electronics

JULY • 1953

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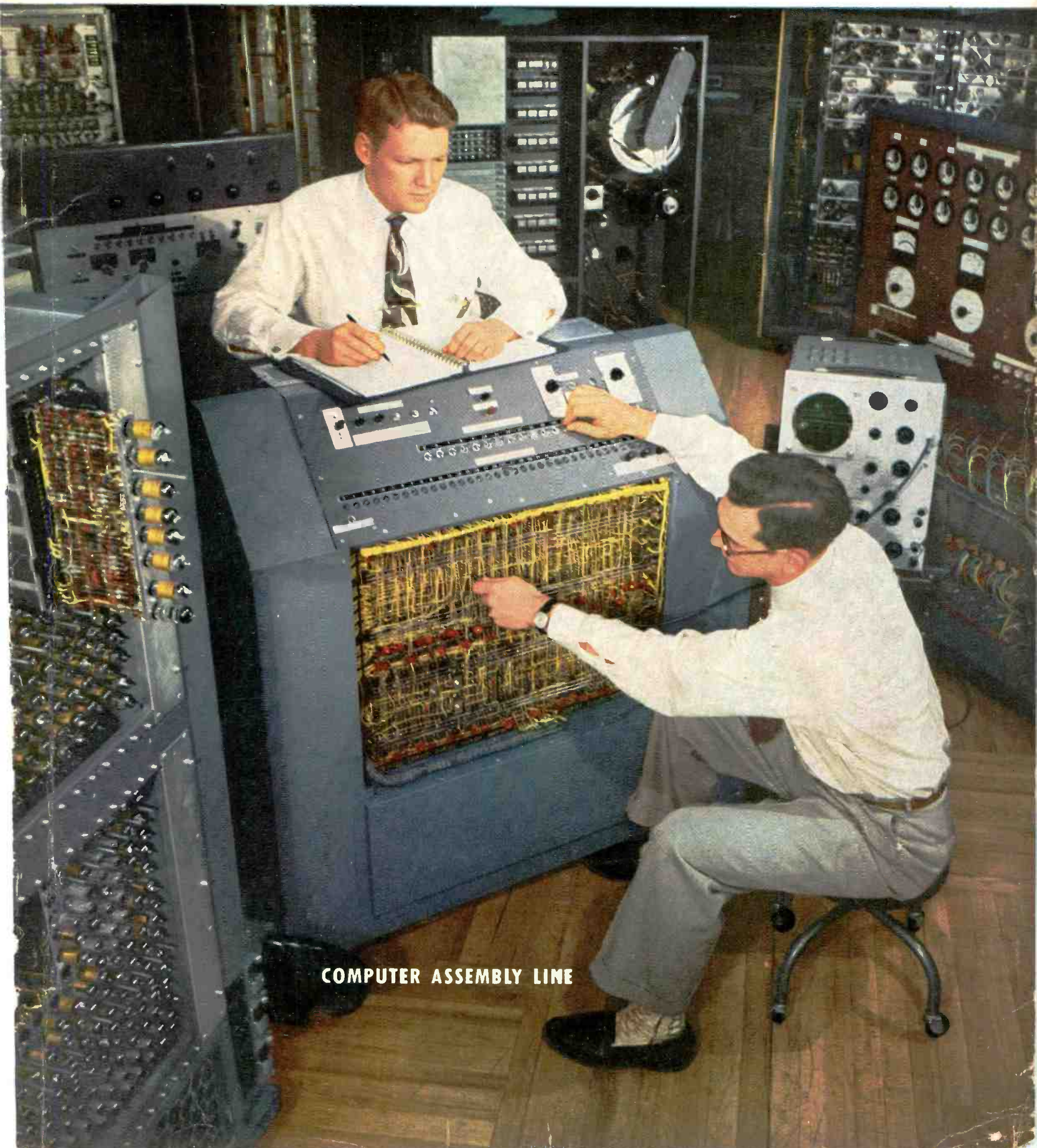

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MINIATURE AUDIO UNITS...RCOF CASE

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.

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JULY • 1953

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COMPUTER ASSEMBLY LINE—Engineers check out IBM electronic data processing machine at Poughkeepsie, N. Y., plant. Built at the rate of one per month, the EDPM-701 is among the first large-scale digital computers to be mass produced (see p 200) .... COVER

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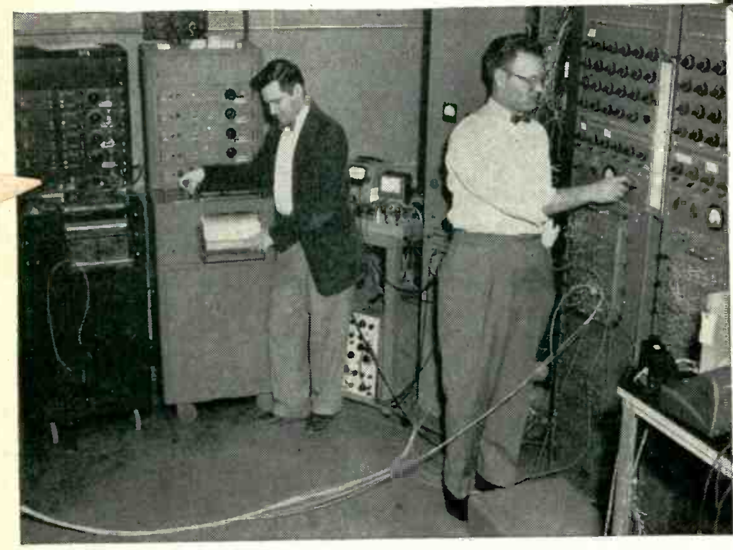
SANBORN OSCILLOGRAPH RECORDING SYSTEMS HAVE MANY APPLICATIONS

Sanborn Recorders Help Speed Flight Design

SPERRY GYROSCOPE COMPANY uses a two-channel Sanborn Recording System for basic research on their Zero Reader* Flight Director, a device which simplifies the manual control of aircraft. The Sanborn System shown above is recording the output of a flight simulator that solves Zero Reader equations.

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

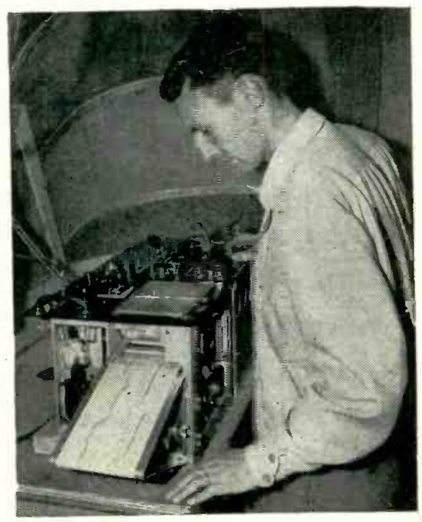


At McDONNELL AIRCRAFT CORPORATION the movements of a guided missile are simulated by high-precision analog computers which in turn send *eight* different resultant electric signals into two Sanborn four-channel Recording Systems (left) for the graphic recording of the hypothetical results of the guided missile problem.

FOUR CHANNEL

TWO CHANNEL

ONE CHANNEL



At DOUGLAS AIRCRAFT COMPANY'S Flight Test Section, a Sanborn two-channel Recording System (shown removed from case for field operation) is used in conjunction with a telemeter radio link to record surface motion vibration in a flying aircraft while it is performing tests requiring continual monitoring. Recorded tracings provide the necessary permanent visual time history for comparison of the two events recorded and a study of their individual characteristics.

How can Sanborn help you?

Sanborn one-, two-, and four-channel Recording Systems can provide an accurate and permanent graphic registration of almost any electrical phenomena whose frequency spectrum falls within the range of zero to 100 cycles per second. The availability and ready *interchangeability* of amplifiers and preamplifiers offer a wide range of use.

Records are traced by heated stylus on plastic coated strip-chart paper, and are in true rectangular coordinates. Other Sanborn advantages include: a high torque movement (200,000 dyne cms per cm deflection); built-in code and time markers; and a wide choice of paper speeds and channels.

Sanborn engineers will be pleased to make recommendations as to what type of equipment will best solve your recording problem. When writing, include the lower and upper limits and the frequency range of the phenomena to be recorded, and the type of transducer.

Ask for a copy of our "Applicability Folder" which presents a table of uses, complete performance data and specifications, brief descriptions of Sanborn Recording Systems and explanations of how their amplifiers may be readily interchanged.

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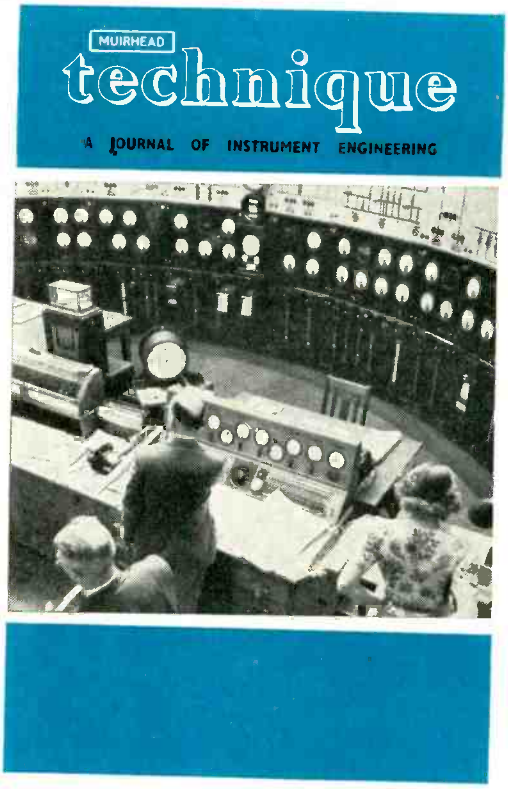

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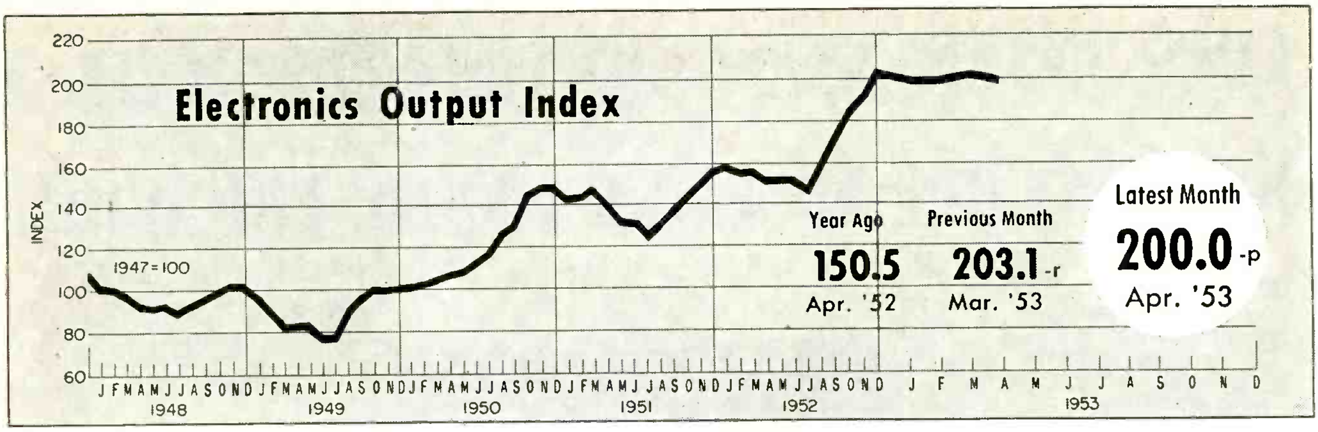


FIGURES OF THE MONTH

	Year Ago	Previous Month	Latest Month
RECEIVER PRODUCTION			
(Source: RTMA)	Apr. '52	Mar. '53	Apr. '53
Television sets	322,878	810,112	567,878
Home sets	286,164	442,101	286,974
Clock Radios	176,003	275,079	187,394
Portable sets	110,529	177,656	201,476
Auto sets	275,250	654,367	483,092
RECEIVER SALES			
(Source: RTMA)	Apr. '52	Mar. '53	Apr. '53
Television sets, units	......	603,704	319,721
Radio sets (except auto)	......	516,618	412,802
RECEIVING TUBE SALES			
(Source: RTMA)	Apr. '52	Mar. '53	Apr. '53
Receiv. tubes, total units	26,247,258	44,691,200	41,342,599
Receiving tubes, new sets	15,334,092	31,367,831	30,441,417
Rec. tubes, replacement	6,095,641	9,949,321	8,236,990
Receiving tubes, gov't.	3,257,119	1,449,857	1,167,234
Receiving tubes, export	1,560,406	1,924,191	1,496,958
Picture tubes, to mfrs.	270,781	808,053-r	721,283
SEMICONDUCTOR SALES			
(Source: RTMA)	Apr. '52	Mar. '53	Apr. '53
Germanium Diodes	......	1,172,475	2,450,015

	Quarterly Figures		
	Year Ago	Previous Quarter	Latest Quarter
INDUSTRIAL EQUIPMENT ORDERS			
(Source: NEMA)	1st '52	4th '52	1st '53
Dielectric Heating	$240,000	$440,000	$340,000
Induction Heating	$2,530,000	$2,420,000	$2,910,000
Welding Control	....	$1,390,000	$1,430,000
Other Electronic Control	....	$970,000	$700,000
INDUSTRIAL TUBE SALES			
(Source: NEMA)	1st '52	4th '52	1st '53
Vacuum (non-receiving)	$11,320,000	$12,790,000	$11,340,000
Gas or vapor	$3,100,000	$3,480,000	$3,140,000
Phototubes	$500,000	$760,000	$930,000
Magnetrons and velocity modulation tubes	$8,460,000	$10,510,000	$10,070,000
Gaps and T/R boxes	$2,450,000	$2,090,000	$2,050,000

	Year Ago	Previous Month	Latest Month
TV AUDIENCE			
(Source: NBC Research Dept.)	May '52	Apr. '53	May '53
Sets in Use—total	17,290,800	23,256,000	23,930,000
BROADCAST STATIONS			
(Source: RTMA)	May '52	Apr. '53	May '53
TV Stations on Air	108	179	189
TV Stns CPs—not on air	0	264	266
TV Stns—Applications	541	612	611
AM Stations on Air	2,352	2,430	2,445
AM Stns CPs—not on air	66	135	130
AM Stns—Applications	323	249	244
FM Stations on Air	630	600	591
FM Stns CPs—not on air	17	21	20
FM Stns—Applications	10	9	9
COMMUNICATION AUTHORIZATIONS			
(Source: FCC)	Apr. '52	Mar. '53	Apr. '53
Aeronautical	32,147	38,822	38,887
Marine	35,116	39,425	39,745
Police, fire, etc.	10,787	12,682	12,956
Industrial	12,766	16,232	16,515
Land Transportation	4,886	5,660	5,769
Amateur	108,648	112,666	110,884
Citizens Radio	971	1,980	2,074
Disaster	31	189	189
Experimental	349	415	432
Common carrier	942	1,094	1,144
EMPLOYMENT AND PAYROLLS			
(Source: Bur. Labor Statistics)	Mar. '52	Feb. '53	Mar. '53
Prod. workers, comm. equip.	331,200	419,400-r	418,700
Av. wkly. earnings, comm.	$64.86	$65.37-r	$66.42
Av. wkly. earnings, radio	$60.91-r	$63.92-r	$64.64
Av. weekly hours, comm.	41.0	40.6-r	41.0
Av. weekly hours, radio	40.5-r	40.2-r	40.4
STOCK PRICE AVERAGES			
(Source: Standard and Poor's)	May '52	Apr. '53	May '53
Radio—TV & Electronics	281.8	298.9	295.3
Radio Broadcasters	273.9	290.7	287.3

p—provisional; r—revised

FIGURES OF THE YEAR

	1952 Total	Totals for First Four Months 1952	1953	Percent Change
Television set production	6,096,279	1,647,709	2,827,821	+ 71.62
Radio set production	10,934,872	3,215,746	4,993,720	+ 55.29
Television set sales	6,144,990	1,592,452	2,100,620	+ 31.91
Radio set sales (except auto)	6,878,547	1,709,805	1,851,673	+ 8.88
Receiving tube sales	368,519,243	112,181,580	163,401,355	+ 45.66
Cathode-ray tube sales	6,120,292	1,311,610	3,053,956	+132.77

electronics—JULY • 1953

Printed Amplifier Strip Goes Into TV Production

Entire video i-f amplifier is assembled on etched-foil strip and dip-soldered

ANOTHER approach to automation in television receiver production, just unveiled by the RCA Tube Department, is a complete prealigned 40-mc i-f amplifier strip produced by a combination of printed wiring and dip-soldering techniques. Chief advantages are improved performance, greater uniformity of production, greater reliability and lower cost. Semi-automatic equipment is being installed to produce these amplifier units in large volume and already at least two manufacturers have scheduled it for inclusion in their new fall lines.

▶ **Secret**—Ingenious design of components makes it possible to anchor as well as connect all i-f transformers, tube sockets, capacitors and resistors simultaneously in one simple dip-soldering operation. After conventional etching of the conductor pattern on one side of a plastic sheet, holes are punched for the parts and for the eyelets which are riveted on later to serve as terminals for attaching input, output and power leads.

Next, operators insert preformed, precut leads of resistors and capacitors in 0.04-inch holes, snap three tube sockets into their self-aligning holes with quick thumb pressure, then insert the mounting tabs and lead projections of six printed coils and transformers in the six sets of rectangular holes punched for this purpose. This completes assembly work. The panel is now gripped by its side edges with a holding tool and dipped first in liquid resin, then in a vat of molten 60-40 solder. A final wax dip makes the unit ready for final test and prealignment.

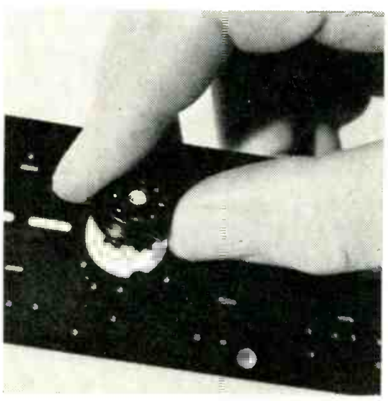
▶ **Significance**—In commercial receivers, evolution of etched circuitry traces slowly through radio sets, vhf tv tuners, interference-suppressing filters, individual components, and now a major tv subassembly. With groundwork well advanced on low-cost printed components, the logical next steps would be printing of the other major subassemblies for a tv set.

Some proponents of etched wiring feel that subassemblies give better control over production than is possible with one-shot assembly of an entire printed tv chassis.

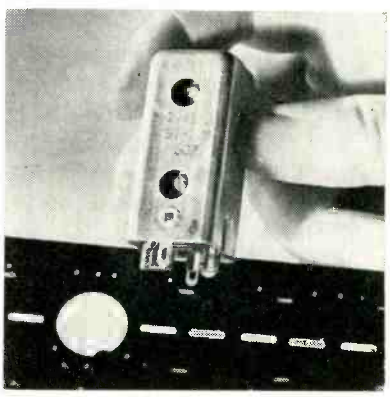
Company Earnings Dropped Slightly

Sales, net assets rose but sales margins, asset returns dropped in electronics

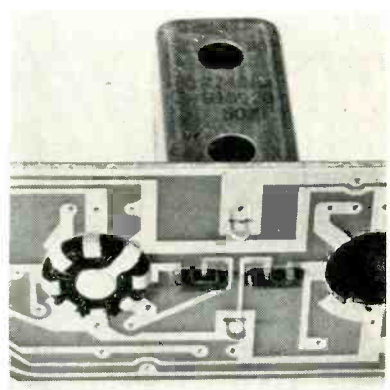
FINAL FIGURES on the financial status of 78 radio-tv-electrical equipment corporations compiled by the National City Bank of New



Inserting socket into punched hole from back of etched-wiring panel. Quick pressure with thumb locks socket in place



Inserting i-f transformer in set of four rectangular slots, two for printed leads and two for mounting tabs that are attached to the shield can



Appearance of printed side of panel after socket and transformer have been inserted. Small holes are for resistor and capacitor leads

York show a downward trend in net profit in 1952.

▶ **Margin On Sales**—Although dollar sales for these companies surpassed those of 1951 by as much as 16 to 20 percent, in most cases the continuing advances in operating costs and taxes squeezed net profit so that for these companies it showed a one-percent decline. The average margin of net profit was cut from 5.2 cents to 4.6 cents per sales dollar, the lowest margin of the last five years. Most industry classifications also experienced smaller profit margins in 1952.

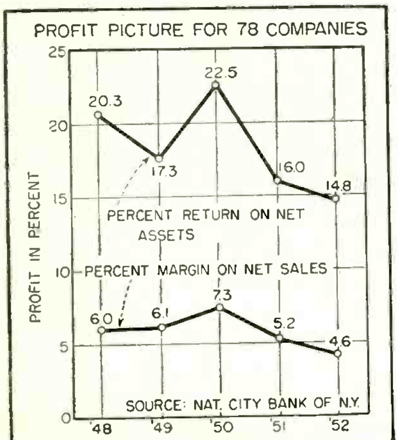
For individual companies the percent of profit for each dollar of sales varied widely in the industry, from as little as 1.9 cents per dollar of sales to 5.8 cents. General Electric and Westinghouse were among the leaders in high margins on sales.

▶ **Return On Assets**—Net profits as a percent of the net worth, or the rate of return on net assets for these companies, also reached a low point in 1952, according to the survey.

It shows the return declined from 16.0 cents in 1951 to 14.8 cents for each dollar reported in book net assets in 1952.

One reason for the drop is the continuing increase in the industry's net worth. For radio-tv electrical equipment firms in the survey, total book net assets carried on the balance sheets in 1948, as the tv boom began, totaled $1.7 billion.

By 1951 net assets had increased to $2.4 billion and at the end of last year had reached $2.8 billion.



▶ **Value Lag**—Tremendous growth in net assets experienced by the industry in the past 5 years is shown by the survey. Financial observers feel that this growth has been understated and that the percent return on assets has tended to be high. They point out that plant and equipment is usually carried on company balance sheets at original cost less depreciation. This is below replacement cost and there is a substantial lag in the process of adjusting book values to current values. Thus, at present replacement costs, the net worth of the radio-tv electrical equipment firms surveyed may approach $4 billion with a resulting lower percentage of return.

Business Briefs

Cutbacks — Consumer goods makers, suspecting they were overshooting their market, are cutting back. Federal Reserve Board's figures show 30-percent drop in tv production between February and April, 9-percent drop in household goods.

Credit—Consumers went in hock for $500 million in April, as much in May. Credit in one year has risen $5 billion to total above $26 billion. Consumer debt now is 13.5 percent of total wages and salaries, 9 percent of total consumer income.

Market—Wall Street's prices hit low for 1953. Experts blamed vaguely the international situation, tight money market.

Trade — Administration has worked a compromise which will allow Reciprocal Trade Agreements Act to be extended one year. Second bill, offered by Rep. Simpson (R-Pa), contains touchy tariff questions.

Tax Cut—Trying to restore more efficient and larger production, Britain has cut sales taxes on radio, tv and appliances as much as 66 percent. Personal and corporate income taxes are down 5 to 17 percent, the largest relief on the smallest incomes. On January 1, 1954, 30 percent of the excess profits tax will go.

Industry Engulfs 1953 Graduates

New crop hard at work after industry's biggest student-courting campaign

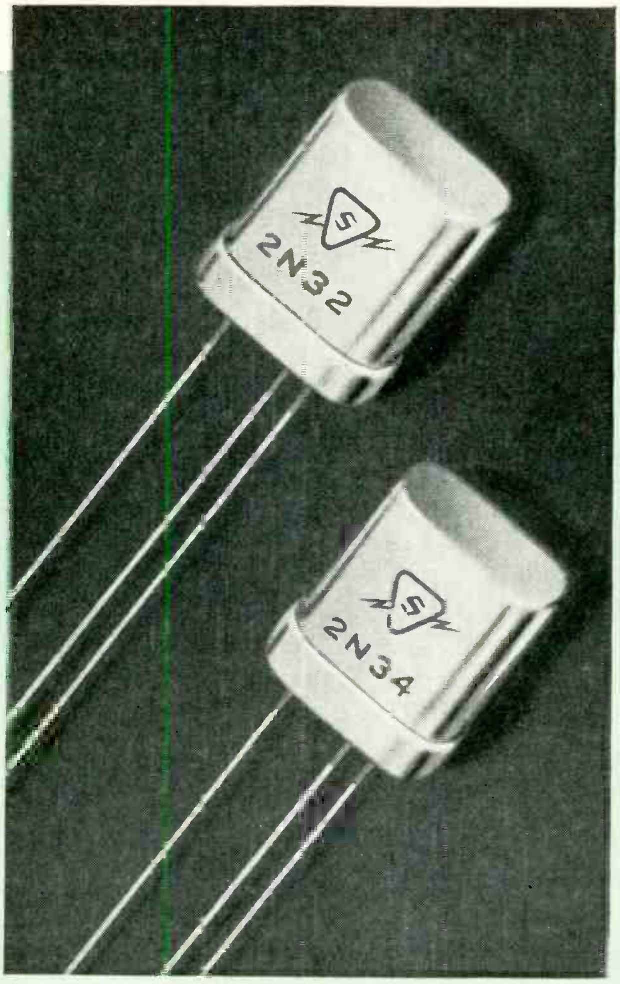
SOME 6,500 graduates with degrees in electrical engineering and physics had that king-for-a-day feeling this spring as they were courted by representatives from hundreds of electronic firms seeking fresh blood. Many a student found himself wooed by upwards of twenty-different firms, offering starting salaries seldom below $350 a month plus a wide variety of extra benefits.

As examples of specific salaries, one large firm landed its quota of 250 new men by starting design and development engineers at $355 a month for a four-year graduate, $370 for a five-year graduate or one having a year of related military electronic experience, $377 for a master's degree, and $392 for a master's plus military experience. Industrial engineers started at $325 but had a faster promotion schedule.

▶ **Figures**—Estimating from latest Engineering Manpower Commission statistics, the EE crop this year was 5,300 with first degrees, 825 with master's and 100 with doctorates. The majority of these took jobs in electronic plants.

Next largest electronic hirings were from the 7,000 graduating mechanical engineers, to meet in-

(Continued on page 8)



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The Sylvania 2N32 is a point-contact transistor, designed especially for switching operations. The Sylvania 2N34 is a junction type transistor for low-frequency, low-power amplifier applications. For further data and characteristics, mail the coupon NOW!

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Company______________________

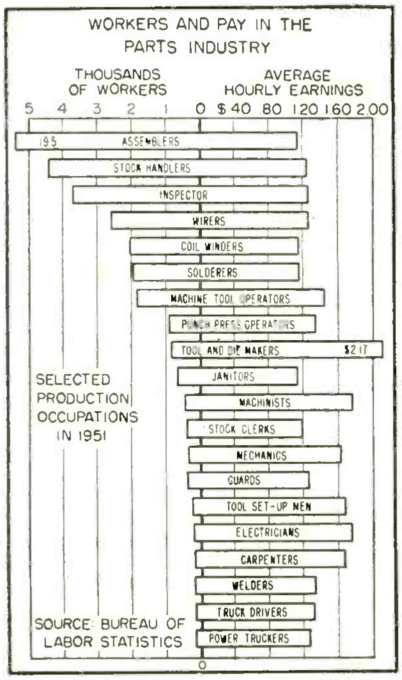
Street______________________

City______________ Zone______ State______ dustry need for integration of electronic and mechanical performance specifications.

A high percentage of the 300 who received degrees in engineering physics were hired by electronic firms. Many of the 2,100 with degrees in general, administrative and management engineering also went to electronic plants.

Allowing for those who took jobs in power-plant electric motor and other non-electronic plants, as well as those who earned higher degrees in night school while already employed, the electronic industry acquired about 4,500 new graduates. This checks closely with the prediction made in Industry Report, p8, June 1952. A recent Columbia University survey noted that those who started at lower salaries tended to get bigger raises, and after a year or two were earning as much as those who started at higher salaries.

Parts Labor Picture



Assemblers made up the bulk of the parts industry's work force in 1951 and earned $1.14, the lowest hourly pay. Highest earnings went to tool and die makers who made $2.17 an hour, nearly $.40 more than electricians and machinists who ranked second on the pay scale. A total of 695 janitors cleaned up $1.15 an hour

PARIS crowds watch ancient rites on hooded outdoor tv receivers, as . . .

Global Hookup Carries Coronation

NINETEEN television cameras occupied vantage spots both in the abbey and along the route of the procession as 2,750,000 set owners in Great Britain, France, Belgium, Holland and Germany received the Coronation program directly.

The BBC's five high-powered tv transmitters were augmented by three lower power units especially for the event, which was carried via microwave to twelve transmitters on the continent.

▶ **Radio**—Hundreds of millions of listeners overseas depended upon a-m radio. More than 100 commentators described the rites in 42 different languages. In Great Britain, all 37 BBC broadcast transmitters carried the ceremony while 48 short-wave transmitters beamed it overseas to six continents. Total cost of the a-m program was about $126,000.

The pageant was recorded on 45 miles of magnetic tape and 60,000 feet of motion-picture film was used for television recording.

▶ **Color**—Public broadcast of color tv in England was highlighted.

Chromatic Television Laboratories in association with Pye, Ltd. installed six receivers using 22-inch Lawrence color tubes, three in hospitals, one in the INS press room, one in the Foreign Office and one in the Pye, Ltd. office. Using 3 Pye tv cameras adapted for 405-line field-seqential color operation, events taking place outside Westminister Abbey were transmitted over the air on 575 mc.

Inventory Trend Is Up In Electronics Field

Value has risen steadily since 1949; reflects the industry's growth and markets

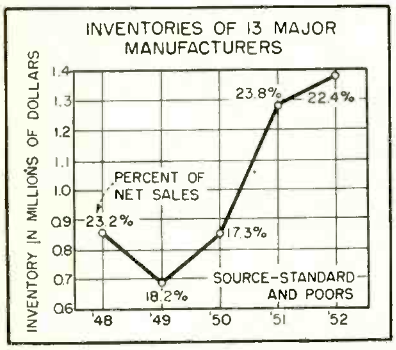
EVER SINCE the "big dump" in 1951, radio-tv industry has held a wary eye on inventories. This year, again, manufacturers, distributors and dealers are watching shelved goods closely and wondering about the seasonal selling lag setting in.

Big problem in getting an up-to-date overall picture is the time lag in the figures. Department of Commerce totals are usually several months behind but the latest report says that total business inventories rose 3.5 billion since last August to a new record of $76 billion in April, 1953.

▶ **Trend**—The radio-tv industry has followed the same trend as

(Continued on page 10)

Want more information? Use post card on last page.



business in general, despite the tight reins most firms keep on inventories. As shown in the chart, the inventories of 13 major electronic manufacturers reached a peak of $13.8 million last year. Inventories for individual companies ranged from $43.3 thousand to $6.2 million. All but three firms increased inventories over 1951.

As a percentage of net sales, inventories were lower last year because sales have risen. The general trend as indicated by the 13 manufacturers shows that at the end of 1952, inventories were 1.4 percent lower than in 1951.

▶ **Breakdown**—Further substantiation of the trend in inventories in the past few years, is the fact that totals for the entire communications equipment industry have increased. According to the Census Bureau, the industry's inventories were $384.4 million in 1947, $522.8 million in 1950 and $776.8 million in 1951. Of these amounts in each year, about 80 percent was in materials and supplies and work in process and the remainder was finished products. The percentages have remained fairly constant although many companies have had to store more material to take care of defense orders. Some observers feel that defense business along with the growth in civilian sales accounts for the industry's rising inventory trend.

Medical Electronics Nears Billion

Manufacturers are cashing in on increasing use of electronics in medicine

GROWING importance of the medical field as an electronic market was emphasized at the recent meetings and exhibits of the American Medical Association in New York City. The value of electronic equipment in use by the medical profession is nearing $1 billion.

▶ **Market**—Size of the medical market for varied electronic products is apparent from the following statistics: According to AMA, there are approximately 195,000 physicians in active practice and every year about 7,000 new graduates. There are more than 6,000 hospitals in the U. S., plus an increasing number of clinics and industrial dispenseries.

▶ **Products**—Big three of the products sold to the medical field, in order of sales importance, are x-ray, diathermy and diagnostic devices. Other important products are electronic surgical instruments and radioisotope instruments for medical use. One medical version of the betatron, costing about $250,000 each installed, is now being used for cancer therapy. Orders for six more have been placed.

Volume of the medical x-ray business is indicated by the fact that over 15,000 medical x-ray tubes were sold in 1952. The total for 1951 was near 21,000. It is estimated that more than 50 percent of the general practitioners in the U. S. are owners of x-ray equipment. With prices ranging between $2,000 and $18,000, total value of equipment in use represents more than $0.5 billion in sales for the ten manufacturers in the field.

There are over 80,000 diathermy machines in use, representing an estimated value of about $60 million.

Electronic diagnostic devices account for the third largest sales volume in the medical field. Electrocardiographs, electroencephalographs and colorimeters are gaining in sales. At the AMA meeting great interest was shown in use of magnetic tape for recording heartbeat signals over long periods at low cost, then rerecording conventionally only the medically significant portions as electrocardiograms.

▶ **TV And Facsimile**—At least four medical schools now have closed-circuit tv equipment in use, three with color tv and one with black and white. A few other institutions have equipment on order.

Telegnosis, the term applied to diagnosis at a distance through use of facsimile equipment for transmitting x-ray pictures, is also gaining. With it, the staff of a distant rural hospital can obtain the services of an expert roentgenologist or medical specialist anywhere in the country within a few minutes. A production model of the facsimile machine has been built by Time Facsimile Corp. and production of it will begin when field tests are completed.

FCC Makes Share-Time Grants To TV Stations

Pairs of tv CP applicants get grants to share time on single channels

FRIENDLY tv station competitors gain with share-time operations now permitted by FCC. In such a grant, each applicant requests his own facility to operate on a share-time basis.

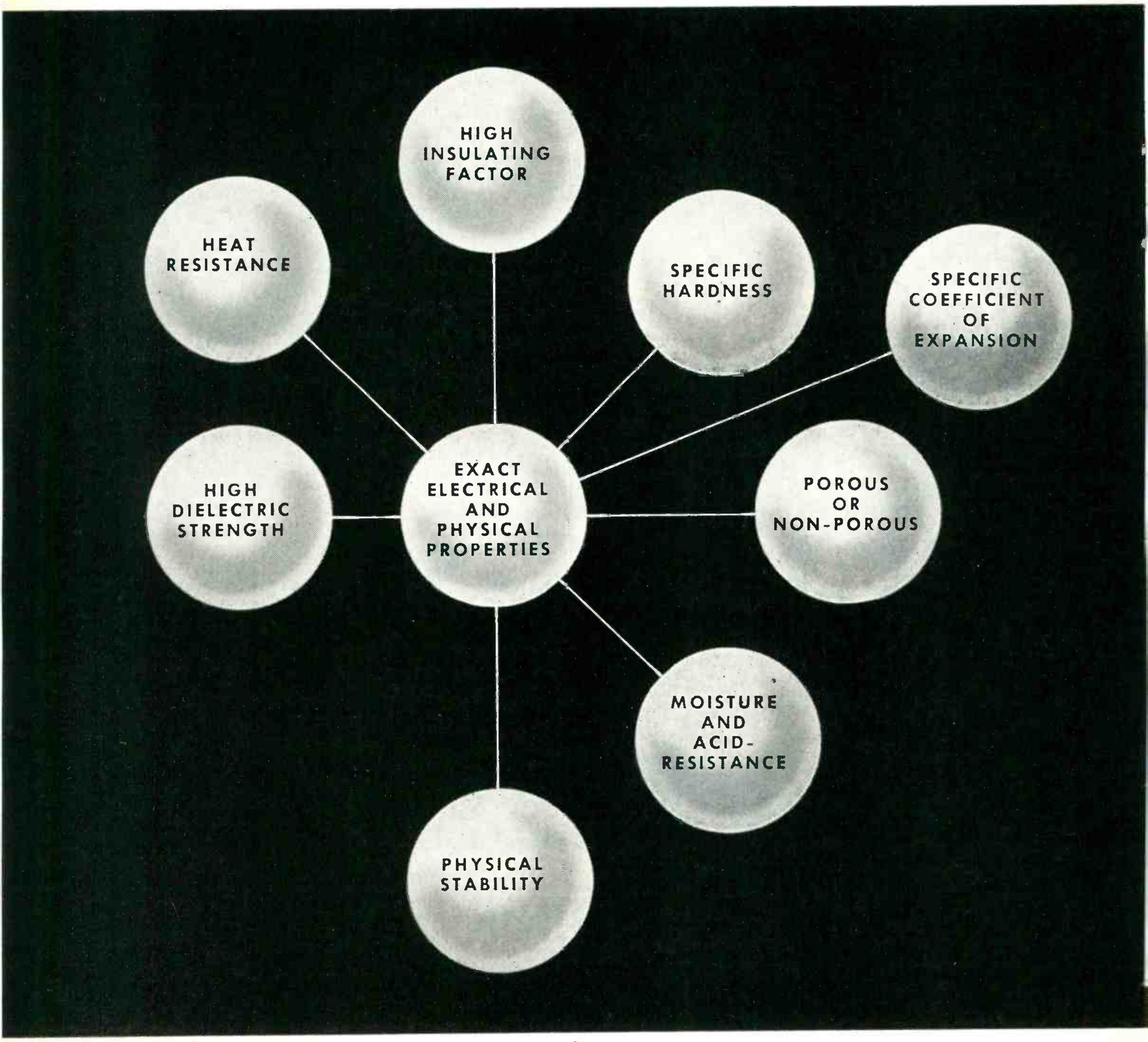
The division of time is settled by the competitors. It is usually a day or night operation, with alternating of the choice time. The Commission does not encourage or discourage this type of operation—it is a question of giving the best service to a community in as short a time as possible.

▶ **Grants**—Share-time tv grants have been made to the following stations: WVET-TV and WHEC-

(Continued on page 14)


STEATITE
ZIRCONITE
CORDIERITE
TITANATE

If your product requires you can make it better with

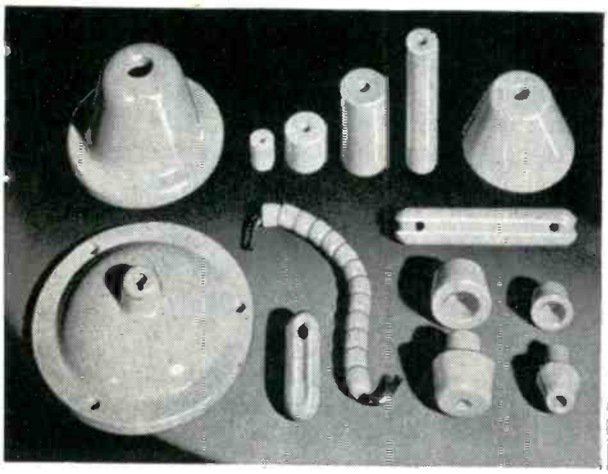


THERE'S a Centralab Ceramic material to match your individual requirements — electrically . . . physically . . . structurally. These materials are unique. We can extrude, mold or press them. What's more, Centralab Ceramics can be worked the same as metal—drilled, turned, ground or tapped. In addition, they can be metalized. Every Centralab Ceramic has some of the properties shown above, and they meet all JAN-I-8 and JAN-I-10 specifications, without exception.

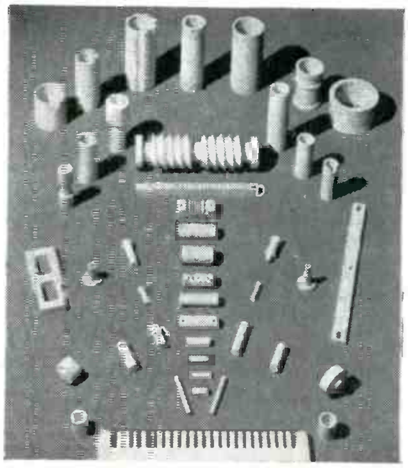
Centralab is the leader in ceramic development — making fine ceramics since 1928. Metalized ceramic material for close tolerance application was a CRL first. We have a complete staff of engineers, physicists and chemists ready to help you develop better product design through the use of Engineered Ceramics. Write for full technical details.

any of these properties, CRL Engineered Ceramics!

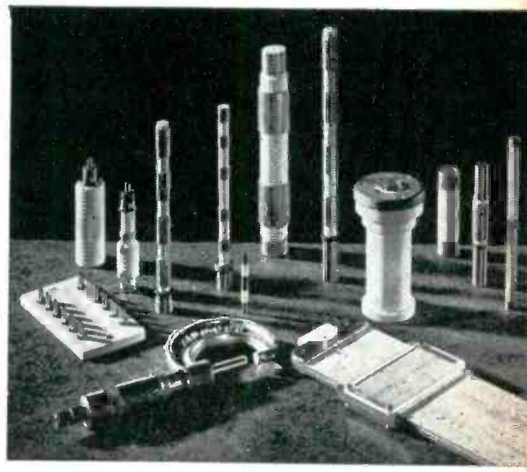
Here are examples of special Centralab Ceramics produced for structural, electrical and electronic use



Note the Standoffs illustrated, upper center. Made to government specifications, they are available commercially at a price lower than most standard units. Note the many types of specialty items.



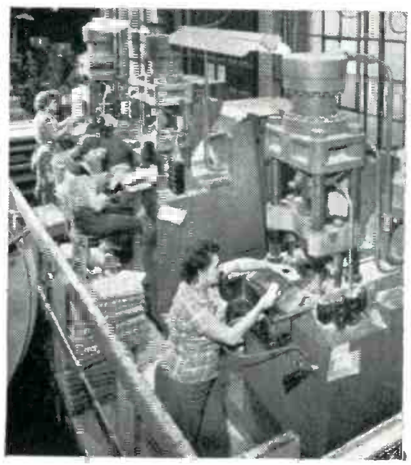
Specialty items include forms for coils and various electronic components, such as variometer rotor and stator bars, heater coils, etc. Commercial units are available in Grade L-5 and L-6 Steatite if required.



Many different ferrous and non-ferrous metals can be applied to ceramic bodies, combining the desirable properties of the metal plus the dielectric strength and other unique properties of ceramics.

FULL Centralab design and production facilities are available to meet your exact need

Centralab engineers constantly improve CRL Ceramics searching for new materials . . . developing more economical production methods. Consult Centralab on your problems.



Production operations — including mixing, molding, drilling, tapping and stamping are mechanized. This assures uniform quality, fast operation, low costs.

There's a quality inspection for Centralab Ceramics after each major operation. Modern methods are used to insure maintenance of unusually high "Average Quality Level."

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Name..

Address..

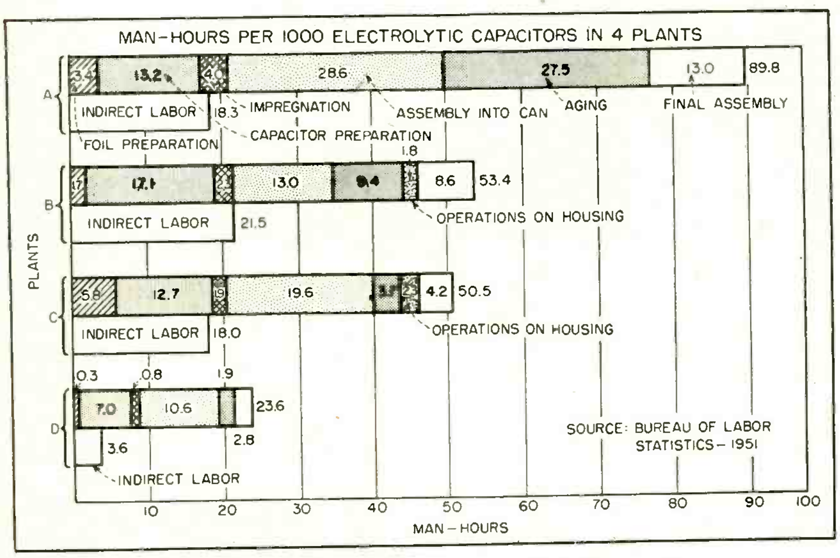
Company.. Title..................

TV, Rochester, N. Y. on channel 10; KSBW-TV, Salinas, Calif. and WMBY-TV, Monterey, Calif. on channel 8; WMIN-TV, St. Paul, Minn. and WTCN-TV in Minneapolis on channel 11; Maricopa Broadcasting and Koy Broadcasting in Phoenix, Arizona on channel 10.

First share-time authorized by the FCC was a grant for separate construction permits to KSBW-TV in Salinas, Calif. and WMBY-TV in Monterey, Calif. joint operation on channel 8.

These applicants originally competed for channel 8 but amended their applications to propose using the channel on a share-time basis as provided in FCC rules which permit sharing channels on a voluntary basis.

▶ **How It Works**—KSBW-TV and WMBY-TV intend to use the same transmission facilities, sharing the cost, and operating with the same power. Their transmitter will be on Baldy Peak about 9 miles from Salinas. They will share time equally—each broadcasting 42½ hours a week. Separate studios will be maintained in Salinas and Monterey, about 14 miles apart.



CASE studies of four capacitor manufacturers result from . . .

U. S. Survey of Capacitor Production

Comparison of techniques in four selected plants show wide variations

IN AMERICAN plants manufacturing dry electrolytic capacitors, key factors contributing to productivity levels are mass production by assembly-line techniques, use of specially designed or adapted machinery, close quality control and inspection, and alertness in adapting innovations in production methods to the electrochemical process necessary for capacitor manufacture. These are the findings of the Bureau of Labor Statistics in a report prepared for the Mutual Security Agency.

These factors enabled one plant in the study to produce 1,000 electrolytic capacitors of a certain specification in 23.6 man-hours. Other plants making capacitors (of somewhat different specifications) required two to three times as many man-hours. A breakdown of operations in the four plants surveyed is shown.

▶ **Foil Preparation**—Low man-hours for plant D in this operation were accomplished, in part, by processing large rolls of foil which are 17½ inches wide and weigh 40 to 45 pounds. The plant also takes advantage of automatic equipment such as a Cameron slitter which cuts the rolls into narrow strips at a speed of 1,850 feet per hour.

▶ **Capacitor Preparation**—Plant B attaches anode tabs to the foil manually which takes the most time. One plant saves time in cutting anode foil to length by shearing 5 rolls at once. Multiple cutting of anode and cathode tabs also saves time.

▶ **Impregnation**—Plants B and C use specially designed centrifuges for impregnations. Plant D, with the shortest time, uses an impregnation paste followed by a heat treatment. Management attributes plant A's comparatively high man-hour requirements to the use of older methods of centrifuge or vacuum impregnation.

▶ **Aging**—Plant A takes almost 12 times as long as plant D for aging. Plant A's management states that efficient aging depends upon the methods used in earlier operations and attributes slower performance in aging to methods of foil impregnation and preparation as well as to aging techniques.

▶ **Conclusion**—The report found that direct labor time for plant A was high because, among other factors, it included material-handling functions not included by other plants. Production workers in the plant carry materials in small paper boxes, thus adding to the unit man-hours of the operators.

Diathermy Business Set For June 30 Boom

Deadline for compliance with radiation regulations to create big market

UNLESS another reprieve is granted by FCC to diathermy users, a market of at least 30,000 diathermy equipment sales representing a dollar volume of over $20 million

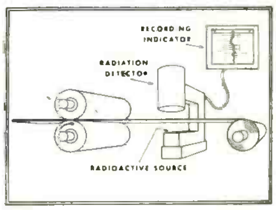
(Continued on page 16)

SHOCK AND VIBRATION NEWS

"Gives the customer THE ULTIMATE IN VIBRATION PROTECTION for his instrument"

Photo courtesy INDUSTRIAL NUCLEONICS CORP.

Type C-2000 Barrymounts for heavy industrial service. Ask for Catalog 504-B.



The AccuRay Beta Gage — a sturdy industrial instrument for continuous production gaging of plastics, textiles, paper, rubber, and metals — is specifically designed to resist vibration. So why does Industrial Nucleonics Corporation use Barrymounts?

> "We use Barry shock mounts solely as a vibration isolator to protect the instrument from externally caused vibrations. We would not consider marketing the instrument without the added safeguard of the mounts. We feel that the use of mounts is indicative of the thoroughness of design of our instrument, and that it gives the customer the ultimate in protection for his instrument."

Is protection against shock and vibration vital to the performance and the life of your equipment — or is this protection a "plus" dictated by thoroughness of design? In any case, Barrymounts give you the assurance that you have the ultimate in vibration protection. Ask the nearest Barry representative for his recommendations.

THE BARRY CORP.

707 PLEASANT ST., WATERTOWN 72, MASSACHUSETTS

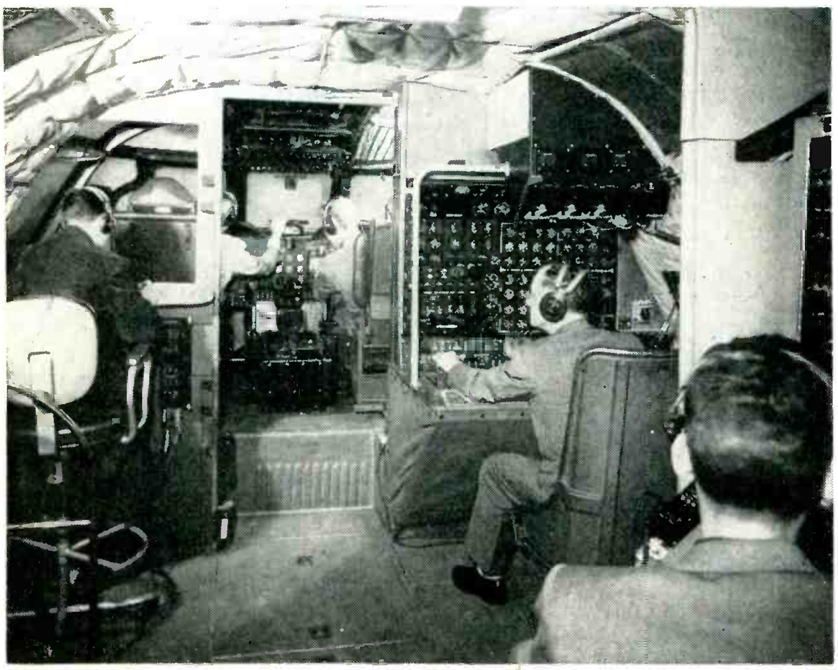
SALES REPRESENTATIVES IN

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

▶ **Market**—Approximately 80,000 diathermy machines are in use in the U. S. Manufacturers estimate that about 30,000 to 35,000 of these meet FCC radiation requirements. The rest should be replaced or rebuilt to meet regulations. However, manufacturers doubt that full compliance by all diathermy owners would be possible. They expect about 15,000 or 20,000 machines to continue in use. The remaining 30,000 represent the replacement market.

▶ **Product**—Two kinds of equipment on the market meet the new FCC requirements. One uses microwave frequencies to do the job while the other uses crystal control. It is estimated that over 50 percent of the 30,000 sales of diathermy equipment made in the past four years have been of the microwave type.

▶ **Future**—In 1952 when the FCC made the one-year extension for compliance with the radiation regulation, it warned that any further requests for extension would be handled on an individual basis, with consideration given to efforts made in each case to replace nonconforming equipment during the period of the extension.



MOCK-UP trains air crew without leaving ground. Although initial cost is high . . .

Simulators Cut Pilot Training Cost

Airlines and Services save nearly 70 percent and turn out better pilots

HIGH initial cost is of secondary importance where electronic flight simulators are concerned. The Air Force has recently taken delivery on the first of four Curtiss-Wright Dehmel simulators for the 200-passenger Globemaster. Each simulator costs over $1 million.

Like predecessors duplicating other aircraft types, the new C-124 simulator is identical in every detail to the business end of the Douglas-built plane. Over 500 tubes and a maze of wires (including some harness runs of almost six-inch diameter) complete the realism with sound effects and electronic circuits that give flight controls the "feel" that can throw even the most confident pilot into a cold sweat when troubles are introduced by an instructor.

▶ **Cost Comparison**—A comparable simulator has shown a saving of over $1.5 million a year—more than the cost of the simulator. This figure is based on an operating cost of $68 per hour for the simulator compared to $350 for the plane—including depreciation for both. These figures do not include the $1,000 plus per hour earning potential of planes released from training.

In the electronic portions of the new simulator, heavy reliance is placed on specially-wound potentiomters operating in conjunction with tight servo systems. Most of the tubes used are in servo amplifiers. Design is conservative to provide minimum down time; during the first 1,046 hours of operation, one simulator was inoperative for only 60 minutes—less than 0.5 percent.

A simulator for the giant 10-engine B-36 bomber is nearing completion at Curtiss-Wright Electronics Division.

Depreciation Reserves Continue To Climb

Sums set aside by electronic firms increased; manufacturers are wary of future

AMOUNTS reserved by the electronic industry for depreciation have steadily increased in the past five years. For ten major manufacturers, such reserves have almost doubled from $60.2 million in 1948 to $105.8 million last year. Amounts set aside by individual firms in 1952 ranged from $190,000 to $59.7 million. All but two companies surveyed increased depreciation totals over the year before.

As a percentage of net sales, funds for the industry have held relatively constant. As shown in the graph, the percentage for ten

(Continued on page 18)

MULTI-PURPOSE POWER AMPLIFIER
with Wide Frequency Range

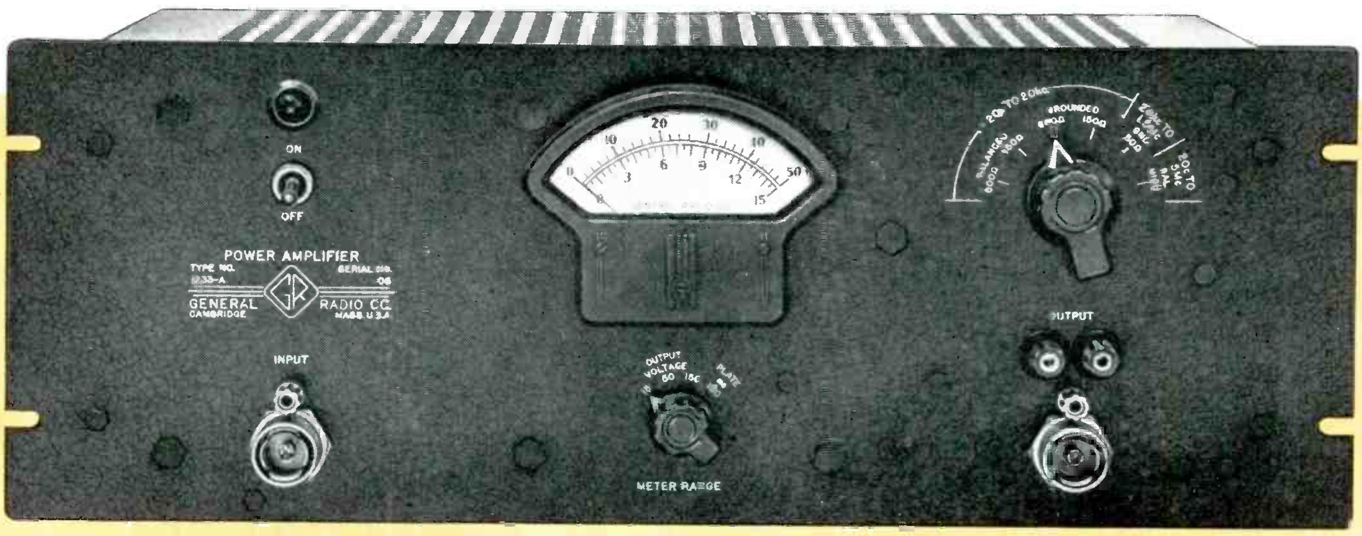
®

- ★ ***Supplies as much as 15 watts***
- ★ ***Negligible overshoot when amplifying pulses with 0.1 μ sec rise times***
- ★ ***Noise level better than 60 db below 15 watts***
- ★ ***Balanced or grounded 150 or 600 ohm output***
- ★ ***Built in voltmeter indicates terminal voltages***

The Type 1233-A Power Amplifier is a versatile instrument of wide frequency range and substantial output. It finds use in the electrical laboratory, production test-station and for a wide variety of applications in industry.

This amplifier is widely used in the testing and development of audio-frequency equipment, and in driving supersonic transducers. At standard broadcast frequencies, it has sufficient amplification for exciting antennas in measurements of gain characteristics. The 20-cycle to 3 Mc range was specifically designed for amplifying oscilloscope deflection voltages.

Where a reliable instrument is needed for undistorted amplification over a wide frequency range, the Type 1233-A Power Amplifier is highly recommended.



★ ***Three Frequency Ranges***

20 cycles to 20 kc	*150 or 600 ohms, balanced or grounded*	*15 watts from 50 c to 15 kc; 8 watts at 20 c and 20 kc*
20 kc to 1.5 Mc	*50 ohms grounded*	*15 watts from 20 kc to 0.5 Mc; 8 watts at 1.5 Mc*
20 cycles to 3 Mc	*high impedance output for connection to oscilloscope deflection plates*	*150 volts peak to peak*

Input Voltage — *Less than 0.2 volts for full output*
Input Impedance — *100,000 ohms in parallel with 37 μμf grounded*

Distortion — *less than 3% at rated output on all ranges*
Dimensions — *19⅜ x 14¼ x 7½ inches, overall*
Price — $525

GENERAL RADIO Company®

275 Massachusetts Avenue, Cambridge 39, Massachusetts, U. S. A.
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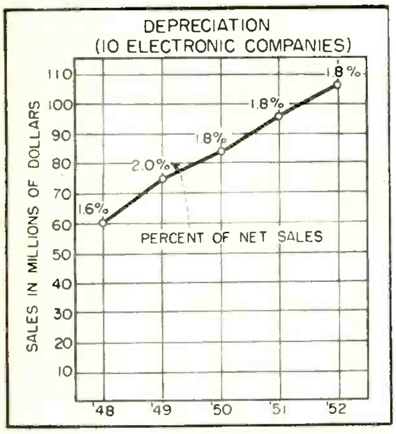
Admittance Meters ☆ Coaxial Elements ☆ Decade Capacitors ☆ Decade Inductors ☆ Decade Resistors ☆ Distortion Meters ☆ Frequency Meters ☆ Frequency Standards ☆ Geiger Counters ☆ Impedance Bridges ☆ Modulation Meters ☆ Oscillators ☆ Variacs ☆ Light Meters ☆ Megohmmeters ☆ Motor Controls ☆ Noise Meters ☆ Null Detectors ☆ Precision Capacitors ☆ Pulse Generators ☆ Signal Generators ☆ Vibration Meters ☆ Stroboscopes ☆ Wave Filters ☆ U-H-F Measuring Equipment ☆ V-T Voltmeters ☆ Wave Analyzers ☆ Polariscopes

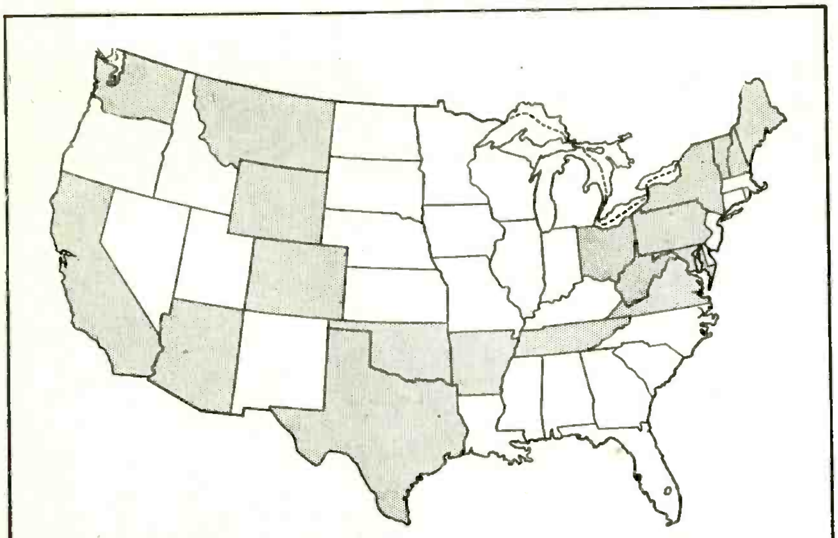


major companies in the field has remained at 1.8 percent since 1949.

▶ **Significance**—Depreciation reserves are an index to expansion plans. According to the sixth annual McGraw-Hill survey of Business Plans for New Plants and Equipment, 85 percent of manufacturing companies covered, including electronic firms, plan to invest all their depreciation funds to keep equipment up to date and to provide capacity for new products and new markets.

▶ **Future**—The industry's depreciation reserves and thus its expansion has been aided substantially by the government's fast-tax amortization policy. Under it, companies in the field have been able to amortize an average of 60 percent of the investment in new defense facilities over a period of 5 years instead of the normal 25 years.

The goal of $396 million in fast tax aid for the industry set by the U. S. is expected to be completed by 1954. Already over 75 percent of the money has been certified.



STATES REPRESENTED IN NATIONAL COMMUNITY TELEVISION ASSOCIATION

DELEGATES from 19 states attend NCTA conclave, as . . .

Community Television Expands

DESPITE post-freeze television-station construction, the National Community Television Association reports a membership increase of nearly 100 percent during its second year of life. Sixty-three of the country's 200-odd community antennamen are now NCTA members.

Nearly 100,000 television sets serving 350,000 viewers are now receiving television programs via video party lines.

▶ **Trends**—International Telemeter, developers of coin-box subscription television, plan to inaugurate experimental pay-as-you-see service in October over their own community tv system in Palm Springs, Calif. Other subscription tv promoters are wistfully eyeing wired-television viewers as a ready-made box office.

Community tv operators are also seriously considering local program insertion. Equipment would range from small industrial-tv cameras working into video carrier-current transmitters to small-scale studio set ups.

A manufacturer has also announced a converter for community reception of uhf television signals.

▶ **UHF or Cable**—Reaction of small-city tv broadcasters to community television has been mixed. One uhf broadcaster has offered to buy a uhf antenna for any community system willing to pick up and distribute his signal. Other cases have been reported where a CP-holder threatened to turn back his construction permit if a tv cable company were granted a franchise in his city.

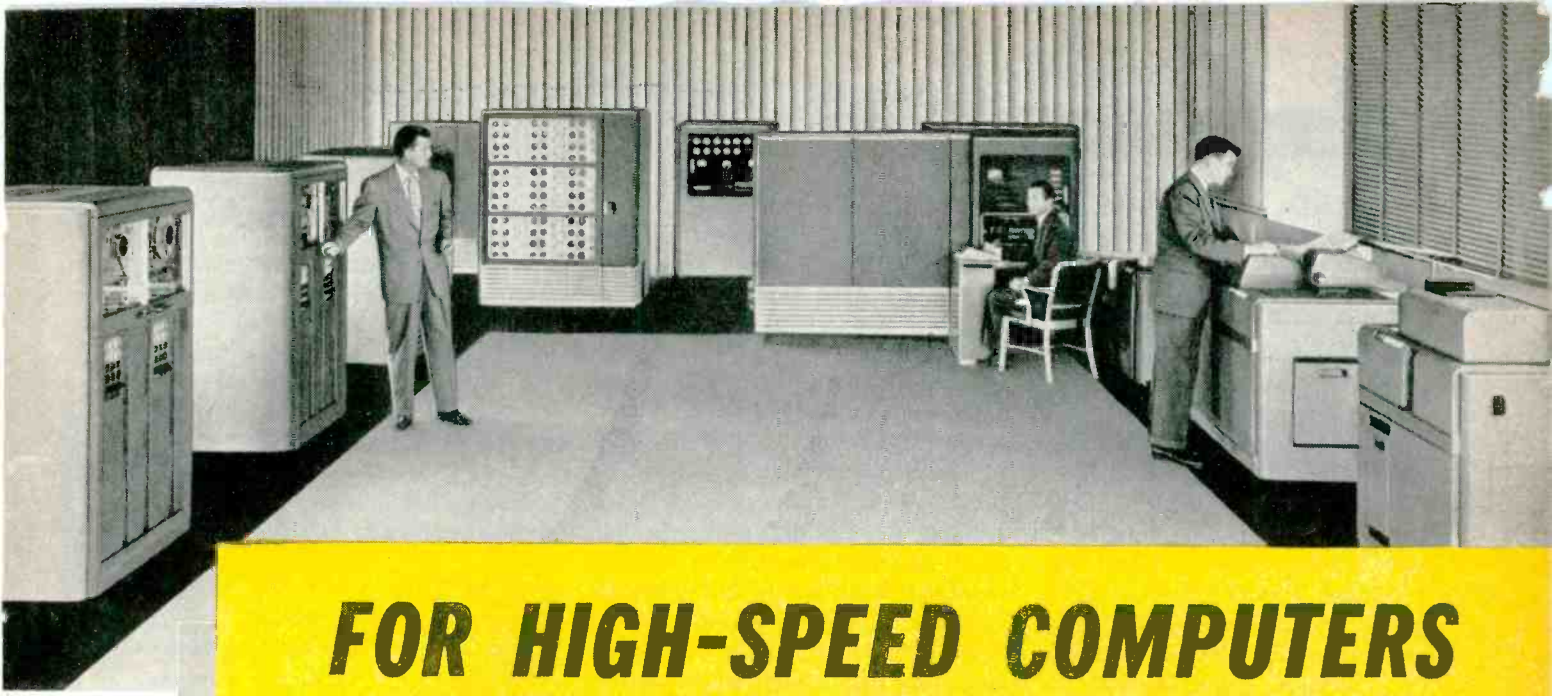
▶ **Problems**—During the past year, radiation has plagued community tv. Most complaints have originated with owners of antenna installations who find that signals radiated from the cable create an objectionable ghost on their tv screens. No legal action has reportedly been taken against operators but the FCC has inquired of equipment manufacturers as to design of their tv equipment.

RTMA Asks U.S. To Set Quartz Crystal Base

POINTING out that the quartz crystal industry is essentially a wartime industry and that its production capacity now has been increased beyond requirements, RTMA asked the Department of Defense and top military officials to set up a production base for the industry which would prepare it to meet both current and full mobilization requirements.

In a letter to defense officials, Mr. George E. Wright, chairman of the Crystal Section of RTMA, said that normal commercial demand for

(Continued on page 20)



FOR HIGH-SPEED COMPUTERS ...G.E.'s NEW TWIN TRIODE!

IBM's new Data Processing Machines have 2,700 GL-5965's in their tube complement. This computer will add and subtract 16,666 times a second, or divide and multiply 2,192 times. It answers an urgent call by defense and industry for faster solution of mathematical problems and better data storage . . . Here is an outstanding example of new computer design which the GL-5965 made possible!

GL-5965
9-PIN MINIATURE

New twin triode for computer applications, as cathode follower and diode driver.

With

—high-perveance design.
—high plate dissipation; 2.2 w per plate, 4 w per tube.
—low heater power requirement.
—balanced cutoff characteristics.
—special cathode designed for "on-off" dependability.
—long tube operating life under cutoff conditions.

Designers:

IBM's use of G-E computer tubes shows 97% still on the job after service equalling 5 years!

LONG LIFE . . . IBM experience with GL-5844's, G.E.'s first computer tube, shows less than 3 percent cumulative failures after 10,000 hours! In other words, 97 out of every 100 tubes are still in use after "on-off" service that roughly equals 5 years' business use at 40 hours a week.

DEPENDABILITY . . . Records kept on a fifth of the million-and-more GL-5844's in IBM Type 604 Electronic Calculating Punches, show a failure rate of .0023 per 1,000 hours. This means that in a period of approximately six months, only 460 out of 200,000 General Electric tubes have had to be replaced!

Add to the new GL-5965's twin-triode flexibility . . . high perveance . . . low heater power . . . these General Electric computer-tube qualities of long life and freedom from trouble, and you have the tube *you* need for your advanced circuit. Ask for full information! *General Electric Company, Tube Department, Schenectady 5, New York.*

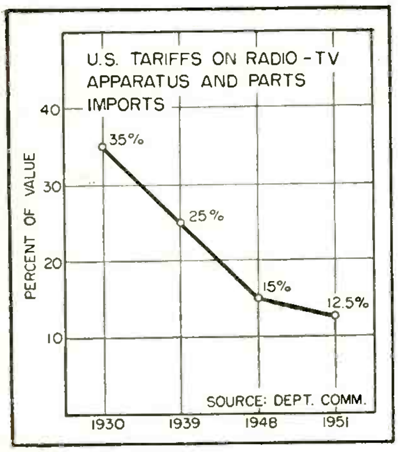
GENERAL ELECTRIC

163-1A7

quartz crystals is about one-tenth of the military requirements experienced in 1951 and 1952, is therefore dependent upon military contracts.

"Lack of careful planning in placement of such contracts, during a period of reduced appropriations, could easily weaken and destroy the nucleus of the industry that will be needed to form a mobilization base," he said.

The RTMA section urged the government to make plans to overcome the instability created by the sharp fluctuation between wartime and peacetime requirements for quartz crystals. RTMA crystal manufacturers suggested that an advisory group, composed of industry and government representatives, be appointed to assist in coordinating the plans for crystal production to meet current and wartime procurement schedules.



RECORD of tariff reductions on U. S. electronic imports shows that . . .

U. S. Radio-TV Import Tariffs Are Low

Imposts on most electronic imports have been reduced more than 50 percent

LEVIES on radio-tv apparatus and parts have steadily declined from 35 percent in 1930 to the present 12.5 percent that went into effect in June, 1951. A reduction in 1939 was made under the United Kingdom Trade Agreement. In 1948 and 1951, the tariffs were reduced under GATT (General Agreement On Tariffs And Trade).

▶ **Breakdown**—Not all electronic equipment comes under the same tariff rates. Radio and television apparatus and parts cover the bulk of electronic imports and have the tariffs shown in the graph. Other equipments have different rates but in all cases they have been reduced since the Tariff Act of 1930 when all had a tariff of 35 percent. Photocells and electronic tubes other than radio now have a tariff of 15 percent and x-ray tubes, with a levy of 10 percent, have the lowest tariff of any electronic equipment.

▶ **Ad Valorem**—All electronic tariff rates are figured according to the value (ad valorem) placed on the equipment by U. S. Customs. The percentage is always taken on the highest valuation. It can be based on the foreign value, the U. S. value, the cost of production or the American selling price, whichever is highest. The classification given the equipment also determines the tariff rate and can be used to obtain the highest revenue.

▶ **Comparison**—Our tariffs on electronic equipment are lower than those of most other nations. In Mexico, for example, import tariffs in 1951 on radio receivers with cabinets were 24.1 percent; on radio receivers without cabinets, 16.1 percent; on spare parts for radio apparatus, 2.1 percent. In addition, all of these imports were restricted. But the rates show why some U. S. radio firms have elected to set up assembly plants in Mexico rather than ship the complete product across the border.

▶ **Reduction**—It is reported that President Eisenhower has agreed to enlarge the U. S. Tariff Commission from 6 to 7 members to get passage of his request for a one-year extension of the Reciprocal Trade Agreement Act.

This is seen by some manufacturers as a victory for protectionist factions that may make further tariff reductions difficult to obtain.

Financial Roundup

PROFIT statements and security transactions in the past month were made by companies in the electronics field. Profits for the first three months of the year for the companies reporting continued to be higher than in 1952.

Company	*Net Profit 1953 First Quarter*	*1952*
American Cable & Radio	$238,799	$200,765
AT&T	101,310,260	86,831,361
Anaconda Wire	1,921,922	1,607,273
Beckman Inst. (9 mos.)	617,870	448,000
British Cable (Annual)	16,858,382	12,839,876
Claude Neon (Annual)	2,559,285	1,938,850
Cornell-Dubilier (6 mos.)	895,000	736,000
Consolidated Inst. (Annual)	501,511	437,591
Daystrom (Annual	1,405,000	771,000
T. A. Edison	110,828	100,531
Emerson (6 mos.)	1,768,694	548,228
General Inst. (Annual)	1,275,863	993,557*
Gray Mfg. (Annual)	408,965	406,049
Philco	3,401,000	2,341,000
Standard Coil	1,737,045	905,116
Westinghouse	16,858,000	15,485,000

* Loss

▶ **Stock Transactions**—Electronic Associates offered to common stock holders the right to buy an additional 10,000 shares of $1 par common stock at $15 per share on a 1 for 10 basis. Proceeds are to be used for additional working capital.

Weston Instruments offered capital stock holders the right to subscribe to 107,055 additional shares at $18 per share on a 1 for 3 basis. Proceeds will be used to reduce loans.

Computer Manufacturing offered 150,000 shares of common stock (par 10 cents) at $1 per share. Proceeds will be used for repaying advances and for working capital.

Erie Resistor registered with SEC covering 62,500 shares of convertible preferred stock, $20 par, to be offered at $20 per share. Of net proceeds, approximately $850,000 will be used for the Erie, Pa. plants and to equip a new plant at Holly Springs, Mass. The balance will be added to working capital.

Applied Science Corp. registered with SEC covering 750,000 of 6-percent sinking fund ten year debenture notes, due April 30, 1963. They will be offered for sale along with 75,000 shares of the common stock (par 1 cent) of

(Continued on page 22)

From
SUBMINIATURE to HEAVY DUTY
From
MILLIWATTS to KILOWATTS

Whatever the DC requirement

there's a Federal

SELENIUM RECTIFIER

to do the job!

FOURTEEN years ago Federal introduced the selenium rectifier to America's electronic engineers and product designers.

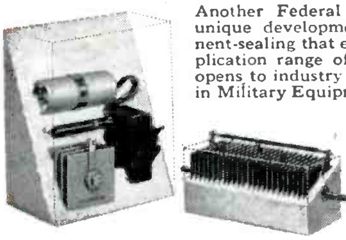
Today, *tens of millions* of these versatile AC-to-DC power conversion units are at work in almost unlimited fields of application . . . from subminiatures with milliwatts of output to heavy duty stacks for the biggest DC-operated equipments.

Here's *proof* of the *high quality* built into Federal's compact, economical, long-life, fully inert selenium rectifiers . . . here's *proof* of their *efficiency* and *dependability* in consumer, industrial and military power conversion jobs!

Write Federal today for information on *your* rectifier requirements . . . whatever the size, type or rating. Give your design the benefit of the research, engineering and manufacturing skill that *pioneered* the selenium rectifier . . . and now *keeps* "Federal" the standard of industry! Address Dept. F-413B

Now Federal Offers ENCAPSULATION OF SELENIUM RECTIFIER STACKS —plus other components

Another Federal "First" . . . a unique development in component-sealing that expands the application range of rectifiers and opens to industry a new concept in Military Equipment Design.



Applications range from tiny rectifiers to sub-assemblies and complete power supplies.

America's oldest and largest manufacturer of selenium rectifiers

FEDERAL TELEPHONE & RADIO FTR — AN IT&T ASSOCIATE

Federal Telephone and Radio Corporation

SELENIUM-INTELIN DIVISION 100 KINGSLAND ROAD, CLIFTON, NEW JERSEY

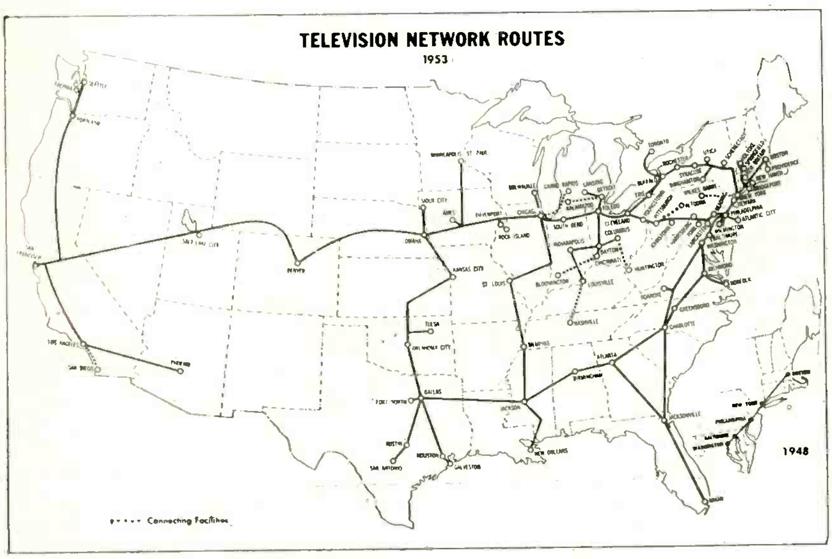
In Canada: Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., N. Y.

Want more information? Use post card on last page.

Bradco, Inc. Proceeds will be used to acquire all the capital stock of Communication Measurement Lab. and of the Applied Science Corp. of Princeton. The remainder will be used for other purposes.

▶**Stock Filings**—Skiatron Electronics filed with SEC covering 10,000 shares of common stock (par 10 cents) to be offered at market (about $2 per share). Proceeds are to be used to carry on public demonstrations of subscriber television.

Triad Transformer filed with SEC covering 10,060 shares of common stock (par $5) to be offered at $10 per share. Proceeds will be used for working capital.



GROWTH of facilities since 1948 shows . . .

Television Network Routes Expand

Number of channel miles to be available at end of year may total 47,000

PLANS to add 13,000 channel miles to existing tv routes by the end of 1953, almost doubling the average number of miles added in any of the past five years have been made by AT&T. Work has already started on a link between Seattle and Yakima, Washington and the company has FCC approval for additional links. By the end of this year, there may be a total of 47,000 channel miles in use.

▶**Growth**—Five years ago, the Bell Telephone System opened for commercial use some 916 channel miles for tv to provide network service to 12 stations in 5 cities. Only Boston, New York, Philadelphia, Washington and Baltimore were linked for network service. By the end of that year more than 2,500 channel miles were added to transmit network programs to 30 stations in 13 cities. Over each of the next four years, an average of 7,000 channel miles were added to Bell System tv facilities. Now the facilities extend some 34,000 channel miles, enabling more than 130 stations in 87 cities to receive live network tv programs. In addition, Bell's facilities have been used on 117 occasions to connect theaters for tv service.

There are over 170 tv stations on the air broadcasting to an estimated potential audience of 95 million. These stations, more than 62 of which have been constructed since July, 1952, are located in some 120 cities.

Lightplane Output Ups Electronics Business

Increasing use of private aircraft by business widens avionic equipment market

MAKERS of lightplane or utility aircraft, as they are now known in the aircraft industry, produced approximately 3,200 aircraft during 1952. For the first time since World War II the industry's falling production rate has reversed. In 1951, approximately 2,477 utility aircraft were built. With cuts in military plane production possible in the future, this sign of revival has not only been good news to aircraft manufacturers but to producers of electronic communications and air navigation equipment as well.

Main reason for the resurgance of the utility aircraft industry is growing use of company-owned aircraft by private industry. According to Aircraft Industries Association, 30 percent of the nation's fleet of active civil aircraft serve business or professions, and 32 percent of the total number of hours flown by these aircraft was for business and industry use. More multi-engined aircraft are now operated by private business organizations for executive transportation than are operated by the scheduled airlines.

▶**Potential**—According to a survey by one of the leading manufacturers of utility aircraft, the average expenditure for electronic aids in their planes is $600, ranging from $300 for radio only to $1,700 for complete equipment (ELECTRONICS, p 20, May, 1952). Thus in this segment of the aircraft industry alone, electronic manufacturers had a potential dollar volume of sales of nearly $2 million. With increasing use by industry, in agriculture and as family transportation, potential sales may well double in 1953.

▶**Manufacturers**—In recent months, manufacturers have stressed private aircraft applica-

(Continued on page 24)

tions of electronic equipment to take advantage of the growing market. For example, Bendix Aviation recently introduced Distance Measuring Equipment (DME), developed by Hazeltine, and expected that the volume sales would come from the executive aircraft field. As military plane production declines, more electronic manufacturers will introduce avionic equipment for the growing utility aircraft market.

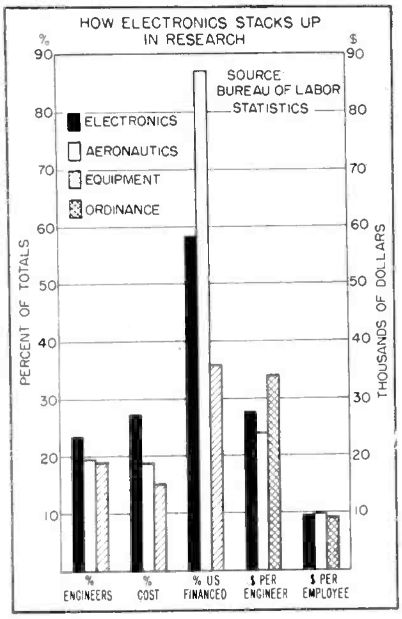
Offshore Oil Men Spot Drills Electronically

MUCH-NEEDED OIL trapped under the Gulf of Mexico can be discovered by essentially the same methods used on dry land. When seismic, or other soundings are made underwater the drilling crew must know within a matter of feet where to set up their rigs. Many oil domes are far offshore and can't be spotted by optical or crude radio-direction-finding methods.

▶ **Government Cooperation**—So vital is the oil need that FCC has been lenient in allowing special use of frequencies that permit electronic surveying of the trackless Gulf.

One prospecting company needs to know the distance between two boats with an accuracy of better than five feet to interpret geophysical data taken simultaneously. A hyperbolic grid system operated by Raydist Navigation Corp. is furnishing such a location service. Other leased service is offered both by this company and Offshore Raydist, Inc. from three networks reaching from New Orleans to Texas. As many as ten separate crews in the Gulf can use the networks as now installed.

Underwater explosion used in the seismic method of locating oil deposits in the Gulf of Mexico is recorded aboard ship (in foreground) and, moments later, at another ship. Distance and direction between ships is measured by Raydist



TOP three research specialties stand out as . . .

Defense Department Reviews Research

Electronics activity claims more engineers and costs more than any other research

PRELIMINARY report of a survey of U. S. industrial research and development capacity in mid-1952, conducted by the Research and Development Board of the Defense Department, classifies companies into 16 research specialties including electronics.

▶ **Engineers**—Nearly 94,000 research engineers and scientists were employed by the companies reporting in January, 1952. Electronics research claimed 23.2 percent of total researchers, the highest percentage of all research specialties. Aeronautics and equipment and supplies followed with 19.6 and 19.0 percent respectively.

▶ **Research Cost**—National outlay for scientific research and development totaled more than $3.5 billion in 1952, over four times the yearly expenditures at the beginning of World War II. The total cost of research for all surveyed companies for 1951 was nearly $2 billion and electronics took 27.3 percent of this money.

▶ **Governments Share**—Close to half of all industrial research was financed by Federal Government agencies, mainly the Department of Defense and the Atomic Energy Commission. Percentages for the top three specialties were: aeronautics, 87 percent; electronics 58.5 percent; equipment and supplies, 35.9 percent. Thus, although electronics research, as shown in the chart, employed more engineers and bore the greatest share of total research costs, U. S. spending with the industry was almost 30 percent less than that spent in aeronautics research.

▶ **Cost per employee**—Average cost per research engineer or scientist in companies in the 16 research specialties ranged from $14,500 for basic and medical science up to $33,900 for ordnance. Electronics ranked second to the top with an average cost per engineer or scientist of $27,600.

Taking all research employees together, including supporting personnel, the allocation of research cost per employee in electronics was $9,800.

TV Is Better Than It Seems

NUMBER of inquiries and complaints about television to Better Business Bureaus in 1952 ranked in sixth place. Television's total was 84,202, representing only 5 percent of the

(Continued on page 26)

Faster... For testing...

COMPACT, PORTABLE

BENCH-TYPE TESTING UNIT FOR RAPID HIGH and LOW TEMPERATURES

Primarily developed for a branch of the armed forces, this high and low temperature testing unit has a temperature range from -80° F. to +185° F. Rapid temperature pull-down to -80° F. requires 30 minutes or less. Heat application is accomplished through reverse cycle refrigeration. Hazards of open heating elements are eliminated. Test chamber dimensions are 12"x12"x12" and the overall dimensions are 50" long, 26" high and 20" deep. Approximate weight is 450 pounds. The unit is compact and is entirely self contained. Controls are simplified and easy to operate. Equipped with air-cooled compressors, the unit is quiet in operation. Cabinet is of stainless steel with all controls visible. A blower is provided for even distribution of temperatures and greater testing accuracy. The door illustrated is a latch type door providing for complete removal from the cabinet. Holes may be drilled for electrical contacts.

This is one of the many examples of WEBBER engineering skill and another of the many firsts built by WEBBER in the low temperature field.

Write for more complete information:

INDUSTRIAL FREEZER DIVISION
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WEBBER
TRADE MARK

COMPLETE TEMPERATURE RANGE
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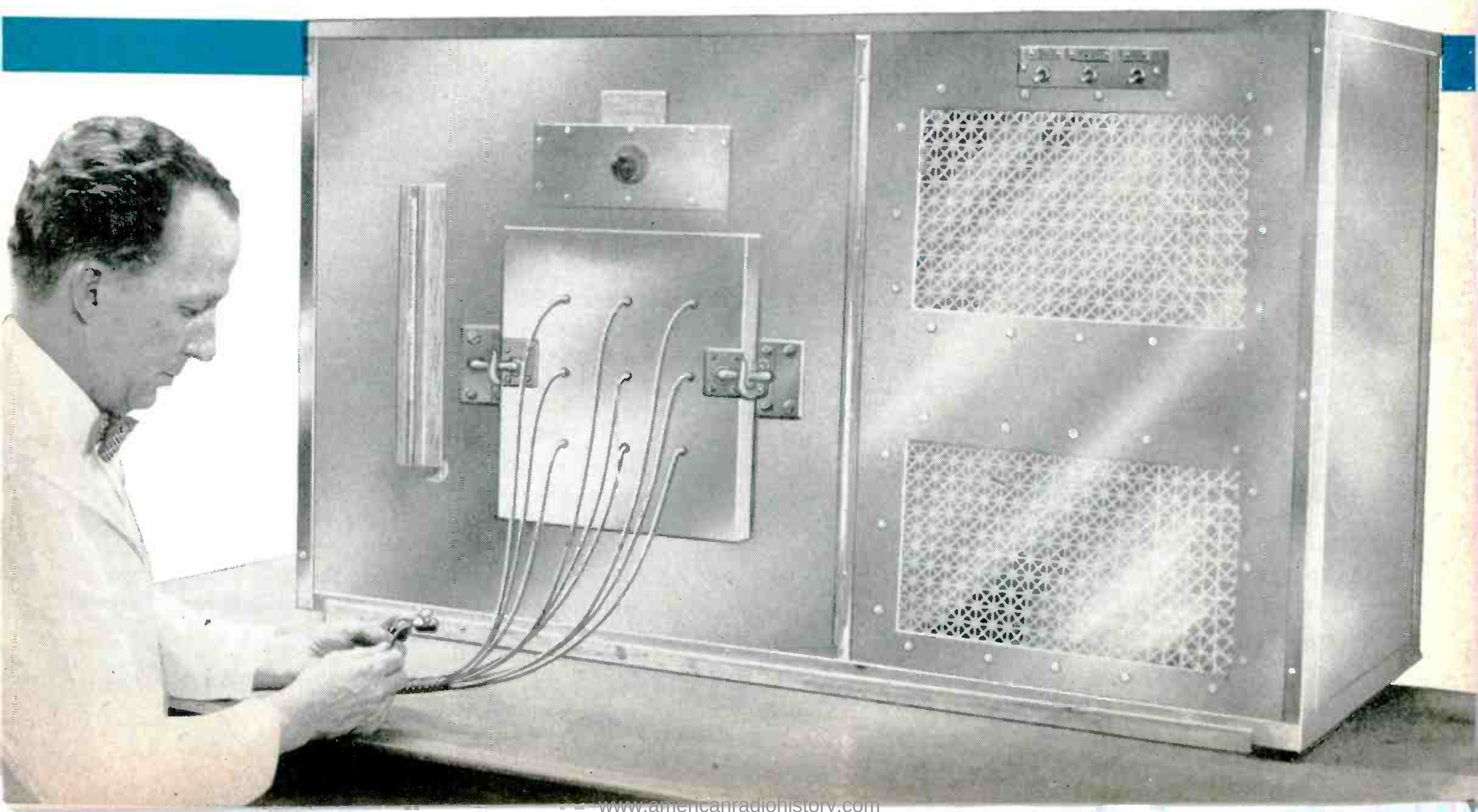
LOW-TEMPERATURE
INDUSTRIAL FREEZERS

THERE'S A WEBBER UNIT FOR EVERY NEED



1.6 million grand total, as compared to 118,450 for solicitations, 93,991 for home appliances, 93,559 for insurance, 93,056 for construction and 85,038 for automotive.

About 75 percent of all requests were inquiries for information about the reliability of companies, products, services, individuals and day-to-day business transactions. The remaining 25 percent were in the nature of complaints.

RADIO relay supplemented damaged telephone cables, as . . .

NATO Microwaves Aided Flooded Holland

Sixty-mile emergency link restored telephone service vital to relief operations

LAST February, when flood-waters inundated large areas of the Netherlands, relief and flood-control operations were imperiled as the elements raised havoc with the Dutch telephone system.

Responding to a request for assistance, the Allied Air Forces Central Europe rushed two RCA type-20A microwave terminals and one repeater to the scene. (See: Microwaves Sharpen Europe's Air Defenses, Industry Report, ELECTRONICS, p 10, Oct. 1952.)

► **Vital Link**—The equipment supplemented a badly damaged cable between Rotterdam and Middelharnis, two main distribution points in the Dutch telephone system. Middelharnis is one of the hardest-hit spots in Holland. Power for the microwave equipment was supplied by portable units brought from NATO headquarters near Fontainebleau.

Despite delay in obtaining accurate maps and technical difficulties encountered in tieing into the local switchboard, within nine days 13 of the 24 available voice channels were placed in use.

MEETINGS

JUNE 29-JULY 3: ASTM Annual Meeting, Atlantic City, N. J.

AUG. 19-21: WESCON (Western Electronic Show & Convention), IRE (7th Region) and WCEMA (West Coast Electronic Manufacturers' Association cosponsors, Municipal Auditorium, San Francisco, Calif.

AUG. 29-SEPT. 6: West German Radio and Television Exhibition, Duesseldorf, Germany.

SEPT. 1-3: International Sight and Sound Exposition, Palmer House, Chicago, Ill.

SEPT. 1-12: British 20th National Radio & Television Exhibition 1953, Earlscourt, London, England.

SEPT. 14-16: Fourth Annual Convention and Manufacturer's Conference, NEDA, St. Louis, Mo.

SEPT. 21-25: Second Analytical Instrument Clinic, Chicago, Ill.

SEPT. 21-25: Eighth National Instrument Exhibit, Sherman Hotel, Chicago, Ill.

SEPT. 28-30: Ninth annual National Electronics Conference, Sherman Hotel, Chicago, Ill.

NOV. 9-12: Conference on Radio Meteorology, Austin, Texas.

NOV. 13, 14: Annual Electronics Conference, Hotel President, Kansas City, Missouri.

Industry Shorts

► **OMIBAC** comprises first letters of GE's Ordinal Memory Inspecting Binary Automatic Computer.

► **Cost** to equip a tv station so that it could transmit network programs in compatible color was estimated at $15,000 by NBC vice-president Sylvester Weaver.

► **First** units in an aircraft radar warning system for the perimeter of Western Europe have been made and delivered by Microlambia of Italy under the U.S. Offshore Procurement program. They are built under a licensing and technical assistance agreement with Raytheon.

► **Sixty-five** percent of those replying to a Purdue University opinion panel post card survey indicated that they would pay one dollar for the privilege of seeing a championship fight on their home tv receivers by subscription tv.

► **Broadcast** receiving licenses totaled 12.9 million in Great Britain and Northern Ireland at the end of April, 1953 including 2.2 million for tv and 186,338 for auto-radios. Television licenses increased by 60,891 during the month.

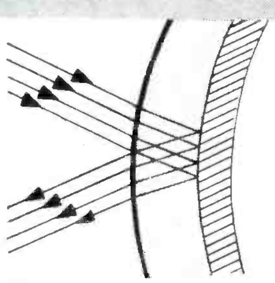
► **Dutch** tv transmissions, still in their initial stages, will end on October 1, 1953 unless the Dutch Government decides to subsidize them, according to the Dutch TV Foundation.

► **Commerce** Department assured RTMA that it will make appropriate provision for the electronics industry if industry divisions are established in the department subsequent to any termination of NPA activities.

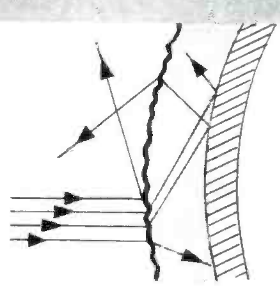
► **Large** deposit of nickel ore recently discovered in Cuba by Freeport Sulphur is believed to constitute one of the most important proven sources of nickel anywhere in the world.

NO GLARE

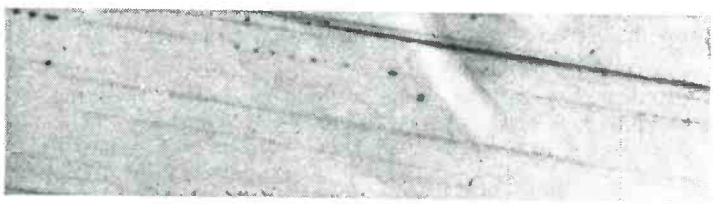
and less distortion, with Westinghouse 21AP4, 21MP4 Metal-Cone Tubes



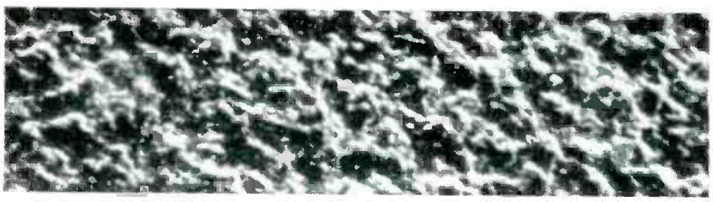
Ordinary face plates act as a polished mirror, reflect majority of light into viewers' eyes.



Etched faceplates scatter ambient light, absorbing a large amount, dispersing remainder unnoticeably.



300X photomicrograph of smooth face shows smooth reflecting surface; tiny scratches are invisible to naked eye.



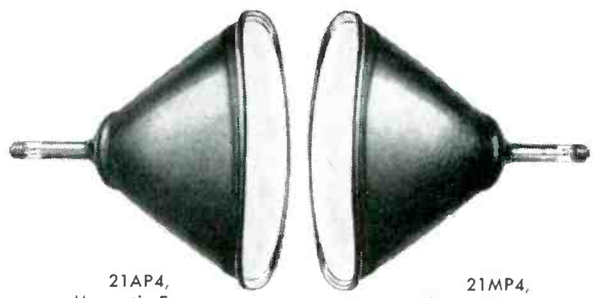
300X photomicrograph of etched face shows surface which disperses ambient light, does not affect picture quality.

"No glare, no room reflection, less distortion, clear picture over full tube area!" Your sets can have these hard-selling, practical advantages if you use Westinghouse 21-inch metal-cone tubes in your designs.

Their etched spherical face plates completely eliminate the annoying problem of room reflections. And best of all—this factual, appealing sales feature can be demonstrated in any retail show room by the purchaser himself.

Westinghouse metal-cone tubes have less distortion due to uniform face plate thickness: Corner focus is better, brightness is uniform. These stronger tubes save money due to less weight, easier handling. Both the 21AP4 and the 21MP4 are available now in production quantities. For technical or application information, write, wire, or phone

Commercial Engineering Department A-207, Westinghouse Electric Corporation, P. O. Box 284, Elmira, New York.



21AP4, Magnetic Focus

21MP4, Electrostatic Focus

ET-95022

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

RELIATRON™ TUBES

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, N. Y.

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Blue Monday!

A washer's a "washout" without fasteners. But luckily for the housewives of America this catastrophe can never happen.

For Lamson & Sessions has long worked hand in glove with the appliance people to develop dependable engineered fasteners for home appliances.

If you, too, want to be *sure* of the "just right" fasteners for your product, check with Lamson during the planning stage. Our engineers will be happy to help you with your selection and possibly suggest fasteners that will save time and money on the assembly operation.

Remember, no matter what your fastener requirements, it's always *pleasant* and *profitable* to do business with Lamson & Sessions.

TAPPING SCREWS
For Fast Sheet-Metal Fastening

Self-tapping screws require no nuts, no tapped holes. Therefore, they are important time-savers on all sheet metal assembly work. A choice of type "A", "B" and "C" threads. Heads available with slotted or Phillips driver recesses.

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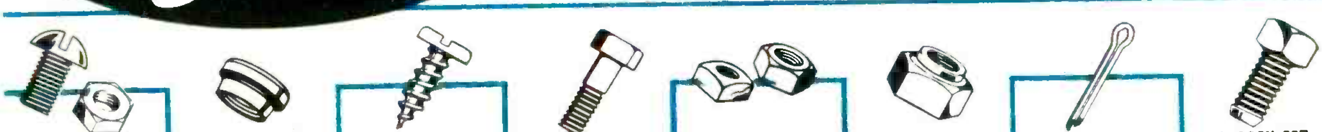


MACHINE SCREWS AND NUTS
Precision made for fast, economical assembly.

PLUG NUTS
Ideal for blind or hard-to-reach places.

TAPPING SCREWS
Choice of round, pan, truss, flat oval, hexagon and Phillips heads.

CAP SCREWS
Bright and "1035" Hi-Tensile Heat-treated steel.

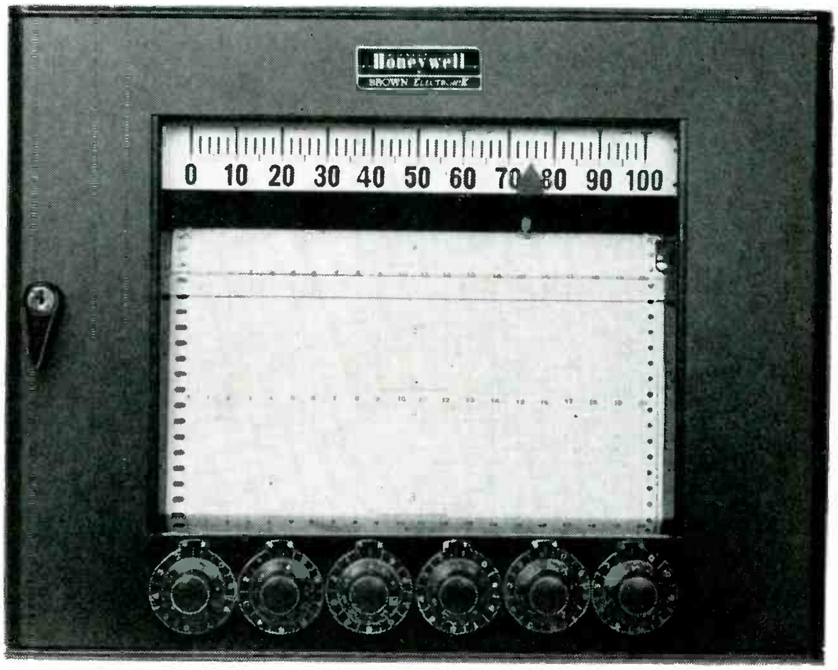
SQUARE AND HEX NUTS
Semi-finished, hot pressed, cold forged.

LOCK NUTS
Economical, vibration proof. Can be used repeatedly.

COTTER PINS
Steel, brass, aluminum and stainless steel.

"1035" SET SCREWS
Cup point type, hardened and heat-treated.

The most versatile test data recorder you've ever seen!



Check these features:

SPAN:
adjustable from 1 to 50 millivolts. Arbitrary dial markings, readily converted to millivolt range by means of calibration supplied with recorder.

ZERO SUPPRESSION:
coarse and fine dials permit movement of zero by ±100% of max. span.

DAMPING:
adjustable to obtain optimum balancing action for almost any span or source impedance.

SENSITIVITY:
automatically adjusts measuring circuit response as span is changed.

SPEED:
full scale pen travel as fast as one second.

WIDE CHART:
11-inch calibrated width gives high resolution.

STANDARDIZING:
manual.

If you need to record results of a variety of tests, this new *ElectroniK* instrument is just what you've been looking for. A simple turn of its dials converts it to practically any range your tests require.

Especially useful with strain gauges, accelerometers, tachometers, differential thermocouples—or any other voltage-producing transducer—it is like having a hundred instruments in one. You can vary its full scale span over a wide range, to spread out test curves in exceptionally readable form. You can move its zero point up and down at will, until the portion of the test curve in which you're most interested is spread across the recorder chart. And you can change its sensitivity and damping to give the recording characteristics that best fit your test. Span and zero adjustments are completely independent.

Our local engineering representative will be glad to discuss how this new instrument can bring new convenience to your test work. Call him today . . . he is as near as your phone.

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Write for Data Sheet No. 10.0-1D "Adjustable Span *ElectroniK* Recorder."

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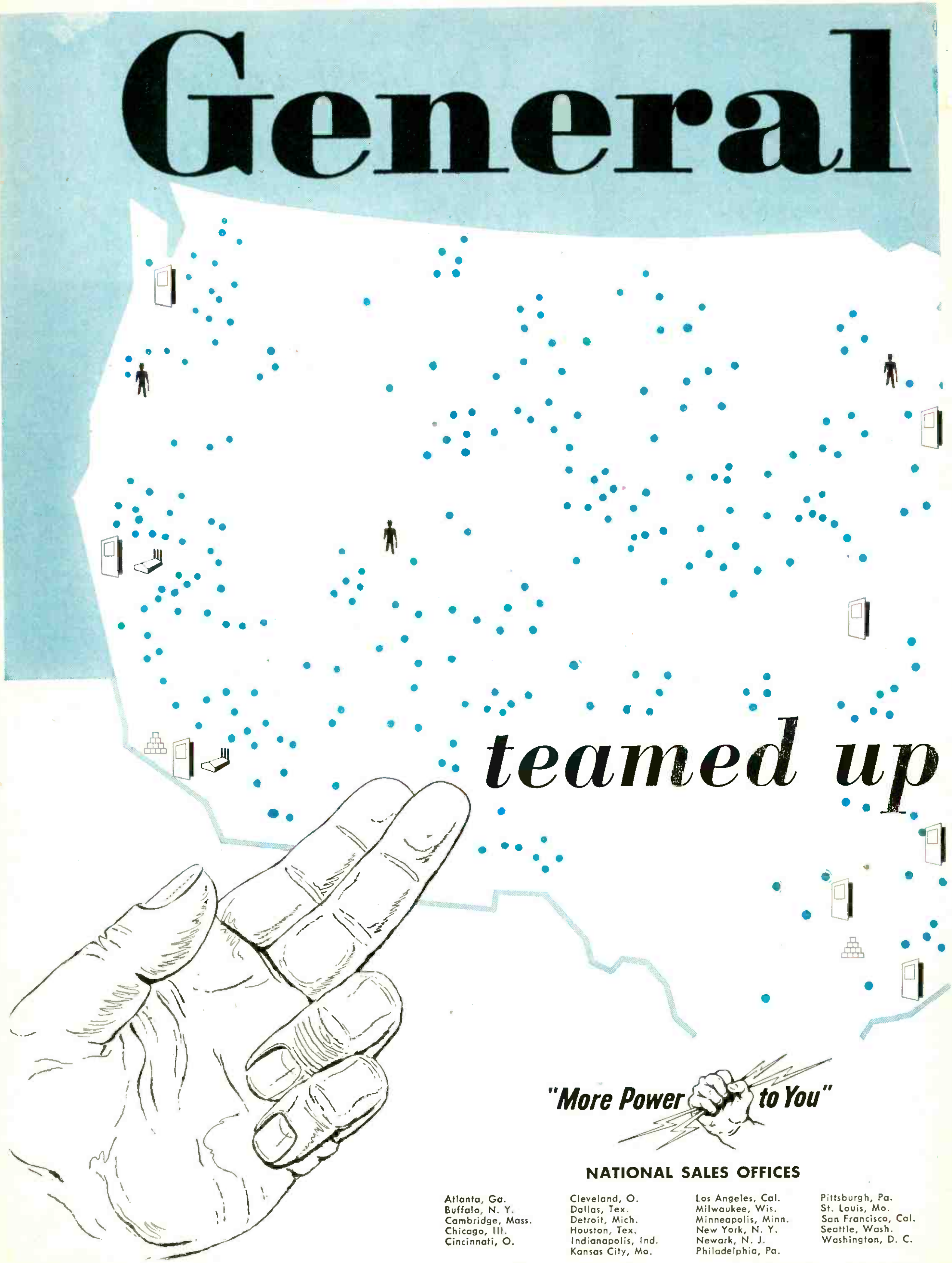
First in Controls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—C. R. Herrick, Director of Traffic, Packard Motor Car Co.

"We can't afford traffic jams at Packard!"

"An automobile plant is geared around its assembly lines. And they can be stopped for lack of a bolt!

"We simply cannot afford to let a traffic jam get started at Packard!

"When we face unforeseen delays on the part of our suppliers, we make extensive use of Air Express. Such shipments may range from 5 lbs. to more than a thousand.

"Recently, for instance, we needed a heavy shipment delivered overnight from the East Coast to meet a production crisis. The vendor was located in a non-airport city. We called Air Express — and the load was rolling into the plant gates at Detroit the next morning!

"Dependability like that is priceless. Yet in a good many weights and distances you actually save money by specifying the fastest service — Air Express.

"We handle several thousand pounds a month via Air Express, every shipment of which is important and must be on time. We give Air Express credit for valuable assistance in maintaining production of 1953 Packards and Packard Clippers from our assembly lines."

It pays to express yourself clearly. Say Air Express! Division of Railway Express Agency.

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GETS THERE FIRST

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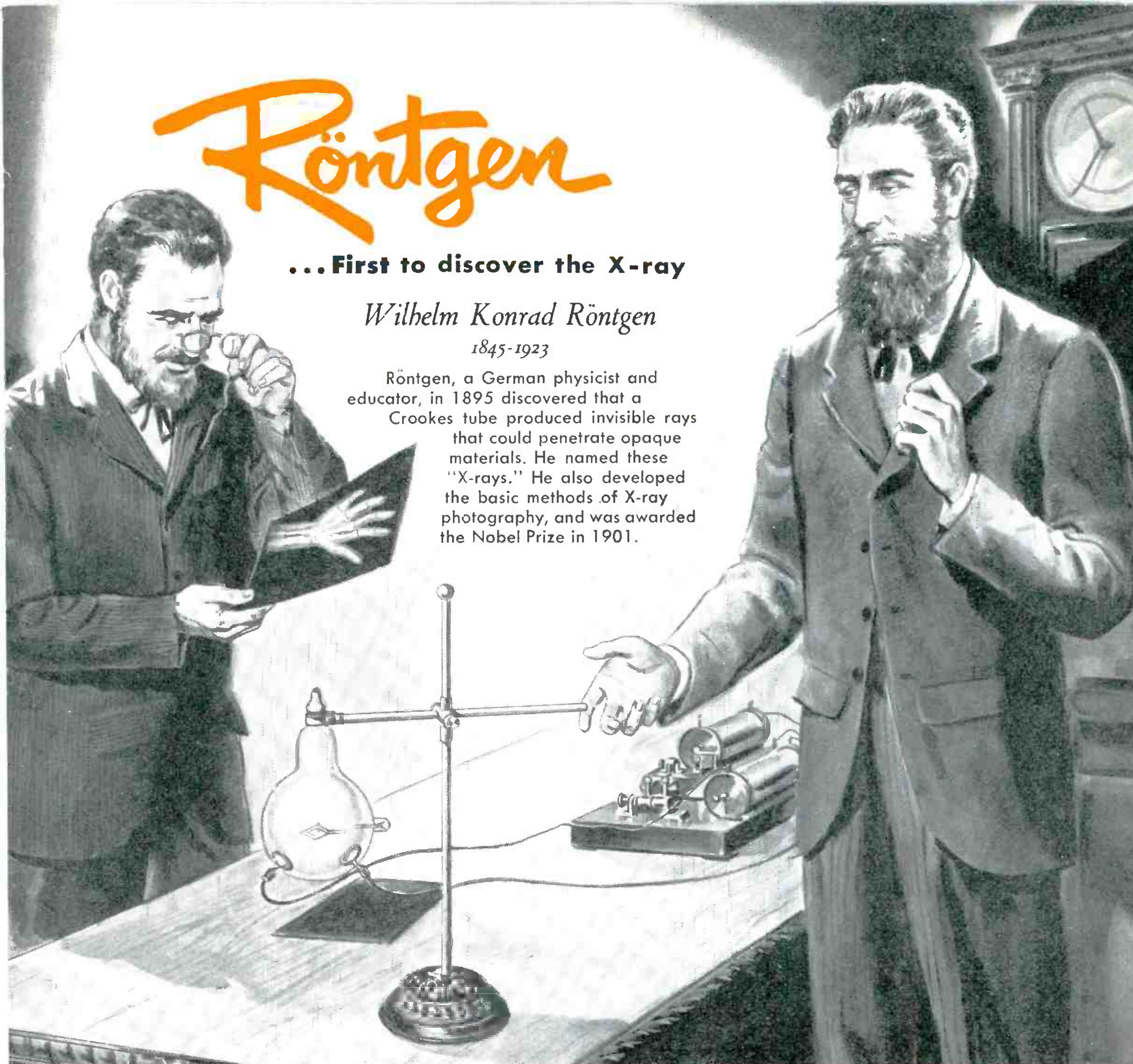

Röntgen

...First to discover the X-ray

Wilhelm Konrad Röntgen

1845-1923

Röntgen, a German physicist and educator, in 1895 discovered that a Crookes tube produced invisible rays that could penetrate opaque materials. He named these "X-rays." He also developed the basic methods of X-ray photography, and was awarded the Nobel Prize in 1901.

From an original drawing made for Ohmite

OHMITE®

...First in rheostats—today

You can *always* tell Ohmite rheostats by their unmatched smoothness of operation, dependability, and long, trouble-free life. Ohmite rheostats *perform* better because they're *built* better . . . designed with patented features that make them the most popular rheostat on the market . . . preferred by manufacturers everywhere. No wonder more Ohmite rheostats are sold than any other make!

Be Right with OHMITE

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Telecomputing announces...

THE TELEDUCER

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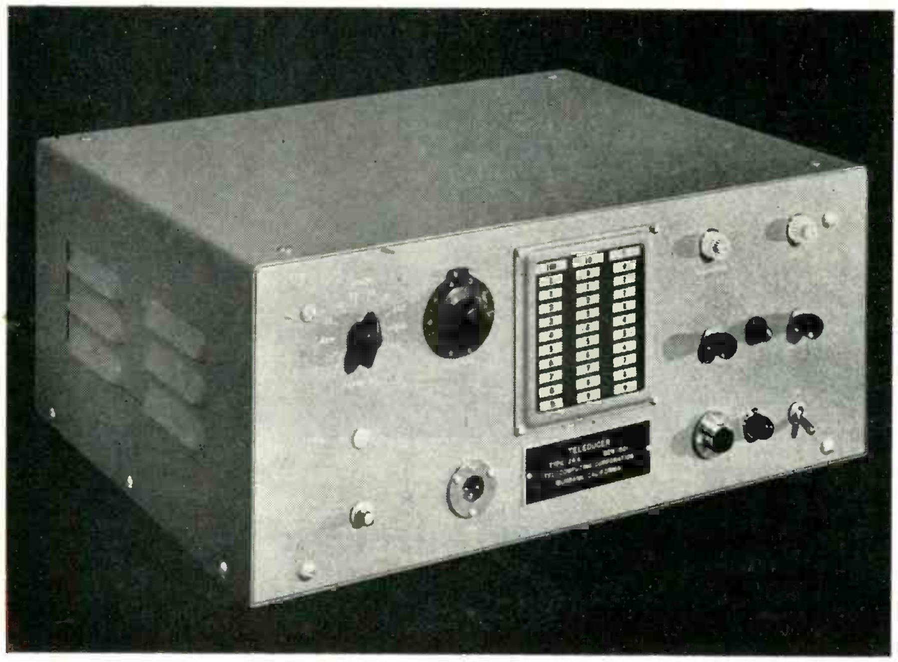
With 0.1% Accuracy



It offers these important advantages:

Provides 0.1% accuracy (1,000 counts full scale).

Provides for minimum full-scale input of 20 millivolts (20 microvolts per count).

Requires only 0.8 second or less for balancing.

Uses a simple bridge-balancing circuit.

Reads low voltage without DC Amplification.

Does not hunt or oscillate.

Presents visual reading of voltage on neon indicator bank.

Permits tabulated digital output when used with Program Unit and Electric Typewriter. (Digital recording in punched IBM cards or teletype tape available when used with suitable program units.)

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Your computing and data reduction problems, large or small, can be handled quickly, efficiently by Telecomputing's staff. Time and cost estimates will be presented if you will send information defining your problem.

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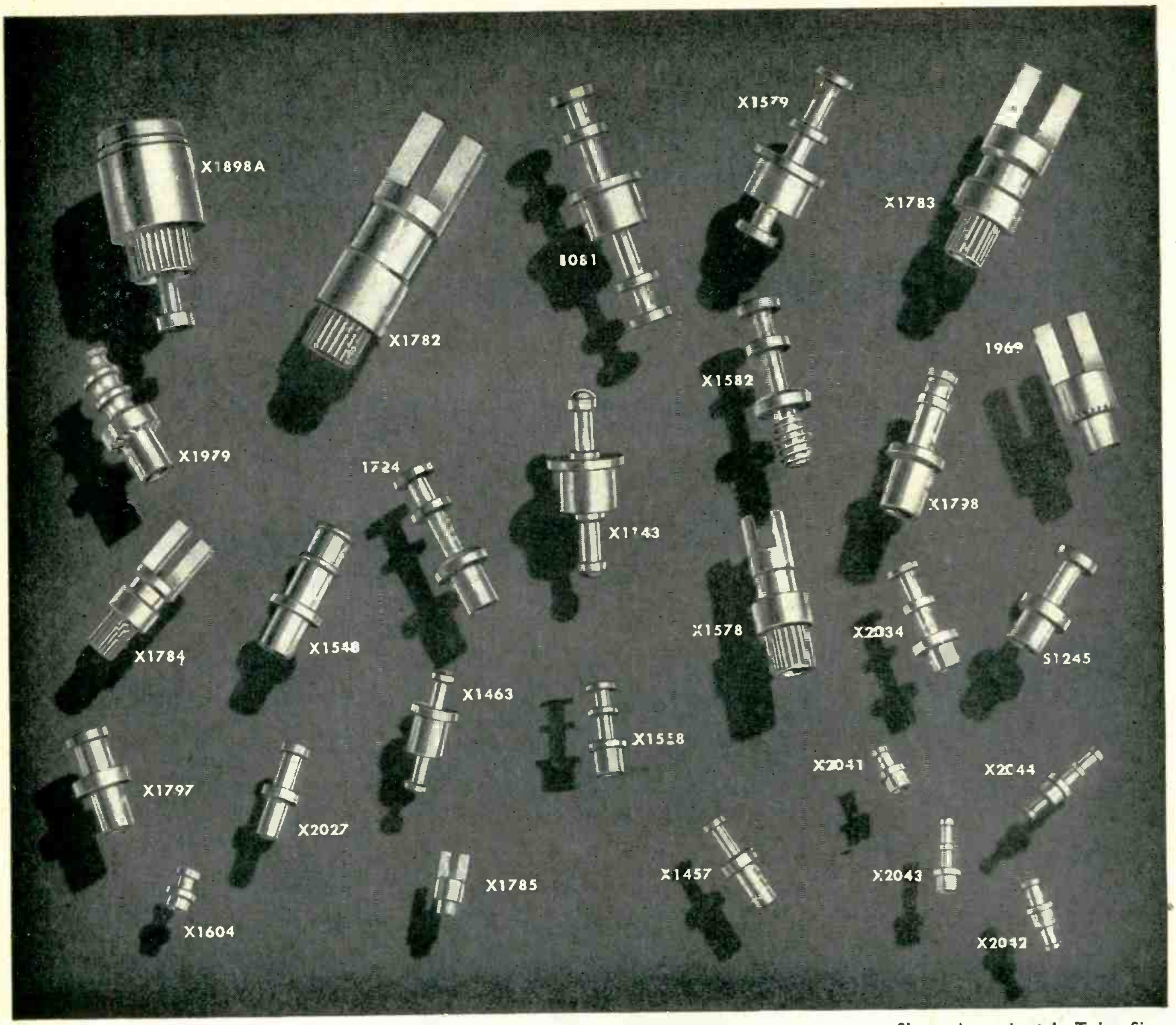

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Everything you need in standard terminal lugs
. . . or made to your own specifications!

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.

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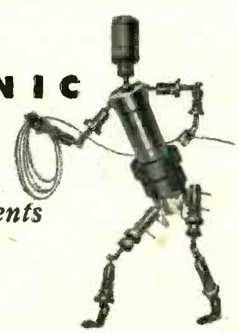

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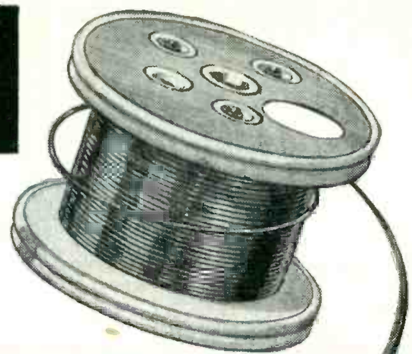

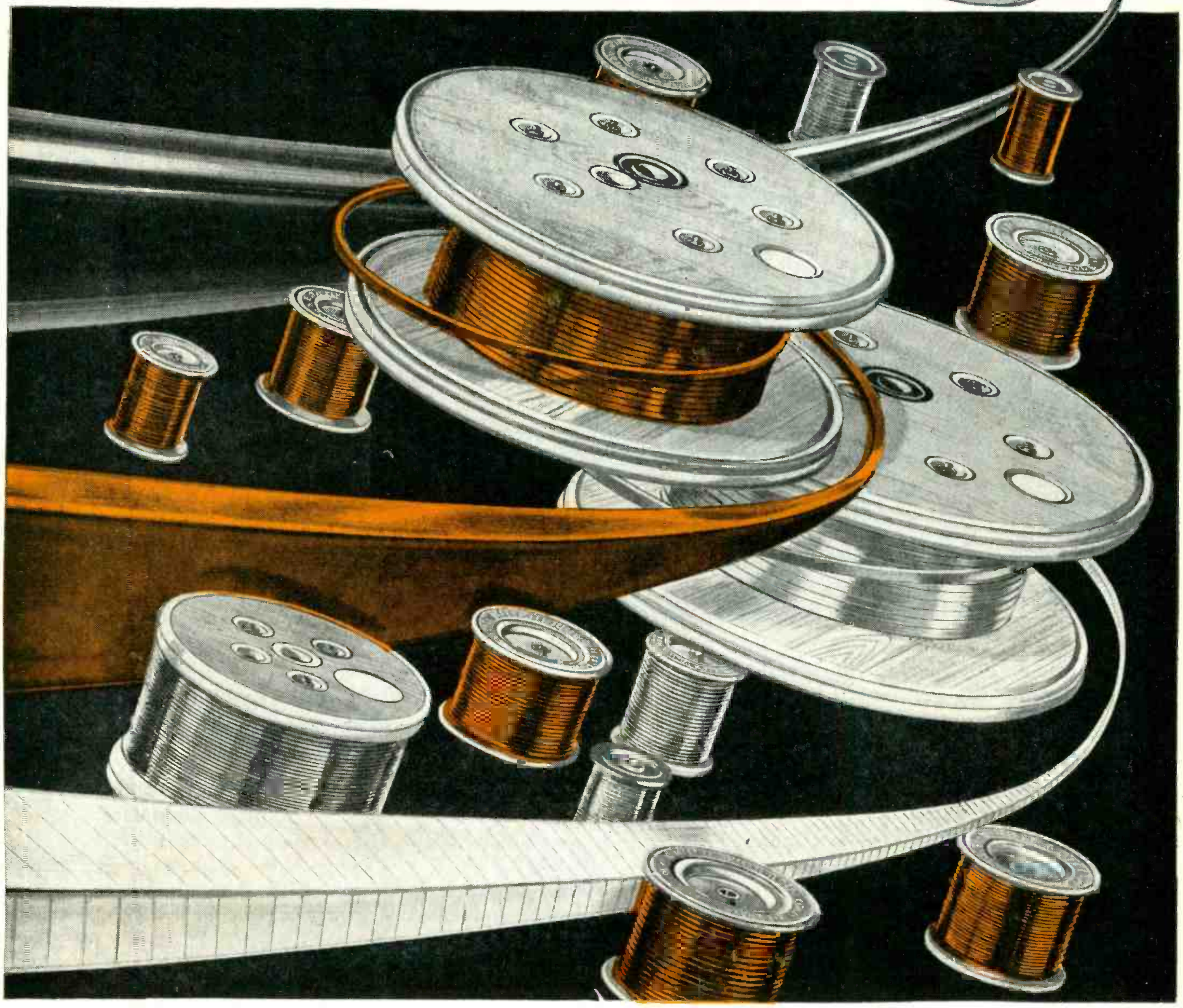

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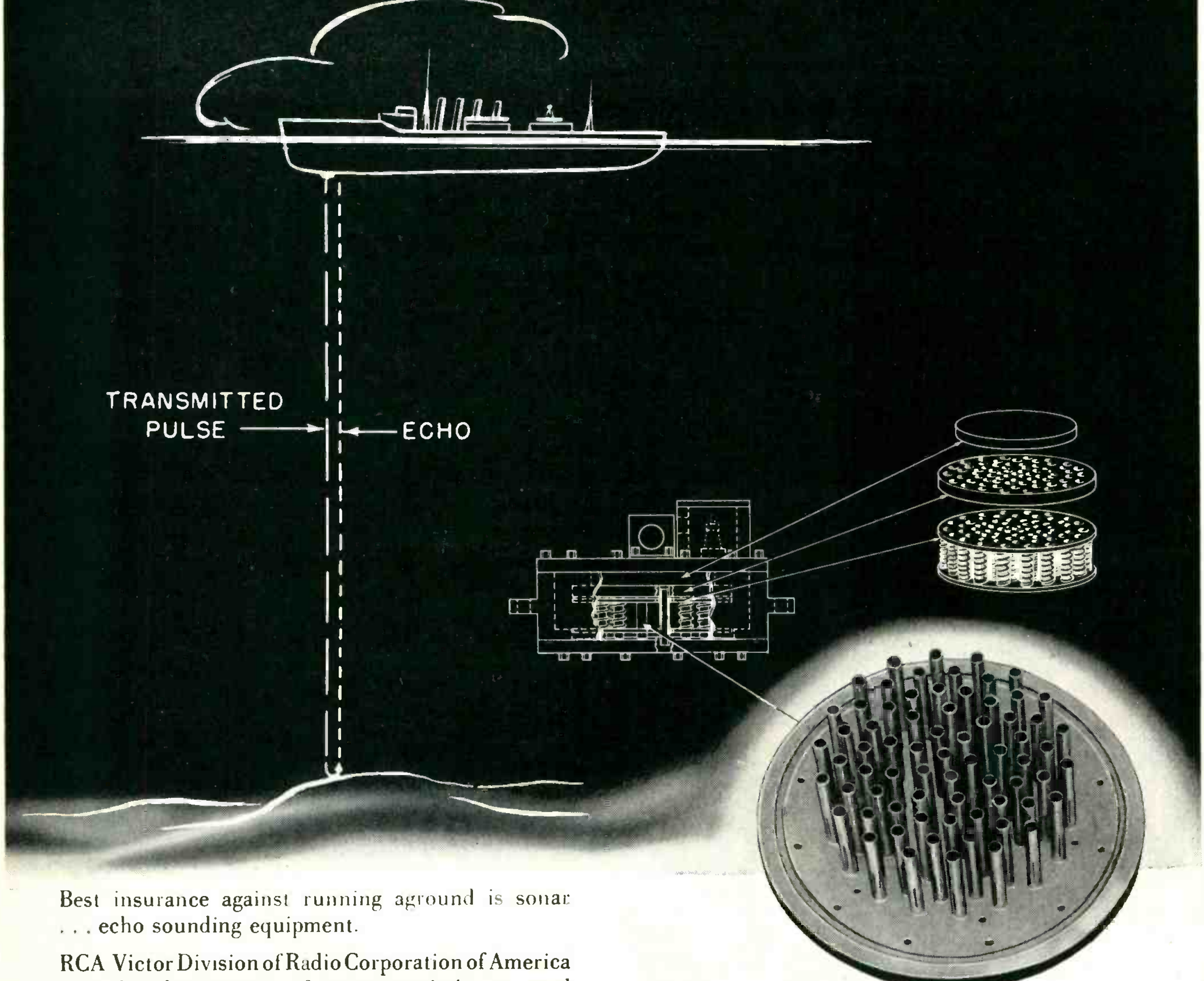
How to measure the depth of D. Jones' locker



Best insurance against running aground is sonar . . . echo sounding equipment.

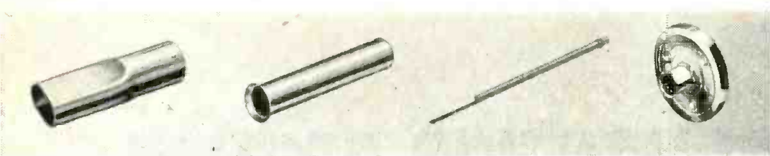
RCA Victor Division of Radio Corporation of America uses the phenomenon of magnetostriction to send and receive supersonic pulses and so determine the distance to a submerged object on the ocean's floor.

Magnetostriction—the familiar "Joule Effect" of your textbook days—is the ability of a ferromagnetic metal to change dimensions when magnetized. The metal of RCA echo sounding equipment is Superior Grade "A" nickel tubing.

70 pieces of Superior seamless nickel tubing, cold drawn to ⅜" O.D. x .020" wall thickness and cut to ¼ of the wave length of the alternating current signal, are soldered to a plate. Each length is enclosed by a coil.

Energizing the coil with alternating current, the tube expands and contracts, creating a piston effect on plate and diaphragm, sending out a supersonic wave. Likewise, reception of the echo wave by the diaphragm again causes the nickel tubes to pulsate and induce a current in the coil.

RCA Victor looks to Superior for accuracy and uniformity of analysis, precision drawing and cutting in large quantities. For cathodes, anodes, or tubing specialties, and tubing technology—ask Superior. Superior Tube Company, 2500 Germantown Avenue, Norristown, Pa.



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All analyses .010" to ⅝" O.D.

Certain analyses in Light Walls up to 2¼" O.D.

Seamless Nickel Anode. Flattened one end. .500" O.D. x .025" Wall x 1.625" long.

Seamless Nickel Cathode. Round, flanged one end, .070"/.072" I.D. x .0025" Wall. .295" long.

Lockseam* Nickel Cathode. Round, tabbed, single bead, .045" O.D. x .0021" Wall. 27 mm long.

Disc Cathode .121" O.D. .312" long.

Many types of nickel cathodes—made in Lockseam* from nickel strip, disc cathodes, and a wide variety of anodes, grip cups and other tubular fabricated parts are available from Superior. For information and Free Bulletin, address Superior Tube Company, Electronics Division, 2500 Germantown Avenue, Norristown, Pa.

*Manufactured under U.S. Patents.

LFE SOLID DELAY LINES STOP TIME!

WIDE RANGES OF DELAY
LOW ATTENUATION
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WIDE BANDWIDTH
SMOOTH PASS BAND
WIDE TEMPERATURE RANGE
MINIMUM SIZE AND WEIGHT
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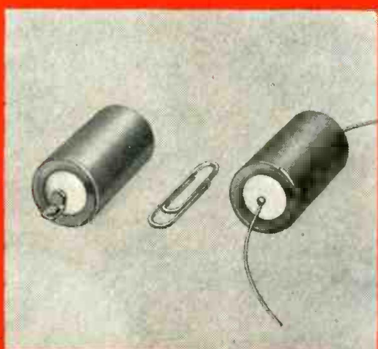
Now available for applications such as video integration, computers, time markers, moving target indication.

LFE solid ultrasonic delay lines utilize fused quartz as the delay medium and offer many advantages in obtaining precise delay intervals for pulse or modulated signals:

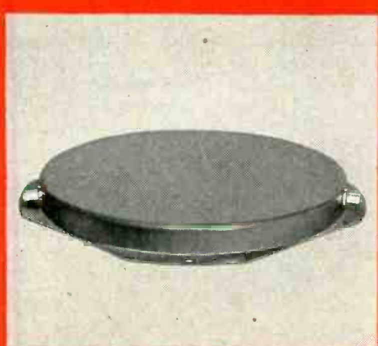


PRECISION RANGE MARKER DELAY LINE

TYPICAL DELAY LINE SPECIFICATIONS FOR PRECISION 1,000 YDS. RANGE MARKER

Delay Time	3.050 ± 0.003 microseconds at 50° C. 3.05 μsec ± 0.02 over a temperature range 0° C. to 100° C.
Attenuation of first pulse	28 db. into 1,000 ohms
Center Frequency	30 Mc.
Bandwidth	7 Mc.
Capacity	15 to 20 mmfds.
Pulse decay	1 to 1½ db. average

This item available from stock



TYPICAL SOLID DELAY LINE

RANGE OF SOLID DELAY LINE SPECIFICATIONS

Delay Time	1-3,000 microseconds can be provided with a high degree of accuracy.
Frequency Range	5-100 Mc.
Spurious Response	Up to 60 db. below desired signal.

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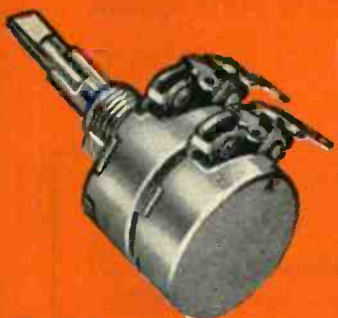
***Exceptionally* good delivery cycle on civilian orders due to tremendous mass production facilities.**

TYPE C45-70

NEW HIGH QUALITY MINIATURIZED "DIME-SIZE" CIVILIAN CONTROL—*Performance Fully Equals Larger Types.*

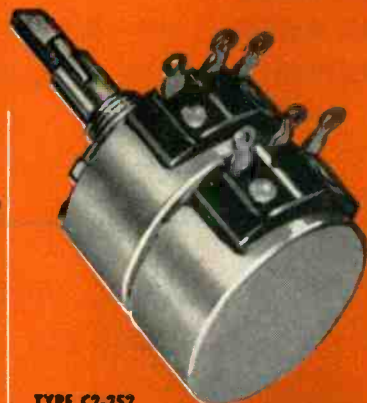
TYPE 70, 3/4" diameter variable composition resistor. Wattage rating: .3 watt for resistances through 10,000 ohms, .2 watt with 350 volts maximum across end terminals for resistances over 10,000 ohms. Also available in concentric shaft tandem construction C45-70 as shown above.

TYPE C2-45



TYPE C2-35

TYPE C2-252



TYPE C2-25

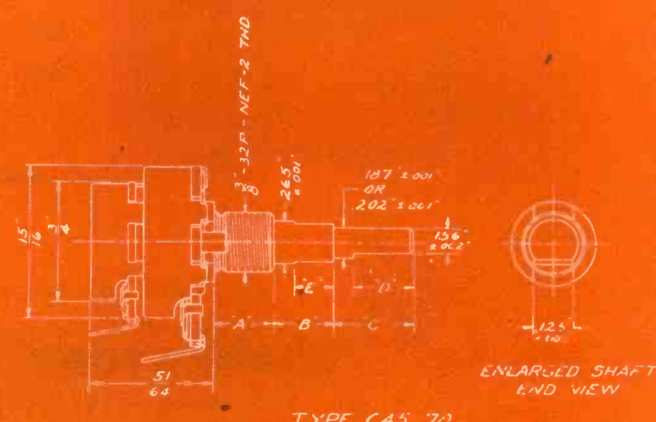
TYPE GC-45, 15/16" diameter variable composition resistor. Wattage rating: 1/2 watt for resistances through 10,000 ohms, 1/3 watt for resistances over 10,000 ohms through 100,000 ohms, 1/4 watt with 500 volts maximum across end terminals for resistances over 100,000 ohms. Available with or without illustrated attached switch and in concentric shaft tandem construction C2-45 as shown above.

TYPE GC-35, 1 1/8" diameter variable composition resistor. Wattage rating: 3/4 watt for resistances through 10,000 ohms, 2/3 watt for resistances over 10,000 ohms through 25,000 ohms, 1/2 watt with 500 volts maximum across end terminals for resistances over 25,000 ohms. Available with or without illustrated attached switch and in concentric shaft tandem construction C2-35 as shown above.

TYPE GC-252, 2 watt, 1 17/64" diameter variable wirewound resistor. Available with or without illustrated attached switch and in concentric shaft tandem construction C2-252 as shown above.

TYPE GC-25, 4 watt, 1 17/32" diameter variable wirewound resistor. Available with or without illustrated attached switch and in concentric shaft tandem construction C2-25 as shown above.

***Typical concentric shaft tandem* with panel and rear sections operating separately from concentric shafts (TYPE C45-70 ILLUSTRATED). Similar construction available for all military resistors.**



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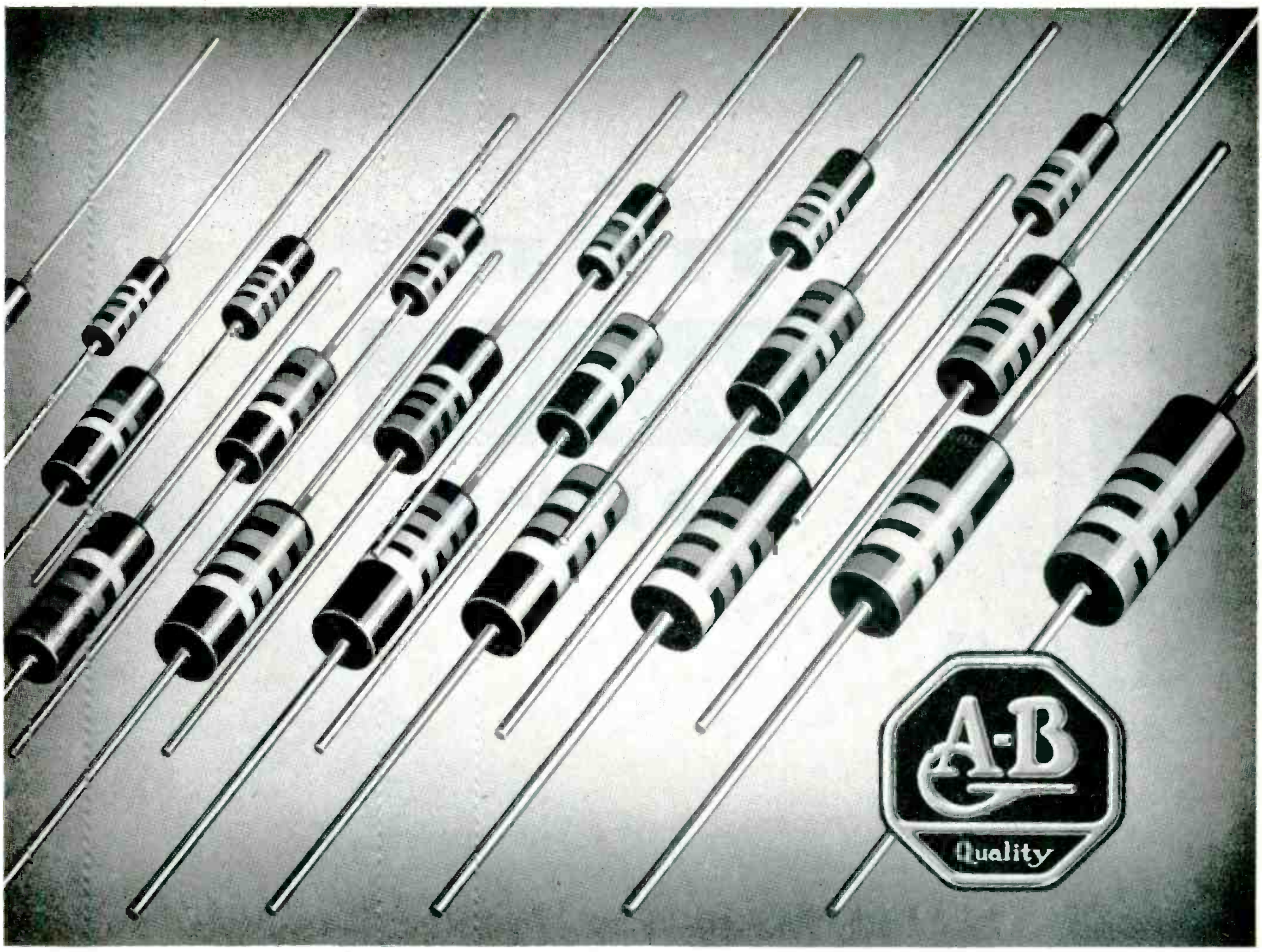

BRADLEYUNITS—*by the Million*

. . . Quality Resistors for Dependable Performance

IMBEDDED LEADS
are differentially tempered

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

Millions upon millions of Bradleyunits have been built into radio and electronic equipment over the past two decades.

Their reputation for high quality is due to the fact that they are rated at 70C ambient temperature . . . not 40C. Under continuous full load for 1000 hrs, the resistance change is less than 10%. They require no wax impregnation to pass salt water immersion tests.

Bradleyunits are available in standard R. T. M. A. values in ½ and 2 watt sizes from 10 ohms to 22 megohms; 1 watt from 2.7 ohms to 22 megohms. They withstand extremes of temperature, pressure, and humidity.

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FIXED & ADJUSTABLE RADIO RESISTORS

Sold exclusively to manufacturers QUALITY of radio and electronic equipment

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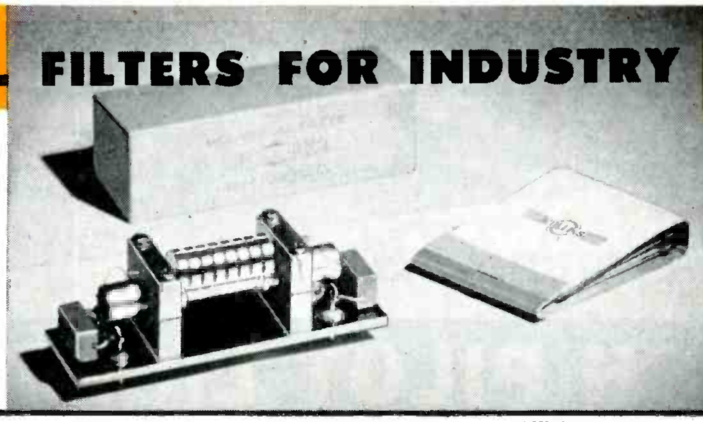
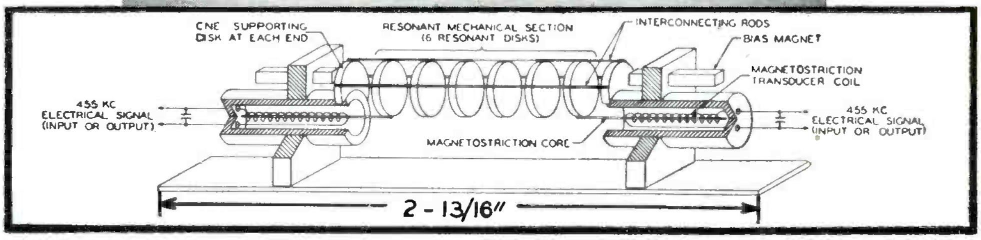
MECHANICAL FILTERS FOR INDUSTRY



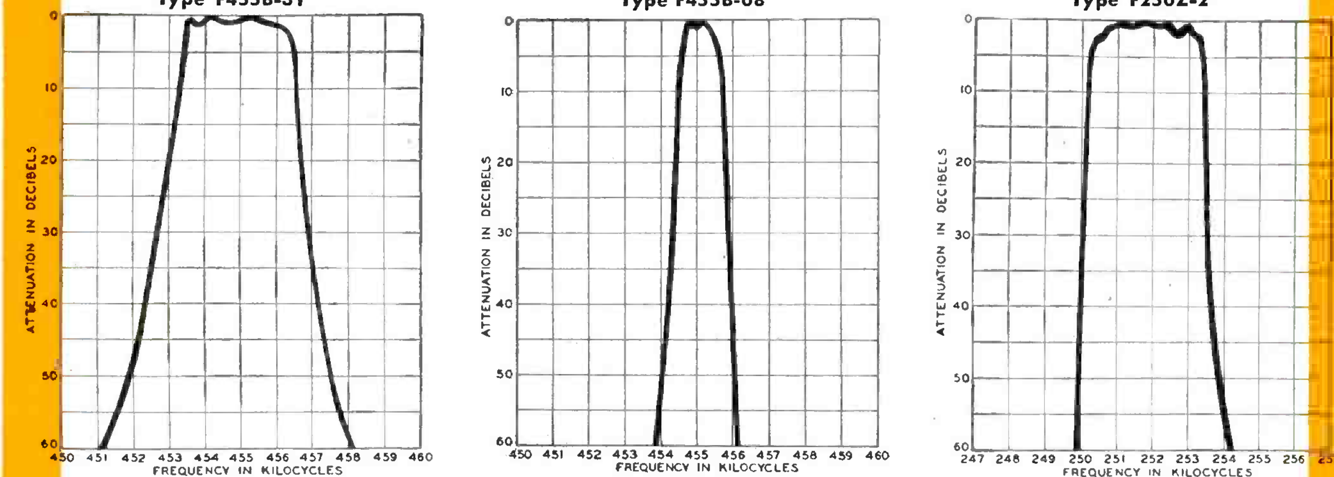
Collins Mechanical Filter with hermetically sealed shield removed. Compare size with matchbook.



Engineers's drawing of 455 kc Mechanical Filter interior.

SELECTIVITY CURVES FOR THREE TYPICAL MECHANICAL FILTERS

Type F455B-31 — Type F455B-08 — Type F250Z-2



THE COLLINS Mechanical Filter was first revealed to the Radio Industry during the 1952 IRE Convention. Since that time the original Mechanical Filter Type F455B-31 has become available in production quantities. Other Collins Mechanical Filters, designed to operate at various bandwidths in the intermediate frequencies, are also available in engineering sample quantities. All of the Mechanical Filters listed here offer a close approach to the ideal rectangular selectivity curve. Consult the chart of available Mechanical Filters (right) for the solution to your selectivity problem.

A request on your letterhead will bring full technical specifications, price and delivery information.

Type No.	Center Frequency	Bandwidth	Terminal Arrangement
F250A-60	250 kc	6.0 kc	Solder
F250Z-1	248.7 kc	3.0 kc	Solder
F250Z-2	251.3 kc	3.0 kc	Solder
F455A-08	455 kc	800 cycle	Solder
F455A-31	455 kc	3.1 kc	Solder
F455A-60	455 kc	6.0 kc	Solder
F455B-08	455 kc	800 cycle	Plug-In
F455B-31	455 kc	3.1 kc	Plug-In
F455B-60	455 kc	6.0 kc	Plug-In
F500A-14	500 kc	1.4 kc	Solder
F500A-31	500 kc	3.1 kc	Solder
F500B-31	500 kc	3.1 kc	Plug-In
F500B-14	500 kc	1.4 kc	Plug-In

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COLLINS

COLLINS RADIO COMPANY, Cedar Rapids, Iowa

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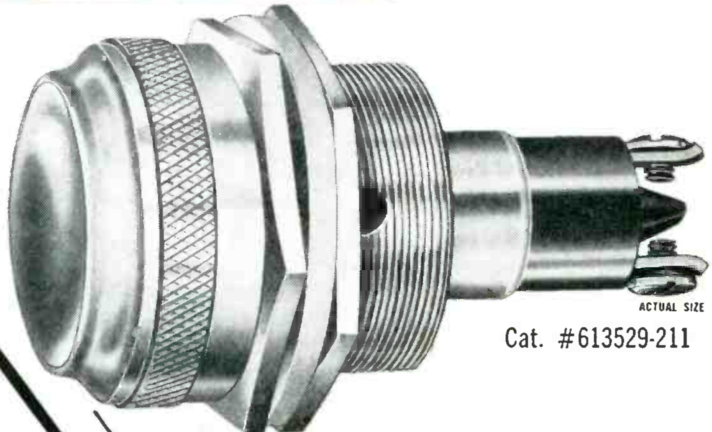
for **YOUR** *product*

WHICH PILOT LIGHT DO YOU NEED?

DIALCO



ACTUAL SIZE

Cat. #613529-211

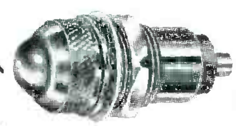
THE BIG ONE

This Pilot Light Assembly was first made to accommodate the *S-11 lamp* and was intended for use in the cabs of great diesel locomotives.

This BIG one

or

this LITTLE one



ACTUAL SIZE

Cat. #8-1930-621

Dialco HAS THE COMPLETE LINE OF INDICATOR and PANEL LIGHTS

THE LITTLE ONE

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Samples to suit your own special conditions and requirements will be sent promptly and *without cost.* Just outline your needs. Let our engineering department assist in selecting the *right lamp* and the *best pilot light* for YOU.

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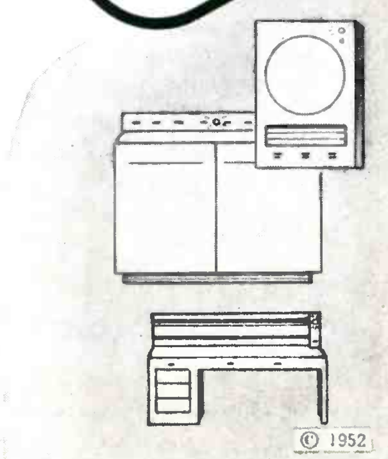

Leece-Neville

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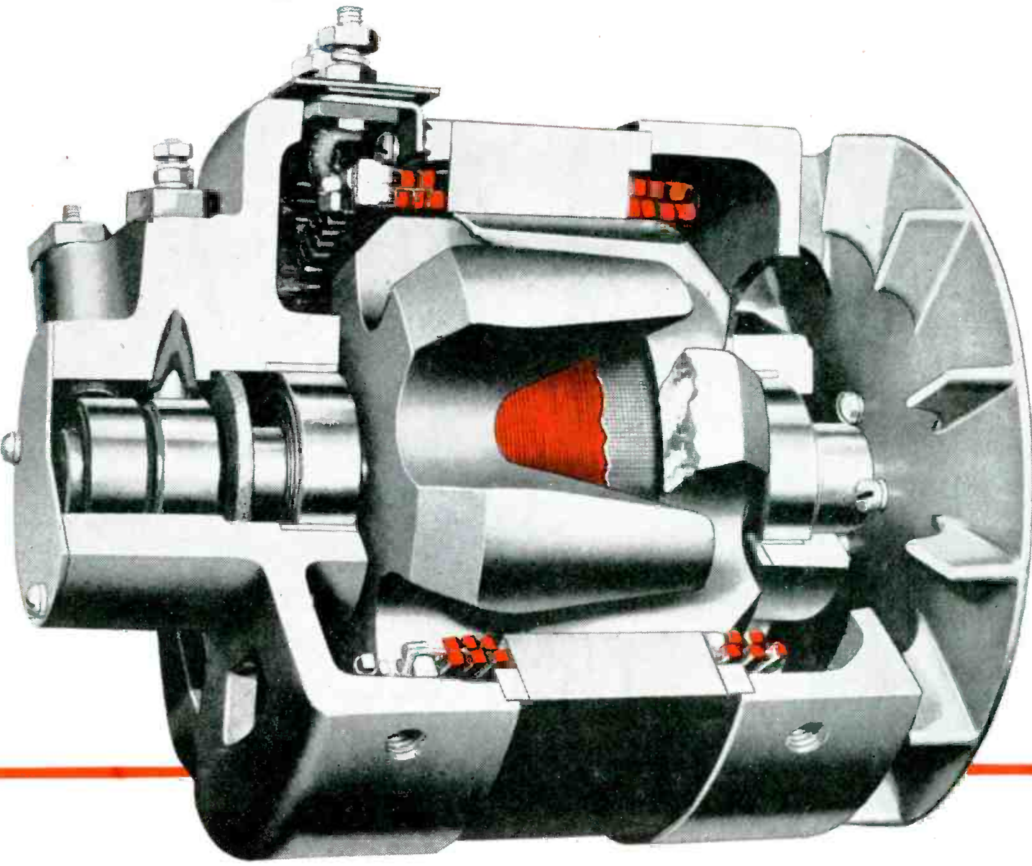

Leece-Neville A.C.-D.C. Alternator Systems have been known to run over half a million miles . . . and perform at top efficiency the entire period. Such unusually long performance . . . effecting great savings . . . can come only from the skillful application of advanced engineering, precise manufacturing and the use of the finest materials. Here, as in the manufacture of many other fine electric and electronic products, Warren Wire is used for its easy handling, efficiency and dependability. There's a Warren Wire Engineer near you trained to help you solve your wire problems right in your own plant. There is no obligation, of course.

Write for new Teflon Specification #1001, dated February, 1953

WW

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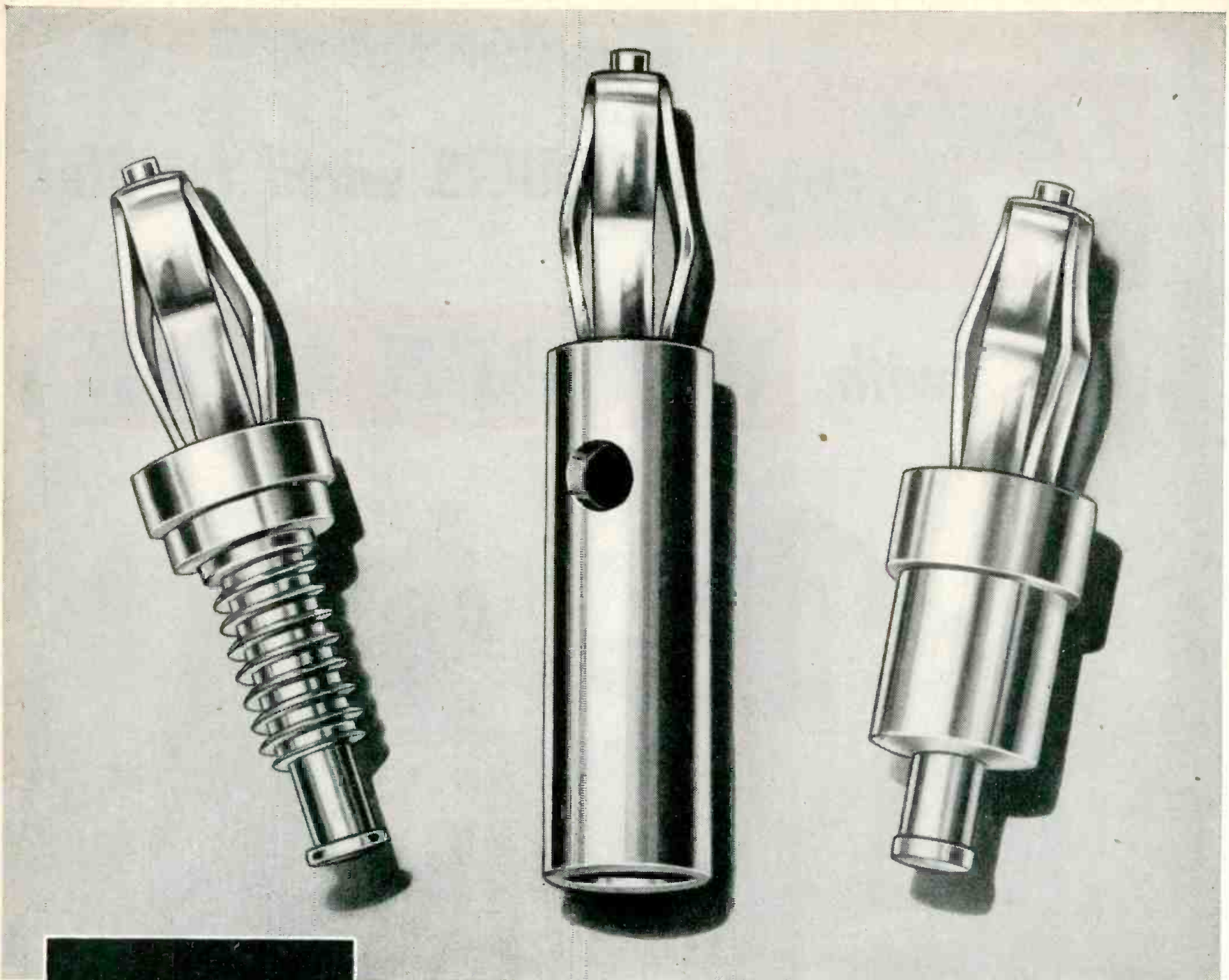

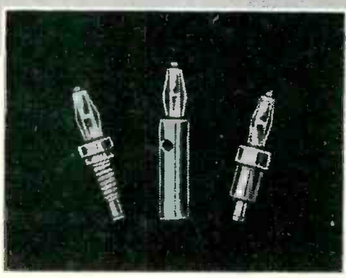

Actual size

6 times enlargement

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Miniature Banana Pins

Ucinite miniature banana pins have springs both soldered and staked to the bodies for solid construction to withstand rough usage.

Springs are designed to fit .093 sockets. Pins are available in a variety of types for assembly by staking . . . with nuts and washers . . . with soldered tails . . . with multiple plug-in features. They are available in cadmium, silver or gold plate.

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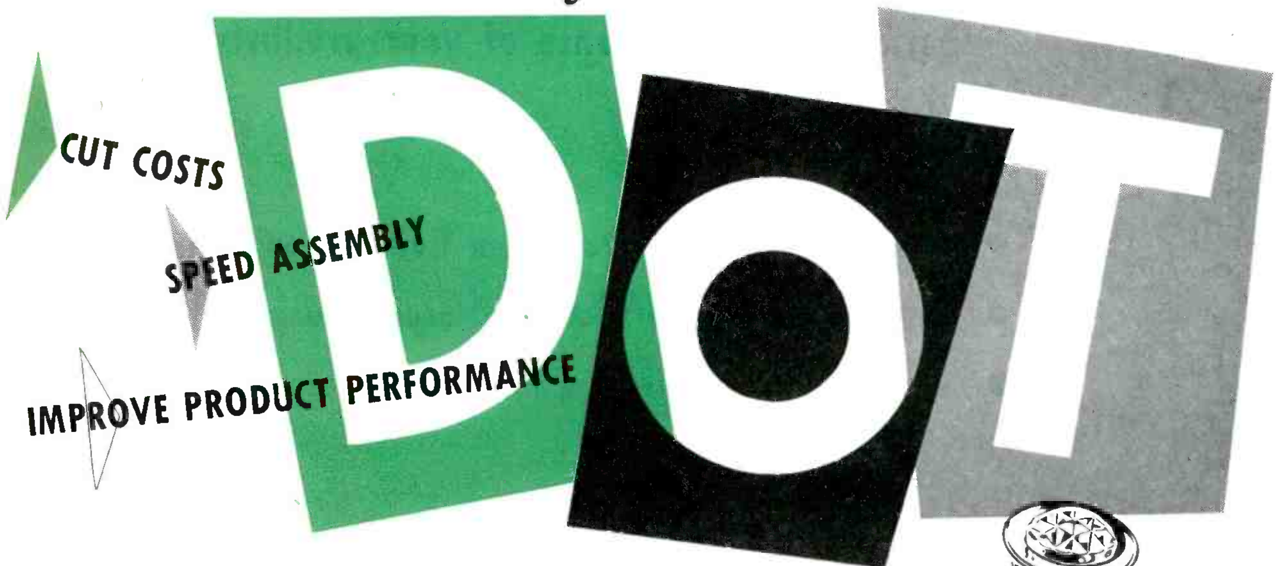
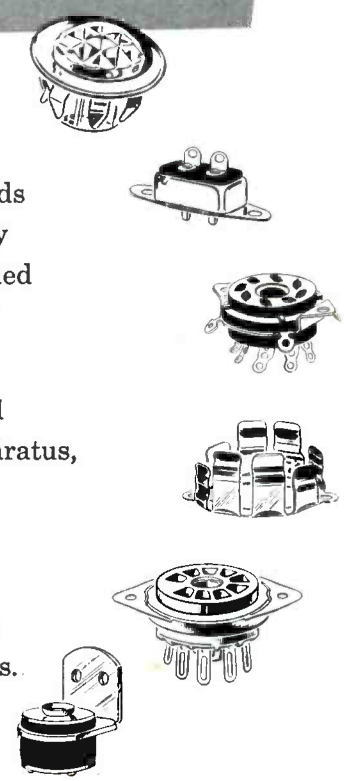


Give DOT the job of keeping your fastening methods up to scratch. A survey of your assembly operations may reveal costly fastener deficiencies that could be remedied simply by using special-purpose DOT fasteners specifically designed for their jobs.

With wide experience in the design and volume production of special fasteners for use in automobiles, aircraft, electronic apparatus, appliances, furniture . . . United-Carr's engineering staff is ideally equipped to serve you.

It is important, however, to call in United-Carr *before* your new designs are frozen for production. It is in the *planning* stage that you can make most effective use of our specialized services.



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INDIANA PERMANENT

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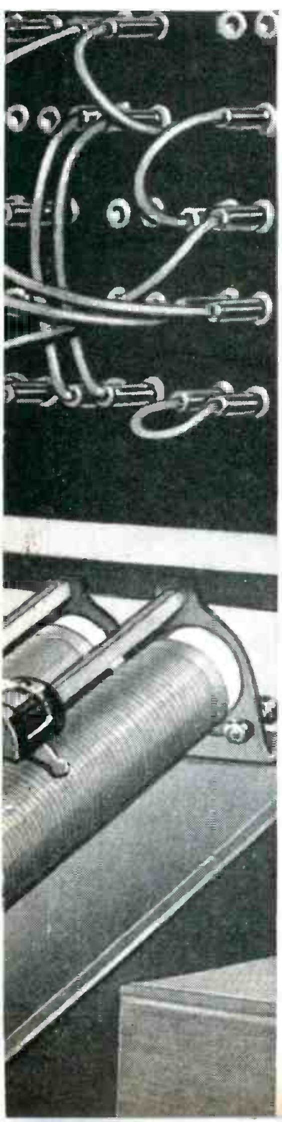
Write for this Permanent Magnet Design Handbook No. 4-A7



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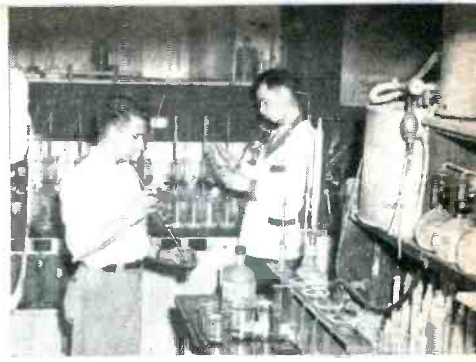
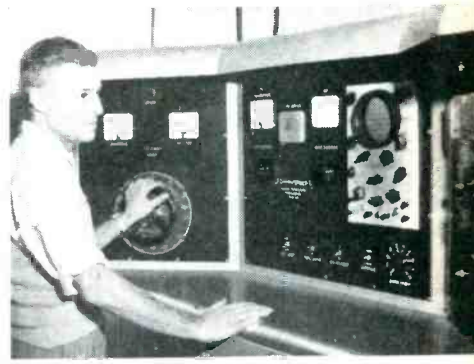
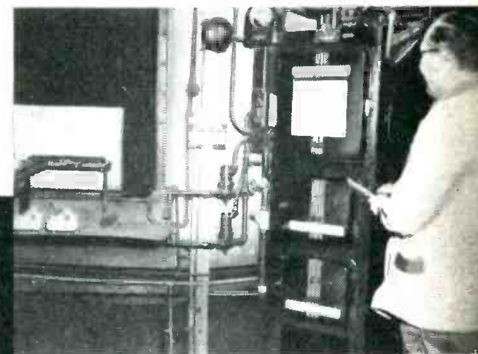


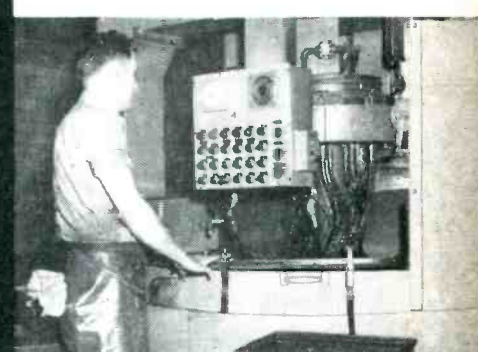
Chemical Analysis—Here alloys are checked for composition and magnetic qualities.



Control Panel for Spectrograph—The spectrograph is used for precise detection and measurement of various alloys in a test sample.



Electric and gas-fired furnaces—special heat treatment assures proper magnetic qualities.



Grinding—high production grinders permit close dimensional tolerances.

Final Inspection—Here magnetic and physical qualities are again checked. A Zyglo unit is also used to detect possible cracks and defects.

NEW VITROHM Rheostat

with 6 exclusive features

provides smoother operation, finer control, longer life

1 **Pressed steel base plate** assures a sturdy, lightweight rheostat base. The black japanned finish is corrosion resistant.

2 **Balanced contact arm** reduces creep from vibration or shock. The arm is keyed directly to one end of the drive shaft.

3 **Solid brass rectangular contacts** provide more steps of control for any given plate diameter.

4 **Reflexed collector ring** supplies a self-cleaning surface. It is permanently held in position by Vitrohm enamel.

5 **Vitrohm enamel** permanently seals and insulates the resistance element, stationary contacts and collector ring.

6 **Contact shoe and bearing** are self-lubricated to provide exceptionally smooth control and low operating torque.

This new line of Vitrohm Pressed Steel Rheostats incorporates 21 advanced design features, including the 6 shown here. They are designed for a wide variety of industrial applications to give smoother operation, lower operating torque, longer life, and more control steps. From raw materials to finished product, close control over workmanship and continual inspection of every component is maintained. These are the most dependable and economical rheostats ever made by Ward Leonard — the leader in rheostat manufacture for over fifty years.

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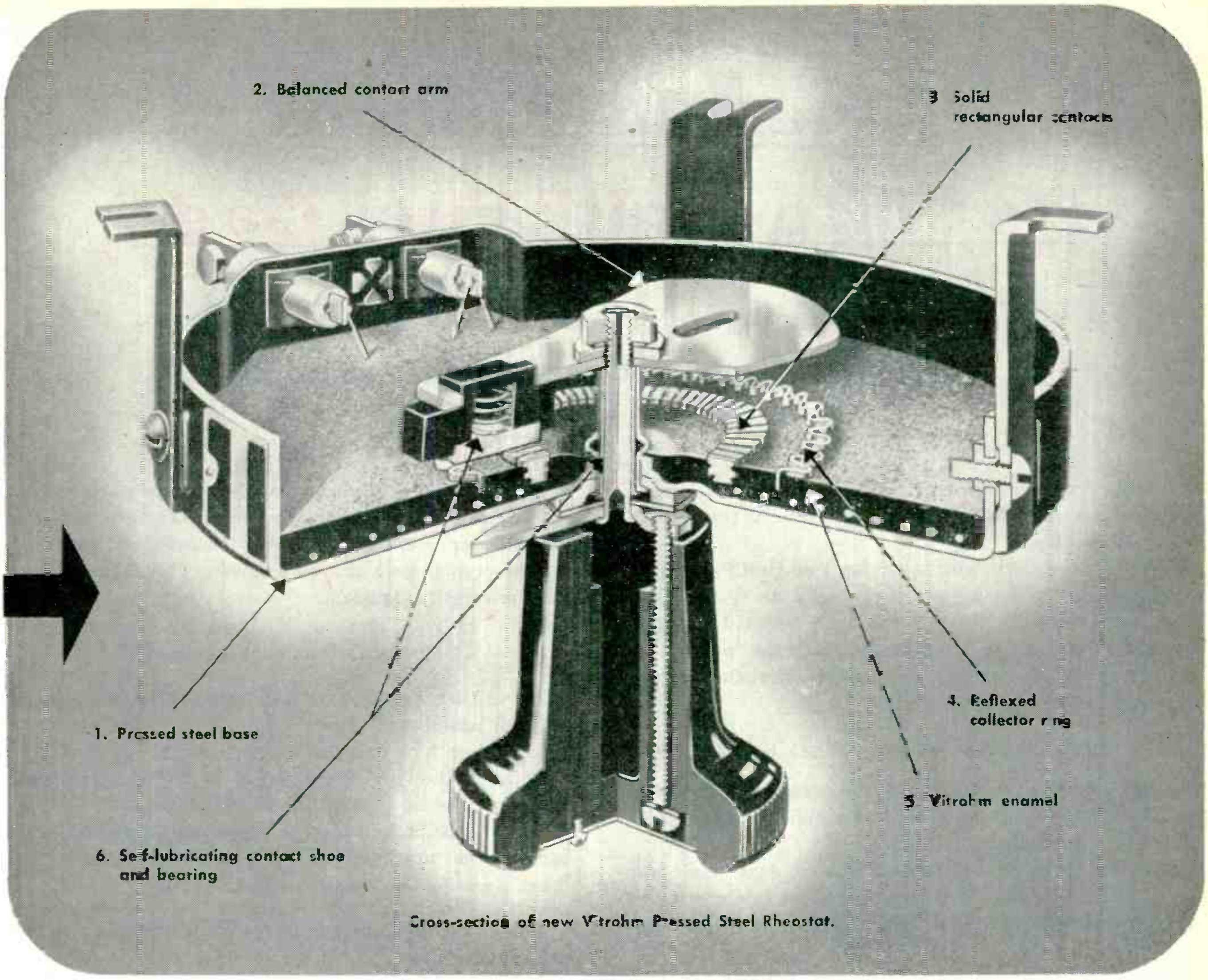


Cross-section of new Vitrohm Pressed Steel Rheostat.

RHEOSTATS FOR EVERY APPLICATION

Ward Leonard manufactures the most complete line of power rheostats ever offered for industrial control applications. It includes standard and special designs for all current ratings up to 400 amperes. A complete description of the entire line with mountings, manual and motor drive accessories, a variety of enclosures, and optional features will be found in the *new* Ward Leonard Bulletin 60a. It will pay you to send today for your free copy. Write to Ward Leonard Electric Co., 31 South Street, Mount Vernon, N. Y.

3-17

Avien Introduces its "Two-Unit" Fuel Gage

This "repackaging" of Avien's capacitance-type fuel gage is 50% lighter and needs no field adjusting

Ever since Avien developed its capacitance-type fuel gage, our engineers have stuck to the task of reducing the system to its simplest form.

Now they've done it, with the Avien Two-Unit Fuel Gage.

Basically, it is the same sharply accurate system that Avien has designed and which has been installed on thousands of modern planes. The big news is in the "package"—for the necessary components have been reduced to a sensing unit and an indicating unit.

Avien has buried the "black box"

Up until now, most fuel gaging systems needed four units; a tank unit, an indicator, a bridge-amplifier, and a shock-mount to guard it against vibration.

No field calibration was required for the Avien tank unit or indicator. Avien held them to such close tolerances, the adjustments for individual installations were actually "built in."

The bridge-amplifier (the "black box") was a different story. This intermediate unit was supplied as a common part, for universal application. And that's where field calibration *had* to be made.

The rigid specs for the bridge-amplifier component have previously held back improvements in the system as to weight, size, cost, performance and flexibility. There was only one answer, as far as Avien was concerned. The "black box" had to go.

In the Avien Two-Unit system, the necessary components for the bridge and amplifier functions have been built into the indicator case. The "black box" is eliminated, and so are certain components which were necessary to make the "black box" universally applicable.

No more field adjustments

The Two-Unit Fuel Gage gets installation down to "plug-in, plug-out" simplicity.

The Avien tank unit and indicator are pre-calibrated for the aircraft they are designed for. Since the intermediate unit is not needed, neither is field calibration.

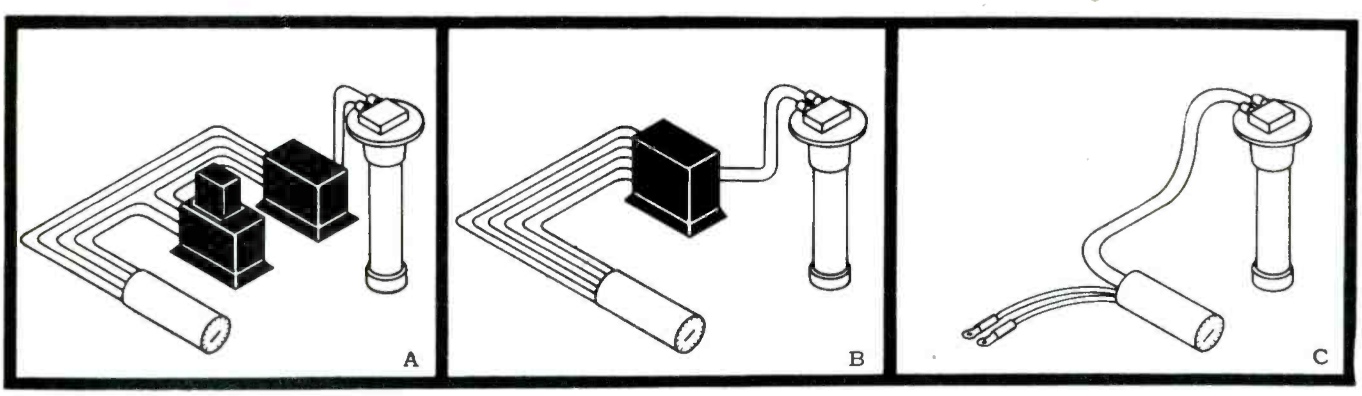
Since no calibration is required, all units designed for the same aircraft are interchangeable. Avien units are now all "shelf items."

The Two-Unit Gage eliminates three drawbacks of field calibration:

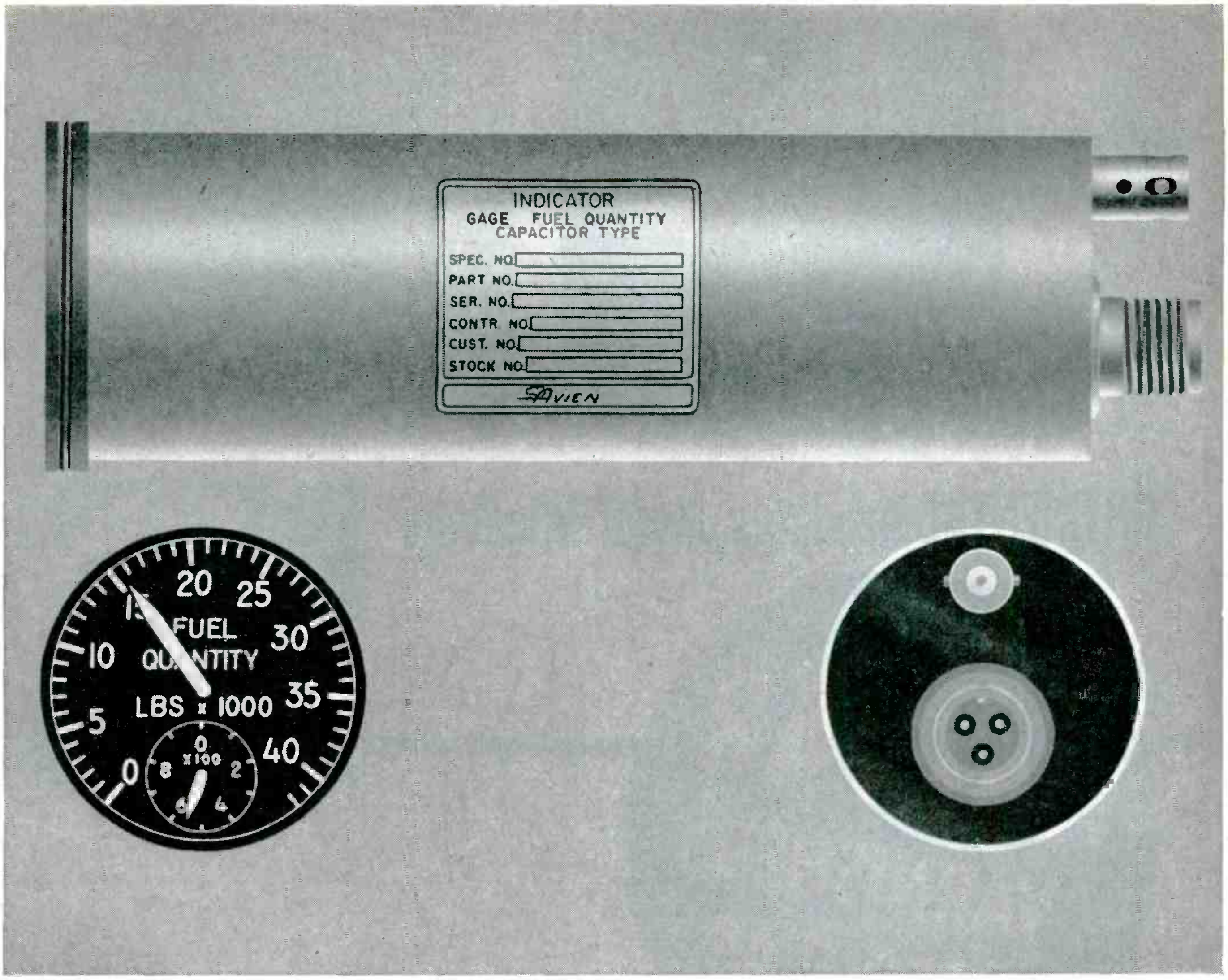
1. *No trained personnel needed.* To err is human, but human fallibility is built *out* of the Two-Unit Gage.

2. *No specialized test equipment needed.* No precision condensers, bridges or calibration boxes required.

3. *No calibration instruction or data needed.* Have you ever run this "paper chase"? By the time you've tracked the information down, it's often obsolete. No more of that!



Fuel gaging progress: Early gaging system (A) had four units. The 1952 system (B) incorporated bridge and amplifier into a single unit, reduced weight almost 15%. Avien's Two-Unit Fuel Gage, now being introduced (C) repackages the system with further miniaturization of components, this time reducing weight by 50%.



Full scale drawing of Avien's Two-Unit Fuel Gage: Front, side and back views of the small-size indicator-amplifier unit. "Plug-in, plug-out" simplicity is the keynote.

Savings all along the line

Simplification means less weight. In the Two-Unit Fuel Gage, the basic system is reduced in weight by 50%.

There are cost savings, too. Less time is spent in installing the Two-Unit Gage. Less wiring and connectors are needed. Less maintenance is required, because there are fewer components to maintain. Trouble-shooting becomes easier, because there are fewer units to cause trouble. And fewer parts must be stocked for replacement and repairs.

Fuel gaging AND fuel management

Avien's Two-Unit system retains an important feature of the former gage. Additional functions for fuel management can be integrated into the basic gage.

This means that simulators, level switches, balancing controls, totalizing equipment, etc., can be hooked up to the basic system — and with even less difficulty.

Another interesting aspect is that the Two-Unit Gage is designed to take advantage of recent improvements in mechanical and electronic design — the new lightweight coaxial cable, the new miniature A N connectors, and Avien's new lightweight tank units.

Now scheduled for production

The Avien Two-Unit Fuel Gage is now available to meet your manufacturing schedules.

The indicator is available in either large or small sizes, with all varieties of dial configurations.

Every month, Avien produces over ten thousand major instrument components for the aviation industry.

We believe that Avien's Two-Unit Gage will contribute to the obsolescence of many earlier systems, including our own.

For further information write or call us.

Avien

AVIATION ENGINEERING DIVISION

AVIEN-KNICKERBOCKER, INC.
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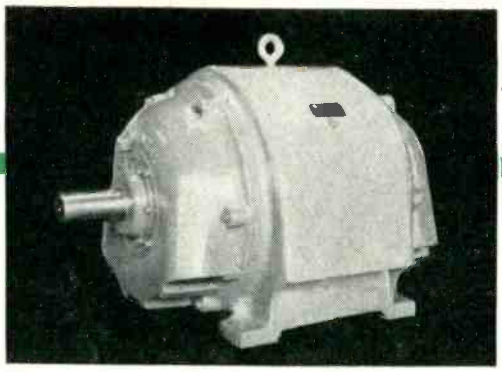
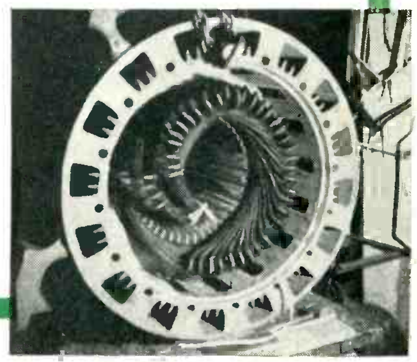


Drip-proof motor of the type used in severe service applications, where motors are exposed to the weather or are subjected to frequent overloads.

A good example of outdoor service is this pole shaver, driven by 5 Continental 440 V. drip-proof type polyphase motors: 2-15 hp. 1800 rpm.; 2-3/1½ hp. 1200/600 rpm.; and 1-3 hp. 1800 rpm.

CONTINENTAL Insulates Motor Windings

with NATVAR VARNISHED FIBERGLAS



Stator of Continental 6600 V. explosion-proof type, showing windings in place. They are insulated with Natvar Varnished Fiberglas to give extra protection against moisture, dirt, and heat.

Continental Electric Co., Newark, N. J., manufactures polyphase motors from 1 – 700 hp. and in several types including drip-proof, splash-proof, and explosion-proof. They also make generators, dynamotors, converters and motor-generator sets.

Thousands of Continentals are giving uninterrupted service in refineries and other field uses with little or no protection from the weather. To insure this performance, insulating materials are carefully chosen for their ability to stand up under severe operating conditions. Natvar Varnished Fiberglas is used because of its superior resistance to both moisture and heat.

If you need flexible insulating materials with good physical and electrical properties, and exceptional uniformity, it will pay you to get in touch with your Natvar distributor, or with us direct.

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- Varnished Fiberglas cloth
- Varnished papers
- Slot insulation
- Aboglas®, asbestos-Fiberglas composite
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- Extruded plastic tubing and tape
- Styroflex® flexible polystyrene tape
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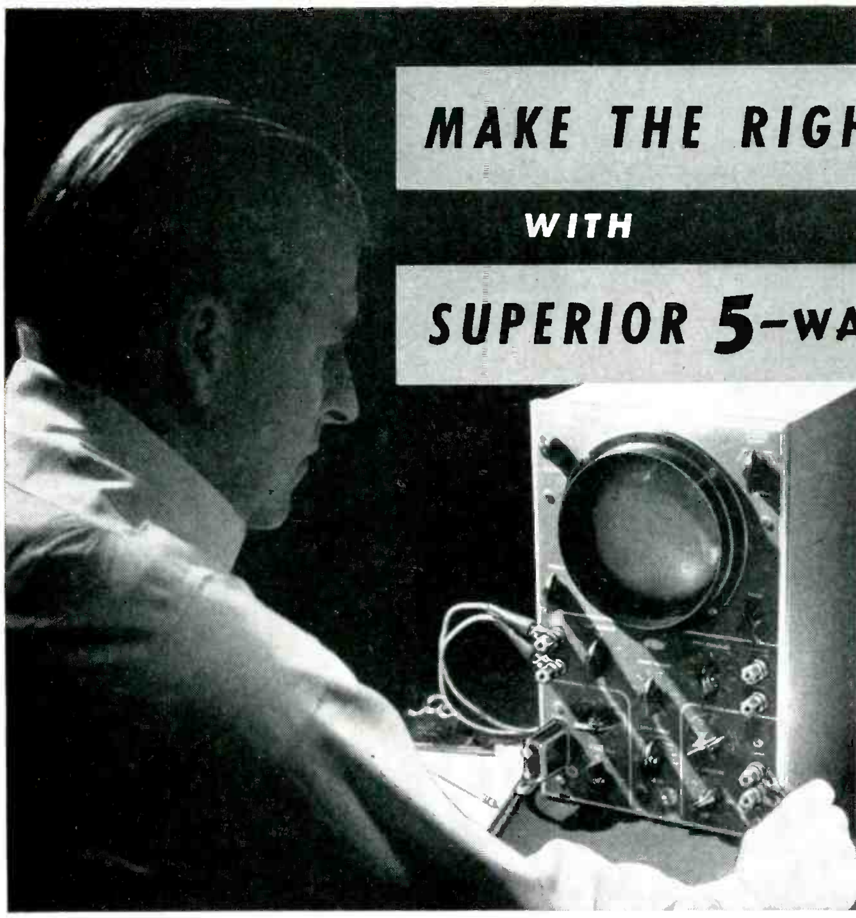

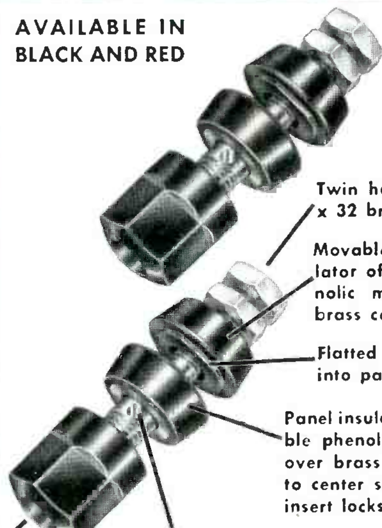

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ACTUAL SIZE

Twin hexagonal 10 x 32 brass nuts.

Movable panel insulator of tough phenolic molded over brass core.

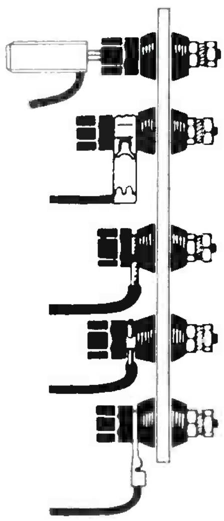
Flatted insert locks into panel.

Panel insulator of durable phenolic is molded over brass core frozen to center shaft. Flatted insert locks to panel.

Hole in center shaft at right angles to insulator flatted surface for permanent clamping accommodates wire up to size No. 12.

Phenolic hex-shaped thumb nut with insert is captive with stud.

5 CONNECTIONS



1. Plug-in for standard 3/4" banana plug
2. Clip-lead to shaft
3. Wire looped around shaft and clamped
4. Wire (up to No. 12) permanently clamped through center hole
5. Clamped spade lug

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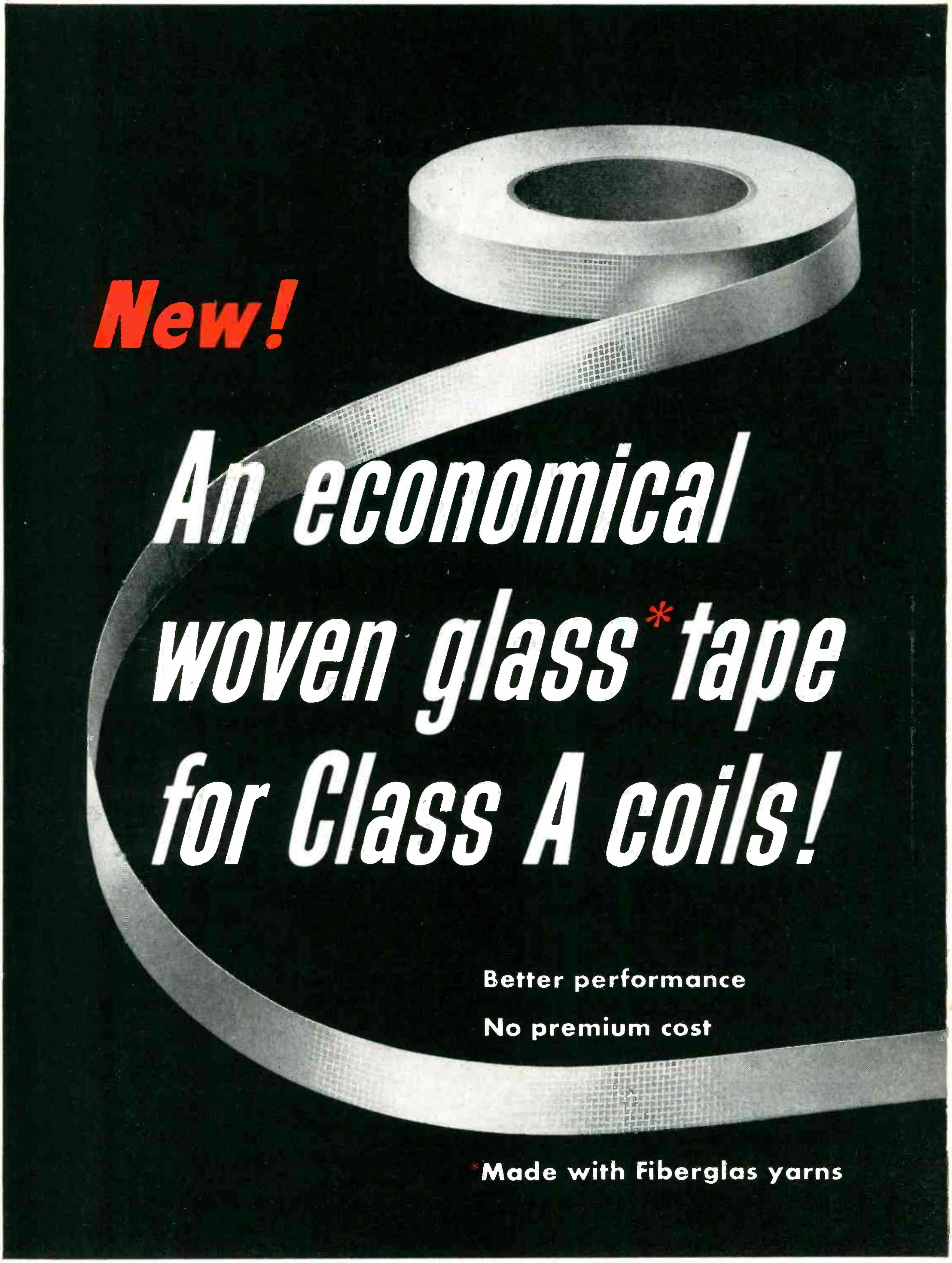

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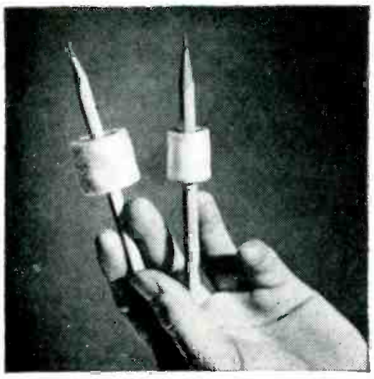
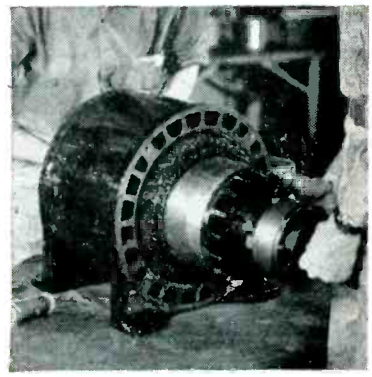


it's thinner . . .

only 4 mils thick, yet designed to replace 7-mil cotton tapes.

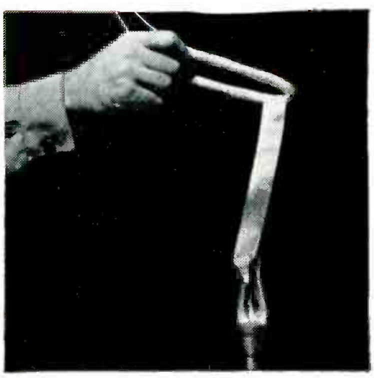
it's stronger . . .

with tensile strength of 125 lbs. per inch width, easily twice that of cotton.



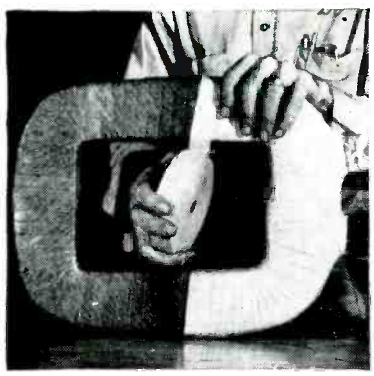
it's longer-lasting . . .

because glass won't rot and resists moisture, oils and most acids.



it's overload insurance . . .

because glass won't burn, withstands higher temperatures.

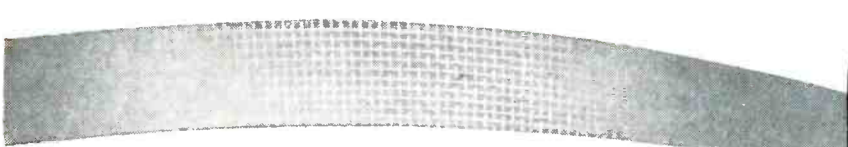


it's easy to use . . .

specially treated for quick, easy hand or machine use.

If you haven't already checked into the possibilities of this tape, be sure to call your supplier today — or write direct to Owens-Corning Fiberglas Corp., Dept. 860, 16 East 56th Street, New York 22, N. Y.

*Fiberglas is the trade mark (Reg. U. S. Pat. Off.) of Owens-Corning Fiberglas Corporation for a variety of products made of or with fibers of glass.



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CHESTER means dependability *plus* in wires and cables for every electronic and electrical application. The compounds used in all CHESTER Wire and Cable constructions are made in the CHESTER plant. Thus, complete control over selection of raw materials and manufacturing techniques, provides full control of quality . . . your assurance of uniformity in every foot of conductor bearing the CHESTER label!

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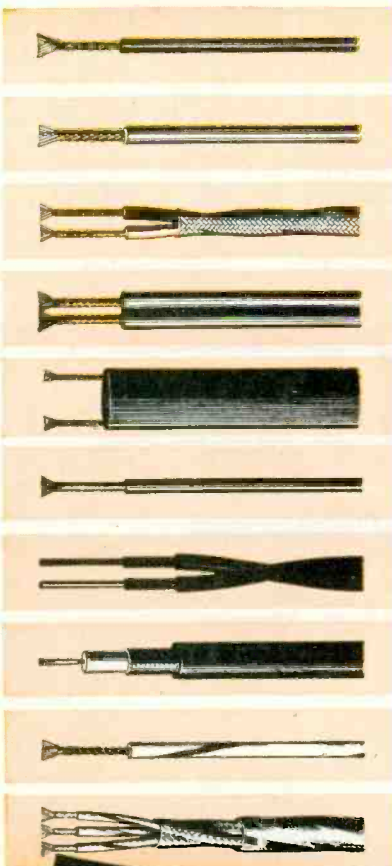

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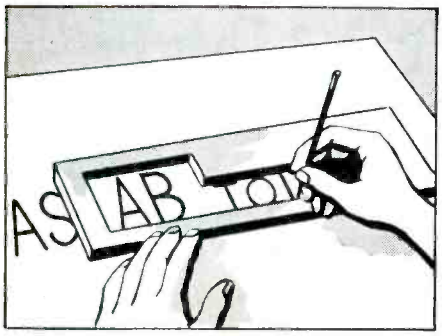
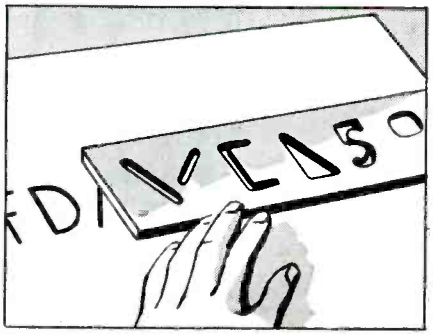
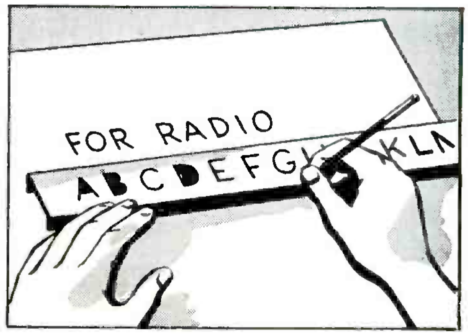
From freehand to stencil
...this better way of lettering



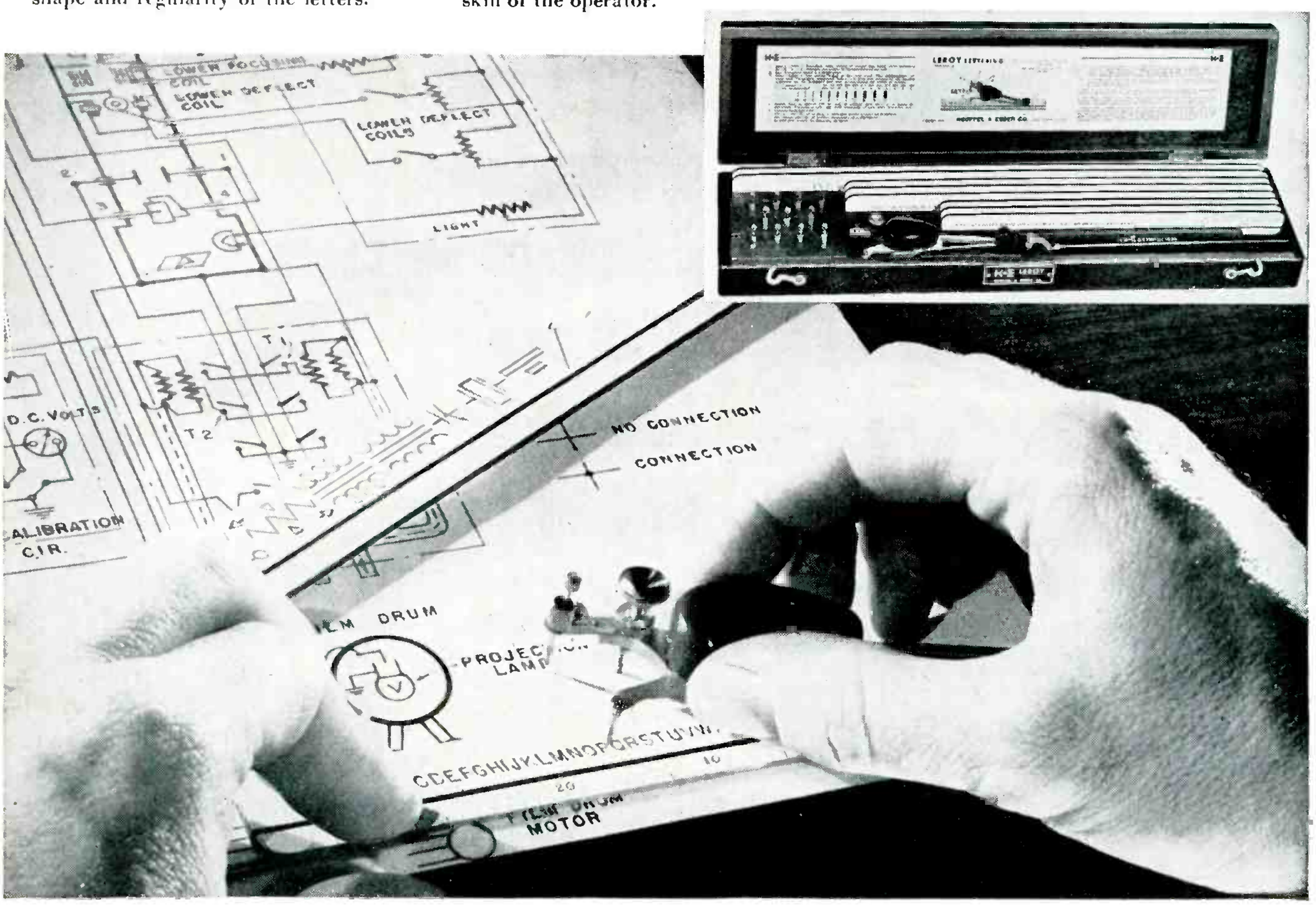
If the results of freehand lettering were always something to be proud of, there would be little or no need of special lettering aids. But as draftsmen know, freehand lettering is often irregular in appearance, and seldom can two men in a department letter exactly alike. Even as simple a device as a height guide helps considerably. Yet it fails in the important function of controlling the shape and regularity of the letters.



An obvious way of controlling shape as well as size is to use a stencil guide. To avoid the broken lines characteristic of stencils, guides were first devised consisting of cut-out portions of letters which could be combined to compose complete letters. However, they covered the work in progress, obscuring it from view, and the appearance of the finished lettering still depended largely on the skill of the operator.

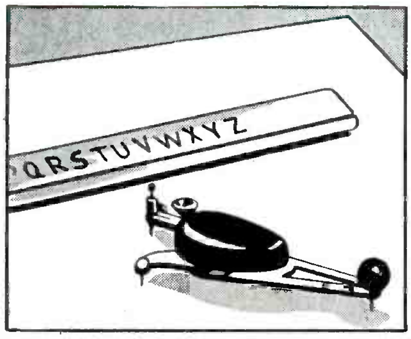


To afford greater control, a stencil guide was developed on which all but a few letters were complete in outline. Shifting the guides with a shuttling motion permitted the breaks in the lines to be filled in. Like all stencils, these too covered up the lettering, and they also had to be supported slightly above the drawing surface so they could be shifted without smearing the work.

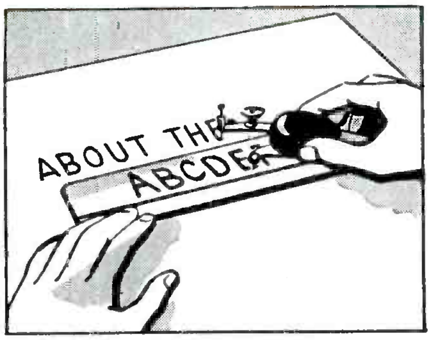


to LEROY ®
was bound to come!

The Right Angle



Instead of stencils, the LEROY Lettering Set has templates with grooved characters which guide the pen virtually by "remote control". In place of a hand-held pen, there is a movable scriber. It combines a lettering pen, a pin that fits in and follows the grooved characters, and a sliding pivot, and it holds them in triangular relationship. Because a straight groove in the template restricts the motion of the pivot, the movement of the pen is governed entirely by the movement of the tracer pin.

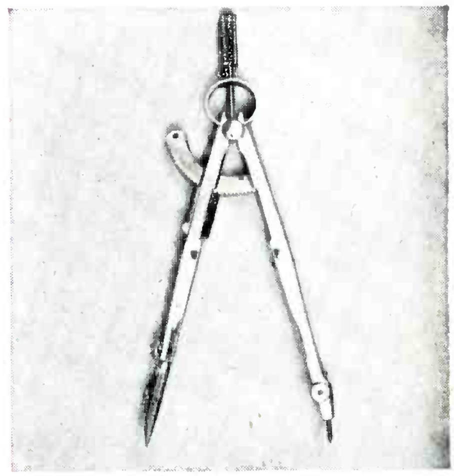


With the LEROY scriber, the lettering is done above the template where it is always visible and safe from smearing, instead of through a stencil. Each letter, numeral or symbol is formed completely with unbroken lines, without moving the template. Its size and shape are entirely controlled by the template grooves, so that rapid, uniform lettering is easy. By a simple adjustment of the scriber, either vertical or slant lettering is possible from the same template.

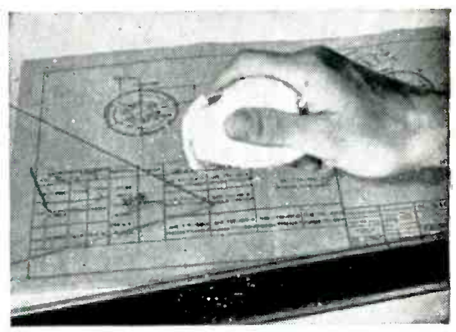
With a LEROY Lettering Set, you can draw capitals, lower case letters and numerals from a single template. You can form perfect letters on the first trial, and can develop speed with a few minutes' practice. No guide lines, no "roughing in", no erasing. You can be sure of uniformity throughout the drafting room, in pencil or ink.

There are LEROY templates and pens for every size and thickness of lettering normally required, as well as templates with engineering and scientific symbols and with special alphabets. K&E can also produce special templates for phrases, symbols or trade marks of your own design.

Ask your K&E Distributor or Branch to tell you about other LEROY features, or write to us for complete booklet on LEROY.



You will find "Quick Set" the handiest large bow combination you've ever used. It has a trigger-quick action for coarse settings plus micrometer adjustment for precise settings. Complete with interchangeable pen and pencil inserts for circles up to 12½" diameter in pencil and 12" diameter in ink.



Cut down on the clean-up with an ABC* Dry Clean Pad. Tiny gum eraser particles sift through the mesh of the pad. Sprinkle them in a light film over the drawing surface before starting work and you'll have no graphite smears. Use it the same way for final clean up. Contains no grit or abrasive.

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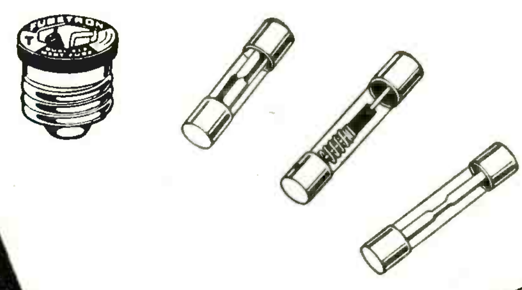
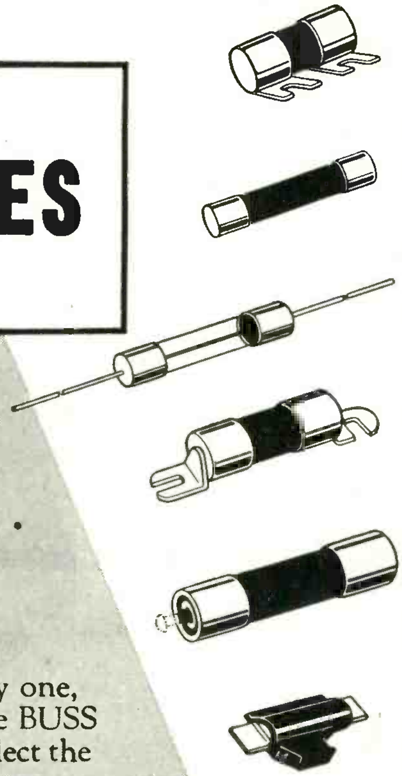

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The makers of BUSS fuses insist on perfection. Every fuse is electronically tested in a sensitive device that rejects any fuse not properly calibrated, properly constructed and right in all physical dimensions.

Take advantage of the profit-saving efficiency that you can gain by standardizing on the complete line of BUSS fuses.

MAIL THIS COUPON *TODAY*...

Plus **A COMPLETE LINE OF FUSE CLIPS, BLOCKS AND HOLDERS**

IF YOU WOULD LIKE ASSISTANCE on your protection problems, BUSS fuse engineers are always at your service. They will be glad to help you select the fuse that will do the job best... if possible, a fuse that is available from local wholesalers' stocks.

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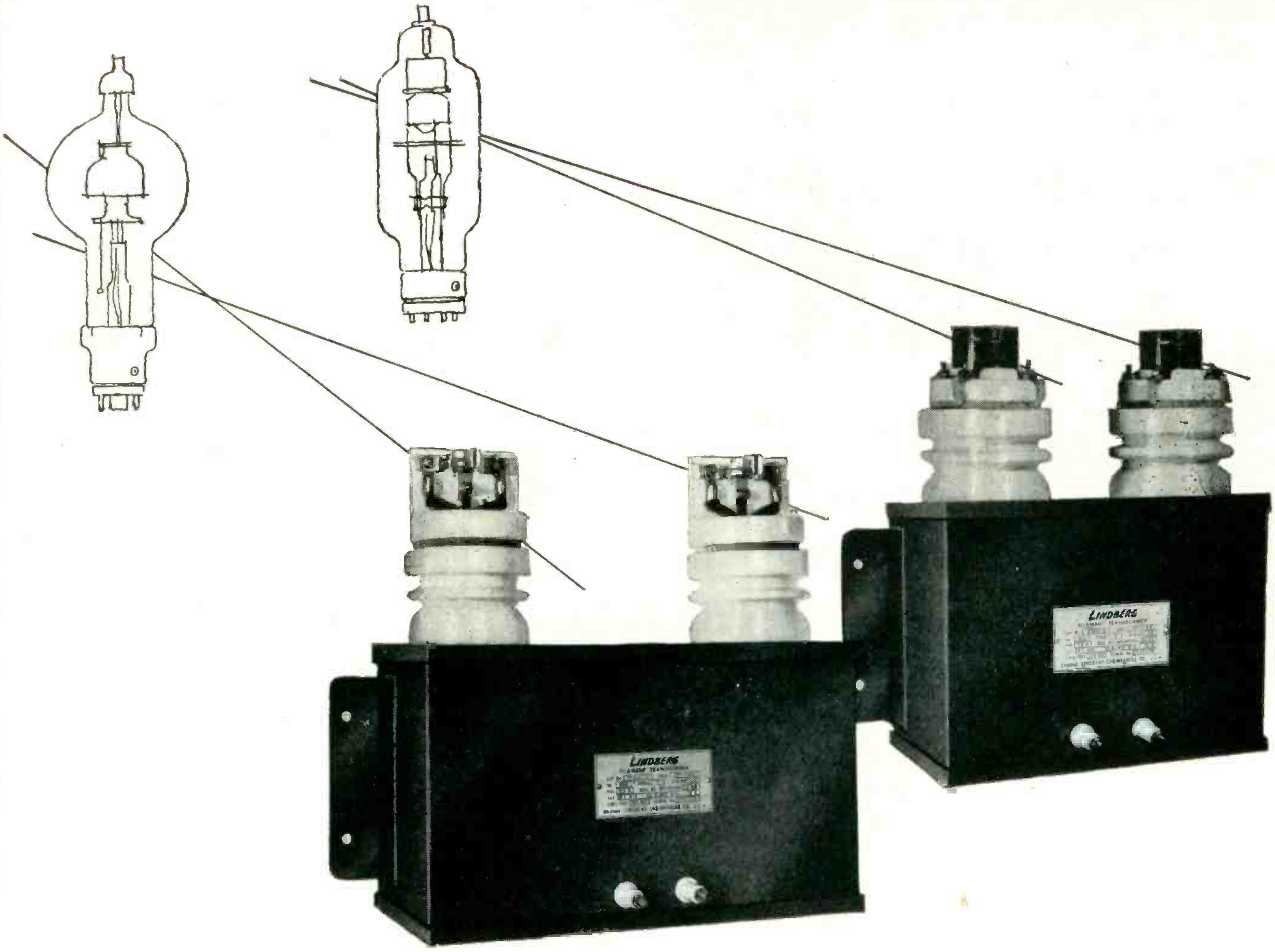


ANNOUNCING.. New LINDBERG Dual Filament Transformers!

Two-in-one!.. they supply filament power for two rectifier tubes simultaneously.
Furnished complete with sockets.. no wiring necessary. Contained in one case.. conserves space.

Lindberg Dual Filament Transformers have been developed specifically for industrial electronic applications. Each transformer supplies filament power for *two* tubes . . tubes of the type used in large induction heating units, dielectric heating units, radio and TV transmitting equipment, light X-ray equipment, and high voltage testing equipment.

Contained in a single enclosure, Lindberg Dual Filament Transformers do the work of two separate conventional-type filament transformers . . and they save space, improve appearance, simplify mounting, wiring and handling.

SPECIFICATIONS . . Lindberg Dual Filament Transformers are available in two sizes.. 100 V.A. and 200 V.A., 115 volt primary, dual 5 volt filament supply. Each secondary circuit center tapped at 2.5 volts. The 100 V.A. size is equipped with tube sockets for use with 575A type tube . . the 200 V.A. with sockets for tube type 869B.

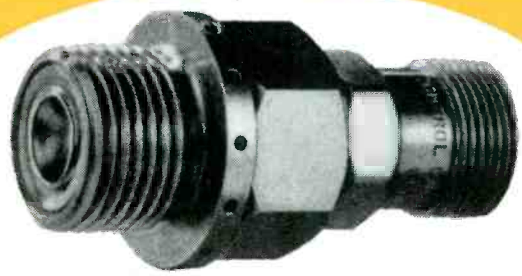
IMMEDIATE DELIVERY . . *Lindberg Dual Filament Transformers are stock items. Orders shipped same day received.*

LINDBERG TRANSFORMERS

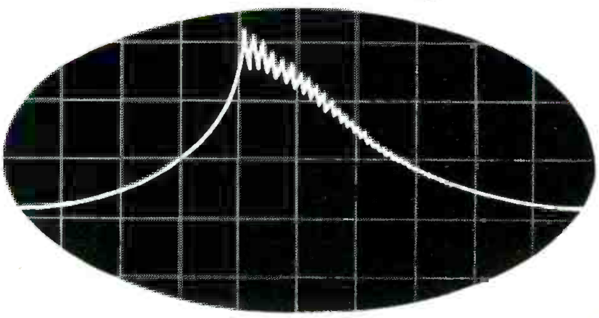
Transformer Division, Lindberg Engineering Co., 2489 West Hubbard, Chicago 12, Illinois

FOR THE FIRST TIME

A COMPLETE *PRESSURE PICTURE*



NORWOOD CONTROLS Type EP Pressure Pickup



Versatility — for use in static and dynamic systems . . . tested and proven on gasoline and diesel engines . . . jet engines . . . rocket motors . . . blast measurements . . . high pressure, high temperature chemical reactions . . . hydraulic and pneumatic systems.

Accuracy — output linear with input to ± 1% over full static and dynamic range.

Full Scale Pressures — 500, 1,000, 2,000, 3,000, 5,000 and 10,000 p.s.i. . . . response down to 0 p.s.i. absolute.

High Frequency Response — flat to 20,000 c.p.s. . . . natural frequency up to 45,000 c.p.s.

Excellent Compensation — transducer is not appreciably affected by rapidly fluctuating gas temperatures up to 2500°F. and is insensitive to extraneous vibration.

Flush Catenary Diaphragm — reduces changes in volume of pressure chamber to a minimum.

NC NORWOOD CONTROLS

CONTROL ENGINEERING CORPORATION
564 Providence Highway, Norwood, Massachusetts

Norwood Controls representatives located in principal cities.
Complete technical information on request.

Want more information? Use post card on last page.

To clock-radio designers
who fall back to sleep

don't forget the Signal Alarm

...available only on Telechron Timers

Model C-78

Sleep through the soft morning music of your clock-radio *just once*, and you'll see an important reason to specify Telechron Timers with signal alarm for your new models.
And you'll see, too, how this exclusive feature can help your clock-radio become a sales success.

There are other exclusive advantages in Telechron Timers. The sealed lubricant reservoir gives better assurance of long timer life and quiet operation. There's extra simplicity of operation in the two knobs that do the work of three.

For any clock-radio price class, there's a Telechron Timer that will meet your needs. We custom style to meet your design requirements. Write for details. Telechron Department, General Electric Company, 47 Homer Ave., Ashland, Mass.

Telechron
SEAL OF ACCURACY

EXTRA SALES ADVANTAGE

Telechron Seal of Accuracy on the clock crystal or our trademark on the dial gives the buyer confidence in the accuracy of your clock-radio.

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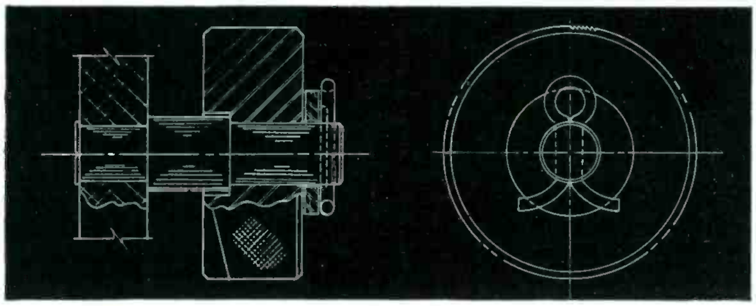
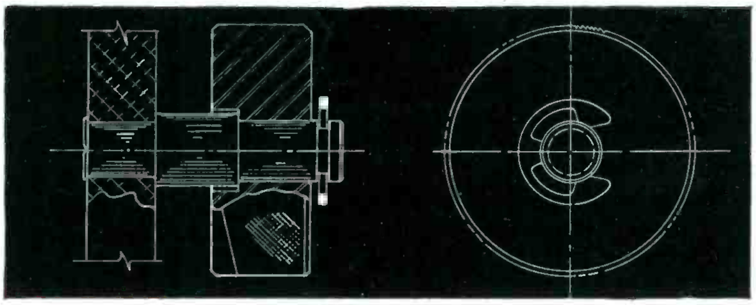
MARK OF TIMING LEADERSHIP

WALDES TRUARC RINGS REPLACE COTTER PINS...

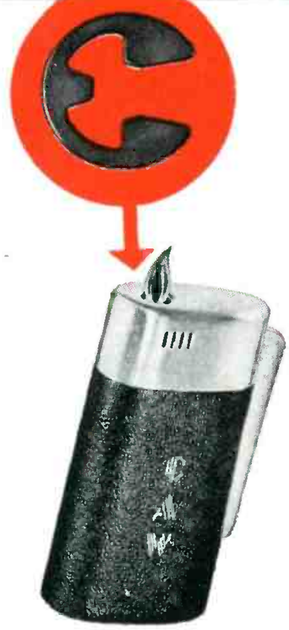
SAVE 44% IN LABOR AND ASSEMBLY COSTS



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.

SEND FOR NEW BULLETINS

WALDES TRUARC

REG. U.S. PAT. OFF.

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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. E075

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

Name__________
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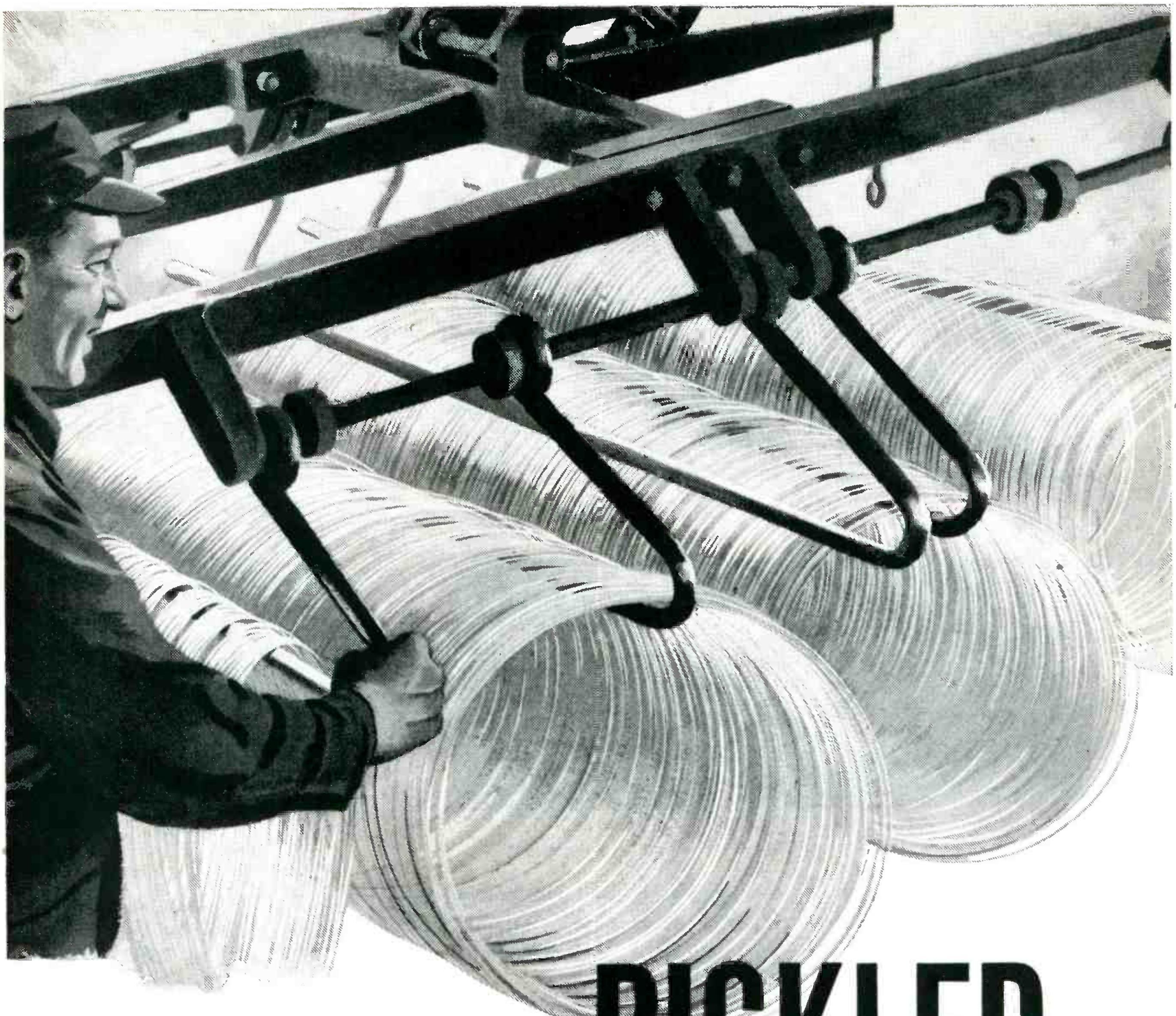
Company__________
Business Address__________
City_____ Zone_____ State_____ 5678

Want more information? Use post card on last page.



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Be sure you're getting clean, even tempered brass or copper alloy wire, free from physical defects. Ask for Chase wire by name.

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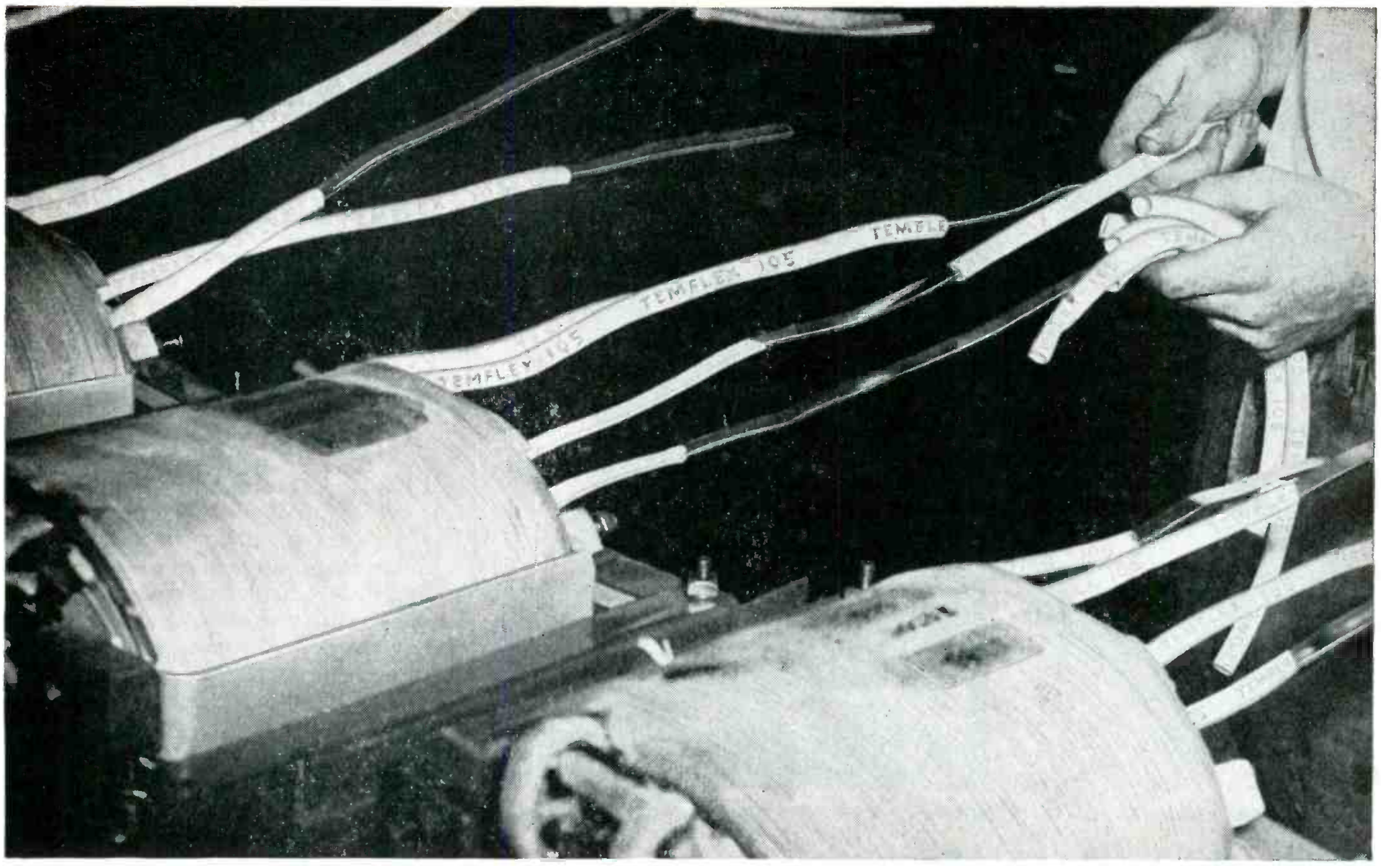
Boston	Detroit	Minneapolis	Providence	
Chicago	Houston	Newark	Rochester†	(†sales
Cincinnati	Indianapolis	New Orleans	St. Louis	office only)



Wagner Electric reports "Long Life" when transformer leads are insulated with **TEMFLEX 105**

Lengths of Irvington's Temflex 105 Plastic Insulating Tubing are quickly and easily slipped over transformer leads at Wagner Electric Corporation. And once they're in place, they're there to *stay* through the toughest service.

This product of Irvington's Fibron division is approved by Underwriters' Laboratories for *continuous* operation at 105° C.—and for 90° C. operation *in oil.*

Temflex 105 Tubing *retains* its original high dielectric strength of 1100 vpm, its flexibility and excellent elongation characteristics even after continuous high-temperature operation, varnishing, baking or immersion in chemicals.

Produced in all standard colors, readily identified by the continuously printed name on the smooth tubing surface. Identify it by name when you buy!

A Technical Data Sheet is yours for the asking — just mail the coupon.

Look to IRVINGTON for Insulation Leadership

- INSULATING VARNISHES
- VARNISHED CAMBRIC
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- INSULATING TUBING
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Irvington Varnish & Insulator Co.
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Gentlemen:

Please send me Technical Data Sheet on Temflex 105 Tubing.

Name.................................Title..............

Company..

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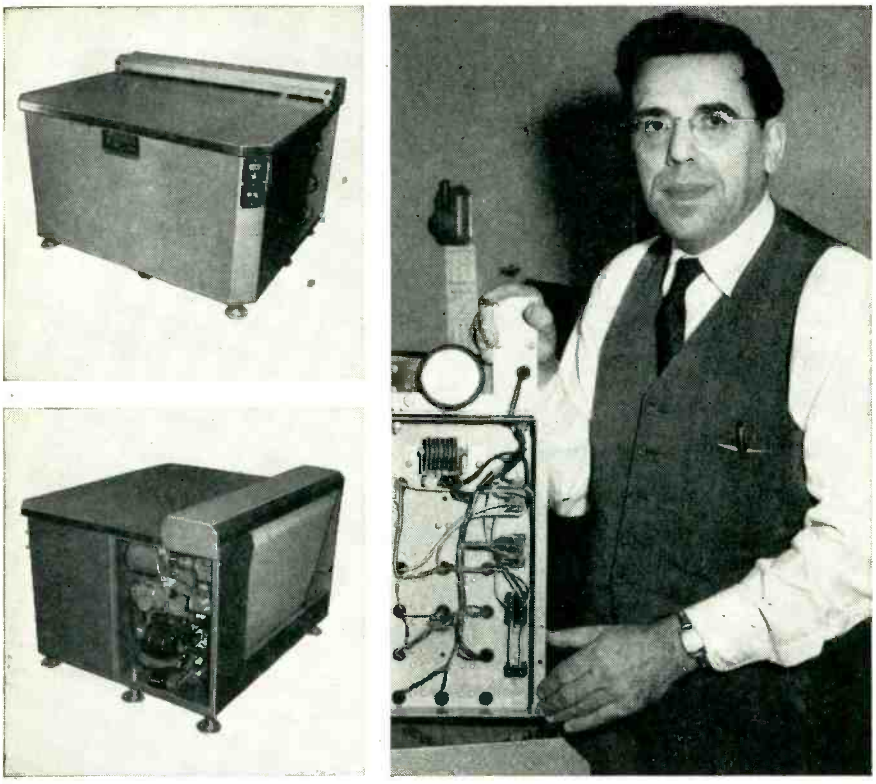


G-E SELENIUM RECTIFIER POWERS CONTROL CIRCUIT OF WRAP-O-MATIC MACHINE

Reliable D-C Power Assured by G-E Selenium Rectifiers

More and more manufacturers of automatic equipment are using General Electric selenium rectifier stacks. They are taking advantage of the reliability and long life of these rectifiers by using them as power supplies for d-c operated relays and contactors in control circuits.

TYPICAL of this type of application is the Wrap-O-Matic, a paper feeding and cutting machine manufactured by the Rosenthal Manufacturing Co. of Chicago, Ill. The Wrap-O-Matic measures paper or cellophane from a roll and automatically cuts it off at one of four pre-selected lengths, depending upon which button the operator presses. Substantial savings in time and reduced paper wastage are reported by users of the equipment.

The Wrap-O-Matic's control system operates at 24 volts d-c, supplied by a small transformer and a G-E selenium rectifier stack. It controls the operation of two G-E motors which feed the paper and drive the cutting knife. D-c coils are employed because of the frequency of operation, and the need for instantaneous, smooth make-and-break.

ADVANTAGES. G-E selenium rectifiers incorporated in your product will assure your customers dependable control and smooth operation. G-E selenium rectifiers have exceptionally low forward voltage drop and high reverse resistance. These two qualities, both readily measurable, assure low heat loss, and long life.

MORE INFORMATION on G-E selenium rectifiers is available from your nearest G-E Apparatus Sales Office, or by writing. Bulletin GEA-5935 describes Miniature Selenium Rectifiers, and GET-2350 gives general application information. Address: Section 461-30, General Electric Co., Schenectady 5, N. Y.

You can put your confidence in—

GENERAL ELECTRIC

METALLIC RECTIFIER FACTS FOR ENGINEERS

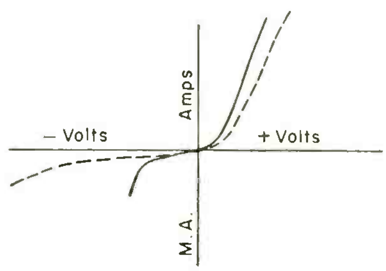
A Look Into The Future

By C. E. Hamann

Metallic rectifiers are often described as static devices. While this term aptly describes the rectifier itself, it certainly does not apply to the fast growing metallic rectifier industry. Scarcely a day passes without the announcement of some new rectifier development or successful application.

New developments in the selenium rectifiers such as improved electrical characteristics, high temperature operation, and longer life, are given widespread publicity. Little mention, however, is made of its older brother, copper-oxide.

Considerable engineering effort has been applied toward improving the electrical characteristics of copper-oxide rectifiers.



RELATIVE CHARACTERISTICS
Solid line—Conventional copper-oxide
Dotted line—High voltage copper-oxide

As a result of constant research, copper-oxide cells of higher voltage rating—perhaps two or three times that of the older type—appear to be a certainty in the near future.

Copper-oxide rectifiers have certain, inherent characteristics not found in other metallic rectifiers. Copper-oxide rectifiers can stand on the shelf for 25 years and still exhibit full blocking ability in the first half-cycle of applied voltage.

In blocking applications in d-c circuits where fast response is desirable, engineers will do well to consider the possibilities of using copper-oxide rectifiers.

For more information on G-E copper-oxide rectifiers, write for Bulletin GEA-5699A.

C. E. Hamann

General Electric Company

That's Why Indianapolis Sweepstakes Champions Choose

Everlock

"CHISEL EDGE" LOCK WASHERS

The Washer That Has The Edge

EVERLOCK washers have been used on the top three cars in every Indianapolis Sweepstakes since 1936! This grueling, rugged grind demands the utmost in protection against vibration and strain. It's significant that, without exception, these winners put their trust in EVERLOCK washers.

EVERLOCK'S alternating chisel edges really bite into the surface—powerful spring steel tension holds them secure. Available in four standard types or made specially to your specifications.

Next time you order screw-washer assemblies—*be sure*—specify EVERLOCK washers.

1-2-3 AGAIN!

This year again Everlock swept the field at the great Indianapolis Classic. The first, second and third place cars were all equipped with Everlock Washers.

Everlock's alternating chisel-edge design assures tight, vibration-proof assemblies for your product, too. On your next order, specify Everlock—the washer that has the edge.

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Spectrum ANALYZER TS-148/UP

NEW AND IMPROVED DESIGN

OUTSTANDING PERFORMANCE

MORE RUGGED CONSTRUCTION

Specifications . . .

Attenuation (Spectrum Amplitude): 3 — 70 db uncal.
Frequency range: 8430 Mcs — 9660 Mcs.
Frequency sweep: 10 — 30 cps continuous.
Frequency swing (FM sawtooth) of analyzer r-f oscillator: 40 — 50 Mcs.
Maximum error: ±4 Mcs.
Maximum dispersion of spectrum: 1.5 Mcs per inch.
Overall i-f bandwidth at half power point: 50 Kcs.
Sensitivity to CW:
  a. Spectrum amplified position: 80 db below 1 W per inch deflection on oscilloscope screen.
  b. Spectrum position: 55 db below 1 W per inch deflection on oscilloscope screen.
Weight: 86 pounds (complete in armored case with all accessories).

TS-148/UP

ACCESSORIES & CASE

SHIPPING AND CARRYING CASE
Armored foot locker with foam rubber cushions inserted.

Partial list of satisfied users of the G & M TS-148/UP include:
Bell Aircraft Corp. (Lab.)
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Fairchild Engine & Airplane Corp. (Guided Missiles Div.)
French Naval Base (Toulon)
Gilfillan Bros. (Electronics)
Royal Canadian Air Force (Lab.)
Westinghouse Electric Corp. (Lab.)

We also manufacture . . .

- I-96-A VHF Bench Test Equipment.
- IE-17-A SCR-536 Test Equipment.
- IE-19-A VHF Portable Test Equipment.
- MB-2 Marker Beacon Test Equipment, Portable.
- TS-E6 Slide Back Voltmeter for E-3, E-4, E-5, etc. Firing Systems).
- TS-E7 Moving Target Simulator (for E-3, E-4, E-5, etc. Firing Systems).
- TS-170-C ILS Portable Test Equipment.
- TS-173-C ILS Portable Test Equipment.
- TS-239/UP Wide Band Oscilloscope.
- UPM-1 Radar Test Set.
- Special items to order, such as:
  - 1 KW Transmitters and Jamming Equipment.
  - 5 KW Transmitters and Jamming Equipment.
  - Direction Finders.
  - Communication Receivers, etc.

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"Where Hi-Quality is Fundamental"

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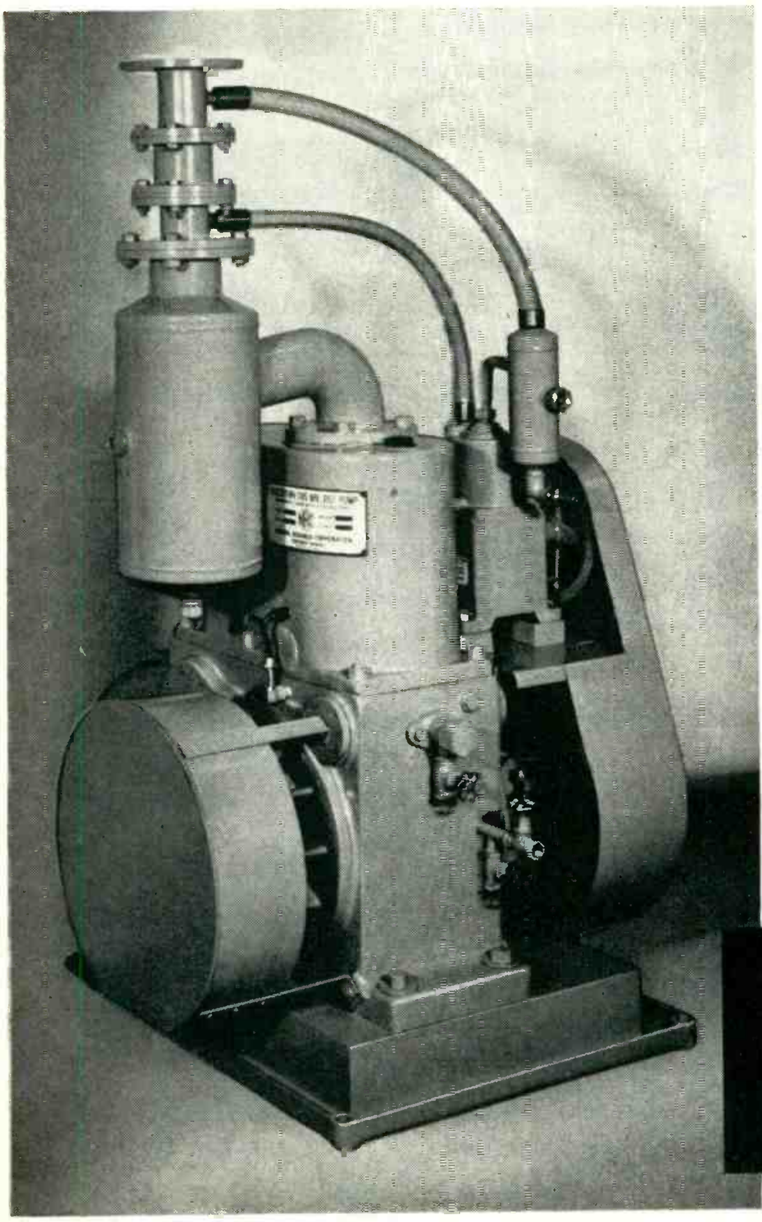
NEW HIGH VACUUM ROTARY PUMP

...Ends Water Vapor Trouble
...Maintains Fast Pump Down Time



NRC Rotary Gas Ballast Pump. Model NRC100M. 2-stage pump unit.

- **Eliminates oil reclaiming units**
- **Provides greater capacity under 1 mm Hg**
- **Requires up to 80% less oil charge**
- **Capacities from 1¼ cfm to 400 cfm**
- **Pressures down to 10^{-4} mm Hg**

For the first time, a high vacuum rotary pump that can pump condensable vapors is available to U. S. A. industry.

In the new NRC Rotary Gas Ballast Pump water vapor is *prevented* from condensing and contaminating the oil . . . so, unlike other type pumps, fast pump down time is *maintained.*

There is a full line of NRC pumps — vane, piston-type and 2-stage.

Send today for the new bulletin that gives a full explanation of the Gas Ballast principle and complete data on the construction and operation of the NRC Rotary Gas Ballast Pump

NRC

National Research Corporation
EQUIPMENT DIVISION

70-A Memorial Drive, Cambridge, Massachusetts

Germanium Transistors and Diodes

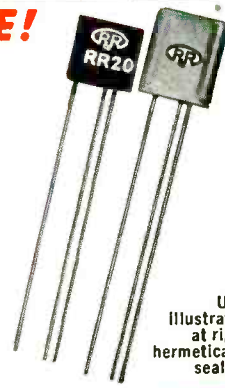
FOR EVERY PURPOSE!

PNP JUNCTION TRANSISTORS

PNP JUNCTION TRANSISTORS (Typical Characteristics at 25° C—Grounded Emitter)			
TYPE NO.	RR14‡	RR20‡	RR21‡
Collector Voltage—volts	−1.5	−1.5	−15.0
Collector Current—ma	−0.5	−0.5	−3.0
Ico—Microamp.*	10	10	30
Current Amplification	25	40	25
Power Gain—db	30	40	—
Noise Factor—db (1 Kc)	22	22	—
Power out—mw (10% Dist.)†	—	—	20.0

* Ie = o, Vc = −1.5 volts.
† With 1000 ohm driving impedance and 5000 ohm load.
‡ RR14H, RR20H and RR21H are hermetically sealed types.

Tiny, stable high gain units, most economical of power, may be soldered in place or socketed in a recommended RTMA transistor socket. They are suitable for audio amplifiers, servo amplifiers and transformer coupled carrier amplifiers. Available in plastic or hermetically sealed in metal and glass.



Unit illustrated at right hermetically sealed.

POINT CONTACT TRANSISTORS

Available in a variety of stable controlled types suitable for both fast and medium speed switching circuits and high frequency amplifiers. Advanced mechanical design for economical production . . . Heat conducting metal case; standard basing, choice of solder-in or plug-in.

POINT CONTACT TRANSISTORS Typical Characteristics at 25° C		
SWITCHING TRANSISTORS		
TYPE NO.	R1698	R1734
Off Collector Current max. ma (I_e= 0)	−2.2 (@ V_c= 40V)	−0.7 (@ V_c= −7V)
On Collector Voltage max. volts (I_e= 3.0)	−4.0 (@ I_c= 5.5 ma)	−1.2 (@ I_c= −4.0 ma)
Collector Dissipation max. m w	120	120
Nominal cut-off Frequency m c	1.5	10.0
GENERAL PURPOSE TRANSISTOR		
TYPE NO.		R1729
Collector Voltage—volts		−30
Emitter Current—ma		1.0
Input Resistance (R_{11})—ohms		190
Output Resistance (R_{22})—ohms		6000
Current Amplification Factor		2.5
Nominal Cut-off Frequency—mc		5.0

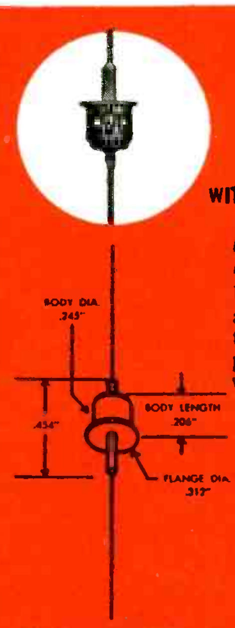
Our engineers will be glad to offer suggestions regarding your Germanium Transistor and Diode applications without obligation . . . Write to Section E.

JUNCTION POWER DIODES

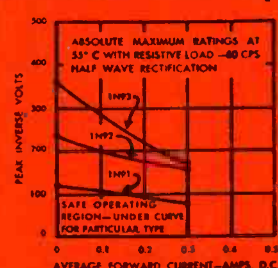
WITH THESE DISTINGUISHING CHARACTERISTICS:

• Very low forward drop • Low reverse leakage • Tiny • Hermetically sealed in metal and glass.

Useful in power supplies, magnetic amplifiers and telephone systems, etc., they have the characteristics of large plate-type power rectifiers and size and weight of a small circuit component.



SHOWN APPROXIMATELY ACTUAL SIZE



JUNCTION POWER DIODES Maximum Ratings at 55° C—Resistive Load			
TYPE NO.	1N91	1N92	1N93
Peak Inverse Voltage (volts)	100	200	300
Peak Forward Current (ma)	470	310	230
D.C. Output Current (ma)	150	100	75
Voltage Drop at Full Load (volts)	0.5	0.5	0.5
Surge Current (amps)	25	25	25
Reverse Working Voltage (continuous volts)	30	65	100
Max. Freq. of Operation (kc)	50	50	50

Coming . . .

JUNCTION POWER TRANSISTORS

. . . For Audio power up to 2 watts

PHOTO TRANSISTORS

. . . To operate power relay with one junction transistor as DC amplifier.

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Specify Unilectric Wiring Systems

TRADE-MARK

for the Wiring of any
ELECTRIC or ELECTRONIC PRODUCT
because if the wiring fails so does
your product's performance

This Unilectric wiring harness protects the performance of a Military Auto Pilot

The military Auto Pilot for which this harness was engineered is now being called upon to perform under the most severe conditions. Performance of the wiring is protected by Unilectric's engineering, meticulous workmanship, and precision quality standards.

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for Real Uniformity, specify STACKPOLE *Ceramag*® ferrite cores!

Most ferrite core users have learned by costly experience, that it's one thing to obtain satisfactory samples—but quite another thing to have these sample cores reproduced in production quantities. *But not at Stackpole!*

Stackpole Ceramag ferrite cores are outstandingly uniform in every physical and electrical respect. The production unit is exactly like the sample. Each production unit is exactly like the other.

In short, Stackpole has perfected control of the complicated problems involved in handling ferrite materials. The result spells cores of outstanding uniformity in their electrical characteristics, highly accurate physical tolerances and with the ability to withstand exceptionally high temperatures without permeability change for many specific uses.

Write for Stackpole Ceramag Bulletin

- ✓ lower losses
- ✓ higher efficiency
- ✓ lower operating temperatures
- ✓ lighter weight—smaller sizes
- ✓ less corona effect

Have you investigated these potential NEW Ceramag core uses?

HIGHER TEMPERATURE OPERATION IN NITROGEN ATMOSPHERES

New equipment designed and sealed in nitrogen, due to high ambient temperatures imposed by miniaturization, poses a real temperature problem for permeability tuning cores as well as for I-F transformer and R-F cores. This is solved handily by Stackpole Ceramag cores thanks to the fact that they stand higher temperatures and show less drift than high-permeability iron cores.

SUPERSONIC-FREQUENCY APPLICATIONS

Ceramag cores assure high permeability with low losses in the supersonic-frequency range.

CENTER CORES FOR POWDERED IRON POT CORES

Used as center cores in powdered iron pot cores operating at less than 1 megacycle, Ceramag increases L by approximately 100% and increases Q on the order of 50%.

INCREMENTAL PERMEABILITY APPLICATIONS

Because Ceramag is more easily saturated than conventional core materials, it is ideally suited for pulse generation, magnetic amplifying and incremental permeability tuning.

HASH AND INTERFERENCE SUPPRESSION

Recent experience indicates that the unique characteristics of Stackpole Ceramag help materially in minimizing "hash" and interference when the cores are used in the filter systems of electrical equipment and tools. Inquiries are invited.

FIXED AND VARIABLE RESISTORS—LINE & SLIDE SWITCHES
CERAMAG® ferrite CORES
IRON CORES
(Side-molded, sleeve, cup, choke coil, threaded and conventional types)
MOLDED COIL FORMS—"GIMMICK" CAPACITORS, etc.

STACKPOLE

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

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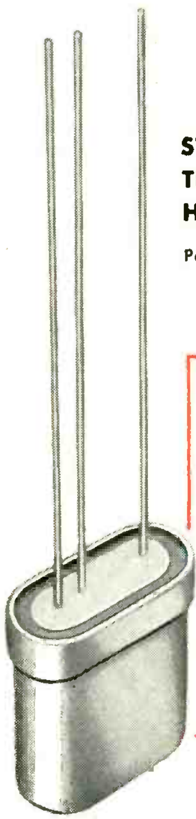
True Hermetic Seal for Transistor and Diode Housings

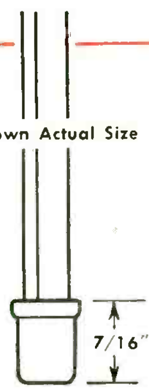
Let Hermetic Show You How to Achieve a

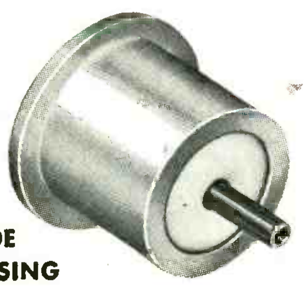
HERMETIC offers the following enclosures selected from a wide variety of available designs:



STANDARD TRANSISTOR HOUSING

Pat. 2577576





DIODE HOUSING

It is axiomatic that the only true hermetic seal is a glass-metal seal. This has been demonstrated in vacuum tube design and operation.

In the development of transistor and diode housings, **HERMETIC** has employed the same principles as those proven in the manufacture of vacuum tubes and has eliminated the necessity of using the high sealing temperatures so detrimental to the performance of semi-conductors.

HERMETIC's long years of experience in the design and production of hermetic seals have enabled its staff of specialist-engineers to create glass-metal housings to meet the most demanding requirements of the semi-conductor industry. **HERMETIC**'s Transistor and Diode Housings have received wide acceptance and usage in the field.

HERMETIC's glass-metal seals of compression or standard design are known to be vacuum tight, moisture proof and contaminant proof by mass spectrometer tests and by virtue of years of successful operation.

Because the production pace of the semi-conductor industry is a swift one, **HERMETIC** has geared itself to produce and deliver in accordance with its customers' schedules.

Contact **HERMETIC** today!

SEALED IN by HERMETIC HEADERS

HERMETIC SEAL PRODUCTS CO., 31 South Sixth St., Newark 7, N. J.

THE EXPERIENCED SOURCE for TRANSISTOR and DIODE HOUSINGS

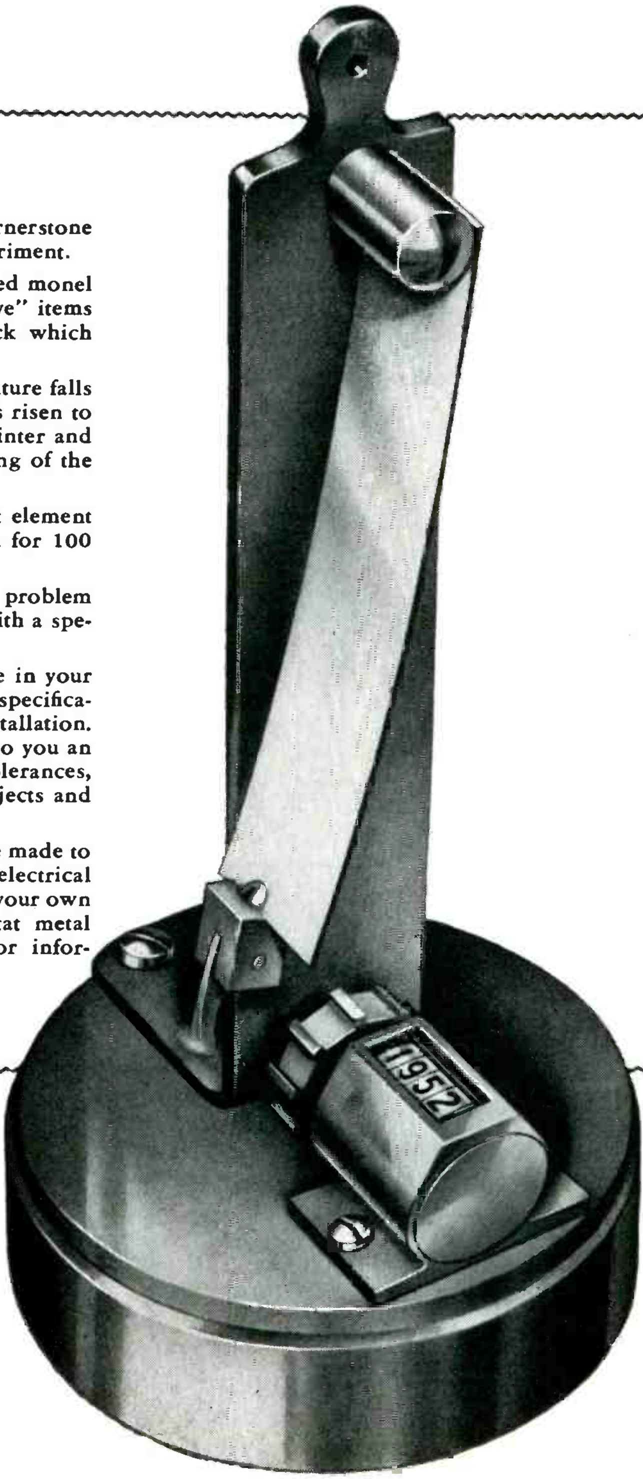
Want more information? Use post card on last page.

PROBLEM:

To get a Thermostat Element with the stability to operate for 100 years without calibration

SOLUTION:

General Plate TRUFLEX® Thermostat Metal provided this stability



The Museum of Science and Industry laid its "living" cornerstone September 3, 1952, thus starting a one hundred year experiment.

Within the 1-ton limestone block is a specially fabricated monel box containing a score of physically or biologically "alive" items from bacteria to metals . . . including a thermostatic clock which will record the years.

This clock is constructed to register once as the temperature falls to 20°F and will not count again until the temperature has risen to 85° and again fallen to 20°. It will register once each winter and count the number of years that have passed since the laying of the cornerstone.

Essential to the reliability of the clock was a thermostat element which would keep its stability without further calibration for 100 years.

The scientist concerned with the project presented the problem to General Plate whose engineers provided the solution with a specially designed Truflex thermostat metal element.

You, too, can obtain constant and accurate performance in your products because General Plate fabricates to your exact specifications, complete Truflex thermostat metal units ready for installation. You get reliable performance because every order comes to you an exact duplicate of the original . . . consistently uniform in tolerances, temperature reaction and performance, thus preventing rejects and costly adjustments in assembly.

General Plate TRUFLEX thermostat metal assemblies are made to meet your specific requirements for temperature range, electrical resistance, corrosion resistance, etc. If you prefer to make your own assemblies, General Plate will produce Truflex thermostat metal sheet or strip to your material specifications. Write for information or engineering assistance.

You can profit by using General Plate Composite Metals!

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

ELECTRONIC TEST INSTRUMENTS

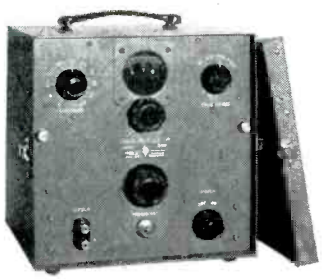
TEST VOLTAGE PROBLEMS 1/100 cps to 10 mc?

Hewlett-Packard has 17 different oscillator models. Some are highly specialized, others are all-purpose instruments. Almost certainly, there's a model to meet your exact requirements. All are precision instruments of highest quality. All embody the famous RC circuit pioneered by *-hp-*. Check the table below for the oscillator that can help you most. Then write us for complete operating and application details.

-hp- 200CD AUDIO OSCILLATOR

World standard for electronic or electrical measurements, now redesigned with wider range, lighter weight, smaller size. Use for any lab, field or production problem in sub-audio, audio, telephony, carrier, supersonic, telemetering or rf measurement fields. Highest stability, low distortion, constant output, no zero set while operating. With carrying strap for bench or portable use; or for rack mounting.

Instrument	Primary Uses	Frequency range	Output	Price
-hp- 200AB	Audio tests	20 cps to 40 kc	1 watt/24.5v	$120.00
-hp- 200CD	Audio and ultrasonic tests	5 cps to 600 kc	160 mw/20v open circuit	150.00
-hp- 200H	Carrier current, telephone tests	60 cps to 600 kc	10 mw/1v	350.00
-hp- 200I	Interpolation, frequency measurements	6 cps to 6 kc	100 mw/10v	225.00
-hp- 201B	High quality audio tests	20 cps to 20 kc	3w/42.5v	250.00
-hp- 202A	Low frequency measurements	.01 cps to 1 kc	20 mw/10v	450.00
-hp- 202B	Low frequency measurements	½ cps to 50 kc	100 mw/10v	350.00
-hp- 202D	Low frequency measurements	2 cps to 70 kc	100 mw/10v	275.00
-hp- 204A	Portable, battery operated	2 cps to 20 kc	2.5 mw/5v	175.00
-hp- 205A	High power audio tests	20 cps to 20 kc	5 watts	390.00
-hp- 205AG	High power tests, gain measurements	20 cps to 20 kc	5 watts	425.00
-hp- 205AH	High power supersonic tests	1 kc to 100 kc	5 watts	550.00
-hp- 206A	High quality, high accuracy audio tests	20 cps to 20 kc	+15 dbm	550.00
-hp- 230A	Carrier test oscillator	35 cps to 35 kc	+14 dbm/600 ohms	275.00
-hp- 233A	Carrier test oscillator	50 cps to 500 kc	3w/600 ohms	475.00
-hp- 234A	Carrier test oscillator	160 cps to 160 kc	+14 dbm/600 ohms	300.00
-hp- 650A	Wide range video tests	10 cps to 10 mc	15 mw/3v	475.00



-hp- 204A Battery-Operated Oscillator

Precision instrument for measurements 2 cps to 20 kc where ac power is not available. Compact, light weight, weather-proofed—extra rugged construction for field duty. Frequencies set and read directly on large dial. Particularly useful for telephone or remote broadcast line checks, strain gauge applications, telemetering and geophysical measurements. Provides completely hum-free signal. Operates from flashlight and 45-volt batteries. Output stable and constant throughout range.

-hp- 650A Resistance-Tuned Oscillator

Highly stable, wide band (10 cps to 10 mc) oscillator particularly useful for testing television amplifiers, receiver alignment, bridge or carrier circuits, wide band systems; determining tuned circuit response. Operates independently of line or tube changes, requires no zero setting. Output flat within 1 db throughout range, monitored with VTVM. 60 db attenuator adjusts in 10 db steps.

-hp- 202A Low Frequency Function Generator

Compact, convenient, all-purpose source of transient-free voltages between 1/100 cps and 1 kc. Provides distortion-free signals for vibration studies, servo applications, medical and geophysical work and other subsonic problems. Generates sine, square or triangular waves. Output 10 v RMS, balanced or single ended, 1% distortion, constant within 0.2 db.

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

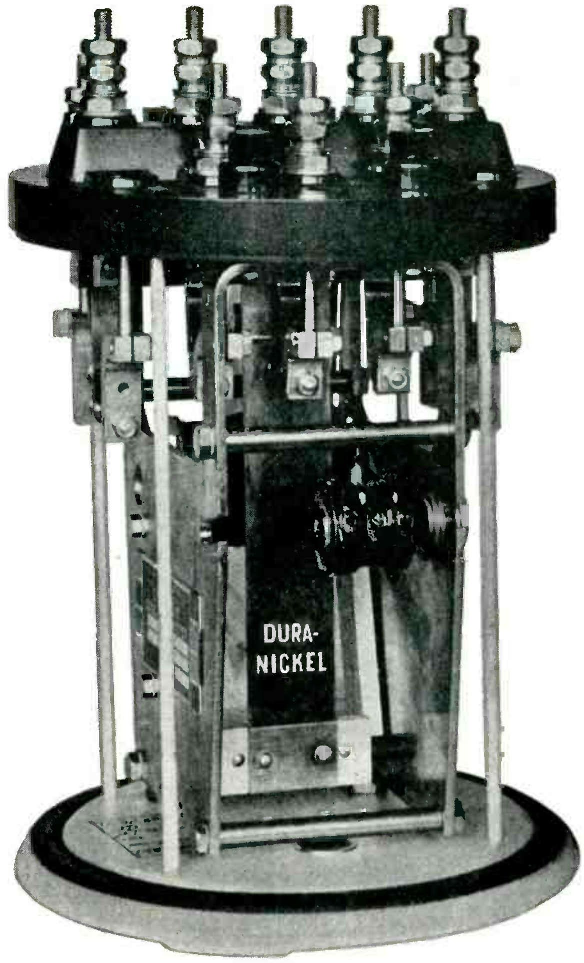
HEWLETT-PACKARD COMPANY
2711A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U. S. A.
SALES REPRESENTATIVES IN PRINCIPAL CITIES
Export: Frazar & Hansen, Ltd., New York City, San Francisco, Los Angeles

Instruments for Complete Coverage

Want more information? Use post card on last page.

They needed "arms" that never got tired

...so they came to Inco for Technical Aid



The arms of this pendulum-type armature are made of fatigue- and corrosion-resisting Duranickel. It transmits as many as 94 million pulses a year, and there has never been any failure due to this alloy.

Coded Track Circuit Control — It's an ingenious signal control system for railroads. Electrical engineers of UNION SWITCH & SIGNAL — division of WESTINGHOUSE AIR BRAKE CO. — developed it.

This complicated electrical system guards trains on thousands of miles of rail across the country — sending out coded pulses that warn the engineer of conditions up ahead on the tracks. One code says "All clear"... another "Slow down"... absence of code, "Stop!"

Now a circuit like this required lots of experimenting and research to design.

And one of the problems was the metal for the arms of the pendulum-type armature in the code transmitters alongside the tracks.

The arms had to vibrate as much as 180 times a minute—up to 94 million flexings a year—without tiring. So, the metal of which they were made had to have exceptional resistance to fatigue as well as to extreme changes in weather—to corrosion as well as to impact.

The designers have tested many alloys but none has had all the necessary characteristics, except one — Duranickel — which they chose with the aid of Inco's Technical men.

In this tough, conductive, corrosion-resisting spring alloy they found the perfect solution to their problem. In all the many systems now installed, there has never been a single instance of failure.

If you're being "side-tracked"—Like trains, designs can sometimes be "side-tracked." They can be held up for many reasons — a tough metal selection problem, for example.

If you have such a problem, talk it over with an Inco Nickel Alloy engineer. Chances are he has the solution at hand. If not, he'll do his best to get it for you. And if you have a spring selection problem, Duranickel may be the answer. So write B. B. Winter at Inco, today, and ask for your free copy of technical bulletin T-32 on "Duranickel."

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

Inco Nickel Alloys

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

INCO

Six facts every engineer and scientist should know about the new

CRC 102-A

Electronic Digital General-Purpose Computer

1. LOW INITIAL COST—The CRC 102-A is one of the lowest priced, large scale, digital electronic computers now available commercially. It may be purchased, rented, or leased with an option to buy. Performance guarantees are given as part of every lease contract.

2. FAST AVAILABILITY—Applying production-line techniques to the construction of the CRC 102-A has resulted in the shortest delivery time of any fully electronic, digital, general-purpose computer. Production schedules call for completion of one CRC 102-A every eight working days.

3. WIDE CHOICE OF INPUT-OUTPUT DEVICES—Data in either octal or decimal form may be entered into the CRC 102-A manually from a typewriter, automatically or semi-automatically from punched paper tape, and automatically from IBM cards or from computer-controlled magnetic-tape units.

The computer will print output data automatically on its typewriter in octal, decimal, or alphabetic form, perforate paper tape in octal or decimal form for reproducing hard copy or for re-entering data into the computer at some later time, punch octal or decimal data on IBM cards for use with punched card equipment, or record data on magnetic tape for later use.

4. HIGH RELIABILITY—The unique circuit design and relatively small number of vacuum tubes and other critical components in the CRC 102-A result in less down time due to machine failure. Complete plug-in circuitry and easily adjusted mechanical components speed up preventive maintenance checks. Each machine undergoes extensive shakedown tests and is operated under actual customer conditions in CRC's Computing Center before delivery to further assure high reliability.

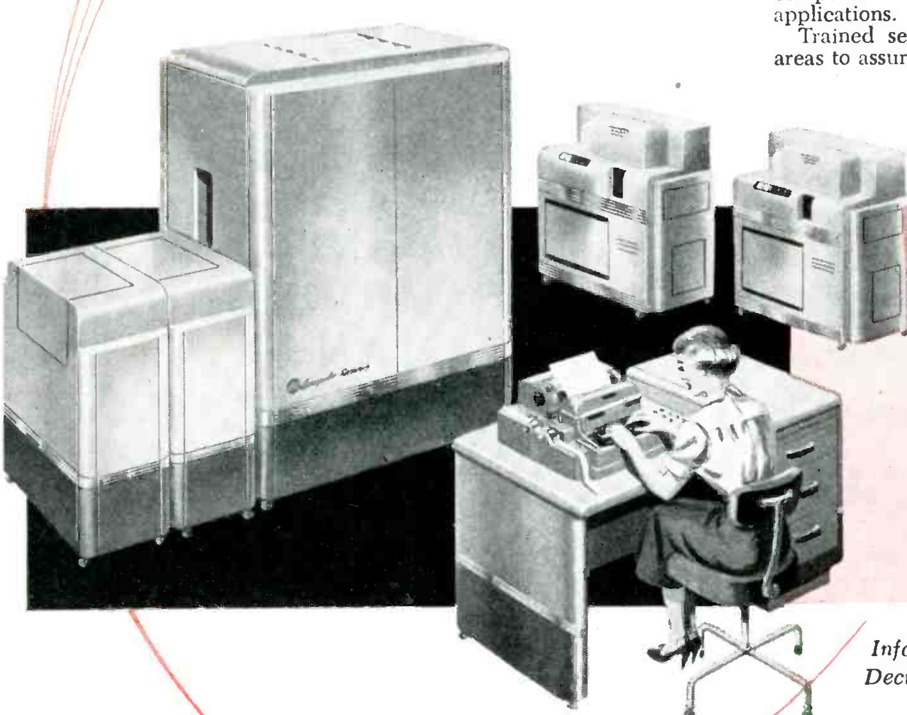
5. EASY PROGRAMMING—Addition of "programmer's" commands, a test switch for program debugging, faster speeds, greater flexibility, and the wide selection of input-output equipment has greatly simplified programming procedures and increased the computer's capabilities.

6. ADDITIONAL SERVICES ARE NOW AVAILABLE—Programming sub-routines, application studies, and training courses on computer operation, are now available from CRC's Applications Division.

Facilities of the new Computing Center enable potential computer users to evaluate the CRC 102-A for their specific applications.

Trained service personnel are now available in most areas to assure proper maintenance of all CRC computers.

For complete, detailed information on the new CRC 102-A write to the Director of Applications.



TYPICAL APPLICATIONS

Wave Propagation Studies
Network Analysis • Antennae Design
Transient Analysis
Electrical Power Distribution
Servo Problems
Solution of Partial Differential Equations
Net Relaxation Problems

Information is also available on the CRC 105 Decimal Digital Differential Analyzer and the CRC 107 Data Processing Computer.

FIRST IN ELECTRONIC COMPUTATION

CRC

Computer Research
CORPORATION

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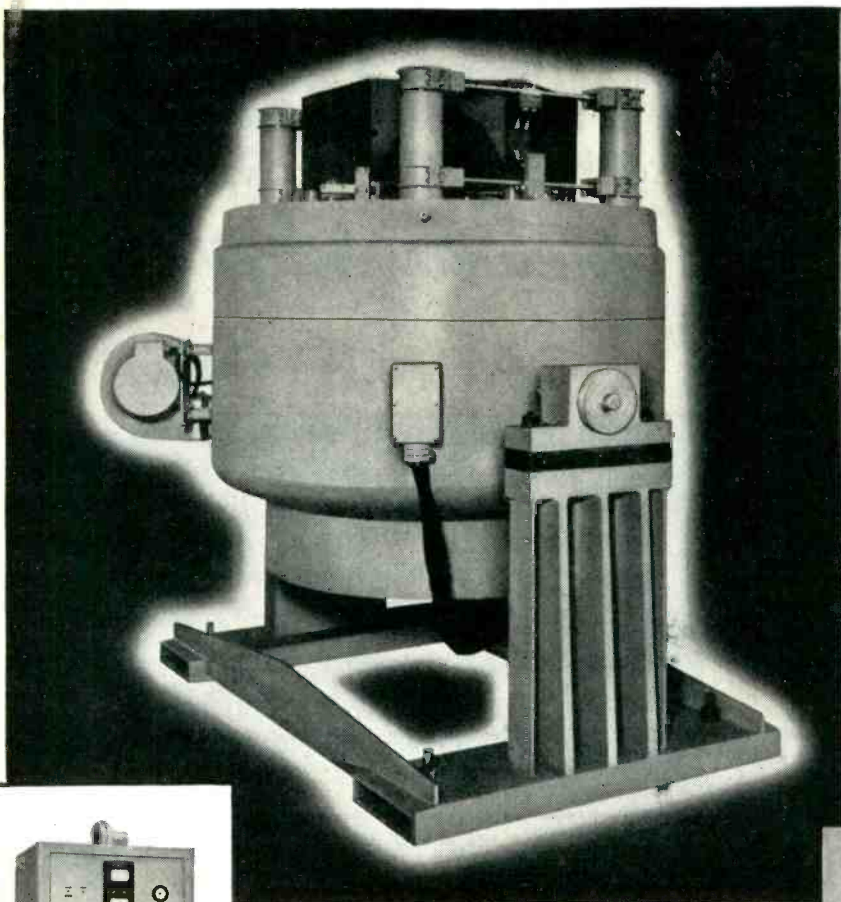
Largest Vibration Exciter Ever Built

▸ ***New MB shaker delivers 10,000 pounds force output!***

▸ ***Widens scope of vibration testing to MIL-E-5272 and other specifications!***



HERE'S the latest—and the *largest* — vibration exciter ever built for shake testing. Developed by MB vibration specialists, this unit incorporates all the advances made in the last seven years for assuring dependable operation, pure table motion, and absence of resonances. These include specially designed table flexures, forced air cooling, built in protection against overtravel of the table and against misoperation of the equipment.

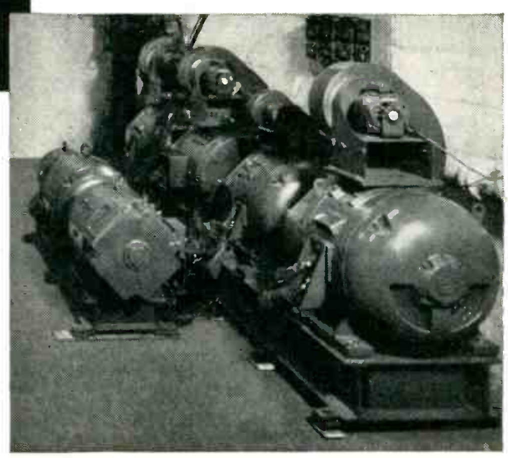
This extra heavy duty, conservatively rated, electromagnetic shaker has the capacity and endurance to permit continuous testing at rated output. It will handle anything from electrical components to air-frame structures.

Remember—available MB Vibration Exciters now range from 5 pounds output size all the way up to this new giant. Make MB your headquarters for help on vibration testing and other problems.

MODEL C-100 VIBRATION EXCITER has ½" total table travel. Flexure design supports heavy table loads without sacrificing stroke. Trunnion support permits operation in all positions from horizontal to vertical, and has built-in vibration isolation. Operating range: 5 to 500 cps.

◂ **CONTROL PANEL** (Model T-100) assures proper operation of equipment with interlocked controls. Accurate, easy, continuous control of force and frequency permits quick adjustments, or "scanning" over entire operating range. MB Vibration Meter provided; also running time meter.

ROTATING POWER SUPPLY rated to deliver full power without need for power factor correction. Blowers cool each unit separately. Alternators feed driver coil of shaker, with minimum harmonic distortion. ▸



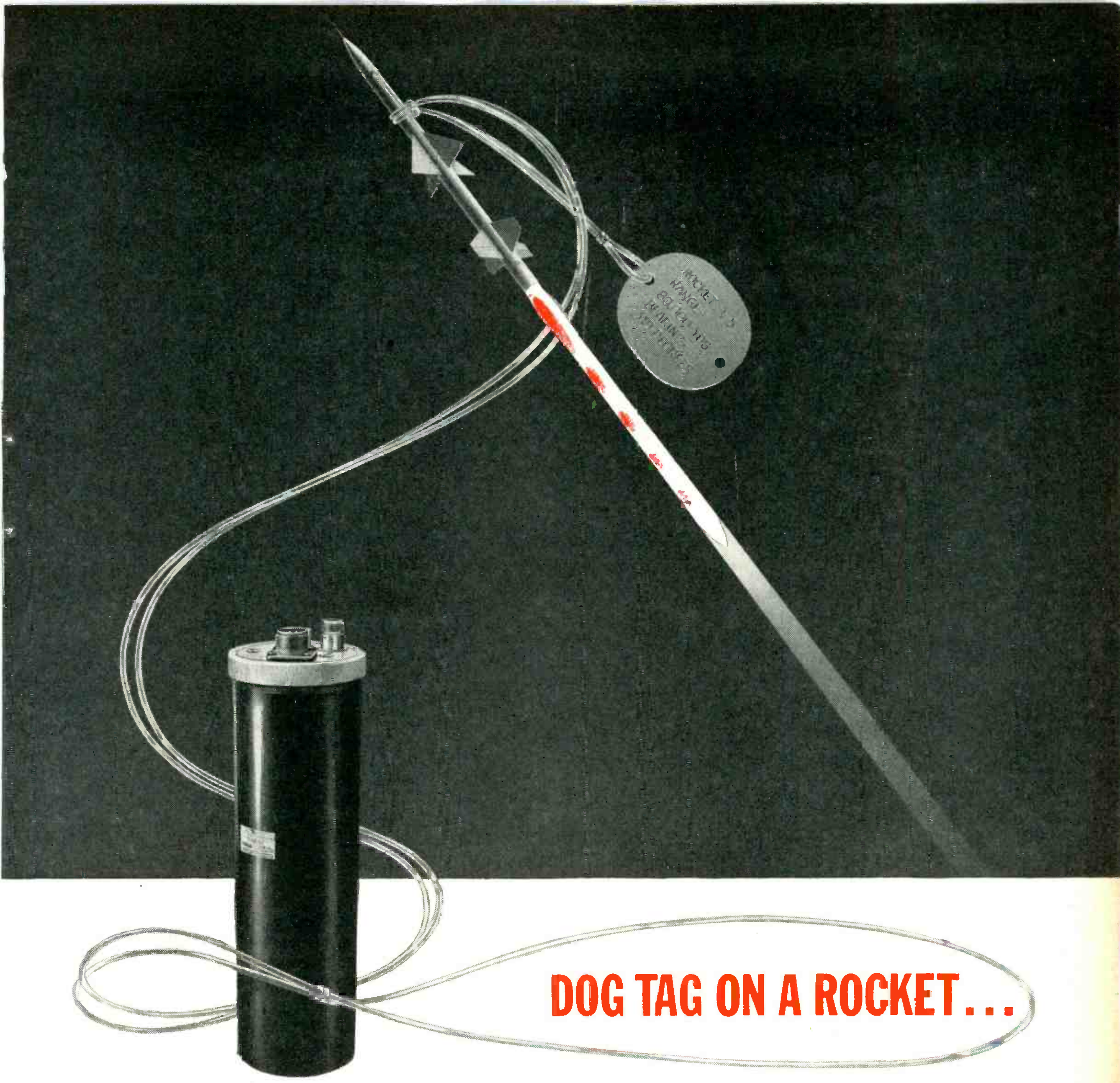
THE MB MANUFACTURING COMPANY, INC.

1060 STATE STREET, NEW HAVEN 11, CONN.

BULLETIN TELLS MORE

Contains specifications, operating information and helpful hints on usages of the complete line of MB Exciters. Write for Bulletin 1-VE-5.

PRODUCTS AND EQUIPMENT TO CONTROL VIBRATION • TO MEASURE IT • TO GENERATE IT



Rockets are elusive weapons which are frequently lost in the radar scope. These fast flying missiles present a minimum target which is hard to track.

But now a Bendix-Pacific Radar Beacon is installed in the missile to provide a reinforced echo that is easily observed—like an identifying dog tag. These Beacons, which weigh only 5½ pounds incorporate both a receiver and a transmitter, providing a powerful signal which is retransmitted in 2 microseconds. In addition to use in missiles, the Bendix-Pacific Beacons simplify air traffic control problems, reduce the time of locating targets for airborne radar checkout and, in effect, increase the size of target drones to simulate larger aircraft.

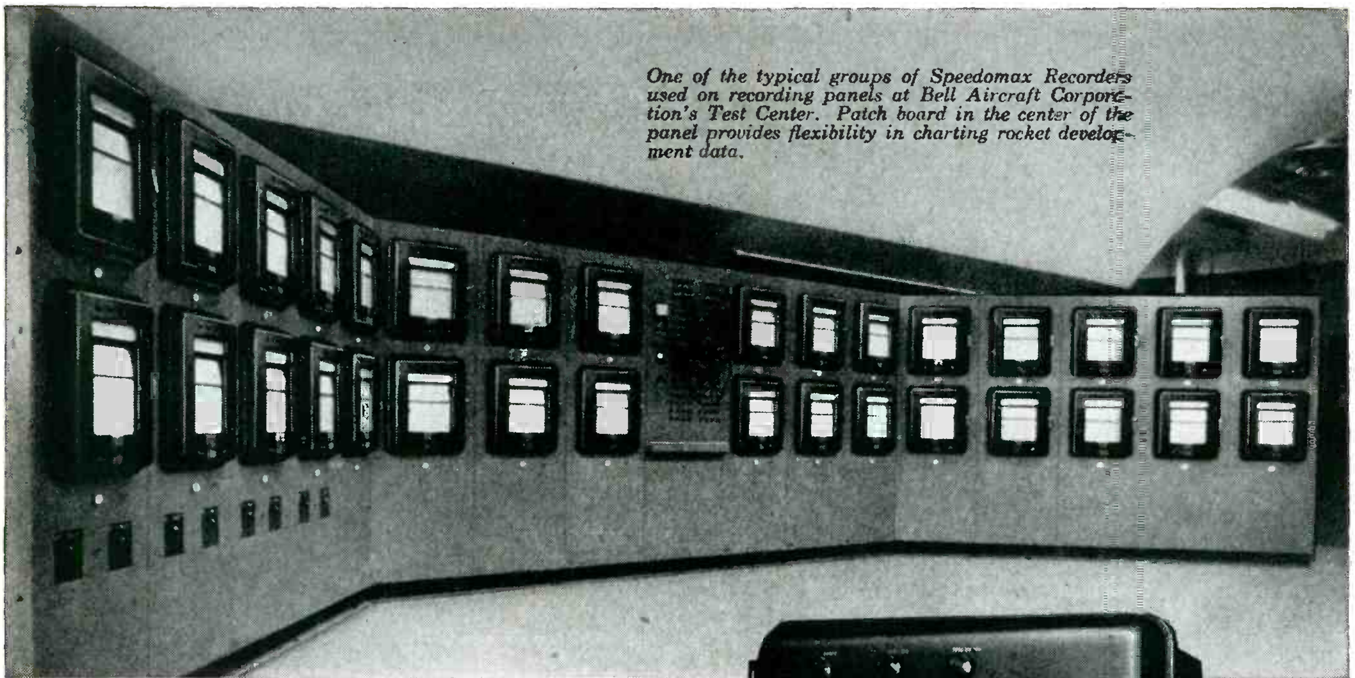
The importance of Bendix-Pacific electronic developments in airborne radar, radio control, telemetering and missile guidance have brought about rapid expansion of this company's engineering and manufacturing facilities. Three plants and a highly specialized group of electronic engineers are available to develop and produce advanced applications to meet your requirements. Your inquiry is invited.

ATTENTION ENGINEERS...

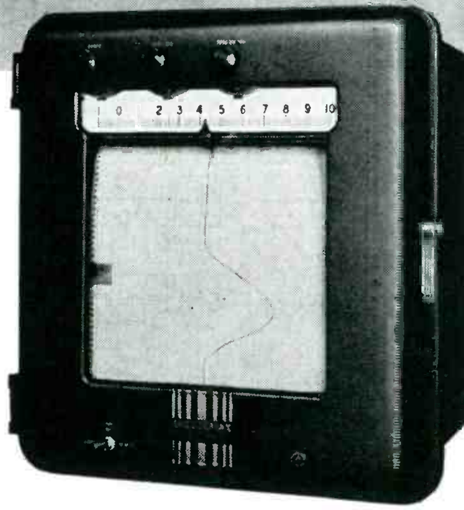
Bendix-Pacific has a few openings for thoroughly qualified engineers in sonar, radar, servomechanisms and telemetering. For those seeking a challenging future under ideal Southern California living conditions, Bendix-Pacific offers worthwhile opportunity. Your inquiry will be considered in strict confidence.

Bendix
Pacific Division
Bendix Aviation Corporation
NORTH HOLLYWOOD, CALIF.

AIRCRAFT HYDRAULIC CONTROLS • AIRBORNE RADAR • SONAR • INDUSTRIAL HYDRAULIC CONTROLS • TELEMETERING • ELECTRO-MECHANICAL EQUIPMENT



One of the typical groups of Speedomax Recorders used on recording panels at Bell Aircraft Corporation's Test Center. Patch board in the center of the panel provides flexibility in charting rocket development data.



Just set the knobs at top of instrument for the desired range and zero, and this AZAR recorder is adjusted to your exact specs . . . spreads any millivolt value from one to twenty across the full chart width, for measuring Force, Weight, Temperature, Speed, Voltage or any condition which yields an electrical recorder signal.

COMPLEX ROCKET-TESTING ROUTINES

Simplified

by Speedomax® adjustable-zero adjustable-range Recorders

• Rocket engine development at Bell Aircraft Corp., of Buffalo, N. Y. involves several unique instrument requirements. The nature of rocket combustion problems demands highly versatile instruments . . . instruments that can be dial-set to meet a wide variety of new test conditions. Furthermore, the instruments must also simultaneously record a combination of motor parameters. The highly flexible Speedomax adjustable zero adjustable range (AZAR*) Recorder provides Bell with just the right instrument combination for speedy, accurate test results.

Data for use in the engineering, designing and testing of rocket motors are obtained from pressure, temperature, force and flow measurements. Electronic transducers provide a d-c voltage proportional to the quantity measured; this signal is relayed to the AZAR Recorders through the patching network located in the center of the panel.

Various types of primary elements are used because of the extreme ranges encountered. All recorders are read in millivolts and converted to the measured quantity during data reduction. Adjustment of the range and zero makes it possible to read any pre-selected portion of the instrument scale.

Duplicate information is relayed to remotely located consoles for the convenience of engineers at the test stands. This is accomplished by electrical signals fed from the retransmitting slidewires of the recorders. Jog pen (used at Bell for time correlation between machines) and other accessory features to meet individual requirements can be incorporated in the versatile AZAR Recorder.

A general description of this instrument is available, and will be especially useful if you can describe to us the nature of your recording problem. Contact our nearest office or write 4979 Stenton Ave., Philadelphia 44, Penna.

* L&N Trademark

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instruments *automatic controls • furnaces*

Jrl. Ad. EM9(4)

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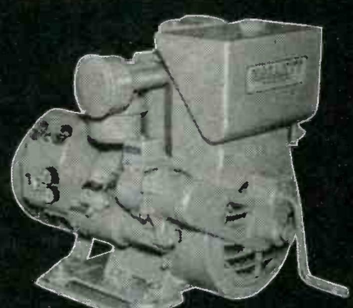
HALLETT

QUICK DISCONNECT COUPLINGS FOR COAXIAL CABLE USE

Investigate the advantages of compact, lightweight Hallett Quick Disconnect Couplings for coaxial cables, TV and radio installations, computers, etc. Manufactured to meet rigid military specifications and all vibration and thermal shock tests. Write for catalog and prices.

HALLETT



DIESEL ELECTRIC GENERATOR SETS

Hallett dependable full Diesel power from 2½ KW to 10 KW in both water and air cooled models for standby power, portable, mobile and stationary units — also available, bare engines with power take-offs for all power applications from 5 HP to 18 HP. Write for catalog concerning your power requirements.

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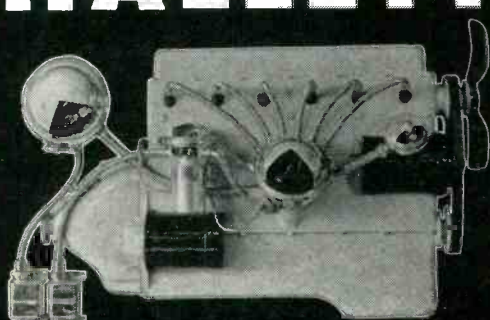

RADIO INTERFERENCE REDUCTION AND CONTROL EQUIPMENT

Stock kits for most engines and tailor-made for special applications. Hallett radio interference reduction and control equipment is the standard of the industry — positively shields out all noise indefinitely. Manufactured in accordance with Government specifications. Technical data upon request.

HALLETT MANUFACTURING COMPANY

Main Plant: 1601 West Florence Avenue, Inglewood, California, Oregon 8-4751; District Sales Offices: Washington, D.C., 13th and E Streets, District 7-0217; Detroit, Mich., Book Tower Bldg., Woodward 1-9553; New York, N. Y., Grand Central Bldg., Murrayhill 3-4752; Chicago, Ill., 600 South Michigan Blvd., Wabash 2-1343

Gentlemen: Please send me more information concerning:

- ☐ Hallett Diesels
- ☐ Quick Disconnect Couplings for Coaxial Cable Use
- ☐ Radio Interference Reduction and Control Equipment

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City ______ Zone ______ State ______

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For *Critical* Applications
Triplett 630-A Has No Counterpart

Accuracy
to 1½%

Readability
with a Mirror-Scale

Adaptability
with ½% resistors

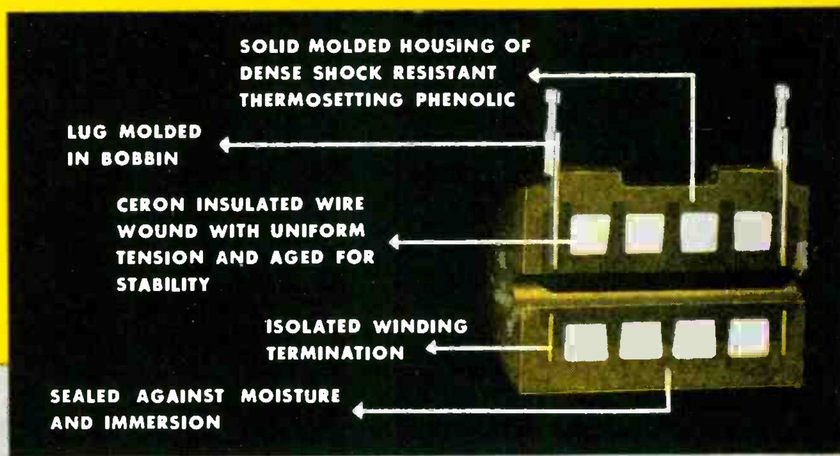
Try This Volt-Ohm-Mil-Ammeter at your distributor's

TRIPLETT ELECTRICAL INSTRUMENT CO., BLUFFTON— OHIO

DURAMEG®

ACCURATE WIREWOUND RESISTORS

ABOVE AND BEYOND MIL-R-93A SPECIFICATIONS



DURAMEG wattage ratings are based on full rated dissipation at 105° ambient. These ratings are from 4 to 5 times the 85°C MIL ratings for the best of conventional resistors.

DURAMEG Resistors pioneered and proved new performance records for reliable, high-accuracy wire-wound resistors. They're molded under high pressure and temperature in mineral-filled, dense phenolic—impervious to moisture—for *positive* protection against electrolysis failure. They'll even withstand the salt water immersion cycling for characteristic A in the former specification JAN-R-93. Installations require no secondary insulation for mounting. Yes, they're also tough and resistant to high mechanical damage.

The long-term stability of Durameg Resistors offers a new scope of performance to equipment designers who must consider initial resistance tolerance of resistors as well as shifts in value with repeated thermal cycling and with age. With Durameg stability, you can design now for *permanent peak performance!*

Duramegs are the first accurate resistors that operate up to a hot spot temperature of 150°C as against the usual 105°C limit—made possible with Sprague's patented ceramic-insulated Ceron resistance wire. The unique combination of Ceron wire, Durameg molding technic and aging treatment, permits dissipation of full rated wattage at 105°C—the same temperature at which MIL ratings prescribe zero % dissipation!

DURAMEG Resistors are now available for commercial applications in dimensions identical to MIL styles. We will be glad to send you complete data upon request. ★ ★ ★ ★ ★

WRITE, WIRE OR PHONE FOR ENGINEERING BULLETIN 120

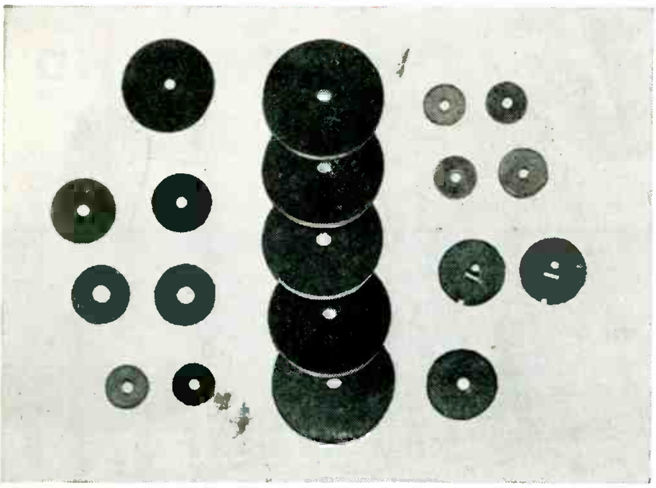
●

SPRAGUE ELECTRIC COMPANY
35 Marshall Street, North Adams, Mass.

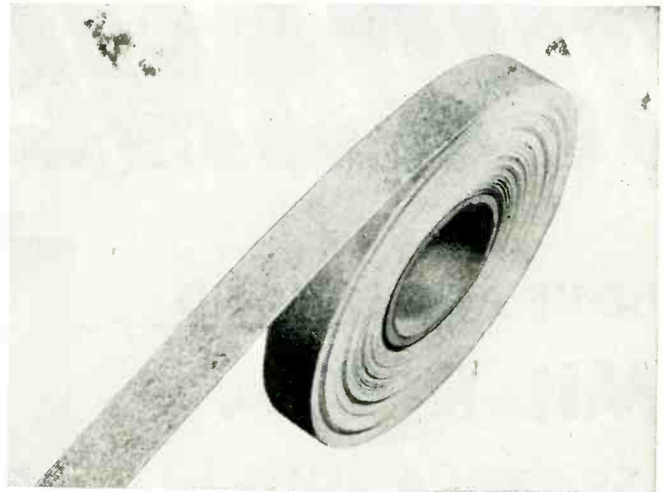
SPRAGUE . . . PIONEERS IN ELECTRIC AND ELECTRONIC DEVELOPMENT

EXPORT FOR THE AMERICAS: SPRAGUE ELECTRIC INTERNATIONAL LTD., NORTH ADAMS, MASS. CABLE: SPREXINT

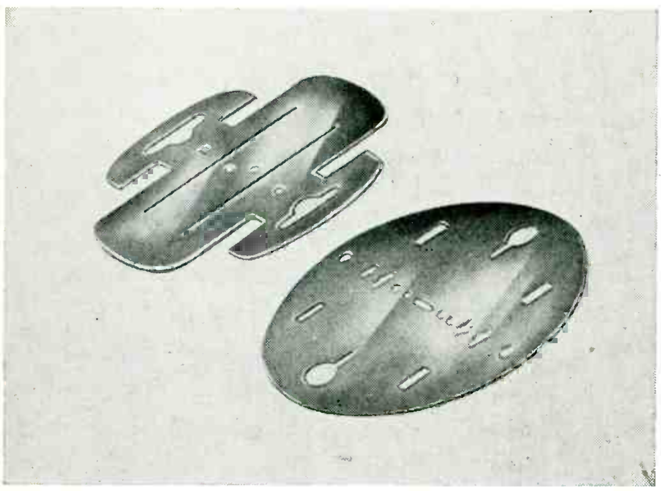
Do you have any of these problems?



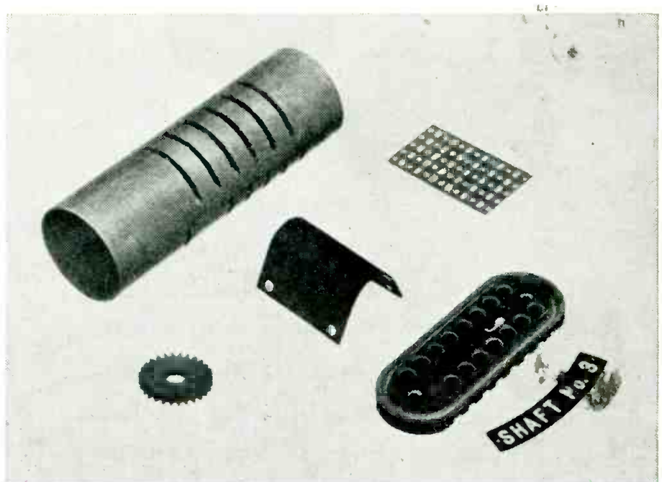
1. Need a combination of gasket sealing and mechanical and electrical properties? Various grades of LAMICOID® — laminated plastic made with organic and inorganic binders — are combined with natural or synthetic rubber to obtain the excellent insulating and mechanical properties of LAMICOID and the sealing properties of rubber.



2. Need a mica tape that can be run on taping machines at high speed? ISOMICA* tapes are made from long rolls of thin continuous mica sheet . . . are more uniform in mechanical and dielectric strength . . . have no high spots or voids. For electrical insulation of class B or class H motors, generators and transformers.



3. Need accurately punched mica stampings for filament, grid and plate supports? MICO produces mica stampings to extremely fine tolerances. Whenever you need precision-fabricated mica parts of the highest quality, call on MICO. We have 60 years of experience in this field.



4. Need special mechanical and electrical properties for brackets, terminal blocks, access panels, etc.? LAMICOID® is half as heavy as aluminum and, weight for weight, stronger than steel. Offers high impact strength, high dielectric strength, excellent abrasion and moisture resistance.

Whatever electrical insulating materials you need, MICO makes them best. We manufacture all standard types and many special materials, and fabricate parts to your specifications. Send us your blueprints or problems today.

*Trademark

1893-1953 60 Years of Leadership in Electrical Insulation

MICO

MICA Insulator COMPANY

Schenectady 1, New York

Offices in Principal Cities

LAMICOID ® (Laminated Plastic) • MICANITE ® (Built-up Mica) • EMPIRE ® (Varnished Fabrics and Paper) • FABRICATED MICA • ISOMICA *

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Who put those teeth in the F3D?

among others,

DALMO VICTOR
SAN CARLOS · CALIFORNIA
DV

One typical DV Development

ANTENNA PATTERN CHECKING

One of the problems of speeding radar-antenna production output has been solved at Dalmo Victor through the development of special automatic space-pattern recording equipment, illustrated. This apparatus reduced final check-out time on each antenna system from the two hours required by the former hand-plotting method to 15 minutes.

Ability to seek out aircraft in flight and score direct hits without visual contact is given to the Douglas F3D Skyknight through radar equipped with search and tracking antennas designed, developed and manufactured by the unique specialist staff of Dalmo Victor Company.

Perhaps you have a problem in the design-through-production engineering of a complex, lightweight, electromechanical device. If so, Dalmo Victor can help.

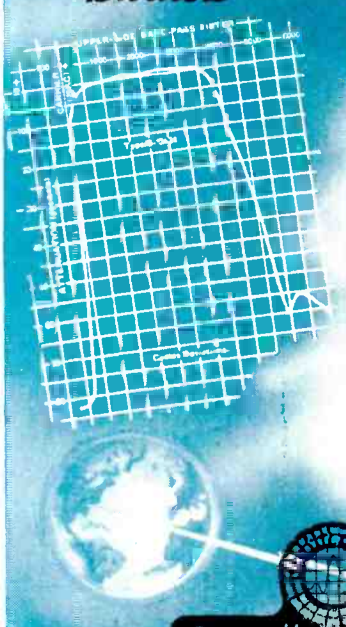
DOWN-TO-EARTH ENGINEERING FOR THE WILD BLUE YONDER

A New Approach in Economical Side-Band Filters

TOMORROW'S FILTERS TODAY ...is...

IN COMMUNICATION NETWORK COMPONENTS

Burnell SINGLE SIDE-BAND FILTERS



Single side band reception of space carrier telegraph and telephone transmissions, despite the improvement in reception attributable to its use, is still considered to be in its embryonic stage. Elimination of the duality of the modulation products, and the attainment of mono-band reception of the intelligence transmitted, has always been the apotheosis of communication engineers. Probably the greatest single factor that has precluded the rapid advancement of single side band systems, has been the excessive cost of the carrier and side band filters. Filters presently produced consist of a complex array of crystals and L. C. networks, which represents not only an expensive design but one not readily obtainable.

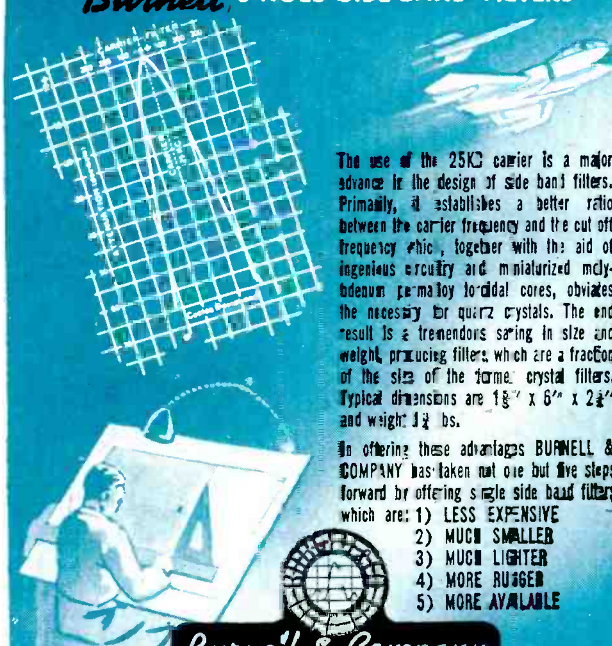
BURNELL & COMPANY'S new approach to this problem, not employing crystals, is based on the use of a system having a 25KC carrier and the exclusive embodiment of toroidal coils in a highly engineered circuit of temperature stabilized and temperature compensated components to produce the sharp-sided curve required in this system.

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

A STEP FORWARD ...

IN COMMUNICATION NETWORK COMPONENTS

Burnell SINGLE SIDE-BAND FILTERS



The use of the 25KC carrier is a major advance in the design of side band filters. Primarily, it establishes a better ratio between the carrier frequency and the cut off frequency which, together with the aid of ingenious circuitry and miniaturized molybdenum permalloy toroidal cores, obviates the necessity for quartz crystals. The end result is a tremendous saving in size and weight, producing filters which are a fraction of the size of the former crystal filters. Typical dimensions are 1⅜" x 6" x 2¼" and weight 1½ lbs.

In offering these advantages BURNELL & COMPANY has taken not one but five steps forward by offering single side band filters which are:
1) LESS EXPENSIVE
2) MUCH SMALLER
3) MUCH LIGHTER
4) MORE RUGGED
5) MORE AVAILABLE

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

and OPENS NEW DOORS ..... in

IN COMMUNICATION NETWORK COMPONENTS

Burnell SINGLE SIDE-BAND FILTERS

The potential demand for single side band equipment has up to now been restrained behind the "locked doors of frustration", so to speak, but we feel that we are helping to unlock those doors and release an even greater demand for side band equipment small enough and inexpensive enough to reawaken the interest of communication equipment manufacturers in this field for both civilian and military application. In the latter field single side band systems were virtually prohibitive because of the inadequateness of crystal filters for field use. The BURNELL system now eliminates all the objectionable features.

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

HIGH SPEED COMMUNICATIONS

Burnell IN COMMUNICATION SINGLE SIDE-BAND FILTERS

In addition to the carrier, lower side band and upper side band filters illustrated for 3.5KC pass bands, there is available a low pass filter for the demodulation circuit. There is also available for wider band operation side band filters having a 6KC pass band, with the same dimensions and weight.

By adding this group of filters to our regular series of multiplex filters we can, with pride, state that BURNELL & COMPANY has gone a long way toward assisting the communications industry to develop high speed communications resulting from more efficient operation and greater freedom from interference.

If you are an engineer in 'communications', you will be interested in our brochure describing the BURNELL single side band filters in greater detail.

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

from a

SINGLE

SOURCE

AMPHENOL

Amphenol builds to the future of Electronics...

AN Connectors RF Connectors
Cables Cable Assemblies Sockets

The electronics industry finds AMPHENOL their prime supplier of all of the above components and for very good reasons. Engineers specify AMPHENOL because of the tested *quality* of each AMPHENOL part. Expert manufacture and close production control guarantee this quality—assure the perfection that is a must in electronic components. Purchasing agents delight in the fact that AMPHENOL represents a *single source* for the majority of their needs. They know that the AMPHENOL line represents the most complete listing of connectors, cables and sockets in the world: over 9,000 cataloged items in steady production from AMPHENOL's five plants! And if a special part is needed, AMPHENOL engineers will work in close cooperation with industry to either develop a totally new component or modify an existing one. AMPHENOL's years of experience in electronics are always at the disposal of industry.

The complete AMPHENOL *line is represented in the following catalogs:*

A-2 AN CONNECTORS For power, signal and control circuits in aircraft and electronics equipment.

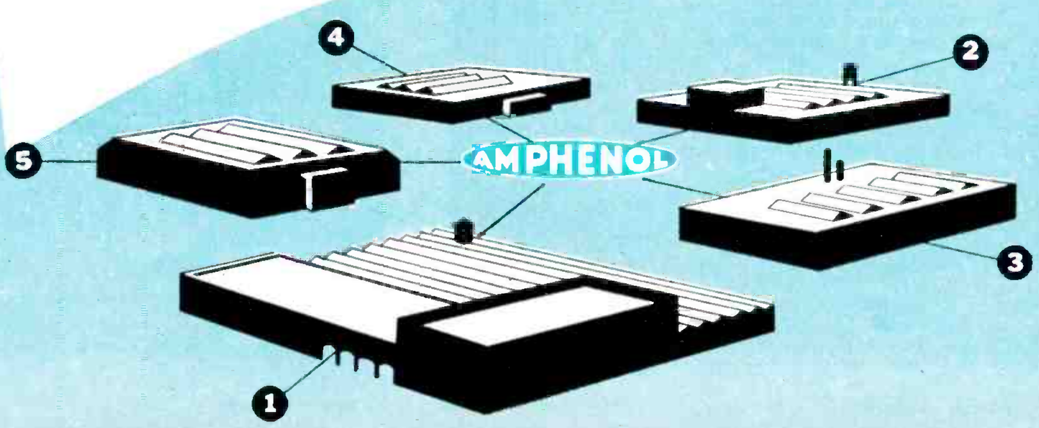
B-2 GENERAL CATALOG OF AMPHENOL COMPONENTS. A condensed listing of all AMPHENOL products.

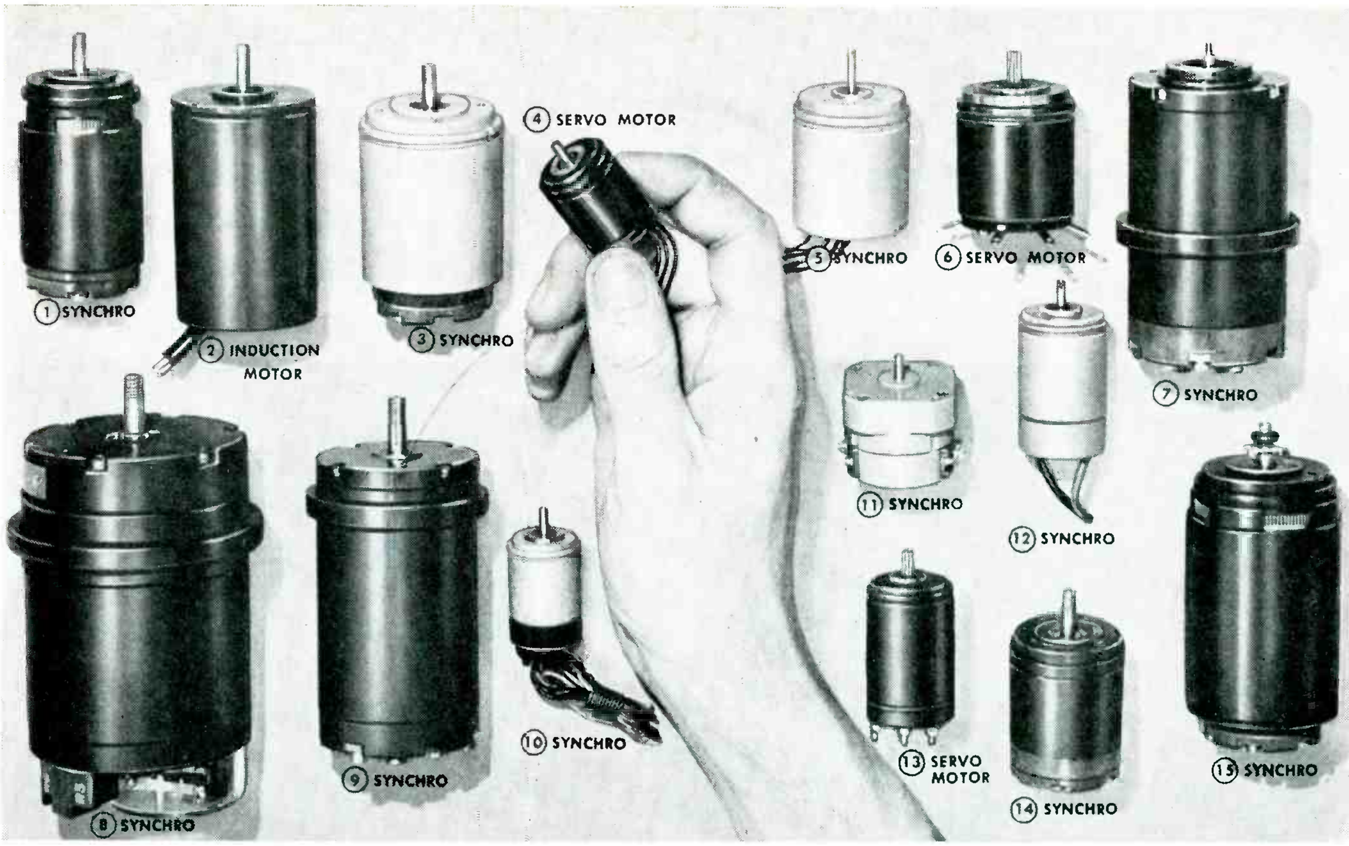
C-3 METHODS MANUAL A presentation of assembly procedures of electrical connectors and components.

D-2 RADIO FREQUENCY CABLES AND CONNECTORS A complete listing including valuable engineering data of AMPHENOL RF Components.

AMERICAN PHENOLIC CORPORATION

chicago 50, *illinois*





Ketay gives you a complete variety of sizes and types of Synchros and Servo Motors

WHATEVER THE NEED
CHOOSE KETAY!
Available as listed

1. SYNCHRO, Size 16, O.D. 1.537", 115 V, 400 Cycles *(Transmitter, Receiver, Control Transformer)*
2. INDUCTION MOTOR, O.D. 1.750", 3 phase 2 Pole, 115 V, 60 Cycles
3. SYNCHRO, Size 18, O.D. 1.750", 115 V, 400 and 60 Cycles *(Transmitter, Receiver, Differential, Control Transformer)*
4. SERVO MOTOR, O.D. .937", 26V, 400 Cycles
5. SYNCHRO, O.D. 1.437", 14.4 V and 26 V, 400 Cycles *(Transmitter, Receiver, Resolver, Differential, Control Transformer)*
6. SERVO MOTOR Mk 7, O.D. 1.437", 115 V, 400 Cycles
7. SYNCHRO, Type 1F or 1HG, O.D. 2.250" 115 V, 60 Cycles *(Receiver, Transmitter)*
8. SYNCHRO, Size 31, O.D. 3.10", 115 V 400 and 60 Cycles *(Transmitter, Receiver, Differential, Control Transformer)*
9. SYNCHRO, Size 23, O.D. 2.250", 26 V and 115 V 400 & 60 Cycles *(Transmitter, Receiver, Resolver, Differential, Control Transformer)*
10. SYNCHRO, O.D. .937", 26 V, 400 Cycles *(Transmitter, Receiver, Resolver, Differential, Control Transformer)*
11. LINEAR TYPE CONTROL TRANSFORMER, O.D. 1.625", 26 V, 400 Cycles
12. SYNCHRO, Size 11, O.D. 1.062", 26 V and 115 V, 400 Cycles *(Transmitter, Receiver, Resolver, Differential, Control Transformer)*
13. SERVO MOTOR, O.D. 1.062", 115 V, 400 Cycles
14. SYNCHRO, Size 15, O.D. 1.437", 26 V and 115 V, 400 Cycles *(Transmitter, Receiver, Resolver, Differential, Control Transformer)*
15. SYNCHRO, Size 19, O.D. 1.90", 115 V, 400 Cycles *(Transmitter, Receiver, Control Transformer)*

KETAY offers high precision rotary and instrument components for most every need in the Armed Forces and Industry. As the world's largest producer of government approved synchros, Ketay stands ready to solve your problems with a complete line of synchros, servos, magnetic amplifiers, computers and control systems.

If you are searching for a specific size or type ... if availability is a problem ... if engineering counsel is needed ... Ketay can help. Why not join us for an exploratory discussion of your particular problem. Write today to Dept. C

Ketay MANUFACTURING CORP.
555 Broadway, New York 12, N. Y.

PACIFIC DIVISION
12833 Simms Ave., Hawthorne, California

DESIGN
DEVELOPMENT
- KINETIX INSTRUMENT DIVISION
- RESEARCH & DEVELOPMENT DIVISION

MANUFACTURE ... *of precision instruments, components, and systems.*

Want more information? Use post card on last page.

for **Bridgeport** BRASS CO. *Service*

OFFICES AND WAREHOUSES IN PRINCIPAL CITIES

BRIDGEPORT WAREHOUSE SERVICE

The Bridgeport warehouses are designed to supply from stock limited quantities of sheet, rod, wire or tubing. It is the policy of the company to maintain adequate warehouse stocks at all times so that small orders can be filled without delay.

The fabricator is in a position to obtain promptly metal to fill orders for experimental work or to start production runs, while waiting for mill shipments.

Bridgeport warehouses make every effort to carry the variety of alloys, sizes and gages which fulfill the requirements of the locality they serve.

To take care of the maximum range of widths of strip metal, slitting service is available—not only to serve warehouse stocks, but also to make customers' stocks of non-ferrous strip metal more flexible.

Bridgeport's Warehouse Stocklist carries weight tables and a technical digest giving the properties of the most popular copper-base alloys. If you do not have a copy, ask your nearest Bridgeport office.

Mills in Bridgeport, Conn. and Indianapolis, Ind.
In Canada: Noranda Copper and Brass Limited, Montreal

BRIDGEPORT BRASS COMPANY

30 GRAND STREET, BRIDGEPORT 2, CONNECTICUT

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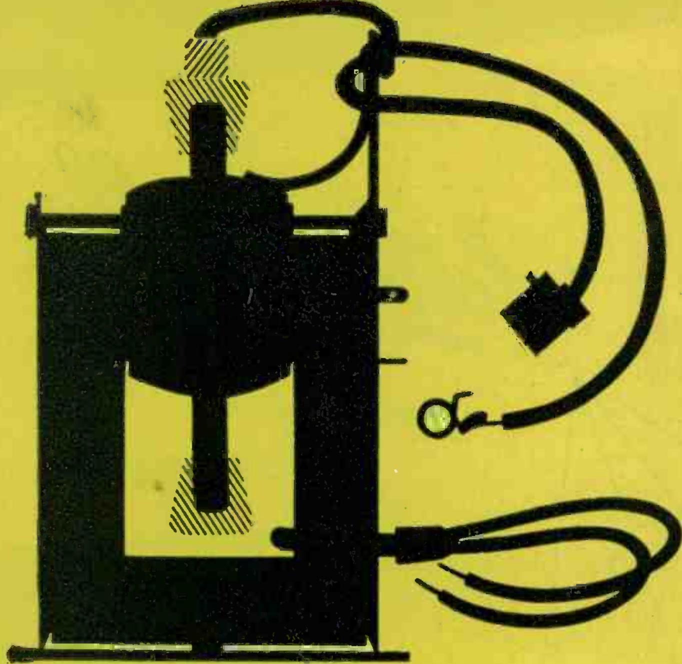


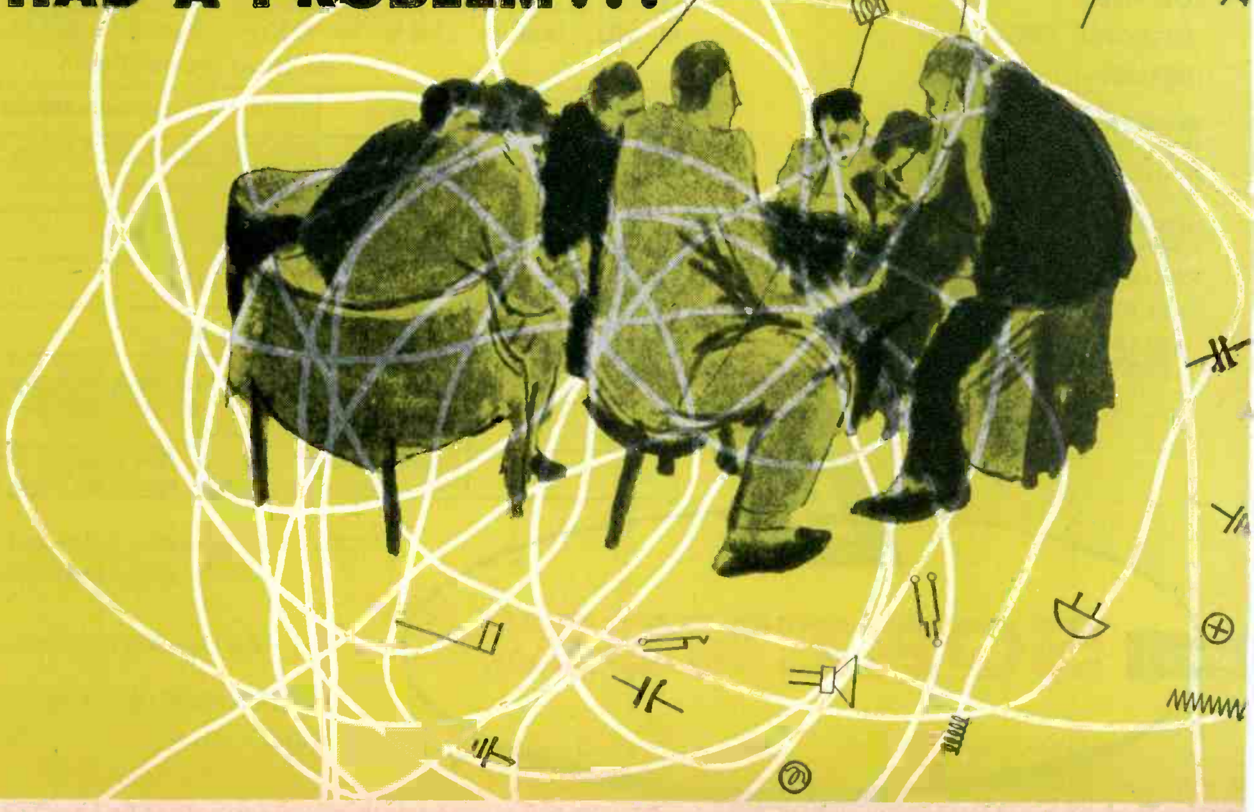
high voltage ARC INHIBITOR by Guthman

When TV manufacturers discovered that higher voltages of the new 27 and 21-inch television receivers rendered existing wax corona ring sweep transformers inadequate, they brought the problem to Guthman.

In a cooperative program with these TV engineers, a flyback transformer with a cast resin corona ring was developed—the perfect answer to this difficulty.

Your problems in the development of coils and transformers are welcome at ***Edwin I. Guthman & Company, Inc.***, 15 South Throop St., Chicago 7, Telephone: CH 3-1600, also Attica, Indiana.

THEY HAD A PROBLEM . . .



Here's a basic new material

Corning fused silica

Made by a radically new process, Corning Fused Silica offers electronic engineers a material with exciting possibilities.

The raw materials used to produce Corning Fused Silica are non-crystalline and of controlled high purity. As a result, it has the outstanding properties shown at right.

In addition, this new material is not darkened by radiation, has superior ultra-violet transmission properties, and is extremely pure chemically.

Because of its structural homogeneity, as evidenced by low attenuation of ultrasonic waves in the megacycle frequencies, Corning Fused Silica is an ideal material for ultrasonic delay lines for radar and computor applications. In addition, it weighs less than other materials used for this application, and is unaffected by vibration.

Its purity has suggested use as a crucible for melting germanium and other semi-conductors.

ELECTRICAL PROPERTIES

	60 cycles/sec.	*1 megacycle/sec.*
S. I. C. (room temp.)	3.9	3.8
S. I. C. (200°C)	3.9	3.8
Power factor (room temp.)	< .0001	< .0001
Power factor (200°C)	< .0005	< .0002
Loss factor (room temp.)	< .0004	< .0004
Loss factor (200°C)	< .002	< .0008

Volume Resistivity: Greater than 10^{17} ohm-centimeters.
Surface Resistivity: Same as for conventional clear fused quartz.

ULTRASONIC PROPERTIES

Velocity of Sound:
Shear wave .... 3.75×10^5 cm/sec.
Compression wave .... 5.96×10^5 cm/sec.
Attenuation: Indications are that the value is less than .05 db/ft./megacycle. (Equivalent to optical grades of fused quartz)
Stress After Annealing .... Less than 50 psi.

If this new material suggests an application to you, we would welcome the opportunity to discuss it. Or mail coupon below for detailed information.

Corning Glass Works
New Products Division
Corning means research in Glass

CORNING GLASS WORKS, Dept. EL-7, Corning, New York
Please send me information on Corning Fused Silica
Name .... Title ....
Company ....
Address ....
City .... Zone ...... State ....

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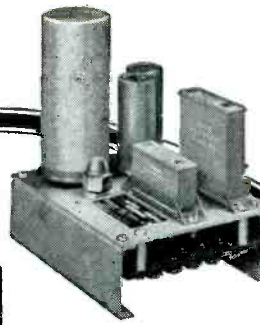
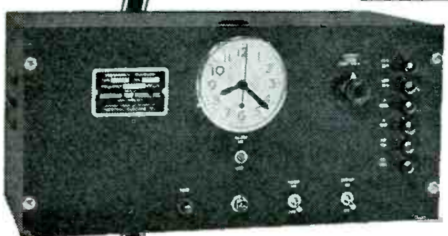


TYPE 2007, BASIC UNIT
Contains shock-mounted fork, double triode and all circuitry. Output, 400 or 500 cycles. Accuracy ± 1 part in 50,000. Octal base container, 1½" x 4½". Weight, 10 oz. Power required, 75 to 200 V.-D.C. at 1 to 5 m.a. and 6.3 V. at 300 m.a. Designed for MIL equipment.

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

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

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



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

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

Precision FREQUENCIES

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

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

WIDELY USED IN SUCH FIELDS AS

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

American Time Products, Inc.

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

OPERATING UNDER PATENTS OF WESTERN ELECTRIC COMPANY

Want more information? Use post card on last page.

Stone's Coil Bobbins are strong, light-weight forms, made to accurate tolerances for winding coils used in:

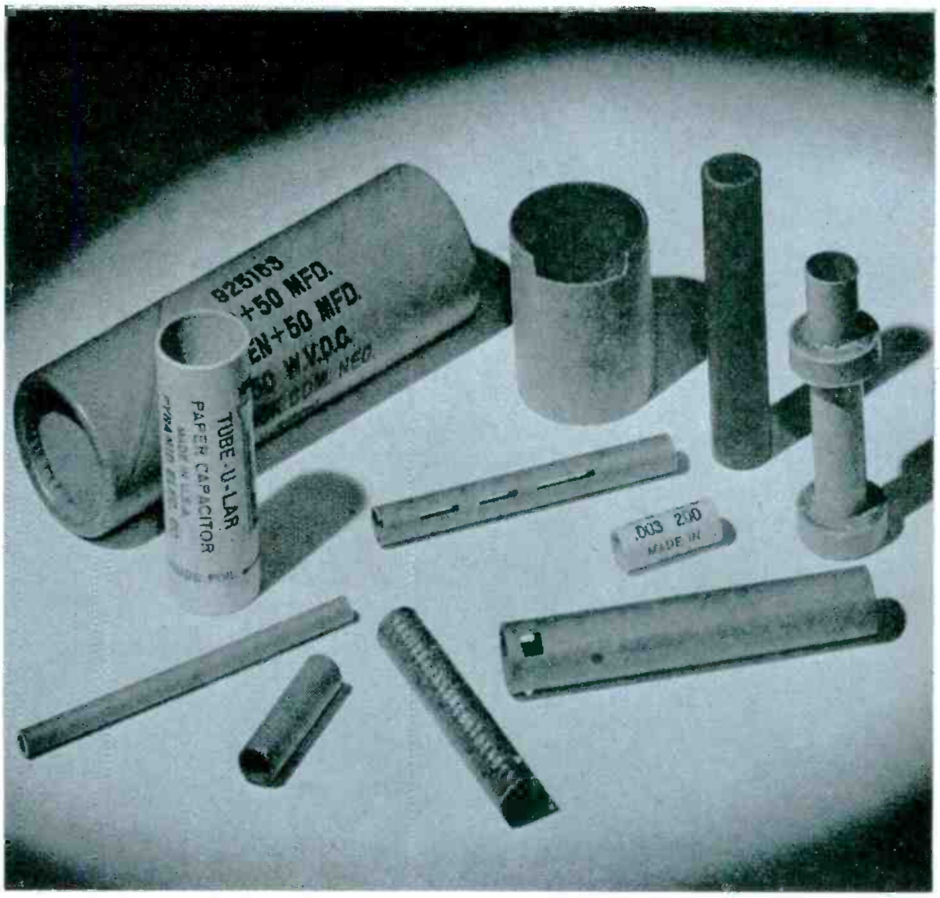
TIMER MOTORS
RELAYS
SIGNAL SYSTEMS
TV SPEAKERS
ELECTRICAL NOVELTIES
SOLENOIDS
ELECTRICAL TOYS

* * *

Stone's Electrical Insulating tubes are used as core or shaft insulating, rivet and screw insulators, spacer bushings, or liner and protector sleeves, in the manufacture of:

FRAC. H. P. MOTORS
RELAYS
SOLENOID SWITCHES
TRANSFORMERS
FLUORESCENT LAMP STARTERS
COMMUTATORS
ELECTRIC BLANKETS
ELECTRIC CORD SETS
INDICATOR LIGHTS
VOLTAGE REGULATORS
ELEC. MEASURING EQUIPMENT
INCANDESCENT LAMPS
ELECTRIC TRAIN SETS

* * *



Stonized spiral phenolic coil forms, lug collars, bushings, and printed covers are used as component parts of many products of the electronics and electrical industries, among them being:

R.F., I.F., AND OSCILLATOR, AND OTHER COILS FOR RADIO AND TV • PERMEABILITY TUNERS • TUBULAR CONDENSERS
TRANSFORMER COILS • ELECTRIC MOTORS • SELENIUM RECTIFIERS • RELAYS • TIME CONTROL ASSEMBLIES

SALES OFFICES

BRIDGEPORT *3-2575*
O. E. Pfannkuch & Co., 952 Main Street

CHICAGO .... *Tuxedo 9-6920*
Joseph L. Pits, 1643 N. Nagle Avenue

CLEVELAND .... *Main 1-8410*
C. E. White & Company, Bulkley Building

LOS ANGELES .. *Pleasant 2-0791*
E. H. Southwell Co., 5957 So. Western Avenue

NEWARK ...... *Humboldt 5-9000*
L. K. Detwiler, 443 Broad St., Room 205

PHILADELPHIA ... *Walnut 2-1182*
I. R. Blair, 401 N. Broad St., Room 740

ST. LOUIS .... *Parkview 3274*
E. B. Henderson Co., 8147 Delmar Blvd.

TORONTO .... *Murry 1106*
Electric Insulation & Fibre Co., Ltd., Mendota Road, Etobicoke

Why Don't You Write Us?

WE HAVE a lot to offer you, particularly if you manufacture any of the items or related products listed on this page.

Stone, alone in the paper tube field, can place at your service the experience gained from an industrial heritage of 126 years. Down through the years, we have been able to improve our accuracy of manufacturing and our mass production techniques to such a point that we can assure you quality products at low cost. Many hundreds of the country's leading manufacturer's know this to be true.

Small diameter spiral wound insulating tubing from 3/64" to 1" ID is our specialty although the larger sizes are available. All Stone tubes are custom-made despite the fact they are mass produced and can be furnished in hi-dielectric kraft, fish paper, and plastic films in various wall thicknesses and lengths. They can also be formed, notched, punched, printed, dipped or impregnated with a variety of waxes and resins.

Why don't you write us or better still, get in touch with our nearest representative? Stone makes many thousands of different items and we are sure that we can either adapt one of the products to your own requirements . . . or develop one specifically for you. You will be certain to find an organization ready and able to offer you unsurpassed service . . . the kind that has made Stone one of the world's largest small diameter paper tube manufacturers.

STONE PAPER TUBE COMPANY
INCORPORATED
900-922 Franklin Street, N. E., Washington 17, D. C.

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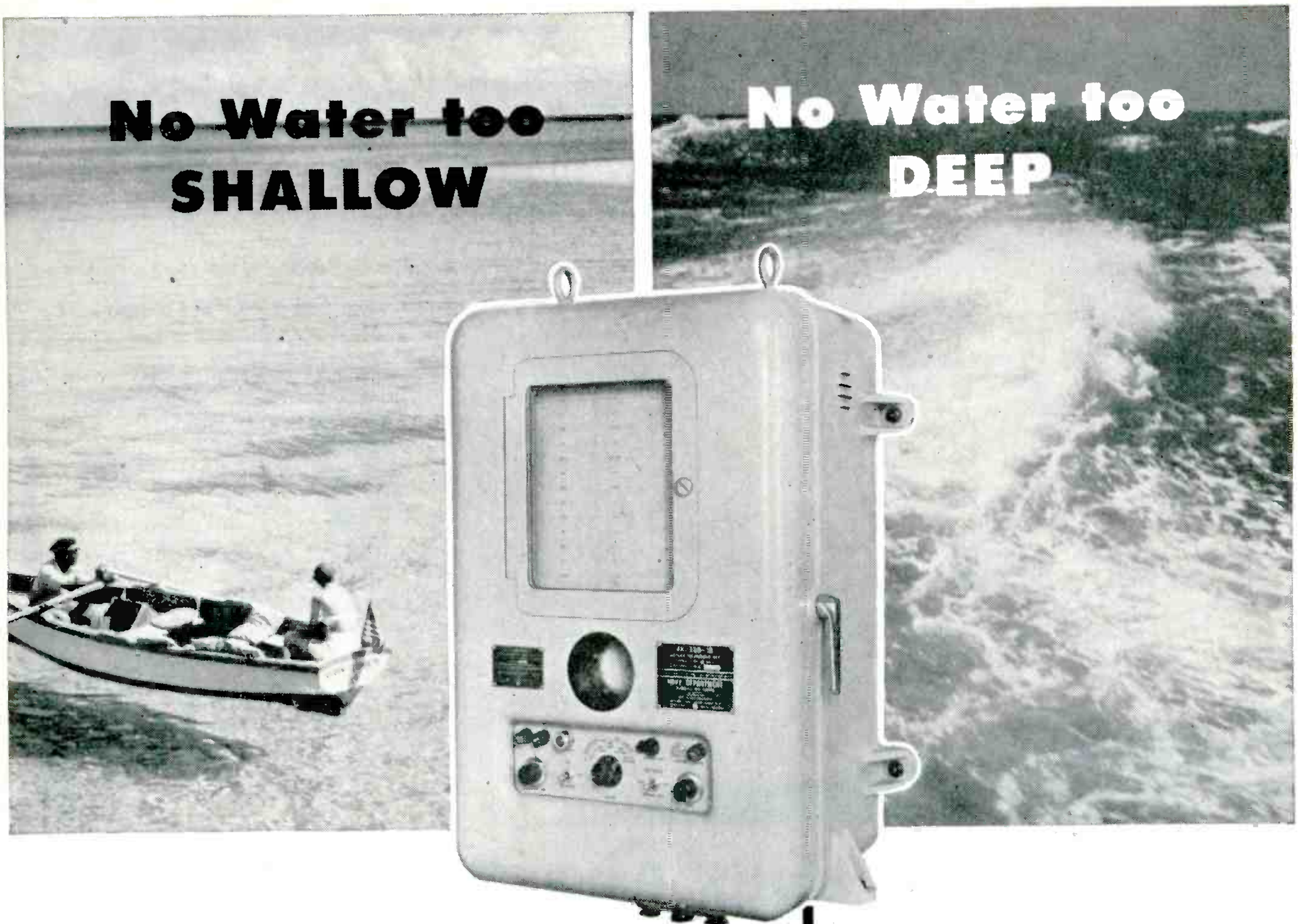


for ACCURATE Measurement by the EDO DEEP DEPTH SOUNDER

In shallow waters or open ocean, the Edo deep depth sounder has been hailed for its remarkable range, accuracy and dependability. Developed for the U. S. Navy, and now in wide use on Navy ships, the Edo 185 is the first depth sounder that can measure any known ocean depth while under way.

Already proven on hundreds of ships and by years of service on survey vessels, the Edo 185 is now available commercially. It represents the ultimate in fine depth sounding equipment, far exceeding other depth finders in performance and usefulness.

RESEARCH AND PRODUCTION GO HAND-IN-HAND AT EDO

Development of electronic equipment such as the Edo 185 Deep Depth Sounder, with performance never before achieved, is part of Edo's continuing program of research in the application of electronics to advanced underwater detection systems of many different types and purposes.

Hand-in-hand with Edo's extensive research experience, go facilities and skilled personnel to manufacture in quantity intricate electronic equipments whose accuracy and dependability have become so well-known.

Behind the design and manufacture of Edo products, stands over a quarter of a century of experience in the design and manufacture of precision equipment. A vast background in the marine and aviation fields assures a highly practical approach to both the design and manufacture of all Edo products. That's why the famed Edo flying fish emblem is recognized more and more as the symbol of quality.

Edo

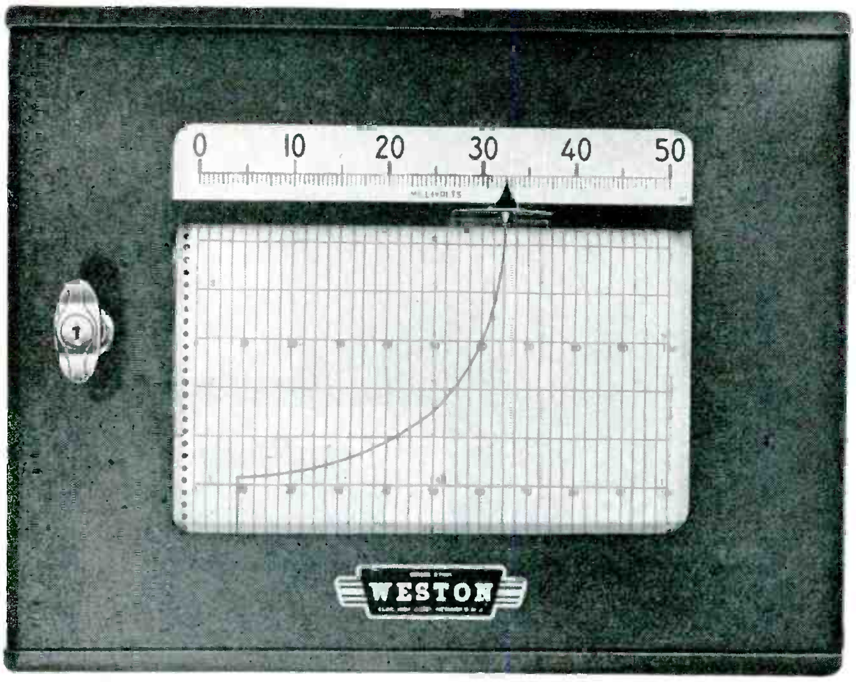
Edo CORPORATION College Point, L. I., N. Y. SINCE 1925

SPECIALISTS IN UNDER-WATER DETECTION EQUIPMENT

THE

Simplicity Features

INSTRUMENT MEN PREFER



Simplified WESTON
Recording Potentiometer

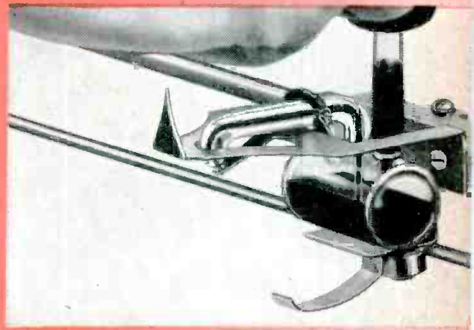
Here is the recorder that has been widely acclaimed by instrument men because its new design concept has contributed new simplicity and new economies in instrument operation and maintenance. More compact, too; and its rugged construction gives it new resistance to vibration and shock, assuring sustained high accuracy over longer periods. Can be used to measure and record temperature, d-c current, d-c voltage, resistance, a-c voltage, a-c current, speed, speed ratio, power, frequency, hydrogen ion (pH), light intensity or any other quantity that can be converted into electrical values. The whole story is available in booklet form. Write for your copy today. WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey. *Representatives in all principal cities. In Canada . . . Powerlite Devices, Ltd., Montreal, Toronto.*

WESTON

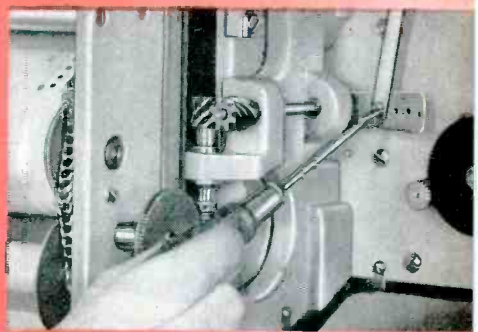
WESTON *Instruments*

INDICATE — RECORD — CONTROL

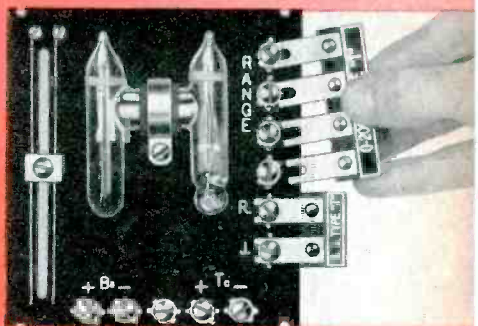
TO CHANGE CHARTS, you simply swing chart frame open a full 180°, insert chart and swing it over timing drum and across front of frame and fasten. No loose pieces to handle!



TO REFILL PEN, simply open chart frame completely exposing pen for quick, easy filling. Recorder continues operation and charts remain in time sequence during filling.

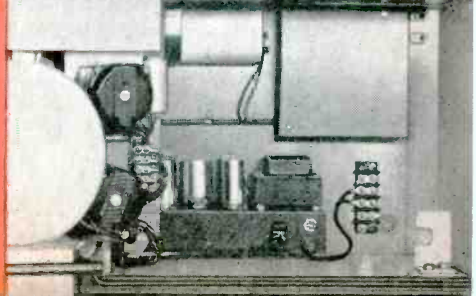


TO CHANGE CHART SPEEDS, a simple screwdriver adjustment gives you a choice of 3 different speeds. These speeds are doubled or quadrupled by changing one worm and gear assembly.



TO CHANGE RANGES, you simply substitute the desired range standard. The reference junction compensation is changed in like manner. No soldered connections to break!

TO REMOVE THE AMPLIFIER, you simply take out two screws and pull two plugs. With no soldered connections servicing is quick and simple. ▼



You get what you set...

Added Evidence that______

Everyone Can Count on

VEEDER-ROOT

Set the predetermining wheels for any run you want. Then, when the counting wheels reach the pre-set number, an electrical contactor makes or breaks the circuit to light a light, ring a bell, or trigger a stop-motion. Yes, this V-R Predetermining Counter is an efficient variable control for *many* types of stop-motion. Short runs and over-runs are prevented on a wide range of machinery, from coil winders to textile looms. Now, figure out how *you* can use this Cost-*Count*rolling Counter. Then write:

VEEDER-ROOT INCORPORATED
"The Name That Counts"
HARTFORD 2, CONNECTICUT
Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

"Counts Everything on Earth"

TAPE DUPLICATION GOES INTO "MASS PRODUCTION"

with the NEW AMPEX Tape Duplicator

Whether you need thousands—or just a few at a time, high fidelity duplicate tapes can now be produced at a cost comparable to disc recordings. The extraordinary fidelity inherent in a good master tape is retained in the duplicates to as high a degree as a sensitive ear can discern. The AMPEX Tape Duplicator is easy to set up, simple to operate and produces up to 80 hours of duplicate performance in 15 minutes operating time.

Duplicate tapes open new opportunities

RADIO BROADCASTING—"Tape networks" and programming services become practical supplements or alternatives to line networks.

BACKGROUND MUSIC—Tape becomes the best medium for background music in that it provides higher fidelity, longer playing and lower attendance costs.

RECORD MANUFACTURE—With mass duplication of tapes now feasible, all performances currently sold on Lp records can also be offered on tape.

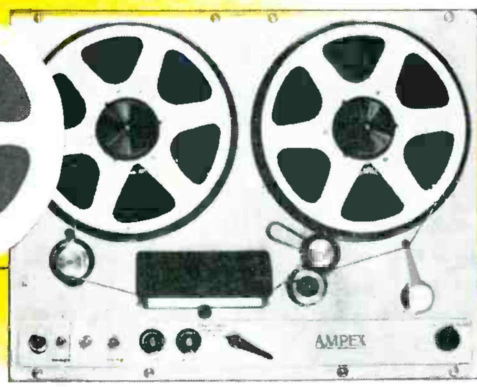
EDUCATION—Systemwide duplication and distribution of educational tapes, music and outstanding school performances becomes practical.

COMMERCIAL DUPLICATING SERVICES—With this efficient equipment now available, excellent business opportunities exist in setting up tape duplication services.

Features of the AMPEX Tape Duplicator

- One to ten simultaneous duplicates (slave recorders can be purchased one at a time as needed)
- Time saving speedup during duplication (as much as 32 to 1)
- *15,000 cycle response on 7½ in/sec. duplicates
- *45 to 50 db signal-to-noise ratio
- Duplicate tapes of any standard speed from any master
- Single or double track duplicates in one pass
- Any standard reel sizes up to 14-inch
- Centralized pushbutton controls

*From master tapes of suitable quality.



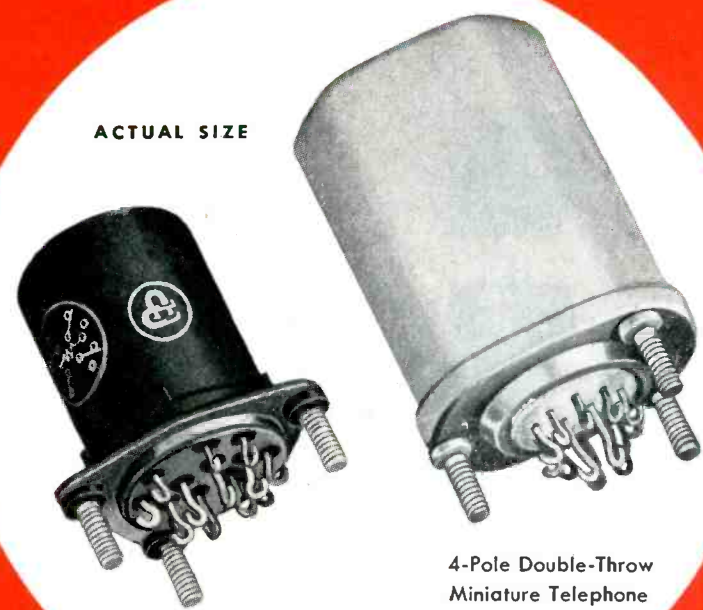
Write Today for further information; Dept. E-1204A

AMPEX
MAGNETIC RECORDERS

AMPEX ELECTRIC CORPORATION • 934 Charter Street • REDWOOD CITY, CALIFORNIA
Distributors in principal cities

ALLIED CONTROL'S NE

- ✓ SIZE CUT 66%
- ✓ WEIGHT CUT 48%
- ✓ RELIABILITY DOUBLED
- ✓ WRIGHT FIELD APPROVED



New MH-12 with Interchangeable Mounting

4-Pole Double-Throw Miniature Telephone Relay

Designed to withstand a shock of 50G, these new Allied Control double-throw miniature relays were developed to meet the rigid requirements of U.S.A.F. Specifications MIL-R-5757A.

Known as the Allied MH series, this new line of relays consists of the 6-pole MH-18, the 4-pole MH-12, and the 2-pole MH-6. Contacts are rated at 2 amps resistive or 1 amp inductive at 28 volts D. C.

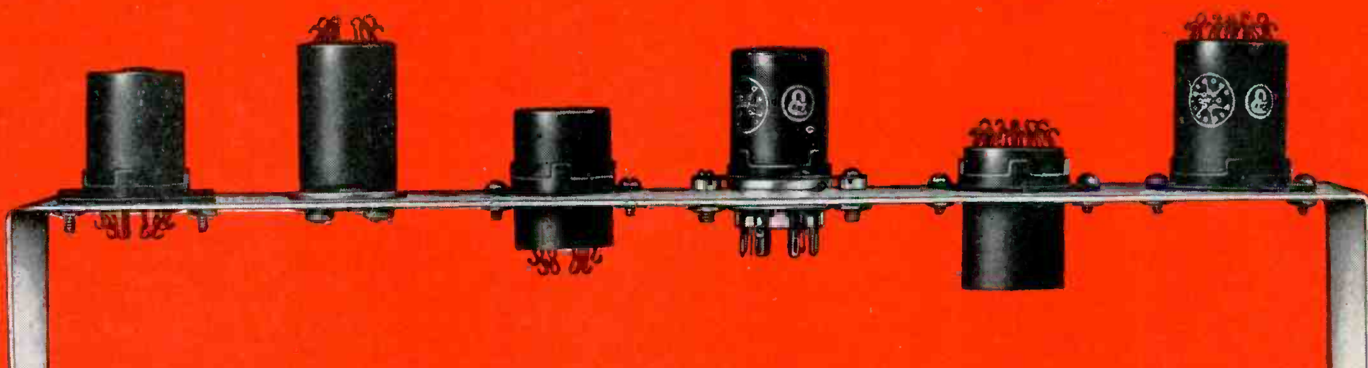
The high performance of these relays has been achieved in an extremely compact, unitized construction and parallels the most recent advances in airborne equipment design. The "actual size" photographs shown above highlight the 66% savings in overall size, the 48% savings in weight and the 30% reduction in chassis area.

For detailed specifications and drawings of these new relays, contact your local Allied Control Representative or write us for Bulletin 1002.

50 G MINIATURE RELAY

APPROVED MIL-R-5757A

SIX DIFFERENT MOUNTINGS



1. Standard Mounting
2. Flush Mounting—2 Studs at ⅝" Centers
3. Thru-Chassis Mounting—Terminals Down
4. Plug-In Mounting With Socket
5. Thru-Chassis Mounting—Terminal Up
6. Flush Ring Mounting

FEATURES

Wide Ambient Temperature Range: *55°C to 85°C standard—65°C to 125°C MHB-type*

Vibration Resistant: *15G's vibration to 500 cycles* • **Operating Shock:** *no contact chatter to over 50G's*

High Altitude: *seal-tested to 70,000 feet*

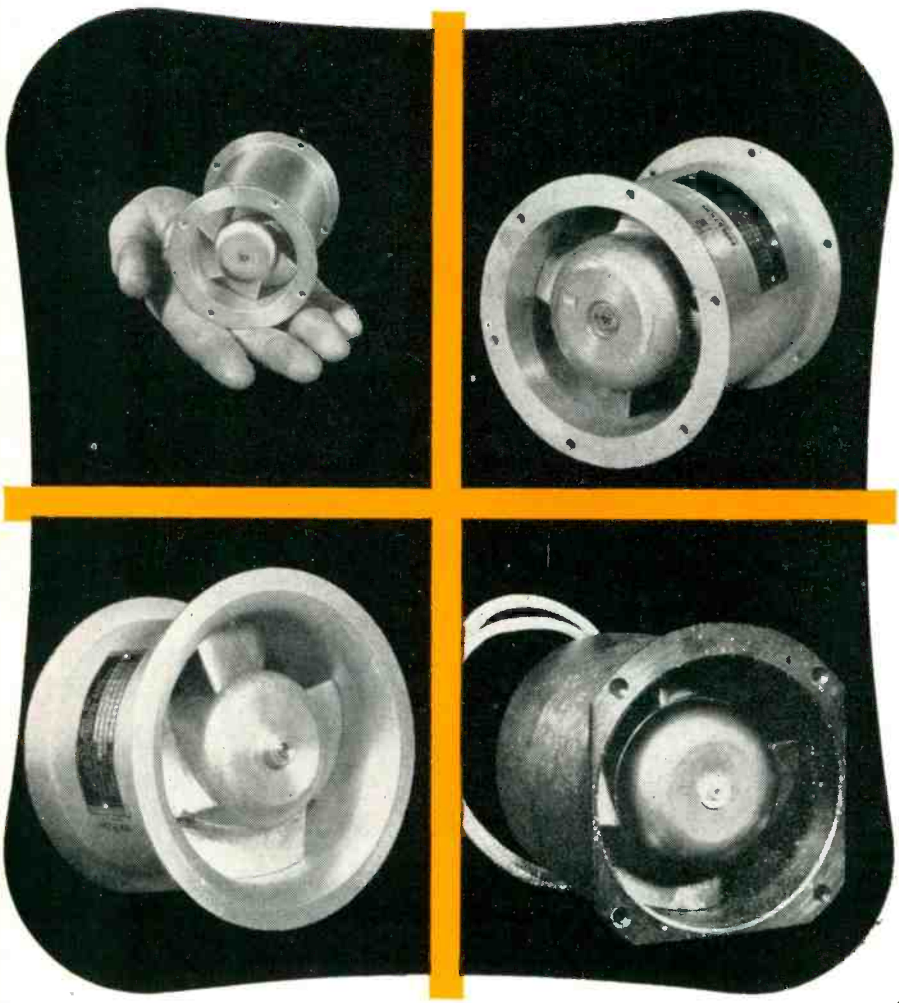
Dependable Operation: *life expectancy of over 1 million operations at rated load*

High Speed: *operate-to-make time under 8 ms.*
release-to-make time under 4 ms.
release-to-break time under 2 ms.

ALLIED CONTROL COMPANY, INC.

2 EAST END AVENUE, NEW YORK 21, N. Y.

Let JOY handle Your FAN ENGINEERING on ELECTRONIC COOLING PROBLEMS



JOY AXIVANE* Fans offer you advantages in electronic equipment cooling which have been thoroughly proved in service. The higher pressure-output of these vaneaxial blowers generally permits more compact arrangement of the equipment. Additional advantages are: light weight, high strength, high shock and vibration resistance, and high efficiency in low or high pressure service.

For minimum weight, JOY electronic cooling fans are made of aluminum, magnesium, or combinations of these metals. They are designed to meet all present Air Force and Naval electronic specifications, and are available in fan sizes from 2″ I.D. up. Totally-enclosed or explosion-proof motors can be furnished where required.

● If you have a problem in heat dissipation from electronic units, no matter what the service conditions may be, let us place at your disposal JOY'S experience as the world's largest manufacturers of vaneaxial-type fans.

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*Reg. U. S. Pat. Office

W&D 1-4010

JOY MANUFACTURING COMPANY

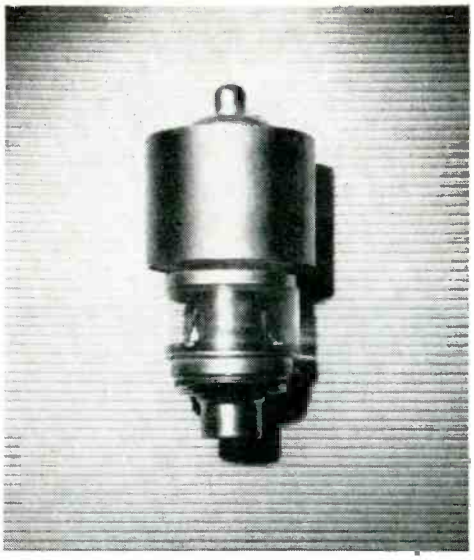
GENERAL OFFICES: HENRY W. OLIVER BUILDING · PITTSBURGH 22, PA.

IN CANADA: JOY MANUFACTURING COMPANY (CANADA) LIMITED, GALT, ONTARIO

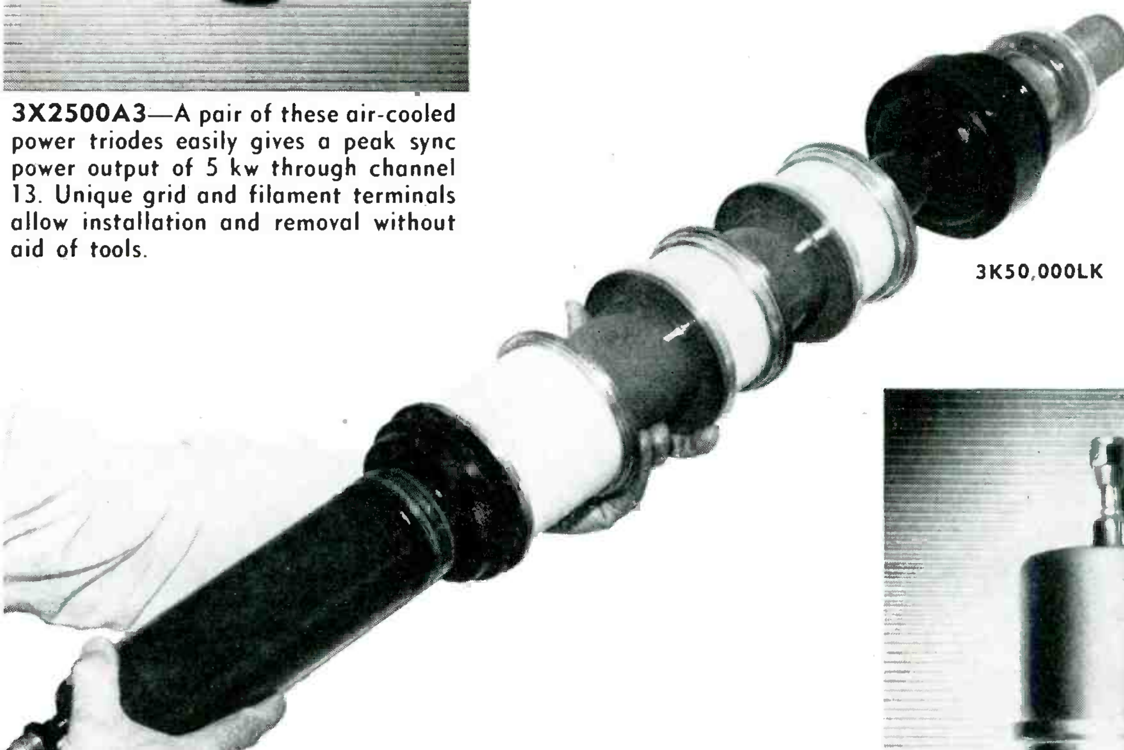
Top Performance for All TV

AT UHF Eimac klystrons provide top power with light weight, convenient external circuitry, economy and spectrum coverage with least amount of tubes.

AT VHF the 4W20,000A and 3X2500A3 typify the outstanding dependability of Eimac's complete line of power amplifier tubes.



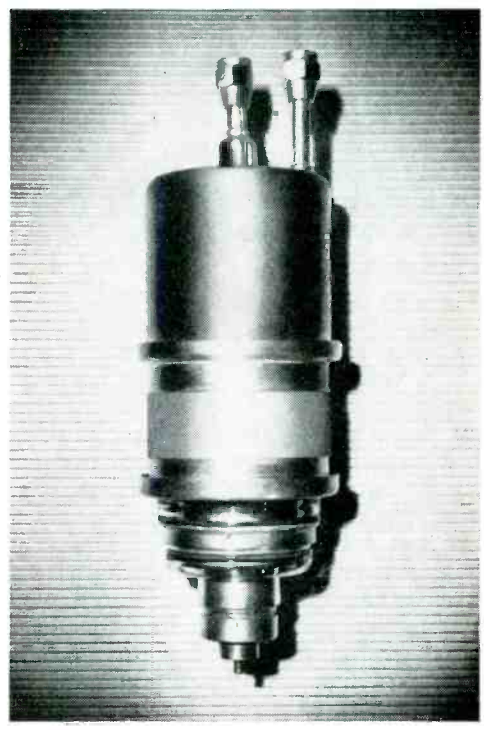
3X2500A3—A pair of these air-cooled power triodes easily gives a peak sync power output of 5 kw through channel 13. Unique grid and filament terminals allow installation and removal without aid of tools.



3K50,000LK

EIMAC KLYSTRONS

type	channels	saturation power	typical peak sync
3K20,000LA	14-32	6 kw	5.5 kw
3K20,000LF	33-55	6 kw	5.5 kw
3K20,000LK	56-83	6 kw	5.5 kw
3K50,000LA	14-32	15 kw	12 kw
3K50,000LF	33-55	15 kw	12 kw
3K50,000LK	56-83	15 kw	12 kw



4W20,000A—A radial-beam power tetrode noted for high power gain and operating economy. Peak sync power output through channel 13 is 25 kw.

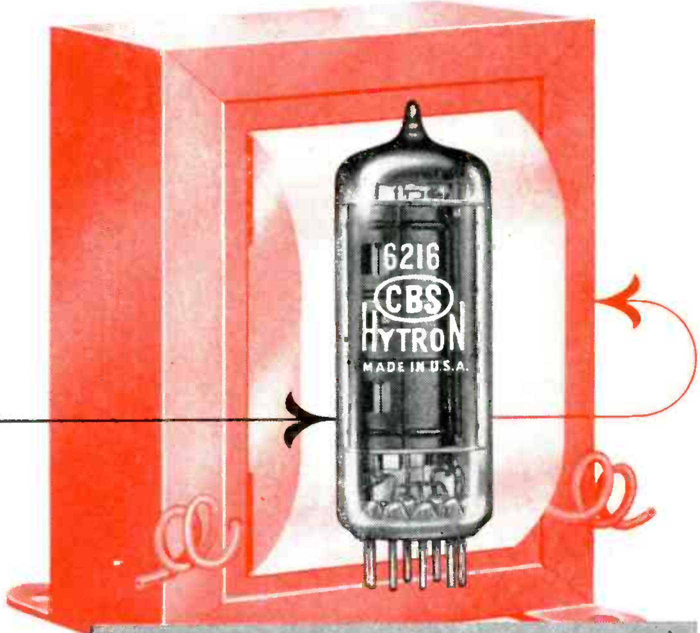
Eimac TUBES

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA
Export Agents: Frazar & Hansen, 301 Clay St., San Francisco, California

Want more information? Use post card on last page.

ANOTHER CBS-HYTRON **FIRST**

CAN A TUBE BE A CHOKE?



Yes, the CBS-Hytron 6216 . . . a 9-pin miniature, beam pentode . . . does the trick. The 6216 filter-reactor tube replaces a bulky, heavy, 12-henry choke rated at 100 ma., 350 ohms.

Light . . . compact . . . vibration-resistant . . . "ruggedized" (for impacts up to 625G), the 6216 is a natural for military airborne and vehicular equipment. Electrical design offers low d-c resistance (tube drop) and high a-c impedance (plate resistance). The two prime requisites of a good filter reactor.

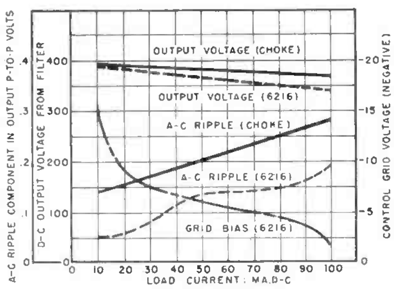
Check the 6216's many features. Note the simple filter-reactor circuit. Compare performance of 6216 with that of an iron-core choke. Note also the many other possible applications for this versatile CBS-Hytron original. Write for complete data. Or order the CBS-Hytron 6216 today.

CBS-HYTRON 6216 *FEATURES*

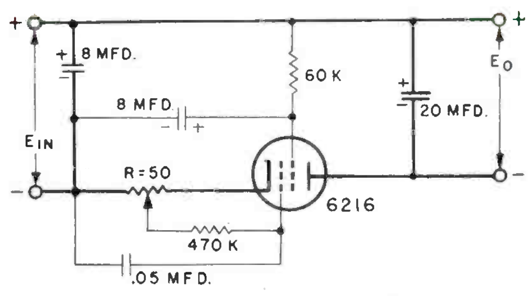
1. "Ruggedized," vibration-resistant construction
2. Inhibited interface formation ("sleeping sickness")
3. Over-all characteristics optimized for maximum efficiency
4. Very high perveance
5. Extreme power sensitivity
6. Conservative ratings for reliable performance

COMPARISON OF FILTERING ACTION 6216 vs. Choke — 12 Henries, 150 Ma.

Operating conditions for 6216: Grid bias, see curve; screen voltage, derived from 400v through 60,000 ohms; filament voltage, 6.3v; unfiltered voltage applied to filter, 400v.



TYPICAL FILTER-REACTOR CIRCUIT USING 6216



How the circuit works: High a-c impedance of 6216 . . . operated above knee of Ib vs Eb curve . . . is in series with load. Limits ripple current. Small voltage across lower portion of R is applied to grid through 0.05 mfd condenser. 6216 amplifies this voltage . . . which develops ripple voltage across load impedance in phase opposition to ripple voltage of load. Inverse feedback suppresses ripple still further. With two 6216's in parallel, d-c resistance is halved; load current for given IR drop and power sensitivity is doubled.

OTHER APPLICATIONS FOR CBS-HYTRON 6216

Special features of CBS-Hytron 6216 offer many advantages as: (1) Wide-band video amplifier. (2) Husky, vhf class C amplifier or frequency multiplier. (3) Class A or B amplifier. (4) Pass tube in electronic voltage-regulated power supply. (5) Passive switching tube, with low cut-off voltage requirement.

FREE DATA. Write for complete 6216 data and curves today.

CBS HYTRON

Manufacturers of Receiving Tubes Since 1921

CBS-HYTRON Main Office: Danvers, Massachusetts

A Division of Columbia Broadcasting System, Inc.

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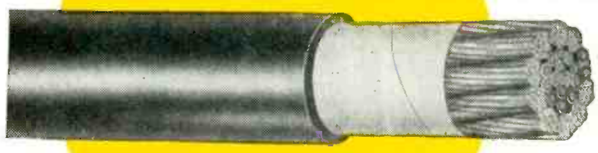
SIMPLE or COMPLEX...

Special Rome Synthinol® 901
HOOK-UP WIRE—8 MIL WALL
with nylon jacket overall

Underwriters' approved for 105° with no assigned voltage

Special 136
CONDUCTOR

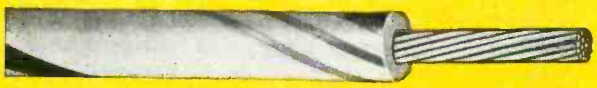


ROME SYNTHINOL INSULATED CABLE

Look to "Rome"

for your special cable requirements

COMMERCIAL TYPE HOOK-UP WIRES



Rome manufactures commercial type hook-up wires with three standard insulations.

ROME HI-TEMP—a rubber insulation with exceptionally high resistance to heat and moisture., Underwriters' approved for 75° C.

ROME SYNTHINOL—a polyvinyl chloride thermoplastic compound, highly resistant to acids, oils, alkalies, moisture and flame. Underwriters' approved for 80° C.

ROME SYNTHINOL 901—offers all the advantages of Rome Synthinol *plus* higher resistance to heat deformation, baking embrittlement, shrinkage and cracking; also improved solderability. Underwriters' approved for 105° C.

Available in sizes 24 AWG to 16 AWG for 300 and 600 volt ratings (Rome Synthinol sizes 18 AWG to 14 AWG for 1000 volts), plain or with outer covering.

MILITARY TYPE HOOK-UP WIRES

Rome Cable is a manufacturer of military types SRIR SRHV and WL, complying with Joint Army-Navy Specification JAN-C-76, as well as shipboard types SRI and SRIB conforming to Specification MIL-C-915A(SHIPS). Insulated with Rome Synthinol, these wires are manufactured in a complete range of specification sizes.

Designing and manufacturing special wires and cables to meet the most exacting requirements of electronic and other electrical equipment manufacturers is a specialty with Rome Cable. Perhaps your specifications call for a complex product like the 136 conductor cable, illustrated above, for electronic computers. Or you may require something as simple as the single conductor, space-saving hook-up wire, with an *8 mil* wall. Regardless, Rome has the techncial skill, engineering experience and plant facilities to offer the exact cable for your particular need.

Rome also produces a wide range of commercial type hook-up wires, television camera cables, intercommunication cables and radio frequency transmission line. All can be manufactured for exceptionally low dielectric losses at all frequencies, high heat resistance and conductivity. For special cables, it pays to go to cable specialists. Make Rome your source for special cables. For complete information, send the coupon below.

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Please send me information on Electronic Wiring

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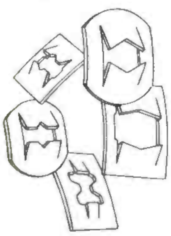
TINNERMAN® Speed Nut SAVINGS STORIES

FASTEST THING IN FASTENINGS®

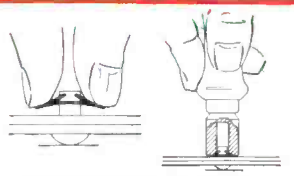
NEW Tinnerman Push-On SPEED NUTS®
...for wide range of applications

—PRICE SAVINGS AVERAGE 25%!



● Tinnerman, originators of Push-On type SPEED NUTS, offers this new C12000 Series at substantial savings! Large volume, high speed production, plus years of engineering and manufacturing experience make this economy possible! These new lightning-fast Push-Ons are available in a complete range of popular sizes, with rust-resistant finish, for round, D-shaped or rectangular studs. A unique feature, exclusive with Tinnerman Push-Ons, is their use over D-shaped studs where removability is desired.

Call or see your Tinnerman representative for full, cost-saving information about these new, low-priced Push-On type SPEED NUT brand fasteners.



NEW C12000 Push-On SPEED NUTS

...are one-piece, self-locking, spring steel fasteners. Start by hand...zip down over integral studs, rivets, tubing, nails, any unthreaded parts; bite lock on smoothest, hardest surface!

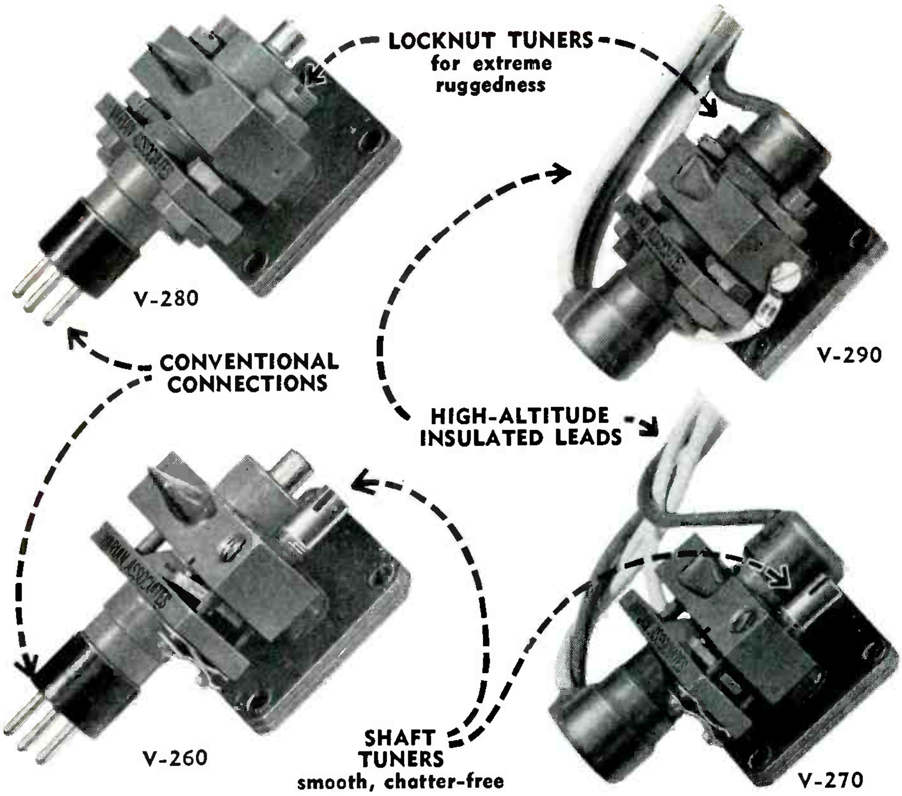
Send today for copy of "Greater Savings Than Ever with C12000's": also FREE Production Samples! Write: TINNERMAN PRODUCTS, INC., Dept. 12, Box 6688, Cleveland 1, Ohio. *In Canada:* Dominion Fasteners Ltd., Hamilton, Ontario. *In Great Britain:* Simmonds Aerocessories, Ltd., Treforest, Wales. *In France:* Aerocessoires Simmonds, S. A.—7 rue Henri Barbusse, Levallois (Seine).

TINNERMAN Speed Nuts®

MORE THAN 8000 SHAPES AND SIZES

VARIAN associates*

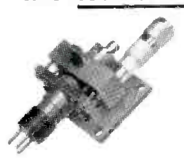
X-BAND KLYSTRONS in QUANTITY



GENERAL DATA	**V-260, V-270**	**V-280, V-290**	**X-13**
Frequency Range, kmc	8.5-10.0	8.5-10.5	8.2-12.4
Heater Voltage, v	6.3	6.3	6.3
Heater Current, amp	1.2	1.2	1.2
Tuner	slotted shaft	locknut	micrometer
MAXIMUM RATINGS			
Resonator Voltage, v	350	385	500
Resonator Current, ma	42	74	65
Reflector Voltage, v	0 to-1000	0 to-1000	0 to-1000

TYPICAL OPERATION	V-260, V-270		V-280, V-290		X-13	
Resonator Voltage, v	200	300	200	300	300	500
Frequency, kmc	9.3	9.3	9.3	9.3	10	10
Resonator Current, ma	17	28	23	42	28	58
Power Output, mw	20	70	15	48	90	560
Electronic Tuning Range, mc	30	48	50	82	46	43
Temperature Coefficient, kc/°C	60	60	60	60	100	100
Reflector Voltage, v	-120	-160	-80	-100	-230	-600
Load VSWR, less than	1.1	1.1	1.1	1.1	1.1	1.1
Warm-up Time, sec to Oscillation	15	15	15	15	15	15

OUTSTANDING FEATURES of the series include rapid warm-up to on-frequency operation in 30 seconds, non-microphonic characteristics, low-voltage operation, lightness (6 oz.), compactness (volume less than a 2-in. cube), negligible barometric-frequency coefficient, smooth, chatter-free rotary-shaft tuners (V-260, V-270), integral-lead terminations (V-270, V-290) brought out through molded silicone-rubber structures to permit unpressurized operation to extreme altitudes and temperatures without arc-over, matched load operation without external matching sections, and waveguide outputs. All tubes are tested under high amplitude vibration conditions.



FOR LABORATORY measurement work at x-band—the familiar Varian X-13 general-purpose signal source (the prototype for this series of tubes) is now available for early shipment in production quantities.

VARIAN associates

FIELD REPRESENTATIVES IN 21 CITIES

rugged local oscillators for radar and beacon services

...full production

...quantity prices

...firm basis for new equipment design

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For full data,
write Section ABAX,
Varian Associates,
Palo Alto, Calif.

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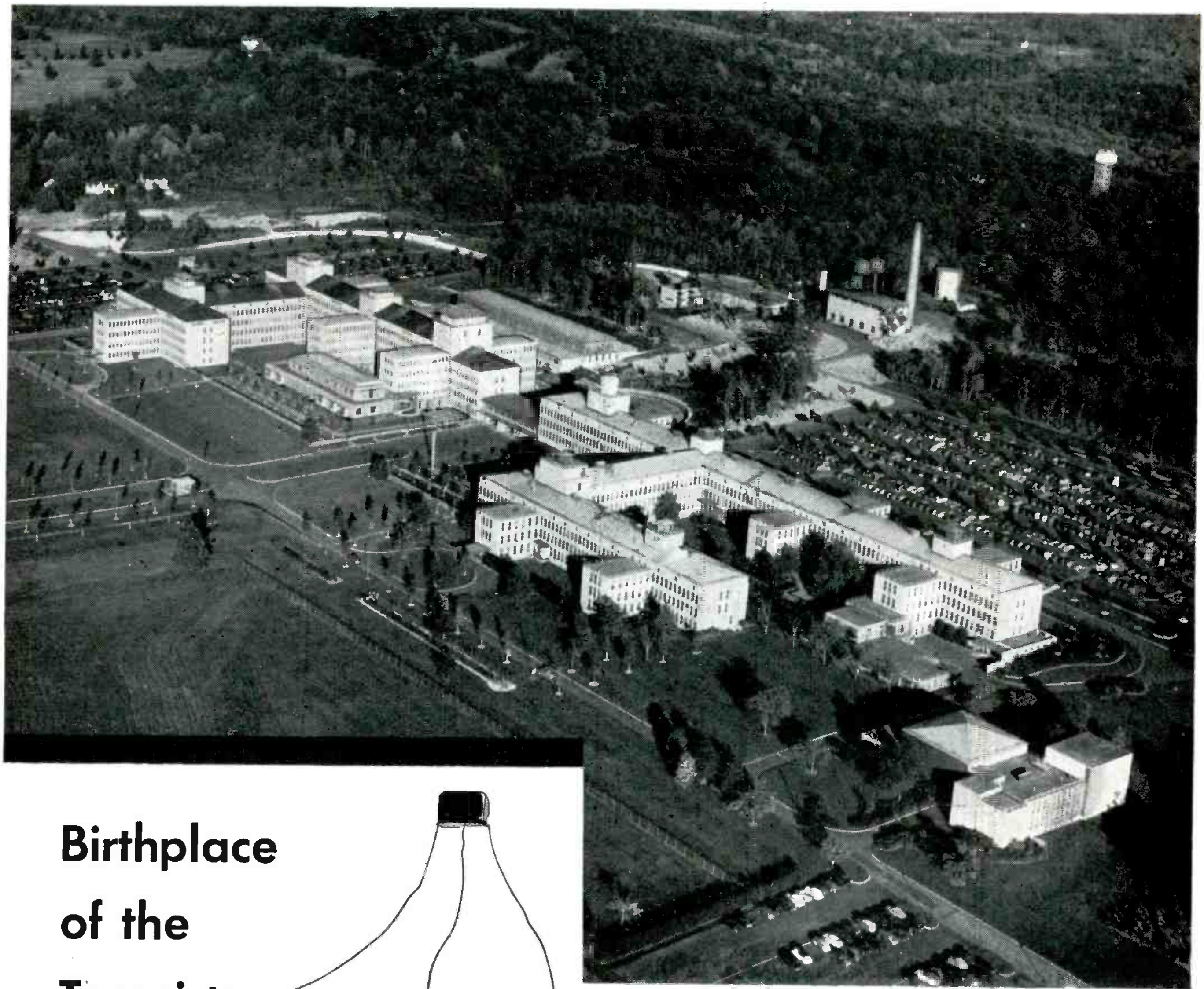

Birthplace of the Transistor

Bell Telephone Laboratories at Murray Hill, N. J. Other laboratories are in New York City and at Whippany and Holmdel, N. J.

The ***Transistor,*** that revolutionary new electronics device, is a product of *telephone* research. It was conceived, invented and developed at Bell Telephone Laboratories by men in search of ways to improve telephone service. It was announced just five years ago.

The ***Transistor*** can do most of the things that vacuum tubes can do—and others, too—but it is not a vacuum tube. It works on entirely new physical principles. Rugged, simple and tiny, the Transistor uses incredibly small amounts of power—and then only when actually operating.

Transistors promise smaller and cheaper electronic equipment and the spread of electronics where other equipment has not been able to do the job as economically. They are already at work in the Bell System, generating the signals that carry dialed numbers between cities, and selecting the best route for calls through complex switching systems. Engineers see many other possibilities: for example, as voice amplifiers in telephone sets to aid the hard of hearing, and as switches.

Recognizing the tremendous possibilities of the ***Transistor*** in every phase of the electronics industry, the Bell System has made the invention available to 40 other companies. Thus, again, basic research to improve telephony contributes importantly to many other fields of technology as well.

TRANSISTOR SUMMARY

Basically, a ***Transistor*** is a tiny wafer of germanium with three electrodes, over-all about the size of a coffee bean.

It can amplify signals 100,000 times on much less power than a pocket flashlight requires. This opens the door to its use in smaller telephone exchanges where vacuum tube equipment would be too costly to operate.

Unlike a vacuum tube, the ***Transistor*** has no vacuum and no filament to keep hot. It operates instantly, without "warm-up" delay. The Transistor can also be used as an electric eye and to count electrical pulses.

BELL TELEPHONE LABORATORIES

There are many opportunities for creative scientists and engineers at Bell Telephone Laboratories. For details see our advertisement on page 401

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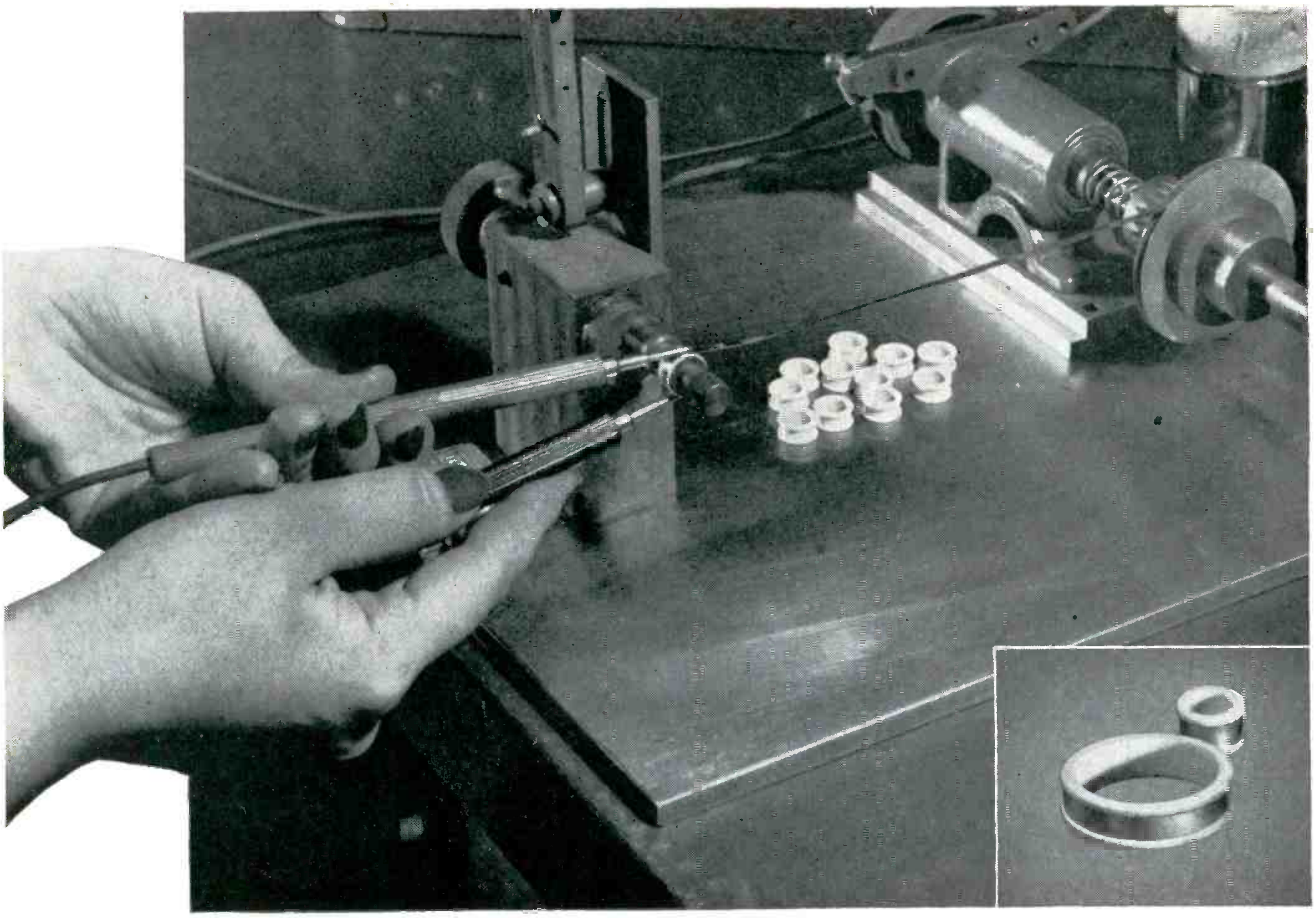

Hiperthin* Cores . . .
newest approach to electronic circuit designs

New circuit designs, often making it possible to replace tubes in amplifiers, computers, modulators and similar electronic equipment, are being developed through the use of Westinghouse Hiperthin Cores.

An entirely new, thin magnetic material, capable of retaining its desirable qualities even when rolled as thin as 1/8 mil, is the reason.

Compounded of grain-oriented silicon or nickel-iron alloys, it combines the fast response, high permeability and low coercive force needed in vhf circuits. Non-deteriorating, it eliminates the periodic replacement problem encountered with tubes, assuring sustained and accurate performance.

To manufacture the new core economically, Westinghouse engineers devised new production methods. The illustration above shows a core being subjected to an electronically controlled spot weld, after being wound. New techniques have also been developed for effectively insulating the turns, and for annealing the metal on a ceramic form as a unit to insure permanent stability.

All your core requirements . . . whether they're for electrical or special electronic applications . . . can be met best by engineers who know and understand your problems. For further information write for reprint No. 4866, *Progress in Core Material for Small Transformers.* Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-70676

*Trade Mark

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

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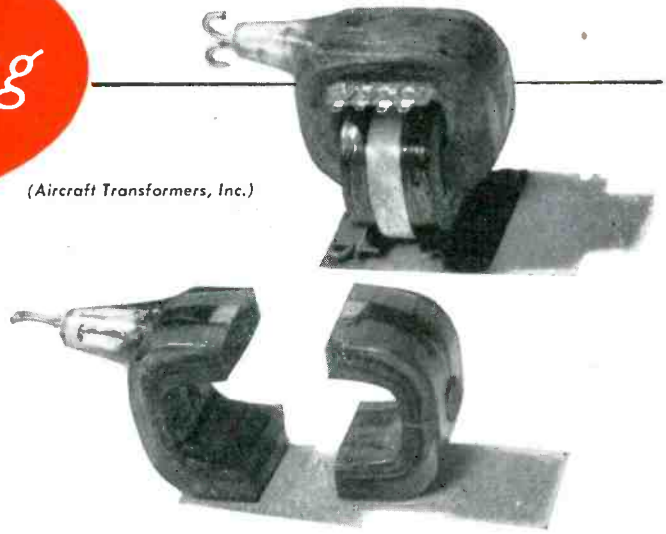
IDEAS *in the making*

Araldite® Bonding, Casting and Coating Resins developed by Ciba Research are simplifying manufacturing methods, improving product efficiency, and opening new fields of product development. You will want to know more about them.

(G. C. Wilson & Company)

ELECTRONIC ASSEMBLY OF AIR-TO-GROUND ROCKET MADE MOISTURE-PROOF AND STRENGTHENED WITH EPOXY COATING RESIN

The time-saving simplicity of coating operations combined with the rugged protection afforded by ARALDITE coating resins make applications such as this routine on either a specialized assembly or mass production basis.



(Aircraft Transformers, Inc.)

EPOXY RESIN ENCAPSULATES TRANSFORMER COILS

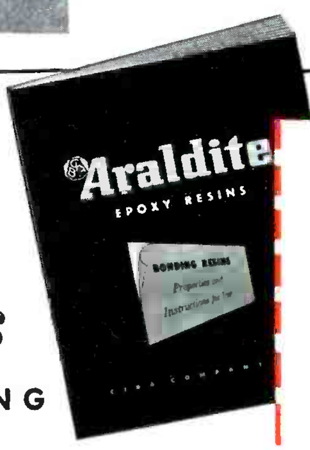
The excellent dielectric properties of ARALDITE epoxy casting resins coupled with high affinity for metals have made them "the resin of choice" among leading electrical and electronic designers and manufacturers for potting and impregnating transformers, capacitators, coils, motor windings and similar apparatus requiring long-lasting efficiency in operation.

(Cordo Chemical Company)

EPOXY RESIN PRE-IMPREGNATES GLASS CLOTH

The application of ARALDITE "CN" epoxy impregnating resins by fabricators of glass laminates suggests a wide field of related uses where the low shrinkage, excellent dielectric strength, exceptional resistance to chemical attack and durable adhesive properties provide unprecedented advantages for product "in use" efficiency. ARALDITE impregnating resins are produced in types suitable for either heat-curing or self-curing. ARALDITE is available as pre-impregnated cloth or as cured laminates.

CIBA
Plastics
BONDING ★ CASTING
COATING RESINS



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

CIBA COMPANY, INC., PLASTICS DIVISION
627 Greenwich St., New York 14, N. Y.
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*Company*__________ *Title*__________

*Address*__________

E-7

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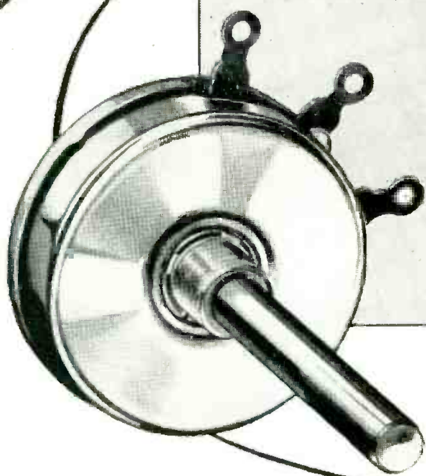
Need a wire wound control with a million cycle life?



Probably not. But if you use wire wound controls you can learn something from an experience of one of our major airlines. They came to us with this problem . . .

> When an aileron moves, resistance through a wire wound control changes . . . transmitting the aileron position to the automatic pilot which instantly and automatically corrects the aileron position. As a result, the aileron control is moving almost constantly within a very narrow range. It was the highly concentrated wear in this area that was causing the trouble.

The answer to the problem was a standard Mallory wire wound control except for special contact materials that provided the needed life. The result was a million cycles of dependable operation with substantial economies in maintenance schedules.

You may never need a control that will last for a million cycles, but you can bet that Mallory will have the answer to your control problems . . . standard or special. For complete information, write for your copy of our new Technical Information Bulletin 76-3 covering both military and commercial types.

Expect more . . .

***Get more from* MALLORY**

P.R. MALLORY & CO. Inc.

Parts distributors in all major cities stock Mallory standard components for your convenience

P.R. MALLORY & CO. Inc.
MALLORY

SERVING INDUSTRY WITH THESE PRODUCTS:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
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Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

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

CROSS TALK

▶ **TARGET** . . . NTSC panel chairmen are working toward a September 1 deadline for the preparation of final reports on compatible color television. It seems certain that a request for a hearing will be filed in Washington well before the first of the year and it is likely that the FCC will accede to the request by then or soon thereafter.

Setting of a hearing date often takes three months or more after the filing of a request, due to the weight of preparatory paperwork and other necessary routine. In this instance it is believed that the Commission may waive some preliminary requirements; it is being kept well informed concerning the Committee's work and is closely following field tests now in progress.

▶ **TESTS** . . . When panel chairmen testify before the FCC in behalf of compatible color television they will be well prepared to answer questions regarding the NTSC system. Tests now in progress in half a dozen cities are exhaustive, covering even such fine points as possible radiation by color oscillators in the amateur bands.

Membership on the Committee is no sinecure. Just a few weeks ago, for example, we spent two days helping to set up specifications and equipment for just one test, and then stayed up all night running off data. Others have done much much more.

▶ **CONTROLS** . . . Experimental compatible-color-tv receivers are indeed more difficult to adjust during installation than the latest commercial monochrome models. It seems to us, however, that the adjustments are not much more difficult than they were on early monochrome sets and that they hold just about as well. Reduction in the number of back-of-set controls and minimizing of interaction between controls should come quickly as the art progresses.

Front-panel tuning is surprisingly simple and stable. There may be more fiddling around by the user of the first commercial models but we remember an early experience with a monochrome set. It resisted informed manipulation but performed beautifully the instant a neighbor's small boy ostensibly threw everything out of whack. This experience is nicely covered by the quotation "And a little child shall lead them."

▶ **MONSTERS** . . . Last month (p 129) it was speculatively noted that this may be the first commercially significant year for circuit mechanization. Since then a number of machines designed for automatic production of electronic devices or subassemblies have been seen, most of them in back rooms.

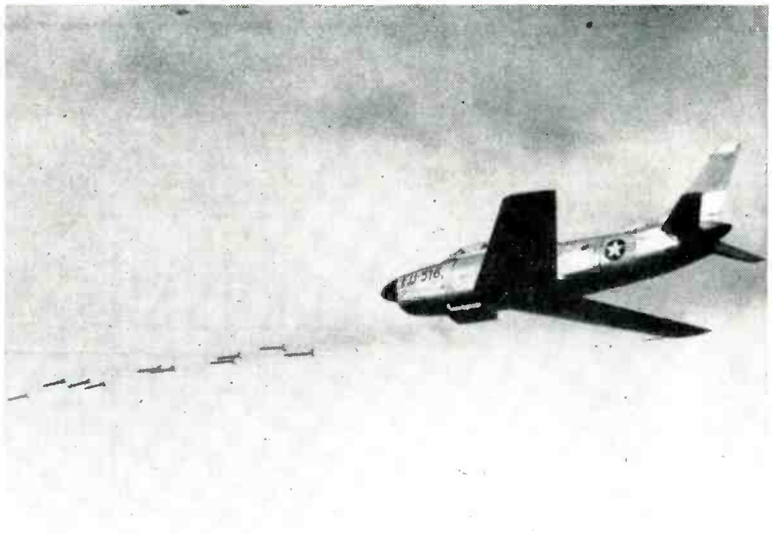
One of the reasons why such machines are just now coming to light is that manufacturers are getting over their hesitancy to invest heavily in relatively inflexible equipment; the design of such things as radio receivers is relatively stable. Another is the development of machines that are, in fact, more flexible than their early prototypes. Still another is a growing tendency to gamble on the retention of necessary production-line help during the transition from women to machines.

The latter problem can be sticky. In one plant production workers refer surreptitiously to a backroom machine as "The Monster."

▶ **TREND** . . . The trend toward 12-volt systems appears to be at least momentarily halted at a mere handful of American automobiles. That handful is pretty important saleswise, however, so several manufacturers of mobile radio equipment and accessories are reluctantly designing so-called "universal" equipment to operate on either 6 or 12. It is, apparently, expensive to convert existing 6-volt gear to 12-volt operation in many cases.

▶ **SHOPTALK** . . . The response to ELECTRONICS' cleaner and more continuous editorial makeup has been substantial and favorable. Many useful suggestions for further improvement have been received. In general, readers, like Oliver Twist, say: "Thanks, give us more." This we will do, as proposals prove out from a practical publishing standpoint.

GROUND-TO-GROUND—Air Force Matador wings over Atlantic near Cocoa, Fla.



AIR-TO-AIR—Mighty Mouse rockets fired from North American Sabre are electronically aimed

How Electronics Controls

Air-defense and surface-bombardment weapons nearing production stage anticipate era of pushbutton warfare. Electronics plays major role in their control and guidance. Details of V-2 control system illustrate how servo loop corrects trajectory and flying position

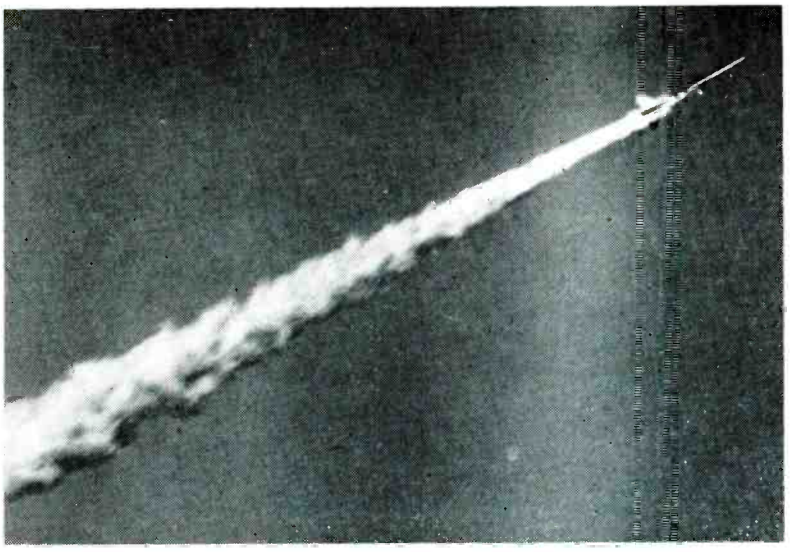
By JOHN M. CARROLL
Assistant Editor
ELECTRONICS

ROCKETING into the skies, missiles like Nike may represent America's last line of defense against hostile bombers laden with atomic bombs. Radar, tracking the invader, would feed course and speed data to ground-based computers that sense guidance information and transmit it to the missile. Developed jointly by Douglas Aircraft and Western Electric, Nike reportedly can track down and destroy supersonic bombers flying at great altitudes.

This and other missile types now nearing production embody the results of an eight-year research program that cost better than $4 billion and employed the talents of countless thousands of engineers and scientists. The work was divided almost evenly between aerodynamists and electronic specialists. Few electronic firms and research laboratories have not been touched in some way by the program.

Cloak and Dagger

The origins of our guided-missile program go back to the holocaust that marked the last days of Hitler's Third Reich. Fleeing their laboratories at Peenemuende on the sandy, wind-swept Baltic seacoast to escape the advancing Red Army, guided-missile experts of the Luftwaffe and army ordnance had scarcely set up shop in the Bavarian-Alps village of Kochel when



GROUND-TO-AIR—Boeing GAPA furnished valuable knowledge about rocket air-defense technique

AIR-TO-GROUND—Navy fighter launches Tiny Tim rocket at Inyokern, Calif., test center

GUIDED MISSILES

news of the collapse of German resistance reached them.

A hasty decision was made to surrender to American forces. Meanwhile, technical intelligence teams following in the wake of the Allied advance uncovered stores of V-2 rockets and parts in the vast underground factories at Nordhausen. Army missile men credit the 120 German scientists and 100 rockets evacuated to the U. S. with saving more than $50 million and five years research time in our program. During the past six years, the Army has test-fired nearly seventy V-2's at White Sands Proving Grounds.

German Missiles

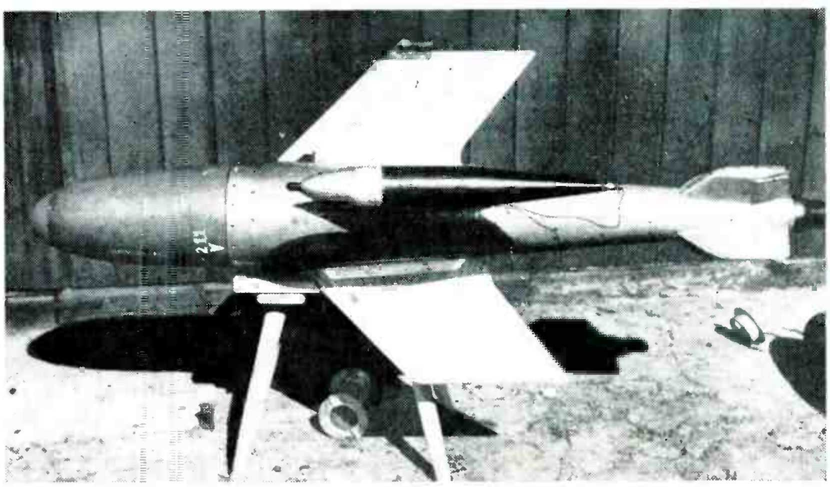
The first V-2 rocket struck London in the fall of 1944. Subsequently 1,152 V-2's were fired against England and 1,314 against the Dutch port of Antwerp after its capture by the Allies. The V-2 was 47 ft long. Loaded, it weighed over 14 tons, including 9.7 tons of liquid propellent. The rocket carried its 2,000-lb warhead 250 miles. Allied intelligence teams delving into German naval research notes unearthed plans to launch V-2's from submarine-towed caissons that could surface near coastal targets.

Forerunner of the V-2, the V-1 was a pulse jet guided by an autopilot with compass and altimeter correction. Thirty feet long, it had a 200-mile range and loafed along at 360 mph.

Tactically more potent than either V-1 or V-2 were radio-controlled glide bombs used with devastating effect against Allied shipping in the Mediterranean. A tone control system enabled the bombardier in a mother plane to correct the bomb's course after launching.

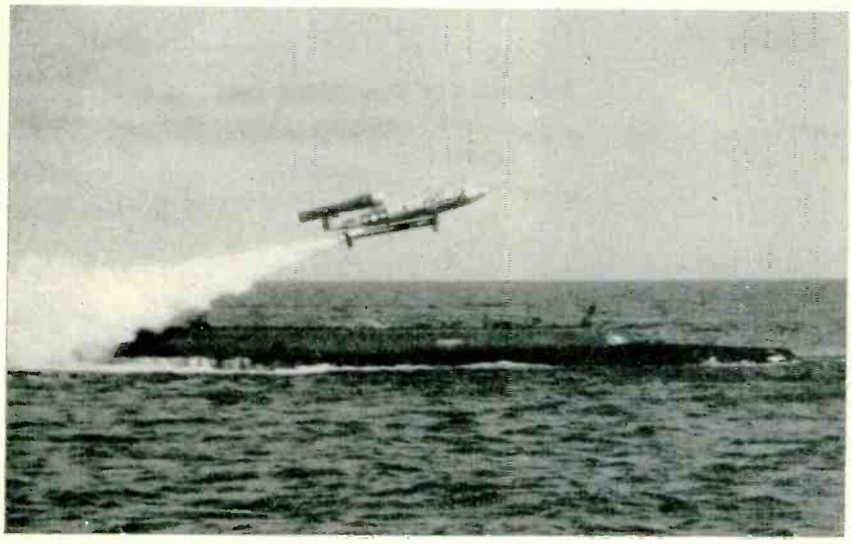
Less publicized were the radio-controlled antiaircraft rockets Rheintochter and Wasserfall. Wasserfall was guided by an automatic aiming device working in conjunction with Wurzburg radar fire-control equipment. It attained a 1,700-mph speed.

Immune to Allied electronic countermeasures was the Spieler, a Luftwaffe air-to-air missile. Spieler received its control signals from the



SPIELER—Developed by German Luftwaffe, this air-to-air missile received control signals over wire, making it immune to electronic countermeasures. Proximity fuze increased missile's deadliness

BOMBARDMENT MISSILES

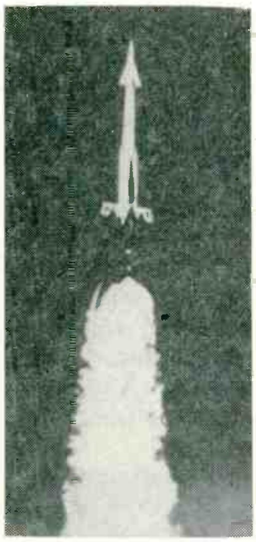


LOON—Navy version of German V-1, this pilotless pulsejet has been successfully fired from submarines. Missile is carried in waterproof hanger aft of conning tower while underwater

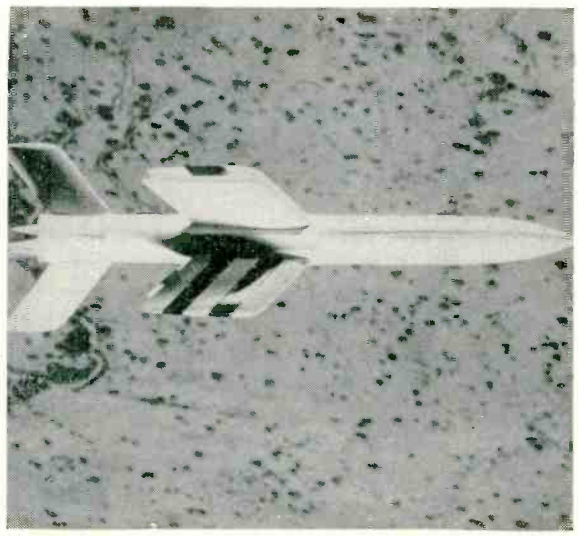
REGULUS—Chance-Vought missile designed for Naval shore bombardment and amphibious warfare

INTERCEPTORS

LARK—Navy ground-to-air interceptor built by Fairchild. Newer Navy interceptors include Terrier, a Johns Hopkins-Convair missile and the Sperry Sparrow



NIKE—Army ground-to-air interceptor developed jointly by Douglas and Western Electric



FIREBIRD—Launched from a mother plane, this early Ryan-built Air Force missile was bracketed on target by mother plane's radar. Other USAF pilotless fighters are Boeing Bowmarc and Hughes Falcon

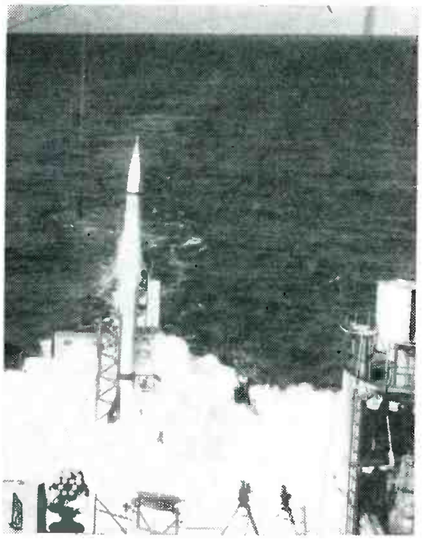
mother plane neither by radar nor radio but over a thin wire that it spun-out spider-like during flight.

Glide Bombs and Drones

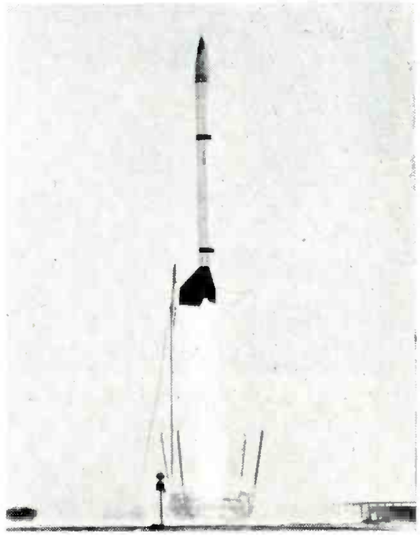
Guided missiles include glide bombs and pilotless aircraft as well as rockets. Prior to 1945 American missiles fell almost exclusively into the first two classes. The Bat, a glide bomb guided to its target by self-contained radar, sank many tons of Japanese shipping. Other guided bombs such as Azon, Razon and Tarzon were used in the ETO.

First pilotless aircraft were target drones. Jet drones like the Ryan Q-2 Firebee are still useful in training antiaircraft gunners and radarmen. Pilotless planes were used tactically during World War II when war-weary B-17 bombers laden with high explosive were crashed into their targets by command signals from a mother plane. The Navy recently used drone-controlled F6F Hellcats against objec-

MATADOR—Designated B-61, this Martin-built Air Force tubojet aircraft is designed for long-range bombardment



VIKING — Launching from seaplane tender Norton Sound. Viking is built by Glen L. Martin



CORPORAL E—Developed for Army by CalTech, this ground-to-ground missile will be built by Firestone

tives in Korea. A built-in television camera was used to provide the pilot with a display of the drone's instrument panel.

Lockheed QF-80 pilotless jet bombers gathered valuable data on radiological hazards within the atomic cloud during nuclear tests at Yucca Flats, Nevada. The QF-80 uses the Sperry E-4 autopilot to correct unwanted deviations while responding to command signals. It can take off and land automatically.

The Loon, Navy version of the German V-1, has been successfully launched from submarines.

Also interested in pilotless aircraft, the Air Force has announced that it is forming squadrons of Martin B-61 Matadors.

American Rockets

Army, Air Force and Navy Bureaus of Aeronautics (BuAer) and Ordnance (BuOrd) share responsibility for running 30-odd missile development programs and 51 major development facilities.

The Army recently announced production of two missiles, Nike for air defense and Corporal E, a missile much like the V-2, for ground-to-ground bombardment. A contract has also gone out to Chrysler to produce Redstone, a long-range, ground-to-ground missile developed by ex-German scientists at Redstone Arsenal. Army guided-missile battalions have already had field training with Nike.

The Navy appears to favor the Convair Terrier as its ground-to-air interceptor missile.

Viking-9, offshoot of an early research vehicle, is the Navy opposite number to the Corporal E. Viking rounds have been launched from the seaplane tender Norton Sound.

A newly-unveiled Navy missile, Regulus, is designed for launching from submarines, surface vessels and shore bases. A BuAer missile developed by Chance Vought, Regulus requires only slight modification of the launching vessel. Tactically,

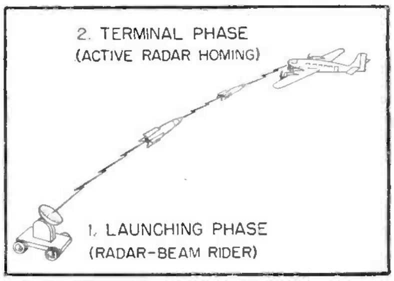


FIG. 2—Guidance system for a hypothetical air-defense missile

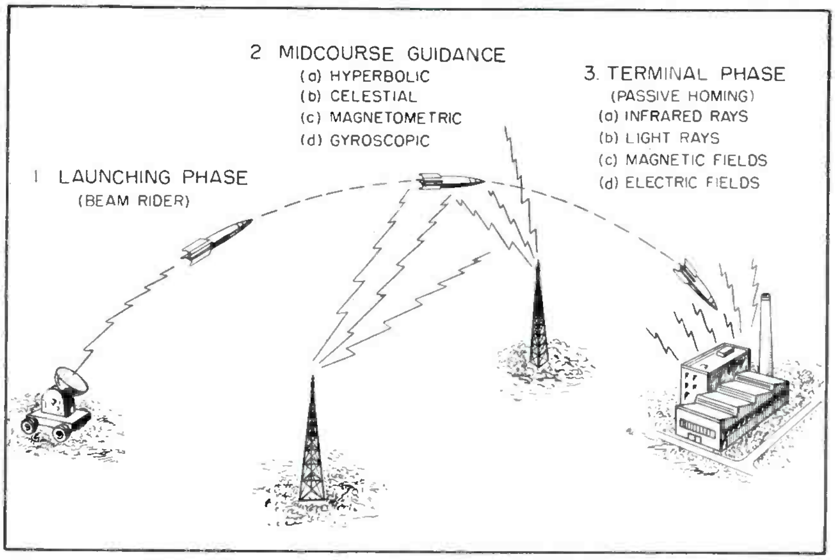
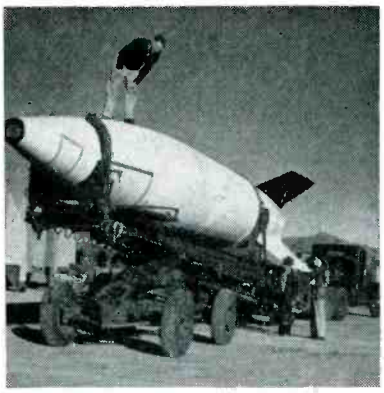
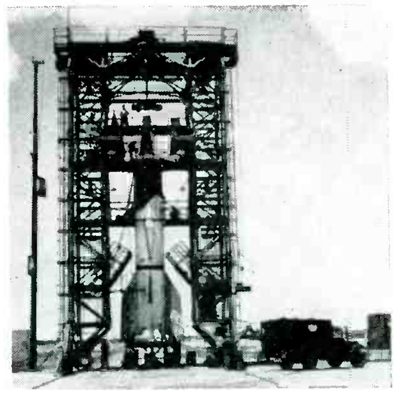


FIG. 1—Guidance system for a hypothetical long-range ground-bombardment missile

Engineers check instrumentation during missile's last "hanger flight"



German "Meillerwagen" has hydraulic lift to position a missile on firing table



Gantry crane secures missile for fueling and final instrument check

Regulus could be used against coastal targets and in amphibious warfare.

Missile Guidance

In rockets, drones and glide bombs electronic guidance and control play essential roles. Control and guidance are often used interchangeably to denote the entire process of intelligence and maneuver that enables a missile to hit its target. In guidance, however, primary emphasis is on flight path and information for determining proper course. In control, emphasis is on course changes during flight. Basic guidance system for a hypothetical long-range ground-bombardment missile is shown in Fig. 1.

There are broadly three types of guidance: guidance in the launching phase, midcourse guidance and terminal guidance. A common system used in the launching phase is beam-rider guidance. A beam, such as radar, forms a line in space along which the missile is directed. Equipment built into the missile enables it to sense deviation from centerline. Amplifiers, servomechanisms and movable aerodynamic surfaces restore the missile to centerline. Basic guidance scheme for a hypothetical air-defense missile is given in Fig. 2.

Midcourse guidance is essentially a problem in navigation. Proposed systems include celestial, hyperbolic, gyroscopic and magnetometric navigation as well as preset guidance.

Celestial navigation provides that a missile, suitably instrumented, follow a predetermined course with primary reference to the relative position of the missile and selected celestial bodies. Determination of the vertical to the earth's surface may also be necessary.

In hyperbolic, advantage is taken of lines of position obtained by measuring the distance of the navigating equipment from two or more transmitters of known location. Loran, Decca and Gee are hyperbolic systems. Navigation systems may also make use of the earth's magnetic field or gyroscopic effects.

Homing

Successful terminal guidance ends with the missile crashing into its target. The problem is one of homing. Active homing recalls the Bat glide bomb that carried its own radar to illuminate the target. Received echos gave directional course correction through gyro stabilizers and servomechanisms moving wing surfaces. An off-center reflector enabled the radar signal to bracket the target.

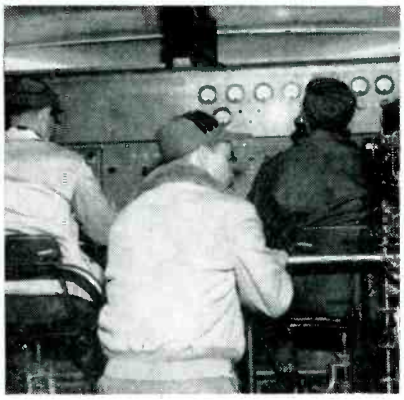
In semiactive homing the missile homes on a target illuminated by a third source. For example, an air-to-air missile may be guided by reflections from a target bracketed by the mother plane's radar.

A missile may also home on the natural radiations of the target. These may be light or infrared rays, electric or magnetic fields. Passive homing suggests use in long-range bombardment missiles that may home on signals from

Table I—Flight History of a V-2 Rocket

Time	*Operation*
X	Time switch starts, missile rises with 1-g acceleration
X–1 sec	Doppler transmitter on
3 sec	Guiding-beam receiver on
4 sec	Inclination program begins
40 sec	Dynamic pressure valve closes, warhead fuze is armed
42 sec	Misssile at 6.2 miles, speed Mach 2
47 sec	Combustion-cutoff receiver unblocked
47–67 sec	Doppler transmitter on
52 sec	Inclination program ends, altitude 10 miles, speed Mach 3
60 sec	Altitude 11.6 miles, speed Mach 4
63 sec	Altitude 15.5 miles, speed Mach 4½. Combustion cutoff, if controlled by integrating accelerometer, occurs when desired velocity is attained. This is usually 3,365 mph
88–90 sec	Doppler transmitter on
90 sec	Time switch completes cycle
175 sec	Missile attains peak of trajectory, about 50 miles
320 sec	Missile strikes target

Missile stands free on firing table minutes before take off



"It is now X minus 15,14 . . ." range officer counts final seconds

"The missile is away" . . . V-2 rises in a cloud of smoke and dust

enemy radio transmitters or heat rays from war plants and power stations.

Electronic Control

Circuit details of modern missile-control systems are classified. However, the control system of the German V-2 rocket embodies some basic principles of missile control.

Range for V-2 is determined by cutting off the fuel supply at the proper instant. This is accomplished either by a preset timing switch or by radio signals from the ground station. Trajectory and flying position are determined by control surfaces, not spin. Direction control is derived from a preset steering device but this is occasionally assisted by a radio beam that determines direction in the yaw plane. The missile also contains a 46-mc radio beacon; using the Doppler principle, the ground crew tracks the rocket by these signals. Every tenth missile is equipped also with a telemetering transmitter to provide ground monitoring of its performance during flight. Instruments and control equipment weight 858 pounds. Power is supplied primarily by 27-volt batteries; d-c/a-c motor-generator sets furnish 40 volts at 500 cps.

Sequence of time-dependent action is controlled by a time switch. The time switch is started by the take-off switch, a plug that flies out as the missile leaves the firing table. The take-off switch also disengages the ground power supply used to power missile circuits prior to take-off to avoid premature discharge of batteries. The electrical fuze network in the warhead has a capacitor filter to smooth out transients introduced by the switching relays.

Direction Control

The control surfaces comprise four tabs and four vanes in the burning jet. The vanes and tabs are numbered to correspond to the rocket's fins. The axes of the missile in flight and the control surfaces are shown in Fig. 3.

Gyro D (Fig. 4A) controls rotation about the D-axis (pitch) through operation of vanes 2 and 4. Gyro EA (Fig. 4B) controls rotation about the E-axis (yaw) and the A-axis (spin) through operation of vanes 1 and 3 (Fig. 3). The radio beam also controls these vanes.

Displacing vanes 1 and 3 in the

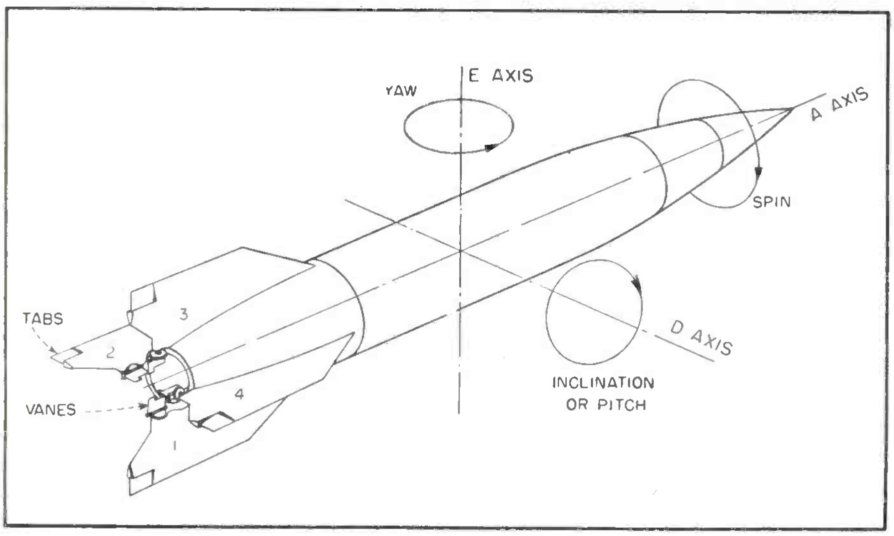


FIG. 3—Sketch of German V-2, showing aerodynamic control surfaces and principal axes

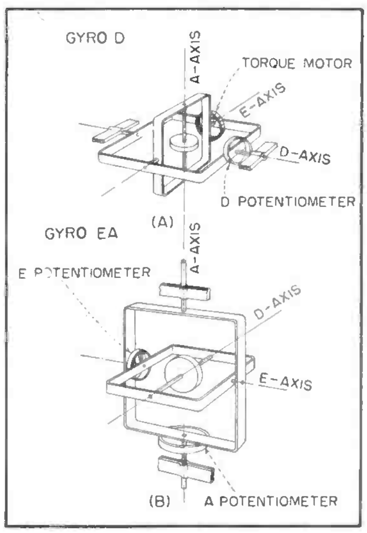


FIG. 4—Directional gyros sense course deviations

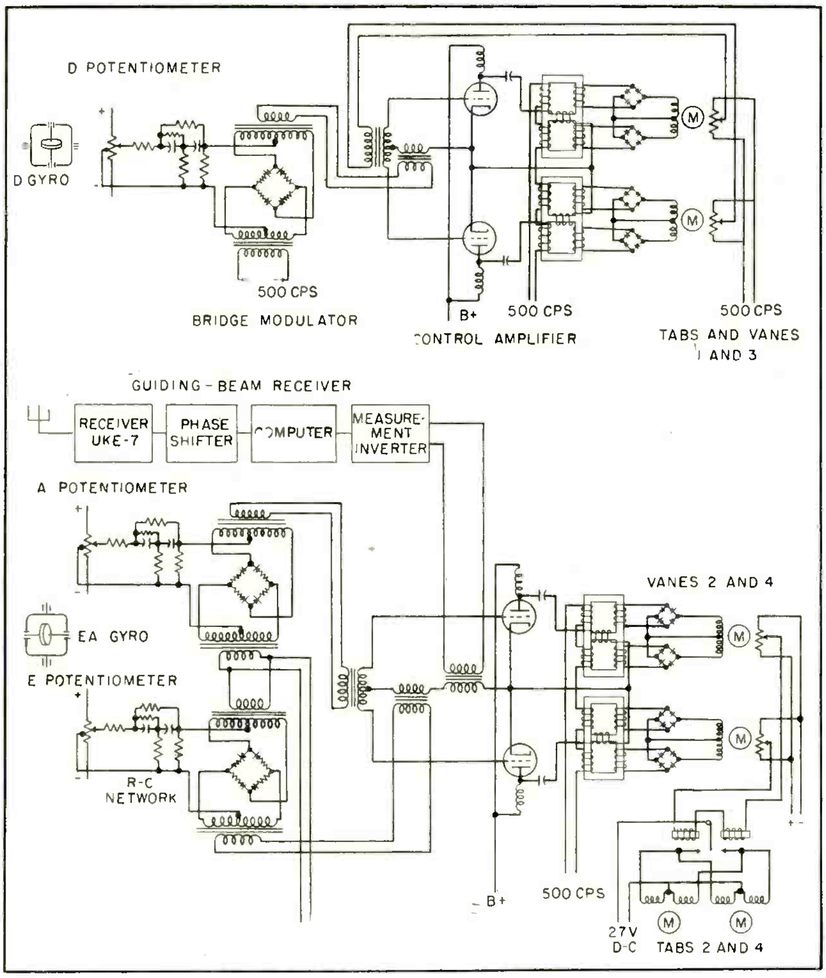


FIG. 5—Servo loop moves control surfaces to correct course deviation. Guiding-beam receiver also can control direction in yaw plane. Resistance-capacitance network reduces missile's hunting about flight path

same direction causes rotation about the E-axis, displacing vanes 1 and 3 in opposite directions causes rotation about the A-axis. Displacing vanes 2 and 4 in the same direction causes rotation about the D-axis.

Tabs are provided as well as vanes; vanes give control at take-off but tabs furnish additional control, particularly over spin, that vanes alone could not give. The tabs turn 12 deg; vanes turn 24 deg. Tabs 1 and 3 are linked to vanes 1 and 3.

Tabs 2 and 4 have separate drive mechanisms that displace them in opposite directions. Tab drive is actuated only when vanes 1 and 3 respond to a large spin signal, greater than 3 deg. The tab drive motors move slowly but once the tabs are displaced, they remain displaced unless a second large spin signal is received. The tabs act to compensate for structural irregularities that tend to produce spin. This adds desired loading to tabs 1 and 3.

The inclination program (Table I) rotates the missile about the D-axis and is produced by a 3,000-rpm d-c torque motor that causes the D gyro to precess about the D-axis. After combustion cutoff, all vanes and tabs return to null position and the missile behaves as a projectile.

Figures 4A and 4B show how course deviations, sensed by the gyros, are converted to error signals by potentiometers. Figure 5 is the circuit that converts these signals into rudder movement. However, if signal voltages from the D-E and A potentiometers were applied directly as control to rudder motors, a vane, moved right to control left deviation, would still be right when the missile passed null. Since this would create oscillation, the vanes are returned to null position before the missile restores to course centerline. The error signal is passed through a double differentiating R-C network before being applied to the control amplifiers. This creates an advance of rudder current ahead of missile oscillation, which can be described as causing a leading phase shift.

Combustion Cutoff

Combustion cutoff can be accomplished either by radio signals from the ground or by an integrating accelerometer in the missile. The accelerometer is a gyro whose rotation speed is proportional to the acceleration so that the number of rotations is proportional to the velocity attained. There are two switch cams located on a large gear wheel driven through a gear drive from the accelerometer. The first switch reduces thrust from 25 to 8 tons. The second switch cuts off thrust. The two-stage cutoff is used so that variations in duration of cutoff do not change range.

The close-up photograph of the V-2 on the firing table shows part of its antenna system. The lower part of the fin is plastic and is used to support rod-antenna mountings. The plastic fin tip also has a copper or cadmium-plated frame connected to the tail section. This frame acts as a loop antenna. Loops 2 and 4 are ganged to receive the radio-control signals for combustion cutoff. Rod antennas 2 and 4 receive the guiding-beam signals. Loops and rods 1 and 3 are telemetering antennas. The doors of sections 2 and 4 in the body of the missile are mounted on insulating wood frames and function as a dipole antenna for the Doppler transmitter.

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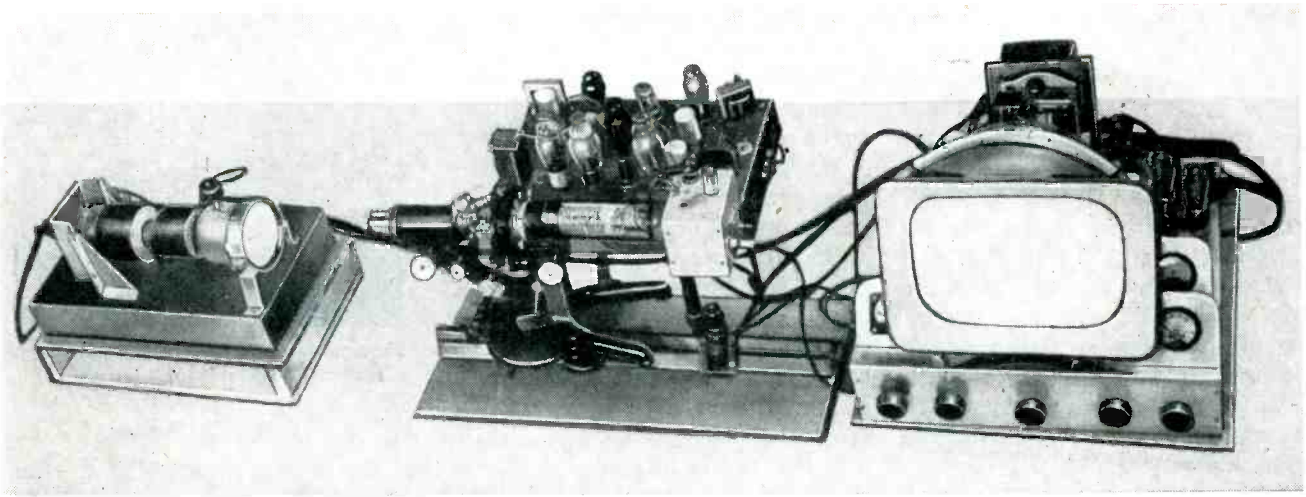

Complete setup of flying-spot microscope consists of scanner (left), optical microscope, phototube (center), time base generator (rear) and viewing monitor. Any number of repeaters may be added, and additional electronic magnification employed

Flying-Spot Microscope

Television-type scanner illuminates specimen in compound microscope to obtain pictures superior in size, brightness, contrast and resolution to those of normal microscope. Discrete particles are automatically counted and sized

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THE FLYING-SPOT MICROSCOPE, as its name implies, is a combination of a microscope and the well-know flying-spot video generator[1]. To convert such a video generator into a flying-spot microscope a standard compound microscope is used in place of the transparency (Fig. 1).

A greatly reduced image of the flying spot on the scanner tube, is projected onto the microscope specimen mounted on the microscope slide. As this imaged spot is approximately of diameter

$$d = \frac{1.22\ \lambda}{N.A.} \quad (\text{in } \mu)$$

where λ = wavelength of light from scanner in $\mu = 10^{-4}$ centimeter and $N.\ A.$ = numerical aperture of microscope objective (varies from low-power value of 0.15 to the high-power oil-immersion value of 1.4). For the green-emitting scanner tube $\lambda = 0.5\ \mu$ and therefore $d = 0.5\ \mu$. This approaches the diameter of the smallest particle that can be resolved in the conventional microscope, and is very small compared with the usual size of microscopic objects.

The microscope specimen is scanned by this spot and by means of the multiplier phototube the two-dimensional density distribution of the microscope specimen is converted into the familiar voltage-time relationship of a typical video signal. The signal from the phototube is amplified by the video amplifier, phase and amplitude corrected for lens aberrations, and used to intensity modulate the display picture tube, giving a bright projection picture of the microscopic specimen. At the same time this output is fed to the appropriate section of the high-speed counting equipment.

Automatic Counting

In chemical engineering, clinical medicine and general microscopic research work it is often desired to count particles such as powders, blood cells, photographic grains and so on. The flying-spot microscope allows this to be done automatically.[2]

A birefringent crystal is mounted at a convenient point between the raster and the specimen, and a polarizing cube is mounted below the condensing lens. An additional phototube is mounted at right angles to the original phototube. An anticoincidence circuit is connected between the phototube outputs and the counter. The counter-start and-stop mechanisms are connected to the microscope frame-blanking amplifier via differentiating circuits.

Thus the flying spot from the objective is split into two spots by the birefringent crystal and the specimen is now scanned by two spots instead of one. The spots are adjusted one line-width apart in the vertical direction and polarized at 90 degrees to one another. The transmitted light from these spots is collected by the condensing lens and passed to the phototubes via the polarizing cube, which transmits the light from one polarized spot to one phototube and reflects the light from the other polarized spot to the other phototube. Each phototube therefore receives light from one spot only.

This process is illustrated in Fig. 2. In Fig. 2A two spots are approaching a microscopic particle scanning from above, one spot being one line-width above the other. First, one spot will hit the particle and be obscured as in Fig. 2B. The result is that a signal will be generated by its associated phototube. This pulse then passes through the anticoincidence circuit to the counter, which registers once.

When this spot returns to the same particle on the next line it will be one line lower, and its companion spot will have taken its former place, one line-width above (Fig. 2C). The result is that both spots are now obscured by the particle and both phototubes generate pulses. These pulses are prevented from operating the counter circuit by the anticoincidence circuit; therefore no count is made until the time when the bottom spot is off the particle, the top spot being obscured (Fig. 2D). A signal is now passed to the inhibiting section of the anticoincidence circuit, and no signal is passed to the counter; the latter will therefore read a count equal to the number of particles.

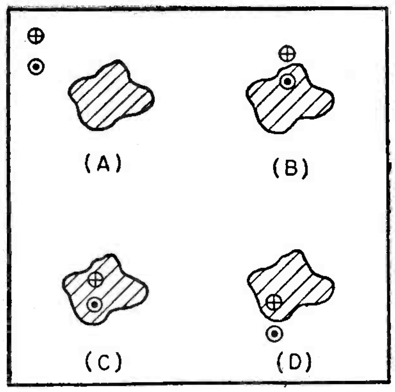
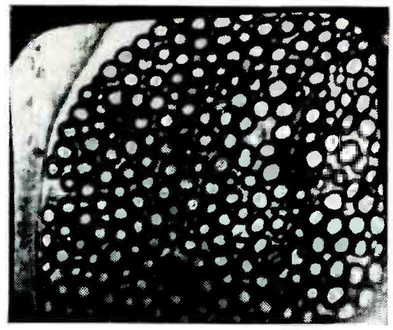


FIG. 2—Drawings show how dual-spot system permits automatic counting


Photograph of screen showing a cross section of a nerve trunk at 300 ×

Biological Applications

Because of the narrow spectral sensitivity of the eye, blue or green light is generally used for illumination with the conventional microscope. However, if the wavelength of the exciting energy is reduced, important gains in resolution and contrast can be obtained.

Resolution being proportional to $1/\lambda$, any reduction in λ will show up

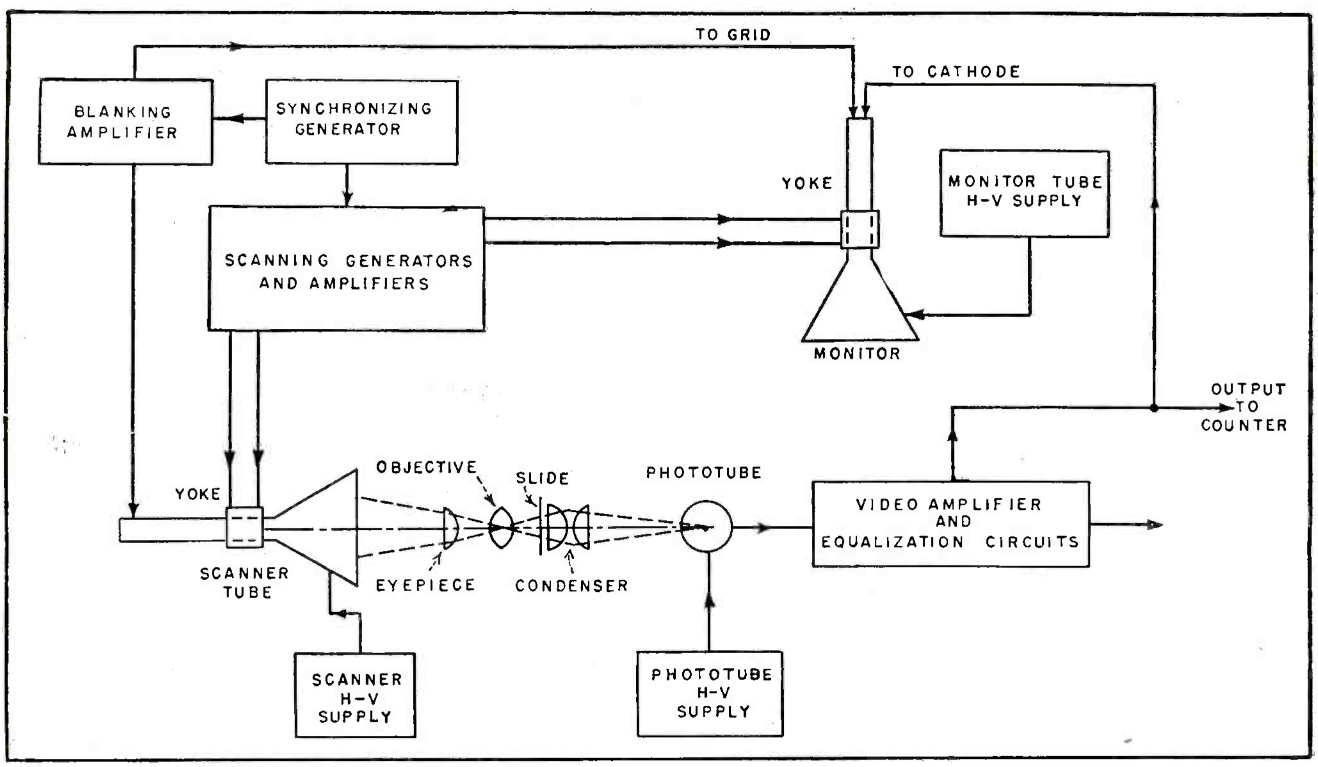
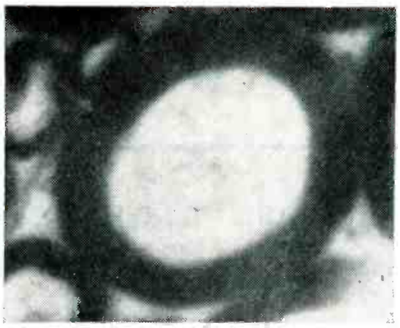
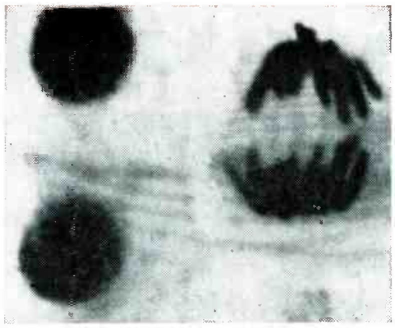


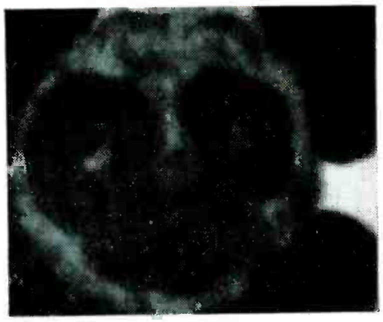
FIG. 1—Block diagram shows use of television scanning system with compound microscope



Enlarged version of portion of nerve trunk (3,000 ×) shows individual fiber



Cell of a "root rip" dividing (5,000 ×) illustrates application to living cells



White cell from bone marrow enlarged 10,000 times by flying-spot microscope

immediately in increased resolving power, providing the lens in use is corrected for the new excitation band. Shortening of the wavelength of the excitation leads directly to the ultraviolet region of the spectrum. This region is most important biologically for some constituents of the living cell show selective absorption over the range 2,500 to 3,000 Angstrom units.

Thus it is no longer necessary to kill cells by staining in order to obtain the contrast necessary for observation. By using color-television technique, it should be possible to color-translate from the deep ultraviolet to the visible spectrum in such a manner that each ultraviolet spectral absorbing characteristic of the living cell is represented by a particular color. The final result would be to obtain a picture of the living cell in color, each shade representing a particular constituent.

Apart from convenience, this method of dealing with the ultraviolet region of the spectrum should show considerable improvements over any photographic method. Ultraviolet radiation is toxic and it is therefore necessary to keep down the dosage. The superior efficiency of the flying-spot technique in the ultraviolet region ensures a much smaller dosage than would be required if either the film or television camera were used.

Other Applications

The examination of the retina of the eye using an ophthalmoscope presents many difficulties. These are greatly multiplied if defects of the retina have to be demonstrated to an audience. A low-power version of the flying-spot microscope can be used to give large-screen pictures of the retina, making observation and demonstration easy. In a simple equipment the lens of the eye itself can be used as the microscope.

In atomic energy research, it is often necessary to view material which is highly radioactive. This has been done by attaching an optical train to the microscope. However, a great deal of light is lost, and the mechanical difficulties are rapidly multiplied as the optical train is increased in length. By the use of the flying-spot microscope, dangerous materials can be examined in comfort at any distance and no limits are set on the power of objective that can be used.

A standard type of long-term memory for machines is the card index. It is bulky and the access time long. By the use of a flying-spot microscope the information stored on microfilm can be passed through an optical gate, the objective lens of the microscope. The flying spot then picks off the information, and the resulting output of the phototube passes to short-term memory equipment or electrical decoders.

The storage capacity and access times of such a memory should be many times better than the standard long-term memory systems.

Tubes Used

While in reference 1 the use of standard kinescopes as scanner tubes is advocated, such tubes are quite useless in flying-spot microscopy because of long afterglow and large spot size. Inexpensive scanner tubes specially chosen for appropriate spectral emission (yellow, green, ultraviolet), spot size and resulting high signal to noise ratio are, however, available.

The phototubes used are specially chosen for high cathode sensitivity and low noise.

While for all the usual microscopic specimens the usual television-type kinescope gives excellent results, certain high-resolution, low-contrast materials, such as live bacteria and certain diatoms, require the magnesium fluoride radar tube display. The time bases are still the standard television speed and as a result the signal to noise is increased by the square root of the numbers of rasters stored in the magnesium fluoride phosphor decay time.

A new equipment, which while retaining television scanning speeds for field finding, allows a four second frame, one thousand line time bases to be switched in, has been developed.

This new machine permits the use of electronic beam switching in place of the calcite and polarizing cube and leads to much cheaper counting equipment. Slow-speed scanning also reduces the dosage to the cell which is particularly important when using ultraviolet.

Acknowledgments

Thanks are due G. O. Norrie for much of the design, to E.M.I. Research Laboratories, Ltd., and Cinema-Television, Ltd, England, for the provision of scanner tubes, and to Philips Research Laboratories, Eindhoven, Holland for work on a deep ultraviolet scanner tube.

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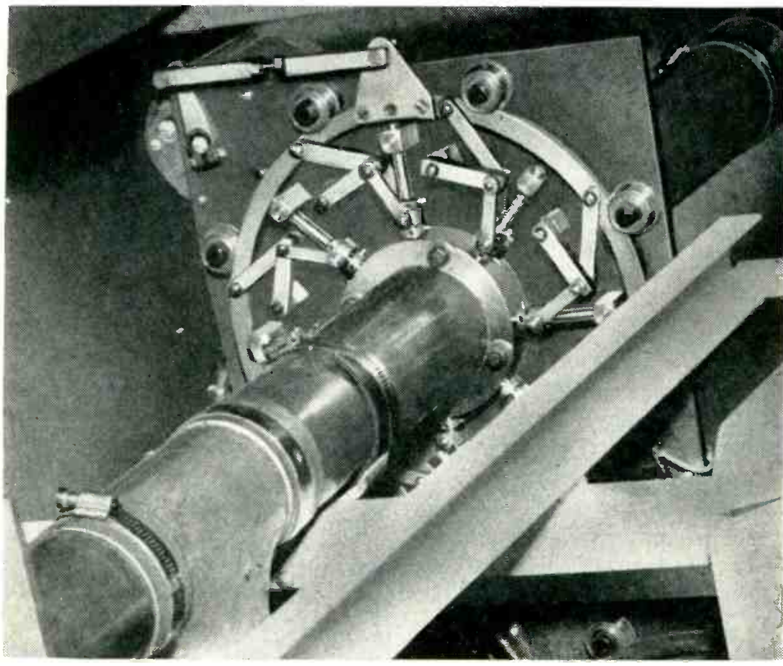
Coaxial Switch for Rapid



Circular lever is driven by motor behind plate at upper left, moving rods into contact with the inner conductor

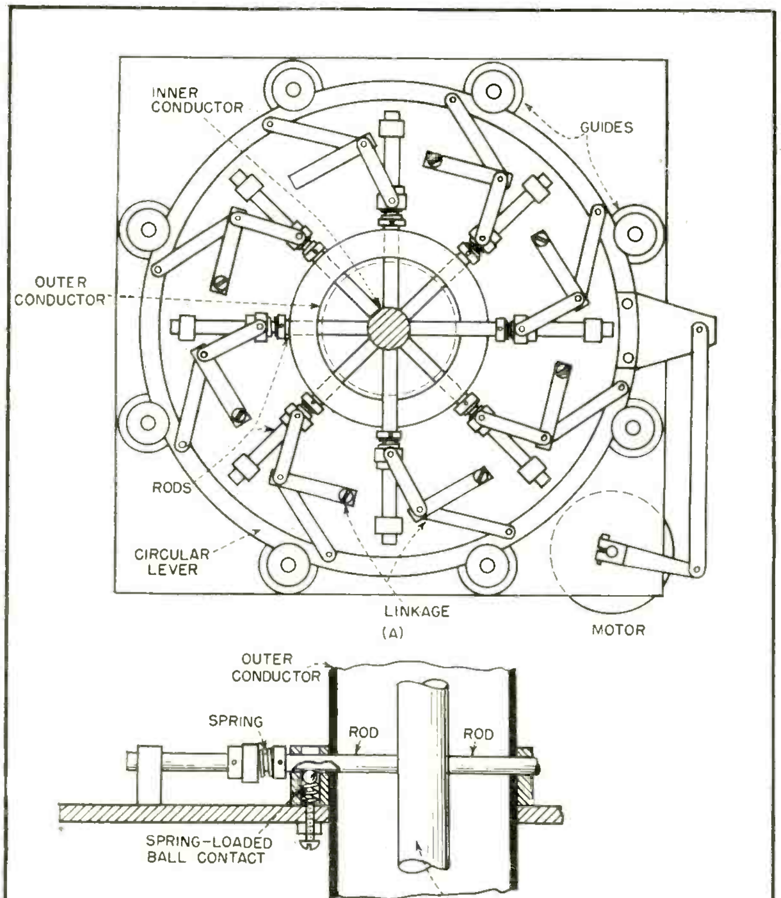


FIG. 1—Coaxial switch (A) uses circular lever to operate eight contacting rods simultaneously. Vertical cross-section (B) shows use of spring-loaded ball as rod electrical contact

By **JOHN T. WILNER**

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A SWITCHING SYSTEM has been described[1] which enables an operator to replace the main transmitter with the emergency transmitter in the event of failure of the first unit. The switch described was designed for use on a low-frequency television channel.

This article describes another switch which can be used on all vhf channels, and probably some of the lower uhf channels, to switch auxiliary transmitters, cut a power amplifier in or out of service, or switch a dummy load to a transmitter for test purposes.

The system is quick acting and introduces no distortion to the television signal.

Operation

The construction of the switch is shown in Fig. 1A.

Eight chromium-plated steel rods pass through the outer conductor of the transmission line to make contact with the inner conductor. The surfaces of the rods which come against the inner conductor have the same radius as the conductor to insure good contact. With the switch in the open position all eight rods are withdrawn until their ends are flush with the inside of the outer conductors so that in the open position, no discontinuity of the transmission line will exist.

The switch is opened and closed through mechanical links connecting each rod to a common circular lever. This lever is moved by a motor-operated connecting rod. Pressure for closing the rod is applied through a spring so that all eight rods make pressure contact with the inner connector.

At the frequency of channel 11 a quarter wave in such a transmis-

Transmitter Changing

Fast-acting system usable on all vhf channels permits switching from main to standby transmitter within four seconds. Standing-wave ratio can be held to better than 1.05-to-1 on channel 11 for 15-mc bandwidth

sion line in free space becomes 14.8 inches. Since the installation of the switch required that the side reactances around the carrier be cancelled out by a stub, it is essential that contact be made between the inner and outer conductor at exactly the same place regardless of the wear or mechanical tolerances of the mechanism during operations.

For this reason a circular millway was cut into the side of each rod as shown in Fig. 1B. A steel ball under spring pressure engaging this millway insures that the rod will always make sliding contact at the same surfaces. This steel-ball contactor also provides the shortest electrical path between the inner and outer connectors, thus maintaining the same characteristics throughout its life.

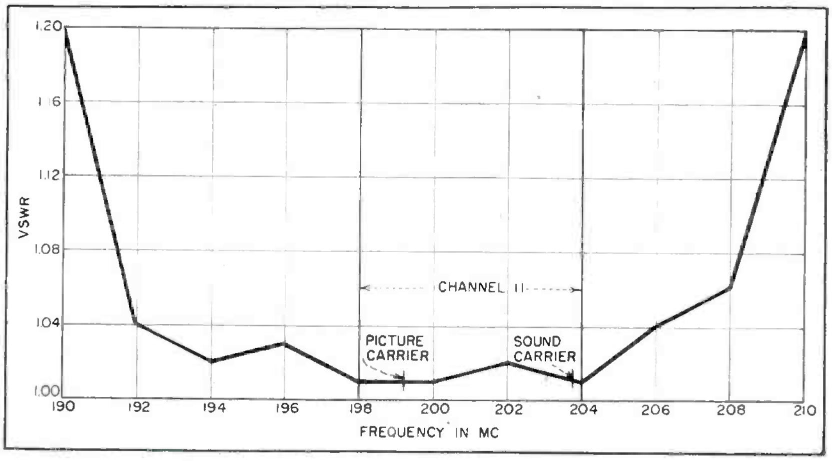


FIG. 3—The vswr of system with dummy load

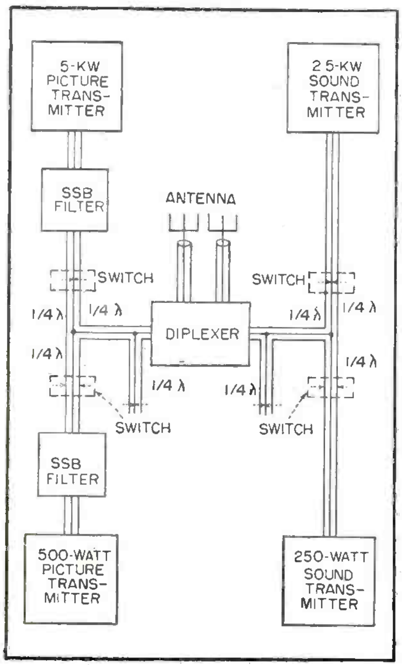


FIG. 2—Placement of switches and shorting stubs in transmission lines

The switch was installed in the transmission lines as shown in Fig. 2. Two switches are required for each of the audio and the video transmitters. In each case the outputs of both transmitters come to a junction T-fitting from which power is fed to the antenna system.

The switches are placed a quarter wavelength on either side of the junction with the ball pressure against the rods on the side away from the junction. A quarter-wave short-circuiting stub is placed one-quarter wavelength from this same junction towards the antenna. Since similar reactances one-quarter wave apart cancel each other, a low standing-wave ratio is obtained over a large portion of the television spectrum. Figure 3 shows the standing-wave ratio of input to the transmission line that the main transmitter would normally see with the antenna disconnected and a dummy load inserted in its place. A standing-wave ratio of better than 1.05-to-1 is obtained for about a 15-mc bandwidth.

After the switches had been in operation several months a check was made on standing-wave ratio and quality of the transmitter picture. No discernible change was noticed.

Controls

A control panel next to the main transmitter operating panel is arranged so that throwing one switch will remove plate voltage from the defective transmitter, operate the r-f switches and apply plate voltage to the standby transmitter. Each of these operations can also be made individually from separate switches on the same panel. The time for the complete operation in the automatic position is 4 seconds, this being determined entirely by the speed of the operating motor.

Acknowledgment is made to members of the engineering department, especially Harrison Brooks, assistant chief engineer, who aided in the development of this project.

REFERENCE

(1) L. A. Looney and F. C. Everett, Reducing Outage at WNBT and WNBT-FM, ELECTRONICS, p 110, Jan. 1952.

Precise Parts Sorting

Operating principles and electronic circuits of three basic types of precision dimension-measuring gages—the electrical switch-type, electromechanical moving-core type and the electronic moving-coil type—in which the sensing spindle moves the contacts, core or coils respectively

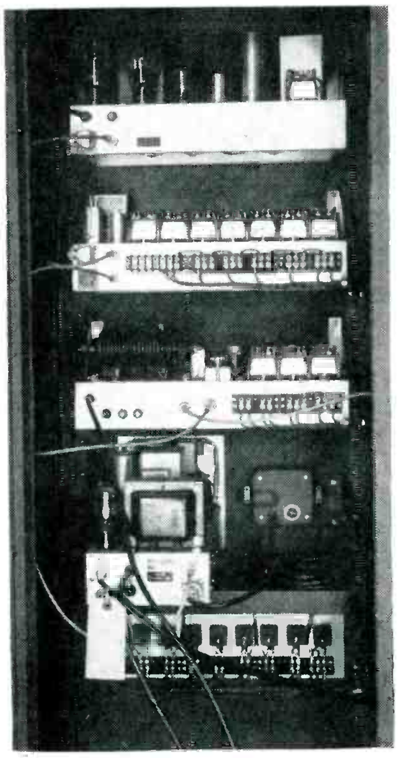
AN AUTOMATIC GAGE is a machine designed to inspect parts on a production-line basis without the aid of many operators. It generally consists of a hopper, a metering or feeding device, a measuring device and provision for disposal of the measured product. This article considers the electronic and electrical devices which do the measuring and actuate the disposal units.

Contact-Type Gages

The simplest of these measuring devices is the electrical contact or switch type which generally incorporates a spindle similar to that of a dial indicator. Changes in size of the workpiece move the spindle which in turn actuates switches. Operation of the switches, one of which is usually provided for the high limit and one for the low limit, sets up electrical circuits which can be used to control disposal traps and auxiliary equipment.

Several makes of this type of unit are available, all of them similar in basic operation. Figure 1 shows the combination electric switch-indicator unit called the Electricator, which is usually used in conjunction with the power unit shown in Fig. 2. Each of the limit switch contacts is tied in with the grid circuit of a separate thyratron tube which is basically an electronic relay. When the switch contact is closed, it causes the thyratron to fire.

Due to the nature of the thyratron on d-c operation, the circuit is nonreversible. If a borderline piece is being measured and the contacts close momentarily, the thyratron tube will go into operation and, regardless of how much the limit switch contacts chatter, a steady signal is received. This is essential for automatic gaging. If the circuit is not instantly self-holding or nonreversing, traps and other elements will chatter and may produce an apparent error in measuring.



Rack contains (top to bottom) power supply, classifier, solenoid supply and gage amplifier

The switch-type unit has several advantages. It is the least expensive basic measuring device available commercially which will set up an electrical impulse in accordance with the size of the part. The repeat characteristics of this type of unit are good, especially considering that it is a fairly inexpensive piece of equipment. The repeat characteristics of this particular unit are on the order of twenty-five millionths of an inch or better. While this means that it can be used for fairly close tolerances, using the customary 10-percent gage maker's tolerance, the unit is generally used where limits are greater than plus or minus 0.00025-inch. There have been cases where it has been used for 0.0001-inch limits, but here gage maker's tolerance is being exceeded.

The main disadvantage of this unit is that it is a mechanical device. As such, it is possible to have a little bounce at the electrical limits if the spindle is moved too rapidly, when pieces are passed under it at high rates of speed. This may cause some apparent inaccuracy at one of the limits. In general, this type of unit is used for jobs where less than 100 pieces per minute have to be checked.

Electromagnetic Gages

In the electromagnetic gage the spindle moves an iron core between two coils as in Fig. 3. This type of gage is generally energized with 60-cycle current. The electromagnetic type of gage can be made extremely sensitive and with very high magnification. It is not uncommon to find such gages with scales graduated in millionths of an inch.

On Production Lines

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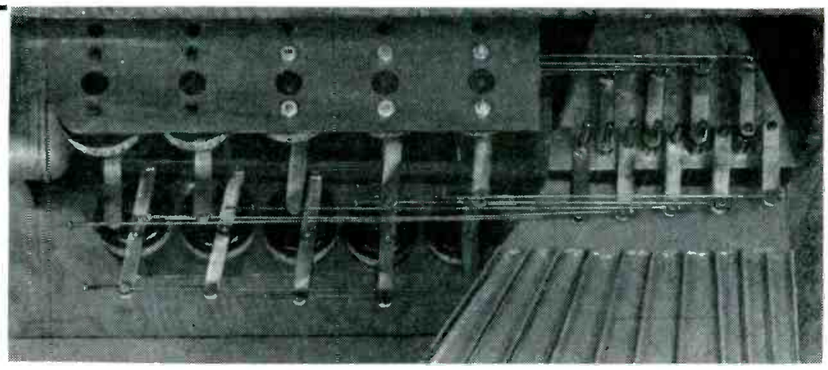

Disposal chute has number of solenoid-operated trap doors, normally open, which direct pieces to proper slides

The electromagnetic gage head contains two coils which are fixed to the gage head casting. These coils have independent magnetic fields with a movable common armature operating approximately midway between them. The armature is pivot-mounted at one end and floats freely at the other end. It is flexibly coupled at the spindle, so any movement of the spindle is transferred to the armature.

The electromagnetic gage circuit, in Fig. 4, is actually a bridge circuit using coils in the bridge legs. Movement of the gage spindle moves the armature relative to the two fixed coils and unbalances the magnetic field. This produces a comparatively large change of current for extremely small movements of the spindle. The microammeter measures the amount of the unbalance and is generally calibrated to show spindle movement to small fractions of an inch.

The magnification of this type of gage is adjustable. By increasing the gap between the two coils and reducing the size of the armature, magnification is decreased. Magnification can be increased by decreasing the air gap.

Despite the electrical actuation of such gages, certain time lags are inevitable. Suppose that an automatic gage is to be built for measuring a small cylindrical piece which is to pass underneath either a cylindrically radiused contact or one with a very small flat. Since a cylindrical piece is being introduced under a cylindrical anvil, the maximum dimension or the time for which the spindle will be in its uppermost position is short.

With the electromagnetic gage operating on 60 cycles, it requires perhaps two cycles or roughly one-thirtieth second and probably a little bit more, to provide a safety factor. This may sound fast but time is required to get the piece from the feed chute into the metering device, push it through the gage and then down the disposal chute. Considering that the time the workpiece must spend under the measuring contact limits the maximum speed of the pusher or metering device, one-thirtieth second is none too fast. It limits the maximum speed of the part past the contact and therefore limits gage design to a maximum speed of possibly 60 to 70 pieces a minute.

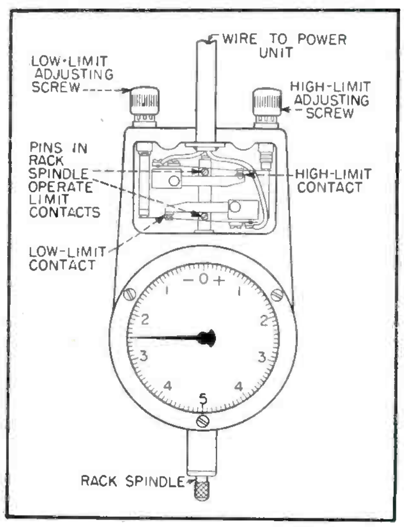

FIG. 1—Combination electric switch and indicator gage

In the electronic-mechanical type of gage, the movable coil is attached to the spindle and two fixed coils are fastened to the gage head casting, as in Fig. 5. Movement of the spindle in accordance with size differences of the parts changes the relative position of the spindle coil to the fixed coils.

High Frequency

While this is not too much unlike the 60-cycle gage, there is an important difference. The current passing through the coils is operating at 100,000 cycles or more per second. For the sake of illustration, assume the same gaging conditions as previously described, wherein a small cylindrical piece is passing under the spindle. If two or three electrical cycles are allowed for the circuit to reach equilibrium, 1/30,000 second has been used for the measurement. While the theoretical speed is never achieved in actual practice, this is roughly 1,000 times as fast as the gage using 60-cycle current. Actual tests with this type of device have shown that the speed is quite high.

The amplifier circuit used with the electronic gage is shown in Fig. 6. The voltage regulator tube in the power supply permits the circuit to withstand a line voltage variation of ±10 percent with less than 1 percent meter variation.

The 100,000-cps frequency of the 6K6 oscillator tube is maintained within close limits by a 6SN7 control tube. Part of the high-fre-

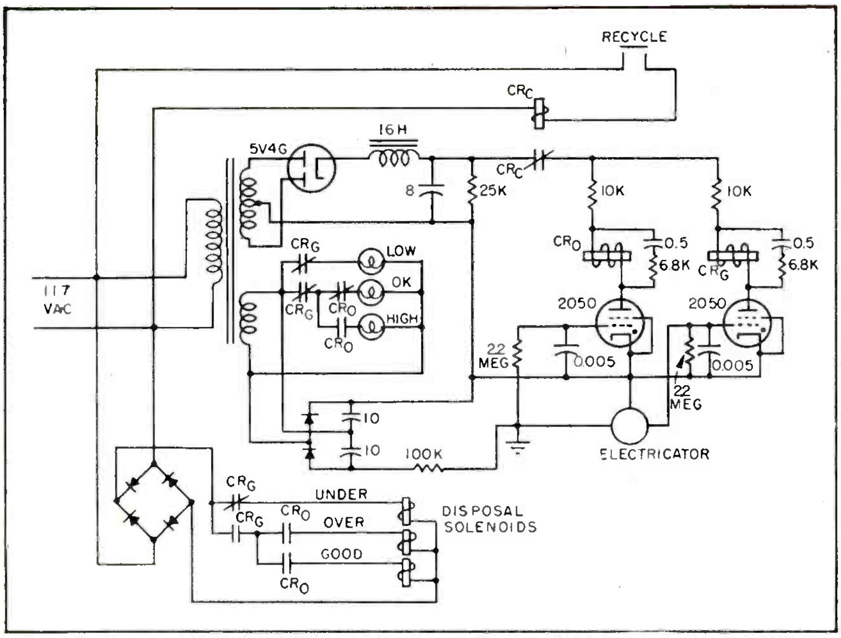

FIG. 2—Thyratrons connected to each limit switch contact acts as electronic relays

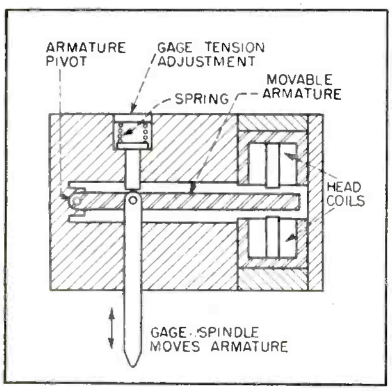

FIG. 3—Electromagnetic gage head has two fixed coils and a movable armature attached to the gaging spindle

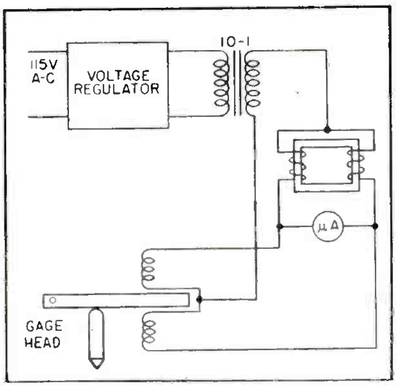

FIG. 4—Coils act as legs in balanced bridge circuit. Microammeter measures the unbalance

quency a-c is applied to the gage head coils and part to the zero adjustment.

The zero adjustment contains a coil almost identical electrically with the head coil assembly. In the gage head, the high-frequency signal energizes the stationary coils, with no direct connection to the spindle coil. However, displacement of the spindle coil from the region around the electrical neutral position induces a varying voltage at 100,000 cps in the spindle coil. This voltage is almost directly proportional to contact point displacement. This induced voltage passes to a four-stage amplifier consisting of three 6SJ7 and one 6K6.

The 6SN7 phase detector is in the circuit to allow measurement with the spindle moving up, or with the spindle moving down and overlooking the opposite spindle motion. The rectifier portion of the 6SN7 converts the amplified 100,000-cps signal into d-c at a potential of between 0 and 50 volts essentially in direct proportion to the spindle position. This voltage operates the meter and is available to operate the classifiers or segregators which are essential to automatic gaging.

Sorting

When a measured workpiece is removed from beneath the spindle of a comparator, the size signal is lost. Some means must be provided to hold the signal, even after the parts are removed, until the part has had a chance to pass through the disposal as the signal directs.

Some means must also be provided to decide into what size category the workpiece belongs. This is also properly a function of the classifier.

The classifier consists of a series of d-c operated, nonreversing thyratrons, one for each size category, as in Fig. 7. Each of these is triggered to fire at slightly higher voltage than its predecessor. As the gage signal voltage (0–50 volts) rises in accordance with the size of the part, one thyratron after another fires. Equilibrium is reached when the gage voltage has reached its peak, operating certain thyratrons, but is not high enough to fire the next one in the series. The last thyratron to fire operates its associated relay, holding that condition until cleared by the operation of a switch.

The disposal system consists basically of a chute in which there are a number of solenoid-operated trap doors. These doors are normally in their relaxed position so that a work-piece can drop straight through. When one of the classifier relays operates, it energizes its associated trap door solenoid. This causes the trap door to move, blocking the free fall of the measured workpiece and directing it into a particular disposal pan or box.

The basic means of measuring with the electronic gage head and a classifier remains the same for all gages using the gage head and classifier. The primary variations are in the sensitivity of the particular electronic gage and the number of

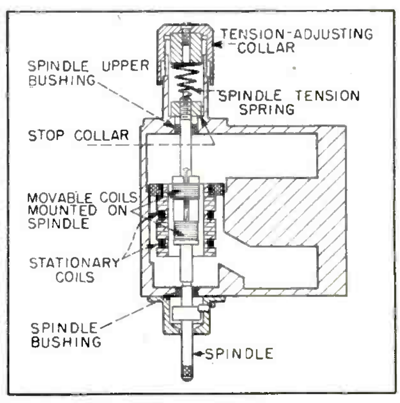

FIG. 5—Electromechanical type gage has movable coils on spindle and two fixed coils

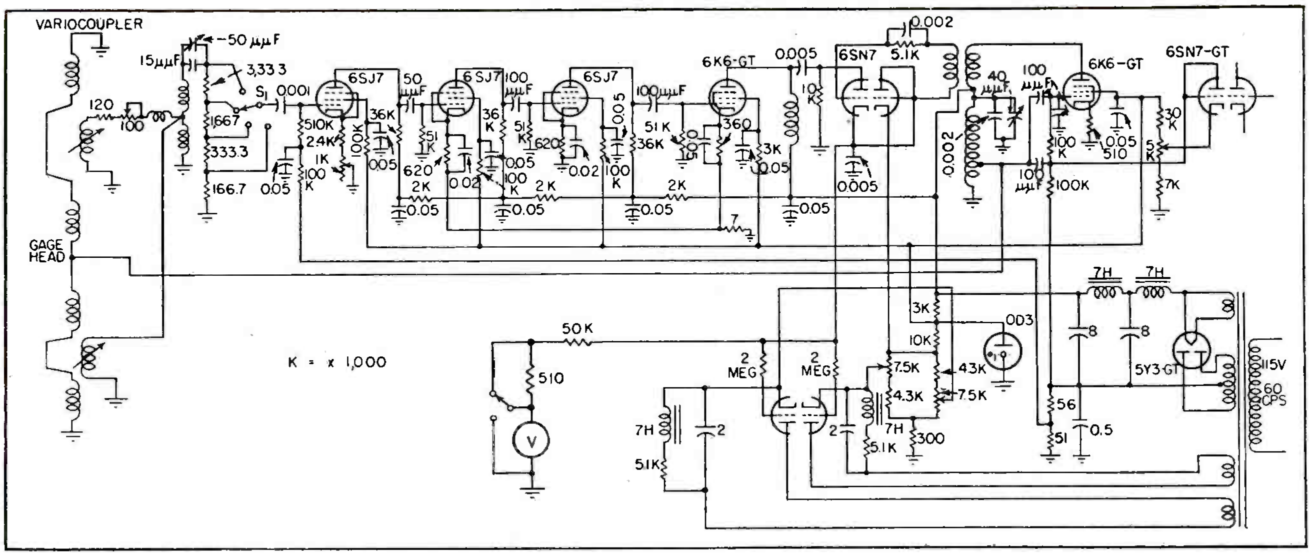

FIG. 6—Circuit of electromechanical gage. Oscillator generates 100-kc signal. Voltage generated by coil unbalance is amplified and rectified to give indication on meter

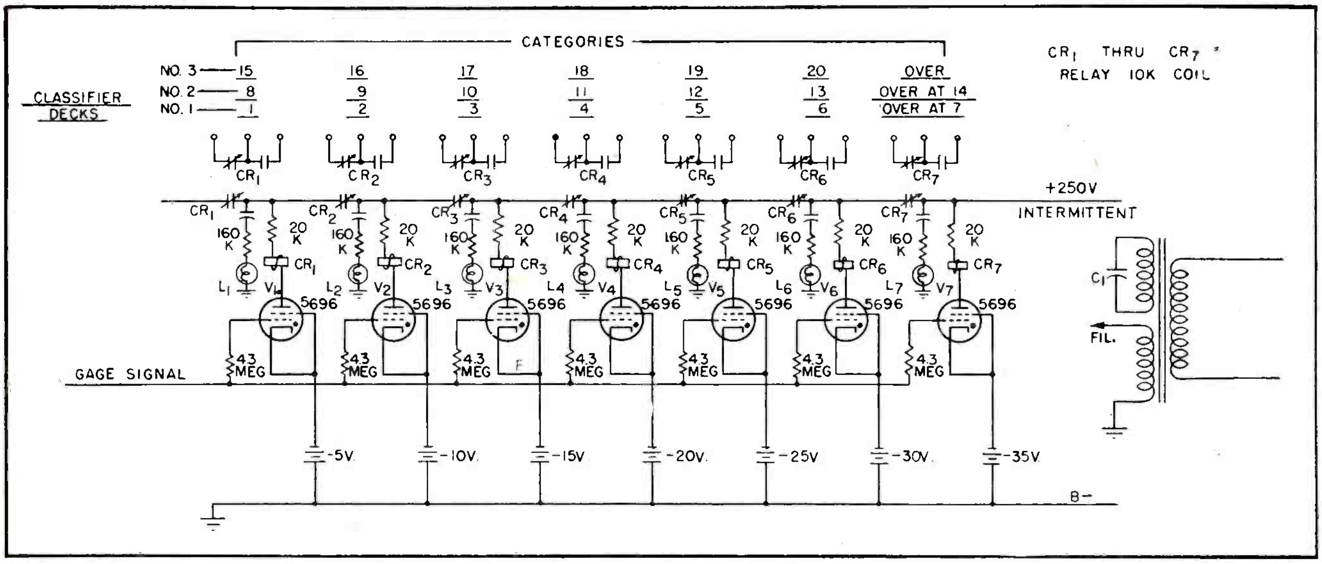

FIG. 7—Classifier is series of d-c operated nonreversing thyratrons which hold part size signal until cleared

classifications needed which, in turn, determine the size of a classifier.

Applications

In the manufacture of contoured zipper wire, the drawing machine occasionally pulls the wire unevenly, causing sections to be smaller than the rest of the wire. When the wire is finished, it is put into automatic zipper-making machines. When one of the undersize or necked-down sections goes through, the machine makes a zipper which will not stay closed.

An electronic gage was put on this job. It was found that small necked-down sections which went by in about 1/500 second could be picked out. It is possible in that extremely short time to pick up the size signal and operate auxiliary equipment.

The high speed possible is not yet entirely practical for automatic gaging because of limitations on speed of material handling. Electronic equipment has already been built that will gage and sort 400 pieces per minute. Tests show that an entire measuring unit, classifier and electrical sorting device can be made to operate at rates better than 500 pieces per minute. For most operations it is not possible to feed at this rate, so up to now the full effectiveness of the gage has not been used. However, this high speed of response gives the gage a high margin of safety.

The electronic-mechanical gage also has the advantage of being able to provide extremely high magnification with scales graduated in millionths. This type of unit must touch the work and is therefore not at all suitable where thickness of soft material must be measured. In continuous measuring it cannot be used where the material has a widely varying pass line or where it is extremely hot, as in a hot-strip mill.

How to Design

By ELBERT ROBBERSON
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Typical dock showing radiotelephone-equipped boats. Every vertical projection (except for obvious telephone pole and bark-encrusted pilings) represents a different hopeful solution to the short antenna problem

ENGINEERS are seldom called upon to provide two-way radio communications under conditions more unfavorable than aboard the small motor yacht or work boat. On these craft, usually 20 to 50-feet in length, they are frequently expected to connect a 10-watt transmitter to an antenna not over 0.05 wavelength long, with a high-resistance ground and a weak battery—then to telephone 100 miles through summer static!

The degree to which efficient operation can be approached depends largely on the antenna system used.

Since many features of marine antennas (both good and bad) are applicable to other communications services, such as the aeronautical, the military and mobile, an analysis should be useful not only to marine technicians, but also to engineers called upon to provide communications under comparably poor conditions anywhere.

Requirements

The primary purpose of marine radiotelephone is lifesaving, the summoning of the Coast Guard or other boats in an emergency. A transmitting range of 50 to 100 miles is desirable for vessels in coastal waters, while those operating offshore need a range at least equal to their cruising radius. The frequencies allocated to this service extend from 2.110 to 2.738 mc, so ground-wave propagation is predominant. Transmitter power is limited to 5 to 100 watts by the engine battery or auxiliary power available, so maximum efficiency is important.

Small boat antennas, unlike those in other services, cannot be rated according to gain. Because of their small size, they must be rated as to loss, as expressed by a comparison of radiation resistance to loss factors.

Radiation resistance at the midband frequency of 2.5 mc is plotted in Fig. 1, along with the basic equivalent circuit of the small boat antenna. As indicated the antenna represents a resonant circuit with an inductive component in the transmitter balancing the capacitive characteristic of the antenna, and with the radiation resistance and the various loss resistances in series.

The power delivered by the transmitter is dissipated in the different resistances in proportion to their numerical value. Usually, most of the available power is wasted. In fact, any small boat antenna system which does not throw away over half of the transmitter power has come to be thought of as a high-gain antenna.

A simplified circuit diagram of the output circuit of a representative marine radiotelephone is shown in Fig. 2. This diagram shows only the basic transmitter output circuit, minus provisions for channel switching, antenna and power changeover, and power-output indication.

The r-f amplifier plate tank cir-

Small Boat Antennas

No single improvement in antenna system design can contribute more to radiation efficiency than increasing antenna capacitance to reduce size of loading coil. Practical problems involved in maritime mobile antennas are discussed

cuit is made up of fixed capacitor C_1, a portion of L_3 and all of L_2. The coil L_2 is of small diameter to make antenna coupling variable in small increments as successive turns are tapped. Load impedances from about 1 to 100 ohms can be accommodated. Antenna circuit resonance is obtained by adjusting antenna loading coil, L_1, so its inductive reactance equals and cancels the capacitive reactance of the short antenna, leaving the circuit one of pure resistance.

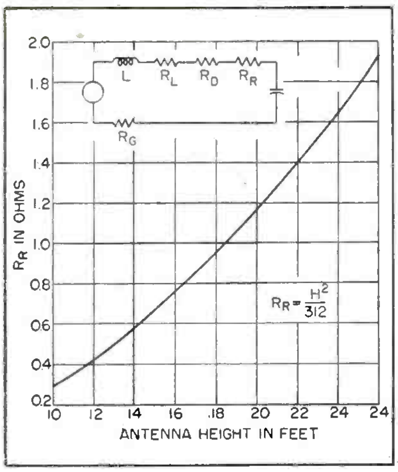


FIG. 1—Curve shows radiation resistance at 2.5 mc versus height of antenna in feet. Insert shows simplified equivalent circuit of marine antenna system

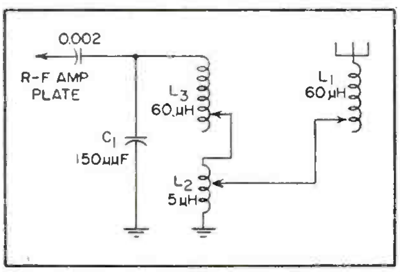


FIG. 2—Simplified schematic of typical radiotelephone output circuit

This is accomplished physically as shown in the photograph of a typical marine radiotelephone. Note the treatment of the r-f output circuit, with its multiplicity of clips and associated leads, connecting back and forth through the chassis to switches, relays and output indicators. Note also the dead-end coil turns, the extreme closeness of the panel, power supply, chassis, and cabinet to the coils.

The consequent coil loss is so pronounced in most marine radiotelephones that a noticeable difference in antenna current occurs at different frequencies in the range of the set, as more or less coil is used.

A typical 12-ft antenna has, at the midband frequency 2.5 mc, a radiation resistance of 0.4 ohm and an effective capacitance of 40 μμf requiring a loading-coil inductance of 100 μh. In order that the coil resistance loss be brought down to the same value as the radiation resistance (so that only half the power would be lost in the coil), a loading-coil Q of 3,920 would be required.

With the loading-coil Q in the neighborhood of 300, which is good for a commercial coil, the effective resistance is still 5.25 ohms. Obviously, then, system design that improves loading-coil Q is helpful, but no spectacular improvement can be expected in this direction. Antennas requiring the very least possible amount of loading coil for resonance are the logical solution.

Dielectric Loss

On a boat, the dielectric loss R_d is variable, fluctuating with weather and wind, as more or less rainwater or spray comes aboard. After a boat has been in the water only a short while, its whole structure, including the decks, bulkheads and masts, becomes a sort of nonhomogeneous variable resistor. With a pocket ohmmeter, heavy conductivity can be found between supposedly insulated fixtures, and even between the screws holding the boat together, or between ground and a probe plugged into the planking that forms the hull of the boat.

Insulators

The insulators most commonly used are Bakelite or the glazed porcelain types employed in broadcasting and commercial services, and with most of them, somewhere underneath, or where the molding flash has been ground off, there is an unglazed surface that acts as an open door not only to solid water, but to moisture from the other materials contacted, and to atmospheric moisture. It is quite common for R_d to be in the neighborhood of one megohm, even on a dry, sunny day.

At first glance, this does not seem to be important but with antennas as short as those used on small boats, shunt resistances that may be tolerable in other fields will completely disable a marine radiotelephone transmitter.

Applied to very short antennas, a shunt resistance has the equivalent effect of a series resistance of the value $R_{series} = X^2/R_{shunt}$ where X is the reactance of the antenna. With the antenna of the previous example, the series equivalent for a leakage resistance of one megohm would be about 2.5 ohms—very much more than the radiation resistance of 0.4 ohm given before.

Even if there were no other loss, 86 percent of the transmitter output would be squandered in heating this resistance. Just one dash of spray will plunge the shunt resistance to 20,000 ohms or less, which is translatable into an equivalent series resistance of 123 ohms. Even if the slight amount of power left for the 0.4-ohm antenna to work on were of any use, there would still be no operation possible, because this extreme change of load resistance is far beyond the compensatory range of the transmitter.

In cases of absolute nonoperation of transmitters, resistances as low as 10,000 ohms have been measured through an insulator between the terminal and the raw underside. Baking such insulators in an oven or over a flame will temporarily restore operation in an emergency—but it would be much better to use absolutely nonhygroscopic material in the first place.

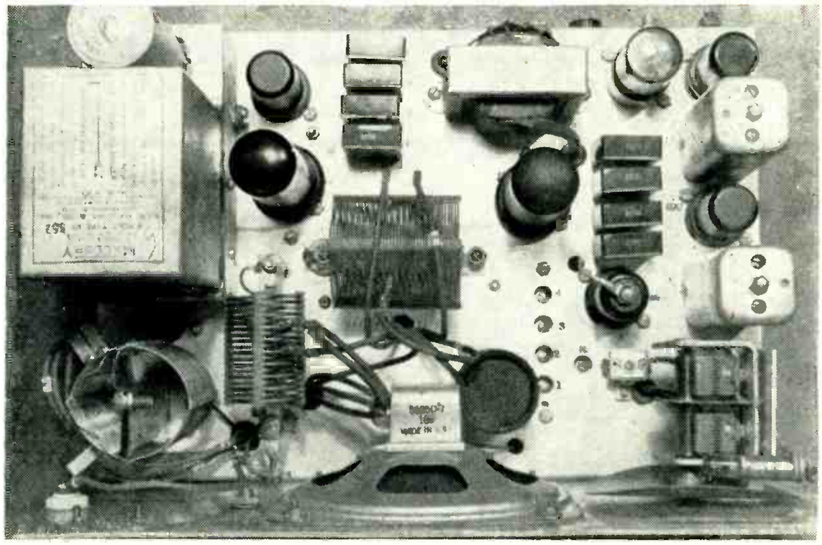
Even nonhygroscopic insulators become lossy when coated by moisture, dirt, or salt spray, so as few insulators as are mechanically essential should be used, and their design should provide a long leakage path.

Ground Loss

There is one important loss remaining in the antenna circuit—the ground resistance R_G. This resistance has been found to range from 0.25 ohm and less to 25 ohms and more.

On two different boats having identical 25-watt transmitters, both delivering rated power to identical antennas, one may have an antenna ammeter reading of 3 amperes, while the other may have a reading of only 1 ampere. This is indicative of a total effective antenna resistance of less than 2.78 ohms in the first boat, and 25 ohms in the second.

The difference between the two installations is all in the ground system—the first transmitter is solidly grounded to a steel hull, while the second, in a wooden boat, is grounded only to the distant engine. This latter case is representative, unfortunately, of at least half the small boat installations now existing.



The r-f nest of a typical 10-watt marine radiotelephone. Transmitter components occupy left half of chassis. Note compromise design for electrical and mechanical convenience

Grounding can be improved on a small boat by the installation on the bottom of the vessel of as large a ground plate as the shape and size of the hull permit, and the bonding to ground of all neutral metal on board, such as piping, engines, rudders, tanks, life-lines and the radiotelephone transmitter itself by as short and heavy a conductor as can be installed.

A summary of typical losses may easily be made by starting from the fact that the usual antenna current for a small boat transmitter developing 25 watts of power is around 1.5 amperes. The total effective antenna resistance is therefore about 11.1 ohms.

At the midband frequency of 2.5 mc, the apportionment of generated power in this case would resemble the following:

Radiation resistance, for antenna height of 18 ft.	0.96 ohms
Coil resistance, for resonating 50-$\mu\mu$f antenna, 80 μh, Q of 250	5.02 ohms
Insulator leakage, 1 megohm, having equivalent series resistance of	1.58 ohms
Ground resistance	3.54 ohms
Total	11.10 ohms

Thus, with the boat fairly dry, only 8.6 percent of the generated power is used for making signals.

In most transmitters, less coil is used than indicated in the above breakdown because of the distributed capacitance of incidental circuitry, but this leads to another shunt loss, on the other hand, so the total loss remains about the same.

Optimum Design

The first essentials of a good marine installation are good insulation and a good ground. That leaves only the loading coil loss as a variable.

The best antenna is the one requiring the least loading coil for resonance. The first efforts toward a reduction were along the lines that if a quarter wavelength at the desired frequency were 94 feet, wrapping that length of wire on a much shorter pole would result in a

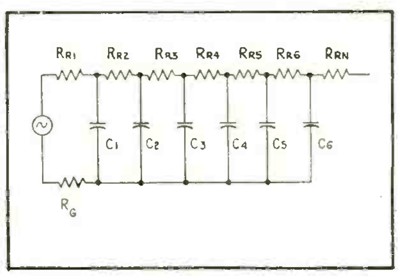


FIG. 3—Distributed R and C equivalent circuit of Marconi antenna shows advisability of placing antenna resonating coil near base of antenna. It is desirable to get maximum current flow through the radiation resistance

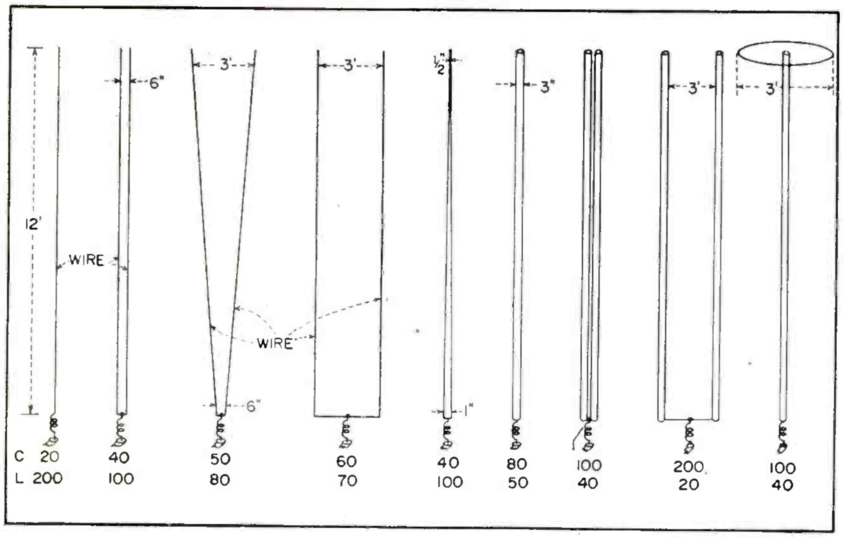


FIG. 4—Typical methods for increasing capacitance of vertical antennas to reduce size of loading coil required. Losses in average 20-μh coil are significantly less than losses in 200-μh coil

quarter-wave antenna of much less than usual height. So entrenched is this fallacy that whole fleets of small boats carry such antennas. The proponents of these designs engage in a perpetual controversy over the proper spacing of the turns in the wire spiral, and the lumping of some of it in close-wound coils in the middle, at the top or at some other esoterically derived spot. Such wrapping may result in improvement but not due to the inductance of the winding, nor the quarter-wave-length of wire used. The effective resistance of such spirals runs from 5 to 15 ohms dry, and 25 to 50 or more ohms after one dash of rainwater. Any improvement over a straight wire realized by the use of such coils in an antenna is due more to the increased capacitance of the system than to anything else.

More improvement can actually be obtained in many such antennas by short-circuiting the whole coil or spiral turn by turn. The performance then approaches that of a metal cylinder of the same diameter. The wood always contributes an added loss due to its inherently poor dielectric characteristics.

Another popular type of antenna is the short metal radiator, with a loading coil in the circuit somewhere aloft and with a metal shield over the coil for weather protection. This does help to achieve resonance with less of the transmitter loading coil in the circuit, but usually not for the reason thought.

The radiation resistance of one such antenna at the midband frequency is 0.3 ohm. The inductance of the bare loading coil is 26 μh, with an effective resistance of 1.9 ohms. Installation of the shield around the coil reduces the coil inductance to only 16 μh, (due to the shield acting as a short-circuited secondary winding) and the effective coil resistance increases to 2.13 ohms (due to secondary loss).

In spite of the coil losses, the antenna performs better with the shield in place, but not because the shield prevents coil wetting. The shield adds to the effective capacitance of the antenna. In fact, this benefit is obtained with the loading coil short circuited or removed.

Figure 3 shows more accurately the equivalent circuit of the very short antenna. As this diagram shows, the farther out from the transmitter the loading coil is situated, the less capacitance to ground exists at the coil's far end. When the coil is located at the very end of the antenna, there is practically no capacitance connected to its far end and a coil of enormous size would be required, since it would have to be self-resonant.

In spite of this, some small boat antennas are made with a coil toward the top or even on the very tip of the antenna, working into a capacitance hat in the form of a wagon-wheel or birdcage.

Placement of coils aloft does have the advantage that less antenna current passes through them, hence their resistance loss is somewhat reduced. A point is reached as a coil is moved toward the end of an antenna, where it is actually better to short-circuit the loading coil, and thereby allow it to act as a capacitance-adding device, rather than to try to make it act like a coil.

Useful gain can usually be obtained by installing a high-Q loading coil just outside the transmitter, or at the base of the antenna. The optimum size of this coil is that which will eliminate the need for any of the transmitter loading coil except a small portion for channel switching. Putting the coil at the base of the antenna has the added value of lowering the lead-in r-f voltage and reducing insulation leakage.

If an effort is also made to increase the capacitance of the antenna, the inductor loss can be even further reduced.

A shape of antenna that concentrates capacitance toward the top also raises the radiation resistance, and would be highly acceptable, if not prohibitive from the standpoint of weight or drag. Most simulated birdcages or wagon wheels do not qualify in this last respect although they do add capacitance. The same weight and drag values reworked into a more pleasing shape can be made to provide comparable loading improvement. Several examples of ways to increase effective antenna capacitance are shown in Fig. 4. As illustrated, increasing the number and size of conductors, or fanning and separating individual conductors can add substantially to the effective capacitance of an antenna. In situations where height is limited no other improvement can provide as much improvement in mobile performance.

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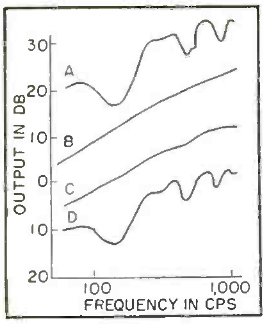

FIG. 1—Irregular response is due to playback head

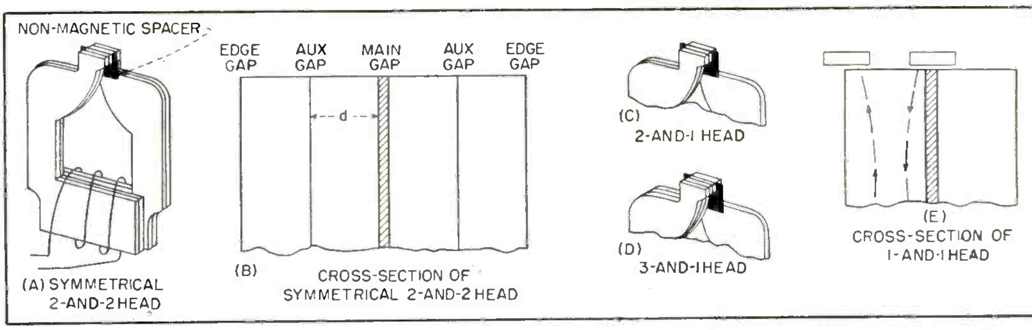

FIG. 2—Examples of various possible arrangements of laminations and nonmagnetic spacers in a playback head, where edge and auxiliary gaps are sources of interfering flux

Improving Response of

THE FREQUENCY RESPONSE of a magnetic tape recording and playback head shows certain departures from smoothness, particularly at the lower frequencies. Practical improvement in the heads may be achieved by an understanding of the reasons for presence of irregularities.

The frequency response of a head is obtained by recording the frequency spectrum at constant current (the record current and bias current being determined in accordance with RTMA Specification REC-134), and then playing the tape back and measuring the output voltage. The output voltage ascends with frequency at about 6 db per octave until the combined effects of high-frequency core losses, the thickness effect in the magnetic tape and the effect of the gap spacer[1] cause the output to reach a maximum and then descend. At 3.75 inches per second, this maximum occurs at approximately 1,000 cps. Where over-all flatness of the frequency response is desired, equalization may be applied to the recording current and/or the playback network.

Source of Irregularities

The irregularities are a function of the playback head only. This is shown in Fig. 1, where two heads are used—a smooth-response head and a head whose response has been purposely made as irregular as possible. In Fig. 1A, the irregular head is used both for recording and for playing back its own signal, and gives an irregular result. In Fig. 1B, recorded by a smooth head and played back on itself, the response is smooth. In Fig. 1C, the response is recorded by the irregular head and played back on the smooth head; again the response is smooth, although there are slight irregularities. Figure 1D shows that the response when recorded on the smooth head and played back on the irregular head is irregular.

In the playback process, it is helpful to think of gaps as sources of flux, which take magnetic flux from the tape and supply it to the coil. In addition to the main gap, there may be two other types of sources of flux in tape heads. These sources, which interfere with the output of the main gap and cause the irregularities, are the edges of the pole pieces (edge gaps)[2] and the spaces between laminations.

In tape heads in which the laminations are at right angles to the direction of tape travel, the spaces between these laminations act as sources of flux. These will be called auxiliary gaps. Since these sources of flux are displaced from the main gap, there will be a phase difference between their output and the output of the main gap. Their output will add to the main gap output at some frequencies, subtract at others, or interfere with the output and produce an irregular response.

Figure 2A shows one type of tape recording and playback head. The two magnetic pole pieces (0.010 inch thick) are separated from each other by a metallic nonmagnetic spacer, which is commonly 0.0005 inch thick. This forms the main gap. In addition to the main gap, the symmetrical head contains two auxiliary gaps (the spaces between the laminations) and two edge gaps as in Fig. 2B. Modifications can have only one auxiliary gap as in Fig. 2C or can have the relative position of the gaps changed as in Fig. 2D.

Two-Lamination Head

Consider the case where there are symmetrical edge gaps alone, displaced from the main gap by a distance b, as shown in Fig. 2E. Let the tape traveling over the head have impressed upon it a magnetic signal of wavelength λ, and be traveling across the head with velocity $v = x/t$, where x is the displacement. The output from the main gap then is

$$e = A \cos \frac{2 \pi x}{\lambda} \quad (1)$$

where A is a variable which includes in it the 6-db-per-octave rise at low frequencies due to the velocity characteristic of the magnetic circuit and the decline in output at the high frequencies (short wavelengths) due to the gap effect.

The output from the edge to the right is

$$e_2 = -C \cos \frac{2 \pi (x + b)}{\lambda} \quad (2)$$

* Now with Electro Engineering Products Co., Inc., Chicago, Ill.

Effect of lamination air gaps on frequency response of magnetic tape playback heads. Edges of pole pieces and spaces between laminations act as sources of interfering flux. Unsymmetrical arrangement of laminations gives smoothest response curve

By ARTHUR H. MANKIN

*Shure Brothers, Inc., Chicago, Ill.**

Magnetic Playback Heads

since the source is located at the point $(x + b)$. The minus sign is in front of the term because there is an inherent 180-degree phase reversal at the edges. An elemental magnet placed at the edge causes flux to flow through the coil in a different direction than a similarly poled magnet placed at the main gap.

Similarly, the output from the edge to the left is

$$e_3 = -C \cos \frac{2\pi(x-b)}{\lambda} \qquad (3)$$

Adding Eq. 1, 2 and 3 gives the total output as

$$e_{out} = \cos \frac{2\pi x}{\lambda} \left(A - 2B\cos\frac{2\pi b}{\lambda}\right) \qquad (4)$$

This last equation is the useful result since it gives the frequency response in terms of the ratio of pole width b to wavelength λ on the tape. This result is shown as curve A in Fig. 3, which is the actual frequency response of a head with pole pieces 0.020 inch in width (in the direction of tape travel) plotted at a tape speed of 3.75 inches per second.

The calculated first minimum for the above set of constants occurs at 167 cps which is in good agreement with the observed value. At 15 inches per second, with ¼-inch pole faces, the first minimum occurs at 60 cps. One method of minimizing this effect is to place the main gap unsymmetrically between the edges; then the separate responses of the edges do not add to each other in phase. Also, by causing the tape to leave the pole pieces gradually, the magnitude of the effect may be decreased.

Four-Lamination Head

Curve B in Fig. 3 gives the frequency response of a head in which there are two 0.010-inch laminations on either side of the main gap. These laminations are arranged at right angles to the direction of travel. Using an exactly similar method as for the two-lamination case, with d as the lamination width, the output voltage is

$$e_{out} = \cos\frac{2\pi x}{\lambda}\left(A + 2B\cos\frac{2\pi d}{\lambda} - 2C\cos\frac{4\pi d}{\lambda}\right) \qquad (5)$$

This gives one term due to the edges plus a term due to the auxiliary gaps. The response from Eq. 5 for a smooth-response head in which the pole pieces are infinitely long is shown by curve C in Fig. 3; here A was arbitrarily given the value 1, B ¼ and C ⅛. The curve corresponds quite closely to the actual response in curve B.

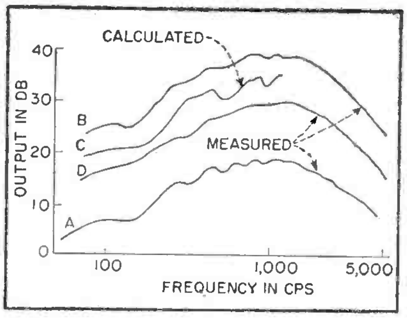

FIG. 3—Frequency response curves for various arrangements of laminations

Three-lamination Head

With two 0.010-inch laminations on one side of the gap and one 0.010-inch lamination on the other, the smoother response of curve D is obtained. The theoretical response for this condition is

$$e_{out} = \cos\frac{2\pi x}{\lambda}\left(A + (B - C)\cos\frac{2\pi d}{\lambda} - C\cos\frac{4\pi d}{\lambda}\right) \qquad (6)$$

It is possible to calculate the response of any configuration of laminations, varying both in number and width, by this method. As another example, the configuration with three laminations on one side of the main gap and only one on the other gives, both theoretically and practically, almost as smooth a response as the 2 and 1 structure used commercially.

Helpful and stimulating conversations on the subject with other members of the Tape Recording Section of Shure Brothers, Inc., including Lee Gunter, Jr. and Thomas W. Phinney are hereby acknowledged.

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UHF-TV Radiators

Directional transmitting systems for uhf-tv broadcast applications make radiating slot preferable to modifications of conventional structures. Scale models indicate ease in obtaining special patterns with simplified feed and support inherent in new designs

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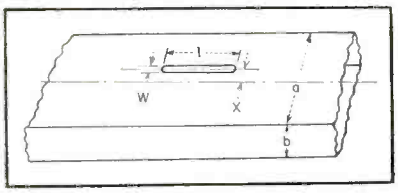

FIG. 1—Longitudinal slot in rectangular waveguide showing parameters discussed in design formulas

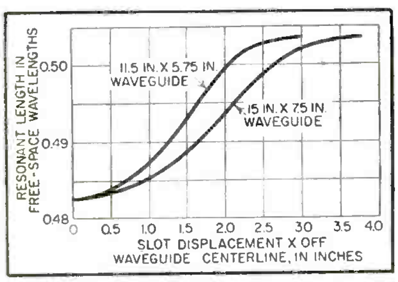

FIG. 2—Resonant length of longitudinal slot in uhf waveguide as a function of displacement

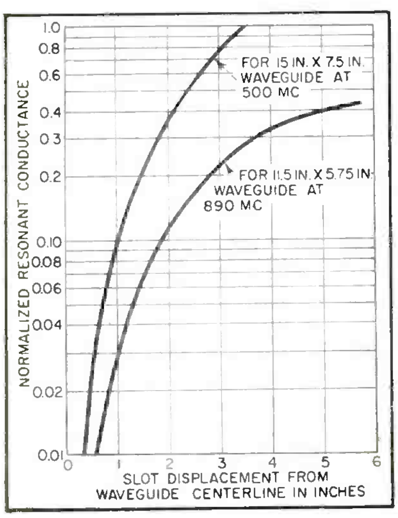

FIG. 3—Resonant conductances of longitudinal shunt slots at 500 and 890 mc

PRIME REQUIREMENTS for television antennas have been high gain, uniform azimuth pattern, minimum feed complexities and structures capable of withstanding all types of weather. In the future it may become desirable to modify the azimuth pattern from omnidirectional and also to shape the vertical pattern. Reduction of feed complexities is also of prime importance. Antennas used at present consist of bays stacked one above the other, each bay requiring a separate feed point.

These systems are complicated and would be even more so if scaling to ultra-high frequencies were attempted. To reduce the number of feed points the traveling-wave principle has been suggested[1]. This antenna uses a helix wound around a central cylinder for support. The helix is designed to operate in the mode that results in a main beam of radiation normal to its axis. The polarization is horizontal and the pattern is omnidirectional in azimuth, the elevation beam being narrow and a function of the length of the helix. Although only one feed point is needed, the construction of this antenna is complex.

Slot Antenna

Since uhf-tv frequencies fall in the lower end of the microwave region, it appears reasonable to use microwave techniques in antenna design. A logical system would comprise a vertical array of longitudinal shunt or inclined series slots on a waveguide. Both these types will give the same general pattern with horizontal polarization. The series slot array has a small amount of cross-polarization.

Secondary Beams

The shunt slot array has secondary beams about 20 db below the main beam that may be undesirable if low side-lobe level is desired. A very low side-lobe level is usually not required.

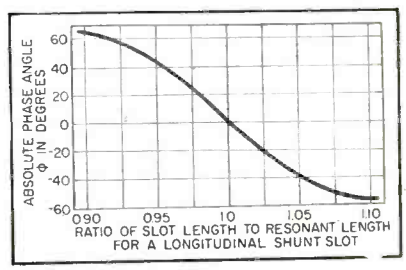

FIG. 4—Absolute phase ϕ of slot radiation vs ratio of length to resonant length for slot width 1/20 wavelength

There are several distinct advantages to using a slot array antenna: linear arrays of discrete elements whose excitation is carefully controlled in general have considerably better aperture efficiency than continuous distributions in which the theoretical distribution is only approximated; cost of manufacturing a slot array is nominal because of its simplicity. Shaped elevation patterns are easily obtainable by varying the aperture distributions and directional azimuth patterns also may be readily obtained. Power

Using Slot Arrays

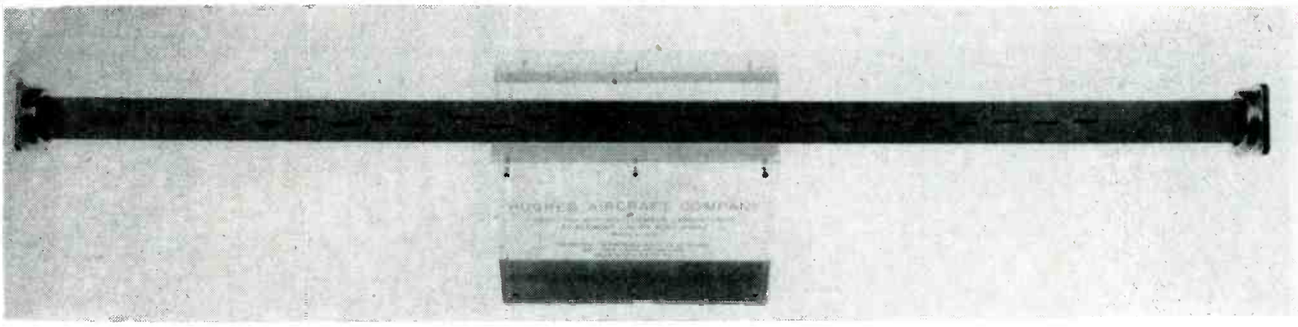

FIG. 5—Longitudinal shunt slot array of 24 elements designed for 9,375 mc with beam width of 3.9 deg

loss in the transmission line is very low. The slot array on its waveguide is self-supporting and need only be secured at the base.

Radiating Slot

Although it is recognized that both inclined slots or displaced longitudinal slots in the broad face of waveguide are essentially acceptable as radiators, the greatest effort has been directed toward determining the characteristics of the displaced longitudinal slot. This type of slot is shown in Fig. 1 and may be represented as a pure shunt element across the transmission-line representation of the waveguide. Sufficient experimental measurements have been made on longitudinal shunt slots[2] to indicate that an extrapolation from the X-band measured data may be made to the uhf-tv frequencies with few, if any, slot measurements.

For instance, the length of a slot as a function of its displacement from the center line of standard $15 \times 7\frac{1}{2}$ in. and $11\frac{1}{2} \times 5\frac{3}{4}$ in. waveguide is expected to be as shown in Fig. 2. The conductance of a resonant slot at 500 mc and at 890 mc in the appropriate standard waveguide is shown in Fig. 3. This curve satisfies the expression

$$G = 2.09 \frac{a}{b} \frac{\lambda_g}{\lambda} \cos^2 \left(\frac{\pi}{2} \frac{\lambda}{\lambda_g} \right) \sin^2 \frac{(\pi x)}{a} \qquad (1)$$

where a = the wide dimension of the waveguide, b = the narrow dimension of the waveguide, x = the displacement of the slot off the waveguide center-line, λ = the free-space wavelength, and

$$\lambda_g = \lambda / \sqrt{1 - \left(\frac{\lambda}{2a} \right)^2} \qquad (2)$$

= the guide wavelength.

Figure 4 shows the phase of the radiation of a nonresonant longitudinal shunt slot. The phase ϕ of the radiation is defined by

$$\tan \phi = B/G \qquad (3)$$

where B is the shunt susceptance of the slot and G is the shunt conductance represented by the slot.

The width of the slots is not critical and may be up to a tenth wavelength wide. This means that at 500 mc the slots will be about 12 in. long by as much as 1 in. wide. To keep insects and birds out of the waveguide and also for weatherizing, it may be advisable to glue thin fiberglass covers directly over the slots.

Elevation Pattern

The elevation pattern will in general be a narrow beam normal to the array. If gain is the main criterion, the aperture distribution will be uniform. The resulting half-power beamwidth may be accurately calculated from the expression

$$\theta_E = 50.9/(l/\lambda) \text{ degrees}$$

where l/λ is the length of the antenna in wavelengths. The array will be expected to have a 10-db width, $\theta\ (1/10)$, of about $\theta\ (1/10) = 1\frac{2}{3}\ \theta_E$ and a 20-db width, $\theta\ (1/100) = 2\ \theta_E$.

The gain of a uniform array de-

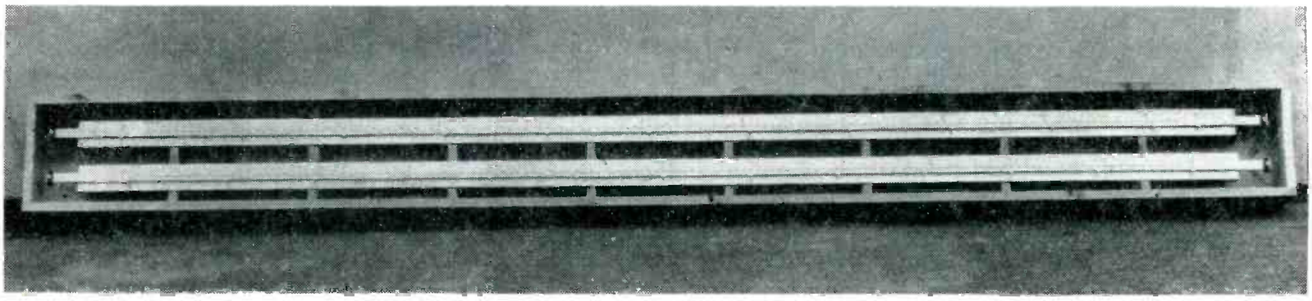

FIG. 6—Array of 144 elements for 10,125 mc. Beam width is 0.71 deg

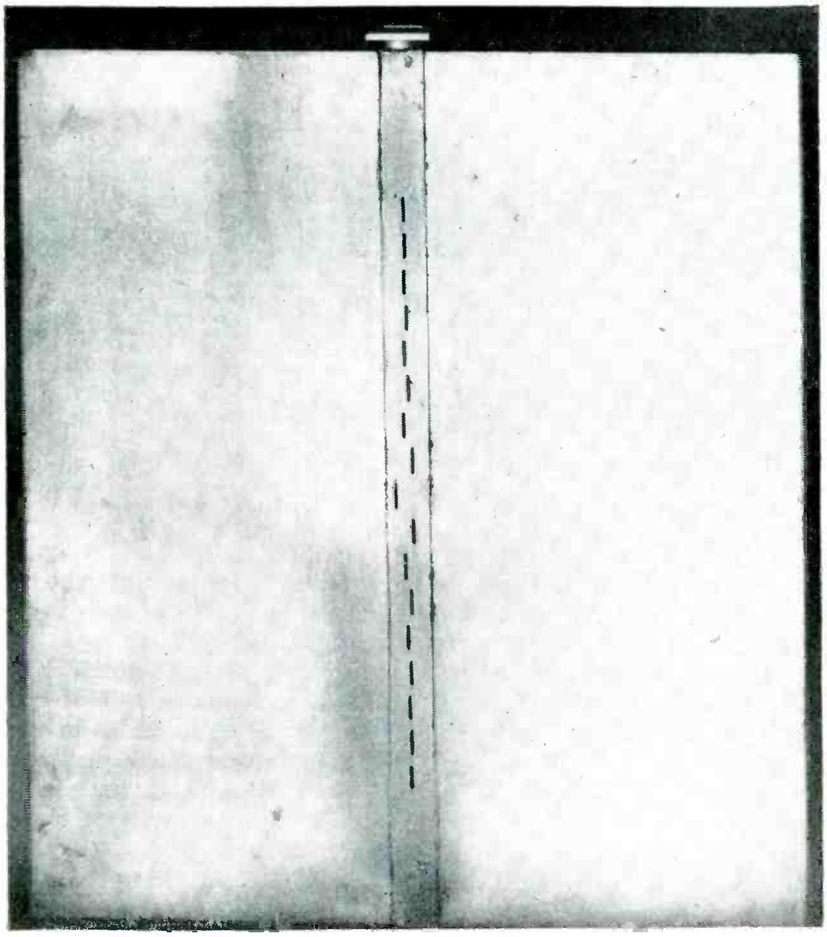

FIG. 7—Longitudinal shunt slot array of 17 elements. Design frequency is 9,910 mc. Idealized aperture shown in Fig. 8 in text is 6 to 60 deg

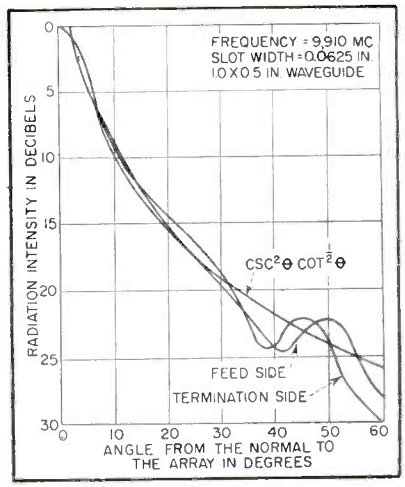

FIG. 8—Radiation pattern of 17-element array shown in Fig. 7

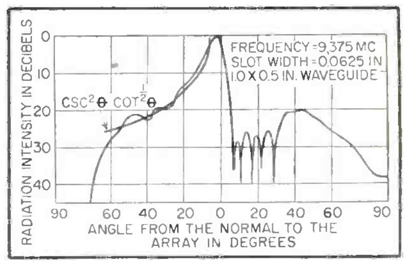

FIG. 9—Radiation pattern of 15-element array of nonresonant longitudinal shunt slots

pends on the azimuth pattern. For an omnidirectional azimuth pattern the power gain is approximately $G = 2l/\lambda$. An array that has an azimuth beam width, θ_A, less than 180 deg will have a power gain given approximately by the expression $G = 32{,}500/\theta_A\ \theta_E$ where θ_A and θ_E are the azimuth and elevation half-power beam widths in degrees.

Slot Array

The slot array consists of N slots cut into the broad face of the waveguide. These slots are displaced from the center-line of the waveguide, adjacent slots alternating about the center-line. The slots are, in general, spaced exactly a half guide-wavelength apart. This is then called a resonant array. The main beam is normal to the array.

The array is terminated a quarter wavelength beyond the last slot with a shorting place. The input admittance is usually designed to be unity. For a resonant array the conductance of the slots is directly proportional to the power radiated. Therefore a uniform array of N slots will consist of identical slots whose conductance is $1/N$.

Shaped beams or low side-lobe level beams are readily achieved. The design of these arrays has been discussed elsewhere[2]. A simple rule for the pattern bandwidth of a resonant array is $\pm$ 50/N percent. This indicates that unless the array is very long there will be no appreciable pattern deterioration over the band of one tv channel. The admittance bandwidth will be a function of the bandwidth of the slots and the admittance design of the array. This will usually be adequate. If necessary, overloading[3] may be used. Overloading is a broadbanding design technique whereby the input admittance is made a large real value and then matched with an iris.

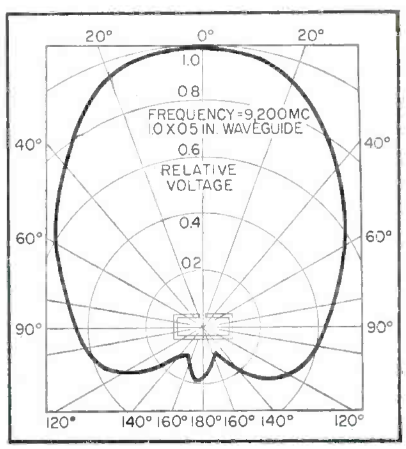

FIG. 10—Azimuth pattern of vertical array with no ground plane

The power-handling capacity of the waveguide is in the tens of megawatts and the power-handling capacity of a one-inch-wide slot will be over one megawatt.

Three linear arrays successfully designed and built by the author are shown in Fig. 5, 6 and 7. The 24-element array was designed for a uniform side-lobe level 30 db below the main beam and measured 28 db at the design frequency. The side-lobe level was better than 26 db over a 15 percent band. The 144-element arrays were designed for a uniform side-lobe level of 40 db down and measured 29 db. This discrepancy is completely attributable to machining tolerances. The 17-element array was designed to have a symmetrical pattern approximately proportional in power to $\csc^2\theta \cot^{1/2}\theta$. The two halves of the pattern about the normal to the array are shown in Fig. 8. The input impedances and beamwidths of these arrays were as designed.

If the antenna is to be constructed high over a city, such as on a mountain top or high building, a beam that has its greatest gain horizontally, a broad beam below and a sharp dropoff above the horizontal would be ideal. This type of pattern, although more difficult to calculate, is possible with a slot array. The pattern of such an antenna which has been constructed is shown in Fig. 9.

Azimuth Pattern

Present antenna designs for television stations have in general called for omnidirectional patterns in the horizontal plane. This is a result of stations being in metropolitan areas. Some uhf channels are allocated to smaller cities and in many cases it will be desirable to have directional azimuth patterns. Slot arrays are almost ideally suited to this application. The variety of patterns and beamwidths available with a slot array are indicated in the patterns of Fig. 10 through 13.

A vertical slot array in a rec-

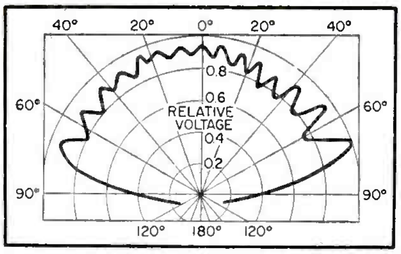

FIG. 11—Azimuth pattern of vertical array of longitudinal slots in 15-wavelength ground plane at 9,200 mc

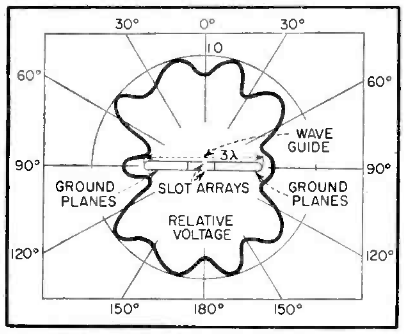

FIG. 12—Azimuth pattern of vertical double array of slots in a three-wavelength ground plane

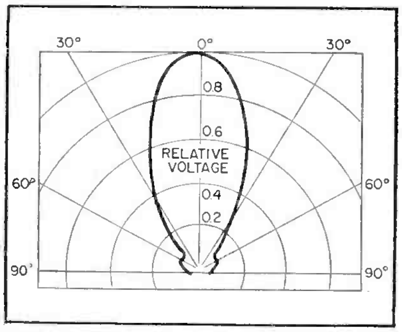

FIG. 13—Azimuth pattern of vertical array of longitudinal slots with horn

tangular waveguide would have the azimuth pattern shown in Fig. 10. The half-power beamwidth is 90 degrees. Figure 11 shows the azimuth pattern of a vertical slot array in a 15-wavelength ground plane. The half-power beamwidth is 165 degrees. The metalized side of a building could be used for the ground plane if this pattern were desired.

The omnidirectional pattern of Fig. 12 is achieved by placing two arrays of slots on opposite sides of the waveguide and placing the ground plane about the waveguide.

The pattern of Fig. 13 was obtained from the linear array and horn shown in Fig. 14. The azimuth half-power beamwidth of this horn-slot combination is 35 degrees. Almost any desired beamwidth may be obtained with appropriate horn dimensions. The horn aperture is given approximately by the expression[4] $A = 60\lambda/\theta_A$ where θ_A is the desired azimuth half-power beamwidth in degrees.

The admittance of the slots is only slightly affected by the presence of the ground planes. The horn has a somewhat more appreciable effect on the slot admittance. The radiation pattern will be essentially undisturbed by these horns but the input admittance to the arrays will be changed and will need correcting. If the horns are placed closer to the slots, if baffles are placed about the slots, or if heavy weatherizing covers are placed over the slots, the admittance characteristics of the slots may be changed quite drastically.

The author wishes to acknowledge the contributions to this material made by many members of Hughes Research and Development Laboratories and especially by members of the Microwave Laboratory.

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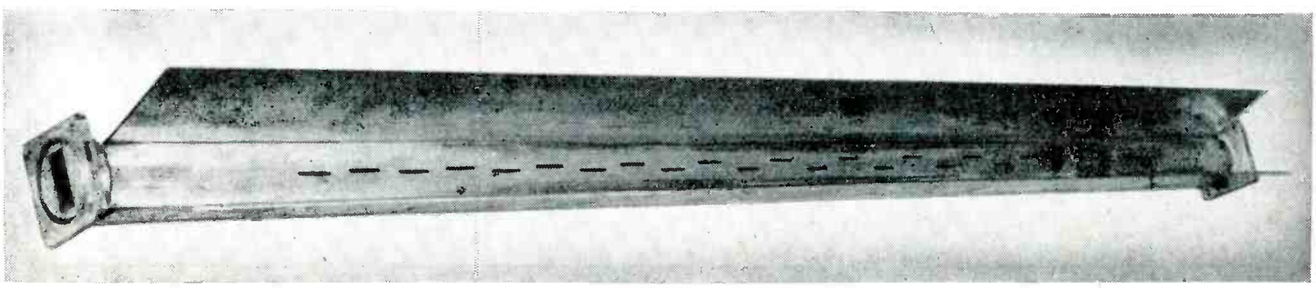

FIG. 14—Twenty-four element array with horn

Linear-to-Logarithmic

By R. C. HOWARD, C. J. SAVANT and R. S. NEISWANDER
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In almost every electronic field, need occasionally arises for linear-to-logarithmic conversion of data. Probably its most extensive use has been in one-dimensional instrument indicators and recorders. Here, for advantageous scale compression, linear inputs are converted to logarithmic values such as decibels. This use can be extended to two-dimensional semilog and log-log oscilloscope presentations.

In electronic-analog computing, the logarithmic converter in conjunction with an antilogarithmic converter conveniently performs multiplication and division by addition and subtraction of voltages and as readily produces integer and non-integer exponent functions.

Evaluation Criteria

A linear-to-logarithmic converter is an electronic device which, when presented with an input x representing some number scaled into d-c voltage, produces an output $y = \log_a x$ where y is also a number scaled into voltage, and a is the base of the logarithm. Over 20 years ago a vacuum-tube circuit using a triode-connected UX-222 tetrode was developed to accomplish this.

Since then many converters have appeared: devices employing germanium diodes, selenium rectifiers, exponential time decays, vacuum-tube diodes, triodes, tetrodes and pentodes [1-6]. Analog-computer, arbitrary-function generators, such as photoelectric cathode-ray-tube devices, can also be used as logarithmic converters.

To evaluate this diverse group the following criteria were established: high-level, moderate-range voltage input; high conversion gain; stable and accurate conversion; reproducible characteristics; and practicable design.

Since the triode converter appeared most promising, development work focused on this item. The most common circuit utilizes the logarithmic relationship between grid current and plate

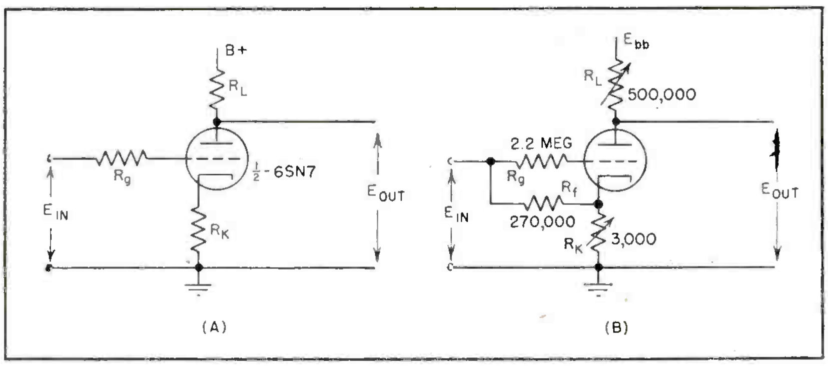


FIG. 1—Conventional triode circuit (A) can be modified to provide high-gain conversion of linear to logarithmic data

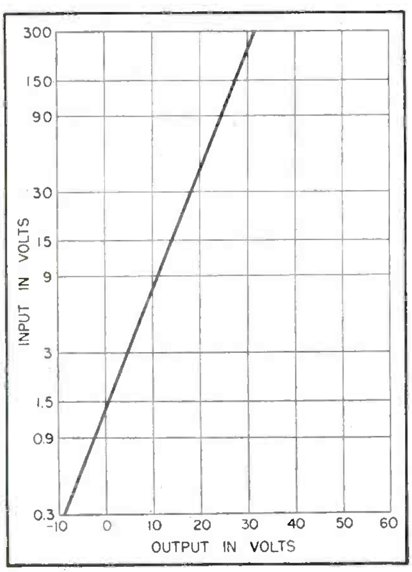


FIG. 2—Conversion characteristic is linear over three log cycles

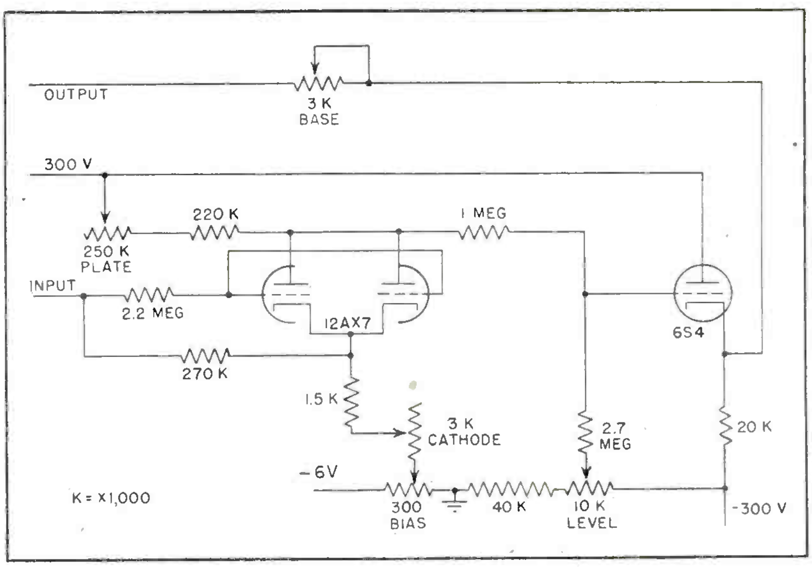


FIG. 3—Complete converter has cathode-follower output to provide isolation and aid in cancellation of offset voltage

Voltage Converter

Conventional triode circuit modified for use with analog computers provides high-gain conversion of linear to logarithmic data over 0.3 to 300-volt range. Converter characteristics are readily reproducible; tubes need not be preselected

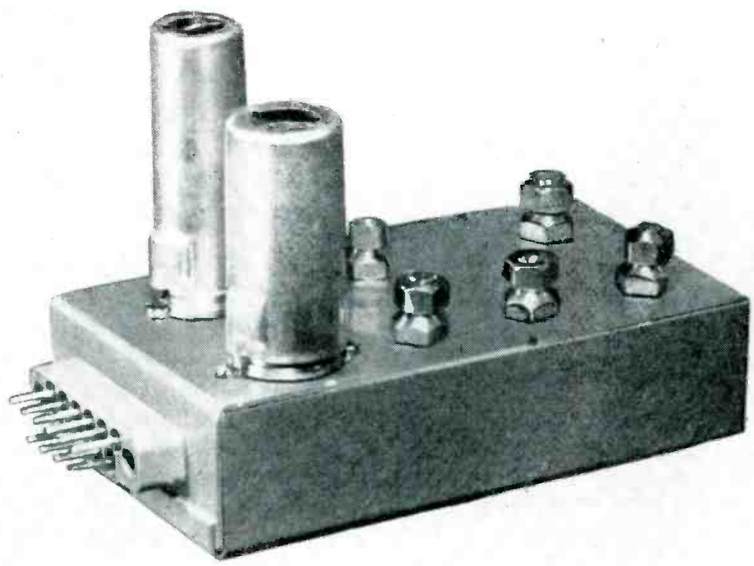
current in some triodes operating at low plate voltages. If a large grid resistor is added for voltage-to-voltage conversion, the basic circuit becomes that of Fig. 1A.

Resistors R_L and R_K and the plate voltage are adjusted to produce an output $E_0 = -\log_a(E_i) + E_{offset}$. With this basic circuit, Nadel[7] succeeded in obtaining a remarkably accurate conversion with a logarithm base of about 3 over a range of 1 to 300 volts.

Modified Triode Circuit

A high-gain conversion characteristic was discovered in the high-plate-voltage region of a few triodes. Typical values for this converter are shown in Fig. 1B. The corresponding response curve is presented in Fig. 2. The input-to-cathode resistor was added to improve the low-input-voltage response; the resistor does not affect higher-level conversion. Tubes do not have to be preselected to maintain similar characteristics. Good stability, 75 millivolts per hour, was attained by 500-hour tube aging.

The output of the converter is of the form $E_0 = -\log_a E_i + E_{offset}$. Both E_{offset}, which arises from the large positive plate voltage, and the logarithm base, a, vary for different tubes. For reproducibility, E_{offset} can be canceled in each converter, and the logarithm base, a, can be made to coincide with some standard.



Linear-to-logarithmic converter is mounted on plug-in chassis

The removal of E_{offset} was directly accomplished by adding a cathode follower to the triode and subtracting E_{offset} at the follower's grid. This addition introduced the further advantage of isolating the triode converter from the actual output.

Adjustment of the logarithm base requires a simple adjustment of gain after logarithmic conversion. This restricted-range gain control is inserted at the cathode-follower's output. The final circuit is shown in Fig. 3.

Although developed for a computer requiring a low logatrithm base and zero d-c level, the same circuit has many possibilities. Table I shows the variety of logarithm bases and output voltages available with different tubes.

Table I—Various Logarithm Bases and Output Voltages Available With Different Tube Types

Case	Tube	E_{bb}	E_f	R_L	R_K	R_f	R_g	E_k	Base	E_0
1	1/2 12AY7	300	5.8	450K	12.4K	470K	2.5Meg	−3.0	1.30	60
2	1/2 12AY7	300	5.8	320	14.0	470	2.5	−8.5	1.38	33
3	1/2 12AU7	280	5.8	100	14.0	5,000	2.5	−13.6	1.78	25
4	1/2 12AU7	280	5.8	27	150.0	5,000	2.5	−3.4	1.78	72
5	1/2 12AT7	290	5.8	36	5.6	1,000	2.5	−24.0	1.18	113
6	1/2 12AX7	290	5.8	18	5.3	150	2.5	−19.0	1.14	231
7	1/2 12AX7	290	5.8	160	6.3	400	2.5	−5.9	1.13	110
8	2/2 12AX7	300	6.0	350	3.0	270	2.2	−3.0	1.26	30

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TRANSISTORS: Theory and Application

Point-Contact

Part V

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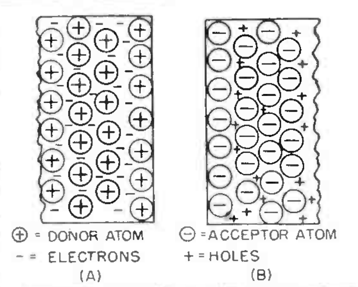

FIG. 1—Donor material (A) and acceptor material (B) show arrays of charged atoms just below surface of germanium

PREVIOUS articles of this series have developed the theoretical concepts associated with *p* and *n*-type semiconductor materials. These principles will be applied to a detailed analysis of the theory of operation of the point-contact transistor.

Temperature Dependence

Much information is obtainable from the covalent bond picture of germanium and silicon. From this picture it is apparent on a qualitative basis that the transistor using germanium or silicon is a temperature-dependent device. An increase in temperature will be accompanied by disruption of some of the covalent bonds thereby freeing electrons to act as carriers.

By definition, the presence of these additional carriers will increase the conductivity. Many of the parameters which characterize a transistor are dependent on conductivity, and these parameters will vary with temperature. If the temperature is increased sufficiently, enough covalent bonds are broken so that additional increases in temperature will have a negligible effect on the number of available carriers. Under such circumstances, the conductivity approaches an upper limit, called the intrinsic conductivity. The word "intrinsic" implies that the conductivity of the semiconductor is essentially dependent upon the properties of the material itself rather than upon the impurities that control its conductivity at lower temperatures.

The intrinsic temperature for germanium normally suitable for transistors is of the order of 100 C. Near the intrinsic temperature, control of the carriers is very difficult because of their very large number and high thermal energy. Since this control is essential to efficient transistor action, it is evident that the intrinsic temperature sets an upper limit for satisfactory transistor operation. In practice, other considerations further limit the maximum operating temperature so that it may be substantially less than the intrinsic temperature.

In Part IV of this series it was shown that impurity atoms occupy lattice sites and by their displacement of germanium atoms give rise to excess electrons or holes. In the conduction process the carriers are the holes or the electrons—the ionized atoms at the lattice sites do not contribute to the conduction.

Conduction in a semiconductor is essentially electronic rather than ionic. In an ionic conduction process, conduction is by atoms that have gained or lost one or more electrons (ions).

At a given instant of time if it were possible to look just below the surface of a semiconductor such as germanium, there would be seen an array of countless germanium and impurity atoms vibrating about their mean lattice positions due to thermal agitation with mobile holes or electrons moving among the atoms. In the case of a donor material, the impurity atoms have a net positive charge and it is convenient for analytical purposes to picture the situation as in Fig. 1A. Here is shown an array of donors, hereafter indicated as a plus sign enclosed in a circle, near the surface of the *n*-type material. For the *p*-type material, Fig. 1B, an array of acceptors with their negative charge is shown. This picture will serve as a useful tool in the analysis of transistor action.

P-N Junction

Figure 2A shows a piece of *p*-type material adjacent to a piece of *n*-type material, such an arrange-

PREVIOUS ARTICLES IN THIS SERIES

Transistors: Theory and Application, Part I, p 98, March 1953.
Energy Levels in Transistor Electronics, Part II, p 138, Apr. 1953.
Physical Properties of Electrons in Solids, Part III, p 162, May 1953.
Transistor Action in Semiconductors, Part IV, p 164, June 1953

Transistor Operation

Detailed discussion of point-contact transistor action is presented, including physical construction, hole and electron movement, potential hills, surface states and relationship of these phenomena to external connections and applied voltages

ment producing a *p-n* junction. It is not possible to make a satisfactory junction by simply taking a piece of *n*-type and a piece of *p*-type germanium and putting them together, regardless of the pressure used to hold them together or how carefully the interfaces are cleaned and polished. Experience has shown that, because an action occurring at a microscopic level among particles of atomic dimensions is involved, it is extremely difficult to get orders of purity and cleanliness or smoothness at the surfaces that are required to obtain a satisfactory *p-n* junction. It is therefore not considered feasible to make a *p-n* junction mechanically. A process for making *p-n* junctions will be described later.

These *p-n* junctions have been used successfully in circuit applications commonly associated with the familiar germanium diode.

This structural arrangement is a convenient device for establishing a general rule for the polarities of applied potentials both for transistors and diodes.

Potential Hills

It might appear at first that under the action of ordinary diffusion, the excess of holes (Fig. 2A) would diffuse into the *n* region and excess of electrons would diffuse into the *p* region so that, in time, the *p-n* junction as such would cease to exist. Of course this does not happen at ordinary temperatures. A very simple analysis, but one which has some very far reaching implications, will show why.

In trying to diffuse into the *n* region, a hole in the *p* region encounters a barrier layer of positively-charged atoms (donors) just across the junction plane. The positive electric field created by the donors opposes the transgression of holes.

Figure 2B shows what the potential variation or distribution looks like to the hole trying to get across the junction. As it approaches the junction, the lines of electric flux extending out impede its motion, and if the hole does reach the junction, it must have had initially a large energy to overcome the opposition of the donor electric field. The increase of energy which a hole must thus possess in order to move against the electric field, is shown in Fig. 2B as a small potential hill. This name is commonly applied to the effect at the junction that prevents the holes from diffusing across it.

At room temperature, for example, the holes will, in general, not have sufficient energy from thermal agitation to climb the potential hill and therefore a significant number of holes do not diffuse from the *p* to the *n* region. Electrons in the *p* region however will, due to the electric field of the donors, diffuse easily into the *n* region sliding down a potential hill. However, the electrons are only minority carriers in the *p* region, and their migration to the *n* region will never annihilate the *p-n* junction because there is already an excess of electrons in the *n* region.

In Fig. 2C is shown the corresponding condition for electrons in the *n* region which would, ordinarily, diffuse into the *p* region under normal kinetic vibration or motion. Analogously for the case of the holes, electrons that approach the junction come under the influence of the negative electric field

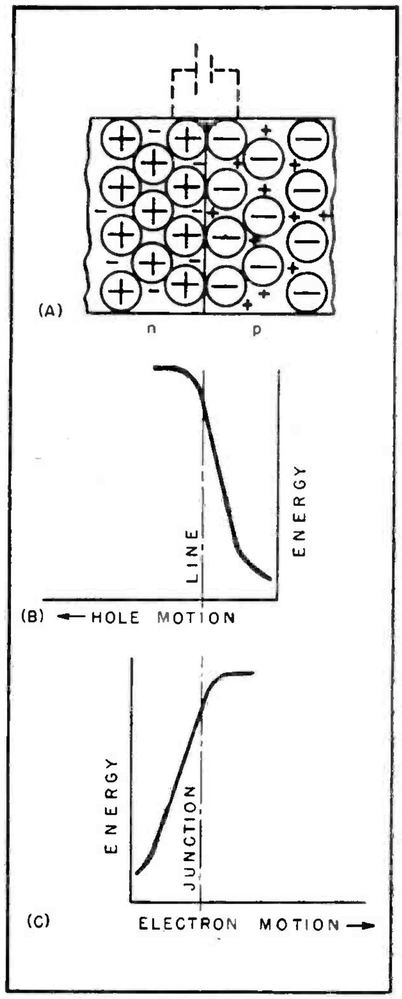

FIG. 2—Donor and acceptor materials arranged as a junction are shown in *A*. Any hole trying to diffuse from acceptor material to donor must climb potential hill due to array of donors near surface of n germanium (B). An electron trying to diffuse from n region to p region must climb potential hill indicated in *C*

due to the array of acceptors and encounter the potential hill that turns back most of them.

The effect due to the array of acceptors and donors is representable as in Fig. 2A by a small battery shown dotted in the figure. For the position shown it will introduce the same potential hills as do the arrays of acceptors and donors. This picture, however, is extremely important because it provides instantly the answer to the polarity problem.

If a battery is connected as in Fig. 3A, it aids the equivalent battery of Fig. 2A and increases the height of the potential hill. With this arrangement the number of carriers that can climb the potential hill is very small and most of the conduction is actually due to minority carriers since this polarity of bias enhances the flow of electrons from the p region to the n and of holes from the n region to the p region. The number of minority carriers is so small that the total current is small and this polarity of bias gives rise to the reverse-current or high-resistance condition.

In Fig. 3B, however, the external battery is connected so as to oppose or flatten out the potential hill or the equivalent battery of Fig. 2A. The flow of holes from the p to the n region and the flow of electrons from the n to the p region is enhanced. This is the low-resistance or forward-current polarity of bias.

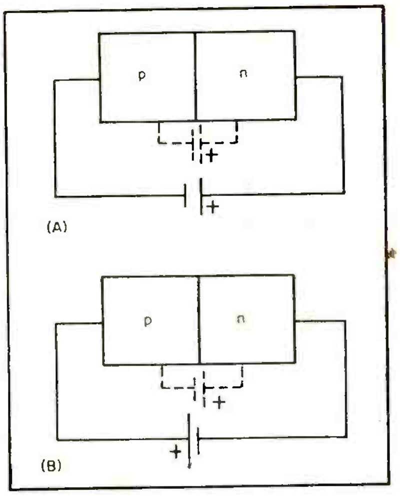

FIG. 3—In A, the potential hill, represented by dashed-line battery, is reinforced or raised by connection of external battery. This is identified as reverse-current (high-resistance) connection. In B, the potential hill, represented by dashed line battery, is overcome or lowered by external battery. This is forward-current (low-resistance) connection

Barrier Potential

The order of magnitude of the potential difference across the junction in the absence of an external battery is in tenths of a volt and it may thus appear that a very small battery connected as in Fig. 3B would be sufficient to completely annihilate the potential hill. This is not so. A semiconductor that has approximately a hundred thousand times the resistance of a conductor such as copper is involved. An important potential drop occurs in the p and n regions without reference to the barrier at all and, of course, as the current increases this drop increases.

The more the barrier is broken down by using the polarity of Fig. 3B the more readily do the carriers move across it. In that sense the resistance of the barrier is decreased. As the current increases the net drop available across the barrier itself for counteracting this contact potential at the barrier decreases, and it is clear that the two actions are opposite in direction. Nevertheless, it is possible to make the potential hill quite small by the use of potentials of the order of one volt. If the battery potential is made too high in the reverse direction voltage breakdown occurs, see Fig. 3A. In the case of the forward connection of Fig. 3B, the application of too high a voltage will permanently damage the junction due to the heating effects of excessively high currents.

State of Theory

Before proceeding to the discussion of the theory of the point-contact transistor it is necessary to make some precautionary remarks. The vacuum tube has been known for over 50 years and vacuum-tube theory is on relatively firm ground. In vacuum tube theory, the reader is accustomed to seeing only the well-worked-out and thoroughly established theories in print, each such theory having had ample time to be checked and cross-checked by many workers in the field. This is in general not true of transistor theory because the entire field is barely five years old.

Authorities in the field today do not unanimously agree upon a theoretical explanation of point-contact transistor operation. To the reader familiar with the calculus this will not appear particularly surprising. The mathematical analysis of physical phenomena occurring at a point such as the pointed tip of the fine wire used for the cat whisker is extremely difficult and involved. Theories that adequately explain all the known phenomena involved in point-contact operation have not been completed. Many of the equations developed are so complex and difficult to verify experimentally that physically significant solutions are not yet available.

There is, therefore, no complete mathematically supported theory of point-contact rectification or transistor action that may be used to interpret observed phenomena or predict future behavior. The theoretical explanation of the action of a point-contact transistor that will be given must be considered to be merely one of the many possible theories. The reader should look upon the explanation proffered with a certain amount of critical reserve. The explanation to be given is, in the opinion of the authors, the best currently available but because the art is so young it is well to bear in mind that it may be considerably modified in years to come.

Theory of Operation

In Fig. 4 is shown the essential arrangement for point-contact transistor operation. The base (or pellet) is a piece of n-type germanium of about 4 to 5 ohm-cm resistivity, approximately 20 mils thick, and about 50 mils in length and width. The cat whiskers are wires of some metal such as phosphor bronze approximately 5 mils in diameter, spaced approximately 2 mils apart with some simple provision such as a bend in the wire, to keep a few grams pressure on the surface of the germanium.

The cat whisker shown on the left is called the emitter for reasons which will appear shortly. The other cat whisker is the collector. The base connection on the underside of the germanium pellet consists of an ohmic soldered connection.

The reader may be concerned with possible deleterious effects of the heating involved in the soldering operation. Actually harmful effects on the electrical properties of the germanium are not observed until temperatures considerably higher than those encountered in the soldering operation are reached. Further, to degrade appreciably the characteristics of the germanium, elevated temperatures must be maintained for times much in excess of those encountered in the soldering process.

It is known that electrons that find their way to the surface of the semiconductor become held or bound in certain conditions or states that are different from the quantum states of the electrons inside the bulk of the material. When the electrons enter into these surface states (surface quantum states) they appear to be bound and do not readily return into the bulk of the material. The result is that a surface layer of such electrons in these surface states is built up on the material. For an n-type material, and mention has already been made that point-contact transistors are usually made with n-type material, this surface layer of electrons, as shown in Fig. 5, combines with the array of donors just below the surface to form a small potential hill, as shown by the dotted battery. This arrangement produces an effect analogous to the p-n junction discussed in connection with Fig. 2.

Rules for Polarity

Two rules may be established for the polarities of connections of transistors, which will apply to all the transistors, point-contact and junction. The reasons for these rules will become apparent during this article and the next.

(1) The emitter is always biased in the forward or low-resistance direction.

(2) The collector is always biased in the reverse or high-resistance direction.

On the basis of these two rules, and if we accept the surface-states electron theory discussed above, it is apparent that the emitter bias or battery E_e of Fig. 4 will be connected to oppose the potential hill at the surface as shown, and the collector battery E_c will be connected to aid the surface potential hill. It is thus seen that without knowing the theory of operation of the transistor the reader by the simple mnemonic outlined, will know exactly how to bias a point-contact transistor, or, as we shall see later, a junction transistor.

Looking at Fig. 4, the surface electrons near the emitter have been removed because of the polarity of the connection, but those a little further away are still present. This is intended to illustrate the concept of bound electrons. If a metal plate, such as in a capacitor, is given a charge the charge will, in general, distribute itself evenly over the surface. If a battery terminal of suitable polarity is connected to the plate, all the charge on the plate can be drained off at once merely by connecting the battery at one point because the charges on a conductor plate are, in general, not bound. This is not true of an insulator or semiconductor. When the cat whisker at the emitter is applied as shown, only the electrons on the surface in the immediate vicinity are whisked away by the battery; the remaining surface electrons remain in their bound states as indicated.

Cat Whiskers

One might wonder why it is necessary to use a cat whisker? Why can't a simple metal-plate connection be used? To answer this question it is necessary first to investigate the general characteristics of a point in electrical work.

An electric field such as may exist between the plates of a capacitor is usually considered to be made up of lines or rays called flux lines. The number of such flux lines depends on the potential, not on the area. Thus, for a given potential, electric flux lines are extremely crowded at a point and the electric flux intensity which by definition is flux lines per unit area is very high.

In a lightning rod, for instance, since the cloud must be discharged into the rod as soon as possible before the cloud accumulates enough charge to cause a lightning flash, the rod is made pointed. By crowding the electric flux lines from the cloud into a point, a sufficient field intensity is developed to cause a current to flow down the electric rod and thus partially discharge the cloud.

Large potentials may not be applied to a transistor because of the possibility of very large currents, which will cause heating or, for the case of reverse connections, voltage breakdown. To break the covalent bonds in the germanium, a high-intensity electric field is needed at the emitter. The only way to get this high-intensity field is to use a point. For this reason the emitter contact is a point contact.

Hole Injection

When the emitter bias E_e is applied, even though this bias is of the order of 1 volt, a high-intensity electric field is created at the point and imparts sufficient energy to the electrons in the valence bonds nearby to raise them into the conduction band and to break these valence bonds. These electrons under the influence of the applied potential immediately flow out of the material and into the emitter. The breaking of the valence bonds creates holes in the immediate vicinity of the emitter as shown in Fig. 4. While the term is somewhat a misnomer, this process of creation of holes is called injection because the effect is the same as if holes had been injected by the emitter. As soon as the holes are created they drift toward the collector under the influence of the electric field between emitter and collector.

Since we are dealing with an n-type material, with free or excess electrons, many of the holes on their way to the collector will recombine with the electrons and cease to exist. As these recombinations are taking place all the time, the number of holes that will combine with electrons increases with the transit time. Since a large number of holes is necessary for maximum effectiveness in transistor action, it is desirable to place the emitter and collector close together. Point-contact transistors of current design have emitter to collector spacings up to approximately 5 mils. If spaced too far apart, the gain and frequency response are adversely effected.

In the region of the collector the

potential hill at the surface limits the current flow and in the absence of holes the current will be of the order of one or two milliamperes. Holes that reach the immediate vicinity of the collector are attracted by the negative charge there and in moving to the collector point tend partially to cancel out or nullify the potential hill at the surface. In this way more electrons are permitted to climb the potential hill and the current at the collector is increased.

This increase in collector current as a result of hole injection is transistor action, and it is observed that small changes in the hole injection such as may be due to a modulation of the emitter bias by an a-c potential result in amplification of the emitter current containing the modulation intelligence.

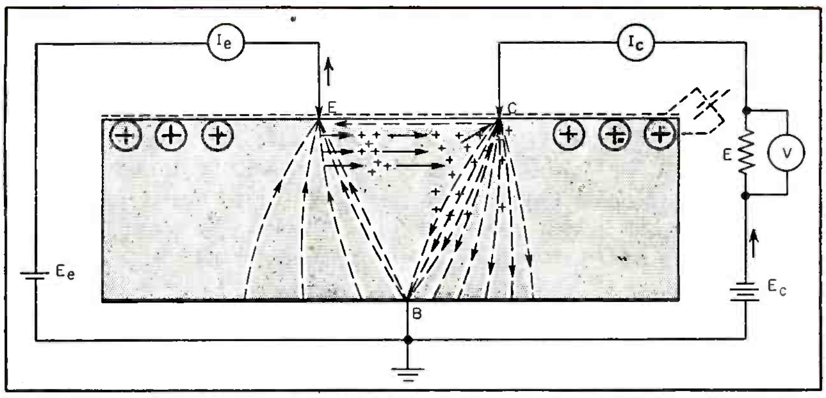

FIG. 4—Drawing illustrating point-contact transistor action shows role of surface states and array of donors with equivalent potential hill denoted by dashed-line battery

Resistance Gain

In transistor action the low-resistance connection is used in the emitter circuit and the high-resistance connection in the collector circuit, referring to the biasing potentials applied. The following rules apply:

(1) The internal resistance of the transistor between emitter and base, usually designated by r_{11}, is always a relatively low resistance. The internal resistance of the transistor between collector and base, usually designated by r_{22}, is always a relatively high resistance.

(2) Transistor action is accompanied by a resistance gain in that the ratio of r_{22} to r_{11} is greater than 1.

The low-resistance connection of the battery E_e in Fig. 4 satisfies the emitter circuit requirement of rule 1 but in the collector circuit the action of the holes nullifies the effect of the surface charge and thereby lowers the internal resistance between collector and base. Because point-contact transistor action is always accompanied by this effect of the holes in decreasing the internal resistance of the germanium, it is seen that the collector-to-base resistance requirement of rule 1 cannot be met. If r_{22} is small, satisfactory voltage and power gains cannot be achieved. However, there is an additional factor involved.

Looking at Fig. 4 it is seen that some holes do not follow a straight-line path from emitter to collector but, by the process of diffusion and random motion, travel in a more or less circuitous or indirect path to the collector. These holes form a positive space charge or cloud within the germanium in the region of the conducting path and thereby evoke or attract additional electrons from nearby sites, lowering the resistance of the path.

The significant point here is that the advent of the holes causes a decrease in the collector-to-base resistance due both to the effect of the holes in annihilating the surface charge and due to the positive space-charge effect. The result is that the resistance of the collector circuit is significantly decreased and a current flows that may be two to three times the emitter current. However, this clearly does not explain a resistance gain.

The condition of low resistance and high current is shown in section *AB* of Fig. 6. In the region from *A* to *B* the current is seen to be proportional to the voltage in accordance with Ohm's law; an increase in voltage is accompanied by a proportionate increase in current. If the applied collector bias is increased beyond point *B* the available supply of electrons soon becomes inadequate to sustain an Ohm's-law current. The supply of electrons is controlled by:

(1) The normal number of majority carriers at room temperature. This is a function of the impurity content.

(2) The neutralizing action of the holes on the surface electrons.

(3) The positive space charge due to the diffused holes.

Above point *B* of the figure, for instance, increases of applied potential V_c are not followed by proportionate increases of the current due to this exhaustion of the available carriers or electrons, and the curve rises steeply as shown in Fig. 6. The slope of the curve in the figure is r_{22}, the collector-to-base resistance.

The transistor is normally operated at approximately point *C* of the figure where the collector-to-base resistance is high. Summarizing, in the collector circuit the reason for the high resistance is not alone the reverse-current connection of the bias, but also the exhaustion of the available current carriers beyond the Ohm's law limit.

Typical Values

Let $i_e r_{11}$ represent the internal voltage drop from emitter to base and $i_c r_{22}$ the internal voltage drop from collector to base. Since i_c is greater than i_e due to the effect of the holes, and r_{22} is greater than r_{11} due to the carrier-exhaustion effect mentioned, the possible voltage gain of the transistor is the product of current gain and resistance gain. It is important to note that voltage and power gain in the point-contact transistor are due both to the current gain and resistance gain.

The ratio of i_c to i_e is usually denoted by the Greek letter α (alpha), and for typical point-contact transistors now on the market is of the order of 2.5. Typical values for r_{11} and r_{22} are approximately 300 and 18,000 ohms respectively, representing a resistance gain of about 60.

Thus it may be seen that typical voltage gains are of the order of 150 and typical power gains are of the order of 400.

In their migration from the emitter to the collector the holes move in an n-type material, and recombinations of holes and electrons are the rule rather than the exception. In fact, the discussion regarding recombination should explain why a very important effort in solid state physics is directed toward improving and controlling the lifetime of these carriers. Single crystals of germanium that are to be used in the manufacture of transistors are compared and evaluated for their lifetimes as a production control. Lifetime of carriers in single-crystal germanium is an important design parameter. Typical values vary from a few microseconds to two or three thousand microseconds.

Frequency Response

The velocity of holes and electrons in semiconductors is not the same as the velocity of electrons in conductors. The reader accustomed to thinking of electron velocities in orders of hundreds of thousands of centimeters per second may be surprised to learn that in semiconductors velocities are of the order of a few thousand centimeters per second. Typical values for germanium are: for electrons, about 3,600 cm per second, for each volt per cm of potential difference or as is sometimes said, of potential gradient; for holes, about 1,700 cm per second per volt per cm of gradient.

Some very important effects in the transistor ensue as a result of this relatively slow movement of holes and electrons in semiconductors. For instance, in a wire information in the form of modulated waves piling up when fed into one end is not a matter of concern. The extremely high velocity of the electrons in the wire that carry the intelligence makes it almost certain that, for any reasonable frequency, the information fed in will move out of the way before the next bit is fed in. In semiconductors, however, because the velocity is so low, this piling up presents a serious limitation. At relatively low frequencies serious modulation distortion results because of the piling up of intelligence connected with the long transit time of electrons and holes.

Another consequence of the large transit time in transistors is evident in the decrease of the current gain, alpha, with frequency. When the period of one cycle is equal to the transit time, the positive half of a sinusoid may still be within the emitter-collector region when the negative half of the same cycle enters. Under these conditions, the effect on the flow of holes due to the positive and negative halves of the cycle cancel, and current gain is zero. This is for the extreme case when frequency is the reciprocal of the transit time. For lower frequencies, the effects are in proportion and the observed fact is that the current gain decreases with frequency.

The decrease of alpha with frequency is also due to the fact that all the flow lines of the holes from emitter to collector are by no means straight lines. In fact, these flow paths resemble more closely the flux lines observed in pictures of the magnetic field between two poles. Since the transit time for these circuitous paths is greater than for the straight paths, neutralizations of the effects of the holes occur, particularly at the higher frequencies (lower periods).

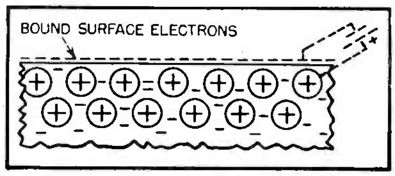

FIG. 5—A layer of electrons may be considered to exist in bound states at the surface of a semiconductor. This layer, in conjunction with the array of donors just below the surface, produces in effect the potential hill represented by the dashed-line battery

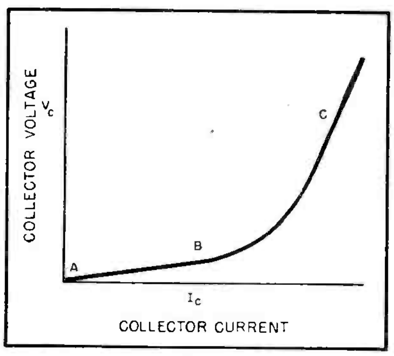

FIG. 6—Typical collector characteristic curve indicating variation of collector current with applied bias voltage. After point *B* insufficient carriers are present to support a proportional current for the applied electric field and the apparent resistance increases rapidly

While figures of frequency cutoff as high as 300 mc have been reported in the literature, these must be regarded as development laboratory values rather than representative limits obtainable from transistors now on the market. For most point-contact transistors currently being produced upper frequency limits are in the neighborhood of 10 mc, typical values around 3 mc. Some remarkable progress is being made along these lines at present and the reader can confidently expect commercially available units with importantly extended frequency limits to appear on the market in the near future.

This frequency limitation does point out, however, the desirability of having the emitter and collector as close together as possible because the frequency response increases rapidly as the spacing is decreased. Mechanical and electrical counter-indications set a lower limit on this spacing.

Resume

(1) The point-contact transistor is capable of current gain due to the action of holes in enhancing the collector current for a given amplitude of emitter current.

(2) Voltage and power gain of the point-contact transistor are due to a combination of current and resistance gain.

(3) The theory of operation of point-contact devices in general is, as yet, not completely understood and it is essential to keep abreast of the literature in order to observe the progress in this field.

(4) The concept of potential hills is essential for the discussion of transistor action and is useful as a convenient mnemonic by which the polarity of applied biases may be remembered.

(5) The frequency response of point-contact transistors is a function of the transit time and the distribution of the flow lines of the carriers from emitter to collector.

Portable Preamplifier for

In field work involving low-frequency vibration analyses, this self-powered preamplifier, used with an electrodynamic pickup and a vibration analyzer or portable oscilloscope, provides good gain and accuracy

VIBRATION analyses in the field are often carried out by means of a vibration pickup and analyzer or oscilloscope. Some form of preamplifier is required between the pickup and the analyzing instrument.

Tests show a preamplifier having an overall gain of only 12 times (22 db) is generally sufficient. The amplifier must have a substantially flat response from 5 to 1,000 cps and be capable of integration accurate to 1 percent throughout this range, while maintaining the quoted gain at the lowest frequency.

Description

Rather than adopt a high-stability design, it was decided to make the circuit as simple as possible and to provide an easy means of checking the gain of the amplifier under working conditions. A meter on the front panel may be switched to read the amplifier calibrating voltage when an a-c power line is connected to an input plug on the front panel. The meter may also be switched to give a check on the battery voltages under load.

The B battery is a compact layer type while the filaments are heated from two flashlight cells in parallel. All the batteries are clipped to the chassis and thus housed within the amplifier case. The front panel also carries the input and output connectors, on-off switch, gain switch, circuit switch and a screwdriver adjustment for the calibrating voltage. The amplifier complete with batteries is housed in a case 6 by 7 by 8 inches and weighs 6½ lb.

The amplifier, Fig. 1, comprises two miniature tubes coupled by a resistance-capacitance network. Integrating stages may be switched into circuit between these stages. Type 1S4 tubes are used in both positions.

Circuit

The input is taken through a stepped attenuator to the grid of the first tube. This is a voltage-amplifying pentode operating at zero bias. The second grid is fed from a voltage divider across the B battery, which produces less distortion of the signal than the more usual series-resistor method of feed. The gain of the amplifier is thus somewhat dependent on B battery voltage, but this is immaterial as the overall gain can be readily checked. The measured gain of the first stage is 22 times and its output is fed through a coupling capacitor to the two-megohm grid resistor of the following stage.

To make available the maximum possible gain, two alternative integrating capacitors are provided. In conjunction with the one-megohm integrating resistor, these give time-constants of 1/20 and ¼ second respectively. The integrating circuits introduce an attenuation of 7.8 times at 25 and 5 cps, these being the lower limits of frequency for each circuit if integration accurate to within 1 percent is desired.

The third position of the circuit switch brings a fixed resistor in place of either of the integrating capacitors. The coupling circuit then has a flat frequency response resulting in a uniform attenuation of 7.8 times throughout the range of the amplifier. This ensures that the output of the amplifier is of the same order whether switched to the "integrate" or to the "straight" condition.

The second 1S4 tube is strapped as a triode to simplify the matching

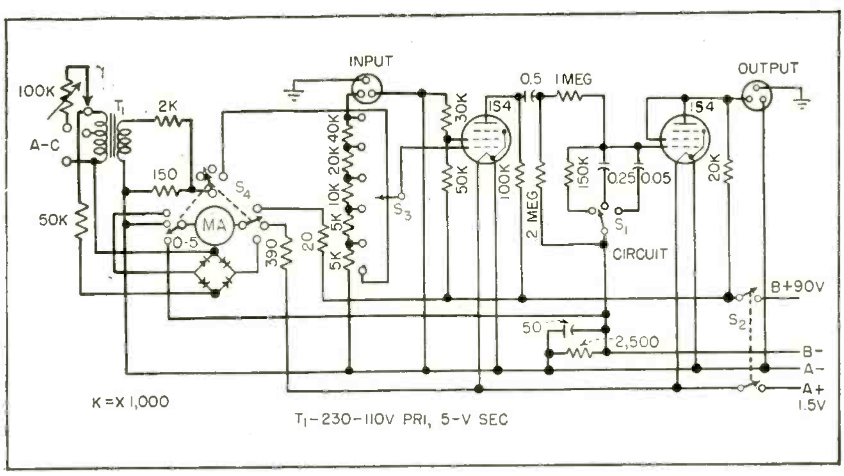

FIG. 1—Preamp circuit comprises two miniature type 1S4's; 5- and 25-cps integrating circuits available by setting switch. Input is taken through stepped attenuator to grid of first tube, which operates at zero bias

Vibration Analysis

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of external loads. Since instruments such as portable vibration analyzers have input impedances as low as 20,000 ohms, it is important that loads as low as this will not affect the linearity of the preamplifier.

Ideally, the output tube might have been a cathode follower, but as this provides no gain, it was necessary to choose between a triode or a pentode with a low value of plate load. The triode was chosen as being the simpler. This tube obtains bias from a by-passed resistor in the B− line. The measured gain of the stage is 5 times. The output is taken directly from the plate since most oscillographs include a blocking capacitor at the input.

In the sixth position of the input attenuator switch the grid of the first tube is connected, via the meter selector switch, to a fixed attenuator across the secondary of a small transformer. The primary of the transformer is fed from an a-c power line through a variable resistor which has a screwdriver adjustment.

When the meter selector switch is set to "calibrate" the meter is connected through a bridge rectifier so that it reads the transformer primary voltage. This voltage may be set to a predetermined value, marked on the meter dial, by means of the variable resistor, irrespective of wide variations in a-c line voltage. A known calibrating voltage is thus injected into the first tube which enables the gain of the preamplifier and any succeeding equipment to be checked, wherever an a-c line is available (by noting the reading on the analyzer output meter, measuring the height of the oscilloscope trace and so on).

The remaining two positions of the meter selector switch connect the meter, through suitable resistors, to the A and B batteries.

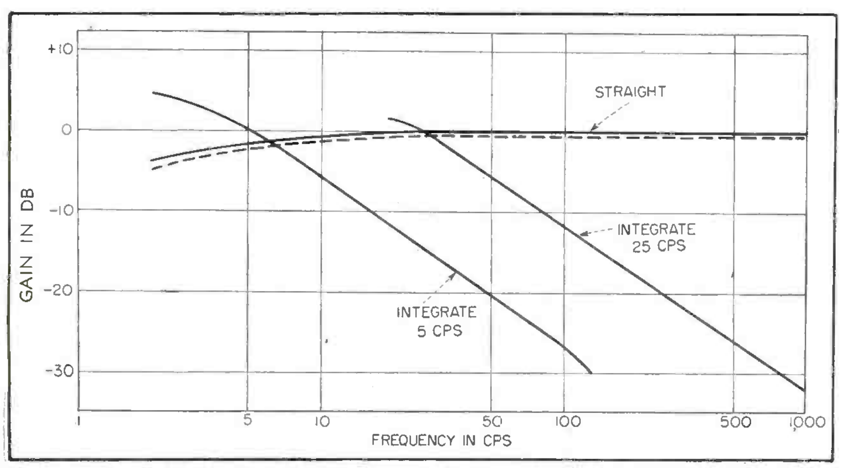
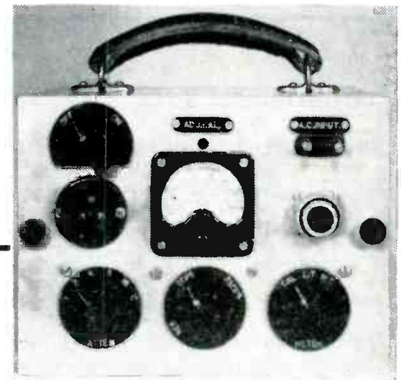


FIG. 2—Response curves for straight amplification with fresh 90-volt battery and 78.5-volt weak battery (dotted curve), and responses with integrate-25-cps and integrate-5-cps circuits switched in



Preamplifier can be calibrated from any a-c source

An indicating mark on the meter dial suffices for both batteries and shows when they have reached the end of their useful lives.

Performance

The measured performance is shown in Fig. 2. The response of the amplifier straight is substantially flat from 5 to 1,000 cps and the two integrating stages give the required slope of 6 db per octave (necessary to achieve correct integration) over the ranges from 5 to 75 cps and 25 to 1,000 cps respectively.

The overall gain (straight) is 14, with 5-cps integrate it is $70/f$. and with 25-cps integrate it is $350/f$ where f is frequency in cps.

The effect of reducing the A-battery voltage from 1.5 to 1.25 volts is negligible.

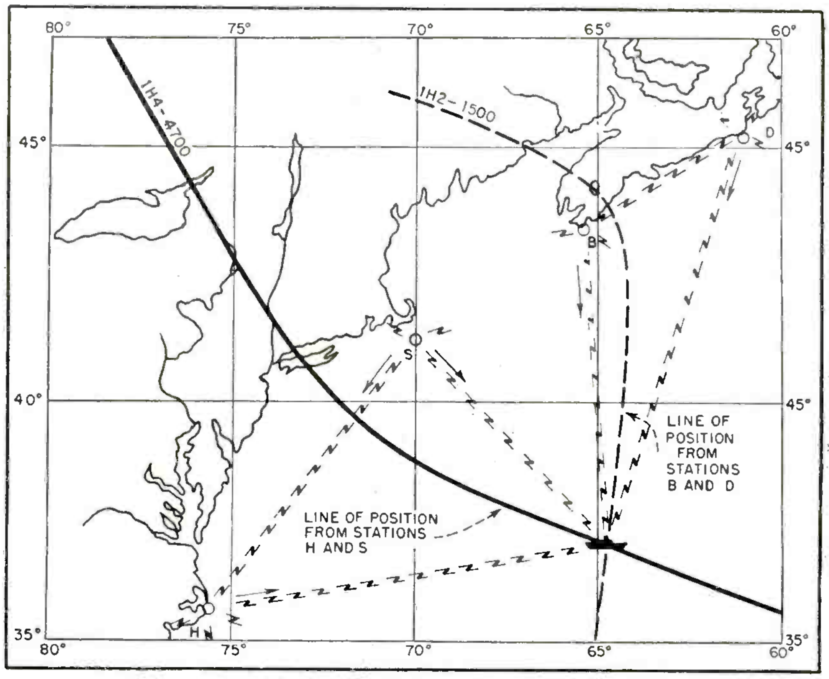
Overall gain of the preamplifier is approximately proportional to B-battery voltage. The figures given above were taken with a new 90-volt battery. Shown dotted on Fig. 2 is the response when the B battery had dropped to 78.5 volts. This resulted in a loss of gain of approximately 1 db.

All the above measurements were made with the amplifier feeding into a load consisting of a 20,000-ohm resistor in series with a 2-μf capacitor. Maximum peak output before appreciable distortion was apparent was 10 volts.

During the many months in which the original amplifier has been in operation, no modifications or repairs have been needed.

Continuous-Indicating

Instantaneous fixes for fast-moving aircraft are obtained with a 12-tube servo-relay attachment for standard navigation equipment. Remote guidance of vessels, such as survival craft, dependent upon continuous positional information can follow an extension of this development



A loran fix is the point of intersection of two lines of position derived from difference of arrival of two pulse signals for each line

FAST-FLYING AIRCRAFT increasingly require immediate and accurate determination of position that can best be given by continuous indication. Automatic or remote control of vessels, such as survival craft, is possible only with continuous position indication. Equipment for this purpose has recently become available as an adjunct to the existing loran navigational service.

Loran,[1,2] is based upon time-difference hyperbolas generated by pulsed emissions from transmitters at the ends of a base line. Each pair of transmitters produces a hyperbolic line of position for the vessel or aircraft equipped with a suitable receiver-indicator. A fix is obtained at the intersection of the lines generated by two pairs of transmitters.

In practice, received pulses are manually adjusted to the same amplitude and superimposed on a cathode-ray screen. The time delay in the arrival of the slave pulse after the master is determined from the delay introduced into movable pedestal circuits that are adjusted for superposition of the pulses. Special charts with an overlay of loran delay lines show the navigator his location.

The loran oscilloscope presentation is shown in Fig. 1. Numbered dials actuating the movable pedestal (B) circuit directly indicate delay between time of arrival of the A (master) and B (slave) pulses for the instant of the observation.

For continuous, automatic indications abroad a moving craft, a 12-tube unit is added to the standard Sperry Mark-2 indicator to synchronize the indicator with the received signals, maintain correct pulse amplitude as shown on the cathode-ray screen and maintain pulse superposition in height and time.

Figure 2 shows a block diagram of the automatic-gain-control and the automatic-amplitude-balance-control circuits. Both these circuits derive their control signals by measurement of amplitude from a region on the leading edge of the loran video pulses. To allow operation with noise and to select the correct portion of the video pulse for amplitude control, short-time samples of the amplitudes of the A and B pulses are made. The correct portions of the video pulses are sampled only when the A-pulse position is controlled by the afc circuit and the B pedestal so placed under the B pulse that the time difference reading is nearly cor-

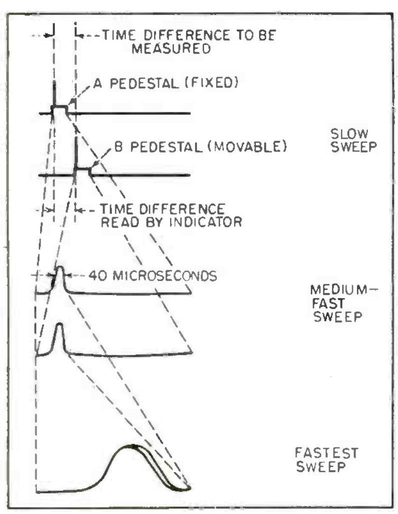


FIG. 1—Typical loran cathode-ray oscilloscope presentation shown with three different sweep speeds

Loran Navigator

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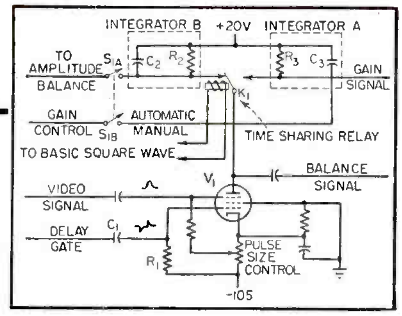


FIG. 3—Pulse-amplitude sampling circuit uses relay

rect. Amplitude samples derived under this matched-pulse condition are integrated in circuits having time constants about 40 to 50 times the pulse-recurrence interval.

The resulting amplitude measurement is thus unaffected by noise bursts and short-time pulse-amplitude fluctuations. Voltage samples of both A and B pulses are measured by a single coincidence circuit and are then separated into A and B integrators by a time-sharing relay or chopper.

The output of each integrator is a d-c voltage proportional to A or B video-pulse amplitude. The A-pulse voltage is amplified and introduced to control the receiver gain as in a normal automatic-gain-control system. The difference between A and B-pulse control voltages is used to control the gain of the r-f amplifier in the receiver differentially. In this manner the video pulses are maintained balanced in amplitude regardless of the difference in pulse amplitudes received at the antenna.

Pulse Amplitude Detector

The pulse-amplitude detecting circuit is shown in Fig. 3. Output from the delayed gate generator is differentiated by R_1 and C_1 to form a positive pulse about 10 microseconds wide delayed about 75 microseconds from the start of the A and the B pedestals. This signal is applied to the no. 1 grid of dual-control pentode V_1. This grid is normally biased below plate-current cutoff for the tube. The positive pulse brings grid 1 above cutoff so that plate current flows during this interval.

The magnitude of this plate-current pulse depends, to a large extent, on the bias existing on grid 3 during the conduction time. If the video pulse is introduced to grid 3 and the sample pulse occurs at the same time, the plate current of V_1 will be a measure of the video-pulse amplitude. Capacitor C_2 with plate load resistor R_2, and capacitor C_3, with resistor R_3, average these current pulses to produce d-c voltages proportional to the A and B video-pulse amplitudes.

The manual gain and amplitude-balance controls allow the original pulse match to be made. Charging C_2 and C_3 to a potential determined by this network prevents sudden changes in receiver gain or changes in amplitude balance when switch S_1 is opened by the operator for automatic operation.

Time-sharing relay K_1 is a fast-acting switch or chopper driven in synchronism with the basic square wave. This square wave is positive during the first half of each loran pulse-recurrence interval and negative during the second half. Since the A pulse always arrives at the receiver during the first half interval and the B pulse during the second half, time sharing of the video-amplitude detection circuit is possible.

Since chopper K_1 contacts the A storage circuits during the A half cycle and the B storage circuits during the B half cycle, the voltage on the arm of the chopper is a square wave equal in magnitude to the difference in A and B video-pulse amplitudes and of a phase according to the sign of the difference. This control voltage is amplified and introduced as a differential bias signal to the receiver r-f amplifier. The amplifier is thus caused to have high gain during one half cycle and low gain during the second half cycle. The phase of the control signal is such as to equalize

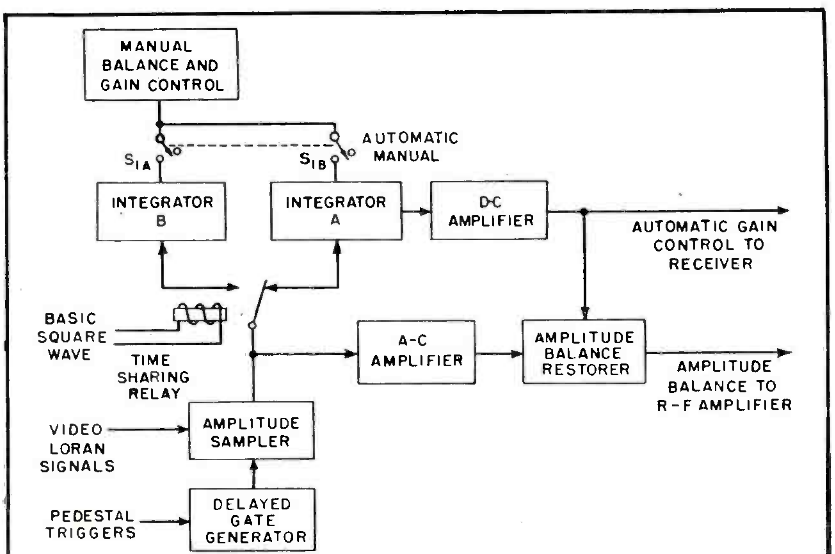


FIG. 2—Automatic-gain-control and automatic-amplitude-balance circuits

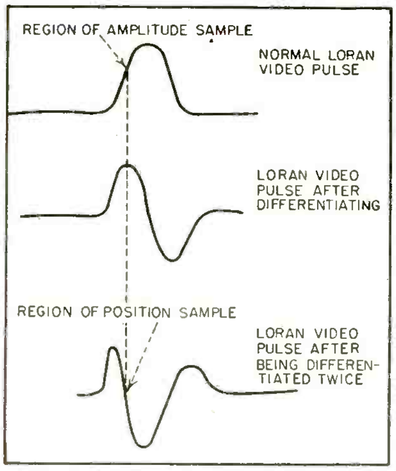


FIG. 4—Waveforms of loran video pulse showing amplitude and position sampling regions

the amplitudes of A and B loran pulses in the receiver, and therefore, the video pulses as seen on the cathode-ray tube.

AFC and ATD

Common to both the afc and automatic-time-difference (atd) circuits is a pulse time-position detector. This detector circuit is a dual-control pentode similar to the pulse-amplitude detector circuit in operation. Video signals at grid 3 of this detector have been differentiated twice by passing through successive high-pass networks. The resulting pulse waveform shown in Fig. 4 has a zero-voltage crossover at the time of maximum slope of the leading edge of the undifferentiated pulse. The region of this slope near the zero crossover has very nearly a linear time-voltage relation.

A short sample of the amplitude of the waveform in this region is then a measure of pulse position with respect to the sample period as well as a measure of the pulse amplitude. If the waveforms being sampled are of the same shape and amplitude, the difference in voltages sampled is a direct measure of the difference in A and B-pulse positions with respect to the A and B-sample periods.

Integration of a number of voltage samples of the A pulse then provides a d-c control voltage proportional to the A-pulse displacement from the A-sample period. This voltage may be used to control the frequency of the timing oscillator as shown in Fig. 5.

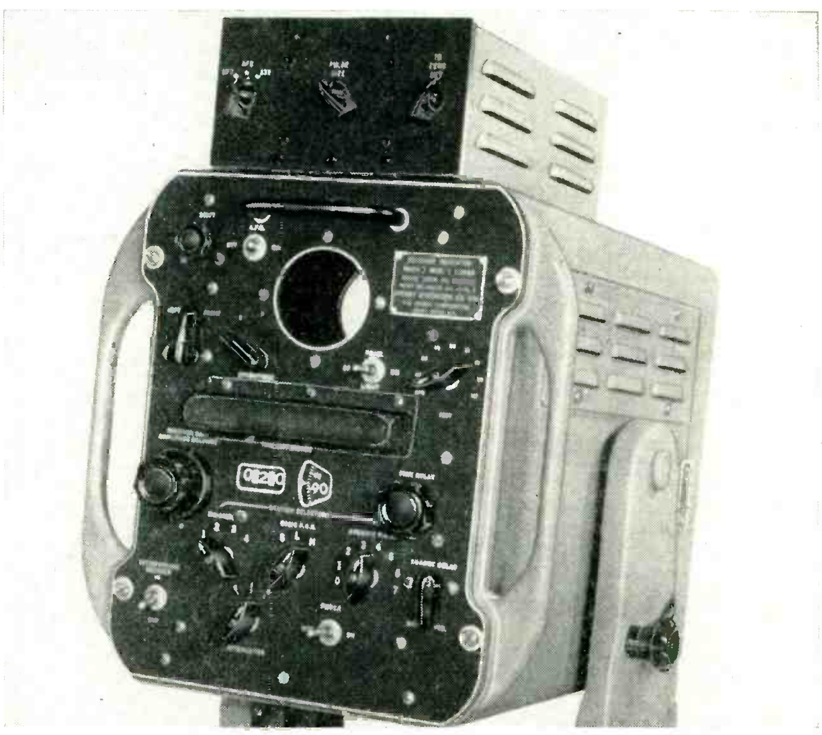
Frequency of the timing oscillator is adjusted with a reactance tube so the sample period occurs at the zero-voltage point of the differentiated video pulse. Samples of the B video pulse are integrated forming a d-c voltage proportional to the B video pulse position with respect to the B-sample period. Outputs of the A and B integrators are amplified and used to control a small d-c motor. The motor operates when there is a difference between A and B video pulse positions with respect to the sample periods. The motor is geared to the time-difference control shaft to move the B pedestal and thus maintain the pulses constantly matched.

Figure 6 shows the pulse-position sampler circuit, which is similar in operation to the pulse-amplitude sampling circuit. The output of the delayed-gate generator is differentiated to form a positive pulse about 10 μsec long. This pulse is applied to grid 1 of dual-control pentode V_2 biased below cutoff. The differentiated video signal is applied to grid 3 of V_2. The amplitudes of plate-current pulses that occur when the gate voltage on grid 1 is positive are determined by the potential on grid 3 during the conducting interval.

Since the shaped video pulse is a time-voltage function, the amplitude of the plate-current pulses is proportional to the time displacement between the zero crossover of the differentiated video pulse and the sample period. The B current pulses are integrated in R_4 and C_4 and the A pulses in R_5 and C_5 depending on the position of relay K_2. This relay is switched in synchronism with the basic square-wave voltage in a manner similar to relay K_1 in the pulse-amplitude sampler. Resistors R_6 and R_7 introduce a rate signal into the output control voltage in order to improve system transient performance. The voltage drop across R_6 or R_7 is proportional to the current through it and is therefore a maximum when the voltage on C_4 or C_5 is changing most rapidly. Thus, the output control signals are the sums of the position signal and the rate of change of the position signal. Capacitors C_6 and C_7 limit the frequency response of the rate network.

Oscillator Control

The resulting d-c control voltage representing the sum of the rate of change of A-pulse position and the A-pulse position, controls the fre-



Twelve-tube servo-relay unit mounts atop standard loran-receiver indicator

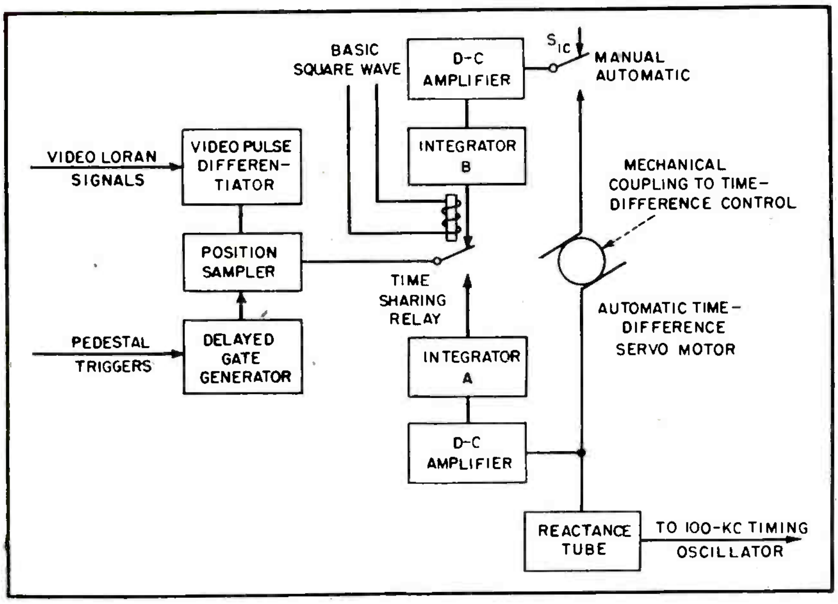


FIG. 5—Automatic-frequency-control and automatic-time-difference circuits

quency of the 100-kc timing oscillator through a reactance tube. The phase of the control signal is such that the 100-kc timing oscillator is locked in phase with the repetition rate of the received master A pulses.

The A-pulse position voltage is also amplified by a d-c amplifier and directly coupled to a cathode follower. The B-pulse rate and position voltage is similarly amplified.

A small d-c motor is connected between the outputs of the cathode followers. This motor has a linear speed-voltage curve, and therefore, runs at a speed proportional to the difference in A and B-pulse positions with respect to their sample periods and in a direction according to the sign of the difference.

The motor is geared to the time-difference control shaft and phased so any time difference between the B pulse with respect to the B-sample period and the A pulse with respect to its sample period is reduced to zero. The time-difference error signal is derived from both the A and the B-pulse positions rather than from the position of the B pulse with respect to the B-sample period alone. By this technique errors in A-pulse position caused by drifts in the automatic-frequency-control system do not affect the automatic time-difference pulse-matching accuracy.

When the timing oscillator frequency is manually set to coincide exactly with the repetition rate of the received pulses, no afc error voltage is required. The A-sample period then occurs when the differentiated video pulse crosses the zero-voltage line. Under this condition both the A and B pulses are sampled at the zero-voltage point so that the automatic-time-difference circuit is unaffected by unbalance in amplitude between the video pulses. If the gain of the afc circuit is sufficiently high the condition of near-zero voltage sampling exists even when the timing-oscillator frequency is slightly in error. Thus, the atd circuits can be made nearly independent of amplitude unbalance between the A and B video pulses.

Pulse Matching

As the vessel or aircraft moves, causing the difference in pulse arrival time and the pulse amplitudes to vary, the automatic control systems described maintain the pulses matched in amplitude and in time difference on the face of the cathode-ray indicator. The operator thus has a continuous indication of one line of position of the vessel. If two continuous indicating loran systems are synchronized on separate pairs of loran stations, the operator has continuous data as to the vessel's exact position at any time.

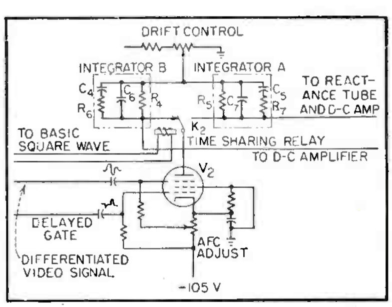


FIG. 6—Pulse-position sampling circuit

Since long time constants are used in both time-difference and pulse-amplitude control channels system bandwidth as measured after the second detector is very narrow and operation at low signal-to-noise ratios is possible. In practice, reliable signal matches have been maintained at 1-to-1 signal-to-noise ratios.

The automatic-gain-control system maintains the A video-pulse height appearing on the cathode-ray tube constant within 6 db over an input signal range into the receiver of at least 100 db, representing antenna input signals from 10 microvolts to 1 volt peak amplitude. The automatic-amplitude-balance system maintains the amplitude balance between video pulses constant within 3 db for unbalance between signals at the antenna input of 60 db, or for a signal-amplitude ratio of 1,000 to 1.

The application of electromechanical servo-type choppers as time-sharing relays is somewhat unique. The loran system, because of the division of A and B pulse occurrence into separate half cycles of the pulse repetition period, is particularly well suited for time sharing. In this instance the time-sharing relays permit the use of a single coincidence circuit for measuring the amplitude of both A and B pulses and another single coincidence circuit for measuring the position of the A and B video pulses. Because of this common usage, and since the difference in pulse position voltages rather than the B-pulse position voltage alone is employed as the error signal, nonlinearities and unbalances in the coincidence circuit do not affect the output error signal.

References

(1) D. G. Fink, The Loran System—Part I, ELECTRONICS, p 94, Nov. 1945.
(2) D. G. Fink, Loran Receiver-Indicator, ELECTRONICS, p 110, Dec. 1945.

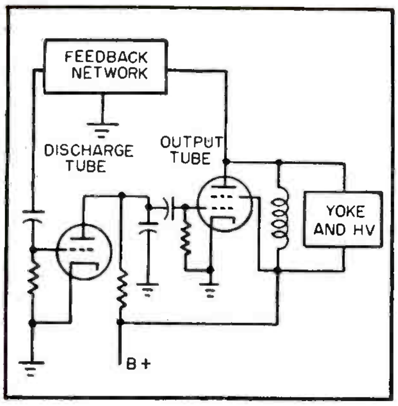


FIG. 1—Oscillatory deflection generator

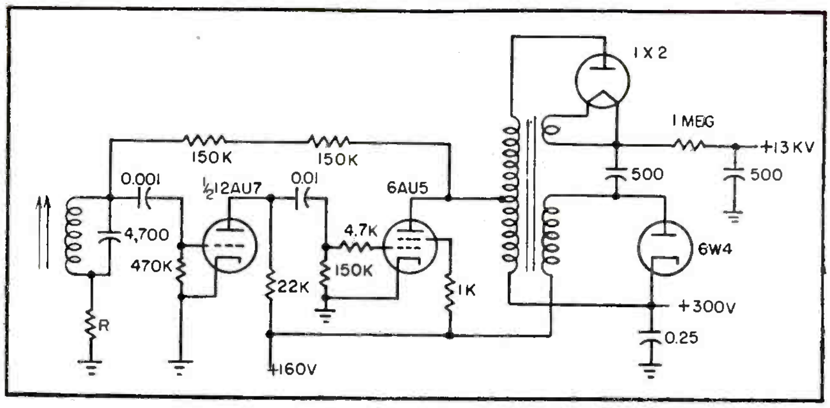


FIG. 2—Horizontal deflection generator circuit

Simplified Horizontal

Cost and complexity of television receiver may be reduced through use of simplified horizontal deflection oscillator-amplifier which uses fewer and less costly parts, as compared to conventional circuits. Automatic frequency control may be applied to give performance comparable to more elaborate systems

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IT IS GENERALLY recognized that the horizontal deflection circuit is responsible for a significant percentage of power consumption and cost of a tv. Much effort has been directed towards the development of more efficient and economical circuits and components.

In the general circuit of the self-oscillatory deflection system (Fig. 1), the voltage fed back to the grid of the discharge tube is of sufficient amplitude to cause grid-current flow. The bias developed cuts off the discharge tube for the scanning period.

Synchronization and other salient properties of the oscillator depend on the nature of the feedback system. The use of a resistor in place of the resonant element would impart to the circuit properties characteristic of a blocking oscillator.

Falling into the category of soft oscillators, the circuit would be readily amenable to impulse synchronization. It would be unsatisfactory however, because of its high susceptibility to noise interference.

A high-Q tuned circuit in the grid circuit of the discharge tube places the circuit in the category of hard oscillators. The superior noise immunity is accompanied, however, by poor impulse synchronization properties manifest as excessive drift in presence of varying phase conditions between the synchronizing signal and the free-running frequency of the oscillator.

Hybrid Circuit

A circuit combining these properties is shown in Fig. 2. The voltage wave-shape at the grid of the discharge tube is sinusoidal with a pulse superimposed on the positive crest. The sine-wave amplitude exceeds that of the pulse by a considerable factor. Since the frequency is mainly determined by the tuned circuit, the favorable noise-immunity characteristics of a sine-wave oscillator are substantially preserved.

The discharge pulse is developed across the peaking resistor *R* (about 4,000 ohms) which can also serve as a convenient point for sync injection. The required sync polarity is positive at this point. The plate circuit of the discharge tube may contain the conventional R-C charging network, but in the particular circuit employed a high degree of peaking was found desirable and the charging capacitor was omitted. A linear growth of yoke current is the result of the inductive nature of the plate load of the output stage when it is in conduction. Negative pulses at the grid of the output stage cut off the tube for the period of retrace.

Automatic Frequency Control

Although a higher degree of noise-immunity is realized when the voltage applied to the grid of the discharge tube is developed across a high-Q tuned circuit, some form of afc is indicated in view of the

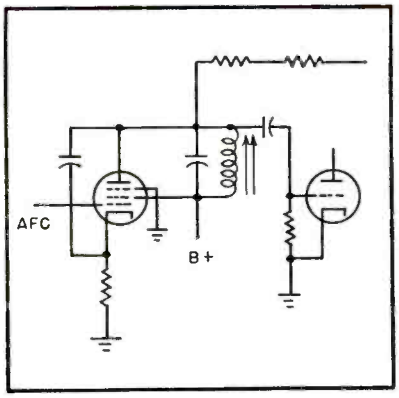

FIG. 3—Reactance tube afc control

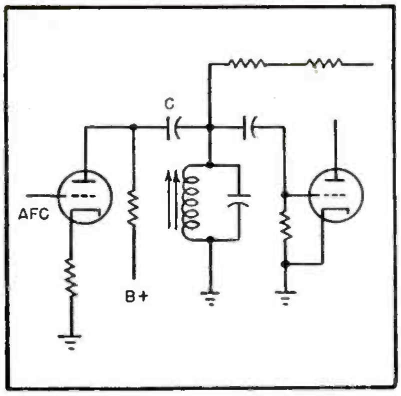

FIG. 4—Using r_p as a control parameter

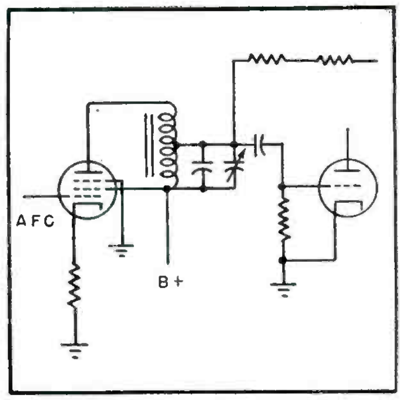

FIG. 5—Using nonlinear ferrite

Deflection Generator

poor phase stability of impulse synchronization. In addition afc itself contributes to noise immunity due to the fact that only a very narrow band of frequencies is allowed to affect the oscillator.

The simplest means of afc perhaps is to rely on the frequency-bias relationship of the particular oscillator. The correcting voltage should be applied to the appropriate grid and in the proper phase.

Sensitivity

Higher sensitivity to the correcting voltage can be realized through the use of either an inductive or capacitive reactance tube (Fig. 3). Since the reactance tube is in shunt with the tuned circuit, a high value of r_p is needed to maintain a high circuit Q. For a given loading effect of the tuned circuit due to the reactance-tube phase-shift network, the sensitivity to error voltage is directly related to the g_m of the reactance tube.

In Fig. 4 the bias applied to the triode control tube determines its plate resistance and thereby determines the effective reactance of the circuit which consists of a capacitor in series with the plate resistance of the tube. The sensitivity of this circuit is a function of the tube characteristics and the value of the capacitance in the control circuit. Sensitivity can generally be improved by increasing the capacitance but the Q is degraded as a result.

Core Control

The afc circuit shown in Fig. 5 makes use of the nonlinear characteristics of ferrite. The correcting voltage controls the magnetizing field of a ferrite-core coil which in turn determines the permeability of the core and the tuned circuit inductance. A high control-winding inductance increases the sensitivity of the system. However, since the stepped-up a-c signal appears across the control winding, the degree of step-up is limited by the available supply voltage and tube ratings, keeping in mind that it is desirable to maintain a substantially fixed value of control current over the a-c swing. The required speed of response is also a factor which limits somewhat the inductance of the control winding.

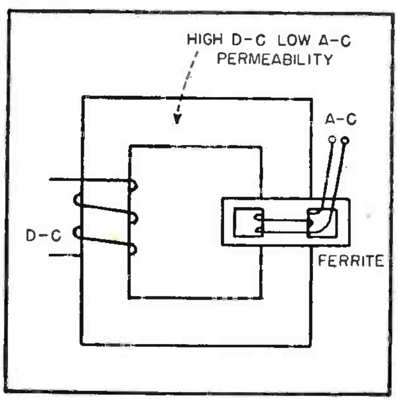

FIG. 6—Split magnetic circuit control

In the interest of Q, sensitivity and speed of response the control tube should have a high r_p and g_m. A sufficient volume of core material should also be used to maintain linearity over the a-c swing.

Many limitations can be obviated by suppressing the a-c voltage in the control winding. This suppression can be accomplished by using two reactors in which the control windings are bucking with regard to the a-c voltage. A single core can be used and cross-coupling eliminated if the axis of the respective windings are made normal to each other. A toroidal structure is very suitable for this purpose.

A more economical design may be based on the use of separate magnetic circuits as shown in Fig. 6. A core having a high d-c but a low a-c permeability, such as annealed pure iron, guides the control flux. The gap of this core contains the saturable a-c magnetic circuit. To minimize a-c losses due to the d-c core, the a-c stray fields should be reduced to a minimum. This can be accomplished by using a cup-core or otherwise providing a low-reluctance a-c return.

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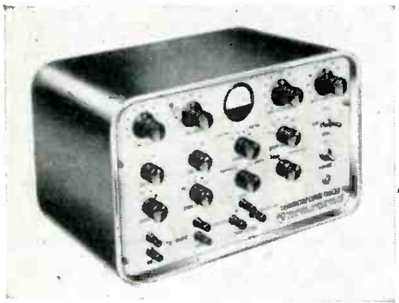

Simplified transistor tester traces characteristics on screen of cathode-ray tube

By B. J. O'NEILL and ARTHUR GUTTERMAN

Chief Engineer *Project Engineer*

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TRANSISTORS can be completely described by four impedances: input, output, forward transfer and reverse transfer. These impedances are a function of the operating conditions and are usually represented graphically by four curves. The input characteristics are a plot of V_e versus I_e with I_c as a parameter, the output: V_c versus I_c with I_e as a parameter, the forward transfer: V_c versus I_e with I_c as a parameter and the reverse transfer: V_e versus I_c with I_e as a parameter. The corresponding impedances are then simply the slopes of the curves.

While all four curves are convenient, two are usually sufficient since the other two can be obtained from these except in the case where the two chosen display only three of the four variables. The most useful curves are the output characteristics, which are used in the same manner that the tube-circuit designer uses the plate family of curves. The other curves are of lesser importance for most applications. They provide information concerning the input circuit and can also be used to find anomalies, although the output characteristics curve will usually indicate them.

All the above curves refer to the grounded-base connection. Since junction transistors are often used with the emitter grounded applying the signal to the base, the output characteristics so taken are very useful to the design engineer.

In addition to the terminal impedances, the current gain alpha is also of importance. Alpha is defined as

$$\alpha = \frac{\Delta I_c}{\Delta I_e}\bigg|_{V_c = \text{Constant}}$$

and can be measured directly or obtained graphically from the output curves. In the grounded-emitter connection, the current gain beta is defined and measured in a similar manner, substituting I_b for I_e.

Curve Taking

Any desired curve can be taken statically using point-by-point methods. This, however, is not only extremely tedious, but is of limited value because of thermal changes in the transistor. During the time a single measurement is being made, the transistor is getting warm; the next measurement will be made at a different temperature. Thus, the resulting curve is not a plot of three variables but contains a fourth undesirable parameter, temperature. Unless the readings are very precisely timed and spaced at exact intervals, it will be impossible to duplicate a family of curves.

This thermal effect is also present if the curves are taken dynamically at very slow sweep rates. At very low frequencies up to several cycles per second, the transistor exhibits a definite thermal effect. Superimposed on the normal transistor output is another output that is not a function of the signal, but is due to the slow heating and cooling of the transistor. Therefore for dynamic curve taking, the sweep rates should be high enough to avoid thermal changes.

An equally troublesome condition is present if the sweep rate is too high. A characteristic curve should represent the operation of the transistor over the normal operating-frequency range and with negligible secondary effects. At high frequencies, shunt capacitance, hole storage and transit time all contribute to the results and the curve is not a true picture of transistor operation in the usual frequency range.

The easiest curves to take dynamically are the output and reverse transfer characteristics. A sweep voltage is applied to the collector and the proper bias to the emitter. The collector voltage for the output curve and the emitter voltage for the reverse transfer curve and the collector current are displayed on the vertical and horizontal axes respectively of a cathode-ray oscilloscope.

By changing the bias in discrete steps a complete family of curves is obtained. If desired, the emitter can be grounded and the bias applied to the base to obtain grounded-emitter characteristics.

Other Curves

To obtain the input and forward transfer curves considerable difficulties are involved. In both curves collector current is a parameter. In the case of the input curve, the emitter is swept and collector current is increased in steps to obtain the family of curves. Since the collector is fed from a constant-current source, the collector voltage can rise to excessively dangerous values. This can be prevented by a clamping diode, but the usefulness of the curves so obtained is limited. A further difficulty appears in the case of junction transistors where some units have collector impedances as high as

for Transistor Testing

Practical curve tracer displays characteristics of *npn*, *pnp* and point-contact transistors in grounded-base and grounded-emitter circuits. Instrument permits speedy grading and selection of transistors for manufacturers and users

100 megohms. The constant-current source should have a substantially higher impedance such as 2,000 to 5,000 megohms. This is extremely difficult to achieve.

Transistor curves are not only used to aid the circuit designer. In manufacturing it is desirable that defective units be picked out. One common anomaly sometimes present in semiconductor devices is hysteresis. The current produced by the sweep voltage does not return along its outgoing path. Therefore, it is important when taking transistor curves that the retrace is not blanked.

The curve tracer to be described provides all the information needed for both the transistor fabricator and the circuit designer. Output or transfer families of curves are automatically displayed on a crt. Excessive collector voltages and elaborate current supplies are avoided. The sweep rate is 60 cycles, conveniently obtained from the power line and safely removed from either the low or high-frequency trouble limits. Using a half-cycle sine wave for sweeping results in identical forward and retrace sweeps. A telephone-type stepping relay, driven by the 60-cycle line, steps the bias after each sweep and assures an equal time interval between each curve of a family to avoid thermal effects. A block diagram of the unit is shown in Fig. 1.

Automatic Bias Circuit

The automatic bias circuit is shown in Fig. 2. A stepping relay selects one of eight different resistors and one open position to vary bias current of either polarity in nine equal steps including zero current. A step increment switch selects six different step increments from 20 to 1,000 μa. This switch is of the constant impedance type and therefore introduces no error. A potentiometer provides smooth control for any step increment between 0 and 1,000 μa if six fixed steps should prove inadequate. Also, the potentiometer provides a smooth manual change of bias current from 0 to 8 milliamperes for careful study of a transistor over the entire operating range. A meter monitors the bias current for all manual operations but is shorted out when the stepping relay is run automatically to display the entire family of curves simultaneously.

The stepping relay is driven by the 60-cycle line through a half-wave rectifier to provide 60 steps

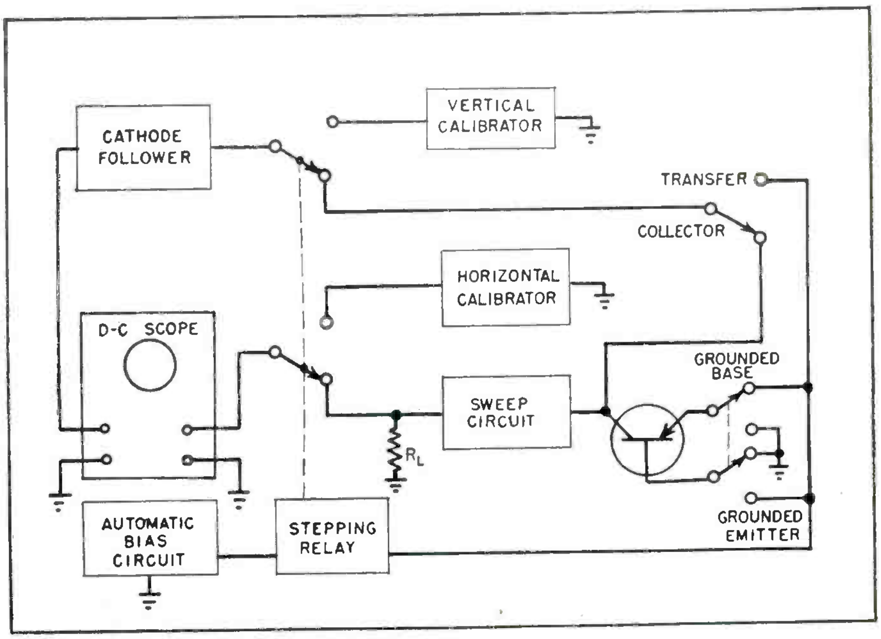


FIG. 1—Block diagram showing switching circuits of transistor-curve tracer. Forming circuit is not shown

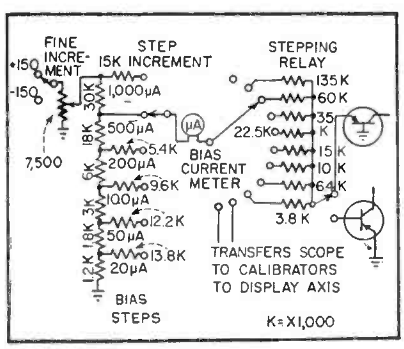


FIG. 2—Automatic bias-stepping circuit employs telephone-type stepping relay

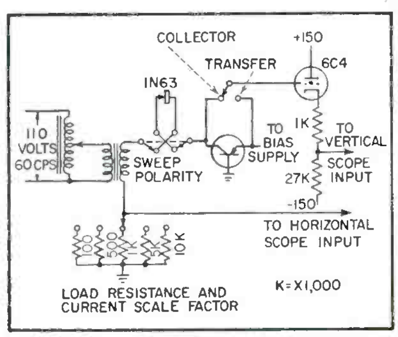
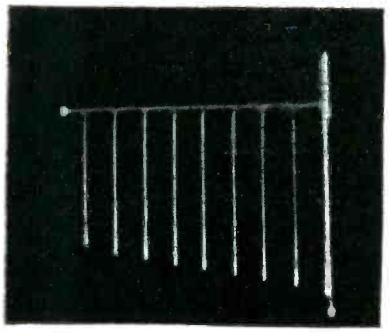
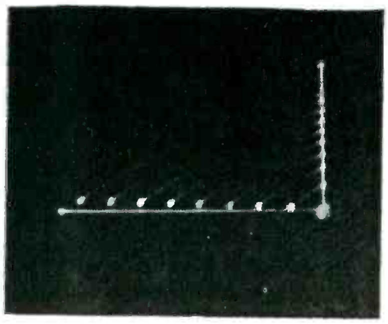
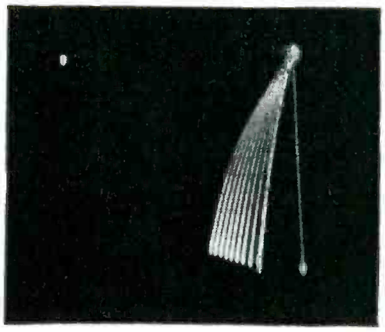


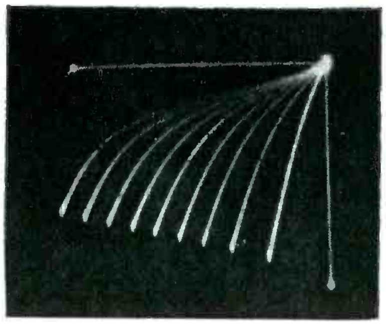
FIG. 3—Sweep circuit provides reversible half-sine-wave sweep voltages





Curves showing excessive base resistance in *pnp* junction transistor. Collector curves start above origin. Vertical scale is 10 volts at top (collector 5 volts below transfer)





Forming is illustrated by collector curves showing point-contact transistor with very low alpha (top) and same transistor after successive forming pulses (bottom). Note increase in alpha

per second. Thus each sweep of the collector occurs just once per bias step resulting in a uniformly illuminated oscilloscope display. If the switch is allowed to run asynchronously, irregularity of exposure will result when the crt display is photographed.

The stepping relay is connected through a three-position switch and a latching relay so it can be turned off, run automatically, or moved one step at a time if it is desired to examine one curve of a family in detail.

Sweep Circuit

A 60-cycle voltage from the power line, adjusted by means of a continuously variable transformer is applied to the collector as the sweep voltage. A crystal diode, connected through a reversing switch permits sweeping either polarity. The sweep current, measured as the voltage drop across one of five different load resistances, is applied to the horizontal scope input. Because it is desired to ground either the base or the emitter, the sweep current as displayed on the scope will be positive from right to left. To preserve the conventional directions of the four quadrants, it is necessary to reverse the horizontal deflection plate connections. Since the sweep voltage is a half cycle of a sine wave, both the forward sweep and the retrace are identical functions and are displayed on the crt.

The sweep voltage applied to the vertical scope input is measured directly from collector to ground for the collector curves and from input to ground for the transfer curves. When plotting the collector curves of a junction transistor, however, the dynamic collector impedance can be very high, sometimes as much as 100 megohms. If the vertical scope input is placed directly across the collector, the maximum dynamic impedance that could be plotted would be the scope input impedance. To avoid this and permit a true indication of collector impedance a cathode-follower isolating stage is used between the vertical input and the collector. A simplified schematic of the entire sweep circuit is shown in Fig. 3.

Voltage Calibrator

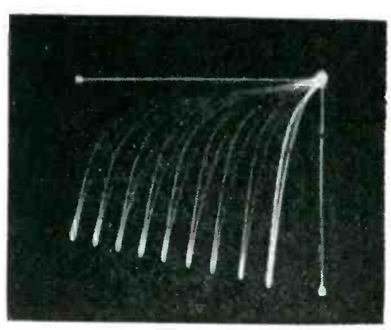
The voltage-calibrator circuit, shown in Fig. 4 consists of a 60-cps voltage, obtained from the secondary of the power transformer, fed through a resistor and a series diode to a clamping diode and a calibrated potentiometer. Thus, the half-cycle sine wave is clamped at a fixed voltage and can be used to calibrate the scope. Two calibrators are used, one for the vertical axis and one for the horizontal axis. A quadrant switch connects the diodes in such a manner that any one of the four quadrants can be selected.

The voltage calibrator is connected through the stepping relay so that after a single family of curves is plotted, the calibrating axes are automatically displayed. The lengths of the axes determining the calibration, are continuously displayed when the stepping relay is running. Thus the origin, the zero-current and the zero-voltage lines are always present on the crt and d-c drift will not affect the results.

Alpha Measurements

The current gain, alpha, in the grounded-base connection (beta, in the grounded-emitter connection) is of interest to the transistor fabricator and the circuit designer. It is comparable both to the amplification factor and transconductance of vacuum tubes and might be considered a figure of merit for transistors. It is an indication not only of the external power gain but also of the internal physical current mechanism.

The simplest method of obtaining alpha or beta is to measure it directly on the collector curves along a constant-voltage line. By varying the step increment alpha can be measured over as small a range as desired and if the crt is carefully calibrated alpha can be measured to an accuracy of 3 percent. Also, when the entire family of collector curves is plotted the behavior of alpha as a step function of emitter current



Collector curves show hysteresis in point-contact transistor can be examined on the scope.

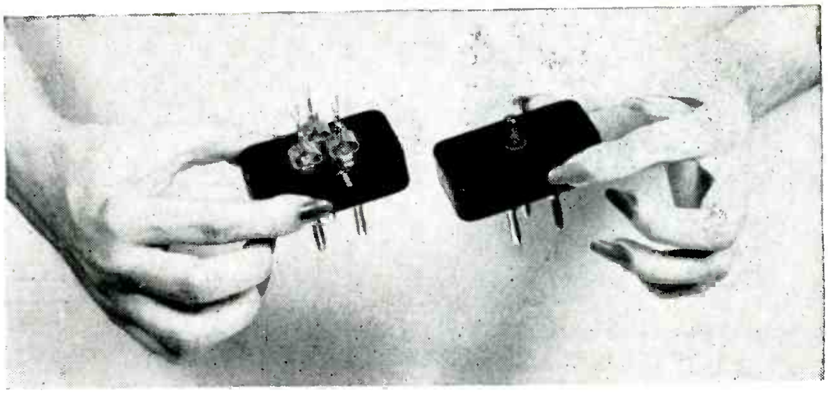
The technique found most useful, however, is to sweep the emitter current over the operating range and plot alpha vs. emitter current on a crt. The complete behavior of alpha can then be observed, all anomalies can be detected and the accuracy can be held to about 3 percent with careful calibration or to any value desired with suppressed-zero techniques. The behavior of alpha as a function of emitter current, especially for small values of current, is of great interest in all phases of transistor development and application. The rate of initial rise of alpha is an indication of the switching speed for point-contact transistors and is a much more fundamental measurement than N on negative resistance curves. (N curves are a plot of emitter voltage vs. current with resistance added to the base to display the negative input resistance region.) The N curves will indicate whether a transistor can be used for switching applications but a swept alpha curve will give a quantitative measurement as well.

Forming

A convenient accessory that can be used with the transistor-curve tracer is a forming attachment. The forming circuit is shown in Fig. 5 and is essentially a capacitor that can be charged to any desired voltage and then discharged into the collector. The capacitor can be discharged either in the forward or reverse direction and after each discharge the transistor can be examined on the curve tracer. One of the accompanying oscillograms shows a common failure found in the point contact-transistor, namely, low alpha, and the result after successive forming. The transistors are formed during manufacture but reforming by the user has resulted in rejuvenating a large number of not only those that have failed in use but also those that are defective when received. Reforming is apparently similar to the forming employed in manufacture and creates a p-n junction under the collector electrode. This junction is usually larger after reforming than when the transistor is originally formed.

In reforming a point-contact transistor, the collector curves are first observed. Then the capacitor (Fig. 5) is charged to a low voltage, which is best determined by experiment. A much lower voltage is used if the capacitor is to be discharged in the forward direction rather than in the reverse direction. In general, reverse forming results in a lower I_{co} but some transistors can be formed only in the forward direction.

After each discharge of the capacitor the collector curves are examined on the crt. If successive pulses produce no further change the voltage should slowly be raised for each pulse. When the curves have fanned out the desired amount, the forming is completed. Reformed transistors seem to have the same life and behavior properties as transistors when they are originally formed. Crystal diodes can also be reformed and their properties can sometimes be improved.



Jigs adapt curve tracer to all types of transistors

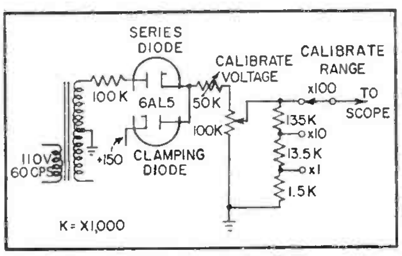


FIG. 4—Voltage calibrator places measured coordinates on scope screen with trace

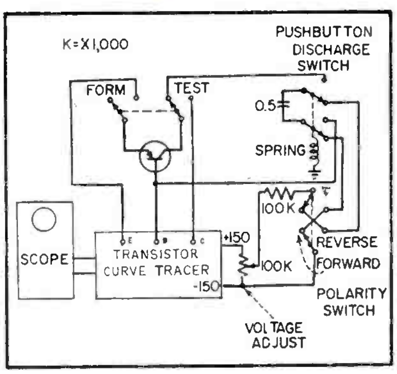


FIG. 5—Forming circuit may be used to rejuvenate many inoperative point-contact units

Operation

Operation of the instrument is quite simple. After selecting a load resistance, which also determines the current scale factor, the calibrator and scope are adjusted to the desired ranges. The bias step is chosen and the function switch set to the characteristics, type of transistor and connection desired. The stepping relay is turned on and the sweep voltage adjusted. The entire family of curves will then appear on the crt. If desired, the stepping relay can be stepped manually, one step at a time, with the meter indicating the bias current. Or, for a careful study of anomalies, the fine-increment control can be used to sweep out smoothly the bias current over the entire range. Extreme flexibility is provided for any type of operation with a minimum of adjustment.

Acknowledgement is made to Raytheon Manufacturing Company and CBS-Hytron for their cooperation.

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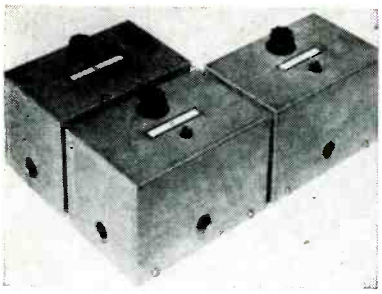
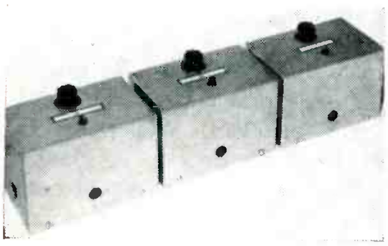
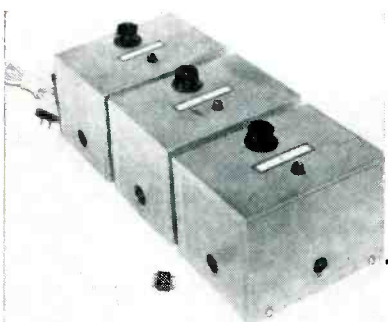


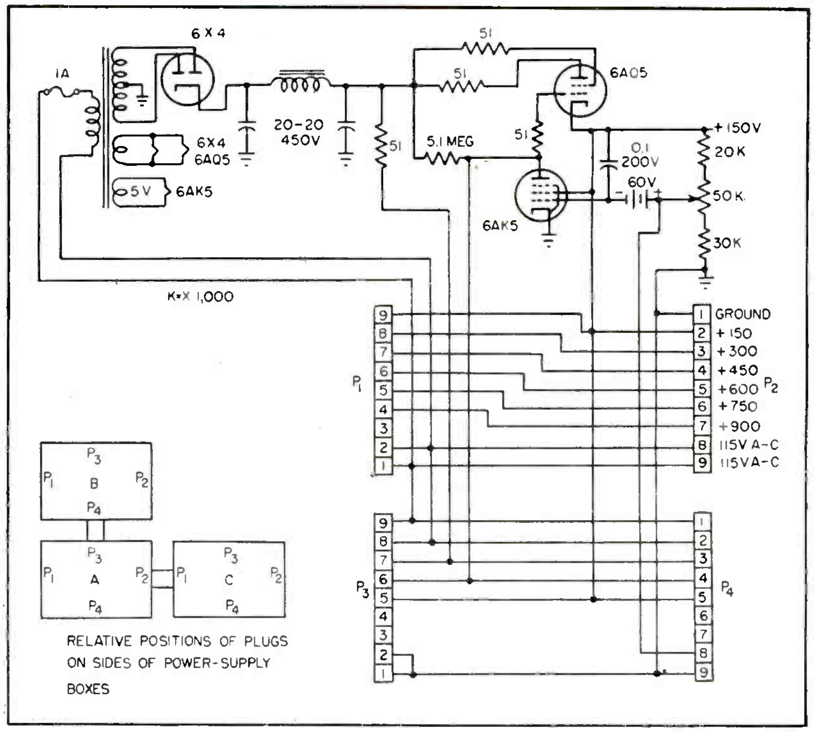
Series-parallel interconnection of power units



Series connection of units for maximum voltage



Parallel connection of units for maximum current



The basic regulated power-supply unit is conventional, but the jack connections allow parallel (unit B) and/or series (unit C) connection to unit A

Regulated

By **JOHN H. BIGBEE**

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Culver City, Calif.

THE PROBLEM of supplying necessary direct-current power for electronic circuits has been approached and solved in many ways. Years ago, when B batteries were in vogue, a large enough quantity of fresh batteries would do the job. It was possible either to parallel or series-connect the batteries and tap off various voltages. The internal impedances were tolerable for most of the useful battery life. However, the deterioration of the cells, together with their bulk, was a nuisance that transformers, rectifiers, and filters eventually eliminated.

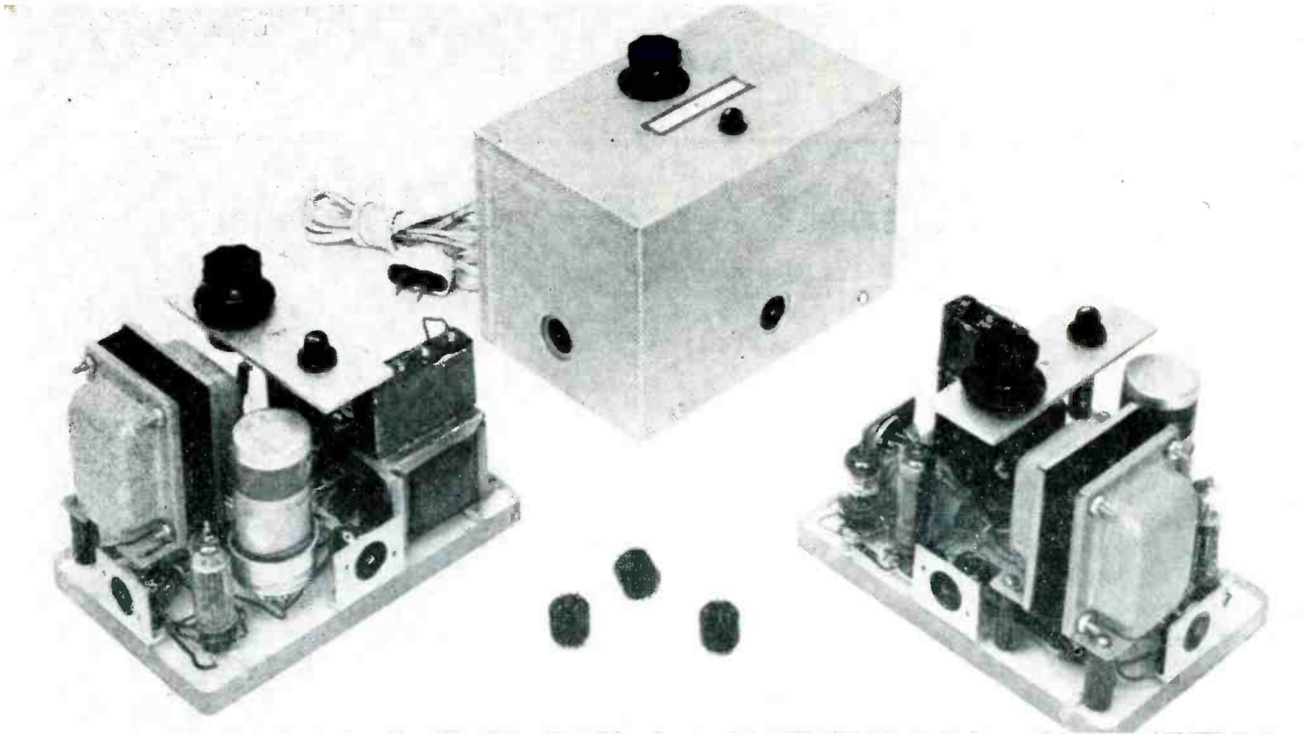
With attempts to improve regulation and reduce the internal impedance of these supplies, many automatic electronic regulators were designed. In addition to solving the problems mentioned, another important advantage was gained—the facility of setting the output voltage smoothly to a desired value. An inexpensive method of reducing slow d-c drift is still needed.

Today a large variety of well-regulated power supply circuits covers a wide range of voltages and currents. Most of these units, however, are designed to satisfy a specific range of power. The supplies designed especially for laboratory use, where broader variations are needed, are inconveniently bulky and expensive.

The supplies pictured are intended to serve as a general solution to the power-supply problem. They can be constructed in such a way as to minimize the space occupied. Each unit is identical in design, providing the economy of standardization.

The basic components were selected with the idea of designing around those manufactured in largest quantity, in order to optimize the quality-versus-cost curves. Of course, size, voltage and current considerations are also important.

The units are each a complete, self-contained, regulated power supply capable of supplying 70 milliamperes and adjustable from 70 to 150 volts. The output ripple voltage is less than one millivolt rms. Care has been taken to hold all insulation ratings above 1,500 volts. The units are designed to connect together through plugs to permit expansion of the



Three identical units with and without protective grille showing external voltage control, fuse holder and interconnection plugs and jacks

Power-Supply Blocks

Compact regulated units provide 70 milliamperes each with smooth voltage control from 70 to 150 volts. Unique plug arrangement allows series, parallel or series-parallel connection like block B batteries for greater voltage, increased current or both

power source for either higher voltage output, higher current output, or both.

Interconnecting Units

For higher voltage output the units connect together along their longer axis as illustrated. Here the units are in series (since the ripple voltages might conceivably add, care was taken to hold ripple to a minimum). Internal impedance has been held low to avoid instability in the regulators.

For greater current output the units may be connected together along their shorter axis. This connects the series regulator tube outputs in parallel. The regulator control tube in the forward unit then acts as control for all the units. The control tubes in the remaining units are automatically biased beyond cutoff when the units are plugged together. Units may be plugged together in both directions to provide whatever combinations of voltage and current are desired.

Intermediate voltages are available from all the plugs as the circuit indicates, and most applications permit adjustment of the voltages to such values as needed without the use of dropping resistors or dividers. The decoupling networks needed in many high-gain circuits can usually be eliminated by the same procedure.

Power for the units is supplied through the a-c cord and plug shown in the photograph. When units are connected together they receive power at 115 v, 60 cycles through the unit to which they connect, thus permitting the supplies to be controlled by a single on-off switch. The interconnecting plugs are made of copper-clad steel pins anchored in a bakelite insulating block.

These plugs insert into standard nine-pin miniature sockets providing ventilation spaces between supply units when connected together, and eliminating exposed pins that might be dangerous in operation.

These little units give the flexibility of batteries without their annoying bulk and short life. In addition they have the advantages of regulated d-c power, a wide range of voltages and currents, and it is possible to standardize completely upon one simple laboratory power supply.

Counter-Circuit

By A. R. VALLARINO, H. A. SNOW and C. GREENWALD

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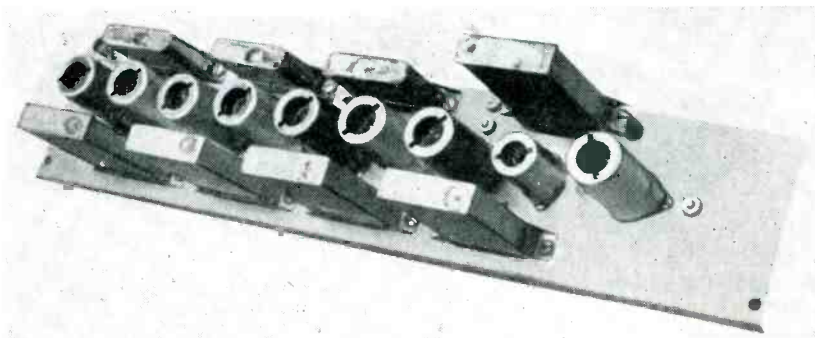
A SIMPLIFIED f-m subcarrier system is illustrated in Fig. 1. The input to this system may be a broadband multiplex signal within the range of 250 cps to 150 kc.

This signal is first applied to an f-m subcarrier transmitter in which the applied signal frequency modulates a 1-mc subcarrier. The modulated subcarrier is then passed to a radio transmitter and modulates the r-f transmitted frequency. At the receiver end the r-f signal is demodulated and provides a 1-mc subcarrier containing the original multiplex modulation. An f-m subcarrier receiver then demodulates this subcarrier and provides the original multiplex signal at its output terminals. This last subcarrier receiver is the one with which this paper is concerned.

Early low-distortion receiver designs were rather complex and contained many tuned circuits including a balanced mixer, balanced discriminator and i-f circuits, all of which required fairly accurate alignment. These receivers were difficult to manufacture and to maintain in the field. This led to an investigation of receivers employing the counter principle.

A counter-type receiver shown in the photograph is simple in construction and has no critical parts to align. It introduces a distortion of only 0.2 percent over the modulating frequency band of 250 cps to 150 kc when operating with a 1-mc f-m subcarrier having a deviation of ±250 kc.



Counter receiver for frequency-division-multiplex systems has no adjustments, thus being ideally suited for field use

Counter Receiver

The receiver block diagram is illustrated in Fig. 2. The circuit centers mainly around two parts; the limiters, represented by the first block in Fig. 2 and the counter, represented by the second block. The remaining filter and video amplifier are conventional.

The limiters amplify and convert the input signal to square-wave pulses of constant amplitude. These pulses are applied to a counter discriminator. The baseband portion of the counter output is then selected by the low-pass filter which cuts off sharply at 200 kc and rejects all higher frequency components. The baseband signal is then amplified to a suitable level by the video amplifier.

The 1-mc square-wave constant-amplitude output of the limiters is applied through a cathode follower to a counter circuit as shown in Fig. 3. The cathode follower supplies voltage to the counter from a low-impedance source, thus maintaining a low resistance in the counter circuit.

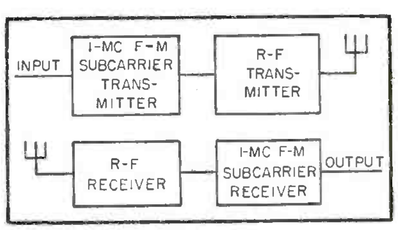


FIG. 1—Simplified block diagram illustrates typical f-m subcarrier system

Capacitor C is charged primarily through the diode and discharged through load resistor R. Across this output resistance pulses are developed having a constant average amplitude for a constant frequency. The average output amplitude varies directly with the number of pulses per second. Thus, this average output amplitude varies linearly with frequency resulting in an essentially linear discriminator action.

Limiters

The major problem in a counter receiver is the design of a limiter that will convert the f-m input signal to square waves of very small rise time and provide equal output amplitudes for each cycle over the entire deviated band, regardless of input level. Thus, in this application, for a ± 250-kc deviation and a 1-mc carrier, a rise time of less than 0.05 μsec and a constant peak-to-peak amplitude over the band of

Multiplex Receiver

Low-distortion f-m counter receiver operates at 1 mc with modulating frequencies exceeding 150 kc, has no tuning adjustments, and most parts values are noncritical. Analysis shows output voltage to be linear function of input frequency

750 to 1,250 kc should be provided by the limiters.

The effect of amplitude modulation of the incoming signal is aggravated by nonsymmetrical clipping of the input wave. There are two primary effects, one of which introduces additional phase modulation into the incoming signal and the other causes amplitude detection in the limiter stages. The phase modulation introduced by nonsymmetrical clipping becomes part of the transmitted signal and cannot be removed in following circuits, while the signal resulting from the amplitude detection falls within the bandwidth of the limiters and can be transmitted through to the final output.

To avoid the distortion that can be introduced into the counter output signal by both of these effects, it is important to maintain symmetrical clipping by the limiters.

Limiter Circuits

The limiters used in this receiver, as shown in Fig. 4, are a well-known type sometimes called cathode-coupled clippers. Each limiter consists essentially of a double triode, the first section being a cathode follower, coupled through a common cathode impedance to the second triode section. The limiter output is produced across a load resistor in the plate of the second triode. The grid bias voltage is supplied by a voltage divider connected from the plus B supply to ground. Since the B supply is regulated, the bias voltage is quite constant and is not affected by amplitude variations of the signal.

Six such stages are cascaded to provide adequate limiting and gain to operate at a nominal input level of 100 millivolts. While all six stages are not limiting at this level, several limiting stages are required to reduce amplitude variation to a negligible amount and to reduce the rise time of the square wave pulses to a value less than 0.05 μsec.

Limiter Characteristics

The tubes best suited for this limiter should have a sharp cutoff, high transconductance, high amplification factor and high current capability. The 12AT7 was selected from available receiving types as best meeting these requirements.

Static characteristic curves of a limiter stage were calculated from the grid voltage-plate current characteristic of these tubes. These curves are shown in Fig. 5 for the circuit conditions shown. The input voltage to the stage is shown on the abscissa and current flow through R_o is indicated at the left side.

Each solid curve shows the output plate current of the stage for a fixed bias on the second grid, as the input voltage to the first grid is varied from minus 10 to plus 60 volts. The dotted curves show the total current through both tubes and are only of interest as an aid in understanding the current division between the two tubes of the stage.

Curves are shown for positive bias voltages at the second grid from 0 to plus 50 volts in 10-volt steps. Bias and input voltages are measured from ground to grid, not cathode to grid. At all times, except on overload, the grids are negative with respect to the cathode so that no grid current flows. The vertical line along the plus 50-volt ordinate indicates a value of input voltage such that the resulting grid to cathode voltage on triode 1 is minus 0.5 volt at which point grid current begins to flow. This is considered the overload point of the stage.

To illustrate the action of this limiter, the heavy curve representing values for a plus 20-volt bias on the second grid, may be followed across Fig. 5 from left to right.

At the left end and up to 16 volts input, the first tube is cut off so that the output current, flowing in the second tube, is constant at a value set by the second tube bias. Above 16 volts input, current begins to flow in the first tube which increases the positive cathode voltage and thus reduces the output current in the second tube. At 20 volts the output current from the second tube has dropped to ap-

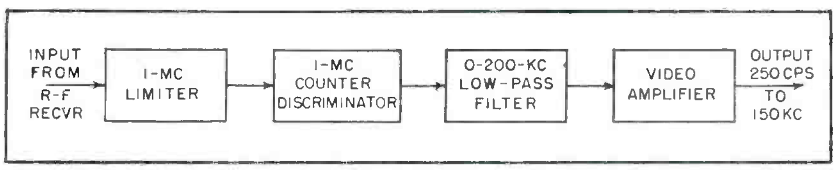


FIG. 2—Subcarrier counter receiver block diagram. Low-pass filter and video amplifier are conventional

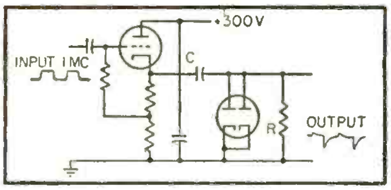


FIG. 3—Counter discriminator circuit has no critical parts values nor tuning adjustments

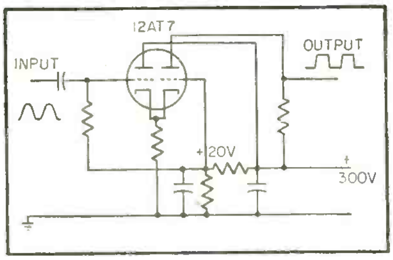


FIG. 4—Cascaded limiters, permit use of simple discriminator circuit

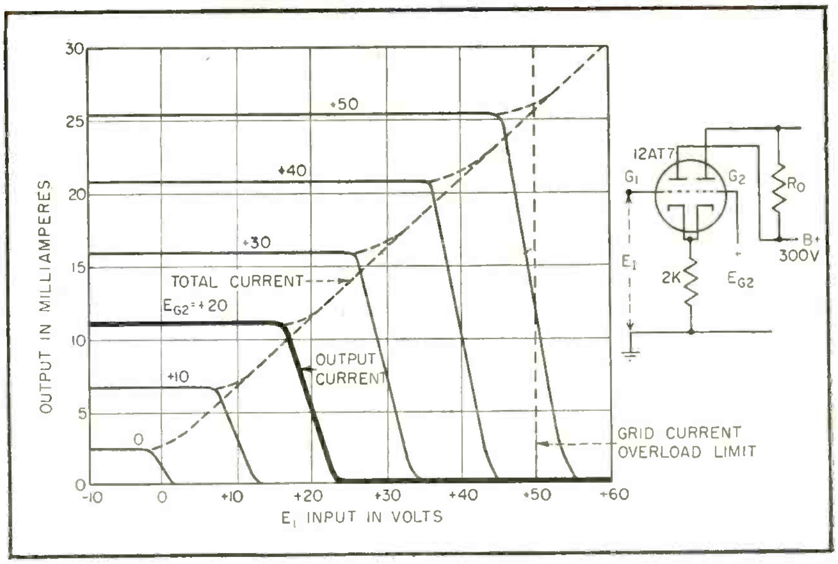


FIG. 5—Symmetrical limiting is insured by biasing tube to center of output current curve

proximately one-half its initial value, due to increasing current in the first tube. At plus 24 volts input, the cathode voltage has been raised by the first tube current to a value that cuts off current in the second tube entirely so that increasing the input voltage beyond this point has no further effect on the output current.

It is apparent that when a fixed bias of plus 20 volts is applied to the first grid, an a-c input signal operates around the center point of the sloping portion of the output current curve. If the signal is less than 3 volts peak, no limiting occurs and the stage acts as an amplifier along the sloping portion of the curve. If the a-c input voltage exceeds 4 volts peak, symmetrical clipping of the peaks occurs. For this curve, a-c voltages of the order of 30 volts peak may be applied before overload occurs, this 30 volts being the difference between the plus 20-volt bias and the 50-volt overload point of the curve.

An example of typical operation using an operating bias of plus twenty volts applied to both grids results in a quiescent output tube plate current of 5.8 ma, and an output current swing of 11 ma. The peak input voltage that can be applied before reaching the overload point is 30 volts. With an output load R_o of 2,000 ohms, for example, a peak-to-peak output voltage of

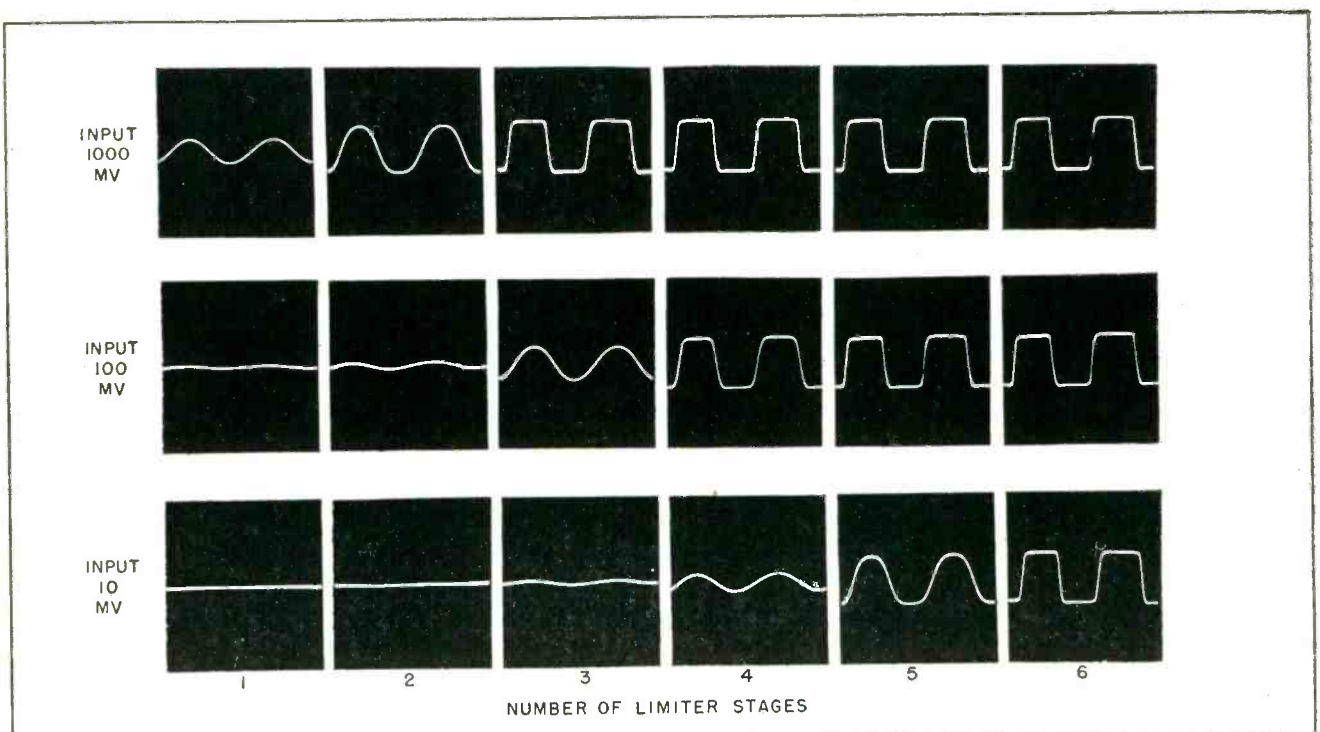


FIG. 6—Oscillograms show effect of cascaded limiters. Strong signals (top row) are first affected, while first limiters serve as amplifiers for weaker signal (bottom row). Strong and weak signals appear identical after six limiting stages

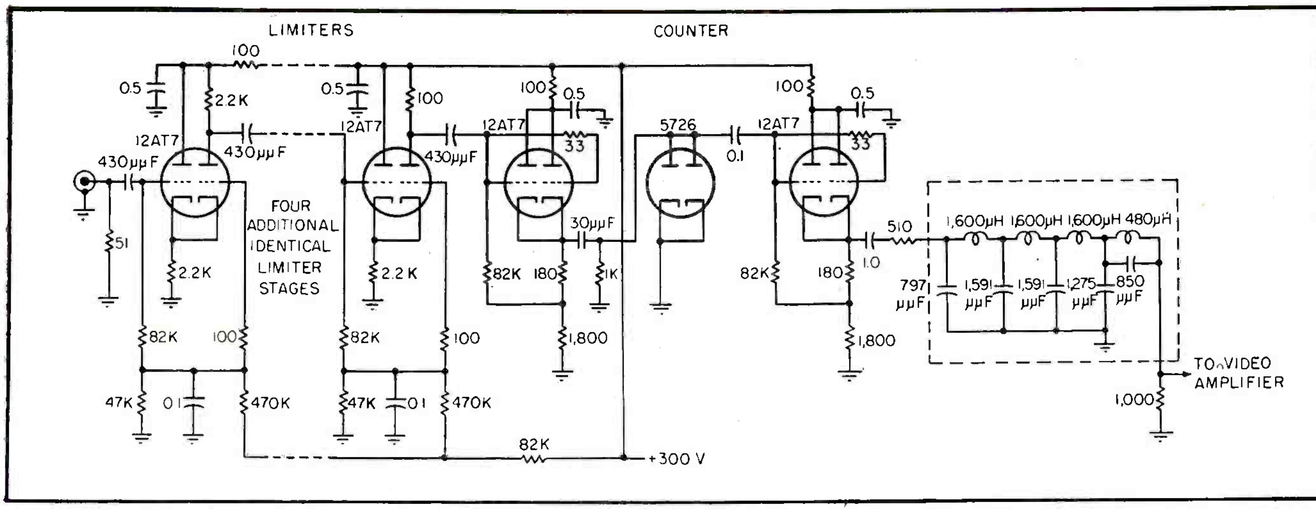


FIG. 7—Counter receiver circuit. Only critical parts values are those used in low-pass separation filter

about 22 volts is available to drive the following limiter.

Other operating regions may be selected by applying equal positive bias voltages to both grids of a limiter stage; higher bias voltages giving a larger output current but a more restricted range of input voltage before overload occurs while lower bias voltages give lower outputs with a greater range of input signal before overload. Exceeding the overload limit results in loss of symmetry in the output due to grid current in the first triode section. Consequently, the optimum operating curve depends on the magnitude of the input voltage swing.

It is of importance to note that the output curves are essentially symmetrical around any operating point when equal values of positive bias voltage are applied to both grids.

Limiter Performance

Figure 6 shows the wave shapes at the output of each of the six cascaded limiters for three input voltages. Each of the 18 curves is an oscilloscope photograph taken with a specially-designed video amplifier capable of passing square waves of 0.03-μsec rise time.

In the upper group of pictures, a 1,000-mv, 1-mc sinusoidal signal was applied to the input of the limiters. The first limiter acts as an amplifier only, as shown by its output waveform. A slight flattening of the output of the second limiter indicates that limiting is just beginning. However, the third limiter is limiting well and the fourth, fifth and sixth limiters exhibit substantially the same output waveform.

Reducing the input level 20 db or to 100 millivolts shows, in the second group of curves, that the first three limiters are essentially amplifiers while the limiting is accomplished in the last three stages.

Reduction of the input levels another 20 db, or to 10 mv, results in practically all of the limiting being achieved in the last two limiter stages with substantially the same waveform at the output of the sixth limiter, as shown with the other input levels.

The rise time of this output wave depends basically on the *RC* time constant in the plate of the last limiter stage over this 40-db change in input level. A dynamic test of distortion over this input range indicates practically no change in distortion figures of 54 db with modulating frequencies up to 150 kc. Figure 7 shows the complete receiver schematic.

Output Formula

The counter discriminator shown in Fig. 3 is driven from a cathode follower source. It consists basically of an *R-C* circuit plus a diode. It provides an output voltage:

$$E_o = -\left[\frac{E_iRC}{T}\left(\epsilon^{-\frac{T}{R_{t_1}C}} - 1\right) - \frac{E_iR_AC}{T}\left(\epsilon^{-\frac{T}{R_{t_2}C}} - 1\right)\right]$$

where E_o = average output voltage across load resistor R; E_i = $(E_{max} - E_{min})$ of voltage from cathode to ground; R = load resistor; R_A = load resistance when diode is conducting, that is, equal to R in parallel with the conducting resistance of the diode; R_{t1} = total counter series resistance when diode is not conducting. This includes resistance of cathode follower source; R_{t2} = total counter series resistance when the diode is conducting, $R_{t2} < R_{t1}$; C = counter circuit series capacitance; $T = 1/f$ = period of input signal where f is frequency.

If $R_{t_1}C << T$, then $\epsilon^{-\frac{T}{R_{t_1}C}}$ and $\epsilon^{-\frac{T}{R_{t_2}C}}$ approach zero and

$$E_o = \frac{E_iRC}{T} - \frac{E_iR_AC}{T}$$

Since $T = \frac{1}{f}$

$$E_o = E_iRCf - E_iR_ACf$$
$$= E_iCf\,(R - R_A)$$

This in effect says that if the $R_{t1}C$ time constant is sufficiently small to allow C to charge up to the maximum input voltage in one-half cycle of the input frequency, and to discharge to the minimum input voltage in the other half-cycle, and if $(E_{max} - E_{min})$ of the input voltage is constant over the entire band occupied by a frequency-modulated signal, then the output voltage E_o is a linear function of input frequency.

Code Practice Keyer

Punched or translucent tape fed through phototube keying head sends perfect 20-words-per-minute Morse code letters at any integral overall speed from 4 to 20 wpm. Electromagnetic clutch controlled from phototubes and variable relaxation oscillator permits use of single tape

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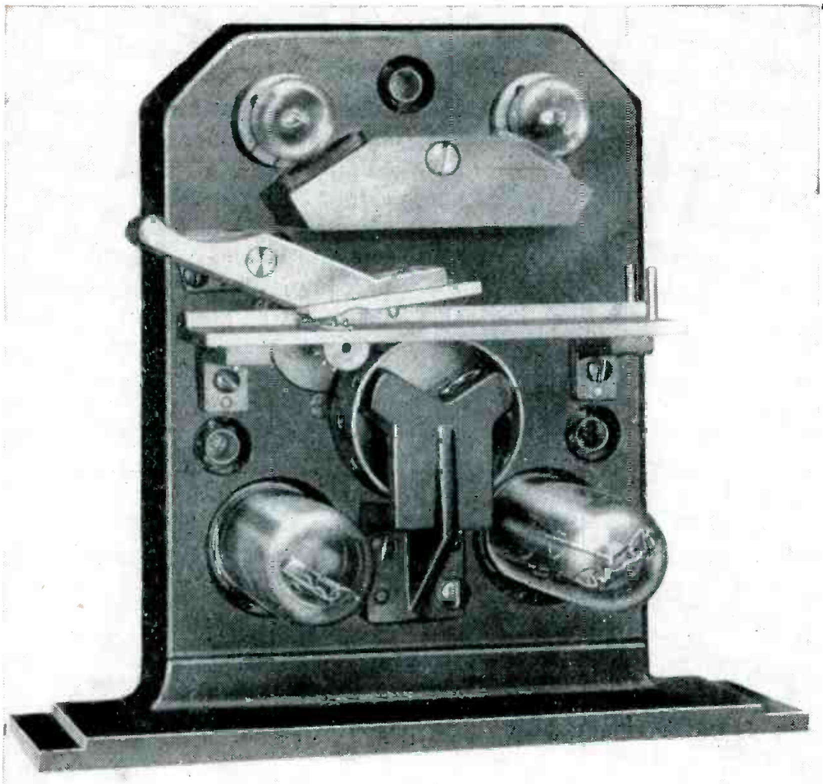

Phototube keying head with exciter lamps, lens system, tape retaining plate, rotating shutter and phototubes below. Continuous tape movement is from right to left across retaining plate, driven by star wheel to left of rotating shutter

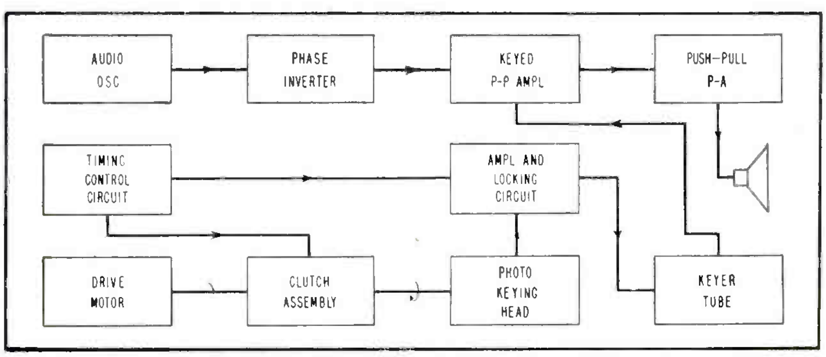

FIG. 1—Circuit functions separated into most important blocks. Voice channel in equipment is not shown here

STUDIES of problems involving student instruction in the audible reception of radiotelegraph code have indicated that a distinct psychological advantage to the learner is obtained by use of a new technique of code training. This technique is based on the fact that it is desirable for the beginner to hear the code characters (such as letters, numbers and punctuation) transmitted at a speed comparable to that he will encounter in later experience (20 words per minute).

A unique electronic and electromechanical device designed to provide this technique of code training is used by the U. S. Navy. Manufactured by H. O. Boehme, Inc., the device, called a primary training keyer, is used to transmit practice code at any one of 17 selected integral rates from 4 to 20 wpm. During 20 wpm transmissions, automatic code tape flows continuously through a phototube keying head, and code messages are transmitted with the element (dot or dash) and space-time relationship in accord with the standard system of automatic code transmission.

During transmissions of 4 to 19 wpm, electronic timing circuits, through the action of a relaxation oscillator that operates an electromagnetic clutch, interrupt the mechanical travel of tape through the keying head. The timing circuits control tape travel to transmit each character at the 20-wpm rate, yet

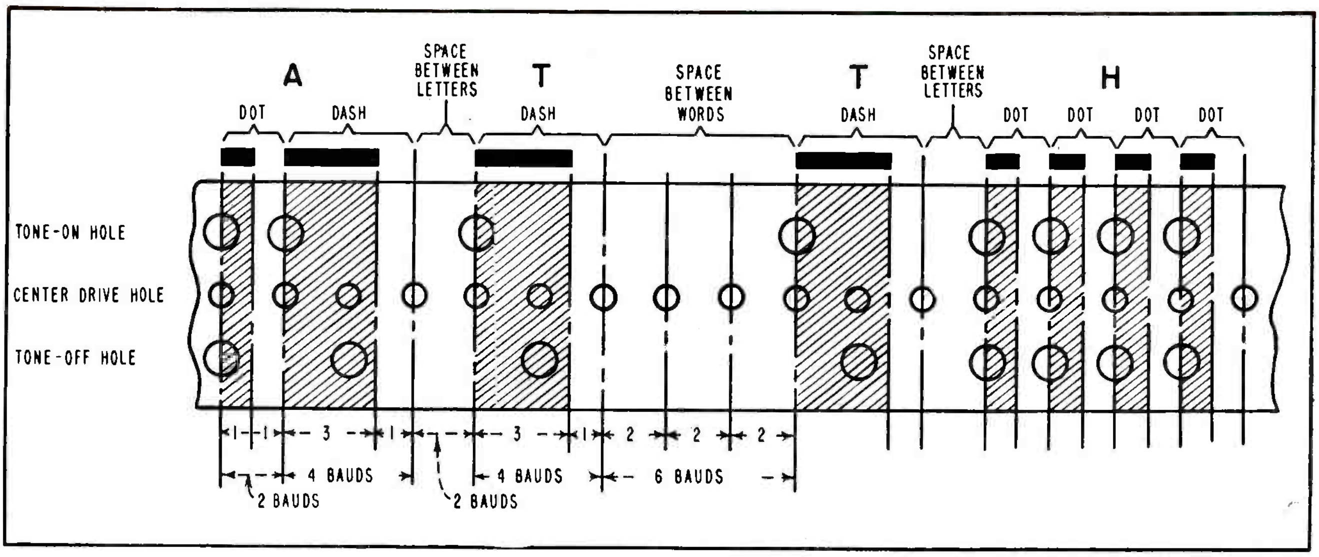

FIG. 2—Spacing standards used in the code keyer for characters and between words. Shaded sections indicate tone-on and unshaded sections tone-off time

insert additional space time between characters. At 19 wpm the added space time is a minimum and progressively increases to a maximum at 4 wpm.

The training keyer consists of an amplifier chassis and a keyer chassis mounted in a sheet-metal cabinet. Interconnection of the more important circuits is shown in Fig. 1.

The amplifier chassis contains a tone-signal oscillator, an amplifier, and a keying circuit that turns the tone signal on and off to form the dots and dashes of practice messages.

Audible dots and dashes are heard in a loudspeaker mounted on the front panel of the amplifier chassis, or in remote speakers and headsets. Provisions are also included for use of an instructor's hand key and microphone for checking practice messages.

The keyer chassis contains timing and phototube amplifier circuits that are energized by light shining through perforations in the automatic code tape as it passes through the keying head. The keying-head motor that drives the tape is mounted on the keyer chassis. The phototube keying head through which the tape is drawn is a detachable unit that plugs into the front panel of that chassis.

Either opaque paper tape furnished with the equipment or standard translucent tape, in which messages have been punched by use of a standard Wheatstone perforator, as shown in Fig. 2, may be used.

In operation, teeth of a starwheel in the keying head engage the center holes of the tape and draw the tape from right to left across a tape retaining plate. The tape is held in place against the plate by a retaining lever.

Mark-Space Phototubes

As the perforated tape passes through the keying head, pulses of light from the exciter lamps pass through the holes and alternately strike the tone-on (mark) and tone-off (space) phototubes. The phototubes conduct and produce alternate pulses of current. These pulses trigger the phototube amplifier to produce a tone-on and then a tone-off condition.

The rotating shutter, through which light from the exciter lamps must pass to reach the phototubes, as shown in Fig. 3, is designed with apertures that permit only sharp pulses of light to initiate or cut off the tone signal. In this manner, clean-cut keying is obtained.

The double-aperture plate is a thin piece of metal containing two small rectangular slits that are parallel but offset from each other as shown. The plate is located in the center of the tape retainer plate directly beneath the focused beams of light from the exciter lamps.

The tone-on and tone-off holes are punched even with each other in the tape (Fig. 2). If light from the exciter lamps were permitted to shine through both holes and reach both phototubes at the same time, the equipment would be inoperative. Staggering the slits makes it possible to initiate the mark signal before the space pulse cuts the tone off. The effect is the same as if the holes in the tape were offset.

Keyer-drive is from a 60-cycle synchronous motor that has built-in gearing to reduce output shaft speed to 80 rpm. The motor shaft is flexibly coupled to an electromagnetic clutch assembly. When the relay coil of the clutch assembly is energized, the moving clutch engages the driving clutch and the output shaft of the motor rotates the star wheel and shutter of the keying head.

When the relay coil, operated by the timing circuit, is de-energized the moving clutch is pulled back against the teeth of the stop clutch. Rotation of the keying head parts, and consequently tape travel through the head, is stopped.

The audible tone is supplied by a modified Wein-bridge oscillator shown in Fig. 4. The frequency is variable over a minimum range of 450 to 3,000 cycles and is varied by rotation of R_{1A} and R_{1B}.

In the selector switch positions of code, hand key, or standby, the audio-tone generator operates con-

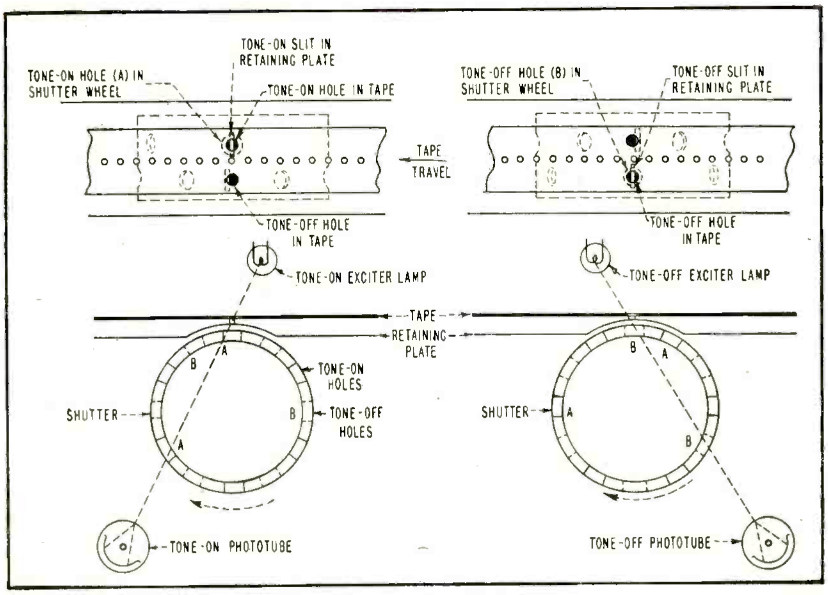

FIG. 3—Tone-control shutters are offset to simplify standard tape punching. Hole and shutter relationship is shown at (A) for tone-on and at (B) for tone-off conditions

tinuously. In code and hand key positions the output of the generator is applied to the input of the phase inverter. In voice operation the audio generator is rendered inoperative by a negative blocking bias applied to the grid of V_{1B} and is also disconnected from the input of the phase inverter V_{3A}.

The microphone preamplifier stage amplifies the output of the crystal microphone used with the equipment to a level sufficient to drive the phase inverter. In voice operation the output of the preamplifier is applied to the phase inverter. In code, hand key and standby operation the preamplifier is disconnected from other circuits.

Tube V_{3A} is a conventional phase inverter. The voice or tone-signal output of the inverter is applied to the grids of the keyed push-pull amplifier V_{4A} and V_{4B}. During voice operation the keyed push-pull amplifier is continuously operative. During code or hand key operation the tone signal is applied to the grid of the keyed stage.

The cathodes of the keyed stage are held at approximately 80 volts by connection to a bleeder across the B+ supply. The plate voltage of V_4 is raised above this value, or reduced below it by operation of the keyer tube. The keyer tube is either conducting or cut off. When V_{3B} is on, plate current flow through R_{10} reduces the voltage at the plate of V_{3B} and at the keyed stage to about 50 volts, blocking it.

When the keyer tube is off, the voltage at the keyed stage plates rises to approximately 200 volts and the stage operates normally. In this manner the constant tone signal applied to the grids is broken into dots and dashes that appear at the plates and are fed to a conventional push-pull output stage.

When selector switch S_3 is in the voice position, -12 volts is applied to the grid of V_{3B}, cutting off plate-current flow and leaving the keyed stage on.

When the keyer is operated at the nominal sending rate of 20 wpm, the tape passes through the keying head at the continuous rate of 0.8 inch per second. The length of the dots and dashes is determined by the rapidity with which alternate on and off pulses of light pass through the tape holes and energize the phototubes.

Operation of the phototube amplifier and locking circuit is effective only when the selector switch is in the code position during automatic code transmission from tape.

The vacuum tubes of the amplifier and locking circuit do not operate as conventional amplifiers, but as switches that are either on (conducting) or off (nonconducting). The triode tubes are connected in bridge-type circuits such that a tube that is off, or blocked, applies a positive voltage to the grid of the following tube, turning it on. This second tube, which is on, then applies a negative voltage greater than cutoff to the grid of the third tube, cutting it off, and so on.

A pulse of light from the exciter lamp strikes tone-on phototube V_7, which conducts. This applies a positive voltage to the grid of V_{8B} turning it on, and turning V_{9A} off. When V_{9A} is off, it turns V_{10A} on. This action turns keyer tube V_{3B} off, the keyed push-pull stage becomes operative and the tone is heard. At the same time, when tube V_{9A} is off, it turns locking tube V_{9B} on. Conduction through V_{9B} holds V_{9A} off, V_{10A} and V_{10B} on, and the keyer tube V_{3B} off. Thus, the locking circuit holds the tone on, even though phototube V_7 and triode V_{8B} conduct only for the instant of the initial pulse.

The tone-off switching and locking cycle may be traced in similar manner. During automatic code operation the outputs of V_{10A} and V_{10B}, which are parallel, are applied to keyer tube V_{3B} and the timing control circuit.

Code Speed Control

The timing-control circuit regulates tape movement through the keying head at transmission speeds of 4 to 19 wpm. The timing circuit is inoperative at 20 wpm because the clutch relay coil is continuously energized by grounding the grid of the clutch relay control tube V_{13}. The moving clutch is then held against the teeth of the driving clutch and the star wheel rotates, drawing the tape through the keying head at the constant rate of 0.8 inch per second.

When the words-per-minute switch is set on any number from 4 to 19, the timing control circuit performs the following functions.

When a light pulse turns the tone on, the amplifier applies a negative voltage to the timing-control circuit. This voltage energizes the clutch relay coil and drives the tape during tone-on time. When the tone-off pulse turns the tone off, the negative voltage keeps the clutch coil energized for the period of time required to drive the tape the one baud of space associated with the element transmitted. Between the characters and spacing units of two bauds, the tape stops. Length of this dead time is regulated by resistors such as R_{11} in the words-per-minute timing control circuit to provide the required wpm rate.

After the dead time has passed, the timing control circuit energizes the clutch coil long enough to cause the tape to travel one spacing unit of two bauds. If the space unit is followed by another the tape stops for another period of dead time. When the space is followed by a dot or dash, the tone-on pulse of the element prevents the relay coil from being de-energized and the tape travels into transmission of the next character without stopping.

Tape-Drive Circuits

A negative voltage during tone-on time from the phototube amplifier is taken from the center arm of R_{12} and this voltage is applied to the cathode of one section of V_{11}. Since the plate of this section is connected to ground through R_{13}, the plate becomes positive with respect to the negative cathode. Current flows from cathode to plate and down to ground through R_{13}, developing a negative voltage on the grid of V_{12A}. This voltage is greater than cutoff and consequently the tube is blocked.

When switch tube V_{12A} is off, the grid of V_{13} becomes positive and the tube conducts. The clutch relay coil is energized and the tape moves through the keying head.

A tone-off pulse striking its phototube causes the amplifier voltage from R_{12} to go sharply positive. The cathode of V_{11} becomes positive with respect to its plate, and the tube ceases to conduct. Although the tone is now off, the tape travel continues because the negative voltage applied across R_{13} has charged C_1. This voltage, applied to the grid of V_{12A} holds that tube at cutoff until the charge leaks off. When it conducts, V_{13} is cut off to de-energize the clutch coil, and halt tape travel.

Switch tube V_{12A} has a fixed cutoff value. Consequently the greater the negative voltage applied across R_{13} during tone-on time, the longer time will be required for that voltage to fall to the conduction point after the tone goes off. Adjustment of R_{12} varies this applied voltage; the potentiometer is set to apply a voltage sufficient to hold the relay coil energized until the tape has traveled the distance of one baud after the element tone-on time.

When the baud of tape travel has passed, the clutch coil is then de-energized and tape travel stops for a period of dead time unless the tone-on pulse of a following dot or dash keeps the coil energized.

When the tape stops, it will not travel again until the clutch is energized, or until V_{12A} is cut off by a negative voltage pulse generated by a relaxation oscillator on the timing control circuit. Such a negative voltage can be applied to the other cathode of V_{11}, producing current flow from cathode to plate, through R_{13} to ground, and cutting off the the grid of V_{12A}.

Voltage from the relaxation oscillator is a sharp sawtooth pulse. The proper period of voltage decay time is adjusted by rotation of time delay control R_{13}. This adjustment changes the RC time constant of R_{13}/C_1 and the time required for the sharp voltage pulse from the relaxation oscillator to leak off to ground. When this voltage reaches the cutoff value of V_{12A}, that tube conducts and de-energizes the clutch coil, thus stopping the tape after one unit of space travel.

When the tape stops for dead time between words, a single pulse from the relaxation oscillator moves the tape forward one spacing unit of two bauds. At this point V_{12A} conducts again and the tape travel stops, inserting a second period of dead time. At the end of the third spacing unit between words, the tone-on pulse energizes the clutch and the tape travels on into transmission of the next character.

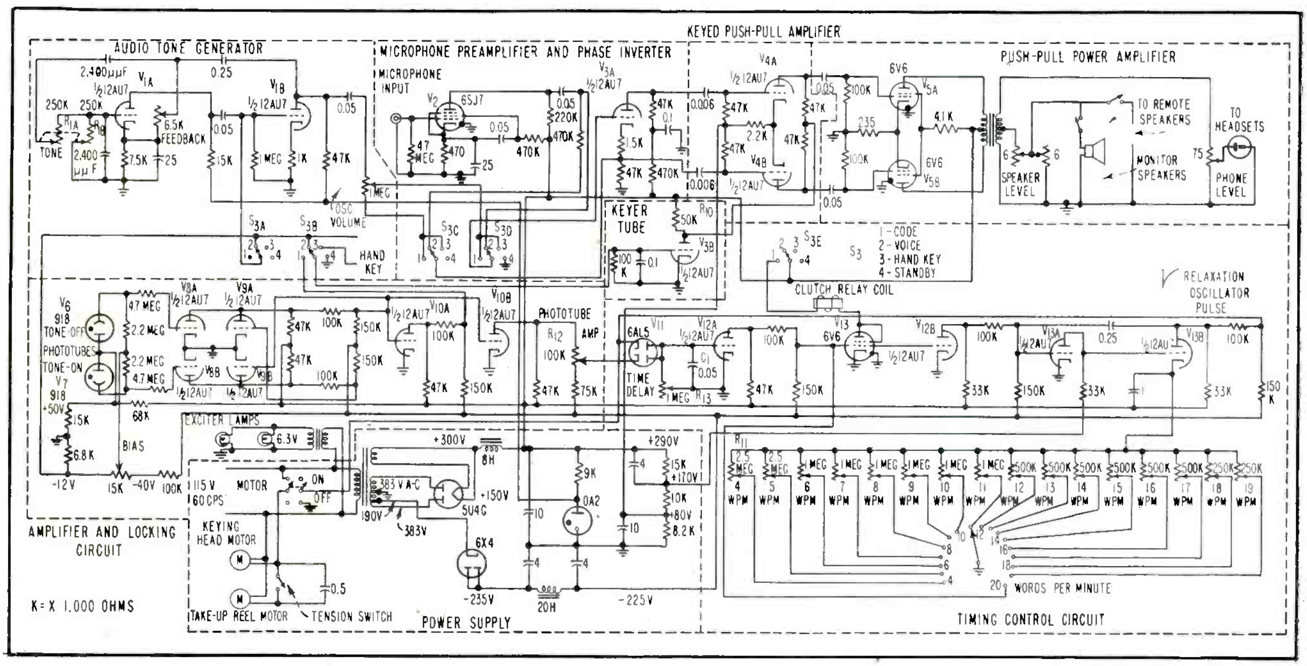

FIG. 4—Complete circuit diagram of the practice tone keyer is described in text

Remote-Tuning Receiver

Inductance of ferrite core coils is changed remotely to tune receiver from 500 kc to 3 mc by increasing control current from 8 ma to 233 ma. Control power required is less than 2 watts. Other possible applications are suggested

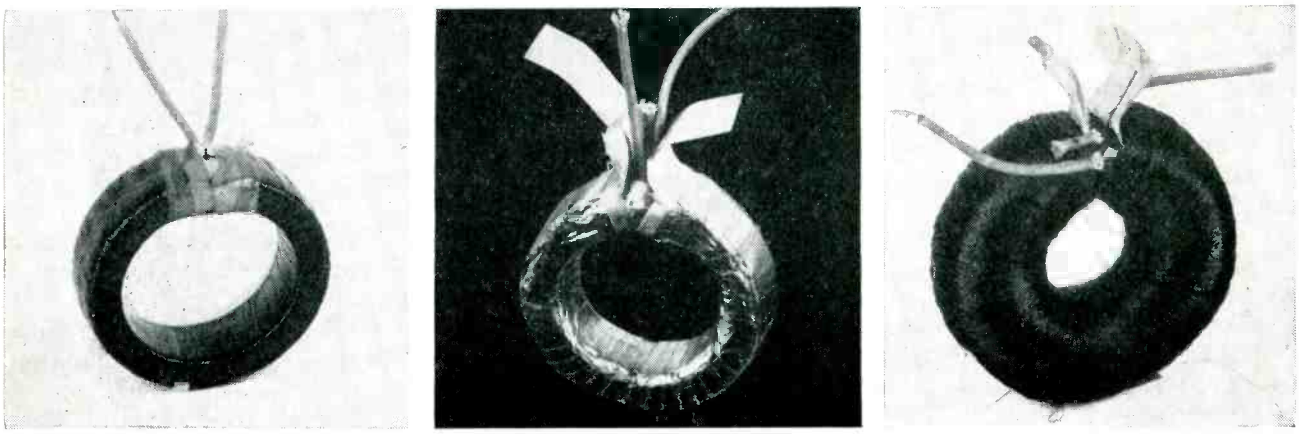

FIG. 1—Photos show steps in coil preparation. Two separate cores with opposing r-f windings are taped together with insulating tape and then surrounded as a unit with the d-c control winding

By SAMUEL STIBER

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At sporadic intervals during the fifty-year development of the communications art attempts have been made to construct controllable, variable inductors without moving parts, for use in resonant circuits to cover as much of the frequency spectrum as possible at reasonable expenditure of control power.

Only in recent years have core materials become available that make such variable inductances feasible. The accompanying photograph shows the r-f portion of a radio receiver using d-c controlled inductances. The receiver covers a frequency range of 500 kc to 3 mc, with incremental-permeability-tuned resonant circuits at the antenna input, first r-f, second r-f, cathode follower and crystal detector stages.

Design Requirements

Use of variable inductances in such applications places rather stringent requirements on the types of core materials and circuitry used.

The Q of the controllable inductor must be fairly high to obtain good selectivity and low noise. The control circuit should not provide a feedback path for the r-f nor introduce noise in the r-f circuit. The r-f signal should not exert a control function within the amplitude range to be expected, as this would cause detuning of the respective circuits or might manifest itself as a reduction of Q with signal amplitude and a consequent reduction in selectivity in the presence of strong signals.

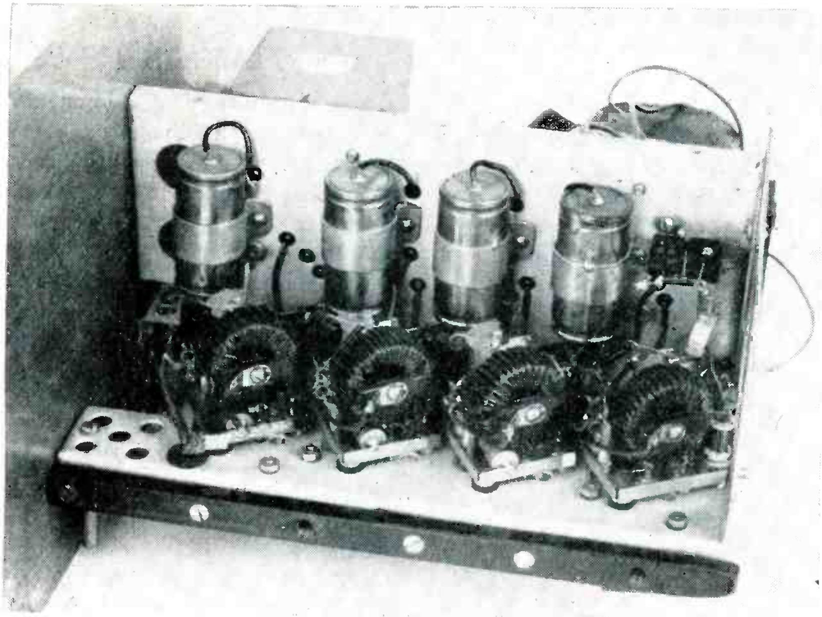
The deviation in inductance with control field must be repeatable. The magnetic core must be free of magnetostriction or other resonance effects that would make behavior of individual tuning elements unpredictable. The coefficient of temperature must be reasonably low or controllable. Power required to effect the inductance change must be low. Structure should be simple and easy to manufacture and the material should not require complex test procedure. Saturation flux density of the core material should be low so that minimum power is required to obtain a change from maximum to minimum permeability. Initial permeability should be high.

Toroid Selection

The toroid form provides a higher effective permeability, lower stray field and less coupling of the r-f to the control winding than any other known arrangement. Two toroids are stacked side by side as shown at left in Fig. 1. Each half of the r-f coil is wound around each toroid in opposing sense so that a voltage induced in each by a modulated control field would produce no emf at the r-f coil terminals. Coupling between coils is negligible. A protective bandage is applied combining the two toroids into one

This article is based on a paper delivered at the 1952 National Electronics Conference. The conference paper appears in the *NEC Proceedings*.

Has No Moving Parts



Radio-frequency portion of trf receiver using d-c controlled inductances to tune from 500 kc to 3 mc

package as shown in the center of Fig. 1. Figure 1 also shows (right) electrostatic shield wound around the combined cover and in turn insulated by a multiturn control winding placed over the radio-frequency coil.

Normalizing

Prior to test and selection, the cores are normalized (reduced to the same history) by heating in an oven above the Curie point, applying a strong a-c field which is then slowly reduced to zero, or by saturating with a strong periodic pulse.

The cores are then compared on a low-impedance bridge against a master selected at the center of the band. Experience has shown that plus or minus 3 percent limits enable tracking to within $\pm \frac{1}{2}$ db.

Frequency Variation

The most promising materials proved to be Ferramic D in the frequency range 30 to 50 mc and Ferroxcube IV in the frequency range 500 kc to 30 mc.

The incremental permeability of a ferrite material decreases without reversal if the flux density is increased from zero to complete saturation of the core. This is independent of the polarity of the flux. The variation of frequency of an oscillator utilizing the variable inductance is shown in Fig. 2. The relative frequency change f/f_0 with a change in control or biasing field H is shown for Ferramic I, G and C. These measurements were made in the frequency range 0.1 to 1 mc. No attempt was made to show the maximum possible range of frequency but rather the relative frequency change for a given power input to the H winding. A large frequency ratio f/f_0 for a small control power is of course desirable. The open area of each loop is a measure of the hysteresis loss in the core and ideally should be as small as possible.

The small r-f signal current in a relatively few turns of the r-f coil represents a negligible change in permeability but in the case of the low-frequency inductance the plate current of the tube represents a significant factor. For example, if the driver coil has 250 turns and the minimum current is 20 ma, the total is 5 ampere turns. The r-f coil has 80 turns and the plate current is 10 ma (0.8 ampere turn). However, the r-f coil is split into two halves, connected in opposite sense and while the one half would aid the driver, the other half would oppose, thus keeping the total permeability approximately constant.

Figure 3 shows measurements taken at elevated temperatures for the frequency band 3 to 10 mc and 20 to 40 mc for Ferramic A and B. These graphs show a room temperature curve versus yoke flux as well as a high and a low-temperature curve.

Inspection of these results indicates that for any magnetic bias the frequency change due to the bias increases with temperature.

Applications

The use of such electronically-tuned r-f components has been suggested for sweep oscillators, frequency-modulated oscillators, automatic-frequency-control systems, magnetic amplifiers, remote tuning of receivers and transmit-

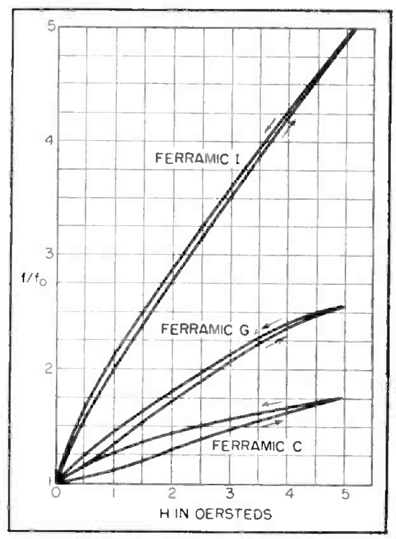


FIG. 2—Variation of normalized oscillator frequency with control field

ters, switching circuits and variable tuned filters. Figure 4 shows the circuit of the front end of a trf receiver that covers the frequency range 500 kc to 3 mc. This receiver has a sensitivity of approximately 2 microvolts for a 2 to 1 signal-to-noise ratio. Its bandwidth is 11 kc at 500 kc and 22 kc at 3 mc.

Means for tracking include one small adjustable series inductance with powdered-iron slug, permitting approximately a 3-percent change in inductance at the high-frequency end of the band. In addition, variable shunt trimmers are utilized to track the low-frequency end of the band. By these two means, continuous tracking is obtained over the frequency range. The tracking problem is seemingly greater than in tracking ganged capacitors, due to the absence of simple means of adjustment, such as slotted end plates on rotors. However investigation into means of tracking shows that two inductances of identical initial permeability and processing will track up to high saturation values.

The requirement for driving the group of variable inductances is that all should resonate at the same frequency with the same control current. Since the driver coils are connected in series, r-f chokes and by-pass capacitors are necessary to provide decoupling.

The operation of a variable inductance has been investigated in reference to its use as a local oscillator in a superheterodyne receiver with Ferramic B as the core material. A Colpitts oscillator using a 6C4 provided an output voltage substantially constant over the frequency range 2 to 6 mc.

Control current required for tuning the tuned-radio-frequency receiver shown is 8 ma at 500 kc and rises to 233 ma at 3 mc. Total control power required to tune through the frequency range 500 kc to 3 mc (6 to 1) is less than two watts.

The receiver may readily be hermetically sealed as there are no moving parts. The use of transistors to replace tubes should facilitate this feature. Tuning can be accomplished remotely at any desired speed.

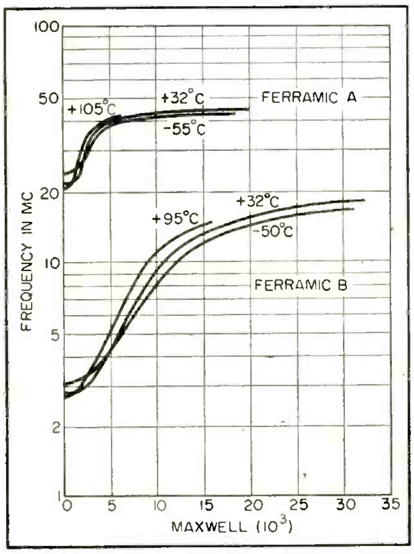


FIG. 3—Curves show dependence of ferrites on temperature

Conclusions

The study and development of ferrite materials sponsored by the Signal Corps Engineering Laboratories has resulted in a variable inductance having a volume of less than one cubic inch, weight slightly over one ounce, which can be shifted in frequency by a 2-watt source as follows: 7 to 1 in the frequency range 500 kc to 3 mc, 4 to 1 in the frequency range 3 to 12 mc, 2.1 to 1 in the frequency range 11 to 25 mc, and 2 to 1 in the frequency range 25 to 50 mc.

The problem of tracking such elements has been made simple. Useful Q's of the order of 25 to 70 are obtainable from 500 kc to 50 mc. Average temperature coefficient of the tuning elements is below 0.1 percent per degree C. No noticeable noise is produced.

Acknowledgement is herewith given to General Ceramics and Steatite Corporation, Keasby, N. J., C.G.S. Laboratories, Stamford, Conn., and to the University of Michigan. Much of the information presented in this article has resulted through work accomplished by these three sources.

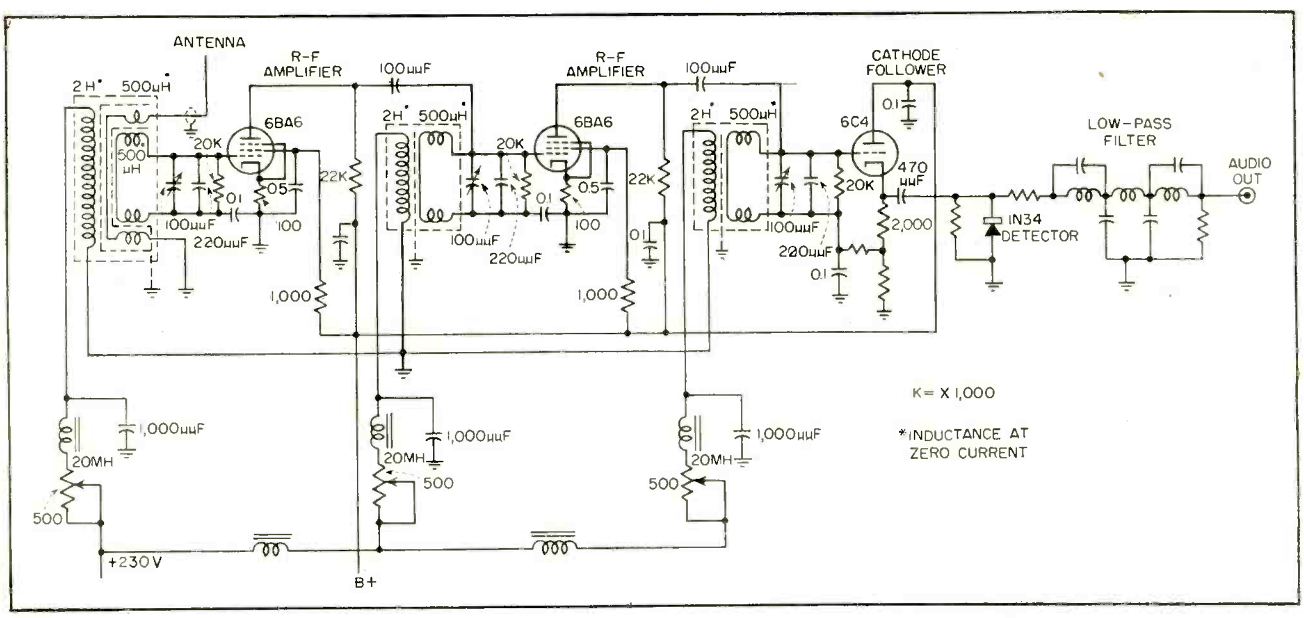


FIG. 4—Complete schematic of remote-tuning receiver using r-f saturable reactors as tuning elements

Magnetic Amplifier Transient Analyzer

Dual-beam oscilloscope displays input and output signals of magnetic amplifier simultaneously and continuously on common time base for studying effect on speed of response of various circuit parameter changes. Permits rapid determination of optimum design as shown in oscillograms made during studies of typical circuits

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MAGNETIC amplification is accompanied by a certain time-lag between the application of the input signal and the attainment of the full output load current.

This sluggishness of response due to magnetic inertia is not an important drawback in some applications where the additional lags arising from external parts of the electrical control system (due, for example, to the thermal inertia of a thermocouple) are appreciably greater than those inherent in the magnetic amplifier itself. But in other applications, especially those in the field of high-performance servomechanisms and some other types of automatic control and instrument work, a very short response time is of paramount importance.

Investigations

Considerable effort has been expended in theoretical and experimental investigations concerning the transient performance of various types of magnetic amplifier circuits.

The object of these investigations is to study the major factors that control the transient response of saturable reactor devices with resistive or inductive loads in their output circuits.

It has been shown that application of rectangular hysteresis-loop core materials[1, 2] in combination with a suitable core construction results in a very close approximation between the usual theoretical assumptions and actual experimental conditions. Therefore, the transient performance of such magnetic amplifiers can be described by simple linear equations with sufficient accuracy to be used in the design of these amplifiers.

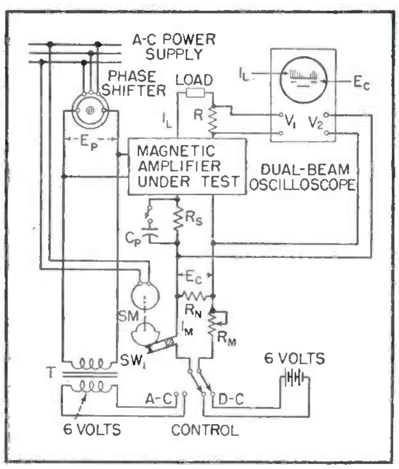


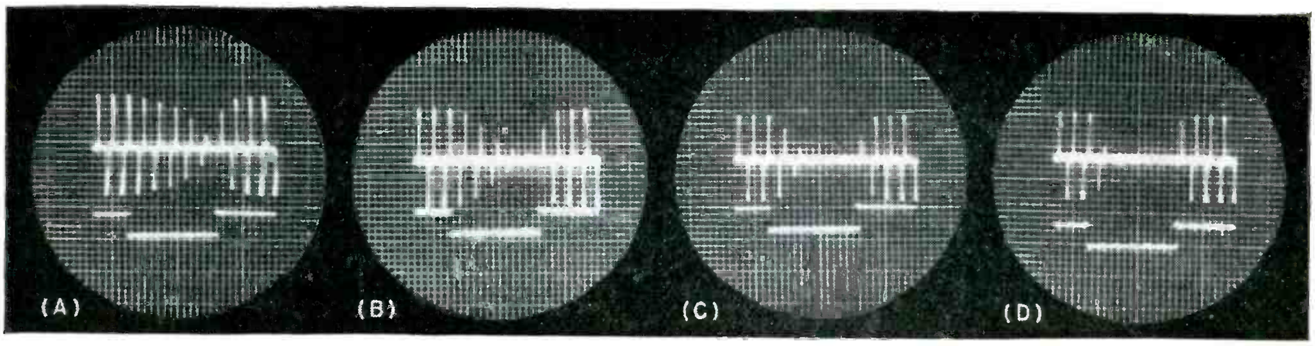
FIG. 1—Diagram of the transient response analyzer exhibiting the complete transient phenomena of the magnetic amplifier permanently as a standing picture on the short-persistence screen of a dual-beam cathode-ray oscilloscope

In considering the accuracy of theoretical methods of determining the response time of conventional types of magnetic amplifiers having a response time of about 6 to 30 cycles it must be remembered that in most practical design problems concerning such low-speed amplifiers an approximate value is all that is required. However, in regard to the transient performance of special magnetic amplifier circuits[3-8] having preferably a very short response time of about one cycle only, experimental methods have assumed increasing importance in the development of such high-speed amplifiers.

Conventional Techniques

The cathode-ray oscillograph is ideally suited for observing the waveforms of electric and magnetic quantities varying with time. The techniques generally used in analyzing the transient response of magnetic amplifiers consist of the following procedure:

The voltage drop produced by the output (load) current across an ohmic resistor is applied to one channel of a dual-beam oscilloscope so that the actual deflection of the beam is proportional to the instan-



Oscillograms show transient performance of a conventional type push-pull self-saturating magnetic amplifier with four series-connected d-c control winding units and a-c load resistor with the following control circuit operating conditions: (A) Series resistance in the control circuit $R_S = 500$ ohms, shunt capacitor $C_P = 0$; (B) $R_S = 1{,}000$ ohms, $C_P = 0$; (C) $R_S = 2{,}000$ ohms, $C_P = 0$; and (D) $R_S = 2{,}000$ ohms, $C_P = 3.5$ microfarads

taneous value of load current.

The input (control) voltage is applied to the second channel of the oscilloscope so that deflection of the second beam is proportional to the instantaneous value of control voltage.

Sweep starting time is then triggered to the start of a photographic exposure in such a way that the transient phenomena associated with making and breaking of the switch contacts that apply or interrupt the control voltage will be recorded during a period of a single sweep of the beam in the desired position on the film or photographic paper of the camera.

This procedure makes it possible to secure adequate conditions in photographic recording of the nonrepetitive transient phenomena of the magnetic amplifier to be investigated, provided that the cathode-ray tube is operated at sufficiently high accelerating potentials. The fact that the waveforms of input voltage and output current are displayed simultaneously on the screen on a common time base enables a precicision and convenience of correlation unobtainable with two individual oscillographs, especially when an illuminated calibrated scale with 0.1-inch cross-section lines is used.

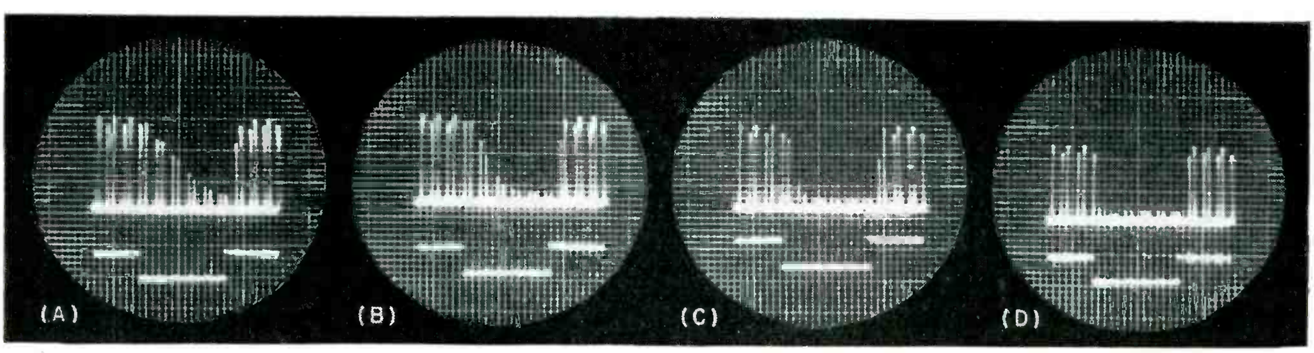
A sufficiently clear photographic reproduction of such an illuminated scale in connection with nonrepetitive transients may be difficult because the necessarily limited time of exposure is very short (for example, 0.2 second corresponding to 12 cycles of a 60-cycle power supply; or even 30 milliseconds corresponding to 12 cycles of a 400-cycle power supply).

Improved Method

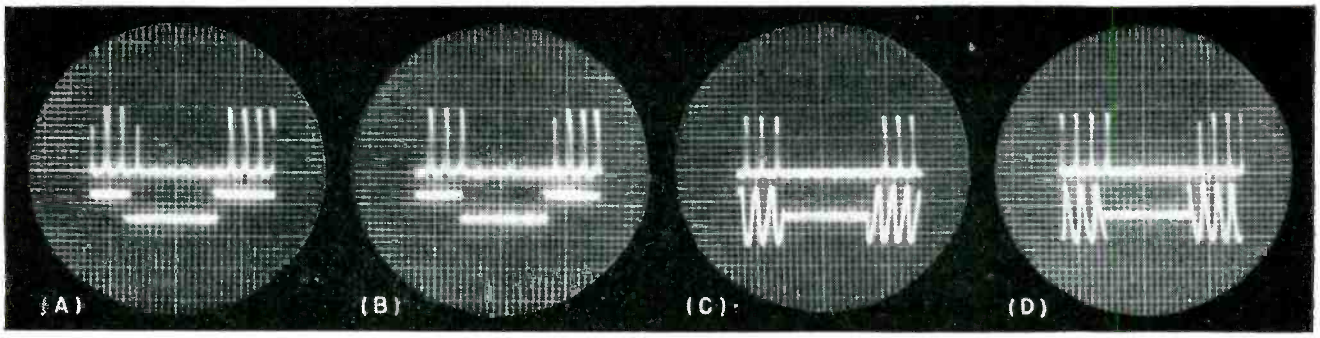
For analyzing the transient response of magnetic servo amplifiers having a very short response time of about one cycle, a cathode-ray dual beam type analyzer was developed. It displays the waveforms of input voltage E_c and output current I_L simultaneously on a common time base in such a way that these waveforms are permanently exhibited on a long-persistence screen.

The complete transient phenomena of the magnetic amplifier to be investigated can be continuously observed, and the effect of any change in circuit operating conditions can easily be studied and conveniently recorded photographically. Since, in this case, the time of exposure may be extended to about 2 or 3 seconds, a very clear reproduction of an illuminated scale with 0.1-inch cross-section lines is secured. It is also possible to apply a projection-type cathode-ray oscilloscope.

The diagram of the transient response analyzer is shown in Fig. 1. According to conventional techniques, the voltage drop I_LR, produced by the output (load) current I_L across an ohmic resistor R, is applied to the one channel (V_1) of a dual-beam oscilloscope, while the



Oscillograms show transient performance of a conventional type push-pull self-saturating magnetic amplifier with four series-connected d-c control winding units and full-wave d-c load resistor with the following control circuit operating conditions: (A) Series resistance in the control circuit $R_S = 500$ ohms, shunt capacitor $C_P = 0$; (B) $R_S = 1{,}000$ ohms, $C_P = 0$; (C) $R_S = 2{,}000$ ohms, $C_P = 0$; and (D) $R_S = 2{,}000$ ohms; $C_P = 3.5$ microfarads



Oscillograms showing the transient phenomena of a high-speed magnetic servo amplifier of the half-wave type having inherent one-cycle response with d-c (A, B) and a-c control (C, D). These oscillograms illustrate the effect of changing actual time interval between instant of opening (or closing) SW_1 (see Fig. 1) and the instant when the 60-cycle power supply voltage E_P of the magnetic amplifier goes through zero

input (control) voltage E_C is applied to the second channel (V_2). The magnetic amplifier to be investigated and a small step-down transformer T are supplied from a phase shifter, whereas a synchronous motor SM operating SW_1 is directly supplied from the three-phase power supply.

This automatic switch is synchronously operated in such a way that it makes during a period of 6 cycles and breaks during the succeeding period of 6 cycles, alternately. Therefore, with a 60-cycle power supply, the cam that operates SW_1 rotates at a synchronous speed of 300 rpm corresponding to 12 cycles per revolution.

The control voltage $E_C = I_M R_N$ supplied from a battery (d-c control) or from the step-down transformer T (a-c control), can be adjusted by means of a variable series resistor R_M, according to the actual requirements.

Figure 1 also illustrates the possibility of varying the operating conditions of the control circuit loop by means of a forcing resistor R_S and a shunt capacitor C_P. In this way, the effect of lead networks on the transient performance of magnetic amplifiers may be investigated.

When the sweeps of the dual-beam oscilloscope are synchronized so that 12 cycles of the (a-c or d-c) output current I_L appear on the screen, then the operation of SW_1 will also be synchronized and a sequence of 6-cycle making and 6-cycle breaking will exhibit the complete transient phenomena of the magnetic amplifier permanently as a standing picture on the long-persistence cathode-ray tube screen.

Introduction of the phase shifter offers the possibility of varying the actual time interval between the instant of opening (or closing) SW_1 and the instant when the power supply voltage E_P of the magnetic amplifier goes through zero. Of course, the phase shifter may be eliminated if the angular position of the cam on its shaft can be continuously changed by mechanical means, in a similar way to conventional Joubert-disk type contact arrangements.

Variations

The arrangement of Fig. 1 may be modified in various ways. The aforementioned sequence of 6-cycle making and 6-cycle breaking has proved to be particularly useful for investigating magnetic amplifiers having a response time of about one to six cycles. It is possible, however, to operate the cam of the switch at 900 rpm and to synchronize the sweeps of the dual-beam oscilloscope so that 4 cycles of the (a-c or d-c) output current I_L appear on the screen.

This procedure has proved useful in analyzing the transient performance of high-speed magnetic servo amplifiers having inherent one-cycle response, particularly in regard to variations of the actual time interval between the instant of opening (or closing) SW_1 and the instant where the power supply voltage E_P goes through zero.

When operating with a power supply frequency of 400 cycles per second, the method can be applied equally well, provided a 400-cycle synchronous motor is used for driving the cam of SW_1 in the control circuit. However, with higher power supply frequencies (up to about 20,000 cycles per second), SW_1 may be replaced by any suitable type of electrical modulator. A dry-disk rectifier bridge circuit, separately excited from a subharmonic generator producing a synchronous auxilary current with rectangular wave-shape may be used in such cases. Of course, electronic types of modulators may be equally well suited for this purpose.

The accompanying oscillograms illustrate the practical application of the transient response analyzer shown in Fig. 1.

These oscillograms demonstrate the capabilities of this visual test device in research and development work on actual magnetic amplifier circuits. In each case, the lower trace shows input voltage and the upper trace shows output current.

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Parallel-Resistor Chart

Permits quick choice of the best combination of two available RTMA preferred-value resistors in either 10-percent or 20-percent tolerance ranges to give a desired higher power rating at a particular resistance value

By MITCHELL ARON
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Commercial Products Division
Radio Receptor Company Inc.
Brooklyn, N. Y.

ONE problem that often comes up in laboratories is making full use of the most readily available standard components. Virtually all labs have a constant supply of ½, 1 and 2 watt composition resistors in the standard 10-percent and 20-percent tolerance ranges. A typical problem might be combining two of these to get a 3-watt resistor of the required value. If making conventional calculations combined with trials, three or four trials are usually needed to find the resistor required. The chart in Fig. 1 reduces all of the calculation to a simple glance. The simplicity of the chart results from the solution of two simultaneous equations.

$$y = \frac{R_2}{A}\, x \qquad (1)$$

$$y = \frac{R_1}{A}\, x + R_1 \qquad (2)$$

Solving these two simultaneous equations, their point of intersection is at

$$x = \frac{R_1 A}{R_2 + R_1} \qquad (3)$$

$$y = \frac{R_1 R_2}{R_1 + R_2} \qquad (4)$$

The y ordinate is the solution for the parallel combination of two resistors or the series combination of two capacitors.

The choice of parallel resistors is, however, dependent upon the power dissipation in each resistor. This information can be derived by multiplying both sides of Eq. 3 by R_2, then substituting combined parallel resistance R for $R_1R_2/(R_1 + R_2)$ to get

$$R_2\, x = RA \qquad (5)$$

Multiplying both sides by E^2 and rearranging gives

$$\frac{E_2}{R}\, x = \frac{E^2}{R^2}\, A \qquad (6)$$

Now assume that the power being dissipated in the parallel combination is 1 watt, and let A be also arbitrarily made equal to 1. Equation 6 then becomes $x = E^2/R_2$. Since E^2/R_2 is the power dissipated in R_2, the abscissa is proportional to the power dissipated in R_2. Thus, for every watt dissipated in the parallel combination R, x watts will be dissipated in R_2. The power dissipated in R_1 is of course the difference between the total and that dissipated in R_2.

A plot of a series of the lines just discussed is given in Fig. 1. For convenience the heavy lines are drawn to the 20-percent series of preferred values and the combination of light and heavy lines form the 10-percent series of preferred values.

Example

Let it be required to find the nearest parallel combination of two resistors in the 20-percent series of preferred values to give a combined resistance of 4,000 ohms. The parallel combination must be able to dissipate 3 watts.

Solution: 4,000 ohms can be rewritten as 4.0×10^3 ohms. Follow the 4.0 horizontal line across, noting that the nearest intersection of two heavy lines is 6.8 and 10.0 and the intersection falls at $x = 0.41$. Thus the parallel combination of 6.8 K in parallel with 10 K is the nearest combination of 20-percent resistors to 4 K, and gives an exact resistance of 4.05 K. Since 10 K $= R_2$ (read on the righthand side of chart), the power rating of R_2 must be $= 0.41 \times 3.0 = 1.23$ watts and the dissipation of R_1 is $3 - 1.23 = 1.77$ watts. Thus the resistors that will fulfill the needs of the problem are 6.8 K, 20-percent, 2-watt in parallel with 10 K, 20-percent, 2-watt.

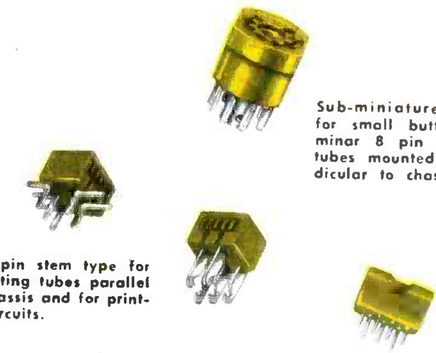
Although it is not required for most calculations of the type just explained, further information can be gleaned from the chart. For example, although the resistances in the preceding problem are not equal, due to standardization, resistances of equal 2-watt power rating are called for. The maximum power that can be dissipated by the parallel combination is determined by the power at which the smaller of the two resistances will dissipate 2 watts. Thus the maximum power for the combination, using the data from the chart, is

$$\frac{2}{1 - 0.41} = \frac{2}{0.59} = 3.4 \text{ watts.}$$

Because of the similarity in the arithmetic, the chart will work equally well for series combinations of capacitors.

(Continued on p 194)

CINCH, the Standard SOCKET



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- High Altitude Airborne Types
- Kinescope; Magnal, Duodecal, Diheptal
- Loktal-Miniature-Multiplug-Noval-Octal (Molded bakelite, steatite, teflon, Kel-F and laminated)
- Plexicon
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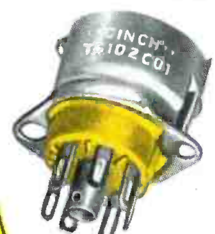

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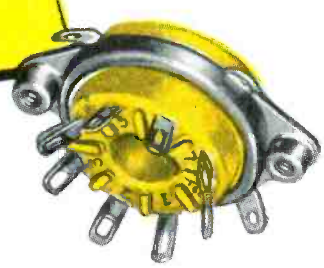

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Parallel-Resistor Chart—*continued from page 192*

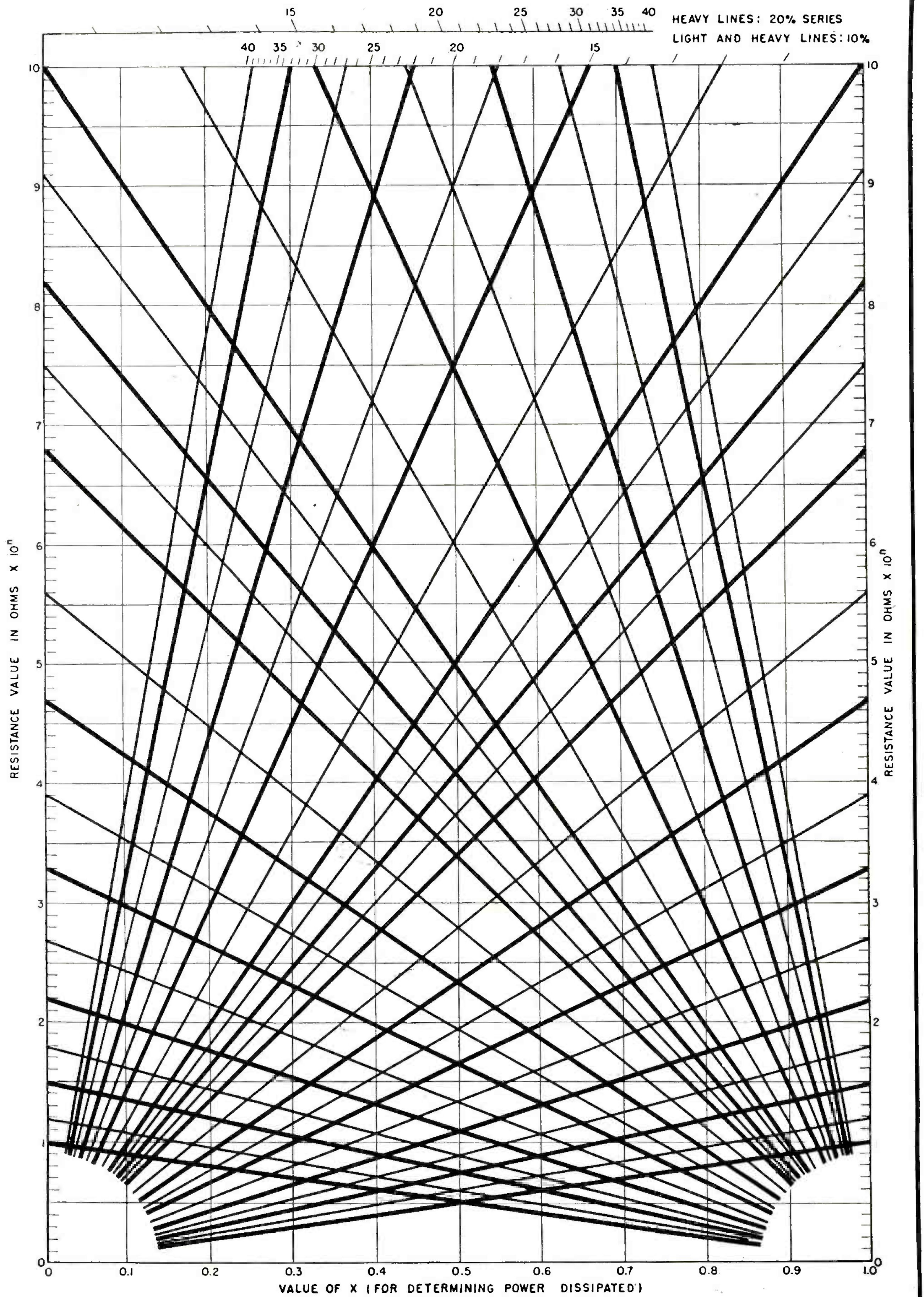
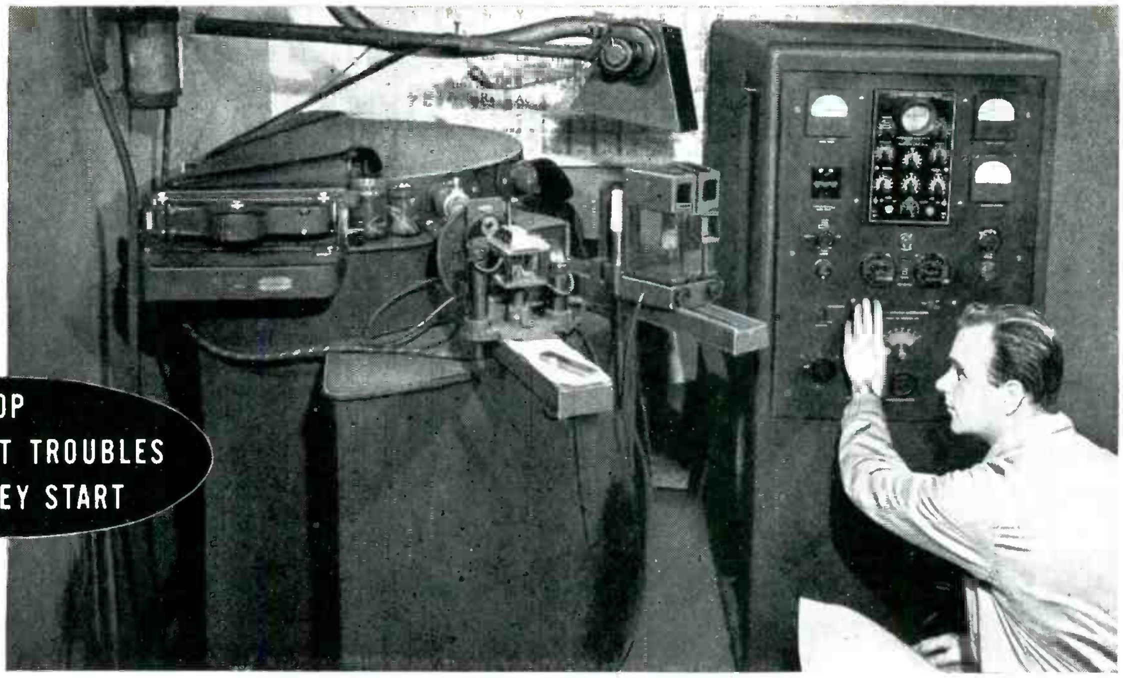


FIG. 1—Trace along horizontal line for desired parallel resistance, note nearest intersection of lines coming from lower left and right corners, and read RTMA preferred values of required individual resistors on side and top scales for these lines

STOP
YOUR CONTACT TROUBLES
BEFORE THEY START



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ELECTRONS AT WORK

Including INDUSTRIAL CONTROL

Edited by ALEXANDER A. McKENZIE

OTHER DEPARTMENTS featured in this issue:

Low-Cost 3-D TV

INTENDED as an inexpensive means of bringing three-dimensional pictures to tv audiences, a system demonstrated on a closed circuit by American Television Inc. uses a rotating-shutter viewer synchronized with the tv cameras by the 60-cycle power-line frequency.

Two tv cameras are coupled together through a mirror system giving views separated by a distance approximating that between eyes. A square-wave generator alternately cuts off one camera then the other, producing 15 images per second from each camera. The images are transmitted in the usual fashion, requiring no change in transmitting standards.

At the receiving end the television receiver need not be altered. The viewing unit has a synchronous motor to rotate a straight flat piece of metal with a cutout in each alternate corner. As the metal strip rotates, it opens the right eye, then the left one in step with the electronic switch at the camera. Since most television stations are local and in the same power network as the receiver the ordinary 60-cycle power system will provide synchronization.

Another possible method eliminating the mechanical viewer, uses a checkerboard system of Polaroid having a right and left alternate series of checkers and then using interdots at the transmitter to correspond with every other image. Polaroid spectacles having the lenses polarized at right angles to each other would be worn. No moving parts need be used in such a system.

The system using a mechanical viewer can also be used as a 2-color tv system. Each camera can be filtered to pick up a separate color and each eye can observe the colors alternately through similar

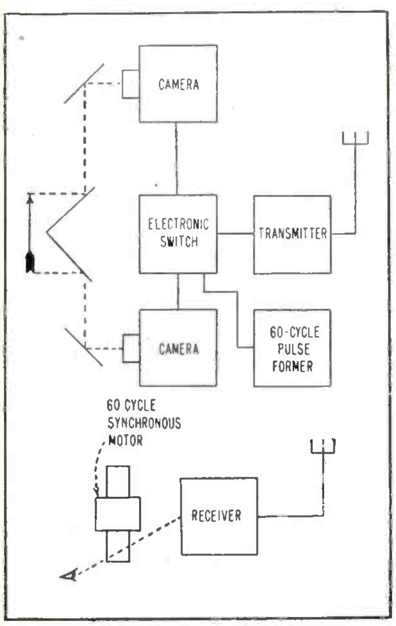
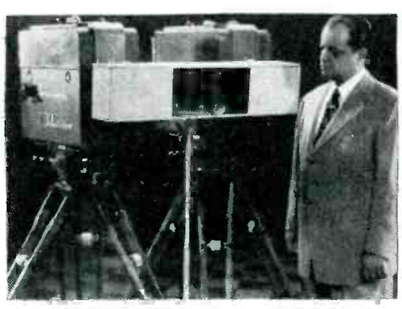


FIG. 1—Three-dimensional tv system synchronized by power-line frequency



Mirror-box takes separate images to two coupled cameras

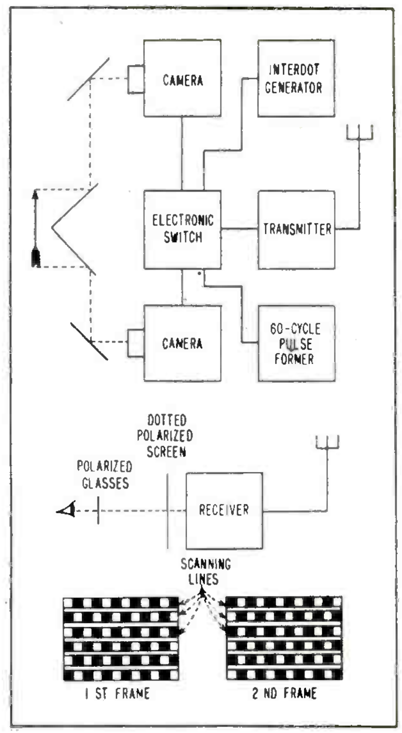
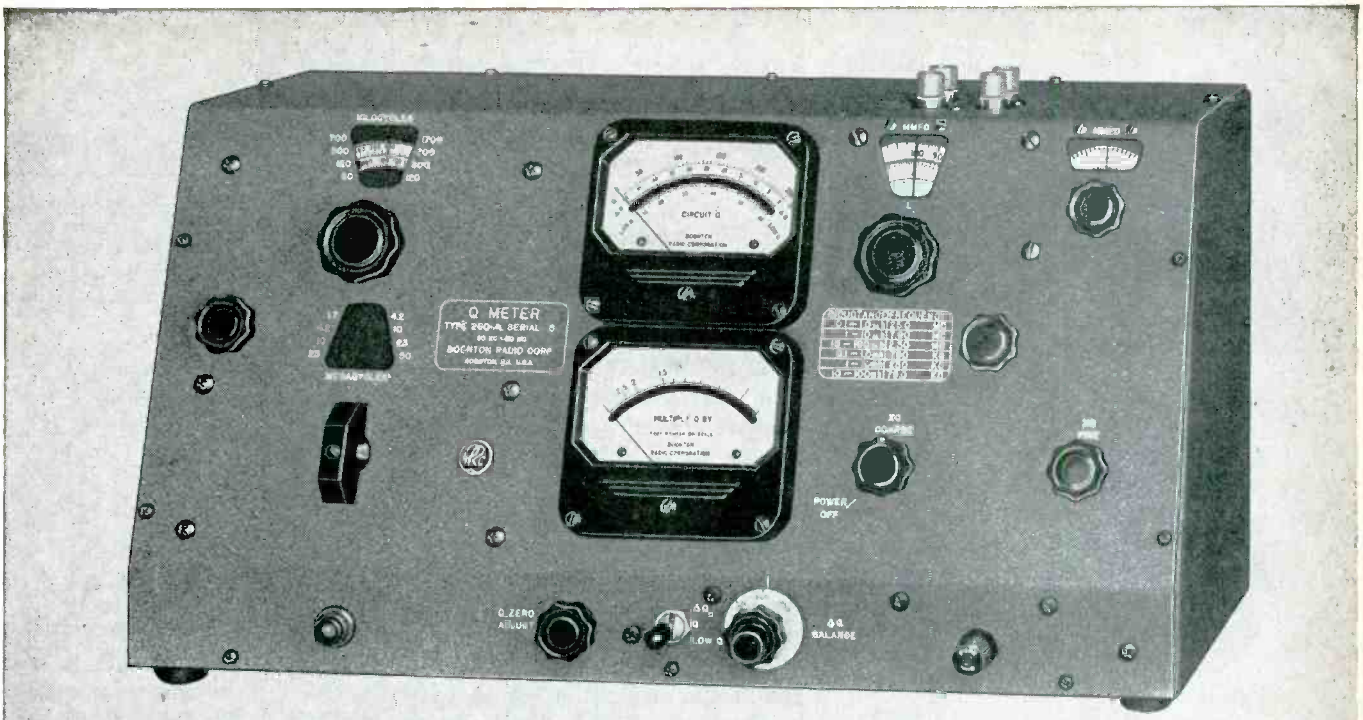


FIG. 2—Alternate method using interdot system to produce separate images



Type 260-A Freq. 50KC to 50MC

18 years of improvements are combined in this NEW Q Meter

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The Q Meter Type 260-A replaces our Type 160-A, one of Boonton Radio's Q Meters which has been standard equipment in laboratories and on production lines for eighteen years. Many improvements have been made during this time, but several of our ideas for a better instrument were too extensive to put into a model already in production. These ideas were carefully tested for use in a new model. The Q Meter Type 260-A includes all past improvements and the extensive changes that we have accumulated.

SPECIFICATIONS:

FREQUENCY COVERAGE: 50 KC to 50 MC Continuously variable in eight ranges.

FREQUENCY ACCURACY: Approximately ±1%.

RANGE OF Q MEASUREMENTS: 10 to 625.

RANGE OF DIFFERENCE Q MEASUREMENTS: 0 to 125.

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Vernier: −3.0 to +3.0 mmf (direct reading) calibrated in 0.1 mmf increments.

ACCURACY OF RESONATING CAPACITOR:
Main Tuning Dial: Approximately ±1% or 1.0 mmf, whichever is the greater.
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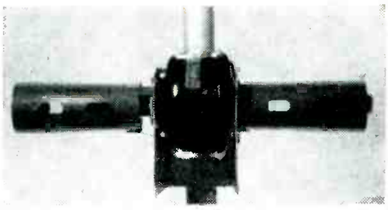


Synchronous motor drives two viewers mounted on shaft

filters on the viewer.

The advantage of the system lies in the low cost of the equipment. At the receiver the only requirement is a viewer that can sell for about $5.00. The tv station uses its present equipment plus one electronic switch.

Peak-to-Peak Voltmeter Probe

WHEN AN OSCILLOSCOPE is not available, the amplitude of complex waveforms can be measured with a vtvm using a crystal probe. The full-wave doubler circuit of Fig. 1 employs two type 1N58 germanium diodes.

Crystal D_1 conducts whenever its cathode is negative. This causes 0.5 μf capacitor C_1 to charge in a negative polarity across 10-megohm resistor R_1, producing a negative direct voltage at the terminals. The other crystal, D_2 connected in opposite polarity produces a positive voltage across R_2.

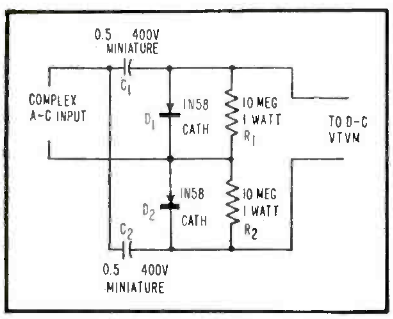


FIG. 1—Crystal-diode voltmeter probe

Since these voltages add in series across the resistors, the vtvm reads peak-to-peak values on the d-c scale.

This information is abstracted with permission from *Sylvania News*, Mar. 1953.

F-M Transistor Oscillator

BY H. H. WIEDER
AND NATHAN CASS

National Bureau of Standards, Washington, D. C.

IT IS GENERALLY KNOWN that certain ferroelectrics, such as the titanate ceramics, exhibit a marked change in capacitance with variations in the applied potential as shown in Fig. 1. A recent paper[1] presented a method of coupling a barium-strontium-titanate capacitor into the resonant circuit of an oscillator in such manner that large frequency deviations with little amplitude modulation could easily be obtained. This method was employed for frequency modulating vacuum tube oscillators in the uhf and vhf ranges by relatively simple means. The essential feature of this system is the provision for an impedance transformation of the titanate capacitor as shown in Fig. 2. The reflected impedance of this non-

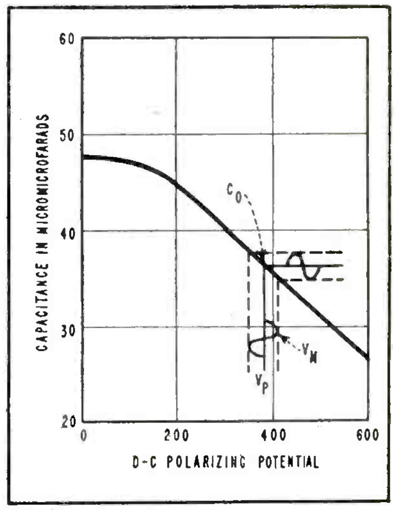
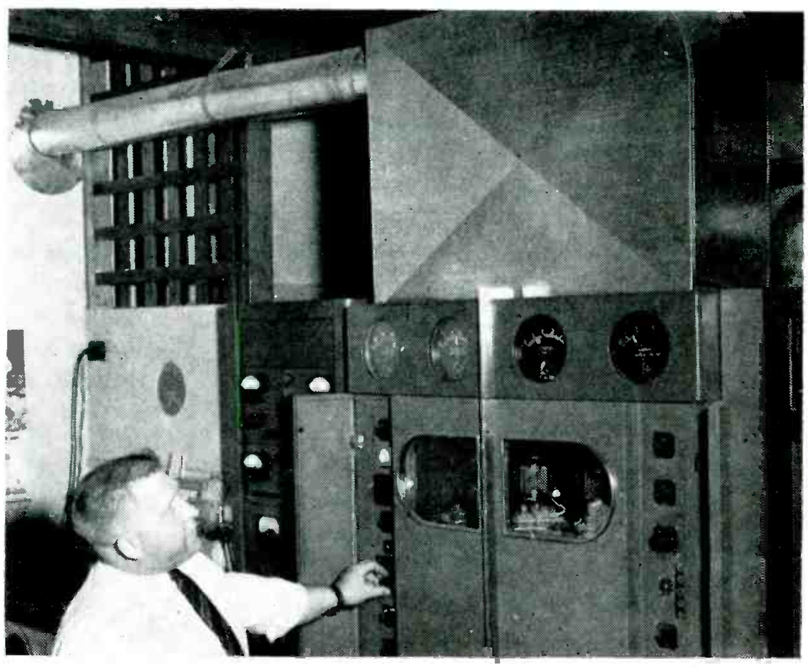


FIG. 1—Capacitance versus polarizing potential for barium-strontium-titanate capacitor when V_M is a-c modulating potential and V_P is d-c polarization potential

linear capacitor is used to vary the resonant frequency of the oscillator tank circuit.

Two advantages are obtained in this manner: The effective Q of the

KILOWATT BROADCAST VENTILATOR



Engineers at WAEB in Allentown, Pa. reduced the ambient temperature within their 1-kw broadcast transmitter from 10 to 15 degrees when they made three changes in the cooling system. Chief Engineer W. R. Gottshall (above) hit upon the idea of installing a duct and exhaust fan connecting the escape vent atop the transmitter to the outside. A supplementary 100-cfm blower circulates room air around power transformers. Additional vent holes were drilled in the cabinet. These holes and existing vent openings are covered with double thicknesses of cheese cloth

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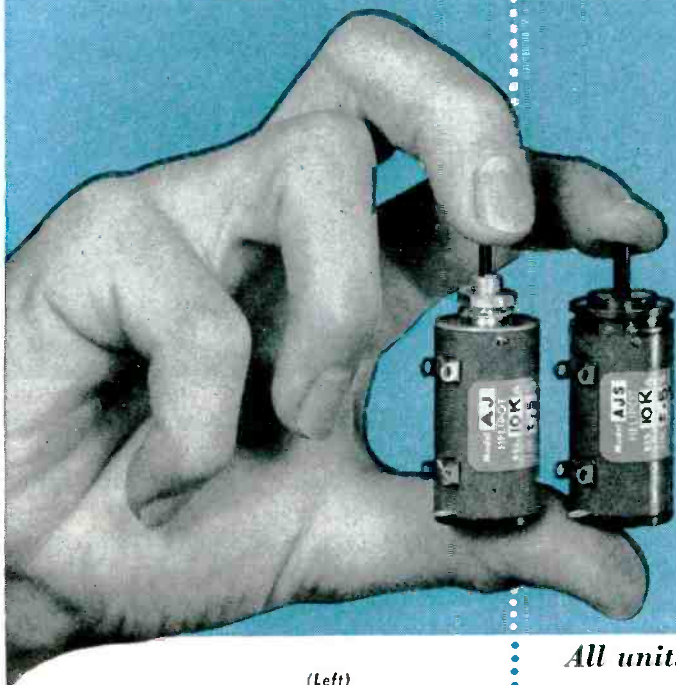
The AJ Series Helipot



(Left) *Model AJ* *Bushing Mounting*

(Right) *Model AJS* *Servo Mounting*

...TINY 10-turn Helipots with BIG performance

12 times the resolution of conventional units!

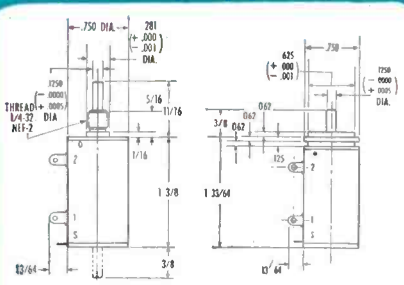
In all airborne and many other modern electronics applications for precision potentiometers, miniaturization, light weight and circuit simplification are key objectives. And you get these features—*and more*—in Helipot's new AJ Models . . . compact potentiometers the diameter of a penny, yet with *12 times* the resolution of conventional potentiometers of the same diameter. Announced only a few months ago, the original AJ has proven so popular that it is now made in two versions to meet the requirements of its many users—the original AJ mounting with a threaded bushing . . . and the new AJS mounting for servo applications. Also, the AJS is available in two bearing arrangements—AJS with *sleeve* bearings, and the AJSP with *ball* bearings.

All units have these important features . . .

SMALL SIZE—LIGHT WEIGHT: All AJ Models are only ¾" in diameter (small as a penny) 1⅜" long—weigh 1.0 oz. They require a minimum of valuable panel space!

HIGH PRECISION—CIRCUIT SIMPLICITY: On many applications an AJ Series will replace two conventional potentiometers, providing *both* wide range and fine adjustment in one unit. The 18" slide wire gives a resolution of 1/3000 in a 100 ohm unit—1/6500 in a 50,000 ohm unit!

RELIABILITY: The AJ models are rugged and simple—built to close tolerances with careful quality control. Their performance and reliability reflect the usual high standards of Helipot quality.



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)
5000 ohms and above	± 0.1%
Below 5000 ohms	± 0.25%
Starting torque	0.75 oz. in.
Net weight	1.0 oz.

Advanced Construction

For light weight, unusual compactness, high accuracy and resolution, coupled with utmost reliability, investigate the AJ series . . .

- All types have bearings at *each* end of the shaft to assure precise alignment and linearity at all times.
- Either single or double shaft extensions can be provided to meet individual needs . . . also, ball or sleeve bearings, special shaft lengths, flats, screwdriver slots, etc.
- By means of a unique Helipot welding technique, tap connections can be made to only ONE turn of the resistance winding, and can be provided at virtually *any* desired point on the resistance element.
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Helipot—world's largest manufacturer of precision potentiometers—has built an enviable reputation for its high design and construction standards, and the AJ models meet these standards in every way.

The resistance elements are made of precision-drawn alloys, accurately wound by special machines on a heat-dissipating copper core.

Each coil is individually tested, then permanently anchored in grooves precision-machined into the case. Slider contacts are of long-lived Paliney alloy for low contact resistance and low thermal e.m.f. . . . and all terminals are silver plated and insulated from ground to pass 1,000 volt breakdown test.

In spite of light weight and compact design, all AJ models are built throughout for long life and rugged service. Potentiometer life varies with each application, of course, depending upon rotation speed, temperature, atmospheric dust, etc. But laboratory tests show that under proper conditions, all of the AJ series have a life expectancy in excess of one *million* cycles each!

Get full details from your nearest Helipot representative—or write for Data File # 702.

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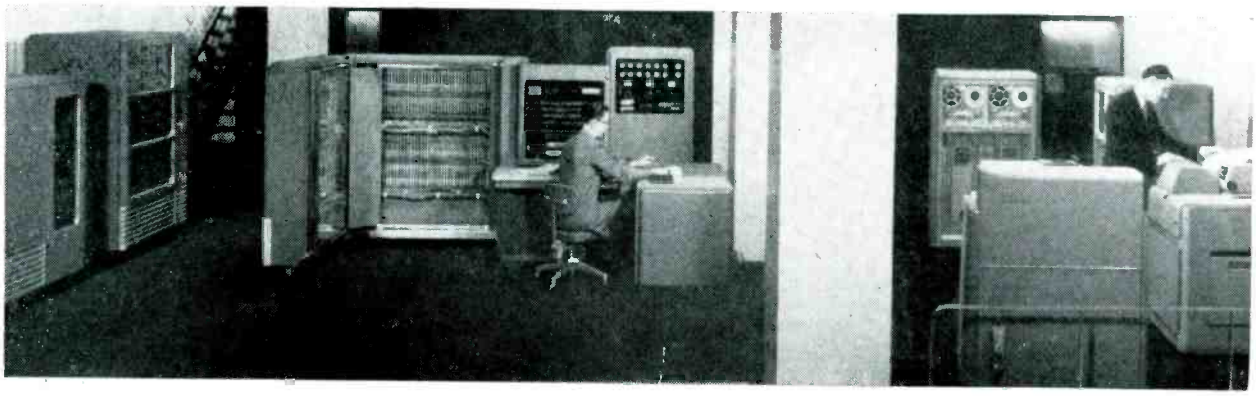
THE FRONT COVER



DESIGNED to speed engineering and scientific computation, the IBM electronic data-processer Model 701 comprises eleven interconnected units. Data on punched cards can be fed to the machine at the rate of 600 equivalent decimal digits per second. Its punched card output is 400 digits per second. Over 16,000 addition or subtraction operations per second can be performed and multiplication is possible at rates exceeding 2,000 operations per second.

The equipment works in a binary notation. Standard word length is 36 binary digits. The master-oscillator pulse-repetition-frequency is one megacycle.

Three information-storage systems are employed: Two electrostatic-memory frames each using 72 specially-designed 3-inch cathode-ray tubes provide storage capacity for 2,048 words. The magnetic-drum memory comprises two drums, each having 72 information tracks and accommodating 8,192 words. Two magnetic-tape units can store 200,000 words and are particularly useful for filing program information.

The machine employs 4,000 vacuum tubes and 12,000 germanium diodes. The unit shown in the photograph is installed at IBM headquarters in New York.

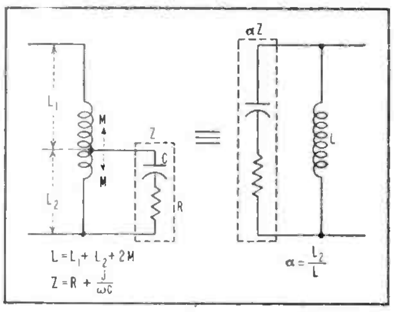


FIG. 2—Inductively coupled resonant circuit and its equivalent. Z is $BaTiO_3$ modulating capacitor

resonant circuit can be made much higher than the low Q of the titanate capacitor. The *IR* drop across the ceramic is reduced to a minimum, eliminating capacitor damage caused by internal dielectric heating.

This method of modulation can be extended to transistor oscillators. An r-f oscillator employing a standard commercial junction transistor and a novel method of providing a polarization potential to the ceramic capacitors by means of a Zamboni pile are described below.

Figure 3 is a schematic of the frequency-modulated pnp junction transistor oscillator. The generalized equations determining the relationships of emitter, collector, and base impedances for a c-w oscillator using point-contact transistors were described by Oser, Enders, and Moore[2], and are equally applicable for the junction transistor.

The collector impedance is zero and the base impedance is maximum at the frequency of oscillation. A stable sinusoidal wave is obtained at 2.5 megacycles. The oscillator delivers about one milliwatt using a 30-volt miniature B battery at one milliampere. The barium titanate modulating capacitor M is coupled to the inductance L by a transformation ratio selected at will. Varying the potential impressed upon the titanate alters its effective capacitance and, consequently, the resonant frequency. It can be seen by referring to Fig. 1, that a polarization potential is necessary to bring the capacitance variations within the linear range of the $\Delta c/\Delta v$ curve.

The Zamboni pile z is used as a polarization source in this circuit. High voltage piles of the Zamboni type were described by Howard[3]; they are characterized by a high internal resistance and exceedingly long life. They have been used with some success in applications requiring high potentials with low current drains (less than 10^{-9} ampere).

Measurements on the a-c impedance at audio and ultrasonic frequencies of two sample piles manufactured at the National Bureau of Standards indicated an essentially resistive value of impedance in the order of a thousand ohms. The function of C_4 in the diagram is to

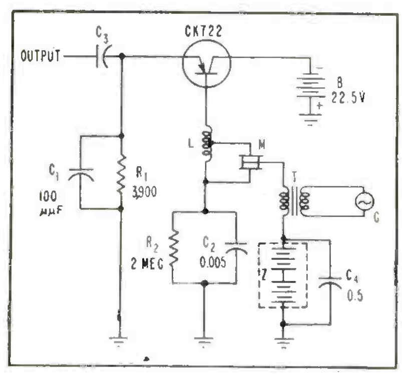


FIG. 3—Schematic of f-m transistor oscillator

pioneers in precision

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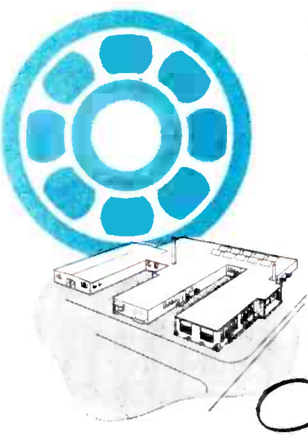
incorporated, pioneered and developed the first miniature radial ball bearings. From a group of five original ball bearings, MPB has designed and developed a completely integrated line of more than 130 types and sizes many of which now form the basis for international standardization. This extensive variety of MPB ball bearings makes possible the application of anti-friction and freedom from attention qualities in thousands of miniaturization projects.

MPB ball bearings are fully ground, lapped, and/or honed to ultra precision finishes (ABEC 5 or better). They are torque tested, ultrasonicly cleaned, supplied in specific tolerances and classified within the tolerances for prompt assembly and maximum service. MPB ball bearings are normally supplied in 10 design series, from 1/10″ to 5/16″ o.d., of selected chrome bearing steel. Most are also supplied in stainless steel, some in beryllium copper, and all are assembled with best quality balls.

More than a million MPB ball bearings have played a vital part in the efficient operation of aviation instruments, railway and marine indicating and recording devices, cameras, medical appliances and other equally fine mechanisms. The wealth of engineering knowledge gained through participation in an extraordinarily broad field of application is available to you.



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"Pioneer Precisionists to the World's foremost Instrument Manufacturers"

save space weight friction

provide bypassing of the pile at audio frequencies. This capacitor must have a high leakage resistance in order to keep the d-c load on the pile at a minimum

Modulation transformer T furnishes an a-c modulating signal that varies the titanate capacitance M about a quiescent value C_o (Fig. 1), determined by the d-c polarization potential. The nonlinear capacitor M is composed of two series-connected 100-$\mu\mu$f capacitors; these are effectively in parallel with respect to the polarization and modulating potentials.

A frequency-modulated oscillator using the Bell Laboratories 1698 point-contact switching transistor at a carrier frequency of 3.5 megacycles gave results equal to those obtained for the junction transistor system described.

Although the frequency-modulated oscillator described is for the low r-f range, this oscillator can be designed for the higher-frequency ranges subject only to the limitation of the transistor frequency response.

Transistors, nonlinear capacitors and Zamboni piles have a limited range of temperatures in which their behavior is satisfactory. A simple afc system added to the transistor f-m oscillator could materially increase its range of stability without affecting the essential simplicity of the modulation system.

The authors are indebted to D. W. Finger of the Battery Research Section, National Bureau of Standards, for providing the Zamboni piles described in this article.

REFERENCES

(1) M. Apstein and H. H. Wieder, A Wide Range F-M System using Non-Linear Capacitors; ELECTRONICS, to be published.

(2) E. A. Oser, R. O. Enders, and R. P. Moore, Transistor Oscillators; *RCA Review*, **XIII**, No. 3, Sept. 1952.

(3) Paul L. Howard, A High Voltage Pile of the Zamboni Type. *Journ. Electrochem. Soc.* **99**, No. 8; Aug. 1952.

Light Source for Phototubes

TRITIUM-ACTIVATED self-luminescent materials for use as light sources have levels of luminosity up to 25 microlamberts. Beta rays emitted by tritium are completely absorbed by a sheet of paper and the ma-

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terial has no penetrating x-rays or gamma radiation.

A tritiated organic phosphor, such as trans-stilbene has peak emission at 3,800 A with some emission in the visible spectrum. By mixing a tritiated solid with an efficient phosphor, such as zinc sulfide, spectral emission characteristics can be chosen with peaks from about 4,000 to 7,000 A.

A light source can be obtained with maximum emission peak at 4,550 A to approximate the 4,800-A peak response of the 5819 multiplier phototube.

From general theoretical considerations, it can be expected that the luminosity of tritiated light sources would follow the rate of decay of tritium, which corresponds to a loss in light output of about 5 percent per year.

Light sources suitable for standardization of phototubes are available from Tracerlab, in Boston, Mass., but approval for purchase is required from the U. S. Atomic Energy Commission.

Ferroelectric Memory Circuits for Computers

FERROELECTRIC PROPERTIES of barium titanate have made this material useful as a storage element in computers and switching systems. Ferroelectric materials are dielectrics in which electric dipoles occur spontaneously and align themselves parallel by mutual interaction. Because of this, the dielectric induction versus applied electric field intensity for ferroelectric materials show hysteresis loops similar to the curves of flux density versus field intensity for ferromagnetic materials.

The basic memory circuit consists of a minute capacitor containing a ferroelectric material as

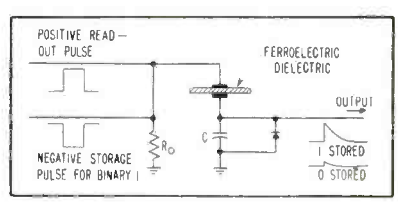

FIG. 1—Circuit of the basic ferroelectric memory unit

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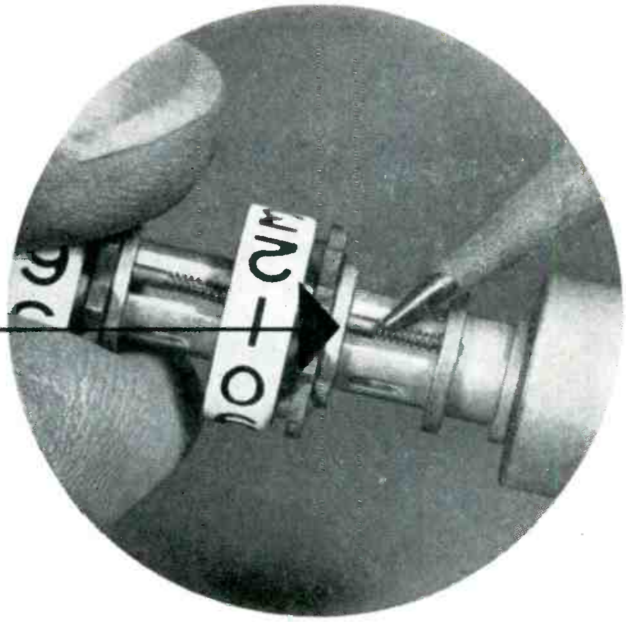
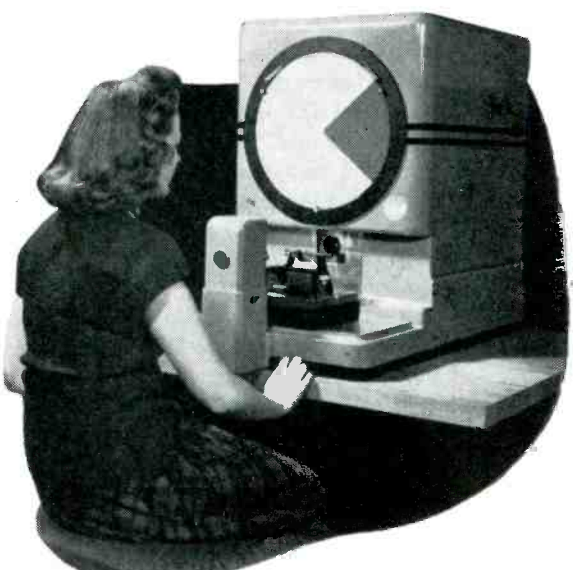


These little plunger pins locate the dials on the Monroe LA Desk Calculator. Each has a 90° cone point that fits into a detent of 110° included angle.

Previously, binocular microscopes were used to check cone angle, length, roundness, and diameter of these pins. But, the inspectors had to spend considerable time just resting their eyes—and running up the cost of the reliability that Monroe customers expect.

Now the microscopes are gone and checking these pins on the Kodak Contour Projector, Model 3, is more like watching television. Moreover, with the unique Surface Illuminator of the Kodak Contour Projector, inspectors are able to check surface finish on the cone tip of the plunger at 50×, to make sure of free movement and positive stopping of the calculator dials.



Many other parts involved in the foolproof operation of Monroe calculating machines are being inspected in large volume on a battery of Kodak Contour Projectors, Model 3. They average about 13 critical dimensions for each part, shapes are mostly rather complex. By carefully engineered mechanical gages, Monroe had brought the inspection time per piece down to an average of about 50 seconds. Optical gaging on the Kodak Contour Projector has brought this average down to 12 seconds.

If you'd like to find out if such economies could be effected in your production program, write and ask us for more information. Eastman Kodak Company, Special Products Sales Division, Rochester 4, N. Y.

the KODAK CONTOUR PROJECTOR

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a dielectric in series with an output capacitor that is shunted by a rectifier or resistor as shown in Fig. 1. The rectifier is used only when it is desirable to prevent storage pulses from appearing across the output of the memory circuit. The ferroelectric material is initially polarized in one direction by a voltage pulse, called the read-out pulse, applied across it and the series output capacitor. This pulse clears out any previous memory condition in the ferroelectric material and restores it to a normal state in preparation for storage.

A binary 0 may be said to be stored when no storage pulse is applied. A binary 1 is stored by applying a voltage pulse opposite in polarity to the read-out pulse.

The stored information is read out by the read-out pulse applied across the ferroelectric and output capacitor. Voltage across the output capacitor will be high if the ferroelectric presents a high capacitance and low if the capacitance is low.

The capacitance of the ferroelectric is determined by the state of the dielectric. When in its normal state (binary 0 stored) the capacitance will be low, and when polarized in the opposite direction to the read-out pulse (binary 1 stored) the ferroelectric presents a relatively high capacitance to the pulse. Thus, the information stored is indicated by the amplitude of the output pulse.

The dynamic hysteresis loop involved in the operation of the circuit described is shown in Fig. 2, with the polarization of the crystal as the ordinate and applied voltage as the abscissa. The applied voltage is equal to the field strength times the crystal thickness. The normal state of polarization is at point A (binary 0). If a positive read-out pulse is applied the loop is traversed from A to C returning to A when the pulse is removed. The slope of the loop along this part indicates a low capacitance. When a binary 1 is stored in the material by a negative pulse the loop is traversed from A to D and back to B when the pulse is removed. If a positive read-out pulse is now applied the state of the material will move from

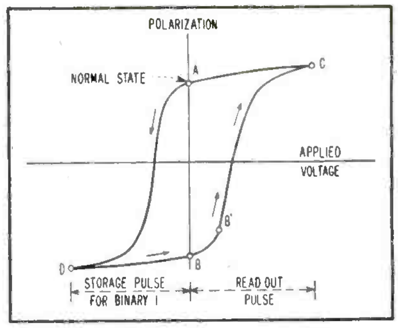


FIG. 2—Dynamic ferroelectric hysteresis loop

B to B' during the initial rise of the pulse.

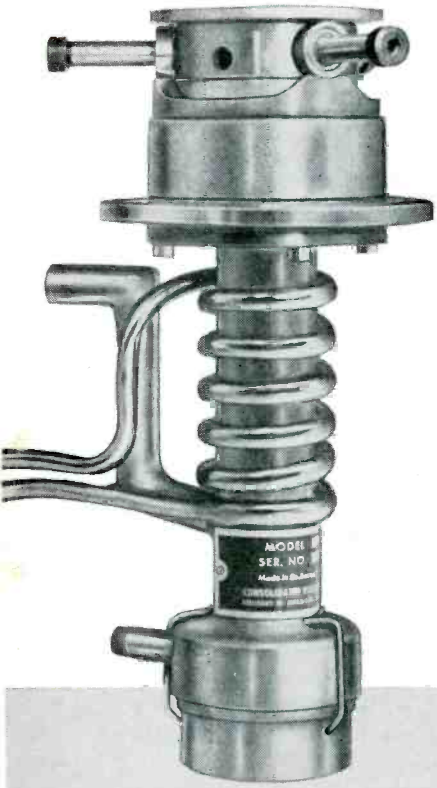
This point occurs where the product of the voltage across the ferroelectric times its capacitance becomes equal to the voltage across the output capacitor times its capacitance. The capacitance at B' is quite high as shown by the steep slope of the hysteresis loop and most of the voltage of the read-out pulse appears across the fixed output capacitor. As the output capacitor discharges through the back resistance of the diode, the voltage across the ferroelectric increases until the saturation point C is reached. When the read-out pulse is removed the loop is traversed from point C back to A and the ferroelectric is left in its normal state.

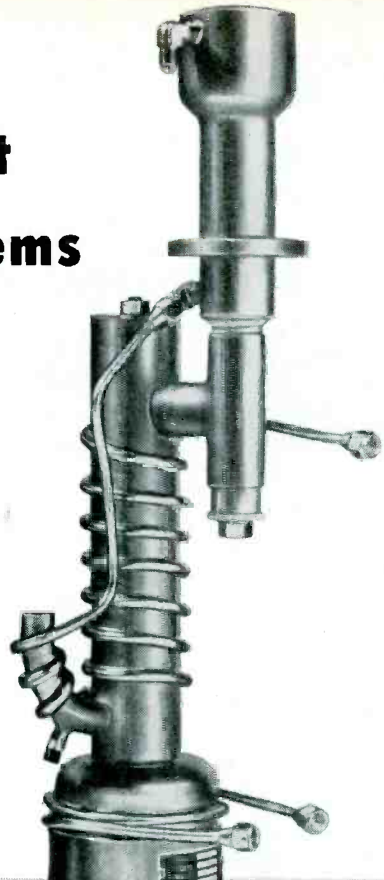
Since the information stored in the ferroelectric material depends upon internal polarization and not on surface charge, the memory will last for several days even when the electrodes are short circuited.

It has been found that several independent sets of electrodes can be placed on the same crystal without appreciable interference between adjacent cells. This characteristic may allow the construction of memory storage units capable of storing as many as 2,500 binary digits on a crystal one inch square and 0.005 inch thick.

In a storage unit such as that shown in Fig. 3, 400 digits could be stored. Each face has a row of parallel electrodes set at a 90-deg angle to those on the other side. Each crosspoint of a top and bottom electrode forms a memory cell. To store a memory pulse in any cell in the array, one half of the required polarizing voltage is applied to the top electrode and an equal but opposite polarity voltage is applied to

It's easy to convert tube exhaust systems with these pump and port units





For most rotary exhaust machines—

CVC's Oil Diffusion Pump model MB-10 and port type TP-02 offer the maximum compactness and performance:

- Together they measure only 8¾" high; operate through any sweep and sliding valve combinations.
- The pump speed is 10 liters/second; ultimate pressure in the port is 10^{-3} mm Hg or lower; high limiting forepressure is 0.5 mm Hg.
- The two-position *mechanically* operated port and valve with its rugged mounting flange is easily attached to standard rotary machines.
- There's a readily removable jet assembly; jet parts separate to facilitate cleaning.
- The heater operates directly from any 115 volt power supply.

For large size TV picture tube exhaust—

CVC's Fractionating Oil Diffusion Pump type MCF-60 with the quick closing port produces pressures of 10^{-5} mm Hg and lower before getter flash in the large size picture tubes. Illustrated above is *CVC's* model MCF-60-013 (19½" high) having a rated speed of 60 liters/second and provided with:

- Water-cooled port for protection of rubber sealing gasket during bakeout.
- Quick opening compression type tubulation seal.
- Easily removable jet assembly.
- Properly located glass trap and clean-out port.

It's pumps like these that make *CVC inline* and *rotary exhaust systems* so efficient and economical to operate.

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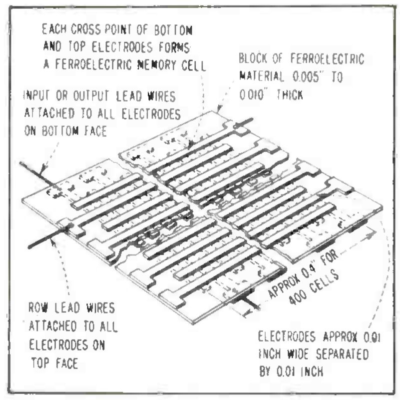

FIG. 3—Construction of a memory unit capable of holding 400 binary digits. Ferroelectric material suitable for this purpose has recently become available

the bottom electrode. The cell in which the digit is stored will be at the cross point of the two electrodes. The full polarizing voltage will appear across a cell at the crosspoint while only half the required voltage will be applied across the other cells.

This type of circuit requires a ferroelectric material that will not change from its original state when positive or negative pulses one half of the polarizing voltage is applied. Such a material has recently become available and preliminary tests indicate that it might be possible to use it for constructing this type of array.

This article has been abstracted from a paper entitled "Ferro-electric Materials as Storage Elements for Digital Computers and Switching Systems" by J. R. Anderson, appearing in the Jan. 1953 issue of *Communications and Electronics*.

Ultrasonic Delay Lines

ULTRASONIC DELAY LINES were first developed during World War II as storage and timing elements for radar systems and computers. Recently they have been made commercially available as standard items with reproducible performance. The ranges in performance given below are extreme and all possible combinations may not be compatible.

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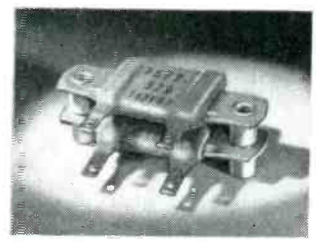

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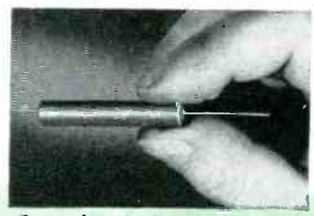

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ducers are mounted to convert the electrical signal into sound and back again. The electrical behavior can be represented closely by a four-terminal network with certain pass bands harmonically related. Operation is obtained between 5 and 60 mc. Bandwidths of 50 to 70 percent of the crystal fundamental are obtained even up to 40 mc where a 24-mc bandwidth to the 3-db points has been measured.

The long delay time is a unique characteristic of the ultrasonic line and is determined by the path length of the sound between the two crystals and the velocity of sound. Delays of 6 to 10 microseconds per inch render possible a great saving in space over other methods. The pass band is unusually wide and the phase characteristics remain unchanged with length of delay, so that such a line is the most practical device for storing short pulses from two microseconds to several thousand.

For short delays less than 100 microseconds, the path may be kept straight. The longer delays require folding the path within the medium into a reflection pattern, which may be of a convenient size. Depending on the overall requirements, a 1,000-μsec line can be packaged in a container less than $1 \times 6 \times 6$ in. and weighing less than one pound.

Operation of any passive element, such as a delay line, in an electronic network results in an insertion loss, which in this case, because of the wide bandwidth and the low conversion action of the transducers, may be considered high. When the optimum condition for power transfer occurs of having the crystal capacitance equal the stray capacitances of the tubes, typical losses may range theoretically from 28 to 36 db. An inductance is usually placed in parallel with the load resistors to tune out the crystal reactance.

To the conversion loss should be added losses due to ultrasonic absorption in the medium. At 15 mc these losses range from 0.1 to 0.3 db per μsec in ordinary glasses and about 0.005 db per μsec in fused quartz. The absorption increases linearly with frequency in solids but distortion of the pass band or pulse shape does not occur. Geo-

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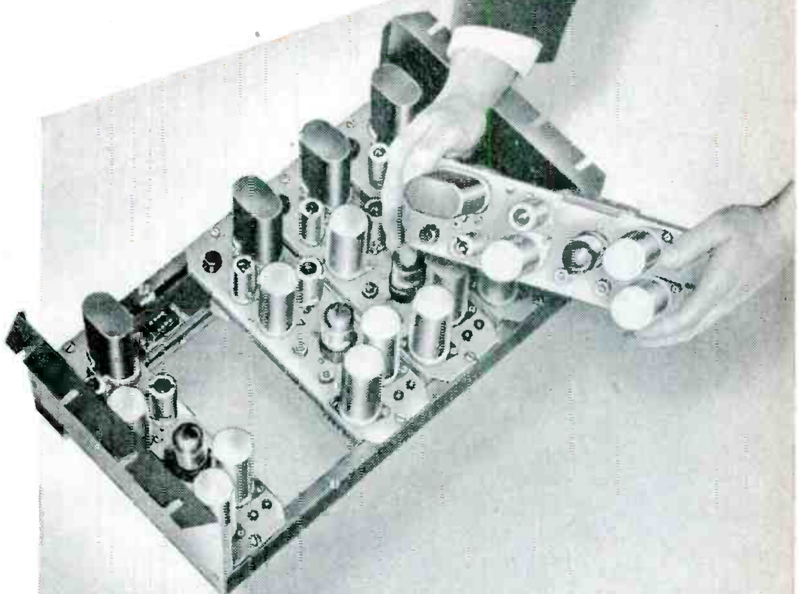

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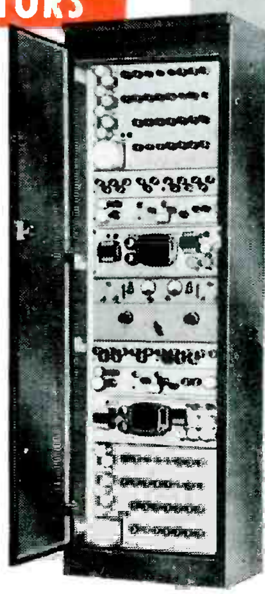

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metric losses due to diffraction effects in the path may be difficult to evaluate but are negligible in short lines. Finally, there are losses of 6 db per crystal when the line is fully terminated to cut down multiple reflections.

Practical delay lines can be made that will have from 30 to 45 db insertion loss into 1,000 ohms and with capacitances from 20 to 80 μμf.

Fixed capacitance of crystals is usually much greater than the optimum value for power transfer because the radiation from one crystal to the other is then better collimated and less difficulty is experienced with reflections from the side walls as unwanted secondary signals. Larger crystals result in a lower than theoretical insertion loss because the power radiated and received is greater.

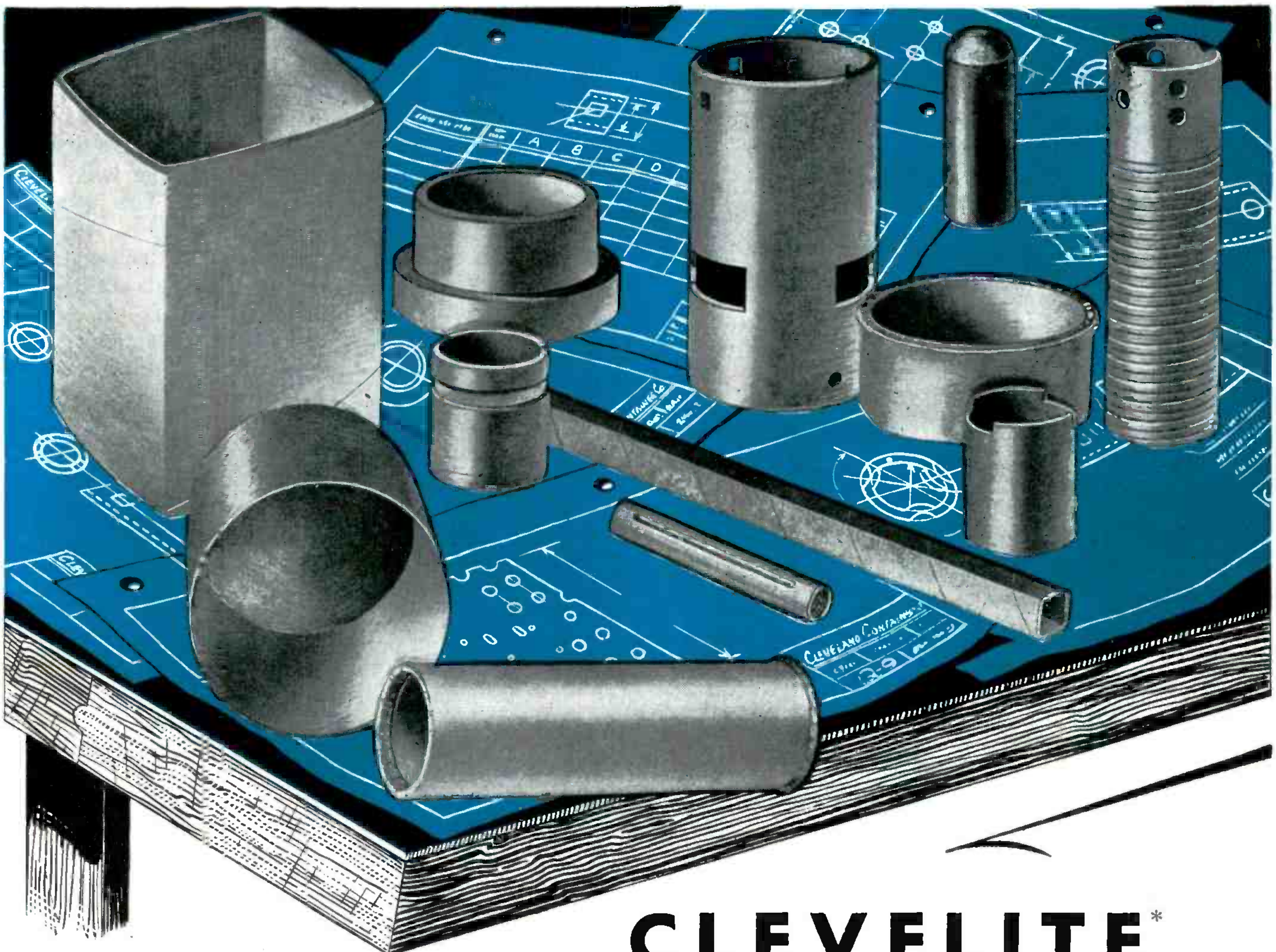
The electrical bandwidth will be lowered because of the increased crystal capacitance unless the input and output resistors are lowered. However, the gain-bandwidth of the system is relatively constant in much the same way as this characteristic holds for vacuum tubes.

A factor often limiting the operation of the delay line is the appearance of secondary signals at times other than the desired delay. The more compact the design and the lower the carrier frequency, the stronger these signals will be. For computer work, reduction of all secondaries including multiples of the main delay to a level of 15 to 20 db is usually sufficient, while for radar systems over 40 to 50 db difference between the main delay and all others may be needed.

For accurate pulse reproduction, the pass band must be flat and uniform. Ripples may be held in such cases to less than 0.5 db departure from a smooth curve.

When the delay lines are used as timing devices, such as range markers in radar systems, many signals may be desired so that the crystals are unterminated and the medium chosen is of low loss.

For special applications when more than one line is used in the same system, the units can be matched to better than 0.01 percent. In the shorter units, low-tempera-



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ture coefficient materials are available. For delays longer than 100 μsec where fused quartz is the best available material, the temperature coefficient of delay will be 108 × 10^{-6} per deg C. The insertion loss and secondary level will decrease with increasing temperature.

Material for this survey has been furnished by D. L. Arenberg, Arenberg Ultrasonic Laboratory, Jamaica Plain, Mass.

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Noise Test for Magnetic Recording Media

BY ROGER C. CURTIS

Project Engineer
Dictaphone Corp.
Bridgeport, Conn.

A SIMPLE DIRECT METHOD of evaluating magnetic recording media for noise has been developed by the Dictaphone Corporation. A minimum of special equipment is required and the test is suitable for quality control as well as for preliminary checks of new media to determine the value of further testing. In its simplest form, the method consists of reproducing from an unrecorded erased medium through an unequalized amplifier to an indicating meter with d-c bias applied to the head. Correlation between the meter readings and subjective listening tests made on regular recording and reproducing equipment has been found to be

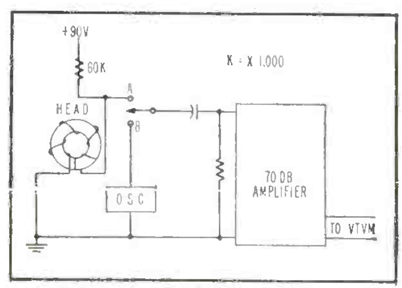
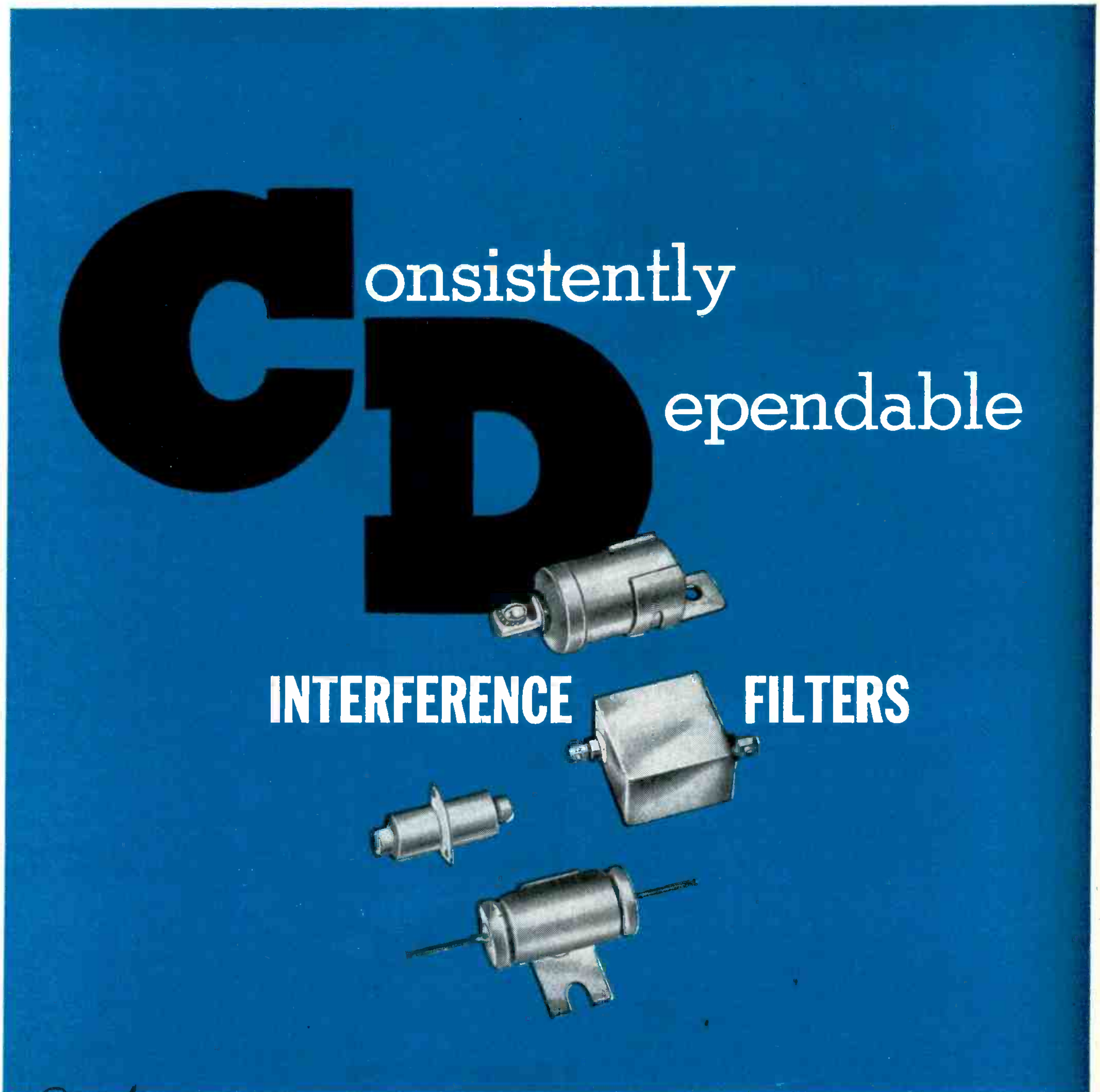


FIG. 1—Circuit of noise tester for recording media. VTVM can be replaced by analyzer to learn frequency distribution of noise



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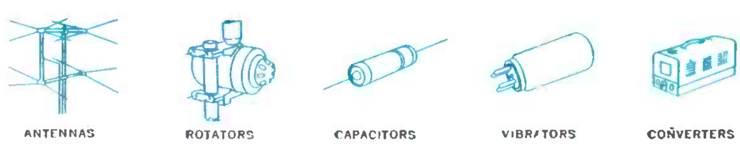

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good so that meter indication may be used as a basis for acceptance of media.

Noise Sources

Noise in magnetic recording arises from inhomogeneity in the recording medium, variations in cross-section of the sound track, variations in contact between the recording medium and the recording and reproducing heads. Modulation noise, or noise behind the signal, is a function of the degree of inhomogeneity of the medium and the magnitude of average induction in the medium. Variations in cross-section of the sound track produce noise because of the variations in the remanent flux for a constant

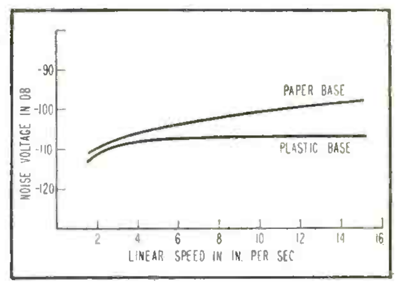
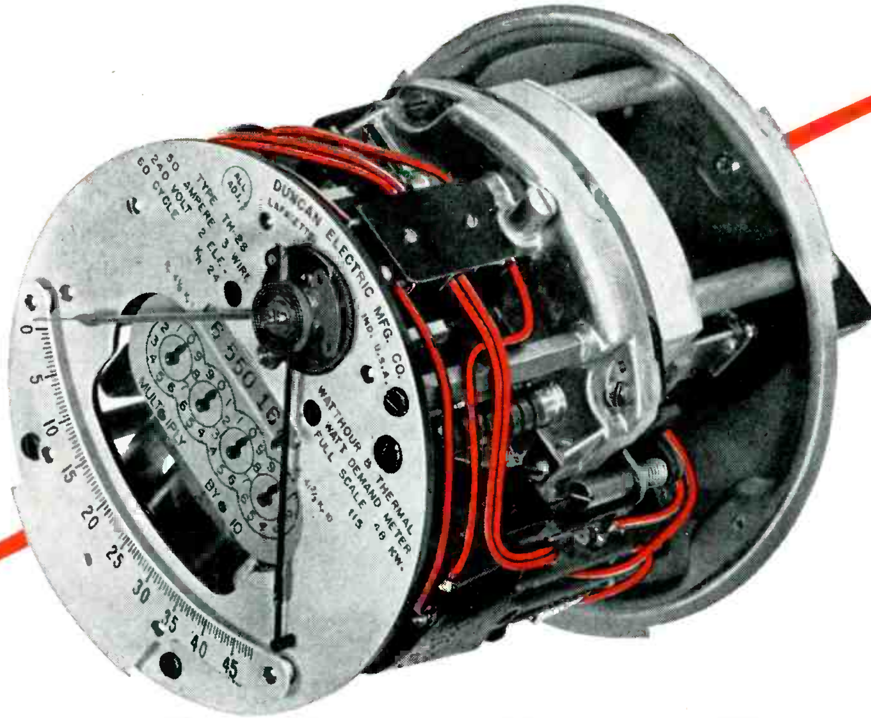


FIG. 2—Graph of noise voltage in relation to speed. Zero db is 0.775 v

value of magnetizing field. Variations in contact between the head and the medium such as caused by surface irregularities produce variations in the reluctance of the magnetic circuit of the head, which appear as variations in the remanent induction when recording and as variations in output voltage in reproducing.

The circuit used for the noise tests is shown in Fig. 1. Bias current is supplied from a well-filtered d-c source through a series resistor. The value of the resistor is high in comparison to the impedance of the head (450 ohms) since it effectively shunts the output of the head. The variations in voltage across the head are fed to the input of a 70-db amplifier through a coupling capacitor. The circuit impedance that loads the head is the parallel impedance of the series bias-feed resistor and the input impedance of the amplifier.

Amplifier gain is standardized by



A polyphase combination watthour-thermal demand meter manufactured by Duncan Electric Manufacturing Co., Lafayette, Indiana. Shown in red are 6 inch lengths of BH "649" Vinyl-coated Fiberglas Tubing used to protect this new, compact meter.

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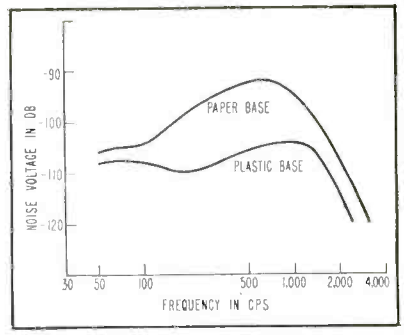

FIG. 3—Frequency distribution of noise in two types of recording tape, one with paper base and the other plastic

a calibrating signal of known level. The switch in Fig. 1 is moved to *B* to connect the circuit to the oscillator for calibration of the amplifier.

Moving the switch to *A* connects the circuit for noise measurement. For total noise measurements, a vacuum-tube voltmeter is used. With high, low or band-pass filters inserted, the noise contribution in various parts of the spectrum may be read. With a harmonic wave analyzer, the distribution of noise through the audible spectrum may be investigated.

Test Results

Figures 2 and 3 show the results of measurements on two media differing only in the base materials, plastic and paper. The curves were made with a head with pole pieces 0.014 inch thick and a 0.001 inch gap. The bias current was 1.5 ma d-c, which is sufficient to saturate the medium. Variation in total noise for the two media with variation in linear speed of the medium is shown in Fig. 2. The lower noise from the plastic base material is apparent.

Cutoff frequency of the head by gap effect varies with linear speed so that the upper-frequency limit of noise is reduced as the speed is reduced. The reduction of effective bandwidth causes the noise output to decrease at the lower speeds. At 4 in. per second with 0.001 inch gap, the theoretical cutoff is at 4 kc. Figure 3 shows curves of the same two media taken at 4 in. per second showing the high-frequency cutoff. The curves also show the pronounced noise output around 700 cps on the paper base tape caused

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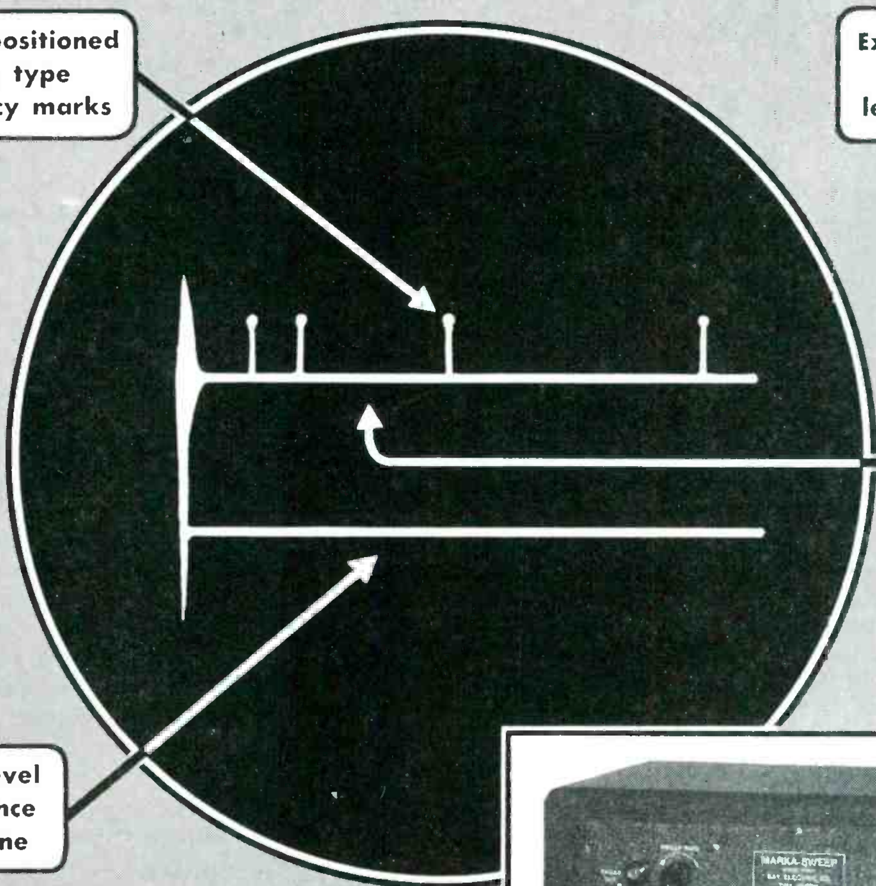

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by the surface irregularities of the paper. The noise output spectrum of the smoother plastic base tape is quite uniform throughout the spectrum up to cutoff indicating the random nature of the magnetic variations.

Reproducing with d-c bias sufficient to saturate any medium that is to be tested gives a measure of the maximum value of total noise that could be produced under normal recording and reproducing conditions. The frequency distribution of the noise is readily determined by the use of wave analyzers or filters. The character of the noise may be judged by direct listening. Surface variations of the coating or of the base material are generally observed as low-frequency noise, while inhomogeneity of the medium is usually random. Data is thus rapidly available from a single, continuous run that gives a good comparative noise figure under easily reproducible conditions.

Low Temperatures in Electronics

THE GENERAL EFFECT of low temperature is the production of ordered states of matter. If, at ordinary temperatures, something occurs with an energy smaller than several hundredths of an electron volt, it is swamped by the random agitation of the world about it, caused by thermal motion. Thus at normal temperatures a lower limit is set on the energy range of phenomena that may be reached.

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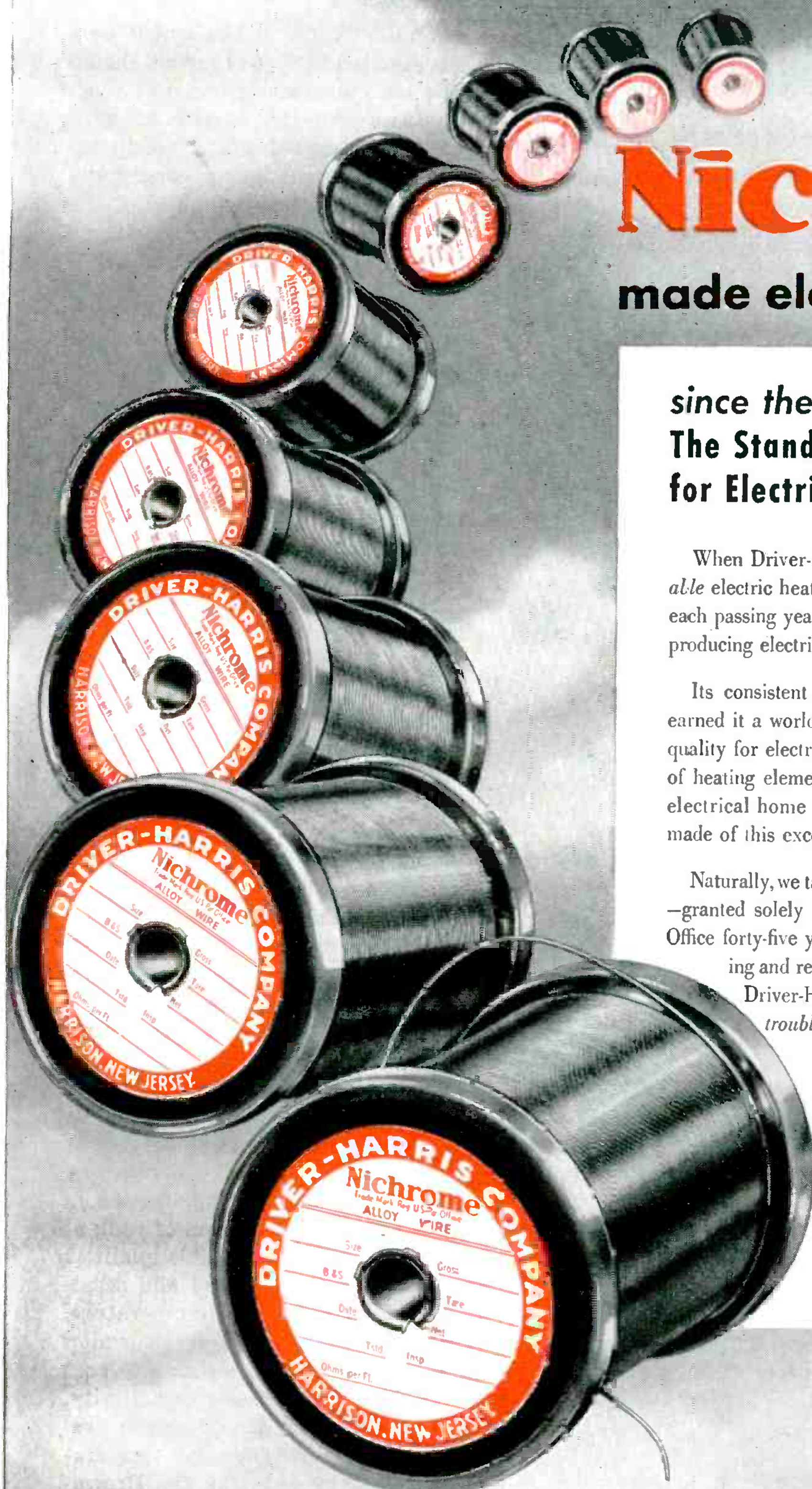
Outstanding among the phenomena unique to very low temperatures is the conversion of certain metals and compounds into perfect electrical conductors. This phenomenon of superconductivity is of sufficient importance to the practical engineer that it should be considered in some detail. The fact that



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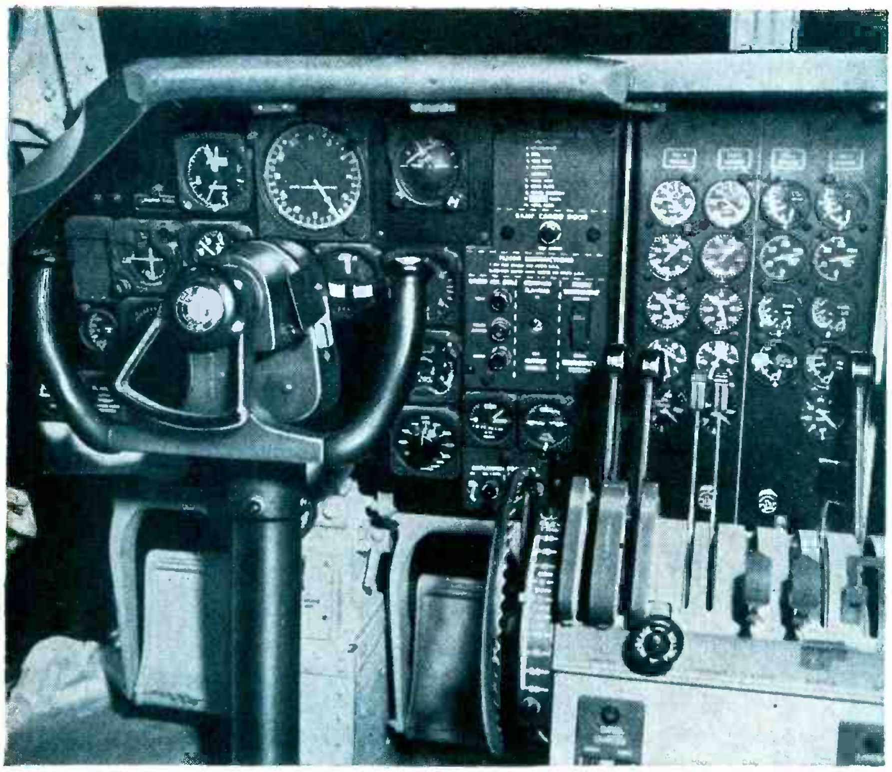

electrical resistance is proportional to temperature is to be expected from theory. On this principle then, the resistance of pure metals should gradually decrease to zero at absolute zero; and this is what happens with the best of normal-temperature conductors such as copper and silver in their pure state.

For other metals, including some that are poor conductors at ordinary temperatures, their resistance vanishes completely at some critical temperature above absolute zero. The electrical resistance of practically all metals has been investigated down to about 1 deg K or lower, and in all, about twenty metals so far have been found to be superconductive. For the most part these lie in a well-defined region in the periodic table and include among others mercury, tin, lead, aluminum and zinc.

It is interesting that the intermetallic compounds of bismuth and nickel and of gold and bismuth become perfect electrical conductors although the components themselves are not superconductors. This is also true of the semimetallic compounds, cupric sulfide, the molybdenum carbides, and the tungsten carbides. In many cases an alloy becomes superconductive at a temperature lower than the transition temperature of either of the individual metals. The highest temperature at which superconductivity has been found is 15 deg K with columbium nitride.

Although superconductivity is not fully understood theoretically, it has already found application in bolometers, for detection of radiant energy. The two desirable qualities in bolometers are speed and sensitivity. At room temperature, thermal fluctuations, or Brownian movement of the electrons, places a limit on bolometer sensitivity. This limit can be effectively removed by lowering the temperature, thereby reducing the Brownian movement.

Briefly, the sensitive element is a superconducting strip of metal maintained in the transition range between normal and superconductivity where a slight change of temperature will cause an enormous change in electrical resistance. For example, the resistance of tin was


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found to decrease gradually with temperature down to 3.7 K; at this point the resistance dropped so sharply that 50 percent was lost in the next 0.0001 degree. Further, low-temperature operation guarantees rapid response by virtue of the low heat capacity and also a low ultimate limit of detectability because of the low level of noise due to statistical fluctuations.

Many bolometers using columbium nitride as the sensitive element have been studied. An improvement in speed by a factor of a hundred over bolometers operating at room temperatures has been realized in practice, and it has been found possible with such bolometers to detect changes in temperature as small as 0.0000001 deg C.

Neglecting atmospheric absorption, which can vary over wide limits, the superconducting bolometer is sufficiently sensitive to detect the heat of a candle at a distance of 25 miles.

When used with an oscillating scanning mirror, the bolometer can pick up images of objects by their own thermal radiation and present crude pictures of the objects on a television screen. If installed inside a warehouse, the bolometer would be able to detect an intruder in complete darkness, transmit the picture by wire for an almost unlimited distance and present the picture on a television screen at a central station. Similarly any temperature difference, even as little as a few degrees, developed by spontaneous combustion or any sort of abnormal heating could be detected and shown on a tv screen at some distant point. Experiments have also been carried out in the scanning of the external walls of a building, where imperfect thermal insulation caused temperature differences that showed up immediately in the picture of the building being shown on the screen.

A superconducting bolometer was also found to be a detector of radio signals, necessarily superior to other types of radio receivers operating at room temperature in its signal-to-noise ratio. More practical interest is being attached to the fact that the superconductive bolometer can be used as an alpha

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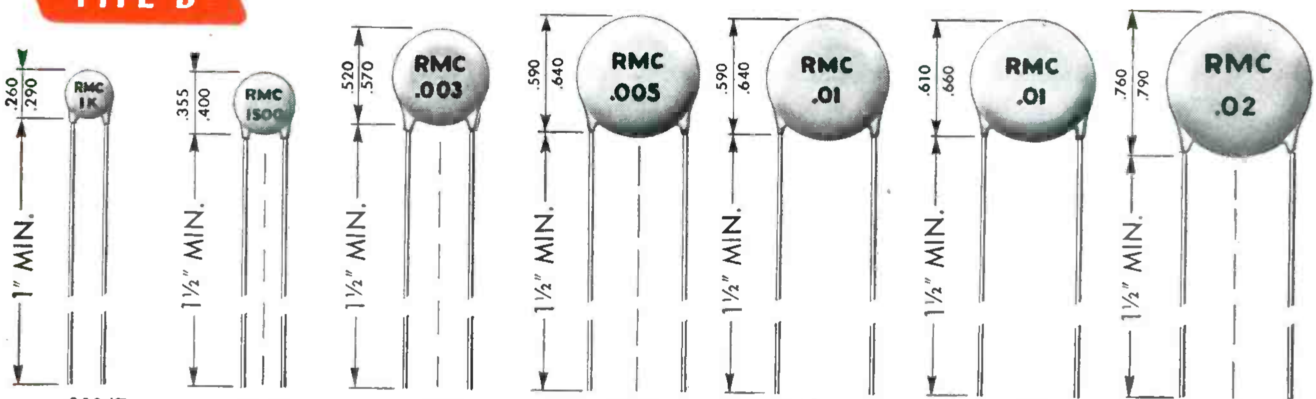

.00047 .00068 .0008 .001	.0015 .002 2x.001	.003 .004* .005* 2x.0015 2x.002*	.0047 .005 2x.002	.01* ±20% .02* +80%−20%	.01* .02*	.01 .02 2x.004

*Rated 600 V.D.C.W. Flash test 1200 V.D.C.

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TEST VOLTAGE (FLASH): 2000 V.D.C.
LEADS: No. 22 tinned copper (.026 dia.)

INSULATION: Durez phenolic—vacuum waxed
INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms
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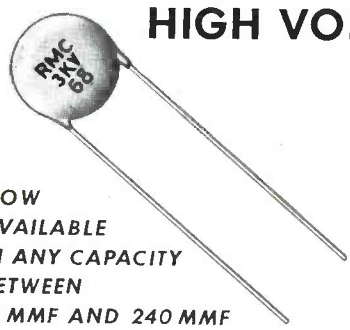

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LEADS: No. 22 tinned copper (.026 dia.)
INSULATION: Durez phenolic—vacuum waxed
INITIAL RESISTANCE: Guaranteed higher than 7500 megohms
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Another subject of potential interest to electronics workers is the temperature dependence of electrical noise. The ordinary noise found in metallic resistors, referred to as Johnson or thermal noise is known to decrease in direct proportion to the temperature and to increase with the value of the resistance used. Thus when thermal noise in a resistor is of great importance, a considerable increase in the signal-to-noise ratio can be expected by making it of metal and lowering the temperature.

Photoconductors, substances that react to light by changing their electrical conductivity, are limited in sensitivity by thermal noise which may be removed with liquid helium.

The field of semiconductors may also benefit from low-temperature measurements or processes. Admixtures of alloying materials markedly affect the conductivity of germanium. The effect is different at very low temperatures from that at room temperatures. Some material as yet undiscovered, may show semiconducting properties at liquid helium temperature and be useful as a low-noise transistor.

Insulators become so nearly perfect at these low temperatures that they may hold a charge for unusually long periods. This may be useful, for example, in a storage tube for computers.

The magnetic properties of matter are greatly changed or at least exaggerated, at low tempera-

tures. The fact that nuclear and paramagnetic resonance at radio and microwave frequencies becomes sharp and strong should be useful in filters and timing circuits. The rare-earth salts that exhibit low-loss ferromagnetics, unusually high permeabilities, and other such properties await application in devices such as magnetic amplifiers.

The material abstracted herein is taken from a forthcoming publication of Arthur D. Little, Inc., Cambridge, Mass.

Piezoelectric Activity of Barium Titanate

UNLIKE normal crystalline piezoelectric materials such as quartz, Rochelle salts and ADP, the piezoelectric qualities of barium titanate are influenced by the process of manufacture. In addition, the activity of barium titanate elements is a function of the method of polarization.

Theoretically, the determination of piezoelectric coefficients of a material can be readily accomplished by applying known loads to the unit and then measuring the charge and voltage developed. In practice, these measurements require use of sensitive laboratory equipment and are not suitable for rapid routine evaluations.

Another system of measurement is to apply an a-c signal to the element and consider its behavior under these conditions. By evaluating this oscillating system by means of an equivalent electrical circuit, Fig. 1A, the resonant and

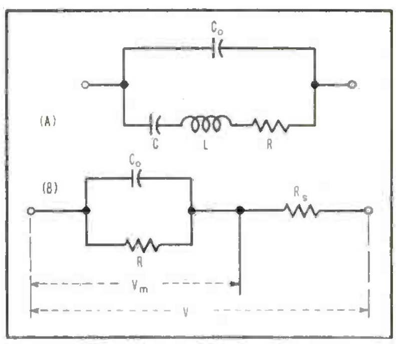

FIG. 1—Equivalent circuit (A) of a piezoelectric element. Circuit in (B) is equivalent circuit at resonance in series with resistance R_s used for measuring activity

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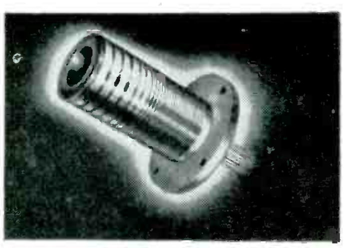

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antiresonant frequencies can be determined. This method is more convenient than direct measurement of charge or voltage but it still requires the use of laboratory instruments capable of frequency determinations within 0.1 percent. Such measurements, while not difficult, are hardly adaptable to production testing.

If we consider the equivalent circuit for a piezoelectric element at resonance the impedance reduces to resistance R in parallel with capacitance C, as shown in Fig. 1B. Resistance $R = U/k^2$ where U is a constant depending on the dimensions and mechanical constants of the piezoelectric element, and k is the coupling coefficient. For a unit of given size and fixed mechanical properties, k can be evaluated by measuring R. To measure R a fixed resistance is connected in series with a piezoelectric element as shown in Fig. 1B. Voltages V and V_m are determined at resonance. From these measurements R can be evaluated from the equation

$$R = \frac{V_m R_s (V_m + \sqrt{V^2 - V_m^2 \omega_o^2 C_o^2 R_s^2})}{V^2 - V_m^2 (1 + \omega^2 C_o^2 R_s^2)}$$

When the coupling coefficient is greater than about 15 percent, R is small compared with capacitive reactance and a good approximation is

$$R = R_s \frac{V_m}{V - V_m}$$

Measurements made by this method indicate that except at very low values of k, R is a valid measure of piezoelectric activity.

The application of this method to production testing is comparatively simple and does not involve elaborate equipment. The output of a variable-frequency, fixed-voltage oscillator is connected across the unit being tested and an ammeter is used to measure the current through the unit. The meter is calibrated by measuring units of known activity. After calibration piezoelectric units may be sorted for activity by noting the deflection of the meter and rejecting units that pass less than a given current value.

This article has been abstracted from a paper entitled "A Rapid Method for Evaluating the Activity

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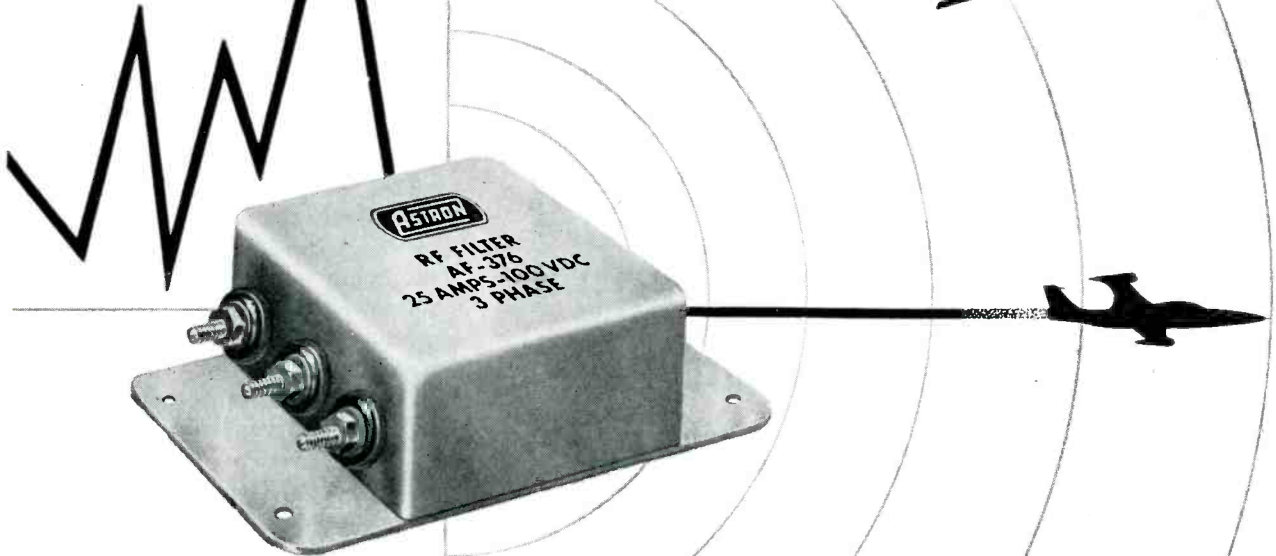

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of Piezoelectric Barium Titanate", by H. I. Oshry and Jan Minkowski, presented at the 7th National Instrument Conference in Cleveland.

Two R-C Oscillator Circuits

By H. L. ARMSTRONG
National Research Council
Ottawa, Canada

THE RESISTANCE-CAPACITANCE coupled oscillator has been in common use in the audio and low r-f ranges where it has important advantages over most other types[1]. Essentially, such an oscillator consists of a noninverting amplifier whose output is coupled back to the input by a resistance-capacitance network arranged to give minimum attenuation and zero phase shift at the desired frequency. The noninverting amplifier has usually been of the ordinary two-stage resistance-coupled type, but other arrangements are possible.

In this article two such circuits are described using respectively the cathode-coupled amplifier and the transitron amplifier. These use fewer components than do the more usual arrangements. In addition the circuit leaves one grid free to be used for keying, gating or modulation.

A circuit diagram of the cathode-coupled oscillator is shown in Fig. 1. This principle has been applied to oscillators using an ordinary resonant tank circuit[2], but the author has not previously seen it used with resistance coupling. This unit was designed for fixed fre-

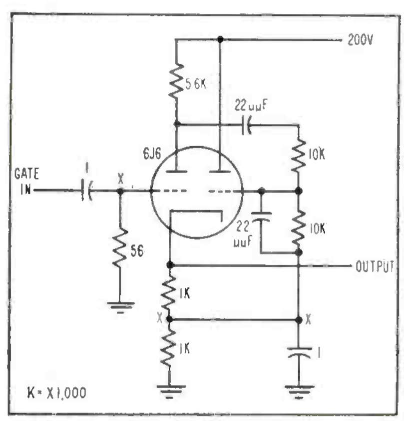

FIG. 1—Circuit diagram of cathode-coupled oscillator

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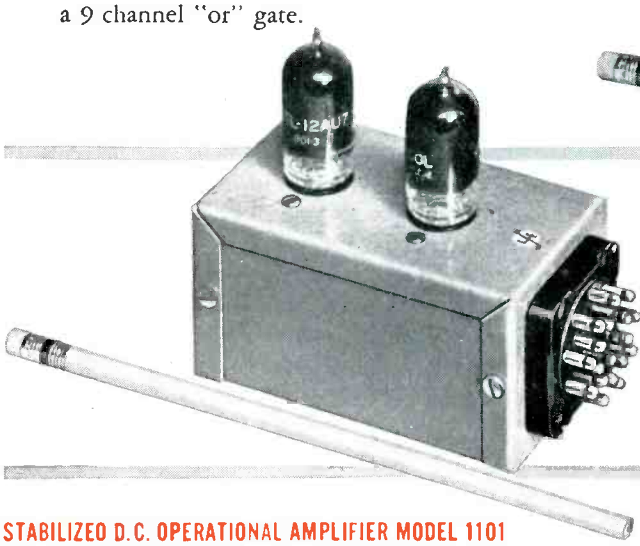

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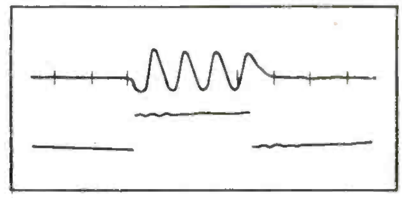

FIG. 2—Oscillogram of cathode-coupled oscillator output with gating pulse

quency operation at about 400 kc. For variable frequency operation the two 22 $\mu\mu$f capacitors can be replaced by a two-gang variable. Output is taken from the cathode giving a fairly low output impedance. The circuit shown was designed to be gated on by a pulse from a low-impedance source applied at the gate in terminal. If steady rather than gated operation had been intended, the points marked *X* would have been grounded directly.

Figure 2 shows an oscillogram of the output when the oscillator is gated on by a pulse of about 10 microseconds duration. Gating pulse is also shown. The output amplitude is about 2.5 volts peak to peak. The rapid starting and stopping of oscillations is apparent.

Another type of noninverting amplifier is the transitron, in which the suppressor control of screen current in a suitable pentode is used. This principle, again, has been used in tank-circuit (or negative-resistance) oscillators[3], but the use in a resistance-coupled circuit, which is shown in Fig. 3, is believed to be novel. This oscillator gave an output amplitude

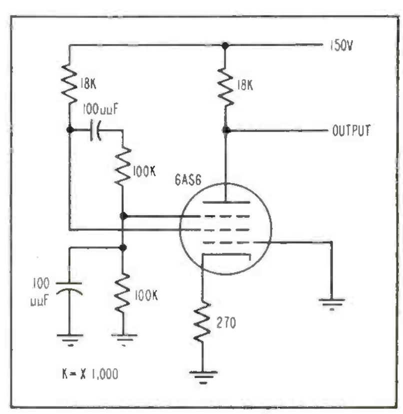

FIG. 3—Circuit diagram of transitron oscillator

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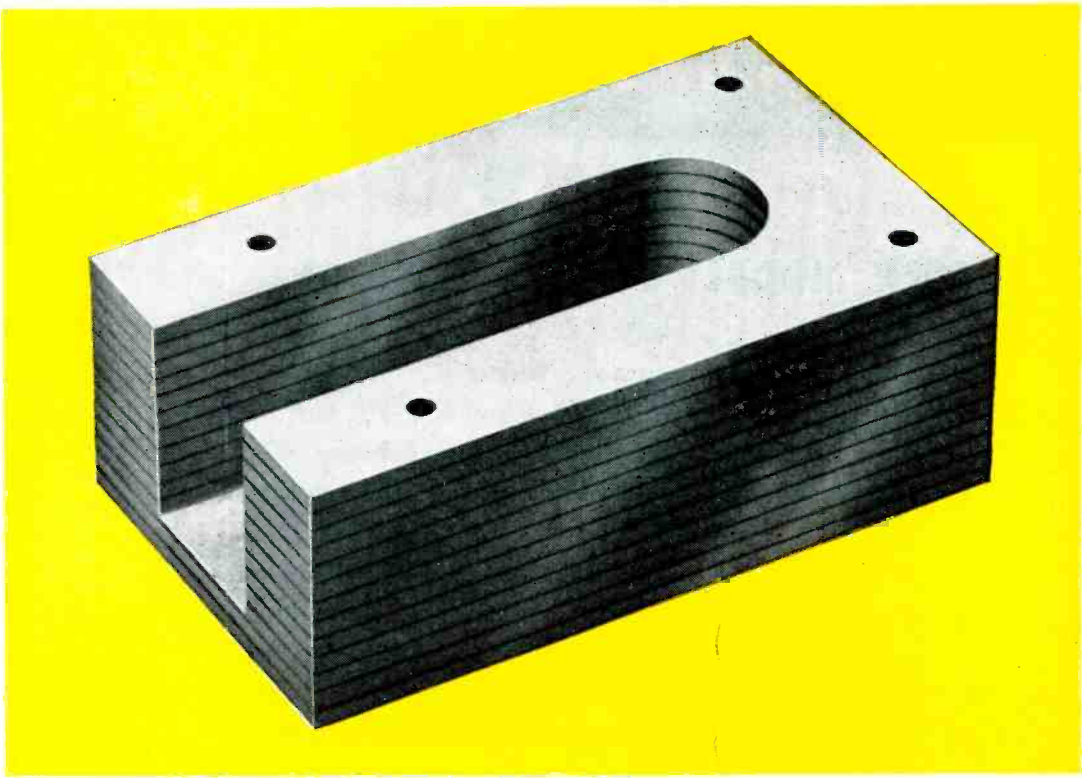

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of about 25 volts peak to peak, and a frequency of about 20 kc.

REFERENCES

(1) F. E. Terman and J. M. Pettit, "Electronic Measurements," 2nd ed. p 482, McGraw-Hill, 1952.
(2) P. G. Sulzer, *Proc. IRE* **38**, p 540, 1950.
(3) B. Chance, V. Hughes, E. F. MacNichol, D. Sayre, and F. C. Williams, "Waveforms" MIT Radiation Lab. Series, **19**, p 124, McGraw-Hill, 1949.

A-C Voltage Regulation With Ordinary Transformers

W. G. SHEPARD
Physical Research Unit
Boeing Airplane Company
Seattle, Washington

CONNECTING A CAPACITOR of the proper value in series with the primary of a transformer results in secondary voltages that are fairly independent of line voltage. Regulation results because the transformer core is operated in essentially a saturated condition so that the core dimensions, rather than the line voltage, determine the output voltage.

Because of the large size of the capacitors needed for large transformers, this investigation was confined to small transformers. One useful application for transformers used in this manner is to supply the first-stage filaments of a d-c amplifier or sensitive vacuum-tube meter circuit.

Operation

The primary of the transformer has a certain inductive reactance

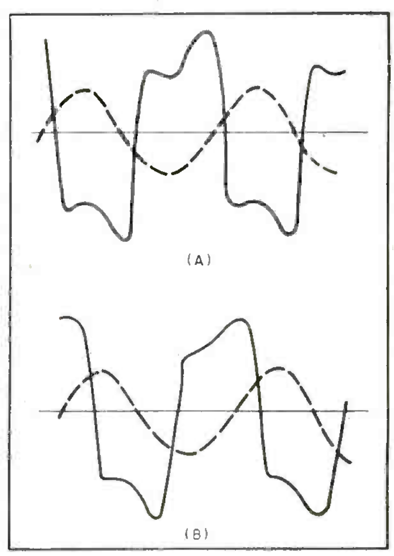

FIG. 1—No-load (A) and load (B) phase relationship of line voltage and voltage across capacitor-regulated transformer primary. Line voltage is dotted

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at the power line frequency. The capacitor chosen should have a capacitive reactance somewhat less than the inductive reactance of the unsaturated transformer primary. The total reactance equals $X_L - X_c$ and can be made much less than the reactance of the transformer primary alone. Thus by placing a capacitor of the proper value in series with the primary, much more current is made to flow through the primary and therefore a considerably greater voltage than 115 volts is developed across it.

This increased voltage and current has the effect of producing sufficient lines of force in the transformer core to saturate it and so cause considerable decrease in the inductance of the primary. The inductive reactance therefore decreases, probably becoming much less than the capacitive reactance during the current peaks. The capacitance, since it is the predominating reactance during these peaks, serves to limit the current flow and thus prevents the transformer from overheating.

Transformer saturation is a cumulative process in that a partial saturation lowers the inductive reactance causing more current to

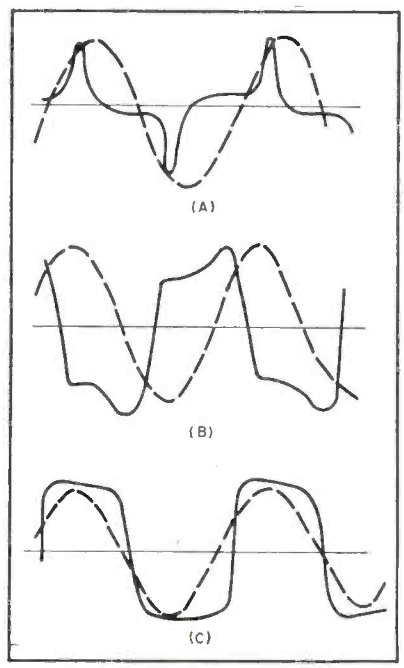

FIG. 2—Primary current (A) with load, voltage output (B) with load and no-load voltage across series capacitor (C) compared with line voltage (dotted) in capacitor-regulated transformer

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flow, which in turn further saturates the core, and so on.

Typical oscillographs of the voltage and current phase relationships with respect to the input line voltage are shown in Fig. 1 and 2. Figure 3 shows a vector diagram of the relationship to be expected between the line voltage, the primary circuit current and the voltage across the saturated primary. The vector relationship shown is an approximation. In general the relationship applies only to the fundamental part of the current and transformer primary voltage waves, since both of these waves contain harmonics.

One factor to be watched when using this technique is the transformer temperature. Because of the

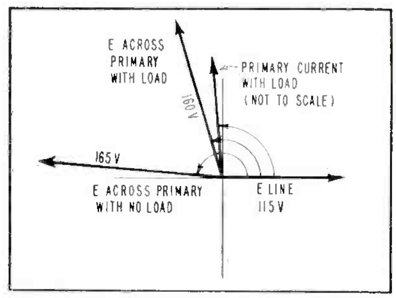
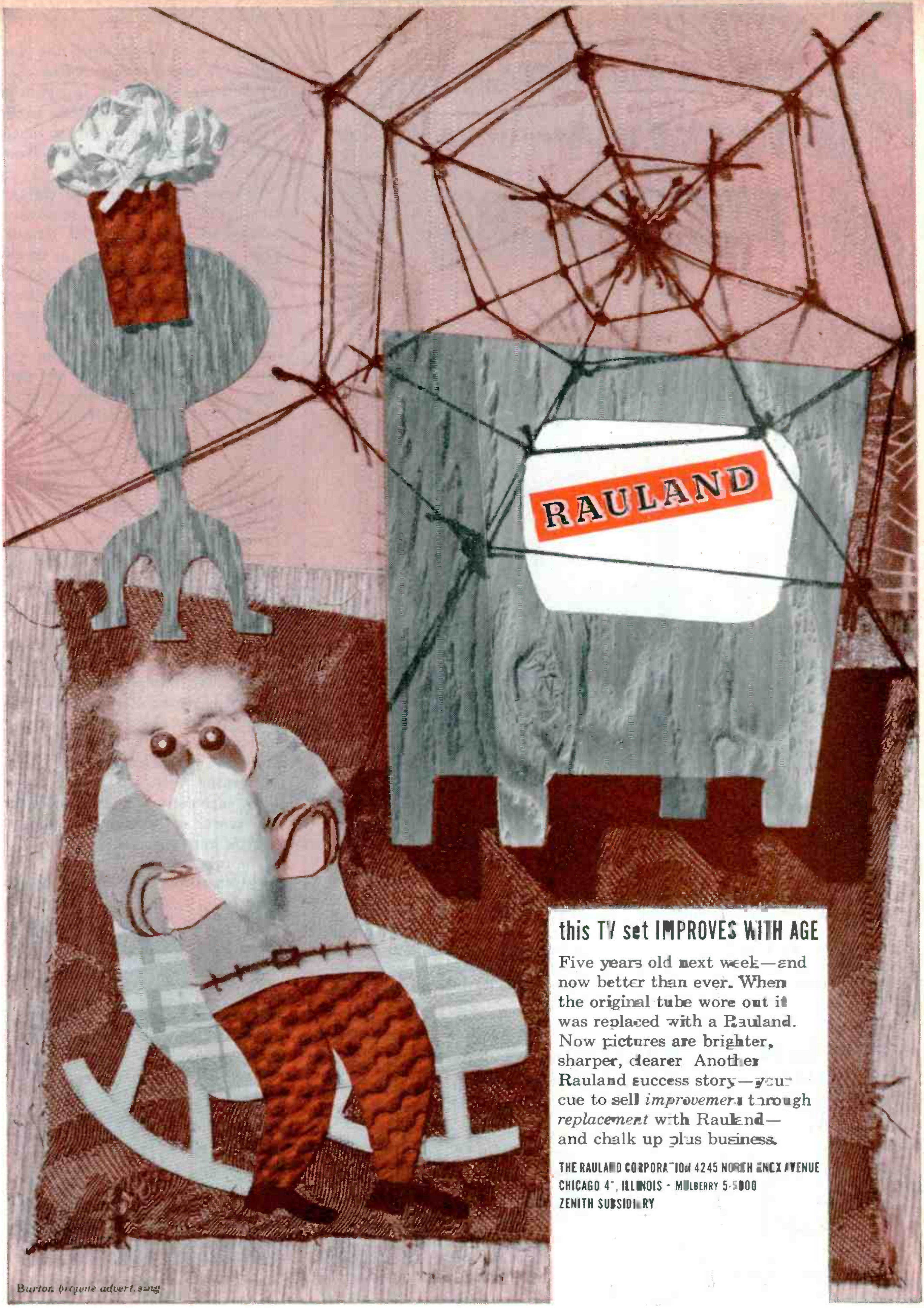


FIG. 3—Vector diagram of relation between primary current and voltage

harmonics present, eddy-current loss is expected to be higher than when the transformer is used in the usual way. This is especially true when thick laminations are used.

Capacitor Size

Various values of capacitance were tried for each transformer. The capacitance determines the degree of saturation of the core and has an effect on the voltage output and the amount of load possible. If the capacitor is too small, saturation is not reached and the transformer does not regulate. Tests made with a variable line voltage showed that if the capacitor is sufficiently large the transformer snaps into regulation as the line voltage is increased. This happens because the saturation is cumulative, as before mentioned. Regu-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lation does not cease until the line voltage is considerably reduced, at which time the action is again a snap action. If, on the other hand, the capacitor is too large, too much heat is developed in the transformer.

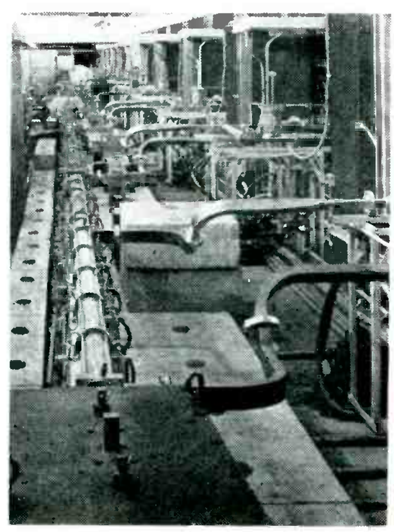
Because of the increased voltage across the primary, the secondary voltage exceeds the rated output. This means that, either a transformer with a lower voltage rating than the desired output voltage must be used, a resistance must be placed in series with the load or turns must be removed from the secondary. The latter is an easy operation since the secondary winding of a filament transformer is on the outside.

High-Power Klystron Amplifier

By John Jasberg
Research Associate
Microwave Laboratory
Stanford University
Stanford, Calif.

The high-power klystron amplifier shown in cross-section in Fig. 1 is a continuously pumped tube designed to provide power at 10.5 cm for the 1-bev linear electron accelerator now nearing completion at the Stanford Microwave Laboratory. The accelerator will use 21 of these tubes, each delivering 17 megawatts peak power in 2-μsec pulses, with a 60-cycle repetition frequency.

The tube is a gridless, three cavity klystron using an oxide-coated,



Linear accelerator with row of klystron units at right

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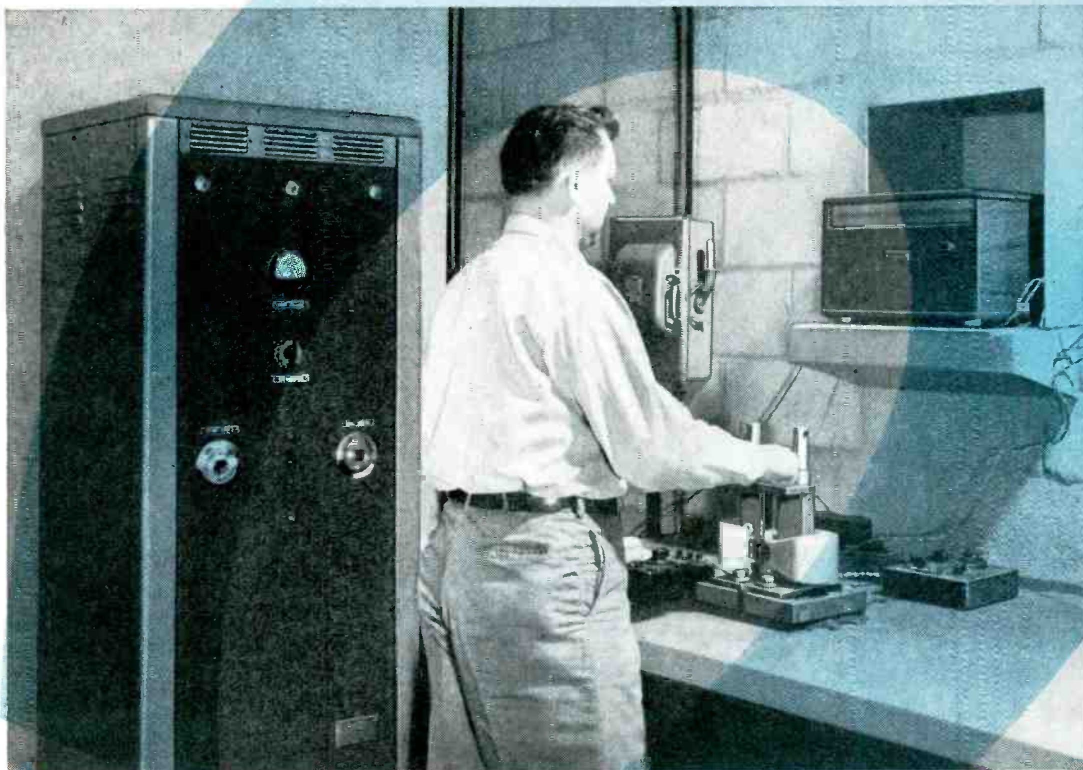

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In operation the cathode is pulsed negatively with respect to the rest of the tube, which is grounded. The

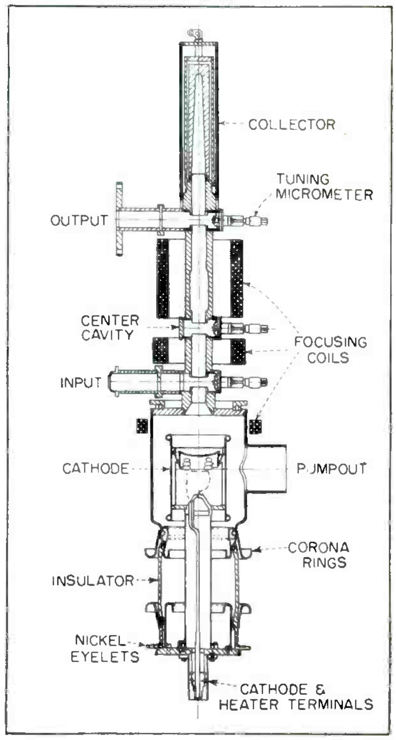

FIG. 1—Cross section of 17-megawatt klystron

peak input power is 100 megawatts. The cavities and drift tubes are surrounded by focusing coils that keep the beam from spreading until it has passed the output cavity. The r-f structure and collector are water cooled. Input and output are fed through resonant windows, glass on the input and ceramic on the output. The output window, not shown on the drawing, is a separate unit bolted to the output waveguide and is still an experimental item. Standard S-band waveguide is used on input and output. The output waveguide is evacuated to prevent voltage breakdown.

The klystron is operated verti-

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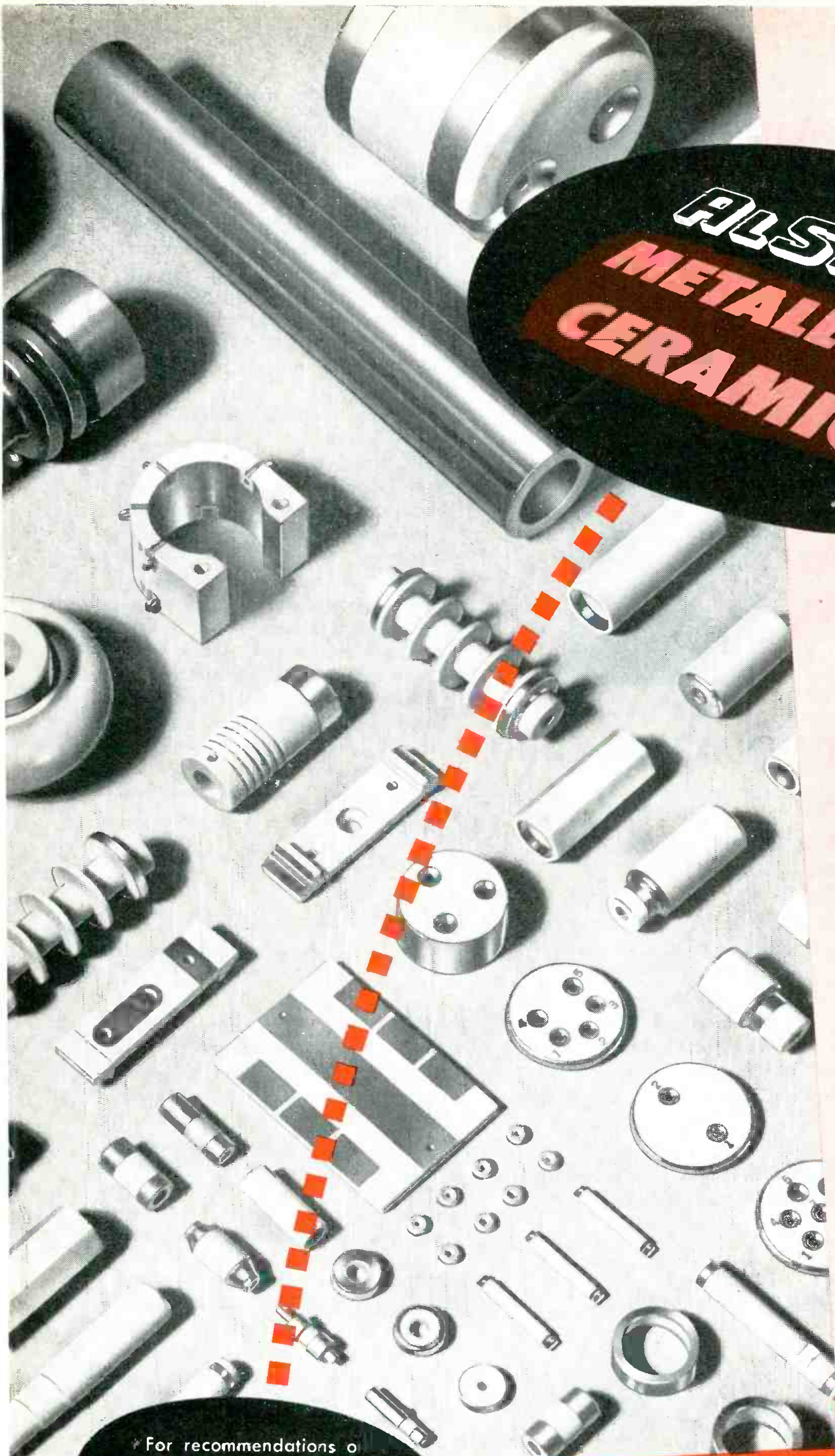

Electronic engineers are gaining one or all of these product advantages from the newly engineered AlSiMag metallized ceramics ideally suited for soft soldering:

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Typical operating conditions for the tube are:

Peak beam voltage...295 kilovolts
Peak beam current...190 amperes
Peak power output...17 megawatts
Power gain ....33 db
Efficiency ....33 percent

Tubes have run for several hundred hours under these conditions and have been tested to over 20-megawatts output. Other tubes have operated the accelerator for periods up to a year at somewhat lower levels. No failures have been directly due to cathode failure, most breakdowns being caused by failure of the output window after prolonged operation at high power.

PERTINENT PATENTS

PATENT 2,631,277 for a "Flight Hazard Warning System" was recently granted to Marvin Skoller, assignor to the Hughes Tool Co., of Houston, Texas.

The purpose of this invention is to provide a warning signal within the pilot's view or his hearing when the aircraft he is guiding approaches an obstacle in its path, such as mountainous terrain ahead.

To accomplish this the inventor has provided a pulse-type uhf transmitter that sends out short bursts of r-f energy. An associated gate-forming circuit and delay lines energize a receiver for a period of time covering some predetermined range. Echoes of the energy bursts are received in a superheterodyne receiver when gated to do so, whereupon the equipment provides a visible and audible warning signal when the echoes received are within the range for which the equipment has been set. The circuit of the in-

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vention is shown in Fig. 1.

Obstruction warning systems such as the Skoller invention might well be standard equipment in all commercial and military aircraft since the type of equipment disclosed should not be costly.

T-W Amplifier

A traveling-wave amplifier tube of an unusual configuration for microwaves is the subject of patent 2,620,458 issued to Percy L. Spencer of West Newton, Mass. and assigned to the Raytheon Mfg. Co.

It has been customary to build

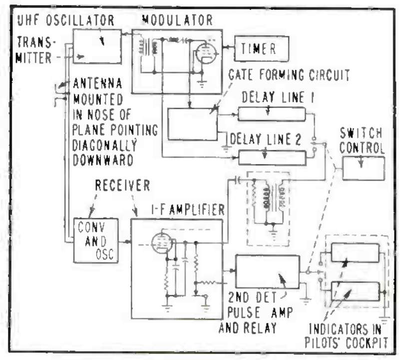

FIG. 1—Flight-hazard warning device employs pulsed uhf transmitter. Receiver is gated to accept reflected echoes

traveling-wave tubes in an elongated configuration with a helical waveguide structure down the center of the tube.

In the present invention the inventor wraps the helical waveguide up in a toroidal form and thereby conserves space and, he claims, reduces manufacturing costs and facilities.

A cutaway view of the microwave amplifier is shown in Fig. 2A. Figure 2B shows the internal details looking down on the structure.

The cathode and heater are familiar structures. The control electrode is a disk-like structure with pins projecting vertically downward between the turns of the toroid of the helical waveguide through which the microwave energy is transmitted. The outer magnetic field coil maintains the circular field to contain the microwave energy within the waveguide toroid.

In operation microwave energy

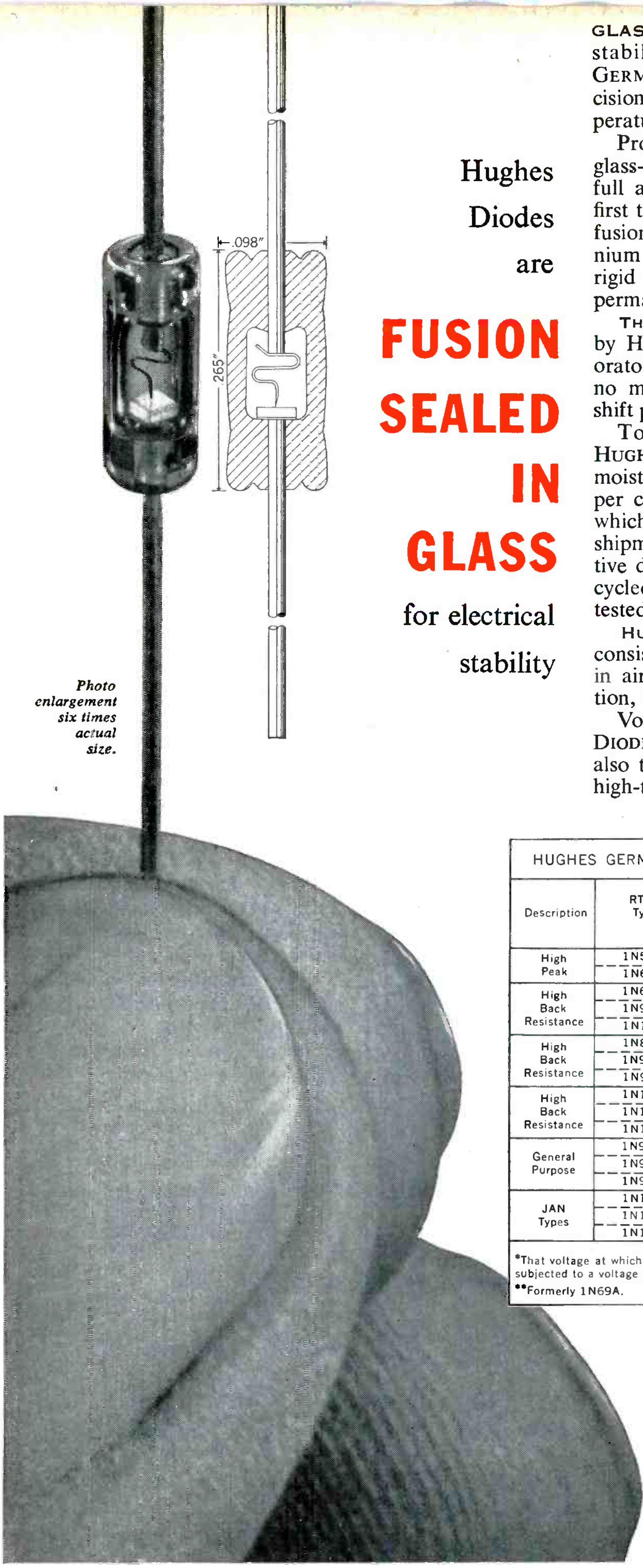

Photo enlargement six times actual size.

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THE HUGHES GERMANIUM DIODE, developed by Hughes Research and Development Laboratories, employs no wax or solder, and has no mechanical joints or pressed-in parts to shift position.

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HUGHES GERMANIUM DIODES have proved consistently able to meet exacting requirements in airborne electronic equipment for navigation, fire control and guided missiles.

Volume orders for most types of HUGHES DIODES can be filled from stock. Diodes are also tested to special specifications, including high-temperature electrical requirements.

HUGHES GERMANIUM DIODE ELECTRICAL SPECIFICATIONS AT 25° C.

Description	RTMA Type	Test Peak Inverse Voltage* (volts)	Maximum Inverse Working Voltage (volts)	Minimum Forward Current @ +1 v (ma)	Maximum Inverse Current (ma)
High Peak	1N55B	190	150	5.0	0.500 @ −150 v
	1N68A	130	100	3.0	0.625 @ −100 v
High Back Resistance	1N67A	100	80	4.0	0.005 @ −5 v; 0.050 @ −50 v
	1N99	100	80	10.0	0.005 @ −5 v; 0.050 @ −50 v
	1N100	100	80	20.0	0.005 @ −5 v; 0.050 @ −50 v
High Back Resistance	1N89	100	80	3.5	0.008 @ −5 v; 0.100 @ −50 v
	1N97	100	80	10.0	0.008 @ −5 v; 0.100 @ −50 v
	1N98	100	80	20.0	0.008 @ −5 v; 0.100 @ −50 v
High Back Resistance	1N116	75	60	5.0	0.100 @ −50 v
	1N117	75	60	10.0	0.100 @ −50 v
	1N118	75	60	20.0	0.100 @ −50 v
General Purpose	1N90	75	60	5.0	0.800 @ −50 v
	1N95	75	60	10.0	0.800 @ −50 v
	1N96	75	60	20.0	0.800 @ −50 v
JAN Types	1N126**	75	60	5.0	0.050 @ −10 v; 0.850 @ −50 v
	1N127†	125	100	3.0	0.025 @ −10 v; 0.300 @ −50 v
	1N128‡	50	40	3.0	0.010 @ −10 v

*That voltage at which dynamic resistance is zero under specified conditions. Each Hughes Diode is subjected to a voltage rising linearly at 90 volts per second.
**Formerly 1N69A. †Formerly 1N70A. ‡Formerly 1N81A.

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to be amplified is applied to the input of the waveguide by means of a coupling loop. The energy is propagated around the helical waveguide and extracted by a coupling loop at the output waveguide. The helical form of the waveguide reduces the phase velocity of the microwave energy to a value below the speed of light.

Electrons emitted by the cathode are influenced by the electric field between the cathode and helical waveguide structure and the magnetic field in the space between the cathode and waveguide to follow paths taken by the electrons in a conventional magnetron. In following such paths the electrons give up their energy to the microwave energy traveling along the waveguide, resulting in amplification of the microwave energy when extracted from the waveguide.

Phase-Modulation Repeater

An ingenious microwave pulse repeater system employing a phase-modulation technique with traveling-wave tubes is the subject of patent 2,619,543 granted to Cassius C. Cutler of Gillette, N. J., and assigned to Bell Telephone Laboratories of New York.

Ordinarily, microwave repeater systems require complex and costly equipment incorporating, receiving, demodulation, remodulation and transmitting apparatus.

In the instant invention all of the operations are performed in a single vacuum tube with its associated equipment thereby effecting a reduction in overall cost.

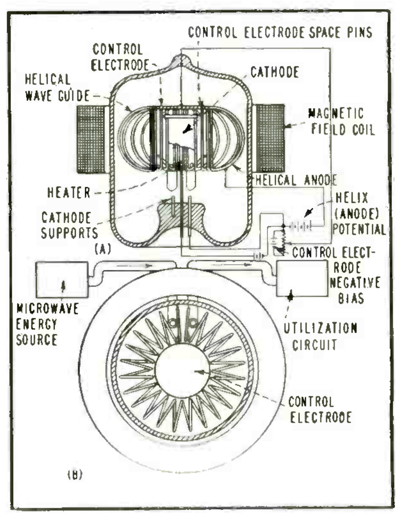

FIG. 2—Toroidal traveling-wave amplifier tube

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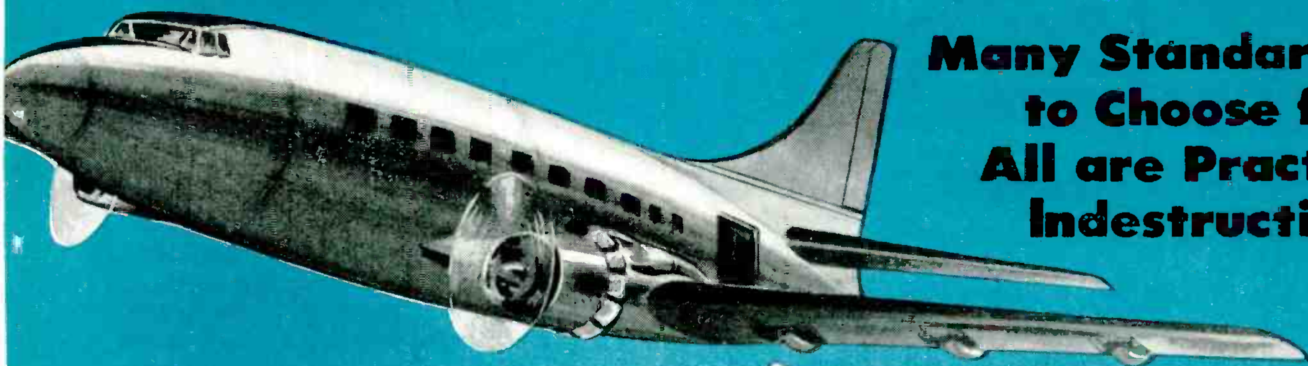

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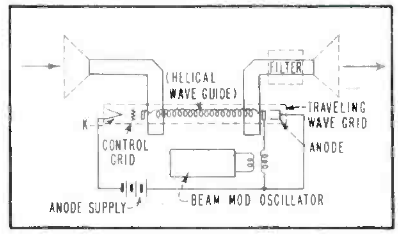

FIG. 3—Pulse-repeater using helical waveguide

In Fig. 3 a single-tube pulse repeater is illustrated wherein there is provided a traveling-wave tube, so designed as to permit a pulse-modulated microwave signal input to the helical waveguide structure within the tube and the application of a periodically varying signal to the output of the helical waveguide. The latter signal is related to the incoming signal in such a way as to phase-modulate the signal passing through the helical waveguide.

Practically, the electron beam of the traveling-wave tube is modulated by a sinusoidal wave of the same frequency as the pulse- repetition frequency of the incoming wave. The frequency and amplitude of the phase-modulating wave are so chosen that the amplification of the amplifier may be varied over wide limits effectively to gate the applied pulses or to generate pulses from a c-w signal to the amplifier.

The resultant effect of the operation is to shift the frequency so that the energy is retransmitted from the output at a different frequency. It is claimed that by this technique frequency shifts of 500 mc are accomplished at a center frequency of 4,000 mc.

The extent of phase shift obtain-

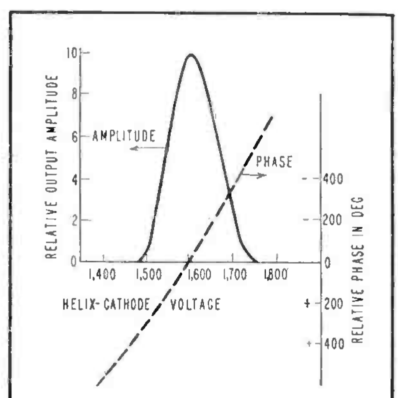

FIG. 4—Phase shift obtained in pulse repeater

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PEAK ANODE VOLTAGE:	
Forward	650 max. volts
Inverse	1300 max. volts
GRID-NO. 2 (SHIELD-GRID) VOLTAGE:	
Peak, before anode conduction	−100 max. volts
Average*, during anode conduction	−10 max. volts
GRID-NO. 1 (CONTROL-GRID) VOLTAGE:	
Peak, before anode conduction	−200 max. volts
Average*, during anode conduction	−10 max. volts
CATHODE CURRENT:	
Peak	5 max. amp
Average*	0.5 max. amp
Fault, for duration of 0.1 sec. max.	20 max. amp
GRID-NO. 2 CURRENT:	
Average*	0.05 max. amp
GRID-NO. 1 CURRENT:	
Average*	0.05 max. amp
PEAK HEATER-CATHODE VOLTAGE:	
Heater negative with respect to cathode	100 max. volts
Heater positive with respect to cathode	25 max. volts
AMBIENT TEMPERATURE RANGE	−75 to +90° C
Maximum Circuit Values:	
Grid-No. 1—Circuit Resistance	2 max. megohms

*Averaged over any interval of 30 seconds maximum.
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Expressly designed for industrial control applications, the new RCA-6012 gas tetrode features the ruggedness necessary to withstand rough industrial usage. It has the additional advantages of low cost and nation-wide renewal distribution...both of importance to the end user.

For motor-control, electronic-inverter, and general relay service at power supply frequencies, the RCA-6012 is rated to withstand a maximum peak inverse anode voltage of 1300 volts, a maximum peak cathode current of 5 amperes, and a maximum average cathode current of 0.5 ampere.

Operating features of the RCA-6012 include a negative-control characteristic which is essentially independent of the ambient temperature over the range from −75° to +90° C, low preconduction currents, low control-grid-to-anode capacitance, and low control-grid current.

The RCA-6012 is compactly designed, and employs a structure that increases its resistance to both shock and vibration. A button stem is used to strengthen the mount structure and to provide wide inter-lead spacing as a means of reducing susceptibility to electrolysis and leakage.

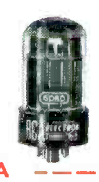
For complete technical data on the RCA-6012, write RCA, Commercial Engineering, Section 42GR, Harrison, N. J. . . . or contact your nearest RCA field office.

FIELD OFFICES: *(East)* Humboldt 5-3900, 415 S. 5th St., Harrison, N. J. *(Midwest)* Whitehall 4-2900, 589 E. Illinois St., Chicago, Ill. *(West)* Madison 9-3671, 420 S. San Pedro St., Los Angeles, Calif.

Tmks. ®

Another **new RCA tube**

RCA-6080 is a current-regulator tube for use in regulated dc power supplies. Similar to the 6AS7-G, it features a button-stem construction for improved resistance to shock and vibration. The 6082 is a similar tube for aircraft power supplies.



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RCA **RADIO CORPORATION of AMERICA**
ELECTRON TUBES HARRISON, N.J.

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able is illustrated in the curve of Fig. 4 and illustrates the characteristics of the circuit of Fig. 3.

The effect of variation in amplification during the time in which an r-f pulse is traversing a traveling-wave tube is illustrated in the curves of Fig. 5. Curve (A) illustrates the type of r-f pulse generated in microwave pulse-modulation systems. If this passes through a traveling-wave amplifier having characteristics as shown in Fig. 4, the amplification is varied by the change in helix-to-cathode voltage curve (B) to produce a net result as shown by the r-f pulse in curve (C) which is sharper than the applied pulse.

Pulse separation in the output is accomplished with conventional microwave filters as illustrated in Fig. 3.

Magnetic Photorelay

A photorelay circuit for which patent 2,627,036 has been granted to N. D. Glyptis of Chicago, Ill., employs a novel technique for increasing photoemission of photoelectric cells.

As is known, the photoelectric effect results from collision of electrons with atoms of an inert or other ionizable gas in the presence of a force such as light. The number of ions released is a function of the number of collisions. If the number of collisions is increased, a greater ion release and consequent increase in output current results. An obvious means of increasing the number of collisions would be to lengthen the path over which the electrons travel. To accomplish this by elongating the tube is prohibitive.

This invention proposes to increase the electron path by the

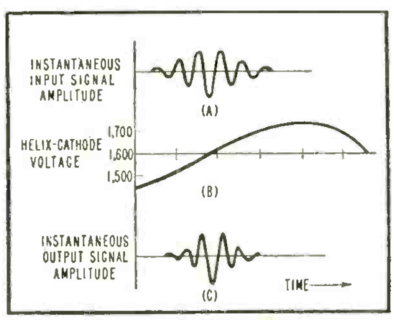

FIG. 5—Variation in amplification during an r-f pulse

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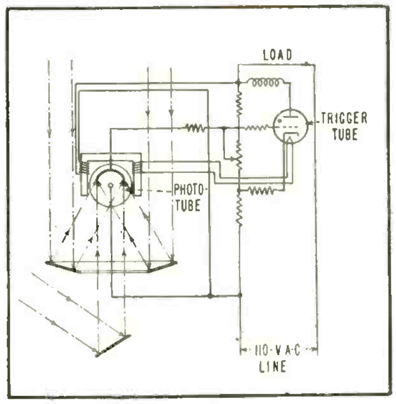


FIG. 6—Magnetic photorelay uses field from filament transformer

application of a magnetic field to the path of electrons thereby to deflect the electrons and increase their length of travel so that more collisions occur in the process.

Figure 6 shows the schematic of an embodiment of the magnetic deflection circuit for the photorelay The filament transformer forms the magnetic field coil and is wound about the photocell.

Figure 7 shows a form of coil that may be used as a magnetizing element. The rest of the circuit operation is conventional.

Mass Spectrometer

Patent 2,627,034 was issued to H. W. Washburn and C. E. Berry of Pasadena, Calif., assignors to Consolidated Engineering Corp. of Pasadena, Calif. for "Mass Spectrometry".

Mass spectrometry has been conventionally accomplished by bombarding gas samples with electrons

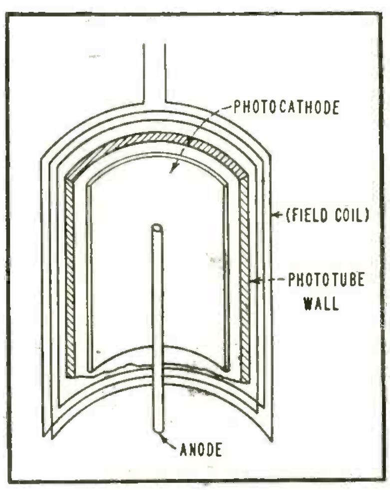
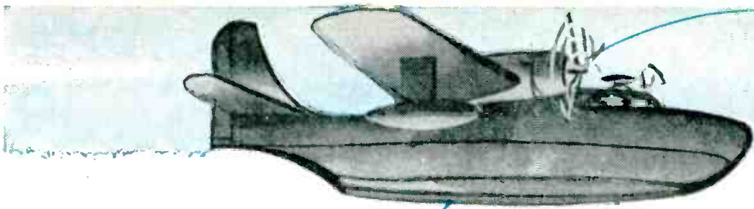


FIG. 7—Magnetizing element using special coil



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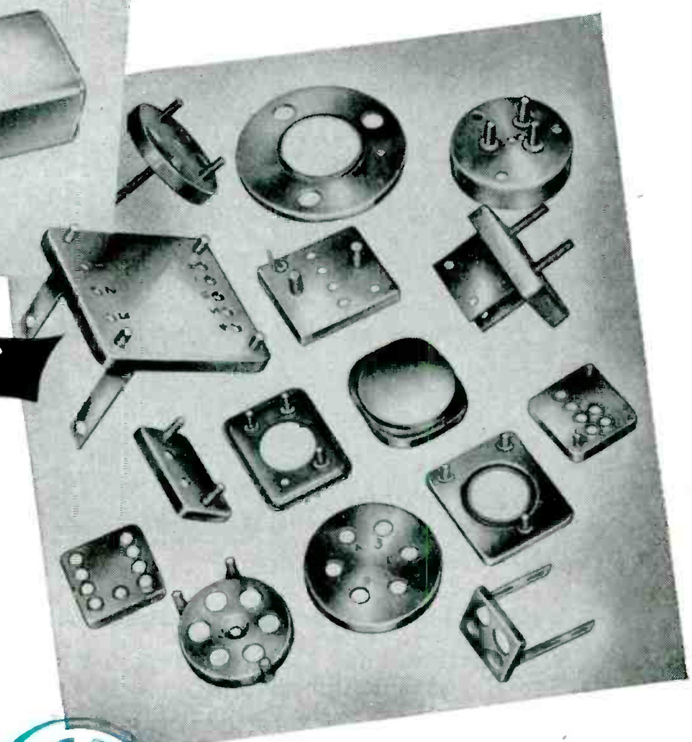

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to produce ions of the various substances in the sample and subjecting the ions to the influence of magnetic or electric fields and selectively collecting the ions of the various components of the sample that arrive at a collector at different velocities in accordance with their mass.

This invention, while employing the well-known basic principles of previously disclosed instruments, obtains improvement and simplicity by subjecting the ions formed in the bombardment to a varying electric and fixed magnetic field that forces the ions in resonance with the field to follow an expanding upward spiral path. Ions not in resonance with the field are sent along another path and so do not impinge on a target set aside for the resonant ions.

The invention features means for generating the fields that cause the spiral stream to exist in pulsations of some predetermined alternating frequency.

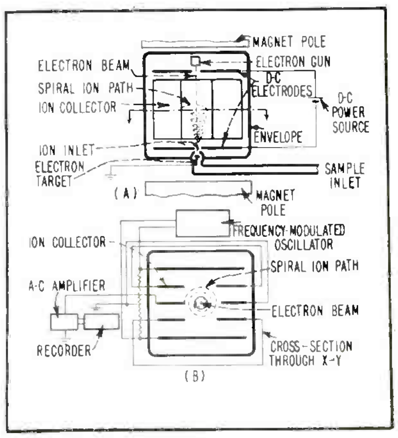

FIG. 8—Mass spectrometer (A) shown in cross section (B)

Referring to Fig. 8, the operation of the mass spectrometer may be seen. An electron gun directs a stream of electrons at a collector in the path of the sample gas. A transverse electric field is generated by differences in the potentials applied to the ion collector and director plates modulated by a frequency-modulated signal.

A magnetic field is set up between the poles seen in Fig. 8A.

The ions are collected at one electrode of the system whence they are applied to an amplifier and recorder.

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Production Techniques

Edited by JOHN MARKUS

OTHER DEPARTMENTS featured in this issue:

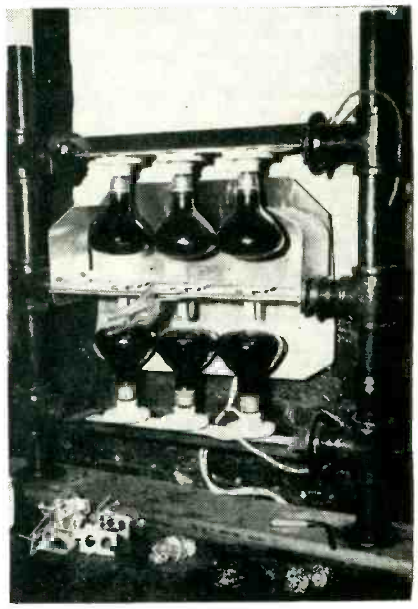
Stockroom Counter Drawers

A POSTOFFICE-BOX system eliminates waiting when a floor leader requires an additional supply of parts in the Coamo, Puerto Rico plant of Carbie Aircraft Radio Corp. The leader fills out an order and places it in her assigned drawer under the counter of the stockroom window, then goes back to her section of the plant. About half an hour later, she returns to pick up the parts which in the meantime have been placed in her drawer by the stockroom clerk.

This procedure eliminates waiting at the window while the stockroom clerk is working elsewhere in the plant. After placing an order in her drawer, the leader rings a bell a few times to attract the attention of the clerk.

The drawers are of simple wood construction, set into a light wood framework under the counter. The name of each leader is neatly lettered on masking tape applied to one side of each drawer.

Floor leader removes order of precut and stripped wires from her drawer under stockroom counter



Infrared soldering of hermetic seals with heat from both sides

Infrared Soldering of Transformer Headers

SOLDERING of hermetically sealed headers to the bases of housings for Keystone excitation transformers is achieved at high speed without cracking the glass terminal beads by applying infrared heat from both sides. Torches gave faster soldering but often cracked the glass, and soldering irons did not give good seals.

Three 500-watt infrared lamps are used on each side of the header. Amplex ruby-red hard glass lamps were needed because they shine into each other and tend to melt each other.

The operator loads three headers

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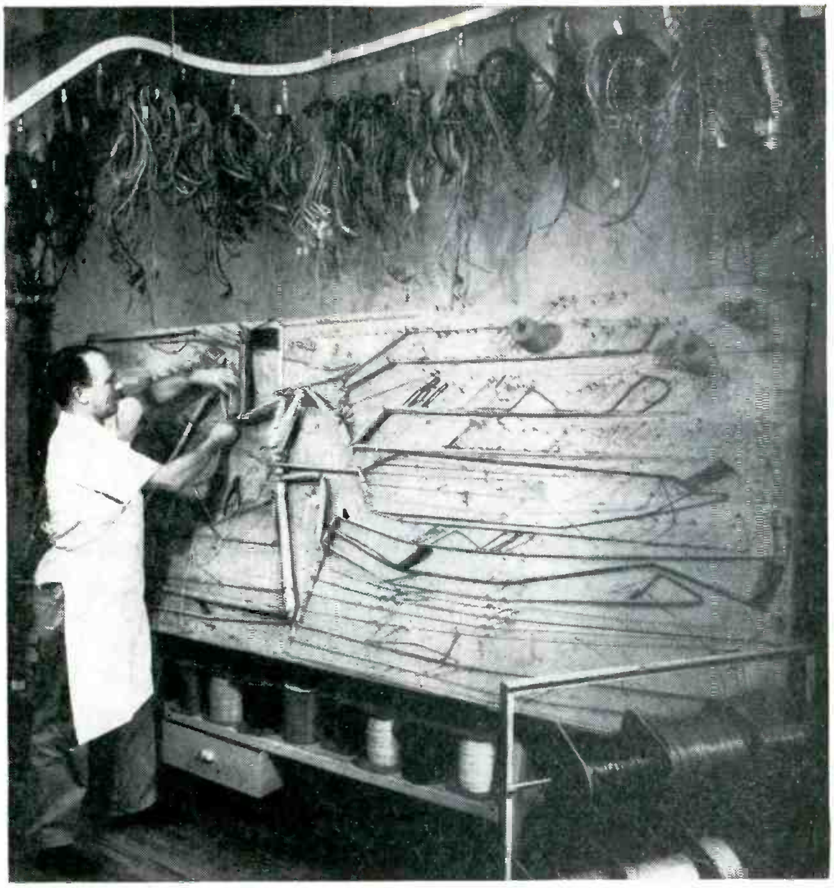
at a time into a hard asbestos panel-type jig, places solder preforms in position, then sets the jig on brackets between the lamps. Vise-Grip pliers with wide jaws, made for sheet metal work, are used to handle the asbestos plate.

After loading, the operator starts an ordinary manual timer, turns on the lamps and proceeds with other work. The lamps apply heat gradually to the glass insulators so there is no cracking. Heat from underneath insures uniform flow of solder.

The infrared soldering setup can be quickly modified for other applications by sliding the lamp-holding brackets up or down on the vertical pipes as required. The lamps are connected in series-parallel to a 220-volt power line.



Tieing up a cable with linen twine after laying it out by the endless wire technique. Rack for wire spools is at lower right. Finished cable lifts off pegs easily for subsequent cutting and stripping. Overhead conveyor provides safe storage for finished cables and moves them from cable room to assembly positions

Winding Technique Used on Large Cable Board

IN FABRICATING cables that may have up to several thousand feet of wire in as many as 75 different colors and sizes, the layout is planned so that each type of wire can be wound around the pins in one fast operation that puts in all conductors of that particular type. The only cutting done during fabrication of the cable is the terminating cut for each type of wire.

After all conductors have been placed on the board, the cable is laced and tied conventionally with linen twine. It is then taken off the board for cutting and stripping of the end loops. This may occasionally involve cutting out sections of wire used to bridge the distance between the end of one conductor and the start of another conductor of the same type. In the Endicott, N. Y. plant of IBM this cabling technique is used in connection with the production of electronic accounting machines.

Cutting Cost of TV Horizontal Oscillator Coils

Operator loads four-coil arbor on one winding machine while other machine behind her is winding four horizontal-oscillator coils

BY REDESIGNING a winding machine and its arbors, the cost of winding horizontal-oscillator coils for television receivers was lowered sufficiently to give a total saving of $11,250.00 per year on 500,000 coils in Motorola's Chicago plant.

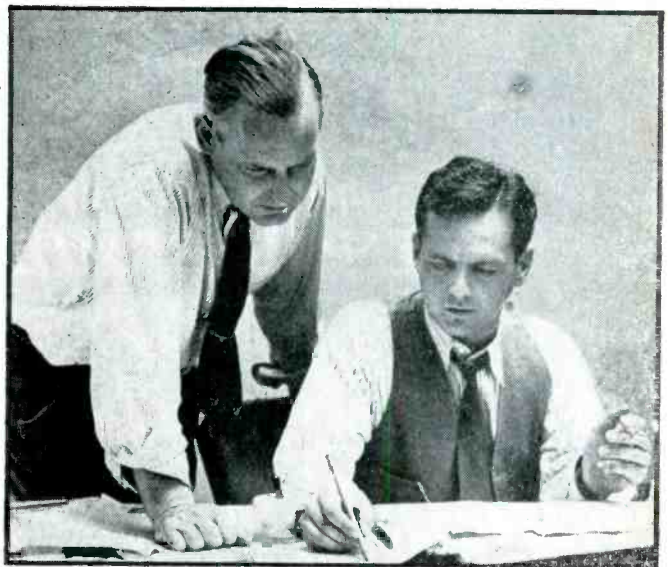
The machine was originally tooled to wind one coil at a time, at a production rate of 48 coils per hour. By having the operator tend an additional machine during the winding time of the first machine, production per operator was increased to 78 coils per hour.

As the next cost-cutting step, a removable arbor was developed for holding two coil forms, and two

ANOTHER PERFORMANCE REPORT FROM CONDENSER PRODUCTS COMPANY

An instrument manufacturer sent us this problem:

"We have a close tolerance, high stability, and high insulation resistance capacitor problem. We need to find a 1.0 mfd. unit, plus or minus 0.5% at 100 VDC for a 1,000 cycle per second bridge. Capacitance change should be less than 0.1% per year. Insulation resistance to approach theoretical infinity."



"CPs" engineers came up with this....

TYPE PAC1C1

The CP Engineering Department designed a plasticon capacitor utilizing CP's Type P plastic dielectric. Specially produced to meet this manufacturer's problem, the PAC1C1 capacitor had the following characteristics at 20° C :

Insulation resistance at 100 VDC—approximately 10^{14} ohms. Capacitance at 1,000 cycles per second 1.0 mfd. plus or minus 0.5%.

After one year, the capacitance changed only .08%.

CP Plasticon Type P capacitors are available in voltage ranges of 100, 400 and 1,000 VDCW—capacitances of 0.1 to 25 mfd. in metal can container, capacitances of .01 to 1.0 mfd. in glassmike container.

• *Your engineering problem will receive the immediate attention of our design and specification engineers.*

Characteristics (at 25° C)
Resistance: 100,000 megohms per mfd. or 100,000 megohms, whichever is less
Power Factor: .05% or less
Dielectric Absorption: .05% max.
Temperature coefficient: Approximately 75 PPM/° C Negative
Temperature Range: −60° C to +90° C
Capacitance Tolerance: ±10% standard, 5%, 2% and 1% also available

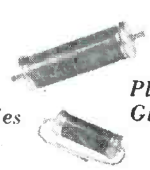
Condenser Products Company

Division of New Haven Clock & Watch Company

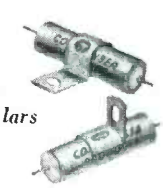
7517 North Clark Street • Chicago 26, Illinois

Send for catalogue sheets and performance charts on any of these CP products:


Plasticon Hi-volt Power Supplies


Plasticon Glassmikes


Plasticon Rectangulars


Plasticon Metal-clad Miniatures


Plasticon Pulse Forming Networks

Want more information? Use post card on last page.

arbors were provided per machine. One arbor was unloaded and loaded while the other was being wound. This new arbor gave an additional increase of 16 coils per hour.

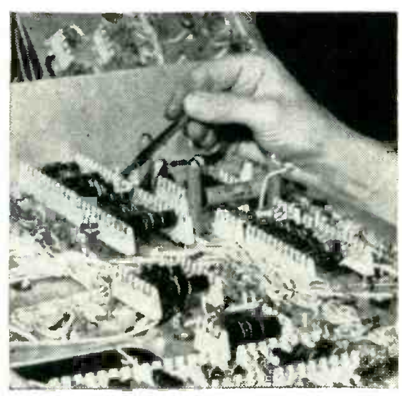
Next, the arbors were redesigned to accommodate four coils. This increased the production per worker to 106 coils per hour, reducing the original labor cost for winding a coil from $0.0324 to the present value of $0.0099 for a saving of $0.0225 per coil.

Notched Ceramic Terminals Reduce Assembly Time

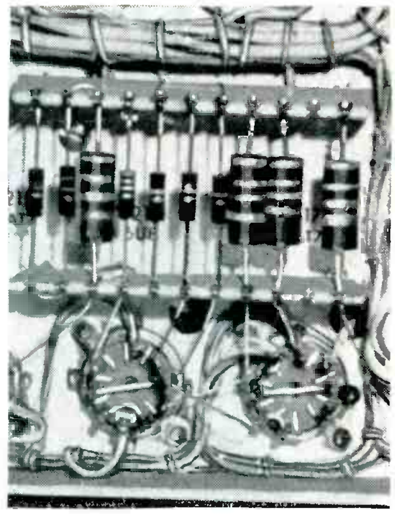
SPECIAL ceramic terminal strips used by Tektronix in the manufacture of cathode-ray oscilloscopes and other electronic equipment save assembly time, reduce inspection and test time, save space, reduce wiring errors, require less heat for soldering and are less expensive.

The notches are cut into the

Leads are soldered conventionally to ceramic terminal strips



Inspecting completed chassis employing ceramic terminal strips for mounting all components

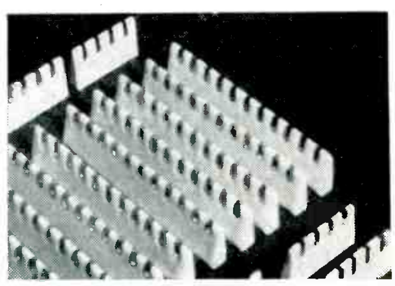


Method of making connections from ceramic terminal strips to adjacent tube sockets

ceramic strips after they are molded, but before hardening, and a silver paste is applied to the notches. After the firing process, the strips are dipped in melted soft solder. A thin coat of solder adheres to the silver, protecting it from oxidation.

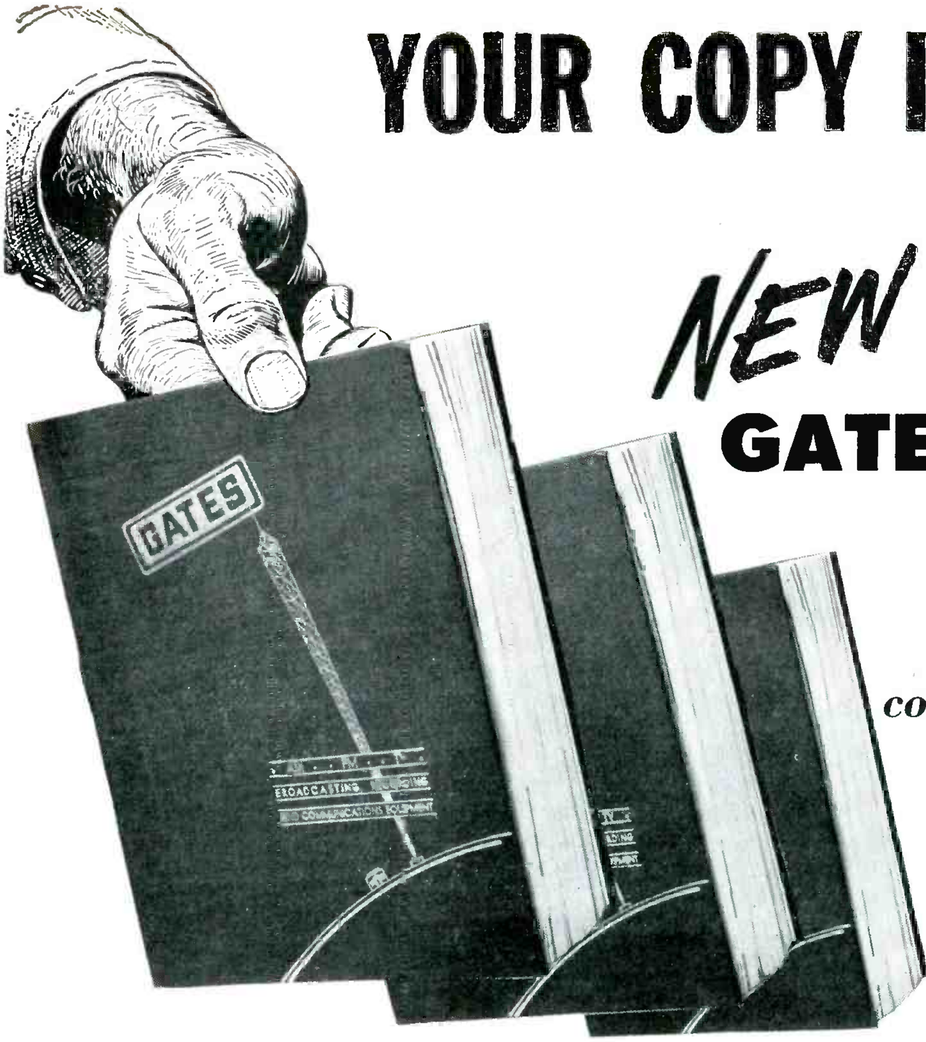
Mounting to the chassis is accomplished through studs previously cemented into the bottom of the strip. The position of standoff nuts on the studs regulates the distance between the strip and the chassis.

In practice, the strips are mounted on the underside of the chassis in parallel pairs, just far enough apart to accommodate the largest component. When the ceramic strips are mounted over tube sockets, the terminals of the sockets are wired before components are added to the strips. This is permissible because no components are soldered directly to the socket and the tube socket wiring itself need never be disturbed in the field. All components are readily accessible



Appearance of terminals before installation in chassis

YOUR COPY IS READY!



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Yes, the new big GATES 250 page catalog of radio transmitters, speech input equipment, tape recorders, antenna towers, remote apparatus and hundreds of complete items as well as materials for the radio or TV station is now off the press! It also contains a wealth of informative, handy reference material that no radio station should be without. Over two truck loads of 80 pound enamel paper have gone into what we believe is the finest and most complete catalog ever offered to the specialized industry of radio broadcasting, communications and industrial electronics.

No doubt you are on our mailing list, but we want to be sure. Will you take just a moment and fill out the coupon? Tear it off and mail to:

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Box 290, Quincy, Illinois

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- 51 E. 42nd Street, New York City

- *International Division,* 13 E. 40th St., New York City
- Canadian Marconi Co., Montreal, Quebec

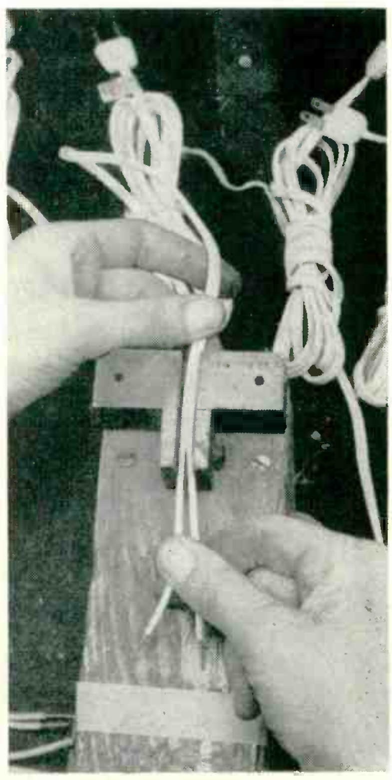
for servicing and are easily removed and replaced in the field when ceramic terminal mounts are employed.

Another advantage of these terminals is elimination of chassis subassemblies. The complete chassis wiring job becomes the responsibility of one person, encouraging high-quality workmanship.

Because of the small mass of each terminal point, less heat is required to solder connections on the ceramic strips. Component leads may be clipped very short without risk of damage by soldering heat.

Zip-Cord Slitter

POWER cords for radio and television sets are slit apart the required distance in one quick movement through a special Crosley-designed slitting fixture. Metal guide blocks mounted on a wood base position the parallel-conductor wire accurately. A razor-sharp cutting blade is vertically mounted midway between the blocks, so that it slits the cord precisely down the middle when the cord is pulled



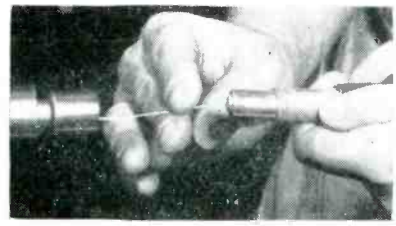
Method of using fixture for slitting power cords through the blocks. The top of the blade is far enough below the blocks so fingers of operators do not get cut accidentally.

A strip of masking tape on the wood base of the fixture serves as a guide; when a cord is pulled out to the tape, the required length of slit is obtained.

Air Cylinder Added to Spinning Lathe

THE OPERATION of anchoring insulating cardboard tubing on hermetically sealed paper capacitors in the Pyramid Electric Co. plant involves slipping the tubing over a unit, inserting the axial leads into the headstock and tailstock tools of a spinning lathe, then bringing the motor-driven tailstock up against the headstock to spin the cardboard smoothly over the ends of the metal housing of the capacitor. Both tools are driven at the same speed of 1725 rpm by independent motors. The friction between the stationary capacitor and the rotating tools at the instant of contact melts the impregnating wax in the housing, facilitating the inward flow of paper. The operator holds the capacitor body loosely with her fingers as the tools come together, and lets it loose to spin

Spinning lathe on which air cylinder has been installed for moving tailstock motor back and forth



Method of inserting hermetically sealed capacitor in lathe for spinning cardboard tubing over metal housing. Both headstock and tailstock tools rotate continuously

after the crimping action has started.

Previously, a manual foot pedal arrangement was used to move the tailstock motor and tool up after a capacitor had been inserted. Spring loading held the motor back out of the way when the pedal was released. To lessen operator fatigue and obtain faster movement of the tailstock motor, a Schrader air cylinder was mounted behind the motor on the lathe, for use with a foot-operated air valve. This valve has three air lines, to provide positive retraction of the tailstock motor when the foot pedal is released, at the same speed as for advance of the motor at the start of spinning.

Adjustable Harness Board

THE OPTIMUM working angle for any size and type of wiring harness board can be obtained in a few minutes with the adjustable hardwood easel used for this purpose in the Coamo, Puerto Rico plant of Caribe Aircraft Radio Corp.

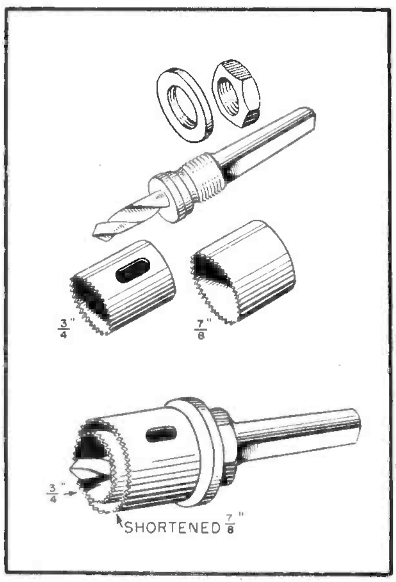
Two bolts and wing nuts passing through hardwood strips at the top of the frame serve to lock the harness board in position. Other

Lacing of finished wiring harness for military radar equipment on board supported by adjustable easel wing nuts passing through holes drilled in the easel support permit quick change of working angles for the boards. The resulting rigid mounting facilitates tight lacing of a finished harness with Gudebrod nylon lacing cord.

Antenna Holesaw

DRILLING of holes for feed-through connectors, terminals and mounts in painted or enameled sheet metal is expedited by modifying a standard $\frac{3}{4}$-inch Black and Decker holesaw. This involves mounting a $\frac{7}{8}$-inch holesaw concentrically on the same mandrel, and cutting back the teeth of this added unit so that they nest about $\frac{1}{8}$-inch behind those of the $\frac{3}{4}$-inch holesaw, as shown in the illustration.

When this tool is used in an electric drill, the $\frac{3}{4}$-inch holesaw cuts through the sheet metal and is then supported by the added holesaw. This prevents the tool from dropping through and damaging components on the other side. Allowing the tool to rotate a few seconds more is then sufficient for the crude teeth to remove about $\frac{1}{16}$-inch of paint around the hole, to get a good ground connection. The entire job



Method of modifying holesaw. Regular washer and locking nut hold both saw blades just as easily as one blade. When grinding down teeth of outer blade, no attempt is made to obtain sharp cutting teeth since they are used only for scraping off the paint of drilling and preparing for mounting is thus accomplished neatly with one tool.

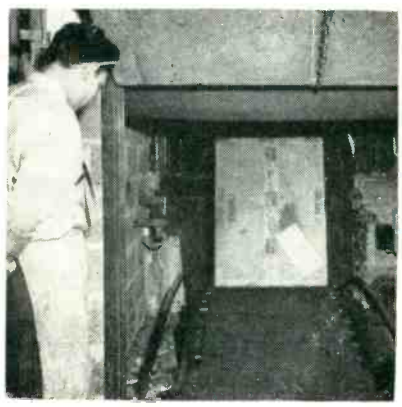
The tool has proved particularly advantageous for installing rooftop antennas for mobile radio equipment, where a good antenna ground is essential. There is no danger of the saw dropping through the roof and tearing the headlining.

Credit for suggesting this idea is given to Sherman Wolf in the January-February 1953 issue of Motorola Newsgram.

Counting Output of Plant

ORDINARY switches and a photoelectric counting system are combined to provide a second-by-second record of daily production on indicators in the office of the director of manufacturing at Olympic Radio & Television. Any interruption in the clicking of these counters is noted immediately by the man responsible for all production, long before anyone would normally call him by phone to tell of trouble.

Belt conveyors are used to take sealed cartons of finished sets from the various floors of the plant down to the loading dock. At the entrance to each of these conveyors is a group of spring-release toggle switches, one for each model of set coming from that floor. After each carton is placed on the outgoing belt, the operator presses the appropriate switch once, thereby actuating the



Operator flips switch on wall with left hand as finished set in carton goes down conveyor tunnel to loading dock. Carton has just interrupted light beam of photoelectric system used to obtain totalized count

B. Bordiga, director of manufacturing, studies counters in his office that indicate number of receivers of each type produced since line started in morning

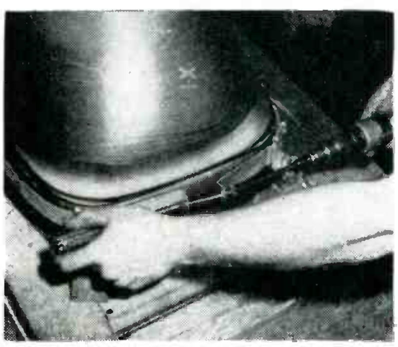
corresponding counter in the head office.

The photoelectric systems are installed in each of the two conveyor tunnels, where they automatically react to all cartons regardless of size and give totalized counts on two separate indicators in the office. This serves as a check on individual counts, since a worker may occasionally forget to flip a switch or may accidentally bump a switch panel and give a false count.

Mounting 21-Inch Tubes

SIMPLE production tools and techniques permit safe and speedy suspension of heavy 21-inch rectangular picture tubes from the top of the cabinet in Olympic television receivers.

After adhesive-backed sponge rubber strips are pressed around the rim of the tube, it is set face down on a cushioned wood pallet and the steel clamping band is applied;



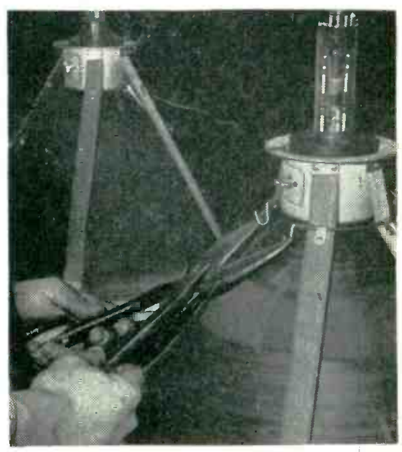
Tightening clamping band of 21-inch picture tube while face of tube is centered on special pallet

Method of using pliers to pull nylon yoke strap over bracket of clamping band

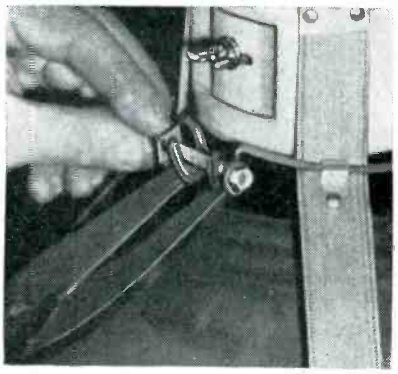
holes in the front-panel mounting brackets of the band mate with steel studs on the pallet during this operation, to insure accurate alignment of the band. After inserting the locking bolt and nut, the operator holds the nut with a socket wrench while tightening the head of the bolt with an air-powered screwdriver.

Next, the deflection yoke assembly is placed over the neck of the tube and the nylon yoke straps are one by one hooked over the rim clamp brackets. Ordinary pliers are used to get a good grip on the short surplus stub of nylon strap during this operation.

A spring steel wire ring is now placed over the nylon straps, so that it sets in steel hooks riveted to the straps. The ends of the ring are pulled together with a pair of large tin snips having a notch for the pur-



Using notched-blade tin snips to pull ends of spring-steel ring together



Holding ends of spring-steel ring together while inserting preassembled bolt in V-shaped ends of ring

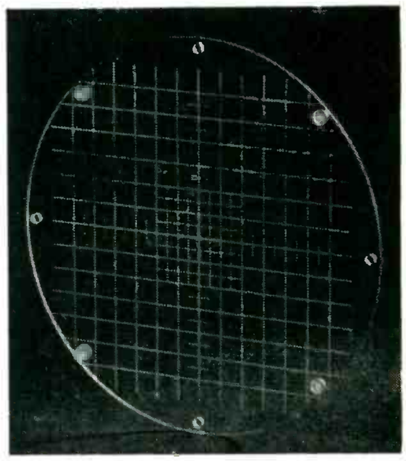
Installing deflection yoke bracket to complete mounting of picture tube in cabinet

pose in the end of each blade. While holding the ring together with the snips in one hand, the operator drops into position a bolt on which the nut has already been started. The ring is now released by removing the snips, and the bolt is tightened conventionally with an air-powered driver until the desired additional tension on the nylon yoke straps is obtained.

With this type of harness, mounting of the picture tube becomes similar to the mounting of loudspeakers in cabinets. The four brackets on the clamping band fit over four stud bolts built into the front panel of the cabinet.

Imprinting on Plastics

A NEW process for marking lines, scales and figures on thermo-setting plastics is announced by Homalite Corp., 11-13 Brookside Drive, Wilmington, Delaware. Lines as thin as 0.007 inch can be produced to an accuracy of 0.002 inch on the material, with a reported 50-percent saving in cost over conventional methods. The lines and figures may be



Example of oscilloscope screen window made by new technique

applied in any color and are almost impossible to obliterate, since there is no known solvent for the material employed.

The chief applications of the new technique are for internally lighted electronic equipment, including oscilloscopes, radar screens and instrument windows.

Making Small Tubing by Electrodeposition on Nylon

METAL tubes with diameters from 1 mm down to 0.1 mm or less are often useful in electronic and instrument techniques. Indirectly heated cathodes for electron tubes are one example. Small metal tubes are generally made either by drawing down larger tubes or by electrodeposition on a mandrel. The first method must generally be used for alloy tubes, but it is difficult to obtain very small diameters. The electrodeposition method can be used for pure metals but in the deposition on waxed or oxidized threads it is difficult to pull out the mandrel without destroying the tube, especially with very thin walls and small diameters.

A variation of the electrodeposition method makes use of the excellent mechanical properties of nylon fiber as a mandrel. Drawn nylon fibers of high strength and with very smooth surfaces are obtainable in exact dimensions.

The first step in making tubes is silvering of the nylon fiber by the Brashear or Rochelle salt method used for glass, as described in "Handbook of Chemistry and

Physics", 30th edition, p 2,537. A better adhesion between nylon fiber and the silver coating is obtained if the nylon fibers before the silvering process are dipped in a solution of 1 g $SnCl_2$ in 1 liter of distilled water and then rinsed in two (not more) baths of distilled water. The silvered nylon fiber is then plated to the necessary wall thickness with the metal desired. In order not to destroy the thin silver coating, the electric circuit must be closed before the fiber is immersed in the electroplating bath.

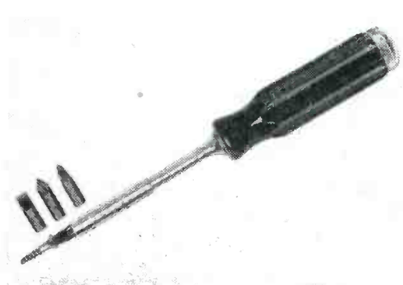
The nylon mandrel may be removed from the metal tube by holding one end of the tube with tweezers and drawing on the free end of the nylon fiber. The fiber will then contract without breaking and free itself from the inside surface of the tube. It can easily be drawn out. If necessary, the thin silver coating inside the tube can be removed by short dipping in dilute nitric acid.

Tubes several inches in length with inside diameters as small as 0.05 mm can be made in this way. Metals such as copper, silver and nickel have generally been used. It is also possible to make hard and corrosion-resistant tubes of a nickel-cobalt alloy by simultaneous electrodeposition of these two metals.

This technique was described in "Review of Scientific Instruments" by Rolf J. E. Gezelius, Research Institute of National Defense, Stockholm, Sweden.

Magnetic Screwdriver

A NEW screw-holding tool suitable for repair and test positions comes with three interchangeable bits for slotted and Phillips screws. A mag-



Convenient compartment in plastic handle of magnetic screwdriver serves for storing bits which are not in use netized bit holder holds each bit in position and provides magnetic holding power for iron or steel screws. When no bit is in the holder, it may be used as a magnetized socket wrench for driving ½-inch hex-head bolts or nuts. The tool was initially available as a premium from Sylvania's advertising department, but is now available through commercial channels as well as from Sylvania distributors.

Filling Transformers with Nitrogen

IN THE PRODUCTION of excitation transformers for radar antenna stabilizers at Keystone Products Co., simple yet effective techniques are employed to obtain a soldered vacuum seal, pump out the air, put in nitrogen and seal the units.

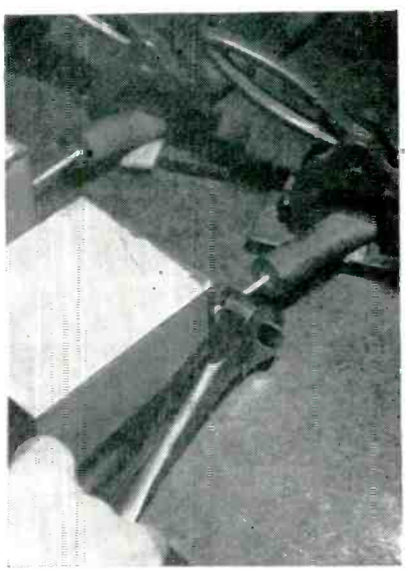
Use of parallel machinist's clamp for aligning housing while soldering cover

Mounting plates are soldered into the transformer housing by hand rather than by induction soldering. Accurate alignment of the sides of the housing is assured through use of parallel machinist's clamps on which extension jaws have been brazed. A heavy electric soldering iron is used to flow solder into the joint. Absence of pinholes during this operation is attributed to a clean and neat preliminary tin-plating of the components.

A refrigerator unit running backward is used as a vacuum pump to get up to and even over 28 inches of

Arrangement of vacuum and gas lines for filling transformers with nitrogen

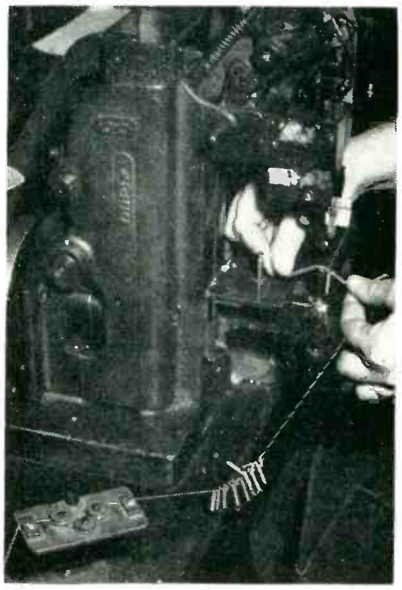
vacuum. For this, an old unsealed type of compressor is required. The units to be evacuated are connected to the vacuum line with heavy rubber hose through copper tubulations previously soldered to the cover plate of each transformer. When the units have been pumped out, a valve in the vacuum line is closed and another valve is opened to admit dry nitrogen from a tank under 3 lb pressure. A cam and bar type



Method of cutting and crimping tubulation to seal off a transformer clamp on each rubber hose is then closed to hold the system under pressure. The copper tubulations of the transformers are then cut and crimped with a dulled cobbler's tool, and the resulting pinch seal is soldered by hand as an extra precaution.

Dial Cord Machine

A STAPLING MACHINE with a steel scale added at its right permits high-speed production of receiver dial cords in Olympic Radio & Television's plant. When starting up, the operator pulls the dial cord from a free-running spool on a floor rack, threads it around two guides and three pulleys on a bench-mounted jig, then threads a dozen or more



Setup for producing dial cords, each with an attached spring. Tension-controlling jig is in foreground

springs onto the cord. The end of the cord is now run out over the steel scale and around an adjustable peg that can be set at any point on the scale to control the over-all length of the cord.

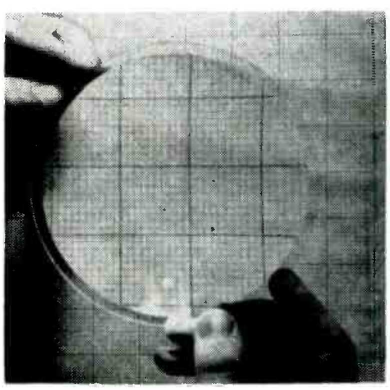
With one spring in the loop thus formed, the operator places the two ends of the loop in the anvil of the machine and presses the foot pedal to drive the clinching staple. The loop is now lifted off the peg behind the anvil to obtain slack, and a second staple is driven to box in the spring. Without cutting off the finished loop, the operator now slides another spring up, rethreads the setup by running the cord around the two pegs, and drives two more staples to complete another dial cord. Cord for each new loop is pulled through the dangling batch of springs and looped around the pegs again. After all springs have been used up in this way, the finished loops are cut apart and the process is repeated.

Illuminated Magnifier Aids Small-Parts Assembly

A FIVE-INCH-DIAMETER specially-corrected lens surrounded by a circular fluorescent lamp permits binocular vision without strain for inspection and work on small parts. The combination of 2X magnification with 400 to 500 ft-candles of substantially daylight shadowless illumination contribute to visual comfort over long periods.

The lens is designed for use six inches from the eyes, with the ob-

Bench-model Magnivision illuminated lenses being used in Raytheon's Quincy, Mass. plant for precision assembly of miniature and sub-miniature tubes



Graphical illustration of distortion-free properties of 2X aspheric lens

Long-reach model, which can be mounted at rear of inspection or production bench up to 37 inches back from center of lens

ject five inches behind the lens. Users automatically seem to assume the optimum viewing position. The manufacturer is Engineering Developments, Inc., Portsmouth, Newport, R. I.

Special Inspection Desks

CONSTRUCTION of special desk-type inspection positions for laboratory tests of incoming materials has boosted the efficiency of Sylvania's inspection department in Emporium, Pa. and at the same time raised employee morale and provided increased protection for costly instruments.

At the rear of each inspection desk are shelves for microscopes, balances and other instruments. Hinged doors close over the fronts of these shelves to keep out dust and protect the instruments during nighttime cleaning operations. The doors swing open to form sides for the work position when the desk is in use.

Construction from ordinary knotty pine lumber proved ideal for the purpose when finished with clear rubbed-effect varnish, giving the atmosphere of an executive office rather than a production laboratory.

Welding Tube Bases

A TWELVE-STATION indexing table combined with a spot welder enables one operator to assemble stainless steel rings to octal bases at a rate of about 1,500 bases an hour in Sylvania's Warren, Pa. plant. The stainless steel bands that form the upper part of this

Left hand of operator loads stainless steel band onto turntable while right hand places molded plastic base over previously positioned band. Finished bases are blown upward into chute at left of table by air blast; occasional bases which stick, like that shown, are removed manually by operator

type of tube base are loaded in one cavity of the table, and the bases are loaded upside down in the next adjoining cavity.

At the next station, a rotating plunger driven from the center of the turntable acts to turn an outer ring which positions the lockseam of the band correctly with relation to the groove in the base. At the same time, the entire assembly is positioned by means of a keyway engaged in the base key. This insures that the proper pin is in the correct position for welding a ground wire internally from the pin to the band.

At the welding station, an overhead spool feeds nickel wire through the pin and a spot welder under the table joins the lower end of the wire to the inside of the band. After the welding operation the wire is cut just above the tube pin, for subsequent soldering to the pin during simultaneous dip soldering of leads to all pins.

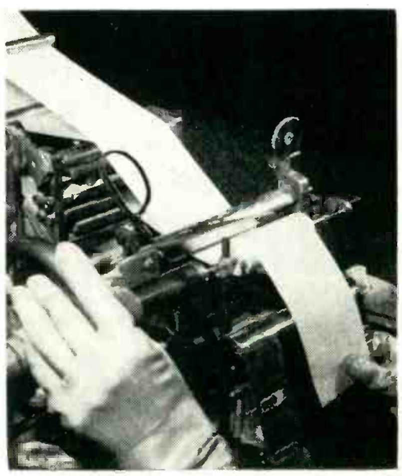
Winding Electrolytics

LARGE ordinary scissors bolted to the headstock of an improvised machine for winding electrolytic capacitors serve as cutoff shears in Pyramid's plant. The downward-facing blade is rigidly mounted in a

Method of using mounted shears to cut strips of insulating paper after winding an electrolytic capacitor

horizontal position just above the strips of insulating paper. The other blade is spring-loaded to keep it normally down, well under the strips of paper. The handle of this blade thus projects upward. Pushing this handle down gives quick cutoff at the end of each winding.

The machine has two foot pedals, one for starting and stopping the arbor and the other for operating the tab-crimping dies just back of the shears. When the precut length of etched aluminum foil has been almost completely wound between the layers of insulating paper, the operator places a metal tab over the



Appearance of winding machine when unit has been almost completely rolled and operator is operating crimping die to fasten a terminal tab to one of the etched foil strips. Die is just back of handle of shears

Method of using sample containers to check diameter of a finished roll

foil in the die and pushes the foot pedal. This drives a number of pointed pins down through tab and foil into mating holes, then flattens the self-riveted assembly. When inserting the etched foil for a new capacitor, it is threaded between the jaws of the crimping die.

This winding machine for electrolytics uses a support for the right-hand end of the arbor to insure uniform winding despite the pull of the relatively heavy metal foil. The pivoted arbor support is spring-loaded to stay upright, but can easily be pushed down out of the way for removal of the arbor pin that locks the start of each winding, then for removal of the finished unit.

One sample of each size of can used for electrolytics is riveted to a metal strip for use as a go-no go gage for occasional checking of capacitor roll diameter. The completely rolled unit must fit smoothy into its can. A tight fit generally means that terminal connections are too bulky.

Paint-On Solder

A SOLDERING alloy pre-mixed in exactly the right proportions with a specially formulated noncorrosive flux can be applied with a small brush, eliminating the need for using one hand to hold rosin-core solder. The new paste material, known as Tin Weld, is a development of Eutectic Welding Alloys Corp., 172nd St. and Northern Boulevard, Flushing, N. Y.

Parts need only to be painted with the paste and heat applied. After cooling, excess flux can be removed with a damp cloth, or by rinsing in water. There is no need for preliminary tinning of parts.

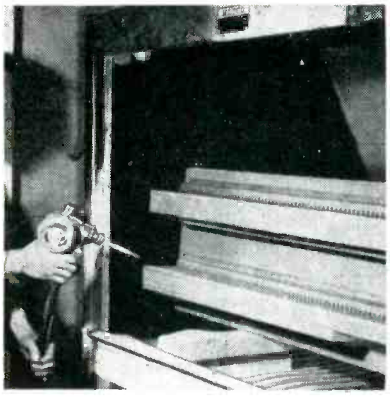
In connection with assembly of radio receivers, one user reports doubling of output after changing to the new paste solder. It has proved ideal for delicate work requiring minimum solder, and minimizes or completely eliminates waste solder. This latter characteristic often more than counteracts the higher cost of the paste solder, which sells for $5.60 a 2-pound can.

The paste can also substitute for solder preforms at lower cost, and can be used in locations where ordinary solders cannot reach, as well as for tinning odd-shaped parts. Strength of joints is reported to be at least as great as that obtained with conventional lead-tin solder. All common metals except aluminum and magnesium can be soldered with full solder-bond strength.

Molten Metal Spray Shields Plastic Parts

ONE of the problems encountered in manufacturing the new Dictaphone electronic recording instruments was adequate shielding of the closely assembled amplifier components while keeping the recorder compact and light for portability. The solution evolved was use of molded Bakelite housings, with shielding being achieved by metallizing the inside of each with zinc. This coating was sprayed on in

Spraying group of 10 Bakelite pivot blocks for electronic dictating machines with molten metal for shielding



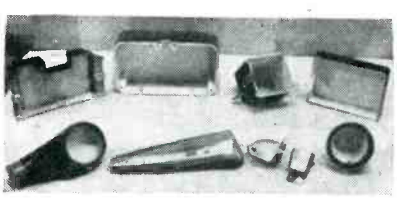
Using molten-metal spray gun to apply shielding layer of zinc to wooden wind chest of an electronic organ

molten form with a Metco metallizing gun, made by Metallizing Engigineering Co., Long Island City, N. Y. Cost of the shielded plastic parts was only about one fourth that of solid metal parts, with a comparable saving and weight. The shielded housings are grounded to the chassis just as if they were metal.

Plastic parts to be metallized are masked first to protect surface finishes, then set up in fixtures holding 10 or more parts and sandblasted to remove surface oxides. This takes a man 3 minutes. After transfer to another similar fixture, the parts are sprayed with molten zinc to give a metallized coating up to 0.003 inch in thickness. This operation takes 6 minutes of one man's time, using $\frac{1}{8}$-inch zinc wire in the gun. Cost is figured at $1.88 per hour for metallizing and $1.75 per hour for sand blasting, plus the cost of materials and an added 300 percent for overhead.

The alternative procedure of shielding the insides of the plastic parts with inserts of lead, copper, zinc or foil would have cost about four times more than metallizing.

In a somewhat similar metallizing operation at Rudolph Wurlitzer



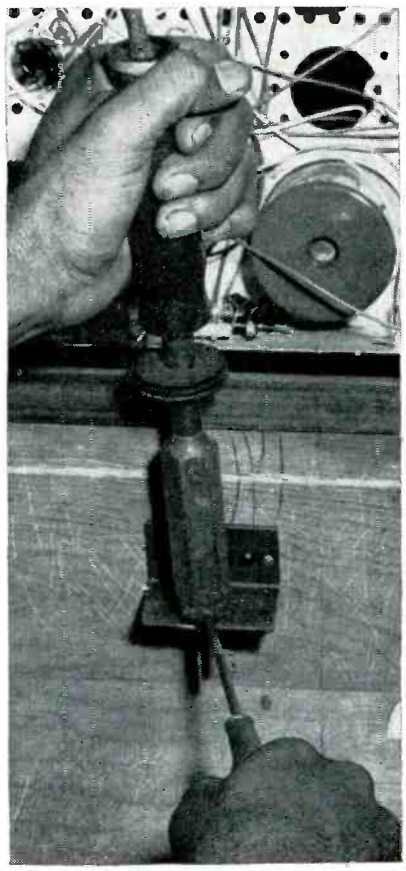
Examples of molded plastic parts having sprayed metal shields inside, used in electronic dictaphones

Co., North Tonawanda, N. Y., organ wind chests of electronic church organs are shielded by spraying on a 0.005-inch-thick coating of zinc. The sections of the wood chest that are not to be covered are masked off with heavy paper. The sprayed shield is grounded to prevent interference and hum that might be caused by shortwave broadcasts, X-ray machines, power lines and other sources of stray signals.

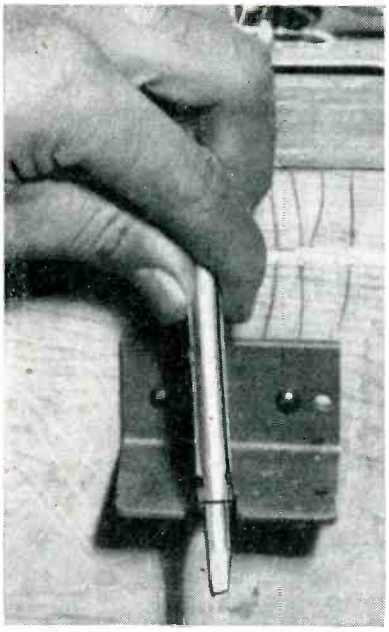
Outdoor-type power capacitors are being given a 0.01-inch coating of pure zinc by metallizing at one Westinghouse plant, to give electrolytic protection against corrosion. As a result of the success of this protective coating in the field, zinc metallizing of large indoor-type capacitors was also adopted by this company.

Bracket Aids Removal of Soldering Iron Tip

THE OPERATING principle of the old boot jack has been successfully applied to the problem of loosening frozen soldering iron tips in the



Method of using bench-mounted bracket to aid in removing hot tip of soldering iron used on television receiver line



Closeup of bracket, showing also how slots are milled into tip of iron

plant of Olympic Radio & Television, Inc. The tips are notched on opposite sides with a milling cutter, to correspond to the recess just above the heel of the boot.

Within convenient reach of each assembly line soldering position, a small bracket is fastened to the bench with wood screws. A slot is cut into this bracket, just wide enough so the notched part of the tip can get in. To remove a tip, the operator slides it into the bracket, loosens the locking screw, then jerks the handle of the iron upward.

Testing Television Receivers

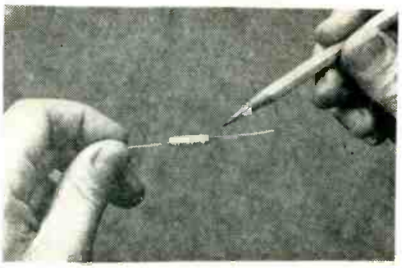
To get a quick check of the horizontal and vertical sync pulses in a television receiver before the picture tube has been inserted, a small pickup coil can be inserted in the deflection yoke and connected to the vertical input terminals of a cathode-ray oscilloscope. The coil can be 50 turns wound in a single layer on a $\frac{3}{4}$-inch outside-diameter form, using any convenient small size of wire. If the sync pulses as viewed on the cro do not stand still, the sync is out of adjustment. This suggestion comes from CBS-Columbia production engineers.

NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

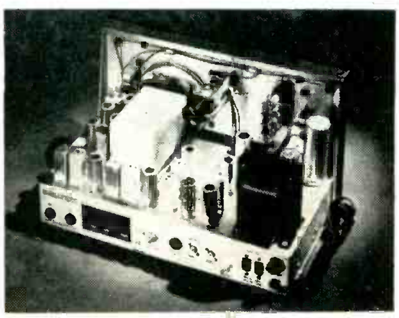
Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered . . . Forty Trade Bulletins Reviewed

OTHER DEPARTMENTS featured in this issue:



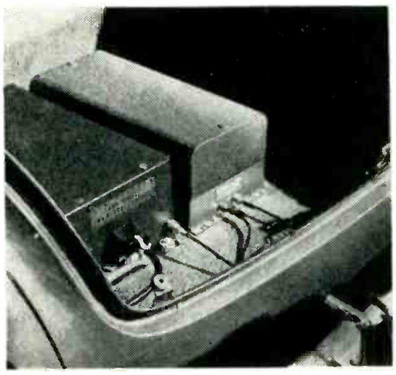
CAPACITOR
for transistor circuits

SANGAMO ELECTRIC CO., Marion, Ill., has developed an electrolytic capacitor for use in transistor audio circuitry. The type EHT capacitor has high-purity tantalum-foil electrodes with high-purity paper separators impregnated with a special electrolyte. Anode and cathode lead wires are securely welded to the foils for maximum electrical contact dependency. Ends are sealed with a polymerizing plastic that embeds the leads and section for maximum rigidity. Solderable leads of tin-coated nickel wire are firmly welded to the tantalum leads external to the capacitor body to preserve minimum leakage current properties necessary in transistor circuits.



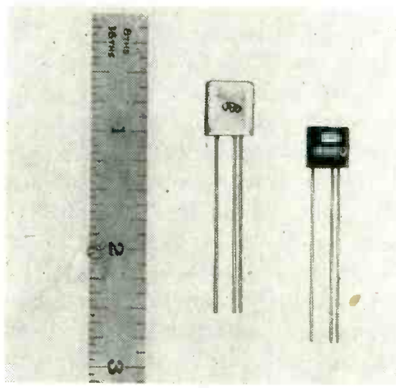
F-M/A-M TUNER
has adjustable afc

FISHER RADIO CORP., 41 E. 47th St., New York, N. Y. Model 50-R f-m/a-m tuner incorporates a two-band superhet circuit with completely independent r-f channels for f-m and a-m. The f-m section comprises a dual triode, cascode, tuned r-f stage for maximum signal-to-noise ratio, and two i-f stages followed by two cascaded limiters. The unit features a sensitivity of 5 μv for 30 db of quieting on 300-ohm antenna input, 2.5 μv on 72-ohm antenna input; adjustable afc; a uniform response of 20 to 20,000 cycles, ±1 db; distortion of less than 0.04 percent for 1 v output; and 10-kc whistle filter. Size is 14¾ in. wide, 8½ in. high and 9¼ in. deep. Weight is 17 lb.



POWER BOOSTER
for the 152-174 mc band

KAAR ENGINEERING CORP., Middlefield Road, Palo Alto, Calif., is now producing a power booster that will increase the power output of any 10-w mobile radiotelephone transmitter six times. The unit is inserted between the low-power transmitter and antenna. The power desired is selected by a switch on the dashboard and the booster is activated when the microphone button is pushed. Because the unit is instant heating, added power is not drawn from the battery until the mike button is pushed. The power booster may be used with any make of radiotelephone operating in the 152 to 174-mc band.

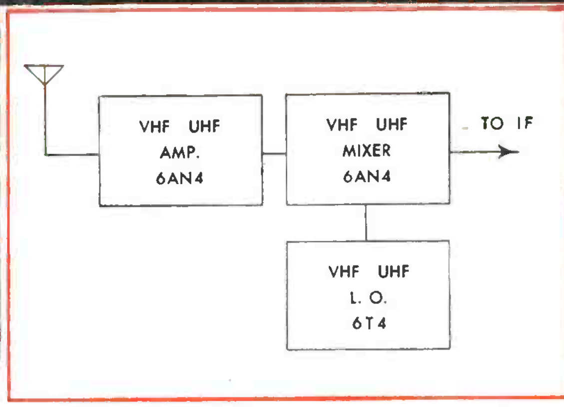


PNP TRANSISTORS
available in three types

RADIO RECEPTOR CO., INC., 251 W. 19th St., New York 11, N. Y., announces availability of three types of pnp junction transistors, useful from d-c to low r-f in high-gain amplifier, oscillators and shaping circuits. These tiny units are sealed in a thin plastic shell only 0.120 in. × 0.343 in. × 0.375 in. Leads may be soldered in, or clipped to plug into a standard transistor or hearing-aid-tube socket. The asymmetrical lead spacing insures proper polarity and fits the standard subminiature socket (proposed JETEC standard). Excellent performance can be obtained with as little as 0.5 ma at 1.5 v collector voltage. Under these conditions the type RR 20 has a current amplifica-

Make your UHF circuits as simple as VHF designs...

Use these two New Sylvania Tubes in tuners and converters



Representative block diagram of combination VHF-UHF tuner using the new Sylvania 6AN4 as rf amplifier and mixer, and the 6T4 as local oscillator.

Equipment Manufacturers! Simplify design of combination VHF-UHF tuners, UHF converters for TV! Two new Sylvania-developed tubes permit adaptation of conventional amplifier-mixer-local oscillator circuit to the new frequency bands—completely eliminate complicated switching arrangements or stage duplication. Leading Tuner Manufacturers have adopted these types for current tuner production.

- Short Bulb T-5½ 7-pin miniature construction.
- Requires no special socketry.
- Designed for use at frequencies up to 1000 mc.
- Double plate and grid leads.
- Designed for high production resulting in lower cost, more uniformity and better availability.

THE SYLVANIA 6T4 is designed for use as a local oscillator at frequencies up to 1000 mc. Used as the companion tube to the 6AN4, it makes possible the design of extremely simple combination tuners and UHF converters.

THE SYLVANIA 6AN4 can be used as a grounded grid, rf amplifier as a mixer. Its performance in the VHF band is comparable to that obtained with tube types capable only of VHF service.

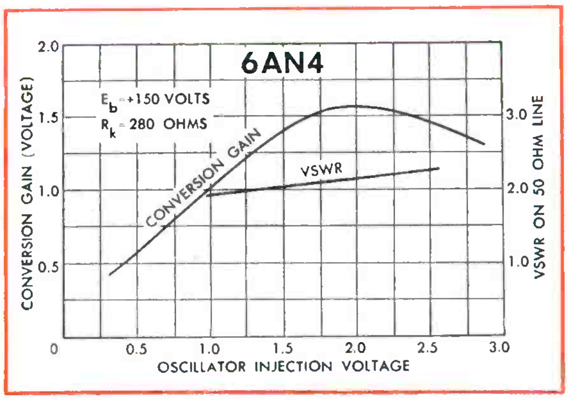
The 6AN4 is designed for both high g_m and high mu. Under representative operating conditions as a Class A amplifier, the transconductance is 10,000 micromhos and the amplification factor is 70.

When used as a mixer, the 6AN4 offers the advantages of a conversion gain and of relatively low oscillator drive requirements.

Complete technical information on operating characteristics, including performance curves, is included in the manual, "Sylvania's UHF Story." A copy is yours for the asking. Write to: Sylvania Electric Products Inc., Dept. 3R-1007, 1740 Broadway, New York 19, N. Y.

COMPARATIVE PERFORMANCE OF THE 6AN4 AT VHF AND UHF

CONDITIONS	INSERTION GAIN db	BAND WIDTH mc	AMPLIFIER NOISE FIGURE db
Single tube in Channel 13 booster	14	10	9
Two tubes in cascode in Channel 13 booster	22	7.5	8
Single tube in open half-wave tuned amplifier at 450 mc.	12	10	12
Single tube in open half-wave tuned amplifier at 900 mc.	10	10	15



Curve shows conversion voltage gain using 50 ohm input and output, and input VSWR of the type 6AN4 when used as a mixer.

SYLVANIA

LIGHTING • RADIO • ELECTRONICS • TELEVISION

In Canada: Sylvania Electric (Canada) Ltd.
University Tower Bldg., St. Catherine St.
Montreal, P. Q.

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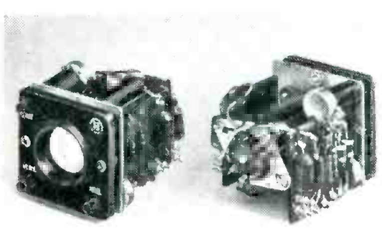
tion of 40 and a power gain of 36 db; types RR 14 and RR 21 have current amplification of 25. The RR 14 and RR 20 have cutoff currents of only 10 μ and a noise figure of 22 db (1,000 cps).

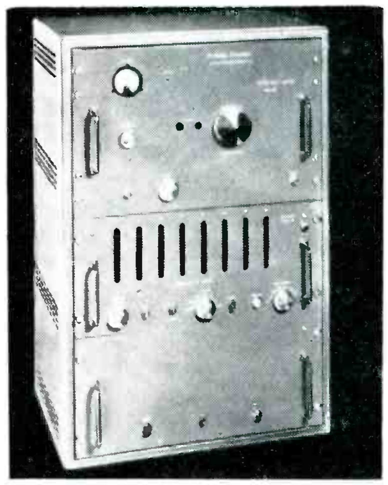
POTENTIOMETERS
operate from 0 to 80 C

BIRKLAN CORP., 200 E. Third St., Mt. Vernon, N. Y. Series 3500 potentiometer achieves a linearity of 0.01 percent through utilization of advanced servo-controlled winding techniques. Each unit is individually calibrated against a standard accurate to 0.001 percent. Resistance range is 2,000 ohms to 300,000 ohms with a standard resistance tolerance of $\pm$ 1 percent. Temperature range of operation is 0 to 80 C. Low temperature-coefficient resistance wire and thermal cycling is used to stabilize resistance value. Electrical and mechanical rotation may be specified to any value between 360 deg and 3,780 $\pm$ ½ deg.



MINIATURE CRO
for instrumentation use

JAMES MILLEN MFG. CO., INC., 150 Exchange St., Malden, Mass. Use of miniature panel-mounting c-r oscilloscopes for instrumentation in place of the conventional pointer-type moving-coil meters is made practical by the new 1-in. oscilloscope just developed. This scope has a panel bezel matching in size and style the standard 2-in. square case meters. It uses the 1CP1 one-in. crt. This compact tube has an extremely bright and sharp trace. There are many places in receiver, transmitter, amplifier and radar circuits where the wave shape and pulse form are of equal or even greater importance than magnitude. By the use of this new unit, magnitude, phase displacement and wave shape are constantly visible on the scope screen.



FREQUENCY METER
is direct reading unit

BERKELEY SCIENTIFIC DIVISION of Beckman Instruments, Inc., 2200 Wright Ave., Richmond, Calif. Model 5570 frequency meter offers a direct-reading instrument capable of measuring frequencies from 0 cps to 42 mc. Possible accuracies of 1 part in 10^7 ± 1 count can be attained. The indicated frequency is displayed in digital form on eight banks of illuminated lucite number panels. Basically the model 5570 consists of two sections: (1) a high speed events-per-unit-time meter, and (2) a heterodyne unit. Frequencies from 2 to 42 mc are applied to the heterodyne section, the mc selector knob turned to the proper harmonic and the results are read directly on the eight decade number panels. By means of accessory heterodyne units, the complete range, up to 160 mc, can be read by this instrument.

DECADE AMPLIFIER
has high gain, low noise

KALBFELL LABORATORIES, INC., 1090 Morena Blvd., San Diego 10, Calif. The Kay-Lab model 102B decade amplifier is a general purpose preamplifier having stabilized gains of 40 db and 60 db, and maximum gain of approximately 80 db. One of its chief features is a very low hum and noise output for a gain-switching amplifier. Another feature is the high output voltage which, in conjunction with low noise, permits a very wide dynamic range. Maximum output is 50 v rms into 20 K ohms or higher load; 40 v rms into 5 K ohms load; 10 ma rms current into low impedance. Input impedance is 3 megohms shunted by 10-$\mu\mu$f capacitance. Power requirements are 105 to 125 v, 60 cycles, 75 w.

CHOPPERS
operate at 10 to 500 cps

STEVENS-ARNOLD INC., 22 Elkins St., South Boston 27, Mass., has available two d-c/a-c choppers that feature uniform performance over the entire range of 10 to 500 cps. Characteristics of the type 364 and the 365 choppers are identical ex-

audiotape

TRADE MARK

BALANCED PERFORMANCE

gives you highest overall sound recording quality

...at no extra cost

audiotape has been designed, formulated and perfected to meet the most exacting requirements for modern, professional sound recording. Its mechanical and magnetic properties are carefully balanced to assure optimum overall performance in *your* recording machines.

Output, frequency response, noise level and distortion are correctly proportioned for the most satisfactory end result — with no compromise on quality anywhere along the line.

Perfected manufacturing techniques and high production volume enable this premium-quality tape to be offered to you at *no increase in price.*

Here are some of Audiotape's extra-value features:

More Uniform Frequency Response — Audiotape's output does not tend to fall off at the higher frequencies. Response remains excellent throughout the complete range of audible sound, requiring no special equalization.

Low Noise Level — Extremely uniform dispersion of magnetic particles results in exceptionally low noise level — completely free from troublesome ticks and pops. Overall signal-to-noise ratio is entirely comparable to that obtainable with average production of any premium price tape on the market.

Low Distortion — Highest quality magnetic oxide, in a coating of precisely controlled uniform thickness, results in exceptionally low distortion over a wide range of bias settings.

Maximum Uniformity — All 7" and 10" reels of plastic base Audiotape are guaranteed to have an output uniformity within the reel of ±¼ db or better — and a reel-to-reel variation of less than ±½ db. What's more, there's an actual output curve in every 5-reel package to prove it.

Complete Interchangeability — Since Audiotape requires no special equalization adjustments, Audiotape recordings can be interchanged freely between radio stations and studios — played back perfectly on any machine.

Highest Coating Adhesion — keeps the magnetic oxide coating from rubbing or flaking off. No danger of fouling heads and guides.

Guaranteed Splice-Free — Plastic base Audiotape, in both 1200 and 2500 ft reels, is positively guaranteed to be free from splices.

Low-Tension Reel Design — with 2¾" hub now standard for all 1200 foot, 7" reels. By eliminating the high tension zone encountered at smaller hub diameters, this reel assures more accurate timing, more constant pitch, slower maximum reel speeds and reduced wear on heads and tape.

COMPARE AUDIOTAPE in an end-to-end run with any other sound recording tape available. Compare the *prices,* too. You'll find that Audiotape speaks for itself — in *performance* and in *cost!*

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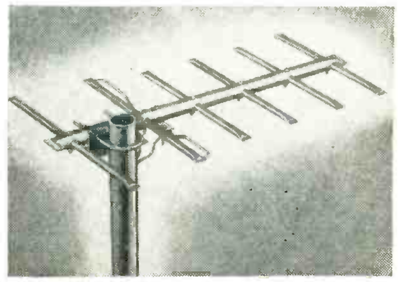
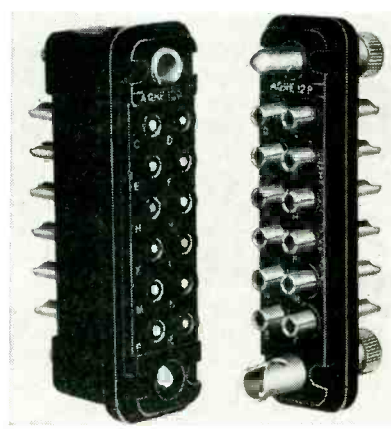
cept that the former is plug-in and the later is nonplug-in. Contacts are gold thus assuring adequate performance in the 0 to 1½ volt d-c range. Long-life rating is 1½ v d-c, 1 mil. Both choppers were designed for mobile military and aircraft service. Contact arrangement is spdt.



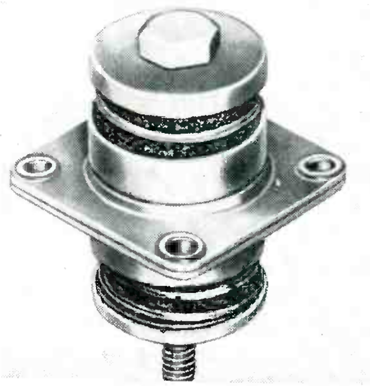
UHF-TV ANTENNA
is unusually rugged

DANFORTH MFG. CO., Monmouth, Ill., is manufacturing the Little Jewel, a new uhf-tv antenna featuring unusually rugged construction. Noncorrosive, heavy ¾-in. aluminum tubing is used for the boom; ⅜ in. for the six elements. Crimped ends eliminate vibration and whistle. The antenna comes fully assembled and ready for instant use. It has high forward gain, excellent front-to-back ratio and directivity. The folded dipole is perfectly matched to a 300-ohm leadin line.



CONNECTORS
for high-current use

WINCHESTER ELECTRONICS, INC., Glenbrook, Conn. A recent addition to the line of quick-disconnecting connectors is the AQRE 12. Twelve large contacts having 0.113 in. diameter solder cups for No. 12 AWG permit the use of higher current (up to 25 amperes) with no sacrifice of electrical characteristics and without increase in overall physical dimensions of the comparable QRE-type connector having the same number of contacts. The specially designed spring-loaded contacts provide easy disengagement of the plug and receptacle, thereby eliminating the need for levers or the use of force which often results in damage. Voltage breakdown between contacts at sea level is 6,250 v d-c; at 60,000 ft altitude, 1,450 v d-c. Weight of plug is 1.2 oz; receptacle, 2.1 oz.



ALL-METAL MOUNT for vibration and shock

ROBINSON AVIATION, INC., Teterboro, N. J., has developed a special double-acting unit mount, model 9302. Noteworthy features are nonlinear deflection characteristic high damping, low amplification at resonance and ability to withstand any conditions of temperature and environment. Made with the all-metal cushioning material, Met-L-Flex, the mount is suitable for the isolation of vibration and shock for positive, negative and radial loads, thereby protecting sensitive components, such as the all-important electronic guidance systems. It is recommended that the units be mounted in the plane of the center of gravity of the equipment for maximum efficiency. Load ranges are presently available between 1 and 7 lb per mount. A range of natural frequencies above 10 cps can be provided depending upon

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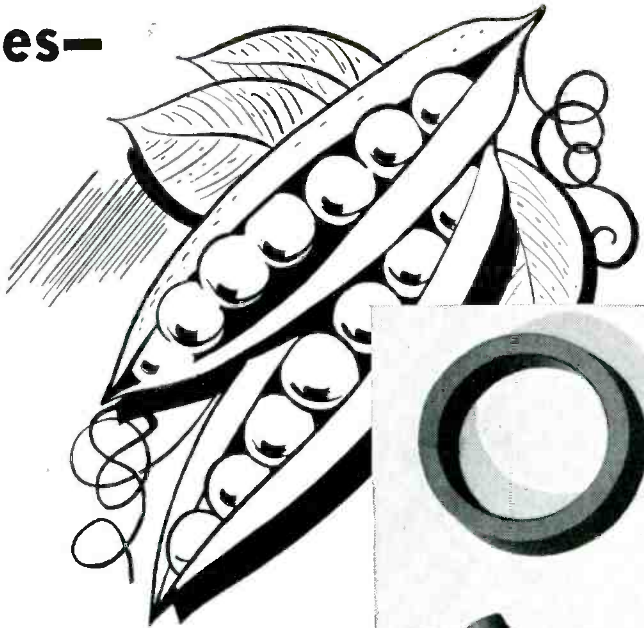
Ferrites—more alike than peas in a pod!



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Now!—Moldite's famed precision production facilities have been augmented with a complete plant specializing exclusively in *continuous, uniform production* of ferrite cores. When you use Ferricores by Moldite . . . you can be certain of absolute uniformity from the first to the millionth unit.

A special Ferricore-Moldite material is available for high temperature applications. For higher frequency applications where minimum eddy-current losses are more important than maximum permeability, a new ferrite material is now ready for production.

You'll find Moldite Ferricores will give you lower losses, greater efficiency, higher permeability . . . and LOWER COST!

FERRITE CORES
MOLDED COIL FORMS
(iron and phenolic)
MAGNETIC IRON CORES
FILTER CORES
THREADED CORES
SLEEVE CORES
CUP CORES

Samples promptly submitted upon request for design, pre-production, and test purposes

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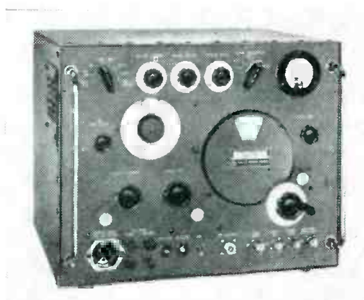
the load and performance requirements.

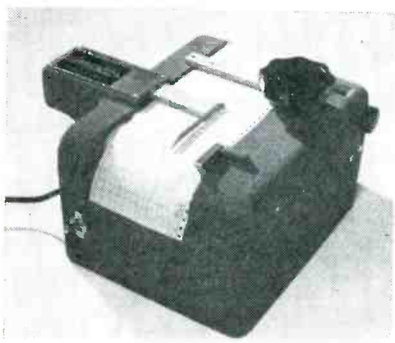
STABILIZER
for power supplies

KALBFELL LABORATORIES, INC., 1090 Morena Blvd., San Diego 10, Calif. Model 122 chopper stabilizer affords standard-cell stability to the output voltage of ordinary power supplies. The model 122B was designed for use with the Super-Regulator, model 121. It can be connected directly to terminals on the regulator provided for this purpose. A unique circuit is employed whereby a fraction of the output voltage is compared to a standard cell. A corrective signal is generated that is fed back to the power supply being regulated. This is a polarized signal of ±30 v and 5 ma. A precision attenuator is calibrated to afford the desired output voltage to an absolute accuracy of 0.1 percent. The chopper stabilizer can be adapted to any power supply.



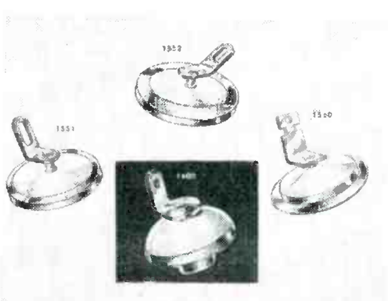
GENERATOR
offers varied pulsing

HEWLETT-PACKARD CO., 395 Page Mill Rd., Palo Alto, Calif. Model 618B signal generator is designed for faster, more accurate measurements of radio-relay, radar, tv-carrier systems and similar applications involving superhigh frequencies. Accuracy and stability is high throughout the continuous frequency range of 3,800 to 7,600 mc. The equipment may be internally or externally pulse modulated. Repetition rate is continuously variable from 40 to 4,000 pps. Pulse width is variable from 0.5 to 10 μsec. Sync-out signals can be simultaneous with the r-f pulse or in advance of the pulse by any interval from 3 to 300 μsec. Model 618B may also be synchronized with an external sine wave, or with positive or negative pulse signals.



PLANIMETER
for flow-chart totalizing

LIBRASCOPE, INC., 1607 Flower St., Glendale 1, Calif., has developed a square-root planimeter for flow-chart totalizing of 3-in. miniature graphic panel-strip-chart recorders. It provides for a true square-root extraction and integration without approximation over the entire range of flow. Totalizing is accommodated from leading to trailing edge of chart paper by means of a motor-driven sprocket. It gives readout to four places on the counter. Weight is 10 lb.



HERMETIC SEALS
with attached lugs

HERMETIC SEAL PRODUCTS CO., 33 S. Sixth St., Newark 7, N. J., has

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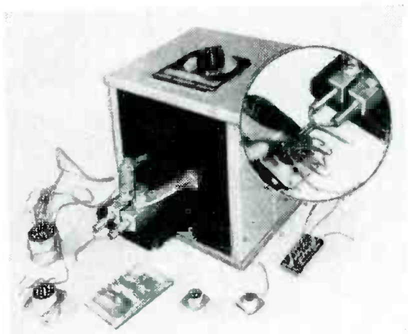
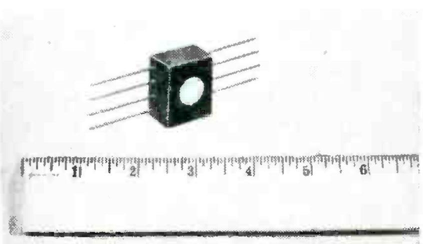
designed a complete series of hermetic seals with attached lugs as an associated line of the self-lug tubing seals. Lugs are affixed by a positive method guaranteed to be secure; and are available for every tubular seal and bathtub-capacitor seal currently used in industry. Lugs are available flat or bent through any angle desired; with pierced holes, or notched for wrap-around connection. Solder-lug feed-throughs, parts 1503-04-05-06, are also available in this series.



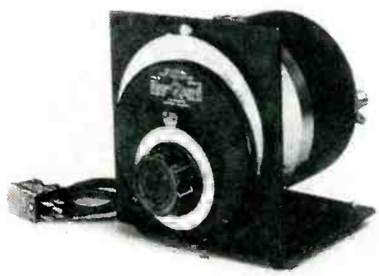
SOLDERING MACHINE
for A-N connectors

JOYAL PRODUCTS, INC., 56 Belmont Ave., Newark 3, N. J., has available a new 250 w A-N connector soldering machine. The equipment can solder from 2 to 30 terminals, and more, on A-N connectors. It can also be used on terminal boards, on printed circuits with high-temperature solder that cannot be handled with a soldering iron, and for military equipment on solder-crimped lugs to government specifications. To use, the operator merely sets the heat and the solder, brings the work to the electrodes and presses the foot switch.



FLIP-FLOP
in tiny, rugged package

COMPUTER RESEARCH CORP., 3348 W. El Segundo Blvd., Hawthorne, Calif. A smaller, more rugged package requiring only ⅓ cu in. for mounting space is featured in the new model 133 ferroresonant flip-flop. The unit was developed as a vacuum-tube replacement for certain counting, scaling and storage applications. It has the long life, low power requirements and low heat dissipation of the saturable reactor, and is small, simple and relatively inexpensive. It will operate on a fraction of the power needed by a vacuum tube of comparable output, and can deliver more than 90 percent of the input energy as usable output since copper and core loss are the only sources of power consumption.



UNIT OSCILLATOR
produces 50 to 250 mc

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Type 1215-A unit oscillator produces frequencies from 50 to 250 mc over a single continuous range. Frequency is read directly from a 6-in. dial with a calibrated slow-motion drive. The tuned circuit is a semibutterfly type that has no sliding contacts. At least 80 mw can be delivered at any frequency into a 50-ohm load. The type 1215-A can be modulated at a-f and r-f; and with the type 1000-P6 crystal-diode modulator and a tv receiver, a tv test generator can be assembled.

COMPARISON BRIDGE
for production lines

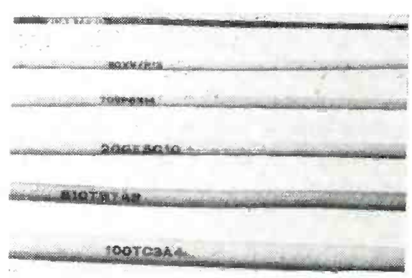
SOUTHWESTERN INDUSTRAIL ELECTRONICS CO., 2831 Post Oak Rd., Houston 19, Texas. Designed for production-line operation but capable of lab accuracy, the Model E-1 comparison bridge provides uni-

Want more information? Use post card on last page.

form characteristics in resistors, capacitors and a-f inductances. The 1-percent scale may be read accurately to indicate differences between components as small as 0.1 percent. A bridge circuit applies 3 v at 60 cycles to the components under test, utilizing a transformer with a special bifilar winding to assure uniformity of two legs. Components with impedances from 1 ohm to 5 megohms at 60 cycles may be compared. The unit operates on 115 v, 60 cycle a-c.

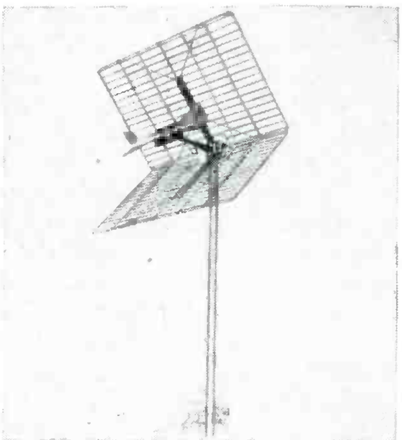
VIBRATION PICKUP
is sensitive and light

TECHNICAL INSTRUMENT CO., 3732 Westheimer Rd., Houston, Texas, has available a new ultra-sensitive inductive vibrometer featuring high sensitivity and light weight. In many applications the highly efficient magnetic circuit provides sufficient output to drive recording galvanometers directly. It can be supplied in natural frequencies ranging from 15 to 80 cps. Units above 22 cps can be mounted in any direction. Output is over 1 v per in. per second for the 600-ohm unit. Size is $1\frac{7}{16}$ in. in diameter x $1\frac{7}{8}$ in. long. Weight is 11 oz.



WIRE MARKER
for mass production

RAM METER, INC., Ferndale, Mich., has developed a new wire-marking machine. Designed and built for their own use, the facilities of this device are now available to manufacturers and war contractors on a production basis in the Ram Meter plant. Where specifications for electrical equipment require, this machine marks each wire legibly and permanently, with a code designation near each end and at intervals for its entire length. Any size insulated wire from 20 to 4 can be hot embossed with either black or white plastic code letters one inch from each end, with additional imprints at intervals of 2 in. to 12 in. (as desired) along the wire, and the wire cut to any desired length from a 2-in. minimum to a maximum of 12 ft. Any number of characters and spaces up to 15 can be used to code wire sizes 20 to 14, and 12 characters and spaces for 12 to 4 wire.



CORNER REFLECTOR
requires no assembly

JFD Mfg. Co., Inc., 6101 16th Ave., Brooklyn 4, N. Y. A new preassembled uhf corner reflector that opens like a book into receiving position produces excellent broadband gain. The wire-frame construction of the UHF400 provides for greater rigidity, resistance to vibration and extra lightness. An important feature is a heavy-duty, 2-section mast bracket, 2½ in. long for wide grippage over the mast. As this bracket is tightened on the mast, it automatically secures the "bowtie assembly" in optimum receiving position. Large-size reflector sections, which accentuate directivity and minimize reflection and interference, combine with a low swr that minimizes energy losses.

CRYSTAL DETECTOR
takes minimum space

AIRTRON, INC., 20 East Elizabeth Ave., Linden, N. J., offers a new miniaturized dual crystal detector designed to work with the direct and reverse crystals developed by Microwave Associates—1N23B and 1N23BR (furnished as a matched pair under the nomenclature 1N23-BRM). Taking a minimum of space, the detector mates with a special adaptation of the miniaturized contact flanges currently being standardized by the RTMA Committee on Waveguide Connectors. It is furnished with type-N fittings or with wired-on connectors; and is adaptable to any type mixer configuration.

ROTARY SWITCH
is printed-circuit type

THE DAVEN CO., 191 Central Ave., Newark, N. J., announces the printed-circuit rotary switch type PCF-I with 60 positions, shorting-type action. Due to the unusual segment design, eyelets are provided for solder connections at every position. Switch segments are silver-alloy bonded to the phenolic contact panel. Contact resistance is approximately 0.003 to 0.004 ohm and does not vary more than 0.0003 ohm over the life of the unit. The diameter is 3 in. and the depth is $2\frac{1}{16}$ in.

TEST PROBE SET
contains four probes

PRECISION APPARATUS CO., INC., 92–27 Horace Harding Blvd., Elmhurst 17, N. Y. The series SP-5 oscilloscope test probe set includes four of the most important test probes for general purpose as well as specialized tv signal-tracing, alignment, trouble-shooting and waveform analysis. Each probe has been engineered for its specific use. A single, universal coax cable accommodates each probe through a quick-change connector. A specially designed shielded plug provides positive cable attachment to the ES-500 and ES-500A vertical input posts. Each probe head terminates in a clip-on type of probing tip permitting operator's hands to be free during tests.

AUDIO OSCILLATOR
has 20 fixed frequencies

TELETRONICS LABORATORY INC., 54 Kinkel St., Westbury, L. I., N. Y., announces model TO-100 audio oscillator that is especially useful for checking f-m/f-m telemetering subcarrier equipment. Twenty accurate, fixed center-frequencies are available. The standard model is furnished with frequencies from 400 to70,000 cps. Each frequency is selected by a push-button control and can be varied ±10 percent by means of a calibrated control. Each frequency is accurate to±1 percent. The output of the oscillator is adjustable by means of a continuously variable calibrated level control and available from either low impedance output terminals or a 600-ohm connector. Maximum total distortion at full output is less than 1 percent.

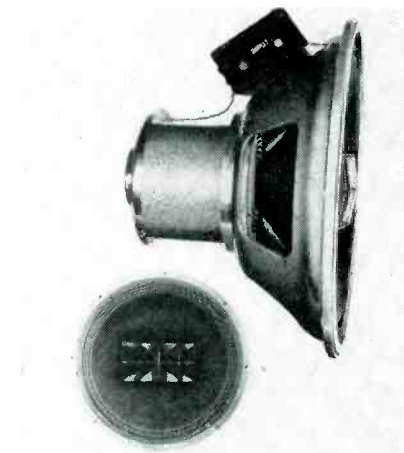
PREAMPLIFIER
is self-powered unit

THE PLAYMASTER DIVISION of Mark Electric Products, Inc., 145 Seneca St., Buffalo 3, N. Y., has available a self-powered equalized preamplifier for use with the Pfan-Tone pickup. This preamplifier uses a single 12AX7 tube. Provisions are made so that it can be used in conjunction with either a non-compensated input such as provided for crystal cartridges, or the magnetic phono input. This component is very small and mounting brackets are furnished so that it can be readily installed in any cabinet. The unit is approximately 3½ in. square and weighs less than 2 lb.

DIRECTION FINDER
is automatic indicating

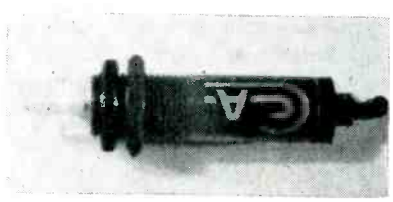
SERVO CORP. OF AMERICA, 20–20 Jericho Turnpike, New Hyde Park,

N. Y. Model DFG-2 is a fully automatic visual-indicating radio direction finder designed for high-frequency applications. It is recommended for fixed-station or transportable field installations, and for applications including aircraft navigation and homing, rescue operations and the location of illicit transmitters. The nominal frequency range for optimum performance is 0.54 to 30 mc. Total power drain is 400 w for visual indication and 150 w for aural-null indication.



COAXIAL SPEAKER
uses 7½-lb magnet

STEPHENS MFG. CORP., Los Angeles, Calif., has developed a new coax speaker, employing a 7½-lb Alnico V magnet (in a round pot structure) designed to improve and extend the frequency response. The 206AX features a new diaphragm and h-f throat structure, together with other improvements. An aluminum die-cast frame has been incorporated into the speaker to provide greater rigidity and eliminate the possibility of warping.



NEON INDICATOR
has 1/25-watt lamp

CIRCUIT CRAFT ASSOCIATES, 5827½ E. Beverly Blvd., Los Angeles 22, Calif., have designed a small-size inexpensive neon indicator for dis-

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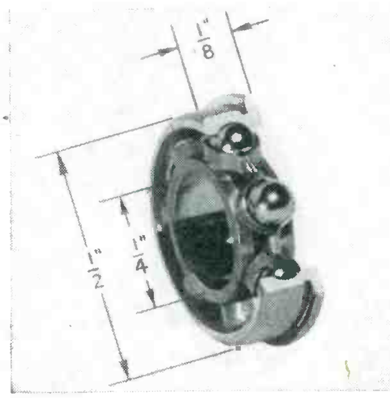
playing information in data systems or computers. Though designed for incorporation in new equipment, it can be used to replace present neon pilot lights in existing computers. It has NE-2 type, 1/25-w neon lamp in clear plastic cap (injection-molded styrene base). The anodized aluminum case (1.3 in. long) has $\frac{3}{8}$ x 32 thread. Assembly is designed to be removable from the rear of panel, thus permitting removal of front panel without disconnecting the soldered connection. Paper-base phenolic-resin insulator at rear of the indicator has a raised center barrier to prevent possible solder short between lugs. Interelectrode capacitance is less than 2 μμf.



FLANGED BEARING
for precision instruments

New Hampshire Ball Bearings, Inc., Peterborough, N. H. Micro FR188 extra-light flanged instrument ball bearing features straight rather than tapered O. D., refined processing to superprecision (ABEC class 5 and higher) tolerances and a two-piece, cone-controlled, cylindrical-pocket, pressed metal cage. The balanced design favors low and uniform running torque as well as quiet operation. Construction is extra light, with all excess metal eliminated to conserve weight and space. It is recommended for gimbals and general precision instrument assemblies.

TRANSFORMERS
made by molding process

Kenyon Transformer Co., 840 Barry St., New York, N. Y., has announced a new line of molded transformers marketed under the name "Ken-Seal." They are intended to supply the demand for units of exceptionally light weight, small size and low cost without any sacrifice in hermetic sealing or other efficiency. Molding process was chosen in preference to dipping or encapsulation because it accomplishes this and in addition produces a finished product that is uniform and controllable to definite dimensions.

SERVO AMPLIFIER
is transistor-magnetic

INDUSTRIAL CONTROL CO., Wyandanch, Long Island, N. Y. The 434-B servo amplifier features transistor-magnetic circuitry in a hermetically sealed enclosure. It drives the BuOrd MK14 and MK7 400 cycle servo motors from synchro data in a positional loop. It is completely self-contained, requires no power supply or damping tachometer and has just 6 connections: 2 inputs, 2 outputs, 2 for 117 v 400 cycles. It weighs 17 oz and the can size is 2 x 2¼ x 3⅛ in.

TEST CHAMBER
simulates altitude

MURPHY & MILLER, INC., 1322 South Michigan Ave., Chicago, Ill., has introduced a new multipurpose environmental test unit that provides an extremely wide range of temperature, vacuum and humidity conditions. Heavy duty electronic control circuits with automatic safety interlocks assure fast, fool-proof operation under any laboratory or production testing programs. Called an altitude-simulation chamber, the unit permits accurate testing of materials and equipment under all externally imposed conditions of heat, cold, moisture and vacuum. The units are lab tested under all operating conditions before shipment, and only water, drainage and electrical services are required to put them to operation.

CONSOLE INDICATOR
saves panel space

LEEDS & NORTHRUP CO., 4934 Stenton Ave., Philadelphia 44, Pa. A new electronic console indicator saves panel space and permits an operator to scan up to 200 thermocouple temperatures as fast as he can log them. The unit incorporates the model-D Speedomax indicator in a special housing that can be pulled out on tracks from the center of the console mounting. Console switch panels are removable. They hold as many as 100 toggle-type switches for 200 indicator or 100 indicator and recorder readings; as many as 96 pushbutton switches for 96 indicator readings. Terminal boards of the unit are centrally located and easily accessible through wide-swinging doors on the back of the console.

PRESELECTOR
covers amateur bands

RADIO MFG. ENGINEERS INC., 300-302 First Ave., Peoria 6, Ill., has announced the new DB23 preselector designed for coverage of all amateur bands from 3.5 to 30 mc. It has three neutralized push-pull stages employing 6J6 dual-triodes in a novel combination of selective and wideband r-f amplifiers. It has a constant gain of 25 db or more with an average image-ratio improvement of approximately 12 db on 21 mc and 25 db on all lower frequencies. Improvement in signal-to-noise ratio is better than 7.5 db over that of the receiver itself. Input impedance combinations match any standard antenna of 50 to 600 ohms and output is a shielded line matching any receiver impedance from 52 to 300 ohms, balanced or unbalanced.

PULSE TRANSFORMER
in an octal tube base

BERKSHIRE LABORATORIES, 506 Beaver Pond Road, Lincoln, Mass. Type PT-2 Labtrans pulse transformer is designed for use in the μsec and fractional μsec ranges. It is compact and convenient to use, being built in an octal tube base. When tested as a coupling transformer with 1-8 and 2-7 windings in parallel as primary and 3-4 and 5-6 in parallel as secondary, characteristic impedance was found to be 100 ohms; rise time, 0.04 μsec; droop in 1 μsec, 20 percent. Diameter is 1.372 in. maximum; and overall height, 1.657 in. maximum.

CONVERTER
can deliver up to 100 va

AVION INSTRUMENT CORP., Div. of American Car and Foundry Co., 299 State Highway No. 17, Paramus, N. J., has developed the model 400 frequency converter, a portable 400-

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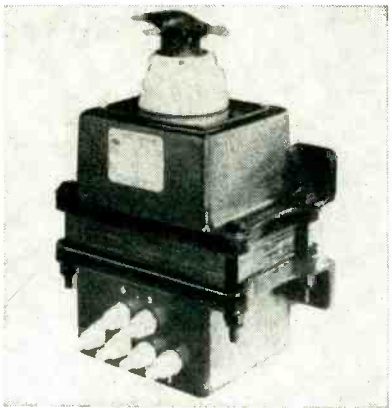
cycle power supply that operates from a standard 60-cycle line and can deliver up to 100 va. It is especially suitable for lab use in the development of low-power aircraft equipment. Output voltage is variable by a front-panel control, from 105 to 130 v, with regulation better than ± 1 percent. Frequency is adjustable from 380 to 420 cps with less than ± 1 cps drift. Total harmonic distortion is less than 3 percent. All of these characteristics are independent of the power factor. Model 400 measures 18 in. long x 9 in. wide x 12 in. high.



TRANSFORMER
is air-cooled

MAGNATRAN, INC., 246 Schuyler Ave., Kearny 1, N. J., announces the addition of an air-cooled filament transformer that is made especially for supplying filament voltages to rectifier tubes because the primary is tapped at several voltages to allow greater accuracy of voltage adjustment. In the model illustrated primary taps are at 200; 210, 220, 230 and 240 v. Any series of taps may be ordered. These may be used on either 50 or 60-cycle lines. Secondary leads are brought out through ceramic insulators and provided with terminal lugs for easy connections. The entire unit is filled with a special compound that effectively transfers heat from coils to case, as well as excluding dust and moisture.

SEALED RELAY
is magnetic-contact type

WESTON ELECTRICAL INSTRUMENT CORP., 614 Frelinghuysen Ave., Newark 5, N. J. A new relay of the Sensitrol (magnetic-contact) type, model 723, is sealed against moisture and incorporates a newly designed, self-shielded core magnet mechanism and a built-in solenoid release device. Sensitivities as high as 2-0-2 μa are available, and both a-c and d-c voltage ranges can be supplied self-contained up to 500 v. Contact capacity of the parallel magnetic contacts is 100 ma at 120 v a-c or d-c. Accuracy is within ±5 percent for d-c and approximately 10 percent for a-c depending on circuit conditions.

POWER AMPLIFIER
is direct-coupled unit

SOUTHWESTERN INDUSTRIAL ELECTRONICS Co., 2831 Post Oak Road, Houston 19, Texas. Model B power amplifier has essentially flat response from 0 to 20,000 cps, and will deliver 6.25 w into a 100-ohm load when driven by a 10-v signal. All types of distortion are held to very low levels. The unit may be used to amplify the output of oscillators and signal generators in order to drive Helmholtz coils, underwater-sound transducers, servo systems, and other power-consuming devices. It is particularly useful in dealing with transient phenomena. The amplifier is mounted in two standard 8¾ in. x 19 in. rack panels, weighs 150 lb and operates on 115 v, 60 cycles a-c at 450 w.

VOLTMETER
with extended range

WAVEFORMS, INC., 333 Sixth Ave., New York, N. Y. Model 520-A extended-range voltmeter is a miniature instrument of high precision and extreme versatility, operating over the frequency range from 10 cycles to 2 mc. A full-scale sensitivity of 1 mv permits measurements as low as 100 μv and affords useful indications at still lower levels. Ranges are provided up to 300 v, as well as decibel readings from −72 to +52 db (referred to 1 mw in 600 ohms). The portable unit weighs only 6 lb and the case is only 6 in. high. It will operate

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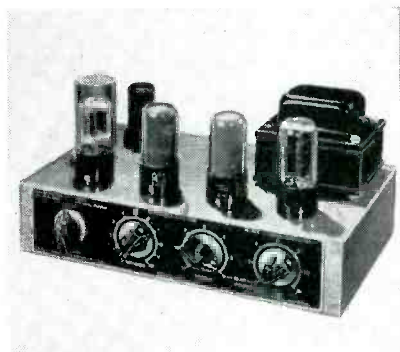
on power lines from 50 to 400 cycles and 95 to 130 v.

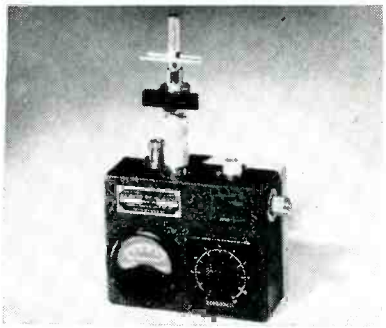
PLUG-IN METERS
in 3 or 4-in. sizes

Cole Instrument Co., 1320 S. Grand Ave., Los Angeles 15, Calif., has announced a line of meters with a convenient plug-in feature. These new instruments can be pulled out and replaced by hand in a few seconds. They are available in a full range of standard calibrations. The meters are supplied in either three or four-in. sizes; the former is available in either round or rectangular cases; the latter in a rectangular case. The use of plug-in meters requires only the installation of the company's plug-in receptacles.



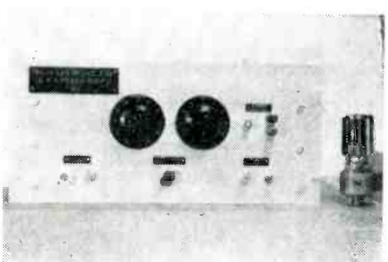
HI-FI AMPLIFIER
has 8-w power output

Precision Electronics, 9101 King Ave., Franklin Park, Ill. Model LJ2 high-fidelity amplifier has a power output of 8 w with a peak of 18w. Distortion at 8w is 1.5-percent harmonic and 4.0-percent intermodulation. Frequency response is ± 1 db, 20 to 20,000 cps at 3-w level. The unit features the following controls: (1) selector switches from radio channel to magnetic pickup; (2) volume control; (3) treble control with 18-db attenuation at 10,000 cps; (4) bass control with off-on switch—15-db boost at 50 cps. Hum level is 80 db below 8 w. Other features of the LJ2 include negative feedback and fused, a-c outlet.



H-F TEST SET
is dual-purpose unit

AMERICAN ENCAUSTIC TILING CO., INC., Kenilworth Ave., Lansdale, Pa. Model 117 wavemeter is designed for measuring operating frequency and making relative power measurements of microve transmitters or signal sources. Applicable to pulsed transmitters as well as continuous wave systems, the operating range of the new wavemeter is 2,400 to 3,400 mc, but it is also being made in other frequency ranges for special applications. A novel feature is the combining of either transmission or reaction type measurements in one instrument. Measurements can be made by direct coupling of the wavemeter to the signal source or at a remote point by means of a self-contained directive antenna.



POWER SUPPLIES
for the research lab

THE ATOMIC CENTER FOR INSTRUMENTS & EQUIPMENT, INC., 489

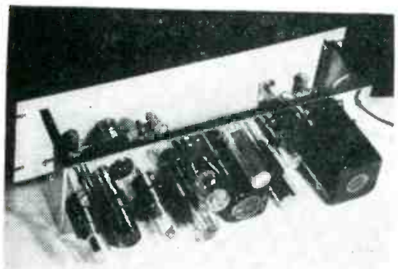
Want more information? Use post card on last page.

Fifth Ave., New York 17, N. Y., presents the Beva models 300 and 301 precision power supplies. These units are used for proportional counting in the radioactivity laboratory and in conjunction with pulse-height analyzer systems, mass spectrographs and other research equipment demanding rigidly precise high voltages. Output voltage for the model 300 is from 500 to 1,600 v d-c, and for the model 301, from 1,000 to 5,100 v d-c. Maximum output current for both units is 1 ma. Regulation is 0.01 percent for load variation from 0 to 1 ma and a line-voltage change from 105 to 130 v. Noise and ripple are less than 0.020 v at 5 kv. Voltage control is obtained by means of 0.1 percent accurate decades and potentiometers. Units can be furnished either positive or negative grounded.

GENERATOR

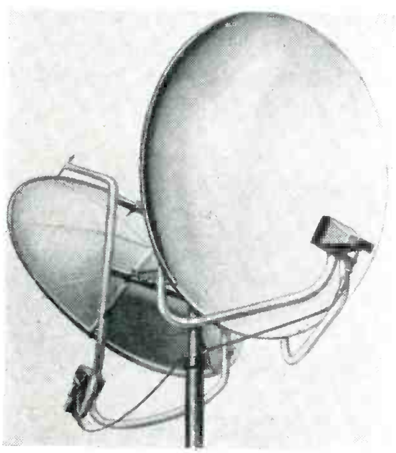
produces a square wave

American Electronic Laboratories, Inc., 641 Arch St., Philadelphia, Pa. Designed for use as a modulator for r-f measurements, the unit illustrated is useful for general experimentation wherever a 1,000 or 400-cps square wave is required. The generator produces a square wave at either 400 or 1,000 cps tunable over a ±10-percent range by means of a front panel control. Output is adjustable in amplitude from 0 to 50 v peak-to-peak, no load, or 12 v peak-to-peak into a 600-ohm load. Both amplitude and frequency are constant within ±2 percent for line voltage variations from 105 to 120 v. Powered from 115 v, 60 cps, the unit is an 8-in. × 8 in. × 8 in. sloping front cabinet with carrying handle.



RADIATION MONITOR
is an automatic unit

DETECTOLAB INC., 6544 Sheridan Rd., Chicago 26, Ill. Model DZ14 Radiation Supervisor is designed to provide continuous automatic monitoring of radiation in a laboratory, and can be used to monitor the lab and sound remote-control alarm system in office or in safety-control centers. The unit uses an infinite-life-type counter that plugs directly into top of chassis.

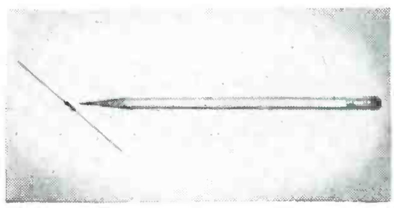


MICROWAVE ANTENNA
features offset feed

WORKSHOP ASSOCIATES DIVISION, The Gabriel Co., Endicott St., Norwood, Mass., has introduced an offset-feed microwave antenna for the 1,750 to 2,110-mc range. The design uses a parabolic reflector with the vertex 9 in. above the rim. Radiation is practically identical in both horizontal and vertical planes. Polarity can be changed by rotating the feed 90 deg. The 6-ft offset feed reflector is made of fiberglas laminations with a polyester resin. The total laminate is composed of a surface layer of fiberglas and a layer of fine wire mesh screening backed by four layers of fiberglas. The result is a strong, low-cost reflector, accurate to ±1/8 in.

RECEIVER
covers 540 kc to 40 mc

THE NATIONAL CO., INC., Malden, Mass., has announced production of a new broadcast and shortwave receiver—the World Master (model NC-88). Designed especially for shortwave listeners and radio amateurs, the receiver covers all frequencies from 540 kc to 40 mc in 4 bands. Features include calibrated bandspread, advanced a-c-powered superhet circuit using 8 miniature tubes, a tuned r-f stage, two r-f stages and a high-fidelity audio output stage.

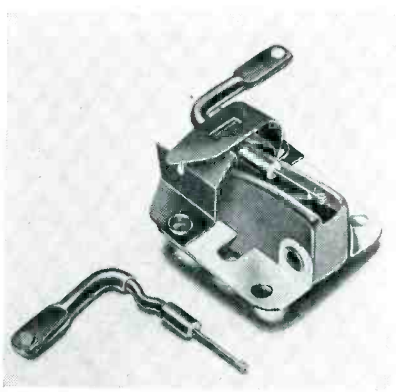


TINY RESISTOR
is deposited carbon type

ELECTRA MFG. CO., 2537 Madison, Kansas City, Mo., has available a tiny deposited-carbon "transistor" resistor of 1/8 w. Designed especially for miniature requirements, the body length is only 9/32 in. and body diameter is 5/64 in. The new resistor has a resistance range from 4 ohms to 250 K ohms. It is rated at a maximum of 250 v. The deposited-carbon manufacturing process makes possible maximum stability regardless of resistance-value tolerance—±1 percent, ±5 percent or ±10 percent are all equally stable. The resistors are available in either standard or hermetically-sealed types.

BRAZING ALLOYS
for high-vacuum systems

WESTERN GOLD & PLATINUM WORKS, 589 Bryant St., San Francisco, Calif., announces two new brazing alloys for high-vacuum systems such as power tubes and vacuum capacitors. Incoro 60 is an alloy of gold, copper and indium that offers to the industry a nonsilver bearing alloy with a melting range (810 to 830 C) near that of the widely used silver-copper eutectic alloy. Incosil 15 is an alloy of silver, copper and indium having a low vapor pressure and a very low melting range (640 to 687C). It is of interest for step brazing techniques and for those applications where the higher flow point of the silver-copper eutectic alloy is undesirable.



CERAMIC PICKUP
uses turnover method

SONOTONE CORP., Elmsford, N. Y. The Titone Turnover uses a high-compliance, high-sensitivity ceramic element and a revolutionary turnover method. Requiring no equalizers or preamplifiers, the cartridge has an output of one volt and is unaffected by moisture or temperature. The jewel needle tips (either diamonds or sapphires) are mounted back-to-back on a single shank, the entire assembly rotating for needle change. When replacement is required, the complete needle assembly, including the lever handle, is removable as a unit. Complete specifications including

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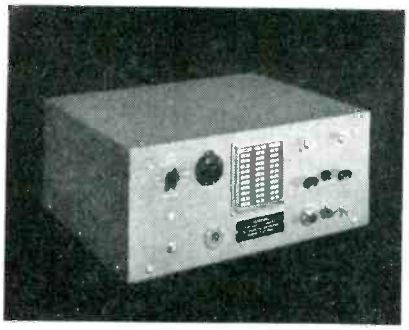
dimensional diagrams are available in a 4-page folder.

SHIELDING PAINT
for c-r tubes and meters

MICRO-CIRCUITS CO., New Buffalo, Mich., is producing RS12 conductive shielding paint for static shielding of c-r tubes, meters, h-v power supplies and h-v generator windings. Special advantages include lost cost, high conductivity, excellent adhesion and durability, heat resistance, complete quality control, very mild pigment settling and a viscosity suitable for spraying as received.

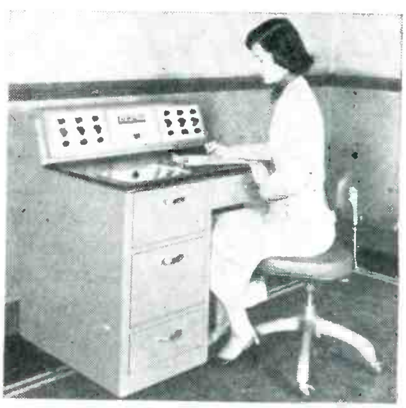
MAGNETIC HEADS
feature broad response

STANCIL-HOFFMAN CORP., 921 North Highland Ave., Hollywood 38, Calif., has announced a new line of magnetic recording and reproducing heads that feature broader frequency response, better performance and longer head life. The standard heads record a track 0.200 in. wide. The record/reproduce head has a 1,000-turn coil and a gap width of approximately 0.0005 in. Heads that are to be used for recording only are available with a lower impedance that permits easier matching for high bias frequencies. The gap width is 0.0007 in. as this has been found to provide the best tape magnetization. Heads for reproduction only have a gap width of approximately 0.0003 in. and a 1,000-turn coil.



TELEDUCER
digitizes low voltage

TELECOMPUTING CORP., Burbank, Calif. Type 24A Teleducer automatically converts analog voltages into decimal digits with an accuracy of 0.1 percent (1,000 counts full scale). The Teleducer operates upon demand, digitizes an input voltage and holds the digital representation for a controllable period of time for purposes of display, recording or any desired readout form. The digital output can be recorded by means of punched cards, an electric typewriter, magnetic tape or punched tape. The instrument digitizes low voltage without d-c amplification and high voltage by means of attenuators. It uses a simple bridge balancing circuit that does not hunt or oscillate and requires only 0.8 second or less to reach balance.



RECORDER
for use with computers

GOODYEAR AIRCRAFT CORP., Akron 16, Ohio. Model R5 GEDA re-

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corder, specifically designed for use with analog computers, provides remote operation of computer systems by built-in control units. It features excellent stability and frequency response, a choice of pens and streamlined design. Six channels of recording are provided either in curvilinear coordinates (ink pens) or rectilinear coordinates (hot-wire pens). The operator determines the choice of pens. Coefficient potentiometers may be provided for connection to the computer, so that the operator need not leave the recorder for many runs that differ only in the values of one or two coefficients or initial conditions. Six d-c amplifiers feature calibrated gain controls and negligible drift. Sensitivity is continuously variable between calibrated steps from 0.01 to 100 v per millimeter.

RELAY RACKS
are available in 3 sizes

PREMIER METAL PRODUCTS CO., 3160 Webster Ave., Bronx, N. Y., announces enclosed relay racks that are rigidly constructed of 16-gage cold rolled steel. Rear doors are hung on loose-jointed hinges and have flush snap catches. Racks are shipped knocked down with all necessary bolts for easy assembly. They are available in 3 sizes—43⅛ × 22 × 18 in., with panel space of 36¾ × 19 in., 67⅝ × 22 × 18 in. with panel space of 61¼ × 19 in., and 83⅜ × 22 × 18 in. with panel space of 77 × 19 in. A complete catalog of the company's products for the electronic and electrical industries is available.

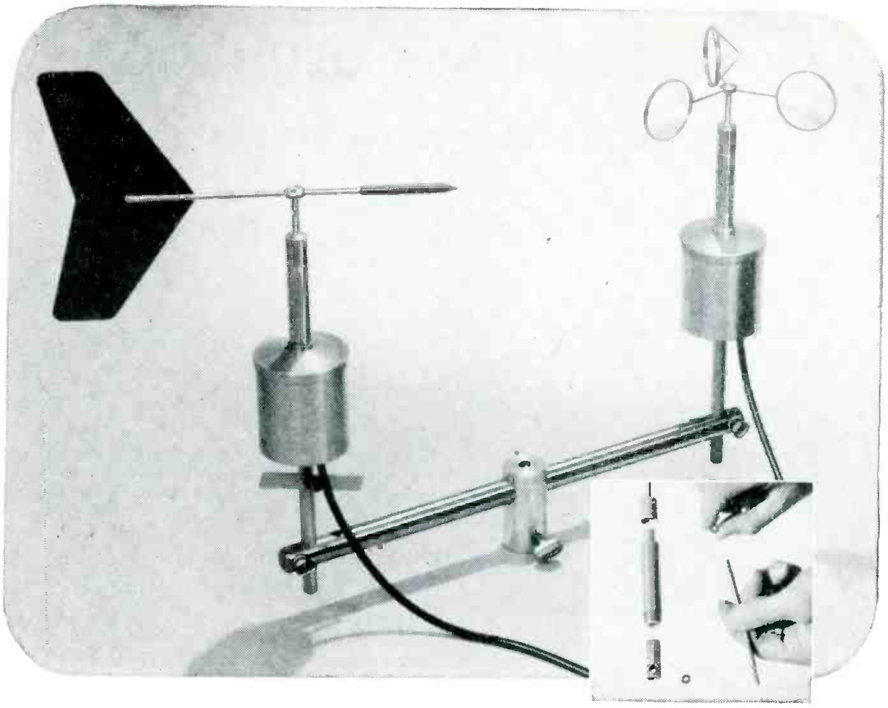
Literature

Hipersil Cores. Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa., has available a 16-page illustrated booklet (B-5402) on type-C Hipersil cores for specialty transformers. The characteristics of Hipersil cores that make them especially suited for electronic and small electrical transformers are discussed. An illustrated section traces the manufacturing procedure from the initial processing of the grain-oriented steel to the packaging of the completed core in a vapor-tight plastic coating. Simple sketches show how type-C cores simplify the assembly of three basic types of transformers—simple core, core-type and shell-type. A number of applications of Hipersil cores are listed, and the adaptability to many transformer designs is illustrated.

Direct-Writing Magnetic Oscillographs. The Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio. A recent catalog sheet illustrates and describes models BL-201 and BL-202 direct-writing magnetic oscillographs that are designed to furnish an ink recording, for immediate use, of electrical phenomena in the frequency range of 0 to 100 cycles when used with an appropriate equalized amplifier. Complete technical specifications are given.

Pulse Transformer. Berkshire Laboratories, 506 Beaver Pond Road, Lincoln, Mass. Descriptive sheet T-36 deals with type PT-1 Labtrans pulse transformer, a versatile unit for use in the microsecond and fractional-microsecond ranges. Along with the description are included four diagrams and a list of technical specifications.

Tantalum Electrolytic Capacitors. Sprague Electric Co., 35 Marshall St., North Adams, Mass. Bulletin 350 shows sizes, ratings and per-



formance data on a new line of tantalum electrolytic capacitors. The 100D Tantalex capacitors discussed are designed for military and industrial applications where low leakage is a primary requirement. The ultra-compact capacitors described are hermetically sealed against moisture, and have ratings available for 85 C or 125 C continuous operation.

Tape-Handling Unit. Computer Research Corp., 3348 W. El Segundo Blvd., Hawthorne, Calif. A recent data sheet gives information on the model 126 tape-handling unit that has been designed to be an auxiliary high-capacity memory for use with electronic digital computers. Mechanical and electrical specifications are included.

Instrument Motors. Servomechanisms, Inc., Post and Stewart Aves., Westbury, Long Island, N. Y. A 20-page illustrated catalog describes a new line of miniaturized hysteresis synchronous, control and damped control instrument motors. The motors described offer the designer various frame sizes, speeds, and input voltages for military and commercial applications. Typical uses of the units discussed include: analog computers, aircraft fire control systems, differential analyzers, remote indicating systems, telemetering devices, control of industrial machinery and many other systems in these categories.

Ultrasensitive Relays. Devtronics, Inc., 221 N. Hermitage Ave., Trenton 8, N. J. A 4-page folder illustrates and describes a line of ultrasensitive relays for laboratory and industry. Included are circuit variations and properties, as well as information on the selection of the proper relay. Also given are prices and specifications of standard stock model relay assemblies with both hermetically sealed and open relays.

Picture Tube. Hytron Radio & Electronics Co., A Division of Columbia Broadcasting System Inc., Salem, Mass. Four pages of engineering data cover type 24TP4, a 24-in. rectangular, 90-deg, all-glass, magnetically-focused picture tube that provides an effective screen area of over 370 sq in. Other features of the tube described are: an aluminized screen for increased brightness spherical filter-glass face plate; single ion-trap gun design and an external conductive coating that serves as a filter capacitor. Electrical and mechanical data and terminal connection information are included.

Insulating Compounds. The Acme Wire Co., New Haven, Conn., has available bulletin No. 575, a mimeographed circular letter, and two circulars describing the thermosetting polyester resin-epoxy combination, a line of insulating compounds for the treatment of coil windings, transformers, or complete electronic assemblies. Transformers impregnated and encapsulated with the components described will meet all the requirements of Government specification MIL-T-27, grade 1, class A, without the use of exterior casings.

Relay Catalog. Sterling Engineering Co., Inc., Laconia, N. H. Catalog No. 53 is a 24-page booklet illustrating and describing the company's general line of relays. Included are typical operating data, dimensional diagrams, specifications and complete ordering information.

H-V Insulating Gas. General Chemical Division, Allied Chemical & Dye Corp., 40 Rector St., New York 6, N. Y., has issued the 16-page technical service bulletin SF_6-A covering sulfur hexafluoride, a new gaseous dielectric for use in the electrical and electronics equipment fields. The gas described, furnished in cylinders at 300 pounds pressure, is designed for use in transformers, capacitors, electrostatic generators, x-ray apparatus, coax cables for tv, radar equipment, waveguides and similar apparatus. Complete physical data are included.

Remote-Control Equipments. Gates Radio Co., Quincy, Ill. A single-sheet bulletin illustrates and describes the RCM-12 and RCM-14 equipments, a complete remote control system for unattended

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operation in broadcasting stations up to 10,000-w power. Sizes, specifications and equipment supplied are listed.

Standby Power for Communications Systems. D. W. Onan & Sons, Inc., Minneapolis 14, Minn., in its folder Form A-307, shows how standby power protects communications systems everywhere. The folder contains examples of portable and mobile electric plants on the job providing primary electric power for mobile tv studios, radio remote broadcasting units, tv maintenance trucks and mobile civil defense centers. Other illustrations describe the company's units used as standby in such vital communications centers as county police departments, taxicab dispatching offices, telephone companies and radio stations. Descriptions of popular models of Onan portable, mobile and standby electric-generating plants as well as automatic line-transfer controls are given.

Relays. Potter & Brumfield, Princeton, Ind. Catalog 122 describes relays and contactors for every electrical and electronic application—power, multiple contact, multiple leaf, latching, plate circuit, impulse, space-saver, telephone, miniature, shock-proof, motor starting, supersensitive and photo flash. Also shown are enclosures for sealing individual relays or multiple groups hermetically; and octal, solder-terminal and miniature plug-in connections. Comprehensive presentation facilitates ordering procedure, offers valuable assistance in development problems and in selecting the proper type relay to meet industrial and military requirements. Easy-to-read charts list complete, up-to-date coil and contact data on every relay.

UHF Antenna Orientation. United Technical Laboratories, Morristown, N. J. Bulletin No. 2 discusses a novel method of placing and orienting uhf antennas for maximum tv picture signal. The method described eliminates need for rooftop shouting or the use of expensive uhf field-strength measurements. (A single serviceman can check the entire roof and obtain maximum picture signal strength). The description shows that, at uhf, a difference of as little as 3 ft in antenna placement, and 5 to 10 deg in orientation, can make a large difference in the strength of the received tv picture.

Educational TV Station Costs. Radio Corp. of America, Camden, N. J. A complete analysis of estimated equipment and operating costs for typical educational tv stations has been prepared in booklet form. The booklet furnishes a guide to costs for both uhf and vhf stations ranging from low-power outlets with simple studio facilities, to high-power stations featuring complex, multistudio facilities, with variations depending on range of coverage and number of hours of operation desired. Number and type of personnel, and costs of salaries and supplies are also included. In addition to cost estimates, a complete station layout and a sample floor plan for a typical small tv station are presented.

Gas-Free Metals. Vacuum Metals Corp., 70 Memorial Drive, Cambridge, Mass., offers technical data sheets on: (1) Cuprovac-E, gas-free high-purity copper with properties suited for vacuum-tube manufacture; and (2) Ferrovac-52100, a gas-free alloy bearing steel, free of inclusions, with greatly improved fatigue properties. The company also offers reprints of a recently published technical article giving details of performance tests and data on Ferrovac-52100.

Asbestos Electrical Insulations. Johns-Manville, 22 E. 40th St., New York 16, N. Y. "Quinterra-Quinorgo" is the title of a new 32-page publication recently issued. It gives complete information about these electrical insulations made of purified asbestos—why they were developed, what their characteristics are, and where they may be used to advantage. The bulletin is both a manual of facts and a descriptive brochure. For the designer of electrical equipment there are tables giving test data on physical and electrical

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properties. Test methods are fully explained and there is a separate table for each of the several types of Quinterra and Quinorgo. For the production man there is advice on application techniques and equipment including step-by-step photographic coverage of methods now in use. In addition to photographs, many of the picture stories have sectional diagrams showing how, in a single piece of equipment, Quinterra and Quinorgo are used in many different places—for core tubes, layer insulation, wire wrapping, interlaminate insulation, end washers and the final wrapper insulation.

Wire-Wound Resistors. Sprague Electric Co., North Adams, Mass. Engineering Bulletin No. 120 on Durameg accurate wire-wound resistors describes a new type of resistor construction for precision wire-wound resistors, with outstanding performance characterictics. Wattage ratings of the resistors described at 105C are from four to five times the 85C military ratings for the best of conventional resistor constructions. Illustrations and technical data are included in the 4-page bulletin.

Piezotronics. Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio. A 32-page booklet is entitled "Piezotronic Technical Data." This reference compares general properties of piezoelectric materials, describes their basic behavior, lists electronic circuit applications and considerations, and gives basic electrical, mechanical and electromechanical properties and equivalent circuit data.

Delay Lines. Anderson Laboratories Inc., 39 Talcott Rd., West Hartford, 10, Conn., has issued a 4-page illustrated bulletin dealing with its solid ultrasonic delay lines. The publication gives chief applications and general technical specifications for the units whose delay times are obtainable in a range from 0.6 μsec to 1,000 and higher.

Foreign Markets. Netherlands Industrial Institute, Hotel Biltmore, Madison Ave. & 43rd St., New York 17, N. Y. Market opportunities for American manufacturers of electrical equipment who are considering establishing manufacturing operations in Holland are outlined in an 8-page booklet "Opportunities for Foreign Participation in the Netherlands Electrical Engineering Industry." The booklet points out that Dutch imports far outbalance exports in such fields as rotating machinery, transformers, rectifiers, storage batteries, switchgear and communications equipment.

Transformer Catalog. Triad Transformer Corp., 4055 Redwood Ave., Venice, Calif. The 1953 catalog TR-53 lists more than 500 items. It features an expanded line of tv components and industrial transformers, including toroids, pulse transformers, transistor transformers and additional miniatures. The catalog—with standard 3-hole punch for convenience in filing—also contains a geophysical section.

High-Temperature Insulation. Electro-Technical Products Division, Sun Chemical Corp., 113 East Centre St., Nutley 10, N. J. A 4-page folder covers two types of class-H insulation known as Sil-Thin-Glas and Sil-Thin-Bestos. The products described were designed to effect size and weight reduction in the design of electrical equipment required to operate at class-H temperatures. Suggested uses and test data are included.

Beryllium Copper Components. Instrument Specialties Co., Inc., Little Falls, N. J. Catalog No. 7A is an 8-page folder entitled "Electronic Components of Beryllium Copper." Included are illustrated descriptions of h-f contact rings, contact strips, short-run specialties, folded-type contact strips, folded-type standard contact rings, a microwave kit and an engineer's assortment that contains 100 beryllium copper helical compression springs, 50 pairs, all different.

Iron Powders. Magnetic Powders, Inc., 1014 Fairview Ave., Johnsonburg, Pa., has available an 8-page illustrated catalog 354 covering complete technical data, including the various photomicrographs, frequency-vs-Q charts and permeability rating graphs, on the uses and applications of annealed carbonyl iron powders, hydrogen reduced iron powders and Magna-tites. The catalog is obtainable for the writing.

Plastic and Fibre Insulations. Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill. Helpful information on the features and uses of fibre and plastic for electrical insulation are incorporated in two catalogs recently published. Imcor reinforced plastics are described in an 8-page catalog while Phenolite laminated plastics, National vulcanized fibre, and Peerless fishpaper products are covered in a 32-page catalog. Both folders give complete descriptions, tabular data and other information on grades, properties and fabricating techniques for sheets, rods, tubes and fabricated or molded parts.

Components Catalog. Industrial Hardware Mfg. Co., Inc., 109 Prince St., New York 12, N. Y., has published a catalog describing and illustrating its facilities for the manufacture of a wide variety of component parts. Parts illustrated include: sockets (octal, noval, miniatures, speaker and vibrator, and kinescope); terminal strips; support assemblies, Bakelite stampings and wired assemblies; battery connectors; terminal boards, assemblies and JAN components; and screw machine parts. Specifications are given.

Solid-Copper Enclosures. RFI Shielded Enclosures Corp., 3634 N. Lawrence St., Philadelphia 40, Pa. Complete application and performance data on solid-copper enclosures for suppressing r-f interference is available in a new publication. Bulletin No. 1 describes how these portable, weatherproof enclosures may be used to eliminate r-f interference when making tests on sensitive electric and electronic equipment as well as to suppress radiation from industrial equipment that would otherwise cause serious radio or tv interference in the community. An interesting section of the booklet is a graph prepared by the Hopkins Engineering Co., an independent laboratory. Conservatively plotted over a range of 100 kc to 100 mc, this graph proves that the enclosures provide a minimum attenuation of 100 db over that entire range. Standard and special sizes, service facilities and air-conditioning are also discussed.

Tiny Indicator Lights. Dialight Corp., 58 Stewart Ave., Brooklyn 37, N. Y. The subminiature lights described in brochure L-153 are made to mount in 15/32-in. clearance hole; and they come equipped with any desired midget flanged base T-1¾ bulb. Units described fall into the following general categories: (1) For plastic plate edge lighting, qualified products list approval QPL-7806; (2) Indicator lights, nondimming; (3) Dimmer types, mechanical or polaroid; (4) Light shield, for lighting dials and instruments; (5) Indicator lights with patented press-to-test feature and dimming or nondimming lens caps. Diagrams and technical data facilitate procurement of units from the brochure.

Germanium Transistors. Radio Corp. of America, Harrison, N. J. An 8-page booklet introduces 4 types of germanium transistors—2 point-contact and 2 junction. Included are descriptions of the 2N32 and 2N33 point-contact transistors and the types 2N34 and 2N35 junction transistors of the pnp and npn type respectively. Each of the four types discussed has a base with three small pins in line and spaced to provide mechanical indexing for socket insertion.

Germanium Diodes. International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif. Bulletin GD-1 describes fully the characteristics and advantages of a new line of germanium diodes. Included are a cross-sectional diagram, technical specifications and information on special purpose types.

Automatic Data Analyses. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Ave., Philadelphia 44, Pa. Automatic analysis of oscillographic data is described in instrumentation data sheet No. 10.0-11. The single-sheet bulletin gives typical applications, accuracy and range, operation in-

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formation and general characteristics. An illustration of the system is included.

Microwave Data. Sightmaster of California Co., Gillespie Airport, Santee, Calif., has announced new microwave handbook data entitled Introductory Concepts to Microwaves, containing 16 full pages of basic microwave and waveguide information. Also included is a catalog appendix of the company's products and developments in the fields of microwave calorimeters and cast waveguides. This information is in easy-to-understand form and includes several cuts and illustrations to make waveguide phenomena better understandable to those with limited past experience in the microwave art.

Microwave Data. Henry L. Crowley & Co., Inc., 1 Central Ave., West Orange, N. J., has available a concise yet profusely illustrated bulletin entitled "Microwave Components." It deals with Polyiron, a material readily molded or machined to any shape, and with which it is possible to attain attenuation up to 300 db per in. with lower standing-wave ratios. The bulletin also deals with various kinds of terminations, stock blank sizes, machining procedures, and drawings of typical Polyiron fabrications.

R-F Attenuation Filters. Cornell-Dubilier Electric Corp., South Plainfield, N. J. Bulletin No. NB-148 is a 12-page catalog with descriptions, illustrations and technical data of a portion of a wide line of Quietone filters. More than 135 types of feed-through, PI and universal filters are listed. Besides complete, detailed, electrical characteristics, the descriptions include outline drawings, physical characteristics, circuit diagrams, photographs and charts.

Automatic Welding Equipment. Federal Tool Engineering Co., 1386 Pompton Ave., Cedar Grove, N. J. A new bulletin describes Tweezer-Weld automatic welding equipment that will weld almost microscopic parts such as diodes at 1,200 per hr; that will weld studs, for example on c-r cylinders up to 6,000 studs per hr; that will do glass beading at 200 pieces per hr. Also featured are Tweezer-Weld automatics to weld tabs to radio-tube cathodes at 2,600 parts per hour—to weld stems (for example on fluorescent starter switches) at a rate up to 3,600 parts per hr. The bulletin also describes the new heavy duty kva welding head that is extensively used in subminiature, miniature and bantam-tube industry.

Altitude Chambers. Tenney Engineering, Inc., 26 Ave. B, Newark 5, N. J., announces a new 4-page bulletin on its standard line of Tenneyzphere altitude chambers. The bulletin covers test chambers for simulating altitudes from sea level to approximately 80,000 ft; temperatures from −100F to +200 F; and relative humidities from 20 to 90 percent. It includes performance data, standard and special features, specifications giving sizes and operating characteristics of all standard models and chamber construction information. Also included are six illustrations showing both inside and outside views of different size chambers and the instrument control panels that make it possible automatically to cycle test conditions.

Intermediate Shaker Systems. The Calidyne Co., 751 Main St., Winchester, Mass. Bulletin 6405 is an 8-page booklet dealing with intermediate shaker systems having 600 to 1,250-lb force output. Illustrations and chief features are included for the models 44 and 58 shakers, model 64 control consoles and model 45 rotary power supplies. Data on accessories and ordering information are given.

Precision Instrument Bearings. New Hampshire Ball Bearings, Inc., Peterborough 1, N. H. Catalog No. 53 includes 28 pages of dimensional and design data on 137 Micro ball bearings, in bore sizes 0.025 to $\frac{3}{16}$ in., O. D. 0.100 to $\frac{1}{2}$ in. Featured are the first ground miniature bearings in the U. S. Loads, speeds, mounting lubrication, tolerances, gaging and handling of instrument bearings are also discussed.

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PLANTS AND PEOPLE

Edited by WILLIAM G. ARNOLD

OTHER DEPARTMENTS featured for this issue:

Electronic Manufacturers Aid Engineering Education

FOURTEEN new scholarships for electronic and electrical engineering students have been established at Pacific Coast universities and colleges by a group of western electronic manufacturing firms. The new scholarships, ranging from $600 to $800 per student will be awarded directly by 8 educational institutions to entering electronic and electrical engineering students. Although designed primarily to encourage first and second year students and junior college transfers to enter engineering, the awards will also be available to graduate engineering students.

Sponsoring the scholarships are the 140 member firms of the West Coast Electronic Manufacturer's Association, a group of concerns employing over 32,000 men and women and contributing over twenty percent of the nation's electronic production.

The scholarship fund was established and will be maintained by voluntary donations from association members. Awards will be granted annually to deserving and needful students regardless of race, color or creed.

In the East, three Massachusetts electronic manufacturers are strengthening the work of the Graduate School of Arts and Sciences of Harvard University with the provision of 5 industrial fellowships through the Harvard Foundation for Advanced Study and Research.

The General Communication Company of Boston has given $5,000 to provide two fellowships of $2,500 each, one in the Division of Applied Science and one in the Department of Physics, for 1953-54; Polaroid Corp. of Cambridge, will give $2,500 for one fellowship in the Department of Physics in 1953-54; Raytheon Manufacturing Co. of Waltham gave $5,000 for 2 fellowships in the Department of Physics during the present academic year, these to be renewed next year as well.

WESCON Technical Program Takes Form

GENERAL outlines of the technical papers program for the fourthcoming WESCON (Western Electronic Show and Convention) in San Francisco August 19-21 are crystallized into 17 sessions including approxi-

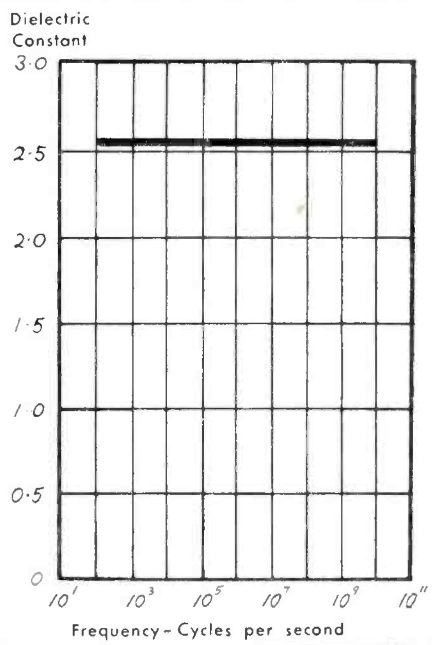
NATIONAL TELEVISION SYSTEM COMMITTEE MEETS

The following members and observers were present at a meeting of the NTSC held recently at IRE headquarters in New York City: Seated (left to right), Mrs. Martha Kinzie, NTSC Secretary; A. N. Goldsmith, consulting engineer; A. V. Loughren, Hazeltine, NTSC vice-chairman; E. W. Engstrom, RCA, NTSC vice-chairman; W. R. G. Baker, GE, NTSC chairman; R. H. Harmon, Westinghouse; W. T. Wintringham, Bell Laboratories; Knox McIlwain, Hazeltine; O. H. Caldwell, Caldwell-Clements; Jerome Bresson, Tele-King; G. L. Beers, RCA; R. E. Shelby, NBC; John Rennick, Zenith; D. E. Harnett, GE; A. G. Jensen, Bell Laboratories; R. M. Bowie, Sylvania; Rinaldo De Cola, Admiral; L. M. Clement, Crosley. Standing (left to right) S. J. Melman, CBS-Columbia; J. M. Miller, Jr., Bendix; I. J. Kaar, GE; J. W. Christenson, CBS Laboratories; C. J. Hirsch, Hazeltine; L. R. Fink, GE; R. W. Mueller, Sentinel; W. W. MacDonald, ELECTRONICS; Richard Hodgson, Chromatic Television Laboratories; J. M. Barstow, Bell Laboratories; W. Feingold, Emerson

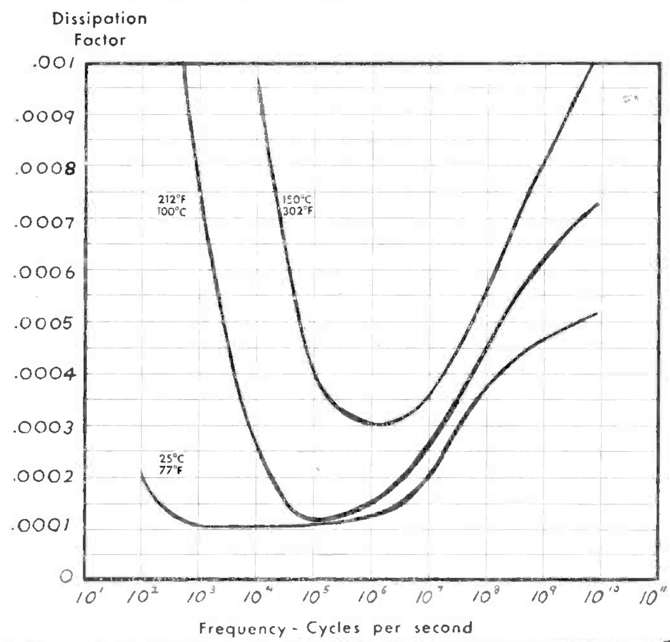
THE REMARKABLE PERFORMANCE

of REXOLITE 1422

DIELECTRIC CONSTANT VS FREQUENCY



DISSIPATION FACTOR VS FREQUENCY



DISSIPATION FACTOR — *EXTREMELY LOW OVER ENTIRE R.F. & U.H.F. RANGE*

DIELECTRIC CONSTANT — *NO CHANGE WITH FREQUENCY*

This wonderful insulation performance coupled with a high heat distortion point (105°—113°C) and the resulting good machinability make Rexolite 1422 an amazing High Frequency insulation. It equals or excels all but a few of the fine qualities of the much more expensive fluorocarbons. Even in the "few," it is superb in its own right and very close to the fluorocarbons — as in the case of Dielectric Constant shown in the above chart.

Rexolite 1422 is a carefully controlled cross-linked polystyrene. Developed by two of the country's greatest laboratories and manufactured for 10 years, Rexolite 1422 is highly dependable in quality, uniformity and performance.

If you have RF or UHF insulating problems calling for sheets, rods, castings or imbedments, check Rexolite 1422. We welcome problems. Write to us for information, full size copies of the above charts and technical bulletins.

THE REX CORPORATION

Manufacturers of UHF Insulating Materials, Microwall Wire**, Kel-F* insulated wire, other Wire Specialties, Rextrude** 105 Electrical Tubing and Custom Plastic Extrusions.

West Acton, Massachusetts, U.S.A.

* T.M. of M. W. Kellogg Co.
** Reg U.S. Pat. Off.

mately 85 papers, according to an announcement by Bernard M. Oliver of Hewlett-Packard Co., WESCON papers chairman. WESCON is jointly sponsored by the IRE (7th region) and WCEMA (West Coast Electronic Manufacturers Association).

Still subject to minor changes, shifts and additions, the program will include two sessions each on antennas, propagation, electron devices, circuits, and computers, and one session each on airborne electronics, microwave techniques, servos and telemetering, instrumentation, transistors, and nuclear-radiation measurements.

Of the evening sessions scheduled; one will be on medical electronics, another on audio, and a third on generalized topics of broad scope.

Meetings on related subjects are being scheduled to be held in the San Francisco Bay area preceding the WESCON program. One of these is a joint UCLA-ONR information theory symposium in Berkeley, August 17 and 18. Another is a special discussion of magnetic recording apparatus and techniques, given for the Federal Court Reporters and sponsored by the San Francisco Section of the Audio Engineering Society.

Electronic Firms Expand Westward and Eastward

CONSTRASTING patterns of plant expansion in the electronics industry are indicated by the recent moves of Aerovox Corp. and Hoffman Radio Corp.

Aerovox announced recently through its president, W. Myron Owen, the acquisition of Cinema Engineering Co. of Burbank, Calif. It marks another addition to the company's west coast facilities in recent months. Aerovox is currently constructing a new plant in Burbank, Calif., to augment its present facilities there and a $900,000 plant in Monrovia, Calif. which will provide additional manufacturing facilities for the west coast market.

In a two-fold expansion program, Hoffman Radio Corp. will increase its tv set production in California and extend its output for eastern and midwest markets through the construction of a $1 million factory in Kansas City. This west-to-east expansion is the first such move by a California tv set manufacturer.

Hoffman expects to employ approximately 1,000 people in the 85,000 sq ft Kansas City factory when it begins operations.

Production Under Way At DuMont's New Plant

Allen B. DuMont Laboratories' new Instrument Division plant in Clifton, N. J. was officially opened in May (ELECTRONICS, p 366, May, 1953). It contains 118,000 sq ft of space for the development and manufacture of cathode-ray instruments. Roughly 30 percent of the plant's output will go to the Armed Forces

ACCEPTS MILLIONTH RADIOSONDE

Brig. Gen. W. Preston Corderman (right) commanding the Signal Corps Supply Agency, Philadelphia, accepts the millionth radiosonde unit manufactured by the Friez Instrument Division of Bendix Aviation Corp. from LeRoy D. Kiley, Friez general manager. Presentation took place as General Corderman inspected an automatic calibrator, designed by Friez engineers, which enables two employees to handle precision tests formerly requiring 30 skilled technicians

GE Makes Changes In Engineering Posts

HARRY A. WINNE, vice-president of engineering of the General Electric Co., has been named to a new post performing special assignments for GE president Ralph J. Cordiner. Mr. Winne's move is in anticipation of his retirement from the company in the latter part of the year.

In his new position, Mr. Winne will serve in a consulting capacity in engineering and will also spend several weeks abroad conducting an investigation on engineering progress in the European electrical industry.

Clarence H. Linder, vice-president and general manager of the company's major appliance division, is to succeed Mr. Winne as vice-president of engineering.

Charles K. Rieger, vice-president and general manager of the Small Appliance Division, is to succeed Mr. Linder as vice-president and general manager of the Major Appliance division.

Willard H. Sahloff, general manager of the electronics Division's Radio and TV Department, is to become general manager of the

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Small Appliance Division.

Herbert Riegelman, manager of marketing for the Radio and TV Department, is to succeed Mr. Sahloff as general manager of the department.

ELECTRONICS CONFERENCE HOSTS

Hosts at the electronic conference in Los Angeles during the RTMA Directors meeting (U. S. and Canada) were, left to right: Robert S. Bell, vice-president of Packard-Bell; H. Leslie Hoffman, president of Hoffman Radio and Charles B. Thornton, vice-president of Hughes Aircraft. Mr. Hoffman was chairman of the 3-man committee

American Car & Foundry Buys Avion Instrument

THE American Car and Foundry Co. has purchased the entire outstanding capital stock of the Avion Instrument Corp., according to Charles J. Hardy, Jr., president of ACF. Avion will continue under the same management, headed by Richard F. Wehrlin, founder and president.

In commenting on ACF's acquisition, Mr. Hardy stated, "The Avion Instrument Corp., in becoming a division of the American Car and Foundry Co., further broadens our field of activity and brings us into the electronics picture. There are unlimited opportunities ahead of ACF and Avion in further developments which will benefit all industry. The combination of Mr. Wehrlin's staff with ACF's re-sources and stability means a greater contribution to the defense effort in which both companies are playing an important part."

ARMY HONORS BAKER

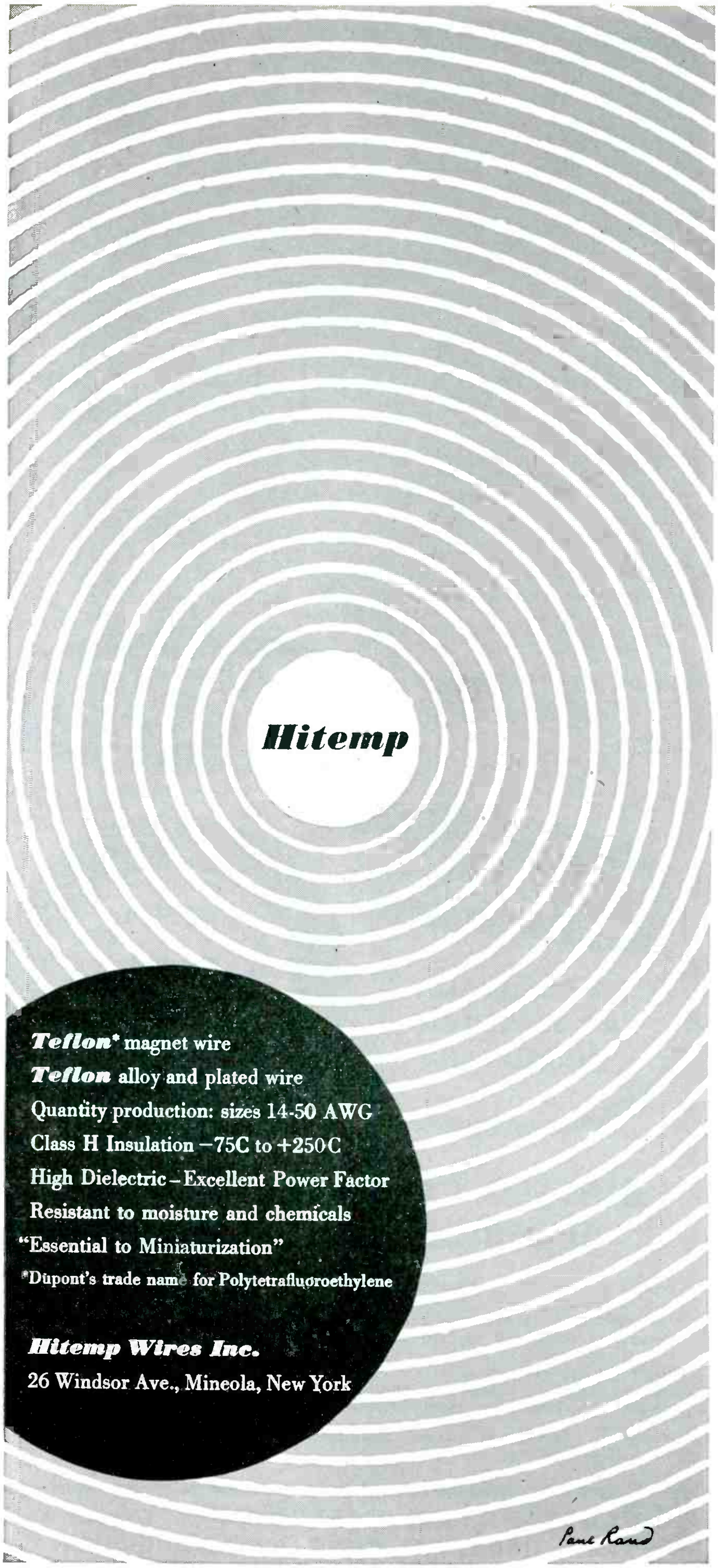
Hon. Earl D. Johnson, Under Secretary of the Army, presented the Medal of Freedom to W. R. G. Baker, vice-president and general manager of GE's Electronics Division, for accelerating the application of electronics to the solution of Army research and development problems. He led a mission of leading scientists and industrialists to Korea last summer to study the problem of utilizing electronic devices and principles to the maximum extent in modern war, thereby increasing the effectiveness of the individual soldier and reducing the cost of human life. According to the citation, Dr. Baker "furnished guidance to the Chief of Staff and the Secretary of the Army which will have a significant impact on the Army's future effectiveness."

Top Executives Change At Sylvania Electric

THE ELECTIONS of Don G. Mitchell as chairman of the board of directors and H. Ward Zimmer as president of Sylvania Electric Products Inc. were announced by the board of directors.

Both officers have assumed their new duties. Their headquarters are at Sylvania's executive offices in New York City.

Mr. Mitchell, who has been president of Sylvania since 1946, succeeds Max F. Balcom, a member of the Sylvania organization and predecessor companies for 25 years. Although Mr. Balcom is retiring from the chairmanship, he will continue to serve Sylvania as a director



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Don G. Mitchell

and in a consultative and advisory capacity.

Mr. Zimmer, the new president, has been executive vice-president since 1950 and for 3 years prior to that time was vice-president in charge of operations.

Following his election as president, Mr. Zimmer announced the election of W. Benton Harrison as a vice-president of the company in charge of finance, a newly created post.

H. Ward Zimmer

Mr. Harrison, whose headquarters are also in New York City, has been treasurer of the company for the past two years.

Giannini Forms European Subsidiary

G. M. GIANNINI & Co., INC. announced the recent formation of a European subsidiary to be known as Giannini Italiana S.p.A., with offices and laboratories located in

Milan, Italy.

The establishment of the Italian company will provide sales and engineering headquarters for the distribution and servicing of the products of G. M. Giannini & Co., Inc. in Europe. In addition, Giannini Italiana will maintain a research laboratory and experimental shop for developing new instruments of European origin.

Reynolds Named RTMA Staff Attorney

WILLIAM L. REYNOLDS assumed the post of staff attorney at RTMA headquarters, executive vice-president James D. Secrest announced recently. Mr. Reynolds, who replaces Ray S. Donaldson, will work under the direction of RTMA general counsel Glen McDaniel. Mr. Reynolds has been an associate of the Washington law firm of Covington & Burling since 1950.

Rauland Appoints Research V-P

THE APPOINTMENT of Constantin S. Szegho as vice-president in charge of research for The Rauland Corp. was announced by W. E. Phillips, vice-president and general manager of the company, following action

Constantin S. Szegho

taken at a recent meeting of the Rauland board of directors.

Since 1942, when he joined the staff at Rauland, Dr. Szegho has

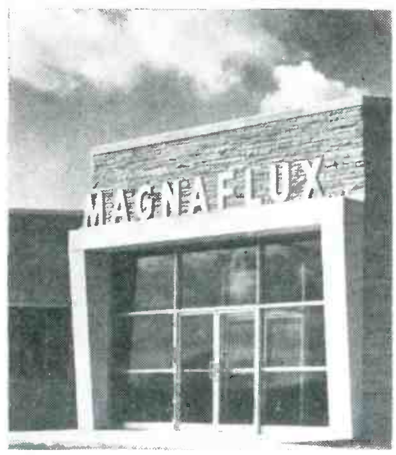
Want more information? Use post card on last page.

been serving as director of research.

Dr. Szegho's improvements in cathode-ray tubes and other special tubes used by the government in defense equipment, his development of the first low-voltage focus television tube and his perfection of the "black" tube are some of his contributions to the television tube industry. His other activities include high-voltage cathode-ray tubes used in radar equipment during the war that are now being utilized in theater television equipment, and color television research.

Magnaflux Opens New Main Plant

MAGNAFLUX CORP. recently opened its newly built main plant in Chicago. It is a one-story building with an area of 74,000 sq ft, nearly double the size of the old plant.



New Magnaflux Plant

With the new facility, the operations of the company are now all combined under one roof. About 65 percent of the space is devoted to research, engineering and field engineering service functions. Approximately 250 people are employed in the plant.

Buetow Named President Of Minnesota Mining

ELEVATION of Herbert P. Buetow, executive vice-president in charge of finance, to the presidency of Minnesota Mining & Manufacturing Co. was announced by the board of

Herbert P. Buetow

directors of the company.

He succeeds Richard P. Carlton who becomes vice-chairman of the executive committee.

Election of H. N. Stephens as vice-president in charge of central research was also announced by the company. He has been in charge of the central research laboratory since 1937.

Earlier this year, 3M announced a long-range building program for research purposes. Ground-breaking ceremonies for the first unit in this program, a $3 million scientific laboratory for the central research group, will take place about June 1. The new laboratory, located on St. Paul's eastern boundary, is due for completion in mid-1954.

Mullard of England Plans TV Tube Plant

THE MULLARD CO. has decided to establish a new factory for the manufacture of cathode-ray tubes in England.

At present, the manufacture of these tubes is mainly concentrated in the company's factory at Mitcham, London. Following discussions with the Board of Trade, it was decided to transfer the manufacture to a new factory in the North-West Lancashire Development Area, to be built under facilities provided for by the Distribution of Industry Act.

The factory will be one of the largest and most modern tv tube factories and will provide valuable addition to the diversification of industry in the textile towns of North-East Lancashire, the company announcement said.

The transfer of the work from Mitchem will make much-needed space available for the manufacture of other electronic devices and this will absorb the workers at present employed on tv tubes there.

Stromberg Appoints Chief Engineer

CHARLES W. FINNIGAN has been appointed chief electronics engineer of the Stromberg-Carlson Co., according to an announcement by Sidney R. Curtis, vice-president in charge of government contracts for the company.

Mr. Finnigan originally joined Stromberg-Carlson in 1941, after considerable experience in the radio engineering and manufacturing field, and remained until 1949, when he took a position with Sylvania Electric Products in Buffalo, N. Y.

In his renewed association with Stromberg-Carlson he will be largely concerned with government contracts. He takes the place of Garrard Mountjoy, who resigned to accept the position of assistant to the vice-president of American Radio-Television, Inc.

GE Adds To Its Buffalo Tube Works

INCREASED production of aluminized tv picture tubes is expected at the Buffalo Tube Works of the General Electric Co. when a three-story addition to the works is completed about June 30th.

The addition, which will cost almost $100,000, will add 7,000 sq ft to the existing 169,000 sq ft. New equipment will be added and certain manufacturing processes will be relocated to improve the flow of production.

Rola Names Torsch Chief TV Engineer

THE APPOINTMENT of Charles E. Torsch as chief television engineer for The Rola Co. Inc. was announced recently by Lawrence A. King, president and general manager.

Prior to joining The Rola Co., Mr. Torsch was with GE, which he joined in 1948 and for whom he organized and headed the cathode-ray sweep systems engineering group. In this capacity he guided the development of the GE 77J1 type ferrite-cored transformers and yokes for 50 degree-90 degree sweep.

Prior to his GE association he was the principal tv receiver design engineer at Bendix Radio. Before that, he was with RCA Victor in various engineering capacities.

Texas Instruments Expands Facilities

TEXAS INSTRUMENTS, INC. and Geophysical Service, Inc. are building a new $1 million plant in Dallas, Texas, that is expected to be completed by mid-July. The current enlargement will supply a total of 150,000 sq ft of floor space, more than doubling present facilities.

Sands Appointed By Langevin

Leo G. Sands

THE APPOINTMENT of Leo G. Sands to the post of sales manager at Langevin Manufacturing Corp. has been announced by Donald S. Morgan, president.

Mr. Sands recently resigned as president of Bogue Railway Equipment Division, manufacturer of railway electrical and communications equipment. He had also served Bogue Electric Manufacturing Co.

as general sales manager.

For several years Mr. Sands was associated with the Radio Division of Bendix Aviation Corp. in several sales management posts, including that of director of public relations and advertising. He has also been associated with Philco Corp.

Honeywell To Open New Illinois Plant

A NEW FACTORY will be opened shortly at Warren, Ill., to expand the production of the Micro Division of Minneapolis-Honeywell Regulator Co., it was announced recently by W. W. Gilmore, president of the division.

The new plant, a 10,000 sq ft building obtained under a lease arrangement, will become the division's fourth manufacturing operation, the other three being in Freeport, Ill., where the division is headquartered. Warren is about 25 miles north of Freeport.

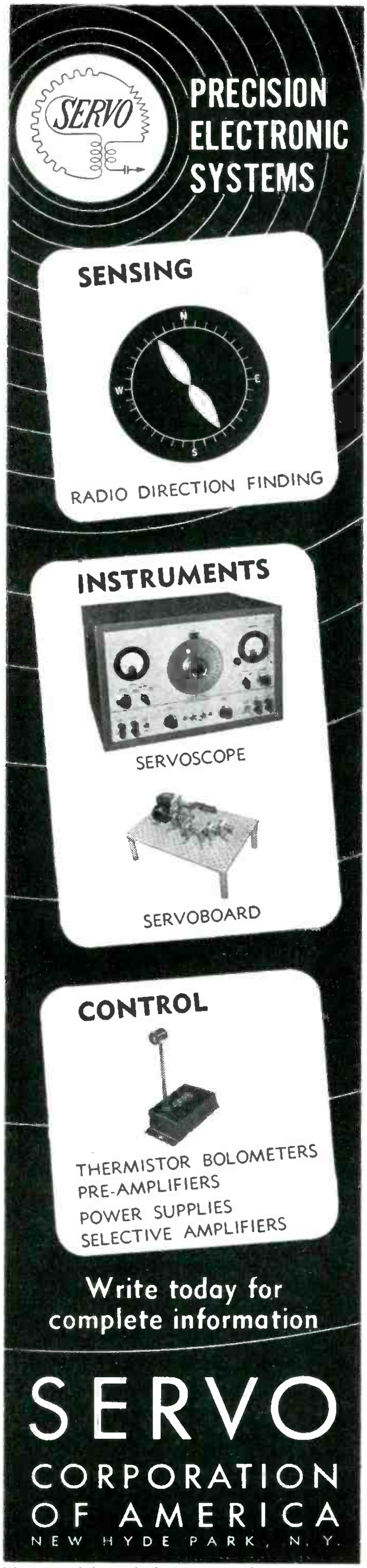
Approximately 150 persons will be employed initially in the new operation.

Emerson Names Levy Assistant Works Head

Maurice L. Levy

MAURICE L. LEVY, who was chief engineer of special products for Emerson Radio and Phonograph Corp. from 1943 to 1949, has returned to the company as assistant works manager, it has been announced by E. J. Kelly, vice-president and works manager.

Mr. Levy has been in the elec-



tronics field since his graduation from Union College in 1924. He has held important engineering posts with leading radio and tv manufacturers, including Emerson, from that time to the present.

Rich-Roth Sells Ultra-Viscoson To Bendix

THE ULTRA-VISCOSON, the ultrasonic "dip stick" that automatically and continuously measures, records and controls viscosity, was sold by its developers, the Rich-Roth Laboratories, to Bendix Aviation.

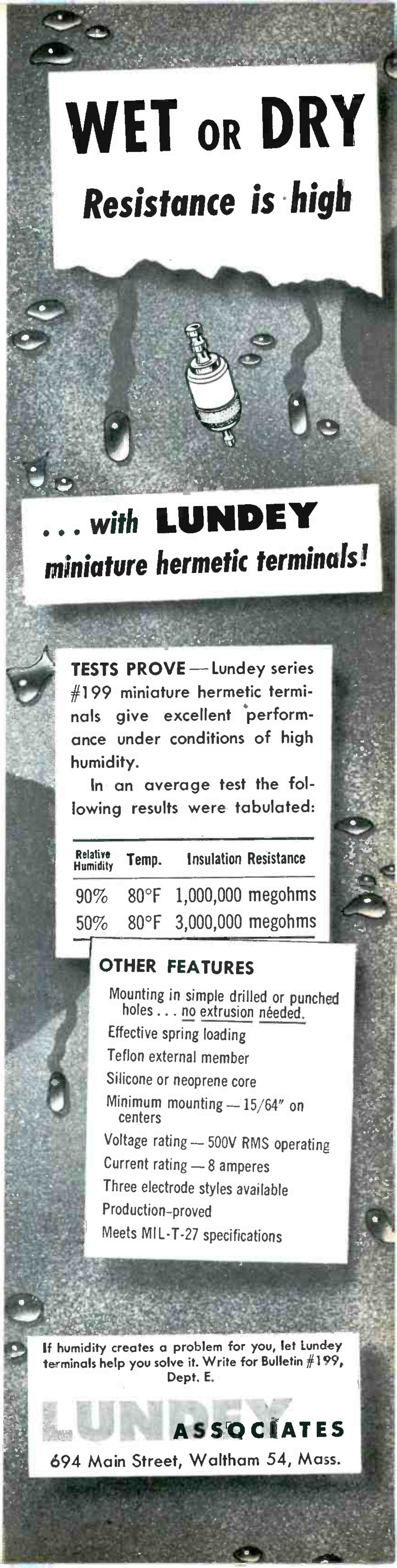
According to Rich-Roth, the heavy demand for the instrument imposed an excessive manufacturing burden upon the Rich-Roth Laboratories which were organized in 1950 for research, development and consulting. The sale of the Ultra-Viscoson to Bendix frees Rich-Roth for further research and developments in the fields of automatic process controls, ultrasonics, electronics and applied physics.

Rich-Roth Laboratories will continue to be closely associated with the Ultra-Viscoson as technical consultants to Bendix. The Ultra-Viscoson is the first of a line of process control instruments to be produced by the Cincinnati Division of Bendix Aviation Corp.

ERA Names McDonald Director Of Research

Robert E. McDonald

ROBERT E. MCDONALD, former director of engineering and maintenance for Braniff International Airways, has been appointed director of manufacturing for Engineering Research Associates Division of



Remington Rand Inc. He will assume directorship of the manufacturing activities at all of ERA's St. Paul plants.

In 1946, Mr. McDonald became a project electrical engineer and later supervisor of aircraft electrical engineering for Northwest Airlines. When he left Northwest in September, 1950, he was superintendent of radio-electrical and accessory overhaul.

He joined Mid-Continent Airlines as chief engineer and later became director of engineering and maintenance. When Mid-Continent and Braniff Airlines merged in 1952 to form Braniff International Airways, McDonald directed all engineering and maintenance of the northern region, including Minneapolis-St. Paul.

Pacific Mercury TV Expands Engineering

EXPANSION of engineering activities has necessitated reorganization of the engineering department of Pacific Mercury Television Mfg. Corp., Joe Benaron, president, announced. Bernard Diener has been named chief engineer of the Radio and TV Division and will have charge of home receiver development and design.

Stan Cutler, who is vice-president of the company and has been chief engineer, has assumed the title of director of engineering and will head the expanded engineering program. In addition, he will be acting chief engineer of the new Special Products Division.

Prior to his association with Pacific, Mr. Diener was a physicist and technical consultant on radio and guided missiles electronics at Hughes Aircraft Co. and formerly senior project engineer on f-m radio and tv for Hoffman Radio Corp.

Gates Promotes Young

HOWARD YOUNG, formerly mechanical and design engineer of the Gates Radio Co., has been promoted to plant manager, it has been announced.

Mr. Young joined the Gates organization as a draftsman in 1945, following army service. Dur-

Want more information? Use post card on last page.

Howard Young

ing the past several years he has been mechanical and design engineer.

It was also announced that Bill Brady has joined the Gates sales staff and will call on Gates customers in North Texas, Mississippi and Eastern Oklahoma.

Textile Firm Buys Aviation Engineering

THE KNICKERBOCKER TEXTILE CORP. has purchased all of the assets and good will of the Aviation Engineering Corp. and the company will be known as Avien-Knickerbocker, Inc., according to Leo A. Weiss, president of Aviation Engineering and Jacob Granowitz, president of Knickerbocker Textile.

Executive head of the company is Leo A. Weiss, who will act as president. Mr. Granowitz will serve as chairman of the executive committee.

Avien-Knickerbocker will be composed of two divisions: the Aviation Engineering Division under the direction of Mr. Weiss, and the Knickerbocker Division under the direction of Mr. Granowitz.

Purpose of the purchase is to provide for growth and expansion.

Control Engineering Appoints Peirce

CONTROL ENGINEERING CORP. announced the appointment of Stanley D. Peirce as manager of the Government Contracts Division. He is a graduate of the Harvard University Engineering School and was previously a senior electronic engineer with the Guided Missile Division of the Fairchild Airplane and Engine Co. He also directed guided missile development for the Bureau of Aeronautics of the U. S. Navy, before coming to Control Engineering.

Silver-Zinc Battery Inventor Honored

ONE of the highest French scientific honors, the Ampere Medal, has been bestowed upon Professor Henri G. Andre by the Societe Francaise de Electriciens in recognition of his outstanding contributions to electrical science and in particular for his work in the field of electrical energy storage.

Henri G. Andre

Professor Andre, who is actively associated with the Yardney International Corp., has devoted many years to the development of the first practical rechargeable silver-zinc accumulator.

Ampex Forms New Research Division

TO FURTHER the development of magnetic recording, the Ampex Electric Corp. has organized a new research division headed by Carl Becker.

The new division will conduct basic research on magnetic recording techniques which will apply both to the familiar sound recording applications and equally important uses in the recording of technical data. Ampex already manufactures a number of models for both fields. New development work will emphasize stereophonic (third dimensional) sound and new data applications.

Cohn Joins Stanford As Microwave Head

SEYMOUR B. COHN has joined the staff of Stanford Research Institute to head the microwave group in the aircraft radiation systems laboratory.

Dr. Cohn was formerly a research engineer with Sperry Gyroscope Co. in New York for five years. During the war years, he worked as a special research associate in the radio research laboratory at Harvard University.

Electric Regulator Enlarges Plant

A NEW 2,100 sq ft addition to the plant of the Electric Regulator Corp. is now under construction, it was announced recently by Laurence W. Burn, general manager of the company.

The addition will have three sections. These will be used for receiving shipments, as stockroom and storage area, and to house emergency stand-by power equipment.

New Transformer Company Formed

SUPERIOR TRANSFORMER CORP. is a new company in Chicago, specializing in all types of transformers and coils.

Walter W. Kunde is president of the organization. Mr. Kunde was formerly chief engineer of Thordarson Electric Mfg. Division of Maguire Industries.

Hudson Wire Expands

A RECORD number of employees, working on a three-shift basis, was registered recently when the Hudson Wire Co. at Ossining, N. Y. attained an all-time peak in shipments of wire manufactured by its

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150 employees.

Due to the recent completion of a new factory in Cassoplis, Mich. manufacturing enameled wire' the expansion of the Winsted Division at Winsted, Conn. and the addition of new customers and increased demands from regular customers, the Ossining plant has been called upon to supply greater quantities of fine wire. Because of the nonseasonal character and standardization of the product, steady employment has been made possible.

Pope Joins Sanders

HAROLD W. POPE, formerly chief engineer at Convair's Guided Missile Division in California, has been elected the fourteenth associate of Sanders Associates, Inc. and is taking direction of its guided missile and aero-mechanical activities.

Harold W. Pope

As chief engineer at Convair, Mr. Pope was responsible for the technical and administrative direction of all phases of guided missile development and production engineering.

Beckman Opens Plant In New Jersey

TRANSFER of its New York offices to a new 20,000 sq ft plant in Mountainside, N. J., has been announced by Beckman Instruments, Inc.

The air-conditioned brick structure triples the size of Beckman's current east-coast operation.

Functioning as northeast sales

and service headquarters for the parent company, this building also will provide a branch manufacturing facility for the Beckman Helipot Division, maker of helical potentiometers. Expansion on a countrywide scale has followed sixfold increases in the company's sales volume since 1949.

Sonotone Names Battery Chief

Harold Engstrom

HAROLD ENGSTROM has joined Sonotone Corp. as general manufacturing manager of the Battery Division, with headquarters in Elmsford, N. Y.

Mr. Engstrom was formerly with Sylvania Electric Products, Inc., where for four years he was chief of industrial engineering. He also supervised Sylvania's policies on installation and control of wage incentives and job evaluation and cooperated with the labor relations department on union contract negotiations.

He had previously been associated in a similar capacity with American Home Products Corp. Prior to that he was chief industrial engineer for five plants of the Bendix Aviation Corp. The 12 preceding years he spent with GE in Bridgeport, Conn.

Warwick Plans New Lab

WARWICK MANUFACTURING CORP. is opening a new research and development laboratory in Chicago, it was announced by John S. Holmes, president.

Edwin B. Hassler, formerly with

Want more information? Use post card on last page.

Edwin B. Hassler

Motorola, Inc., has been appointed director of engineering to head the laboratory. He will be in charge of radio, television and electronic product development and the testing and improvement of component parts.

In addition to the standard radio and television set development, the laboratory's engineering staff will work on color television, record players, auto radios and transistor and printed circuit research.

The company recently purchased the 200,000 sq ft Fieldcrest Mills plant in Zion, Ill. which is being remodeled for tv production.

Consulting Firm Formed

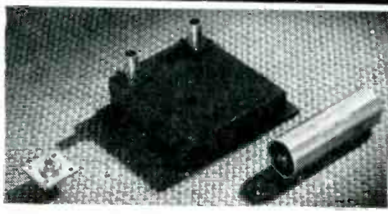
TECON, TECHNICAL CONSULTANTS, INC. has been formed for the purpose of sales engineering, field servicing and technical consulting in the electrical, electronic, electro-mechanical and mechanical engineering fields.

Officers of the corporation include J. Herrmann, president and P. Marcus, vice president. Mr. Herrimann was formerly associated with the Westinghouse Electric Corp. and Taylor Instrument Co. Mr. Marcus comes to Tecon from Bell Recording Co., where he held the position of chief engineer.

Auerbach Advances At Burroughs

ISAAC L. AUERBACH has been appointed manager, special electronic equipment department, in the research activity of Buroughs Corporation, formerly Burroughs Adding

BREW DELAY LINES



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SPECIFICATIONS

MODEL	CENTER FREQUENCY	RF OUTPUT 50 ohm * TERMINATION	SWEEPWIDTH CONTINUOUS ADJUSTMENT	FREQUENCY MARKER
SM I	100 KC to 14 MC	1 volt RMS	150 KC to 14 MC	100 KC to 14 MC
SM II	500 KC to 50 MC	0.2 volt RMS	150 KC to 20 MC	500 KC to 50 MC
SM III	500 KC to 75 MC	0.1 volt RMS	150 KC to 20 MC	500 KC to 75 MC

FLATNESS: Less than 1 DB variation over maximum sweepwidth range.
FREQUENCY MARKER: Engraved calibration accurate to ±2%.
HORIZONTAL DEFLECTION: A 60 cps sine wave for application to horizontal input of oscilloscope is supplied.
BLANKING: The RF signal may be operated continuously or blanked out for ½ of each 60 cycle period.
EXTERNAL DETECTOR: Blocking capacitor of 400 volt breakdown capacity.

*75 ohm available when specified

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Machine Company.

At Burroughs Research, Mr. Auerbach has been actively engaged in the design of electronic data processing systems and initiated work on magnetic components and circuits. He was responsible for the design of the static magnetic memory system for the ENIAC.

Prior to joining Burroughs Research in 1949, he worked on the BINAC and UNIVAC systems at the Eckert-Mauchly Division of Remington Rand, Inc., in Philadelphia.

Radio City Products Expands

A 2½-ACRE tract of land has been leased by Radio City Products Co. at Easton, Pa. for the erection of a new one-story manufacturing plant to adjoin their present production center. The new building will provide for an additional 13,000 sq ft, and thus give the company a total production area of 27,000 sq ft. Administration, sales and engineering will continue to be located in New York City.

Jerome M. Hollander, formerly with Allen B. DuMont Laboratories, has been appointed senior engineer of the company. He will be principally responsible for the company's test equipment design.

Mr. Hollander was also previously associated with the engineering departments of GE and Oak Ridge Products.

Hughes Labs Adds Two

MAX A. ANDERSON AND JOHN R. BURGENER have joined the field engineering department of Hughes Research and Development Laboratories. Mr. Anderson was formerly associated with WRAP-TV. Mr. Burgener was formerly with the National Bureau of Standards.

Makepeace Co. Builds For Electronic Industry

THE D. E. Makepeace Company, one of New England's oldest and largest precious metals manufacturers, has a new building under construction as part of a program to diversify and expand production for the electronics industry, it was announced by W. F. Mittendorf, vice-president and manager.

Weathers Appoints Gately

PAUL WEATHERS of Weathers Industries announced recently the appointment of Edward J. Gately, Jr., as project engineer. Mr. Gately was formerly associated with Clifton Precision Products and is connected with Gately Development Laboratories.

Allison Named To New Sprague Post

William M. Allison

APPOINTMENT of William M. Allison as technical advisor has been announced by Carroll G. Killen, manager of field engineering of the Sprague Electric Co.

Mr. Allison has been a senior executive in the Sprague research and engineering department for the past 20 years, contributing to nearly all phases of Sprague technological development in his prior posts of supervisory engineer and chief design engineer. He holds six patents pertaining to capacitors.

Starks Named Head Of Atomic Committee

JAMES C. STARKS, on leave from Sandia Corp., contractor to the Atomic Energy Commission, has been named executive director of the Research and Development Board's committee on atomic energy. Mr. Starks has been associated successively with McQuay Norris Co., St. Louis, Mo., the Crosley Radio Corp., Cincinnati, Ohio and the Westinghouse Corp. with whom he developed electronic equipment for the Navy.

Sobin Is President Of Olympic Radio

MORRIS SOBIN, executive vice-president of Olympic Radio & Television, Inc., since July 1952, was elected president of the company at the organization meeting of directors following the annual meeting of stockholders. Mr. Sobin, associated with Olympic since 1942, initially as chief accountant and, from 1946 to 1952, as vice-president and treasurer, succeeded Percy L. Schoenen, who previously announced his retirement.

Erie Resistor Adds Industrial Department

AN industrial sales department has been organized within the electronics division of the Erie Resistor Corporation, according to an announcement by Allen K. Shenk, sales manager. E. S. Willis, sales representative, has been appointed to head up the new department.

The department will coordinate sales efforts involving all companies except those which primarily manufacture radio and tv home receivers and radio and radar equipment for the U. S.

Rogers Joins National Bureau Of Standards

GEORGE J. ROGERS has joined the electronics division of the National Bureau of Standards. As a member of the engineering electronics section Mr. Rogers will be engaged in the development of miniaturized electronic equipment.

Before joining the NBS staff, Mr. Rogers was an electronics engineer with the Engineer Research and Development Laboratories, Ft. Bel-

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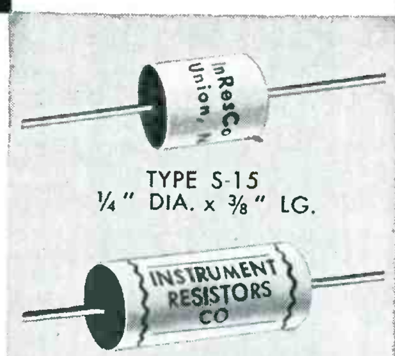

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APPLICATION-DESIGNED RESISTORS FOR ELECTRONICS AND INSTRUMENTATION voir, Virginia, where he assisted in the development of electronic mine-detectng equipment for both metallic and non-metallic mines.

Diener Named Chief Engineer of Pacific TV

BERNARD DIENER of Pacific Mercury Television Manufacturing Corp., Los Angeles, has been named chief engineer of the firm's Radio and Television Division in charge of home receiver development and design. Another change moved Stan Cutler, vice-president and chief engineer, to a post as director of engineering and acting chief engineer of the new Special Products Division.

Foulds New V-P Of GPL

ELECTION of Blair Foulds as a vice-president General Precision Laboratory, Inc., has been announced by Hermann G. Plance, president of the company.

Mr. Foulds has served for several years as commercial engineering director of the company, with responsibility for government liaison and contract administration as well as marketing of commercial products including broadcast studio and theatre television equipment.

Before joining GPL in 1949, Mr. Foulds was commercial engineering director of Brush Development Company, Cleveland, manufacturers of industrial instrumentation and magnetic recording devices.

Sightmaster Forms New Subsidiary

THREE electronic and metallurgical companies have been consolidated to form Sightmaster of California as a new subsidiary of Sightmaster Corp. of New Rochelle, N. Y. Headquarters are at Gillespie Airport, Santee, Calif., a suburb of San Diego.

Electronic Division of Transport Products Corp., Louisville, Ky. was acquired by purchase, Technical Products and Services Co. by exchange of stock, and Chemalloy Associates by exchange of stock. The transaction secured for the

PLANTS AND PEOPLE (continued)

new firm the TPC-KAHL microwave calorimeter and other electronic developments and services, as well as the Chemalloy aluminum and zinc fluxless soldering and welding process.

Bushnell Acting Chief Of Common Carrier Bureau

CURTIS M. BUSHNELL has been designated as acting chief of the common Carrier Bureau of FCC. He succeeds Jack Werner, resigned.

Bakelite Completes Expansion Plans

COMPLETION of plans for the largest single expansion program in the entire history of the plastics industry was recently announced by Bakelite Co., a division of Union Carbide and Carbon Corp.

In making the announcement, H. S. Bunn, president of Bakelite, stated that a three year expansion program calls for the construction of three large new plants with facilities to produce Bakelite polyethylene plastic, its compounds and other chemicals from natural gas.

"This Union Carbide expansion program, when completed in 1955, will double present U. S. polyethylene production, bringing total annual production of Bakelite polyethylene to over 250 million pounds," Mr. Bunn stated.

On the occasion of the announcement of completion of the company's expansion plans, Under Secretary of the Army Earl D. Johnson revealed that total savings of $153 million in current defense procurement of wire and cable are largely due to the use of polyethylene.

Replacing old-style cable with a new type using polyethylene insulation has saved taxpayers $50 million since the Korean fighting began, he said. "The Signal Corps spent just $288,000 in a research contract granted for the development of this synthetic material as insulation for Army wire and cable. Thus, for $228,000 the Army's Research and Development program in the fiscal year 1953 will produce savings of about $12.4 million on field wire alone. Total savings in the last two and one-half years on wire and cable have amounted to over $153 million."

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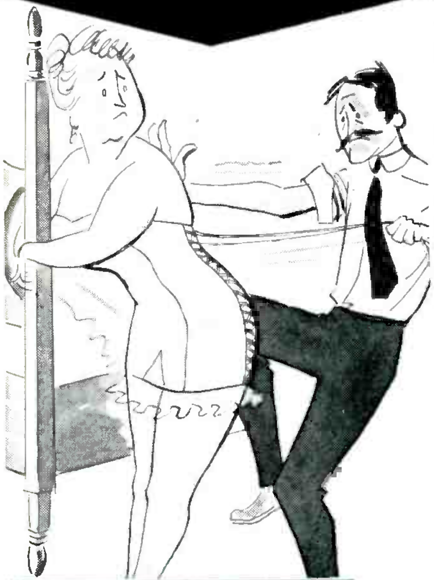
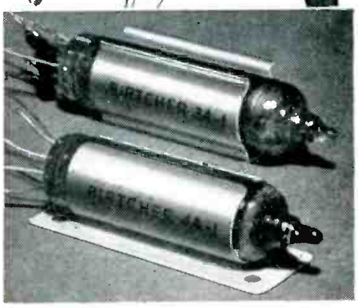




NEW BOOKS

Signal, Noise and Resolution in Nuclear Counter Amplifiers

By A. B. Gillespie. *McGraw-Hill Book Co., New York*, 1953, 155 *pages*, $4.50.

THIS is the first of a new series of monographs under the general title of "Electronics and Waves" sponsored in London by Pergamon Press, and under the editorship of D. W. Fry, who, like the author of the present volume, is a member of the staff at the Harwell atomic energy establishment.

The title reveals exactly the nature of the book—the factors which determine the signal-to-noise ratio and the resolution in nuclear counters. The first chapter deals with the nature of the signals from an ionization chamber. Then follow discussions of tube and circuit noise, along with the signal-to-noise ratio and how best to maximize it. The final two chapters deal with amplifier sensitivity and proportional and scintillation counters.

Mr. Gillespie evidently writes from experience and not from a mere theoretical interest in the subject. Intermixed with the useful and clear analytical treatment will be found many practical hints involving tube and circuit types and their relative advantages for particular jobs.

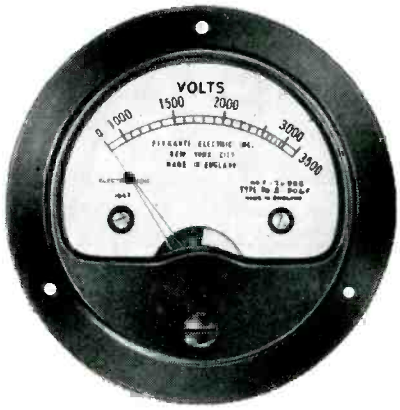
This would be an excellent starting point for anyone about to get his first experience with nuclear research.

Other volumes to appear in this new series are "Microsecond Pulse Techniques", "Particle Accelerators", "Probability, Information Theory and Radar ", "Secondary Electron Emission", and "The interaction between Electrons and Electromagnetic Waves."—K.H.

Essentials of Microwaves

By Robert B. Muchmore. *John Wiley & Sons, Inc., New York*, 1952, 236 *pages*, $4.50.

IN THIS BOOK the author attempts, with considerable success, to present a physical picture of the phenomena which collectively make up the microwave field. Thus, such



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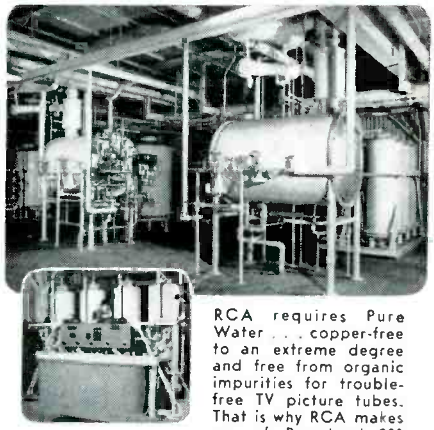

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matters as waves and wave guides, resonators and filters, antennas for microwaves, tubes for generating microwave power, the problems of noise, relay systems, radar, applications of microwaves to physical research, and microwave research are described in turn.

Virtually the only mathematics is in the first chapter, which deals with Maxwell's laws; the reader can easily skip over this. In fact, the average reader—that is, one who does not already know the facts of microwaves—is advised not to worry too much about these equations or their explanation but to plunge into the rest of the book. For the truth is that this attempt to sugar-coat Maxwell is not too successful and might easily frighten away the reader who can grasp all the rest of the book. The mathematics in the appendix is much easier to handle.

The book provides an excellent review for those who have been exposed to the field and is a good first book for those who have had adequate scientific background. A teacher would be required to bring out the best of the concepts described for the man who has limited background.—K.H.

Radio and Radar Technique

BY A. T. STARR, *Pitman Publishing Corporation, London, Toronto, and New York*, 1953, 812 *pages*, $15.00.

THE dollar-outlay for this new British-produced encyclopedic guidebook to the physics and mathematics of radio, broadly defined, is justified for the teacher, scientist, practicing research engineer and technical library. It purposely omits information readily obtainable in elementary undergraduate textbooks; and, devoid of anything but the barest mention of specific applications, packs the broad scope of its title into 510 closely-knit pages on the physics of communication and electronics, followed by 281 pages of mathematical appendices and by author and subject indices to the entire volume. The compression-ratio of the work is enhanced by the copious use of tiny but adequate diagrams and graphs. There are no pictures and no tabulations of data.

The seven chapter headings are:

Methods of Communication and Physical Limits (modulation methods, noise, information theory, pulse and Droppler radar); The Electromagnetic Medium (propagation, guided waves); Microwave and Short-Wave Techniques (discontinuities, couplers, transformers, resonators, filters, measurements); Antennae (dipoles, arrays, horns, lenses, reflectors); Valves (emission, discharge, high-frequency effects, klystron, travelling-wave, magnetron, pulse-modulators); CW Circuit Technique (network theory, transfer impedances, amplifiers, frequency modulators); Waveform Circuit Technique (waveform amplifiers, modern pulsing methods).

Relegation of the mathematics to 30 appendices accelerates the pace of the main text. The appendices include such subjects as Fourier analysis, Bessel's functions, vector analysis, Maxwell's equations, Heaviside analysis and Laplace transforms, as well as extensive treatments of modulation, noise, radiation, space-charge effects and networks.

Cross-References

The skeletal framework of each subdivision is expository, but the particular historical contributions of each authority in the field are meticulously identified, with cross-references to original source-material, which follows each of the chapters. The author has drawn as freely upon American as British and German books and periodicals for his bibliographical references. His intent, as expressed in the preface, is to lend aid to the radio or electronic engineer ordinarily "confronted with a bewildering task when he tries to find what he may need in the vast literature." One who is familiar with the American technical press will find himself under no parochial handicap in using this British book not only for its own liberal content but as a guide to extended inquiry.

One test of a compendium is to have its minutiae critically probed by experts. With that in mind, I turned over to one of my associates thoroughly conversant with microwaves and waveguides the pertinent portions of the work under review, for spot-check. (P. S.—He married the book.)—I. S. COGGESHALL, *International Communications, Western Union Telegraph Company, New York, N. Y.*

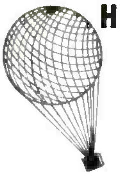
Description of a Magnetic Drum Calculator

Vol. 25 of the Annals of the Computation Laboratory of Harvard University, by the staff of the Computation Laboratory. Harvard University Press, 320 *pages,* $8.00.

THE magnetic drum calculator which is the subject of this book was developed for the Bureau of Ordnance of the U. S. Navy by the Computation Laboratory. It is an electronic computing machine in which numerical quantities and coded operating instructions are stored with the aid of magnetic pulse recording techniques. The calculator has the capacity to store 4,200 quantities of 16 decimal digits each in 4,000 sequencing operations. The device itself appears to be well conceived and a valuable contribution.

The book is divided into 10 chapters and two appendices which cover the following subjects: Organization of the Calculator; Basic Circuits; Storage System; Arithmetic Units; The Elementary Functions; Numerical Input and Output Devices; Sequencing and Control; Instructional Tape Preparation and Solution of Typical Examples; Constants in Fast Storage; List of Codes. It is profusely illustrated with 28 plates and a large number of figures.

It is difficult to review this book because the intended audience is not stated. It appears to be a report of fine accomplishments which has been photo offset for publication. As a report it is thorough, detailed and useful for those already skilled who wish to build, operate or service such a device. It is written by experts for experts. On the other hand, the layman who picks up the book to learn about this type of computer is easily lost in an underbrush of constructional detail. The book needs an introductory chapter to pull it together into an organic whole. It needs the brass-plated admiral painted on the paper jacket



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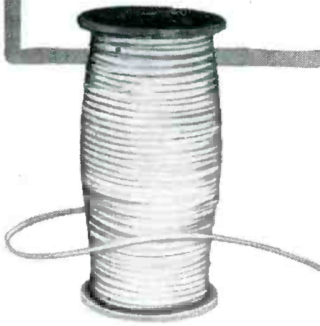

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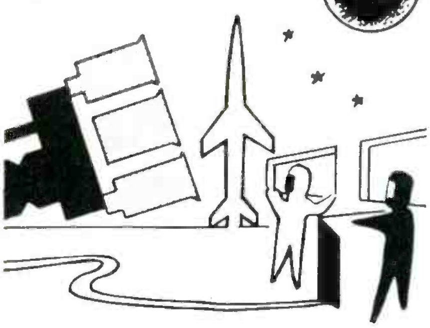

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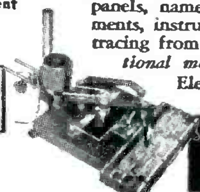

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by Artzybasheff to discipline the scattered components into a clear pattern. While the main point is the use of magnetic drums for memory, the relation between this memory and the basic circuits is not visible without considerable digging. No comparison is made with other computers which operate on different principles.

Some of the plates are useless. One of these, Plate IV, shows a typical chassis. The parts of this chassis are unlabelled with the result that it might be part of a television transmitter, a radar amplifier or a computer. Plate XIII, which shows the underside of this chassis, is so full of cables that not a single component is visible. It is as if the authors took pride in complexity. This plate would be more effective if the chassis were shown only partly wired. Plate XV shows the exploded view of cables and connectors. Surely this is superfluous in a book of this sort.

Basic circuits are standard, easily understood, and include gates, ring counters, step switches, cathode followers and phase inverters.

The book is a thorough report of a valuable contribution. As such it is a useful addition to the shelves of a computer library.—C. J. HIRSCH, *Chief Research Engineer, Hazeltine Corporation, Little Neck, N. Y.*

Recurrent Electrical Transients

BY L. W. VON TERSCH AND A. W. SWAGO. *Prentice-Hall, Inc., New York,* **1953. 399** *pages,* **$10.35.**

THIS book is one of the Prentice-Hall Electrical Engineering Series. Its object is "primarily to teach a technique of analysis, while acquainting the reader with representative types of circuits in which the steady-state waveform may be considered as a series of recurring transients." It may be used as a textbook in an electrical engineering or physics curriculum. Although prerequisites are not stated, it is apparent that a knowledge of elementary physics and electronics and of mathematics through differential equations will be helpful.

The method of teaching employed

is to consider in detail each of a number of circuits of a given type, obtaining the wave shape of the output wave for given input wave shape. The highest level of mathematics employed is the use of the "D" operator in solving differential equations. Transform methods are not employed and the time-constant concept is used rather than that of frequency response.

After defining fundamental concepts and deducing the response of a number of simple basic combinations of L, R, and C to sine and step-type signals, the authors devote a chapter each to clamping circuits, clipping circuits, electric and magnetic deflection of cathode-ray tubes, trigger circuits and multivibrators. It may be noted that the subjects of pulse amplification and general transient analysis were purposely omitted.

The 347 figures are mostly well-made line drawings of wave shapes and circuits. Some of the graphs are difficult to read because of insufficient contrast between major and minor divisions and because words and symbols were lettered directly on the grid without blanking out a part of the latter.

The authors include numerous solved examples illustrating their methods of analysis. The first of these has two numerical typographical errors, and the second lacks information essential to a numerical solution as well as showing an example of an exponential decay which actually departs considerably from that shape. After these lapses the quality improves.

A notable feature of this book is the large number (376) of references to the technical literature of both this and foreign countries. In a test, the reviewer found every one of his own dog-eared file card references on multivibrators to be in the book, as well as many others.

This book is legibly printed, with few errors in the text or in the drawings. Circuits are frequently shown with only a single input or output terminal, which is to be deplored.

As a college text this book rates well. The style is clear and direct. From a pedagogic standpoint the criticism may be advanced that this book devotes too much time to the analysis of specific circuits or circuit elements, to the neglect of more general and fundamental considerations. This approach is probably characteristic of the infancy of the art. In due time it may seem more reasonable or feasible to start with Maxwell's equations and show how all things flow from them.

The engineer will find this book somewhat tantalizing. To design, for example, a single-cycle multivibrator having given characteristics with the aid of this book requires following the analysis of this circuit until a suitable design equation is encountered among the many that describe the potentials or currents in various parts of the circuit. Nevertheless, the relations are there.

In short, this book should serve its intended purpose well. It does not appear to duplicate any other book in this field.—RAMOND C. WADDEL, *Naval Research Laboratory*.

Elements of Electricity 4th Edition

BY WILLIAM H. TIMBIE AND ALEXANDER KUSKO. *John Wiley & Sons, Inc., New York*, 1953, 631 *pages*, $5.50.

MANY years ago when the time came for this reviewer to write a book, he took as his model Timbie's famous "Elements," a fact which has never been regretted. Careful study indicated that Professor Timbie had a way with technical words, a style and technique for explaining technical matters that was not only beautifully clear but positively seductive. If, therefore, homage to an author and a book, which first appeared in 1910, seems a bit overdue, it is still sincere. This reviewer strove hard to duplicate the professor's methods. but he admits he could only approach and not equal them.

The basic idea and style of the earlier editions have been retained in this thorough revision which contains not only what was required previously but which now deals with the newer concepts, newer devices and newer subjects. New material covers such things as ceramic capacitors, transistors, radar, tele-

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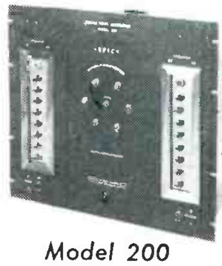

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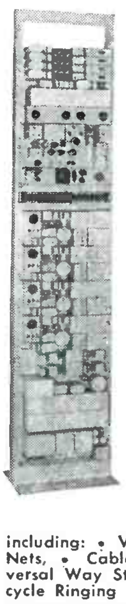

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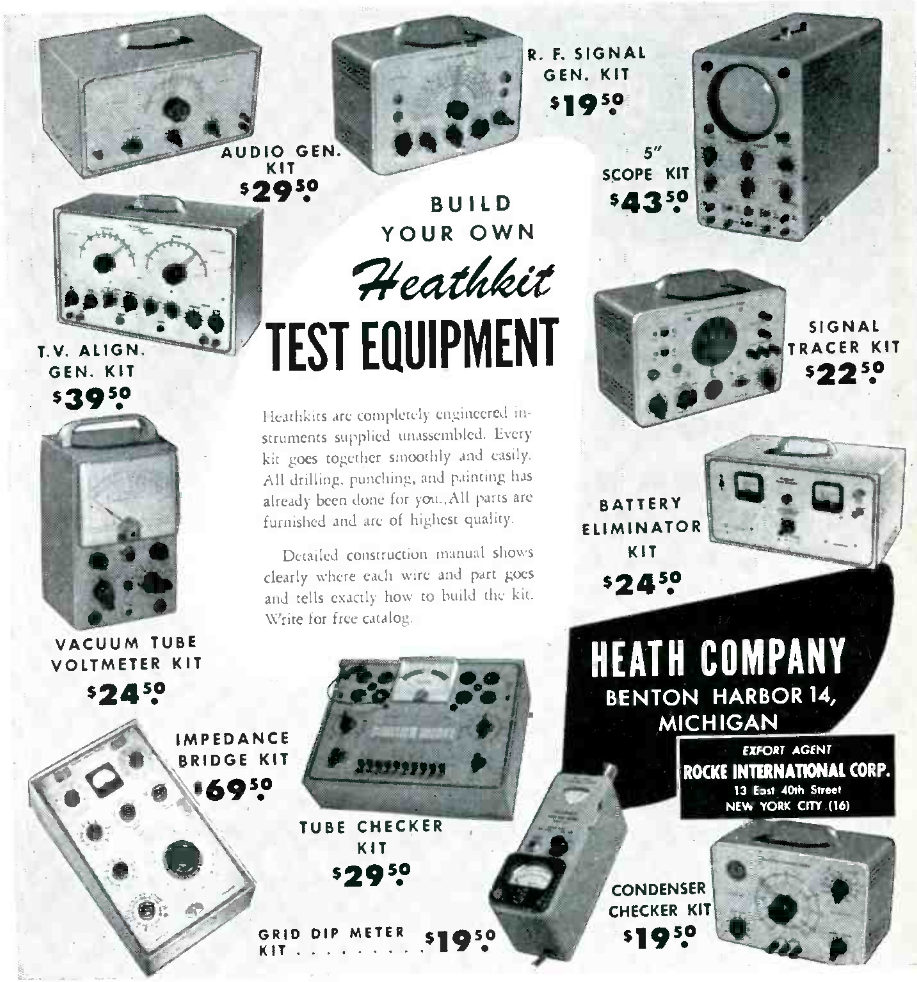

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vision, dry and gaseous rectifiers; revisions in older material include such subjects as circuit analysis, d-c machinery, electromechanical processes and gaseous conduction. New problems deal with contemporary applications of electronics and control; and there are numerous other additions and changes.

This book is still a model of elementary textbook writing.—K.H.

Hearing Aids, Their Use, Care, and Repair

BY MATTHEW MANDL. *The Macmillan Company, New York*, 1953, 158 *pages*, $3.50.

A BOOK primarily for the technician but containing considerable material useful to the hard-of-hearing. For the latter the second and third chapters are most useful since they discuss the psychological problems involved in first employing a hearing aid, and the physical problems of how best to use the instrument. In the other chapters, however, are hints which are useful to the nontechnician.

Most of the contents deal with the electrical and mechanical characteristics of the instruments, how to care for the units as well as their components, and how to make repairs when they are needed.

The final chapter deals with future trends and mentions the effect transistor will have on the future, as well as such matters as binaural hearing.

Grundlagen der Elektronenoptik

BY WALTER GLASER. *Springer-Verlag in Wien* 1, *Molkerbastei, Germany*, 1952, 699 *pages*, $28.60 *clothbound*.

DR. GLASER'S pioneering contributions to the theory of electron optics span the past two decades. With this volume he presents the most extensive and up-to-date treatment of electron image formation by static electric and magnetic fields which has appeared so far. The method of presentation is, of course, mathematical. Experimental techniques are alluded to briefly.

The first half of the book is taken up with Gaussian dioptrics and image formation by rays close to the optic axis, while the second half is divided approximately equally between aberration theory and the application of wave mechanics to electron imaging.

After a brief introduction answering the question "Why electron optics?" and the establishment of the basic laws of electron motion, the author examines in detail similarities and differences in light optics and electrostatic electron optics. This is followed by the derivation of the path equations in plane and axially symmetric electric fields, including the effect of space charge and, for plane fields, of superposed deflection. The remainder of the first half of the book is taken up essentially with axially symmetric electric and magnetic fields and their imaging properties.

The section on geometric aberrations deduces the aberration expressions from the Hamiltonian characteristic function and discusses their properties in detail. The expressions are given both in terms of object and aperture plane coordinates and in terms of object coordinates and initial aperture and inclination angles of the imaging pencils, a form particularly well suited for the imaging conditions normally realized in the electron microscope. Numerical values are worked out in detail for the magnetic bell-shaped field.

The last section applies the wave concept to electron motion and the imaging process. It is indicated clearly within what range the methods of classical mechanics (or geometric optics) are valid and where a wave-mechanical approach must be employed. A semiclassical approach is found sufficient for determining the resolving power of the electron microscope; here the intensity distribution in the image plane is determined by wave optics from the form of the characteristic function at the exit of the lens system.

The book is to be recommended particularly to anyone who wishes to attain a thorough understanding of the imaging process and the fundamental limitations of the electron microscope—other than those imposed by the properties of the object and plate or screen, which are not covered. The designer of cathode-ray tubes and related devices will find the general theory of value but will have to look elsewhere for detail regarding the lenses and fields which he may find useful. The book is scarcely designed for the beginner, in spite of numerous interesting analogies and illustrations. The very wealth of material presented, the extended discussion of fine points, and the insistence on rigor and generality might well prove too overwhelming to him.

Apart from this, the author and publisher are to be complimented on producing a book which should prove a reliable guide through many of the more involved aspects of electron optics which are not covered elsewhere. The unusually large proportion of material derived from original researches of the author and his coworkers make it a monument to the extensive contributions of Dr. Glaser to the science of electron optics.—E. G. RAMBERG, *RCA Laboratories Division, Princeton, N. J.*

AUTOMATION; The Advent of the Automatic Factory

BY JOHN DIEBOLD, *D. Van Nostrand Company, Inc., New York*, 1952, 181 *pages*, $3.00.

THE PUBLISHERS claim, through a blurb on the dust-jacket, that "Automation" is "A provocative study of the possibilities, limitations and social and economic consequences of the revolutionary new machines of the electronic age and what they will mean in terms of jobs, cost of goods and services, standards of living and increased leisure time." However, the author claims, under Scope of This Book, that "This book is primarily an essay on the *business* problems of automation and indicates the manner in which the technological developments can be useful to the businessman. It points out the obstacles that will confront the businessman in making use of automation and suggests courses of action by which these obstacles may be overcome. Finally, it discusses the important economic and social effects of the new technology."

On reassessing both claims after reading the book, the reviewer is of the opinion that the author's claim

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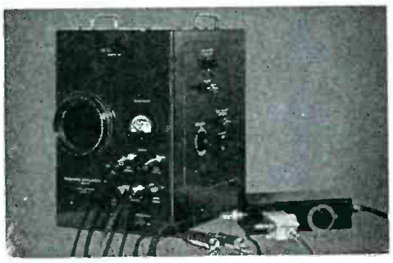

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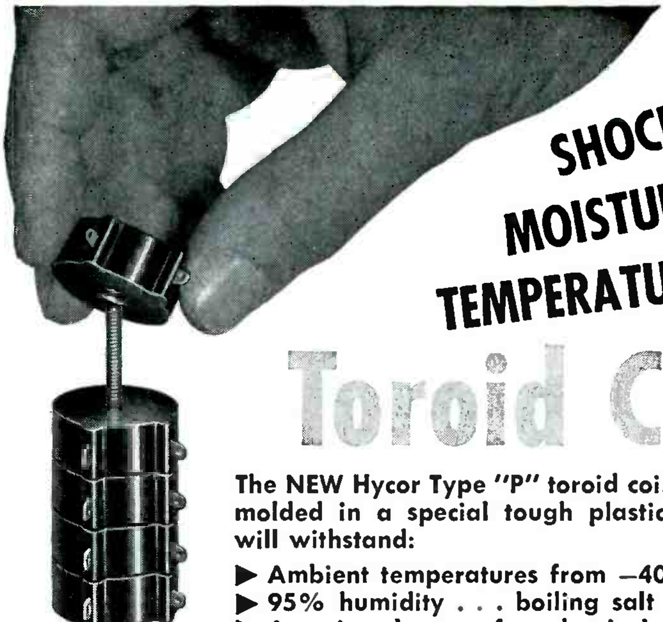
is somewhat the more accurate of the two.

Of the seven chapters comprising the text, the first—fittingly enough—encompasses an account of reasons why a businessman ought to read this book. The second, in keeping with the author's remark that "In no sense does this book pretend to be a contribution to the body of technological knowledge on the subject of control", presents a brief *descriptive* resume of the basic concepts of closed-loop control and a like account of the prime factors differentiating analog from digital computers. The third chapter advances a collection of instances illustrating how "rethinking" a process or product may yield substantial automation of the course or manufacture thereof; and the fourth outlines means by which the performance of the correspondingly-needed machinery can be "automized". The fifth chapter discusses the automatic handling of information in such diverse activities as accounting, stock-market trading and reserving plane or train space. The sixth entails conjecture regarding some of the consequences of automation on business proper, while the final seventh chapter closes with speculation as to certain general social and economic effects of automation.

The writing is lucid, fluid and well-paced. The factual content is fairly accurate (in support of this carping adjective the reviewer notes that: Maxwell's paper on governors was published in 1868 rather than "toward the end of the century" (p. 18); Nyquist—not Wyquist—wrote on feedback amplifiers and not on servomechanisms (p. 19); contrary to the author's remark (p. 22) that "Again, tools capable of the required precision were not available; the mechanisms were never built", Lord Kelvin actually constructed machines using integrating and differentiating components—for example, his famed Tidal Harmonic Analyzer, detailed in *"Minutes of the Proceedings of the Institution of Civil Engineers,* 1882"; and similar remarks could be advanced on points in the remaining nine-tenths of the text). The sketch of the present state of automation in industry and business is nicely handled, sharply delineated, and well bulwarked by aptly-chosen examples excellently illustrative of current industrial practice. The author's circumspect, if somewhat convoluted, estimate of the future progress of automation, "(1) Automation will not progress as far as the proponents of a completely automatic society have predicted, and (2) the changes will not occur as quickly as most forecasts have led us to believe", can scarcely be gainsaid. Finally, while his conjecture as to the eventual social and economic effects of automation foretells a less sharply-differentiated state of society than that of the card-programmed, IQ-sorted active engineer or stalagmitic worker type of state envisioned in Vonnegut's recent amusing novel, "Player Piano", it is probably no less accurate in forecast.

Within the framework of the author's own statement of purpose and scope the reviewer is of the opinion that the writer has accomplished a resume of the status of automation which ought be both intelligible and of interest to the business executive concerned primarily with management or production and, also, to those communications engineers who maintain an interest in such socio-economic phases of their work as are discussed in, to name a recent popular work, Norbert Wiener's "The Human Use of Human Beings". However, in this connection it is to be remarked that the discussion of those social and economic effects which may stem from automation that comprises Chapter VII is a rather brief one. Accordingly, a reader with considerable interest in this subject might well complement his reading of this chapter by a subsequent perusal of Wiener's just-mentioned interesting and well-documented book, particularly Chapter X, "The First and the Second Industrial Revolution" and also his very recent article, "The Future of Automatic Machinery", in *Mechanical Engineering*, February 1953, pages 130–132.

In conclusion, it would seem fitting to point out the publisher's



contributions to "Automation". These include a nice quality of paper, good binding, excellent typography and a striking dust-jacket. This latter evidences a well-posed photograph of the author, a short account of his professional antecedents and several rather fanciful blurbs. Among these last is one which forecasts the happy lot to accrue to the engineering educator teaching in an "automized" society: "The training of purely management personnel of broad business background with the kind of engineering knowledge necessary to run a modern firm introduces a new concept in the use of this technology and will release our short supply of competent engineers for the all important job of advanced design. Equally important, it will free our engineering schools from the burden of teaching those who make only partial use of their original training". Anent this last surmise, it is the reviewer's thought that the publisher might well have bent his editorial aides to a more knowledgeable effort—THOMAS J. HIGGINS, *Professor of Electrical Engineering, University of Wisconsin.*

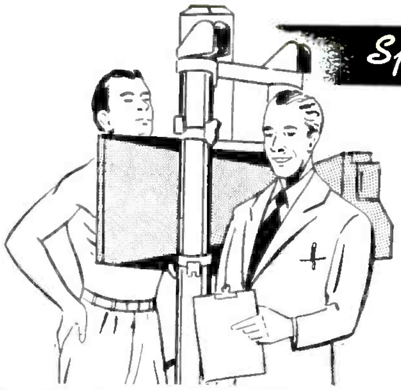
THUMBNAIL REVIEWS

Generalization of Gravitation Theory. By Albert Einstein. Princeton University Press, 1953. Reprint of Appendix II from 4th Edition, of the "Meaning of Relativity" in which the eminent author goes further in his attempt to arrive at a pure field theory of the universe and yet to explain the atomic character of energy.

Radio Frequency Power Measurements. By Roald A. Schrack. National Bureau of Standards Circular 536, March 16, 1953, 15 cents, U. S. Government Printing Office. A 16-page pamphlet outlining present methods of calorimetry, substitution methods, use of single-value devices (such as voltage or current meters), two-variable-devices (wattmeters) and directional couplers.

Progress in Nuclear Physics, Volume 2. By O. R. Frisch. Academic Press, Inc., 125 East 23 St., New York, N. Y., 1952. 295 pages, $9.25. For physicists. Chapters on magnetic beta-ray spectrometers, nuclear paramagnetic resonance, luminescent materials for scintillation counters, neutron-proton interaction, fission, low-lying excited states of light nuclei, the nuclear shell model, and ionization by fast particles.

Experimental Nuclear Physics, Volume 1. By E. Segre, editor. John Wiley &



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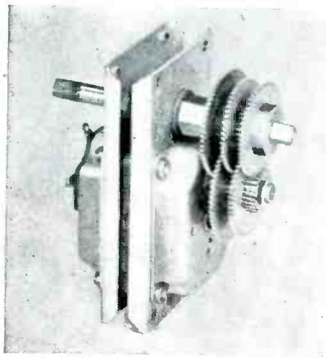

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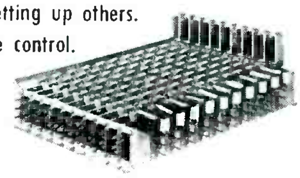

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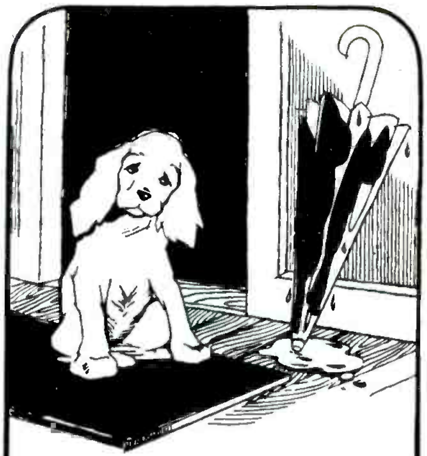

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Sons Inc, New York, N. Y., 1953, 789 pages, $15.00. Contents: detection methods, passage of radiations through matter, nuclear moments and statistics, nuclear two-body problems and elements of nuclear structure, and charged-particle dynamics.

1952 Book of ASTM Standards. Published in seven parts, American Society for Testing Metals, 1916 Race Street, Philadelphia, 1953, 9,975 pages, $76.00. Ferrous and non-ferrous metals, cement, concrete, ceramics, thermal insulation, road materials, water proofing and soils; paint, naval stores, wood, building constructions, etc; fuels, petroleum, aromatic hydrocarbons, antifreezes; rubber, plastics and electrical insulation; textiles, soap, shipping containers, etc.

TV Sweep Alignment Techniques. By Art Liebscher. John F. Rider Publisher, Inc., New York, 1953, 122 pages, $5\frac{1}{2} \times 8\frac{1}{2}$ inches, paperbound, $2.10. Methods for putting a TV receiver in best working condition by combining conventional peak alignment and sweep alignment into a single system; a new and apparently more responsive technique.

1953 Radio Annual and Television Year Book, 16th Annual Edition. Jack Alicoate, Editor. Radio Daily Corp., New York, 1953, 1,206 pages, included with subscription to Radio and TV Daily at $15 a year. Reference volume of the broadcasting industry, containing statistics, telephone numbers, personnel, agency listings, station listings by states and by call letters, network data, program producers, film producers and distributors, tv personalities, announcers and MC's, directors, women commentators, disc jockeys, radio-tv newspaper editors, etc.

Vade-Mecum, Equivalent Radio Tubes. P. H. Brans, Ltd., Antwerp, 1953, 303 pages, large format, $5.50. A quick reference for possible exchanges or substitutions of tubes with equivalent or near-equivalent characteristics but having different type number. Arranged in convenient tables, and including army tubes, power tubes up to 250 watts rated dissipation, crystal diodes and triodes.

UHF Antennas, Converters & Tuners, 1st Edition. By Milton S. Kiver. Howard W. Sams & Co., Indianapolis, 1953, 134 pages, $6\frac{1}{2} \times 8\frac{1}{2}$ inches, paper cover, $1.50. Practical aspects of uhf which the tv service technician will require for successful work. Factual, applicable data with many comparisons to vhf practices.

TV Manufacturers' Receiver Trouble Cures, Volume 3. By Milton S. Snitzer. John F. Rider Publisher, New York, 1953, 118 pages, $5\frac{1}{2} \times 8\frac{1}{2}$ inches, paperbound, $1.80. Deals with specific tv troubles and their cures; manufacturers are alphabetically arranged from Kaye-Halbert to Philco.

Engineering, A Creative Profession. Engineers' Council for Professional Development, New York, N. Y., 1953,

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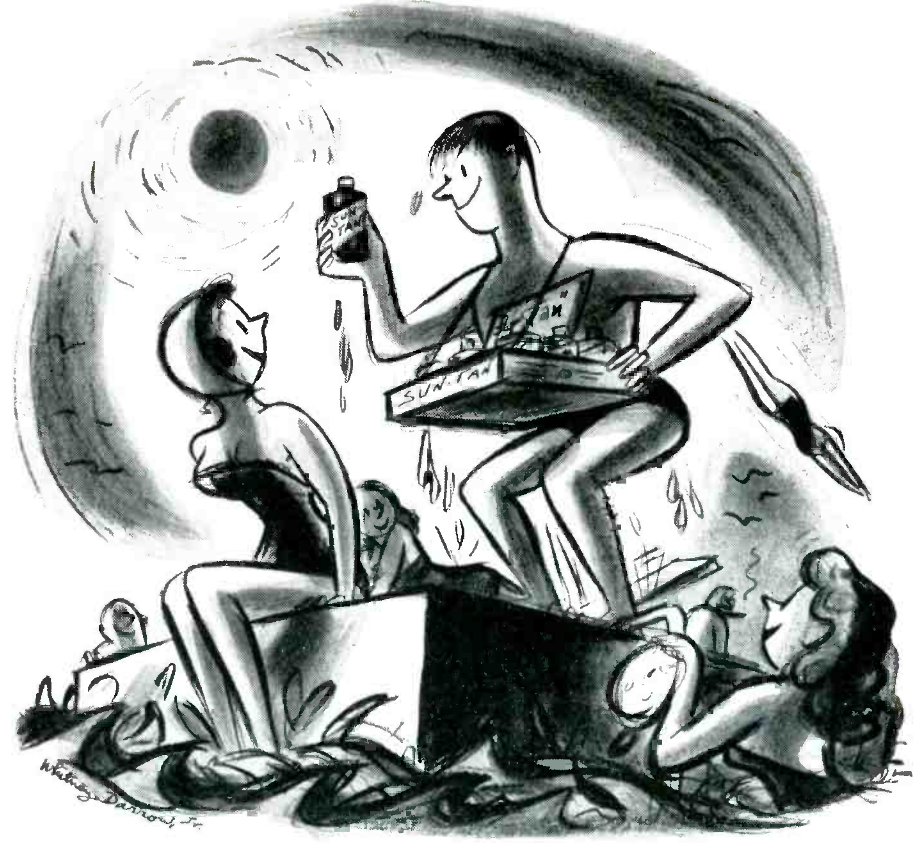

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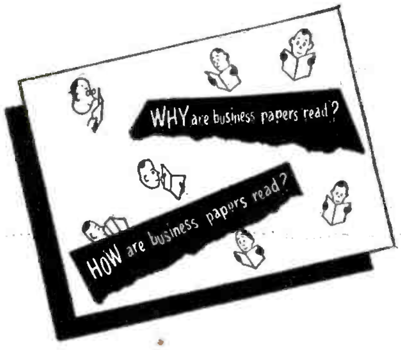

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Secondary Electron Emission at High Current Densities. By Dietrich Alfred Jenny. Verlag Leeman, Zurich, Switzerland, 77 pages, 1952, paper-bound, 8 francs. Study of the multiplication ratio. In English.

Principles of Television Engineering. By Carter V. Rabinoff and Magdalena E. Wolbrecht. McGraw-Hill Book Co., New York, 1952, 560 pages, $7.50. TV servicing guide, practical procedures, up-to-date circuits, shop reference material, trouble-shooting manual.

A Television Policy For Education. Edited by Carroll V. Newsom Associate Commissioner for Higher Education of New York State. American Council on Education, Washington, D. C., 285 pages, 1953, $3.50. Comprehensive handbook on educational television instructs local communities on how to apply for license to operate TV station, finance station construction and operation, produce effective programs, and secure films from other educational stations and commercial producers. Also describes significant types of educational programs that have been produced.

Electromagnetics. By John D. Kraus. McGraw-Hill Book Co., 1953, 603 pages, $9.00. A thorough-going text on the basic principles of electromagnetic field theory, with approximately equal emphasis on electronics, power, radiation and propagation.

Beama Catalogue 1952-53. Published for the British Electrical & Allied Manufacturers' Association by Iliffe & Sons, Ltd. London, for private distribution. 1,020 pages, large format. A buyer's guide to electrical products produced in Great Britain plus a five-language glossary of technical terms.

Ferroelectricity. By E. T. Jaynes. Princeton University Press, 137 pages, $2.00. A monograph relating to the change in piezoelectric activities of Rochelle salt and similar materials at certain temperatures. The several theories for this change are given, for the theoretical physicist rather than for the practicing engineer.

High Fidelity Simplified. Harold D. Weiler. John F. Rider Publisher, Inc., New York, 1952, 208 pages, paper-covered, $2.50. Practical information on modern equipment and its proper selection and use, for the enthusiast who prefers ready-made quality equipment. Three opening chapters set the stage theory-wise, three deal with the all-important loudspeaker and its enclosures, two with amplifiers, two with choice and use of record players and one each with tuners, tape recorders and use of the complete home music system.

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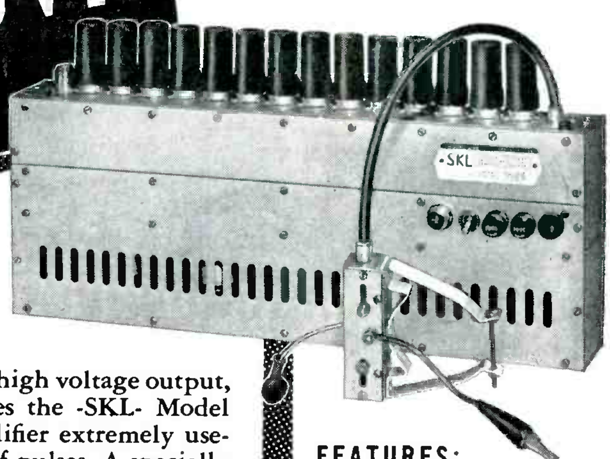

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BACKTALK

Useful Data

DEAR SIRS:

AS AN AMATEUR of 21 years standing, an advertising agency executive, and a faithful reader of ELECTRONICS, I was much interested in the letters by W9KQX and W5CA on what's wrong with the technical advertising of electronic products (Mar. 1953, p 492; May 1953, p 413).

There is no question but that these gentlemen are right when they recommend that tube manufacturers make available circuitry using the advertised product, and provide other "useful data" for maximum advertising effectiveness.

Many advertisements *do* contain such information—the majority of tube ads show characteristic curves. Unfortunately, it is impossible to put everything into a 7 × 10-in. page; readership studies and keyed coupon returns show that in general a cluttered up ad that looks forbidding does not do as good a sales job as an attractive-looking ad that makes one strong point.

In the case of tubes, the answer to this question (and I'm surprised more companies don't do it) is to print an inexpensive folder, or even a single sheet, which give schematics showing how to use the product, outlines complete operating data, etc. This folder could be offered in the ads, given out at shows and sent to a direct mail list.

One tube company has done an outstanding job along this line where its diodes are concerned.

Two manufacturers may pay the same rate in ELECTRONICS, or any other publication, but all they are buying is white space in which to print a sales message. If advertiser *A* makes twice as effective use of the space he buys as does advertiser *B*, then his space cost is one-half of the *B*'s. True rates are determined by how efficiently a company uses the space it buys, not by the publisher's rate card.

W9KQX and W5CA have made a sound suggestion on how tube manufacturers can use their space more effectively.

As far as the Art Directors and

non-technical personnel who prefer a "pretty ad" to a "useful one," I'm afraid the fault lies at the manufacturer's door for permitting this to happen. Nor, I fear, is it true that technical advertising would be of higher quality if engineers' ideas always prevailed. The most effective advertising results from the best thinking of the engineers and of professional printed word salesmen.

Congratulations on doing such a consistently fine editorial job in ELECTRONICS!

STUART D. COWAN, JR., W1RST
Vice President
Cowan and Dengler, Inc.
New York, N. Y.

Tantalum-Foil Capacitors

DEAR SIRS:

IT WAS most interesting to read the article "Tantalum-Foil Capacitors Save Space" by L. W. Foster in the *"Electrons at Work"* section of the May 1953 issue of ELECTRONICS (p 242). Articles like this may go a long way toward educating engineers specifically in the properties of components.

There are several points, however, in Table I that do not fit with some of our current knowledge of paper and aluminum-electrolytic capacitors. One line in the table indicated that insulation resistance of paper dielectric capacitors is low, while that of aluminum electrolytic is high. It is well known that any electrolytic capacitor allows some moderate leakage current to flow, while the insulation resistance of even an average quality paper capacitor is on the order of 500,000 megohms.

The shelf life of aluminum-electrolytics at the three temperatures shown in the table is said to be better than that of paper capacitors. This is quite opposite to our experience. A shelf life of two years for an average aluminum-electrolytic capacitor is unusually long.

The cost comparison for capacitors in the 500 to 5,000 volt range shows that the cost of paper units is high while that of aluminum units is low. It is my understanding that it is not feasible to manufacture aluminum-electrolytic capaci-

tors with voltage ratings greater than 600 volts d-c.

The information as given does not seem to present a proper comparison of the merits of the capacitors considered.

B. B. PAINE
Standards Engineer
MIT Digital Computer Laboratory
Cambridge, Mass.

(Editor's Note: A switch in column headings by the printer was not caught by the editor-proofreader and hence ascribes paper-capacitor characteristics to aluminum-electrolytics, and vice versa. A correction by the reader's pen will make the table on p 244 truly useful. Headings should read left to right, Tantalytic, Aluminum-Electrolytic, Paper.)

Help P-p-please

DEAR SIRS:

WE ARE requesting ideas from your readers on a medical research problem we are considering. We are investigating the tremor rate of the tongue during moments of stuttering. The way the problem was handled before, was to insert a pneumatic pressure bulb in the mouth and have changes in pressure actuate a recording device to obtain amplitude and frequency. The size of the bulb, its mechanical inertia, distracting tubes, etc. limited the usefulness of this system. However, data of definite clinical and therapeutic value were obtained.

It has been suggested that a drop of paint containing iron filings could be placed on the tongue, and by magnetic or electronic means, movements could be recorded. Metal in the teeth would have to be accounted for. Amplitudes of 0.01 to 2 or 3 inches and frequencies of 1 to 100 per second seem to be about the necessary range of the instrumentation.

We are requesting suggestions from your readers on possible systems and procedures and other possible methods that may come to mind.

Full credit on publication.

Please forward replies to Dr. Van Riper, Speech Clinic, Western Michigan College, Kalamazoo, Michigan.

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Professional Engineer
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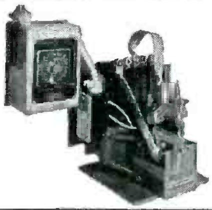

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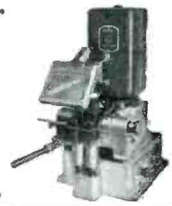

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MILITARY AND COMMERCIAL
Design, development and manufacture of Servomechanisms, Controls, Toroids, Saturable Reactors, Magnetic Amplifiers.
FIDELITY INSTRUMENT CORPORATION
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Have you problems in - Metal to Glass Seals?
NAME IT . . . WE'LL MAKE IT!
TERMINALS
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END SEALS . . . SPECIAL ITEMS
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ELECTRICAL COILS
Bobbin, spool, form, layer, interleaved, interwoven types. Made of any material, any finish, for any application.
Send blue-prints and specifications for prompt quotation.
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One inexpensive modern device . . .

can frequently help speed up operation and maintenance or production.

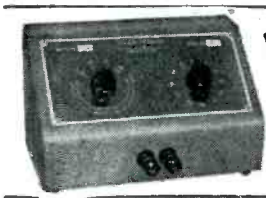
One product advertised in the "Contacts" Section may be the answer to your problem . . . a real money-saver.

To be informed—and reminded—on modern aids to economical operation, maintenance and production, check "Contacts" advertising regularly . . . every issue.

Shorted Turn Indicator
Sensitive, rugged, non-shocking for unmounted coils; $150. f.o.b. HUNTINGTON BEACH, CALIF.
KARTRON

WALKIE-RECORDALL BATTERY RECORDER-PLAYBACK
Continuous, permanent, indexed recording, up to 4 hrs., only 3c hr. Instantaneous, permanent playback. Picks up sound up to 60 ft. Records conferences, lectures, dictation, 2-way phone & sales talks; while walking, riding or flying. Records in closed briefcase with "hidden mike"! Write for Detailed Literature.
MILES REPRODUCER CO., INC.
812 BROADWAY Dept. E-7 NEW YORK 3, N. Y.

HIGH VOLTAGE POWER SUPPLIES
Available in ranges from 2,500 to 25,000 volts D.C., with or without built-in meters. Regulated or unregulated types available. Delivery good on all standard models.
Send for free catalogue—Dept. EI*
PRECISE MEASUREMENTS CO.
942 KINGS HIGHWAY, BROOKLYN 23, N. Y.
Phone ES 5-9435

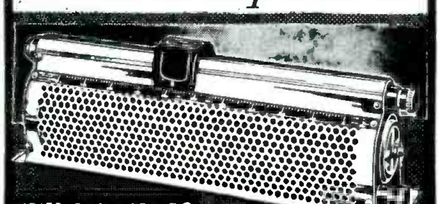


WIDE RANGE DECADE RESISTOR
Especially designed for use in development and production laboratories where standardized RTMA resistor values are to be determined easily and quickly.
For descriptive literature write or wire
Rochester Electronics Co., Inc.
DEPT S-4 Box 227 PENFIELD, NEW YORK

MICROMETER FREQUENCY METER
Measures center frequency of any number of transmitters, AM or FM, 0.1 to 175 MC., 0.0025% accuracy. Price $220.00.
LAMPKIN LABORATORIES, INC.
BRADENTON, FLORIDA

FLUXES
SODERING
BRAZING & WELDING
L. B. ALLEN CO. INC. Chicago 31, Ill.
6751 BRYN MAWR AVE.

We invite inquiries on



WRITE FOR CATALOG
REX RHEOSTAT CO.
BALDWIN, L. I., N. Y.

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CLASSIFIED SEARCHLIGHT SECTION ADVERTISING

EMPLOYMENT • BUSINESS • OPPORTUNITIES • EQUIPMENT—USED or RESALE

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$1.50 a line, minimum 3 lines. To figure advance payment count 5 average words as a line. POSITION WANTED & INDIVIDUAL SELLING OPPORTUNITY WANTED undisplayed advertising rate is one-half of above rate, payable in advance.
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INFORMATION

DISCOUNT 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

EQUIPMENT WANTED OR FOR SALE Advertisements acceptable only in Displayed Style.

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The advertising rate is $14.00 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

AN ADVERTISING INCH is measured 7/8 inch vertically on one column, 3 columns—30 inches—to a page. ELECT.

Send NEW ADVERTISEMENTS to N. Y. Office, 330 W. 42 St., N. Y. 36, for the *August issue closing July 2*. The publisher cannot accept advertising in the Searchlight Section, which lists the names of the manufacturers of resistors, capacitors, rehostats, and potentiometers or other names designed to describe such products.

TRANSFORMER DESIGN ENGINEER

Immediate opening for Top Level Senior Electrical Engineer with well established electronic component manufacturing concern.

Work includes design of transformer (audio, power and pulse), reactors, and filter networks.

Salary $10,000 up commensurate with experience and ability.

Write giving age, education, and complete work history.

P-8245, Electronics
330 W. 42 St., New York 36, N. Y.

RADIO TUNER (Dev.) $10,000

TITLE—ASST. CHIEF ENGINEER

Very aggressive company seeking a promotable man with some exp. in this field.

Contact Ray Edwards

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"America's Largest"

64 E. Jackson, Chicago, Ill. Tel. WAbash 2-1884

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)

POSITIONS VACANT

CHIEF DESIGN Engineer—M.E. Degree and outstanding product design achievement in electronic equipment and/or related fields. Should now be assistant chief design engineer. Must have heavy experience in industrial product design; Military Development Contracts; keen appreciation of shop viewpoints. Established Northern New Jersey manufacturer. P-8149, Electronics.

ELECTRICAL ENGINEER—Degree and heavy production design experience on 0-10 KW gas discharge lamp transformers and ballasts. Must have demonstrated ability in production design and cost reduction. To 40 yrs. of age. Established Newark electrical-electronic manufacturer. P-8148, Electronics.

ASSISTANT CHIEF Engineer. Ohio company manufacturing electronic equipment has opening for electronic engineer approximately 27-31 years of age in capacity of administrative assistant to the Chief Engineer. Duties will include engineering office work, supervision of laboratory projects and occasional traveling. Must have at least 5 years professional experience in the circuit design and project supervision. Starting salary $7000 per year. Allowance for moving expense. Replies held in confidence. Submit resume to P-8145, Electronics.

POSITIONS WANTED

ELECTRONICS ENGINEER. Mature administrative eng. with 16 yrs. heavy R. and D. experience radar T.V. and radio, industry and govt., U. S. and Europe. Now with large comp. at high level project direction and customer liaison. Prefer suburban living. Salary $12,000 or equiv. Full details at personal interview. PW-8119, Electronics.

When Answering
BOX NUMBERS . . .

to expedite the handling of your correspondence and avoid confusion, please do not address a single reply to more than one individual box number. Be sure to address separate replies for each advertisement.

MANUFACTURERS' AGENT WANTED

—one who is now contacting electronic companies in New Jersey, New York, Connecticut and Pennsylvania—to develop continuing subcontracting work for our Machining Division which is now doing *extreme* precision work on aluminum and stainless steel parts for electronic companies.

Exact Level and Tool Manufacturing Company, High Bridge, N. J.

Leading research and development organization needs the following engineers:

ELECTRO-MECHANICAL ENGINEER for development and application of methods for measurement of mechanical parameters.

VIBRATIONS ENGINEER to conduct work on measurement and control of vibration phenomena.

Outstanding opportunity to conduct challenging programs and to grow in professional stature. Financial assistance for graduate study. Write Personnel Manager, Armour Research Foundation of Illinois Institute of Technology, Chicago 16, Illinois.

POSITIONS WANTED

ELECTRONICS ENGINEER, 35, B.S. 7 yrs. experience development and production eng'g. System emg'g. project scheduling, planning, radar and telem. systems, mil. and comm. equip. with eastern firm. Previous Navy exp. 3 yrs. Staff Radar Officer. Seeks growth company. Family. PW-8094, Electronics.

ELECTRICAL ENGINEER University degree (Warsaw) A.M.I.E.E. 7 years Design and Production, Electrical Apparatus 11 years Radar (including 7 years R.A.F.) Present adviser to Argentine Air Force. Seeking suitable position. Write S. W. Czarnecki, Echeverria 2685 Buenos Aires, Argentina. Speaks English.

GRAD. DUTCH Eng., 27 yrs., 5 yrs. exp. in des. and constr. of var. sorts of ionosph. meas. eq. and ant. desires pos. in same or allied field in U. S. A. Please write PW-8236, Electronics.

ELECTRONICS ENGINEER, age 32, graduate of Technical Institute of Munich, U. S. citizenship in 1954. 3 years experience in television receiver trouble-shooting and improvement. Seeking position as junior engineer. PW-8228, Electronics.

SELLING OPPORTUNITY WANTED

ELECTRICAL LINES Wanted for Florida by established Manufacturers Agent Contacting Electronic Engineers & Contractors on Gov. Projects. Experience as Mechanical & Elect. Field Engineer on commission. RA-8069, Electronics.

BUSINESS OPPORTUNITY

Wanted: Well established manufacturer with versatile manufacturing equipment wishes to contact designer or inventor with some new product or improved element to add to his line under a royalty or licensing agreement. Write P. O. Box 369, Delaware, Ohio.

NEW YORK EXECUTIVE REPRESENTATION

Save executive time and travel. Have ON THE SPOT representation in New York area.

ENGINEER - ATTORNEY

experienced all phases business-engineering management will:

- Initiate and follow thru sales contacts
- Interview new personnel
- Conduct sub-contract liaison
- Expedite orders in this area
- Handle credit problems
- Provide PERMANENT N. Y. office.

adjustable annual fee.

RA-8131, Electronics
330 W. 42 St., New York 36, N. Y.

EXPERIENCED SALES—TECHNICAL ENGINEERING APPLICATION SERVICE

For Electro-Mechano-Plastics Components Manufacturers Requiring Concentrated Contacts Among Industrial Maintenance—Manufacturers in Northern New Jersey—Est., 1945.

JAMES L. FITZSIMMONS
39 Lackawanna Plaza, Bloomfield, N. J.

WANTED

To Manufacture and Sell NEW Electronic Accessory Items

For—

FACSIMILE • RADIO TELEPHONE • TELEVISION

URGENT—We have a special immediate need of Facsimile Equipment for Intra-Office and Plant use.

URGENT—To locate Doctors in Hospitals. Need miniature Selective Radio Signal Receiver to be carried in pocket — weight must be under 10 ounces.

WILL FURNISH CAPITAL IF NECESSARY TO COMPLETE DESIRABLE DEVELOPMENTS

What have you to offer?

Radio Engineering Co.
Inquirer Bldg. Phila. 30, Pa.

Auction Advertising page 405, Equipment Wanted Advertising page 424

ENGINEERS

FOR ATOMIC WEAPONS INSTALLATION

Mechanical Engineers, Electronics and Electrical Engineers, Physicists, Aerodynamicists, and Mathematicians. A variety of positions in research and development open for men with Bachelors or advanced degrees with or without applicable experience.

These are permanent positions with Sandia Corporation, a subsidiary of the Western Electric Company, which operates the Laboratory under contract with the Atomic Energy Commission. The Laboratory offers excellent working conditions and liberal employee benefits, including paid vacations, sickness benefits, group life insurance and a contributory retirement plan.

LOCATE IN THE

Healthful Southwest

Albuquerque, center of a metropolitan area of 150,000, is located in the Rio Grande Valley, one mile above sea level. Albuquerque lies at the foot of the Sandia Mountains which rise to 11,000 feet. Cosmopolitan shopping centers, scenic beauty, historic interest, year 'round sports, and sunny, mild, dry climate make Albuquerque an ideal home. New residents experience little difficulty in obtaining adequate housing in the Albuquerque area.

APPLICATIONS NOW BEING ACCEPTED FOR TECHNICAL WRITERS

These are not Civil Service Appointments

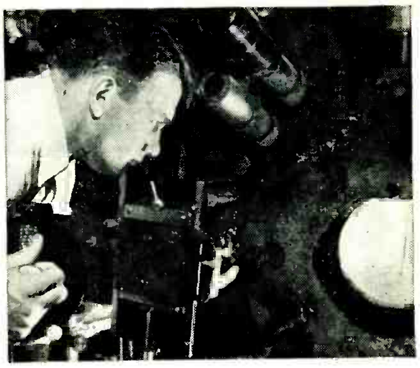
Make Application to the

PROFESSIONAL EMPLOYMENT DIVISION

SANDIA Corporation

SANDIA BASE

ALBUQUERQUE, N. M.



Design, development engineers . . .

Interested in the why of things?

Most engineers are—but too often their jobs don't give much chance to investigate.

Not so at Honeywell. We're always after new basic knowledge—in many fields. Witness our young engineer above making a photometric study of fire.

And right now we have some specially good openings for experienced engineers who would like to know the *why* of things in the following areas:

- Servomechanisms
- Gyros
- Relays
- Transformers
- Vacuum tubes
- Electromechanics
- Aircraft Control Systems

Duties of the jobs. Research leading to knowledge that will enable us to bring into design form a new or modified instrument, device or control system.

Requirements. B. S. or M.S. in Electrical, Mechanical or Aeronautical Engineering desirable.

Atmosphere. A company that understands engineering—where one out of every ten employees is actively engaged in engineering or research.

Openings. In Minneapolis, Philadelphia and Freeport, Illinois.

Write J. A. Johnson, Engineering Placement Director, Dept. EL-7-150, Honeywell, Minneapolis 8, Minn. Learn in detail how you can delve into the why of things at Honeywell. Ask for our book, "Emphasis on Research."

MINNEAPOLIS **Honeywell**

H HONEYWELL *First in Controls*

DESIGN RESEARCH DEVELOPMENT

key words to your employment opportunities at GOODYEAR AIRCRAFT . . . pioneer and leader in lighter-than-air craft . . . an established and growing company building an outstanding technical reputation

DESIGN ENGINEERING opportunities exist in the fields of airships, airplanes, and components, airframes, power-plant installations, controls, hydraulics, electronics systems, fuel cells, canopies, and wheels and brakes

DEVELOPMENT of missiles, jet aircraft, and helicopters, electric and electronics system, servomechanisms, fiber resin laminates, and many other projects present an urgent need for capable engineers

WELDING ENGINEERS, civil engineers, mechanical engineers with ability in metals fabrication, and industrial engineers experienced in time study are needed. Job opportunities also exist for technical editors and illustrators

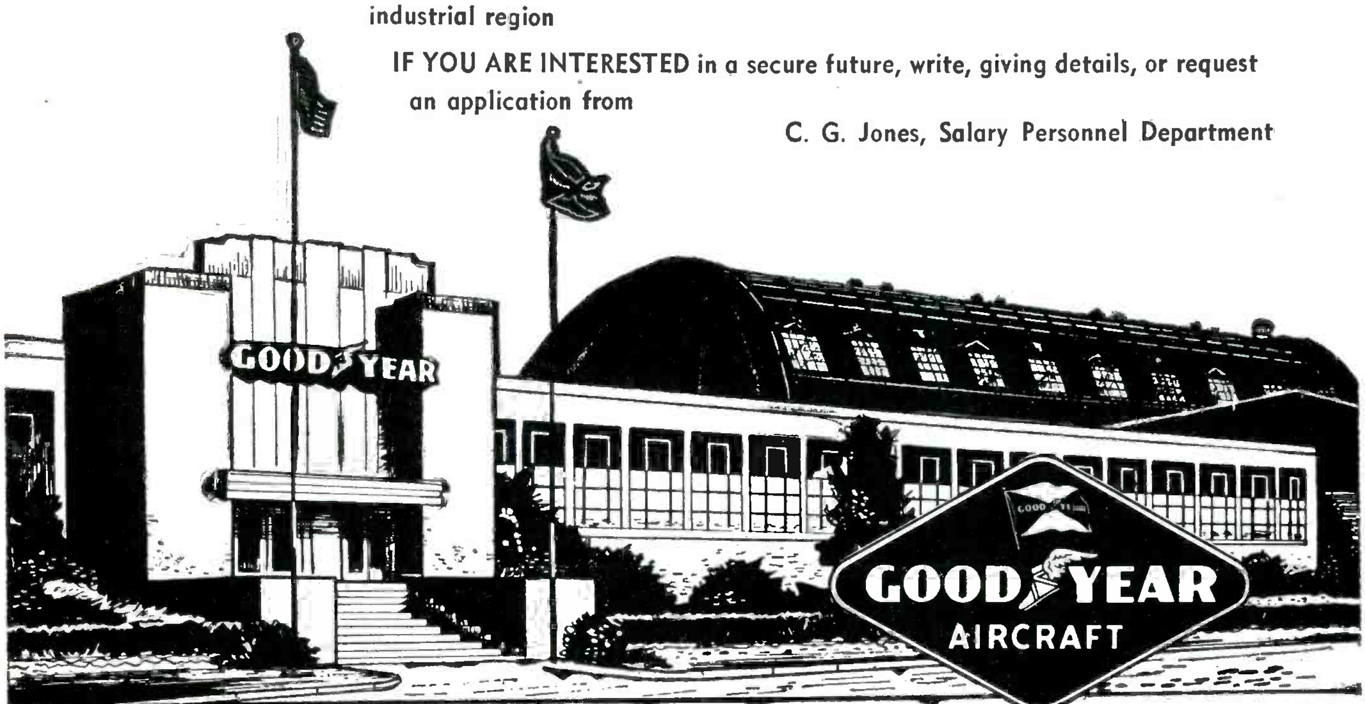
POSITIONS are open at several levels, and inquiries are also invited from recent graduates. Salaries are based on education, ability, and experience

PAID VACATIONS, free group life insurance, a good hospitalization plan, paid sick leave, company-sponsored pension plan, planned recreation, and free parking are among the facilities at the plant

A FRIENDLY CITY, Akron, Ohio, is located in the center of the midwestern industrial region

IF YOU ARE INTERESTED in a secure future, write, giving details, or request an application from

C. G. Jones, Salary Personnel Department



GOODYEAR AIRCRAFT CORPORATION, 1210 Massillon Road, Akron 15, Ohio

ELECTRONICS ENGINEERS
WANTED
SOUTHERN CALIFORNIA

Attractive opportunities offered to Engineers experienced in and qualified to design aircraft flush antennas and radomes.

Complete modern facilities for laboratory testing and evaluation available.

Salary dependent upon experience and ability.

Contact Mr. J. C. Buckwalter,
Chief Engineer

DOUGLAS

DOUGLAS AIRCRAFT COMPANY, Inc.
LONG BEACH, CALIFORNIA

BIG opportunities for JUNIOR ENGINEERS with new Bendix plant!

Here, indeed, are outstanding opportunities for recent college graduates. In this new, fast - growing Bendix Division, the future holds advancement commensurate with your ability to assume additional responsibility. Fascinating work on NEW ELECTRONIC PRODUCTS. Good salaries, paid vacations and holidays and ideal living conditions in beautiful suburban area.

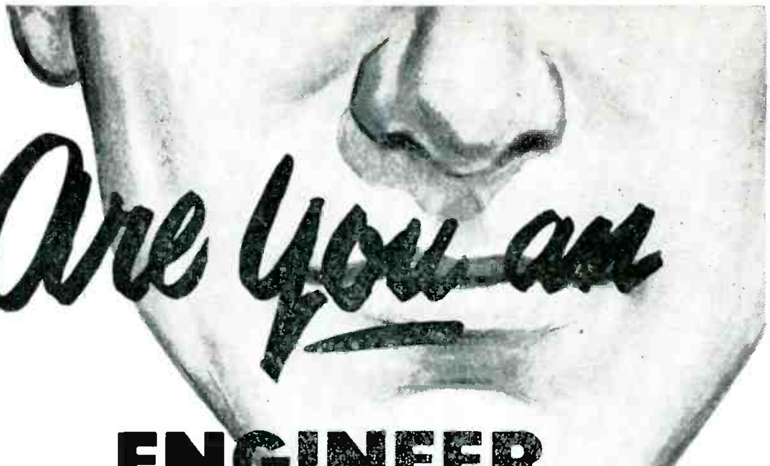
BENDIX YORK ALSO NEEDS ENGINEERS AT THE INTERMEDIATE LEVEL!

Send Resume of Education and Experience to:
Mr. L. D. Smith,
Employment Supervisor

Bendix

AVIATION CORPORATION
YORK DIVISION

Phone: York 5521 York, Penna.



Are you an ENGINEER ANONYMOUS?

An Engineer Anonymous is one of those capable men with good potential . . . confined to routine assignments that offer little challenge or opportunity to move ahead.

There are no Engineers Anonymous at Magnavox!

Magnavox is a medium-sized organization with a closely-knit engineering staff working under conditions most engineers consider ideal.

New engineering laboratories, top-notch model shop facilities, a complete drafting department, and a chemical engineering department which cooperates on all material problems — these allow the Magnavox engineer to concentrate on the more creative aspects of his work. And an ably-staffed test equipment design section handles all test equipment design problems — factory as well as laboratory.

With such fine facilities at their command . . . with active encouragement and recognition by management, it is not surprising that Magnavox engineers have contributed many "firsts" in radio and television, and are today among the leaders in the electronics industry.

Consider, too, the unusually generous insurance and retirement plans which rank with the best in all industry.

You'll be interested in the many advantages offered by Fort Wayne, Indiana, called "The Happiest City in the U. S." by Look Magazine, an ideal community for a well-integrated family life.

OPPORTUNITIES ARE GROUND FLOOR IN THE FIELDS OF:

Radar	Synchros — Servo Systems
Radio — Commercial and Military	Magnetic Devices
Television — Monochrome and Color	Electro-Mechanical Devices
Magnetic Amplifiers	Navigational Aids — Fire Control

DESIGN — DEVELOPMENT — CIRCUITRY

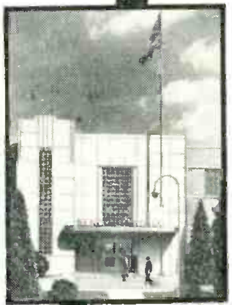
Electrical Engineers — Mechanical Engineers — Physicists

Please forward complete resume to:
MR. BYRON D. SITES

THE MAGNAVOX COMPANY
FORT WAYNE, INDIANA

Engineers

Open this door to a bright future!



- TV RECEIVER DESIGN ENG.
- ELECTRONICS ENG.
- FIELD ENGINEERS
- TEST & INSPECTION ENG.
- COMPONENTS ENG.

You're needed to work on: Radar, G.C.A., Mobile Radio, Auto Radio, Airborne Communication & Navigation Equipment, Television, Antennas, Microwave Equipment, Servo Mechanisms and Guided Missiles.

Write,
Wire or Phone
MR. E. O. COLE
Dept. J

You will benefit from high wages, a modern, air-conditioned plant, paid vacations and holidays, group insurance and a good chance for advancement.

Housing immediately available in the beautiful suburban and county areas that surround the Bendix Radio plant.

Bendix Radio

DIVISION OF BENDIX AVIATION CORPORATION

Baltimore-4, Md. Phone: VAlley 3-2200

Makers of the World's Finest Electronic Equipment

UHF
and
MICROWAVE ENGINEERS

This rapidly growing Organization in south central Wisconsin, approximately 100 miles from Chicago, has several openings for Junior and Senior Engineers in the U.H.F. and Microwave fields.

UNUSUAL SALARY OPPORTUNITIES

exist under ideal working conditions in large, well-equipped laboratories. Personnel benefits such as sickness, accident, and life insurance in addition to a very liberal pension system are offered.

For more information concerning the positions that are open we invite you to write to Personnel Director, Department A.

GIBBS MANUFACTURING & RESEARCH CORPORATION

Janesville, Wisconsin

Engineers & Physicists

- Mechanical Engineers
- Servo Engineers
- Operations Research Analysts
- Electrical Engineers
- Chemical Engineers
- Physicists

The diversified research and development programs now in progress at

melpar, inc.

The Research Laboratory

of Westinghouse Air Brake Co. and its subsidiaries

offer excellent opportunities for professional achievement to qualified men.

Write to Personnel Director,
MELPAR, INC., Dept. E-1
452 Swann Avenue
Alexandria, Virginia

ELECTRO-MECHANICAL DESIGNER

Requires thorough knowledge of hydraulic, pneumatic and electric servomechanisms for work on gas turbine control systems. Three to five years experience in design and development of electro-mechanical control devices such as relays, solenoids, actuators, pressure switches, regulators and instruments of aircraft quality.

Unusual opportunity for qualified engineer seeking responsible position with a progressive yet informal company in sunny San Diego. Outstanding employee benefits including profit sharing, low cost group insurance and medical care, free polio insurance to all employees and their families, paid tuition for university night school courses, periodic salary merit and adjustment reviews, paid vacations, and many others.

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SOLAR AIRCRAFT CO.
2200 PACIFIC HIGHWAY
SAN DIEGO, CALIF.

. . . *An invitation to*

Experienced

ELECTRONIC ENGINEERS

and

PHYSICISTS

We have several positions of technical leadership available in our growing Guided Missile Division. Applicants must have over four years experience and/or advanced degrees in either missile guidance systems, radar, servomechanisms, fire control computers, or U. H. F. techniques.

Our plant is located in beautiful suburban St. Louis, where you can enjoy the comforts of "county" living with easy access to "big city" shopping, entertaining, medical and educational facilities. Moving allowance for qualified applicants. Our Housing Representative will assist you in relocating.

Address replies to:

Technical Placement Supervisor
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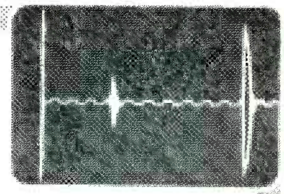
McDONNELL
Aircraft Corporation
ST. LOUIS 3, MO.

ENGINEERS:

what's simac*?



It's newer than radar, sonar, loran and TV
Its commercial uses are almost limitless
It's the fast-growing field in which Sperry ultrasonic equipment is paramount

IT'S
SONIC
INSPECTION
MEASUREMENT
AND
CONTROL

SIMAC, the most advanced method for non-destructive testing of metal and other materials.

ELECTRONIC ENGINEERS

Sperry Products, Inc. now offers you an opportunity to diversify your experience, to join an expanding, completely independent organization, if you have had experience in planning, design and development of circuits for gating and timing, pulse generation and amplification, sweep generation and amplification or servo mechanisms applications.

- Work for a smaller company in which your ability can be recognized quickly, your talents can thrive.
- Move your family to Danbury, Conn. in the foothills of the Berkshire Mountains, less than 2 hours drive from New York City. Moving expenses paid.

Find out more about available positions: send complete resume to W. J. Hatcher.

SPERRY PRODUCTS, INC.
DANBURY CONNECTICUT

* trade mark

ENGINEERS

AND

PHYSICISTS

BS—MS—Ph.D:

Responsible positions in mechanical, electrical or electronic engineering, physics or engineering physics for advanced development and design of special equipment and instruments. Prefer men with minimum of two years' experience in experimental research design and development of equipment, instruments, intricate mechanisms, electronic apparatus, optical equipment, servomechanisms, control devices and allied subjects. Positions are of immediate and permanent importance to our operations. Southwestern location in medium sized community. Excellent employee benefits. Reply by letter giving age, experience and other qualifications. All applications carefully considered and kept strictly confidential.

Ind. Rel. Manager
Research & Development Dept.

PHILLIPS PETROLEUM COMPANY
Bartlesville • Oklahoma

ENGINEERS

Join a leader in electronic development and manufacturing in Southern California. Real opportunity for expressing creative ability and accepting professional challenge.

Electronic Engineers

Qualified and experienced in development of functional circuitry and product design.

Mechanical Engineers

To design electro-mechanical equipment items.

Radio Receiver Specialists

Develop new standard and display types, V.H.F.-U.H.F. range. Advanced concepts of receiver principles. Interesting long term projects.

Relocation expense allowed accepted candidates.
Excellent conditions including regular advance review, health and disability insurance, 40 hour week, standard paid holidays and annual vacations. Central location. Relocation should not disturb urgent military projects.

Send complete resume with income history & requirements to engineering employment mgr.

Hoffman LABORATORIES, Inc.
3761 SO. HILL ST. LOS ANGELES 7, CALIF.
(A Subsidiary of Hoffman Radio Corp.)

PROJECT ENGINEER

FOR DEVELOPMENT WORK

Well established antenna company is willing to train qualified electrical engineer for antenna development work.

A minimum of 3 to 5 years of electrical design background is required.

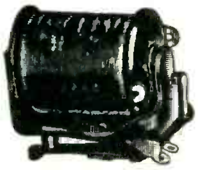
Experienced in antenna micro-wave plumbing or net works is desirable but not essential.

Salary to $9,000 depending upon experience and education.

DORNE & MARGOLIN
30 Sylvester St. Westbury, L. I.

Buy TOP Radio-Electronic Values!

SENSITIVE RELAYS



MIDGET TYPE RELAYS

Automatic Electric Type R-45, 6500 ohm Coils. Normally open contacts except as noted.

Stock No.	Contacts	M. A.	Price Each
102152	S.P.S.T.	2.0	$1.25
102249	2.P.S.T.*	4.5	1.50
102264	3.P.S.T.	6.0	2.00

*1 Norm. open-1 Norm. closed.

Same type and style as above, but has 24 V.A.C. coil. Intermittent duty. Will operate on 6 V.D.C. Continuous duty. Contacts: S.P.S.T.-N.O. and S.P.D.T.

Stock No. 102248A Price Each **$1.25**

U. T. C. TYPE A-25 HI-FIDELITY SINGLE PLATE TO MULTIPLE LINE.

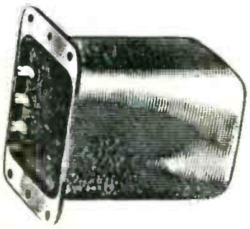
Stock No. 6290A **$17.50 Value For $5.95**

TCS. GENERATORS

High voltage continuous duty fully enclosed D.C. Generator. Delivers 440 volts at 200 M.A. Motor driven by 3450 RPM motor (not furnished). Made to Navy Specs. for Collins Radio TCS. Transmitters.

Stock No. 6147A Price Each **$15.00**

THORDARSON AUDIO PASS FILTER



Band pass 800 to 1200 cycles input 10000 ohms — Output 25000 Ohms Level 10DB

Stock No. T48500 Price to $5.50 ea.

CONNECTORS

J.A.N.—"UG" and "AN" Types

For immediate service on all types of connectors and fittings meeting the latest J.A.N. specs. Call write or phone us. Certification supplied. We can help you overcome shutdowns resulting from slow or delayed deliveries.

J.A.N. toggle switches and many other items too.

FILAMENT TRANSFORMER

20 VOLTS TAPPED AT 14 VOLTS @ 20 AMPS. PRIMARY TAPPED IN 5 VOLT STEPS FROM 210 TO 240 VOLTS 50-60 CYCLE STANCOR SS10696. 4" x 5" x 5" HIGH.

Stock No. 6292A **$4.95**

TYPE "J" POTENTIOMETERS

500 Ohm—2 Watt Type J Pot. 3/8" Long Shaft. 1/4" long Bushing. Complete with Knob.

Stock No. A6123 Price Each **49¢**

100 ohm Type I with 3/8" bushing and locking nut. Screw-driver slot.

Stock No. 6270A Price Each **$.49**

LAB. POTENTIOMETERS

MODEL 260. 6 Watt 20,000 OHM Laboratory, Potentiometer. Resistance tolerance plus or minus 5%. Five finger bronze wiper. Bakelite shaft 3/8" Diam. x 1 1/4" Long.

Stock No. 6277A Price Each **$1.50**

MIL—T—27 FILAMENT TRANSFORMER

PRIMARY: 107.5; 112.5; 117.5; 122.5; 215; 225; 235 and 245 Volts 50/60 cycle.
SECONDARY: 6.3 Volts @ 5.3 AMPS and 6.3 Volts @ 3 AMPS. Ceramic bushings with solder lug terminals. Rated for continuous duty under Mil-T-127, Class "A" Grade I specs. Hermetically sealed case, 2 3/4" x 3 1/2" x 3 1/8" high.

Stock No. 6284A Price Each **$3.50**

MICA CONDENSERS

Type 9 and A2 5000 Volt Test Mica Condensers

Stock No.	Cap. Mfd.	Price Each
6274A	.002	$ .60
6275A	.01	$1.00

SWEEP CAPACITOR

5-10 MMFD. Sweep Generator Capacitor. Has cylindrical silver plated rotor, concentric to silver plated stator plates. Rotor has high speed ball bearings. Completely enclosed in moulded bakelite housing. Ideal for motor driven sweep generators.

Stock No. 6276A Price Each **$2.00**

8 MFD—220 V.A.C.

Capacitor. 2" Diam. x 4" high can. Bakelite insulated solder lug terminals.

Stock No. 6278 Price Each **$.80**

2 x 4 MFD—600 VOLT

Capacitor made for "TCS" equipment. Mounted in transformer style case with flange mtg. Case 2 1/4" x 2 3/8" x 3" high.

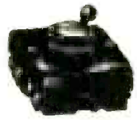
Stock No. 6279A Price Each **$2.00**

10 MFD.—600 VDC

Sprague No. R2-157, 10 Mfd. 220 VAC 600 VDC Capacitor with Universal Mounting Ring. 2-7/16" Diameter, 3 3/4" high. Bakelite insulated terminals.

Stock No. 5958A Price Each **$1.25**

HEAVY DUTY SWITCH



H&H 4.P.D.T. Toggle Switch. 5 AMP. @ 250 Volt. 10 Amp. @ 125 Volt. Single 3/4" hole mount. Ball handle.

Stock No. 6203A Price h **$1.95**

CUTLER HAMMER TYPE 8905K628

4 Pole D.T. Neutral Center Toggle Switch. Luminous Tip—Bat Handle. 2 Hole Mtg.

Stock No. 6291A Price Each **$1.95**

RECTIFIERS

A precision balanced copper oxide double bridge rectifier. Housed in a sealed metal container 1" x 1-3/4" x 1" high. Tapped mtg holes in bottom. Discs have vaporized gold contact surfaces. Made by Bradley Labs. to W. E. spec. D 220005. Nominal input volts 10.5 V.A.C. 5 MA.

Stock No. 6283A Each Price **$1.50**

BRADLEY INSTRUMENT RECTIFIER

BRADLEY #CX2E4E-69 Copper Oxide Rectifier. 3 color coded insulated wire leads.

Stock No. 6184A Price h **50¢**

304TL's

EIMAC JAN 304TL's INDIVIDUALLY BOXED $10.95

SPECIAL PURPOSE AND TRANSMITTING TUBES

Tubes listed below are "Jan" types in original boxes and are new. Some in limited quantities. All are standard brands such as RCA, G.E., Nat. Union, Western Electric, Machlet, Etc.

Type	Price Each	Type	Price Each
OB3/VR90	$ .85	814	$ 2.75
OC3/VR150	.85	826	.85
1B22	2.00	837	1.00
1B23	7.50	860	4.50
2C22/7193	.25	864	.35
2J36	75.00	955	.25
204A	75.00	956	.35
3B7/1291	.50	10Y	.35
3D6/1299	.50	12GP7	14.95
3B24	5.00	CK1090	1.00
3BP1	5.95	1616	.75
316A	1.25	1619	.25
371B	.75	1625	.35
450TL	45.00	1626	.35
5FP7	5.00	1B32/532A	5.00
705A	2.00	GL-8002R	95.00
718BY	40.00	8020	1.25
724B	3.00	8025	4.00
801	.45	9001	1.50
807	1.75	9006	.30

SIGNAL CORPS & NAVY TRANSFORMER

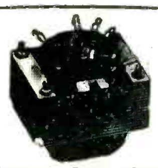
Over 200,000 transformers, chokes etc. For Signal Corps and Navy Equipment. Send us your requirements, or ask for our catalog listing, by Signal Corps Numbers. DON'T DELAY!

6.3 VOLT FILAMENT TRANSFORMERS

Primary 115 Volt 60 Cycle 1600 Insulation Three 6.4 Volt Secondaries

6.3 Volts @ 4.9 Amps.
6.3 Volts @ 4.5 Amps.
6.3 Volts @ 1.1 Amps.
Stock No. 5254A

Horizontal Half Shell Mounting. 2 1/4" x 2 13/16" Mounting Centers. 2 13/16" x 3 3/8" Core Size. 1/2" above Chassis. Soder Lug Terminals—All Terminals Marked.



Price Each **$2.65**

TERMS:

Open Accounts 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.

ORDER TODAY!

Radio Surplus Corp.

732 South Sherman Street
Chicago 5, Illinois
Phone: HArrison 7-5923

WRITE FOR OUR FREE BULLETIN
MORE GOOD ITEMS

GUARANTEED BRAND NEW

LECTRONIC RESEARCH

Receiving Tubes

Type No.	Price
OOA	$1.50
OA1	.67
OZ4	.59
OZ4A	.63
1A3	.71
1A5GT	.72
1A6	.72
1A7GT	.79
1B3GT	.99
1B4P	.79
1B5	.74
1C5GT	.85
1C6	.69
1C7G	.69
1D5GP	.69
1D7G	.69
1D8GT	.71
1E5GP	.71
1F4	.69
1F5G	.69
1F6	.70
1G4GT	.69
1G5G	.69
1G6GT	.69
1H4G	.89
1H5GT	.69
1H6G	.75
1H6GT	.79
1J5G	.74
1J6G	.69
1L4	.69
1LA4	.87
1LA6	.99
1LB4	1.01
1LC5	.81
1LC6	.93
1LD5	.93
1LE3	.93
1LH4	.82
1LN5	.74
1N5GT	.83
1N6G	.75
1P5GT	.69
1Q5GT	.99
1R4	.69
1R5	.69
1S4	.71
1S5	.69
1T4	.71
1T5GT	.71
1U4	.73
1U5	.77
IV	.65

Type No.	Price
1X2	.93
2A3	1.28
2A5	.79
2A7	.79
2B7	.79
2E5	.94
2X2	.50
2X2A	1.85
3A4	.65
3A5	.95
3A8GT	1.50
3B7	.57
3C6	1.15
3D6	.57
3LF4	.91
3Q4	.77
3Q5GT	.83
3S4	.77
3V4	.79
5AZ4	.54
5R4GY	1.59
5T4	1.91
5U4G	.59
5V4G	.98
5W4	.82
5X4G	.79
5Y3GT	.47
5Y4G	.71
5Z3	.87
5Z4	1.40
6A6	.82
6A7	1.05
6A8	.95
6AB4	.83
6AB7	.98
6AC5GT	1.19
6AC7	.85
6AC7W	3.25
6AD6G	.98
6AD7G	1.29
6AE6G	.89
6AF6G	.89
6AG5	.79
6AG7	1.45
6AH6	1.29
6AJ5	1.95
6AK5	.84
WE-6AK5	1.85
6AK5W	2.95
6AK6	.99
6AL5	.59
6AL5W	2.65
6AQ5	.72
6AQ6	.79
6AR5	.79
6AS5	.99
6AS6	2.25
6AS7G	4.25
6AT6	.63

Type No.	Price
6AU5GT	1.21
6AU6	.65
6AV6	.55
6B4G	1.25
6B5	1.20
6B7	.95
6B8	.75
6B8G	.75
6BA6	.65
6BA7	1.20
6BC5	.88
6BC7	1.10
6BD5GT	1.60
6BD6	.85
6BE6	.65
6BF5	1.10
6BF6	.83
6BG6G	1.89
6BH6	.95
6BJ6	.95
6BK7	1.60
6BL7GT	1.45
6BN6	1.59
6BQ6GT	1.26
6C4	.55
6C5	.70
6CB6	.79
6C6	.73
6C8G	.96
6CD6G	2.21
6D6	.88
6D8G	.83
6E5	1.10
6F5GT	.83
6F6	.99
6F6G	.87
6F7	1.05
6F8G	.91
6G6G	.99
6H6	.66
6H6GT	.66
6J5	.59
6J5G	.64
6J5GT	.55
6J6	.95
6J7	.99
6J7GT	.79
6J8G	1.28
6K5GT	.99
6K6GT	.65
6K7	.79
6K7G	.86
6L5G	1.06
6L6	1.87
6L6G	1.49
6L6GA	1.39
6L7	.99
6L7G	.85
6N7	.99

Type No.	Price
6N7GT	.89
6P5GT	.96
6Q7	.89
6R7	.79
6S4	.72
6S7	1.06
6S7G	.99
6SA7	.71
6SA7GT	.67
6SB7Y	1.04
6SC7	.93
6SD7GT	.94
6SF5	.83
6SF5GT	.80
6SF7	.75
6SG7	.75
6SH7	.75
6SH7GT	.75
6SJ7	.71
6SJ7GT	.69
6SJ7Y	.85
6SK7	.72
6SK7GT	.72
6SL7GT	.81
6SN7GT	.73
6SN7WGT	2.10
6SQ7	.65
6SQ7GT	.65
6SR7	.63
6SS7	.99
6ST7	1.05
6T7G	1.09
6T8	.98
6U5	.98
6U7G	.65
6V6	1.49
6V6G	.89
6V6GT	.67
6W4GT	.64
6W6GT	.88
6X4	.59
6X5GT	.59
6Y6G	.99
6ZY5G	.89
7A4	.76
7A5	.79
7A6	.75
7A7	.76
7A8	.78
7AD7	1.44
7AH7	1.08
7B4	.79
7B5	.79
7B6	.79
7B7	.79
7B8	.78
7C4	.45
7C5	.79
7C6	.79

Type No.	Price
7C7	.79
7E5	.79
7E6	.58
7E7	.83
7F7	.99
7F8	1.35
7G7	.89
7H7	.79
7J7	1.10
7K7	1.10
7L7	.97
7N7	.97
7Q7	.79
7R7	.94
7S7	1.11
7V7	1.11
7W7	1.11
7Y4	.73
7Z4	.79
10	.39
12A	.65
12A6	.64
12A6GT	.64
12A7	1.16
12A8GT	.77
12AH7GT	1.32
12AL5	.79
12AT6	.55
12AT7	.99
12AU6	.71
12AU7	.86
12AV6	.54
12AV7	.99
12AW6	1.20
12AX7	.99
12BA6	.69
12BA7	.95
12BD6	.99
12BE6	.66
12C8	.65
12F5GT	.79
12H6	.69
12J5GT	.55
12K8	.70
12Q7GT	.67
12SA7GT	.69
12SF5	.79
12SF5GT	.79
12SF7	.85
12SG7	.85
12SH7	.73
12SJ7	.71
12SJ7GT	.65
12SK7	.69
12SL7GT	.93
12SN7GT	.89
12SQ7GT	.68
12SR7	.79
12SR7GT	.89

Type No.	Price
12X3	.89
12Z3	.89
14A4	.97
14A7	.74
14B6	.74
14B8	.89
14C5	1.10
14C7	.93
14E6	.99
14E7	1.09
14F7	.89
14H7	.89
14J7	.89
14N7	.89
14R7	.89
14S7	.89
14W7	.89
14X7	.89
18	.89
19	.89
19T8	.99
22	1.16
24A	.89
25A6	1.16
25L6GT	.69
25Z5	.79
26	.79
27	.69
28D7	1.95
30	.70
30 Spec	.45
31	.54
32	.69
32L7GT	[illegible]
33	[illegible]
34	.69
35/51	.59
35A5	[illegible]
35B5	[illegible]
35L6GT	[illegible]
35W4	[illegible]
35Y4	.72
35Z4GT	.69
35Z5GT	.55
36	.64
37	.69
38	.69
39/44	.59
41	.71
42	.79
43	.79
45	.79
45Z5GT	.89
46	.81
47	.99
50	1.09
50A5	.89
50B5	.69
50C5	.69

Type No.	Price
50L6GT	.63
50Y6GT	.92
53	.95
55	.99
L55B	.32
56	.69
57	.69
58	.69
59	1.24
70L7GT	1.29
71A	.79
75	.85
76	.69
77	.69
78	.79
79	.89
80	.59
81	1.41
82	1.19
83	1.11
83V	1.25
84/6Z4	.75
85	.79
89Y	.55
117N7GT	1.89
117P7GT	1.89
117Z3	.65
117Z6GT	.97
FM-1000	1.59

Transmitting and Special Purpose Tubes

Type No.	Price
OA2	$ .95
OA3	1.15
OA4G	1.25
OB2	1.10
OB3	1.19
OC3	1.10
OD3	.95
1B21A	2.65
1B22	2.50
1B23	9.60
1B24West	12.95
1B24Sylv.	18.95
1B24A	39.50
1B26	3.73
1B27	14.95
1B29	2.75
1B32	3.75
1B35	11.00
1B36	12.50
1B37	14.25
1B38	32.50
1B40	4.95
1B41	47.50

Type No.	Price
1B42	9.80
1B49	50.33
1B54	32.50
1H20	.88
1P21	35.00
1P23	4.10
1P24	1.27
1P29	2.66
1Q23	118.75
1S21	9.50
1Z2	3.75
2A4G	1.22
2AP1	8.95
2AP5	8.95
2B4	2.10
2B22	2.20
2C21	.65
2C22	.45
2C26	.39
2C26A	.49
2C33	4.95
2C34	.49
2C39	22.00
2C39A	29.00
2C40	12.00
2C42	23.75
2C43	17.75
2C44	1.20
2C46	21.50
2C51	5.75
2C53	11.75
2D21	1.55
2E22	1.85
2E24	4.10
2E26	2.85
2J21	8.75
2J22	8.95
2J26	24.75
2J27	22.95
2J31	27.00
2J32	36.50
2J33	39.50
2J34	27.00
2J37	13.70
2J38	17.50
2J39	36.50
2J40	34.50
2J48	49.50
2J49	65.00
2J50	39.50
2J54	67.50
2J56	148.50
2J61	45.25
2J66	165.00
2K23	37.50
2K25	28.50
2K26	105.00
2K28	29.50
2K29	27.50

Type No.	Price
2K33	265.00
2K33A	280.00
2K39	135.00
2K41	145.00
2K45	129.50
2K55	135.00
3AP1	8.95
3AP4	10.25
3B22/EL-1C	2.60
3B23	4.75
3B24	5.20
3B24W	7.50
3B25	4.50
3H26	3.75
3B27	4.20
3B28	7.75
3BP1	5.75
3C22	89.50
3C23	9.65
3C24	1.85
3C27	6.95
3C31/EL-C1B	3.95
3C37	32.50
3C45	12.95
3CP1	2.25
3D21	2.98
3DP1	4.85
3DP1A	6.75
3E29	13.75
3EP1	4.75
3FP7	2.90
3FP7A	6.95
3GP1	3.95
3HP7	3.95
3J31	145.00
4-125A	29.50
4A1	1.18
4AP10	4.40
4B22/EL5B	8.95
4B24	5.75
4B25/EL-6CF	8.95
4C35	27.00
4E27	21.50
4J36	150.00
4J38	120.00
4J52	275.00
4X150A	36.00
4X500A	114.95
4X1000A	125.40
5AP1	5.95
5AP4	4.75
EL-C5B	3.95
5BP1	5.50
5BP4	5.50

COAXIAL CONNECTORS

83-1AC	$ .42	83-1RTY	$ .65	83-22R	$ [illegible]
83-1AP	.30	83-1SP	.45	83-22SP	.80
83-1F	1.10	83-1SPN	.50	83-22T	1.95
83-1H	.12	83-1T	1.30	83-168	.12
83-1HP	.22	83-2AP	1.95	83-185	.12
83-1J	.73	83-22AP	1.40	83-765	.24
83-1R	.40	83-22F	2.10	83-776	[illegible]
		83-22J	1.40		

FULL LINE OF JAN APPROVED COAXIAL CONNECTORS IN STOCK UHF—N—PULSE—BN—BNC

UG-7/AP	$6.30	UG-23B/U	$1.50	UG-58/U	$ .70	UG-10[illegible]	$1.40	UG-185/U	$ .95	UG-261/U	$1.10
UG-12/U	.95	UG-23C/U	1.10	UG-58[illegible]/U	.90	UG-10[illegible]/U	[illegible]	UG-191/AP	.80	UG-262/U	1.10
UG-[illegible]/U	1.25	UG-24/U	1.30	UG-5[illegible]A/U	2.15	UG-107B/U	2.75	MX-195/U	.75	UG-273/U	1.45
UG-18/U	1.25	UG-25/U	1.35	UG-60A/U	1.75	UG-108/U	2.60	UG-197/U	2.80	UG-274/U	2.30
UG-18B/U	1.05	UG-27/U	1.25	UG-61A/U	2.10	UG-109/U	2.60	UG-201/U	1.95	UG-275/U	5.50
UG-19/U	1.60	UG-27A/U	2.25	UG-83/U	1.75	CW-123A/U	.45	UG-203/U	.65	UG-276/U	2.75
UG-20B/U	1.60	UG-28A/U	2.95	UG-85/U	1.60	UG-146/U	1.95	UG-206/U	1.80	UG-290/U	.90
UG-21/U	.85	UG-29/U	.95	UG-86/U	2.25	CW-159/U	.60	UG-224/U	1.15	UG-291/U	.95
UG-21A/U	1.50	UG-29A/U	1.85	UG-87/U	1.40	UG-166/U	32.50	UG-236/U	3.85	UG-306/U	2.65
UG-21B/U	1.00	UG-29B/U	1.75	UG-88/U	.90	UG-167/U	3.75	UG-245/U	2.25	UG-349/U	2.65
UG-21C/U	1.05	UG-30/U	2.30	UG-89/U	1.10	UG-171/U	2.25	UG-246/U	2.35	MX-367/U	.85
UG-22/U	1.30	UG-34/U	9.75	UG-90/U	1.15	UG-173/U	.35	UG-254/U	2.75	UG-414/U	1.95
UG-22B/U	1.20	UG-36/U	12.50	UG-98/U	1.85	UG-175/U	.12	UG-255/U	1.95	UG-498/U	1.80
UG-22C/U	1.20	UG-37/U	17.[illegible]	UG-102/U	.80	UG-176/U	.12	UG-260/U	.85	UG-536/U	1.65
UG-23/U	1.20	UG-57B/U	1.[illegible]	UG-103/U	.68	UG-177/U	.24			UG-625/U	1.35

QUOTATIONS UPON REQUEST ON ANY CONNECTORS NOT LISTED HERE

M-358	MC-277	PL-259A	L-325				
M-359	MC-320	PL-274	S[illegible]-239	93-C	49120	D-163950	ES-685696-5
M-359A	PL-258	PL-284	SO-264	93-M	4921A	D-166132	ES-689172-1
M-360	PL-259	PL-293	TM-[illegible]1				

COAXIAL CABLE

Type	Price Per M Ft.	Type	Price Per M Ft.	Type	Price Per M Ft.	Type	Price Per M Ft.
RG-5/U	$140.00	RG-13/U	$218.00	RG-26/U	$475.00	RG-57/U	$325.00
RG-6/U	180.00	RG-17/U	[illegible].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.

OIL FILLED CONDENSERS

MFD	VDC	Price
2	400	$ .55
5-5	400	1.65
1	600	.55
2	600	.69
2-2	600 R'd	1.65
3	600	.95
4	600	1.65
4	600 R'd	1.65
5	600	1.75
6	600	1.85
8	600 R'd	1.85
8-8	600	1.95
4-4-4	600	2.50
4 x 3	600	2.50
10	600	3.25
50	600	7.95
1	1000	.65
2	1000	.90
2	1000 R'd	.95
3.5-.5	1000	1.85
4	1000	1.95
6	1000	2.50
8	1000	3.25
1	1200	.85

MFD	VDC	Price
1-1-1	1200	$1.85
[illegible]	1500	.69
3	1500	2.50
4	1500	2.95
.1-.5	2000	.95
.25	2000	1.50
.3	2000	1.30
1	2000	1.95
12	2000	8.95
1	2500	2.75
1-1	2500	3.85
32	2500	15.80
.5	3000	2.40
1	3000	3.40
2	3000	5.85
3 x .2	4000	2.95
2	4000	7.95
.2	5000	2.50
1	5000	5.75
2	5000	18.50
5	5000	29.50
.01-.03	6KV	1.65
1	6000	$9.95
.1	7000 R'd	1.79

MFD	VDC	Price
.1-1	7000	5.95
.1	7500	2.85
.5	7500	7.95
1-1	7500	26.50
.075-.075	8KV	6.50
1	10KV	29.50
.1	12KV	8.95
1	15KV	47.50
.045	1[illegible]KV	6.70
.05	16KV	6.95
.25	20KV	19.95
1	20KV	54.00
1	25KV	85.00
.001	50KV	24.50

MFD	VDC	Price
.005	50KV	$34.50
.025	50KV	42.50
.2	50KV	85.00
.25	50KV	95.00
7.5	220VAC	1.95
20	236VAC	3.95
1-3	330VAC	1.95
12.75	330VAC	4.10
15	330VAC	4.50
5	440VAC	3.10
2.9	660VAC	3.50
7	660VAC	4.25
8	660VAC	4.50

CILMITES

MFD	V.	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

CM EQUIPMENT

K Band RF Head RT-99/APS-32; (incl 3J31 Magnetron, 2K33A Klystron etc.) $650.00
Radar Transmitter T-85/APT-5 300-1600 MC—complete $175.00
10 CM Crystal Mixer—Pound Type—type N fittings $19.50
AN/APR-4 Broad Band Receiver and Tuning Units TN-16 (38-95MC), TN-17 (76-300MC), TN-18 (300-1000MC) Ideal Lab. Receiver—Prices on Request.
3CM Pickup Horn Antenna AT-48/UP $9.95
10CM Signal Generator I-138A $185.00
10CM Freq. Meter CW 60 ABM $97.50
3CM RF Load—150W. Avg. Pwr. TS-108A/AP. $32.50
10CM RF Load CG-97/AP $22.50

PULSE TRANSFORMERS

UTAH OA-18 9278 9340 X124T-2 9280 9341 9262 9318 9350 UTAH

G.E.—K2464	AN/APN-9 (352-7250)
G.E.—K2468	AN/APN-9 (352-7251)
G.E.—K2469	AN/APN-9 (901756-501)
G.E.—K2744B	AN/APN-9 (901756-502)
G.E.—68G627	Westinghouse—132AW2
G.E.—68G828	Westinghouse—139DW2F
G.E.—68G929G1	Westinghouse—166AW2F
G.E.—80G13	Westinghouse—176AW2F
G.E.—80G152	Westinghouse—187AW2F
Philco—352-7071	Raytheon—UX-7350
Philco—352-7149	Raytheon—UX-10066
Philco—352-7150	W.E.—D-161310
Philco—352-7178	W.E.—D-163247
Philco—352-7190	W.E.—D-163325
Philco—352-7224	W.E.—D-164661

FILAMENT TRANSFORMERS

INPUT—115 V., 50/60 CYCLES

Kenyon — 5V 60A $15.25
Kenyon — Input 105-125V — Sec. 5V 115A $19.50
Amertran — Input 105-125V — Sec 5V. 190A. Insulation 35KV RMS test $29.50

INPUT—208/230 V., 50/60 CYCLES

GE 2.5 V.CT. @ 10A., Insul.-5KV Encl. Case. $2.10
GE 5V. CT. @ 7.5A; Insul.1.5 KV Open Frame 3.45
GE 5 V. CT. @ 7.5A; Insul.7KV Open Frame.. 5.25
GE 5V.CT. @ 7.5A., Insul.-10 KV Encl. Frame 6.25
GE INPUT 190.5V., 50/60 CYCLES; Sec.-4.3V. to 25.98V. by 6 taps Open Frame 7.95
GE INPUT 220V 60 CYCLES; Sec.-5V.CT., @ 7.5A., Insul.-5KV-Open Frame.... 4.60

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5CP1	4.95
5CP7	9.50
5D21	19.50
5FP7	1.95
5HP1	5.50
5HP4	5.75
5J29	18.50
5JP1	26.50
5JP2	26.50
5JP4	26.50
5LP1	21.75
5LP5	19.75
5MP1	10.50
6-8B	.85
C6A	6.75
6AN5	3.30
6AR6	3.25
6C21	27.50
6C24	52.50
6F4	5.95
C6J	9.95
6J4	6.85
7-7-11	1.19
7BP1	8.65
7BP7	6.50
7BP12	14.95
7BP14	14.95
7CP1	14.95
9GP7	11.75
9LP7	4.50
10BP4	17.95
10FP4	22.50
10T1	.88
10Y	.39
12DP7	14.50
12GP7	18.50
12HP7	14.75
13-4	.80
13T4	.85
15E	1.95
15R	.65
FG-17/5557	4.95
REL-21	1.95
23D4	1.15
24G	1.85
HK-24	4.95
RK-25	3.82
FG-27A	8.25
FG32/5558	6.75
FG33	17.50
RK34	.49
35T	4.95
35T ION gauge	5.95
35TG	4.95
REL 36	.45
T-40	3.75

Type No.	Price
FG-41	122.50
RK-47	4.92
EF-50	.79
VT-52	.45
53A	5.60
RK59	2.44
SK-60	6.62
VT-62 Br.	1.15
RK-63	22.50
FG-67	14.80
VT-67	.48
RK-69	2.25
72	1.32
73	1.32
RK-75	3.50
75T	5.80
VR-75	1.15
VR-78	.64
FG-81A	3.95
VR-90	1.19
91	14.80
FG-95/5560	25.00
VT-98/Br.	19.50
C100A	2.30
C100E	2.30
100R	2.90
100TH	9.95
WE-101F	3.62
WE-102F	2.85
FG-104/5561	24.60
FG-105	19.50
VR-105	1.10
WE-113A	1.32
HY-114B	.75
WE-117A	.95
F-123A	7.75
WE-124A	3.80
F-127A	22.50
VT-127A	3.60
AB-150	12.50
VR-150	.95
FG-166	48.50
FG-172	29.50
FG-178	14.50
FG-190	12.15
HF200	16.50
L-200B	65.00
203A	7.40
203B	6.33
204A	47.50
CE-206	3.15
211	.95
WE-211D	12.50
WE-211E	12.50
212E	42.50
WE-215A	.24

Type No.	Price
217C	8.95
221A	1.95
227A/5C27	4.60
WE-231D	2.25
232CH	240.00
RX-233A	4.95
FG-235A/5552	94.50
WE-245A	2.35
WE-249B	3.50
WE-249C	3.50
250R	17.50
250TH	22.50
250TL	22.50
WE-252A	5.65
WE-254A	5.90
WE-257A	3.77
FG-271/5551	62.50
WE-274A	5.50
274B	2.85
WE-275A	6.95
WE-283A	4.25
WE-285A	5.57
WE-286A	7.90
WE-294A	5.75
304TH	8.75
304TL	8.75
307A	4.25
WE-309A	6.45
WE-310A	6.25
WE-313C	4.15
316A	.89
327A	4.25
WE-331A	9.75
WE-343A	185.00
WE-346A	2.75
WE-350A	6.95
350B	4.95
WE-356B	5.45
361A	4.75
368A	6.95
371A	.95
371B	.95
388A	2.95
393A	8.60
394A	4.50
WE-399A	4.70
410R	185.00
414	114.00
GL-415/5550	39.50
417A	16.95
434A	24.50
446	1.75
446A	1.95
446B	2.95
450TH	42.50
450TL	42.50

Type No.	Price
451	5.75
471A	2.65
473	156.75
481A	4.05
502A	1.67
503AX	1.25
506AX	1.25
507AX	1.47
527	17.50
530	17.20
531	7.50
532A	3.75
WL-533	19.50
559	2.20
561	3.50
575A	18.90
579B	13.50
KU610	12.50
HY615	.49
616	213.75
KU-623	39.50
624	43.20
KU627	19.80
KU-628	22.50
KU-629	11.70
632B	26.10
KX642	11.34
WL-652/5551	62.50
WL-654/659	82.00
WL-670A	8.70
WL-672	22.00
672A	31.50
KU-676	52.25
677	52.25
678	42.30
WL-681/5550	39.50
700A	24.50
700B	24.50
700C	24.50
700D	24.50
701A	6.95
703A	5.95
704A	.95
705A	2.25
706AY	45.00
706BY	45.00
706CY	45.00
706FY	45.00
706GY	45.00
707A	7.95
707B	14.90
708A	4.75
709A	3.85
710A	1.70
713A	1.45
714AY	10.75

Type No.	Price
715A	6.25
715B	8.95
715C	19.50
717A	1.47
718AY	45.00
718BY	45.00
720DY	95.00
721A	3.95
722A	2.25
723A	9.95
723A/B	18.50
724A	3.22
724B	3.22
725A	8.95
726A	14.50
726B	45.00
726C	65.00
730A	25.00
731A	2.45
788Y	1.40
800	1.75
801A	.45
803	4.95
805	4.50
806	24.50
807	1.65
808	2.65
809	2.95
810	10.95
811	3.60
812A	4.50
813	10.50
814	3.95
815	2.95
816	1.45
826	1.25
828	11.25
829	9.95
829A	11.95
829B	12.95
830B	2.95
832	7.95
832A	9.95
833A	39.50
836	4.10
837	1.45
838	3.75
841	.49
843	.59
845	5.75
845W	6.75
849	29.50
851	67.00
852	19.50
857B	198.55
860	4.95
861	22.50
864	.35
865	1.28

Type No.	Price
866A	1.48
866AJr./2B26	1.25
868	2.25
869B	125.40
872A	3.95
874	1.15
876	1.60
878	1.85
884	1.75
885	1.75
886	2.60
889RA	280.25
891	211.85
892	211.85
892R	343.90
893A	598.50
893AR	1092.50
895	902.00
895R	1235.00
902P1	9.95
905	3.50
917	3.15
918	1.65
919	1.95
920	3.74
923	1.35
924	2.97
925	2.16
926	2.61
927	1.85
928	2.57
931A	5.00
954	.39
955	.55
956	.49
957	.49
958A	.69
959	2.25
991	.45
1003	.90
CK-1005	.69
CK-1006	3.30
E-1148	.35
1201	.79
1203	.45
1291	.57
1294	.69
1299	.57
1602	2.25
1613	.89
1614	2.00
1616	1.07
1619	.39
1620	6.25
1622	2.25
1623	3.56
1624	1.90
1625	.39

Type No.	Price
1626	.30
1629	.30
1630	.95
1631	1.38
1632	.75
1636	3.10
1638	.70
1642	.65
1644	.95
1655	1.90
1665	1.80
1904	14.80
1960	.70
2050	1.70
2051	1.10
5516	7.70
5518	514.59
5549	362.60
5550	39.50
5551	62.50
5552	94.50
5553	251.70
5554	180.55
5555	351.50
5557	4.90
5558	6.75
5559	19.15
5560	25.01
5561	24.60
5581	2.00
5582	2.63
5583	2.90
5584	3.89
5588	117.68
5592	1204.40
5593	85.72
5604	513.05
5610	2.10
5611	115.09
5619	370.50
5621	13.20
5622	12.23
5623	13.25
5624	13.23
5626	22.03
5627	26.45
5628	25.46
5629	20.48
5651	2.78
5654	2.95
5663	1.86
5664	8.49
5665	50.00
5670	4.10
5671	1187.50
5674	85.75
5675	16.95
5683	8.49

Type No.	Price
5685	28.71
5686	3.68
5687	4.80
5691	8.55
5692	8.55
5693	6.95
5696	1.87
5713	173.48
5718	8.33
5719	8.33
5720	20.70
5725	4.16
5726	1.72
5727	3.43
5734	17.63
5736	152.00
5740	73.50
5741	83.30
5742	14.21
5743	13.72
5749	1.96
5750	2.45
5751	3.43
5763	1.72
5770	975.10
5771	532.14
5779	78.40
5786	76.44
5794	16.43
5796	13.06
5814	3.43
5822	135.85
5826	1274.00
5830	122.50
5840	10.54
5846	123.50
5855	75.46
5876	18.38
5879	1.72
5890	25.48
5893	19.50
5896	7.10
5899	10.53
5902	10.78
5915	1.18
5934	13.50
5936	1045.00
5939WA	43.20
5974	209.00
6005	3.68
6012	4.41
6026	2.89
6072	5.39
6082	5.19
6135	2.69
6136	3.19
6137	2.45
6159	4.80

Type No.	Price
6201	5.39
UX6653	.65
7193	.45
8003	12.60
8011	.87
8012	2.60
8013	2.75
8013A	4.90
8014A	55.00
8016	1.05
8020	1.25
8025	6.95
8025A	4.75
9001	1.50
9002	.95
9003	1.50
9004	.45
9005	1.95
9006	.35
189048	3.79
189049	3.79
199698	2.69

Crystal Diodes

Type No.	Price
1N21	$1.19
1N21A	1.69
1N21B	3.00
1N22	1.25
1N23	1.95
1N23A	2.75
1N23B	3.45
1N27	1.79
1N31	7.90
1N34	.66
1N34A	.90
1N38	1.50
1N39	6.10
1N40	8.50
1N41	9.85
1N42	18.00
1N43	1.45
1N45	.94
1N52	1.05
1N55	3.05
1N60	.55

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Amertran—Type RH—Input 115V 400 cycles. Output—75-120V 6 Amp....$6.95 ea.
Amertan—29144—Input 115V 60 cy 1 ϕ. Output—103-126V 2.17 Amp....$8.25 ea.
Powerstat-Superior 1226—Input 115/230 VAC 50/60 cy.—Output 0-270V 9 Amp 2.4 KVA....$37.00 ea.

TRANSFORMERS

Westinghouse—Hipersil—Pri—115V 60 cy.—3/4 KVA—Sec #1—240V @ 1.56A.; Sec #2—240V @ 1.56 A....$18.75
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Constant Volt. Transformer—Sola 30807—Input 95-125 VAC 60 cy. Output 115 VAC 250 VA....$49.00

TYPE "J" POTENTIOMETERS $1.25 ea.

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	1/2"
500	SS	10K	1/2"	250K	SS
500	1/2"	15K	SS	250K	3/4"
500	5/8"	15K	1/2"	250K	3/8"
650	1/2"	20K	SS	500K	SS
1K	SS	25K	SS	500K	1/4"
1K	1/2"	30K	1 1/8"	500K	7/16"
2K	3/8"	40K	SS	1 Meg	SS
2500	SS	50K	SS	2.5 Meg	SS
4K	SS	50K	1/4"	5 Meg	SS
5K	SS				

DUAL "J" POTS—$2.95 ea.

50 SS	500 SS	10K SS	2.5 meg SS
50 1 1/8"	1K SS	220 K 1/2"	5 meg SS
100 SS	2500 SS	1 meg SS	1K/25K 3/8"

TRIPLE "JJJ" POTS—$3.95 ea.

100K/100K/100 K 3/8" 2 / 150K/15K 3/8"

2 ϕ LOW INERTIA SERVO MOTORS

Diehl FPE-25-11—75V 60 cy. .11 Amp 4 Watts. Each....$34.50
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....$14.50
PIONEER—CK 13 115 volt 400 cycle—includes damping signal generator (autosyn)....$47.50

TACHOMETER GENERATOR

Elinco type PM-1M.
DC Tachometer
Generator-New.... **$27.50**

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ARMY ORDNANCE—NAVY ORDNANCE—COMMERCIAL

AY-101D	5D	6DG	X	2JD5E1	C-78248
1CT	5DG	6G	2J1F1	C-44968-6	C-78249
1DG	5F	7DG	2J1G1	C-56701	C-78254
1F	5G	7G	2J1H1	C-56776-1	C-78410
1G	5N	A	2J1M1	C-69405-2	C-78411
1HG	5SF	B	2J5A2	C-69406	C-78414
1SF	5SG	M	2J5D1	C-69406-1	C-78415
5B	6CT	N	2J5HA1	C-77610	C-78670
5CT			2JD5A2		C-79331

SYNCHRO CAPACITORS
SYNCHRO BLOWN FUSE INDICATORS
SYNCHRO OVERLOAD INDICATORS

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GENERATORS AND INVERTERS

Pioneer 12133-1A Inverter—28VDC to 115VAC 400 cy 3 ϕ 250 VA 0.8PF-Volt. and Freq. Regulated. ea. $225.00
Pioneer 12137-1A Inverter—24VDC to 115VAC 400 cy 3 ϕ 250VA—Volt. and Freq. Regulated. ea. $225.00
Pioneer type 716-3A (Navy Model NEA-3A) Output-AC 115V 10.4A 800 to 1400 cy. 1ϕ: DC 30 Volts 60 Amps. Brand new....$38.50
Pioneer type 1235-3A. Output-30 Volts DC 15 Amps. Brand New—Original Packing....$15.50
PE-109D Inverter—13.5 VDC to 115 VAC 400 cy. 175 VA 1ϕ (new)....$79.50
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
Pioneer type 12121-1A Inverter—Voltage and frequency regulated—24VDC 18 Amp input—AC output 115V 3ϕ 400 cy 250 VA 0.7 PF—(new) $225.00
Pioneer type 12116 Inverter—28 VDC to 115 VAC 400 cy 1 ϕ 50 VA....ea. $79.50
Pioneer type 12117 Inverter—28 VDC to 26 VAC 400 cy 1ϕ 6 VA....ea. $33.50
Leland 10563 Inverter—28 VDC to 115 VAC 400 cy. 3ϕ 115 VA....ea. $75.00

CERAMIC-CASED TYPE G MICA CONDENSERS

.09 MFD 1500 VDC G1....ea. $9.25
.02 MFD 3000 VDC G1....ea. 9.25
.004 MFD 6000 VDC G1....ea. 18.10
.00015 MFD 20000 VDC G3....ea. 24.50

GAMMA RADIATION SURVEY METER

Victoreen Model 247A—Range 0-2.5/25/250/2500 milli-roentgens Per hour

NEW $179.50

A.C. MOTORS

HAYOON SYNCHRONOUS TIMING MOTOR—110V 60 cy. - 2.2W - 4 RPM....EA. $2.29
AC/DC BRUSH TYPE SERIES MOTOR — 110V AC/DC - 0.3 Amp. 1/20 HP - speed 5000 RPM Rated - suitable for sewing machine, hi speed grinder, etc. - Dim. 2 3/4" dia. x 3 1/4" lg. Shaft 1/4" dia. x 3/8" lg....EA. $2.95
SIGNAL ELECTRIC TYPE V512 Blower Motor - 115V - 60 cy. - 0.7 Amps. - Dim. 3" dia. x 3 1/4" lg....EA. $4.75
EAD TYPE J71-11 CAPACITOR INDUCTION MOTOR — 115V - 1 ph. - 60 cy. - 0.6 Amp. - MFD Capacitor - Dim. 3 1/4" dia. x 3 1/8" lg. 3200 RPM - 1/75 HP - intermed. duty - uses 5 EA. $28.50
EAD TYPE LH711 NCJ-2 SYNCHRONOUS HYSTERESIS MOTOR — 115V - 1 ph. - 60 cy. - 1.0 Amp. - 1800 RPM - 1/50 HP - Cont. Duty - Uses 4 MFD. Capacitor - Dim. 3 7/8" dia. x 4 3/8" lg....EA. $37.50
BARBER-COLMAN PYAZ 4278 SPEED REDUCER MOTOR — 115V - 60 cy. - 31W - Gear Ratio 100:1 - 2 RPM - stall torque - 65 lb.-in. EA. $19.50
G.E.-MODEL 5SMY54H16 SYNCHRONOUS INDUCTOR MOTOR — 110V - 60 cy. - .36 Amp. - 75 RPM - 75 oz.-in. torque. Dim 4" dia. x 5 3/4" lg. - shaft 3/8" dia. x 1 1/8" lg....EA. $22.50
HOLTZER-CABOT RBT-2505 AC Induction Motor - 115V - 60 cy. 3 ph. - 1725 RPM - 9W - Torque 2.5 in.-oz....EA. $5.25
DIEHL C78291-FP-83-3.1 or DIEHL C78318-FP-83-12 AC MOTOR — 115V - 60 cy. - 3450 RPM - .22 Amp.; 50V - 50 cy. - 2850 RPM - .48 Amp. - 1/40 HP - 3 ph. cont. duty - Dim. 4" dia. x 4 1/2" lg....EA. $4.25

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(Approx. size overall . . . 3¾" x 1¼" diameter)
DELCO TYPE #5069600: 27.5 volts DC; 250 RPM **$19.95**

PM Motor, Delco Type #5069371; 27.5 volt; DC Alnicò Field; 10,000 r.p.m.; dimensions 1" x 1" x 2" long; shaft extension ½", diameter 0.125" **$15.00**

PIONEER GYRO FLUX GATE AMPLIFIER

Type 12076-1-A, complete with tubes **$27.50 ea.**

AC CONTROL MOTOR

A. C. SYNCHRONOUS MOTOR Type RBC 2505; Volts 115; Cycles 60; RPM 60; Mfg. HOLTZER CABOT ELECT. Approx. size: 2⅝" x 2⅝" x 2⅝"..............**$15.00 ea.**

400 CYCLE MOTORS

BENDIX-PIONEER, Type CK1000-1-A; 400 cycle **$35.00**
PIONEER: TYPE CK5 2 Phase; 400 cycles **$35.00 ea.**
EASTERN AIR DEVICES TYPE J49A: 115 V; 0.1A; 7000 r.p.m. Single phase 400 cycle ....**$17.50 ea.**
AIRESEARCH: 115V; 400 CPS; Single phase 6500 RPM; 1.4 amp; Torque 4.6 in. oz.; HP .03..................**$10.00 ea.**
EASTERN AIR DEVICES TYPE JM6B: 200 VAC; 1 amp; 3 phase; 400 cycles, 6000 RPM ....**$12.50 ea.**
EASTERN AIR DEVICES, TYPE J31B: 115 V. 400-1200 Cycle. Single Phase **$12.50 ea.**
AIRESEARCH: AC Induction, 200 V; 3 Phase, 400 Cycle, 2 H.P.; 11,000 RPM; 8 amps. ....**$79.50 ea.**
AIRESEARCH: AC Induction, 200 V; 3 Phase, 400 Cycle, .12 H.P., 6500 RPM; 1.5 amps. **$25.00**
Electric Motor: PNT—1400—A1—IA Serial No. 207, 208 V., 400 cycles, 3 phase Kearfott Co., Inc. ....**$17.50 ea.**

SERVO MOTOR 10047-2-A; 2 Phase; 400 Cycle, with 40-1 Reduction Gear

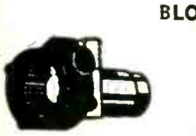
SMALL DC MOTORS

DELCO #5072000: 27.5 VDC; 11.75 rpm **$15.00**
DELCO #5068750: constant speed; 27 VDC; 160 RPM; built-in reduction gears and governor ....**$17.50 ea.**
J. OSTER: series reversible motor; 1/50th H.P.; 10,000 RPM; 27½ VDC; 2 amps; **SPERRY #806069;** approx. size 1⅝" x 3½" **$7.50 ea.**
(Approx. size....4" long x 1¼" dial.)
General Electric Type 5AB10AJ37; 27 volts, DC; .5 amps. 8 oz. inches torque; 250 RPM, shunt wound; 4 leads; reversible.**$15.00 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 **$15.00 ea.**
GENERAL ELECTRIC DC MOTOR Mod. 5BA10AJ64. 160 r.m.p.; 65 amp; 12 oz.-in. torque; 27V DC................**$19.95 ea.**

REVERSIBLE MOTOR

U.S.N. No. 451-1314 . . . Rotational Speed 2.3 RPM. A lightweight unit suitable for all types of rotation application. Excellent for rotating light beams, antennas or anywhere a low RPM high torque motor is needed. Output torque approx. 100 lbs. Consists of high speed series reversible motor. Requires 24 VDC or 24-40 VAC @ 1 amp. Overall size 6"L x 4"W x 4½" dp. Shipping wt. 6 lbs. USED,GOOD...**$11.95**

BLOWER



Eastern Air Devices, Type J31B; 115 volt; 400-1200 cycle; single phase; variable frequency; continuous duty; L & R #2 blower; approx. 22 cu. ft./min. **$15.00**

BLOWER ASSEMBLY

115 Volt, 400 Cycle, Westinghouse Type FL, 17CFM, complete with capacitor. New ....**$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.**

INVERTERS

10563 LELAND ELECTRIC

Output: 115 VAC; 400 cycle; 3-phase; 115 VA; 75 PF. **Input:** 28.5 VDC; 12 amp. ....**$69.50 ea.**

PE 218 LELAND ELECTRIC

Output: 115 VAC; Single Phase; PF 90; 380/500 cycle 1500 VA. **Input:** 25-28 VDC; 92 amps; 8000 RPM; Exc. Volts 27.5 **BRAND NEW** ....**$39.95 ea.**

PE 109 LELAND ELECTRIC

Output: 115 VAC, 400 cyc.; single phase; 1.53 amp.; 8000 RPM; **Input:** 13.5 VDC; 29 amp. **$69.50**

MG-0-75 ONAN

Navy Type PU/11 . . . **Output:** 115 VAC; 480 cyc.; single phase; 5.3 amp and 26 VDC @ 3.8 amp. **Input:** 115/230 VAC; 60 **cyc.;** single phase **$225.00**

MG 153 HOLTZER-CABOT

Input: 24 V, DC, 52 amps; **Output:** 115 volts—400 cycles, 3-phase, 750 VA. and 26 Volt—400 cycle, 250 VA. Voltage and frequency regulated ....**$95.00 ea.**

PIONEER 12130-3-B

Output: 125.5 VAC; 1.15 amps, 400 cycle single phase, 141 VA. **Input:** 20-30 VDC, 18-12 amps. Voltage and frequency regulated ....**$89.50 ea.**

12116-2-A PIONEER

Output: 115 VAC; 400 cyc; single phase; 45 amp. **Input:** 24 VDC 5 amp....**$90.00 ea.**

10285 LELAND ELECTRIC

Output: 115 Volts AC, 750 V.A., 3 phase, 400 cycle, .90 PF, and 26 volts, 50 amps, single phase, 400 cycle, .40 PF. **Input:** 27.5 VDC, 60 amps. cont. duty, 6000 RPM. Voltage and Frequency regulated...**$195.00**

10486 LELAND ELECTRIC

Output: 115 VAC; 400 Cycle; 3-phase; 175 VA; .80 PF. **Input:** 27.5 DC; 12.5 amp; **Cont.** Duty ....**$90.00 ea.**

PIONEER 10042-1-A

DC INPUT 14 Volts; **OUTPUT** 110 Volts; 400 Cycle 1-Phase; 50 Watt............**$90.00**

94-32270-A LELAND ELECTRIC

Output: 115 Volts; 190 VA; Single Phase; 400 Cycle; .90 PF. and 26 Volts; 60 VA; 400 Cycle; .40 PF. **Input:** 27.5 Volts DC; 18 amps; cont. duty, voltage and freq. regulated **$95.00**

115 VOLT GENERATORS

Brand new Eclipse generators: 115 VAC; 9.4 amp; 1000 watts; single phase; 800 cycles, 2400-4200 rpm. DC output is 30 volts at 25 amp. Unit has spline drive shaft and is self-excited **$29.95**

MICROPOSITIONER

Barber Colman AYLZ 2133-1 Polarized D.C. Relay: Double Coil Differential sensitive, Alnico P. M. Polarized field. 24V contacts; .5 amps; 28 V. Used for remote positioning, synchronizing, control, etc.......**$12.50 ea.**

TRANSFORMERS

SOLA TRANSFORMER, #30663; 1 KVA; 210-270 Volts; 240 Sec.; 3-Phase....**$100.00**
FILAMENT, Gen. Elec. #7455321: Primary 110/125 Volts. Secondary 11 Volts 65 Amps. 975 KVA. Shipping wt. approx. 60 pounds. **$24.95**
FILAMENT. AMERTRAN #29048: Primary 115 Volts, 50/60 cycle. Secondary 5 volts, 190 amp. Shipping weight approx. 75 lbs. **$36.50**
VARIABLE, AMERTRAN #29144: 250 VA, 103-126 commutator range, fixed windings, 115 volts, max. 2.17 amps..............**$19.95**

BROWN CONVERTER, CHOPPER

Type CARL 20380; 50/60 Cycle . . . for use with Brown Recorders. Special......**$19.95**

Immediate Delivery

ALL EQUIPMENT FULLY GUARANTEED

All prices net FOB Pasadena, Calif.

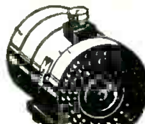
TACHOMETER INDICATOR

SINGLE

Sensitive Type, Kollsman Mark V; Range 0-3500 RPM in 3½ revolutions of the indicating pointer.**$9.95 ea.**

Tachometer Indicator and Generator (above) ....**Both $33.50**
TACHOMETER GENERATOR (MARK V) **$25.50 ea.**

G. E. GENERATORS



General Electric Type 5ASB-31JJ3; 400 cycles out at 115 volts; 7.2 amps; 8,000 rpm.; size 6" long x 6" dia. **$99.50 ea.**

SINE-COSINE GENERATORS

(Resolvers)

Diehl Type FJE43-9 (Single Phase Rotor). Two stator windings 90° apart, provides two outputs equal to the sine and cosine of the angular rotor displacement. Input voltage 115 volts, 400 cycle.........**$30.00 ea.**
Diehl Type FPE-43-1 same as FJE-43-9 except it supplies maximum stator voltage of 220 volts with 115 volts applied to rotor ....**$25.00 ea.**
Arma Resolver Type 213014; equal in size to size 5 synchro; 55-60 cycle; single phase primary, 2 phase secondary..........**$79.50**

VOLTAGE GENERATORS (RATE)

ALNICO MIDGET D.C. VOLTAGE GENERATOR Type B-35-D..................**$17.50**
ALNICO MIDGET D.C. VOLTAGE GENERATOR Type B-44-D..................**$17.50**
A.C. GENERATOR: 67 V., 20 Cyc., 2-Phase, .015 Amps, Type PM-1, 1200 R.P.M...**$15.00**

SYNCHRONOUS SELSYNS

110 volt, 60 cycle, brass cased, approx. 4" dia. x 6" long. Mfg. by Diehl and Bendix.

Quantities Available.
REPEATERS ....**$20.00 ea.**
TRANSMITTERS ....**$20.00 ea.**

SYNCHROS

AUTOSYN MTR, KOLLSMAN Type #403; 32 VAC; 60 cycle; single phase......**$22.50**
AUTOSYN MTR., BENDIX Type #851; 32 VAC; 60 cycle; single phase.........**$22.50**
SYNCHRO TRANSMITTER, KEARFOTT Type R-212-1A-A Rotor: 26 Volts; single phase; Stator: 11.8 Volts; 3 phase; 400 cycle **$25.00**
MICROSYN UNIT, Type 1C-006-A....**$35.00**
IF Special Repeater (115V-400 Cycle) **$15.00 ea.**
2JIF 3 Generator (115-400 cyc.)..**$10.00 ea.**
5CT Control Transformer; 90-50 Volt; 60 Cy. ....**$50.00 ea.**
5F Motor (115/90volt—60 cyc.)..**$60.00 ea.**
5G Generator (115/90 volt—60 cyc.) **$50.00 ea.**
5/DG Differential Generator (90-94 volts —400 cyc.) ....**$30.00 ea.**
TRANSMITTER, BENDIX C-78248; 115 Volt, 60 Cycle......................**$25.00 ea.**
Differential—C-78249; 115 Volt; 60 Cycle **$5.00**
REPEATER, BENDIX C-78410; 115 Volt, 60 Cycle ....**$37.50 ea.**
REPEATER, AC synchronous 115 V., 60 cycle, C-78863 ....**$15.00 ea.**
REPEATER, DIEHL MFG. No. FJE 22-2; 115 Volt; 400 Cycle; Secondary 90 Volt **$27.50**
7G Synchro Generator (115/90 volt; 60 cycle) **$75.00**
6G Synchro Generator (115/90 volt; 60 cycle) **$60.00**
6DG Synchro Differential Generator (90/90 volt; 60 cycle)......................**$60.00**
2JF5J Selsyn Control Transformer: 105-55 Volts; 60 Cycle......................**$50.00**
5JD5HA1 Selsyn Generator: 115-105 Volts; 60 cycle **$50.00**
2JIF1 GENERATOR: 115—57.5 Volt; 400 cycle ....**$12.50 ea.**
2J1H1 DIFFERENTIAL GENERATOR: 57.5 —57.5 Volt; 400 cycle..............**$12.50 ea.**
2J1G1 CONTROL TRANSFORMER: 57.5—57.5 Volt; 400 cycle..................**$7.50 ea.**

PIONEER AUTOSYNS

AY-1........26 Volt—400 Cycle.......**$6.95**
AY-5........26 Volt—400 Cycle.......**$7.95**
AY27D **$12.50**
AY6—26 Volt—400 cyc..............**$4.95 ea.**
AY30D—26 Volt—400 cyc.........**$25.00 ea.**
AY14D **$10.00**
AY34 ....**$20.00**
AY20—26 Volt—400 cyc..........**$12.50 ea.**

PIONEER TORQUE UNITS

TYPE 12625-7-A; 400 Cycles, 26 Volts **$95.00**
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 12602-1-A: Same as 12606-1-A except it has a 30:1 ratio between output shaft and follow-up Autosyn...........**$70.00 ea.**
TYPE 12602-1-A: Same as 12606-1A except it has base mounting type cover for motor and gear train............**$70.00 ea.**

C and H Sales Company

BOX 356-X EAST PASADENA STATION • PASADENA 8, CALIFORNIA

Reliance Specials

GEAR ASSORTMENT

100 small assorted gears. Most are stainless or brass. Experimenter's dream! .... Only $6.50

HAYDON TIMING MOTOR

1 R.P.M., 115 V., 60 Cycle...$1.95

TIMING MOTOR

8 RPM 115 V 60 cyc
E. Ingraham Co.

$1.79

400 CYCLE INVERTERS

Leland Electric Co.

#10800 in: 20-28 V.D.C., 92 A. 8000 R.P.M. Out: 115V. 400 Cyc. 1 phase, 1500 V.A. 90 PF.............. $29.50

3 AG FUSES

Amp.	Per 100	Amp.	Per 100	Amp.	Per 100
1/8	$4.00	3/4	$4.00	8	$3.00
3/8	4.00	1	3.00	10	3.00
1/2	4.00	4	3.00	15	3.00
		5	3.00		

3 AG FUSE HOLDERS (Finger) 25¢

RESISTORS

Type EB	½W	10%	6¢ ea.	$4.00 per C
EB	½W	5%	12¢ ea.	8.00 per C
Type GB	1W	10%	9¢ ea.	7.00 per C
GB	1W	5%	18¢ ea.	14.00 per C
Type HB	2W	10%	12¢ ea.	9.00 per C
HB	2W	5%	24¢ ea.	18.00 per C

AVAILABLE IN ALL STANDARD RMA VALUES

RAYTHEON PLATE TRANSFORMER

TYPE U8355A

PRI. 110V/220V/440V/60 cy.
SEC. #1 300V @ 4 AMPS
SEC. #2 300V @ 4 AMPS
1780 RMS TEST
9¾" x 9½" x 8½" HIGH.................. $19.95

Brand New Meters—Guaranteed

0-10 ma. D.C. 3½"..$3.95 0-80 Amp. D.C. 2½"..$2.50
0-1 Ma D.C. 3½" DeJur..(Scale Reads 0-4 KV)..$5.75

SELENIUM RECTIFIERS

Full Wave 200 MA 115V.............................. $1.70
Half Wave 100 Ma 115V..............................91

TS-10 SOUND POWERED HANDSET

Used, Excellent Condition

INCLUDES 6 FT CORD & CLAMPS — USES NO BATTERIES OR EXTERNAL POWER SOURCE .... $18.95 PAIR

Dynamotor DM 33A............................ $3.95 ea.

Rheostat 8 ohm 50 W S.S. shaft.................. 98¢

Power Tap Switch—OHMITE (#312-5 Taps) nonshorting 25A 150 V. A.C. $3.95

Timer—Industrial Timer Corp. 15 min. on 15 min. off continuous 115 V. A.C. Fully cased Plugs into octal socket $5.50

BC 221 FREQUENCY METER.................. $80.00

Sound Powered Chest Set RCA— With 24 Ft. Cord
Per Pair
USED $17.60
NEW $26.40

POSTAGE STAMP MICAS

AVAILABLE IN ALL STANDARD RMA VALUES

PRICE SCHEDULE

5 mmf to 910 mmf..................... 5¢
.001 to .0013 mfd..................... 8¢
.0015 to .0056 mfd..................... 15¢
.0062 to .0091 mfd..................... 20¢
.01 mfd..................... 28¢

SILVER MICA

mmf	mmf	mmf	mmf	mmf	mmf	mfd	mfd	mfd
10	50	100	170	360	510	.001	.0024	.0047
18	51	110	180	370	525	.0011	.0025	.005
22	56	115	208	390	560	.0013	.0027	.0051
23	60	120	225	400	570	.0015	.0028	.0056
24	62	125	240	410	680	.0016	.003	.006
25	66	130	250	430	700	.0018	.0033	.0068
27	68	135	255	470	800	.0022	.0039	.0082
30	75	150	260	488	900	.0023	.004	.01
40	82	155	270	500				

Price Schedule

10 mmf to 700 mfd..................... 10c
.0011 mfd to .002 mfd..................... 20c
.0022 mfd to .0082 mfd..................... 50c
.01 mfd..................... 95c

PULSE TRANSFORMERS

UTAH—9262 9278 9289 9318 9340 9350
WESTERN ELECTRIC—D166173 D161310
KS8696, KS9800, KS9862, KS13161
GENERAL ELECTRIC—80-G-5
JEFFERSON ELECTRIC—C-12A-1318
DINION COIL—TR1048 TR1049
also 352-7250-2A; 352-7251-2A; T-1229621-60

AN CONNECTORS

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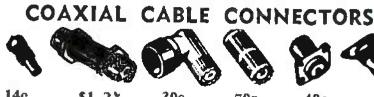
COAXIAL CABLE CONNECTORS



14c	$1.2	30c	70c	40c	12c
UG175/U	83-1F	83-1AP	83-1J	SO-239	HOOD

83-1AC	$0.42	PL-274	$1.10	UG-88/U	.90
83-1AP	.30	PL-275	2.10	UG-89/U	1.10
83-1BC	.35	SO-239	.40	UG-102/U	.80
83-1F	1.10	UG-13/U	1.70	UG-103/U	.68
83-1H	.12	UG-18B/U	1.05	UG-104/U	1.40
83-1HP	.22	UG-20B/U	1.60	UG-105/U	1.50
83-1J	.73	UG-21/U	.85	UG-106/U	.15
83-1R	.40	UG-21B/U	1.00	UG-107B/U	2.75
83-1RTY	.65	UG-21C/U	1.05	UG-146/U	2.00
83-1SP	.45	UG-21D/U	1.45	UG-167/U	3.75
83-1SPN	.50	UG-22/U	1.30	UG-175/U	.12
83-1T	1.30	UG-22A/U	1.60	UG-176/U	.12
83-2AP	1.95	UG-22B/U	1.20	UG-185/U	.95
83-2J	2.10	UG-23/U	1.20	UG-196/U	1.65
83-2R	1.65	UG-23B/U	1.50	UG-203/U	.65
83-22AP	1.40	UG-23C/U	1.10	UG-224/U	1.15
83-22F	2.10	UG-24/U	1.30	UG-255/U	1.95
83-22J	1.40	UG-27/U	1.25	UG-260/U	.85
83-22R	.68	UG-27A/U	2.25	UG-261/U	1.10
83-22SP	.80	UG-27B/U	2.95	UG-262/U	1.10
83-22T	1.95	UG-28A/U	2.95	UG-273/U	1.45
83-168	.12	UG-29B/U	1.75	UG-274/U	2.30
83-185	.12	UG-30/U	2.30	UG-290/U	.90
CW-123A/U	.45	UG-57B/U	1.85	UG-291/U	.95
M-358	1.30	UG-58/U	.70	UG-306/U	2.65
M-359	.30	UG-58A/U	.90	UG-414/U	1.95
M-359A	.65	UG-59A/U	1.90	UG-499/U	1.25
PL-258	.75	UG-83/U	1.75	UG-625/U	1.35
PL-259	.45	UG-85/U	1.65		
PL-259A	.50	UG-87/U	$1.40		

NEW COAXIAL CABLES

	Price per 1000 ft.		Price per 1000 ft.
RG 5/U*	$140.00	RG 22/U*	$150.00
RG 6/U	180.00	RG 22A/U	285.00
RG 7/U*	85.00	RG 24/U	675.00
RG 8/U*	100.00	RG 26/U	475.00
RG 9/U*	250.00	RG 29/U*	50.00
RG 9A/U	275.00	RG 34/U*	300.00
RG 10/U	240.00	RG 35/U	900.00
RG 11/U*	100.00	RG 41/U*	295.00
RG 11A/U*	150.00	RG 54A/U	97.00
RG 12/U	240.00	RG 55/U*	110.00
RG 13/U*	216.00	RG 57/U*	325.00
RG 17/U	650.00	RG 58/U*	60.00
RG 18/U	900.00	RG 58A/U*	70.00
RG 19/U	1250.00	RG 59/U*	55.00
RG 20/U	1450.00	RG 62/U*	75.00
RG 21/U*	220.00	RG 77/U*	100.00

Add 25% for orders less than 500 feet.
* No minimum order—other 250 minimum.

UNIVERSAL JOINT ALUMINUM

Includes Two 6-32 Set Screw Holes
¼" hole x ½" O.D.
1⅛" long
85¢

TYPE "J" POTENTIOMETERS

100	S.S.*	1,500	1/4S.S.	15K	1/4	200K	S.S.*
150	S.S.	2,000	1/4	25K	S.S.	250K	5/8
300	S.S.*	2,500	S.S.	70K	S.S.	250K	S.S.*
400	S.S.	3,000	3/8	80K	S.S.	500K	S.S.*
500	S.S.	4,000	3/8	100K	7/16	1 Meg	S.S.
1,000	3/8	5,000	3/4*	100K	S.S.*		
1,000	S.S.	10K	5/8	200K	5/8		

*Split Locking Bushing **$1.25 EACH**

TYPE "JJ" POTENTIOMETERS

Ohms	Shaft	Ohms	Shaft	Ohms	Shaft
1000	S.S.	30K-10K	3/8"†	1 Meg.	1/2"
10K	5/16"	3K-90K	1/4"	1 Meg.	S.S.
15K	S.S.			1 Meg.	S.S.

SD—Screw Driver
*—Split Locking Bushing
†—With Switch

PRICE—$2.50 EACH

JONES BARRIER STRIPS

2—140Y	$0.17	3—141W	$0.27	8—141¾W	$0.64
3—140¾W	.21	4—141	.24	9—141	.48
6—140	.28	5—141	.29	9—141Y	.71
10—140W	.59	5—141¾W	.41	3—142	.24
10—140¾W	.59	7—141¾W	.56	2—150	.43
3—141¾W	.27	8—141	.44	3—150	.60

TIME DELAY RELAY

Raytheon CPX 24166
1 Min. Delay. 115 V., 60 Cycle

2½ second recycling time spring return • Microswitch contact, 10A • Holds ON as long as power is supplied • Fully Cased • ONLY $6.50

TELEPHONE FIELD WIRE

W-110-B

½ MILE COIL.... $7.95
1 MILE REEL.... $14.95

PRECISION RESISTORS—¼ WATT—30¢

2	11	13.52	62.54	125	301.8	2,193
3.5	11.25	13.89	79.81	147.5	366.6	3,500
6.68	11.74	14.98	105.8	147.8	414.3	8,000
10.48	12.32	15.8	123.8	220.4	705	59,148
10.84	13.02	16.37				

PRECISION RESISTORS—½ WATT—35¢

.25	13.3	125	1,500	6,500	16,000	36,000
.334	25	130	2,200	6,650	16,700	37,000
.502	30	180	2,230	7,000	17,000	45,000
.557	46	210	2,250	7,300	20,000	46,000
.627	50	235	2,500	7,500	20,150	47,000
.76	52	260	2,850	8,000	25,000	50,000
1	55.1	270	3,427	8,500	26,500	54,500
1.01	65	298.3	4,000	8,800	30,000	59,000
1.53	66.6	400	4.285	10,000	32,700	68,000
2.04	75	723	4,300	12,000	32,888	79,012
5.26	87	750	4,451	14,825	33,000	80,000
11.1	97.8	855	5,000	15,000	33,300	100,000
13.15	97.85	970	5,900	15,750	35,888	

PRECISION RESISTORS—1 WATT—45¢

.2	4.3	13.52	38	2,200	10,000	55,000
.861	4.35	14	54.26	3,300	12,000	56,000
1.01	5.1	15	250	5,000	17,300	65,000
2.55	5.21	20	270	7,000	20,000	68,000
2.58	12	22	420	8,250	50,000	84,000
3.39	13.333	28	425	9,000		

PRECISION RESISTORS—1 WATT—60¢

100,000	130,000	260,000	348,000	590,000
105,000	132,000	270,000	500,000	600,000
120,000	150,000	296,000	520,000	645,000
128,000	240,000	320,000	522,000	700,000

PRECISION RESISTORS—2 WATT—75¢

4,385	6,000	10,000	19,977	23,000
5,000				

1 MEGOHM 1 WATT 1% $1.50

DIFFERENTIAL

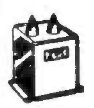
115 V., 60 Cycle #C78249

Used $4.95
New $9.95

3⅜" dia. x 5⅝" long
Used between two C78248's as a dampener. Can be converted to 3600 RPM Motor in 10 minutes. Conversion sheet supplied. (Converted)......... $5.50
Mounting Brackets—Bakelite for selsyns, and differentials shown above................. 35¢ pair

OIL FILLED CONDENSERS

MFD	V.D.C.	Price	MFD	V.D.C.	Price
6	400	$0.85	1	3,600	$3.95
3 x 3	400	1.00	3 x .2	4,000	2.50
4	500	.85	2	4,000	7.95
4-4	500	1.30	3	4,000	10.95
8	500	1.35	.01	5,000	.95
1	600	.45	.01-.03	6,000	1.40
.5-.5	600	.40	.03-.03	6,000	1.50
2	600	.80	1	6,000	9.95
4	600	1.63	.02-.02	7,000	1.55
8	600	2.05	.02-.03	7,000	1.60
10	600	2.95	.1	7,000	1.95
4 x 3	600	1.75	.1-.1	7,000	2.25
8-8	600	1.79	.1	7,500	2.25
1	800	.60	.3-.3	7,500	4.50
1	1,000	.75	.075-.075	8,000	1.85
2	1,000	.95	.15-.15	8,000	2.95
3	1,000	1.70	.25	20,000	19.95
6	1,000	2.75			
8	1,000	3.25			
1	1,500	1.45			
.02	2,000	.65			
.1-.1	2,000	1.30			
.1-.5	2,000	1.65			
3	2,000	3.75			
8	2,000	7.95			
.25	3,000	2.25			



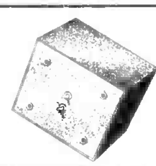
1 mfd
6,000
V.D.C.
G.E.
$9.95

OIL FILLED AC CONDENSERS

MFD	V.A.C.	Price	MFD	V.A.C.	Price
.2	750	$0.69	15	440	$6.25
8	660	7.50	4.4	375	2.15
6	660	5.95	25	330	7.50
5	660	5.45	20	330	6.75
4	660	4.95	4	330	2.25
3	660	4.45	3	330	1.45
2.9	660	4.35	1.75	330	.85
2	660	3.95	20	220	4.95
1	660	2.95	7.5	220	2.00

IN34 Crystal Diode..79¢ IN43A (WE400A) $2.25

Choke
10 hy
400 MA
90 OHMS
HERMETICALLY SEALED



$4.88

2J1G1 SELSYNS $8.50

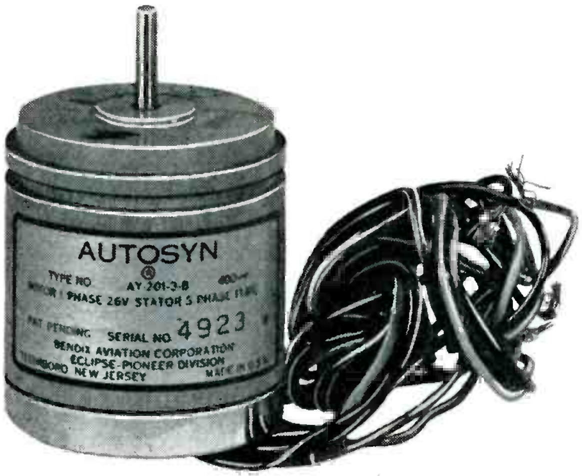
400 CYCLE BRAND NEW

Minimum Orders $3 All orders f.o.b. PHILA., PA.

RELIANCE MERCHANDIZING CO.

Arch St., Cor. Croskey Phila. 3, Pa. Telephone Rittenhouse 6-4927

LOW PRICES • IMMEDIATE DELIVERY • FULLY GUARANTEED



PIONEER PRECISION AUTOSYNS

AY-101D—Transmitter or Control Transformer —$24.50

AY-131D—Differential—$27.50

AY-201-3-B—Transmitter or Control Transformer—$27.50

AY-231-3-B—Control Transformer—$34.50

New with minimum 5" lead length

DIEHL PM MOTOR
Type FD6-21. 27.5 volts d-c 10,000 rpm. May be used as rate generator.
Special at $8.75 each

B-64 D-C SERVO MOTOR
1/165 hp at 3100 rpm—Shuntwound with high impedance rotor for operation from "hard" or small thyratron tubes. Armature 80 volts, 20 ma. at no load. Field 200 ma. at 27.5 volts.
SA-211 . . . . $16.50

1/100 HP SHUNT MOTOR
Universal Electric—W.E. Type KS-5603-L02 27.5 volts at .6 amp. 4 lead reversible type motor. Speed approx. 6500 rpm.
SA-233 . . . . $6.75

400 CYCLE SERVO MOTOR
KEARFOTT TYPE R-108-2A
Two phase 115/115 volts, 400 cycles at 15-20 watts per phase. 2.4 in.-oz stall torque. 1.4 in.-oz at 6000 rpm. 10,000 rpm no load.
SA-413 . . . . $39.50

SELSYN-SPECIALS
General Electric 2J1F1—2J1G1—2J1F3 115 volt 400 cycle Selsyns in small size. Will operate from 30 volts 660 cycle. Army Type VII (C-78248) 115 volt, 60 cycle Synchro Generator—Similar to size 5G Army Type IX (C-78410) 115 volt, 60 cycle Synchro Repeater—Similar to size 5F. Send for special prices.

HIGH FREQUENCY MG SETS
Electric Specialty—Input 220 volts 3 phase 60 cycle. 10 hp motor at 3450 rpm. Output 220 volts, 2000 cycles at 21 amp., .8 p.f. Cont. duty.
Priced for quick sell-out $275.00

DELCO D-C SHUNT MOTOR
27.5 volts at 1.5 amp. 4 in. oz torque at 5400 rpm
SA-240 . . . . $9.75

PERMANENT MAGNET D-C MOTOR
John Oster 27.5 volts—10,000 rpm. As a rate generator—2 volts per 1000 rpm. Open construction.
SA-281 . . . . $6.75

D-C TO A-C ROTARY CONVERTER
Holtzer-Cabot. Input 220 volts d-c at 5 amp. Output 600 watt, 150 volts at 60 cycles.
SA-351 . . . . $29.50

DIEHL FD52-2 SHUNT MOTOR
27.5 volts d-c at 2 amp. 3000 rpm. Used by Sperry (No. 803010) as a "follow-up motor". 4 lead reversible.
SA-363 . . . . $4.75

1SF NAVY SYNCHRO
115 volts 400 cycle. May be used as transmitter or receiver. Will operate from 30 volts 60 cycle.
SA-29 . . . . $49.50 each

400 CYCLE INVERTERS
LELAND 10563
Input 28 volts d-c at 12 amp. Output 3 phase 115 volts at 115 va. Adjustable frequency and voltage. Weighs only 8.7 lbs.
SA-159 . . . . $79.50

G-E 5AS131NJ3
Input 24-28 volts at 100 amp. Delivers 1500 va of 115 volt 400 cycle power at 9 p.f.—Western Electric #KA-5601-L1. Weight 37.5 lbs.
SA-286 . . . . $19.50

PIONEER 12120-4-A
Input 115 volts d-c at 1.0 amp. Output 115 volts 400 cycles single phase. Adjustable frequency and voltage. Only 4000 rpm. (very quiet running).
SA-406 . . . . $119.50

E.A.D. J-49B MOTOR
115 volt 60 cycle induction motor. Rated 1/250 hp at 3000 rpm. 4 leads. Uses a 1 mfd. capacitor.
SA-238 . . . . $9.75

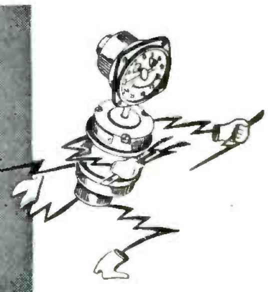
DELCO 5072520 GEARHEAD PM MOTOR
24-28 volts d-c. Output speed is 190 rpm. Output gear designed to fit sub-assembly.
SA-416 . . . . $17.50

WRITE FOR LISTING

Prices F.O.B. Hawthorne

Telephone: HAwthorne 7-3100

Servo-Tek PRODUCTS CO.
INCORPORATED



1086 GOFFLE ROAD
HAWTHORNE, N. J.
Cable Address: SERVOTEK
WUX Hawthorne, N. J.

COMMUNICATIONS EQUIPMENT CO.

HIGH-POWER GEAR

TRANSTAT:

Type TH45BG: Input 130/260V, 50-60 cy. 1 ph. Output Range: 0-260V, 45A. Max. 11.7 KVA two-unit bank, parallel connected. Completely enclosed in cabinet with handwheel atop. Brand New **$325.00**

CIRCUIT BREAKER:

ITE Model KJ. Will handle 600 VAC at 115A. Break time adjustable from instant. to 10 minute. Break amperes adjustable from 115A to 1000% overload. Brand New..... **$15.00**

ALTERNATOR:

Louis-Allis Co. Type "AL", 198-C: Output 110/220V —1 ph, 60 cy. .9 P.F. 1200 RPM, completely self-regulating with built-in exciter. Brand new, original crates....... **$795.00**

10 KW TRANSMITTER PARTS

1) Plate XFMR: Amertran 33134. Pri: 198/220/240V, 60 cy., 1 ph. Sec: 3650V. 16.7 KVA, 30 KV insulation. Oil Immersed.
1) Reactor, Modulation. Amertran 33153. 50 H @ 3.0 amps. DCR=80 ohms. Freq.—.03 cy. to 10 KC. Level: 63 DB. 40 KV Test. Impedance: 3000 ohms. A great value. Both units (Trans & Choke) for **$695.00**

P-4 SYNCHROSCOPE

For observing Magnetron or Radar Modulator Pulses, Waveforms, Transients, etc. Designed by the Radiation Laboratory, this versatile scope has the following specifications:
Writing Speed: .04/0.1666/0.5/2 inches/ USEC
Local Oscillator: 500/1000/2000/4000 PPS
Trigger Gen. Output: 135V positive
Tube Line-up: 1—5LP1/ 2—2X2/ 1—5Z3/ 1—6SK7/ 2—6SL7 6—6SN7/ 1—7V7
P-4 Synchroscope, used, A-1 cond.. **$125.00**

T-1 BOMBSIGHT PARTS

Main Servo Unit, Complete Mfr's. Pt. #1594486
Double Angle Servo Unit Assy. Pt. #1592448
Servo Motor Assy. Pt. #1590816
Write for prices

PULSE TRANSFORMERS

UTAH X-151T-1: Dual Transformer, 2 Wdgs. per section 1:1 Ratio per sec. 13 MH inductance 30 ohms DCR $7.50
UTAH X-150T-1: Two sections, 3 Wdgs. per section, 1:1:1 Ratio, 3 MH, 6 ohms DCR per Wdg....$7.50
68G711: Ratio: 4:1 6.7 Ohms, Pri: 0.23 Ohms sec.$4.50
TR1049: Ratio: 2:1 Pri. 220 MH, 50 Ohms, sec. 0.75H, DCR 100 Ohms........$6.75
K-901695-501: Ratio 1:1, Pri. Imp. 40 Ohm, Sec. Imp. 40 Ohms. Passes pulse 0.6 usec with 0.05 usec. rise $8.95
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 .25 usec. @ 600 PPS........$39.50
G.E. K2450A. Will receive 13KV, 4 micro-second pulse on pri. secondary delivers 14KV. Peak power out 100 KW G. E........$34.50
Ray UX 7896—Pulse Output Pri. 5v. sec. 41v....$7.50
Ray UX 8442—Pulse inversion—40v + 40v........$7.50
RAY UX361 ....$5.00
PHILCO 352-7250, 352-7251, 352-7287
RAYTHEON: UX8693, UX5986........$5 ea.
W.E.: D-166310, D-166638, KS 9800, KS9948.
UTAH # 9262, with Cracked Beads, but will operate at full rated capacity........$5.00
UX 8693 (SCS # 2Z9627-54): 3 Wdgs, 32 turns #18 wire. DCR is: .362/.372/.4 ohms. Total voltage 2500 vdc $5.00
D169271: Pulse input transformer. Response: 200—1mc Sec. Imp. ratios: 16.507/16.547/16.592 ohms. Turns ratio: 5.75/6.2/6.46........$27.50
D-166173: Input: 50 ohms Z. Output: 900 ohms. 3 Wdgs. Freq. range 10 kc-2mc. P/O AN/APQ*-13 $12.50

PULSE NETWORKS

15A—1-400-50: 15 KV, "A" CKT. 1 microsec. 400 PPS, 50 ohms imp........$37.50
G.E. #3E (3-84-810) 8-2.24-405) 50P4T; 3KV "E" CKT Dual Unit; Unit 1, 3 sections, 0.84 Microsec. 810 PPS, 50 ohms imp.; Unit 2, 8 Sections, 2.24 microsec. 405 PPS, 50 ohms imp........$6.50
7-5E3-1-200-67P. 7.5 KV "E" Circuit, 1 microsec 200 PPS, 67 ohms impedance 3 sections.......$7.50
7-5E4-16-60, 67P. 7.5 KV, "E" Circuit, 4 sections 16 microsec. 60 PPS, 67 ohms impedance........$15.00
7.5E3-3-200-6FT, 7.5 KV, "E" Circuit, 3 microsec. 200 PPS, 6 ohms imp. 3 sections........$12.50
#755: 10KV, 2.2usec., 375 PPS, 50 ohms imp....$27.50
#754: 10KV, 0.85usec., 750 PPS, 50 ohms imp..$27.50
KS8865 CHARGING CHOKE: 115-150H @ .02A, 32-40H @ .08A, 30,700V Corona Test, 21KV Test $37.50
G.E. 25E5-1-350-50 P2T. "E" CKT, 1 Microsec. Pulse @ 350 PPS. 50 OHMS Impedance........$69.50
KS9623 CHARGING CHOKE: 16H @ 75 MA, 380 Ohms DCR. 9000 Vac test........$14.95
G.E. 6E3-.5-2000 50 P2T: 6 KV., "E" Circuit 0.5 usec /2000 PPS/50 ohms/2 sections........$7.50

MAGNETRONS

Type	Price	Type	Price
2J21	$8.75	2J39	$24.50
2J22	7.50	2J49	59.50
2J27	19.95	2J61	34.50
2J31	24.50	2J62	34.50
2J32	28.50	2J31	85.00
2J37	12.50	725-A	Write
2J38	16.50	730-A	24.50

QK 60, 61, 62—$85 ea.

MICROWAVE COMPONENTS

"S Band," RG48/U Waveguide

POWER SPLITTER for use with type 726 or any 10 CM Shepherd Klystron. Energy is fed from Klystron antenna through dual pick-up system to 2 type "N" connectors........$22.50 EACH
DIRECTIONAL COUPLER, Broadband type "N" Coupling. 20 db. with std. flanges. Navy #CABV 47AAN-2 ....$37.50
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 60K5 (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
WAVEGUIDE TO 7/8" RIGID COAX "DOORKNOB" ADAPTER CHOKE FLANGE, SILVER PLATED BROAD BAND $32.50
AS14A AP-10 CM Pick up Dipole with "N" Cables $4.50
OAJ ECHO BOX, 10 CM TUNABLE........$22.50
HOMERELL-TO-TYPE "N" Male Adapters, W.E. #D167284 ....$2.75
I. F. AMP. STRIP: 30 MC. 30 d.b. gain, 4 MC Bandwidth, uses 6AC7's—with video detector. A.F.C. less tubes $24.50
POLYROD ANTENNA, AS31/APN-7 in Lucite Ball. Type "N" feed........$22.50
ANTENNA, AT49A/APR: Broadband Conical, 300-3300 MC Type "N" Feed........$12.50
"E" or "H" PLANE BENDS, 90 Deg. less flanges $7.50

7/8" RIGID COAX—3/8" I. C.

ROTARY JOINT. Stub-supported, UG 46/UG 45 fittings $27.50
10 CM STABILIZER Cavity, tunable, standard UG46/UG 45 fittings $45.00
RG 44/U RIGID COAX, stub support, 5 ft. sections, with UG46/UG45 connectors........$12.50
RIGHT ANGLE BEND, with flexible coax output pickup loop $8.00
RT ANGLES for above........$2.50
SHORT RIGHT ANGLE BEND, with pressurizing nipple $3.00
RIGID COAX to flex coax connector........$3.50
RT. ANGLE BEND 15" L. OA........$3.50
FLEXIBLE SECTION. 15 L. Male to female....$4.25
7/8" RIGID COAX. BULKHEAD FEED-THRU $14.00

X Band—RG 52/U WAVEGUIDE

UG 39 Flanges........$1.10
UG 40A/U Broadband Choke Flanges........$1.65
1" x 1/2" waveguide in 5' lengths. UG 39 flanges to UG40 cover ....per length $7.50
Rotating joints supplied either with or without deck mounting. With UG40 flanges........each, $17.50
Bulkhead Feed-thru Assembly $15.00
Pressure Gauge Section 15 lb. gauge and press nipple $10.00
Pressure Gauge, 15 lbs........$2.50
Directional Coupler, UG-40/U Take off 20 db..$17.50
TR-ATR Duplexer section for above........$8.50
Waveguide Section 12" long choke to cover 45 deg. twist & 2½" radius. 90 deg. bend........$4.50
Waveguide Section 2½ 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
90 degree elbows. "E" or "H" plane 2½" radius $12.50
90 degree twist 6" long........$8.00
45 degree twist........$8.00
Microwave Receiver, 3 CM. Sensitivity: 10-13 μ Watts. Complete with L.O. and AFC Mixer and Waveguide Input Circuits. 6 I.F. Stages give approximately 120 DB gain at a bandwidth of 1.7 MC. Video Bandwidth: 2 MC. Uses latest type AFC circuit. Complete with all tubes, including 723A/B Local Oscillator $175.00

K Band—RG 53/U 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
APS-34 K-Band Pillbox Antenna........$22.50
Slotted Section, with Carriage & Probe........$45.00

MICROWAVE MIXER

CV-12/APR-6: Waveguide/mixer unit, 4000-6000 mc. Designed for use with microwave receiver. Has pick up loop for coupling to lighthouse cavity local oscillator. RF input is to 1" x 2" waveguide (contact flange). Output (thru 1n21 xtl.) is from standard 50-ohm coax connector. Brand new, complete with crystal. As shown........$35

THERMISTORS

D-164699	Bead Type DCR: 1525–2550 Ohms @ 75 Deg. F, Coefficient: 2% Per Deg. Fahr. Max. Current 25 MA AC/DC........	$2.50
D-167332	Bead Type. DCR is 1525–2550 Ohms. Rated 25 MA at .825–1.175 VDC..	1.50
D-167613	Disk Type DCR: 355 Ohms @ 75 Deg. F. P.M. 2.5%, 1 Watt.....	1.50
D-166228	Disk Type 7120 Ohms @ 60°F. 4220 Ohms @ 80°F 2590 Ohms @ 100°F, 1640 Ohms @ 120°F.......	1.50

MICROWAVE ANTENNA EQUIPMENT

AT49A/APR—Broadband Conical. 300-3300 MC. Type N Feed $12.50
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 4½" x 3'. New....$100.00
Dipole for above........$12.00
TDY "JAM" Radar rotating antenna, 10 cm. 30 deg. beam, 115 V AC drive. New........$150.00
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
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
APS-34 Pillbox Antenna, waveguide input: 2400-27000 MC $22.50

RADAR ANTENNAS

AS-12/APS-3	AS-125/APR
AS-17/APS-2	AS-217/APG-15
AS-13/APG-2	AT49/APR
AS69/APT	AS14/AP

400 CYCLE TRANSFORMERS

(All Primaries 115V. 400 Cycles)

Stock	Ratings	Price
M-7467886	2X140V/.014A, 120V/.012A, 1200 VRMS TEST, P/O MX-8/APG-2.	$4.95
352-7102	6.3V/2.5A........	1.45
M-7472426	1450V/1.0MA, 2.5V/.75A, 6.4V/3.9A, 5V/2A, 6.5V/.3A, P/O ID-39/APG-13........	4.95
52-7039	640VCT @ 380MA, 6.3V/.9A, 6.3V6A 5V/6A........	5.49
7027241	9800/8600 @ 32MA........	8.95
K59584	5000V/290MA, 5V/10A........	22.50
KS9607	734VCT/.177A, 1710VCT/.177A.....	6.79
352-7273	700VCT/350MA, 6.3V0.9A, 6.3V 2.5A 6.3V/.06A, 5V/CA........	6.95
352-7070	2X2.5V/2.5A (2KV TEST) 6.3V/2.25A, 1200/1000/750V. @ .005A........	7.45
352-7196	1140/1.25MA, 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	900V75MA, 100V/.04A........	4.29
UX8855C	900VCT/.067A, 5V/3A........	3.79
RA6405-1	800VCT/65MA, 5VCT/3A........	3.69
T-48852	700VCT/806MA5V/3A, 6V/1.75A....	4.25
352-7098	2500V/MA, 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
KS8984	27V/4.3A, 6.3/2.9A, 1.25V/.02A.....	2.95
52C080	650VCT/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.....	4.79
	ALL CT	
70G30G1	600VCT/36MA........	2.65
M-7474318	2100V/.027A........	4.95
352-7069	2-2.5V Wdgs. at 2.5A, Each Lo-Cap., 22 Kv Test........	5.95
352-7096	2.5V/1.75A, 5V/3A, 6.5V/6A, 6.5V/1.2A, P/O BC800........	4.95
352-7099	360VCT/20MA, 1500V/1MA, 2.5V/1.75A, 6.3V/2.5A, 6.3V/.6A, P/O BC-929........	6.45
D163253	5200V/.002A, 2.5V/5A........	5.35
M-7471957	2.5V/20A, 12KV Test........	4.85
352-7179	250V/100MA, 6.5V/12ACT 5V/2A...	3.45

MAIL ORDERS PROMPTLY FILLED. ALL PRICES F.O.B. NEW YORK CITY. SEND M.O. OR CHECK. ONLY SHIPPING SENT C.O.D. RATED CONCERNS SEND P. O. ALL MDSE. SUBJECT TO PRIOR SALE AND PRICES SUBJECT TO CHANGE WITHOUT NOTICE. PARCELS IN EXCESS OF 20 POUNDS WILL BE SHIPPED VIA CHEAPEST TRUCK OR RAILEX.

131 Liberty St., New York 7, N. Y. Dept E-7 Chas. Rosen Phone: Digby 9-4124

COMMUNICATIONS EQUIPMENT CO.

RECTIFIER TRANSFORMERS

Pri: 115V/60 Cy. Sec. 12/14/16 V @ 3.5A......$ 2.49
Pri: 115V, 60 Cy. Sec: 28V/3.1A, 26V/8.4A
7.3V/14A 12.95
Pri: 115V 60 Cy. Sec: 20 V @ 10A......... 3.95
Pri: 115V 60 Cy. Sec: 8.1V @ 1.5A 1.39
Pri: 115V 60 Cy. Sec: 18.5V @ 3.5A....... 2.79

SELENIUM RECTIFIERS*

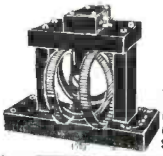
Current (Continuous)	18/14 Volts	36/28 Volts	54/42 Volts	130/100 Volts
1 Amp.	$1.25	$2.10	$3.60	$7.50
2 Amps.	2.20	3.60	6.50	10.50
2½ Amps.	.....	.....	.....	13.00
4 Amps.	3.75	.....	8.75	.....
5 Amps.	4.95	7.95	12.95	27.00
6 Amps.	5.50	9.00	14.00	33.00
10 Amps.	6.75	12.00	20.00	40.00
12 Amps.	8.50	16.00	25.50	50.00
20 Amps.	13.25	24.00	36.00	90.00
24 Amps.	16.00	31.00	39.50	98.00
30 Amps.	18.50	36.00	*Full Wave Bridge	
36 Amps.	25.50	45.00		

TELEVISION TEST GEAR

KAY MEGASWEEP. T.V. Allgn. Gen.........$215.00
KAY MEGAPIPPER T.V. Mark. Gen. 85.00
KAY MEGAMARKER SR. Chan 2-13 Marker Gen. 95.00
* All Equipment is used, but excellent. Guaranteed to be in A-1 shape.

RCA TEST PANEL

Complete RCA TV Service and Test Laboratory comprising the WV-95A Master Voltohmyst, WA-54A Beat Frequency Oscillator, WO-55A Oscilloscope, WR-67A Test Oscillator, WR-59A TV Sweep Generator, WR-39A TV Calibrator on a sturdy metal display rack. A complete TV service bench **$597.00**



HELMHOLTZ PHASE-SHIFTER

Stator consists of 4 loops oriented at 90 degrees to each other. Total stator inductance is 40 MH. rotor: 10MH. total phase shift 0-360 deg. Designed for range unit of SCR-268...... **$3.95 each**

APN-3 SPARE PARTS

K-901684-501: SCS #229632.306, Trans. $2.49
K-901689-501: SCS #229631.238, Trans.......... 2.25
K-901692-503: SCS #229617-70, Xfmr, Fil. 2.49
K-901699-501: SCS #229617-68, Fil. Xfmr. 3.45
K-901698-501: SCS #229618-38, Plate Xfmr.... 4.29
K-901695-501: SCS #229627-19, Pulse Xfmr.... 3.50

AUDIO TRANSFORMERS

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
AT602 Output to H. S. or line PRI: 14,200 ohms SEC: 8000/600 ohms $1.10
AT449 HI-Fi Driver (5000 ohms) to P.P. output grids (4,000 ohms) 100-10.000 CY, 10 W 6V6 to PP 805's $2.39
AT666 Intercon Input: Spkr (-4-8 ohms) to grid (250,000 ohms) $0.69
AT415 Plate (18,000 ohms C.T.) to line (125 ohms) 175 w.—500-600 CY $1.95
AT858 Plate (10,000 ohms C.T.) to line (125 ohms) 125130 ohms) HI-Fi—50 W $6.95
AT070 Mike-or-Line (250 ohms) to grid (250,000 ohms C.T.) $1.20
AT765 Mike-or-Line (600 ohms to grid (50,000 ohms C.T.) $0.69
AT-694 HI-Fi Output: 3 Watts, 8500 Ohms P-P to V.C. (15 Ohms) 15-15KC PM 1 db.....................$1.49
AT4-1: 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

BIRTHER TUBE CLAMPS

926B-16	926C-19	926C-24
926B-15	926C-15	926K-2

PRICE: 18¢ EACH OR $16.50/100

TELEPHONES

DESK TYPE PHONE, IDEAL FOR PRIVATE — INTERCOM, AMATEUR MIKE, ETC. USES HI-QUALITY CARBON TRANSMITTER, POWERFUL MAGNETIC RECEIVER. A GREAT, ONCE-IN-A-LIFETIME VALUE. AS SHOWN, used, excellent........ **$3.50**
RINGER BOXES FOR ABOVE, WOOD CASE 3.00
RINGER BOXES FOR ABOVE, METAL CASE 5.00

DYNAMOTORS

ALL BRAND NEW—ORIGINAL PACKING

TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT AMPS	PRICE
PE 86	28	1.25	250	.060	$4.25
DM 416	14	6.2	330	.170	6.75
DM 33A	28	7	540	.250	3.95
BD AR 93	28	3.25	375	.150	7.50
23350	27	1.75	285	.075	3.95
B-19 Pack	12	9.4	275	.110	8.95
			500	.050	
DA-3A*	28	10	300	.260	6.95
			150	.010	
			14.5	5.	
5053	28	14	250	.060	3.95
PE 73 CM**	28	19	1000	.350	**
337	14	8	425	.160	7.95

* Replacement for PE 94.
** Price sent on request.

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
NAVY CQR-211095: Input 22-30 VDC/75-60A. OUTPUT: 115V/400 CY. 1 KVA/8.7A. RPM: 4800. With coupling provision for motor. Brand New, Original packing $150.00

MOBILES! C. D. MEN! CAP!!

IDEAL DYNAMOTOR — CONVERTS EASILY TO SUPPLY UNIT OELIVERING

12 Volt Input—		6 Volt Input
610 V @ 150 MA	OR	300V @ 90 MA
325V @ 125 MA		160V # 110 MA

Brand New with Conversion Data...........$3.75

VIBROPACK, Mallory Type G-556. Input 12 VDC. Out.: 225/250/275/300 VDC @ 100 MA. Brand New with 2 spare vibrators $12.50

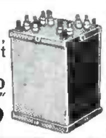
VIBRATOR, -TR 1210. For use in industrial Inverters Delivering 115 Vac @ 100 Watts from 12 VDC.................................$1.69

GN 35 HAND GENERATORS

BRAND NEW, IN ORIGINAL CARTONS. WILL DELIVER 8 V @ 2.5A AND 325-365 V @ 100 MA OR 10 V 1.25A ANO 380-420 V @ 70 MA. LESS HAND CRANKS. A GREAT VALUE $17.50

H.V. FILAMENT XFMR

NO. FT-38A—
Primary: 115V 60 Cy. 1 PH.
SEC.: 2 Wdgs. 2.5V at 7 Amps each, and 1 wdg. 6.3V @ 2.5A tested at 7500 VDC between all points.
HERM. SEALED. Size 5½" H x 3½" D x 4" W. Has 4 studs, ½" L on 2⅞" x 3" Centers. As shown **$2.79**



BAND PASS FILTERS

INPUT IMPEDANCE: 2000 OHMS. OUTPUT: TO GRID. AVAILABLE IN FOLLOWING RANGES:

CHANNEL	Fr.	F1*	F2*
5	1155	830	1620
7	2270	1620	3180
8	3180	2270	4450
9	4450	3180	6230
10	6230	4450	720

* Fr.: Center Freq. in CPS; F1 and F2 are lower and upper limits (CPS) respectively, at —20 db points.
Price, $4.95 Each

JAN/UG CONNECTORS

UG 9/U	$0.85	UG 58/U	$0.70
UG 10/U	.95	UG 89/U	1.05
UG 21/U	.80	UG 102/U	.75
UG 22B/U	1.25	UG 188/U	1.15
UG 22/U	1.20	UG 254/U	2.50
UG 27/U	1.20	UG 261/U	1.10
UG 27A/U	2.25	D-166366	.75

SPARES FOR APN-9

Power Trans., Pt. No. 352-7295-2.........$4.95 each
Counter Trans., T111, T112, T117, Pt. No. 352-7251-2 ....$2.50 each
Counter Trans., T113, T114, T115, T116, T118, T119, T120, Pt. No. 352-7250-2....$2.50 each
I. F. Trans: T107-T110 Pt. #352-1554S....$1.00 each
Resistor: R150, R157, R162 84,000 OHMS.. .50 each
Resistor: R130, 220,000 ohms .... .50 each
Resistor: R159 120,000 ohms .... .50 each
Resistor: R152, R164, 17,000 ohms......... .35 each
Resistor: R142, 4300 ohms .... .35 each

POWER TRANSFORMERS

Comb. Transformers—115V/50-60 cps Input
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..................... 9.95
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-403 350VCT .026 A 5V/3A............ 2.75
CT-931 585VCT .086 A 5V/3A, 6.3V/6A.... 4.25
CT-456 390VCT 30 MA 6.3V/1.3A, 5V/3A.. 3.45
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/200MA, 6.3V/8A, 6.3V/5A........ 6.49
CT-444 230-0-230V/.085A, 5V/3A, 6V/2.5A....... 3.49

Filament Transformers—115V50-60 cps Input

Item	Rating	Each
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, 16 KV TEST	18.95
FT-608	6.3V/3A/750V Test	1.79
FT-873	4.5AV/.5A, 7V/7A	2.19
FT-899	2x5V A 5A, 29KV Test	24.50

Plate Trans.—115V, 60 cps

Item	Rating	Price
PT-699	300/150V.05A, 300/150V/.05A	$2.79
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-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

FILTER CHOKES

Stock	Description	Price
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-8-35	2/.5H/380 MA/25 Ohms	1.79
CH-776	1.28H/130 MA/75 ohms	2.25
CH-344	1.5H/145MA/1200V Test	2.35
CH43A	10HY/15MA—850 ohms DCR	1.75
CH-366	20H/300MA	6.95
CH-999	15HY/15MA—400 ohms DCR	1.95
CH-511	6H/80MA—310 ohms DCR	2.45
CH3-501	2 x .5H/400MA	2.79
CH-188M	5HY 200MA	1.79
CH-488	10HY .030A	1.19
CH-791	Dual 1.75-.125 HY 100 MA	1.27
CH-981	15HY .110A	1.59
CH-22-1	1 HY .100A	1.17
CH-779	.6 HY .490A	1.25
CH-25A	SW .09/.018 HY 3/.3A	8.95
CH-922	10000 HY O MA	2.75
CH-043	2.2 HY 80 MA	.98
CH-89A	2 x 1.52H @ .167A	1.39
CH-69A	Mult. Choke SECT. 1. Swing 3-12H/.52-.05A SECT. 2. Smooth 5H/.52A SECT. 3. Swing 3.25-18H/.138-014A SECT. 4. Smooth 3.4H/.138A	14.95
CH-445	0.5 HY/200 MA, 32.2 OHMS, 3000V.T.	1.39
CH-170	2x0.5H/380 MA, 25 OHMS	2.79
CH-533	13.5H, 1.0 AMP DC, 13.5KV INS.	39.95

MAIL ORDERS PROMPTLY FILLED. ALL PRICES F.O.B. NEW YORK CITY. SEND M.O. OR CHECK. ONLY SHIPPING SENT C.O.D. RATED CONCERNS SEND P.O. ALL MDSE. SUBJECT TO PRIOR SALE, AND PRICES SUBJECT TO CHANGE WITHOUT NOTICE. PARCELS IN EXCESS OF 20 POUNDS WILL BE SHIPPED VIA CHEAPEST TRUCK OR RAILEX.

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SEE OUR PREVIOUS ELECTRONICS ADS FOR LISTINGS OR WRITE FOR CIRCULARS

MINIATURE RELAYS

COOK 482; 24VDC; DPDT; 500 ohm #R918 .... **$1.75**

G.E. CR2791G11OF2 24VDC; DPDT; 300 ohm; #R919 .... **$1.50**

CLARE A20545; 8VDC; 1B; 45 ohm; #R920 .... **$1.25**

AUTOMATIC 754A; 12VDC; DPDT 6 Amp; 200 ohm; #R921 .... **$1.75**

AUTOMATIC 754; 6VDC; DPDT 6 Amp; 50 ohm; #R922 .... **$1.75**

POTTER BRUMFIELD KR11D; 6VDC; DPDT; 75 ohm; #R923 .... **$1.95**

SIGMA 41F; 6VDC; SPDT; 62 ohm; #R924 **$1.75**

SIGMA 41F; 12VDC; SPDT; 340 ohm; #R925 **$1.95**

D163221 AMER. TOTALIZATOR, 24 VDC, DPDT 300 ohms, Anti-Capacity Arms. #R134 .... **$1.75**

CLARE 24VDC; 4PDT; 300 ohms; #R524. **$2.90**

MINIATURE 24VDC; 4PDT; 425 ohms; #R525 .... **$3.25**

23012-0 RBM, 24VDC, SPDT, 250 ohms. #R172 .... **$1.50**

7251 ARC, 24VDC, SPDT, 300 ohm #R406. **$1.50**

7252 ARC, 24 VDC, DPST, n.o. (2As) 300 ohm, Anti-Capacity Arms, Ceramic Insulation, #R354 .... **$1.50**

A21577 CLARE, 24VDC, DPST n.o. (2As) 250 ohms, #R352 .... **$1.50**

P3 LEACH (Pair on Bakelite Strip) Each relay; VDC, SPDT, 1 ohm #R353 **pr. $2.50**

ZH77628-1 AUTOMATIC, 12VDC, Make One, Break Two (1B, 1C) 640 ohms Dual Telephone Type Contacts #R244 .... **$1.50**

73A23 ALLIED, 24VDC. Make 3 Break 1, (2As, 1C) 300 ohms, #R403 ...... **ea. $1.75**

TB 302 PRICE, 24VDC, Make 3, Break 1, (2As, 1C) 300 ohms, #R404 ...... **ea. $1.75**

RIO COOK, 12-24VDC, 3PST n.o. (3As), One contact 10A, 250 ohm, #R427 ...... **$1.75**

ARC 1 & 3 MINIATURES

23025 RBM 48VDC. SPDT, 8000 ohm, 6 ma #R428 ...... **$2.50**

55251 Telechron, 24VDC, SPST n.o. (1A) 300 ohm. #R174 **$1.25**

55340 Price, 24VDC SPST n.o. (1A) 300 ohm #R170 .. **$1.25**

55342 Telechron, 24VDC. Makes 3 Breaks One (2As, 1C) 300 ohm, Anti-Capacity Arms, Low Loss Bakelite Insulation #R171 .... **$1.75**

55526 Cook, 24VDC. Makes 2, Breaks One, (1A, 1C) 300 ohm Ceramic Insulation, #R107 ...... **$1.75**

55528 G.E. 12VDC, 6PST n.o. (6As), 150 ohm, #R426 .... **$2.00**

55531 Cook. 12-24VDC. Makes 4, Breaks (2As, 2Cs) 150 ohm #R405 .... **$1.95**

55836 G.E. 24VDC. SPDT, 250 ohm, R402 .. **ea. $1.50**

55837 G.E. 24VDC. Double Make, 300 ohm. R108G **$1.25**

55837 RBM. Same as #R108G, #R108R **$1.50**

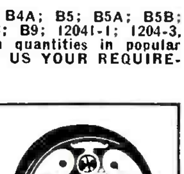
55837 Allied. Same as #R108G, #R108 ...... **$1.75**

23012-0 RBM. 24VDC. SPDT, 250 ohms, #R172 **$1.50**

AIRCRAFT SOLENOID CONTACTORS

All types B2; B2A; B4; B4A; B5; B5A; B5B; B6A; B6B; B7A; B7B; B8; B9; 12041-1; 1204-3, etc. available from stock in quantities in popular makes at low prices. SEND US YOUR REQUIREMENTS.

WESTON MODEL 705 SENSITROL



Combines high sensitivity and comparatively high contact capacity (5 watts at 110 volts). Positive action at 10 microamperes d-c. Stationary contact is small permanent magnet; movable contact is iron rider mounted on D'Avsonval movement pointer. Operating torque moves pointer into magnetic field of stationary contact which draws movable contact and holds it firmly. Contacts remain closed until reset.

WESTON 705 TYPE 4: 10 XX microamp; SPST n.o. (1A); 24V AC or DC reset solenoid; #R523 .... 10 for $200.00 ...... $22.50 ea.

WESTERN ELECTRIC MERCURY RELAY 275C: Hermetically sealed; 2 coils; 700 & 3300 ohm. With coils in series, makes at 6.6 ma, breaks at 5.2; SPDT; High current capacity; High speed; #R464 .... $17.50 ea. 10 for $150.00

STEPPING SWITCHES

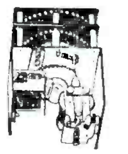
AUTOMATIC ELECTRIC TYPE 13

25 Position: Self Interrupter Springs; Norm. Oper Volts: 24 VDC; Max 30VDC; 0.6 Amps; 30 Ohm.

Three Levels Auto. Elec. RA92; #R900 ...... $17.75

Four Levels Auto Elec. RB12; #R901 .... $19.50

Five Levels Auto. Elec. RB20; #R902 .... $22.50



STEPPING RELAYS GUARDIAN SERIES R

Three basic types for 24V AC operation:

1. Continuous rotation: In this type the contact finger advances one step each time the circuit is made and broken.
2. Electrical reset. Resets when a second coil is energized.
3. Add and subtract. Steps back one or more contacts at a time instead of resetting completely.

10 Pulses per second. Contacts are rated at 1 ampere at 110 volts, 60 cycles, non-inductive AC. The electrical reset type has up to 36 active contacts while the continuous rotation types each have 40 contacts. SEND US YOUR REQUIREMENTS.

FERRULE AND OTHER

WIRE WOUND RESISTORS

AT A FRACTION OF MANUFACTURERS' ORIGINAL COST!

IMMEDIATE DELIVERY

From Our Wide Assortment from 0.2 Ohms to 15 Megohms.

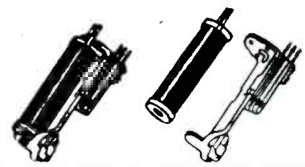
ENAMEL • GLASS

FIXED • ADJUSTABLE

New and in Perfect Condition. Nearly all made to JAN Specifications.

Send us your requirements. We have 250,000 wire wound resistors in a large variety of sizes in stock.

TELEPHONE TYPE RELAYS



These relays have been standardized so that coils and frames of most manufacturers can be interchanged without affecting adjustments. A wide variety of applicable combinations are thus possible from a comparatively small number of relays.

Listed below are frames and coils from our stock. They may be purchased separately. However, a complete relay consists of coil and frame. In ordering complete relays specify which coil with which frame, i.e.: F101 with K117.

Representative completed relays are also listed with voltage and current ratings. Values are indicative of sensitivity that may be expected from similar combinations.

CLARE, 6500 ohm, 8maDC, 3 makes (3As) #R276 $4.25

5035A7 AUTOMATIC, 1300 ohm, 8maDC, SPST n.o. (1A), #103 .... $1.75

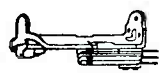
CLARE K101, 6500 ohm, SPDT, 2 ma DC. Fast Action #175 .... $4.25

A18258 BENDIX (Cook 102) 8-12 VDC, Copper Slug. Slow Release, SPDT, 200 ohm, Part of SCR 522, #R365 .... $2.49

R5229A1 AUTOMATIC 6VDC, 3PST n.o. (3As), 75 ohms, Slow Release, #412 .... $2.50

R5021A1 AUTOMATIC 1300 ohm, 20maDC, SPST n.c. (1B), #R413 .... $2.95

FRAMES



(For Cost of Relay Add Price of Frame to Price of Coil)

Stock No.	Contacts	Price each	Stock No.	Contacts	Price each
F101	1A	1.25	F114	1B, 3A	2.00
F102	2A	1.50	F133	1B, 1C	1.75
F103	3A	1.75	F108	1B, 1A, 1C	2.00
F104	4A	2.00	F131	1B, 9A, 1C	4.00
F127	8A	3.00	F107	2B, 1A	1.75
F128	12A	4.00	F135	2B, 1C	2.00
F106	1A, 1B	1.50	F112	2B, 2A, 2C	3.00
F107	1A, 2B	1.75	F129	2B, 2A, 6C	5.00
F108	1A, 1B, 1C	2.00	F136	2B, 3A, 1C	2.75
F109	1A, 1C	1.75	F121	5B, 1C	2.75
F110	1A, 2C	2.25	F122	1C	1.50
F111	2A, 1B	1.75	F123	2C	2.00
F137	2A, 1C	2.00	F109	1C, 1A	1.75
F112	2A, 2B, 2C	3.00	F137	1C, 2A	2.00
F129	2A, 2B, 6C	5.00	F117	1C, 5A	2.75
F114	3A, 1B	2.00	F133	1C, 1B	1.75
F136	3A, 2B, 1C	2.75	F135	1C, 2B	2.00
F115	3A, 2C	2.75	F108	1C, 1A, 1B	2.00
F117	5A, 1C	2.75	F136	1C, 3A, 2B	2.75
F130	6A, 4C	4.50	F121	1C, 5B	2.75
F131	9A, 1B, 1C	4.00	F131	1C, 9A, 1B	4.00
F120	1B	1.25	F110	2C, 1A	2.25
F132	2B	1.50	F115	2C, 3A	2.75
F134	3B	1.75	F112	2C, 2A, 2B	3.00
F106	1B, 1A	1.50	F130	4C, 6A	4.50
F111	1B, 2A	1.75	F129	6C, 2A, 2B	5.00

SPECIAL CONTACT ARRANGEMENTS

We can supply any contact arrangement up to 20 contact leafs (10 form A or 10 form B; or combinations; or 6 form C) for a nominal extra charge. To compute cost of custom made frame add: 1.00 for blank frame plus .50 for each form C. plus .25 for each form A or B and 2.00 as the nominal extra charge. Thus a frame with 2A, 3B, 1C would cost 1.00 + .50 + .75 + .50 + 2.00 = 4.75.

TERMS:—All Prices F.O.B. Our Plant. Rated Firms Net 10 Days: All Others Remittance with Order.

COILS

(For Cost of Relay Add Price of Coil to Price of Frame)

Stock No.	Ohms	Price each	Stock No.	Ohms	Price each
K101	0.75	1.25	K109	1000	1.75
K131	5.0	1.25	K136	1200	2.00
K102	12	1.25	K111	1300	1.75
K132	175	1.25	K137	1425	2.25
K153	300	1.50	K138	1500	2.25
K154	400	1.50	K139	1600	2.25
K104	450	1.50	K112	2000	2.25
K105	500	1.50	K140	2300	2.50
K133	600	1.50	K155	2500	2.50
K134	700	1.50	K113	3000	2.50
K107	750	1.50	K116	6500	2.75
K135	800	1.75	K118	40.000	3.25
K108	900	1.75			

SLOW-ACTION COILS

SLOW-MAKE			SLOW-RELEASE		
Stock No.	Ohms	Price each	Stock No.	Ohms	Price each
K122	33	1.50	K149	3.9	1.50
K146	125/1300	2.50	K123	75	1.50
K147	500/1500	2.50	K124	200	1.50
K148	1300	2.00	K150	800	2.00
K146	1300/125	2.50	K151	1000	2.00
K147	1500/50	2.50	K152	1300	2.25
			K127	2500	2.50

A-C COILS

Stock No.	Vo'tage	Price each
K119	6VAC	1.75
K121	110VAC	2.60

DUAL COILS

Stock No	O	Price each	Stock No.	Ohms	Price each
K141	50/2000	2.25	K145	1000/1000	2.25
K142	125/1300	2.25	K106	1100/500	2.00
K143	200/1000	2.00	K142	1300/125	2.25
K106	500/1100	2.00	K144	1800/500	2.50
K144	500/1800	2.50	K141	2000/50	2.25
K143	1000/200	2.00			

A = Normally Open; B = Normally Closed; C = Double Throw.

Orders Under $10 Remittance With Order, Plus Approximate Shipping Charges (overage will be returned.)

324 CANAL ST., N.Y.C., 13, N.Y. WAlker 5-9642

Universal general corp.

SPECIAL PURPOSE TUBES

C1A	$6.25	3DP1A	5.00	RK-73	1.00	310A	4.50	706AY	30.00	812	2.00
1B22	1.75	3E29	10.50	FG-81A	3.00	311A	4.75	706FY	30.00	813	9.00
1B24	7.75	3EP1	3.50	FG-95	16.50	313C	2.25	706GY	30.00	814	2.50
1B35	8.00	3FP7	1.00	100TH	7.00	316A	1.00	707A	4.50	815	2.50
2AP1	6.75	3GP1	3.00	F-128A	65.00	323A	11.25	707B	9.50	829A	7.50
2C40	5.75	3JP12	15.00	VT-158	50.00	328A	4.25	708A	2.75	829B	9.00
2C43	8.75	3KP1	9.75	FG-172	18.75	329A	6.00	709A	2.75	832	6.00
2C44	1.00	4C27	12.75	FG-190	9.00	348A	4.50	714AY	4.25	832A	7.50
2E22	1.75	5BP1	3.50	203A	4.50	349A	6.50	715A	3.50	833A	30.00
2J22	5.25	5BP4	3.50	204A	37.50	353A	3.25	715B	4.50	836	2.50
2J26	11.25	5CP1	3.50	F-207	180.00	354A	15.00	715C	13.75	837	1.00
2J27	11.25	5CP7	7.00	212E	32.00	355A	10.50	719A	18.25	838	2.50
2J31	20.25	5D21	13.75	WL-218	35.00	368AS	5.25	721A	1.50	846	65.00
2J32	22.50	5FP7	1.50	221A	1.50	375A	10.50	722A	1.50	849	22.50
2J33	20.25	5FP14	12.25	F-232CH	180.00	394A	3.00	723A/B	13.50	860	2.75
2J34	18.75	5JP1	16.75	250R	7.00	417A	6.00	724A	2.00	861	10.00
2J38	9.00	5JP4	16.75	250T	10.00	GL-434A	9.75	724B	2.00	866A	1.00
2J50	15.75	5JP11	16.75	250TH	13.50	446A	1.00	725A	4.75	872A	2.25
2J55	63.75	5J23	30.00	250TL	11.25	446B	2.25	726A	9.25	878	1.50
2J56	122.50	5J29	9.00	253A	11.75	450TH	35.00	726B	35.00	884	1.25
2J61	30.00	5J30	29.50	267B	8.75	450TL	35.00	728CY	25.00	902-P1	4.75
2X2A	1.25	5R4GY	1.00	271A	7.25	GL-451	3.00	728DY	25.00	918	1.25
3AP1	6.00	6C21	18.25	272A	5.25	464A	6.00	728EY	25.00	927	1.00
3BP1	3.75	6CF	12.75	274B	2.25	WL-530	12.75	728GY	25.00	931A	3.75
3B24	3.75	C6L	9.00	276A	7.50	575A	10.50	730A	18.75	CK-1006	2.75
3B26	2.75	7BP7	4.50	282A	10.25	700A	12.50	803	3.00	1622	1.50
3C23	8.75	9LP7	2.25	286A	6.00	700D	12.50	805	2.25	1624	1.00
3C24	1.25	12DP7	10.75	304B	5.75	701A	4.50	807	1.25	2050	1.00
3C31	2.50	12GP7	13.50	304TH	6.00	702A	2.00	808	2.00	8012	2.00
3D21	2.25	RX-21	2.75	304TL	5.00	703A	3.50	810	7.50	8013	2.00
3DP1	3.00	RK-60	1.50	307A	3.25	705A	1.25	811	2.25	8025	3.50

- *Receiving tube quotations upon request*
- *Usual terms apply*

western engineers

ELK GROVE, CALIFORNIA

GEORGE WHITING, OWNER

- *Unconditional guarantee extended*
- *Subject to prior disposition*

WANTED

ARC-1, 3, ART-13, BC-342, 348, APS-10, 15, TS-13, 35, 146, 147, 148, 174, 175, 263 ETC. ALL SCR, BC, AN, TS. ALL TUBES.

RADALAB

1964 Webster Ave., Bronx 57, N. Y.

TEL: WE 3-3232-3

TERMS—Minimum order $25.00 all prices FOB New York City. 25% deposit with order, balance COD. Rated firms open account. Prices subject to change without notice.

RADAR

APS-15A&B

Complete sets available checked out.

APS-3

Complete sets avail. checked out..$1050.00

APS-4

Complete sets avail. checked out..$1050.00

APN-2

Complete sets avail. checked out SCR729 also avail.

ASD

3CM search & nav. radar compl. sets avail. $1000.00

APS-10 3cm lightweight navigational & search radar 5" PPI
UPN-4 3cm portable radar beacon
APR-1 38-1000mc receiver
APR-4 38-4000mc receiver
APR-5 1000-6000mc receiver
APT-5 300-1300mc Trans.
SCR-522 100-156mc Xmit-Rec.
SCR-555 18-65mc long range direction finder
SCR-536 Handi-Talkies
BC-312 and **BC-342** 1.5-1.8mc Receivers

Many other airbourne, ground and marine military equipment available. "WRITE"

TUBES ALL FULLY GUARANTEED

OA2	$.89	845	5.40
OB2	.95	866A	1.40
1B24	9.75	869BX	52.50
1P21	29.75	872A	3.25
2C40	9.25	884	1.80
2C42	8.50	931A	5.25
2C43	12.95	958A	.75
2J41	WRITE	959	2.95
2K25	30.00	1603	5.15
2K28	31.50	1624	1.40
2K50	WRITE	5516	5.25
3C45	14.95	5643	7.25
3D21A	4.69	5651	2.65
3DP1	3.50	5654	1.95
3DP1/S2	5.95	5670	4.00
3E29	11.75	5672	1.40
3J21	WRITE	5676	3.30
5LP1	14.75	5687	3.95
6C21	19.75	5691	7.65
6J4	5.90	5692	7.65
100TH	8.95	5693	6.50
211	.96	5702	2.95
250TH	16.50	5703	1.89
250TL	16.50	5704	2.40
304TH	7.90	5718	6.50
304TL	7.90	5719	8.65
307A	6.25	5726	1.69
703A	3.95	5814	2.75
705A	1.85	5876	16.50
707A	7.95	6005	4.35
707B	15.95	8005	6.40
715B	9.25	8020	1.10
715C	19.75	8025	4.75
721A	2.80	9001	1.40
723A/B	18.75	9003	1.50
725A	7.40	FG17	3.50
726A	14.50	FG32	11.75
803	3.75	FG57	17.50
805	4.25	FG97	22.50
807	1.69	FG105	17.50
811	2.95	FG172	35.00
813	10.50	OA3/VR75	.97
814	2.95	OB3/VR90	.89
815	3.75	OC3/VR105	.95
829B	11.75	OD3/VR150	.98
832	7.95	WL676	49.50
832A	9.40	WL677	45.00
833A	39.50		

Complete stock of receiving tubes available

TEST SETS

TS-3/AP S band power, freq. meter.$215.00
TS-13/AP 3 CM sig. gen. power meter, freq. meter 110 v. 60 cycle.
TS-14/AP 10 CM sig. gen. power meter, freq. meter. 110v 60 cycle........$650.00
TS-34/AP portable syncroscope.....$290.00
TS-35/AP 3 CM sig. gen. power meter, freq. meter 110v 60 cycle.
TS-45/AP 3 CM sig. gen. and freq. meter.
TS-61/AP 10 CM echo box.
TS-62/AP 3 CM echo box.
TS-125/AP 10 CM precision power meter.
TS-148/UP 3CM spectrum analyzer.
TS-226/AP 300-1000 MC power meter.
I-100 radio compass test set.
I-208 V.H.F. field radio test set.
BC-221 freq. meter Mod. $175.00
Unmodulated $125.00
IE-19 100-156MC test set.
IE-36 SCR 522 test set..............$40.00
TSX-4SE spectrum analyzer.

SPECIAL

K-band 23,000, 24,000 MC RF heads using 2K50 klystrons and 3J21 packaged magnetron and magic TEE AFC mixer very late type. Also K-band complete dual-scanner antenna system. TS-259A/AP K-band sig. gen. power meter, freq. meter also available. Write

X and K-band Wave Guide Components

Slotted lines, term., adapt., crys. mounts, etc. in stock. SEND YOUR REQUIREMENTS.

WRITE FOR OUR CATALOGUES

CHECK AND COMPARE OUR COMPLETE STOCKS

The following is just a partial list of the current electronic and aircraft equipment now in our warehouse. Write for complete information. Prompt replies to all inquiries.

RC-103 & AN/ARN-5 ILS
New in original cartons. Complete. Consists of all accessories, plus AS-27A, R89B/ARN-5 and BC-733D. Modified to flag alarm.

TBS 4 & 5, NEW, COMPLETE
IE-17 TEST SET
AN/ARN-7 COMPLETE
SCR-269 COMPLETE
AN/ARC-1 VHF EQUIPMENT

BC-611 & BC-721 HANDIE TALKIES, Plus SPARE PARTS.
Quantity available.

AN/ART-13 EQUIPMENT

ATC XMTR	T-47A/ART-13 XMTR
T-47/ART-13 XMTR	CU-24 ANT. LOAD
CU-25 ANT. LOAD	DY-11 & 12 Dynam't'r
MT-283 MOUNT	0-16 LFO
MT-284 MOUNT	ATC DYNAM'T'R
SA-22 ANT. LOAD	C-87 CONTROL BOX

AN/APG-13A RADAR
Absolutely complete, brand new

AN/APN-2	MG-153
SCR-729 New	APS-2, 3, & 15 Components
TA2J-24	AN/ARC-5 VHF
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BC-1016	
APA-6 INDICATOR	R-4/ARR-2 Receivers
APA-11 INDICATOR	BC-640 VHF XMTR
APA-17 RADAR	SCR-510
HS-33 HEAD SETS, NEW	SCR-522
MG-149F & H	MG-153

SPARE PARTS

SCR-720	SCR-522
SO-7	AN/ART-13
AN/ARN-7	AN/ARC-1
SCR-269	BC-611

SCR-718 A, AM, B & C
Altimeter equipment—complete

To insure the finest of service and quality of merchandise, we have just recently put into operation our own reconditioning and function-testing plant, complete with all facilities.

WANTED
ART-13 CFI UNITS ART-13 BC-788 I-152 BC-348 Q & R
TOP DOLLAR PAID

EXPORT INQUIRIES INVITED
We carry an unusually large stock of Airline Equipment, Test Equipment, Radar Sets, etc. Write for our low prices and complete information. We furnish immediate answers to all inquiries. Write today!

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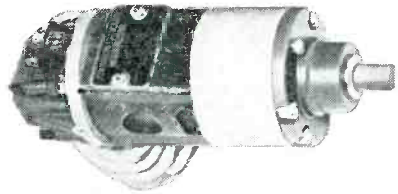
Perhaps the smallest reversible GEARED-MOTOR in the world

Delco-PM-Permanent Magnet Alnico Field Motor #5071895 some with 11/16" gear, some with smooth ¼" shaft. 250 RPM, 27 volts, 100 ma. Speed depending on the voltage. Designed to be used in bombsights, automatic pilots, etc. Cost at the factory $26.10. Delivery 4 months. OUR PRICE, Immediate Delivery!! **$17.50**



Packaging for parcel post costs money; it costs no more to pack two motors in the same box, so you can take advantage of our

SPECIAL COMBINATION ½ Price OFFER

1st motor....$17.50, 2nd motor....$8.75
2 MOTORS AT FRACTION OF FACTORY COST...............$26.25
Also #5067127
Clamps to hold motor: $1.50 ea.
Subject to prior sale

GRAIN OF WHEAT LAMPS

#322	3 V.	.19 amp
#328	6 V.	.2 amp.

100 for $25.00 10 for $3.00

MARKTIME 5 HOUR SWITCH
A 10 amp. timing device. Pointer moves back to zero after time elapses. Ideal for shutting off radios and TV sets when you go to bed. Limited supply at this special PRICE **$4.90**

Also available in 15 min., 30 min., 1 hr. at $5.90

10 Seconds to 24 Minutes Timer
A hand wound electric TIMING SWITCH. Pointer moves back to ZERO and shuts off RADIO—TV—Electric Mixer—Photographic Devices—Time Delay etc. Furnished with Calibration Chart and Pointer Knob. Biggest bargain we ever had... **$1.25**

3" Round Elapsed Time Meter **$12.50**
General Electric $15.50
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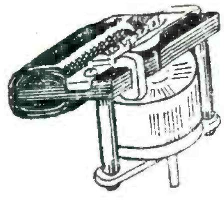
REDMOND Powerful 5" Blower or Ventilator 115 volts AC 60 cycles 18 watts. For Kitchen — Laboratory. Heat or Cold or Chemicals....$7.50

A Miracle Switch that will not leave you in the Dark. Delayed Action Light Switch



Genuine TELECHRON Motors

2 RPM.....	$2.90
3 RPM.....	3.90
4 RPM.....	3.90
3.6 RPM...	3.15
1 RPM.....	3.95
60 RPM ...	4.30

1800 RPM SYNCHRONOUS Motor; 115 volts AC, 18 watts 1¼ lbs.; 2"x3"x2".... **$4.50**

Hand Cranked A.C. Generators Removed from Ancient Telephones: 2 bar..$4.50; 3 bar..$5.50; 5 bar..$6.50

Polarized Bell or Buzzer Works on Magneto or 115 volt A.C. **$1.50**

Complete 2 Station Magneto Ringer Telephones. Incl. Batteries—wire.... **$17.50**

ZENITH Motorized Remote control made for T.V. but ideal for opening doors—windows—Turntables—Gadgets—Tuning Radios. Complete with Transformer 16 ft. cable and reversing button. A few more left........................ **$8.95**

NE-2	1/25 Watt NEON Pigtail lamp. 10 for $1.00. 100 for..	$7.50
NE-16	¼ Watt NEON lamp D.C. Bayonet Base. 10 for.......	$3.00
NE-21	¼ Watt NEON lamp S.C. Bayonet Base. 10 for.......	$2.50
NE-48	¼ Watt NEON lamp D.C. Bayonet Base. 10 for.......	$2.00
NE-30	1 Watt NEON lamp Med. Screw Base. 10 for.........	$2.50
AR-1	2 Watt ARGON lamp Med. Screw Base. 10 for.........	$3.00
NE-40	3 Watt NEON lamp Med. Screw Base. 10 for.........	$3.50
#313	28 volt .2 Amp. Pilot lamp Miniature Bay. Base. 10 for	$2.80
#1820	28 volt .1 Amp. Pilot lamp Miniature Bay. Base. 10 for	$2.00
#49	2 volt .06 Amp. Pilot lamp Min. Bayonet Base. 10 for	$1.00
1¾ volt	Transformer made for #26 tube filament. Will light 30 of the above #49 lamps.....	$1.50
#C1256	6 volt Automobile lamp D.C. but no pins to hold it in socket. 20 for..........$1.00 Special—100 for	$3.50
#1800	1.35 volt .06 Amp. Pilot lamp Miniature Screw Base 10 for	$1.00
#112	1.1 volt Flashlight lamp single pen-lite Battery. 20 for	$1.00

HAYDON SYNCHRONOUS TIMING MOTOR

110 v. 60 cycle 30 RPM...	$2.60
110 v. 60 cycle 1/10 RPM..	$2.35
110 v. 60 cycle 1 RPM....	$2.85
220 v. 60 cycle 2 RPM....	$1.65

New Sound Powered HAND SET TELEPHONES. 50' Flex. Rubber covered cable FREE. Pair **$19.00**

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UNIVERSAL VACUUM TUBE CORP.
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All types for industrial and experimental application. Tubes, cables and components.
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ARC—1's, ART—13's, RTA 1B's, BC348's
AND COMPONENT PARTS FOR ABOVE
WRITE OR CALL FOR BULLETIN
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166-08 DOUGLAS AVE. JAMAICA, N. Y.
RE 9-5960

TELEPHONE RELAYS

Large Stock of
CLARE, TYPES C D & E
COOKE, AUTOMATIC—ELECTRIC
ALL TYPES of COILS and PILE-UPS

Send Us Your Specs. for Our Quote

CLARE TYPE C STANDARD SIZE SENSITIVE TELEPHONE RELAYS

	Coil	Contacts	Will Close at	Price
1)	6500 ohms	1A	4 MA	$2.25 ea.
2)	6500 ohms	1C	2 MA	3.00 ea.
3)	6500 ohms	1B-1C	3.5 MA	2.75 ea.
4)	6500 ohms	2A	4 MA	3.00 ea.
5)	6500 ohms	3A	4 MA	3.00 ea.
6)	6500 ohms	3A-1B	4 MA	3.00 ea.
7)	6500 ohms	5A	5 MA	3.25 ea.

CLARE TYPE G HALF SIZE SENSITIVE TELEPHONE RELAYS

	Coil	Contacts	Will Close at	Price
1)	6500 ohms	2A	5 MA	$2.50 ea.
2)	5800 ohms	3A	4 MA	2.50 ea.
3)	5800 ohms	2B-1C	5 MA	2.50 ea.
4)	4850 ohms	1C	4 MA	2.50 ea.
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)	400 ohms	1A	12 or 24V.	1.65 ea.

CONTACT SYMBOLS

A=Norm. Open B=Norm. Closed C=S.P.D.T.

G.E. Relays #CR2791-B109P36 Coil—10,000 ohms Contacts 1A, 1B Operates on 8 MA..Price $1.65
Signal Wheelock Relays #KS9665 Coil—2,000 ohms Contacts-1A, 1B, 1C Oper. at 9 Ma Price—2.75 ea.
Leach Relays Type 1025-SN-BF. Coil—24V. 425 ohms. Contacts—D.P.S.T. Norm. closed. Rated at 10 Amps ....Price—$1.50 ea.
Five Prong CR-2791 G.E. Plug In Relays.
1) C-103C25 2200 ohms SPDT 4.5 MA...$4.00 ea.
2) C-104B28 700 ohms SPDT 6 MA......$3.00 ea.

Slow Release (For SCR-522-A) Telephone Relays. Part #A18258, Signal #2Z7650.3....Price $2.00 ea.

Clare SK-5032 (Hermetically Sealed) Plug-In Relays. Coil—30 ohms 6 volts Contacts—DPDT. Price—$4.00 ea.

Sigma Type 5F Sensitive Relays Coil Resistance—70 ohms each, contacts—S.P.D.T. Price .... $3.00 ea.

TYPE H TRANSMITTING MICA CONDENSERS

1)	.003 MFD	2500v.	DCW	$.45 ea.
2)	.01 MFD	1200v.	DCW	.45 ea.
3)	.001 MFD	1200v.	DCW	.35 ea.

Chase Electronic Supply Co.
222 Fulton St.
New York 7, N. Y.
Digby 4-3088
HOllis 4-5033

INVERTERS:

5D21 NJ3A—27 VDC input; output 110 Volt 400 cycle, 1 Phase 485 VA......................$39.50
PE-109D—Input 13.5 VDC 29 A; output 115 V 400 cycle, 1 Phase 1.53 Amps....................$59.50
PU-7/AP—Input 28 VDC 160 A; output 115 V 21.6 A 400 cycle 2500 VA..........................$89.50
PE-118—Input 28 VDC 100 A; output 115 V 400 cycle, 1 Phase 1500 VA.. ......Used: $14.95
PE-218—Input 28 VDC 100 A; output 115 Volt 400 cycle, 1 Phase 1500 VA.............Used: $24.95 NEW: $49.95
PE-115 or PE-206—Input 28 VDC 36 A; output 80 Volts 800 cycle 7.2 Amps........Like New: $12.95
TYPE 800-1-D—Input 28 Volts 62 A; output 115 V 7 Amps, 1 Phase 800 cycle...........Used: $39.95 NEW: $69.95

TRANSFORMERS AND CHOKES:

400 TO 2600 CYCLE

PLATE TRANSFORMER—Primary: 0-80-115 Volt 400-2600 CPS Max. VA 785; Sec.: 2000-0-2000 .3 Amps. Ins. 9000 Volts, Thermador #CS-5626 $19.95

FILAMENT TRANSFORMERS:
Primary: 0-80-115 Volt 400-2600 CPS Max. VA 35; Sec.: 2.5 Volts 10 Amps. Ins. 5000 Volts. Thermador #CS-8751 ....$6.95

Primary: 0-80-115 Volt 400-2600 CPS Max. VA 100; Sec.: 5 Volts 15 Amps. Ins. 5000 Volts. Thermador #CS-8750 ....$9.95
FILTER REACTOR—Inductance 2 Hy. DC current, 0.3 Amp. Ins. 5000 Volts...................$6.95

BLOWERS

115 Volt 60 cycle BLOWER (pictured), approx. 100 CFM Dis. 2¼" intake; 2" outlet. Quiet running Motor size: 2½"x3¼". NEW — not Gov't surplus.
Order No. 1C939 **$8.95**
DUAL BLOWER—Same as RN-520 above, except has blower assembly in each side of motor. Order No. 1C880 ....$13.95
COMPACT TYPE—108 CFM. motor built Inside squirrel case. 4-½" Intake: 3-⅜" x 3" Dis. Complete size: 4-¼" W. x 9-⅜" H x 8-⅛" D. Order No. 2C067 ....$14.50
FLANGE TYPE—140 CFM, 3-½" Intake: 2-½" Dis. Complete size: 8-½" W x 7-¼" H x 6-¾" D. Order No. 1C807 ....$13.95
FLANGE TWIN—275 CFM, 4-½" Intake: 3-¼" x 3" Dis. Complete size: 11-¾" W x 9-⅜" H x 8-1/16" D. No. 2C069 ....$21.95

DYNAMOTORS:

PE-103 Dynamotor with Filter Base and Cables, 6 or 12 VDC input; output 500 VDC 160 MA. NEW: ....$39.95 — Used: $29.95
DYNAMOTOR and BLOWER: 9 Volts DC Input: output 450 volts 60 MA. 4500 RPM. **At 6 Volts DC input**: output 260 Volts 65 MA. 3000 RPM.....$4.95

ALSO—PE-73; PE-36; DM-63; DM-33; 5055; DM-416.

MOTORS:

24 VOLT DC 1/10 H P
2800 RPM Reversible Motor, Size: 5-¼" x 3-½". Shaft Size: 1" x ¼". Emerson #186-0412 — Price $5.95
GEAR HEAD for above motor. Ball Bearing Geared Shaft, 10 to 1 reduction......Price: $5.95
COMBINATION: Motor and Reduction Gear $10.00
24 VAC OPEN FRAME—20 RPM Double Shaft Back Gear Motor with Disengage Clutch. Shaft size: 1-½" x 3/16" ....Price: $6.95
24 VAC OPEN FRAME—3 RPM Back Gear Motor. Shaft size: ⅝" x 3/16"................Price: $5.95
24 VDC REVERSIBLE—5000 RPM with Magnetic Brake, Flange Mount, Spline Shaft—size: ⅝" x 3/16". Motor: 4" L. x 2-½" Dia. GE Motor only #5BA25AJ32A ....Price: $8.95
24 VDC AIRWAY MOTOR—Model #Z-350. Approx. 5000 RPM. Motor size: 2-½" x 1-⅝". Shaft size: ½" x ¼"..........................Price: $4.95
26 VOLT 60 CYCLE—60 RPM Synchronous Cramer Motor #1147. Shaft size: 1" x ⅛"...........$1.95
110 VDC 1/70 HP. 1550 RPM. Motor size: 4" x 2-½". Shaft size: 1" x 3/16". Redmond #157..$4.95
6 VDC 1/20 HP. 4000 RPM. Motor size: 5" x 3". Shaft size: ¾" x ¼". Redmond #E-56..Price: $4.95
12 VDC 1/30 HP. 4500 RPM. Motor size: 3" x 2-½". Shaft size: 1 "x 3/16". Delco #5047520........$4.95

24 VDC REVERSIBLE

MOTOR—3.7 RPM, 40 lb. Torque Motor Size: 5-½" x 4-1/32" x 3-5/16". Shaft Size: 21/32" x 5/16". Also operates 24 VAC, Philco No. 441-1008 ....$5.95
27.5 VDC—6000 RPM. 1.5 oz. in. Shaft Size: 1-⅛" x ¼". Motor Size: 2-½" x 1-½". No. 5069-267 ....$6.95
27VDC—1-10 HP—3500 RPM. Shaft Size: ⅝" x ¼". Motor Size: 4" x 3-½", Air Assoc. No. EE-763 $6.95
80 VDC—1/50 HP—3000 RPM. Shaft Size: ⅜" x ¼". Motor Size: 5" x 3". G.E. No. 5 PN38HA10..$8.95
28.5 VDC—1/35 HP—2200 RPM. Shaft Size: 1-½" x ¼". Motor Size: 4-½" x 3-¾". Electrolux No. 16876 ....$5.95

TRANSFORMERS—100V. 60 Cycle Pri.

5 VOLT CT-25A—10,000 V. Ins. OPEN FRAME—6" x 5" x 4-½"......$7.95
Sec. Two 12 V. 4 A. Windings—gives 12 V. 8 A or 24 V. 4 A............$5.95
Sec. 24 Volt ½ Amp. ..$1.50
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Sec. 24 Volt 6 Amp ...$5.95
Sec. 6-24 or 30 Volts 8 Amp. $5.95

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CFD-B 4-channel pilot regulated telephone repeaters.
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ISOLATION XFORMER 35 watts 115v prim., sec. 115v or 135v & 6.3..45A tap 2¼x2½x3". 2.45
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LINK mobile xmtrs #25UFM 30-40 MC....59.50
SUBMINIATURE tube socket 5 pin. 100 for 10.00
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VARIABLE 3-15 mmf Hammar. HF 1½" shft.69c
PL-144, SO-124, PL-68, AN-3106-10s-2s. 83-1H
BIRTCHER CLAMPS 926A, 926B, 926C......25c
FUSES: 3ag, mdl, mikes, switches j pots
SPARES for: BC1296A, MK11 Radar, AN/TPN-2
2% .002 Silver Mica CM30. Ask for flyer
300-3500 cycle 1400 w variable freq. electronic generator, 220v 60 cy. input. CML #1400.

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POWER RHEOSTATS

ohms	W	Ea.	ohms	W	Ea.	ohms	W	Ea.
.1	150	4.89	50	50	2.10	500	100	3.60
.5	25	1.98	60	25	1.86	500	150	4.63
.5	50	2.34	75	25	1.86	500	300	6.93
.5	150	4.89	75	50	2.10	750	25	1.86
1	50	2.34	75	75	3.25	750	150	4.90
2	50	2.34	80	50	2.10	1000	25	2.10
2	100	3.86	100	25	1.86	1000	50	2.22
2	300	6.93	100	50	2.10	1200	225	6.41
3	100	3.86	100	100	3.60	1200	300	6.93
3	225	6.41	125	25	1.86	1250	50	2.22
5	25	1.86	150	50	2.10	1250	150	4.90
5	50	2.10	175	25	1.86	1500	25	2.10
5	100	3.86	185	25	1.86	1500	50	2.22
5	150	4.63	200	25	1.86	1600	50	2.22
6	25	1.86	200	100	3.60	1800	150	5.15
6	50	2.10	200	150	4.63	2000	25	2.10
6	75	3.25	225	50	2.10	2000	50	2.22
7	25	1.86	250	25	1.86	2250	150	5.15
7.5	75	3.25	250	50	2.10	2500	50	2.22
7.5	225	6.41	300	50	2.10	2500	100	3.71
8	50	2.10	300	75	3.25	2500	150	5.15
10	25	1.86	300	100	3.60	3000	25	2.22
10	50	2.10	350	25	1.86	3000	100	3.71
10	100	3.60	350	100	3.60	5000	25	2.22
12	25	1.86	350	150	4.63	5000	50	2.34
12	50	2.10	370	25	1.86	7500	50	2.34
15	25	1.86	378	150	4.63	7500	100	4.40
15	75	3.25	400	25	1.86	10000	50	2.50
15	100	3.60	400	75	3.25	10000	100	4.75
20	50	2.10	500	25	1.86	15000	25	2.75
22	50	2.10	500	50	2.10	20000	150	6.98
25	25	1.86	500	75	3.25			
50	25	1.86						

Specify Type Shaft Required—1/8" S5 or Knob Type
(Special Prices to Quantity Users)

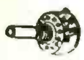
HIGH POWER TR. MICA

G-1 TYPE		.0005	10KV	.006	10KV
.0001	6KV	.00065	10KV	.015	7KV
.00015	6KV	.001	10KV	.25	1.6KV
.0002	6KV	.002	10KV	**G-4 TYPE**	
.0004	6KV	.03	2KV	.00025	30KV
.0008	6KV	.045	2KV	.0006	35KV
.001	6KV	**G-3 TYPE**		.0025	25KV
.01	4KV	.0001	20KV	.0039	20KV
.032	2KV	.00015	20KV	.0075	15KV
.04	1KV	.00025	20KV	.01	15KV
.051	1.5KV	.0004	20KV	.01083	12KV
.08	1.5KV	.00045	15KV	.03	8KV
.09	1.5KV	.00047	20KV	.056	5KV
G-2 TYPE		.0005	20KV	**OTHERS**	
.0001	10KV	.00095	5KV	.000155	30KV
.00015	10KV	.001	20KV	.0004	30KV
.0002	10KV	.0012	20KV	.000533	30KV
.0003	10KV	.00124	15KV	.001	30KV
.000375	10KV	.0015	20KV	.007	15KV
004	5KV	.0051	10KV	(Many Others)	

TRANSMITTING MICAS TYPE "4" and "9"

mfd.	wv	ty p	ea.	mfd.	wv	type	ea.
0001	600	4	.36	.0015	600	4	.36
003	600	4	.36	.00162	600	4	.42
00005	600	4	.29	.002	600	4	.39
00005	2500	9	.57	.002	1200	4	.72
0001	600	4	.29	.0025	600	4	.39
0001	2500	9	.57	.003	600	4	.43
00015	600	4	.36	.004	600	4	.45
0002	600	4	.29	.005	1200	9	.99
00025	600	4	.29	.0047	600	4	.47
.0005	600	4	.29	.005	2500	9	1.86
.0005	2500	4	.75	.006	600	4	.54
.0005	2500	9	.77	.01	600	4	.65
.0006	2500	9	.85	.01	1200	9	1.41
.0007	600	4	.36	.02	600	4	.92
.00075	600	4	.36	.02	1250	9	2.12
.0008	600	4	.36	.025	600	4	1.08
.0009	600	4	.36	.03	300	4	.99
.001	600	4	.36	.03	600	4	1.34
.001	1200	4	.54	.043	600	4	1.75
.001	1200	9	.57	.05	300	4	1.19

Many other sizes in stock



TYPE "J" POTENTIOMETERS

TYPE "J" $1.25 TYPE "JL" $1.50 TYPE "JJ" $2.95

ohms	ohms	o n	ohms	c l m
150*	4000†	80K†	500-500*†	130K-130K*
200†	5000*†	100K*†	600-600†	150K-150K†
200*	6500*†	125K*	1500-1500*	100K-200K†
300†	9000†	150K†	2000-2000*†	250K-250†
400*†	10K*†	165K†	2000-50K	300K-300K†
500*†	12K†	250K*	2200-25K*	350K-350K*
600†	15K*†	300K†	5000-35K†	2meg-2meg†
650*†	20K*†	400K*	25K-10K† sw	25K-25K*†
750†	25K*†	1meg*	2000-20K†	10K-10K*†
1000*	30K*†	1meg†	25K-10K†	1meg-1meg†
1400†	50K*†	2meg*†	7K-1meg†	5K-5K*†
1500*†	60K*	3meg*	300K-5K†	400K-400K†
2000*†	75K†		25K-400K†	500K-500K†
			1meg-500K†	50K-50K*†

Type "JJJ" $4.95

20K-200K-20K†	750K-750K-750K†
45K-27K-2.5K 1/4 sh	800K-800K-800K†
700K-700K-700K†	1meg-1meg-1meg†

(*) 1" screwdriver slotted shaft. (†) Knob type shaft. (*†) Both types.

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  4J52, 2K25, 723A/B, etc.
- **RADAR**
  APS-4, APS-6, APS-31, APS-33, SCR-720. Type SU and others.
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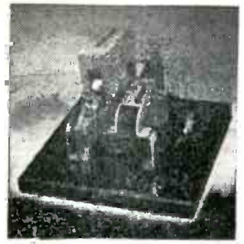
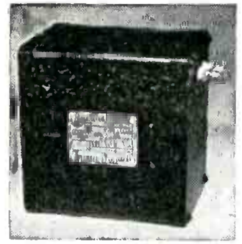


CONTACTOR— HEAVY DUTY— G.E.#2249960-G186: 40 amps, 230 volts, 60 cycles, single pole. Base mounting centers 6½" x 7" $9.95

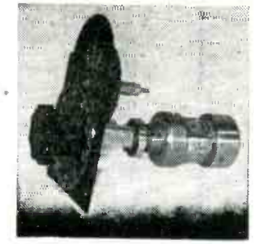
REDMOND BLOWER MOTOR: Type L 3¼" fan 5¼" length 115 volts 60 cycles 140 CFM 1600 RPM $9.50

HI-PASS FILTER: F-29/SPR-2 for over 1000 MCS. Type "N" connections. $12.50

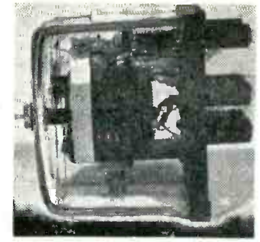
FILAMENT TRANSFORMER—AMERICAN TRANSFORMER CO.—TYPE EFS: Primary: 210/240 volts, 60 cycles. SEcondary: 5 volts & 10 amps. Johnson 50 watt socket #123-210. Height 12" $14.95



FILTER REACTOR— AMERICAN TRANSFORMER CO. TYPE PB: Test: 2.5KVAC oper: .5 KVDC Resistance 65 ohms 5 henries @ 300 mils to 25 henries @ 30 mils. Size: 5½" x 4¼" x 5-¾" $8.50



K BAND CAVITY — TKF-7SW: Gear Tuning, calibrated range 23400 — 24500 MCS. Panel mounting $47.50



TIME DELAY RELAY— WESTINGHOUSE: Type TD 115 volts 60 cycles single pole adjustable 0-90 secs. $19.75

TYPE G MICA CONDENSERS

MFD	Voltage	Type	Price
.04	1 KV	G-1	$12.50
.09	1.5 KV	G-1	16.30
.08	1.5 KV	G-1	16.30
.0008	3 KV	UC-2509K	13.75
.02	3 KV	G-1	19.50
.00095	5 KV	C-D48274	14.50
.0015	5 KV	CRV-48416	15.50
.006	5 KV	CRV-48415	19.50
.00025	6 KV	PL-586-59	15.90
.00024	6 KV	G-1	15.90
.0006	6 KV	G-1	16.40
.0004	6 KV	G-1	16.25
.0002	6 KV	1950-207	15.90
.004	6 KV	G-1	19.50
.001	6 KV	G-1	17.50
.0012	7 KV	CRV-48157	15.00
.003	7 KV	UC 3048	17.50
.002	8 KV	UC 2371	27.50
.000375	10 KV	CRV-48418	28.50
.00068	10 KV	MX-61	28.50
.00057	10 KV	CD-38879-2	28.50
.00025	10 KV	CRV-48155	28.50
.00015	10 KV	UC-3123	28.50
.00002	10 KV	UC-3292	25.50
.0008	10 KV	CRV-48417	28.50
.0005	10 KV	UC-2617	28.50
.0002	10 KV	48270-B5	28.50
.001	10 KV	UC-3296	28.50
.02	10 KV	PL-133-52	87.50
.0025	12 KV	XPXW	57.50
.008	12 KV	G-4	62.40
.00532	15 KV	1980-318	60.40
.00002	15 KV	MX-60	49.50
.002	15 KV	G-3	52.90
.0025	15 KV	1970-218	54.10
.01	15 KV	1940-225	92.50
.00035	20 KV	PL-289-51	52.40
.00025	20 KV	G-3	52.40
.00015	20 KV	1970-404	53.50
.0066	20 KV	PL-1391-97B	59.50
.0005	20 KV	G-3	54.70
.0003	20 KV	UC-3112K	54.70
.0002	20 KV	G-3	52.50
.0001	20 KV	G-3	49.90
.004	20 KV	G-3	99.50
.0025	25 KV	G-4	190.00
.002	30 KV	1940-217	210.00
.0005	35 KV	G-4	210.00
.001	35 KV	1940-214	225.00
.001	75 KV	PL 49-728	360.00

VACUUM CONDENSERS

MFD	VDC	Type	Price
50MMFD	5K	8047	$5.50
12 MFD	20 K	VC-12	7.50
50 MFD	20 K	VC-50	12.50
50 MFD	20 K	W-50	11.50
100 MFD	7.5 K	1L33	14.50

HIGH VOLTAGE CAPACITORS

MFD	VDC	Type*	Price
.00365	15 K	14F162	$22.50
.0091	15 K	14F222	27.50
.005	25 K	25020	29.50
.025	10 K	Y-3605	9.90
.035	400 K	P6756	1.25
.045	16 K	D-4495	10.25
.075	16 K	572	19.75
.1	7.5 K	25F175	7.50
.1	12 K	26F628	10.25
.1	15 K	14F63	9.75
.1/.1	7.5 K	7520	7.25
.15	8 K	8020	7.50
.15	65 K	14F72	92.50
.15/.15	5K/8K	Vitamin "Q"	37.50
.25	15 K	26F359	27.50
.25	20K	TK 200002-2	42.50
.25	25 K	D-91281	57.50
.25	50 K	14F97	72.50
.33	8.5 K	26F267	22.50
.35	30 K		62.50
.49	10 K	LD	42.50
.5	25 K	14F103	62.50
.5/.5	9 K	PC 2151	35.50
.51	10 K	LD	42.50
1.	7.5 K	26F213	22.50
1.	10 K	14F267	42.50
1.	13 K	25F313	45.00
1.	15 K	14F63	47.50
1.	25 K	TJ	82.50
1.25/1.25	7.5 K	26F360	31.00
2.	7.5 K	56	27.50
2.	32 K	43J861-Z30	210.00

MICA CONDENSERS

TYPE 4

MFD	VDC	Price
.00005	1200	$ .69
.0022	1200	.69
.025	600	1.49
.022	600	1.25
.004	1200	.79
.001	600	.49
.01	500	.89
.01	600	.69
.01	1100	1.25
.01	1200	1.35
.01	2500	2.25

TYPE 9

MFD	VDC	Price
.0005	1200	$ .69
.024	1500	2.50
.005	2500	1.50
.003	2500	1.90
.01	2500	2.05

TYPE F MICA

MFD	VDC	Price
.00055	5000	$6.90
.00051	5000	6.90
.0009	3000	5.10
.0001	3000	5.25
.056	1000	3.90
.025	2500	5.10
.02	2000	4.90

TYPE E

MFD	VDC	Price
.00005	3000	$7.25
.001	8000	10.25

RESISTORS STANDARD BRANDS

25 WATTS

Ohms		Price
22	Adj.	$.63
50	Adj.	.63
75	Adj.	.63
160	Adj.	.63
200	Adj.	.63
1K	Adj.	.63
1.5 K	Adj.	.64
2.5 K	Adj.	.64
3.5 K	Adj.	.64
5 K	Adj.	.65
9 K	Adj.	.70
10 K	Adj.	.70
20 K	Adj.	.70
100 K	Adj.	.75

50 WATTS

Ohms		Price
1	Adj.	.85
2	Adj.	.85
10	Adj.	.79
25	Adj.	.79
150	Adj.	.79
200	Adj.	.79
500	Adj.	.79
750	Adj.	.79
1 K	Adj.	.79
1.5 K	Adj.	.82
2 K	Fixed	.59
4 K	Fixed	.59
5 K	Fixed	.59
8 K	Adj.	.89
10 K	Adj.	.89
15 K	Fixed	.70
20 K	Fixed	.70
25 K	Fixed	.78
25 K	Adj.	1.02
30 K	Adj.	1.03
33 K	Adj.	1.03
35 K	Fixed	.78
40 K	Fixed	.78
[illegible]	[illegible]	1 .10

100 WATTS

Ohms		Price
15	Adj.	1.19
25	Adj.	1.19
50	Fixed	.81
75	Fixed	.81
100	Adj.	1.19
125	Fixed	.81
500	Fixed	.81
500	Adj.	1.19
750	Fixed	.81
5 K	Fixed	.87
20 K	Adj.	1.34
50 K	Fixed	1.12

200 WATTS

Ohms		Price
5	Fixed	.81
10	Fixed	.81
25	Fixed	.81
50	Fixed	.81
50	Adj.	1.19
100	Fixed	.81
150	Fixed	.81
250	Fixed	.81
1 K	Fixed	.81
1.5 K	Fixed	.85
2 K	Fixed	.85

420 WATTS

Ohms		Price
10	Fixed	1.99

PULSE NETWORKS

SPRAGUE:

6-A5-½-2000-50M
6-E3-.25-2000-50P
9-E3-.25-2000-50P
9-E3-.5-2000-50P
9-E5-2-1000-50P
10-E3-.5-2000-50P
10-E5-1-400-50P
15-E3-½-400-50P (Vitamin "Q")
15-E3-.4-800-50P
15-E4-1-400-50P
15-E3-.5-2000-50P
15-A-1-800-50
25-E5-4-120-50P

PULSE TRANSFORMERS

UTAH:

9280	9286	9340
9281	9287	9350
9282	9287-D	X 124 T2
9283	9288	X 124 T3
9284	9289	X 143 T3
9285	9318	X 146 T1

RAYTHEON:

UX 7307	UX7361 A	UX 10066
UX7350	UX 8092	U 12920

WESTINGHOUSE:

1P1	132 AW	145 EW2
1P2	132 BW	145 EWP
1P4	132 BW2	166 AW
1P8	132 DW	176 AW
1P13	133 AW	407 CW2
1P26	134 EW	
1P29	145 EW	

GENERAL ELECTRIC:

68G627	68G894	80G59
68G666	68G979	80G625
68G709	80G13	
68G813	80G58	

FREED:

#22647	K 2478	K 35J564-D2
	K 2721A	BX 17-17
K 2449	K 2728	7472407
K 2460	K 2746 A	

SPECIAL

PRECISION RESISTOR

Wire Wound
IRC TYPE WW5
1 Meg. 1 W 1%
Quantities Available 4.00 ea.

TUBE LISTING

STANDARD BRANDS — FULLY GUARANTEED

1B22	4.25	2J34	42.50	3CP1	2.50	5FP7	4.90
1B23	9.50	2J37	14.50	3D21-A	5.50	5GP1	5.75
1B24/REL30	14.95	2J49	70.00	3DP1	5.00	GL-5J29	17.50
1C21	2.20	2J50	67.50	3DP1-A	6.25	5J30	47.50
1P23	4.75	2J54	97.50	3DP1-S2	7.50	5JP1	32.50
1P28	12.50	2J54-B	147.50	3E29	11.90	5JP2	32.50
1P40	1.85	2J61	63.00	3EP1	4.85	5LP1	22.50
1P42	5.60	2J62	63.00	3FP7	4.50	5LP5	47.50
2AP1	8.95	2K22	68.00	3FP7-A	22.50	6AN5	3.50
2AP1A	10.25	2K23	68.00	3GP1	4.50	86J	14.50
2AP5	9.90	2K25	33.50	3J30	99.50	6C21	49.00
2B22	3.95	2K28	57.50	3JP1	17.50	6C24	57.50
2C22	1.50	2K29	30.00	4B22	6.25	6G12	.98
2C26	.89	2K33	299.00	4B25	8.50	7BF7	19.50
2C34/RX34	.89	2K33A	310.00	4C35	27.50	7BP7	8.50
2C39	29.50	2K34	190.00	4D32	26.50	7H12	.98
2C40	14.95	2K43	125.00	4E27	17.50	9JP1	27.50
2C44	2.10	2K44	125.00	4J32	250.00	10T1	.75
2C46	21.00	3B22/EL1C	2.95	4J36	250.00	10Y	.99
2D21	1.65	3B23/38222	5.00	4J37	250.00	12GP7	17.50
2E22	2.20	3B25	6.25	4J63/QK-72	320.00	13-4	1.25
2E30	2.25	3B26	5.90	5AP1	6.00	15E	2.75
2J22	12.50	3BP1	5.90	EL-5BHD/4B23	11.50	15R	1.20
2J26	22.50	3C21/CEQ	6.50	5BP1	5.90	TUF-20	5.50
2J27	22.50	3C23	9.90	5BP4	5.90	D-21	5.25
2J31	42.50	3C24	1.75	5D21	22.50	RX-21	8.50
2J32	31.00	3C37	32.50			23D4	1.25

FG-27A	17.50	100-TH	11.50	304-TH	13.75	GL-502	1.85
28D7	1.85	HF-100	12.50	304-TL	14.00	527	15.00
RK-34	.99	FG-105	37.50	310-A	6.10	532-A	3.95
35-T	7.50	VR-105	1.25	311-A	7.50	559	3.10
35-TG	8.00	VU-111	1.25	313-C	3.50	GL-562	92.50
39/44	.35	X-111	675.00	316	1.75	575-A	19.50
CHS-41	.75	111-A	2.50	316-A	2.50	HY-615	.60
VR-54	1.25	111-H	2.50	327-A	6.25	616	35.00
55-1	.99	HY-114B	.89	332-A	45.00	635	11.50
RK-60/1641	2.50	C-120	12.50	350-A	7.50	651	75.00
QK-60	100.00	121-A	8.75	350-B	5.95	ZP-653	225.00
QK-61	100.00	VR-150	1.10	355-A	22.50	WL-672	25.00
VR-65	1.75	211-JAN	1.50	CK359-A	7.90	700-A	37.50
HY-69	3.25	212-E	42.50	368-AS	8.25	700-D	37.50
71-A	.85	RX-215	9.25	371-B	1.25	702-A	3.10
CEQ-72	.95	227	4.50	388-A	4.25	703-A	5.75
RKR-72	1.20	RX-233A	4.90	393-A	13.50	704-A	1.25
QK-72/4J63	320.00	233-A	3.75	394-A	6.00	705-A	1.95
RKR-73	1.50	249-B	8.25	FP-400	17.50	706-AY	57.50
B-74	49.50	249-C	9.50	417-A	22.50	706-B	57.50
75-T	13.50	250-R	19.25	GL-434A	21.00	706-BY	57.50
FG-81A	9.25	250-TH	22.50	446	2.90	706-CY	57.50
83	1.10	257B/4E27	15.75	446-A	4.50	706-EX	57.50
VR-90	.99	267-B	5.25	446-B	15.00	706-GY	57.50
VR-91	1.25	271-A	7.50	464	17.50	707-A	9.90
VR-92	1.25	274-B	3.25	GL-471A	12.50	707-B	17.50
C-100-E	17.50	300-B	12.50	CK-501-LX	1.50	707-BY	45.00

708-A	4.75	815	2.50	CRC-876	1.50	1201	1.25	CK-5608	5.95
709-A	3.70	816	1.50	884	1.90	1203-A	.84	5640-A	12.50
713-A	1.25	822	19.50	885	1.50	1603	5.75	5651	3.30
714-A	12.50	826	1.60	886	2.75	1612	2.25	CK-5672	3.50
715-A	5.90	SD-828A	6.00	902	9.00	1613	1.08	6050	3.65
715-B	8.25	828	12.50	902-PI	10.50	1616	2.25	7193	.71
717-A	1.10	829	10.50	SD-917	2.75	1619	.49	8000	15.25
719-A	27.50	829-B	13.50	918	2.80	1620	5.90	8005	7.50
721-A	4.50	830-B	3.10	921	2.05	1624	3.40	8011	1.65
723A/B	27.50	832	7.50	925	1.80	1625	.49	8012	2.90
724-A	4.25	832-A	9.75	927	2.30	1626	.49	8013	2.75
724-B	2.90	833	37.50	930	1.75	1629	.51	8013-A	5.90
725-A	9.25	833-A	47.00	931	5.50	1630	1.25	8016	1.25
926-A	13.50	836	4.75	931-A	6.10	1631	2.59	8020	1.90
726-B	54.00	837	1.50	954	.49	1632	.99	8025	5.25
726-C	105.00	838	2.50	955	.41	1633	1.00	9002	1.20
728-EY	250.00	841	1.32	956	.49	1634	.75	9003	1.75
801-A	.90	843	.60	957	.49	1636	3.05	9004	.57
803	4.75	849	75.00	958-A	.75	1638	.49	9005	3.75
805	4.75	851	109.95	959	3.50	1644	2.75	9006	.48
807	1.50	860	6.75	966-A	1.35	1655	3.50	CRC-38022	.99
808	7.50	CG-861	36.50	991	.55	1656	12.00	38089-X	.99
809	3.50	864	.89	CK-1006	3.50	1960	4.50	38222/3B23	4.90
810	12.50	865	3.00	CK-1089	2.75	2050	1.70	CK-38233	.75
811	2.75	866/866A	1.60	CK-1090	3.25	2051	1.25	D-79512	7.50
812	3.25	872-A	3.90	R-1130	16.00	5558	14.00		
814	3.50	874	1.60	R-1130B	17.50	5582	2.65		

INDEX TO THE SEARCHLIGHT ADVERTISERS

JULY, 1953

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SEARCHLIGHT SECTION
(Classified Advertising)
H. E. Hilty, Mgr.

OUTSTANDING MID-YEAR SPECIALS

SELSYNS—SYNCHROS

**Immediate Delivery
Fully Guaranteed**

1CT Control Transformer, 90/55V 60~	$69.95
1G Generator, 115/90V 60~	69.95
IF Motor, 115/90V 60~	64.50
1HCT Control Transformer, 90/55V 60~	84.50
1DG Differential Generator 90/90V 60~	79.95
1D Differential Motor, 90/90V 60~	99.50
1N Motor, 115/90V 60~	49.50
1SF Motor, 115/90V 400~	17.50
1F Special Motor, 115/90V 400~	15.00
2J1D1 Generator, 115/90V 400~	12.50
2J1F1 Generator, 115/57.5V 400~	9.50
2J1F3 Generator, 57.5/57.5V 400~	9.50
2J1G1 Control Transformer 57.5/57.5V 400~	9.50
2J1H1 Differential Generator 57.5/57.5V 400~	12.50
2J1H2 Generator 115V 400~	17.50
2JD1J1 Motor, 115/90V 400~	15.00
2JD5R1 Motor, 115/90V 400~	27.50
5SF Motor, 115/90V 400~	32.50
5SG Generator, 115/90V 400~	32.50
5SDG Differential Generator 90/90V 400~	32.50
KS5950 Generator, 115/90V 400~	15.00
KS5950L2 Generator, 115/90V 400~	15.00
2JA39BB2 Motor, G.E., 110/55V 60~	55.00
2J5FB1 Control Transformer 105/55V 60~	60.00
2JD5C2 Motor, 115/105V 60~	60.00
2J5H1 Generator, 115/105V 60~	50.00
2J5F1 Control Trans 90/55V 60~	60.00
2J5A4 Generator, 115/105V 60~	60.00
2J5S1 Differential Generator 90/90V 60~	60.00
2JD5J2 Motor 115/90V 60~	60.00
2J5H2 Generator 115/90V 60~	60.00
2J5D1 Control Trans 90/55V 60~	60.00
2J65F1 Generator 110/55V 60~ (used)	35.00
5A Generator, 115 Volts 60 Cycles	22.50
5B Generator, 115 Volts 60 Cycles	22.50
5CT Control Transformer 90/55V 60~	45.00
5HCT Control Transformer 90/55V 60~	77.50
5D Differential Motor, 115/90V 60~	50.00
5DG Differential Generator 90/90V 60~	50.00
5F Motor, 115/90V 60~	45.00
5G Generator, 115/90V 60~	45.00
5M Motor, 115 Volts 60 Cycles	22.50
5N Motor, 115 Volt 60 Cycles	22.50
2J6F2 Generator 115/90 Volts 60~	64.50
6SG Generator, 105/90 Volts 60~	60.00
6CT Control Transformer 90/55V 60~	60.00
6DG Differential Generator 90/90V 60~	60.00
6G Generator, 115/90V 60~	57.50
7G Generator, 115/90V 60~	79.95
C44968-6 Type 11-1, Repeater, 115V 60~	22.50
C56701 Type 11-4 Repeater, 115V 60~	22.50
C56776-1 Repeater AC Syn. 115V 60~	22.50
C69406 Diehl FJ84-8 Transmitter 115V 60~	22.50
C69406-1 Type 11-2 Repeater, 115V 60~	22.50
C78248 Transmitter AC Syn. 115V 60~	22.50
C78249 Differential AC Syn. 115V 60~	9.50
C78254 Type XII Differential 115V 60~	22.50
C78411 Transmitter AC Syn. 50V 50~	14.50
C78414 Transmitter AC Syn. 115V 60~	49.50
C78359 Diehl 84-4, Receiver 115V 60~	22.50
C78360 Diehl 84-5, Transmitter 115V 60~	22.50
C78386 Type XV Transformer 115V 60~	22.50
C78791 Transmitter AC Syn. 115V 60~	22.50
C79331 Transmitter AC Syn. 115V 60~	22.50
C81369 Type 11-8 Repeater, 115V 60~	22.50
PATT-6547 Admiralty Transmitter 115V 60~	17.50
PATT-6548 Admiralty Transmitter 115V 60~	17.50
Admiralty Size 1 Manslip Motor 115V 60~	2.95
Repeater Type X, CAL5328A-1, 115V 60~	32.50
Transmitter Type 130-1, 120/90 VDC	32.50
CA14914-4 Type 851 Bendix Motor 32V 60~	22.50

HIGH VOLTAGE CAPACITORS

Cat. #	Mfd.	WVDC	Price
22F28	10	1.5KV	12.50
18F269	60	3KV	$65.00
22F985	2	4KV	14.50
22F221	4	4-KV	22.50
PFD40244G	7	4KV	32.50
14F1	4	5KV	32.50
14F2	7	5KV	52.50
19F210	0.1	6KV	37.50
A7548	2x.25	6KV	17.50
TK00020	2	6KV	27.50
7520	2x1.0	7.5KV	27.50
14F338	4.5	7.5KV	79.50
CC21B	2x0.5	9KV	32.50
24717	0.2	10KV	6.50
10020	0.1	10KV	9.95
14F104	1.0	10KV	25.00
26F68	0.1	12KV	9.95
TK120065	.65	12.5KV	19.95
15020	.25	15KV	19.50
14F17	1	15KV	45.00
14F63	1	15KV	45.00
14F18	1.5	15KV	62.50
20020	.25	20KV	27.50
14F64	.25	20KV	27.50
37485	.25	20KV	27.50
26F585	.06	25KV	17.50
XSW200	.25	20KV	27.50
20005	0.5	20KV	45.00
14F136	.75	20KV	50.00
14F22	1.0	20KV	52.50
14F139	.01	22KV	15.50
Inerteen	.5	25KV	57.50
25020	.5	25KV	57.50
14F24	.5	25KV	57.50
14F83	.75	25KV	72.50
Inerteen	1.0	25KV	85.00
A6734	1.0	25KV	85.00
1258441	1.5	25KV	145.00
14F112	.001	50KV	24.50
14F98	.025/.025	50KV	37.50
14F127	.025	50KV	37.50
14F126	.2	50KV	50.50
14F97	.25	50KV	70.00

SINE-COSINE GENERATORS

(Resolvers)

Diehl Type FJE43-9 (Single Phase Rotor). Two stator windings 90° apart, provides two outputs equal to the sine and cosine of the angular rotor displacement. Input voltage 115 volts, 400 cycle .... $30.00 ea.

Diehl Type FPE-43-1 same as FJE-43-9 except it supplies maximum stator voltage of 220 volts with 115 volts applied to rotor .... $25.00 ea.

TRANSTATS

Amertran type 29144, 250VA, 103-126V Commutator Range, Fixed Windings, 115V, 2.17A max $8.50

Amertran type TH-2½B, 0-260V Commutator Range, 2.5A, 570VA $17.50

Amertran type TH-10A, 0-130V Commutator Range, 10A, 1.3KV max $29.95

Amertran type TH-11B, 0-260V Commutator Range, 11A, 3KVA max $49.95

Amertran type Voltage Regulator, 0-130V Commutator Range, 100A, 11.5 KVA max. May be reconnected for 230V 50A $225.00

PULSE NETWORKS

Sprague #7.5-E4-16-60-67-P. 7.5KV	$7.95
Sprague #7.5-E-3-3-200-67-P. 7.5KV	$6.75
Sprague #8-E5-1-1000-50P. 8KV	$22.50
Sprague #10-E3-0.5-2000-50P	$29.95
Sprague #15-A-1-400-50P	$27.50
Sprague #15-E4-0.91-400-50P	$19.95
Fast #15-ES-1.33-700-50P2T	$29.50
25E5-1-500-50P	$75.00
Raytheon Pulse Trans. Type WX-5137. Pri: 4KV, 1 Mu. Sec., Sec: 16KV 16A	$22.50

HEAVY DUTY COPPER OXIDE RECTIFIERS

Hammett Model SPS-130. Input AC:208/230V 60 cy 3ph 21A. Output DC: 28 volts @ 130A, Cont. Duty. Output voltage variable by means of power tap switch. complete with indicating meters on front panel. Self Cooled. Schematic available. Brand New. Export Packed $297.50

DIEHL AC CONTROL MOTORS

FP25-2, 22V 60~ 2ph. 85A 1600RPM	$24.50
FP25-3, 20V 60~ 2ph. 60A 3200RPM	$22.50
FPE25-9, 100V 400~ 2ph. 44A 7W 4 pole	$24.50
FPE25-11, 75V 60~ 2ph. 11A 4W 2 pole	$27.50
FPE25-12, 115V 60~ 2ph. 16A 5W 2 pole	$34.50
FPE25-16, 20V 60~ 2ph. 85A 1600 RPM	$27.50

TRANSMITTING AND SPECIAL PURPOSE TUBES

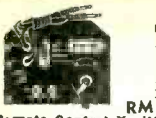
OA2	.95	2C44	1.20	3E29	14.95	RK20A	9.95	267B		706DY	58.50	841	.65	1641	2.65
OA3	1.04	2C50	4.50	3FP7	3.95	24G	1.85	270A	99.50	706GY	59.50	843	1.26	1642	.85
OA4G	1.05	2C51	6.25	3FP7A	14.00	25T	9.00	267B		707A	18.25	845	13.50	1663	
OB2	1.25	2C52	5.75	3GP1	6.95	FG-27A	23.00	270A	99.50	707B	19.25	849	59.95	1846	
OB3	1.10	2C53	11.50	4-65A	19.50	28D7	2.35	FG271	57.50	708A	4.75	851	75.00	1851	1.95
OC3	1.10	2D21	1.60	KC4	50.00	FG32	15.00	274B		709A	3.85	852	27.50	1960/5836	
OD3	.95	2E22	2.50	KC4-3	39.95	FG33	23.00	FG280	59.50	713	1.98	857B	225.00	2050	1.85
OZ4	.95	2E30	2.00	4B24	8.50	FK34	85.00	282A		714AY	12.50	860	4.95	2051	1.15
VG1A	8.75	2E31	2.10	4B26	11.00	35T	9.00	304TH	13.50	715	5.00	861	29.95	4120/SS501	3.25
ELC1B	6.75	2E32	1.60	4B28	6.25	35TG	9.00	304TL	11.95	715A	5.75	864	.35	R4330	12.00
1B21A	2.95	2E36	2.25	4B32	11.00	35T1G	9.00	307A	4.95	715B	12.50	865	2.35	R4410	15.00
1B22	2.10	2E41	3.35	4C35	32.50	CE36C		308A	55.00	715C	24.50	866A	1.60	5528/C6L	10.00
1B23	8.75	2E42	2.65	4E27	22.50	RK39	14.50	CE309	5.25	717A	1.75	868	2.50	5557	7.25
1B24	9.00	2G21	2.20	4E27A	35.50	EF50	1.30	310A	6.50	718BY	79.50	872A	4.25	5559	18.50
1B25	3.75	2G22	2.20	4J31	135.00	53A	5.95	311A		719A	42.50	874	1.50	5651	3.35
1B27	21.25	2J21A	7.50	4J32	195.00	FG57	14.95	313C	4.20	720CY	65.00	885	2.00	5654	4.00
1B29	2.75	2J22	9.00	4J33	195.00	58A	1.35	316A	3.00	721A	4.50	886	1.70	5659	
1B32	2.25	2J26	25.00	4J52	225.00	QK59	65.00	319A	23.25	723AB	22.50	905	3.95	5660	
1B35	11.50	2J27	23.00	C5B	4.25	RK65		323B	12.50	724A	2.75	913	15.50	5661	3.75
1B36	16.75	2J30	69.50	5BP1	5.25	FG67	22.50	320A	4.75	724B	3.15	923		5663	2.00
1B38	39.95	2J31	27.50	5CP1	4.50	CEQ72	.85	331A	3.50	725A	9.50	926	2.45	5664	
1B41	45.00	2J32	37.00	5D21	18.35	RKR73	.75	S340	2.65	726A	14.50	927	1.95	5670	7.00
1B42	17.50	2J34	32.00	5FP7	2.50	RK75	4.25	349A	1.35	726C	75.00	929	1.40	5691	8.45
1B50	32.50	2J37A	37.50	5FP7A	12.50	FG81A	9.25	350A	8.00	SN729	3.25	930	1.65	5692	8.45
1B51	12.00	2K22	45.00	5FP14	27.50	89Y	.95	368AS	7.95	730A	28.95	931A	6.00	5693	6.95
1B54	37.50	2K23	45.00	5JP1	27.50	FG95	27.50	371B	1.39	WL762		932	4.25	5732	
1D21	3.95	2K25	37.50	5LP1	27.50	FG97	25.00	388A	4.75	801A	.85	954	.49	5749	3.95
1N21	1.25	2K26	95.00	5LP2	35.00	FG98A	27.00	393A	12.50	802	4.20	955	.69	5751	3.75
1N21A	1.55	2K28	29.95	5LP5	14.50	HF100	15.00	394A	4.50	803	14.95	956	.69	5783	1.65
1N21B	3.00	2K29	29.95	5RP1A	27.50	ML100	59.95	417A	17.50	804	16.50	957	.69	5803/VX-34	5.25
1N23	1.35	2K33	195.00	5RP2A	37.50	100TS	2.95	446A	3.75	805	4.95	959	3.25	5814	3.95
1N23A	2.35	2K39	195.00	5R4GY	1.75	FG104	24.95	446B	16.75	806	17.50	991	.39	5838	4.75
1N23B	3.35	2K41	150.00	5R4WGY	3.25	FG105	24.95	446D	16.75	807	1.69	CK1005	.95	5871	
1N25	5.25	2K45	135.00	5UP11	22.50	VU118	1.00	450TH	65.00	807W	3.25	CK1017		5931/5U4WG	4.95
1N26	8.25	2K56	98.00	6AJ5	2.55	114B	2.35	450TL	65.00	808	6.95	CK1089	1.25	X6089	1.75
1N34	.60	2RA3	1.95	6AK5	1.30	RX120A	14.50	464A	8.95	809	3.50	CK1090	.75	UX6653	1.25
1N34A	.90	2V38	2.75	6AN5	3.15	F123A		471A	12.50	810	13.50	R1111	3.50	7193/2C22	.49
1N35	1.75	2X2	.75	6AR6	3.35	F124A	26.50	GL502A	1.80	811	2.95	R1131C	7.50	8002R	105.00
1N36		2X2A	1.85	6AS6	2.95	VT127	1.95	530	16.95	812	4.75	E1148	.95	8011	1.00
1N47	5.25	3AP1	12.25	6AS7	4.50	VT127A	2.75	532A	3.75	813	13.50	1201	1.25	8012	3.00
1N58A	1.15	3B22	4.75	6BG7	1.80	F128A		549	34.50	814	3.25	1203A	.95	8013	3.35
1N60	.60	3B24	5.50	6BM6	75.00	FG172	29.95	559	1.75	815	2.95	1206	.85	8013A	5.50
1P21	42.50	3B24W	7.50	C6J	7.95	GL203A	11.00	615	1.75	816	1.50	1274		8020	2.15
2AP1	6.50	3B26	6.75	6C21	49.95	203D	3.25	WL616		826	1.25	1614	2.10	8025	5.45
2AP1A	10.50	3B27	4.25	6J4	6.95	204A	69.95	617	11.00	828	12.50	1615	1.25	9001	1.25
2B22	3.25	3B29	14.95	6K4	4.50	207	230.00	KU628	32.50	829	9.00	1619	1.25	9002	.95
2C21	.95	3BP4	7.50	7BP7	8.95	211	1.45	F631		829A	11.00	1620	6.50	9003	1.55
2C22	.49	3CP1	4.75	9LP7	37.50	CE213	2.50	FG632A		829B	13.95	1622	2.25	9004	.65
2C26A	.59	EL3C	8.75	10Y	.65	217C	10.95	649	6.95	830B	3.25	1623	4.00	9005	2.25
2C33	3.65	3C24	1.95	12DP7	17.50	RX233A	3.95	651/656	69.50	832	8.50	1625	.49	9006	.45
2C36	27.50	3C27		12GP7	17.50	FG235A	72.50	F660	37.95	832A	9.95	1626	.49	AX9903	
2C39	27.50	3C31	3.95	12HP7	17.50	249B	7.95	653	9.95	833A	37.50	1629	.49		
2C39A	33.75	3C35		CA13	.70	250TH	21.50	672A	34.50	834	13.50	1630	.85		
2C40	7.50	3C45	18.50	15E	1.85	250TL	19.00	GL675		836	4.65	1632	.85		
2C43	18.00	3DP1	9.50	15R	1.05	264C	3.45	705A	2.35	837	1.65	1633	1.10		
		3D23	2.50	FG17	5.25			706AY	59.50	838	4.95	1634	.85		

The above listings represent only a small portion of our tremendous instrument stock. Allow us to quote you on your instrument or test equipment requirements. All prices F.O.B. Boston. Subject to change without notice. Merchandise Fully Guaranteed.

ESCO ELECTRO Sales Company Inc. ESCO

50 EASTERN AVE., BOSTON 13, MASS. CAPITOL 7-3456

RM29



For Field Phone Use or Remote Control of Transceiver. Simple 2 wire 15 mile Operation. Includes talk listen & ringing Circuits. NEW............$10.95

RM 53

Remote Control Xmitter or Intercom. Less Relay Plugs & Cable. Includes Condensers, Switches, Jacks & Matching XFMR Mike to grid. Line to Grid & Line to Line, in 7½x4½x3¼" Metal Box. NEW............$1.25

MICROWAVE

Klystron Mts Assy (723AB) & Coupling to 2 Type "N" Co-Ax Fittings. As Shown $9.98; 2 for $18.00
1 Microsecond Delay Line "Millen" $2.95; 4 for $10.00
Microwave Lighthouse Assy —P/O RT39 APG5 & 15, osc and Tr Cavities, Tunes 24-2700 MC. SPECIAL $20.00; 2 for $36.00
Variable Attenuator 3CM, Vernier ADJ, RND Choke to Straight Flange 1"x½"............$39.95
X Band Adaptor UG39 to UG40 Choke to Plane Flange Sperry Lab Dsgn.......$1.69; 4 for $6.00
X Band Straight Wave Guide Per/Ft........$2.
AN/APS10 Modulator Assembly. New Mfgrd G. E. Design #ML-766 3911-G1, Includes 2J42 & Magnet 3C45 & (2) 3B24............$198.00

CONDENSER SPECIALS

2 MFD 330 VAC
1000 VDC
STD MFGR
25¢ Lots of 10

Smaller Quantities Each........49c; 3 for $1.25
2MFD 600VDC Porcelain Insulators W/Adj Mtg Clamp............3 for $1.50

METER BUYS

0-5MA DC Tuning: Aircraft Mtg. "AN" Type.........$1.29
0-30 VDC "AN"..1.49; 2 for 2.49
0-60 ADC "AN" Type Mtg Less Shunt.........2.98; 2 for 5.00
0-15 VAC GE 2½ Rnd 800cy 1.29
0-150 VAC/W stghs/2½ Rnd 3.49
0-150 VAC/25-125cy/3½" Sq/RA35/Wstgh............5.98
0-1 MADC GE 3½" Rnd Bklt CSD.......5.39
0-1 MADC Wstghs 3½" Sq RA35........6.49
0-50 Microamps Weston 301 3½" Sq.....13.98
0-500 MADC/2½": Rnd Triplett 221T.....4.98
VU-20 +3 **Weston** 301 3" Sq. L.P. $41...14.98
0-120 MARF 3½" Rnd Weston 301........9.95

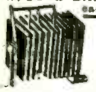
PULSE TRANSFORMERS

PULSE-XFMR 1000 Pulse Per Sec. 5 Watt, TR1025 P/O LU-3 Test Equipment........$7.98
7.5 KV Pulse, Pri 4 KV. 50-1000 ohm imped. Permalloy Core, W Eco D-163247.........$12.00
Pulse Blocking Osc. 3 wndgs. 1:1:1 ratio 1 mh wndgs GE H'Sld, HVins..............$2.98
PULSE SHAPING Xfmr Raytheon UX12819. 1 MU Sec. 2000 CY..............$5.00
UTAH 9340 P/O CP-5A/APS-15..........$5.00

FEDERAL RECTIFIER KIT

"Federals" all purpose selenium rectifier kit You can make 24 different rectifiers ½ WAVE. FW/CT & Bridge. 8 plates rated 18V/12AMP each. All Hardware & lugs..$17.59

SELENIUM RECTIFIERS



We specialize in Rectifiers and Power supplies to your specifications. Immediate delivery.

Current Cont.	18/14 Volts	36/28 Volts	54/40 Volts	130/100 Volts
1 Amp	$1.35	$2.15	$3.70	$7.50
2 Amp	2.20	3.60	5.40	10.50
4 Amp	4.25	7.95	12.95	25.25
6 Amp	4.75	9.00	13.50	33.00
10 Amp	6.75	12.75	20.00	40.00
12 Amp	8.50	16.25	25.50	45.00
20 Amp	13.25	25.50	39.00	79.50
24 Amp	16.25	32.50	45.00	90.00

Full Wave Rect & Trans. 115V/60cy inputs.
up to 14VDC at 12 amps..............$23.98
up to 28VDC at 12 amps..............31.98
up to 28VDC at 48 amps..............129.00
C "TAB" fast delivery SPECIALS

RECTIFIER XMFRS

18—12—9—CT—9—12—18V/4Amp.......$8.75
18—12—9—CT—9—12—18V/12 Amp.......16.75
36VCT—24V—18V/24 Amp..............35.75
18V/2A..............$1.98; 3 for $5.49

DC POWER-SUPPLY

0 to 1 VDC/2 AMP variable D supply—inpt. 115v/60 cy. Usable LAB supply, fila nt D.C. platin, battery arging, model railroad incl des voltage or speed control nd center off reversing sw. Ideal for two "HO" loco's.........$10.95; 2 for $20.0

RECTIFIER CHOKES

4Amp	.17 Hy	.6 Ohm	$7.95
12 Amp	.01 Hy	.1 Ohm	14.95
24 Amp	.04 Hy	.025 Ohm	29.95

BATTERY CHARGER RECTIFIER

10-0-10 Volts (CT) 100 Amp (Fan Cooled), Replace Your Old Inefficient Sulphide Rect. with the New Selenium Types. SPECIAL..$11.98

GENUINE SWEDISH CROSSCUT SAWS

FIRST QUALITY

STOCK NUMBER	SIZE	TEETH PER/IN	PRICE
701-20-10	20"	10 PT	$3.95
701-24-10	24"	10 PT	4.15
701-24-8	24"	8 PT	4.15
701-26-8	26"	8 PT	4.25
701-26-6	26"	6 PT	4.25
701-26-10	26"	10 PT	4.25
701-28-8	28"	8 PT	4.35
701-28-6	28"	6 PT	4.70
701-30-6	30"	6 PT	4.50

FL-5 FILTER

Range or voice. Filters 1020 cycle audio, excellent for CW Work...59c; 2 for $1.00

BANDPASS FILTER

Sharp Cutoff HIQ, Cased & Shielded 60, 90, 150 cycles..............Each $1.75; 2 for $3.00
UTC 854, 1024, 1250 Cyc Ea. $1.50; 2 for $2.50

SELSYNS

2J1H1 GE Selsyns..................Each $6.95
2J1F3 GE Brand New 115V/400 cy. ea......9.75
C78248 Sync. Trans. 115/60 cy $39.95; 2 for 75.00
C78249 Sync. Diff. 115V/60 cy 12.95..2 for 25.00
Sync. Repeater 115/60 cy Type 11-4..2 for 99.00
Bendix Autosyns AY1 & AY5.........2 for 6.95
Bendix AY20 New Orig Crtns..............12.98
OTHER TYPES IN STOCK

DYNAMOTORS

INPT 6VDC, Output 200V/100ma. or 12/24V Output 500V/50ma 'P' Magnt. As Illustrated.. 6.95
Inpt 28VDC/1.4A Output 250V/60ma........ 3.69
DA3A 28V/10.5A out 300VDC/260ma 150VDC/10ma. 14.5vdc/5amp............ 6.75
PE94 Plate Supp., Uses DA3A (SCR522)... 8.98
PE97 Plate Supp., Less Tubes.............. 9.98

"TAB" THAT'S A BUY

STORAGE BATTERIES

36 Volt WILLARD Mini-BRAND NEW 5 os Designed Portable Equip. Models...98c; 4 for $3
(4) 36V BATTERIES w/Acid.............. 3.35
2V 20AH Willard PLUS 2V. Vibrator..... 2.98
2V 20AH Batt. W/Vib. & Acid............ 3.59
6V/6AH Willd NT6/BB214U.............. 2.98
6V/6AH Batt. W/Acid.................. 3.25
6V/40AH Willard...................... 6.98
6V/40AH Batt. W/Acid................ 9.25
Hydrometer 1.06 to 1.24 Sp Grav. USN... 1.98
Spec Grav Ind & Merc. Thermom........ .98
* Acid is shipped in Bottles. R'Exp only

UHF ANTENNAS

Microwave Antenna AS125/APR 1000 to 3400 MC W/UG58U Terminal. Inbuilt Hi Pass filter, Flange mtg Special..........$5.98
Mobile Whip Ant 6 ft, Spring Steel, Broad response, W/ant matching Base...............$2.89
UHF Antenna 12" 30CM AT5/ARRI, usable Citizen & Ham band, insul coax Terminal, Mobil mounting— 39c; 4 for $1.00
PL-259 plug for above ant..................65c

POTENTIOMETERS—Type J

10 ohm Type J ½" shaft, $.93
200 ohm Type J ½" Slotted shaft....93c; 12 for $10.00
1000 ohm Type J ½" shaft....93c; 12 for $10.00
2000 ohm Type J ½" shaft....93c; 12 for $10.00
3500 ohm Type J ½" shaft....93c; 12 for $10.00
5000 ohm Type J ½" shaft....93c; 12 for $10.00
25K ohm Type J ½" Slotted shaft....93c; 12 for $10.00
50K ohm Type J ½" shaft....93c; 12 for $10.00
100K ohm Type J ½" shaft....93c; 12 for $10.00
1 meg Type JJJ (Triple) 1½" shaft.......... 3.69

ALL SIZES & TYPES IN STOCK

YOU PICK THEM — 39¢ Lots of 10 — WHILE THEY LAST

ELECTROLYTIC CONDENSERS

20MF/25VDC	2X15MF/350VDC
20MF/450VDC	2X20MF/25V, 30MF/450V
25MF/300VDC	40MF/250V, 20MF/25V
50MF/350VDC	3X100MF/35VDC
100MF/25VDC	30/15/10MF/250VDC

ALL SIZES & TYPES

CRYSTAL DIODES

1N23B Sylvania $1.98 Lots of 10
Smaller Quantity, Unit Price $2.25

1N21..............85c; 6 for $ 4.00
1N21A...........$1.55; 5 for $ 7.00
1N21B...........$2.89; 4 for $10.00
1N27............$1.55; 5 for $ 7.00
1N46..............69c; 5 for $ 3.25

INFRARED SNOOPERSCOPE

SEE IN DARK TUBE

Image-Converter Tube HiSensitivity simplified design 2" dia. Willemite screen—Resolution up to 350 line/in. Complete data & tube........ea. $4.98; 2 for $9.49
Snooperscope Pwr Supply 1800VDC/35MA, Using Doubler Crkt. Transformer, Rectifiers, Sockets, Resistors, Capacitors and Diagram 115V/60cy Oper..........................$6.98

KITS AND COMPONENTS

Oil Condensers Assorted...... 5 for $1.25
Electrolytics Assorted......... 5 for 1.25
Silver & Mica Cndsrs.........15 for 1.25
Controls, Popular Values....... 5 for 1.25
Resistors, ½ & 1W, to 2 Megs. 50 for 1.25
Vitreous W W Resistors....... 8 for 1.25
Sockets, Asstd. 8, 7, 5, 4P......12 for 1.25
Iron Core Slug & Screw......50 for 1.25
Knobs, Asstd. w/Insert........10 for 1.25

"TAB" Special — YOU PICK 'EM — $1.00 Lots of 5

★ SOLDERING GUNS & IRONS ★

"WELLER" GUN 115VAC 100 Watt.......$8.69
"WEN" GUN 115VAC 250 Watt 9.49; 3 for 25.50
"PRIMAX" GUN 115VAC Korodless Tip 7.69
PHILIPS "Versa TOOL" 115VAC 250W Including 4 Tips. Special..............10.83

ESICO IRONS 120 V AC/DC

55 Watt/¼ Tip/11½ Lng/.38 Lbs.......... 1.25
60 Watt/¼ Tip/12" Lng/.38 Lbs.......... 1.91
100 Watt/⅜ Tip/12" Lng/.5 Lbs.......... 2.55
130 Watt/½ Tip/12" Lng/.75 Lbs......... 3.17
ESICO INDUSTRIAL CONST: USE IRONS 120VAC/DC
Similar to American Beauty types as shown
61A60/60W/¼ Tip/7" Lng/2.5 oz.......... 3.20
#38/Am. Beauty 3138/100W/⅜ Tip........ 5.29
#58/Am. Beauty 3158/200W/⅝ Tip........ 6.30
#78/Am. Beauty 3178/300W/7/8 Tip....... 8.18
#98/Am. Beauty 3198/550W/1½ Tip.......10.08
Kester Solder one Lb. .062 Roll Reg...... 1.29
With any soldering iron. Special......... 90c

AUDIO COMPONENTS

Western Electric Push-Pull Pentode Output Transformer 197A. Rated 10 Watts for 6V6's or 6AQ5's. Excellent Freq. Response Flat 30 to 15,000 Cycles. Secondary 600 Ohm.
"TAB" Special....3.49; 2 for $5.98
UTC Varimatch line to voice coil or line, 30 Watt New..............$1.98
XFMR HMT-SLD UTC Super Electric 3 Wdg. 600 Ohm Ct & 400 Tapped 250 & 150 Ohm. Can be Used Mike to Grid, Line to Line & Line to Grid.
Special 49c........10 for $4.49; 100 for $25.00

TUBES

"TAB" TESTED & GUARANTEED

PRICES SUBJECT TO CHANGE
WRITE FOR COMPLETE TUBE LISTING

OA2	$0.95	3C45	12.89	6SF5	.77	VT127A	3.90	808	2.59
OA3/VR75	1.04	3D6/1299	.69	6SF7	.73	CV148	4.98	809	2.43
OB2	1.37	3D21A	4.98	6SG7	.72	FG166	49.00	810	9.95
OB3/VR90	1.09	3D22	13.95	6SH7	.61	FG172	29.00	811	2.39
OC3/VR105	1.15	3D23	4.90	6SJ7	.70	211/VT4C	1.25	812	2.70
OD3/VR150	.90	3E29	14.95	6SK7GT	.69	RX215	9.95	813	12.49
1B3/8016	.81	4C35	22.25	6SL7GT	.69	250TH	18.97	814	2.97
1B21/471A	2.85	EL5BHD	16.98	6SN7GT	.70	250TL	17.75	815	5.97
1B22	2.20	5C21/C6J	6.95	6SQ7GT	.63	304TH	8.90	816/866Jr.	1.07
1B23	9.90	5C22	42.05	6SR7	.65	304TL	8.90	826	.95
1B24	9.45	5C30/C5B	3.95	6SS7	.75	388A	1.49	829	11.49
1B26	2.45	5D21	19.50	6ST7	.98	WL417A	8.95	829B	12.45
1B27	12.75	5D23/RK65	36.50	6V6	1.39	417A/5842	18.50	832	8.97
1B32/532A	3.90	5J29	12.40	6V6GT	.57	GL434A	12.69	832A	9.65
1B35	9.15	5R4GY	1.55	6W4GT	.57	446A	1.05	833A	39.45
1B37	16.98	5R4GYW	1.75	12AK5	1.98	446B	3.89	836	4.75
1B38	29.95	5T4	2.49	12AK5W	2.98	450TH	49.97	837	1.45
1B41	49.95	5U4G	.69	12AL5	.75	450TL	52.00	849	29.45
1B42	18.00	5V4G	1.10	12AT6	.89	460/HF200	15.95	860	4.90
1B46	1.98	6AG5	.79	12AT7	.81	GL471A	2.69	861	23.95
1B53	49.95	6AG7	1.39	12AU6	.72	CK501X	1.26	865	1.29
1B56	38.50	6AH5G	1.49	12AU7	.63	CK501AX	2.20	866A	1.50
1B58	175.00	6AH6	1.22	12AV6	.49	CK502AX	1.49	872A	3.29
1B60	69.75	6AJ5	1.40	12AV7	.98	CK503AX	1.49	917	2.59
1B63	50.00	6AK5	.74	12AW6	1.79	CK505AX	1.79	925	1.69
1B63A	75.00	6AK5W	2.98	12AX4GT	1.20	CK506AX	1.49	927/CE25	1.49
1L4	.69	6AK6	1.05	12AX7	.79	CK509AX	1.79	CK1005	.85
1L6	.98	6AL5	.54	12AY7	2.79	CK512AX	1.48	CK1027	2.98
1P21	33.00	6AL7GT	1.29	12AZ7	1.49	CK522AX	1.29	5651	2.35
1V2	.70	6AN5	2.90	12BA6	.59	CK525AX	1.29	5654	2.79
1X2A	1.29	6AQ5	.55	12BA7	.79	CK526AX	1.49	RK5657	350.00
2C36	27.00	6AQ5W	3.98	12BD6	1.23	CK528AX	1.49	5663	1.85
2C39	21.00	6AQ6	.81	12BE6	.59	CK529AX	1.79	5670	5.30
2C39A	29.50	6AQ7GT	1.29	12BF6	.85	GL530	22.00	CK5672	1.29
2C40	7.29	6AR5	.79	12BH7	1.29	CK531DX	1.89	CK5678	1.89
2C43	17.75	6AR6	2.98	12BY7	1.35	531	6.98	5687	5.49
2C43/464A	9.49	6AS5	.79	12BZ7	1.25	CK532DX	1.89	CK5702	3.49
2C44	1.20	6AS6	2.43	12SA7GT	.69	WL532	3.98	CK5703	1.29
2C51	5.49	6AS7G	4.66	12SC7	.80	CK533AX	1.29	5812	2.99
2D21	1.26	6AT6	.63	12SF5GT	.72	CK534AX	.99	5814	3.64
2E31	1.49	6AU5GT	1.10	12SF7GT	.49	CK536AX	.99	5840	12.34
2E36	1.49	6AU6	.59	12SG7	.83	CK537AX	3.04	8020	1.28
2E43	1.49	6AV5GT	1.29	12SH7	.63	CK538DX	.98		
2G21	1.49	6AV6	.49	12SJ7GT	.59	CK539DX	2.19	**Xtal Diodes**	
2J31	27.00	6AW6	1.89	12SK7	.72	CK541DX	1.99	1N21A	$1.55
2J31A	79.95	6B4G	1.23	12SL7GT	.65	CK543DX	.99	1N21B	2.89
2J32	37.00	6BA6	.63	12SN7GT	.75	CK544DX	.99	1N21C	21.50
2J33	27.00	6BA7	1.27	12SQ7GT	.63	CK546DX	1.99	1N22	1.25
2J34	27.00	6BC5	.63	12SR7	.63	CK547DX	1.98	1N23	1.35
2J36	108.00	6BC7	1.23	FG17	3.95	CK571AX/		1N23A	2.20
2J37	12.70	6BD5GT	1.65	19T8	1.09	5886	2.49	1N23B	3.49
2J38	11.75	6BD6	.83	19V8	1.62	CK573AX/		1N25	4.98
2J39	44.00	6BE6	.59	RK20A	8.95	6029	3.49	1N26	8.75
2J42	187.00	6BF5	.98	24G/3C24	1.90	WL579	10.49	1N27	1.55
2J48	24.25	6BF6	.65	25BQ6GT	1.19	WL579B	12.98	1N34	.64
2J49	67.25	6BF7	2.55	25L6GT	.69	WL652	65.00	1N34A	.90
2J50	21.25	6BG6G	1.39	25Z5	.79	WL673	117.00	1N35	1.65
2J52	249.50	6BG7	1.98	25Z6GT	.99	WL676	39.95	1N38	1.43
2J55	85.00	6BH6	.63	FG27A	8.70	703A	4.75	1N38A	1.15
2J56	149.00	6BJ6	.69	28D7	1.95	705A	1.98	1N41	8.95
2J61	49.95	6BK7	2.15	FG32/5558	13.85	707A	7.90	1N42	16.95
2J62	49.45	6BL7GT	1.45	35Z5GT	.59	707B	13.50	1N43	1.73
2K22	39.45	6BN6	1.79	50L6GT	.69	715A	6.00	1N44	1.24
2K23	39.45	6BN7	1.69	RK61/XFG1	3.05	715B	11.90	1N45	1.45
2K25	28.49	6BQ6GT	1.20	80	.69	715C	24.00	1N46	.69
2K25/723AB	24.90	6BQ7	1.65	81	1.69	717A	.90	1N47	4.00
2K28	29.00	6BY5G	1.59	82	1.19	718BY	48.45	1N48	.55
2K33	259.00	6C21	29.45	82V	1.39	718CY	48.45	1N51	.45
2K35	389.95	6CB6	.69	83	1.45	719A	28.50	1N52	1.39
2K41	126.00	6CD6G	1.69	83V	1.79	721A	2.49	1N54	.89
2K42	145.00	6D4	2.70	84/6Z4	.99	722A/287	2.45	1N54A	1.15
2K48	120.00	C6J/5C21	6.95	FG95/5560	24.85	723A	11.95	1N55	3.10
2X2	.49	6J4	6.66	FG98	19.95	723A/B	25.00	1N57	.89
3B22	2.70	6J5GT	.47	100TH	7.83	724A	3.95	1N58	1.19
3B23/RK22	4.95	6J6	.63	FG104	37.98	724B	3.45	1N58A	1.15
3B24	6.97	6K4A	6.45	FG105	17.64	725A	8.49	1N60	.60
3B25	4.50	6L6	2.09	117L/M7GT	1.59	726A	21.97	1N61	2.07
3B26	3.70	6L6G	1.35	117N7GT	2.49	726B	45.00	1N63/K63	2.49
3B28	7.90	6L6GA	1.35	117P7GT	1.39	726C	79.95	1N64	.69
3C22	89.00	6L6GAY	2.29	117Z6GT	1.19	801A	.45	1N69	.98
3C23	9.90	6SA7GT	.63	117Z7GT	1.49	803	3.89	1N86	1.15
3C31/C1B	3.45	6SC7	.90	F123A	7.90	805	3.90	1N87	1.15
3C33	14.98	6SD7GT	.80	F127A	19.98	807	1.65	1N88	1.15

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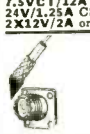

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AN3102-14S-5P	45c	AN3057-4	25c
AN3108-14S-7S	69c	AN3057-12	30c
AN3108-16S-4P	67c	GK-C8-21 1/2B	1.15
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A	.03	600	69c; 5 for 2.39
A	.02	600	69c; 5 for 2.25
A	.015	2500	1.75; 2 for 3.00
B	.01	600	56c; 3 for 1.20
B	.01	1000	49c; 3 for 1.25
B	.01	1200	69c; 3 for 1.49
B	.008	600	39c; 3 for 1.00
A	.005	2500	1.19; 3 for 2.95
B	.004	600	49c; 3 for 1.10
B	.002	1200	58c; 3 for 1.25
A	.002	2500	98c; 3 for 2.25
A	.001	1200	55c; 3 for 1.20
C	.00075	5000	2.98; 2 for 5.00
C	.0007	3000	89c; 3 for 2.39
A	.0004	2500	39c; 6 for 1.95
A	.0001	600	25c; 5 for 1.00
C	.0001	3000	89c; 3 for 2.00
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