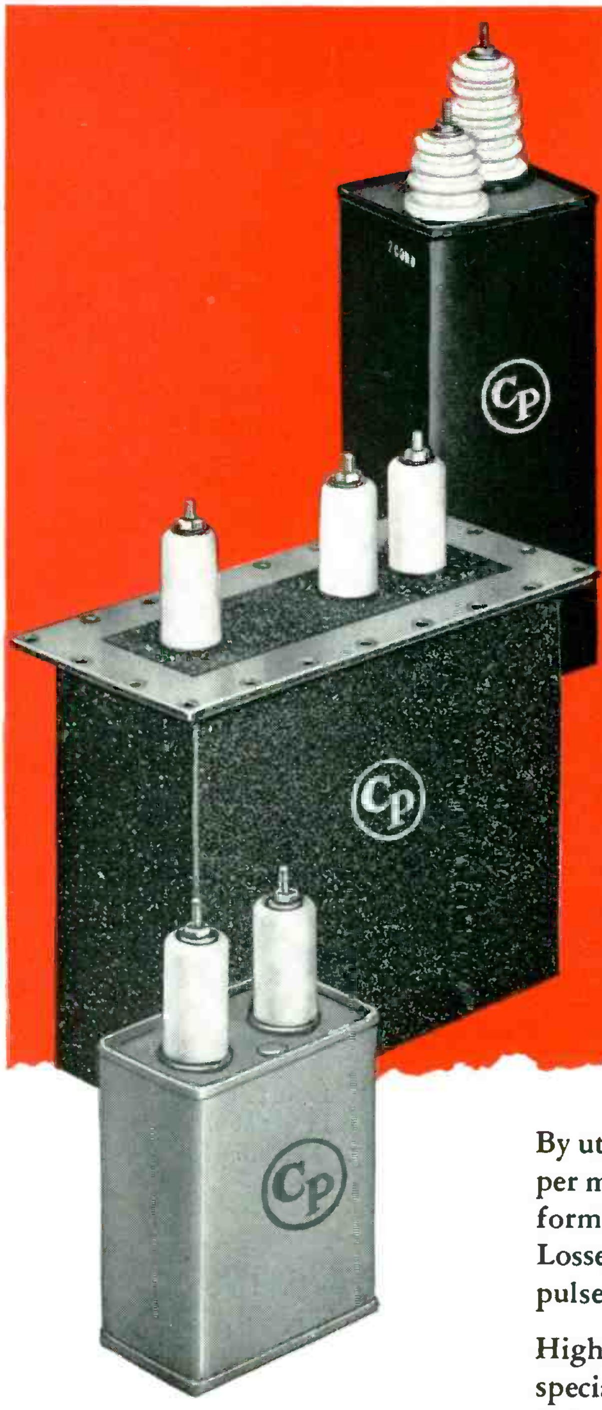
The operator positions the chassis so each socket hole is over an anvil pin, places a socket over the anvil pins, slides the anvil to one limit of movement and operates the press to feed and clinch one tubular rivet, then slides the anvil to the other limit of movement and operates the press again to finish the job. This technique is used in the Television Receiver Division of Allen B. DuMont Labs., Inc., in East Paterson, N. J.



Addition of two-pin anvil makes single riveting machine do work of dual machine

Spotlight for Welding

A LUCITE rod mounted on a Bausch & Lomb microscope substage projection lamp gives an intensely bright beam of light at the electrodes of a small welder, to facilitate welding of getters and other small parts to



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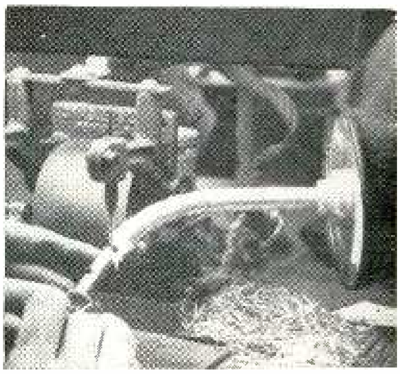


Lucite rod on end of lamp housing bends light beam to illuminate small parts being welded

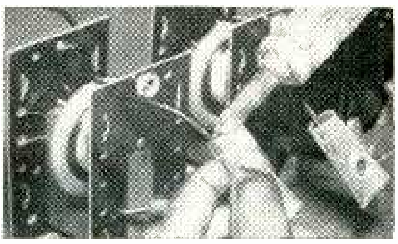
the electrode structure of miniature and subminiature tubes. The projector contains a 21-cp auto lamp operated from a 6.3-volt filament transformer.

Being thermoplastic, the Lucite rod is easily bent to the optimum shape and position by heating with an infrared lamp or hot plate after the projector is mounted on the bench. Aluminum foil is wrapped around the rod to prevent loss of light except at the end where desired. The rod is clamped to a metal disk set into the opening of the projector housing. This technique for supplementing fluorescent table lamps during assembly of small parts is in use at the Emporium, Pa. plant of Sylvania Electric Products Inc.

Heat-Fusing Polystyrene

USE of a polystyrene sleeve over a coil-spring connector for the plate top cap of type 1B3 tubes, in place of the more common molded plastic top-cap connector, cut production costs of the high-voltage power supply for Tele-tone television receivers.

The sleeve came from an outside vendor with one end sealed and a hole punched for the top cap. On



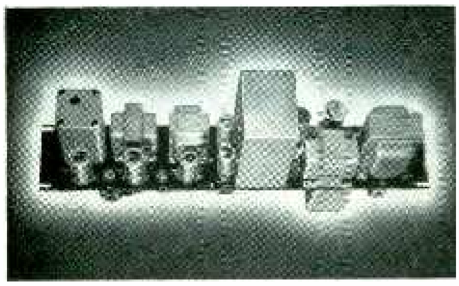
Heating open end of polystyrene sleeve

HAMMARLUND

DATA TRANSMISSION • SELECTIVE CALLING AND SUPERVISORY CONTROL EQUIPMENT

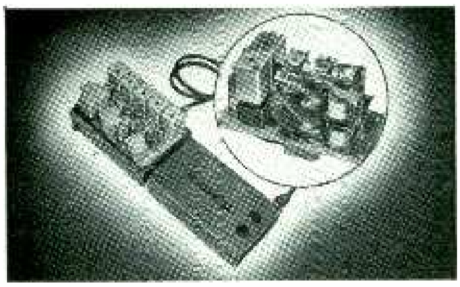
For the past seven years The Hammarlund Manufacturing Company has specialized in designing and developing electronic control equipment. Based on this experience, and the knowledge gained from 42 years of communications engineering and production, Hammarlund today produces a standard line of equipment for data transmission, supervisory control, telemetering, selective or group calling or signalling, fault alarm and other similar applications. This equipment is designed for use on microwave, radio or wire circuits.

POINT TO POINT SIGNALLING



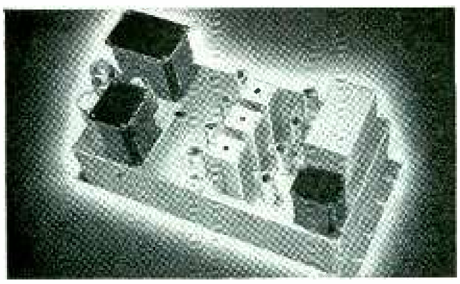
The Hammarlund Standard Duplex Signalling Unit consists of a tone generator and receiver designed to operate over wire lines, telephone or power line carrier, and radio or microwave communications circuits for signalling, dialing, slow speed telemetering, supervisory controls or other information. Transmitters and receivers are available for 33 frequency channels between 2000 and 6000 cps. This equipment is being used by military and governmental agencies, pipeline and power companies, railroads and other groups requiring remote on-off switching, continuous indication of operating conditions, and automatic detection of wire line or power source failures along their systems.

SELECTIVELY CALLING OR SIGNALLING



Hammarlund Selective Calling equipment, added to 2-way radio systems used to control large fleets of vehicles, or distant fixed stations, adds privacy, speed, safety, quietness and convenience to day-in-day-out operations. By the push of a button the dispatcher within 0.8 of a second selects the station which he wants to contact. Only the selected operator or group of operators can receive the call. If the operator of the car or station being called doesn't answer, an indicator lamp remains lighted to show he was called. This simple equipment can be added to any present installation, or incorporated in any type of installation now projected.

PROTECTION THROUGH SUPERVISORY CONTROL



The Hammarlund "Multi-Gate" Remote Supervisory and Control System is engineered to provide highly efficient, fully reliable operational controls of important remote equipment such as used by refineries, pipelines, utilities, railroads, civil defense and other commercial, as well as military, groups. Because of a unique design by which a single tone activates a receiver, which in turn will then accept a second tone to operate a relay, this equipment can be used where disturbances on connecting wire or radio circuits make ordinary tone-operated remote controls impractical. Up to 21 individual on-off functions can be handled over a single circuit employing only 7 audio signalling tones.

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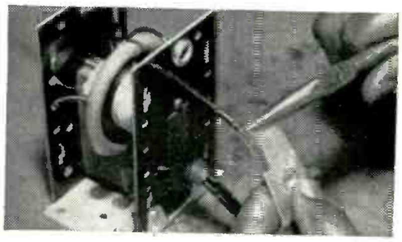


Squeezing heat-softened plastic to form seal

Method of using sleeve on 1B3 high-voltage rectifier

the horizontal output transformer subassembly line, the sleeve was pushed over the spring clip and the open ends heated with an ordinary soldering iron, then squeezed together quickly with long-nose pliers to seal the sleeve in position.

Panel-Holding Fixture

GROOVED wood uprights mounted on a wood base are used to hold a small panel for the Signal Corps I–193 relay test set in a vertical position for mounting of parts from both sides in the East Newark, N. J. plant of Utility Electronics. Parts

Simple wood fixture holds panel upright for maximum convenience in mounting parts on both sides

are mounted with nuts and bolts, and this fixture permits holding the slotted head of the bolt with a screwdriver on one side of the panel while tightening the nut with a spin-type socket wrench on the other side.

The operator inserts a wood block under the panel to raise it to most convenient height in the vertical slides.

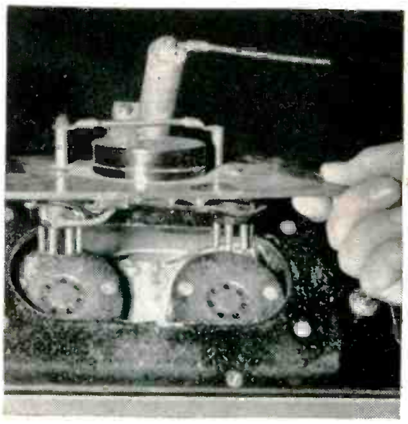
Reject Indicator Lamp

Two lamps indicate the quality of assembly-line work in Du Mont's East Paterson, N. J. television receiver plant. When the amber lamp is on, the reject rate is within acceptable control limits. When the red lamp is turned on by the line foreman, the workers know that their reject rate is too high.

Plug-in Panels and Meters For Test Sets

HIGH-SPEED production test sets for locating shorts and gas in newly manufactured tubes can be quickly changed for another tube type at

Testing 6CD6G in universal shorts and gas test set. Tube socket panel is held down by locking latch at right, needed for larger tubes. Coil spring makes top cap connection

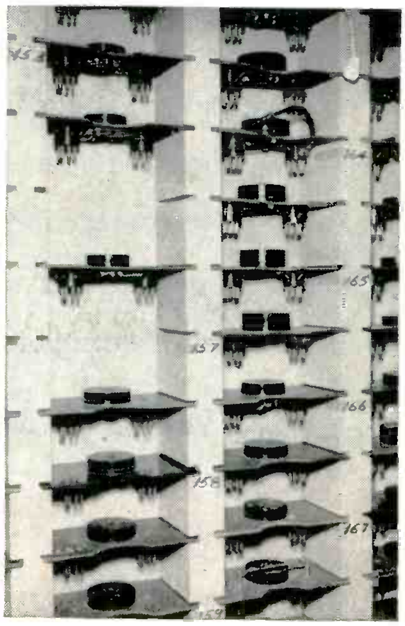


Plug-in socket panel for tube under test. Coil spring stretched between posts back of socket makes connection to shell of 6SQ7 for checking continuity to No. 1 pin

the Emporium, Pa. plant of Sylvania Electric Products Inc., through use of plug-in connections instead of conventional permanent test circuitry.

Three types of changes are made. The socket for the tube under test is mounted on a small insulating panel having pins that plug into two permanently connected 7-pin sockets in the test set. A complete file of sockets for different tube types is kept in racks on the production floor, so that correct pin connections for a particular tube are made automatically by inserting the correct socket panel for that tube.

All meters on the test set have



Rack used for storing socket panels. Some have a special top-cap connecting lead or a shield-connecting spring

HERMETICALLY SEALED

SOLA *Constant Voltage* TRANSFORMERS

FOR USE ON MIL-T AND JAN PROJECTS

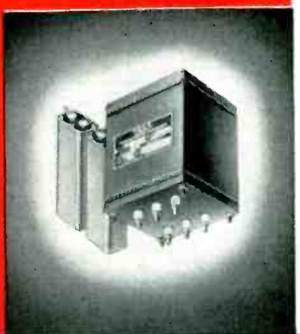
The patented SOLA Constant Voltage Principle provides the following advantages over ordinary transformer design: regulation within ±1% with total primary variations as great as 30% . . . automatic, instantaneous regulation . . . freedom from moving parts, maintenance and manual adjustments . . . self-protection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

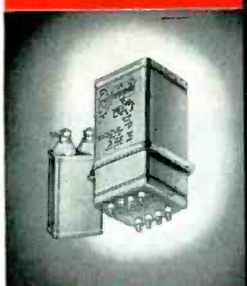
Today's complex electrical and electronic defense equipment requires unfailing accuracy and dependability under extreme conditions of humidity, heat, mechanical shock and other adverse conditions. To meet those needs SOLA voltage regulators can be provided in hermetically sealed housings which conform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

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

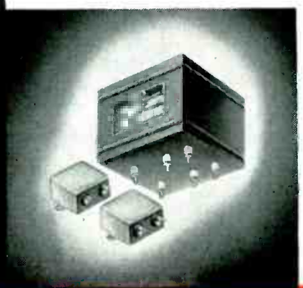
Often the precise voltage input upon which a device's design was predicated is not available. Yet, input voltage level must continuously meet design requirements for satisfactory performance. You can guarantee optimum performance for your unit by stabilizing input voltage with a SOLA Constant Voltage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

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





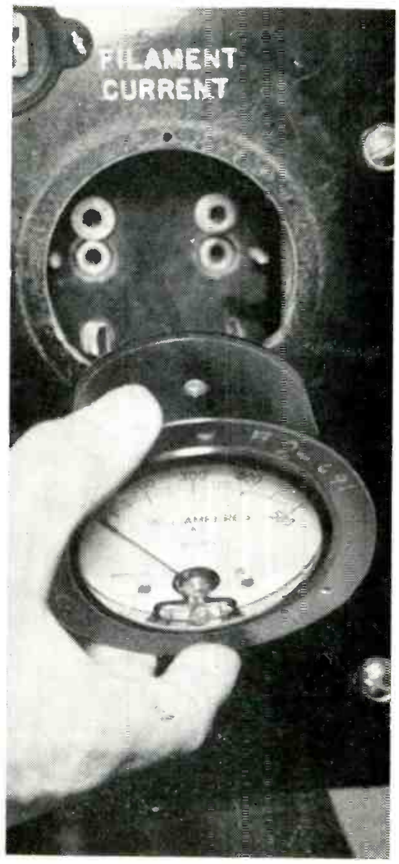
Typical types of Hermetically Sealed SOLA Constant Voltage Transformers



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

SOLA *Constant Voltage* **TRANSFORMERS**

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

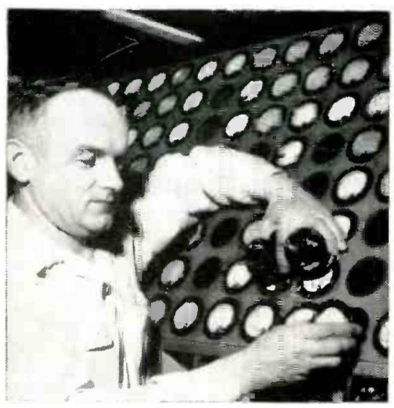


Plugging meter into test set

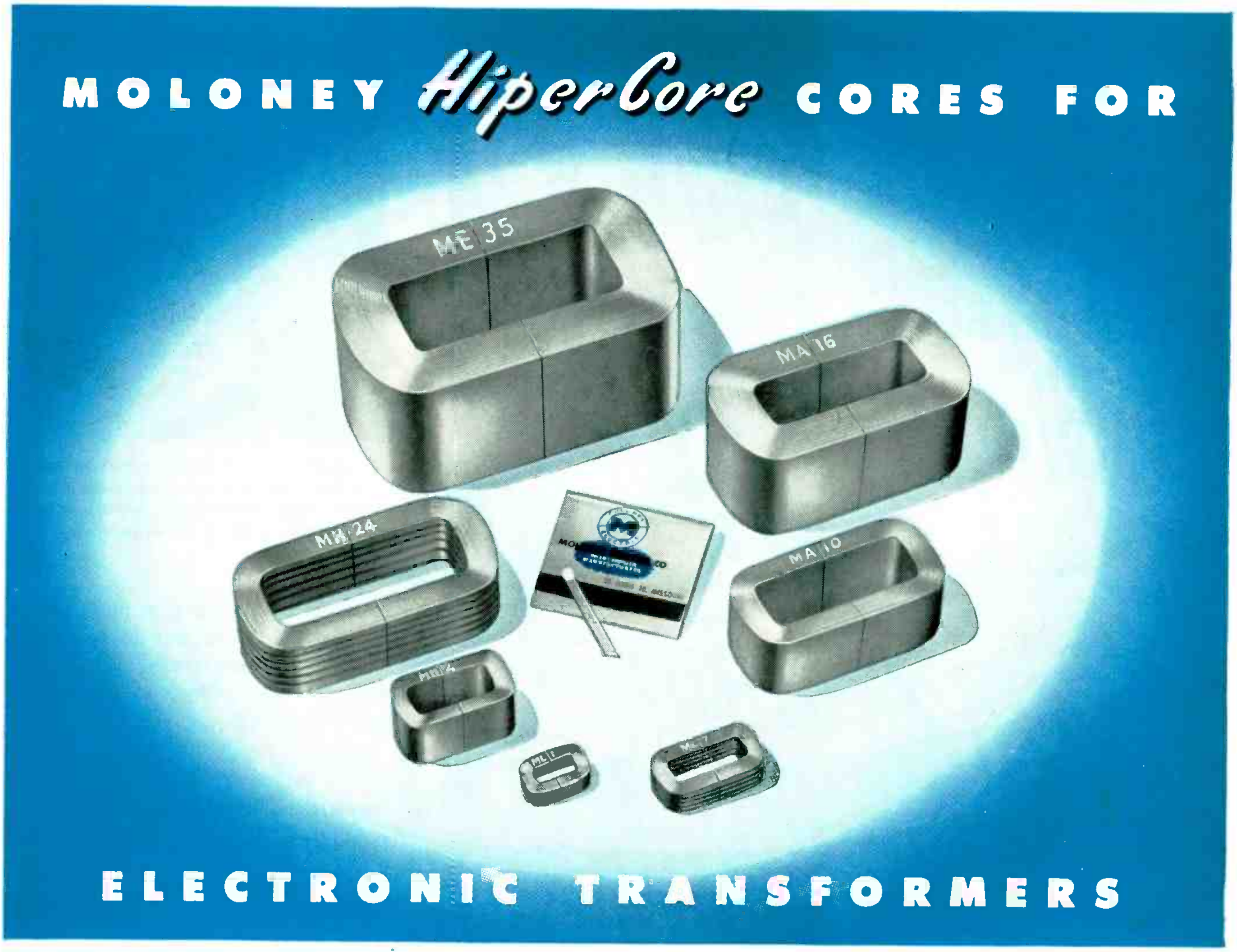
banana-plug terminals that fit into jacks located behind panel holes. This permits quick changing of meters when different ranges are needed. Meters not in use are stored on a sloping plywood panel having an individual cut-out hole for each meter.

A plug-in patch panel, also using banana plugs, serves to tie the correct d-c test voltages to the test adapter socket. An ordinary drawer handle on the panel makes insertion and removal easy.

A coil spring permanently mount-



Meter-storing panel



Better Performance

These wound cores of high permeability, cold-rolled, oriented steel are identical in design and material with the cores used in the famous Moloney HiperCore Transformers. You get greater flux carrying capacity and lower losses without increasing the core size.

Increased Production

Eliminates the need for stacking thus saving assembly costs. In all types of electronic transformers this saving in assembly time makes possible a greater accelerated production schedule.

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Cold-rolled silicon steel has higher permeability in the direction of the grain of the steel. HiperCore design most advantageously utilizes this feature and therefore results in a smaller mass without sacrificing performance.

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Up to 30% reductions in weight of the core and coil unit are obtained with HiperCore. This can be reflected in the complete product with subsequent savings in material and assembly costs.

A complete range of core sizes from 1 to 12 mil for electronic application is available for prompt shipment. Contact our St. Louis office for information concerning delivery of cores which meet your specifications.

ME52-20

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Changing voltage patch panel in test set. Switches and controls provide additional circuit changes that make test set as nearly universal as possible

ed on an insulating post on the test set makes connections to top caps of tubes automatically. When not needed, this spring can be swung out of the way.

Swaging Paper Capacitors

ENDS of rolled paper-and-foil units for tubular paper capacitors are swaged by holding them against a metal cylinder that is rotating in a bath of 650-C molten aluminum. The rotating cylinder, belt-driven by a motor, keeps sludge off the

Holding uncased paper capacitor unit against cylinder, rotating in molten aluminum, to swage foil ends together


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1800 insulated wire terminations per hour!
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THE FASTEST MOST ECONOMICAL WAY TO APPLY TERMINALS TO WIRE IS TO USE AMP AUTOMATIC MACHINES WITH AMP PRE-INSULATED* CORROSION PROOFED TERMINALS!
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2100 Paxton Street, Harrisburg, Penna.

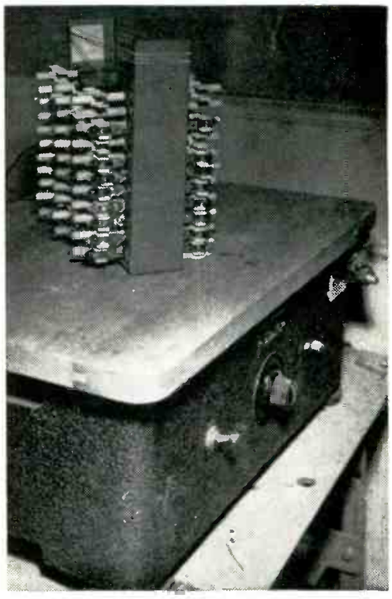
capacitor since the sludge does not adhere to the smooth moving surface.

Exposed foil ends of the rolled capacitor units are completely swaged together and coated with fresh aluminum in preparation for soldering of end leads. The technique is used by Astron Corp. in East Newark, N. J.

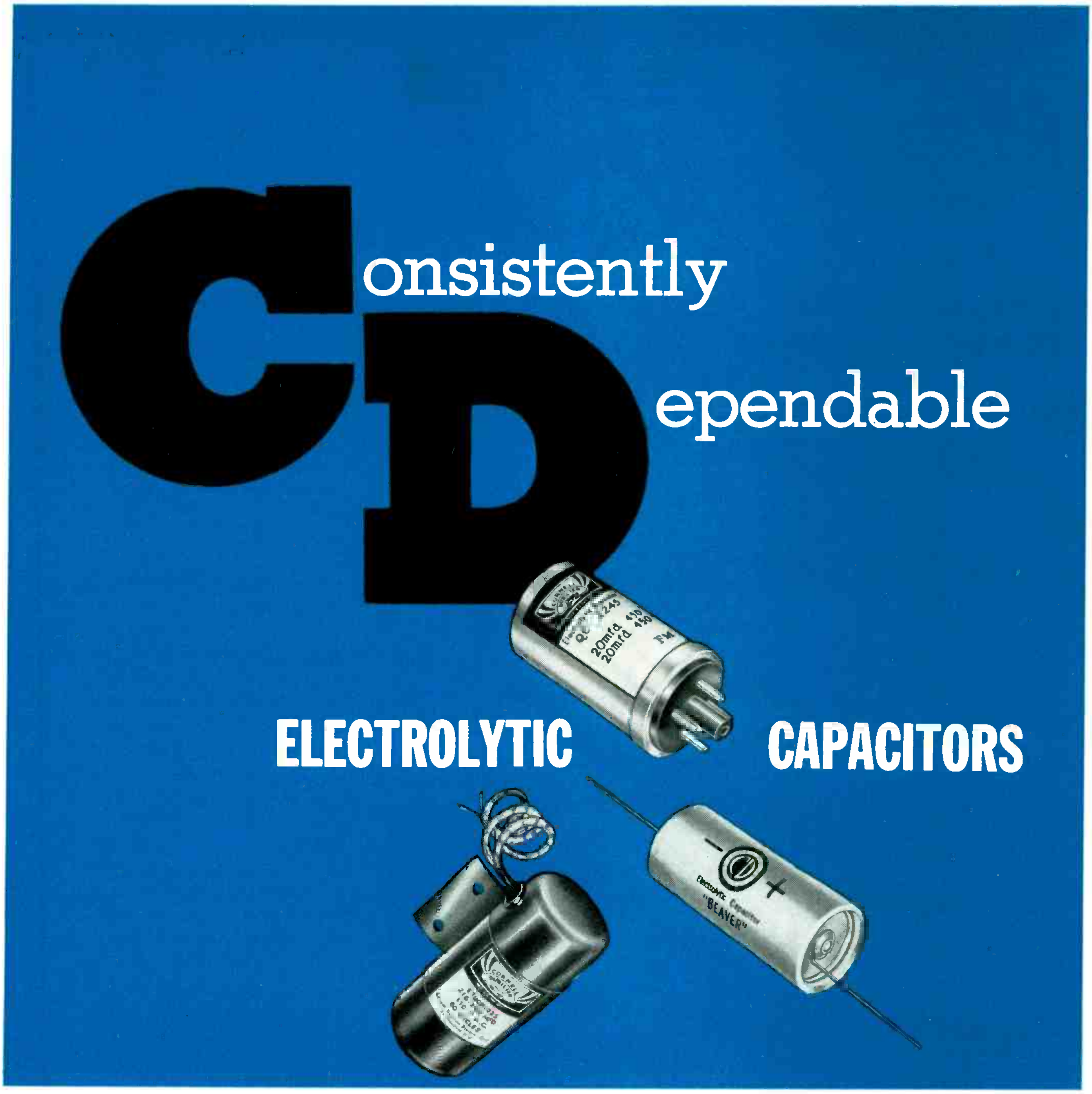
Vibration Test Setup

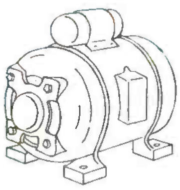
PREMIUM subminiature tubes are given a 96-hour vibration test at $2\frac{1}{2}$ g on a Syntron style 1774 paper jogger of the type used in printing plants to line up paper sheets. The tubes are first placed in holding racks, each of which holds 12 tubes in fuse clips.

Heater voltage is applied during vibration by allowing heater leads to project on opposite faces of the insulating rack. Other leads go into holes provided in the rack to keep unconnected leads out of the way. Each rack has a copper strip along the entire length of one face. Racks are stacked with all copper strips down. The strips are connected in parallel alternately by bringing one end of each strip around onto the other face and using a U-shaped jumper on the other end, so that all



Vibration-testing type 5900 premium subminiature tubes a hundred at a time in fixture resting on table of paper jogger. Amplitude-measuring coil is at right rear corner of table





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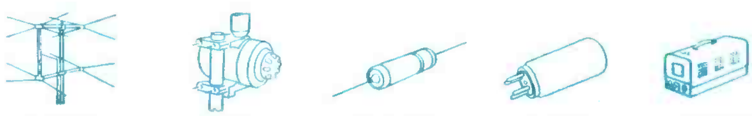

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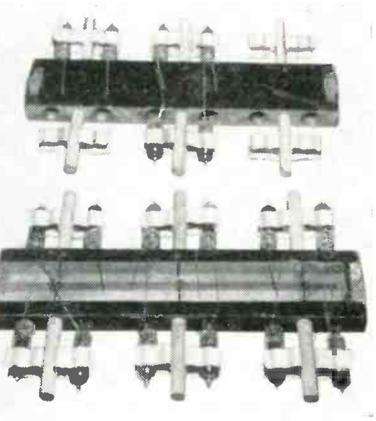

Tube-holding racks. Phosphor bronze heater-connecting strip is on one side of rack only. Strip folds over end at left. Short metal piece folded over end at right serves to connect together the strips on the two adjacent racks when they are stacked

tube heaters are automatically connected in parallel when the racks are stacked in a metal holding fixture. Knurled clamping wheels hold the racks in position tightly to get good heater connections and to insure transmission of vibration from the jogger to all tubes.

At one corner of the vibrating table is a permanent magnet, moving up and down inside a coil that is bolted to the stationary base of the jogger. Measurement of the a-c voltage generated in this coil provides an easy means of checking the amplitude of vibration, once coil output has been correlated with

Corner of paper-jogger table, showing how amplitude-measuring coil is mounted

IT PUTS THE SQUEEZE ON MAINTENANCE COSTS!

WESTON MODEL 633

CLAMP VOLT-AMMETER

A-C Current—five full scale ranges of 1000/250/100/25/10 amperes, with range overlap for good readability. Measurements under 10 amperes readily obtained.

A-C Voltage—three self-contained ranges of 700/350/175 volts insure accurate readability, in the upper half of the scale. Instrument insulated for 750 volt service.

Isolated Voltage and Current—with circuits insulated from each other, instrument can be connected to both voltage and current sources at same time.

Convenient 6 position switch—easily operated with gloved hand, a flick of the thumb selects any of the 5 current ranges, or the Volts position.

Adjustable pointer stop—red stop facilitates measuring starting current of motors.

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measured amplitudes of table movement. Frequency is constant at 120 cps for all tests, hence equivalent gravity values are easily computed.

Testing is done in three different planes, by turning over the tube-holding fixture at 32-hour intervals. The technique is used for sampling inspection at the Emporium, Pa. plant of Sylvania Electric Products Inc.

Testing Incoming Tubes

By Curtis R. Schafer
The Liquidometer Corp.
Long Island City, N. Y.

In the manufacture of capacitance-type fuel gages for high-octane and JP series aircraft fuels, customary statistical percentages of deviations or failures in components cannot be tolerated. An error in the weight of fuel indicated by the gage or its failure can mean loss of an airplane and its crew. For this reason, incoming tubes for fuel gages are given thorough tests at Liquidometer Corp. in production-type test setups that minimize need for operator judgment in making 100-percent tests of incoming shipments of tubes.

The test circuit arrangement of Fig. 1 is used for testing types 5751, 5814, 12AT7, 12AX7, 2101C,

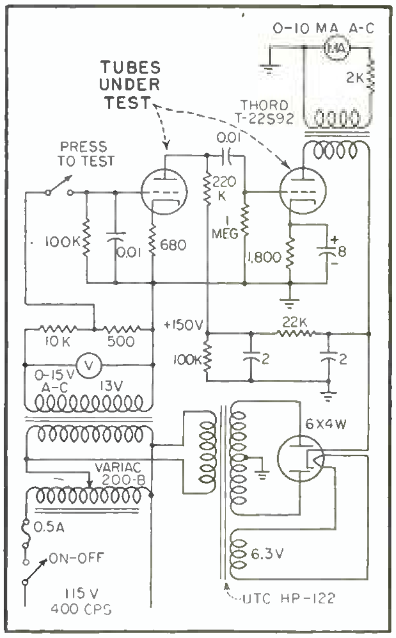


FIG. 1—Circuit arrangement for incoming-inspection test of voltage amplifier tubes for airborne electronic equipment

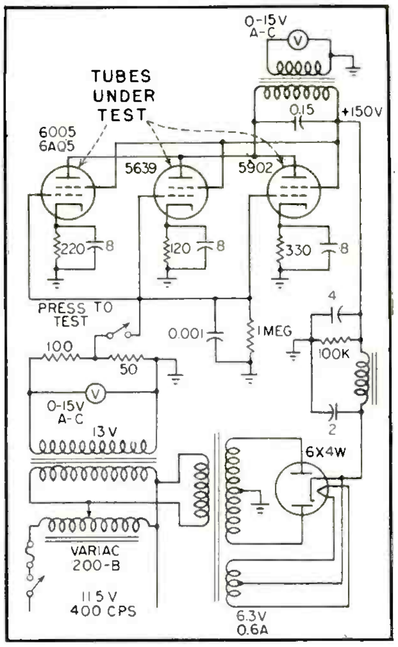
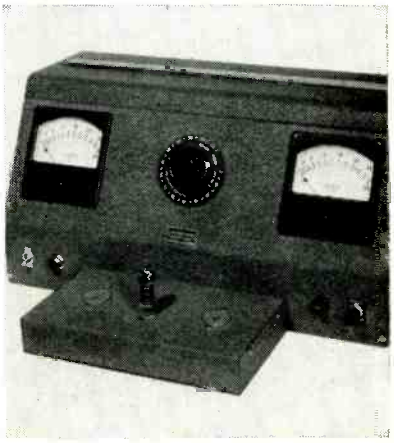


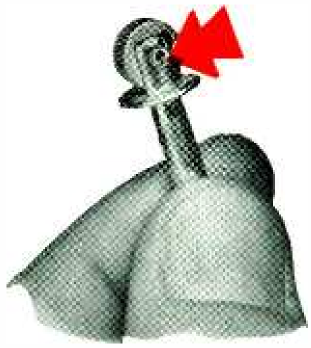
FIG. 2—Test circuit for measuring output of tube for given grid voltage

5719 and 6112 tubes. The tubes are tested as voltage amplifiers, being required to exceed a stated output current through a load resistance when a given input voltage is applied.

By a multiple socket arrangement, single triodes are tested in pairs (one of the pair may be a known good tube used as a standard). Dual triodes are tested by cascading the two triode sections. A Variac is used to control the voltage across the secondary of the input transformer and the power transformer; setting this voltage automatically provides the correct operating voltages throughout the unit. Octal sockets are provided to take the proper Sylvania adapt-

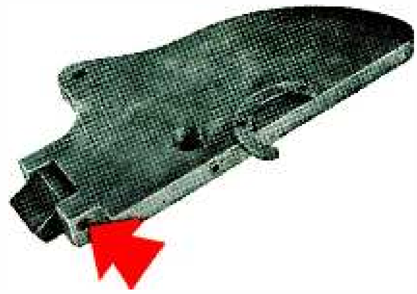


Tube test setup using circuit of Fig. 2

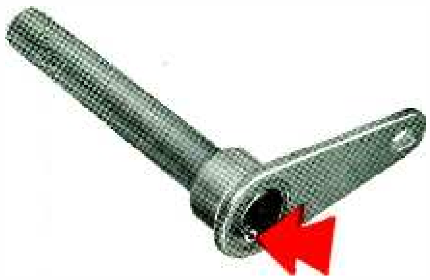


AS A SHAFT . . . Rollpin serves as an axle for the sparkwheel of a cigarette lighter. No riveting or threading necessary . . . faster assembly. Note flush, clean fit.

AS A DOWEL . . . Rollpin is used here to prevent rotation of a thrust bearing. No reaming, no special locking. Easily removed. Lowest possible dowel pin cost.



AS A CLEVIS PIN . . . here Rollpin holds firmly in clevis, permits free action of moving member. Rollpin application above is with the plate of a home workshop tool.



AS A KEY . . . Rollpin demonstrates its ability to do away with precision tolerances, in this heating system damper arm. Faster, cheaper and more satisfactory than usual assemblies.

AS A STOP PIN . . . in this application, Rollpin is shown in a ratchet wrench adaptor. With its light weight and high shear strength, Rollpin functions perfectly . . . cuts assembly costs.

AS A SIMPLE FASTENER . . . Rollpin replaces a set screw in pinning a gear to a shaft. Assembly time is shorter, service life longer. Vibration-proof flush fit. Easily removable.

YOUR IMPORTANT FASTENING JOBS

are cheaper . . . faster, with ROLLPIN

TRADE MARK

Rollpin is a pressed-fit pin with chamfered ends. It drives easily into holes drilled to normal tolerances, compressing as driven. No reaming, no tapering, no extra assembly steps required. Rollpin fits flush, *locked* in place by the constant pressure it exerts against the hole walls. Can be inserted with automatic press, or by hand—removable with a drift or pin punch.

Rollpin is reusable again and again.

Elastic Stop Nuts with the famous red collar are another ESNA product

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MAIL COUPON TODAY. If your present operations or plans include the above applications—or set screws, rivets, hinge pins, cotter pins, pivot pins, taper pins—you can't afford to be without complete details on Rollpin. Write now—find out how much faster and cheaper Rollpin can do the job.

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Please send me the following free information on ESNA self-locking fasteners:

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☐ Elastic Stop Nut Bulletin ☐ Here is a drawing of our product. What fastener do you recommend?

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City______________ Zone_____ State________ ers for testing subminiature types. A pin straightener is used by personnel of the incoming inspection department to insure that the miniature types will not damage the sockets in the test unit or in the aircraft fuel gage equipment for which the tubes are intended.

The somewhat similar test unit in Fig. 2 is used to check types 6005, 6AQ5W, 5902 and 5639 tubes. The output voltmeter measures the actual power output delivered by the tube for a given grid voltage. The operator inserts the tube, allows a minute or so warmup time, presses the pushbutton and notes the output power reading.

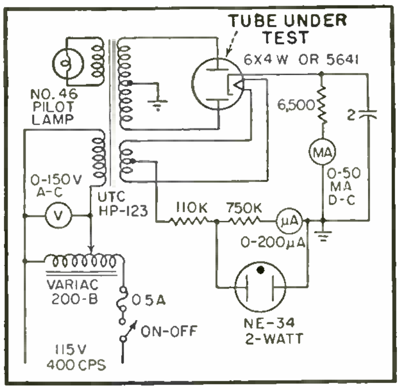

FIG. 3—Simple test circuit for checking 6X4W ruggedized and 5641 Arinc rectifier tubes

The input signal voltmeter, when correctly set by means of the Variac, insures the correct voltages elsewhere in the unit.

For checking 6X4W and 5641 rectifiers, the circuit of Fig. 3 is used. Correct operating voltages are set with an input voltmeter and Variac, and the total cathode emission is measured with an 0-50 ma meter. Heater-to-cathode leakage, which should not exceed 10 microamperes in this circuit, is indicated on the microammeter. This meter would be damaged by a heater-to-cathode short or even excessive leakage, so two resistors and a neon lamp are incorporated as a protective circuit for the meter.

In operation, the microammeter indicates actual leakage currents up to 100 μa. If these currents exceed that amount, the lamp fires and shunts most of the current around the meter. The only alternative would have been to place

a fuse in series with the meter. Then, however, if a blown fuse from a heater-cathode short was undetected by the operator, all successive tubes checked would indicate no heater-cathode leakage. The magnitude of this leakage is quite important to the proper functioning of the electronic fuel gage, for the rectifier tubes are operated with one side of the heater grounded, which gives 150 v between heater and cathode.

Actual construction of all three tube test units was done by Arthur Hull.

Mica-Sorting Fan

MICA WAFERS for tubes are sorted as to thickness by a blast of air at the RCA Tube Department's Harrison, N. J., plant. The punched out wafers are fed onto a conveyor belt that carries them to the top of the sorting machine. As wafers fall off the belt at the top, they drop into a constant stream of air produced by a powerful electric fan. This air stream distributes the falling micas according to their weight and resistance to air, so that only those with the proper

Loading mica spacers into hopper that distributes them over conveyor belt of sorting machine

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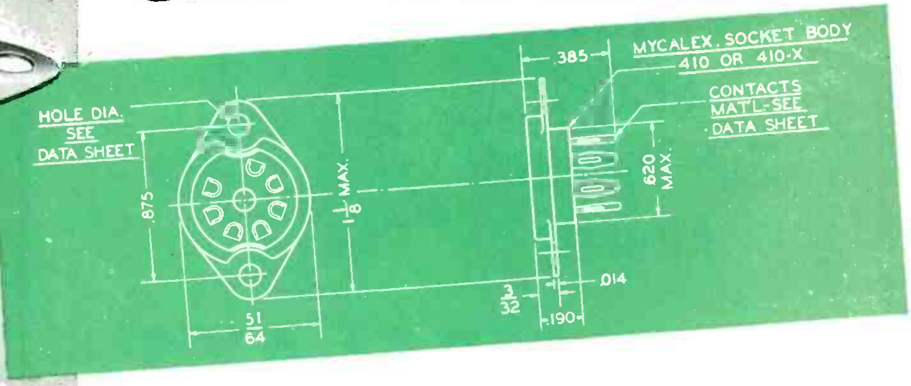

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MYCALEX engineers designed these sockets to provide a complete, yet economical, solution to UHF tube mounting problems. Exhaustive tests have proven their mechanical excellence and high electrical efficiency. The use of "MYCALEX 410" (injection molded glass-bonded mica) with its great dimensional stability permits a minimum amount of dielectric to be used in the body structure. This plus other unique design features results in extremely low inter-electrode capacitance. In addition to its other advantages—high arc resistance, high dielectric strength, non-porosity, etc., "MYCALEX 410" has very low dielectric loss at all frequencies including UHF and thereby offers great advantage over phenolic materials. "MYCALEX 410" operates continuously in temperatures up to 650°F with practically no change in electrical properties or mechanical structure. Soldering operations will not cause body distortion.

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TROUBLE-FREE CONTACT TERMINALS!

Contact terminals on these sockets are so designed that the effective inductance from soldered connection to the tube base is no greater than if the connection was made directly to the tube pin. Special design results in high contact area pressure that effectively reduces contact resistance. Contact terminals are secured in the body in a manner that permits 90° bending of the tab without weakening.

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dimensions are collected in the main bin. Those that are too thick or too thin fall into their respective reject bins.

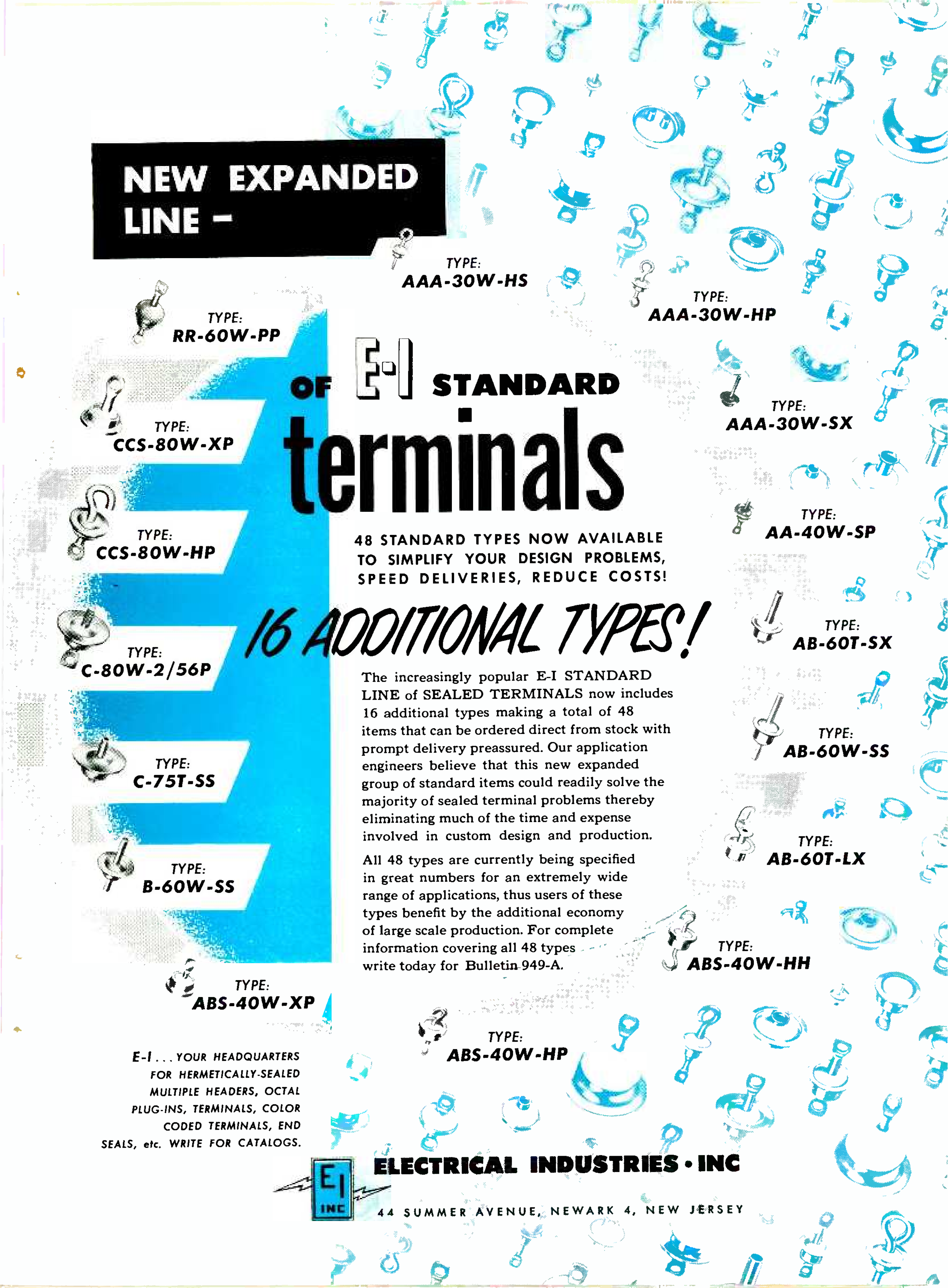
Electronic Attenuator

ALIGNMENT of receivers while moving past the operator on a conveyor is facilitated by use of electronic attenuation at Philco. The technique keeps signal level at a low constant level while trimmers are peaked, eliminating need for turning down gain controls of signal generators during i-f alignment.

The tone-modulated 455-kc signal is fed directly to the stator of the antenna section of the tuning gang through a 0.1-μf capacitor in a connecting jig that can be fitted over the tuning capacitor frame in one easy motion. Voice-coil voltage of a dummy loudspeaker is fed through a diode rectifier to a d-c voltmeter that is watched by the operator while adjusting the six i-f trimmers in turn to resonance. The rectified voltage is also used to control the bias voltages of a two-stage r-f amplifier inserted between the signal-cage line and the chassis being aligned. Increasing voice coil voltage thus gives greater negative bias on the amplifier, automatically attenuating the input signal.

ROSIN-FUME FAN

Fan running in reverse pulls soldering fumes away from operator's nose at each soldering position on CBS-Columbia television assembly line in Brooklyn. Simple hardware-cloth cage gives more protection than ordinary fan guard. Fan action can be reversed by putting fan on motor shaft backward or by rebending fan blades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TYPE: AA-40W-SP
TYPE: C-80W-2/56P
TYPE: AB-60T-SX
TYPE: AB-60W-SS
TYPE: C-75T-SS
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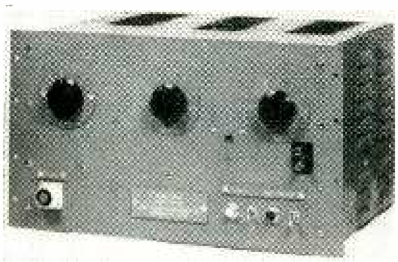
NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

Recently Developed Test Instruments, New Materials and Components and Controlled Characteristic Power Supplies Are Described . . . Thirty-three Trade Bulletins Are Reviewed Under *Literature* (p 295)



Precision Power Supplies

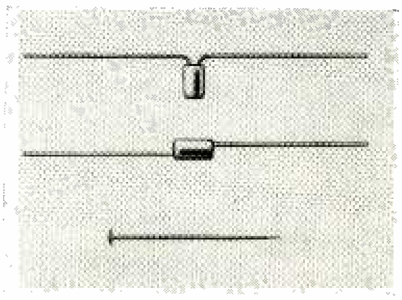
JOHN FLUKE ENGINEERING CO., P. O. Box 755, Springdale, Conn. Series 400 precision d-c power supplies are especially designed to meet nucleonic needs. Typical models are the 400B and 400C, the former with an output voltage from 1,000 to 5,000, and the latter from 500 to 1,500. Both are rated 1 ma and hold their output voltages constant to ± 0.01 percent short term, and to ± 0.1 percent per day. Noise and hum do not exceed 0.01 percent of the lowest output voltage.

Electrometer

SPECIAL INSTRUMENTS LABORATORY, INC., 1003 Highland Ave., Knoxville, Tenn. Model 145 electrometer is a-c operated and features direct measurement on a panel meter of d-c potentials from 0 to 150 mv. Special modification to give full scale deflection of 30 mv is available. Input impedance of 10^9, 10^{10}, 10^{11} or 10^{12} ohms may be selected. All useful circuit points are available through panel connectors, and provision is made for connection to a strip chart recorder.

Tubular Paper Capacitors

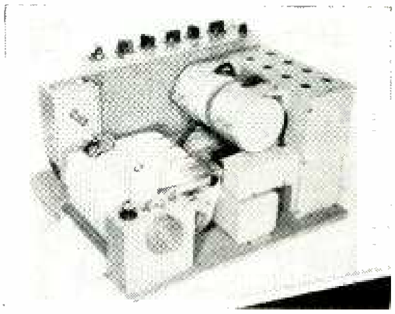
PYRAMID ELECTRIC CO., 1445 Hudson Blvd., North Bergen, N. J., is producing a new type of molded tubular paper capacitor, embodying several extremely rugged characteristics. The "Imps" are molded of thermosetting plastic which renders the capacitor impervious to moisture and capable of operating at temperatures ranging from −40 to + 100 C. Each section is noninductively wound, and is available in capacitance values ranging from 0.00025 μf to 0.5 μf in 200 and 400 volt ratings, and from 0.00025 μf to 0.25 μf in a 600-volt rating.



Selenium Diodes

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif., has developed a line of subminiature selenium diodes designed for stable operation in an ambient temperature range of −60 to +100 C. Type 1T1 measures 1/8 in. in diameter and 1/4 in. long. They are currently available for output voltages of 20, 40, 60 and 80 v at average output currents of 200 μa and 1.5 ma. Some of the uses for these diodes are: bias supplies, sensitive relays, digital and analog computers, hearing aids, electronic organs and many compact airborne electronic equipments.

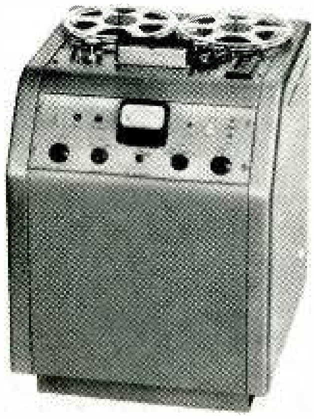
OTHER DEPARTMENTS
featured in this issue:



Recorder-Amplifier

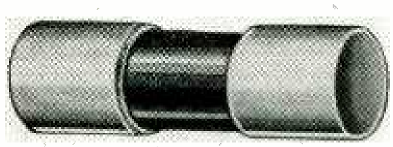
RAHM INSTRUMENTS INC., 12 West Broadway, New York 7, N. Y. Type R03-E6-1 is a multichannel system providing 9 channels for direct recording of transient phenomena. The instrument is suited for telemetering problems where in a 0 to 20-cps flat frequency response is re-quired. Three signal channels utilizing a 40-mm chart grid width are provided. Five channels are supplied for off-on functions and one channel is assigned to an integral time pulse generator. Features of the instrument include a stylus motor system which permits operation in any plane, six-speed semiautomatic chart drive and auto-

matic reroll mechanism. The complete unit is contained on a chassis 11 in. x $18\frac{3}{4}$ in. x $11\frac{1}{2}$ in.



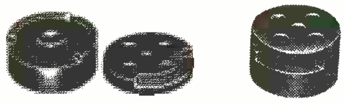
Recorder Console

AMPEX ELECTRIC CORP., Redwood City, Calif., announces a new dual-speed console for audio magnetic recording. Features include all pushbutton control and a built-in microphone preamplifier. It has 15,000-cps response at the $7\frac{1}{2}$-in. speed. At present two models are available: the model 402 has half-track heads, and model 403 utilizes the full width of standard quarter-inch tape. Complete details and specifications are available for the writing.



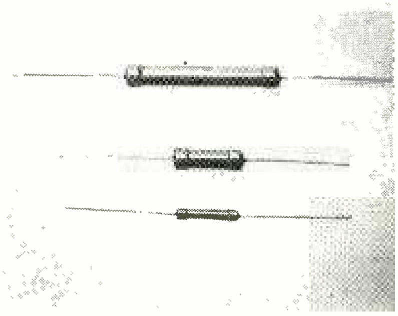
Resistor

TELEWAVE LABORATORIES, INC., 100 Metropolitan Ave., Brooklyn, N. Y., announces its type R resistor, a stable, metal film on glass resistor, for microwave applications. It is ideal for power measurements, resistive pickup loops, pads, impedance matching, attenuators, in both waveguide and coax. An application note is available describing suggested uses of this resistor.



Adjustable Cup Cores

GENERAL CERAMICS AND STEATITE CORP., Keasbey, N. J., announces a new line of adjustable cup cores made of high efficiency Ferramic materials suitable for frequencies from low audio up to 1500 mc with Q values to 300. Both core and cover illustrated are notched on the outside circumference. Angular displacement of one piece with respect to the other will change the effective permeability and therefore the inductance of the coil through a range of 20 percent. Sizes of these cores range from 0.5 in. to 1.5 in. with 11 variations available. Maximum inductance obtainable with the larger size is approximately 20 henries. Complete dimensional and other data will be supplied on request.

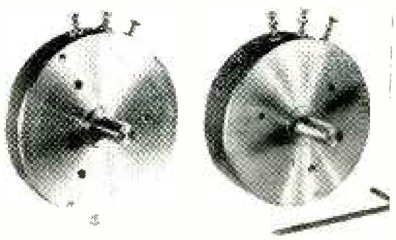


Deposited Carbon Resistors

DALE PRODUCTS, INC., Columbus, Nebraska, are offering a line of deposited carbon resistors in three resistance ranges: 50 ohms to 5 megohms, 50 ohms to 10 megohms, and 100 ohms to 50 megohms. Temperature coefficients vary only slightly—140 to 500 parts per million per deg C, depending upon resistance. Voltage coefficient is less than 0.002 percent per volt with the average coefficient about 0.0012 percent. Resistors are supplied with 1-percent tolerance and are calibrated at 25 deg. C. If such precision is not required, resistors can be supplied with tolerances of 2 percent and 5 percent.

TV Receiver Tube

SYLVANIA ELECTRIC PRODUCTS, INC., 1740 Broadway, New York 19, N. Y. A new high-perveance double triode designed for vertical deflection and oscillator service in tv receivers has been announced. The type 6BX7GT is $1\frac{9}{32}$ in. in diameter, $3\frac{5}{16}$ in. long, and $2\frac{3}{4}$ in. high when seated. Electrical characteristics include: heater volts, 6.3; heater current, 1.5 amperes; plate volts (each section), 250; plate current (each section), 42 ma; plate resistance, 1,300 ohms; transconductance, 7,600 micromhos; and amplification factor, 10.



Miniature Potentiometers

AVION INSTRUMENT CORP., 299 State Highway No. 17, Paramus, N. J., is offering a line of precision potentiometers of miniaturized computing type, available as single units or ganged assemblies. Series N potentiometers cover linear windings and those nonlinear functions which can be fitted by tapping and shunting techniques. Series C incorporates a cam-corrector which makes possible accurate fitting of

TIME DELAY...

matched to your specific circuit protection needs

AIRCRAFT MODEL . . . small, light and shock resistant.

TIME DELAY is an essential factor in *any* circuit protection equipment. Yet, only the hydraulic-magnetic operating principle of HEINEMANN Circuit Breakers allow you to select a time delay response curve fitted to the equipment or circuit you are protecting.

Hydraulic-magnetic time delay allows you to start motors and light lamps . . . tolerating the initial current inrush . . . without sacrificing protection of your equipment to any degree.

Choice of three time delay curves are available in HEINEMANN Circuit Breakers to meet your specific needs:

CURVE NO. 1—For motors, allows the characteristic prolonged current inrush period.

CURVE NO. 2—For mixed circuits of lamps and motors.

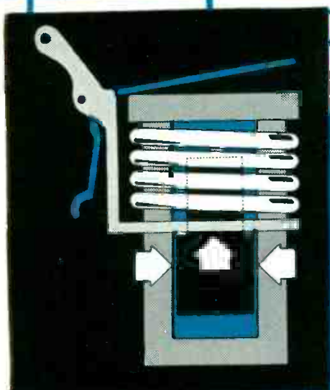
CURVE NO. 3—For electronic equipment, permits high flash inrush but then provides extremely sensitive protection against overloads and short circuits.

Only this hydraulic-magnetic principle gives you such positive performance under all conditions. HEINEMANN Circuit Breakers always trip instantaneously at 10 times rated current . . . regardless of ambient temperature. Performance standards less than these are a sacrifice of protection for your equipment.

don't use heat... *USE POWER*

PANELBOARD MODEL . . . compact and economical.

GENERAL PURPOSE MODEL . . . rugged for industrial service.



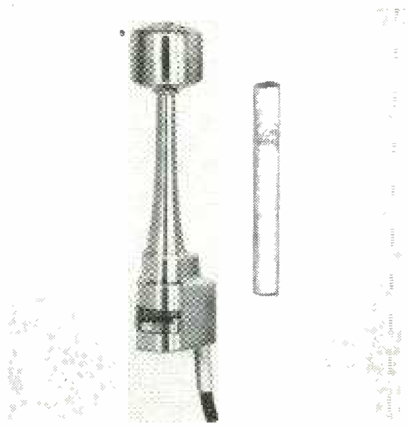
TIME DELAY is provided by a hermetically sealed, hydraulic-magnetic element. On small overloads the delay is provided while the movable core is drawn toward the pole piece, increasing magnetic flux to trip the circuit breaker. On short circuits, the core is not a factor and tripping is instantaneous. Between these extremes the delay is proportioned to the overload in accordance with the time delay curve selected.

Send for Bulletin SW.

HEINEMANN ELECTRIC CO.
97 PLUM ST., TRENTON 2, N. J.

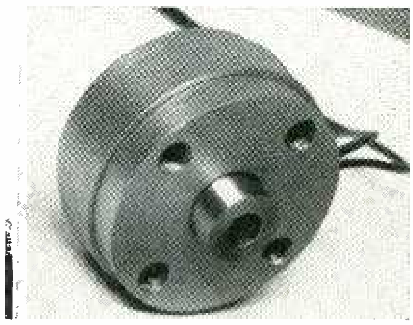
HEINEMANN Circuit Breakers

HEINEMANN Circuit Breakers... One, two and three pole... 10 milliamps to 100 amperes an additional class of more difficult functions. Both types may be ganged separately or intermixed. Accuracy for linear functions is ± 0.1 percent, for nonlinear, ± 0.25 percent.



Crystal Microphone

THE TURNER CO., Cedar Rapids, Iowa. Model 80 crystal microphone features miniature styling and versatility. Frequency response is 80 to 7,000 cps with sensitivity of approximately 58 db below 1 volt per dyne per sq. cm.



Synchronous Brake

ALLARD INSTRUMENT CORP., 30 Broad St., New York, N. Y. Developed for lightweight, airborne instrumentation, the synchronous brake supplies a means for controlling speed of a rotating device. Motive power is derived from a motor running a little above the maximum speed desired. The brake, interposed between motor and load, is actuated by signals of the desired frequency from a vacuum-tube amplifier. The brake mechanism is phase sensitive and has no 180-degree ambiguity. Several devices each equipped with

he's working for you

THIS FELLOW IS TRAINED IN YOUR BUSINESS. His main duty is to travel the country — and world — penetrating the plants, laboratories and management councils . . . reporting back to you every significant innovation in technology, selling tactics, management strategy. He functions as your all-seeing, all-hearing, all-reporting business communications system.

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

its own brake, can be driven at different speeds from a common shaft.

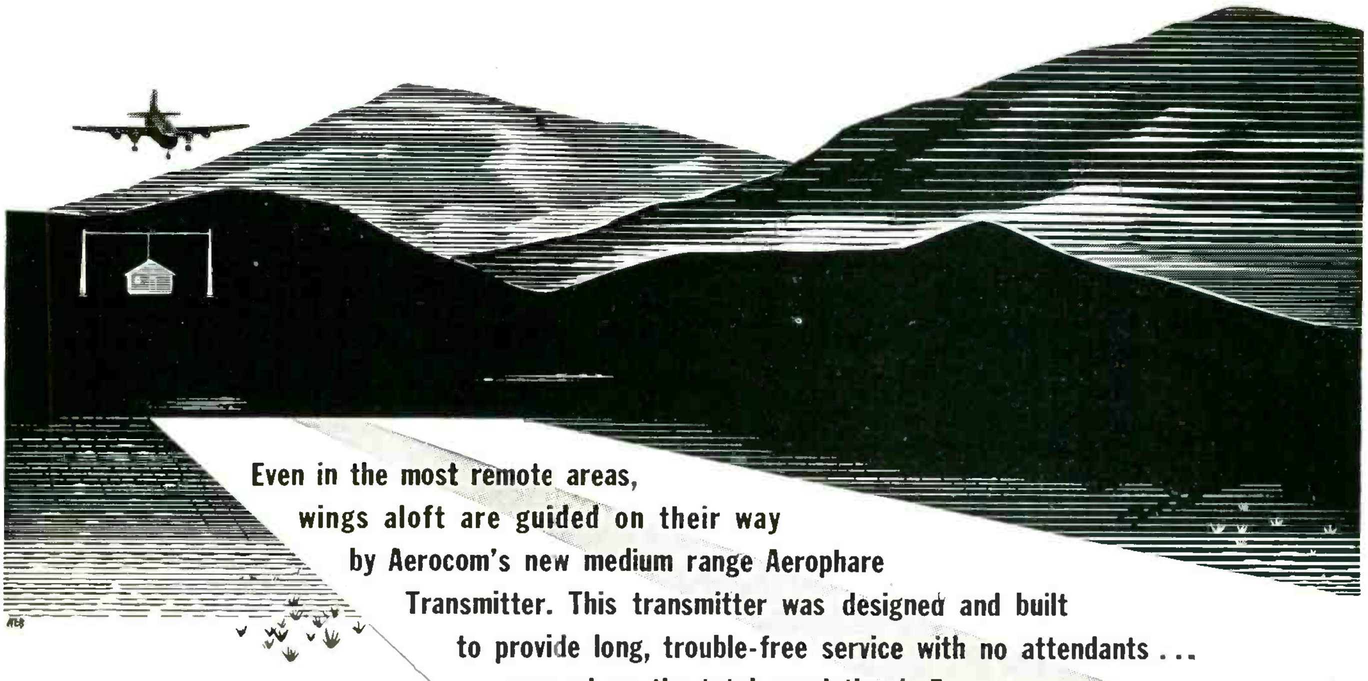
Nylon Tip Jacks

E. F. JOHNSON CO., Waseca, Minn., announce their new line of Nylon insulated tip jacks. Breakdown rating is 11,000 v. Nominal capacitance to ⅛-in. panel is 2.0 μμf. Silver plated contacts, either phosphor bronze or beryllium copper, are supplied. Accepting 0.081-in. diameter pins, engagement is positive insuring low contact resistance. Minimum withdrawal force is 1 lb. Integral solder terminals are hot tin dipped.

Constant Current Supply

WESTON ELECTRICAL INSTRUMENT CORP., 617 Frelinghuysen Ave., Newark 5, N. J. Model 50220 constant-current supply provides a steady d-c source from an a-c line. Designed primarily for use with potentiometer indicators, recorders and controllers, where automatic standardization is not feasible or where use of batteries is not desirable, it is also used with resistance thermometers, strain gages or other devices requiring a constant d-c current. The standard unit is designed for a 10-ma output at 1.4 v d-c and provides a current with a high degree of stability to well within the limitation of ±0.1 per-

POPULATION-O



AEROCOM'S

Dual Automatic Package-Type Radio Beacon

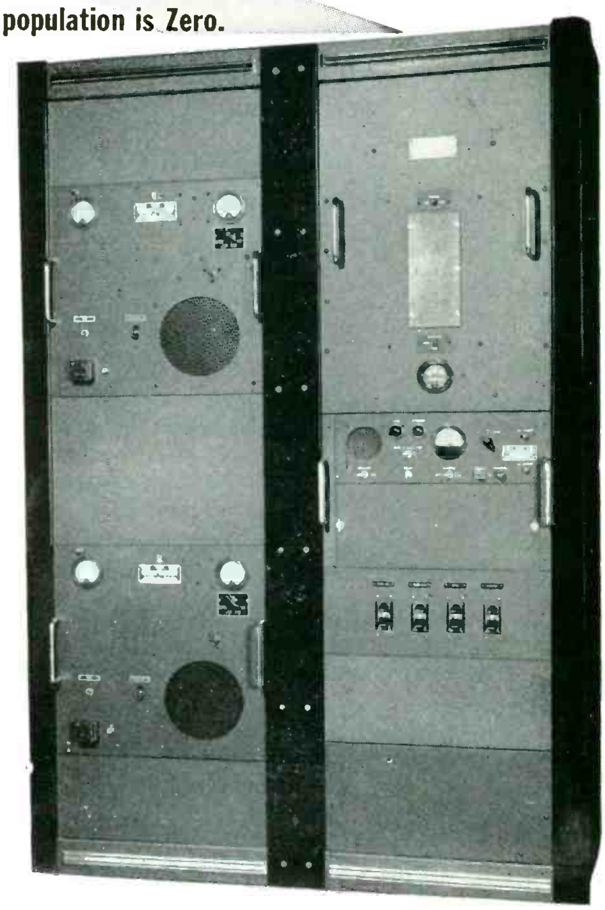
for completely unattended service. This aerophare (illustrated) consists of two 100 watt (or 50 watt) transmitters with keyer, automatic transfer and antenna tuner. (Power needed 110 or 220 volt — 50/60 cycles, 520 V.A. for 50 watt, 630 V.A. for 100 watt.)

Frequency range 200 — 415 kcs.: self-contained P.A. coil and "plug-in" crystal oscillator coil cover entire range. (Self-excited oscillator coils covering 200-290 and 290-415 kcs. are available.) High level plate modulation of final amplifier is used, giving 40% tone modulation in 100 watt transmitter and 60% in 50 watt model. Microphone P-T switch interrupts tone, permitting voice operation.

This unit can be operated in air temperature range 0°C to + 45°C using 866A rectifiers, or from — 35°C to + 45°C using 3B25 rectifiers; humidity up to 95%.

The "stand-by" transmitter is selected when main transmitter suffers loss (or low level) of carrier power or modulation. Audible indication in monitoring receiver tells which transmitter is in operation.

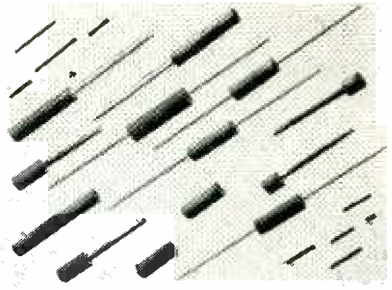
Unit is ruggedly constructed and conservatively rated, providing low operating and maintenance costs.



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

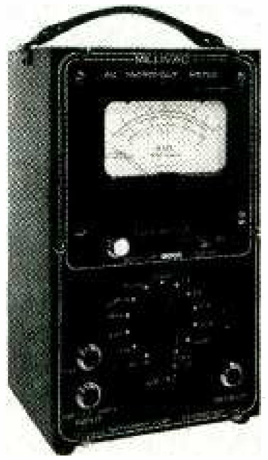
3090 DOUGLAS ROAD MIAMI 33, FLA.

cent. Its special compensated feedback circuit allows a flat-current characteristic over an input voltage range of 80 to 140 v.



Ferrite Core Kit

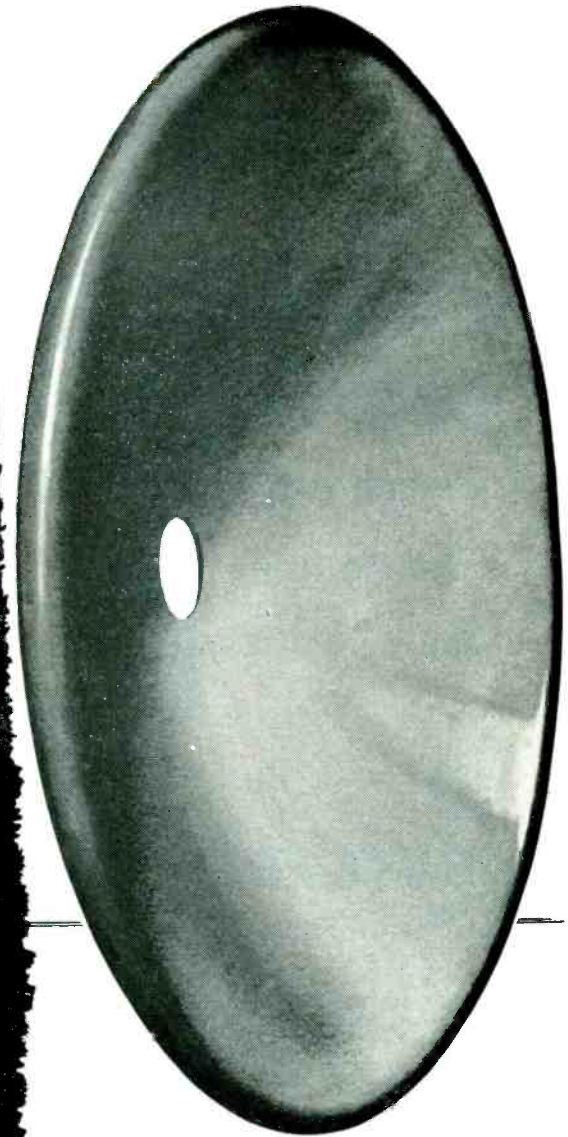
GRAYBURNE CORP., 103 Lafayette St., New York 13, N. Y. Type FCK Ferrite core kit consists of 27 various-sized cores which are well adapted for experimentation in i-f, r-f coils, solenoids, linearity, width and other variable controls, and in many electromechanical applications.



A-C VTVM

MILLIVAC INSTRUMENT CORP., 444 Second St., Schenectady 6, N. Y., has announced a new low-frequency voltmeter designed to satisfy both linear and logarithmic scale requirements. The new dial used in the MV-12A a-c voltmeter features zero suppression of its linear voltage scale. This spreads the logarithmic decibel divisions sufficiently to avoid congestion beyond a point where accurate reading would be difficult. Another feature of the meter is its high sensitivity and

your choice of over 50 "dishes"



The extensive WORKSHOP chucks and dies are now available to you . . . to give you parabolic reflectors — "dishes" — in the widest range of diameters and focal lengths in the industry.

Sizes range from 4" diameter, 1.26" focal length, to 120" diameter, 35.8" focal length. Modifications of standard sizes on request.

If you manufacture or experiment with microwave, there is an economically priced WORKSHOP reflector for you. Write for complete listing of standard sizes.

for example

WORKSHOP has slashed "dish" costs by perfecting a new stamping technique that holds close tolerances. Now available in 4 foot diameter, 18" focal length.

- ±.015" surface tolerance
- 1/8" thick 2SO aluminum
- rolled rim
- supplied unfinished

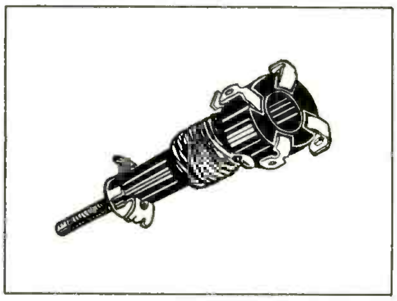
Model 48-18-ST, only $40.00 each f.o.b. Ashtabula, Ohio—quantity prices on request.

WORKSHOP ASSOCIATES DIVISION

THE GABRIEL COMPANY

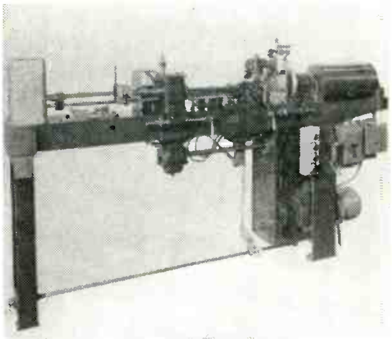
Endicott Street • Norwood, Mass.

Designers and Manufacturers of a complete line of microwave antennas wide voltage range (0.7 μv to 1,000 v). Its frequency range is 20 cycles to 250 kc.



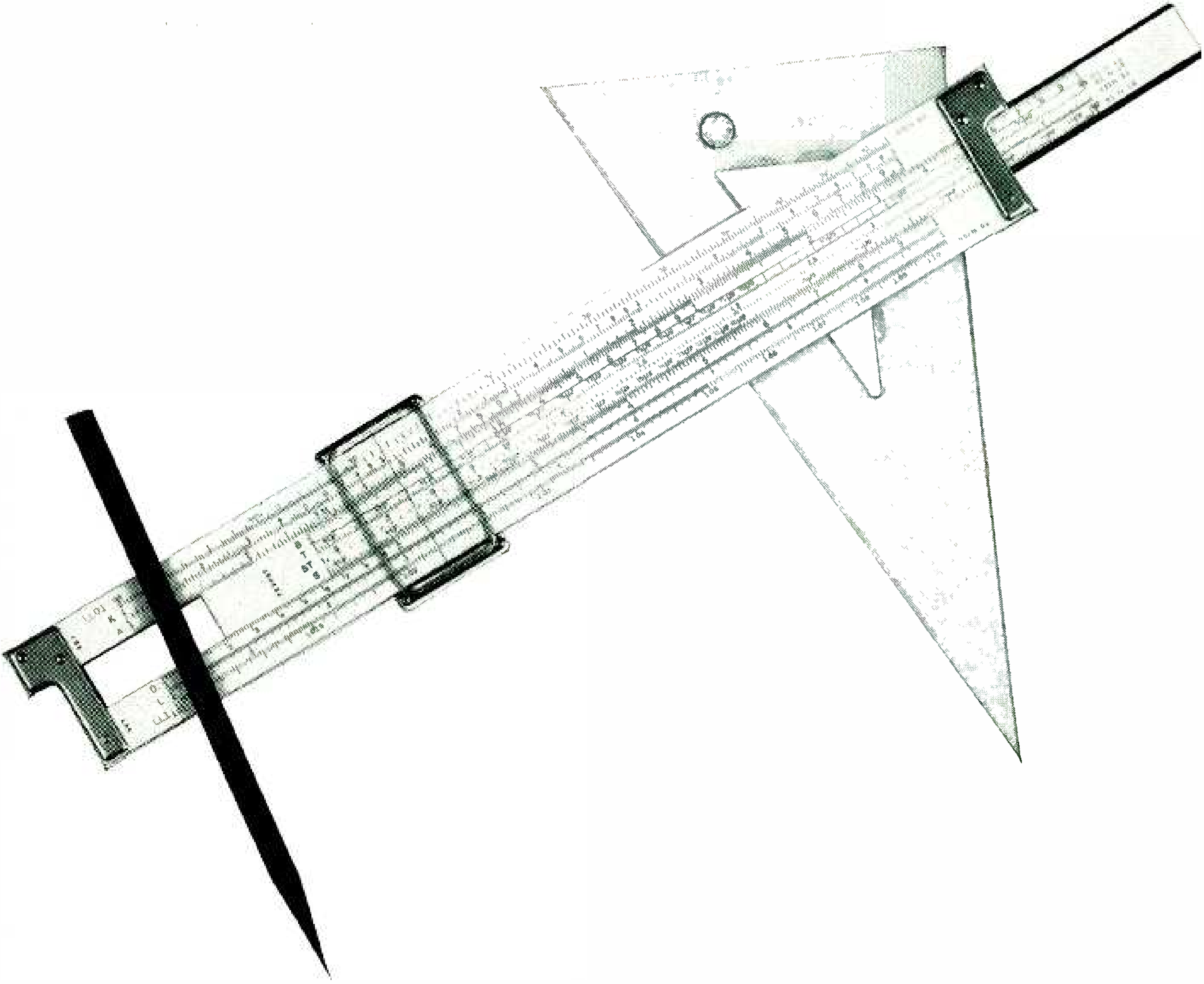
Variable Inductance Coils

NORTH HILLS ELECTRIC CO., Box 427, Great Neck, N. Y., has announced a new series of variable inductance coils covering the 2-to-180-μh range completely. Designed for such applications as video peaking, r-f and i-f amplifiers and filter networks, these coils feature compact plastic forms, four rugged terminals (two of which may be used as separate tiepoints), and durable windings.



Grid Winding Machine

KAHLE ENGINEERING CO., 1323 Seventh St., North Bergen, N. J. Especially designed to produce higher pitches, up to 500 turns per in., this semiautomatic grid winder is sturdily constructed for vibration-free operation and increased durability. Provision is made for variable pitch and for swaging the side wires. Accurate stop and start positioning is achieved by brake motor and pushbutton control. The pneumatic cutter rises and disappears automatically leaving the work field clear for complete accessibility. Because the lead screw nut is never disengaged grid wind-



You'll find classmates—and a future—at Boeing!

Men from more than 120 top engineering schools are building rewarding careers at Boeing. So chances are, you'd be working with some of your classmates here. And you'd be a member of an Engineering Division that has earned world-wide renown for its trail-blazing contributions to both military and civil aviation.

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There are opportunities at Boeing for experienced and junior engineers in all fields, for aircraft

- **DESIGN**
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also for servo-mechanism and electronics designers and analysts, and for physicists and mathematicians with advanced degrees.

You can work in Seattle, in the Pacific Northwest, or in Wichita, Kansas. Boeing provides a generous moving and travel allowance, gives you special training, and pays a good salary that grows with you.

You'll be proud to say, "I'm a *Boeing* engineer!"

Write today to the address below, or use the convenient coupon.

JOHN C. SANDERS, Staff Engineer—Personnel
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Boeing Airplane Company, Seattle 14, Wash.

Engineering opportunities at Boeing interest me. Please send me further information.

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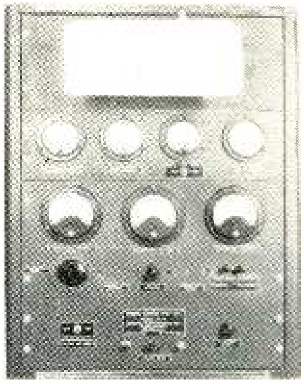
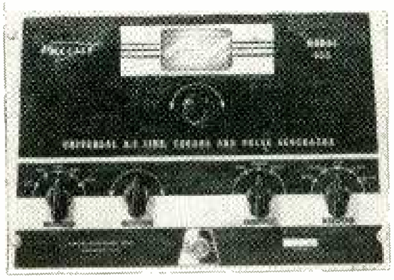
ing is always in perfect register. The machine is fully geared without the use of ratchet-pawl.



Power Output Tester

GENERAL ELECTROSONICS, INC., 32 W. 22nd St., New York 10, N. Y. Model TS-4 power output test set is designed to measure the useful r-f power output of any vacuum-tube oscillator, including miniature and subminiature types, capable of delivering 1 watt of power or less. It features variable filament and regulated plate supplies, provision for use of an external r-f bridge and a self-contained calibration circuit. Dimensions are 28 in. high × 21 in. wide × 15 in. deep.



Multigenerator

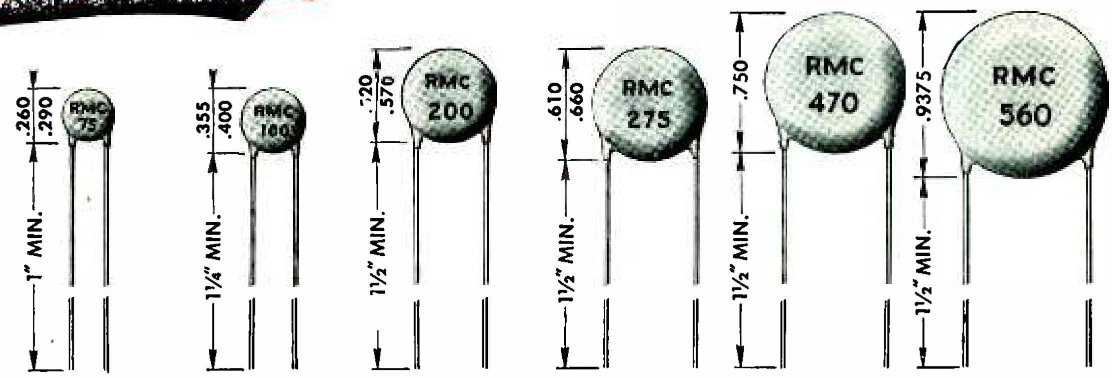
PRECISE DEVELOPMENT CORP., Oceanside, N. Y., has announced the model 635-Universal a-f sine, square and pulse generator, designed to ascertain all audio and video troubles. Among its attributes are: Wien bridge oscillator; sine waves; square waves; pulses variable-impedance output; voltage regulation to insure a constant output; cathode-follower output; minimum overshoot and round-off through 30,000 cycles on square waves and

NOW RMC

Temperature Compensating as well as By-Pass

DISCAPS®

are Rated at 1000 Working Volts!



TC	1/4 Dia.	5/16 Dia.	1/2 Dia.	5/8 Dia.	3/4 Dia.	7/8 Dia.
P-100	—	2– 9 MMF	10– 30 MMF	—	—	—
NPO	2– 12 MMF	13– 27	28– 60	61– 75 MMF	76–110 MMF	111–150 MMF
N– 33	2– 15	16– 27	28– 60	61– 75	76–110	111–150
N– 80	2– 15	16– 27	28– 60	61– 75	76–110	111–150
N– 150	2– 15	16– 30	31– 60	61– 75	76–110	111–150
N– 220	2– 15	16– 30	31– 75	76–100	101–140	141–190
N– 330	2– 15	16– 30	31– 75	76–100	101–140	141–190
N– 470	2– 20	21– 40	41– 80	80–120	121–170	171–240
N– 750	5– 25	26– 50	51–150	151–200	201–290	291–350
N–1400	15– 50	51–100	101–200	200–250	251–470	480–560
N–2200	47– 75	76–100	101–200	201–275	276–470	471–560

If the samples you need are not here — send for them.

SPECIFICATIONS

POWER FACTOR: LESS THAN .1% AT 1 MEGACYCLE

WORKING VOLTAGE: 1000 VDC TEST VOLTAGE: 2000 VDC

DIELECTRIC CONSTANT: P-100 14K N-750 88K N-2200 265K NPO 35K N1400 165K

CODING: CAPACITY, TOLERANCE AND TC STAMPED ON DISC

INSULATION: DUREZ PHENOLIC—VACUUM WAXED

LEAKAGE RESISTANCE: INITIAL 7500 MEG OHMS AFTER HUMIDITY 1000 MEG OHMS

LEADS: #22 TINNED COPPER (.026 DIA.)

LEAD LENGTH: ¼" BODY 1", 5/16" BODY 1¼", ½" AND LARGER BODY 1½"

TOLERANCES: ±5%, ±10%, ±20%

RMC DISCAPS are Designed to Replace Tubular Ceramic and Mica Condensers at LOWER COST

SEND FOR SAMPLES AND TECHNICAL DATA

DISCAP CERAMIC CONDENSERS

RMC

RADIO MATERIALS CORPORATION

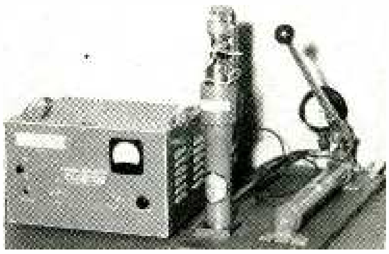
GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.

FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Two RMC Plants Devoted Exclusively to Ceramic Condensers pulses; sine waves through 200,000 cycles; coaxial type fittings and 1.0-percent ceramic resistors.

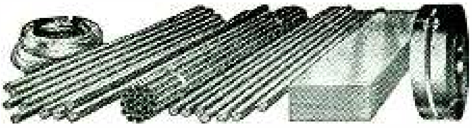
Local Control Unit

BENDIX RADIO, Baltimore 4, Md., has introduced the MS-255A local control unit that resembles an ordinary telephone. The desk-type control unit, which is a part of the Command-Air series of mobile communication equipment, consists of handset, loudspeaker, volume control, squelch control and channel selector in the one unit. An added feature is muting of the speaker to provide for private conversation when handset is removed from base.



Surface-Resistance Indicator

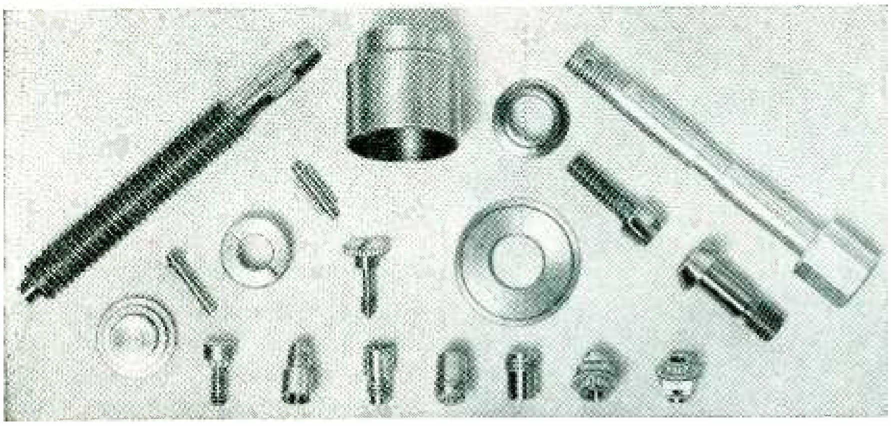
GENERAL ELECTRIC Co., Schenectady 5, N. Y. The portable surface-resistance indicator illustrated was designed to help produce a better resistance welding bond by providing a rapid and accurate measurement of the resistance between pieces of metal to be welded. The instrument supplies a simple check on prewelding cleaning processes, upon which surface resistance of the metal depends. It consists of two parts, a microhmmeter and a sample holder. The unit has two ranges: 0 to 200 and 0 to 2,000 microhms. The measured resistance is indicated directly in



BRIDGEPORT BRASS COMPANY

COPPER ALLOY BULLETIN

"Bridgeport" BRASS CO. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL



Precision-made automatic screw machine products—
Courtesy Senese Manufacturing Company, Inc., Bridgeport, Conn.

Making Precision Quality Screw Machine Items from Brass

Many companies shy away from taking on an extremely "fussy" screw machine job which calls for close tolerances and numerous gauge and visual inspections, although it may have long run possibilities. However, if the company decides to tackle it, and the job is finally developed, the rewards will more than pay for the long hours spent in experimental work.

Among the essentials for successful operation of precision jobs are:

1. A company policy committed to making precision quality. It must be willing to set up an inspection department with the necessarily large investment in special gauges and equipment.

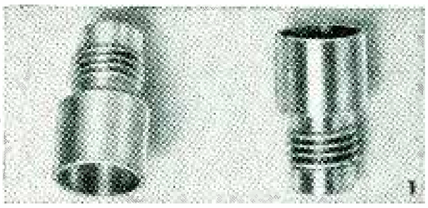
2. Screw machines must be in perfect order. Although new machines are preferred, old ones will serve if they are first properly rebuilt, then carefully maintained.

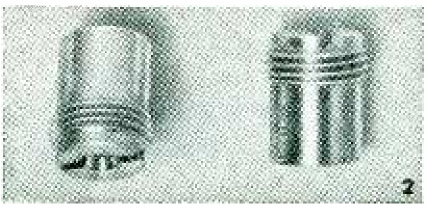
3. Prompt notification to the operator if the work deviates even slightly from specifications. A trained inspector should sample the work from the machine at regular intervals. After putting parts through the necessary gauging and visual inspections, he reports his findings to the operator.

Carbide tools are a "must" to maintain the close tolerance requirements on long runs. "Fussy" jobs should be run at moderate speeds and special attention should be given to produce a smooth, clean finish.

Items 1 & 2. The delay element illustrated here easily come under the "fussy" classification. The delay holder requires 17 gauge and 5 visual inspections while the primer holder must pass 23 gauge and 8 visual inspections.

All of the operations are made on single spindle No. 00 Brown & Sharpe machines with a spindle speed of about 3800 rpm. Deburring is done as a secondary operation.

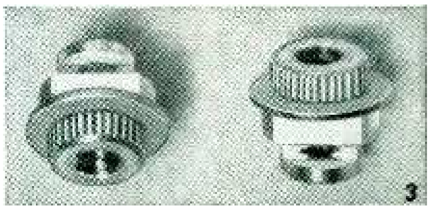


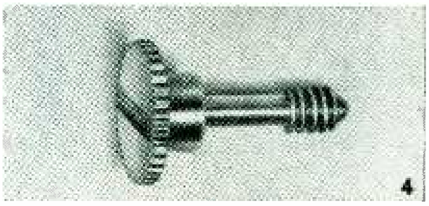


Item 3 is also difficult to make. It has knurl on one end and a threaded hole through the center. The milling on the side is done as a secondary operation.

Item 4 is also an unusual job as it is completely finished on the screw machine. In addition to knurling, the head is also slotted.

Precision screw machine items require dependable quality brass rod for maximum operating efficiency. Freedom from defects is one of the essentials. In Bridgeport mills, accuracy in

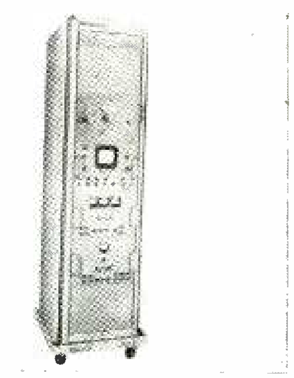




gauge and smoothness of surface result from the use of carbide drawing dies. Straightness is also desirable; consequently the rods should be properly stored if not immediately used.

Bridgeport's laboratory works closely with metal fabricators. Although the standard free turning brass rod alloy No. 6 (61% copper, 3.4% lead, and remainder zinc), meets about 90 per cent of requirements, certain items may require a modification in temper, or possibly a change in alloy. For conditions requiring machining plus some cold working operations such as roll threading, knurling, forming or expanding too severe for Ledrite standard, we supply Ledrite 2, Medium Leaded (approximately 63% copper, 1.8% lead, remainder zinc). Naval brass 24 (approximately 60% copper, 0.65% tin, remainder zinc) may be required to resist sea-water corrosion. This alloy can also be supplied with 0.6% lead (Alloy 28) or with 1.75% lead (Alloy 29) without materially affecting the corrosion resisting properties. (8622)

microhms on a linear 100-division scale. Voltage fluctuations in the supply mains do not affect the reading.



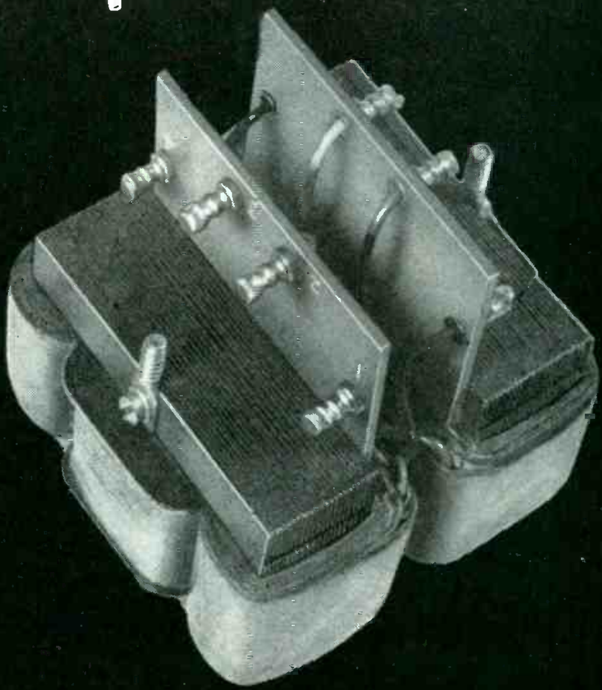
Spectrum Analyzer

POLARAD ELECTRONICS CORP., 100 Metropolitan Ave., Brooklyn 11, N. Y., announces a new and improved all-band direct-reading spectum analyzer, covering the frequency range from 10 mc to 21,000 mc. This range is covered by means of four tuning units. Its features include continuous unidial tuning over the entire range with 5-kc resolution at all frequencies. The frequency can be read to an accuracy of 1 percent and dispersion is independent of frequency and available from 250 kc to 25 mc. A frequency marker is provided to measure frequency differences from 0 to 25 mc. The microwave tuning units use the latest design nonconducting shorts to insure accurate resettability and long mechanical life.

Sampling Switch

APPLIED SCIENCE CORP., P. O. Box 44, Princeton, N. J., has announced a new type of sampling switch for zero drift correction of d-c amplifiers in analog computers. Motor-driven, the switch makes possible the use of one a-c amplifier alone for zero correction and gain im-

MAGNETIC AMPLIFIERS

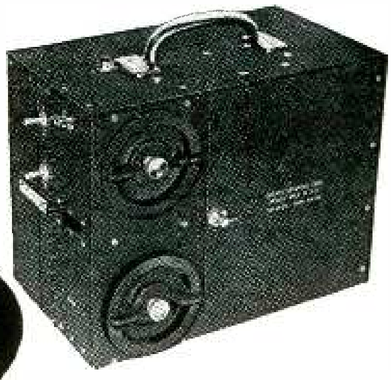


Typical Keystone Magnetic Amplifier, open unit. Also supplied hermetically sealed.

Keystone is noted for its specialization in magnetic amplifiers. No standard "line" . . . rather we build magnetic amplifiers of all sizes, your design or ours. We'll ship them right on schedule, open or hermetically sealed. If magnetic amplifiers for Servo systems are your problem, we'll give your inquiry prompt, intelligent attention. No obligation to consult our engineering department.

KEYSTONE PRODUCTS COMPANY

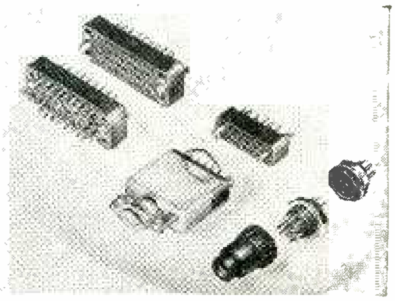
UNION CITY 2, N. J. • UNion 6-5400



provement of as many as 30 d-c computing amplifiers. The unit has two poles with 60 contacts per pole and the sampling rate is 3½ rps. It has intercontact resistance over 1,000 megohms. The design is compact for easy installation and weighs only 7½ lb including the 110-v 60-cycle motor.

Regulated Power Supply

OREGON ELECTRONIC MFG. CO., 2232 E. Burnside St., Portland 15, Ore. Model D4 regulated power supply provides two completely independent outputs each continuously variable from 0 to 400 v with 0.5-percent regulation at loads from 0 to 200 ma. The two outputs may be paralleled to double the output current or put in series to double the output voltage. Also featured are two continuously-variable bias supplies of 0 to −150 v d-c stabilized. Ripple of all outputs in less than 10 mv. Separate meters monitor output voltage and current of each supply.



Multi-Contact Connectors

DE JUR AMSCO CORP., 45-01 Northern Blvd., Long Island City, N. Y., has available a line of miniature precision multicontact connectors. The contacts float in the plug and receptacle, thus insuring selfalignment of the individual contacts. Polarization is unusually positive making engagement possible only in the proper position. These connectors are interchangeable with those now being manufactured by other companies. Features are a molded body of Melamine per MIL-P-14 B type MME; socket contacts of spring temper phosphor bronze; pin contacts brass silver plated. gold flash. Voltage breakdown is

NOW — an expanded metal NESTIER for all dipping, degreasing, cleaning, plating operations

IT NESTS IT TIERS

— performs the same functions as the standard Nestier.

Nestiers nest to save space. Bails prevent complete telescoping, eliminate jamming or sticking. Tiered, bails lock units to form rigid stack. Parts in all units are visible and accessible from either end.

The demand for a Nestier to fulfill the requirements of all dipping operations has led to the design of this new expanded metal basket.

Expanded metal sheet is actually more rigid than an equal weight of solid steel plate or wire mesh. Formed to the distinctive Nestier shape and equipped with Nestier bails and runners, you have a unit which retains not only its original strength but all of the features which have made the Nestier outstanding.

This new Nestier, available in the two standard Nestier sizes, is made of flattened expanded steel mesh, electro-zinc plated, and is interchangeable with the standard Nestier.

EVERY MATERIALS HANDLING ENGINEER WILL WANT THIS BULLETIN

Write for this brochure describing the Nestier System, including complete information on racks, trucks, conveyor hangers and inserts.

Our service includes complete engineering advice to systematize small parts handling in your plant.

SPECIFICATIONS

NesTier	Gauge	Mesh	Length	Width	Weight
No. 220	13-15	5/16" x 1"	22 5/8"	12 1/2"	6 lb. 14 oz.
No. 175	16-18	5/16" x 1"	18 1/16"	9 1/8"	4 lbs.

No. 220 — Cubic content — 880.3 cu. in. Capacity — 200 lbs. each. 5/16" bails will support maximum load of 600 lbs. or 3 tiers of loaded units.

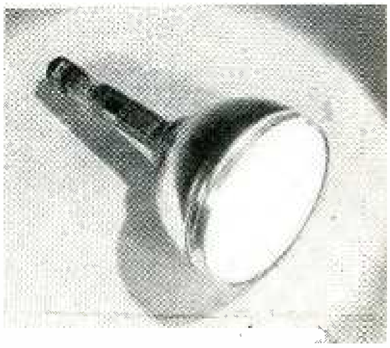
No. 175 — Cubic content — 395.6 cu. in. Capacity — 100 lbs. each. 1/4" bails will support maximum load of 400 lbs. or 4 tiers of loaded units.

THE CHARLES WM. DOEPKE MFG. CO., INC., ROSSMOYNE, OHIO

NESTIER® IT NESTS — IT TIERS

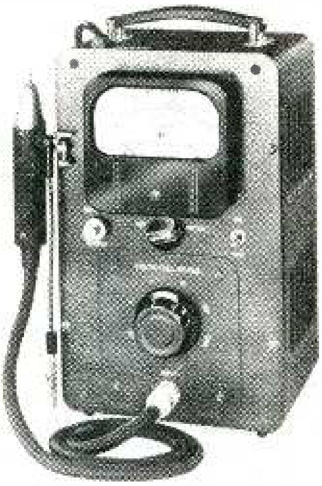
Metal Specialties Division

3,600 v rms; current rating, 5 amperes; and contact size, No. 20 AWG wire.



C-R Tube

GENERAL ELECTRIC CO., Schenectady 5, N. Y., has announced development of a new c-r tube, type 7UP7, for radar indicator service. It employs magnetic focus and magnetic deflection and can be used as a replacement for the 7BP7 or the 7BP7-A. Use of a reflective aluminized screen reduces undesirable screen charging, permitting more accurate plotting directly from the face of the tube. It also uses an improved anode contact design aimed at decreasing corona discharge permitting operation at higher altitudes. A recessed small-cavity cap has been used on the anode contact instead of the conventional recessed small-ball cap.



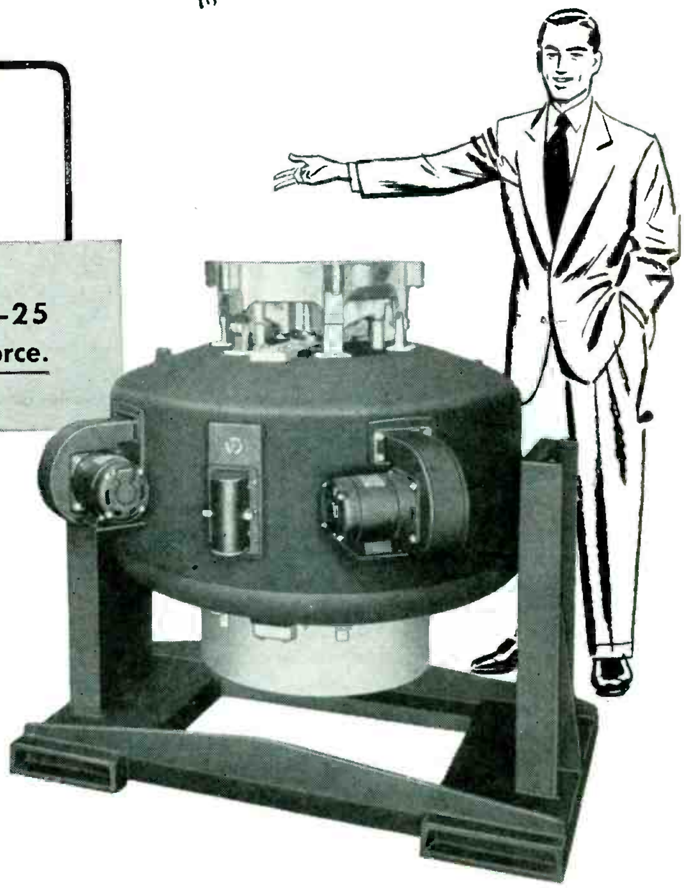
Electronic Voltmeter

BALLANTINE LABORATORIES, INC., Boonton, N. J. Model 314 electronic voltmeter is a recent development in the field of sensitive, accurate,

Vibration Engineering that solves your problems

PROBLEM: To perform vibration tests to MIL-E-5272 specification.

SOLUTION: The MB Model C-25 Vibration Exciter rated at 2500 lbs. force.



Shake testing gives a quick method of developing a product to withstand vibration. Such testing is vital for military equipment—and a good idea for any product. To meet this need, MB has applied its specialized vibration engineering to develop a range of shakers in various ratings for testing everything from electron tubes to airframes.

The big C-25 model illustrated develops large "brute forces" to satisfy specification MIL-E-5272. It has heavy duty capacity for a wide range of work, including fatigue testing. It features accurate, continuous control of force and frequency. Its control panel is available with an automatic cycling system for specific cycling tests called for in the MIL-E-5272 specification.

One of the largest and most dependable electromagnetic shakers available, the C-25 model is a good example of the quality of vibration engineering that has made MB "headquarters" for products to isolate, control, reproduce, detect, or measure vibration. More information on MB Vibration Exciters in Bulletin 1-VE-5. Write us.

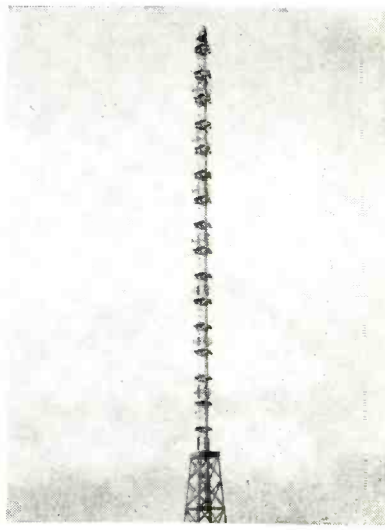
Want a standard mount for vibration isolation in the special class?

With the Isomode* Type 17 Isolator, you not only conform to MIL-I-5432 specification but also get an unusual degree of isolation efficiency. It has equal spring rates in every direction. This means better control of all modes of motion. For details on this mount, write to Dept. 5.

**Trade Mark Reg. U.S. Pat. Off.*

THE MB MANUFACTURING COMPANY, INC.
1060 STATE STREET, NEW HAVEN 11, CONN.

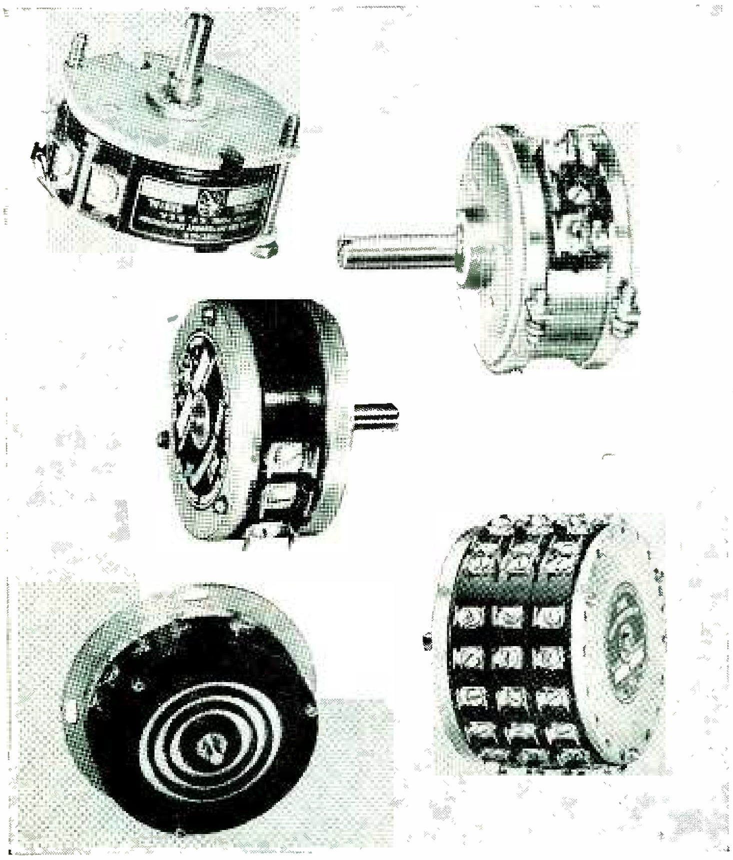
PRODUCTS AND EQUIPMENT TO CONTROL VIBRATION • TO MEASURE IT • TO REPRODUCE IT stable, wide-band electronic voltmeters and measures a-c voltages from 100 μv to 1,000 v in the frequency range of 15 cycles to 6 mc. Its accuracy of 3 percent up to 3 mc and 5 percent above is the same at all points on the single logarithmic voltage scale. With its probe, the input impedance is 6 μμf shunted by 11 megohms and the voltage range is 1 mv to 1,000 v in 6 decade ranges. Without its probe it may be used to measure down to 100 μv but the input impedance is reduced to 22 μμf shunted by 1.1 megohms. It may also be used as a wide-band amplifier with maximum gain of 60 db variable in 20-db steps and flat within ½ db from 100 cycles to 3 mc and within 1 db from 50 cycles to 6 mc.



Antenna-Amplifier Combination

INTERNATIONAL TELEPHONE AND TELEGRAPH CORP., 67 Broad St., New York 4, N. Y. A high-gain antenna and high-power amplifier combination designed to meet the FCC specification of 316-kw maximum effective radiated power for channels 7-13 has been announced. The antenna is the 16-bay triangular loop antenna with a radiated power gain of 17. It features light weight and simple base structure, requires only one transmission line and is supplied complete with diplexer. The 25-kw air-cooled amplifier utilizes an extremely stable grounded-grid, screen-type circuit with a rated power gain of

Sample Precision Potentiometers now available in 4 to 6 weeks



Better delivery than ever before of Fairchild Precision Potentiometers is the result of recently improved facilities and additions to personnel. Now you can expect delivery of sample standard units with windings to meet your requirements in 4 to 6 weeks after your final approved specifications are received. The same reasonable prices prevail, too.

Enlargement and realignment of facilities and personnel also enable us to start delivery of production orders in 3 to 4 months after receipt of your order.

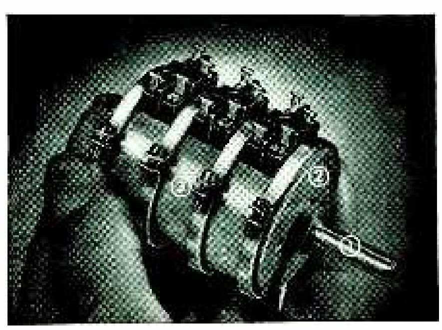
Thus, when you look to Fairchild for your precision - potentiometer requirements you get products built to the highest standards of quality coupled with sound engineering help that starts with your idea and carries through to final delivery.

HOW PRECISION IS DESIGNED AND BUILT INTO FAIRCHILD POTENTIOMETERS

1. Shaft is centerless-ground from stainless steel to a tolerance of +0.0000, −0.0002 in. which, together with precision-bored bearings, results in radial shaft play of less than 0.0009 in.

2. Mounting plate has all critical surfaces accurately machined at one setting to insure shaft-to-mounting squareness of 0.001 in./in. and concentricity of shaft to pilot bushing within 0.001 in. FIR.

3. Housing is precision-machined from aluminum bar stock. Close tolerance of this construction permits ganging up to 20 units on a single shaft with no eccentricity of the center cups, even though only two bearings are used.



4. Windings are custom-made by an exclusive technique. This, together with precious metal alloy contacts results in guaranteed accuracies of ±0.5% linear and ±1.0% non-linear in standard type potentiometers. Higher accuracies (to 0.05%) are available in other types.

DO YOU HAVE CONTROL PROBLEMS?

Fairchild Sample Laboratory engineers are available to help you with potentiometer problems. To get the benefit of their knowledge and experience write today, giving complete details, to *Potentiometer Division, Fairchild Camera and Instrument Corporation, Park Avenue, Hicksville, L. I., New York, Department 140-29A*

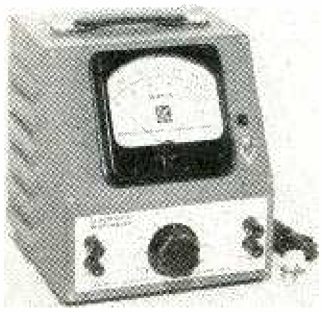
FAIRCHILD

PRECISION POTENTIOMETERS

9 db. Approximately 3.5 kw of sync peak drive power is required for full output.

Drawn-Oval Capacitors

General Electric Co., Schenectady 5, N. Y. Drawn-oval capacitors for electronic applications are shown with the rectangular-styled units which they will replace. The new capacitors are stronger, smaller and cost less than the rectangular units. The new units are available in ratings of 600 to 1,500 v d-c, 330 to 660 v a-c and 2.0 μf to 10.0 μf.

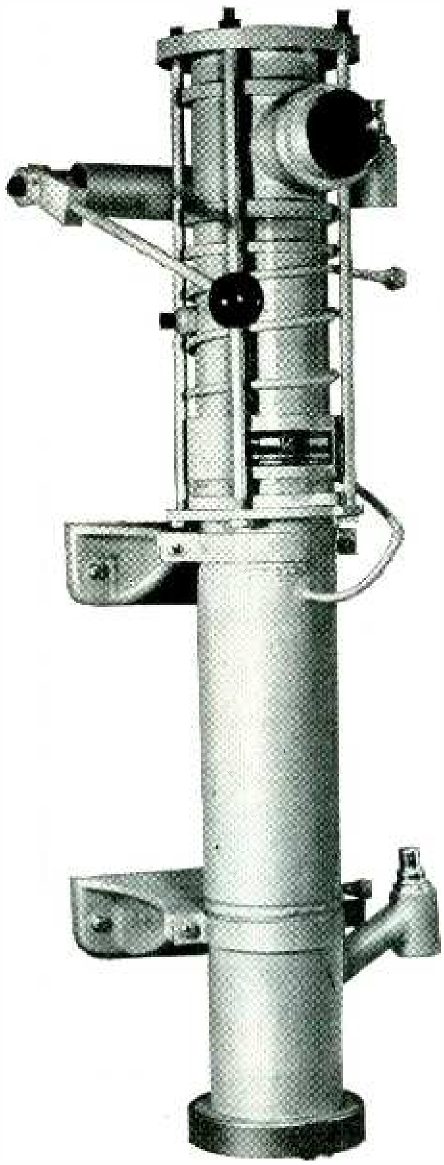


Wattmeter

Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio. Model 109 electronic wattmeter employs an amplifier to drive the potential coil of a dynamometer wattmeter. Advantages include an input impedance of 500,000 ohms, eliminating errors due to potential coil current. A frequency response of 20 to 3,0000 cps permits accurate measurement at all power frequencies and their harmonics, of nonlinear circuits with harmonics, and of low audio frequencies. Ranges of 300, 100, 30, 10, 3, 1, 0.3, 0.1 and 0.03 watts are provided, with full-scale accuracy within 2 percent. Maximum permissible current is 1.0 ampere, with external shunts

LITTON INDUSTRIES NEWS

PRODUCTION EXHAUSTING TO VACUUM 5×10^{-8} WITH ALL-METAL LITTON OIL VAPOR PUMPS



In applications ranging from laboratory research to high vacuum under production conditions, Litton Model PB Vacuum Pumps are meeting today's requirements for higher vacuum more swiftly obtained.

Precision-built Litton pumps are of all-steel construction to eliminate glass breakage, avoid loss of engineering and production time and lengthen pump life. Each unit is water-cooled to insure complete independence of room temperature. Pump heaters are external and mount with a simple clamp for easy replacement. The nozzle assemblies are of stainless steel of high chromium content.

For evacuation problems such as organic distillation, etc., Model PB Pumps may be used without accessories. For other problems, a charcoal baffle system with a 2-inch side outlet is provided. This baffle has an adapting ring and collar which can be soldered to 2-inch tubing to form a manifold, or through a metal-glass seal to a glass manifold. Baffle systems are water-cooled, and contain a charcoal cell with a built-in heater and lead terminal. Heating voltage required is 18 volts.

An additional accessory is a high-vacuum valve which attaches to the charcoal baffle unit. This valve is available with its own side outlet. It is sufficiently tight so that a manifold may be let down to atmosphere—*and a new tube sealed on and roughed out by auxiliary pump*—while the Litton vapor pump is still operating. This can materially increase production speed by eliminating outgassing of baffles each time the system is opened to atmosphere.

Boiler, charcoal baffles and high-vacuum valves are easily demountable for cleaning. Units of the pumps are available individually so combinations may be selected appropriate to the research or production problem.

Specifications

Ultimate Vacuum under following conditions:

1. Pump and water baffle only, 1×10^{-6} mm. of Mercury (ion gauge indication).
2. Pump, water and charcoal baffles, 5×10^{-8} mm. of Mercury.
3. Pump, water, charcoal baffles and valve, 5×10^{-7} mm. of Mercury.

Speed (measured at 10^{-5} mm. of Mercury)

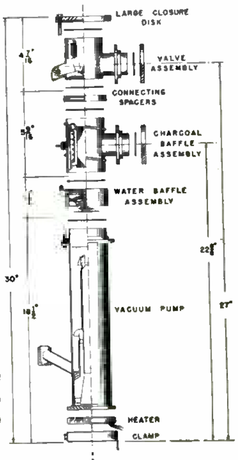
1. Pump only, at connecting inlet, 280 liters.
2. Pump and water baffle at inlet, 200 liters.
3. Pump, water and charcoal baffles, straight through type, at inlet, 75–100 liters.
4. Pump, water and charcoal baffles, and valves, straight through type, 50–75 liters.

High vacuum inlet, top—3⅜" ID., 3½" OD.
High vacuum inlet, side—2" ID., 2⅛" OD.
Forepump outlet—1" copper tubing.
Height of pump only—18½".
Height of pumps complete with baffles and valve—30".
Width, max. width at high vacuum outlet—7¼".
Construction—pump stainless steel. Auxiliaries—steel, tin clad.
Weight of pump only, with mounting brackets—16½ pounds.
Weight completely assembled—33 pounds.
Cooling—water.
Amount of oil—6 ounces.

Recommended oil—Litton Molecular Lubricant, Type "C," 375 watts.
Silicone Pumping Fluids, DC702, 400 watts.
Silicone Pumping Fluids, DC703, 425 watts.

Boiler heaters—Voltage available, 230, 208 and 115 volts; power, 375 watts.

Charcoal baffle heater—Voltage, 18 volts AC; power, 75 watts.



MOLECULAR LUBRICANT FOR USE WITH MODEL PB VAPOR PUMPS

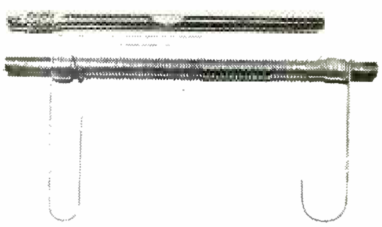
Litton Molecular Lubricant "C" (Molube "C") is a highly refined petroleum product with a narrow boiling range. It has a vapor pressure of approximately 10^{-7} mm. Hg. at room temperature. In the presence of ionization, it will give an indicated pressure of 10^{-6} mm. Hg. It is designed for use in Litton Oil Vapor Vacuum Pumps and with anti-friction bearings operating within dynamic vacuum systems.

Prices, delivery information on request.

LITTON INDUSTRIES
2477 SAN CARLOS, CALIFORNIA, U. S. A.

DESIGNERS AND MANUFACTURERS of:
Glassworking Lathes and Accessories, Vertical Sealing Machines, Burner Equipment, Precision Spotwelders, Oil Vapor Vacuum Pumps, Glass Baking Ovens, Vacuum Tubes and Tube Components, Magnetrons, High Vacuum Molube Oil, Microwave Equipment.

available for measurement 3.0, 10 and 30 ampere circuits.



Ferrite Rod Antennas

HEPPNER MFG. CO., Round Lake, Ill., has announced a new line of Ferrite rod antennas including the following sizes: $\frac{1}{2}$ in. diameter × 8 in. long, $\frac{5}{16}$ in. diameter × 8 in. long, $\frac{3}{8}$ in. diameter × 5 in. long and $\frac{5}{8}$ in. diameter × 7 in. long. Inductances are held to ± 0.5 per cent and matched to the set for which they are intended. The antennas come without mountings or with mountings to the specifications desired.

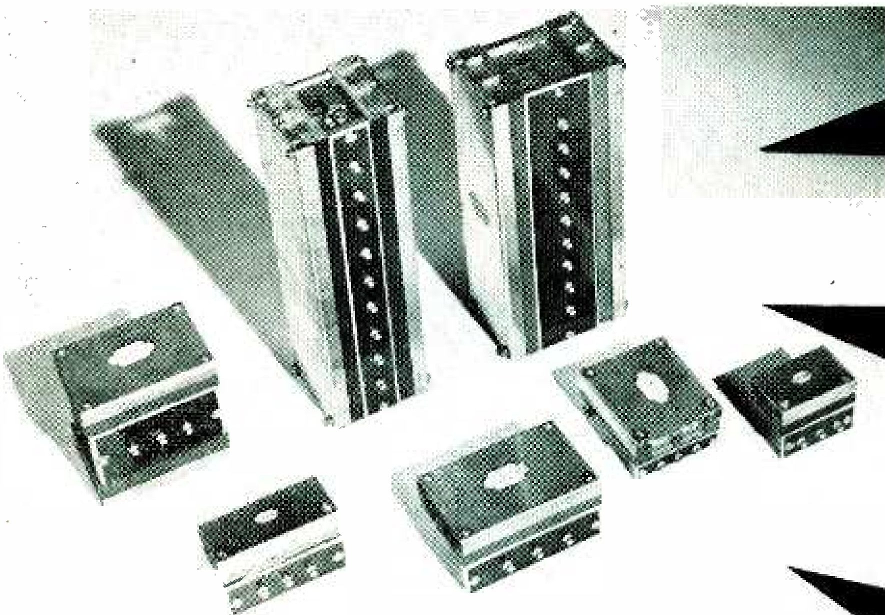
Mercury-Vapor Detector

GENERAL ELECTRIC CO., Schenectady 5, N. Y. The type A completely redesigned portable mecury-vapor detector was developed for indicating concentrations of mercury which could be harmful to industrial workers. The electronic instrument is designed to give an instantaneous indication of mercury vapor by resonant absorption of ultraviolet energy. It will give instant readings ranging from 0.01 to 3.0 mg of mercury per cubic meter of air, and features greater operational stability independent of line voltage. This is possible because of an additional phototube in a bridge-circuit which measures the visible light, thus maintaining the bridge balance although the line voltage may vary. Accuracy for

ELECTRONIC ELECOM COMPUTER

REVOLUTIONARY

DELAY LINES



LOWEST LOSS — ½db to 3db

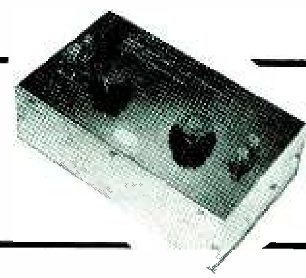
WIDEST RANGE — Up to 1 millisecond delay

MOST COMPACT — 100 μs delay 2 μs rise time in 2½" x 3½" x 9" space

For further information, please write specifying:

- Required delay
- Delay tolerance
- Maximum rise time
- Required impedance
- Special features such as unusual temperature range, available space, tapping, etc.

DECADE DELAY LINES



ELECOM decade delay lines are entirely new items of laboratory equipment. Each line provides adjustment over a two decade range, and as much as 1.1 milliseconds delay with excellent rise time is obtainable in a single unit of relatively small size.

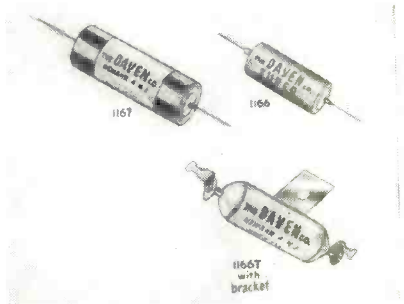
Specifications of other ELECOM components available. Please write.

ELECTRONIC COMPUTER CORPORATION

Designers and Manufacturers of Electronic Computers and Components

OFFICES: 160 AVENUE OF THE AMERICAS, NEW YORK 13, N. Y.
PLANT: 265 BUTLER ST., BROOKLYN 17, N. Y.

determination is within ± 5 percent.



Subminiature Resistors

THE DAVEN CO., 191 Central Ave., Newark 4, N. J., has available series 1166 and 1167 hermetically sealed, wire-wound subminiature resistors. They can be furnished with wire leads or with solid terminals. Series 1166 is 1 in. long and $\frac{13}{32}$ in. in diameter; 1167 is $1\frac{5}{8}$ in. long and $\frac{13}{32}$ in. in diameter. Each has leads $2\frac{1}{2}$ in. long. The units are available with temperature coefficients as low as 20 parts per million per deg C. Tolerances as close as ±0.1 percent can be supplied. The wattage for series 1166 is 0.5; for 1167 it is 1 watt. The resistors meet all requirements of specification JAN-R-93 for type RB51A.

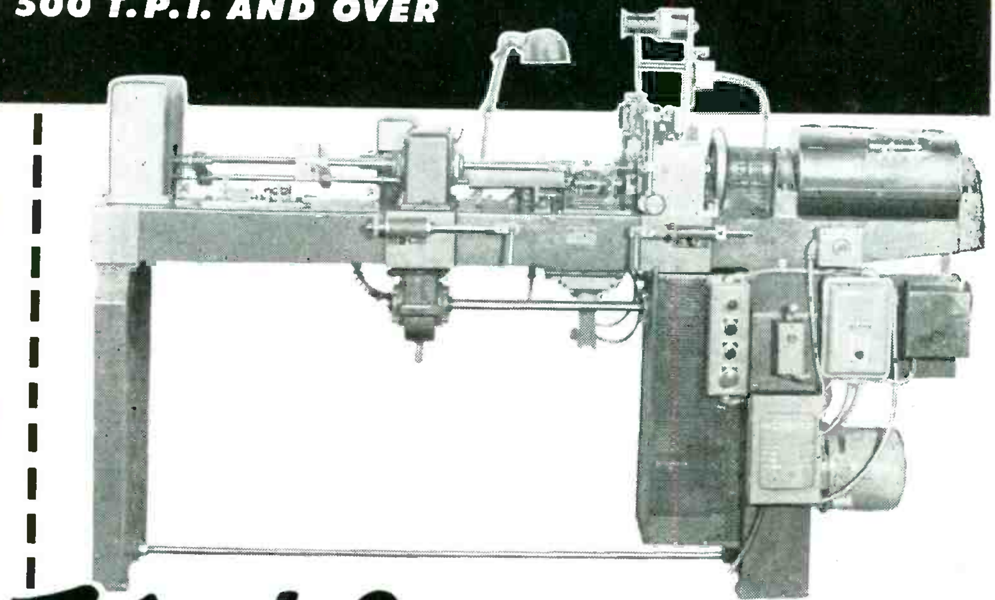
Production Comparator

HERMAN HOSMER SCOTT, INC., 385 Putnam Ave., Cambridge 39, Mass. Repetitive measurements in production testing and research instrumentation are made faster and more simply with the type 610-A production comparator. The instrument directly reads the percentage or db difference between two a-c voltages. Thus test units can be directly and continuously compared with a single standard unit previ-

NEW SUPER-DRIVE GRID WINDER

FOR HIGHER PITCH PRECISION

TO 500 T.P.I. AND OVER



THE PROBLEM:

to produce grids of higher pitch and top precision at greater speed . . . and, at the same time, to cut labor and maintenance costs.

THE SOLUTION:

Kahle developed a grid winder with extra heavy, oversize parts to provide greatly increased smoothness and sensitivity of operation. Vibration was cut to a new low by carrying main and draw spindles on extra large bearings, by using flexible couplings and by replacing ratchet and pawl with gears. Lubrication is fully automatic requiring nothing more than occasional attention to the oil level.

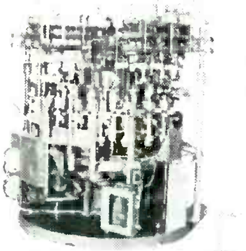
Kahle HIGH SPEED AUTOMATIC GRID WINDING MACHINE

NEW EXCLUSIVE FEATURES INCREASE PRODUCTION SPEED AND PRECISION

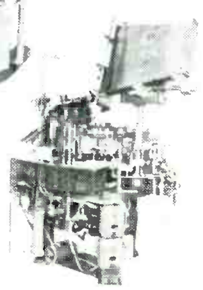
- spool carriage rides in its own two bearings and is dynamically bolonced
- main and draw spindles are extra long; each mounted on two individual bearings
- double-row precision bearings are pre-loaded, extra large, anti-friction
- lubrication is provided by the Bijur fully automatic system
- mandrel head, draw spindle and cam shaft drives are sealed and run in an oil bath
- lead screw and nut are never disengaged, assuring exact register at all times
- exclusive gear and clutch arrangement operates instantly at a flick of the finger
- pneumatic cutter rises, cuts and recedes automatically leaving mandrel completely accessible
- tension control of grid wire spool is a special hysteresis-magnetic brake
- cutting, notching, peening knives are easily adjustable to micrometer precision
- side wire (mica-stop) swaging
- smooth leg gapping; constant and variable pitch
- operates at 1000 rpm, both right and left hand
- makes grids up to 7/8" diameter or width.

WRITE TODAY FOR COMPLETE SPECIFICATIONS AND PRICES

Kahle specializes in equipment for manufacturing sub-miniature, miniature, power and cathode-ray tubes.



1979
Seal—EX
Automatic
Sealing
Exhaust Machine



1934
Automatic Bulb Making Machine for round Sub-Miniature bulbs (also available for flat sub-miniature bulbs)

Ask about the new Kahle Filament Tab Welding Machine.

KAHLE ENGINEERING CO.
1309A SEVENTH STREET • NORTH BERGEN, NEW JERSEY

Specialists in high-speed electronic tube machinery for over 40 years ously tested by conventional means. The comparator accuracy is ± 1½ percent. Normal meter range is ± 40 percent, with a minimum detectable difference of ± 1½ percent, with a minimum detectable difference of ±1 ½ percent, though both range and sensitivity can be increased. Dimensions are 9½ × 6½ × 6½ inches. Weights is 6½ lb.

H-F Power Supply

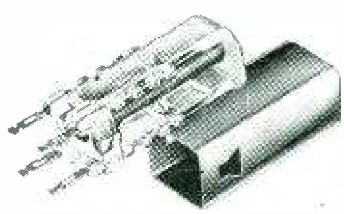
AMERICAN ELECTRIC MOTORS, 4811 Telegraph Rd., Los Angeles 22, Calif. A new 400-cycle motor alternator, meeting AN-E-19 requirements for power supplies, offers marked freedom from maintenance. It utilizes no rotating coils, requires no brushes or springs, is small in size and unusually compact. Total size measures approximately 22 in. × 12 in. × 12 in., and weight is approximately 125 lb. Outputs are furnished in wattages up to 1,000 for single phase or 1,800 for 3-phase. Owing to the shape of the inductor, the skew of the inductor laminations and other design considerations, a waveform of unusual purity results. Less than 5-percent total harmonic content exists. Voltage regulation is ±1 percent. Output voltage is 115 v single phase: 115 or 200 v, 3 phase.

Double Rheostats

REX RHEOSTAT CO., 3 Foxhurst Rd., Baldwin, N. Y. A group of double rheostats is now available for 1,120, 1,560, and 2,000-watt capacity. Two tubes of the same length are mounted between sturdy mounting brackets, while only one slider moves a double contact arm with double copper-graphite contact brushes. These models have the advantage of two ranges connecting both tubes in series or in parallel.

Laboratory Power Supply

SAGA, INC., Science Park, Evansville, Ind., has announced a new portable Variac-controlled laboratory power supply. It has continuously variable voltage output, automatic reset, auxiliary circuit protection, positive or negative output, excellent filtering and all necessary switches and controls. The standard model operates from 105 to 125 v, 50 to 60 cycles, providing output of 0 to 2,000 v at 1 ampere maximum, with overload trip selection at 25, 50, 100, 500, 650, 800 and 1.000 mils. Other voltages are available on special order.



Standardized Coils

FUGLE-MILLER LABORATORIES, Metuchen, N. J., announces a new line of

NOW—IMMEDIATE DELIVERY
on stock models of
HELIPOT
PRECISION POTENTIOMETERS
(both Multi-Turn and Single-Turn)

The demand for HELIPOT Precision Potentiometers to meet the requirements of constantly expanding applications in the electronic industry has been so great that our production simply couldn't keep up. So some six months ago we stepped up our expansion program . . . doubled our plant space—trained additional personnel in our precision operations—and added many new machines and testing facilities.

Today, HELIPOT capacity is approximately *double* that of only six months ago . . .

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- We can give you immediate delivery on most stock models of HELIPOT single and multi-turn potentiometers when ordered in reasonable quantities!
- In *large* quantities of stock items, we can make rapid initial deliveries and maintain volume delivery schedules.

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- Our engineering facilities have been increased so that we can more promptly solve your individual potentiometer engineering problems.
- Special HELIPOTS to meet your engineering specifications can also be manufactured—in volume—to meet your delivery requirements.

So whatever *your* need in precision potentiometers, bring your problem to HELIPOT and get the benefit of the unequalled "know-how," advanced engineering and volume-production facilities of the largest manufacturer of precision potentiometers. HELIPOT's objective is to provide for you the same flexibility and efficiency that you would expect from a division of your own manufacturing operations.

Send for descriptive literature on the HELIPOT potentiometers now in production!

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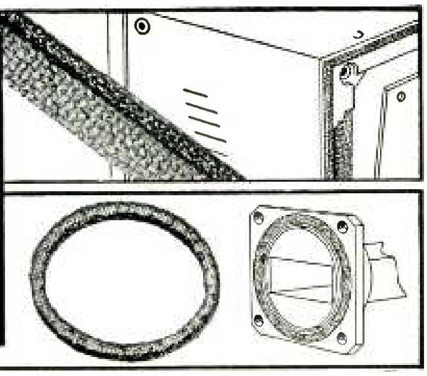
effectively and economically solved with
METEX
electronic "Weather Strips"



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.

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KNITTERS OF WIRE MESH FOR MORE THAN A QUARTER CENTURY

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THREE NEW HIGH-ENERGY CHAMBERS

FOR USE WITH . . .

THE VICTOREEN CONDENSER r-METER

Three new models have been added to Victoreen's regular line of thimble chambers for use with the Condenser r-Meter. These supplement the previous models by having walls sufficiently thick to achieve electronic equilibrium for radiation from one and two million volt X-ray machines, cobalt 60, and radium. These chambers are the Model 552, 2.5r; Model 553, 25r; and Model 554, 250r. The new models are calibrated in the same careful manner as the red precision thimbles used for many years with the Model 70 Condenser r-Meter.

Write Our Sales Department for Bulletin 5043.

Victoreen Instrument
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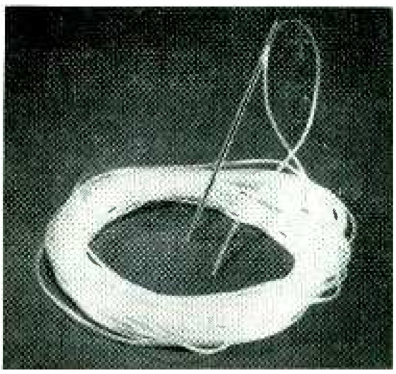
standardized coils designed for radio, f-m and tv receivers. The coils fit standard chassis punchings and areas. Windings can be supplied to meet exactly customers' requirements in all usual types including r-f, i-f, discriminator, oscillator and others. Overall dimensions are $2\frac{7}{16}$ in. × $\frac{3}{4}$ in. × $\frac{3}{4}$ in. including terminals. Complete details will be supplied on request.



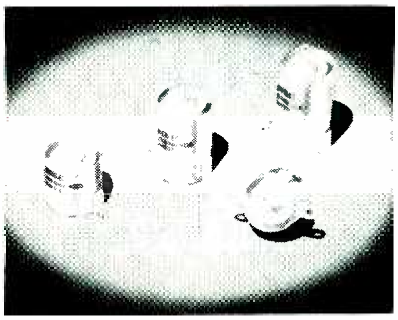
Extruded Plastic Tubing

IRVINGTON VARNISH AND INSULATOR Co., 6 Argyle Terrace, Irvington 11, N. J., has developed an extremely fine diameter extruded plastic tubing for use on small and miniature electrical and electronic components. The tubing, 0.012 in. i.d. × 0.012 in. wall in size, was designed to meet the demands of the expanding electronic industry for a wire covering in miniature motors, relays capacitor leads and similar applications. Regardless of its small diameter, all the physical characteristics of the company's regular Temflex 105 and Transflex tubing are maintained. Samples are available.

Equalizer Preamplifier

HERMON HOSMER SCOTT, INC., 385 Putnam Ave., Cambridge 39, Mass. The 120-A equalizer preamplifier

provides versatile remote control and compensation for music reproduction. The record-compensator adjusts for virtually all recording characteristics and levels. Treble roll-off and bass turnover equalization is provided on 8 positions. Combined with the equalization is a 3-position input-selector for tuner and tv. Frequency response is flat from 19 to 35,000 cps. The preamplifier is entirely d-c operated to minimize hum. Tubes used are one 12AX7 and two 12AU7's.



Ceramic Capacitors

SPRAGUE ELECTRIC CO., 35 Marshall St., North Adams, Mass. An optimum combination of high Q, capacitance stability and excellent retrace characteristics is available in a new precision metal-encased tubular ceramic capacitor. Types B20, B21, B22 and B23 capacitors greatly extend the capacitance range available to circuit designers in close-accuracy ceramic capacitors at rated voltages of 500, 1,000 and 1,500 v a-c. Their extreme stability often makes possible a controlled capacitance tolerance within ±1 percent and temperature coefficient tolerances within ±10 ppm per deg. C. For less critical applications, the usual tolerance on temperature coefficient is ±30 ppm or ±15 percent of the nominal temperature coefficient, whichever is greater.

Universal Binding Post

HUGH H. EBY, INC., 4700 Stenton Ave., Philadelphia, Pa. A new binding post incorporates a female sleeve connection in the post top to accommodate insertion of a banana plug. Standard cross drill is supplied in the stem for insertion of wire; the top screws tight to wire. It is available in three types of base: plain knurled; with dowel;

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Acme's extensive know-how in the development of Magnetic Amplifiers can provide you with the precise component to fit your exact requirement.

These characteristics can be supplied—

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- *Carrier operating frequencies from 60 cps to 100 kcs*
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- *Input sensitivity to 0.10 microwatts*

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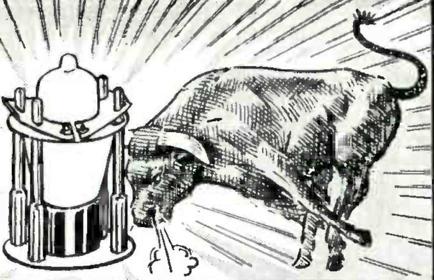
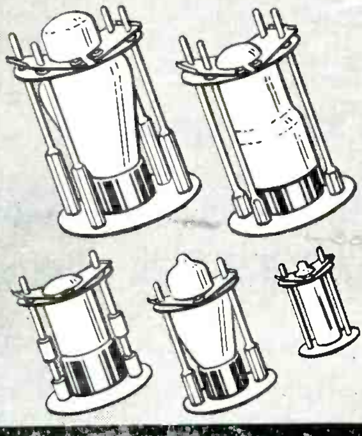
SHOCKPROOF VACUUM TUBE RETAINERS





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.

Manufacturers of Electronic Components

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and with boss extending from bottom of base to provide insulation through a metal panel, and flatted to prevent rotation.

Regulated Power Supply

EASTGAP Co., 285 Columbus Ave., Boston 16, Mass. Model One 300-v d-c regulated power supply is an electronic laboratory instrument designed and constructed for longest life and utmost reliability. Conservative load rating is 0 to 300 ma. output voltage is manually adjustable over a ± 10-percent range by means of a precision bridge. Abundant filtering and a high-gain regulator produce an impedance level below 0.1 ohm, with combined ripple and jitter less than 0.5 mv. To withstand impulse loads, the output terminals are directly shunted by a 15-μμf oil capacitor. All transformers and inductors are hermetically sealed, all having grain-oriented cores. Model One is for either bench or rack usage, and operates from the standard 50-to-60 cycle, 115-v line.

Literature

Oscillograph. General Electric Co., Schenectady 5, N. Y. Bulletin GEC-580A deals with the type PM-18 oscillograph for simultaneous recording of 2, 3 or 4 steady-state or varying quantities. Included are an illustrated description, a list of typical applications, operation, prices and information on optional accessories.

Fuses. Littelfuse, Inc., 1865 Miner St., Des Plaines, Ill., has published a completely illustrated list price sheet containing actual-sized drawings of 25 fuse types and blowing characteristics. By matching the blown fuse to the illustration one can determine quickly the fuse needed. A companion sheet accurately illustrates and prices various assortments and kits as well as the complete line of fuse mountings for quick, sure identification.

High-Gain Corner Reflector. Product Development Co., Inc., 307 Bergen Ave., Kearny, N. J. Bulle-

tin 252 covers a new high-gain cavity-fed corner reflector for 360 to 420, 890 to 960 and 1,850 to 1,990 mc. The antennas described provide a substantial gain over conventional corner reflectors and have a front-to-back ratio of better than 20 db.

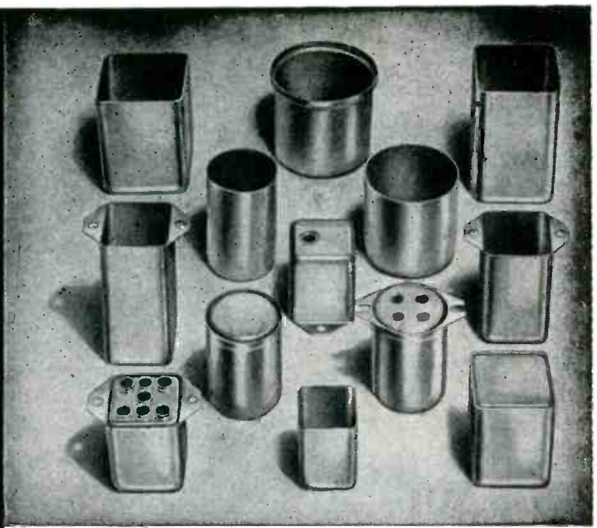
Printed Circuits. The Formica Co., Spring Grove Ave., Cincinnati 32, Ohio, has available a 4-page folder describing its developments in the field of printed circuits and their advantages in many types of electrical and electronic production. As illustrated in the brochure these printed circuits employ a photo-etch process on foil-clad plastic laminates to convert a working drawing to a working part.

Pressure-Sensitive Tapes. Minnesota Mining and Mfg. Co., 900 Fauquier St., St. Paul 6, Minn. Two dozen Scotch brand pressure-sensitive tapes that meet various government specifications are described in a new 16-page manual. The booklet contains 42 photographs and illustrations, and gives complete data on tapes for packaging, holding, mending, masking, sealing, mounting, protecting, insulating and splicing jobs. It also lists 11 tapes for the construction and maintenance of electrical and electronic equipment, plus two magnetic recording tapes for such jobs as telemetering, computing and industrial training programs.

Wideband Sweep Generator. Polytechnic Research and Development Co., Inc., 55 Johnson St., Brooklyn 1, N. Y. Vol. 1, No. 1 of PRD Reports is a 4-page article illustrating and describing, complete with specifications and prices, the type 907 wideband sweep generator for both vhf and uhf tv. The publication will be sent regularly upon application. Position and company address should be included in the request.

Tachometers. Metron Instrument Co., 432 Lincoln St., Denver 9, Col. Technical data sheet No. T4 describes the principle of operation of hand, portable and fixed installation tachometers. The literature

drawn cases



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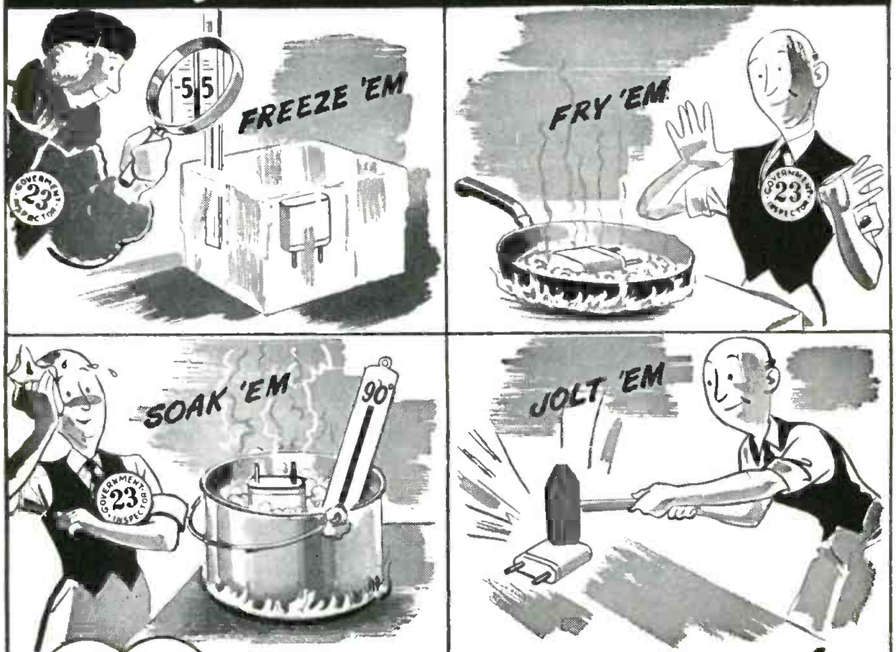

-and dish it out!

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contains simplified circuit diagrams and pictures many available models. The basic circuit and its advantages are described in detail.

Instrument Amplifier. Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio. An improved instrument amplifier which greatly increases the accuracy of oscilloscopes and vacuum-tube voltmeters is the subject of a new 4-page bulletin. The instrument described has an input impedance of over 200 megohms shunted by 6.0 $\mu\mu f$; gains of 1.0, 10 and 100; and frequency response from 5 to over 150,000 cps.

Sound-Survey Meter. General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass. Volume 27 No. 11 of the "Experimenter" contains an 8-page article on the type 1555-A sound-survey meter. The article is well illustrated and gives complete specifications and prices for the unit described.

Rack and Panel Connectors. Hugh H. Eby, Inc., 4700 Stenton Ave., Philadelphia, Pa., announces publication of an 8-page data catalog describing the company's line of new compact connectors for electronic and aircraft use. Included are dimensional drawings, and detailed description of male and female rack and panel connectors having 3, 4, 7, 8, 11, 14, 15, 18 or 34 pins; miniature 5, 7 and 9 pin connectors, and watertight and universal binding posts.

Decimal Counting Units. Berkeley Scientific Corp., Richmond, Calif. Construction, basic design, typical applications and specifications for a line of decimal counting units are given in a recent four-page folder. The units described are direct-reading, electronic counters capable of operating at speeds up to 1,000,000 counts per second and resolving paired pulses separated by as little as 0.8 microsecond.

Capacitor Clip. Prestole Corp., 1345 Miami S., Toledo, Ohio. A recent catalog bulletin deals with a newly designed capacitor clip that features a retaining tongue

on each side that supports the clip by gripping tightly to the mounting surface, thus providing fatigue-free holding and longer life. A fully illustrated description and specifications for the seven available sizes are given.

Wattmeter. Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio. A 2-page bulletin deals with the electronic wattmeter that is especially useful where a high input impedance or sensitivity to low-voltage and low-power circuits is required. The publication contains detailed description, specifications and suggested uses, including transformer core loss and copper-loss tests, measuring audio power to speakers, and power measurements at aircraft frequencies.

Miniature Terminals. Garde Mfg. Co., 588 Eddy St., Providence 3, R. I. A single-page bulletin describes and illustrates the company's miniature insulated Feed-Thru terminals with voltage breakdown of 4,500 v rms, 60 cycle test. Dimensional drawings and chief features are included.

General Purpose Computer. Computer Research Corp., 3348 W. El Segundo Blvd., Hawthorne, Calif., has issued a 6-page folder describing the chief features and functions of the CRC 102 general purpose computer that solves any type of arithmetic or mathematical problem in which characteristics can be expressed in numerical form. A sample problem and its solution are included.

Electron Microscope. Radio Corp. of America, Camden, N. J., has issued a new brochure entitled "The Electron Microscope at Work in Industry." The booklet emphasizes only typical applications of the electron microscope by industries in the automotive, chemical processing, metal fabrication, petroleum, rubber, food, drug, textile and radio and electric fields. Ask for Form 2R8195.

Germanium Crystal Diode. Berkshire Laboratories, 506 Beaver Pond Road, Lincoln, Mass., has

published bulletin B-46 on the type GCD-1 high back resistance germanium crystal diode for high and low frequency rectification. The units described are useful in computers and other electronic applications. The bulletin includes specifications and price.

Speaker Catalog. Oxford Electric Corp., 3911 South Michigan Ave., Chicago, Ill., has released a catalog containing complete information on a line of speakers including the new Hi-Fidelity speakers and speakers for auto, p-a, inter-com, outdoor and radio and tv, portables and permanent-magnet and electrodynamic applications. Illustrations of the various speakers are included in the 3-colored catalog.

Variable Resistors. Chicago Telephone Supply Corp., Elkhart, Ind. Complete details on 167 types of military variable resistors are given in Stock Sheet No. 162. Included are JAN-R-94 and JAN-R-19 types and non-JAN controls. Pages 2 and 3 list and describe the 167 types of controls available. Six key controls are illustrated and dimensional drawings of five shaft types are given. Page 4 gives pertinent performance characteristics in full detail.

V-T Electrometer. Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio. Vacuum-tube electrometer applications are discussed in a recent two-page article reprint. The paper explains basic advantages and features of the instrument, includes several circuit schematic diagrams, and discusses many measurements easily made—including accurate measurement of potentials, currents, capacitance and resistance.

Electrical Wire and Cable. United States Rubber Co., Rockefeller Center, New York 20, N. Y., has issued a 52-page engineering catalog on its line of electrical wires and cables for the coal mining industry. The booklet includes complete performance and specification data on insulation and jacket compounds, portable cords and cables with a voltage rating up to

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Frequency Range: 2KC-300KC, stabilized linear scale
Scanning Width: Continuously variable from 200KC to zero
Four Input Voltage Ranges: 0.05V to 50V. Full scale readings from 1 millivolt to 50 volts
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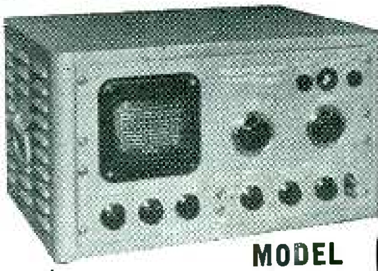

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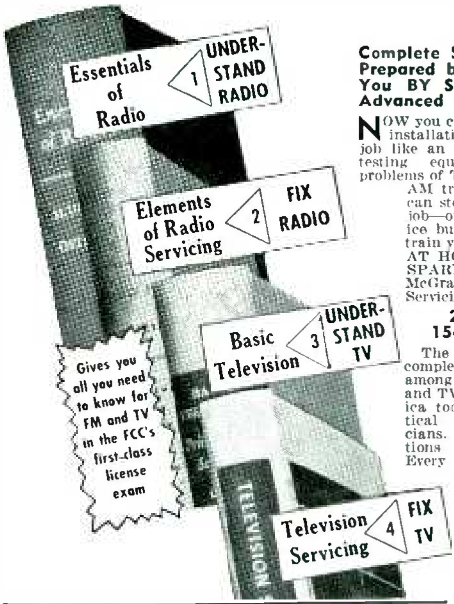

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Clipper Diode. Lewis and Kaufman, Inc., 50 El Rancho Ave., Los Gatos, Calif. A new tube data sheet describes the type 719A clipper diode. It illustrates the tube, gives outline data with dimensions, and lists the general electrical characteristics. Operating curves are supplied as follows: (1) for pulse-current characteristics over a voltage range from 0 to 2,000 v and a current range from 0 to 20 amperes; (2) for plate-current characteristics from 0 to 200 v and 0 to 800 ma. Maximum ratings are included.

Fault Locator. Echo Electronics Co., 3966 Peachtree-Dunwoody Road, Atlanta 5, Ga. A four-page folder gives an illustrated description, theory of operation, chief features, specifications and price of its new fault locator. The instrument discussed was especially designed for measuring the distance to a fault on an open wire circuit.

Audio-Frequency Testers. D & R, Ltd., 402 E. Gutierrez St., Santa Barbara, Calif., has available a 4-page brochure illustrating and describing a line of audio-frequency test equipment. Instruments covered include the model 1M3B intermodulation meter, model 2F flutter meter, and model TD2A tape distortion meter.

Tape Recorder. Tapemaster Inc., 13 W. Hubbard St., Chicago 10, Ill. Bulletin No. 102 illustrates and describes the tapeMaster portable model PT-125 professional-quality dual-speed tape recorder — the models TH-25 and PA-1 dual-speed transport mechanism and bias-erase oscillator for custom installation—the model SA-13 portable

power amplifier and speaker for use with the PT-125 or for other applications. It gives details and specifications on these new units, points out their important features and explains how they make high-fidelity tape recording and playback available to everyone.

Tubing Data. Reflin Co., 8525 Higuera, Culver City, Calif., has issued a 4-page brochure of engineering information on a new lightweight, corrosion-resistant, thermosetting plastic and Fibreglas-reinforced tubing for defense and commercial applications. The tubing described is claimed ideal for underground conduits, fuel, natural gas, irrigation or sanitary lines, shipboard piping systems and housings for airborne equipment and components.

Electrometers and Accessories. Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio. A new eight-page bulletin on vacuum-tube electrometers and accessories describes the instruments in complete detail and gives application diagrams of 17 basic uses. These include potential measurements to 200 v, extreme sensitivity in location and detection of static fields, current measurements to 10^{-14} ampere and resistance measurements up to 10^{16} ohms.

Resistor Catalog. Ward Leonard Electric Co., Mount Vernon, N. Y., has issued catalog No. 15, a 64-page publication illustrating and describing a complete line of Vitrohm power-type wire-wound resistors for every use. Listed are resistor ratings ranging from 5 to 550 w and resistance values from 0.04 ohm to 1.75 megohms. Full details on terminals, mountings and enclosures are given. Valuable technical information is presented, including selection and application data with numerous detailed charts and useful data tables.

Ball Bearings. Miniature Precision Bearings, Inc., Keene, N. H., has issued a new catalog containing complete specifications on

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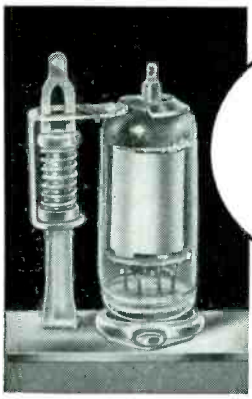

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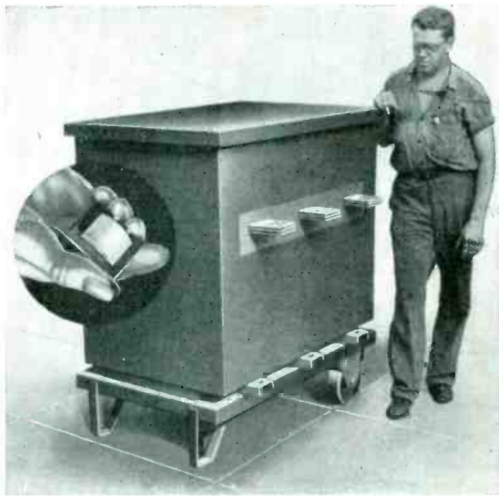

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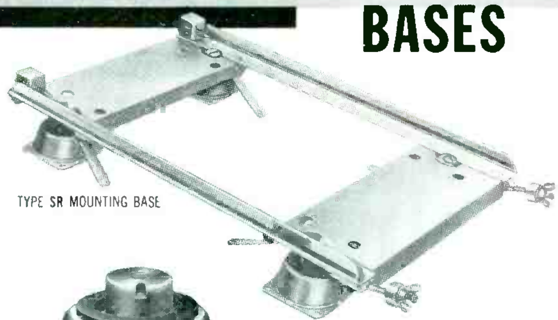

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Instrument Amplifier. Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio. An instrument amplifier that greatly increases the accuracy of oscilloscopes and vacuum-tube voltmeters is the subject of a new 4-page bulletin. The model 102 Phantom Repeater described has an input impedance of over 200 megohms shunted by 6.0 $\mu\mu$f; gains of 1.0, 10 and 100; and frequency response from 5 to over 150,000 cps.

Capacitor Catalog. Hammarlund Mfg. Co., 460 W. 34th St., New York 1, N. Y., has published a new 1952 capacitor catalog. The detailed and illustrated 2-color, 12-page brochure includes complete drawings and electrical and mechanical specifications covering a broad selection of standard variable air capacitors.

Capacitor Catalog. Pyramid Electric Co., 1445 Hudson Blvd., North Bergen, N. J. Catalog J-7 is a 32-page compilation of paper, electrolytic, oil-paper and metallized paper capacitors. Specifications, construction and engineering data, sizes and prices on 18 different types are included.

Electrical Fittings. Buchanan Electrical Products Corp., 225 Route 29, Hillside, N. J. Catalog 52 gives a 12-page description of the company's complete line of solderless wire connectors, cable and conduit fittings and wiring devices. It contains illustrated descriptive information on pressure connectors for solderless wire splicing and terminating, Bushend insulated conduit bushings, box connectors for nonmetallic sheathed cables, conduit locknuts and molded terminal blocks. The publication gives complete specifications, dimensional data, application instructions and ordering information.

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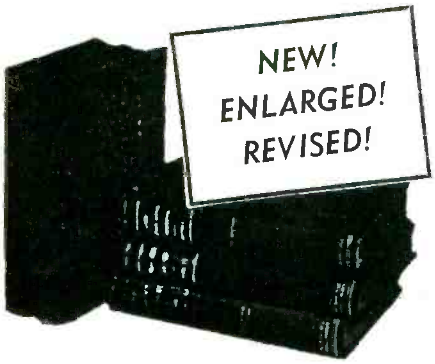

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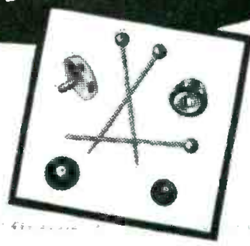

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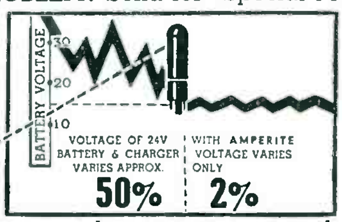

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PLANTS AND PEOPLE

Edited by WILLIAM P. O'BRIEN

West Coast Manufacturers' Activities

RECENT news from the west coast reports the activities of four companies:

Hoffman Radio Corp. has established a wholly-owned subsidiary, Hoffman Laboratories, Inc., which will specialize in the electronics field. The new subsidiary will be housed in three plants—3761 South Hill St. and 3716 South Grand Ave. in Los Angeles, and 335 South Pasadena Ave., Pasadena, and will operate as a separate corporate entity.

Coast Coil Co., Los Angeles, Calif., recently announced the opening of a new plant for the manufacture of toroidal coils and associated components. The engineering department is equipped to design filters, inductors and magnetic amplifiers to customer specifications. Facilities are available for baking, potting and coating to AN specifications.

Davis Electronics, manufacturers of a new tv antenna particularly suited for fringe area installations and for insuring high gain on all channels (2 through 13), has moved from Los Angeles to a new enlarged plant at 4313 W. Magnolia Blvd., Burbank, Calif.

Helipot Corp., South Pasadena, Calif., has announced that it will soon open a 15,000-sq ft factory branch within the New York metropolitan area.

NBS Reorganizes

THE Ordnance Development Division of the National Bureau of Standards has been reorganized into three new divisions and three new division chiefs have been designated. In addition an associate director for ordnance development has been appointed.

Wilbur S. Hinman, Jr., former chief of the Ordnance Development Division, was appointed to the newly established position of associate director. He will coordinate NBS work in the field of ordnance research and development.

The NBS ordnance program is concerned with research, development and engineering of electronic ordnance devices—in particular, proximity fuzes for a wide variety of weapons. The Bureau serves as a primary developmental facility for the Army Ordnance Corps and through that agency fulfills needs of the Army, Navy and Air Force for particular electronic ordnance items.

The three divisions and their chiefs are: Division 13, Ordnance Development Program A, with M. G. Domsitz as chief; Division 16, Ordnance Development Program B, with Jacob Rabinow as chief; and Division 17, Ordnance Development Program C, with Harold Goldberg as chief.

FIFTIETH ANNIVERSARY MEMENTO

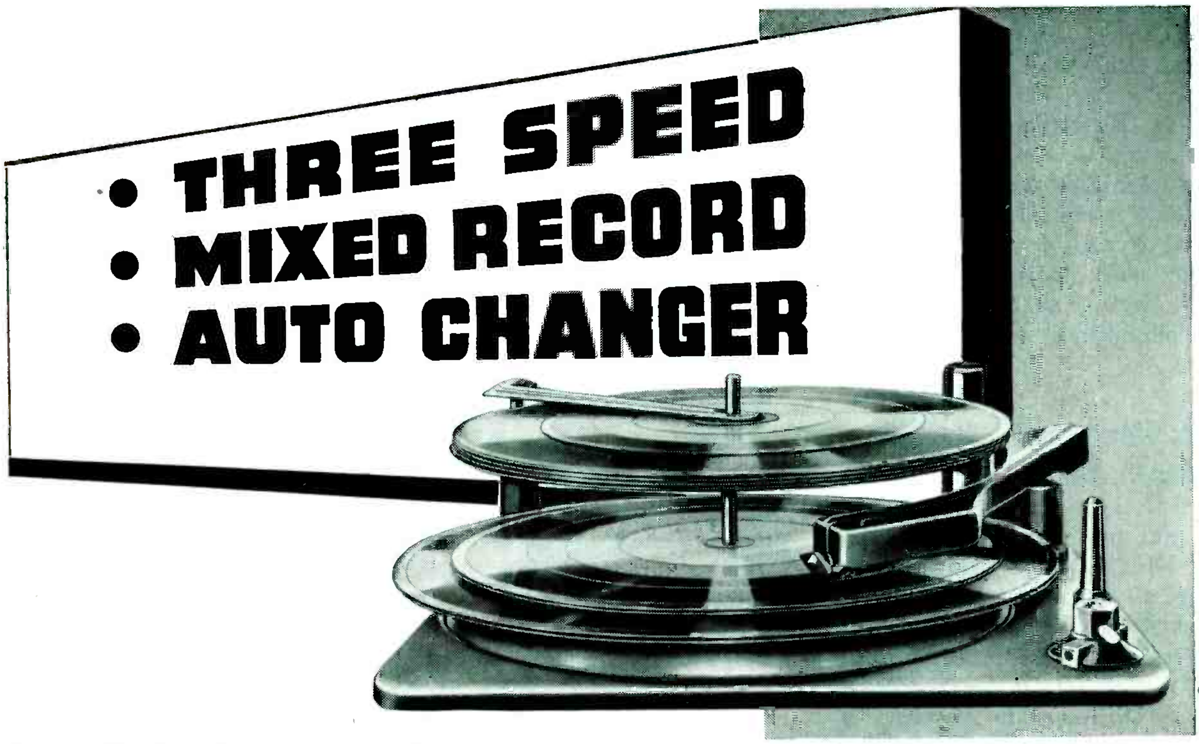
R. L. Triplett, president of Triplett Electrical Instrument Co., Bluffton, Ohio, receives gold watch from his sales force, commemorating his fiftieth year in the electrical measuring instrument industry. Making the presentation is E. K. Seyd, left, 20 year veteran of the Triplett sales organization. Looking on is A. D. Plamondon, Jr., president of The Indiana Steel Products Co., Valparaiso, Ind., and vice-president of RTMA, of which Mr. Triplett is also a director

OTHER DEPARTMENTS featured in this issue:

California IRE Doings

TWELVE professional groups from the 7th IRE region will have technical papers read Aug. 27 to 29 when the 1952 Western Electronic Show & Convention will be held in the Long Beach, Calif., municipal auditorium. WCEMA and IRE jointly operate the exhibits and the speaking program.

The groups are: airborne electronics, antennas and propagation, audio, broadcast and television receivers broadcast transmission systems, circuit theory, electron devices, electronic computers, information theory, instrumentation,



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Never before has there been a record changer equal to the B.S.R. Monarch, which without doubt gives tremendous sales appeal to any instrument in which it is mounted. It includes all features demanded by the discriminating listener and has a styling and colour that will blend with any cabinet design.

Simplicity of design guarantees long life and trouble-free operation. The controls consist of one knob only, no levers to adjust, no loose fitments, no confusing adjustments for playing the increasingly popular 7″ L.P. records.

A brilliant new three diameter selector enables different diameter records to be played automatically. The machine thinks for you by automatically adjusting itself for all three diameters.

Quality of reproduction is unequalled due to the outstanding performance of the latest B.S.R. reversible pick-up cartridge with two sapphire styli for standard and long playing records.

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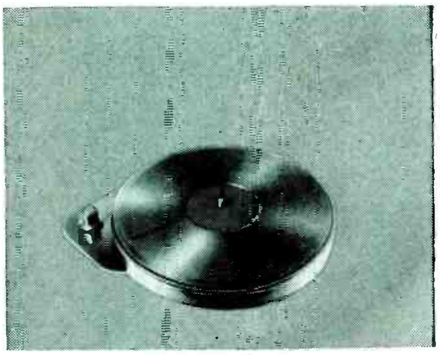

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Frederick Suffield of Manhattan Beach, Calif., is chairman of the papers committee.

During the three-day gathering, the 7th IRE region will present its Electronic Achievement Award to an outstanding electronics man selected by secret ballot of the regional committee. John P. Day, junior past chairman of the San Diego Section, will be chairman of the nominations committee.

NPA Personnel Changes

GEORGE W. HENYAN has resigned as chief of the components branch of the National Production Authority's Electronics Division, and returned to the General Electric Co. as assistant to the general manager of the Tube Department in Schenectady, N. Y.

J. A. Milling, who has been director of the Electronics Division of the NPA, on leave from his post as operating vice-president of RCA Service Co., Inc., has resigned both positions to become executive vice-president and general manager of Howard W. Sams & Co., Inc., Indianapolis, Ind. He will be in charge of the firm's expansion program in behalf of Photofact Publications and allied enterprises in the electronics field.

J. A. Milling

Richards W. Cotton has been given a temporary leave of absence from Philco Corp., where he has been assistant to the president on special assignments, to accept appointment as Chairman of Electronics Production Board of the Defense Production Administration and Director of the Electronics Division of NPA. As Director of NPA's Electronics Division he will be responsible for obtaining critical materials for manufacturers of electronic components and end equipment and solving other production problems. Through the Electronics Production Board, representing all defense agencies concerned with procurement and production of electronic equipment, he will keep tabs on the development and production of military electronics, and initiate action to prevent production losses or delays.

NAVY POSITION SWITCH

Captain Willis H. Beltz, USN, (right) is greeted by Captain Frederick R. Furth, USN, at the Naval Research Laboratory in Washington, D. C. Captain Beltz becomes Director of the NRL. He succeeds Captain Furth who in turn relieves Captain Beltz as Assistant Chief of the Bureau of Ships for Electronics

AIEE Elects President

ELECTION of Donald A. Quarles as 1952–53 president of the AIEE was recently announced at the Summer General Meeting of the Institute in Minneapolis, Minn. He takes office as head of the society in August.

Mr. Quarles is president of Sandia Corp. at Albuquerque, N. M., and is a vice-president of Western Electric Co., N. Y. He is former vice-president of the Bell Telephone Laboratories.

Bogue Expands Facilities

TO MEET the increased demand for its products, Bogue Electric Mfg. Co. is building a new plant, its third in Paterson, N. J. The new structure will add 25,000 sq ft of floor space.

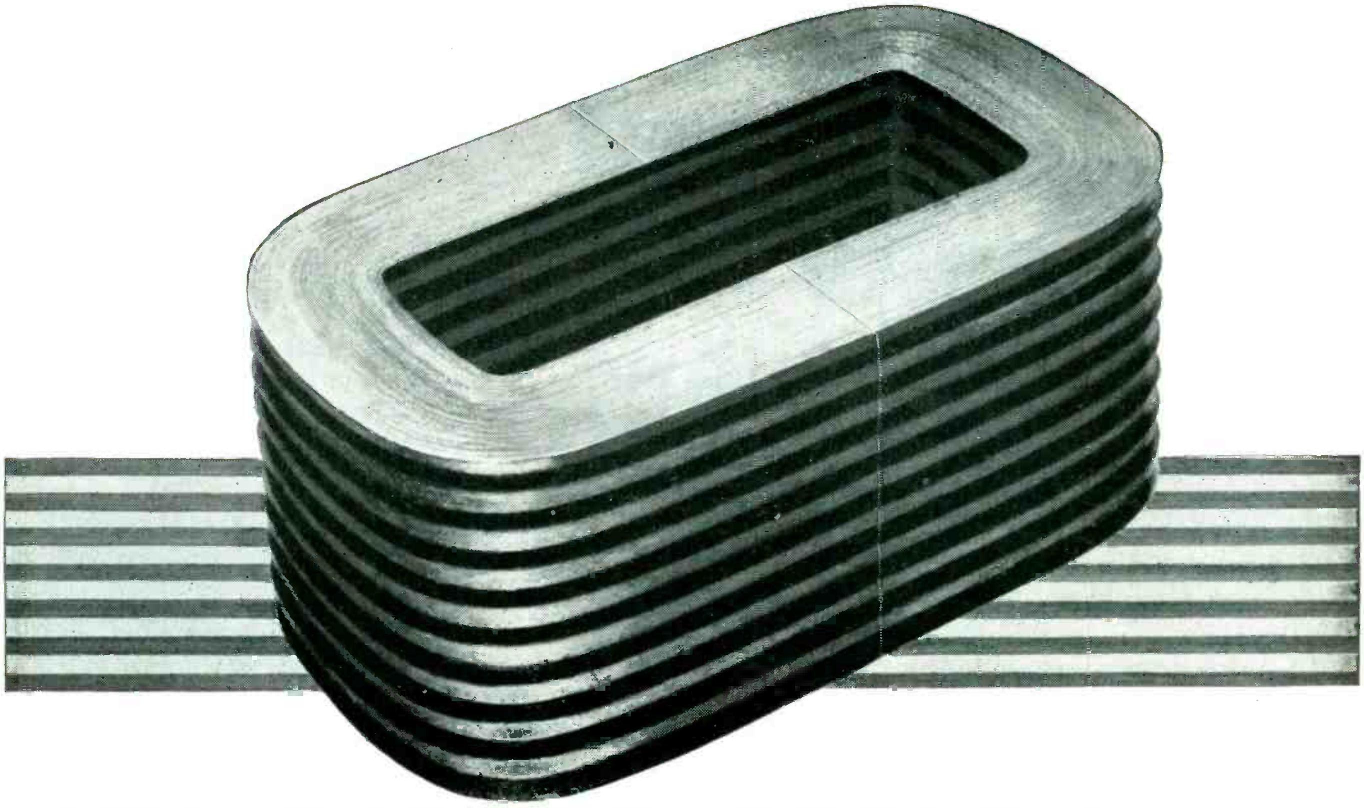
The company is a major builder of electric motors and generators, selenium rectifiers, magnetic amplifiers and automatic industrial controls as well as electronic and electrical equipment for railway applications.

Six New Engineering Appointments

AMERICAN RECTIFIER CORP. of New York City, manufacturers of large industrial selenium rectifiers, has announced the appointment of Samuel Heller as chief engineer.

Ultrasonic Corp., Cambridge, Mass., has named William M. Pease vice-president and director of engineering, and Paul Travers chief engineer.

Stanley Kramer has been promoted from project engineer for



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the Radio Receptor Co. Inc.'s Communications Division to chief applications engineer of the company's newly formed Germanium Products Division. Also in the new division, Herbert Friedman, after four years with Columbia University as electronics development engineer, has been appointed sales engineer.

S. H. Van Wambeck has joined the Hammarlund Mfg. Co., designers and producers of variable capacitors, all-wave receivers and remote control equipment, as chief engineer. He was previously di-

S. H. Van Wambeck

rector of research and enginering for Knapp-Monarch Co. in St. Louis and director of a U. S. Army Signal Corps project, making studies of special types of radio receiving equipment.

Companies Set Up Separate Divisions

FAIRCHILD CAMERA AND INSTRUMENT CORP., Jamaica, N. Y., has announced the formation of a new Potentiometer Division to be devoted exclusively to the development and manufacture of precision potentiometers. The new division, to be located in a recently acquired building in Hicksville, L. I., N. Y., will provide completely integrated facilities for engineering, production and sales.

The Gabriel Co. of Cleveland, Ohio, recently established the Gabriel Laboratories as a separate division of the company. The Laboratories, formerly the engineering department of the Workshop Associates Division, Needham, Mass., will serve as the research and

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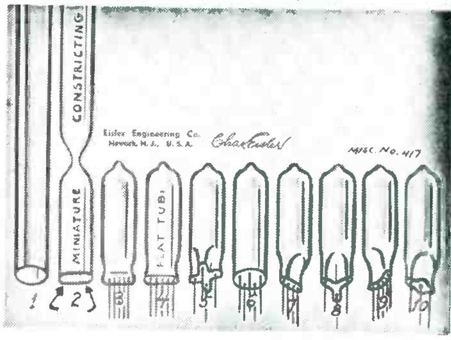

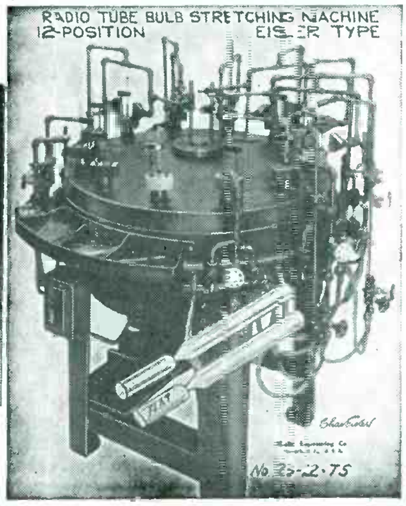

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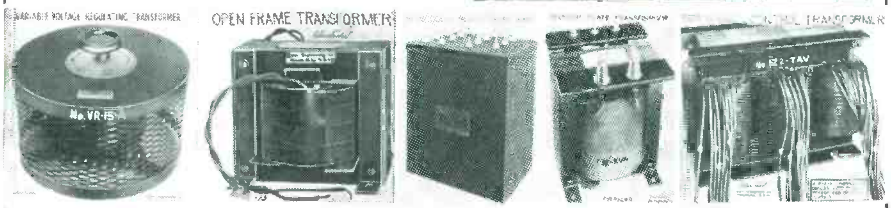

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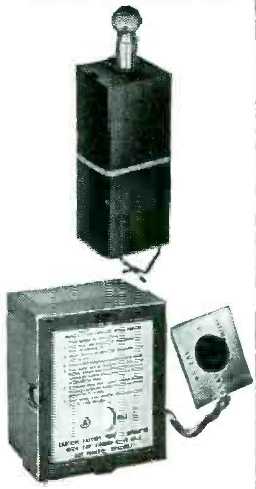

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GE Expands in South

THE General Electric Co. recently opened a new $6,000,000 electronic tube plant near Oxford, three miles south of Anniston, Ala. Total floor space is more than 160,000 sq ft and current employment is about 300. By next year the plant will employ an estimated 2,000 people in the production of miniature glass receiving tubes for radio, television and a wide variety of other communications and industrial equipment.

The plant marks another step in GE expansion in the south. The company has plants in Owensboro, Louisville and Lexington, Ky., and Jackson, Miss., and recently announced plans for a transformer plant at Rome, Ga.

Besides the Anniston Tube Works, six other GE tube manufacturing plants are in operation in Owensboro, Ky.; Tell City and Huntingburg, Ind.; Schenectady, Syracuse and Buffalo, N. Y. Another plant in Scranton, Pa., is being converted to tube production.

Westinghouse Names Two Executives

JAY M. ALLEN has been named manager of manufacturing and Ricardo Muniz has been appointed superintendent of manufacturing at the Westinghouse Television-Radio Division plant in Sunbury, Pa.

Mr. Allen, formerly superintendent of production, had previously held executive positions at Federal Telephone and Radio Corp., RCA, Erie Resistor Corp. and Stewart Warner Corp.

Mr. Muniz comes to this assignment from the Trad TV Corp. where he was vice-president and operations manager. He has previously held executive posts at DuMont, Radio Navigational Instrument Corp. and Munston Mfg. and Service Co.

The appointments are part of a general staff reorganization and increase in the overall company expansion program in tv and radio.

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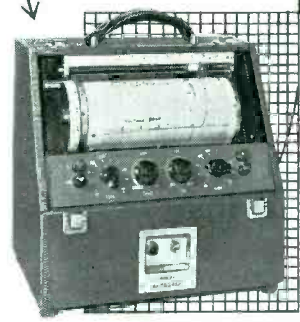

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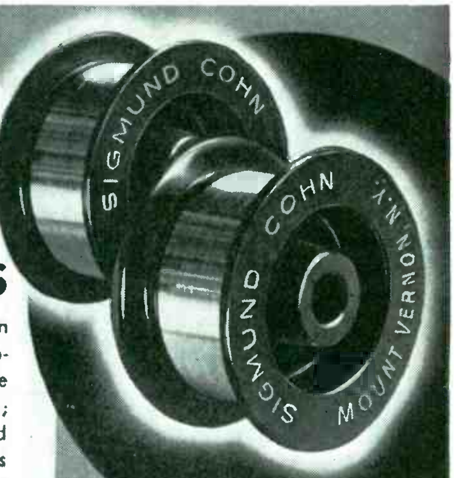

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Radio Antenna Engineering

BY EDMUND A. LAPORT. *McGraw-Hill Book Co.*, 1952, 563 *pages*, $9.00.

THIS book is a practical treatment of antennas for frequencies up to 30 mc and down to 30 kc. In addition to considering the antenna problem proper, the author also discusses the many other considerations which are directly related to the radiating structure proper. These considerations, which are generally illustrated by concrete examples, include: coupling networks and feed systems, ground systems, problems of voltage breakdown on wires and insulators, propagation phenomena, methods of array construction and transmission line problems.

The standard problems of radiation pattern analysis and determination of the input impedance of antenna elements have not been slighted, by any means. Methods of designing arrays to produce given coverage diagrams are discussed in detail. Computation of the input impedance taking into account the mutual impedance is also discussed. Most of the design formula have been given without proof, since the book is intended to help nonspecialists with some of the ordinary antenna problems that occur in practice. This represents no great omission since a substantial number of books on antenna theory and allied topics have appeared within the past decade.

Mr. Laport's book consists of six chapters, the first three of which respectively treat l-f antennas, m-f broadcast antennas and h-f antennas. These chapters, which comprise the first two-thirds of the book, are mainly concerned with the antenna problem, although the associated topics have not been neglected. The last three chapters respectively treat r-f transmission lines, graphical synthesis of impedance-matching networks and logarithmic potential theory. The book closes with a collection of appendixes, half of which are a collection of numerical data useful in antenna design.

The reviewer has only two minor

comments to make regarding this text. The first is in connection with the sections on the suppression of the secondary lobes in broadside arrays. Here, the author shows how secondary lobes can be reduced by pattern-splitting techniques and also by the use of binominal current distributions. However, no discussion is given of Dolph's theory of current distributions that produce the Tschebycheff type of pattern in which the relationship between beamwidth and side-lobe level has been optimized. This technique has proved quite useful in the design of linear arrays at microwave frequencies and could well prove useful in designing high-frequency curtain arrays. The second comment is with regard to the author's preference for the rectangular transmission line chart. In recent years, the Smith chart type of circle diagram has found essentially universal acceptance for working impedance problems so that a brief discussion of its form and uses would have been appropriate.

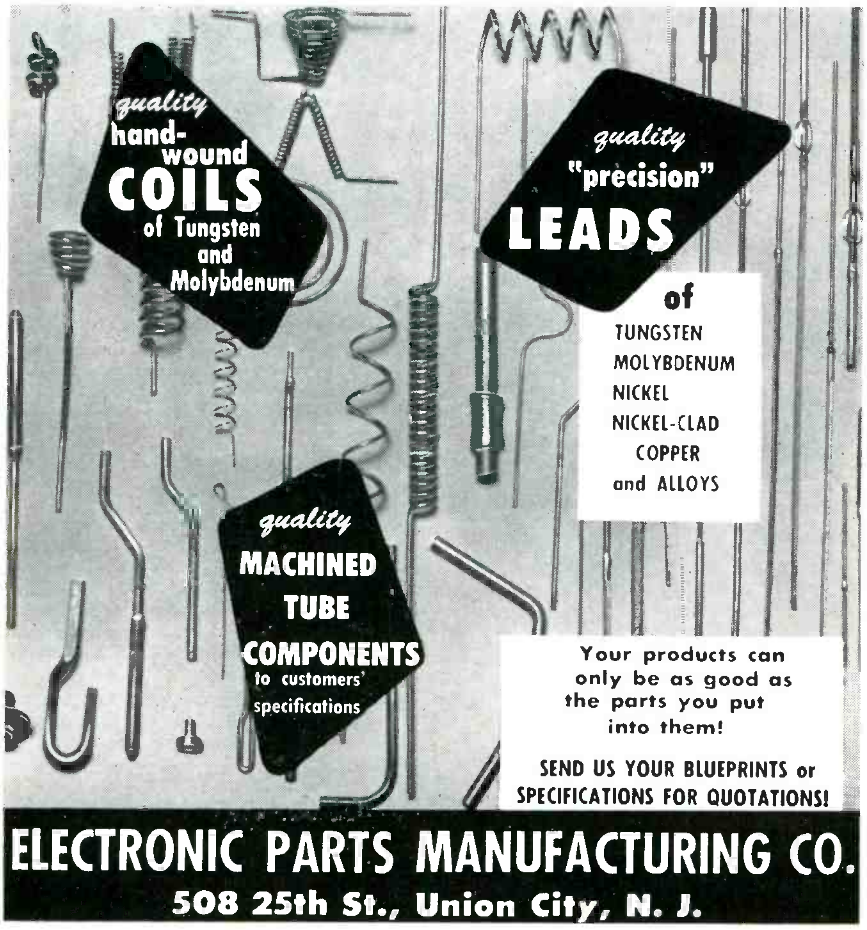
On the whole, the book does an excellent job of treating its subject and should be of great use to those who are concerned with antenna problems in the frequency range below 30 mc. The book is well organized and easy to read. Not the least of the book's merits is its large collection of photographs showing the details of construction of numerous antenna arrays and transmission line systems.

Mr. Laport is to be commended for having made available his wealth of experience in practical antenna design.—HENRY JASIK, *Assistant Supervising Engineer, Antenna Section, Airborne Instruments Laboratory, Mineola, N. Y.*

Electrical Measurements

BY FOREST K. HARRIS, *National Bureau of Standards. John Wiley & Sons, Inc.*, 784 pages, $8.00, 1952.

ALTHOUGH numerous books on the general subject of electrical measurements have been written in the last few years, this volume by Dr. Harris of the Bureau of Standards appears to be outstanding in its completeness in many respects. It is the first book on electrical meas-



urements to make reference to currently available instrument standards such as the American Standard C39.1 for Electrical Indicating Instruments. There is considerable discussion on this and other standards, and of parallel importance is the discussion on how to write specifications for the instrumentation required for any particular electrical project.

The first chapter on the art of measurement appeals enormously to this reviewer because of the very pertinent discussion on accuracy and experimental errors. The point is well made that the order of accuracy of the several components in the measuring system should be the same; a low-accuracy link in the chain may spoil the whole result, but by the same token a too-precise element requiring excessive manipulation leads to no greater accuracy in the end. The discussion of random errors and root-mean-square deviation, the so-called standard deviation, is rarely found in books of this type and an understanding of this philosophy is most helpful.

The section on laboratory practices should be read by everyone involved with laboratory work; anyone who has burned out an instrument or a circuit component will be doubly interested in the pertinent comments as to the use of protective resistors, the order of making connections, applying potential and the like.

The chapter on electrical units is excellent, giving some brief history as to the basis of the International Units used until a few years ago, and the new Absolute Units with their conversion factors from those used previously. It is noted that there is no discussion of any special parameters commonly used in electronics and high-frequency work, and the book thus appears to be rather definitely limited to power frequencies except as the extension to high frequency may be made directly.

Direct-current instruments are discussed in great detail, starting with galvanometers which are discussed through the various phases of design and including the equations of motion, response time and damping. There is a considerable discussion of sensitivity limits,

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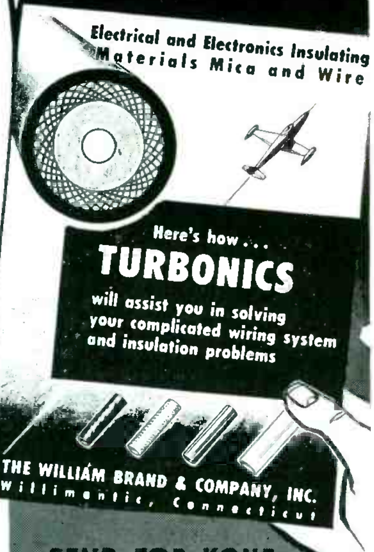

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along with several excellent tabulations of the sensitivities of galvanometers commercially available.

Proceeding with indicating instruments there is a discussion of springs, bearings, scales and pointers and magnetic systems, all of which may be of more interest to the instrument manufacturer than to the user who is rarely in a position to modify any such items in his laboratory equipment. Nevertheless a general picture of what is involved may be of some value in a better understanding of instrument physiology.

The potentiometer (not a circular rheostat!) is considered in great detail and many types are shown which are rarely seen in the modern laboratory. This section of the book, along with the discussion of standard cells, is perhaps of more use to those involved with instrument calibration and maintenance than to the engineer with a pressing problem in electronics. Nevertheless, the potentiometer approach to measurement, effectively a balance or substitution method, is a powerful approach and one which frequently can be used in r-f measurements where a thermoelement or a bolometer can convert the end result into d-c phenomena.

The section on resistors, including decade boxes, is quite valuable and there is a considerable discussion of the time constants of resistors which should be important in resistance measurements at higher frequencies. Bridge methods are similarly discussed and again will find considerable utility in all measurements since the bridge or balance approach to measurement is most useful.

The section on magnets and magnet testing is particularly pertinent today in view of recent advances in magnetic materials. From the ferrites through the powdered and sintered materials to the anisotropic alnicos, the spread in magnetic testing requirements has enormously broadened in recent years and this section will be of value to those concerned with ferromagnetism from the loudspeaker permanent magnet to the tv fly-back transformer.

Basic a-c measurements of current, voltage and power are discussed in detail and it might be

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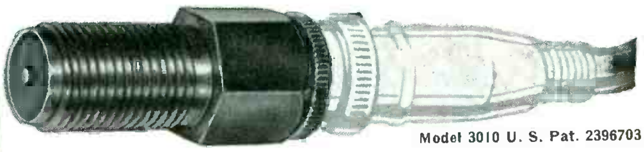

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While the discussion of oscillographs is reasonably complete and includes a discussion of the modern scope with a set of typical Lissajous figures, the section on electronic instruments is limited to some fourteen pages. This seems unfortunate in view of the rather enormous utility of electronic gear in the measurement art and it might well be that an additional chapter showing the detailed use of amplifying and detecting techniques derived from the vacuum tube would be well worthwhile.

In general, however, Dr. Harris has written an outstanding book on the subject of electrical measurements; no errors of fact have been located. The manuscript having been based on a great deal of prior work, it seems likely that the book can be used as a reference for many years to come.—JOHN H. MILLER, *Weston Electrical Instrument Co.*

Electric Transmission Lines

BY HUGH HILDRETH SKILLING. *McGraw-Hill Book Company, New York,* 1951, 438 *pages,* $6.50.

IN THE preface of his new book concerning transmission line theory, Dr. Skilling indicates that it is intended as an introduction to the field and states " . . . the purpose of this book is to give as much on circuits with distributed constants, and their practical applications, as

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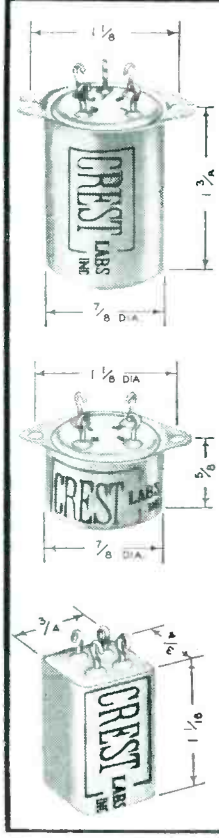

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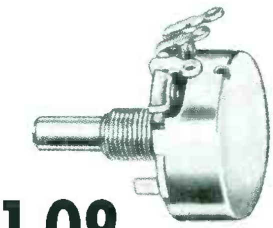

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is needed by all electrical engineers. . . . but it is not intended to train the specialist." The treatment as evolved by Dr. Skilling progresses significantly toward that ambitious goal. Dr. Skilling presents the subject in the same lucid and logical style which characterizes his other books.

Chapters 1 through 8 discuss the theory of transmission lines starting from the simplified high-frequency, low-loss point-of-view; thus the student is introduced to the unfamiliar world of distributed constant circuits in the familiar environment of trigonometric functions. After a discussion of traveling and standing waves, the treatment is generalized, using complex hyperbolic functions, to include the line with loss. A discussion of line parameters (characteristic impedance, propagation constant, etc), line constants (inductance, capacitance, effective resistance, etc), and artificial lines completes the theoretical section.

Chapters 9 through 13 consider application of the theory to l-f power lines, m-f telephone lines, h-f radio lines, and uhf wave guides. It is stressed that the behavior of each of these is best specified by different forms of the equations, and the specialized analysis techniques applicable to each are described. The different characteristics of lines associated with their operating frequency are matters that few engineers appreciate. The treatment here is gratifying.

The theory of wave guides is approached as an extension of transmission line concepts with hardly a mention of Maxwell's equations. The ideas of phase and group velocity, cut-off phenomenon, reactive and resistive attenuation, etc, are derived from the suitably modified line equations. The matters of higher modes, reactive obstacles, terminations, and coax-to-waveguide couplings are discussed somewhat heuristically. Chapter 10 is an introduction to filter theory from the traditional point of view. The final chapter, Chapter 14, discusses transient waves of arbitrary form traveling on periodic structures. Single and multiple reflections and the transition to steady-

state behavior are considered.

The viewpoint taken in this book is one which fundamentally separates transmission line theory from electromagnetic field theory. There are, of course, other approaches to the subject which some will consider preferable and more basic. On the other hand, their opinion will not be shared, perhaps, by their students, who will be striving for an intuitive grasp of the subject. This matter is one which must be decided according to the desires and objectives of the prospective user. Similarly, there will be those who desire to change the emphasis, as placed by Dr. Skilling, on various subjects. For example, although inherent in the treatment of traveling waves, there is no mention of the important use of lines for delaying and storing electrical signals. Also, the treatment of distortionless lines starts from the seemingly arbitrary condition, $r/g = l/c$, rather than from the perhaps more logical requirement of flat amplitude and linear phase response. This latter condition is the requirement for facsimile transmission through any network. Such criticisms, however, must be considered as secondary when the overall objective of conveying to the students an understanding of transmission lines in considered. In that, Dr. Skilling succeeds admirably. — WINSTON E. KOCK, *Director of Acoustics Research, Bell Telephone Laboratories, Murray Hill Laboratory.*

The Design of Switching Circuits

BY WILLIAM KEISTER, ALISTAIR E. RITCHIE AND SETH H. WASHBURN, *Bell Telephone Laboratories. D. Van Nostrand Co., Inc. New York*, 1952, 556 *pages*, $8.00.

THE field of switching circuits and its application to data processing machines has developed rapidly in the last few years, but there has been very little information published on the techniques of organizing the elementary switching circuits into the complex arrangements required in these applications. This, one of the first books concerned with a systematic treat-

ment of the subject, is an exposition of the principles of the logical design of relay circuits as developed by members of the Bell Telephone Laboratories. Its treatment of the time sequential properties of these circuits is the first published presentation of this subject known to the reviewer. Part of the book is concerned with an extension of the techniques to electronic switching circuits employing gas tubes, vacuum tubes and semiconductor devices.

For the most part, this book is a description of the logical properties of relays and several classes of relay circuits used in telephone systems. It presents a large amount of design information which forms the basis of the "inspection" techniques used by the experienced designer. An attempt at development of a mathematical theory of switching circuits is made with a description of Shannon's treatment of the Boolean algebra of relay circuits. The algebra is introduced in terms of a sort of physical analogy between relays and logic. The notation and operations of the algebra are presented before any mathematical definition of the symbols is made. In the chapter on electronic switching circuits, the algebra is applied without mentioning what properties of the circuits are identified with the binary digit values of the algebraic-letter symbols, except for an implication that activation of a terminal has something to do with the mathematics. This vagueness must make the presentation confusing to the beginner as well as lacking in rigor.—ELDRED C. NELSON, *Head, Computer Systems Department, Hughes Aircraft Co., Culver City, Calif.*

Transient Electric Currents

BY H. H. SKILLING, *Professor of Electrical Engineering, Stanford University, McGraw-Hill Book Co., New York, 2nd ed.*, 1952, 361 *pages*, $6.00.

THIS book is written at an undergraduate level, for engineering students taking a first course in transients or for engineers desiring a home refresher course. Classical methods for solving transient problems are used in the first nine chapters. Transformation methods are

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presented in the last chapter.

The theory of transient voltage drops and of current and energy flow in a network are presented in great detail. A reader with a working knowledge of differential and integral calculus should follow the developments readily. Practical examples, introduced from time to time, indicate the utility of the material and the importance of transients.

The first two chapters consider the *RL* and *RC* series circuit. The operator *p* is introduced and a method for solving transient problems is standardized, thereby obtaining four readily remembered rules that can be applied to the above types of circuits to obtain a solution easily.

Chapter three discusses first-and second-order differential equations and their solutions. The fourth chapter considers the series *RLC* circuit for underdamped, critically damped and overdamped conditions. Simultaneous solutions for first- and second-order differential equations are discussed in chapter five, which treats simple networks. Chapter six discusses the transient current in series *RL*, *RC* and *RLC* circuits when a sinusoidal driving voltage is applied. A few pages are devoted to transient currents in a network when a nonsinusoidal periodic or a nonsinusoidal nonperiodic (other than a step-function) driving voltage is applied.

The seventh chapter discusses transient currents in coupled resonant circuits. This chapter is an extension (for a particular case) of the fourth chapter with regard to the simultaneous solution of second-order differential equations. Transient currents in circuits with variable parameters are discussed in chapter eight. Two methods of solution are presented for simple *RL* and *RLC* circuits in which the inductance is a function of current.

Transmission lines are considered in chapter nine. Differential equations for a transmission line are developed and their solution is shown to lead to a voltage (or current) that is a function of position and time; that is, a traveling wave. Reflections are treated for the case of a d-c step-function driving volt-

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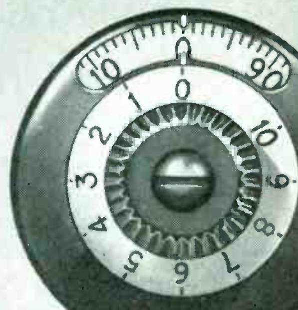
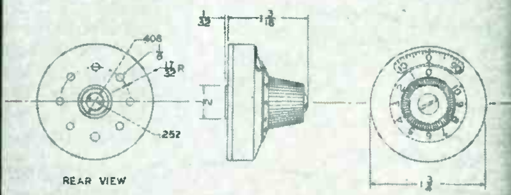


ACTUAL SIZE



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age. This chapter avoids the mathematical complexity of other texts on elementary transmission-line theory.

Chapter ten introduces the reader to the transformation method. The Fourier-series transform is then discussed and the Laplacian transform is introduced by analogy to the Fourier-series transform.

Occasionally material elsewhere in the book is referred to incorrectly. For illustration, on page 173 reference is made to an example in Section 19; actually the example is in Section 18. The reader will find that if he understands the text, the continuity is not disturbed and the correct material can be easily found and verified.

Although this review has stressed the mathematical aspects of the book, it should be pointed out that the physical descriptions are complete and that, when necessary, the mathematical steps taken to reach a particular expression are fully described.

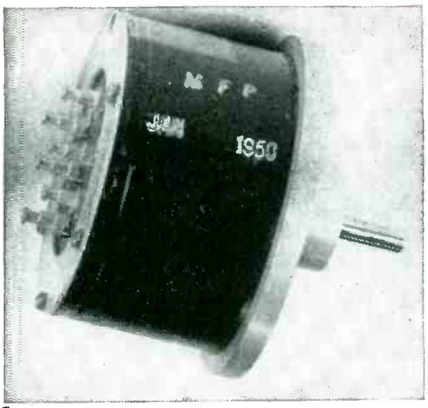
The first two-thirds of the book can be considered a first course in transients. The last part of the book, especially chapter ten, should prove most interesting to engineers dealing with transients.—WALTER J. DAUKSHER, *Engineer, Airborne Instruments Laboratory, Mineola, New York.*

Materials Technology for Electron Tubes

BY WALTER H. KOHL. *Reinhold Publishing Co., New York, N. Y.*, 1951, 493 *pages*, $10.00.

EVER since Espe and Knoll published their classic work sixteen years ago, tube development engineers have hoped for a similar authoritative book in the English language. This book is the first attempt to fill this need. The purpose, according to its preface, is "to present the physical characteristics of the solids used in the fabrication of vacuum tubes and to describe some of the processes for the application of these materials."

The book contains a great deal of well-indexed information hitherto not available in a single source and is to be especially commended for its excellent and complete bibliog-



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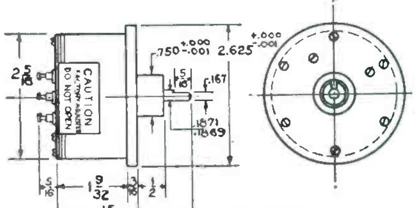

RL-11C

CONDENSED SPECIFICATIONS	RL 11-C	RL 14-MS
Total resistance	16,000 ± 10%	35,400 ± 1%
Percent resistance within brush circle	Approx. 85%	99 ± ¼%
Angle of rotation	360°	360°
Weight	4.75 oz.	1.8 lbs.
Torque (Approximate)	¾ oz. in.	2 oz. in.
Wire	80 Ni 20 Cr	80 Ni 20 Cr
Resolution	.4°	.2°
Angular accuracy	±.6°	±.5°
Amplitude accuracy	±.8%	±.6%
Maximum volts across winding	150	350
Maximum speed	60 rpm	60 rpm
Expected Life	350,000 cycles	200,000 cycles

Illustration shows RL-11C unit, RL-14MS unit is approximately twice as large. Minor variations of these standard designs, available on special order, permit operation at high rotational speeds with some loss of accuracy but, with a substantial increase in expected life. Sine and cosine voltages are produced simultaneously. Resistances other than those shown above are available within certain limits.

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raphy. However, on the one hand it contains much material which is irrelevant to tube design and construction while, on the other hand, it omits or slights other material of prime importance. For example, most of the copper alloys and most of the solders mentioned contain metals of high vapor pressure and could, therefore, not be used inside vacuum tubes. The tabulation of refractory minerals includes many that are rare and are not commercially available. Although much space is given to porcelain and magnetic ferrites, neither finds use as internal parts of tubes. No mention is made of phosphors so important to cathode-ray tubes nor of chrome-copper alloys so important to receiving tubes.

Glass, ceramics and soldering are covered in adequate detail. Other matters such as metals, getters, processing operation and emission, if one may judge by the space given to them, received rather limited treatment. For example, the chapter on emission is devoted primarily to the thoriated-tungsten filament and the L-cathode, with little mention of the very important oxide-coated cathode.

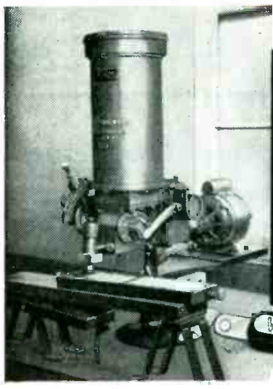
In all, this is not a book for the inexperienced reader but rather one which requires considerable judgement to evaluate the material presented and to choose from it. Although the book suffers from the faults common to first efforts, it does contain much which the tube engineer will find valuable, including an especially complete and useful bibliography.—STAN UMBREIT, *Tube Department, Radio Corporation of America, Harrison, N. J.*

THUMBNAIL REVIEWS

INTRODUCTION TO ELECTRICAL ENGINEERING, 2nd edition. By Robert P. Ward. Prentice-Hall, 416 pages, 1952. For a first course; uses MKS units throughout.

VADE-MECUM, 1952. P. H. Brans, Antwerp, Belgium, 416 pages, $5.60, 1952. Now divided into two volumes, this 9th edition of a world-wide list of tubes contains only receiving and transmitting tubes; the 10th edition, yet to be published, will list picture tubes, phototubes, crystal diodes, klystrons, etc.

ATOMS, SPECTRES, MATERIERE. By Yvette Cauchois. Albin Michel, Paris, 640 pages, 119 figures, 1,800 francs. A paperbound text on the structure of matter, in French. According to the publisher's blurb, "l'ensemble est agreable a lire" and a glance through the volume indicates that this is, indeed, true.



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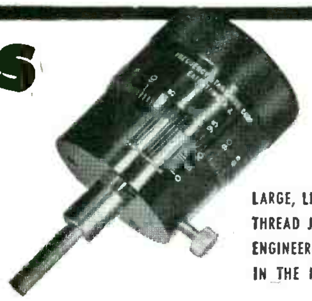

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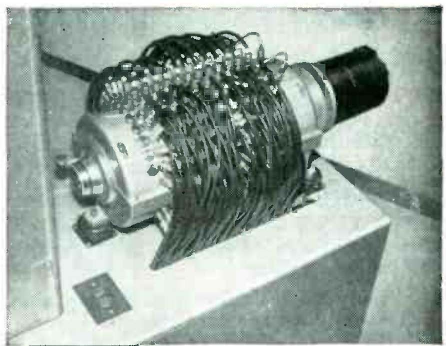

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BACKTALK

Medical Electronics

THE FOLLOWING are abstracts from a small sample of letters to Dr. Herman I. Kantor regarding his article "Electronics Engineering Needed In Medicine" (ELECTRONICS, p 82, Feb. 1952)

DEAR SIR:

THIS LETTER is written as a result of your very stimulating article in the February issue of ELECTRONICS. It has long been my hope to make some useful contribution to the field of medical instrumentation. This goal exists for me because, like many engineers, I have been largely occupied in the last ten years by various phases of weapon making and I yearn to apply the same efforts to some positive good.

I have previously studied the possibility of applying electronics to such jobs as simplifying the presentation of some of the information that is now available with the electrocardiograph. It seems reasonable to presume that if heart malfunctions can be heard with a stethoscope the same variations can be made visible and thus subject to quantitative interpretation.

As a nonmedical man and since I have been unable to enlist the interest of my family doctor I have been at a loss as to where to turn for advice.

DONALD V. RICHARDSON
Glenwood Landing, N. Y.

DEAR PROF. KANTOR:

I HAVE just read your interesting article in ELECTRONICS where you so daringly use statements like "pseudo science" and "art of medicine." I am an electronics engineer and the manager of a factory which produces medical electronics instruments. Some time ago we made a trial run of 20 chronaximeters, for which I had accumulated the electronic specifications out of American, English, French, Italian and German handbooks on physiotherapy. These 20 units were sent to 20 outstanding neurologists at various institutions all over the U. S.—free of charge for examination, application and comments. The result was a huge correspondence without

any positive comments, very few negative comments, but mainly enquiries regarding application and necessity of these instruments. Two "scientists" phoned me to say that these instruments were too easy to operate and would therefore annihilate the importance of specialists!!!

This and previous personal experience plus your article lead me to believe that during the few thousand years of medical experiments with that same old object, the human being, very little has changed so far. However, in less than a hundred years electronics has been speeded up by international cooperation of, for example, radio amateurs who had the urge to read everything printed about a subject and who communicated and compared their simple results with each other.

MARK M. SIERA
Forest Hills, New York

DEAR SIR:

I WAS very much interested in your article on medical electronics in the February issue of ELECTRONICS. I have been looking around for some spare-time projects, but unfortunately, I have absolutely no connections in the medical profession. Could you suggest someone in this part of the country whom I could interview and thereby get a fuller grasp of the problems involved? A small independent laboratory such as mine would find it necessary to work in close cooperation with one or more hospitals, I would think.

ARTHUR S. KRAMER
Cedar Grove, New Jersey

(Editor's Note: Most of the other letters received by Dr. Kantor, regarding his article, praised him for taking his stand and all correspondence from electronics engineers expressed eagerness for additional information about the needs of medicine. We have already made arrangements for several medical electronics articles to be published in the near future to meet the overwhelming demand expressed by our readers as a result of Dr. Kantor's article and *Backtalk* letter. The following is a sample of letters illustrating the effect of Dr. Kantor's article as expressed in letters directed to this office.)

Congratulations Doctor

DEAR SIRS:

YOUR *Crosstalk* item entitled, "Medicos" (ELECTRONICS, p 97, May 1952) has aroused my curiosity. Your assertion that any article that draws about 10 letters

requesting further information rates high is not surprising.

The reason that so few letters are received by authors of most articles is, in my humble opinion, that most articles are mainly spectacular and shall we say of the pedantic. Such articles are of specific importance to but a minor percentage of readers, though perhaps this percentage is at some particular instant a very important one.

As soon as you publish an article that has an appeal for 25 percent of your readers, it will draw attention and the writer of such an article will, as I personally know from experience, find that he has landed a bigger fish than his line can cope with.

May I therefore offer my congratulations to Dr. Kantor, and also to your discerning staff responsible for once again including something of both interest and importance among the humdrum of academicals and involved technical specialties.

JAMES R. CORNELIUS
Cornelius Electronic Instruments
Coventry, England

(Editor's Note: From our experience it is difficult to predict reader interests in our field. An extensive survey conducted a few years ago, revealed many interesting, and some surprising, facts about subscribers' likes and dislikes. Our selection of articles is based on such survey information and spot checks in the field. Comments from subscribers on this subject are always welcome and will help guide us toward making a more useful ELECTRONICS.)

Interprofessional Meeting

DEAR SIRS:

THIS REFERS to the *Backtalk* letter written by Dr. Herman I. Kantor that appeared in the June 1952 issue of ELECTRONICS (p 332). As he points out, many electronics engineers are eager to apply their knowledge to medical problems.

I don't know if the IRE has a committee on medical electronics. (See Editor's Note at the end of this letter.) I would like to see a program set up wherein some recognized group of engineers would meet regularly with some recognized group of doctors, under joint sponsorship of the American Medical Association and of some other organization in our field, such as the IRE.

The goal, I believe, should be formally only the transmission of information relative to problems

and their solution. Suitable publishing of problems such as Dr. Kantor refers to, after screening by the electronics committee and conversion to terms conducive to attack by electronics development engineers, would get the information before the people best equipped to handle it. I venture to say that, if large laboratories are too busy these days to attack the problems themselves, then small groups of men, in their spare time, will do the job for the medical industry, for the electronics industry, for humanity and for themselves.

With large medical and biological research laboratories in existance, as they are now, I know of one specific case (and there must be more), where physicists and electronics men are so directly responsible to and are so directly controlled by the doctors who are unaware of the capabilities of the electronic and physical approach, that really significant work has yet to emerge from the combination. Giving the electronics boys complete freedom (as they would have to have if they tackled the jobs voluntarily, even on their own time) will help to avoid this situation.

In any case, I volunteer to serve on a committee, (as senior member of the IRE and a member of the American Physical Society I imagine I qualify), and I think I could find time to perform individual effort at design if required. Your comments will be appreciated.

WILLIAM B. LURIE
Fleetwood Laboratories
Bronxville, N. Y.

(Editor's Note: There is a professional group within the Institute of Radio Engineers for Medical Electronics, but it is in a formative stage at the present time. Plans are being made for special meetings and symposiums at the National IRE Conferences. Requests for further information should be directed to the present chairman of the group, Mr. L. H. Montgomery, University School of Medicine, Vanderbilt University, Nashville, Tenn., or direct to the IRE.)

Flat But Not Dull

DEAR SIRS:

THE LETTER by Mr. Walter E. Sellman in *Backtalk* of the June, 1952 issue of ELECTRONICS contains a statement which is indicative of a false impression to which many have fallen prey over the years. Unfortunately some of these are num-

bered among the engineering profession. Mr. Sellman, while citing various reasons for the admittedly poor sound quality of network programs as mentioned in a previous editorial in the March, 1952 issue of ELECTRONICS discussing the "flat, dull" tone of radio networks, made the statement "One of the limitations, of course, is the 5,000-cycle limit on a-m broadcast transmitters."

We a-m broadcasters have enough difficulty sneaking our little signals into the far corners of our claimed coverage areas amid all the interference of an overcrowded band without being saddled with an upper limit of 5,000 cycles in our transmitters. The "flat" truth of the matter is that a-m broadcast transmitters are not limited to a frequency response of 5,000 cycles. The false impression that they are, possibly stems from the fact that since a-m broadcast frequencies are separated by 10,000 cycles, to broadcast any sound intelligence containing frequencies higher than 5,000 cycles would result in sidebands spilling over into an adjacent channel. But standard a-m braodcast stations are not licensed by the FCC on adjacent channels in the same local area. The FCC Standards of Good Engineering Practice contain a requirement that "the audio frequency transmitting characteristics of the equipment from the microphone terminals . . . to the antenna output does not depart more than 2 decibels from that at 1,000 cycles between 100 and 5,000 cycles." However, this requirement does not place an upper limit of 5,000 cycles upon the transmitting equipment. In fact, the FCC does not place any upper limit on a-m broadcast transmitters except to say that "in the event interference is caused to other stations by modulating frequencies in excess of 7,500 cycles . . . the licensee shall install equipment or make adjustments which limit the emissions to within this band or to such an extent above 7,500 cycles as to reduce the interference to where it is no longer objectionable." In the absence of such interference no upper limit exists from a legal standpoint. In passing it might be added that the FCC Standards do

require a-m broadcasting equipment to be capable of at least 85 to 95 percent modulation at 7,500 cycles with not more than 7.5 percent harmonic distortion.

In the interest of reducing such sideband interference most manufacturers of broadcast transmitters include in their design a low-pass audio filter, or other means, whose purpose it is to present a rapid attenuation of audio frequencies above 10,000 cycles, and the frequency response of the transmitting equipment is therefore not seriously impaired over the audio band of 50 to 10,000 cycles. Several standard a-m stations broadcast signals having substantially flat response out to 15,000 cycles. These facts may come as a surprise to many who have never troubled to equip themselves with a good a-m receiver with a wide band-pass i-f section and a creditable audio amplifier and speaker. In fact, while listening with such a receiver to the station at which the writer is chief engineer, the principal technical faults of our a-m broadcasting will be found to be the ever-present small dynamic range and susceptibility to atmospherics. The real reason for the seeming poor frequency response of a-m broadcasting stations airing "non-network" programs will often be found in the narrow band-pass and poor audio sections of the millions of "$39.95 and equivalent" a-m receivers studding the U.S.A.

ELMER TROUTMAN
Chief Engineer, WIRC
Hickory, N. C.

Graph Paper Available

DEAR SIRS:

IN M. W. Scheldorf's recent article, "Antenna Gain by Graphical Means" (ELECTRONICS, p 144, Mar. 1952), three special types of graph paper were illustrated in Fig. 3, 4 and 5.

These graph sheets are available for purchase from Andrew. Type numbers are as follows:

Fig. 3 K-13901
Fig. 4 K-13902
Fig. 5 K-13900

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Old established Toronto firm in radio and electronics industry requires the services of a sales engineer, with college degree in Communications Engineering or Electronics, to handle one of the world's leading lines of laboratory test equipment. Should have at least two or three years practical engineering experience. Must have ability to meet and handle people. Permanent position. Live in Toronto, but willing to travel throughout Canada. Please submit all pertinent information, including salary required to:

SW-4736, Electronics
330 W. 42 St., New York 36, N. Y.

POSITIONS OPEN

Location
KANSAS CITY, MO.

Electronic & Mechanical Engineers

ELECTRONIC ENGINEERS: Must have considerable development experience in radio transmitting and receiving equipment. Ability to fill position of Senior Project Engineer a requisite.

MECHANICAL ENGINEER: Must have development experience in mechanical design of electronic or similar precise equipment. Practical and theoretical knowledge of materials, finishes, sheet metal, and machine shop design are basic requirements. Position is one of considerable responsibility.

SALARY: Open.

These positions are permanent.
Write stating educational and professional history direct to:

Jay V. Wilcox, *President*
WILCOX ELECTRIC COMPANY, INC.
1400 Chestnut St. Kansas City 1, Mo.

Dependable communications since 1931

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42nd St. (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

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INTERESTING OPPORTUNITY. Long established Ohio professional engineering organization requires ingenious B.S. for design and development of electronic circuits for industrial clients. 0-5 years experience. Salary and bonus plan. P-4714, Electronics.

WANTED—GRADUATE electrical engineer for work in Connecticut. A man having approximately 3 years experience in design of transformers or electrical machinery could qualify. Salary commensurate with ability. The Superior Electric Company, Bristol, Connecticut.

POSITIONS WANTED

CHEMICAL ENGINEERING, electronics, degrees, age 40, 10 years chemical experience, first class phone license, Sigma Xi, available immediately. PW-4691, Electronics.

ELECTRONICS ENGINEER desires Foreign position, married—several years experience in research, development, design of electronic circuity-radar advanced degree. PW-4619, Electronics.

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SALES REPRESENTATIVE Engineers are seeking additional lines in electronics and allied fields. Metropolitan N. Y. location. Organization offers over 20 years experience in field. RA-4191, Electronics.

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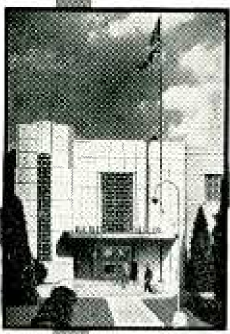

- TV RECEIVER DESIGN ENGINEERS
- ELECTRONICS ENGINEERS
- FIELD ENGINEERS
- TEST & INSPECTION ENGINEERS
- LAB. TECHNICIANS

NEEDED TO WORK ON: Radar, G.C.A., Mobile Radio, Auto Radio, Airborne Communication & Navigation Equipment, Television, Antennas, Microwave Equipment, Servo Mechanisms, Guided Missiles and Test Equipment Design.

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ELECTRONIC
and
Electro-Mechanical

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Minimum Requirements

Four years' experience in advanced research and development on Radar Systems, Computers, Wave Guide and Antennas, Servo-mechanisms, Pulse Techniques Gyroscopic Equipment and Related Fields.

If your skills are now being fully utilized in a vital defense industry, please do not apply.

Kindly send resume and salary requirements to

The W. L. MAXSON CORPORATION
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RICO

ATTENTION!
Former Field Engineers

We urgently need men with electronic background, and preferably radar or computer experience, to supervise, instruct and assist in installation—maintenance of electronic equipment.

Excellent starting salary during factory training, plus overtime premium in field. Substantial insurance program. Domestic & overseas assignments available. Salary will be commensurate with experience.

Please forward your personal experience record to:

Personnel Supervisor
Field Eng. Div.
Reeves Instrument Corp.
215 East 91st St.
New York, 28, N. Y.

SALES ENGINEER

- ELECTRONIC COUNTERS
- AUTOMATIC CLERICAL SYSTEM
- DATA HANDLING EQUIPMENT
- DIGITAL COMPUTERS
- PRECISION TIMING INSTRUMENTS
- AUTOMATIC MACHINE CONTROL
- FLYING TYPEWRITER

Excellent opportunity for a man with electronic background, mechanical aptitude, and IMAGINATION.

— Well-established and expanding company —

Please send resume of education and experience to Sales Manager.

POTTER INSTRUMENT COMPANY
115 Cutter Mill Road,
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STAVID ENGINEERING, INC.

has openings for Graduate

ELECTRONIC ENGINEERS

MECHANICAL ENGINEERS

Experience in Design and Development of Radar and Sonar necessary.

Broad knowledge of Search and Fire Control Systems; Servo Mechanisms, Special Weapons, Microwave, Antenna and Antenna Mounts, etc.

Mechanical Engineer should have experience in packaging of Electronic Equipment to Gov't specifications including design of complex cabinets, shock mount and sway brace structures, Servo Mechanisms.

Positions are available in Field Service and Technical Writing.

Liberal personnel benefits including life, sickness and accident insurance, and a worthwhile pension system. Paid holidays and vacations.

Personnel Office
200 W. Seventh St.
Plainfield, N. J.
Telephone Plainfield 6-4806

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CHEMISTS
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Through the opportunity to work with leading scientists on important advanced projects . . . through continued advancement possibilities . . . and the stability of association with a company whose products are vital to American defense, industrial and consumer needs, you can be more certain of a future of satisfaction and achievement.

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MOBILE COMMUNICATION
MULTIPLEX MICROWAVE
COMMUNICATIONS
ELECTRONIC COMPONENTS
TELEVISION, TUBES & ANTENNAS

Bachelor's or advanced degrees in Electrical or Mechanical Engineering, Physics, Metallurgy, or Physical Chemistry and/or experience in electronics industry necessary.

Do not apply, please, if your best skills are being used for vital defense work.

Please send resume to:
Dept. 82-E, Technical Personnel
ELECTRONICS PARK

GENERAL ELECTRIC
SYRACUSE, N. Y.

ELECTRONIC ENGINEER

for

Challenging Opportunity in

ATOMIC ENERGY

Tracerlab, Inc., the foremost commercial firm in the development of peacetime applications of atomic energy and electronic instrumentation for measuring radioactivity seeks an outstanding Electronic Engineer to take complete responsibility for a group of major projects.

Position requires a B.S. in Electronic Engineering, with an M.S. preferred. Minimum of 5 years industrial experience. Familiarity with applications and limitations of manual and machine tools used in sheet metal work, good knowledge of drafting practice and complete understanding of electronic test equipment necessary.

Unparalleled opportunities await the qualified applicant. Salary commensurate with training and experience. Please send resume to:

Industrial Relations Department

TRACERLAB, INC.
130 High Street Boston 10, Mass.

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Missile Electronics

Prominent well-established aircraft and missile manufacturer offers an outstanding opportunity to a person qualified to head an expanding electronics organization. Must have at least ten years experience in airborne electronics, five of which should be in missile or radar design and development. Advanced degree preferred. Position reports to chief engineer. Send detailed resume of background and recent photograph to

P-4684, Electronics
520 N. Michigan Ave., Chicago 11, Ill.

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Mechanical Designers for Research and Engineering

To work in the design and development of new electronic equipment. Excellent working and living conditions, good salaries and exceptional employee benefits. Write, giving full details including education and experience. Personal interviews will be arranged.

THE NATIONAL CASH REGISTER COMPANY
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Small electronic research and development laboratory, located 8 miles outside of Washington, D. C., has several openings for junior and senior electronic engineers. Degree essential. Varied projects include analog computers, servo mechanisms, special test equipment, etc. Liberal salaries dependent upon experience.

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Applied Physics Laboratory
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Microwave theory and practice in communications or radar using pulse techniques

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Electronic physics — information theory background

We have excellent facilities and opportunities in modern research laboratories.

For further information write

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Salary $12,000 — $15,000

Well - established, medium - sized company located on Long Island, N. Y. Continually expanding. Products include electronic measurement instruments, industrial control equipment and electronic business machine systems. Ideal opportunity for industrious and talented manufacturing superintendent. Engineering degree required.

Must be qualified for supervision of—

Electronic and Electromechanical Manufacture

Experimental & Production Machine Shop

Sheet Metal Construction

Quality Control

Production Scheduling

Send summary of education and experience to:

P-4759, Electronics
330 W. 42 St., New York 36, N. Y.

ELECTRONIC AND MECHANICAL ENGINEERS

Electronic or electrical engineer with at least three years' experience in either development or production of electronic equipment; to act as liaison between development laboratory and production facilities. Salary commensurate with experience.

Electronic or electrical engineer with at least two years' experience in development of electronic equipment; to assist product engineers in the analysis and solution of problems arising when components coming out of a development laboratory are put into production. Salary commensurate with experience.

Senior electronic engineer for the design and supervision of design of electronic instrumentation for underwater ordnance. Salary commensurate with experience.

Mechanical design with at least two years' of machine design experience in the small mechanisms field. Design work on a model basis, with an eye on future production problems. Salary commensurate with experience.

Opportunities for graduate study.

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ORDNANCE RESEARCH LABORATORY
THE PENNSYLVANIA STATE COLLEGE
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Write Giving Full Details To:
Personnel Director, Dept. A.

GIBBS MANUFACTURING AND RESEARCH CORPORATION
Janesville, Wisconsin

ELECTRONIC ENGINEERS

Degree in Electrical Engineering Plus Maintenance or Repair Experience on SCR-584 Radar

ELECTRONIC ENGINEERING COMPANY OF CALIFORNIA
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Electronic Engineers

Man with electrical engineering degree and three to five years' experience (circuits, video, optical) for position in Reasearch Department. This job offers:

(1) Position with expanding organization interested in color motion pictures and television..
(2) Employment in Southern California with excellent long-range peace-time prospects.
(3) Excellent employee benefits such as group insurance, pension, etc.

If interested contact Personnel Department describing educational and industrial background.

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of
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Positions now available for highest caliber personnel in the field of airborne automatic electro-mechanical control equipment.

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ELECTRONIC ENGINEERS
SERVO ENGINEERS
ELECTRONIC DESIGNERS
MECHANICAL DESIGNERS

New and expanding division of an established firm with 20 years of successful experience in the instrument field. Work involved deals with the manufacture and development of highly complex equipment of the most advanced type.

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AC Spark Plug Division
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1925 E. Kenilworth Place
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entrance into the field of ELECTRONIC DEVICES for HELICOPTER use has created an immediate need for

RADIO ENGINEERS

Minimum of 5 years experience in the design and development of high frequency FM transmitters and receivers. Engineering graduates with advanced degrees preferred.

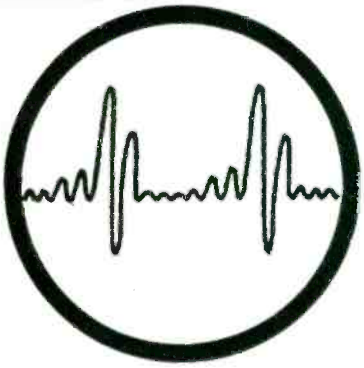
RADIO and ELECTRONIC TECHNICIANS

3 to 5 years experience in the construction testing and operation of high frequency FM transmitters and receivers. Engineering graduates preferred.

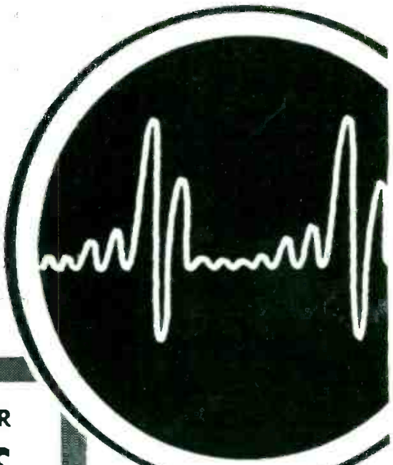
ELECTRO-MECHANICAL TECHNICIANS

3 to 5 years experience in aircraft servo-control systems. Engineering graduates preferred.

Please send detailed resume to
W. M. TYNAN
Administrative Engineer
Department E
KAMAN AIRCRAFT CORPORATION
Windsor Locks, Connecticut



Senior Engineers
SEE PAGE 342
JULY ISSUE ELECTRONICS FOR OPENINGS IN CONVAIR'S COMMERCIAL CHARACTRON PROJECT



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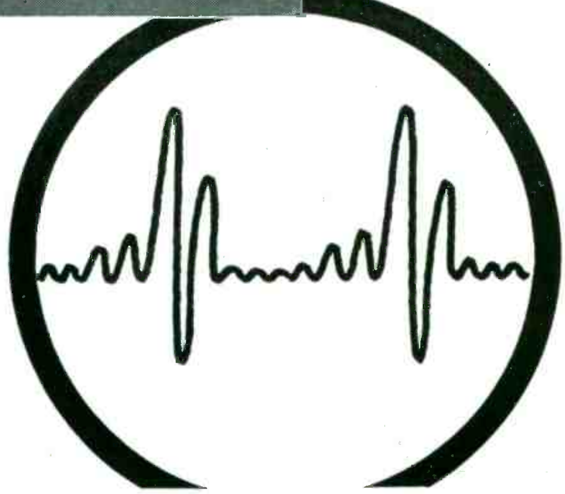


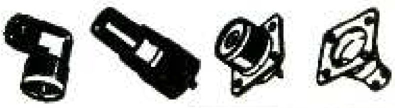
OIL FILLED CONDENSERS

MFD	VDC	Price	MFD	VDC	Price	MFD	VDC	Price	MFD	VDC	Price
2	400	$ .55	.1	1500	.59	.1	7000R'd	1.79	.125	27KV	37.50
5-5	400	1.65	.5	1500	1.25	.1-.1	7000	5.95	.001	50KV	24.50
1	600	.55	3	1500	2.50	.1	7500	2.85	.025	50KV	42.50
2	600	.69	4	1500	2.95	.5	7500	8.95	.2	50KV	85.00
2	600R'd	.69	.1-.5	2000	.95	1-1	7500	22.50	.25	50KV	95.00
2-2	600R'd	1.65	.25	2000	1.50	.075-.075	8KV	6.50	7.5	220VAC	1.95
3	600	.95	.3	2000	1.30	.5	10	16.50	1-3	330VAC	1.95
4	600	1.65	1	2000	1.95	1	10KV	29.50	10	330VAC	3.95
4	600R'd	1.65	3	2000	3.75	.1	12KV	8.95	12.75	330VAC	4.10
5	600	1.75	12	2000	8.95	1	15KV	37.50	15	330VAC	4.50
6	600	1.85	1	2500	2.75	.045	16KV	4.70	5	440VAC	3.10
8	600R'd	1.85	1-1	2500	3.85	.05	16KV	4.95	2.9	660VAC	3.50
8-8	600	1.95	32	2500	15.80	.075	16KV	8.95	7	660VAC	4.25
4-4-4	600	2.50	.5	3000	2.40	.25	20KV	19.95	8	660VAC	4 50
4 x 3	600	2.50	1	3000	3.40	1	20KV	54.00			
10	600	3.25	2	3000	4.50						
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	.01-.03	6000	1.65						
1-1-1	1200	1.85	1	6000	9.95						

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	MC-277	PL-259A	PL-325	93-C	49120	D-163950	ES-685696-5
M-359	MC-320	PL-274	SO-239	93-M	49121A	D-166132	ES-689172-1
M-359A	PL-258	PL-284	SO-264				
M-360	PL-259	PL-293	TM-201				

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.

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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-2 26 volt 400 cycle....................$15.00
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

OIL-FILLED 35 KV AND 50 KV ISOLATION TRANSFORMERS

Pri. 460V 60 cy. Sec. 115V 200 VA Insulated for 50KV DC—G. E. Form EIR—36" H x 13" D......$125.00
Pri 115V 60 cy. Sec. 115V 250 VA Insulated for 35 KV DC—G. E. Form EIR—29" H x 12½" D.$125.00

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	1N48	.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"	1 Meg	SS
2500	SS	40K	SS	2.5 Meg	SS
4K	SS	50K	SS	5 Meg	SS
5K	SS	50K	1/4"		

$1.25 each

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 Volts 60 Amps. Brand new....................$38.50
Eclipse-Pioneer type 1235-1. Output-30 Volts DC 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
- CW1-60AAG 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
- BC-221 Freq. Meter (late models)........*$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

PULSE TRANSFORMERS

UTAH 9262 9278 9280	UTAH 9318 9340 9350
G.E. 68G-627	Westinghouse 232-AW2
G.E. 68G828	Westinghouse 232-BW-2
G.E. 68G929G1	AN/APN-4 Block Osc.
G.E. 80G13	Philco 352-7149
G.E. K-2469A	Philco 352-7150
G.E. K-2744B	Philco 352-7071
AN/APN-9 (901756-501)	Philco 352-7178
AN/APN-9 (901756-502)	Raytheon UX-7350
AN/APN-9 (352-7250)	W.E. D-161310
AN/APN-9 (352-7251)	W.E. D-163247
Westinghouse 132-AW	W.E. D-163325
Westinghouse 139DW2F	W.E. D-164661
Westinghouse 176AW2F	W.E. KS-9563
Westinghouse 187AW2F	

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

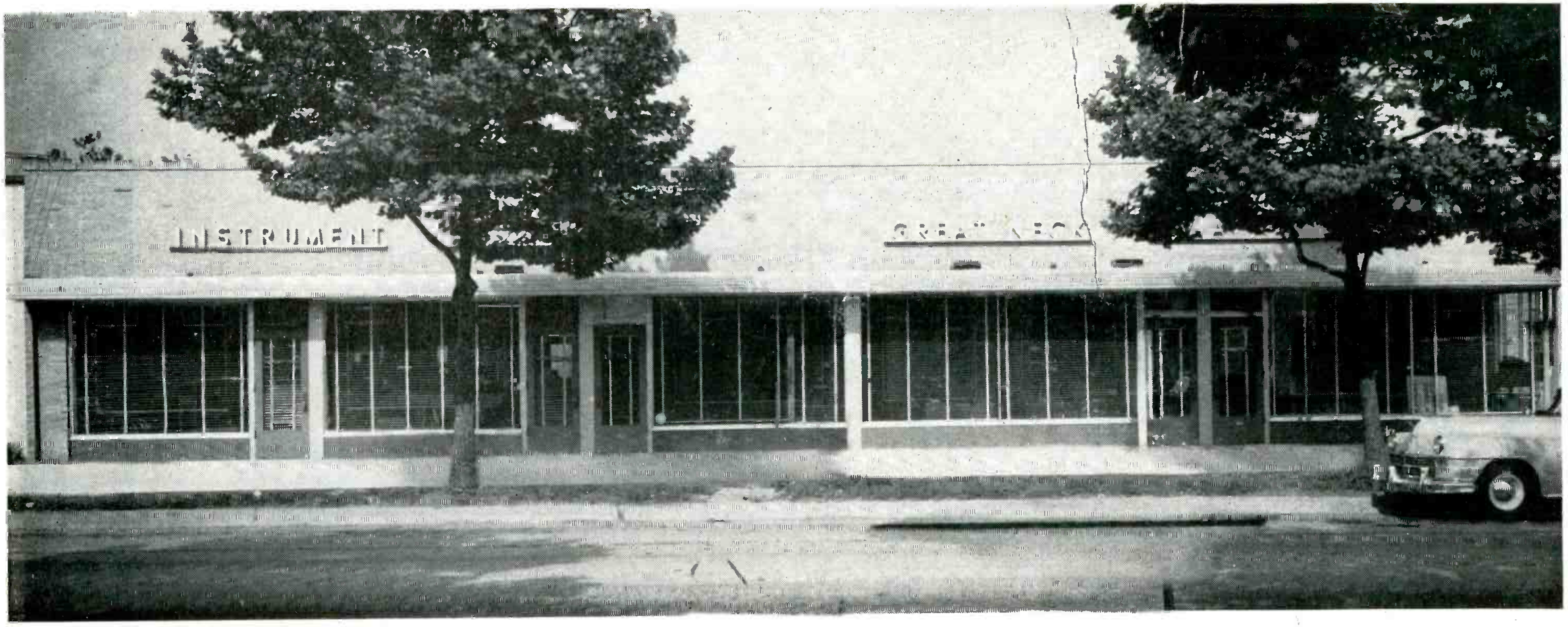
SPRAGUE PULSE NETWORKS

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

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


INSTRUMENT

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 joint 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

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Telephone GReat Neck 4-1147

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WUX Great Neck, N. Y.

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WESTERN ELECTRIC C-114

Loading coils $2.95 ea.

TOGGLE SWITCHES

Stock No.	Mfg.	Action	Rating	Price
5443A	H & H	S.P.D.T.	6A–125V	35¢
5281A	Carling	S.P.S.T.	10A–125V	39¢
5444A	C-H. (B6B)	S.P.S.T.	5A–125V	25¢

OTHER TYPES AVAILABLE

FILAMENT TRANSFORMERS

Primary 115 Volt, 60 Cycle, 1600 Volt Insulation. Horizontal half shell. Mounting centers. 2-13/16" x 3-3/8" core size. 2-1/2" above Chassis. Solder lug terminals—All terminals marked.

6.3 Volts @ 4.9 Amps; 6.3 Volts @ 4.5 Amps; 6.3 Volts @ 1.1 Amps

Stock No. 5254A Price Each $2.65

PRI: 115 volt 60 cycle. Secondaries: 5 volt @ 3 Amp.; 6.3 volt @ 5 Amp. Open Frame. 2½"x2"x3".

Stock No. 6008A Price Each $1.50

PRI: 115 volt 60 cycle. Secondaries 6.5 volt C. T. @ 8 Amp.; 6.5 Volt @ 4 Amp.; 5 volt @ 2 Amp.; 5.2 volt C. T. @ 5 Amp.; 71 volt C. T. @ 40 MA. U.T.C. type RC-125 case.

Stock No. 6014A Price Each $3.00

HIGH CURRENT FILAMENT TRANSFORMER

Primary 115 VAC 60 Cycle. Secondary 1.25 VAC at 100 AMP.

Stock No. 5783A Price Each $5.00

PLATE TRANSFORMER

Primary 210-220-230-240-250 Volts 60 Cycle; Secondary 500 Volts Center Tapped 130 Mils.

No. 672-2830A Stock Price Each $1.50

POWER TRANSFORMERS

Vertical Double Half Shell Type. Pri.: 117 VAC. 60 Cycle. Secondary Delivers 200 VDC. @ 70Ma., 6.3VAC. @ 1.2A. 3000 Volt Ins. 2¾" x 2-9/16" x 3⅛". 2" Mtg. Centers. Wire Leads.

Stock No. 5969A Price Each $1.25

PRI: 200-220-240 Volt 50/60 cycle. Sec.: 1400 Volt C. T. @ 350 MA. 5" x 6" x 5¾". Sig. Corps No. 2Z9601.51. Mfd. by SOLA.

Stock No. 5990A Price Each $19.75

PRI: 115 volt 60 cycle. Secondaries: 1600-390-0-390-1600 volts @ 200 MA.; 12 Volt C. T. @ .5 Amp. U.T.C. type RC-175 Case.

Stock No. 5996A Price Each $10.95

TRANSMITTING MICAS

Stock No.	Cap.	Test Volts	Type No.	Price Each
5493A*	.01	1000	1445	.35¢
5494A	.02	1000	144T	.40¢
5495A	.006	1200	A 2	.40¢
5496A	.001	1500	BE 15	.20¢
5498A	.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	F2L	1.00
5606A	.000025	10,000	PL-341	1.95
5607A**	.00015	10,000	PL-315	7.95

* Supplied with Meter Bracket
** D.C. Working Voltage

OTHER TYPES AND SIZES AVAILABLE

MICA CAPACITORS

Sizes from 10 to 7,000 MMFD in CM20, CM30 CM35 and CM40 case sizes. Tan mica and silver mica.
Complete lists with prices available upon request

G. E. SATURABLE REACTOR

15 KVA. #67G469 $100.00

FILTER CHOKES

4 Hy. 280 MA.—50 Ohms D. C. U. T. C. type RC-125 case.

Stock No. 6002A Price Each $2.25

SELENIUM RECTIFIER TRANSFORMER

Made by Thordarson — CHT Case. 105 Volt @ .43 A, 25 to 60 Cycle. Secondary 68 Volt @ 550 Mils. Mounting Centers 2⅝" and 2¾". Size 3" x 3⅜" x 4¼".

Stock No. T64799A Price Each 95c

AUDIO PASS FILTERS

Band pass 800 to 1200 cycles input 10000 ohms—Output 25000 ohms Level 10DB

Stock No. T48500A Price to $5.50 ea.

J-38 KEYS

Signal Corps Type J-38 Keys.

Stock No. 5293A Price Each 95¢

10" PM SPEAKERS

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

Stock No. 5458A Price Each $1.95

ELECTRO-VOICE—602 DIFFERENTIAL DYNAMIC MICROPHONE

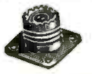
A close talking, noise-cancelling Speech Microphone. 150 Ohm Impedance Dynamic Unit comes complete with press-to-talk switch and 5 Ft. Shielded Four Conductor Cable. Brand New. Individually boxed.

Stock No. 5282A Price Each $15.00

72 OHM COAX

Plastoid RG-59/U Coax.

Stock No.		Price
5324A	1000 Ft. Spools	$60.00
5325A	100 Ft. Coils	7.00



83-1R COAX CONNECTOR

Stock No. 5657A Price Each 50¢

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. .15 mfd 8000 VDC Two Ceramic Ins. Terms. 1¾ x 3½ x 4¾ High Can.

Stock No. 6052A Price Each $4.95

Oil Filled Condenser 10 MFD. 220 V.A.C. Round Can, 2-½" Diameter x 3-⅞" High.

Stock No. 5658A Price Each $.95

4 MFD.—1000 VOLT

C.D. Type MC888. Bakelite Insulated Solder Lug Terminals. 2½" x 1¼" x 4¾". High Can. Figure "B".

Stock No. 5865A Price Each $1.95

4 MFD.—600 VOLT

C-D No. KG3040. Bakelite insulated solder lug terminals. 2½" x 1-3/16" x 3¼" high can.

Stock No. 5994A Price Each $1.50

4 MFD.—4000 VOLT

C.D. Type CP70 BIDM 405X. Ceramic. Insulated Screw Terminals. 4⅝" x 3¾" x 8½". High Can. Figure "C".

Stock No. 5866A Price Each $9.95

LINE TO GRID XFORMER

PRI. #1 500 ohms tapped @ 250. PRI. #2: 50 Ohms tapped @ 15. SEC: P. P. Parallel 6L6 grids class AB2. 60 to 8000 CPS. plus or minus 2 DB. Vertical half shell Mtg.

Stock No. 6013A Price Each $1.50

HIGH FIDELITY TRANSFORMER

P.P. 10,000 ohm to 250 ohm Line. Frequency Response 30 to 20,000 C.P.S. plus or minus 1 DB. Grey Rectangular Case 3" x 2½" x 3⅝" high. Bottom Solder Lug Terminals. 4 Stud Mtg. Bolts.

Stock No. 5792A Price Each $3.75

HIGH VOLTAGE TRANSFORMER

21,000 volt 100MA. Half Wave oil filled. Maloney Electric Co.

Stock No. 5728A Price Each $300.00

HAND MICROPHONE

Replacement for T-17 Mike. English make. Single Button. Removable element. Press-to-talk switch. Stock No. 5883A. Unshielded cable.

Price Ea. $3.25

TERMS:

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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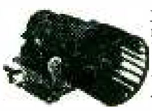
BLOWER ASSEMBLY



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.

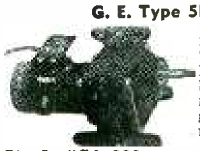
Radio Compass Indicator

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

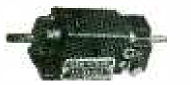


24 volts at 2.9 amps. 75 in/lb. torque. 3 lead shunt with brake. 1 minute rating. Double worm gear reduction. 4 rpm reversible.

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

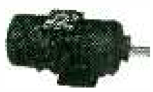
G.E. Type 5BN58LA5
125 volts DC at 1.2 amps. 4000 rpm. Int. duty Internal fan cooled. 3½" sq. front mounting flange.

Stock #SA-312
Price $19.50 each.

60 CYCLE AMPLIDYNES

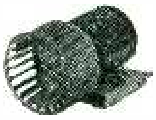
G.E. Types 5AM45DB15 and 5AM73AB95. Type 45DB15 input 115 v. 60 cy. at 5 amps. Output 250 volts DC at 0.6 amps. Stock #SA-147.
Type 73AB95 input 115 volts 60 cy. at 9 amps. Output 250 volts DC at 1.5 amps. Stock #SA-257.
PRICES ON REQUEST

DELCO CONSTANT SPEED MOTOR A-7155



1/30 hp. 27.5v d-c 3600 rpm. Cont. duty, 2½" diam. x 5¼" 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.

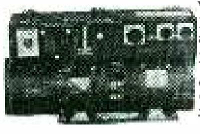
Pioneer Servo Motor

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.

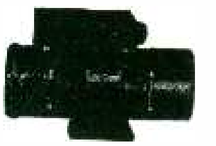
MOTOR GENERATOR SET

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.

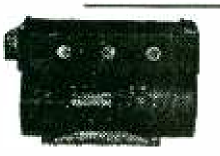
INVERTERS



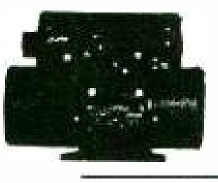
WinchargerPU-7/AP Input 28 VDC at 160 amps. Output 115 v. 400 cy. 1 ϕ at 2500 VA. Voltage and frequency, regulated. Cont. duty. Stock #SA-164.
Price $119.50 each.



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-218E Inverters 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.

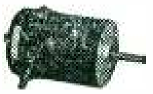
Leland SD-93—(10285)—Input 28 volts DC at 60 amps. Output 115 volts three phase 400 cycles at 750 va. 0.90 P.F. Second output voltage of 26 volts 400 cycles at 50 V.A. Voltage and frequency regulated. Designed for use with various autopilots. Stock #SA-209.

Price $99.50 each

DIEHL DC MOTOR

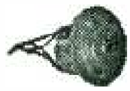
Type FDE-83-2. 24v @ 9.5 Amps. 1/6 hp. 6350 rpm. Cont. duty. Motor 4¼" diam. x 5" Lg. with 1" shaft ext. x ⅝" dia. front mtg. flange 4¼" Sq. Stock #SA-354. Price $19.50 ea.

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.

Servo-Tek products co.
4 Godwin Ave. Paterson, N. J.

WRITE FOR LISTING
Prices F.O.B. Paterson
Phone ARmory 4-3366
Teletype PAT. 199

SPECIALISTS IN FRACTIONAL HORSE POWER MOTOR SPEED CONTROL

COMMUNICATIONS EQUIPMENT CO.

- Audio Transformers
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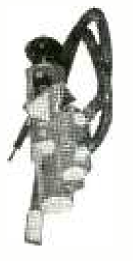
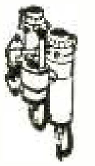
- Shock Mounts
- UG Connectors

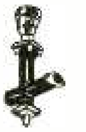
PULSE TRANSFORMERS

U-10198. PRI: 4.5KV. 97A PK. SEC. 18KV 26A. PRR—350-500 Cy. DURATION 1.3 usec....$42.50
G.E.K.-2745....$39.50
G.E.K.-2744-A. 11.5 KV High Voltage. 3.2 KV Low Voltage @ 200 KW oper. (270 KW max 1 microsec. or 1/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. No. 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 microsec. 60-400 cy....$5.00
PHILCO No. 352-7250, 352-7251, 352-7287
UTAH Nos. 9262, 9332, 9278, 9341.
RAYTHEON: UX8693. UX7428. UX7350.
WEST. ELECT: D-161310. D-166638. D-166173. D-169114. D-161929. KS9948.
U-11716 PRI: 13.2 KV @ 20A.
SEC: 3.6 KV @ 72A 2 u sec pulse. RRR—500 PPS....$65.0

S BAND – 3" x 1½" WAVEGUIDE







CAVITY WAVEMETER, 2700-3400 MC. 3-Digit Counter Dial Mfg. WE. Calib. Chart, as shown....$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. Bernard 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
ASI4A/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, 1-1/2" x 3"....per ft., $4.65

7/8" RIGID COAX—3/8" 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

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 version of DC Resonance type. Uses two 705-A's as rectifiers. 115 v. 400 cycle input. New with all tubes....$49.50

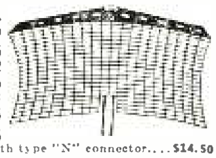
PULSE NETWORKS

15A—1-400-50: 15 KV. "A" CKT. 1 microsec 400 PPS. 50 ohms imp....$37.50
G.E. No. 6E3-5-2000-50P2T. 6KV "E" circuit. 3 sections .5 microsecond, 2000 PPS 50 ohms impedance....$6.50
G.E. No. 3E (3-84-810) (8-2.24-405) 50 P4T; 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
7.3E3-1-200-67P. 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. 8KV 50 ohms imp....$16.50
D-165997: 1 1/4 microsec....$7.50
RCA 255686-502, 2.2μ sec. 1400 ohms....$2.00

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)....$75.00
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

140-600mc 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. 2A289-223-A. New....$49.50 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
TS 268/UP Crystal Test Set....$50.00

X BAND – 1" x ½" WAVEGUIDE

Cross-Guide Directional Coupler, UG-40 Take-off, 20 db Coup.. $24.50
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 5.5kv, 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
3 cm. 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....$375.00

1¼" x ⅝" WAVEGUIDE

Mitered Elbow H Plane UG51-UG52....$12.00
CG 98E/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
Stub 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

THERMISTORS

D167018	$1.50
D167332	1.50
D167613	1.50
D166228	1.50
D164699	2.50
D-163903	1.95
D-166792	2.15

MAGNETRONS

Tube
2J27
2J31
2J21 A
2J22
2J26
2J32
2J38 Pkg.
2J39 Pkg.
2J49
2J61
2J62
3J31
5J30
718DY
720BY
725-A
730-A
QK 62
QK 61
QK 60
700 A, B, C,
706 AY, BY, DY, EY, FY, GY

VARISTORS

D171812	$1.50
D172155	1.50
D167176	1.50
D168687	1.50
D167208E, D171858	1.50
308A, 3A, 27-B	1.50
D168403	2.15

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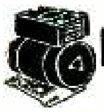


DYNAMOTORS

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"x5½"x10½". New $22.50
LELAND No. 10536: IN: 28 VDC, 12A. OUT: 115V, 115VA, 400 CY 3 PHASE. EXC. COND. $70.00

SELENIUM RECTIFIERS

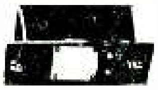
RU/GF COIL SETS SINGLE BAND RCVR UNITS

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

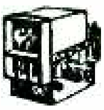
HI CAP. FILTER CONDENSERS

Cap.	WVDC	Price
2000	6	$1.85
500	200	2.00
4000	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/75 MA, 11H/60 MA 5KV DC Test	4.69
CH-119	8.5H/125 MA	2.79
CH-69-1	Dual; 120H/17 MA	2.35
CH-8-28	2 x .5H/380 MA/25 Ohms	1.79
CH-776	1.28H/130 MA/75 ohms	2.25
CH-344	1.5H/145MA/1200V Test	2.35
CH-43A	10HY/15MA—850 ohms DCR	1.75
CH-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	6.3/1A, 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/7A, 6.4V/10A, 6.4V/2A	8.95
FT-463	6.3VCT/1A, 5VCT/3A, 5VCT/3A	5.49
FT-55-2	7.2V/21.5A, 6.5V/6.85A, 5V/6A, 5V/3A	8.95
FT-986	16V @ 4.5A or 12V @ 4.5A	3.75
FT-38A	6.3/2.5A, 2x2.5V/7A	4.19
FT-A27	2.5V/2.5A, 7V/7A, TAP 2.5V/2.5A, 16KV TEST	18.95
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 Intercom 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-A8: 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	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	5.95
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, 6.3V/2.9A, 1.25V/.02A	2.95
52C080	526VCT/50MA, 6.3VCT/2A, 5VCT/2A	3.75
32332	400VCT/35MA, 6.4V/2.5A, 6.4V/.15A	3.85
68G631	1150-0-1150V	2.75
80G198	6VCT/.00006 KVA	1.75
302433A	6.3V/9.1A, 6.3VCT/6.5A, 2.5V/3.5A, 2.5V/3.5A	4.85
KS 9445	592VCT/118MA, 6.3V/8.1A, 5V/2A	5.39
KS 9685	6.4/7.5A, 6.4V/3.8A, 6.4V/2.5A ALL CT	4.79
70G30G1	600VCT/36MA	2.65
M-7474318	2100V/.027A	4.95
95-G-45	2000V/.002A, 465V/.6A, 44V/10A, 6.3V/23.5A, 6.3V/1.8A, 5V/9A, 2X2.5V/1.75A	17.95
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

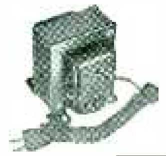
GIBSON GIRL, Emerg. Xmtr. 500 kc	$42.95
BC 306 ANTENNA TUNING UNIT, NEW	$6.95
R9/APN-4, New, With Tubes	$75.00
ID6/APN-4, New, With Tubes and Crystal	$75.00
A-62 Phantom Antenna	$9.50
2 Meter Choke, 1000 MA, 20-144	8/$1.00
Supersonic Crystal Head, M-1, 22-27KC Hi-Z	$27.45
Underwater Microphone, Model 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, 1mc	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.
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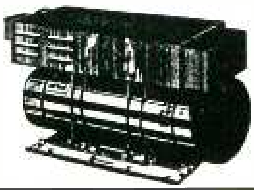
SURPLUS EQUIPMENT

INVERTERS



PE 218 Leland Electric

Output: 115 VAC; Single Phase; PF 90; 380/500 cycle 1500 VA. Input: 25-28 VDC; 92 amps; 8000 RPM; Exc. Volts 27.5. BRAND NEW.....$39.95 ea.

16486 Leland Electric

Output: 115 VAC; 400 Cycle; 3-Phase; 175 VA; 80 PF. Input: 27.5 DC 12.5 amp; Cont. Duty $90.00 ea.

10563 LELAND ELECTRIC

Output: 115 VAC; 400 cycle; 3-phase; 115 VA; 75 PF. Input: 28.5 VDC; 12 amp. ....$80.00 ea.

12116-2-A PIONEER

Output: 115 VAC; 400 cyc; single phase; 45 amp. Input: 24 VDC 5 amp...$90.00 ea.

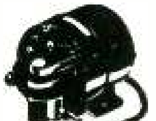
MG 153 HOLTZER-CABOT

Input: 24 V, DC, 52 amps; Output: 115 volts—400 cycles, 3-phase, 750 VA, and 26 Volt—400 cycle, 250 VA. Voltage and frequency regulated ....$95.00 ea.

94-32270-A LELAND ELECTRIC

OUTPUT: 115 Volts, 190 V.A., Single Phase; 400 cyc.; .90 PF, and 26 Volts, 60 V.A., 400 cyc., .40 PF. INPUT: 27.5 Volts DC, 18 amps; Cont. Duty, Voltage and frequency regulated $95.00

5 RPM GEAR HEAD MOTOR



Mfg. RAE., Type 7519, 115 Volts AD, DC, Fractional HP, Overall dimension: 5½" ....$12.95 ea. Lots of 10......$11.95 ea.

METERS

AMMETER: DC: 2" 100-0-100, complete with external shunt.............$5.95 ea.
AC Volt, Westinghouse, Type NA-35—3-inch round. F.S.-10 MA..........$6.95 ea.

MICROPOSITIONER

Barber Colman AYLZ 2133-I Polarized D.C. Relay: Double Coil Differential sensitive; Alnico P.M. Polarized field. 24V contacts; .5 amps; 28 V. Used for remote positioning, sychronizing, control, etc........$12.50 ea.

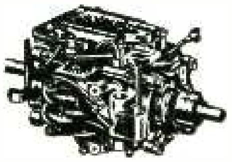
VEEDER ROOT COUNTER
MODEL S-1

5-figure (0-99,999) non-reset type. Adds ten for each complete revolution of shaft in one direction. Subtracts ten for each revolution in opposite direction. Black figures on metal background. Size: ¾" high x ¾" wide x 1-5/16" long. Dovetail mounting — Lever arm removable ....$1.95 ea.
10 for $17.50

6 RPM GEAR BOX MOTOR

110 Volt, 60 cyc., Single Phase; Ratio—544:1; Mfg. by Merkle-Korff Gear Co., Overall dimensions approx. 3½" x 3½" ....$9.95 ea.
Lots of 10..........$9.50 ea.

WESTINGHOUSE HYDRAULIC TRANSMISSION



Ideal as hydraulic torque converters. Contains hydraulic pump and hydraulic motor; 10 ball bearings; has reversible controls. High quality precision workmanship . . . made to exacting specifications for use on 2-ton 40 mm anti-aircraft guns. Overall dimensions: 12" long x 5½" wide x 6½" high. Shipping weight: 20 lbs. Government cost more than $300. LIKE NEW, UNUSED...........$29.95 ea.

AC CONTROL MOTOR

Diehl Mfg. Co., FPE-25-7, 20 Volts, 2 phase, 1600 RPM, .85 amps.............$15.00 ea.

G. E. ALTERNATOR

208 Volts, 400 Cycle, 3 Phase Mod. 2CM97B1 55.5 Amps., PF .75, Speed 8000 KW 15, Cont. Duty, Limited Quantity..$320.00

SERVO MOTOR 10047-2-A: 2 Phase; 400 Cycle; with 40-1 Reduction Gear $10.00 ea.

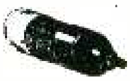
PIONEER TORQUE UNITS

TYPE 12604-3-A: Contain CK5 Motor coupled to output shaft through 125:1 gear reduction train. Output shaft coupled to autosyn follow-up (AY43). Ratio of output shaft to follow-up Autosyn is 15:1 $70.00 ea.
TYPE 12606-1-A: Same as 12604-3-A except it has a 30:1 ratio between output shaft and follow-up Autosyn..........$70.00 ea.
TYPE 12602-1-A: Same as 12606-1-A except it has base mounting type cover for motor and gear train...........$70.00 ea.

BLOWER ASSEMBLY

115 Volt, 400 Cycle. Westinghouse Type FL 17CFM, complete with capacitor. New ....$12.50 ea.

ALNICO FIELD MOTORS



(Approx. size overall) . . . 3¾" x 1¼" diameter)
Delco-Type 5069230: $27.50
volts; DC; 145RPM $19.95 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.

400 CYCLE MOTORS

AIRESEARCH: 115V; 40 CPS; Single phase; 6500 RPM; 1.4 amp; Torque 4.6 in. oz.; HP .03....................$10.00 ea.
EASTERN AIR DEVICES TYPE JM6B: 200 VAC; 1 amp; 3 phase; 400 cycles; 6000 RPM ....$12.50 ea.
EASTERN AIR DEVICES, TYPE J31B: 115 V, 400-1200 Cycle, Single Phase. $12.50 ea.
PIONEER, CK-2, 400 cycle 2-phase. $20.00 ea.
AIRESEARCH: AC Induction, 200 V; 3 Phase, 400 Cycle, 2 H.P.; 11,000 RPM; 8 amps.................................$79.50 ea.
AIRESEARCH: AC Induction, 200 V; 3 Phase, 400 Cycle; .12 H.P., 6500 RPM; 1.5 amps. $25.00

SYNCHROS

1F Special Repeater (115V-400 Cycle) $15.00 ea.
2JIF3 Generator (115V-400 cyc)...$10.00 ea.
5CT Control Transformer; 90-50 Volt; 60 Cyc. ....$50.00 ea.
5F Motor (115/90 volt—60 cyc.)...$60.00 ea.
5G Generator (115/90 volt—60 cyc.) $50.00 ea.
5SDG Differential Generator (90/90 volts —400 cyc.) ....$30.00 ea.
5DG Differential Generator (90/90 volts 60 cycle).........................$50.00 ea.
TRANSMITTER, BENDIX C-78248; 115 Volt, 60 Cycle..................$25.00 ea.

REPEATER, BENDIX C-78410: 115 Volt, 60 Cycle ....$37.50 ea.
1F Synchro Motor 115 V. 60 cycle..$50.00 ea.
REPEATER, AC synchronous 115 V.. 60 cycle, C-78863 ....$15.00 ea.

POWER RHEOSTATS

Standard Brands: 5 Ohms; 100 Watt; 4.48 amps 100 Ohms; 100 Watt; 1.0 amp.

Boxed, Brand New with Knob $2.50 each — or — $25.00 per Doz.

SMALL DC MOTORS

(Approx. size....4" long x 1¼" dia.)
General Electric-Type 5AB10AJ37; 27 volts, DC; .5 amps. 8 oz inches torque; 250 RPM; shunt wound; 4 leads; reversible..$12.50 ea.
General Electric. Mod. 5BA10FJ33: 12 oz. inches torque, 12 V DC. 56 RPM, 1.02 amp. $15.00 ea.
General Electric-Type 5BA10AJ52C: 27 volts, DC; .5 amps. 8 oz. inches torque; 145 RPM; shunt wound; 4 leads; reversible $12.50 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 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.

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OD3	1.25	2D21	1.75	3E29	15.50	7DP4	10.00	312A	3.95	715A	7.95	829B	15.95	1611	1.95
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C1B	6.95	2E30	2.75	SN4	5.50	15E	1.95	327A	3.95	715C	25.00	832	7.95	1616	2.95
1B21A	2.75	2J21	17.95	4A1	1.75	15R	.95	328A	9.95	717A	1.95	832A	9.95	1619	.89
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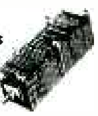

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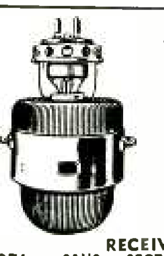

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OB2	1.00	6AK5	.70	872-A(GE)	3.25
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shielded cable with terminal lug each end 100' and 150' lengths

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500	25	1.20	200,000 1/8 SD	AB "J"	1.40
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10Y	.45	957	.40	RKR-72	1.15
15R	.70	CK1005	.50	RK-73	.69
30 Special	.45	CK1007	.90	5BP4	4.95
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315A	.65	7193	.50	3A4	.65
WL-531	5.50	8011	1.50	5U4G	.57
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.25 HY 4 Amp .5 ohm 20,000 Test. New.
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24" Parabola in turret 360° span at 12 RPM DC, motor control and reversing switch New

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RELAY 115v 60cy adjustable 6 sec. to 2 minutes Cramer TD2-120S. Also TD60S 6 to 60 sec..$12.95
RELAY 3PDT 24vdc 250 ohm Clare Type K...$1.95
BLOWER MOTOR 400-1800cy 115v EAD J31C..$9.95
SYNCHRO MOTOR IF Special 115/90v400cy..$11.95
FIL XFRMR 6.3 @ 1.3A (other sizes avail.)..$.99
250 WATT OUTPUT XFRMR PP-8ohm KS-9496.$12.95
CHOKE 4H 70ma...69c; 2H 70ma 110 ohm...$.49
BIRTCHER CLAMPS 926A, 926B, 926C........$.25
3-15MMF variabl No. HF...49c; MC-100-S....$.99
MICRO & Acroswitch pin pl. spst. spdt (others).$.59
ISOLATION XFORMER 35 watts prim 115v sec. 115 or 135v & 6.3 tap 2¼x2½x3"........$2.45
SUBMINIATURE tube socket 5 pin, 100 for..$10.00
POWER XFRMR 760VCT @ 170ma 5 @ 3, 6.3 @ 4.................$4.95
SILV TRMR TS2A 1.5-7, 7-45 @ 35c; MICA 3-30.$.04
AN3106-10S-2S, PL-68, PL-259A, 83-1H, S8, JK33A
CONDENSERS: BATHTUB, MICA, AIR, OIL, HV. CER. JPOTS, RELAYS, MIKES, 3AG&MDL fuses, **SWITCHES**
SPARES for: **BC-1296A, MK11** Radar, **AN/TPN-2**
2% .002 Silver Mica CM30; many other items.

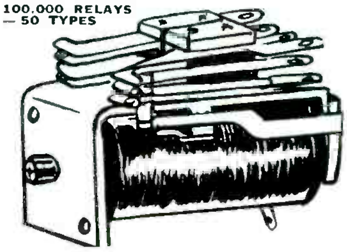
EMPIRE ELECTRONICS COMPANY

409 Avenue L Brooklyn 30, N. Y.
CLoverdale 2-2411 BRyant 9-1220

RELAY SPECIALISTS

100,000 RELAYS — 50 TYPES

E X A M P L E



MINIATURE AIRCRAFT TYPE—4 Pole D.T. contacts. 1½" overall. 280 ohm coil. 24 V.D.C...$2.95

RADIO DEVELOPMENT & SALES CO.
323 Atlantic Ave. Brooklyn 2, N. Y. ULster 5-0488

FOR EMERGENCY ELECTRONIC TUBES CONTACT

T. R. LOWENTHAL CO.

electronic components
Technical Radio Since 1919
1205 West Sherwin Ave. Chicago 26, Ill.
Phone: Rogers Park 4-0784

ANNUAL CLEARANCE

ON OUR ENTIRE STOCKS OF BRAND NEW, *GUARANTEED* TUBES

OA2	.89	2C43	14.95	4J42/700A	17.50	5D21	24.00	331A	6.95	707A	7.95	715C	22.50	1608	3.95
OA3/VR75	1.04	2C44	.75	5AP1	3.49	REL5	45.00	350B	3.95	708A	3.75	829B	12.95	1616	.69
CB2	1.05	2J22	7.50	5C30/C5b	3.75	FG81A	3.49	353A	3.95	710A/8011	.75	830B	2.75	1619	.35
CB3/VR90	1.05	2J26	19.95	5FP7	3.95	VT90	.75	357A	14.95	713A	.92	841	.39	1625	.45
CC3/VR105	1.10	2J27	19.95	C5B	3.75	VT98	75.00	371B	.89	714AY	4.95	843	.25	1626	.45
CD3/VR150	.85	2J39	19.50	C6A	5.75	HY114B	.65	388A	1.29	715A	4.95	846	49.95	1629	.30
1B22	2.09	2J40	29.50	6AK5	.85	VT127	1.75	394A	4.75	715B	6.95	851	39.50	1636	2.95
1B26	2.25	2J61	39.50	6K7G	.45	205B	1.49	417A	14.95	717A	.98	860	6.50	1642	.59
1B27	14.50	2J62	29.95	7EP5	14.95	211	.65	450TH	37.50	721A	1.75	861	21.50	1851	1.69
1B29	2.45	2V3G	.75	7C4	.35	211 GE	1.75	530	16.95	722A	1.89	864	.75	2051	.95
1B36	7.50	2X2	.49	7E5	.39	217C	6.95	531	6.75	723AB	19.95	865	1.25	7193	.30
1B56	24.50	3B7/1291	.30	10Y	.39	250TH	18.95	533	45.00	724B	2.49	866A	1.35	8011	.75
EL1C	2.49	3B22	2.49	12A6	.49	250TL	16.95	559	2.25	725A	6.75	872A GE.	3.95	8012	2.75
1D8GT	.59	3C24	1.49	24G	1.49	257B	9.95	HY615	.15	800A	1.75	874	.69	8013A	2.25
1L4	.59	3C28	4.95	RK34	.39	285A	4.95	700A	17.50	801A	.25	876	.59	8021	1.95
1R4/1294	.69	3CP1/S1	1.49	45 Special	.29	286A	6.95	701A	4.95	803	3.25	879	.49	8025A	5.45
1T4	.59	3DP1	3.95	FG17	4.50	304TH	7.50	702A	2.49	805	3.69	931A	4.25	9001	1.25
2C21/1642	.44	3D6/1299	.35	CRP72	1.00	304TL	8.75	703A	4.75	807	1.59	954	.35	9002	.95
2C22/7193	.29	3D23	4.75	RK72	1.00	307A	3.50	704A	.89	808	1.75	955	.45	9003	1.65
2C26A	.15	3FP7	1.75	CRP73	1.00	316A	.49	705A	1.95	812	3.25	957	.45	9004	.35
2C34/RK34	.39	3Q4	.59	RK73	1.00	328A	7.95	706AY-DY	39.50	813	9.95	E1148	.29	9005	1.45
2C40	8.49	4B28	2.95	RK75	3.50	329A	7.25	706EY-GY	29.95	814	2.69	CK1005	.65	9006	.25

6 Amp Westinghouse Tungar $2.95

MARITIME INTERNATIONAL COMPANY

11 State Street, New York 4, N. Y. Cable Address "Foxcroft" Phones: DIgby 4-3192-3

EMPLOYMENT

(Continued from page 361)

To EMPLOYERS Who Advertise for MEN:

Frequently, when there are many applicants for a position, only the most promising letters are acknowledged. The other applicants never know whether their letters reached a prospective employer or not. These men often become discouraged, will not respond to future advertisements and even question their bona fide character.

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McGRAW HILL PUBLISHING CO., INC.
"Put Yourself in his place."

QUARTZ CRYSTALS

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	FROM	TO	FROM	TO
1915	1995	6100	6173.3	8025	
2030	2065	6200		8050	
2125	2155	6250		8075	
2300		6275		8100	8175
2320	2390	6206	6292	8200	8275
7420	2490	6300	6375	8300	8375
2604		6400	6498	8385	
2605		6500		8400	8475
2750		6506.6	6675	8500	8575
2880		6700	6775	8600	8650
2940		6800	6875	8786.25	
3110		6815		8808.75	
3215		6830		8876.25	
3652	3689	6900	6975	8921.25	
3729	3799	6978.75		9135.0	
3805	3823	7228	7281	9254	9284
4014	4100	7325	7375	9342	9399
4104	4150	7458.75		9405	9499
4244	4290	7425	7475	9500	
4300		7500	7597	9516	9589
4305	4397	7606	7673.3	9608	9668
4400	4480	7625		10075	
4600	4690	7650		12608	12698
4735	4799	7675		12700	12783
4800	4898	7700		12800	12890
4913	4941	7725		12902	12998
5065	5092	7728.8		13004	13009
5100	5195	7750		13010	13099
5200	5295	7751.25		13100	13196
5300		7773.75		13213	13299
5320	5397.5	7775		13302	13361
5630		7716	7784	13400	13496
5633.3		7800		13500	13554
5655.5		7825		13636	13684
5677.7		7850		13702	13799
5700		7875		13837	13897
5706.6	5775	7900		13903	13996
5800	5892	7925		14038	14092
5900	5975	7950		14110	14198
6000	6075	7925		14281	14391
6150		7906	7968		
6175		8000			

CR 1A/AR or FT241

Prong spacing ½", Prong dia ⅛"
Price 79¢ ea. 12 for $9.00

FROM (Frequencies in KC)	TO	FROM (Frequencies in KC)	TO
2853		7650	
3988		7738	
4188		7740	
4285		7750	
4300	4374	7760	
4640		7770	
4788		7775	
5020	5090	7778	
5100		7780	
5120	5180	7790	
5200	5295	7800	
5250		7810	
5300	5396	7825	
5410		7830	
5470		7850	
5500		7851	7880
5648		7900	
5740	5780	7910	
5810		7925	
5891		7930	
5910		7940	
5923	5960	7950	
6011	6080	7970	
6130	6195	7975	
6203	6275	7990	
6270		8000	
6300	6375	8001	
6370		8002	
6400	6499	8008	8010
6490		8007	
6500	6590	8012	
6600	6685	8010	8092
6744		8205	8298
6815	6877	8308	
6905	6980	8300	8370
7270		8407	
7330		8412	
7440		8405	8490
7460		8506	8561
7500		8645	
7560		8630	8650
7600		8985	
7620		11677	
7625			

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	7750	7873	8475
7541		7950	8750
7550	7775	8275	
7640	7800	8325	
7650	7825	8450	
7700	7850		

EDLIE ELECTRONICS, Inc.

154 Greenwich Street,
New York, N. Y.
Telephone DIgby 9-3143

LOOKING FOR
HARD-TO-FIND EQUIPMENT

SWEET DEALS
from a
SWEET OUTFIT

Here is just a partial list of What we have to offer:

- BC-348's
- BC-342's
- ART-13's
- ARC-1's
- ARC's
- LM's
- SCR-522's
- BC-221
- BC-611
- VARIOUS TEST EQUIPMENT

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SWEET PRICES
for your
RADIO & AIRCRAFT EQUIPMENT

We want to buy parts or equipment — and we'll pay top dollar to get it. Just send us the complete dope on what you have, the type and condition of your equipment—and your asking price. You'll get fast, profitable action. It's just like taking "Candee" from a baby! Write today!

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Burbank, California
CHARLESTON 0-1486 ROCKWELL 9-1070

SURPLUS NEW GUARANTEED

A.C. AMMETERS

100 MAAC, WESTON 476, 3½" rd.......@ $7.50
150 WESTINGHOUSE NA-35, 3½" rd., 5 amp mvt., use with 150:5 C.T........@ 6.00
CURRENT TRANSFORMERS, Donut type, 150.5 or 200:5 ....@ 7.50

R.F. AMMETERS

1.5 GEN. ELEC. DW-52, 2½" rd., metal case, black scale ....@ $3.50
2 WESTON 425, 3½" rd... ....@ 8.50
2.5 McCLINTOCK MD3001, 3½" rd., S.C. Stock # 3F311 ....@ 6.50
2.5 WESTON 425, 3½" rd...................@ 8.50
3 GEN. ELEC. DO-44, 3½" rd............ 6.50
5 GEN. ELEC. DO-44, 3½" rd...........@ 7.50
8 WESTON 425, 3" sq...................@ 10.50
10 WESTON 425, 3½" rd..................@ 10.50

A.C. VOLTMETERS

15 WESTINGHOUSE NA-35, 3½" rd., AWS type MR35WO15ACVV ....@ $5.50
300 BURLINGTON 22A, 2½" rd., metal case ....@ 6.00

D.C. MILLIAMMETERS

0-5 GRUEN, GW-124, 2½" rd., MR25WOO5DCMA ....@ $4.50
0-10 WESTON 301, 3" sq. ....@ 7.50
0-15 SIMPSON 26, 3" rd., AWS type MR35WO15DCMA ....@ 6.00
0-30 WESTON 301, 3" sq. ....@ 7.50
0-50 GRUEN, GW-124, 2½" rd., MR25WO5ODCMA ....@ 4.50
0-150 GEN. ELEC. DO-41, 3½" rd........@ 5.50
0-150 GRUEN 508, 2½" rd................@ 3.95
0-200 SIMPSON 26, 3½" rd., AWS type MR35W200DCMA ....@ 5.95
0-500 GEN. ELEC. DW-51, 2½" rd.......@ 4.50
0-500 DEJUR 312, 3" sq.................@ 5.00
0-800 DEJUR 312, 3½" rd., S.C. Stock # 3F980 ....@ 4.50

D.C. VOLTMETERS

0-30 WESTON 301, 3½" rd., 62 O. per V.@ $9.50
0-50 WESTINGHOUSE NX-35, 3½" rd., 200 ohms per volt ....@ 6.95
0-50 GRUEN, GW-515, 2½" rd., MR25WO50DCVV ....@ 4.50
0-300 SUN 2AU346, 2½" rd., 1000 O. per V @ 6.00

MISCELLANEOUS

PORTABLE TACHOMETER, MULTIPLE RANGE. JONES MOTROLA, 300-1200, 1000-4000, and 3000 to 12,000 RPM and FPM. Complete in case with accessories. Meets Navy spec. 18-T-22, type B. Class A. List Price $75.00..........ONLY $37.50

AIRCRAFT METERS

*with external shunt
(prices on request)

30 AMP WESTINGHOUSE AX
30 AMP WESTON 606—T202 P
30-0- 30 AMP GENERAL ELECTRIC DW-53
30-0- 30 AMP WESTON 606—T203 P
60 AMP GENERAL ELECTRIC DW-53*
60 AMP WESTON 606—T205 P*
60 AMP WESTINGHOUSE AX*
60-0- 60 AMP WESTINGHOUSE AX*
60-0- 60 AMP WESTON 606—T208 P*
120 AMP WESTON 606—T224 P*
120 AMP WESTINGHOUSE AX*
120-0-120 AMP WESTINGHOUSE AX*
240 AMP WESTON 606—T223P*
240 AMP GENERAL ELECTRIC DW-53*
240 AMP SUTTON-HORSLEY*
240 AMP WESTINGHOUSE AX*
240-0-240 AMP GENERAL ELECTRIC DW-53*
480 AMP WESTINGHOUSE AX*
50 AMP WESTON 606—T124*
50-0- 50 AMP WESTON 606—T23
20-0-100 AMP HICKOK*
20-0-100 AMP WESTON 506*
150 AMP WESTINGHOUSE* F-1
300 AMP WESTINGHOUSE* E-1
30 VOLT WESTINGHOUSE AX
40 VOLT WESTON 517
40 VOLT WESTINGHOUSE NA-33

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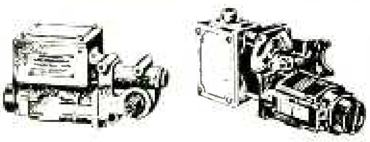
SMALL GEARHEAD MOTORS



LEAR—(Left fig.) Stock #GHM-L6. 24 VDC, 5.5 amperes, series wound, reversible. Motor turns 9000 RPM driving a 1500 to 1 gear reduction box which turns final take-off shaft at 6 RPM. Has limit switches to control limit of travel. Size 4½ x 5 x 9". Wt. 4½ lbs. Price NEW......$7.50

LEAR—(Right fig.) Stock #GHM-L11C. 24 VDC, 7.6 amperes, series wound, reversible motor with overload clutch. Motor turns 11,000 RPM driving through a 10 to 1 gear reduction box which turns the final take-off shaft 1100 RPM. Unit has adjustable limit switches to control limit of travel. Take-off shaft is adaptable to flexible or rigid drives. Size 4½ x 5 x 9". Wt. 4½ lbs. Price NEW..$8.50

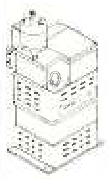
3,750 WATT RECTIFIER TUBE

Continental Electric Co.—Type CE202. Half-wave mercury vapor. Rated up to 250 VDC at 15 amp. Filament 2.5 volt—20 amps. Mogul base. Price NEW $9.95

MAGNETRON TUBE

RAYTHEON—No. 2J56. Price NEW........$29.50

INDUCTION VOLTAGE REGULATOR



General Electric Spec. #3263300. Single phase 60 cycle. Primary voltages (0-460 V) applied to regulator can be varied smoothly and infinitely 78.6% above and below their values by remote control. Operated by 115 V type KCP control motor. Continuous ratings for typical inputs are: **120 VOLT**-output 26 to 214 V at 1.85 amp., **240 VOLT**-output 52 to 428 V at 1.63 amp., **460 VOLT**-output 98 to 822 V at 1.40 amp. Size 8½x11x22". Wt. 122 lbs. List over $300.00. Price **NEW**..............$29.50

ELAPSED TIME METER

AERO INSTRUMENT CO.—Model 1001. Records operating time of AC electrical and electronic equipment. Registers up to 9,999.9 hours in 1/10 hour steps, then automatically resets. 1/10ths shown in red numerals, others in black. Excellent for recording running time of tube life, TV equipment, maintenance schedules, machinery overhaul, etc. Totally enclosed in heavy bakelite case. Front measures 3½" in diameter and has glass covered face. 120 VAC 60 cycle. Price NEW........$8.50

SPECIALS

AMPLIDYNE MOTOR GENERATOR. Emerson Electric. #5AM31NJ18A. Input 27 VDC—44 amps. Output 60 VDC—8.8 amps. 530 watts. 8300 RPM. 6x8x12". Wt. 34 lbs. Price NEW....$7.95

WHITE-ROGER SERVO MOTORS—24 VDC Torque 150 in., lbs. Reversible. Control box on top has limit switches, relays, and selenium rectifiers (to block AC out of motor). 5x5x4". Can be supplied in Models 6904—5 RPM. 6904—3½ RPM or 6905—2½ RPM. Price each NEW..........$8.95

OPEN TYPE TRANSFORMERS—60 CY.

#0692. Input 115/230 V. Output 18 V at 100 amps. Secondary leads 18" long. 7¾x5x6". Wt. 40 lbs. Price NEW $16.50

PROMPT DELIVERY ON ALL ORDERS
ALL MERCHANDISE FULLY GUARANTEED

Terms: Prices FOB St. Louis. Cash or 25% with orders. Balance COD. Rated Concerns (D&B) Net 10 days cash. Prices subject to change without notice

McNEAL ELECTRIC & EQUIPMENT CO.

4736 Olive St. St. Louis 8, Mo.

AUGUST SPECIALS

New Material

TOGGLE & MICRO SWS. — RELAYS RHEOSTATS — OIL CONDENSERS

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

lush 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.—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-SA-1¼" Bat. Handle	.32 L.T.
8905K-722	3PST	10A	Off-Mom. On	.79 L.T.
8911 K-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

8894K-1 SP-4 Pos. Cir. Breaker #110003—Auto On-Off—Decr. RPM Mom. On Incr. RPM Mom. On Plain Tip Bat Handle **$1.75**

PLM60 Klixon Cir. Breaker–Man. Reset–60 Amps. **$.98**

Ant. Change-over Knife Sw. #962 Sq. D. SPDT–32K9503–20..............................**$.95**

MICRO SWITCHES

Number	Actuator	Circuit	Term.	Price
WLR-31	Pin	SPST-N.C.	Screw	.49
WZR-31-M	MC2711 Plunger	SPST-N.C.	Screw	.69
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
W2RO41	Plunger	SPST N.C.	Screw	.89
YZR-31	T-Actuator-LH	SPST N.O.	Screw	.79
Y27RDTC	Plunger	SPST N.O.	Solder	.69
Y23RDT	Plunger	SPST N.O.	Screw	.69
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

RELAYS & CONTRACTORS

Type#	Volt	Ohms	Current	Action	Price
1027	12 Leach	67	8	DPDT	1.25
1077-BFW	24 Leach	160	¼Cont.	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		100	SPST N.O.	2.95
6046-H1A-C1	24 CH		50	DPDT	9.95
6046-H1B-C1	24 CH		50	DPDT	9.95
6046-H2B-C2	24 CH		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

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Mfd.	Volts	Price	Mfd.	Volts	Price
.5	400V	$.19	4	600V	1.10
1	500V	.58	7	600V	1.25
1	600V	.40	8	600V	1.50
1	25KV	Quote	12	600V	1.95
2	600V	$.59			

Thousands of Other Types—See July & May Issues
Power Supply—Special @ **$6.75**

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	Coil	Contacts	Will Close At	Price
1)	6500 ohms	2A	5 MA	$2.50 ea.
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
5)	3600 ohms	1C	6 MA	2.00 ea.
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.

Other Type G Telephone Relays

1)	1300 ohms	1A-1C	24 or 48V.	2.50 ea.
2)	700 ohms	2A-1C	24V.	2.50 ea.

Legend (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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TS-8A/U	TS-63/AP	TS-175/U	TS-324/U	I-167A	BC-1236/A
TS-10A/APN-1	TS-76/APM-3	TS-184/AP	TS-328	I-177	BC-1255/A
TS-11/AP	TS-87/AP	TS-189/U	TS-338	I-178	BC-1287/A
*TS-12	TS-89/AP	TS-192/CPM-4	TS-359A/U	I-196A	BC-1277
*TS-13	TS-96/TPS-1	TS-194/CPM-4	TS-363/U	I-198A	BE-67
TS-14	TS-98/AP	TS-197/CPM-4	TS-375	I-208/A	LAD
TS-15B/AP	TS-100/AP	TS-198/CPM-4	TS-377/U	I-212	LAF
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TS-23/AP	TS-110/AP	TS-210/MPM	I-56	I-233	LU-3
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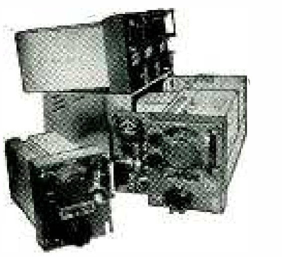

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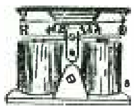

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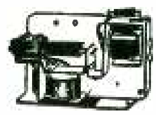

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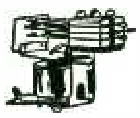

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Leach 1154	50VAC	2A‡	R431	2.49
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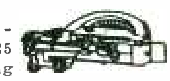

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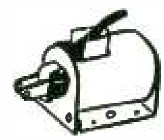

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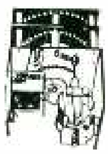

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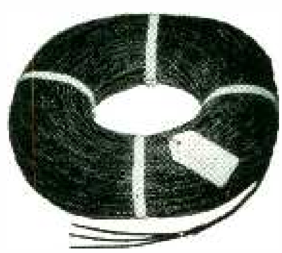

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INDEX

SEARCHLIGHT

August, 1952

This index is published as a convenience to the readers.

TO THE ADVERTISERS

August, 1952

Care is taken to make it accurate but ELECTRONICS assumes no responsibility for errors or omissions.

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1B23	9.75
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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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2C26A	.18
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2D21	1.35
2E22	1.92
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2J21A	8.95
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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
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2K25/723AB	28.75
2K28	32.50
2K29	21.75
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3AP1	9.95
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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
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3C23	10.95
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3CP1S1	1.95
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3FP7	1.65
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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
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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
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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
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FG17	4.89
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FG32	8.95
FG57	14.95
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HF100	8.95
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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
WL697	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	.60
6J7G	.65
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	.95
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	.55
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	.35
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	.55
41	.69
42	.65
43	.65
45	.75
45Z3	.54
45Z5	.69
46	.78
47	.79
48	1.25
49	.75
50A5	.89
50B5	.75
50C5	.67
50L6GT	.65
50Y6	.72
53	.68
56	.55
57	.62
58	.63
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	.28
117L7/M7	1.29
117N7	1.29
117P7	1.29
117Z3	.65
117Z6	.89

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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
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30 units 21.6MFD/3000VDC/64.8 watt sec..$7.95

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16MFD 600VAC 2800VDC Intermittent... 6.95
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OIL CAPACITORS

Mfd.	Each
50 wvdc	
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
.1	.69
.2	.69
.25	.61
.5	.65
1	.75
2	.92
3	1.08
4	1.89
5	1.98
6	2.69
8	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.1	.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
8	3.98
2000wvdc	
1	1.49
2x.1	1.75
1	1.89
2	2.98
3	[illegible]
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
1	[illegible]
4	19.98
7000wvdc	
.002	1.69
.0075	1.98
.1	4.98
7500wvdc	
.03	2.98
.05	3.49
10000wvdc	
.03	3.49
12000wvdc	
.02	4.98

Mfd.	Each
12500wvdc	
2	95.00
15000wvdc	
.0016	9.98
25000wvdc	
.00025	7.49
1	95.00
AC RATED	
220vac/600dc	
2	.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	[illegible]
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
8	4.98
10	6.98
16	7.98

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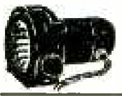
QUANTITY USERS, WRITE FOR SPECIAL PRICES

BLOWERS



40CFM 28 vacdc..........$5.98
250CFM 28 vacdc.......... 9.95
250CFM with 28 to 115 vac Trans..........11.95
175CFM 220 vac..........11.98
40CFM 24 vdc BL1000. 6.90
70CFM 115V 400 Cycle. 8.98

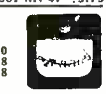
UHF ANTENNA

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 InBuilt HiPass Fltr Flange Mtg Incl. H'ware..........$5.98
ANT AN130B. 33" Whip..........1.98

SECTIONAL ANTENNAS

MS49-52. 12½ ft..........$1.69
MS49-53. 16 ft..........2.49
BASES: MP22 3.98; MP48 3.98; MP47 3.75

METER SPECIALS
DC MILLIAMMETERS

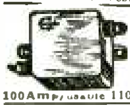


0-1Ma 3" sq. Weston..........$7.50
0-25Ma. Weston 3" sq..........6.98
0-100Ma 2¼" Rnd..........5.98

MISCELLANEOUS TYPES

0-50 Micro Ammeter 3" sq. Weston..........$16.98
—20+3 VU. Weston Vol. Level Indicat..........16.98
0-8V A.C. 3" Rnd Weston..........3.49
0-150V A.C. 3" sq. Weston Rect. Type..........8.98
57-63 Cycles Freq. Mtr. 3" RND..........4.98
0-120MA RF 3½" Rnd Weston..........14.98
0-800Volt DC Weston 3" Sq..........12.98

LINE FILTERS



10Amp/130vacdc 0.1 to 1000 Mc's..........$1
30Amp/250vacdc 0.1 to 1000 Mc's..........3.98
50Amp600vac/250vacdc. Fltrs both sides of line. 9.98
100Amp/........ 110 vacdc GE..........2 for $1.98

HIGH CURRENT MICA CNDRS
CYLINDRICAL SIMILAR TYPE "G"

MFD	KV	AMPS	MC	EACH
.01	10	30	3	$49.50
.004	20	22	3	45.00
.0025	20	22	3	45.00
.005	15	30	1	48.00
.0025	12	20	3	28.95
.001	30	30	3	110.00
.0012	20	16	3	35.00
.002	20	22	3	40.00

BALL BEARINGS

	ID	OD	Thickness	Each
R4S Barden	16/64	40/64	13/64	$ .78
34KDD Fafnir	10/64	40/64	12/64	.75
38KDD Fafnir	20/64	55/64	17/64	.98
13304 SKF	23/64	1 1/64	20/64	.90
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

866A KIT AND XFORMER

2 Tubes, Sckts, xmfr 115v 60cye Inpt. outpt 2.5vct, 10A/Hvinsul..........$6.98

"TAB" THAT'S A BUY

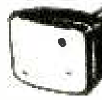
DYNAMOTORS

Inpt 28VDC/1.4A out 250V/60ma..........3.69
DM4 12 & 24V out 225V/100ma, 400V/200ma..........11.98
DA3A 28V/10.5A out 300VDC/200ma 150VDC/10ma, 14.5vdc/5A..........6.75
PE94 Plate Supp., Uses DA3A (SCR522)..........8.98
PE97 Plate Supp., Less Tubes..........9.98
INPT 6VDC/27.5A Oupt 590VDC/150MA Carter Mag Motor..........29.95

SELSYNS

2J1H1 GE Selsyns..........2 for $6.98
2J1F3 GE Brand New 115V/400 cy. ea..........9.75
C78248 Sync. Transf 115/60cy 15.95..2 for 29.95
C78249 Sync. Diff. 115V/60 cy 12.95..2 for 25.00
Syne Trans. C-69405-2 Type 1-I..........2 for 50.00
Sync Repeater 115/60 cy Type 11-4 New Indiv. Crtn $32.50..........2 for 59.50
Bendix Auto Syn AY1 & AY5..........2 for 4.95

TV PICTURE TUBES



10 inch Round..........$14.95
12 inch Round..........17.95
14 inch Rectangular..........20.95
16 inch Round..........22.95
16 inch Rectangular..........23.85
17 inch Rectangular..........24.85
19 inch Round..........26.50
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 toward 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.

TUBE SPECIALS

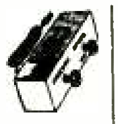
ELECTRICALLY PERFECT, & GUARANTEED KEYS ARE BROKE

1B3GT, 6H6, 6K6GT, 6SN7GT, 6V6GT, 12SN7GT—ea 50c..........5 for $2.00
6BG6G, 6B06, 6L6G—ea 79c..........3 for $2.00

NEW THRIFT-LITE LIFETIME PHOTO-FLASH

Not a kit. Incl Pwr pck, Life std Lamp, Rflctr & 15' cord 1/1000 Sec flash every 7 sec. True daylite color. Usable all cameras oper 115VAC w/lite Type AC40..........$39.69
Complete Outfit for AC & Battery opr. Incl AC40&BP25 portopak & all accessrs for KODAK&COMPUR shutters. Complete..........$53.98
AC45F Photoflash Unit; Features Selective Time Delay 115V/60CYL Operation..........$49.40
AD15 Intensifier DBL's Light Output of Basic Unit..........$15.69
Write for Complete "THRIFTLITE" Data Boosterpacks, Ext lites, Units for Focal plane shutters & accessories.

Selenium Power Supply



0 to 12 VDC/2 Amp. 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 speed 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	2.5A 13.
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	
24AMP	16.00		31.00	39.50	
30AMP	18.50	24.30	36.00		
36AMP	25.50		45.00		

C.T. Rect 100 amp 10-0-10V..........$44.95
80 amp 18-0-18V 29.95; 36-0-36V 80 amp 53.95
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

END EQUIPMENT BUYS

R4/ARR2 Rcvr w/Tubes & Dyna..........21.95
BC733D Rcvr As is Less Tubes..........19.98
RM29 Control Unit. BRAND NEW..........12.98
EE65 Time Interval Signal, Used..........3.98
I-108 Range Calibrator. Metal Case..........29.98
I-198 Sig. Gen. Good Cond., Less Tubes..........14.95
SCR595 I F. Less Tubes, As Is..........3.98
BC605 Amp. Less Tubes, As Is..........3.98
BC906 Freq. Mtr. exc. cond..........29.95
I222A Sig. Gen. 115V/60 Cy..........129.50
BC221 Sig. Gen. Exc. Cond..........125.00
I222 Sig. Gen., As Is..........79.50
SCR522A Less/Xtals w/Tubes..........69.95
ANTENNA Relay BC442-A, Meter. Thrml Couple, 50 mmf vac Cndsr Complt..........8.95

CONNECTORS CABLE

831R/SO239 Receptacle..........$0.50
831SPN/PL259A Plug..........65
831SP/PL259 Plug..........50
83IJ/PL258 Junction..........95
CORD CD307A W/JK26 & PL55 5 ft long..........1.09
CORD same as above 8 ft $1.29; 12 ft..........1.49
CORD RG8U COAXIAL CABLE per ft..........12
CORD RG11U 5 foot lengths per ft..........08
CORD CD277 6/CNDTR. P/O BC312..........1.89
RG59U CABLE per ft. .08; 100 ft. 5.98; 1M ft..........49.98
300 ~ Twinex 100 ft..........1.80

TUBES

"TAB" TESTED & GUARANTEED
PRICES SUBJECT TO CHANGE
WRITE FOR COMPLETE TUBE LISTING

OA2	.98
OA3/VR75	1.23
OB2	1.37
OB3/VR90	1.09
OC3/VR105	1.19
OD3/VR150	.98
1B3/8016	.83
1B21/471A	2.85
1B22	2.20
1B23	9.90
1B24	17.49
1B26	2.45
1B27	14.98
1B32/532A	3.90
1B35	10.98
1B37	16.98
1B38	29.95
1B40	4.95
1B41	49.95
1B42	18.00
1B46	1.98
1B53	49.95
1B56	38.50
1B58	350.00
1B60	69.75
1B63	50.00
1B63A	75.00
2C39	33.98
2C40	9.98
2C40 JAN	19.90
2C43	26.75
2C43/464A	9.49
2C44	1.20
2C50	3.69
2C51	6.45
2C52	5.98
2E31	1.49
2E36	2.19
2E41	2.39
2E43	1.39
2G21	2.39
2J31	29.75
2J31A	79.95
2J32	59.95
2J33	39.39
2J34	38.50
2J36	120.00
2J37	12.70
2J38	17.75
2J39	49.50
2J42	250.00
2J48	28.50
2J49	39.45
2J50	27.50
2J52	249.50
2J55	85.00
2J56	199.50
2J61	49.95
2J62	49.45
2K25	39.95
2K25/723AB	39.00
2K28	32.00
2K29	23.95
2K33	300.00
2K35	398.00
2K39	100.00
2K42	145.00
2K43	135.00
2K46	360.00
2K47	460.00
2K48	118.00
3B22	2.70
3B23/RK22	4.95
3B24	5.40
3B25	4.50
3B26	3.70
3B28	7.90
3C22	125.00
3C23	12.45
3C31/C1B	3.45
3C33	14.98
3C34/HK24	5.49

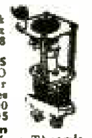
3C45	17.98
3D6/1299	.69
3D21A	3.98
3D22	13.95
3D23	4.90
3E29	14.95
4-125A	29.95
4-250A	40.95
4-1000A	108.50
4C35	27.25
EL5BHD	16.98
5C21/C6J	6.95
5C22	49.95
5C30/C5B	3.95
5D21	27.45
5D23/RK65	36.50
5J29	12.40
5R4GY	1.80
5R4WGY	1.75
6AG5	.89
6AG7	1.99
6AH5G	1.49
6AH6	1.99
6AJ5	1.40
6AK5	.90
6AK5W	2.98
6AK6	1.49
6AL5	.69
6AL7GT	1.29
6AN5	2.90
6AQ5	.59
6AQ5W	3.98
6AQ6	1.00
6AQ7GT	1.29
6AR5	.79
6AR6	2.98
6AS5	.79
6AS6	2.79
6AS7G	4.35
6AT6	.82
6AU5GT	1.49
6AU6	.69
6AV5GT	1.29
6AV6	.59
6AW6	1.89
6B4G	1.59
6BA6	.79
6BA7	1.27
6BC5	.69
6BC7	1.23
6BD5GT	1.65
6BD6	.89
6BE6	.79
6BF5	1.06
6BF6	1.49
6BF7	2.55
6EG6G	1.65
6BG7	1.98
6BH6	.89
6BJ6	.99
6BK7	2.15
6BL7GT	1.45
6BN6	1.49
6BN7	1.69
6BQ6GT	1.29
6BQ7	2.15
6BY5G	1.45
6C21	29.45
6CB6	.89
6CD6G	2.49
6D4	2.70
C6J/5C21	6.95
6J4	7.65
6J5GT	.59
6J6	.89
6K4A	6.45
6L6	2.09
6L6G	1.69
6L6GA	1.69
6L6GAY	2.29
6SA7GT	.89
6SA7GTY	3.37

6SB7Y	1.19
6SC7	1.39
6SD7GT	.99
6SF5	.89
6SF7	.89
6SG7	1.39
6SH7	.99
6SJ7	.89
6SK7GT	.89
6SL7GT	.89
6SN7GT	.79
6SN7WGT	2.25
6SQ7GT	.79
6SR7	.69
6SS7	1.12
6ST7	1.33
6SU7GTY	3.37
6V6	2.25
6V6GT	.69
6W4GT	.69
12AH7GT	1.45
12AK5	1.98
12AK5W	2.98
12AL5	1.11
12AT6	.59
12AT7	.93
12AU6	.89
12AU7	.74
12AV6	.69
12AV7	1.35
12AW6	1.79
12AX4GT	1.20
12AX7	.99
12AY7	2.95
12AZ7	1.49
12BA6	.79
12BA7	.79
12BD6	1.75
12BE6	.89
12BF6	.85
12BH7	1.29
12BY7	1.35
12BZ7	1.25
12SG7	1.05
FG17	3.95
19T8	1.09
19V8	1.62
RK20A	8.95
24G/3C24	1.90
25BQ6GT	1.19
25L6GT	.69
25Z5	.79
25Z6GT	.99
FG27A	8.70
HV27	10.95
RK28A	4.89
28D7	1.39
FG32/5558	13.85
35Z5GT	.59
RK39	2.89
RK48	6.85
RK49	7.50
50L6GT	.69
80	.69
81	1.69
FG81A	3.90
82	1.19
82V	1.39
83	1.45
83V	1.79
84/6Z4	.99
FG95/5560	24.85
FG98	19.95
100TH	8.89
FG104	37.98
FG105	18.98
117L/M7GT	1.59
117N7GT	1.79
117P7GT	1.39
117Z6GT	1.19
117Z7GT	1.49
F123A	7.90

F127A	19.98
VT127A	3.90
CV148	4.98
VT158	14.49
FG166	49.00
FG172	31.50
250TH	22.25
250TL	18.50
304TH	8.90
304TL	8.90
388A	1.49
417A	8.95
417A/5842	18.50
GL434A	29.95
446A	1.05
446B	3.89
450TH	44.00
450TL	52.00
460/HF200	15.95
WL468	13.95
GL471A	2.69
CK501X	1.26
CK501AX	1.26
GL502A	1.79
CK502AX	1.79
CK503AX	1.79
CK505AX	1.79
CK506AX	1.79
RH507	9.98
CK509AX	1.26
CK512AX	3.15
CK522AX	2.49
CK525AX	3.15
CK526AX	3.95
CK528AX	2.39
CK529AX	2.98
GL530	22.00
CK531DX	1.98
531	6.98
CK532DX	1.98
WL532	3.98
CK533AX	1.39
CK534AX	.89
CK536AX	.89
CK537AX	4.98
CK538DX	.89
CK539DX	1.98
CK541DX	1.98
CK542DX	.98
CK543DX	.98
CK544DX	.98
CK546DX	1.98
CK547DX	1.98
CK571AX/5886	4.98
CK573/AX 6029	4.45
WL579	10.49
WL579B	12.98
KU627	18.00
WL652	65.00
WL676	39.95
WL686	35.00
707A	7.90
707B	17.49
715A	6.45
715B	8.90
715C	29.85
717A	1.49
718BY	48.45
718CY	48.45
719A	49.95
721A	2.49
722A/287	2.45
723A	11.95
723A/B	25.00
724A	3.95
724B	3.45
725A	8.90
726A	8.45
726B	59.95
726C	69.95

801A	.45
803	3.89
805	3.90
807	1.65
808	2.98
809	2.43
810	9.95
811	2.90
812	2.70
813	12.49
814	3.45
815	2.98
816/866Jr	1.07
826	.95
829	11.49
829B	12.45
832	7.65
832A	9.65
833A	39.45
834	5.95
836	4.75
837	1.45
849	29.45
860	4.90
861	23.95
865	1.29
866A	1.50
869	36.95
872A	3.29
893A	250.00
CK1005	.85
CK1027	3.35
CK1028	9.98
CK1089	2.98
CK1090	2.98
Xtal Diodes	
1N21A	1.55
1N21B	3.00
1N21C	21.50
1N22	1.25
1N23	1.35
1N23A	2.35
1N23B	3.49
1N25	4.98
1N26	8.75
1N27	1.55
1N29	3.50
1N32	23.75
1N34	.64
1N34A	.98
1N35	1.65
1N38	1.43
1N39	4.15
1N40	9.98
1N43	1.69
1N44	1.21
1N45	1.39
1N46	.69
1N47	5.49
1N48	.59
1N51	.45
1N52	1.85
1N54	.89
1N55	2.35
1N56	.89
1N57	.89
1N58	1.19
1N60	.60
1N61	2.10
1N63/K63	2.49
1N64	.69
1N67	1.95
1N69	1.98
K34	1.39
CK705	.77
CK706	.54
CK707	1.80

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

400 CYC XFMRS

Mfgrs Tell Us Your Needs. Give Mfgrs and Sig Corps Stock Numbers

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/8A, 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

POWER TRANSFORMERS

2500V 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
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
900V/35MA, 2x2.5V/2A, xcint 1800V dblr two 2x2 fil. windgs hsld..........3.49
840VCT/110MA, 530vct/21ma, 2x5V/3A, 6.3vct/1A, 6.3vct/.3A..........4.98
770VCT/85MA, 5/2A, 6.3V3.5A. Thrcd..........3.98
750VCT/200MA, 6.3V/5A, 5V/4amp..........5.95
720VCT/115MA, 2x6.3V/.6A, 5.05V/2A, 6.3V/3.8A..........3.95
700VCT/120MA, 2x6.3V/3A, 6.3V/1A..........3.98
600VCT/100MA, Tapped 350vct, 6.2V/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

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6VCT/5A, 6V/5A, 5VCT/5A..........$5.95
6.3vct/4A (gud 6.5A) H'Sld HVins..........2.69
6.3vct/1A..........$1.98; 6.3v/.6A..........1.98
2.5v/2A..........79; 7.5vct/12A 15Kvins..........10.98
24v/6a csd..........4.98; 24v/1.25 csd..........1.98
2.5vct/10Amp 5Kvins..........3.59; 2x12V/2A..........3.89
5V/2A, 6V/3A..........2.25; 6V/6A..........2.95
5V/60A..........13.98; 5V/115A..........16.95

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3000V/10MA Csd WE 161913 Hvins..........8.95
5500VCT/650MA USN Watghs Csd..........69.95

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10Hy/85ma @ .98;.....2 for 1.79
10Hy/125ma/UTC/Csd/H'Sld/1KVins..........1.69
50Hy/125ma/Csd/H'Sld..........2.89
Dual/12Hy/150ma/Csd/2KVins..........2.98
12Hy/300ma/Csd/5KVins/H'Sld..........4.95
20Hy/300ma or 15Hy/400ma/12KVins..........8.95
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10HY 200ma Hmsld Jefferson..........2.95
8HY 225ma Thordason..........3.50

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Fig. B. .001 mf, 10c; .006 mf, 23c; .01 mfd, 35c.

Fig. C. Solder Lug Terminals & Mtg Holes

Mfd.	Each
600 WV	
.0001	$0.29
.001	.42
.002	.45
.004	.53
.005	.55
.006	.59
.008	.63
.01	.66

Mfd.	Each
600 WV	
.02	$0.76
.03	1.19
1200 WV	
.002	.66
.004	.68
.005	.71
.01	.78
2500 WV	
.00047	.59

Fig. D. Screw Term & Mtg

Mfd.	Each
600 WV	
.0001	$0.29
.00055	.37
.00085	.42
.0012	.44
.003	.49
.005	.54
.015	.71
.02	.78
.03	1.19
.033	1.29
.039	1.98
.04	2.09
.05	2.39
1200 WV	
.001	.61
.002	.66
.0051	.71
.0068	.75

Mfd.	Each
1200 WV	
.01	$0.78
.013	.89
.03	1.89
.033	2.39
2500 WV	
.0004	.59
.002	1.09
.0022	1.09
.0024	1.13
.0035	1.15
.0036	1.19
.0043	1.29
.005	1.45
.006	1.55
.01	1.89
.015	2.19
3000 WV	
.005	1.65

Fig. E. Upright Xmtg Micas

Mfd.	Each
250 VDC	
.05	$0.47
.2	2.59
1500 VDC	
.04	.89
.05	1.08
2000 VDC	
.003	1.08
.005	1.19
.006	1.25
.01	1.39
.015	1.68
.02	1.98
.03	2.35
2500 VDC	
.0025	1.08
.006	1.65
3000 VDC	
.00005	.78

Mfd.	Each
.0001	$1.08
.0003	1.15
.0007	1.19
.0056	1.39
3000 VDC	
.0055	1.35
.008	1.79
3500 VDC	
.000033	.78
5000 VDC	
.000082	1.65
.0001	1.79
.00015	2.29
.00018	2.39
.0003	2.75
.00043	2.85
.0006	3.59
.001	3.89
.01	4.79

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Grid — Plate		86. mmfd.
Grid — Filament		116. mmfd.

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For complete technical data on the RCA-6146 and RCA-6159, write RCA, Commercial Engineering, Section 42HR, Harrison, N. J., or your nearest Field Office.

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