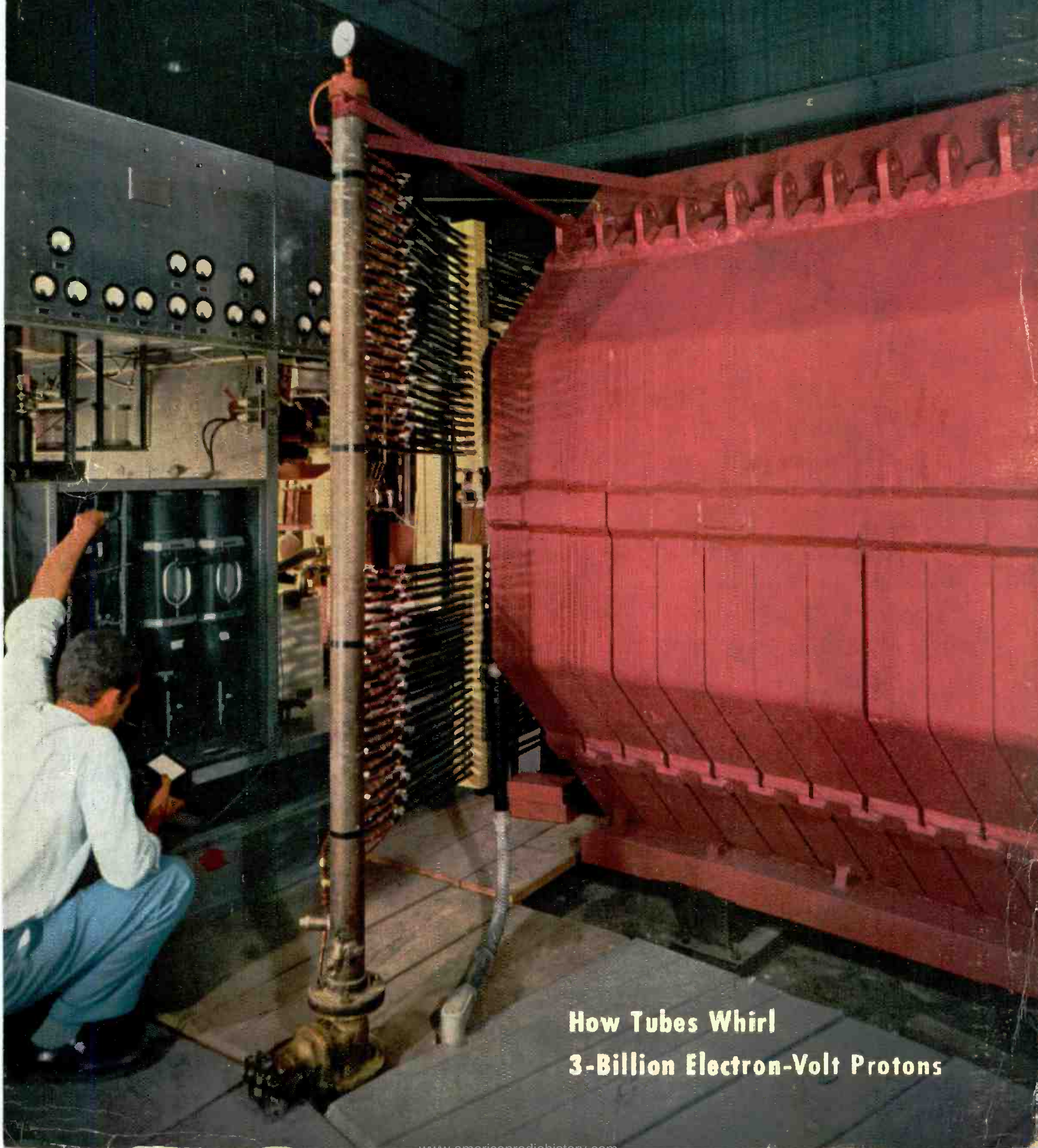
FEBRUARY · 1954

PRICE 75 CENTS

electronics

A McGRAW-HILL PUBLICATION



How Tubes Whirl

3-Billion Electron-Volt Protons

NEW "M" TYPE TOROIDS Maximum Q Minimum Size

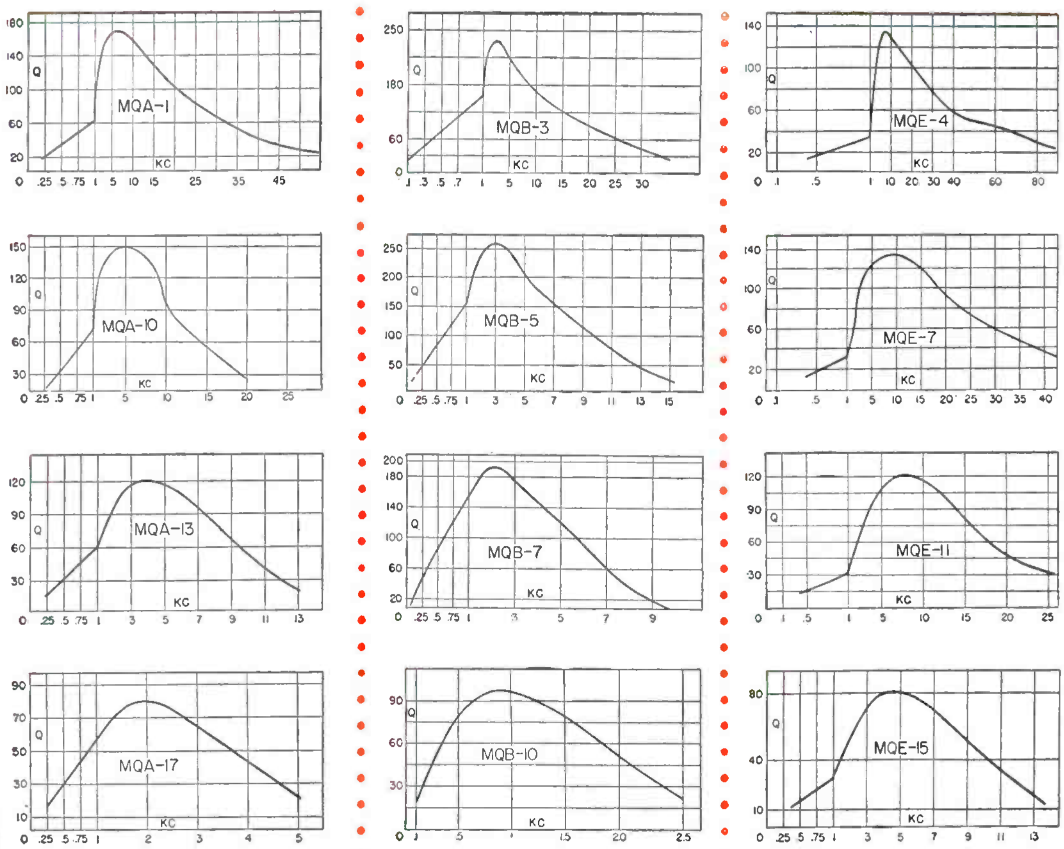
UTC Permalloy Dust Toroids have been the standard of the industry for over 15 years. The MQ series of coils provide the highest Q factor in their class (see curves below), with miniaturized dimensions. All units are hermetically sealed to MIL-T-27 Specifications.

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

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

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

TYPICAL Q CURVES



MQA TYPES

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

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

MQB TYPES

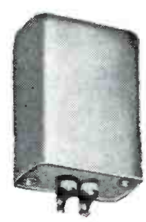
Type No.	Inductance	*DC Max.
MQB-1	10 mhy.	400
MQB-2	30 mhy.	250
MQB-3	70 mhy.	170
MQB-4	120 mhy.	120
MQB-5	.5 hy.	60
MQB-6	1 hy.	40
MQB-7	2 hy.	30
MQB-8	3.5 hy.	22
MQB-9	7.5 hy.	16
MQB-10	12 hy.	11
MQB-11	18 hy.	9
MQB-12	25 hy.	8

MQE TYPES

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

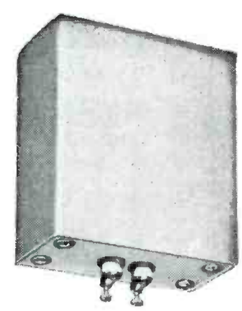
MQE CASE

Length .... 1 1/16"
Width .... ½"
Height .... 17/32"
Unit Weight .... 1.5 oz.



MQA CASE

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



MQB CASE

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

United Transformer Co.

150 VARICK STREET NEW YORK 13, N. Y.

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electronics

FEBRUARY • 1954

A McGRAW-HILL PUBLICATION

HOW TUBES WHIRL 3-BILLION ELECTRON-VOLT PROTONS—Radio-frequency generator develops 100-kw f-m signal across accelerating gap of Brookhaven National Laboratory's 3-billion electron-volt cosmotron (see p 160) COVER

February, 1954 ELECTRONICS Member ABC and ABP Vol. 27. No. 2

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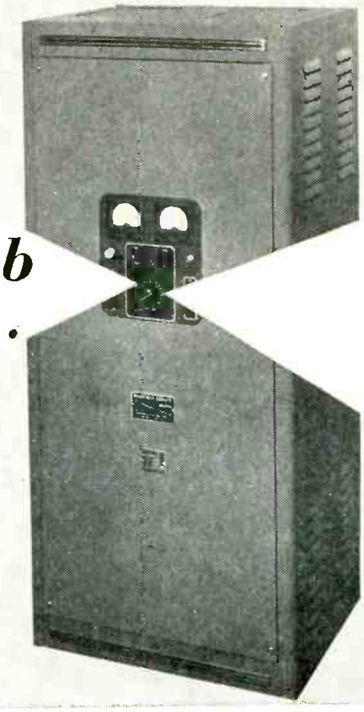
Here's the versatile, regulated DC source you've been looking for -

NOBATRON*-Ranger

turning this knob gives you . . .



100-300VDC at 1-10 amps
(model SR2)

5-135VDC at 1-10 amps
(model SR100)

5-30VDC at 3-30 amps
(model SR30)

with ±0.25% regulation accuracy!

The Sorensen Nobatron-Ranger is essentially an adaptation of the proved Nobatron circuit**, with the added feature of continuously adjustable output voltage over a wide range. This makes the RANGER an exceptionally good investment for the many laboratories and test installations where a multi-purpose DC source can be used to advantage.

ELECTRICAL CHARACTERISTICS

Input voltage range	95-130VAC, 1Ø, 50-60~ for models SR30 and SR100 190-260VAC, 1Ø, 50-60~ for model SR2
Output voltage and load range	5-30VDC at 3-30 amps in model SR30 5-135VDC at 1-10 amps in model SR100 100-300VDC at 1-10 amps in model SR2
Regulation accuracy	±0.25% at any output voltage setting with an input between 105 and 125VAC. The accuracy will be slightly less at the extreme value of the input.
Ripple	1% RMS max. of output setting

All RANGERS are 22″ wide by 17¼″ deep by 47¼″ high. They are self contained in handsome cabinets, equipped with casters for easy mobility. Meters are furnished as standard equipment, and there is adequate protection against overload, overvoltage, and tube filament failure.

Write for further information, and for your free copy of the new Sorensen general catalog, to Sorensen & Co., Inc., 375 Fairfield Ave., Stamford, Conn. In Europe, please correspond directly with Sorensen A.G., Gartenstrasse 26, Zurich 2, Switzerland.

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375 FAIRFIELD AVENUE
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*Reg. U. S. Pat. Off./**Model SR2 uses a circuit device patented by Wm. J. Brown.

THE NEW
MUIRHEAD-WIGAN DECADE OSCILLATOR

TYPE D-650-A

THIS precision laboratory oscillator, which covers a range of 1 to 111,100c/s with an overall frequency accuracy of ±0.2% or ±0.5c/s, employs the decade tuning system, by means of which the frequency can be set quickly and accurately on four decade dials and a range switch. This system of tuning ensures the highest possible frequency accuracy and stability. It also enables a given frequency setting to be repeated exactly, and permits the addition or subtraction of a fixed number of cycles per second, thus giving an incremental accuracy of an extremely high order. No other type of oscillator possesses all these advantages.

FEATURES

Frequency range: 1-11,110c/s and 10-111,100c/s.

Frequency accuracy: ±0.2% or ±0.5c/s.

Hourly frequency stability: ±0.02% over most of range.

Maximum output: 2W into 8000 ohms above 20c/s.
50mW into 8000 ohms below 20c/s.

Harmonic content: 1% at 1W output.

Hum level: –80db relative to maximum output at 1000c/s.

Power supply: 95-125V, 60c/s; 90W.

Dimensions: $17\frac{1}{4}$ in. wide x $10\frac{1}{2}$ in. high x 13 in. deep.

Weight: 83 lb.

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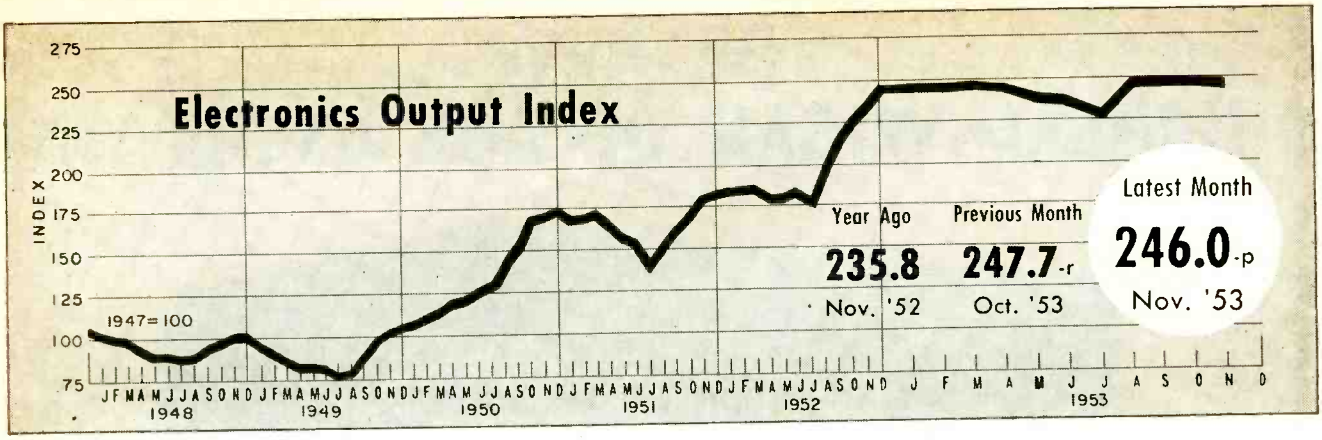


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Year Ago	Previous Month	Latest Month
	Nov. '52	Oct. '53	Nov. '53
Television sets	780,486	680,433	560,197
Home sets	421,853-r	370,178	457,151
Clock Radios	202,438-r	189,230	171,356
Portable sets	180,753-r	135,009	127,316
Auto sets	232,820-r	358,076	309,962

RECEIVER SALES

(Source: RETMA)	Nov. '52	Oct. '53	Nov. '53
Television sets, units	803,327	621,768	678,295
Radio sets (except auto)	486,800	385,229	697,062

RECEIVING TUBE SALES

(Source: RETMA)	Nov. '52	Oct. '53	Nov. '53
Receiv. tubes, total units	36,942,664	34,928,108	31,606,971
Receiving tubes, new sets	25,898,849	23,028,120	20,761,999
Rec. tubes, replacement	8,568,037	9,509,908	9,008,578
Receiving tubes, gov't.	1,712,080	439,691	435,227
Receiving tubes, export	763,698	1,950,389	1,401,167
Picture tubes, to mfrs.	876,712	719,055	520,981

SEMICONDUCTOR SALES

(Source: RETMA)	Nov. '52	Oct. '53	Nov. '53
Germanium Diodes	......	772,381	733,029

INDUSTRIAL TUBE SALES

(Source: NEMA)	Quarterly Figures: Year Ago	Previous Quarter	Latest Quarter
	2nd '52	1st '53	2nd '53
Vacuum (non-receiving)	$12,110,000	$11,340,000	$10,400,000
Gas or vapor	$3,150,000	$3,140,000	$3,300,000
Phototubes	$480,000	$930,000	$700,000
Magnetrons and velocity modulation tubes	$9,830,000	$10,070,000	$10,500,000
Gaps and T/R boxes	$2,140,000	$2,050,000	$1,700,000

TV AUDIENCE

(Source: NBC Research Dept.)	Year Ago	Previous Month	Latest Month
	Nov. '52	Oct. '53	Nov. '53
Sets in Use—total	19,751,200	25,690,000	26,364,000

BROADCAST STATIONS

(Source: FCC)	Dec. '52	Nov. '53	Dec. '53
TV Stations on Air	129	334	356
TV Stns CPs—not on air	144	216	211
TV Stns—Applications	812	236	178
AM Stations on Air	2,391	2,509	2,521
AM Stns CPs—not on air	133	113	115
AM Stns—Applications	251	185	172
FM Stations on Air	616	561	560
FM Stns CPs—not on air	14	20	20
FM Stns—Applications	12	5	4

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Nov. '52	Oct. '53	Nov. '53
Aeronautical	34,187	42,974	42,667
Marine	38,166	43,292	43,455
Police, fire, etc.	11,956	14,315	14,478
Industrial	15,347	19,287	19,564
Land Transportation	5,427	6,287	6,380
Amateur	117,069	114,275	114,665
Citizens Radio	1,803	4,026	4,070
Disaster	87	254	254
Experimental	503	480	495
Common carrier	1,020	1,374	1,392

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Oct. '52	Sept. '53	Oct. '53
Prod. workers, comm. equip.	308.5	410.9 -r	408.3
Av. wkly. earnings, comm.	$68.18	$67.80-r	$66.97
Av. wkly. earnings, radio	$63.79	$65.76-r	$65.84
Av. wkly. hours, comm.	41.8	40.6 -r	40.1
Av. wkly. hours, radio	41.1	40.1	39.9

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	Dec. '52	Nov. '53	Dec. '53
Radio—TV & Electronics	322.7	261.8	268.1
Radio Broadcasters	304.4	261.1	274.1

p—provisional; r—revised

FIGURES OF THE YEAR

	1952 Total	TOTALS FOR THE FIRST ELEVEN MONTHS: 1952	1953	Percent Change
Television set production	6,096,279	5,175,193	6,765,000	+30.7
Radio set production	10,934,872	9,436,614	12,267,441	+30.0
Television set sales	6,144,990	5,095,220	5,600,423	+09.9
Radio set sales (except auto)	6,878,547	5,363,859	5,608,477	+04.6
Receiving tube sales	368,519,243	324,512,611	413,687,529	+30.2
Cathode-ray tube sales	6,120,292	4,736,823	7,168,838	+51.3

INDUSTRY REPORT

electronics—FEBRUARY • 1954

Single-Gun Color Tubes Studied By Industry

Manufacturers intrigued by shortcuts inherent in phosphor-strip type

SEVERAL television receiver makers are studying with renewed interest tricolor picture tubes of the Chromatron type (p 29, Dec. 1951) employing a single electron gun, phosphor strips and switching at wire grids near the screen.

Among the potential advantages of such tubes are simplification of the color registry problem and good light efficiency. Among the initial disadvantages are relative picture coarseness and the necessity for fairly large amounts of switching power, with attendent radiation difficulties.

▶ Hazeltine Helps—Current interest is due in large measure to experimental work recently done by the Hazeltine Corporation, an organization which contributed heavily to the development of NTSC standards and is responsible for a number of circuits that are proving valuable in the operation of phosphor-dot shadow-mask picture tubes.

Working independently of tube and set manufacturers, this laboratory has

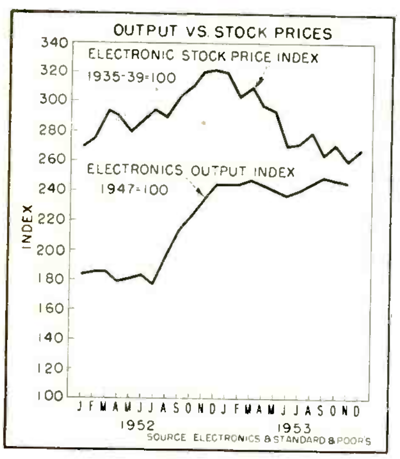
(1) Demonstrated that it is possible to directly translate color signals transmitted simultaneously into signals that can be decoded essentially by the Chromatron itself for sequential display.

(2) Indicated that redesign of the framework holding the tube's grid wires, plus reasonable shielding and circuit refinements can materially reduce radiation at the color subcarrier frequency.

▶ More Work Ahead—At least three tube makers are working toward further refinement of design, with emphasis upon reduction of picture coarseness, removal of support structures which cast some electronic shadows, selection of phosphors providing warmer tones when receiving monochrome programs and greater precision of parts placement in production models.

At least two set makers have made progress in the direction of circuits that minimize color-switching power requirements and, particularly, in the development of circuits that simplify factory adjustment of color balance or grey scales and reduce the need for subsequent adjustment in the field.

Experiments with single-gun tubes of the phosphor-dot shadow-mask variety have in the past indicated that the color registry problem is not unlike that encountered in connection with three-gun types. The experiments are no doubt continuing but results of recent work have not been publicly divulged.



Output Is Up, But Stocks Drop

Buyers of stock are cautious about electronic stocks despite industry's solid output

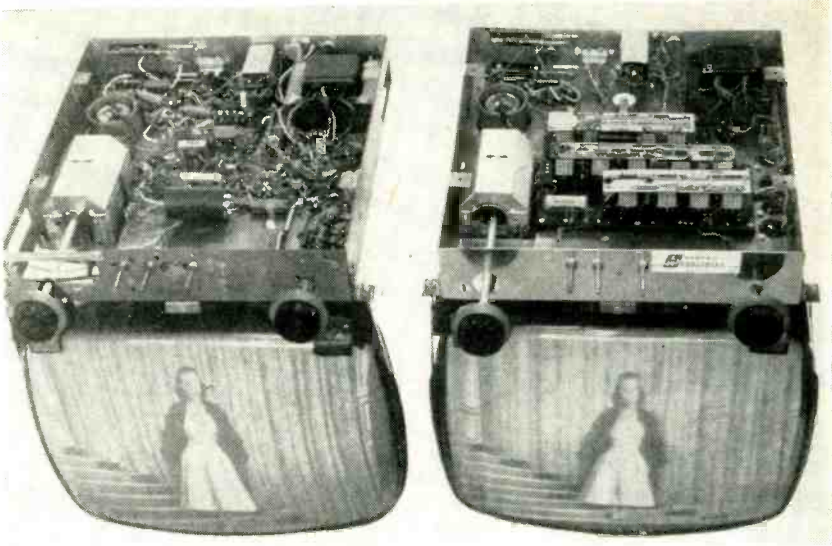
ELECTRONIC stocks reached their high point in December of 1952. Since then, according to Standard & Poor's electronic stock index, they have declined steadily by 54.4 points from 322.7 in Dec 1952 to 268.3 in December, 1953.

The index for 90 stocks, representing all industries, fell to 197.7 in December, 1953 from 204.7 in December of 1952, a decline of only 6.8 points. Electronic stocks dropped more and faster than the market in general.

Despite the decline, the output of the electronics industry as reflected in ELECTRONICS output index has shown only a slight readjustment. In December of 1952, the output index stood at 245.5 and in November of 1953, a month when cutbacks in employees and output took place, the index stood at 246.0, a slight increase for the industry during the period.

▶ **Why**—Financial observers see several factors as the cause of the decline in electronic stock prices despite the continuing high output of the industry. They point to the declining ratio of net profits to sales, the apparent slowing of black-and-white sales in the final quarter of 1953, dim prospects of substantial color sales in 1954, tough, competitive selling for the industry in 1954, higher inventories, a possible decline in defense business for 1954, and the possible drag on black-and-white tv sales in 1954 due to color.

▶ **Industry**—Some electronics industry leaders are not inclined to agree with all the possible deterrents that security buyers foresee. They point out that excess profits tax relief will help raise the ratio of net profits to sales, that black-and-white sales slowed only temporarily in the fourth quarter and actually spurted in the final weeks of the year. They feel that color sales may be more substantial in 1954 than estimates indicate and forecast that as many as 200,000 color sets may be sold. But, many electronic manufacturers go along with financial observers who see tougher competition in 1954.



NEARLY 600 hand-soldering operations are eliminated and production and material costs are reduced as . . .

TV Set Uses Tinkertoy Construction

COMMERCIAL application of Project Tinkertoy modular construction was demonstrated in a tv receiver shown by Sanders Associates, Inc., Nashua, N. H. Using thirteen modular units on three plug-in printed circuit chassis, the set eliminates almost all hand soldering and wiring in assembly operations.

The set was built to show manufacturers the possibilities in this type of construction. No cost figures were given, but reduced hand labor and lower materials costs indicate that savings in manufacturing will be obtained using the techniques.

▶ **Drawings Available**—Specifications for hand tools required to set up pilot runs or for model shop production of electronic modules are now available to the public.

The drawings, including those of jigs, dies and fixtures and an engineering handbook of the hand tool process (PB 111277), are now available at the Office of Technical Services, Department of Commerce, Washington 25, D.C.

Code name Project Tinkertoy has been dropped for Modular Design of Electronics (MDE) and Mechanized Production of Electronics (MPE).

Silicon Transistor Announced

New surface-barrier units give excellent current gain, withstand high temperatures

CONTINUED development of the silicon transistor, announced last month by Philco's research division, may open the way for design of extremely compact, low-power electronic equipment useful at temperatures up to 300 C. The new transistor should be particularly useful in airborne and military gear and in power output stages where the perverse high-temperature behavior of germanium has limited the use of conventional transistors.

▶ **Performance**—Silicon transistors having current gains of 0.95 appear readily realizable; the highest gain reported was over 0.995. Dozens of experimental units have been produced and close uniformity of electrical characteristics noted. Frequency response is above 10 mc. Effect of humidity on silicon appears to differ little from that observed with germanium. In any event, the units are hermetically sealed.

▶ **Production** — The surface-barrier technique (ELECTRONICS, p 10, Jan. 1954) is used to prepare the silicon transistors. A thin slab of monocrystalline silicon is etched

(Continued on page 8)

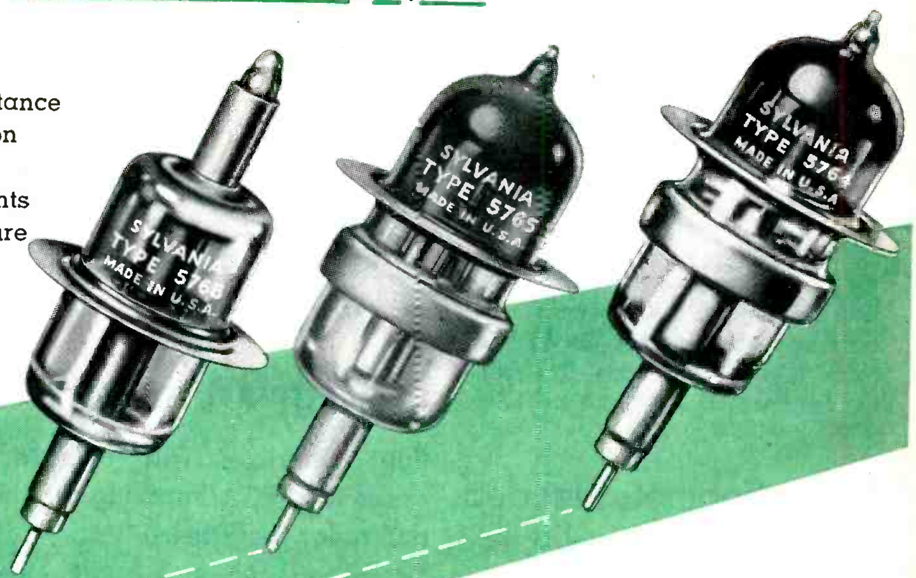
SYLVANIA

ROCKET TUBES

(PLANAR TRIODES)

The Answer to Efficient Power at 1000 to 4000 Megacycles

Low Lead Inductance
Low Interelectrode Capacitance
Rugged Planar Construction
Small Size
Moderate Input requirements
Good frequency-temperature Characteristics



TYPICAL APPLICATIONS

TYPE	SERVICE	FREQUENCY MC	OUTPUT
2C36	Pulsed oscillator	1000	125 Watts
2C37	CW oscillator	1000-3300	450 MW.
5764	Pulsed oscillator	2900	200 Watts
5765	CW Tunable oscillator	900-2900	250 MW. Av over the band
5768	CW Tunable amplifier	1000-3000	10 db. av gain
RT434	CW oscillator for butterfly type circuits	1000-3000	400 MW.

Still more reasons why it pays to SPECIFY SYLVANIA

For complete information concerning Sylvania Rocket Tubes or other electronic tubes write to Sylvania, Dept. 4E-1602.

SYLVANIA

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

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away by opposing jets of current-carrying salt solution directed against its broad faces. A current reversal then plates out metal, in this case zinc, on the freshly etched surface. Work has been done with both n and p type silicon.

▶ **Problems**—Philco officials stress that the silicon transistors produced are laboratory models only and that commercial manufacture is some ways off. A major problem is developing a source of silicon pure enough for transistor work. The silicon used in the transistors thus far made was obtained by a costly and tedious repurification process. What is desired is a convenient supply of extremely pure polycrystalline metallic silicon. Several military contracts to study the problem have been let. Among the firms engaged are Du Pont and Eagle.

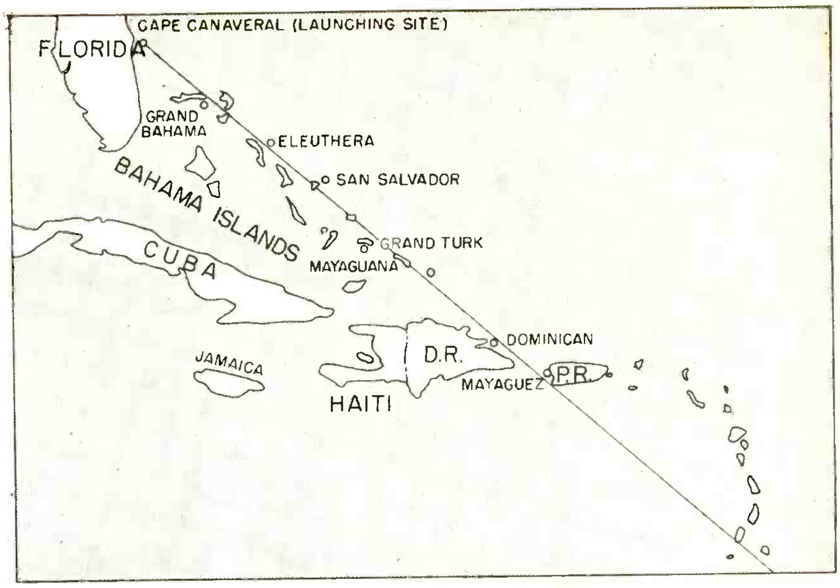
Better Cabinets Needed Navy Study Discloses

STUDY of 270 shipboard units carried out at Naval Research Laboratory over an eight-year period indicates that 90-percent of damage to equipment from shock and vibration can be eliminated by proper equipment design.

▶ **Design problems**—Greatest improvement can be made in the mechanical design of chassis, cabinets and frame structures. What seems to be needed is greater structural rigidity along with proper use of shock mounts.

The study found that vibration was as serious a problem as shock although the gravity forces encountered in vibration were low compared to those encountered in shock.

▶ **Component parts**—In general, standard components withstood shock and vibration well when properly placed and mounted. Only the performance of electron tubes and relays was found to be critical with regard to shock and vibration. An apparent cure for tube and relay problems is use of ruggedized electron tubes and completely enclosed rotary-type relays.



GUIDED-MISSILE test range spans Caribbean area, where . . .

Industry Enters Rocket Testing

Pan American will operate range with RCA handling radio and radar facilities

FLIGHT-TESTING of long-range guided missiles at Patrick Air Force Base, Cocoa, Fla. will be handled by private industry on a contract basis under terms of an agreement between Pan American Airlines and the Air Force. Pan American will operate and maintain the 1,500-mile over-water range that extends from the launching site at Cape Canaveral, Fla. southeastward over the Bahama Islands, Santo Domingo and Puerto Rico.

▶ **Electronics**—Radar tracking and telemetering at the launching site and seven down-range tracking stations (ELECTRONICS, p106, May 1952) will be handled by the RCA Service Corp., subcontractor, as will radio communications for the range and miscellaneous electronic instrumentation.

Transfer of range maintenance and operation together with data gathering and reduction chores to private firms is in line with Defense Department policy of calling upon industry whenever this proves to be the best and most economical course.

Some missile-range operations at White Sands Proving Grounds, N. M. have for some time been handled for Army Ordnance by been handled for Army Ordnance by Land-Air Inc., a private firm. Wind tunnel test at the Air Force's Arnold Engineering Development Center, Tullahoma, Tenn. is done under contract by ARO Inc., of St. Louis.

FCC Surveys Post-Freeze TV Stations

Despite limitations, report indicates early trends in tv station operating finances

STUDY made by the Federal Communications Commission of post-freeze tv stations shows that of 83 stations reporting, 16 had overall profitable operations while 67 reported an overall loss, as of August 1, 1953.

However, as the report points out, the survey has limitations. The average reporting station had only been in operation 4.9 months at the time of the survey and the stations covered represent less than 50 percent of the number of stations on the air in December, 1953. In addition, most stations

(Continued on page 10)

HIGH VOLTAGE

molded ceramic filter CAPACITORS

Specifically engineered for reliable service in the high voltage supply filter circuits of modern television receivers and cathode ray instruments are Sprague's new molded jacket "doorknob" capacitors.

These moderately priced units incorporate an improved ceramic dielectric element encased in a thermosetting, non-flammable housing for maximum protection. Fifteen different terminal combinations are standard to meet practically every mounting requirement.

Standard capacitance rating is 500 mmf. Voltages are 30,000, 25,000, and 20,000 volts d-c to fit all applications in television receivers from 27-inch down to 17-inch screen size.

Complete engineering information on these capacitors is contained in Bulletin 606A, available on letterhead request to Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

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

SPRAGUE

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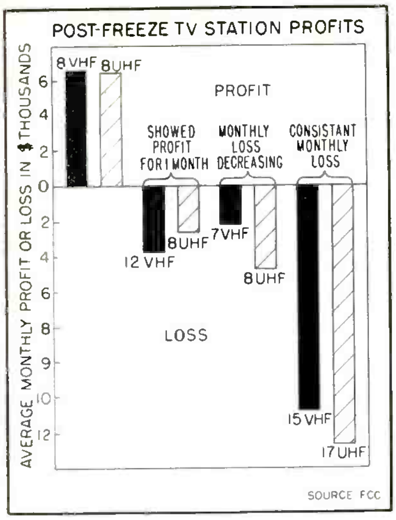


surveyed were alone in their communities and only two of the uhf stations covered were in markets with pre-freeze vhf stations. Finally, the survey was conducted during months that are normally below other months in station business activity.

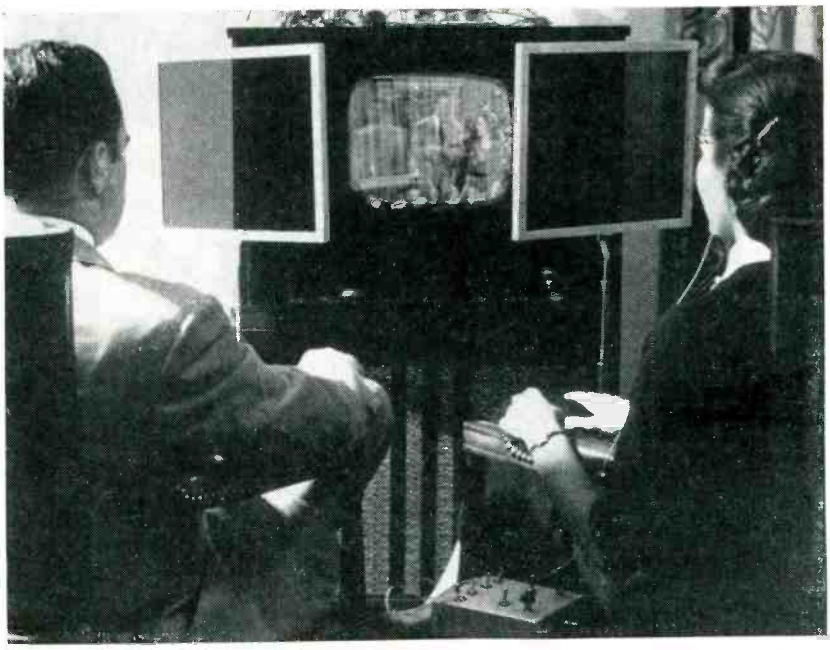
▶ **Markets**—Stations in the larger-sized markets generally fared better than those in smaller cities although four of the profitable vhf stations were in small cities and four were in markets of over 100,000. Total of 33 of the 41 reporting uhf stations were located in markets above 100,000 compared to 18 for the reporting vhf stations.

▶ **Equipment**—RETMA advised FCC that during the period of Jan. 1, 1952 to Aug. 31, 1953, a total of 124 vhf and 108 uhf transmitters had been manufactured. The vhf transmitter power ratings ranged up to 50 kw and uhf up to 12 kw. Bulk of the vhf were 10 kw or less while most of the uhf had 1-kw rated power. The major transmitter manufacturers indicated that uhf transmitters of 50-kw rated power are not expected to be in commercial production until late 1955 or early 1956.

RETMA also reported that during the period up to August 31, 1953, a total of 2.4 million units, sets or devices to equip sets for uhf, had been produced. Approximately 1.0 million uhf sets and 0.7 million tuners and converters were shipped by manufacturers; tuners and converters and sets in factory inventory totalled 0.7 million units.

During the same period up to August 31, 1953, a total of 1.4 million uhf strips were produced. About 15 percent of all sets made from January to July, 1953, were uhf equipped, according to RETMA. In subsequent months, the percentage of uhf sets to total production increased as follows: Aug., 17.3; Sept., 25.1; Oct., 29.8; Nov., 35.0.

▶ **Reaction**—Comment came quickly from the UHF Television Association. It is reported that the association has asked FCC to conduct a follow-up study as soon as possible since the report applied only to those post-freeze stations on the air prior to August 1, 1953. The association feels that the survey did not adequately cover the current situation since it did not, for the most part, include uhf stations in areas where vhf stations are in operation.



TELEVISION receiver with two superimposed images that can be separated by polaroid glasses is shown by DuMont as . . .

TV Set Makers Show New Models

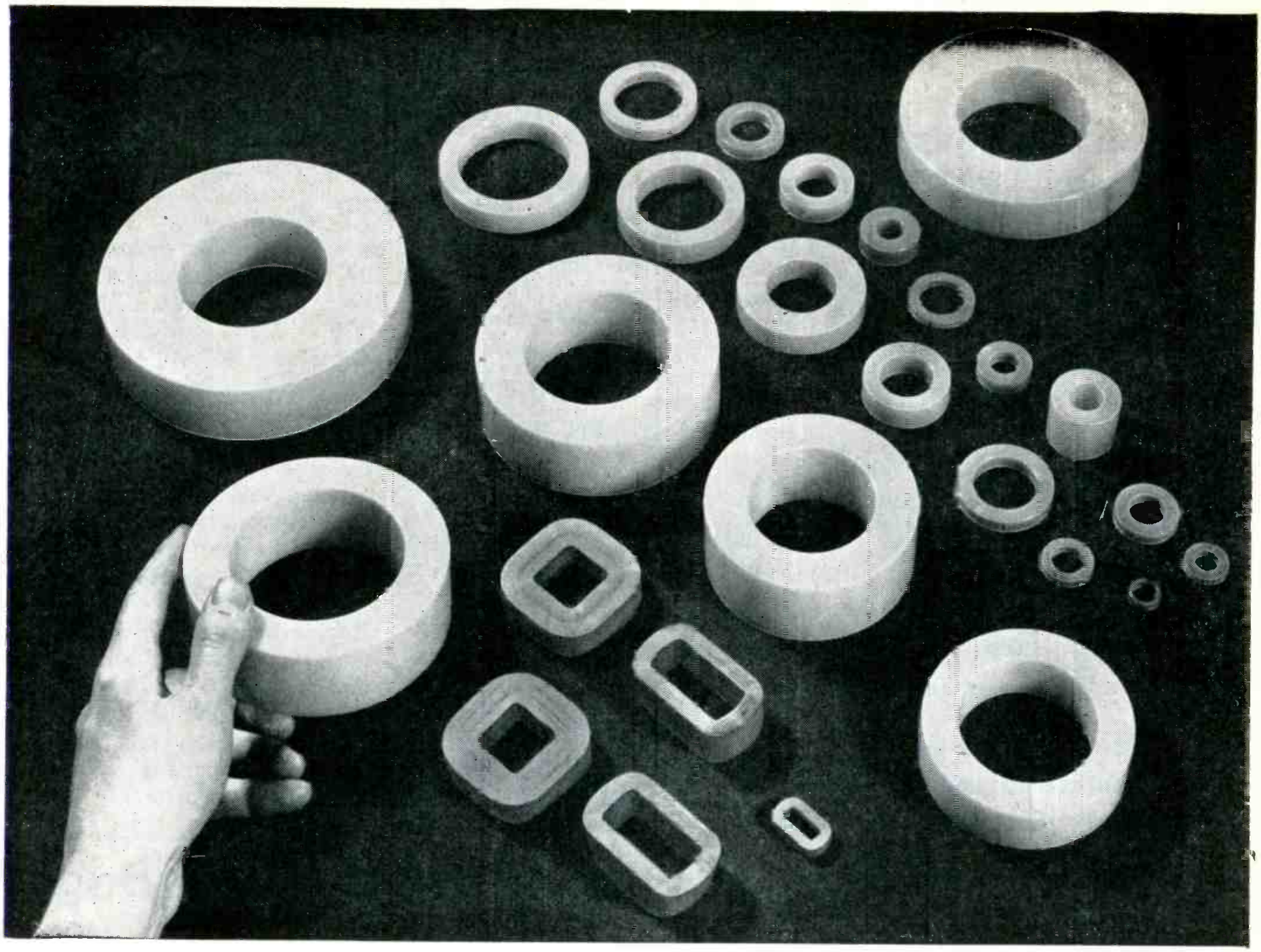
Color sets and lower priced black-and-white receivers dominate manufacturers' displays

IN January, many tv set manufacturers demonstrated color sets to the trade, added new monochrome models to their lines or lowered prices on some existing models.

▶ **Color**—The colorcast of the Tournament of Roses parade goaded set makers into demonstrating color tv sets in January and at least 10 major producers had experimental models on display in cities receiving the colorcast. One manufacturers has set a price of $1,175 on a color console and is ready to take orders. Another plans to introduce a color console shortly that will retail for $975.

▶ **Monochrome**—New black-and-white sets have been added to existing tv lines. Lower priced 21-inch sets dominate the new additions, as low as $179.95 for a table model. In the face of the strong low-price trend, other set manufacturers reduced prices on some cur-

(Continued on page 12)



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rent 21-inch sets in their lines.

Notable, also, in the new b-w introductions was the number of set manufacturers who displayed new 17-inch sets at lower prices, some as low as $159.95. RCA, one of the last of the major set producers without a 24-inch set in its line, introduced its first 24-inch sets in January. Last season, the company produced 21-inch, 27-inch and 17-inch receivers.

Of 12 manufacturers introducing new sets, only one added a new combination set. All five receivers introduced by one manufacturer were 21-inch table models.

Electronic Firms Review 1953; Preview 1954

RETMA and major manufacturers outline accomplishments and assess prospects

COMBINATION of high production of radio and tv sets, transmitters, components and an even greater output of military electronic equipment and parts made the year 1953 the most productive to date in the history of the electronics industry, according to RETMA.

▶ **Sets**—About 7.2 million tv receivers with a factory value of $1.2 billion and more than 13 million radios, including 5 million auto sets, valued at $0.25 billion were made by the industry, according to preliminary estimates. The figures represent better than a million more tv sets and two million more radios than were produced in 1952. Tv set retail sales volume for 1953 may exceed that of 1950, when production reached 7.4 million units.

▶ **TV Stations**—Transmitter manufacturers provided equipment for 225 new tv stations during 1953. GE announced that it delivered 40 uhf transmitters of the 12-kw type during the year. RCA mapped production schedules in 1953 to provide more than 30 stations with necessary color equipment to broadcast network-originated programs. DuMont's transmitter division almost doubled its output during 1953.

▶ **Military**—Greatest dollar volume of business for the electronics industry was military in 1953, as in 1952. Estimates indicate that between $2.7 and $3 billion in electronic and communications products were manufactured.

Estimates placed GE's 1953 defense business at $800 to $900 million. RCA estimated that government business accounted for $160 million, or 19 percent of its total sales in 1953. The company backlog at the end of 1953 was estimated to be $500 million. Sylvania estimated that approximately 22 percent of its total sales were for defense, compared to 30 percent in 1952. The current backlog of unfilled defense orders for the company totals $90 million against $85 million at the end of 1952.

▶ **Future**—RETMA expects that the electronics industry should be able to sell at least 6 million tv sets and 10 million radios in 1954. Individual manufacturers estimate that between 100,000 and 200,000 color sets will be made this year and they expect from 200 to 250 new tv stations to go on the air.

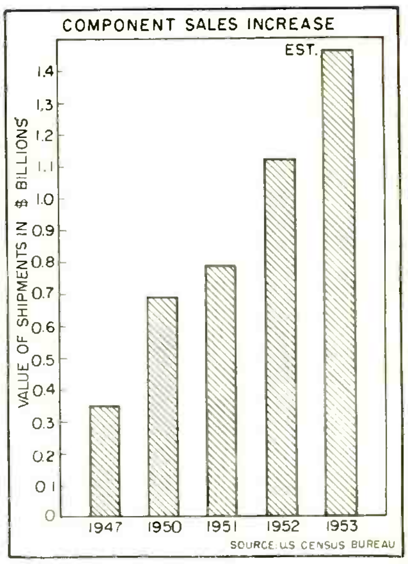
Other 1954 business estimates covering a wide range of products have been made by electronic manufacturers. GE sees a high level of military electronics production this year with a trend away, in the late part of the year, from standardized field equipment toward development and manufacturing of advanced forms of electronic apparatus. It sees the market for germanium devices reaching $17 million this year. Admiral estimates that the hi-fi potential for 1954 will exceed $200 million. RCA predicts a 10-percent rise in phonograph record sales for 1954, pushing industry volume past the $250-million mark.

Parts Business Outlook Is Bright

Steady increase in dollar volume of component manufacturers seen continuing in the future

ELECTRONIC MANUFACTURERS in the component parts business look forward to bigger than ever dollar volume in 1954 and the years ahead.

Business has steadily increased in the past four years as the chart indicates. Value of shipments of electronic components for communications equipment alone in 1952 totaled over $1.1 billion, an increase of over $300 million over 1951 shipments. Projection for 1953 business puts it at $1.4 billion. Sales of replacement parts alone in 1953 are estimated at $500 million for radio and tv sets.

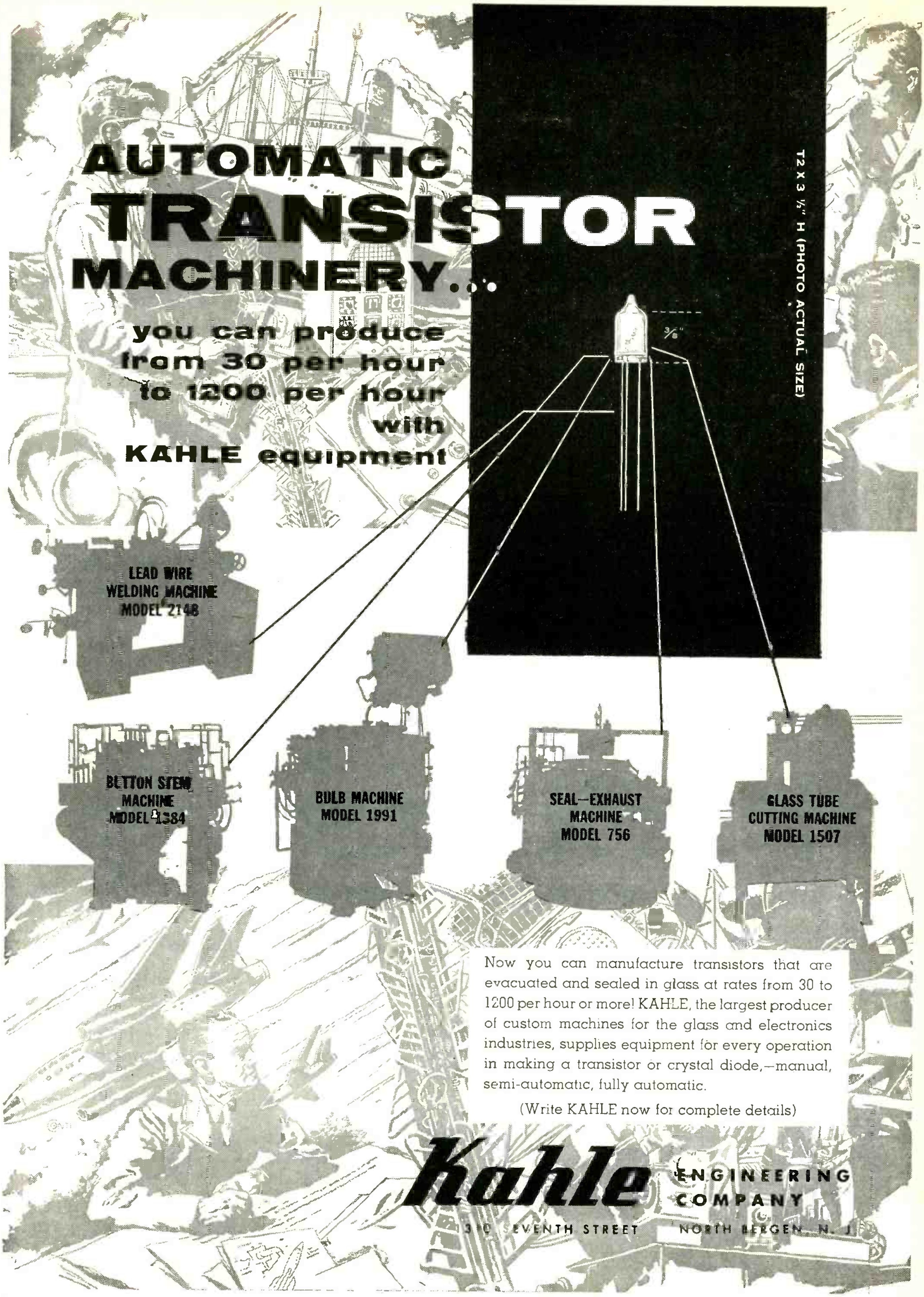


▶ **Sets**—More than 700 million resistors and 500 million capacitors were produced and sold for radio and tv sets by parts makers in 1953. Adding sales for communications equipment, industrial and military electronic equipment swells unit output to astronomical totals.

▶ **Companies**—Size of the parts business is indicated by the fact that there were over 100 resistor manufacturers and 100 capacitor makers in the electronics industry in 1953.

How parts firms fared in 1953

(Continued on page 14)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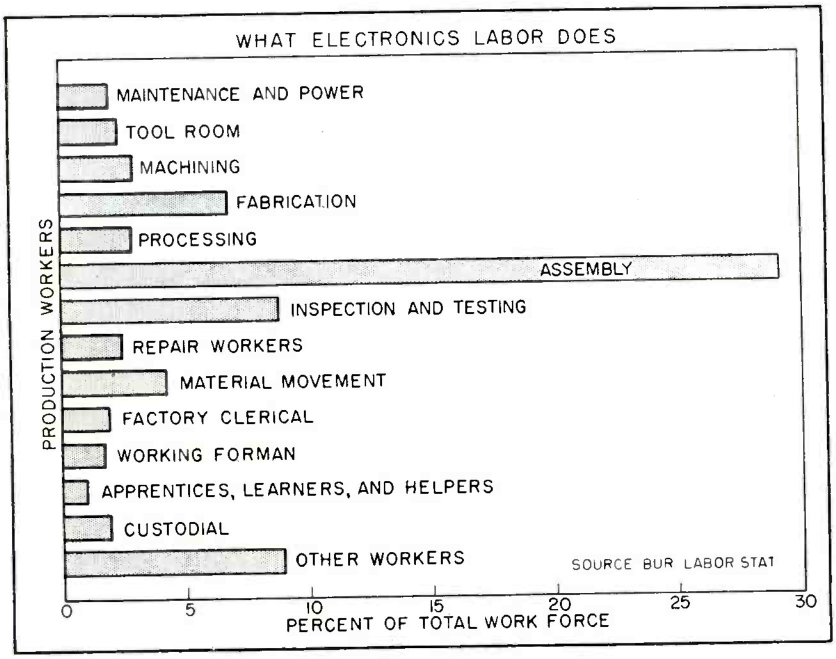
is indicated in profit statements. Cornell-Dubilier reported net profits of $1.2 million in the first nine months of its fiscal year in 1953 compared to $1.1 million in the comparable period in 1952. For the first 9 months of 1953 Sangamo reported $1.6 million compared to $1.4 million in 1952. Standard Coil, recently sold to Storer Broadcasting for about $8 million, reported net profits of $3.3 million for the first 9 months of 1953 compared to $1.9 million in 1952.

▶ **Future**—Color tv is one main reason why component parts makers look to the future with optimism. There are approximately 250 capacitors and nearly 300 resistors, approximately 2.5 times as many of these parts alone, in color sets compared to black and white, in addition to the many other components used.

With more critical circuits in color sets, higher unit prices for certain components are expected. Thus, though the total number of tv sets sold may drop in 1954, dollar volume for parts sales may very well increase.



U.S. Analyzes Electronics Work Force

Occupational make up of production and nonproduction workers varies with product

CHANGES in electronics equipment production techniques as well as changes brought about by military electronics production have had their effect on the occupational composition of the electronics industry. An analysis made by the Department of Labor of job patterns in electronics in 1953 shows the status of the electronics workforce.

▶ **Production Workers**—In 1953, over 76 percent of the industry's workforce were in production jobs. Almost 30 percent of these employees were estimated to be in assembly occupations and 9 percent were in inspection and testing jobs. Less than 3 percent were in metal-machining occupations and about 10 percent were employed in fabricating and processing work.

▶ **Products**—In military and industrial electronics manufacturing, according to the analysis, fewer inspection and testing workers were employed than in either radio and tv sets or parts manufacturing but over twice as many production machinists and machine tool operators were employed. Military electronics plants employed a higher proportion of skilled workers in almost all occupational groups, especially in assembly, inspection and testing operations and a higher proportion of stock control workers.

▶ **Non-Production Workers**—Nearly 24 percent of the electronics industry's workforce was employed in stenographic jobs and executive, professional, technical and administrative occupations. About one out of every 14 non-production employees was a professional or technical worker such as an engineer, draftsman or engineering aide.

Engineers comprised 8.4 percent of the total workforce in military and commercial electronics plants compared to 4.7 percent in receiver and tube plants and only 2 percent in parts factories. Draftsmen represented 2.2 percent of employees in military and commercial plants and 0.6 percent of those in other electronics plants.

▶ **Size**—Although plant size affects the make-up of electronic occupations less than product, indications were that small plants with less than 500 employees had a higher proportion of skilled workers and less semiskilled and unskilled employees than large factories. The ratio of all engineers to all employees in large plants with over 500 employees was twice the ratio in small plants and the proportion of engineering aides and draftsmen was also substantially higher.

Computer Translates Russian Language

LINGUISTS of Georgetown University and IBM engineers recently demonstrated a new application of a standard digital computer—translation of Russian into English.

Text to be translated is fed into the computer on standard punch cards. Using stored dictionary, syntax and grammar information, the computer finds the proper English equivalents of Russian words and prints them in smooth-reading English sentences. For example,

(Continued on page 16)

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the Russian sentence "VYELYI-CHYINA UGLA OPRYEDYELYA-YETSA OTNOSHYENYIYEM DLYINI DUGI K RADYIUSU" is translated "Magnitude of angle is determined by the relation of length of arc to radius."

▶ **Future**—In three to five years, sufficient work will be completed in the mechanics of various languages to permit multilingual translations in such highly specialized fields as enginering and medicine. This would release valuable information not now available because of translation difficulties.

Industry Concentrates On Marketing Plans

INCREASED buyers' resistance in 1954 is expected by most manufacturers in the electronics industry. As one major producer put it, "The 14-year old sellers' market is gone. Many industries are now adjusting their operations to meet the demands of a buyers market. Careful planning and hard selling are needed to maintain volume."

▶ **Spending**—A National Industrial Conference Board survey of 155 manufacturing companies, which included 10 firms in the electronics field, shows that 70 percent expect their 1954 promotion budgets to equal 1953 expenditures, despite possible lower output. Fifty percent of the surveyed firms expect to increase their over-all sales expense expenditures in 1954, partly as a result of intensified sales efforts and partly because of rising costs. It is reported that GE expects to spend \$45 million to \$50 million in 1954 on sales-bolstering work, which is about \$10 million more than was spent in 1953.

▶ **Salesmen**—Manufacturers are intensifying their efforts to recruit salesmen. A third of 155 companies surveyed by NICB intend to put more men in the field this year. About half of the new sales recruits will come from colleges and universities. This is especially true for technical sales personnel, according to the Board.

New England Surveys Electronics

And finds it is young, specialized and fast growing, with plans to grow more

COMPOSITION of New England's electronics industry is revealed in replies of 170 companies in the field to a survey by the Federal Reserve Bank of Boston.

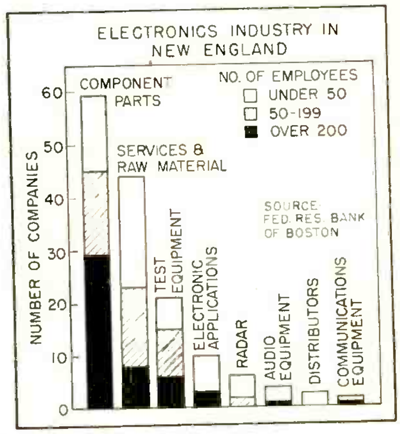
As shown in the chart, Yankee electronics producers specialize in component parts manufacturing, services and raw materials and in test equipment. No major tv receiver manufacturers have assembly plants in the area so set manufacturing is virtually nonexistent.

New England electronics manufacturers vary considerably in size and employ from two to several thousand workers. Slightly over one-third of the reporting firms had less than 50 employees in January, 1953.

The electronics industry is the most rapidly growing one in New England, according to the survey. Total employment in 142 electronics firms advanced from 38,466 in January, 1951 to 58,697 in January, 1953, for a 53-percent increase. And it is young. Nearly half of the reporting companies started operations since the end of World War II.

▶ **Sales**—New England electronics manufacturers sales are about evenly divided between the northeastern states and the rest of the U. S. The typical concern ships one-fifth of its products to other companies located in New England, one-fourth to firms in New York and New Jersey and almost one-half of its total output to other parts of the U. S. Only two out of 5 firms reported any export business and for them, foreign sales averaged only 3 percent of total sales.

Defense sales accounted for a large part of the electronics business. From 35 to 50 percent of the typical company's sales depended



on the defense program in the spring of 1953.

▶ **Competition**—Most important outside competitors of New England electronic producers are located in New York, New Jersey, Pennsylvania, Illinois and California. New York competitors were mentioned more than twice as frequently as those from any other non-New England state. About 25 companies reported important competition from New Jersey, Pennsylvania and Illinois concerns. Competition from the West Coast was reported by 15 firms.

Army Opens Electronic Proving Grounds

DEPARTMENT of Army has set up a large proving ground at Fort Huachuca, Arizona for testing weapons that use electronics.

It was found that Signal Corps electronic and aviation activities require more experimental space than is available at Fort Monmouth, N. J., where they have been located. The area of Fort Huachuca, in stand-by status since June, 1953, was selected as the only suitable and economical site of those studied.

The major Signal Corps activities at Fort Monmouth, including research and development laboratories and the Signal Corps school,

(Continued on page 18)

the Chief Engineers' Best Friend

EVEN <u>BEFORE</u> GETTING ON THE AIR!

The G-R Type 1183-T TV-Station Monitor is one of the most reliable frequency-indicating devices commercially available. It is, in addition, an *accurate measuring tool* which is indispensible to station operating personnel . . . even before the transmitter is on the air.

Chief Engineers, who have had this TV Monitor at their disposal during preliminary transmitter setting-up stages, are its most enthusiastic supporters. They are impressed by its adaptability to a wide variety of station measuring problems during the early periods of operation. These men stress the importance of having one of these monitors available at the station at the earliest possible time.

Current deliveries are within 60 days from date of order.

A few of the many ways in which the Type 1183-T TV-Station Monitor will aid you, in the adjusting and testing period preceeding commercial operation:

★ *By indicating correct tuning of aural and visual transmitter frequencies and insuring correctness of inter-carrier spacing*

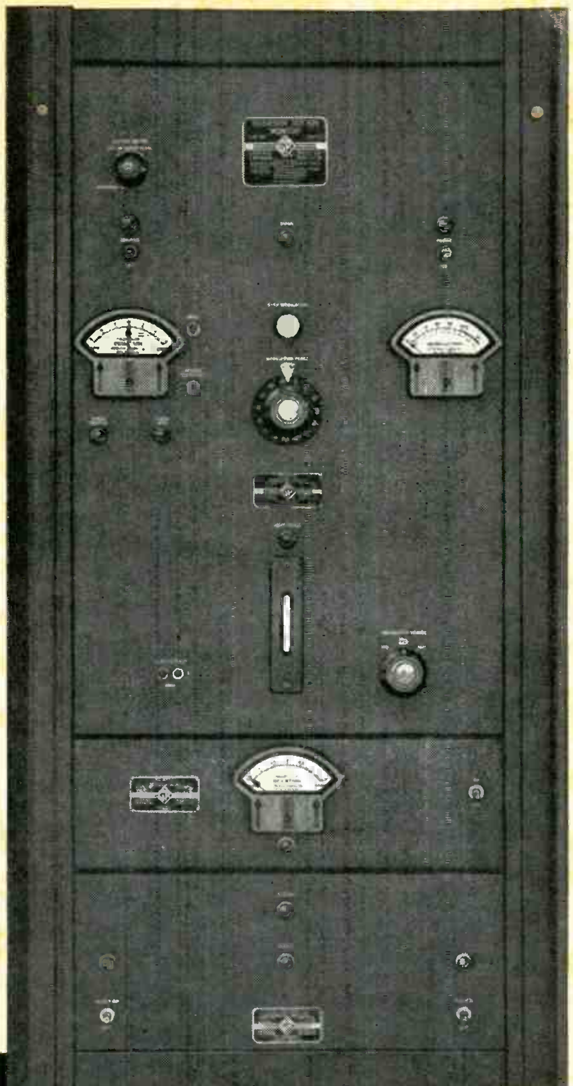
★ *Providing reliable indications of modulation percentage, useful for calibrating transmitting-station audio circuits*

★ *Helping locate, analyze and eliminate distortion and noise in transmitter aural channel*

★ *Measuring a-m noise in f-m channel when used in conjunction with the Type 1932-A Distortion Meter and Type 1932-P1 A-M Detector Unit*

The Type 1183-T TV-Station Monitor has evolved over a quarter century of G-R leadership in the development and manufacture of precision frequency-measuring instruments. It indicates carrier-frequency deviations with an accuracy of much better than one part in one million, and faithfully monitors distortion, noise and modulation level for "proof of performance" testing.

This instrument meets every requirement of the FCC for offset carrier operation. It will indicate correct intercarrier spacing within 300 cycles for 30 days and within 500 cycles for 6 months — more than accurate enough to meet FCC specifications for NTSC color broadcasting.



Type 1183-T
T-V Station Monitor
now in use by nearly every television station
$2830 to $2905
depending on frequency

FEATURES

★ Sound and video carrier frequencies are compared with multiplied frequency of highly-stable crystal oscillator invented and patented by G-R — two large scale, illuminated meters indicate frequency deviations of carriers

★ Aural modulation in both percentage and db is shown on third meter; panel switch provides for indication of positive peak, negative peak, or both peaks simultaneously — for convenience, overmodulation-alarm-lamp flashes when aural modulation exceeds predetermined level set by dial

★ Visual carrier indications accurate within ±500 cycles. Aural carrier indication within ±1000 cycles

On all v-h-f channels, the above accuracy is guaranteed for at least thirty days — at the lower u-h-f frequencies, the period is over sixteen days — at the higher u-h-f frequencies, the period is ten days or more

★ High fidelity audio output provided for distortion and noise-level measurements, and for audio monitoring — residual noise level is down 70 db or better for 25 kc deviation

★ Overall monitor distortion is less than 0.1% for ±25 kc swing, allowing measurement of very low-level transmitter distortion

★ VHF Monitor has high impedance and sensitivity of 1-volt or better — 500 mw sensitivity for low-impedance UHF input

★ Signal to noise ratio is excellent through channel 83

★ Complete remote metering facilities — terminals are provided for connecting remote center-frequency meters and additional modulation and over-modulation indicators

★ Center-frequency indications and distortion measurements are accurate even under heavy modulation — counter-type discriminator has excellent linearity over ±100 kc range

★ Separate power input for crystal-oven heaters enables direct connection to station standby power

★ Convenience in operation — pilot lamps on front panel indicate adequate input power — input-level meters at rear are immediately adjacent to input-level adjustments

★ For safety, all a-c power leads are fused on both sides of the line — short to ground cannot cause fire — fusible link in crystal oven prevents accidental overheating

★ Cabinet is arranged for maximum heat dissipation and easy installation — interior is readily accessible for servicing

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remain unaffected by the transfer.

▶ **Personnel**—Commanding officer for the new Army electronic proving ground is Brig. Gen. Emil Lenzner, formerly chief of Signal Corps plans and operations division in Washington, D. C. Executive officer of the new center is Col. Earle Cook, previously commanding officer of White Sands Signal Corps Agency, White Sands, New Mex.

Color TV Service Training Programs Set

SEVERAL major tv set manufacturers have announced plans for color tv service training.

Westinghouse has held a two-week color tv service school for its field service engineers who will train distributor service personnel. RCA held color tv servicing clinics for receiving-set licensees in January and will begin a series of two-day technical clinics for servicemen to be held in 65 cities starting early in February. RCA Institutes will start a color tv home study course for technicians.

General Electric has invited service personnel and technicians from its distributors and key dealers to a color tv symposium in January for 35 hours of indoctrination into all phases of color tv.

Raytheon has announced a new pictorial system which enables a tv set owner to identify reception troubles of a color or b-w set to a serviceman by telephone.

▶ **Set Design**—Color tv servicing is already having its effect on the design of color sets and methods of shipments. One manufacturer expects to make the tops of all color tv sets removable to make alignment and adjustment easier.

As in the early days of monochrome tv, color sets and picture tubes may be shipped in separate cartons to reduce possible shipping damage. As a result, a technician will most likely have to make an initial call to install the tube. Such extra calls and other factors are expected to set service contract prices for color sets high.

Tube Registrations Increased In 1953

New tube types up nearly 60 percent; transistors and crystals quadruple

MORE than 250 new tube designs were registered with RETMA by tube makers in 1953 compared to about 160 in 1952.

▶ **Types**—Classed with tubes, the largest increase in 1953 was in the solid-state device category which includes transistors and crystal devices. In 1952 only 11 registrations were made in this field while last year 53 were registered.

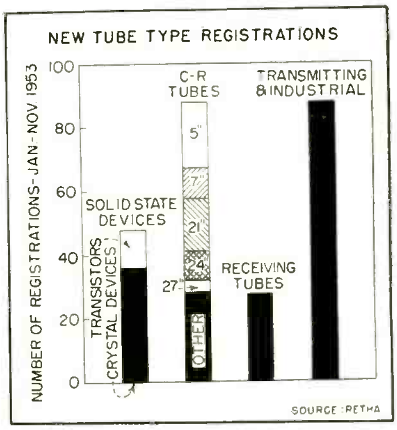
Cathode-ray tubes were next in registration growth, with over 30 more registrations than in 1952 for a total of 88. About 60 registrations were made in the transmitting and industrial tube classification in 1952 compared to 97 in 1953. Only classification to show a decrease in new registrations in 1953 was receiving tubes which dropped to 31 registrations from 34 in 1952.

▶ **Companies**—Tube manufacturers registering new tube types in 1953 cover almost the complete roster of the tube industry. Solid-state device registrations reported by RETMA for the first 11 months of 1953 show Hughes registered 12; GE, 11; CBS-Hytron, 10; RCA, 4; Amperex, Lansdale, National Union and Sylvania had 3 each and National Semiconductor & Microwave Assoc. registered 2 each.

DuMont accounted for about 40 percent of new c-r tube registrations in 1953 with 35 registrations. Westinghouse and Electronic Tubes of England registered 9 each. National Union and GE listed 7 and 5 respectively and 8 other manufacturers registered from 1 to 4 new crt types.

Sylvania led in receiving-tube registrations in 1953 with 9 registrations and five foreign tube manufacturers registered 9 new receiving-tube types during the period. Six other U. S. manufacturers registered 3 or less during the year.

For transmitting and industrial



tubes, Amperex registered 31 new tube types during the year followed by GE with 11, Sylvania with 10, Raytheon with 8; RCA, 8; Bendix, 7. Eleven other manufacturers registered 6 or less.

Magnetic Tape Seen For Court Reporting

APPROXIMATELY 5,000 court reporters may be considered as prospects for magnetic tape recording systems when suitable equipment for their needs is made available.

Total dollar business could range from \$5 million to \$50 million, depending on the system chosen. Portable systems would find use at conventions, legislative sessions and other affairs requiring a record of spoken words.

▶ **Choice of System**—First design decision to be made is whether main reliance shall be on man or machine, to continue the present role of shorthand and use tape to increase accuracy, or eliminate shorthand, with the reporter to monitor and identify each speaker. The choice depends on cost, complexity and interference with courtroom procedure.

▶ **Supplementary Version**—Use as an aid to shorthand would require a machine that will record up to four hours without attention. A minimal but satisfactory system

(Continued on page 20)

NEW RAYTHEON hermetically sealed GERMANIUM DIODES

a new sealed package worth crowing about

- Completely sealed against atmospheric conditions
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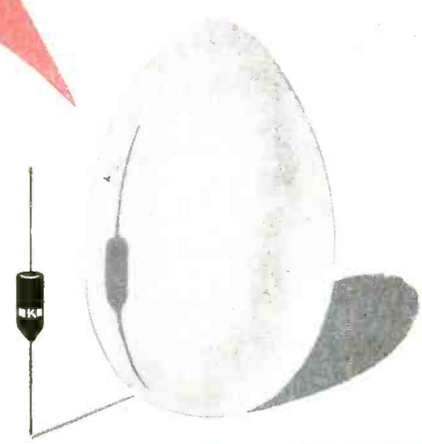

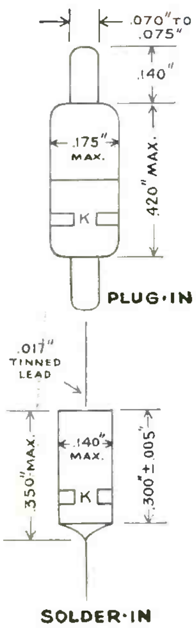

TYPE	TYPICAL APPLICATION	MAX. DC INVERSE VOLTAGE	MAX. PEAK ANODE CURR. ma.	MAX. AVG DC ANODE CURR. ma.	MIN. FORWARD CURRENT AT +1V ma.	MAXIMUM INVERSE CURRENT AT —5V ma.	AT —10V ma	AT —50V ma.	AT —100V ma.	MIN. INVERSE VOLTAGE	AVG INVERSE CURRENT —50V
IN67 IN67-P	50V DC Restorer	80	100	35	4.0	0.005		0.05		100	0.1
CK705 CK705-P	Gen. Purpose Diode	60	150	50	5.0		0.05	0.8		70	0.43
CK705A CK705A-P	Gen. Purpose Diode	60	150	50	5.0		0.01	0.8		70	0.43
CK707 CK707-P	50V DC Restorer	80	100	35	3.5	0.010		0.10		100	0.1
CK708 CK708-P	100V DC Restorer	100	100	35	3.0				0.625	120	0.15
CK713 CK713-P	Computer Diode	65	150	50	30 at +2V			0.25 at —40V	(DC characteristics at 50°C)		

P Indicates plug-in type DC Characteristics measured at 25°C

These types are available in production quantities through Newton, Chicago and Los Angeles sales offices. They are also stocked by over 500 Raytheon Special Tube Distributors.

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Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY

Receiving Tube Division — for application information call

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RAYTHEON MAKES ALL THESE:

RELIABLE SUBMINIATURE AND MINIATURE TUBES • SEMICONDUCTOR DIODES AND TRANSISTORS • NUCLEONIC TUBES • MICROWAVE TUBES • RECEIVING AND PICTURE TUBES

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should include four unidirectional microphones at $60 each, special avc amplifiers and mixers at $500 and a recorder at about $200, for a total of about $1,000 before modification and installation.

▶ **Robot Version**—With tape replacing shorthand completely, system failure could not be tolerated. This would mean duplicate three-channel tape machines and amplifiers, and a battery-operated reserve power supply.

Microphones for the judge and the prosecuting or plaintiff's attorney could share one recording track. The witness and the defense attorney could have the second track. The reporter at the controls would use his own mike on a third track to identify speakers and describe visual events.

Probably a permanent installation, the robot system would comprise two $2,500 three-channel tape machines, a $2,000 control center including duplicated components, at least six mikes, a reserve power supply and accessories that would total upwards of $7,500.

This look into the future of court reporting was given by Vincent Salmon of Stanford Research Institute before a San Francisco convention session of the National Shorthand Reporters Association.

Educators Start Using Channels

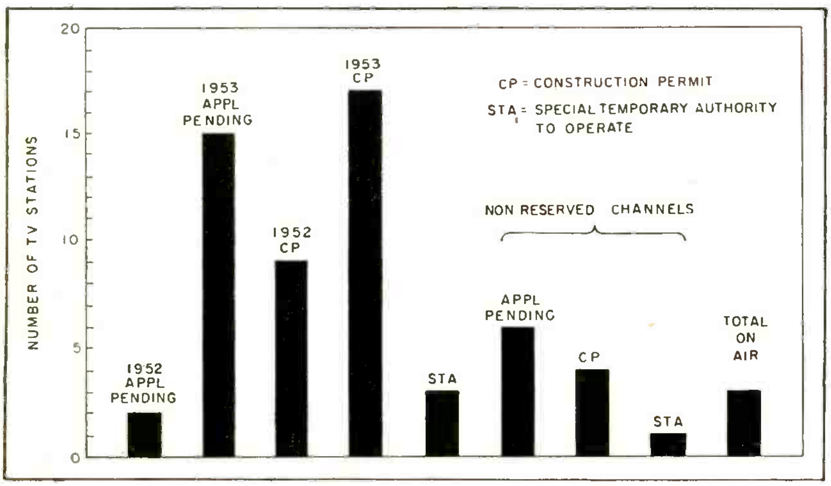


Chart shows status of educational television using both reserved and commercial (nonreserved) channels. Data was taken from JCET report

Total of 30 stations expected on air by end of year; more may come

WITH two noncommercial stations on the air (KUHT, Houston and KTHE, Los Angeles) and one commercial license assigned to a college (WOI-TV), Ames, Iowa), educational tv is beginning to roll.

Despite predictions of alarmists, frequencies are still being kept available and money is trickling in.

As shown in the chart, educators have filed a total of 46 applications, have been granted 26 construction permits and 3 STA's (special temporary authorizations to operate).

Municipal and educational institutions have filed a total of 12 applications for nonreserved (commercial) channels. Stations in St. Louis and Green Bay are testing and may be on the air within the next couple of months. Educational programs furnish revenue to several commercial tv outlets.

▶ **Future Bright**—The National Citizens Committee for Educational TV forecasts a total of 25 to 30 educational stations on the air before the close of the year. Says Robert R. Mullen, executive director of NCCET, "many of the most famous educational and cultural institutions of the United States will be engaged actively in noncommercial television programming."

Industry Scrutinizes Foreign Trade Status

NEMA study of exports, imports and labor yields picture of electronic foreign business

COMPREHENSIVE report made by the National Industrial Conference Board for the electrical manufacturing industry shows the position of the industry in foreign trade.

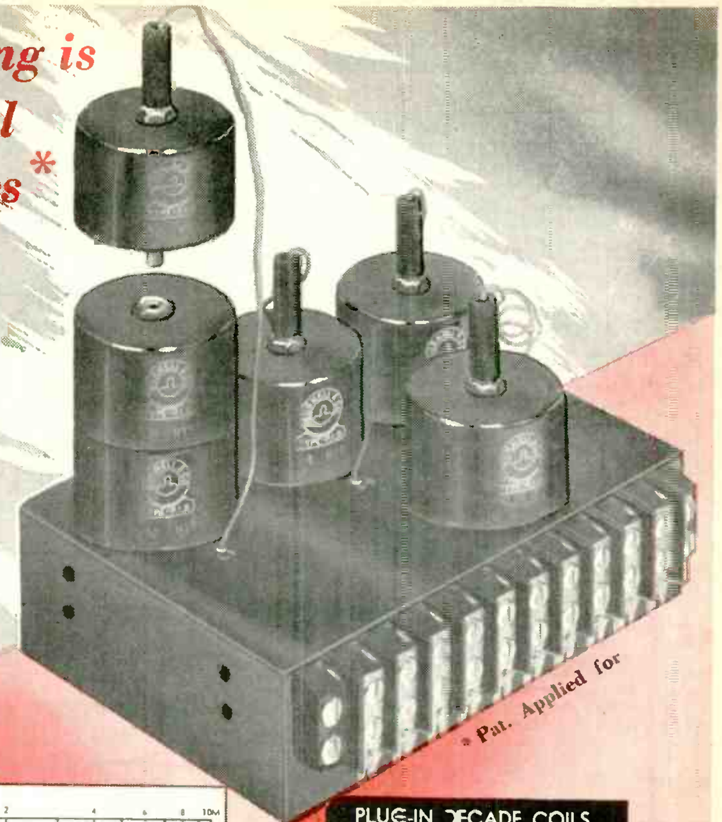
Conclusions of the 240-page NEMA report are: Wage differentials between U. S. electrical equipment manufacturers and their foreign competitors have broadened; Subsidies and aids by foreign nations exceed those enjoyed by U. S. competitors; Exchange controls and other restraints on foreign trade have increased and discriminate against the U. S.; Dollar gap in foreign balance-of-payment-positions has been replaced by a dollar surplus; Trade taking the place of aid might benefit Germany more than our World War II Allies.

▶ **Exports**—For the electronics industry, the study shows that Mexico, Cuba, Canal Zone and the other areas between the Rio Grande and the Panama Canal were the biggest customers for electronic equipment mainly because they were volume buyers of tv sets. These countries bought as many tv sets as all of the other world areas covered in the study did, combined. This area, along with South America, was also the electronics industry's biggest foreign customer for radios, radio-phonographs and broadcast equipment in 1952.

Canada, which ranked second as customer of U. S. electronic exports, was only $2.0 million under the combined countries listed previously. It ranked as the number one market for radio and tv set components using almost one-third more than the rest of the world areas combined. The Dominion was also one of the leading importers of radio and tv re-

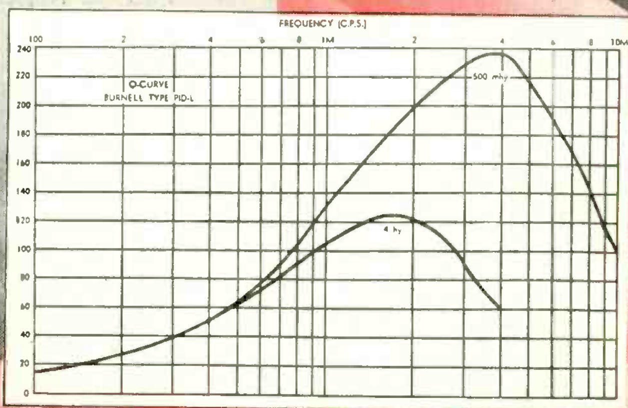
(Continued on page 22)

A New Level in Engineering is Achieved in the Functional Design of Toroidal Decades*



This unique development permitting precision toroids to be combined in decade steps of inductance will appeal to all engineers who are familiar with the disadvantages of the ordinary type of inductance decade box.

All the decade units in the plug-in decade series are higher Q toroids such as are employed in the Burnell attenuation filters. They are guaranteed to a tolerance of 1% of the marked inductance and have extremely good stability of inductance vs. voltage and temperature.



PLUG-IN DECADE COILS CAN ALSO BE DESIGNED WITH SPECIAL CHARACTERISTICS FOR SLIGHT EXTRA CHARGE. UNITS GENERALLY AVAILABLE FROM STOCK ARE AS FOLLOWS:

P.I.D. 1 (MHYS)*
P.I.D. 2 "
P.I.D. 3 "
P.I.D. 4 "
P.I.D. 8 "

P.I.D. 10 (MHYS)*
P.I.D. 20 "
P.I.D. 30 "
P.I.D. 40 "
P.I.D. 80 "

P.I.D. 100 MHYS
P.I.D. 200 "
P.I.D. 300 "
P.I.D. 400 "
P.I.D. 800 "

P.I.D. 1000 MHYS
P.I.D. 2000 "
P.I.D. 3000 "
P.I.D. 4000 "
P.I.D. 8000 "

P.I.D. 10000 MHYS
P.I.D. 20000 "
P.I.D. 30000 "
P.I.D. 40000 "
P.I.D. 80000 "

*Also available in P.I.D.-H Type for higher frequency range.

OTHER RECENT *Burnell* ACHIEVEMENTS IN TOROIDS AND FILTER NETWORKS

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Our most recent engineering development in communications filters has already stirred the interest of the leading receiver manufacturers in the country.

The new side band filters which eliminate, for most applications, the necessity for expensive crystal filters are expected to accelerate the advancement of single side band communications.

MINIATURE TELEMETERING FILTERS

In recognizing the need for miniaturization of the presently bulky telemetering equipment, our engineering staff has succeeded in reducing the size of telemetering filters to as little as 25 to 50% of the original volume.

SUB MINIATURE TOROIDS

Toroids for intermediate frequencies of 100KC to 1 megacycle. A wide variety of coils ranging in size from ⅝ inch provides high Q in the frequency range betweeen audio and RF.

The tiny toroid about the size of a dime has been welcomed by designers of sub miniature electronic equipment for the transistor, guided missile and printed circuit field.

Literature for all the above available on request

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See us at the I R E show booth 678 Kingsbridge Armory, N. Y. City, March 22-23-24-25.
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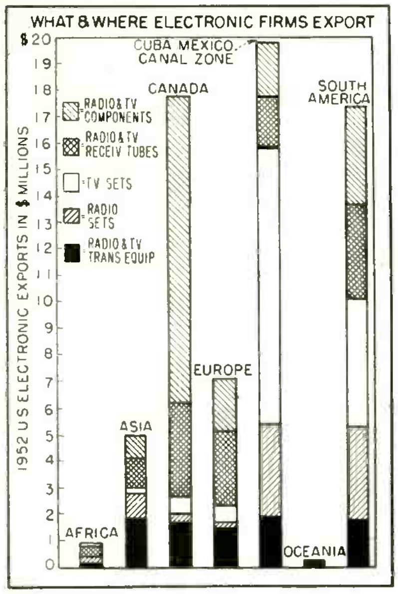


ceiving tubes ranking second only to all of South America.

▶ **Labor**—The survey indicated that foreign manufacturers of electronic and electrical products have a large labor cost advantage over U.S. companies. In 1952, total monetary hourly wages and wage supplements of nine nations covered by the survey ranged between 10 percent of U.S. figures in Japan to 33 percent in Belgium and Sweden.

▶ **Private Study**—A U.S. manufacturer of electrical equipment recently made a study of prevailing labor rates and general efficiency in the use of labor and materials in the industry in seven foreign countries. For electronic equipment producers, it showed the following:

Country	Product	Percent of U. S. Labor Rate
England	Radio Tubes	35%
Germany	Electronics	22%
Holland	Electronics-x-ray ..	38%

The effectiveness of labor, compared to the U.S., was 50 percent for England, 110 percent for Germany, and 75 percent for Holland.

This study concluded that labor costs of various electrical products in the seven countries ranged between 20 and 75 percent of U. S. labor costs of the same products.

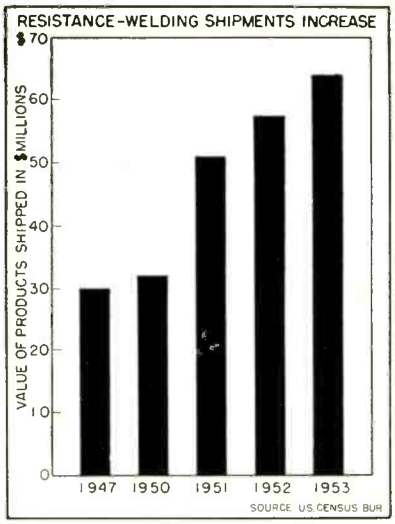
Ignitron Sales Gain In Volume

Resistance-welding equipment and power rectification for railroads are growth markets

CONTINUED increasing sales of ignitrons by electronic manufacturers are indicated by current developments in the field. As shown in the chart, resistance welding represents a substantial and growing market for the units. Sales to this market in 1953 are estimated at nearly $1 million.

▶ **Market Change**—Survey of ignitrons in use in the U. S., made by AIEE in 1950, covering about 44 percent of all users, shows that the electrochemical field was the leading market for the tubes. Indications are that now resistance welding and railroading may take the lead market-wise.

▶ **Railroads**—Accenting increased sales to railroads, application in quantity of new rectifier equipment



to multiple-unit railroad cars will be made on the New York, New Haven and Hartford Railroad early this year.

One-hundred such cars, using ignitron rectifiers to convert 11,000-volt, 25-cycle alternating current from the trolley to nominal 600 volts of direct current will be placed in service shortly, according to Westinghouse engineers. The rectified power will operate four spring-supported motors on each car.

▶ **Ahead**—A new General Electric ignitron is temperature controlled and can save industrial users hundreds of thousands of gallons of water normally used for cooling these tubes. This development may substantially increase sales of units to welders.

Increased use of ignitrons in steel mills is also predicted. Westinghouse engineers report that ignitron rectifiers have proved to be well suited as main power supplies for hot-strip mill drives. Units have been installed for the purpose at the Fairless Works of U. S. Steel.

Financial Roundup

MORE manufacturers in the electronics field report substantial profits from 1953 business and stock offerings continue to be active. Eight firms reported net profits for varying periods of 1953:

Company	Net Profit 1953	1952
American Broadcasting—Paramount Theaters (9 m) .	$7,559,000	$5,435,000
American Cable & Radio (10 m)...	1,016,000	524,000
Beckman Instruments (3 m) ...	223,422	190,793
General Precision Equip. (9 m) ..	2,283,830	890,433
IBM (9 m)	24,092,078	21,251,233
Raytheon (6 m) ..	1,639,000	1,913,000
Remington Rand (9 m)	5,325,769	6,827,794
Ultrasonic (12 m).	268,818	105,441

▶ **Registrations** — Eitel-McCullough registered with SEC covering 114,000 outstanding shares of capital stock (par $1) to be offered at $7.30 per share. No part of the proceeds will be received by the company. The selling stockholders, W. W. Eitel, president, and J. A. McCullough, vice-president-treasurer, own 207,000 and 267,000 shares respectively constituting 30.4 percent and 39.2 percent of the outstanding stock. Eitel will sell 45,000 shares and McCullough, 69,000 shares.

Decca Records registered with

(Continued on page 24)

INDUSTRIAL REMOTE CONTROL SYSTEMS CAN GREATLY REDUCE YOUR OPERATING COSTS

Hammarlund equipment centralizes control, ups man-hour output!

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

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

Proven Performance

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

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

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

- ✔ PETROLEUM REFINING
- ✔ PIPE LINE OPERATIONS
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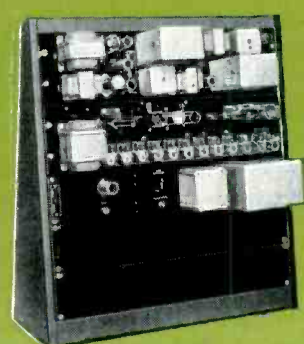

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SEC covering 145,842 shares of capital stock (par 50 cents) to be issued only in exchange for shares of common stock ($1 par) of Universal Pictures.

▶ **Offerings And Filings**—Clary Multiplier filed with SEC covering 16,000 shares of common stock (par $1) to be offered at $6.25 per share or the last sales price at the Los Angeles Stock Exchange, whichever is lower. Proceeds will be added to working capital.

Packard-Bell offered and sold 4,000 shares of capital stock (par 50 cents) at $12 per share. Proceeds go to H. A. Bell, the selling stockholder.

Raytheon placed privately an issue of $7.5 million in 4¾% notes due Nov. 15, 1965. Proceeds will be used to repay loans totaling $3.3 million and for working capital.

Consolidated Engineering borrowed $1 million through sale of 4¼% promissory notes due June 1, 1955 to 1968. Proceeds are to be used to repay bank loans, finance plant expansion and increase working capital.

Philco will acquire The Dexter Co., home laundry equipment manufacturers, in stock exchange of 1.05 shares of Philco common stock for each 3 shares of Dexter. Total of 70,000 shares of Philco common stock will be used.

MEETINGS

FEB. 4–6, 1954: Sixth Annual IRE Conference And Electronics Show, Hotel Tulsa, Tulsa, Oklahoma.

FEB. 4–6: West Coast Audio Fair, Los Angeles, Calif.

FEB. 11–12, 1954: Joint IRE, AIEE, ACM West Coast Computer Conference, Ambassador Hotel, Los Angeles, Calif.

FEB. 18–19: IRE, AIEE Conference on Transistor Circuits, Philidelphia, Pa.

MAR. 22–25: IRE National Convention, Waldorf-Astoria Hotel and Kingsbridge Armory, New York, N. Y.

FEB. 24: Cleveland IRE, Electronic Show, Tomlinson Hall, Case Institute of Technology, Cleveland, Ohio.

APRIL 5–10: International Convention of Soundtrack Recording, Paris, France.

APRIL 15–16: RETMA Conference On Reliability of Electrical Connections, Illinois Institute of Technology, Chicago.

APRIL 19–20: Symposium on the Automatic Production of Electronic Equipment sponsored by Stanford Research Institute and U.S. Air Force, Fairmont Hotel, San Francisco.

APRIL 22–23, 1954: AIEE Conference On Feedback Control, Claridge Hotel, Atlantic City, N. J.

APRIL 24, 1954: Eighth Annual Spring Technical Conference, Cincinnati IRE, Cincinnati.

APRIL 27–29: AIEE Electronic Components Conference, Washington, D. C.

MAY 4–6: The 1954 Electronic Components Symposium, Department of Interior auditorium, Washington, D. C.

MAY 5–7: 1954: Third International Aviation Trade Show, 71st. Regiment Armory, New York, N. Y.

MAY 5–7: IRE Seventh Region Conference & Electronic Exhibit, Multnomah Hotel, Portland, Oregon.

MAY 7–8: New England Radio Engineering Meeting, IRE, Sheraton Plaza Hotel, Boston, Mass.

MAY 10–12: The National Conference On Airborne Electronics, Dayton Biltmore Hotel, Dayton, Ohio.

MAY 17–20: 1954 Electronic Parts show, Conrad Hilton Hotel, Chicago, Ill.

MAY 24–26, 1954: IRE, IAS, ISA, AIEE Conference On Telemetering, Morrison Hotel, Chicago, Ill.

MAY 25–27: Eighth NARTB Broadcast Engineering Conference, Palmer House, Chicago, Ill.

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

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

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

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

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

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

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

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

Industry Shorts

▶ **Magnetic** recording manufacturers licensed by Armour Research total some 60 companies throughout the world.

▶ **Isle of Man** has been chosen as the site for a low-power temporary tv station by the BBC.

▶ **Hair-removing** equipment users have asked FCC for additional time to meet regulations governing their equipment.

▶ **Airborne** radar tests conducted by United Air Lines show that C-band radar will penetrate a minimum of 15 miles of 60 mm per hour rainfall, using a transmitter power of 75 kw, and is the optimum for airborne weather mapping purposes.

▶ **Price**—to set manufacturers of $175 has been set by RCA for its color tv tube.

▶ **Tuna** fish catch of 55 tons, valued at $20,000, was landed in one day by use of Honeywell's sea scanar in commercial tuna fishing.

▶ **Proposal** of FCC may help f-m broadcasters income by allowing second program on multiplex channel at any time or beep radio during nonbroadcast hours. Beep system uses ultrasonic tone to activate special receivers.

▶ **Reports** of interference requiring FCC investigation rose from 10,124 to 21,749 in last fiscal year with tv cases predominating.

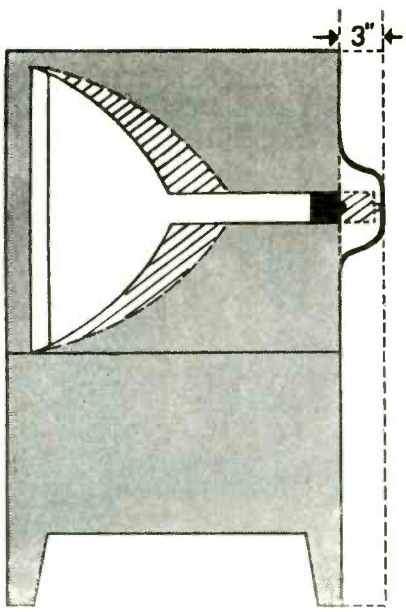
▶ **Russian** decree has been issued calling for the manufacture of 2.8 million radios and 325,000 tv sets in 1954.

▶ **Commercial** f-m transmitters are on the air in four Austrian cities and there are plans to place three more in operation.

THIS IS 13 SQUARE INCHES

13 SQ. IN. BIGGER PICTURE
3 IN. SHORTER CABINET

WITH NEW WESTINGHOUSE 90°, 21-INCH TUBE



The new Westinghouse 90° deflection picture tubes give you a 5 percent larger picture than any other 21-inch tube — 13 square inches more actual picture area than that of the largest 70° tubes.

What's more, the overall length of the tube has been cut at least three inches. Here's the way to reduce TV cabinet depth — or to eliminate the "hat" from the back of the set.

But still more, the new Westinghouse 90° tubes will actually produce a sharper picture than old 70° types. Electrostatic types are equipped with the new Westinghouse electrostatic focus gun which produces sharp, clearly defined pictures because of its smaller spot size. Magnetic focus tubes contain the simply constructed magnetic focus gun which gives crisp pictures in all areas.

New Westinghouse aluminized screens are available, too.

Investigate these Westinghouse 90° deflection 21-inch tubes today. They will make your black-and-white sets sell faster in the months ahead. Call your Westinghouse sales representatives for complete data and sample tubes or write, wire or phone Dept. A-2024 at the address below.

21-INCH WESTINGHOUSE 90° DEFLECTION TUBES ARE AVAILABLE WITH:

- Electrostatic Focus
- Electromagnetic Focus
- Aluminized Screens
- Non-Aluminized Screens

ET-95044

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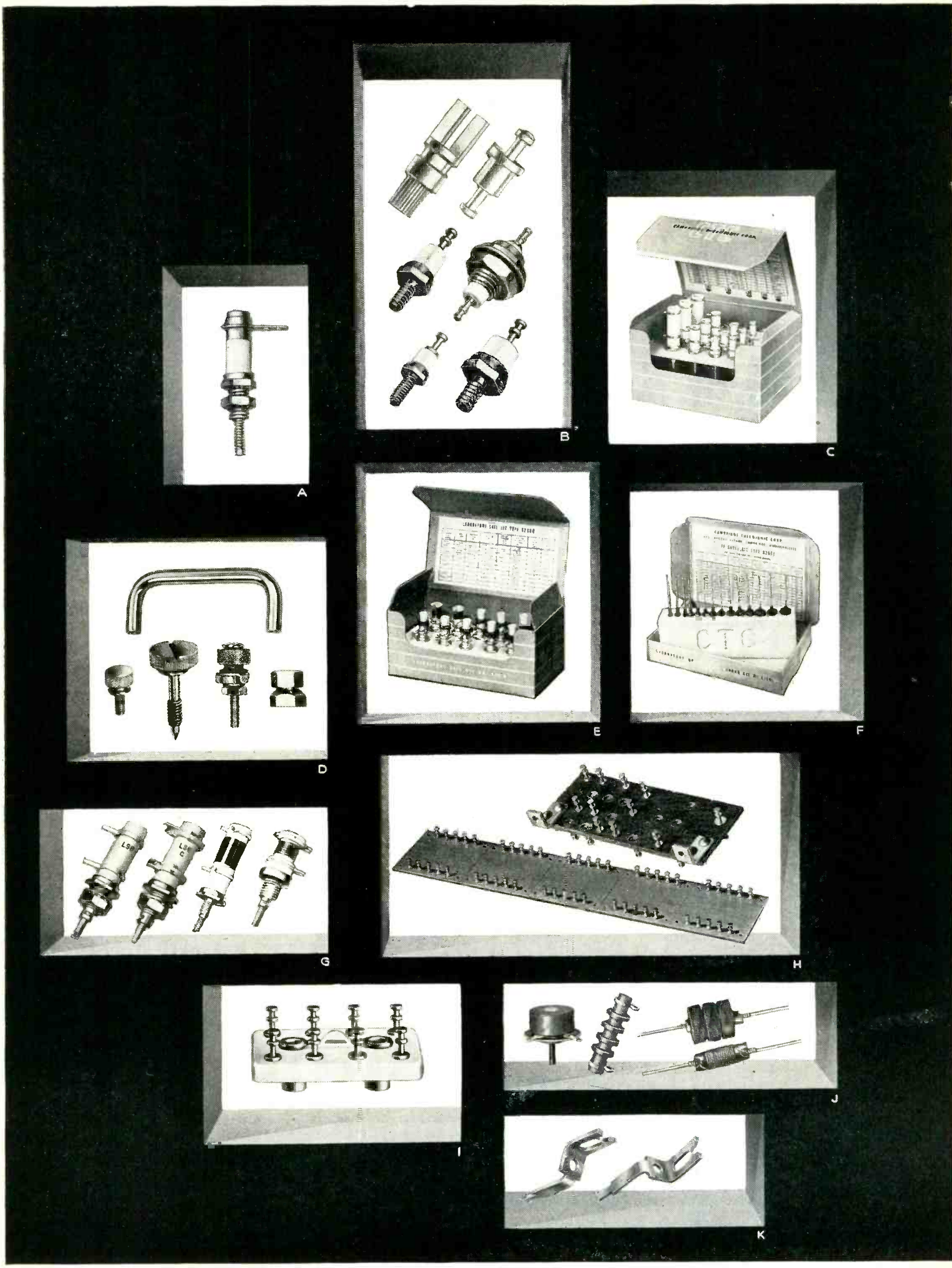
Westinghouse

RELIATRON® TUBES

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, N. Y.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One big family with a single thought

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

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

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

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

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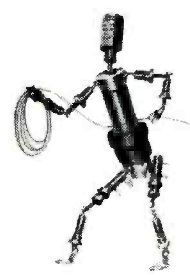
makers of guaranteed electronic components, custom or standard



SEE THE CTC COMPONENTS ON DISPLAY AT BOOTH 502, IRE SHOW, KINGSBRIDGE ARMORY, NEW YORK, MARCH 22-25th.

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

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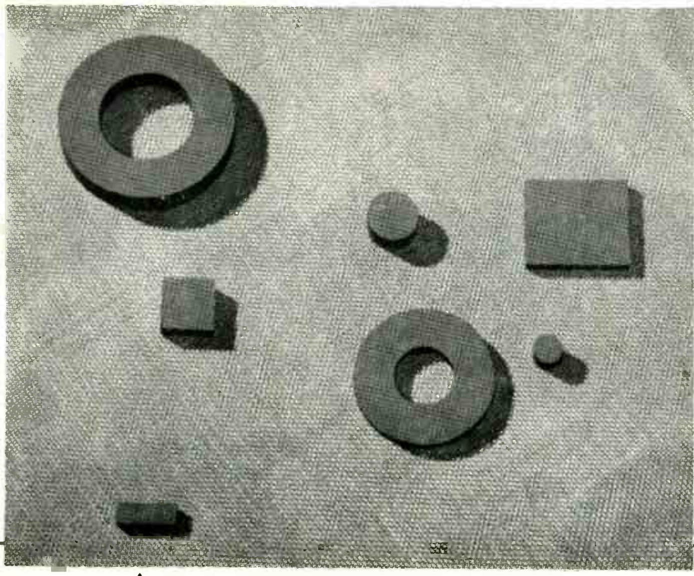
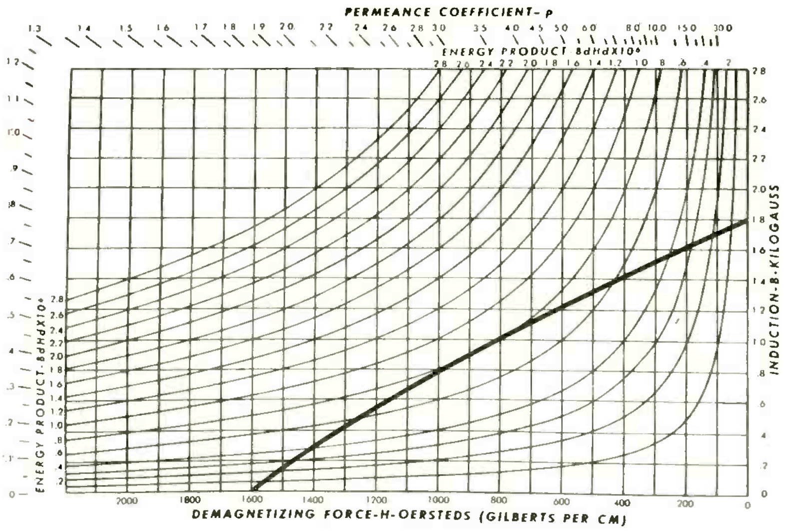
Presenting INDOX I . . . A

NEW CERAMIC PERMANENT MAGNET



▲ Typical INDOX I Permanent Magnets



▲ Demagnetization and Energy Product Curve for INDOX I

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- Negligible hysteresis and eddy-current losses in magnetic circuits having an alternating-current component.
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- No critical materials required.
- Lightweight.
- Magnetization practical prior to assembly.

Let our forty-three years of accumulated permanent magnet experience help you to utilize this new magnet in your products. Write to Dept. 2A for complete details.

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WORLD'S LARGEST MANUFACTURER OF PERMANENT MAGNETS

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Tested and
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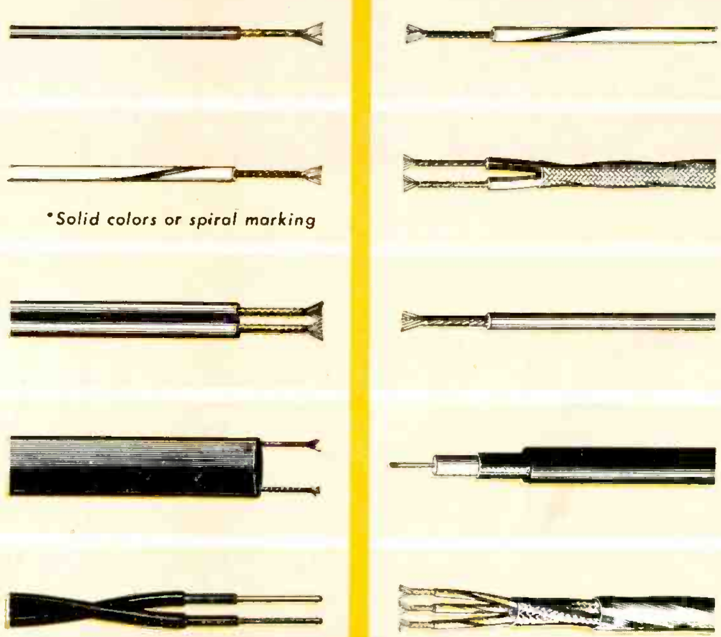
Chester ENGINEERED plastic insulation, laboratory and field tested to more than meet specifications provides both easier working qualities and longer service life. These rugged plastic coatings offer maximum immunity to abrasion, weather, oil and most chemicals. Smooth and pliable, they pull through channels and conduit easily and offer excellent appearance in open wiring. Chester single or multi-conductor wires and cables are available for electrical, electronic, TV, radio, telephone and many other industries. Call or write for illustrated bulletins, today!



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SPECIAL WIRES & CABLES
TO SPECIFICATIONS

"*Chesty*" HAS THE ANSWERS — Plasticord and Plasticote wires are available in standard constructions or custom built to specifications. For a practical solution to unusual insulated wiring problems, call or write.

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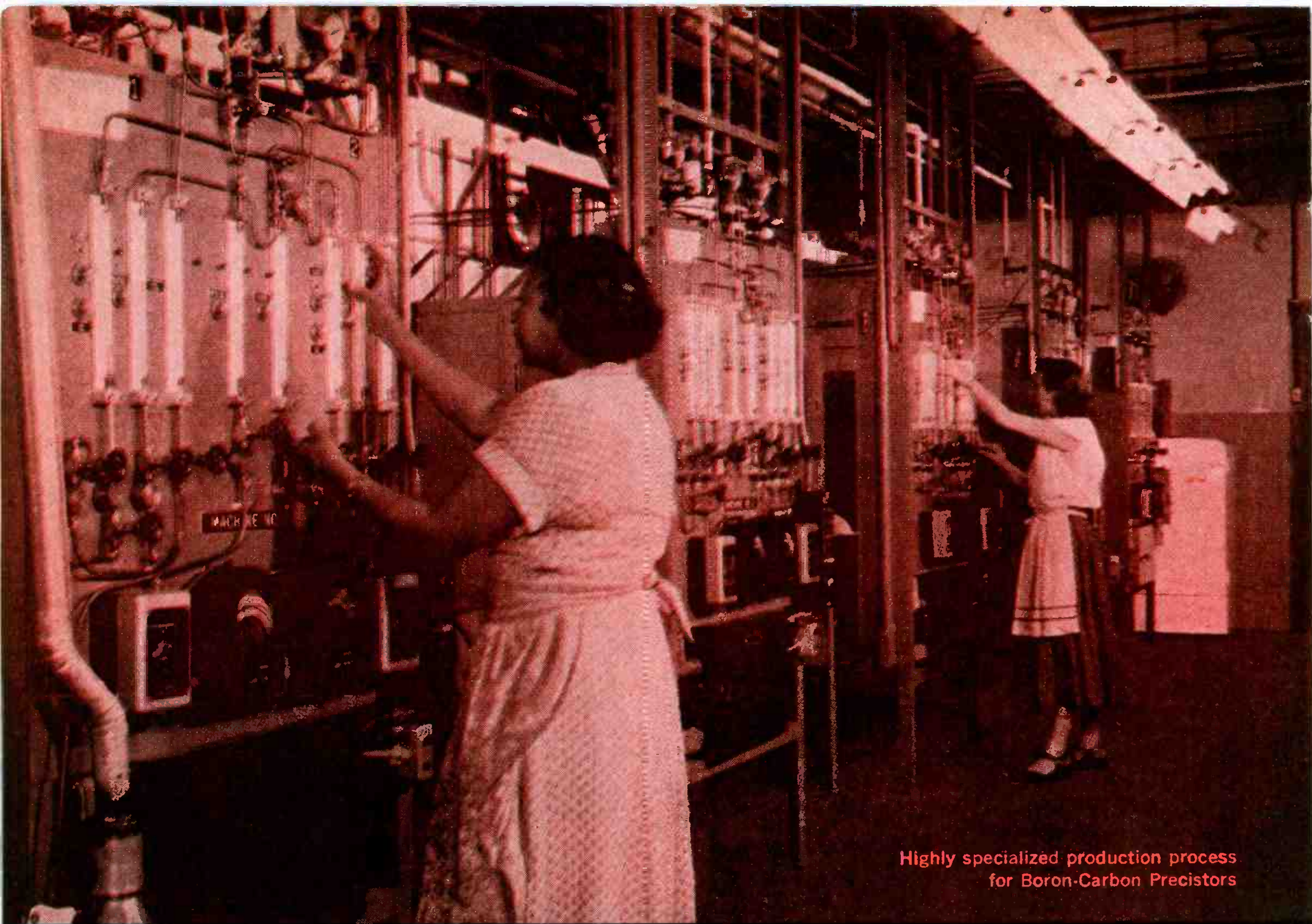
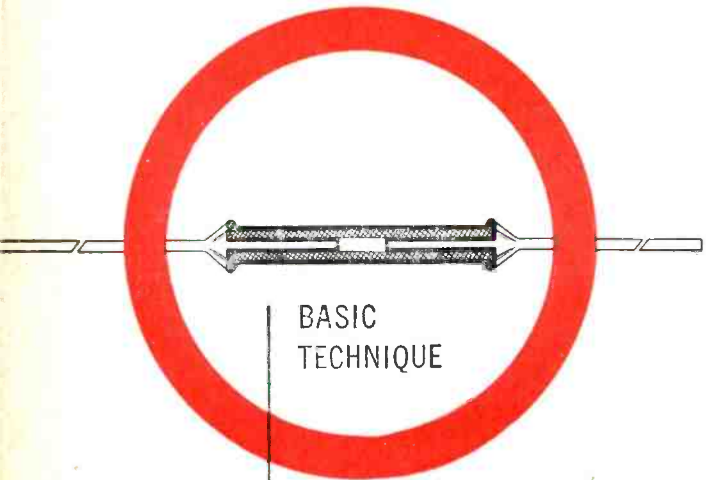


Highly specialized production process for Boron-Carbon Precistors

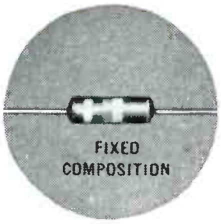
ONLY FILM TYPE RESISTORS MEET HIGHER



BASIC TECHNIQUE

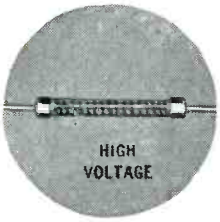
A thin coating of pre-cured and stabilized resistance material is bonded to special glass or an inorganic core to form IRC's exclusive filament type element. This is in contrast to the carbon pill or slug principle of construction. Its uniformity and stability have proved superior since the earliest days of radio.

Advancing requirements of instrumentation, military electronics and television focus emphasis on greater stability for non-wire wound resistors. IRC believes its filament type construction offers the best answer to more exacting standards. For over 28 years the film type resistance element has proved its superior stability—even in today's newest IRC Boron-Carbon Precistor.



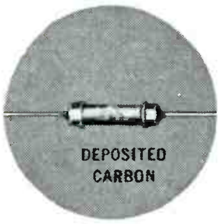
high popularity—high stability

More IRC Filament Type BT Resistors are used in radio and TV sets than any other brand. They meet and beat JAN-R-11 specifications, and have been tested and approved by most producers of government equipment. Exceptionally stable—in ⅓, ½, 1 and 2 watts. Send coupon for Data Bulletin.



high voltage—high stability

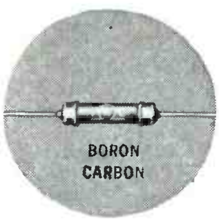
IRC Type MV High Voltage Resistors offer outstanding stability even in very high resistance values. Filament resistance coating in helical turns on ceramic tube provides a long, effective conducting path. 2 to 90 watts. Check the coupon for detailed information.



high economy—high stability

Type DC Deposited Carbon Resistors combine accuracy and economy with high stability. Excellent where carbon compositions are unsuitable and wire wound precisions too large or expensive. Available in ½, 1 and 2 watts. Use coupon for further facts.

STABILITY STANDARDS



high accuracy—high stability

The ultimate in *stable* non-wire wound resistors. Type BOC Boron-Carbon ½ watt Precistors are ideally suited for critical circuits where stability and high accuracy under widely varying temperatures are important. Extraordinary load life. Send for Bulletin.

NEW

resistor

MOLDED

boron-carbon precistor

Eliminates Possibility of End-Cap Trouble

Eliminates Danger of Mechanical Damage

Improved Electrical Characteristics

The new Type MBC ½ watt, 1% resistor offers the inherent superiority of a Boron-Carbon resistor plus the advantage of a fully insulated unit. Send coupon for full details.

Boron & Deposited Carbon Precistors • Power Resistors • Voltmeter Multipliers • Low Wattage Wire Wounds • Insulated Composition Resistors • Volume Controls •

Wherever the Circuit Says

IRC

Precision Wire Wounds • Ultra HF and Hi-Voltage Resistors • Low Value Capacitors • Selenium Rectifiers • Insulated Chokes • Hermetic Seal Terminals •

INTERNATIONAL RESISTANCE CO.

403 N. Broad St., Philadelphia 8, Pa.

In Canada: International Resistance Co., Ltd., Toronto, Licensee

Send me full data on: ☐ DC Deposited Carbon; ☐ BT Insulated Filament Type Resistors; ☐ MV High Voltage Resistors; ☐ BOC Boron - Carbon Precistors; ☐ MBC Molded Boron-Carbon Precistors

Name ______

Title ______

Company ______

Address ______

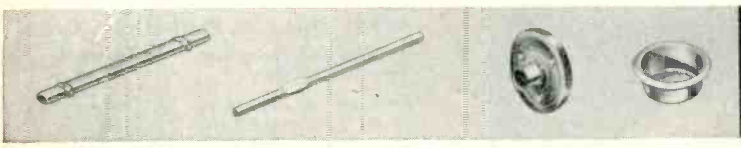
City ______ Zone ______ State ______

Magnetron illustrations courtesy of Raytheon Manufacturing Company

Source of UHF waves that make possible the radar screen guarding our continental perimeter is the magnetron.

Essential elements of the magnetron, and the anodes and cathodes of the companion direct-reading oscilloscope are produced by Superior Tube Company. For example, in the Raytheon magnetron above, Superior furnishes: A. The cathode (heart of the magnetron); B. The anode; C. The sleeve on the wave trap (or choke) assembly.

All of these parts are made from Superior seamless nickel tubing. As a matter of fact, there is Superior tubing *in every one* of the 400 different types of Raytheon magnetrons—a record possible only because of great satisfaction with Superior alloys, fabrication, deliveries and service. Put *your* chief dependence upon Superior. Superior Tube Company, 2500 Germantown Ave., Norristown, Pa.



Superior
THE BIG NAME IN SMALL TUBING

All analyses .010" to ⅝" OD.

Certain analyses in Light Walls up to 2 1/16" OD.

Seamless Nickel Cathode. Oval, double bead, .025" x .048" x .003" Wall. 12mm long.

Lockseam* Nickel Cathode Round, vertical emboss, .045" OD x .0021" Wall. 26.5 mm long.

Disc Cathode* .121" OD, .312" long.

No. 2 Grid Cup, 305 Stainless Steel, Rolled edge. .499" OD x .010" Wall x .262" long.

Many other types of nickel cathodes—such as Lockseam*, made from nickel strip, disc cathodes, and a wide variety of stainless anodes, grid cups and other tubular fabricated parts are available from Superior. For information and free literature on these products as well as Cathaloy A-30, A-31**, our latest Cathode Alloys, address Superior Tube Company, Electronics Division, 2500 Germantown Avenue, Norristown, Pa.

*Manufactured under U.S. Patents
**U.S. Trademark applied for

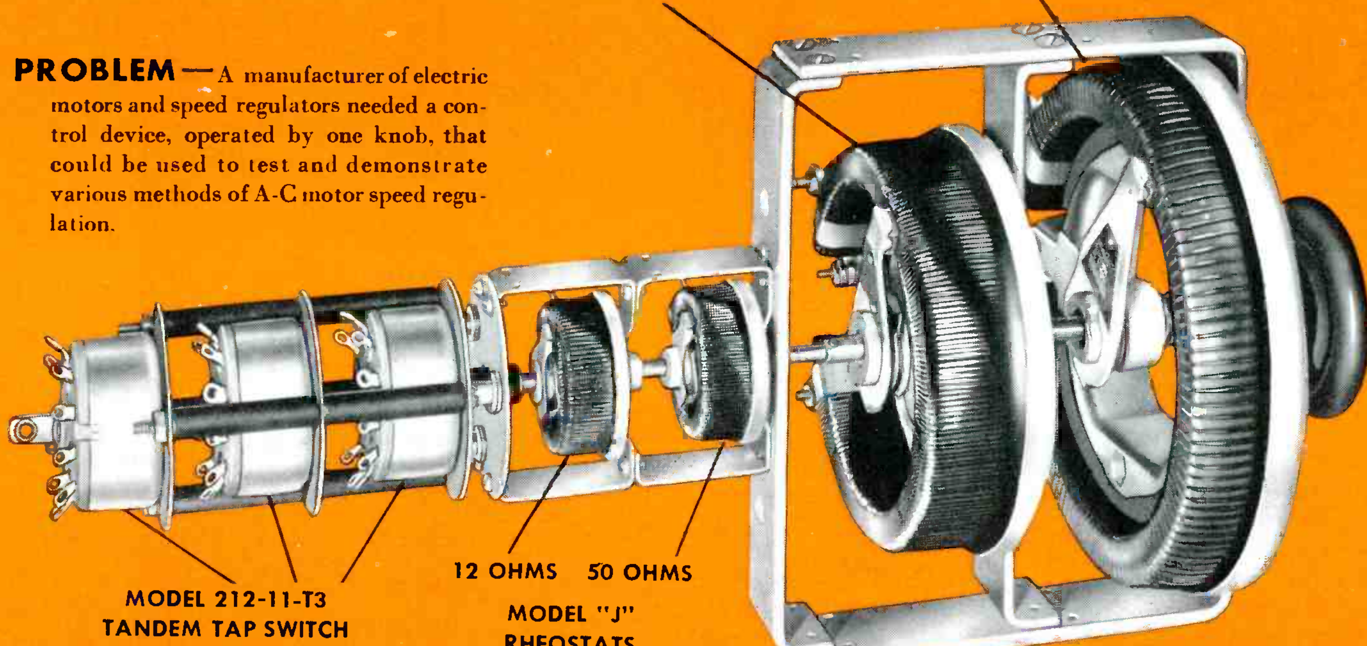
OHMITE®

RHEOSTATS

in Special Tandem Assemblies

MADE TO ORDER TO SOLVE YOUR UNUSUAL CONTROL PROBLEMS

PROBLEM—A manufacturer of electric motors and speed regulators needed a control device, operated by one knob, that could be used to test and demonstrate various methods of A-C motor speed regulation.



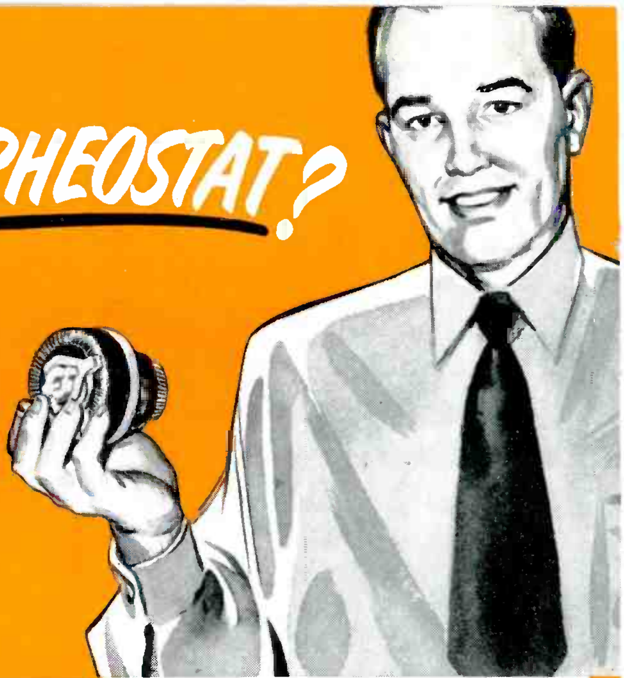
SOLUTION—Ohmite produced a special combination of four rheostats and three 11-position switches, all coupled together in tandem, and operated by one knob. The tap switches are loosely coupled to the rheostats so when the quick-make taps close, the rheostat settings are not changed. All units are electrically independent. Any unit or all units can be connected in the circuit to be tested, and can be wired in any desired manner. As a result of this special control device, test and development work was greatly speeded up.

Ohmite is prepared to develop special combinations of standard rheostats, resistors, and tap switches to meet your individual requirements. Consult your Ohmite representative.

BE RIGHT WITH OHMITE®

RHEOSTATS • RESISTORS • TAP SWITCHES

What Special Feature do you need in a RHEOSTAT?



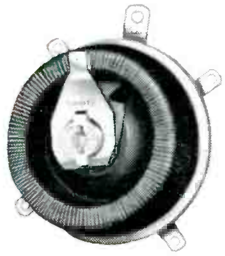
OHMITE CAN SUPPLY IT!

In addition to standard rheostats, Ohmite offers rheostats with a wide variety of *special features.* All have the distinctive Ohmite design features: smoothly gliding metal-graphite brush; all-ceramic construction; insulated shaft and mounting; windings permanently locked in place by vitreous enamel.

BUSHINGS FOR SPECIAL PANEL THICKNESS

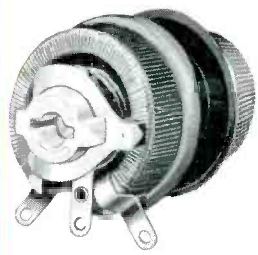
Extra-long bushings and shafts allow mounting on panels up to 2 inches in thickness. Seven bushing lengths are available, from ¼ to 2⅛ inches.

360° WINDING



Two small models available with continuous circular core and endless winding. Unlimited rotation of shaft and contact arm. Taps supplied at any desired angle on windings.

DEAD LUG OFF POSITION



Opens the circuit at the high or low resistance position as the contact passes on to the lug, which is disconnected from the winding. Recommended for light duty.

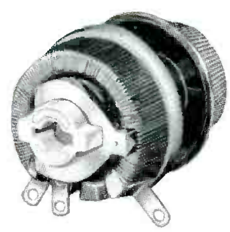
SCREW DRIVER SLOT SHAFT

Where infrequent adjustments are needed, shaft ends can be slotted for operation with a screwdriver. Tampering with the shaft setting is thus minimized.

SEALED, ENCLOSED CAGES

Compact, corrosion-resisting metal enclosure, permanently sealed by a double seam, protects the unit completely. Available with rheostat Models H and J.

SNAP-ACTION OFF POSITION

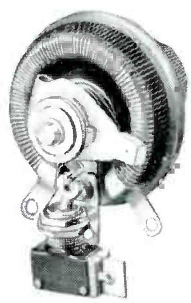


Opens the rheostat circuit at the high or low resistance position. The circuit is opened as the brush snaps into an insulated notch next to the lug, providing indexing.

TANDEM ASSEMBLIES

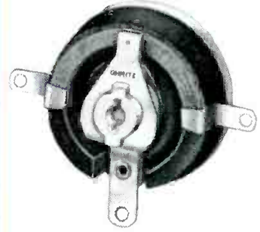
Ohmite rheostats can be mounted two or more in tandem, for simultaneous operation of several circuits. Universal joints provide smooth, positive mechanical action.

TOGGLE SWITCH



Toggle switch is operated with a positive snap by the movement of the contact arm. Opens the rheostat circuit or switches an independent circuit. Available for all models.

LESS THAN STANDARD ROTATION



Rheostats can be supplied with winding space and angle of rotation less than standard. Rheostats can also be supplied with fixed or adjustable stops.

OHMITE MANUFACTURING COMPANY
3610 Howard St., Skokie, Illinois (Suburb of Chicago)

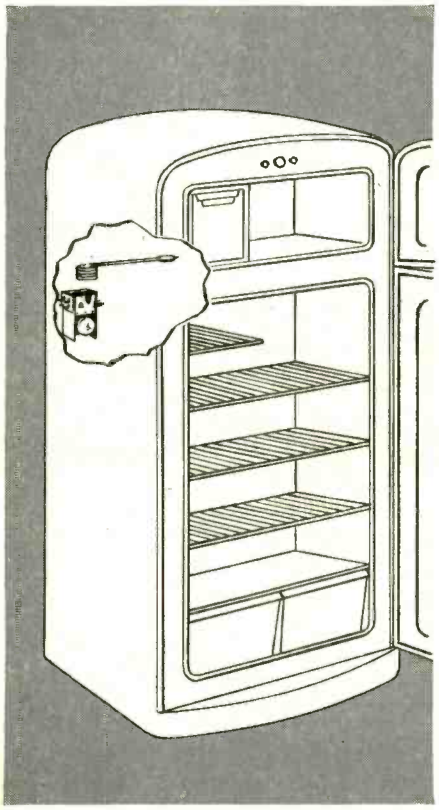
WRITE on Company Letterhead for Catalog and Engineering Manual No. 40.

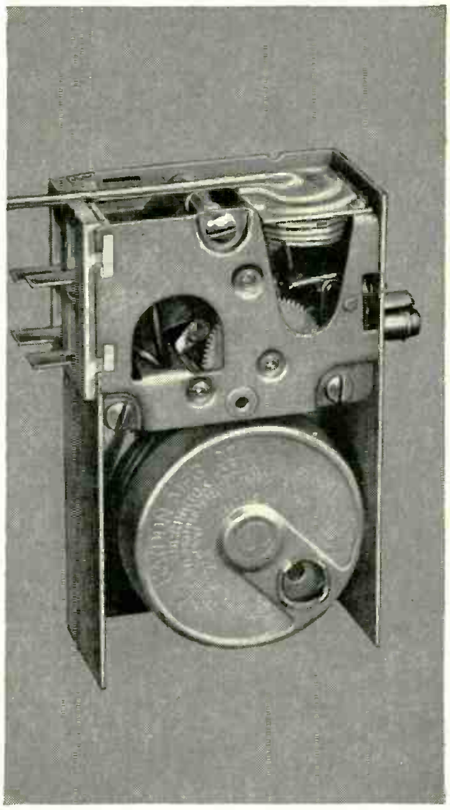
Be Right with

OHMITE®

RHEOSTATS • RESISTORS • TAP SWITCHES

IDEAS that started in a BELLOWS





PROBLEM: TO START UP A REFRIGERATOR AUTOMATICALLY

To run efficiently, refrigerators must be defrosted periodically. They must also be started up again within a definite time. How to do this *automatically,* without relying on the housewife's judgment, was once a problem.

NOW "STANDARD PROCEDURE"

Automatic timers now start defrosting process at a pre-determined time. Thermostat then automatically turns current on when temperature reaches pre-determined point. Food spoilage is averted and frozen foods kept from melting.

AND HERE'S THE ANSWER

Automatically starting up refrigerating units at low cost was solved through the use of bellows assemblies by Haydon Manufacturing Company. This vapor-actuated assembly gives the close temperature control essential.

Have you ever worked with Bellows?

Although bellows seldom get the spotlight in engineering courses, they have proved invaluable in solving some of today's important engineering problems.

Clifford vapor-actuated thermostatic bellows assemblies are simply designed, dependable and easy to install. They provide an accurate temperature control that is not costly.

They have gained wide acceptance for temperature control for this purpose in all types of Diesel engines, stationary and automotive, as well as truck and passenger car gasoline engines. They are used, too, in water heating or cooling tanks, steam coolers, acid baths, glue heaters, bottle washers, tempering baths, and other equipment. For additional information, fill out and mail coupon below.

CLIFFORD MANUFACTURING COMPANY, Waltham 54, Massachusetts. *Division of Standard-Thomson Corporation.* Sales offices in New York; Detroit; Chicago; Los Angeles; Waltham, Mass.

HYDRON METAL BELLOWS — CLIFFORD MANUFACTURING CO. WALTHAM, MASS. DIVISION OF STANDARD-THOMSON CORP. — HEAT EXCHANGERS

CLIFFORD MANUFACTURING COMPANY
119 Grove Street, Waltham 54, Massachusetts
Gentlemen:
Please send me information on bellows application for temperature control. Also for ☐ Vacuum tube adjustments ☐ Transmitting motion between two mediums ☐ Sealing rotary shafts or packless valves ☐ Transmitting motion hydraulically to remote points ☐ Providing for thermal expansion ☐ Providing shock mounting or vibration dampening ☐ Differential pressure control

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Company Name..

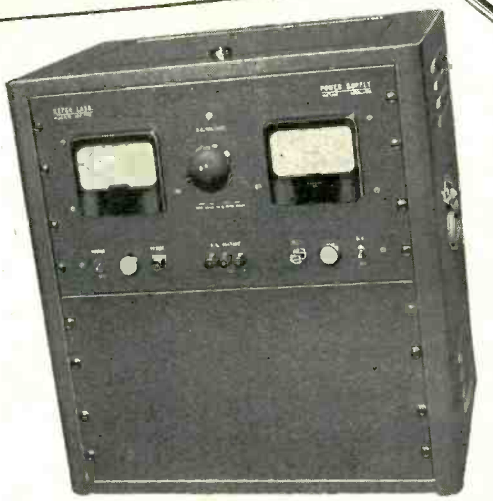
No. and Street..

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

KEPCO

VOLTAGE REGULATED POWER SUPPLIES

VOLTS	CURRENT	REGU-LATION	RIPPLE	6.3 V.† AC. CT.	MODEL
0-1500	0-200 Ma.	0.5%	20 Mv.		1520
0-1200	0-20 Ma.	0.1%	10 Mv.	10 Amp.	1220
0-1000	0-500 Ma.	0.5%	20 Mv.		1350
200-1000	0-500 Ma.	0.5%	20 Mv.		1250
0-1000	0-50 Ma.	0.1%	10 Mv.	10 Amp.	1020
0-600	0-3 Amp.	0.5%	10 Mv.		780
0-600	0-2.25 Amp.	0.5%	10 Mv.		770
0-600	0-1.5 Amp.	0.5%	10 Mv.		760
0-600	0-750 Ma.	0.5%	10 Mv.		750
0-600 0-150 Bias	0-300 Ma. 0-5 Ma.	0.5% *	10 Mv. 5 Mv.	10 Amp.	615
0-600	0-300 Ma.	0.5%	10 Mv.	10 Amp.	500R
#1 0-600 #2 0-600	0-200 Ma. 0-200 Ma.	0.5% 0.5%	5 Mv. 5 Mv.	10 Amp. 10 Amp.	800
0-600 0-150 Bias	0-200 Ma. 0-5 Ma.	0.5% *	5 Mv. 5 Mv.	10 Amp.	815
#1 200-500 #2 200-500	0-200 Ma. 0-200 Ma.	0.5% 0.5%	5 Mv. 5 Mv.	6 Amp. 6 Amp.	510
200-500	0-200 Ma.	0.5%	5 Mv.	6 Amp.	245
0-400 0-400 0-150 Bias	0-150 Ma. 0-150 Ma. 0-5 Ma.	0.5% 0.5% *	5 Mv. 5 Mv. 5 Mv.	10 Amp. 10 Amp.	2400
0-400 0-150	0-150 Ma. 0-5 Ma.	0.5% *	5 Mv. 5 Mv.	10 Amp.	400
100-400	0-150 Ma.	0.5%	5 Mv.	10 Amp.	141
100-400	0-150 Ma.	0.01%	1 Mv.	10 Amp.	2000
0-350	0-3 Amp.	0.5%	10 Mv.		730
0-350	0-2.25 Amp.	0.5%	10 Mv.		720
0-350	0-1.5 Amp.	0.5%	10 Mv.		710
0-350	0-750 Ma.	0.5%	10 Mv.		700
100-325 0-150 Bias	0-150 Ma. 0-5 Ma.	0.5% *	5 Mv. 5 Mv.	10 Amp.	131
0-300 0-150 Bias	0-150 Ma. 0-5 Ma.	0.5% *	5 Mv. 5 Mv.	5 Amp.	315
0-150	0-50 Ma.	0.5%	5 Mv.		150
3-30	0-30 Amp.	0.5%	0.1%		3030
1-13	0-10 Amp.	0.5%	10 Mv.		3200
0.3-3	0-100 Ma.	5 Mv.	1 Mv.		3100



MODEL 700

OUTPUT DC: 0-350 volts, 750 ma.

REGULATION: ½% for both line, 105-125 volts, and load variations, 0-750 ma.

RIPPLE: 10 millivolts.

This unit is available delivering:
- 1.50 amp.—Model 710
- 2.25 amp.—Model 720
- 3.00 amp.—Model 730

KEPCO

Voltage Regulated Power Supplies are conservatively rated. The regulation specified for each unit is available under all line and load conditions within the range of the instrument.

DC POWER SUPPLY SPECIFICATIONS

REGULATION: As shown in table for both line fluctuations from 105-125 volts and load variations from minimum to maximum current.

***REGULATION FOR BIAS SUPPLIES:** 10 millivolts for line 105-125 volts. ½% for load at 150 volts.

†All AC Voltages are unregulated.

All units are metered except Models 131, 315 and 3100.

All units are designed for relay rack mounting or bench use.

WORKMANSHIP

Workmanship is of a quality with the highest existing production standards and best instrument electronic practices consistent with the intended use of the item as a continuous duty voltage regulated power supply. Oil filled paper condensers and resistor-board construction are included in the design.

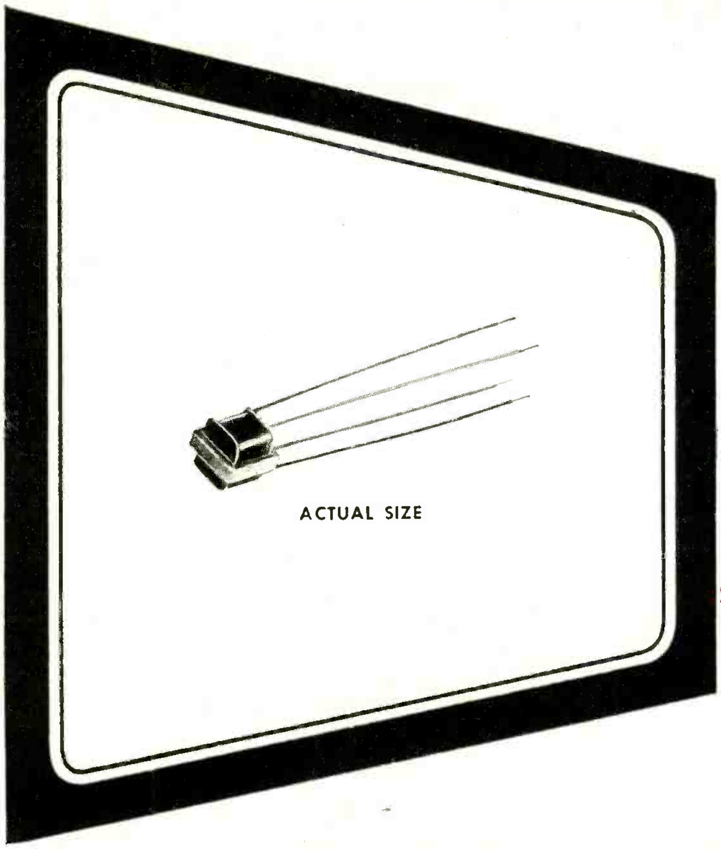
FOR NEW POWER SUPPLY CATALOG — WRITE DEPT. No. 789

MANUFACTURERS OF ELECTRONIC EQUIPMENT • RESEARCH • DEVELOPMENT

KEPCO LABORATORIES

131-38 SANFORD AVENUE • FLUSHING 55, N.Y.

specified as standard equipment by leading manufacturers



ACTUAL SIZE

TRANSISTOR HEARING AIDS
• **GUIDED MISSILES**
• **POCKET RADIOS**
• **MINIATURE AIR-BORNE EQUIPMENT**
• **SMALL TRANCEIVERS**

TRANSISTOR TRANSFORMER

GRAMER TINYFORMERS

● Gramer TINYFORMERS, first choice of design engineers, are pacing the transistor to shrink otherwise large devices down to minute size. Gramer TINYFORMERS match inputs and outputs in transistor circuits, improve their frequency response, will help reduce your product to minimum size while maintaining the highest degree of operating efficiency.

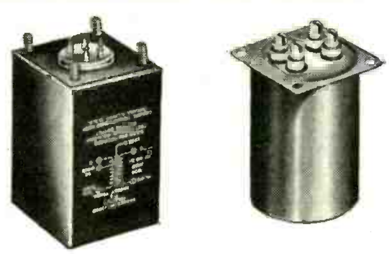
7 types available for immediate delivery!

PART NO.	TYPE	MATCH. IMPEDANCE		D.C. RESISTANCE		SIZE IN INCHES	WT. LBS
		PRI.	SEC.	PRI.	SEC.		
M1	Interstage	20,000	1,000	1,150	175	11/32x3/8x3/8	.005
M2	Interstage	20,000	1,000	930	95	11/32x3/8x3/8	.005
M4	Output	600	50	66	7.7	11/32x3/8x3/8	.005
M5	Output	400	50	70	9.3	11/32x3/8x3/8	.005
M6	Input	200,000	1,000	2,600	135	11/32x3/8x3/8	.005
M7	Output	1,000	50/60	160	9	11/32x3/8x3/8	.005
M10	Choke	12 Hy. O D.C.		830		21/64x3/8x3/8	.005

plus **A COMPLETE LINE OF TRANSFORMERS FOR EVERY TYPE OF INDUSTRY**

Hermetically Sealed

Meet MIL-T-27 Grade 1, Class A or B; and Grade 2, Class C Specifications.



Send your specifications now for cost-free recommendations

GRAMER TRANSFORMER CORPORATION

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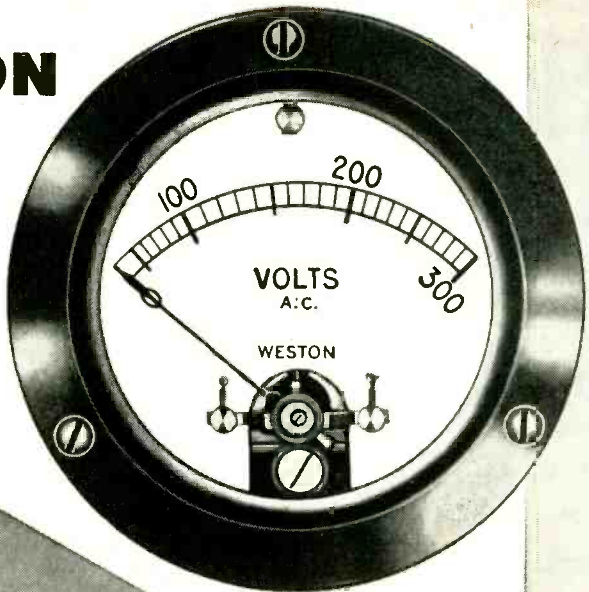
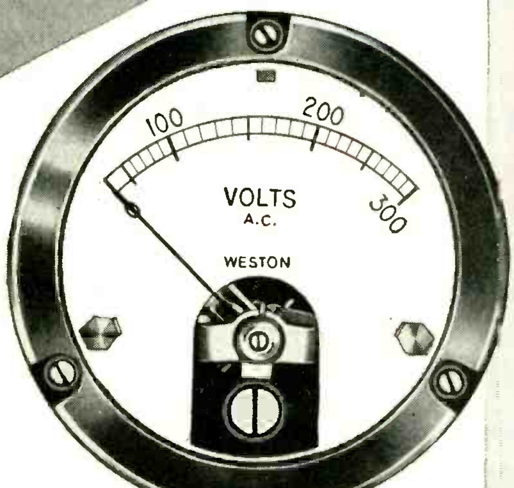
Want more information? Use post card on last page.

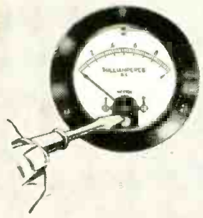
another WESTON FIRST

A-C ruggedized instruments





WESTON Ruggedized Instruments are available not only in D-C but in movable iron A-C, rectifier type A-C and thermo. *All* are supplied with essential sealed *zero correctors*—shock-resisting flat plastic windows—and connection terminals molded into internal rubber, *leakproof, breakproof and effectively insulated.* For complete details, write for bulletin. Weston Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey.



All Weston Ruggedized instruments have externally operated sealed zero correctors.

Insulated, breakproof connection terminals are molded into internal rubber.

Tough, flat plastic windows are really shock resistant.

WESTON ruggedized instruments

glass-to-metal seals

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

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

STUPAKOFF CERAMIC & MANUFACTURING COMPANY

LATROBE, PENNSYLVANIA

BIG SCOREBOARD

for Scores of Manufacturing Processes

Added Evidence that —

Everyone Can Count on VEEDER-ROOT

This husky long-lived Box-type Counter is available with 6 figures, in either the ratchet model, or in the new *geared* model with bearing inserts. This new gearing permits speeds of 1,000 counts per minute, which makes the counter adaptable to practically any manufacturing process where large figures are wanted for easy reading at a distance. Figure out how this counter can be *built into* your product as a new sales advantage over competition. Write:

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

"The Name that Counts"

Want more information? Use post card on last page.

The Right Match

for miniature equipment requiring a dependable miniature chopper . . .

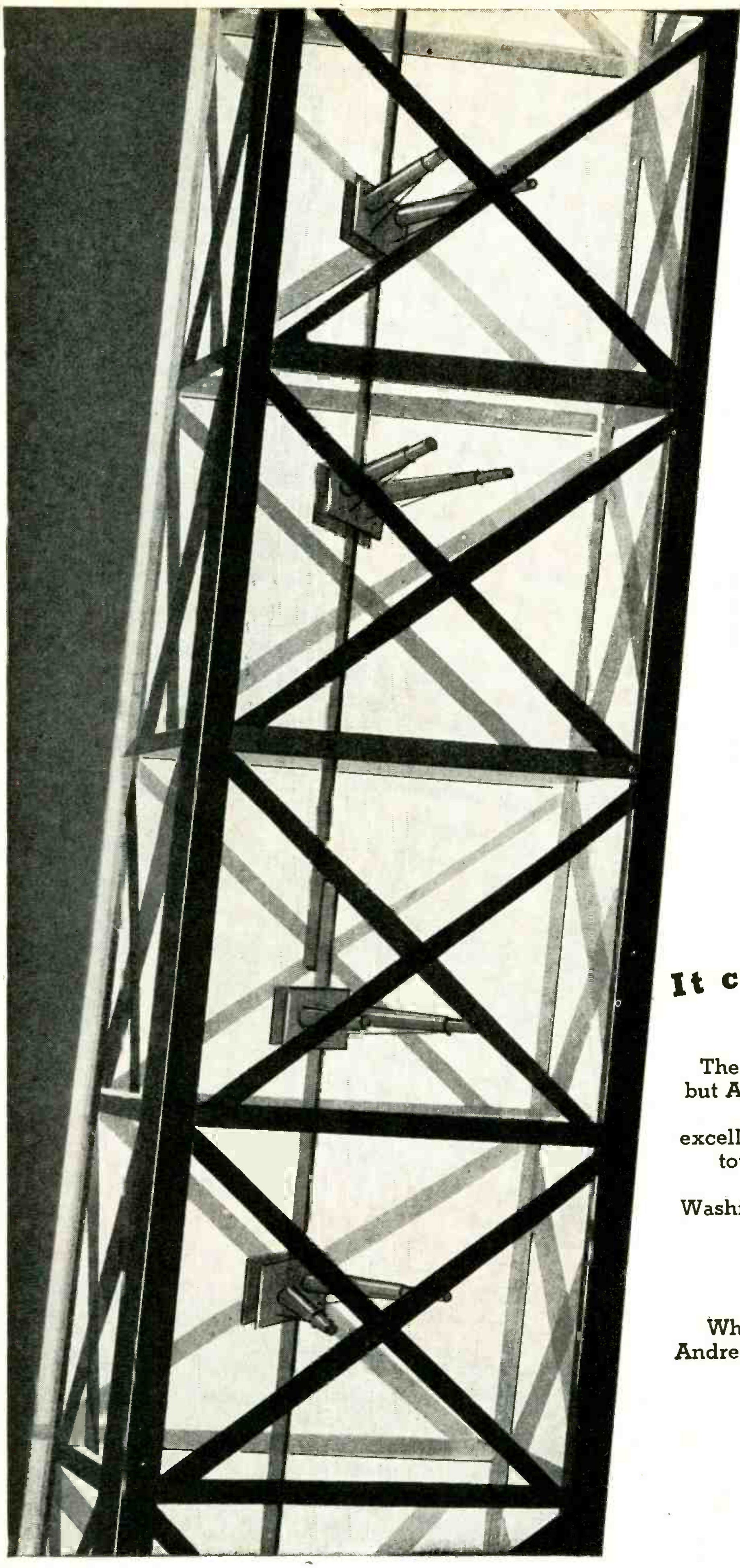
AIRPAX C747

"MIDGET"

400 CYCLE CHOPPER

Statistics prove that Airpax leads the nation in quantity and quality of choppers. Model C747 is available in quantity for immediate delivery from separate facilities at either of our two plants. Performance, rating and life are equal and better than that of our larger models. The MIDGET has 6.3 volt, 400 cycle drive, phase angle of 65°, SPDT contacts of about 135° dwell time. Contact our Sales Department for complete specification details, our Engineering Department for quick assistance with your application.

AIRPAX PRODUCTS COMPANY, MIDDLE RIVER, BALTIMORE 20, MD.



It couldn't be done?

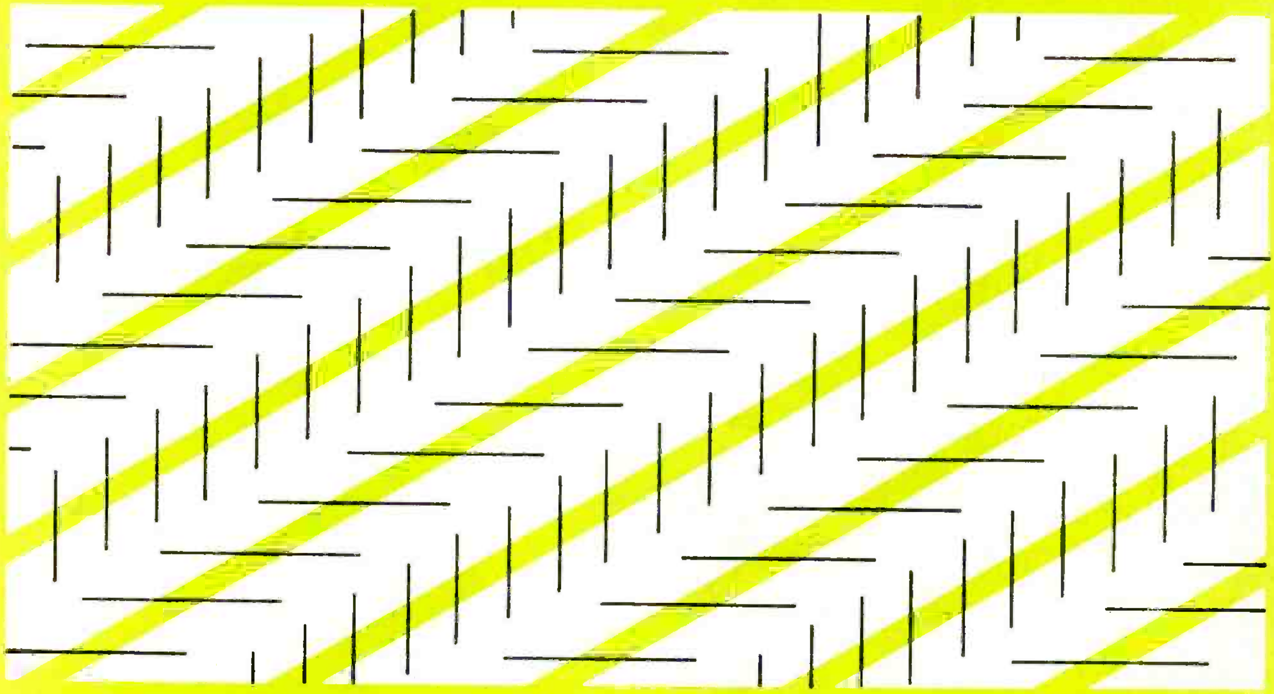
The books said it couldn't be done—but Andrew engineers went ahead and designed an antenna that gives excellent coverage mounted *inside* the tower! This ingenious development enabled station WTOP in Washington, DC to use their television tower for FM too—and so save thousands of dollars.

Whatever *your* problem in antennas Andrew ingenuity will find the answer. Be sure to consult us.

Andrew CORPORATION

363 EAST 75TH STREET, CHICAGO 19

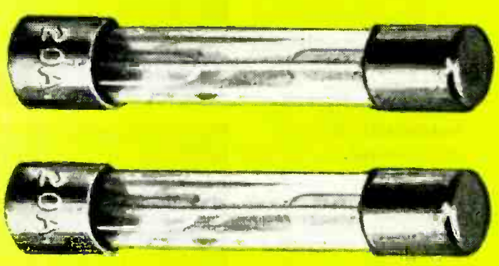
Want more information? Use post card on last page.

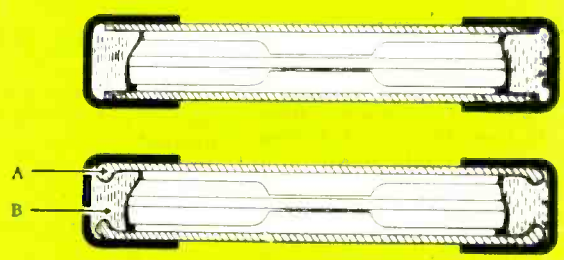


THINGS ARE NOT AS THEY SEEM...

The long lines are strictly parallel—that they appear otherwise is an optical illusion.

This fuse merely has the metal caps cemented to the glass.





The difference between these two fuses is no illusion . . .

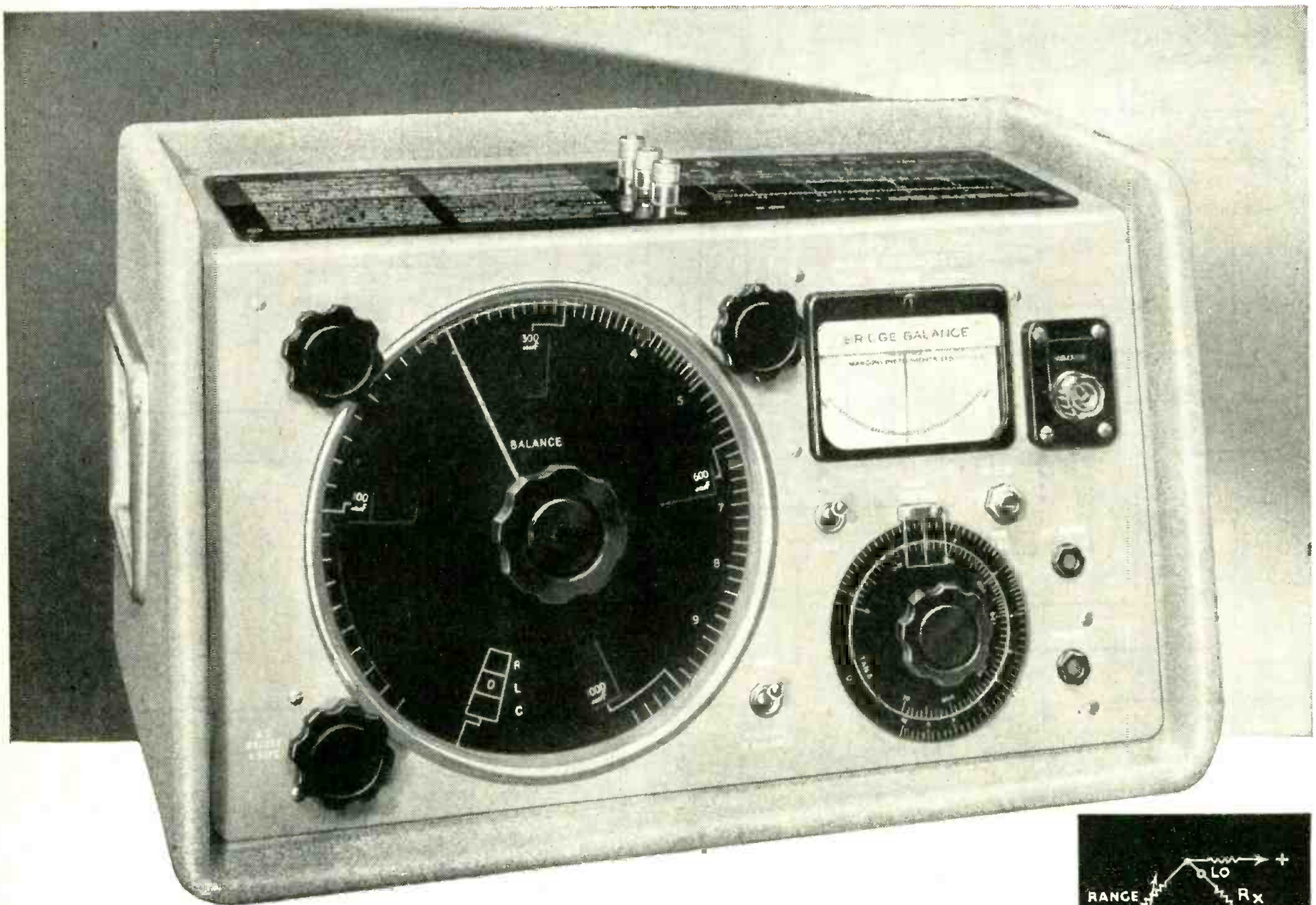
This Littelfuse has the caps locked to glass like this.

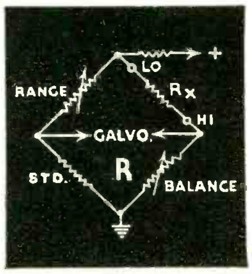
The ends of the glass are formed[A]. The solder which is bonded in a separate operation to the cap reflows through the small aperture and spreads out to form a permanent collar-button lock[B] between cap and glass—impervious to moisture and vibration. The exclusive Littelfuse feature eliminates fuse failure due to loose caps.

Littelfuse leads all other fuse manufacturers in design patents on fuses. Lock-cap assembly patent no. 1922642

LITTELFUSE

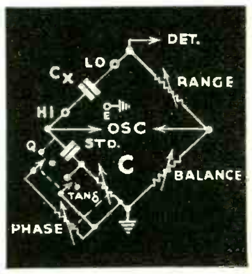
DES PLAINES, ILLINOIS





R, C AND L ACCURATELY MEASURED

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

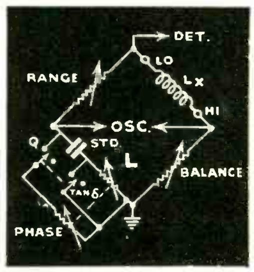


UNIVERSAL BRIDGE TYPE TF 868

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

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

Continuously variable bridge voltage and automatic detector sensitivity control.



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

UNIVERSAL BRIDGE TF 868 · FM DEVIATION METER TF 934
FM/AM SIGNAL GENERATOR TF 995 · STANDARD SIGNAL GENERATOR TF 867
ALSO
VACUUM TUBE VOLTMETERS · FREQUENCY STANDARDS · OUTPUT METERS
WAVEMETERS · WAVE ANALYSERS · Q METERS · BEAT FREQUENCY OSCILLATORS

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C64

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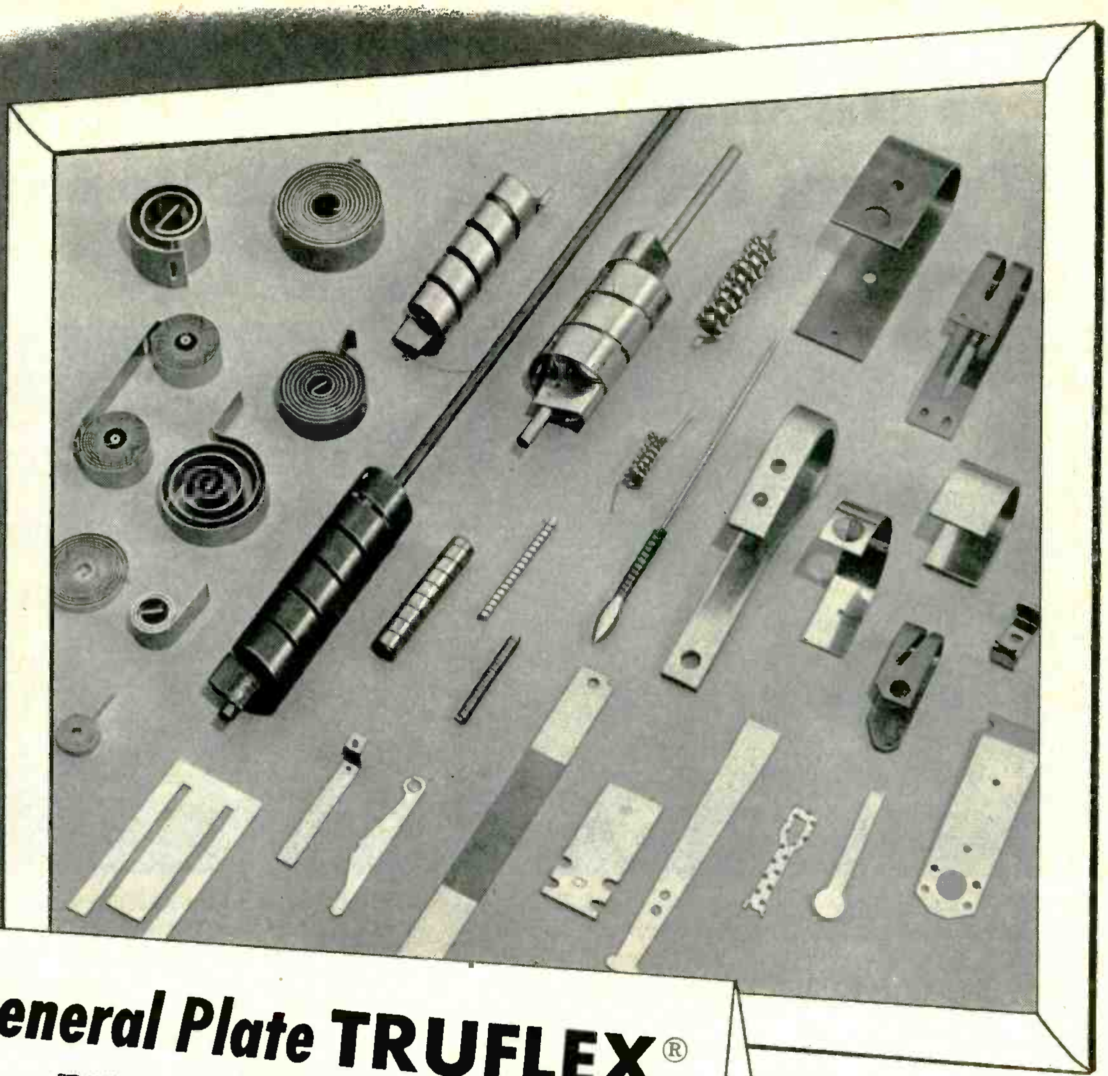


General Plate TRUFLEX®

THERMOSTAT METALS

Fit Into Your Product Picture

for Temperature Reaction, Accurate Performance and Economy!

General Plate *Truflex* Thermostat Metals and Fabricated Assemblies can cut your costs and give you reliable performance in your products requiring temperature control, indication or compensation required.

Advanced General Plate production methods coupled with the best equipment available insure positive consistency in thermal and mechanical performance, and in maintaining close dimensional tolerances, hardness, etc. Every lot, whether it is 10 or 10,000, is a duplicate of the original, thus eliminating rejects and costly adjustments in assembly.

General Plate *Truflex* fabricated assemblies are engineered and manufactured to your specifications, ready for installation into your products. They eliminate costly fabrication problems . . . needless special equipment costs . . . experimental and assembly adjustments.

For you who desire to manufacture your own parts, *Truflex* Thermostat Metals are available as strip in coils or flat cut lengths.

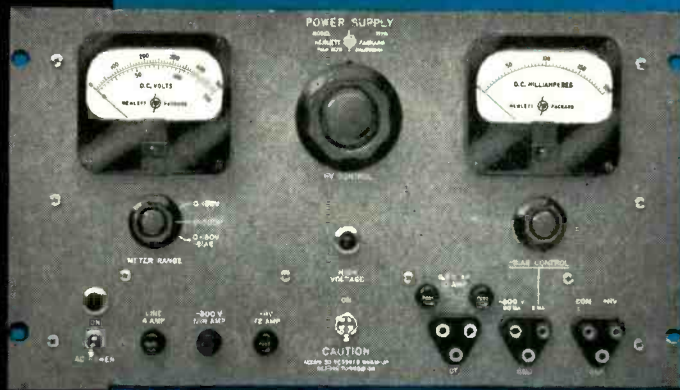
It will pay you to investigate General Plate Truflex Thermostat Metals for your requirements. Write for engineering assistance and catalog.

You can profit by using General Plate Composite Metals!

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

New! HIGH REGULATION Power Supply

- **REGULATION 0.01%**
- **0.1 MILLISECOND TRANSIENT RESPONSE**
- **INTERNAL IMPEDANCE 0.1 OHM, 25 μH**
- **HUM LESS THAN 500 μV**
- **SEALED TRANSFORMERS, CHOKES, CONDENSERS**



***-hp-* 712B Power Supply**

Model 712B Power Supply is deliberately designed to give you the finest performance obtainable plus broadest usefulness and the lowest price consistent with quality. It offers high regulation, low internal impedance, low ripple, and the exceptionally fast transient response of 0.1 milliseconds. It also provides four outputs for maximum applicability, and less than 50 millivolts change (no-load to full-load) at any regulated output voltage. The instrument has a 0 to 500 volt, 200 ma regulated supply, and a fixed −300 volt tap making available a 50 ma, 300 to 800 volt variable supply for klystron operation. Continuously variable bias voltages, separate voltage and current meters, and generous overload protection are provided.

Model 712B will meet the most exacting requirements of heavy duty laboratory or production work. It is particularly useful in powering temporary setups, oscillators, small transmitters, complex systems and certain types of klystrons.

To insure long, trouble-free operation, Model 712B has sealed transformers and chokes, oil-filled filter condensers, and is fully fused. Only high quality components are used, and no electrolytic condensers are employed.

OTHER *-hp-* POWER SUPPLIES

-hp- also offers two other high stability, high regulation DC or AC power supplies. *-hp-* 710A provides output continuously variable 180 to 360 volts with regulation of 1% and hum less than 0.005 volts. *-hp-* 710B is identical except has voltage range of 100 to 360 volts. *-hp-* 710A, $85.00; *-hp-* 710B, $100.00 f.o.b. factory.

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

HEWLETT-PACKARD COMPANY
2948D Page Mill Road • Palo Alto, California, U. S. A.

SPECIFICATIONS

OUTPUT VOLTAGES:
DC Regulated High Voltage: 0 to +500 volts (without switching), 200 ma. max. load.
DC Regulated Fixed Bias: −300 volts, 50 ma. max. load.
DC Variable Bias: 0 to −150 volts, 5 ma. max. load.
AC Unregulated: 6.3 volts CT, 10 amps max. load.

REGULATION:
(for line voltage 115 volts ± 10%)
DC Regulated High Voltage: Less than 50 millivolts change no-load to full-load at any output voltage.
DC Regulated Fixed Bias: Less than 50 millivolts change no-load to full-load.
DC Variable Bias: Regulated against line voltage changes. Internal impedance 0 to 10,000 ohms depending on bias control setting.

RIPPLE: Less than 500 microvolts.

INTERNAL IMPEDANCE:
DC Regulated High Voltage: (For frequencies above 20 cps.)
Full-load: 0.1 ohm in series with 25 μH max.
No-load: 1 ohm in series with 50 μH max.

RECOVERY TIME: Upon application of full-load: 0.1 millisecond max.
Upon decrease from full-load to:
(a) 0 ma. —0.5 millisecond max.
(b) 25 ma. —0.1 millisecond max.
Maximum transient voltage —1 volt.

METERING: Current Meter: 0 to 200 ma. (high voltage only).
Voltmeter: Three ranges, 0 to +500 volts, 0 to +150 volts and 0 to −150 volts. Panel switch connects meter to DC regulated high voltage or DC variable bias and selects range.

TERMINALS: Either positive or negative DC regulated high voltage terminal may be grounded. Positive terminals of both bias supplies and negative terminal of DC regulated high voltage are common.

OVERLOAD PROTECTION: AC line, DC regulated high voltage, DC regulated fixed bias and filament supply are separately fused. DC regulated high voltage drops to zero if bias fuse blows.

POWER SUPPLY: 115 volts ± 10%, 50 to 1000 cps.

CABINET: Rack Mount. 10½" high x 19" wide x 14⅛" deep. Detachable End Frames with handles for bench use, $5.00 pair. (Specify *-hp-* 17 End Frames.)

WEIGHT: 62 lbs. net, shipping weight 100 lbs.

PRICE: $350.00 f.o.b. factory.

Data subject to change without notice.

See the 712B and many other new *-hp-* instruments at the I. R. E. Show—Booths 248, 250

at I. R. E. Corner INSTRUMENTS AVENUE and RADIO ROAD

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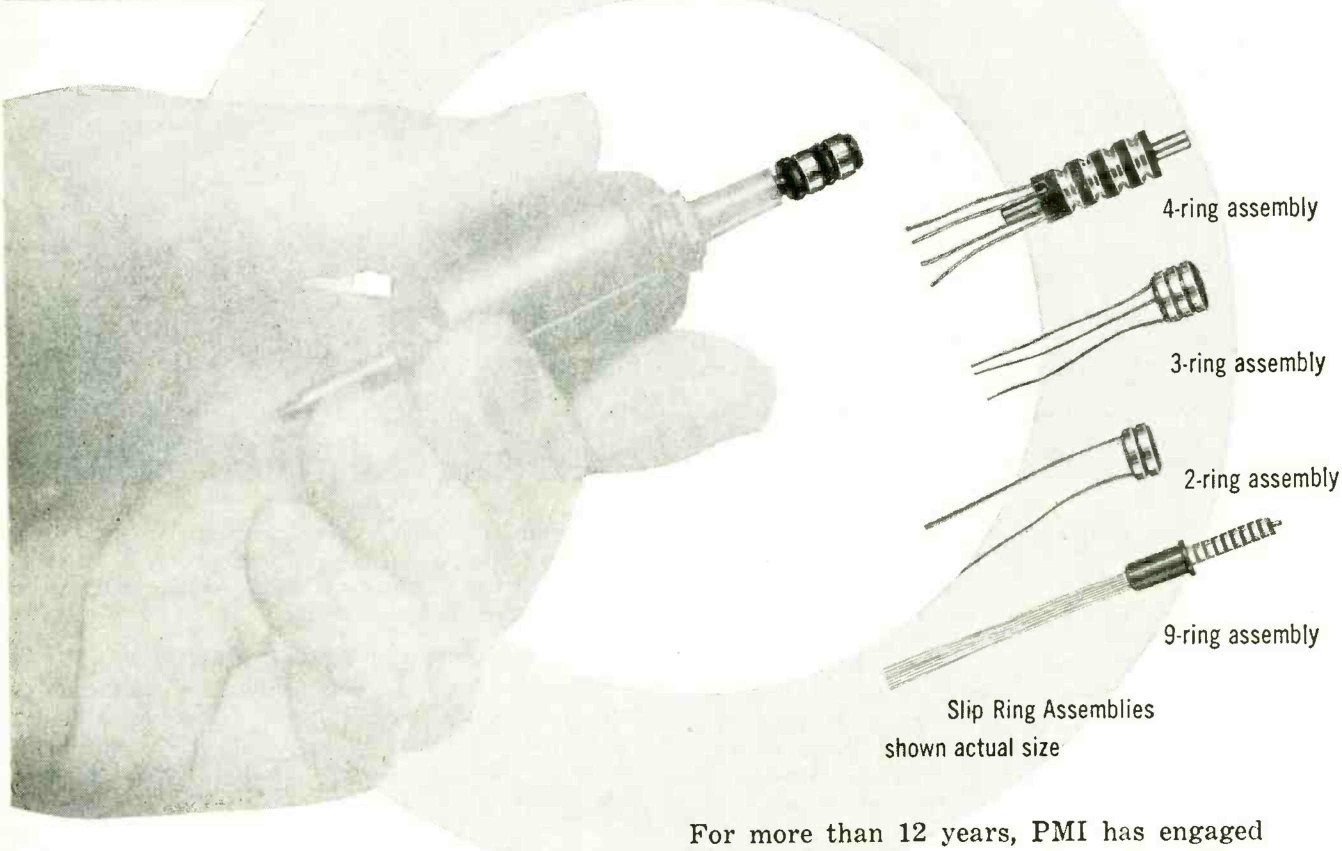
miniature slip ring assemblies for synchros • gyros • resolvers



For more than 12 years, PMI has engaged intensively in the design, development, and manufacture of Slip Ring Assemblies, including the miniature "synchro type" slip rings. These are now being produced on a high-volume, low-cost basis, with the same precision and high quality found in PMI's large and highly complex units.

PMI is widely recognized as a leading designer and manufacturer of trouble-free, long-lived, heavy duty Slip Ring Assemblies for radar antennas, gun directors, aircraft detectors, strain gage instrumentation, and similar applications. PMI experience includes the use of all known acceptable materials and all practicable assembly techniques.

PMI miniature Slip Ring Assemblies are manufactured in accordance with customer or government specifications. All units are subjected to 100% inspection prior to shipment. Government source inspection is also available if desired.

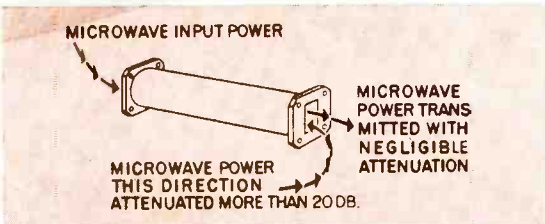
Your request for further information will receive prompt attention. Please write on your business or professional letterhead to P M Industries, Inc., Stamford, Conn.

PMI

P M Industries, Inc., *Stamford, Conn.*
Design-Development-Production • Electro-mechanical Assemblies

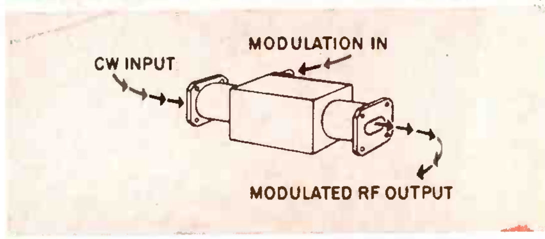
THE MICROWAVE FERRITE DUO

THE UNIDIRECTIONAL TRANSMISSION LINE



The Uniline section is a new development specifically designed for use in test measurements particularly where the impedance of the load is variable. For example, one of the several possible applications for the Uniline is as a replacement for the loss-type attenuator commonly used for isolation between source and load. In this instance, very substantial isolation is provided with negligible loss in transmitted power. Up to 100 times as much power is available for test purposes when the Uniline is used. The Uniline is a truly non-reciprocal transmission line element, not a directional coupler.

THE MICROWAVE AMPLITUDE MODULATOR



This new ferromagnetic resonance device is essentially a continuously variable microwave attenuator controlled by an applied magnetic field. Amplitude modulation of a CW microwave signal may be obtained by varying the magnitude of the magnetic field by means of an external modulating source. The Gyraline thus permits the microwave oscillator to be operated on a CW basis to eliminate undesirable frequency modulation and double moding frequently present when one of the klystron elements is directly modulated. The Gyraline also offers many possibilities as an electronically controlled microwave attenuator.

TECHNICAL SPECIFICATIONS

FREQUENCY RANGES: (Five models available) . .
5900-6400, 6400-6900, 6900-7400, 8800-9600, 9600-10,400 megacycles.

ATTENUATION, FORWARD DIRECTION: Less than 1 DB.

ATTENUATION, REVERSE DIRECTION: 20 DB. (Approx.)

VOLTAGE STANDING WAVE RATIO: 1.3 : 1, (or less) either direction.

FREQUENCY RANGES: (Five models available) . .
5900-6400, 6400-6900, 6900-7400, 8500-9900, 9600-11,200 megacycles.

INSERTION LOSS: Less than 1 decibel . . . .

MODULATION FREQUENCY: Up to 3000 c.p.s. . .

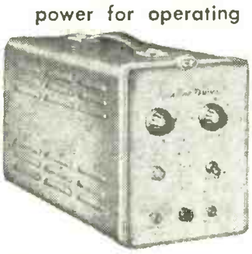
VOLTAGE STANDING WAVE RATIO:
1.4 to 1. (or less) . . . .

POWER HANDLING CAPABILITIES:
Maximum continuous microwave power dissipation, 2 watts . . . . .

COIL IMPEDANCE:
Nominal coil impedance at 1000 cps: 500 or 2000 ohms (either). . . . .

D-92 AUDIO DRIVER FOR GYRALINE

Provides a flexible and convenient source of audio power for operating the Gyraline.

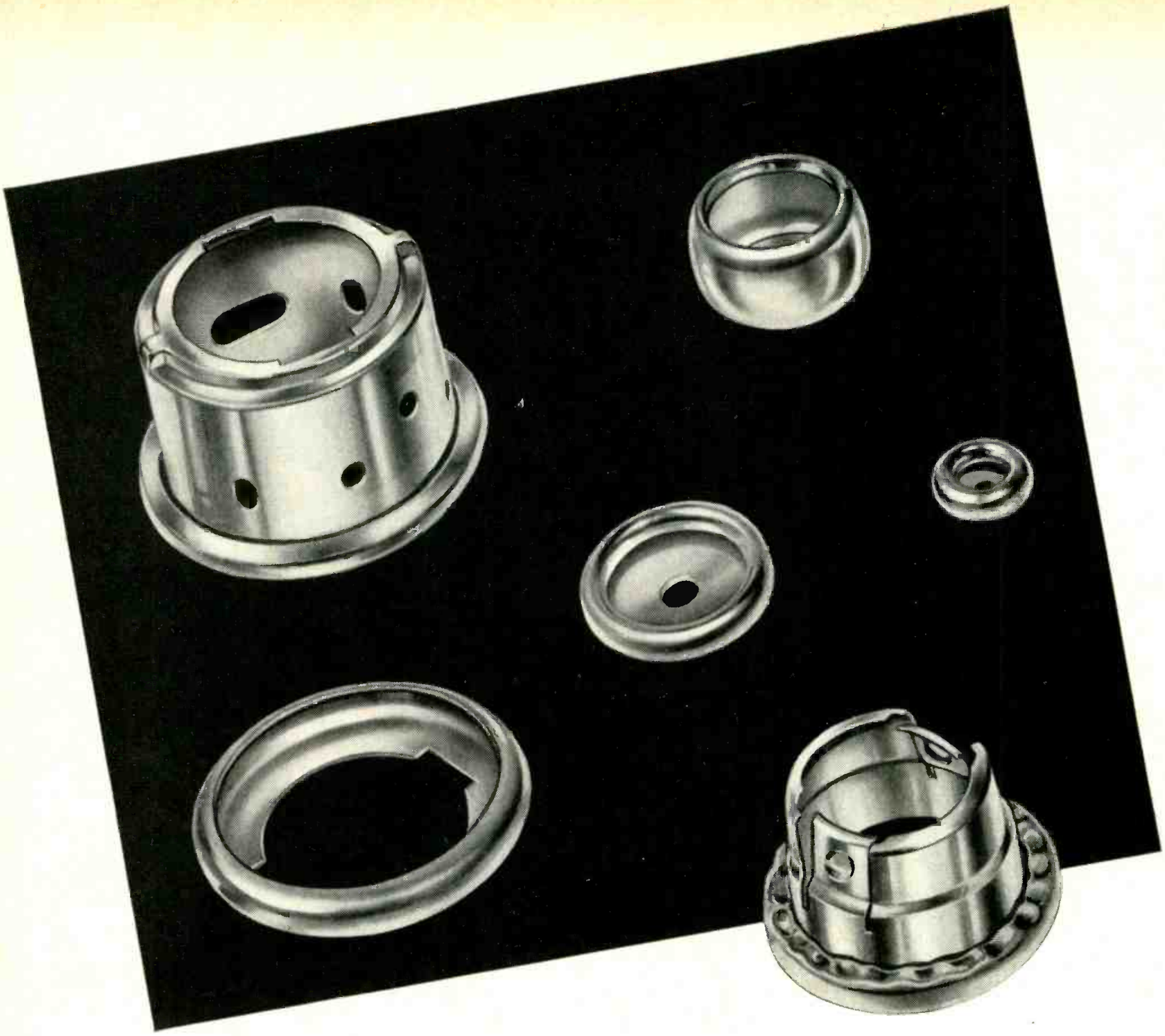


Circuit consists of an audio oscillator which provides sine wave modulation from 800 to 1200 cps. This oscillator drives an 8 watt output amplifier which is matched to the Gyraline coil. The gain of the D-92 Driver is sufficient to drive the Gyraline to greater than 90% modulation.

Complete information upon request.

Write for descriptive bulletins.

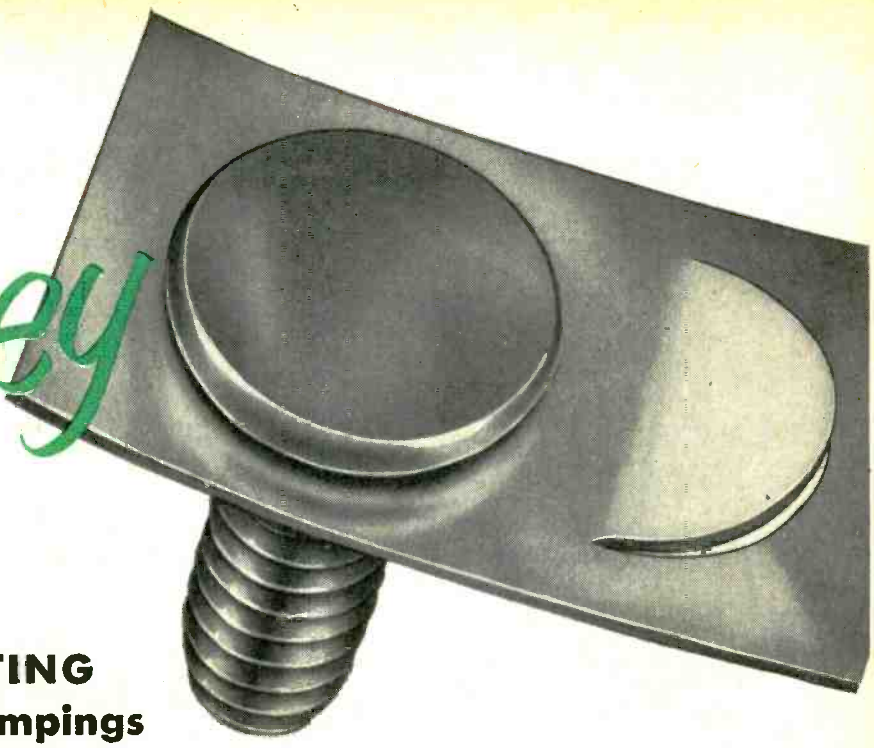
CASCADE RESEARCH CORPORATION
53 VICTORY LANE, LOS GATOS, CALIF.



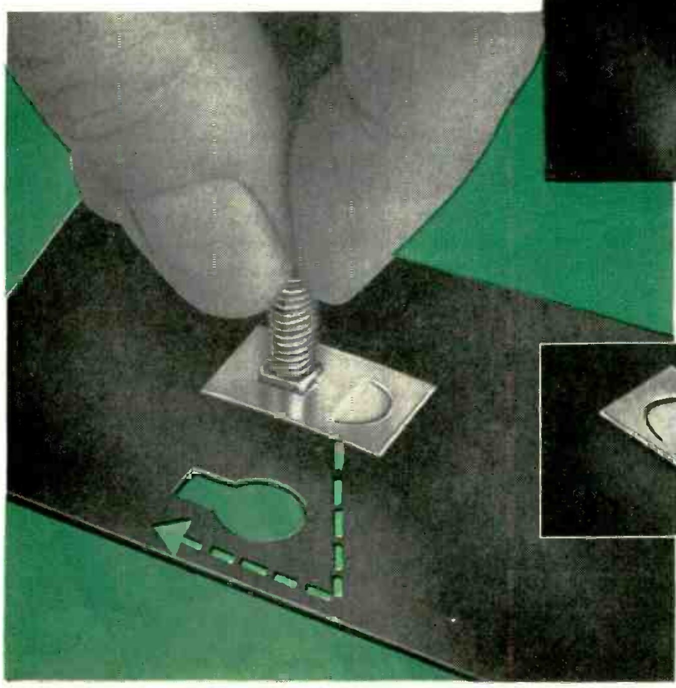
NEW

Quickey

FASTENER



- **FACILITATES NESTING of sheet metal stampings**
- **ELIMINATES DAMAGE due to welded or staked studs**



Not this

Welded or staked studs are easily damaged in transit from one department to the next or during processing, painting, polishing, etc. The bolts themselves can cause serious damage, denting, scratching or chipping painted or polished surfaces.

But this

QUICKEY SNAPS IN just before final assembly . . . allows finished parts to be nested for economical transportation *without* protruding studs of any kind. Installed at the last moment, every Quickey is perfect. If damaged during later assembly operations, any Quickey can be removed and replaced easily and quickly, even in blind assemblies.

•

Like thousands of other fasteners and allied devices, designed and manufactured by United-Carr, Quickey helps speed assembly and cut costs. Available in a complete range of sizes and in volume quantities; further details on request.

UNITED-CARR

MAKERS OF **DOT** FASTENERS

UNITED-CARR FASTENER CORPORATION, CAMBRIDGE 42, MASSACHUSETTS

STACKPOLE

Ceramag® CORES

(Ferromagnetic)

for real uniformity! Wherever ferromagnetic cores are used, Stackpole Ceramag Cores have set the quality standards. But proved superiority in essential characteristics is only part of the story. Even more important is the fact that Stackpole Ceramag core characteristics are maintained with remarkable uniformity regardless of size, shape or production quantity. *The sample matches your specification "on the nose"—and each production unit is exactly like the sample!* Write for Ceramag Bulletin RC-9A including details on available grades and latest characteristic curves.

STACKPOLE

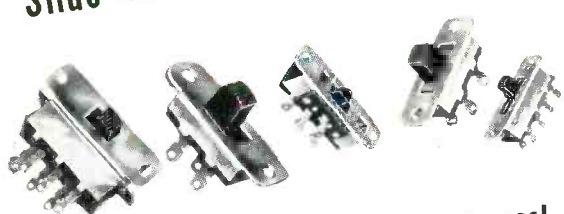
Molded COIL FORMS

Cut Assembly Costs!

You can reduce coil sizes and cut assembly costs with simplified point-to-point wiring and fewer soldered connections with these Stackpole molded coil forms. Types available with iron core sections. Axial or "hairpin" leads. Write for Catalog RC-9.

STACKPOLE

Slide SWITCHES



. . . the economy switches of 1001 uses!

Over 20 types of these inexpensive little Stackpole slide switches cover just about every mechanical and electrical switching requirement for radio and television equipment, small motors, appliances, electrical toys, instruments, etc. For complete details, write for Stackpole Switch Bulletin RC-9B.

Engineering Samples are proof of the pudding!

Engineering samples of standard Stackpole components are available to quantity users. Send details of your requirement for recommendation by Stackpole engineers.

ELECTRONIC COMPONENTS DIVISION

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

STACKPOLE

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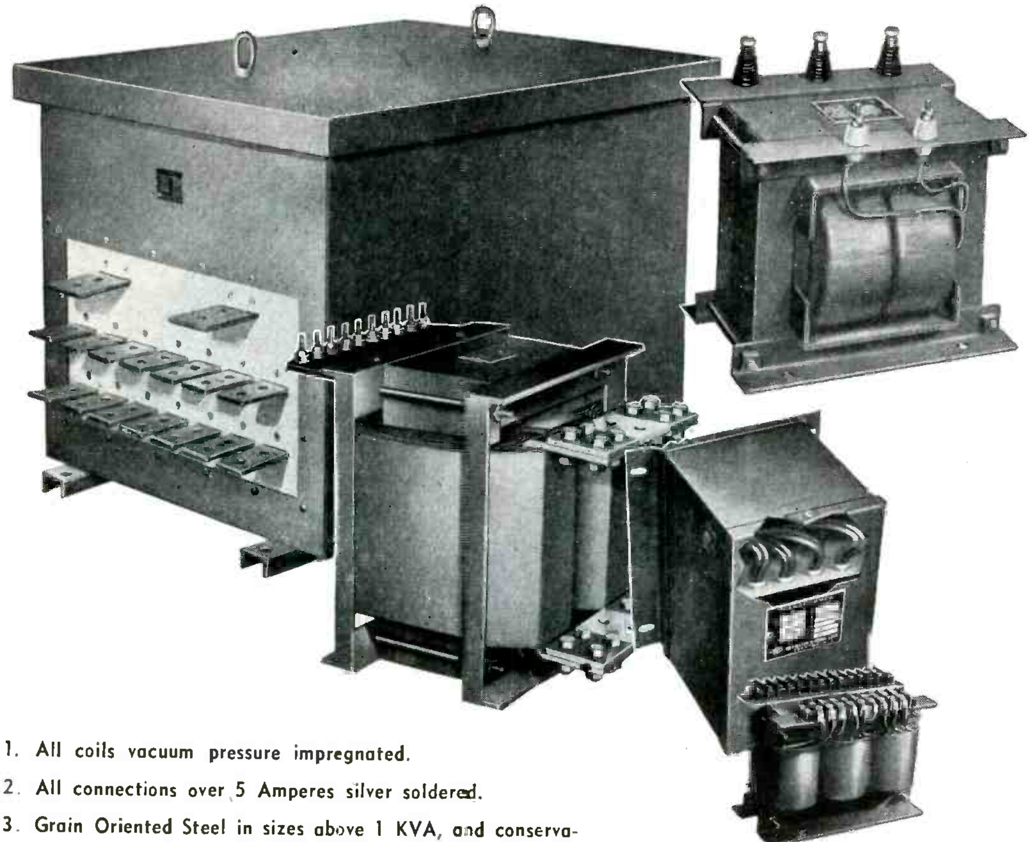
If you are interested in **H-E***
24 hour duty performance

GET ALL THE FACTS ABOUT

NWL NOTHELFER TRANSFORMERS



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TRANSFORMERS FOR:

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HIGH and LOW VOLTAGE

1. All coils vacuum pressure impregnated.
2. All connections over 5 Amperes silver soldered.
3. Grain Oriented Steel in sizes above 1 KVA, and conservative copper assures high efficiency and low losses.
4. All units individually tested to assure quality performance.
5. Only the highest quality materials used.
6. We sincerely believe NWL Transformers are superior, and we have built our business on this policy.

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Manufacturers of Electrical Transformers—
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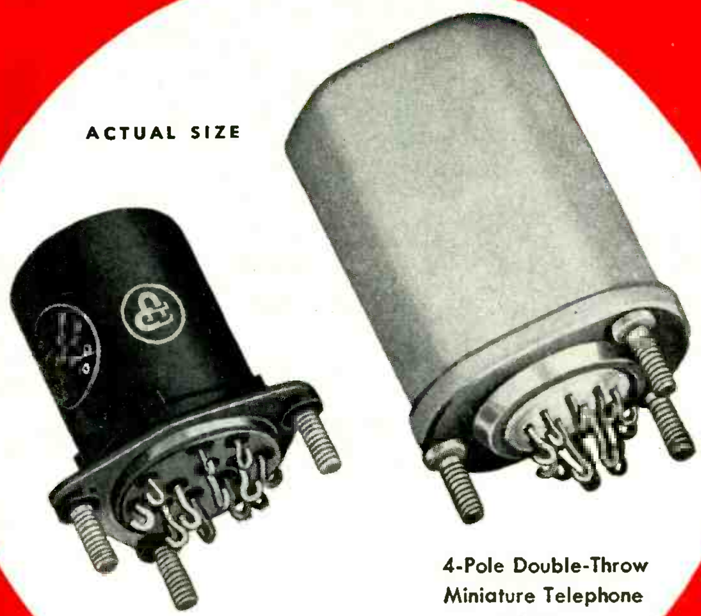
✓ SIZE CUT 66%

✓ WEIGHT CUT 48%

✓ RELIABILITY DOUBLED

✓ WRIGHT FIELD APPROVED

ACTUAL SIZE



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.

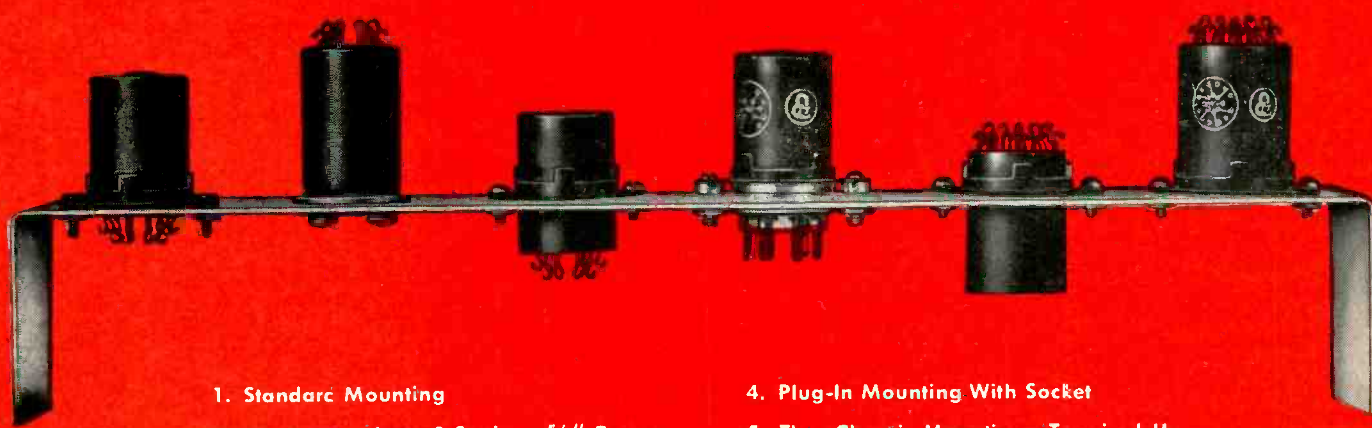
The high performance of these relays has been achieved in an extremely compact, unitized construction and parallels the most recent advances in airborne equipment design. The "actual size" photographs shown above highlight the 66% savings in overall size, the 48% savings in weight and the 30% reduction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

6-POLE
MH-18

4-POLE
MH-12

2-POLE
MH-6

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.

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Save production dollars with R&R

TAPERED

Germanium Diodes

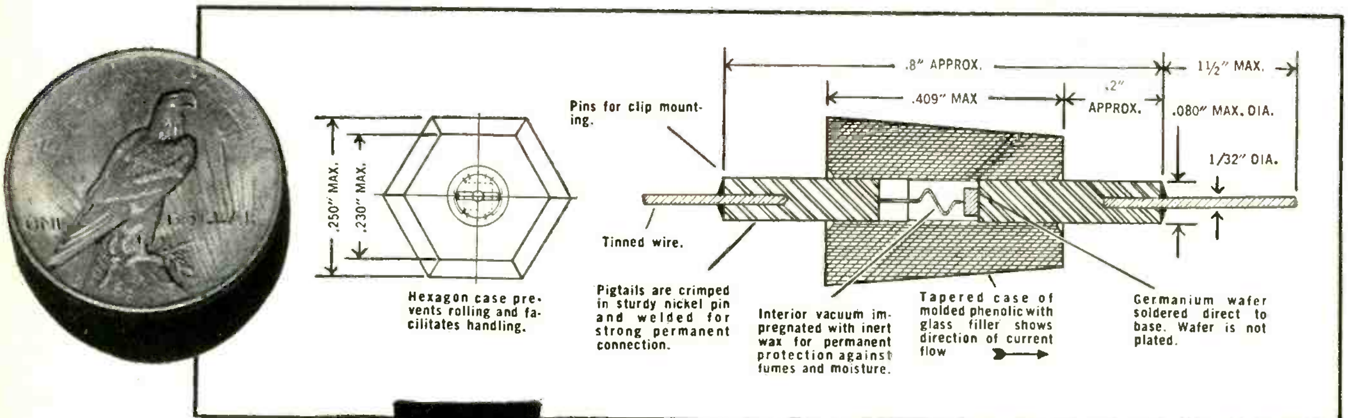
Speed Assembly In Your Circuitry | *Eliminate Errors!*

With a unit as tiny as a germanium diode chances of error in assembly are multiplied. . . . But the tapered design of the Radio Receptor diode case works for you to eliminate these problems.

Allowing polarity identification at a glance or touch, the taper goes a long way to reduce error in connecting the diodes into your circuit. The hexagon shape assures ease of handling and prevents rolling, especially when the leads are cut off to permit mounting the diode in clips. All this means less rejects, increased production and *real dollar savings!*

Precision made to meet strictest requirements, Radio Receptor diodes are being specified in an ever increasing number of electronic circuits where stability, dependability and durability are of prime importance.

Our engineers will gladly submit their recommendations. Write us today—without obligation, of course. We also manufacture Germanium Transistors and SELETRON Selenium Rectifiers.



Seletron and Germanium Division

RADIO RECEPTOR COMPANY, INC.

In Radio and Electronics Since 1922

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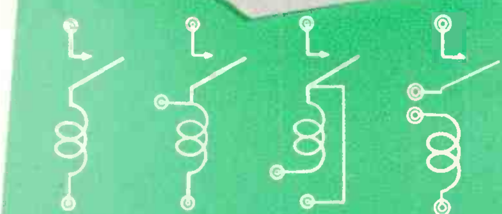
Telephone: WAtkins 4-3633 • Factories in Brooklyn, N.Y.

Need Something Special in a Circuit Breaker?

Perhaps the problem of protection or control of your equipment can be solved by a HEINEMANN Circuit Breaker.

Operating on a hydraulic-magnetic, solenoid principle . . . with or without inverse time delay . . . HEINEMANN Circuit Breakers offer almost unlimited possibilities in fulfilling standard or special functions.

Your requests for special information will receive prompt attention.



Overload Trip | Calibrating Tap | Shunt Trip | Relay Trip

SPECIAL CIRCUITS

SPECIAL OR FRACTIONAL RATINGS

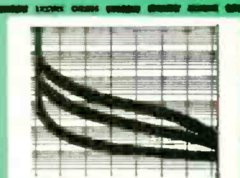
Close tolerances of protection may be obtained by precise, fractional rating between 10 milliamperes and 100 amperes.

ALARM CONTACTS

Alarm contacts are available on certain models to permit visual or audible signal on tripping of circuit breaker.

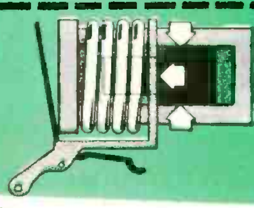
DUAL RATINGS

A single circuit breaker may be furnished with two coils for operation on different currents.



SPECIAL RESPONSE CURVES

Time vs. per cent overload response curves may be selected to match protection characteristics to the requirements of your product.



The hydraulic-magnetic principle allows maximum flexibility for special applications, ratings and protective characteristics. Since it does not employ thermal elements, set tripping points are completely unaffected by ambient temperature.

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HEINEMANN ELECTRIC CO.

97 PLUM STREET TRENTON 2, N. J.

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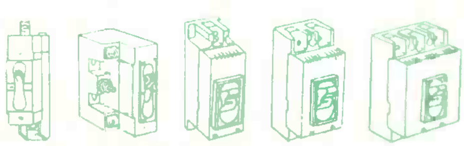
HEINEMANN

Circuit breakers



HEINEMANN Circuit Breakers . . . One, two and three pole . . . 10 milliamps to 100 amperes

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CALIFORNIA

Selenium Rectifiers

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Widest range in the Industry
Power Factor 95%
Ratings to 250 KW
Efficiency to 87%
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HIGH VOLTAGE RECTIFIER CARTRIDGE TYPE

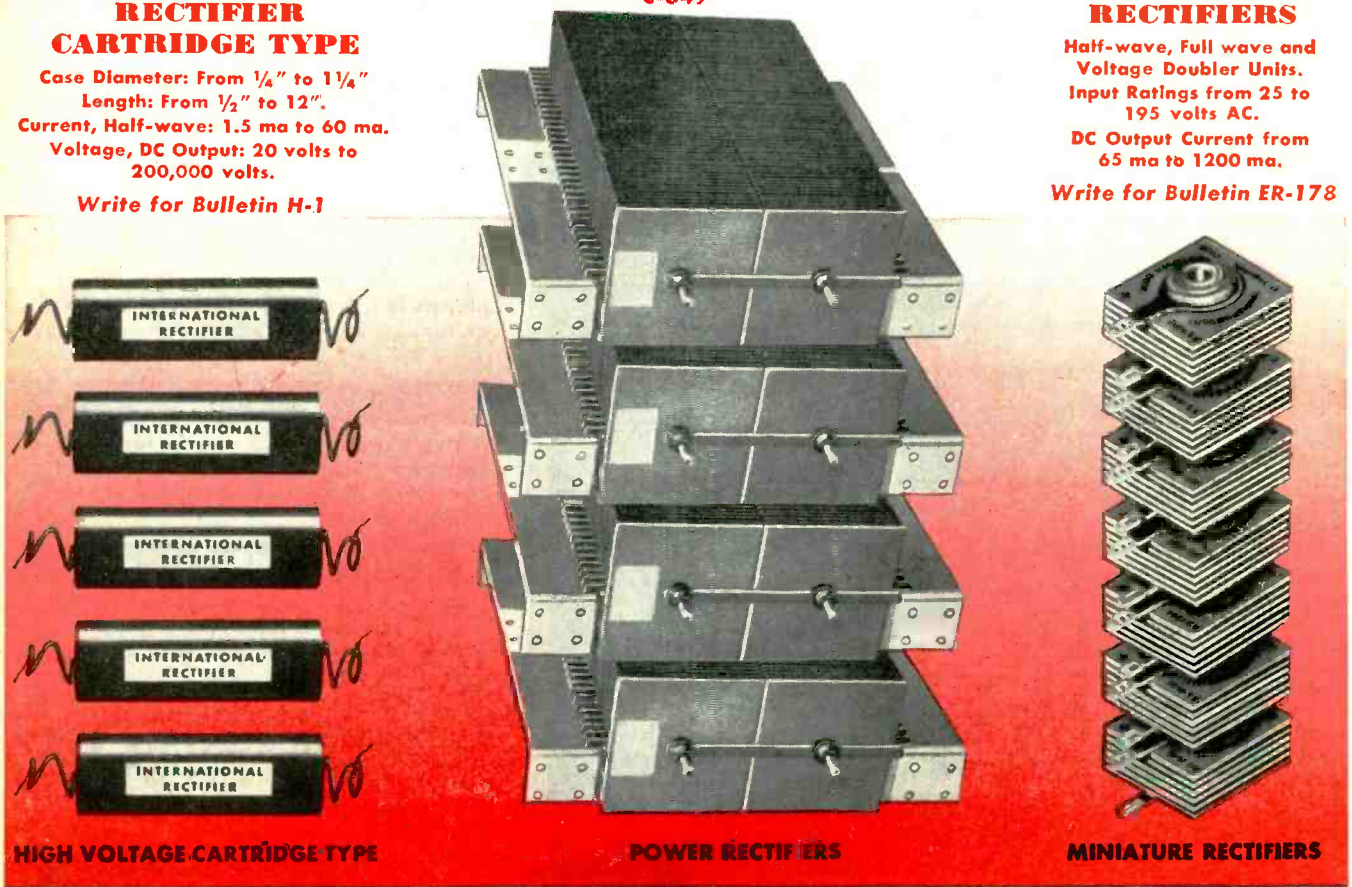
Case Diameter: From ¼" to 1¼"
Length: From ½" to 12".
Current, Half-wave: 1.5 ma to 60 ma.
Voltage, DC Output: 20 volts to 200,000 volts.

Write for Bulletin H-1

MINIATURE RECTIFIERS

Half-wave, Full wave and Voltage Doubler Units.
Input Ratings from 25 to 195 volts AC.
DC Output Current from 65 ma to 1200 ma.

Write for Bulletin ER-178



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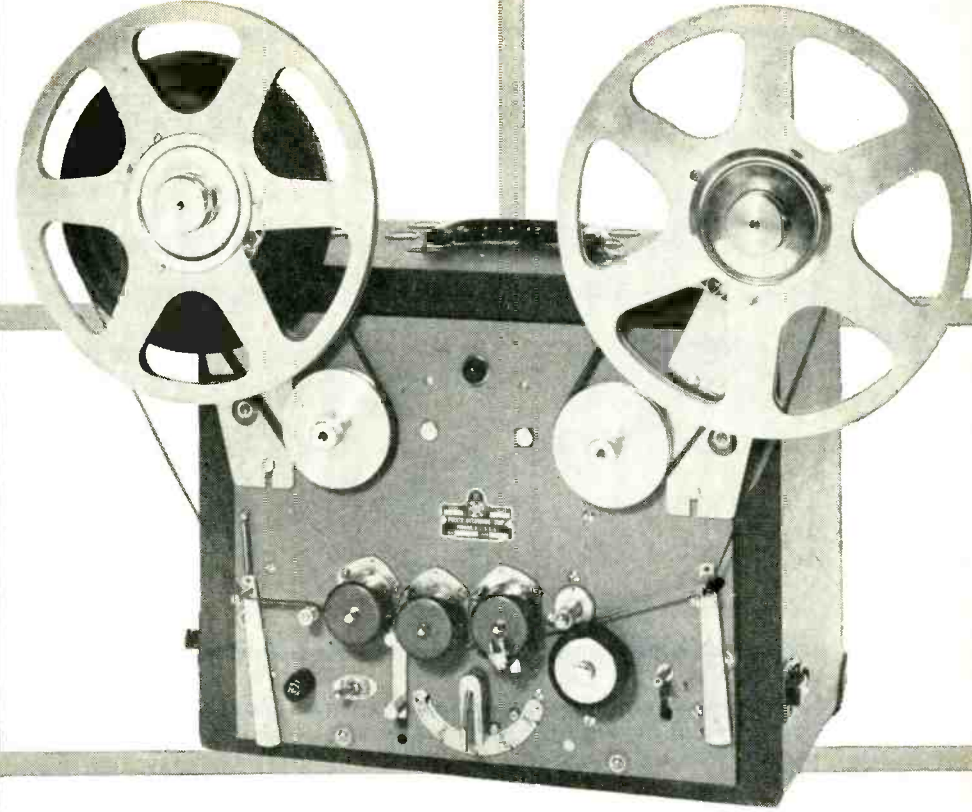
Regardless of model . . . Presto has only one quality

Take, for instance, the finely engineered . . .



PRESTO RC-7 TAPE RECORDER

EQUIPMENT SPECIFICATIONS

- Dynamic range better than 50 db at 3% distortion.
- Three-motor drive system.
- No friction clutch or friction brakes.
- Heavy-duty construction throughout.
- Separate erase-recording-playback heads.
- Twin speed: 7½"/sec. or 15"/sec.
- Frequency response 50 to 15,000 cps.
- Reel size: 7" standard, 10½" with RA-1 adapter.
- Flutter: at 7½"/sec., 0.25 — at 15"/sec., 0.20.
- Available in 110 or 220 volts and 60 or 50 cycles.
- Weight: 41 lbs.

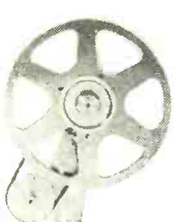
The completely portable PRESTO RC-7 is a precision recorder in every detail. Yet it's rugged and durable for heavy-duty field recording, and equipped with every feature this service demands. Built around a sturdy 3-motor drive, the RC-7 contains the same high-quality components found in Presto's fine studio equipment.

The RC-7 has separate recording and reproducing heads. Monitoring from tape is instantaneous. Mechanical friction devices, which always require constant adjusting, are totally eliminated from the RC-7, and virtually no adjustment is needed throughout the life of the machine. Note the RC-7's other features in the column at the left.

All of PRESTO's engineering experience as the world's foremost producer of precision recording equipment has been devoted to making the RC-7 the outstanding leader in fine tape recorders, in flawless performance, simplicity of operation, and long and thoroughly satisfactory service.

Write for complete engineering data and price

NEW RA-1 REEL ADAPTER



enables owners of the RC-7 and 900-R1 recorders to use 10½" reels. Carries out all normal functions, such as fast forward and rewind speeds. Easily attached.

PRESTO RECORDING CORPORATION

PARAMUS, NEW JERSEY

Export Division: 25 Warren Street, New York 7, N. Y.

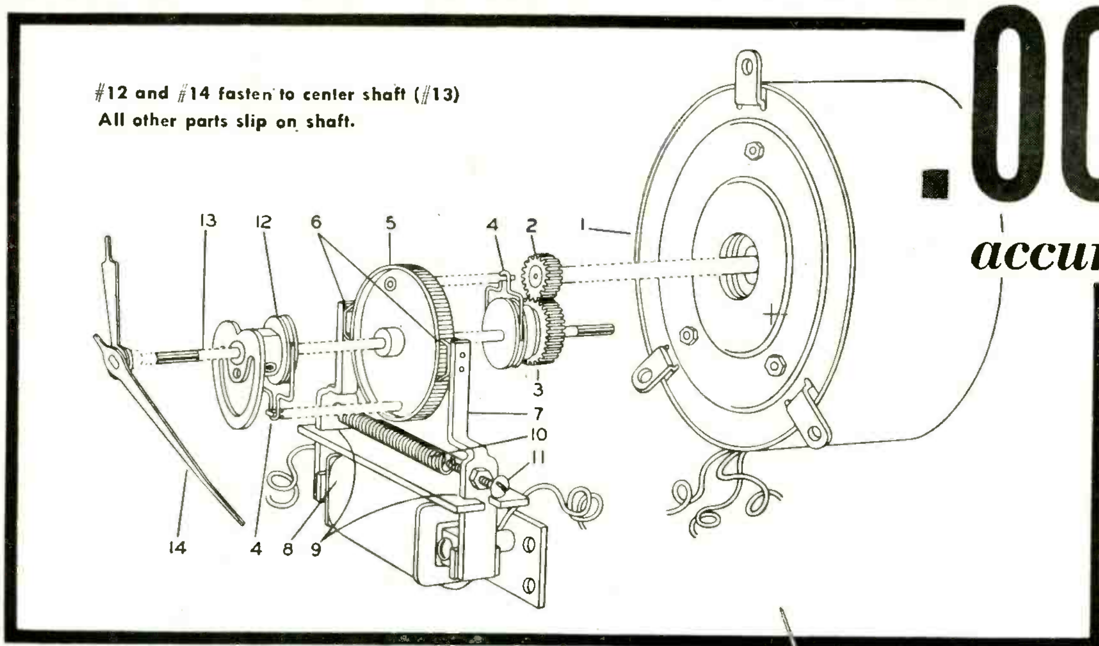
Canadian Division: Walter P. Downs, Ltd., Dominion Square Bldg., Montreal

WORLD'S LARGEST MANUFACTURER OF PRECISION RECORDING EQUIPMENT AND DISCS

Facts behind the S-1 TIMER'S extraordinary

.005 SEC.

accuracy...



Formula S-1: **Expensive high torque, ball bearing motor, low inertia of moving parts, high proportion of precision and ground parts, no thrust bearings as found in ordinary clutches.**

- High torque (2 inch-ounce at 100 RPM) industrial grade motor (#1) with no internal gear train so small changes in load due to binds or hand acceleration cause no phase shift between rotor and rotating field... runs continuously to eliminate starting error.
- Precision cut gears (#2, #3). Any eccentricity or inaccuracies in gearing reflect directly in timer reading.
- Slip clutch composed of hardened steel spring (#4) riding a V-grooved graphited (for long wear) collet, applies .6 inch-ounces of torque to aluminum (for low inertia) control disc (#5) with over 314 tiny teeth in its periphery.
- To hold control disc (#5) at rest, 2 hardened steel brake shoes (#6), ground to square knife edges, grip periphery of control disc in 4 places . . . control disc position to under ½ of a degree (1/720 second).
- Electro magnet (#8) pulls brake shoes away from control disc through armatures (#7). Air gaps kept to minimum for speed. Precision made fulcrums prevent stickiness or unequal movement of armatures.
- Adjusting screw (#11) adjusts tension of armature spring (#10) so that time between energizing magnet coil and starting of control disc is same as time between de-energizing magnet coil and stopping of control disc. This compensates for starting and stopping errors.
- Second friction clutch (#12) transfers control disc motion to center staff (#13); allows hands to be reset when control disc is held stationary.

"Gentlemen . . . Let me give you the formula for our astounding final accuracy of .005 sec. obtained with our D-C clutch S-1 Timer."

To Split the Split Second with ACCURACY, Take a Minute Now and Write Us for Engineering Data

SINCE 1884 STANDARD

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electrolytic capacitors

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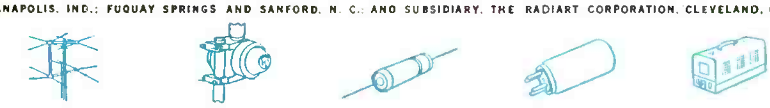
Engineering samples sent on request. For your special design and application problems, use our Technical Advisory Service. Write to:

Cornell-Dubilier Electric Corp., Dept. K-24
South Plainfield, New Jersey.

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

CORNELL DUBILIER *Capacitors*

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



ANTENNAS ROTORS CAPACITORS VIBRATORS CONVERTERS

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New Jobs
for the World's
Most Useful
Metal
—*Straits Tin*

Tin mining in Malaya. Here a test boring is being removed.

New tin-alloy platings improve products, cut costs

The number of new ways you can use Straits Tin to make better products at lower cost is today growing faster than ever, and lower cost means higher profit.

New tin-alloy platings, for example, are giving increased protection against corrosion to steel.

Tin-zinc and tin-cadmium platings have been found to be many times as resistant to corrosion as either zinc or cadmium alone.

Tin-copper electrocoatings are increasingly useful. Red bronze can now be used as a more durable undercoating for chrome—white bronze for applications similar to those of silver plate.

And because tin is as handsome as it's adaptable, a new tin-nickel alloy is proving itself a more attractive, more corrosion-resistant decorative plating than the conventional chromium on nickel copper.

New plating alloys represent just one of the ways Straits Tin can do more for you today.

Over a third of the global tin output is mined and smelted in Malaya. Known as Straits Tin, this metal is over 99.87% pure, and is world-famous for its absolute reliability of grade.

Whether you're planning a new product, working to improve an old one, or simply seeking ways to avoid the squeeze between rising manufacturing costs and resistance to higher product prices, a careful reappraisal of the properties of Straits Tin may uncover a profitable answer to your problem.

Write now for any information you may need about versatile, plentiful, economical Straits Tin.

A free copy of our new bulletin "How Straits Tin Can Help You," is yours for the asking.

MALAYAN TIN BUREAU

THE MALAYAN TIN BUREAU

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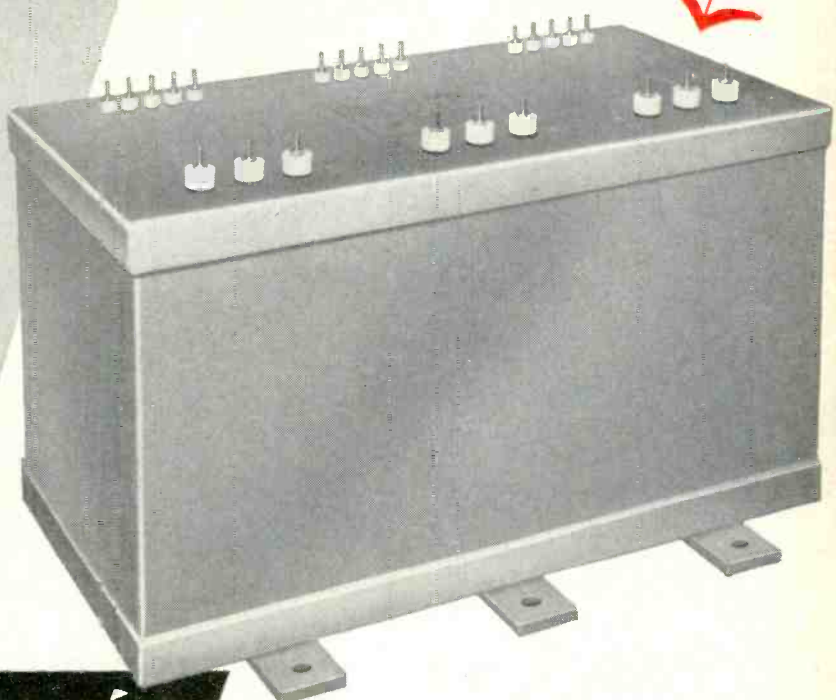
—or anything in between!

Langevin

TRANSFORMERS

—custom-built to military specifications or your specific performance needs



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1 Complete MIL-T-27 tests for qualification approval can be made in our own laboratory—often saves weeks on contract completion.

2 Samples and short runs are handled in our model shop staffed and equipped for high speed, economical service on small quantities.

3 Large stocks of materials prevent delays. Hundreds of types and sizes of wire, core materials, cases, terminals, brackets, etc., always in stock.

Langevin specialization insures faster delivery and highest quality

You can depend on LANGEVIN for every transformer requirement, large or small, including pulse transformers, charging reactors, saturable reactors, high cycle transformers and units built to the most rigorous specifications. Highly specialized facilities permit fast handling of short or long runs with maximum economy and rigid quality control. For prompt quotations or engineering collaboration, call or write today without obligation.

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CONFIDENCE is born in one look at the eyes... the set of the shoulders..."the cut of his jib". In a second, you *know* he's had years of training and weathered it well. You know you couldn't be in better hands...and if anyone can get you there, *he will.*

Yes, it takes years to build confidence like this, in any line. And the whole organization of Bristol Brass... young yet experienced... is keyed to keep the confidence that any promised shipment of Bristol Brass sheet, rod, or wire will get there at the promised time, if it's humanly and mechanically possible to do so. In fact, that's what 'Bristol-Fashion" means... a term still in use that came to be first applied to the old clipper ships out of Bristol, England... always shipshape, correctly manifested, *and right on time.*

• • •

The BRISTOL BRASS CORPORATION, makers of Brass since 1850 in Bristol, Conn. Offices or warehouses in Boston, Chicago, Cleveland, Dayton, Detroit, Los Angeles, Milwaukee, New York, Philadelphia, Pittsburgh, Providence, Rochester.

"Bristol-Fashion" means Brass at its Best

DESIGN and PRODUCTION NEWS

FOR ELECTRICAL AND ELECTRONIC ENGINEERS

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

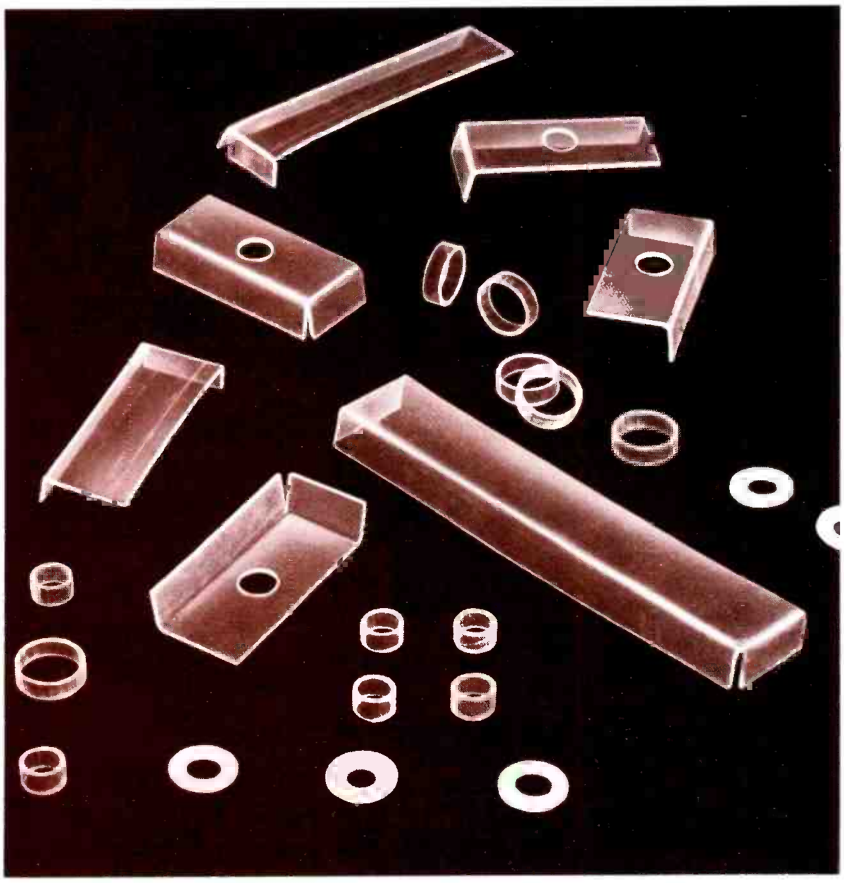
Cosmotron's 17,000 Parts of Kel-F® Keep 11 Million Joules in Check... Under 5 x 10⁶ mm. Vacuum!

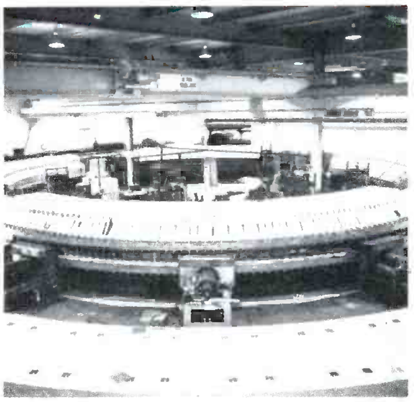
Consistently high dielectric and mechanical strength and an extremely low gassing rate are three of the unique combinations of properties of "Kel-F" polymer which are utilized in Brookhaven National Laboratory's famed Cosmotron.

Each of the Cosmotron's 2432 magnet grid bars is effectively insulated with "boots" and bolt covers whose dielectric strength remains consistently high in presence of large magnetic and electrical fields. "Kel-F"—non-porous and non-volatile—assists in maintaining the vacuum chamber at the required low pressure.

The insulating "boots" were fabricated from 1/32" polymer sheet stock precision-molded by Reiss Manufacturing Corporation, New York, N. Y., from unplasticized "Kel-F" polymer Grade 300. Plastone Products Company, Inc., Lindenhurst, N. Y., blanked, punched and formed the sheet to dimension. The Brookhaven National Laboratory molded the insulating washers and bushings.

For further information ask for Application Report E-120





Brookhaven Cosmotron's 2432 magnet grid bars, operating in high vacuum, are "gapped" and insulated with "Kel F" plastic.

Have You Checked These Recent Significant Developments in Kel-F?

Pressure-sensitive Tape—silicone adhesive combined with "Kel-F" permits manufacturers to apply corrosion and solvent resistant coatings at their own plants. Tape retains basic chemical, electrical, mechanical properties of "Kel-F"—stays tacky from minus 65°F to 300°F—adheres to metal (with 32 oz. in. strength), synthetics, wood.

Coating on Aluminum—bond between "Kel-F" and metal strong enough to permit forming without damaging chemically-inert coating. Coating—.005" to .010" thick—has no pinholes, cannot peel or be stripped or damaged by bending metal. New England firm furnishes this service including coating and forming.

KEL-F

TRIFLUORO CHLORO ETHYLENE POLYMERS

KEL-F

MOLDING POWDERS

KEL-F

FLUORO CHLORO CARBON PLASTIC

KEL-F

DISPERSION COATINGS

KEL-F

TRIFLUORO CHLORO ETHYLENE POLYMERS

KEL-F

OILS WAXES GREASES

® *Registered trademark for The M. W. Kellogg Company's trifluorochloroethylene polymer products.*

(SEE REVERSE SIDE)

KEL-F

TRIFLUORO CHLORO ETHYLENE POLYMERS

KEL-F

MOLDING POWDERS

KEL-F

FLUORO CHLORO CARBON PLASTIC

KEL-F

DISPERSION COATINGS

KEL-F

TRIFLUORO CHLORO ETHYLENE POLYMERS

KEL-F

OILS WAXES GREASES

CONTINUED FROM PRECEDING PAGE

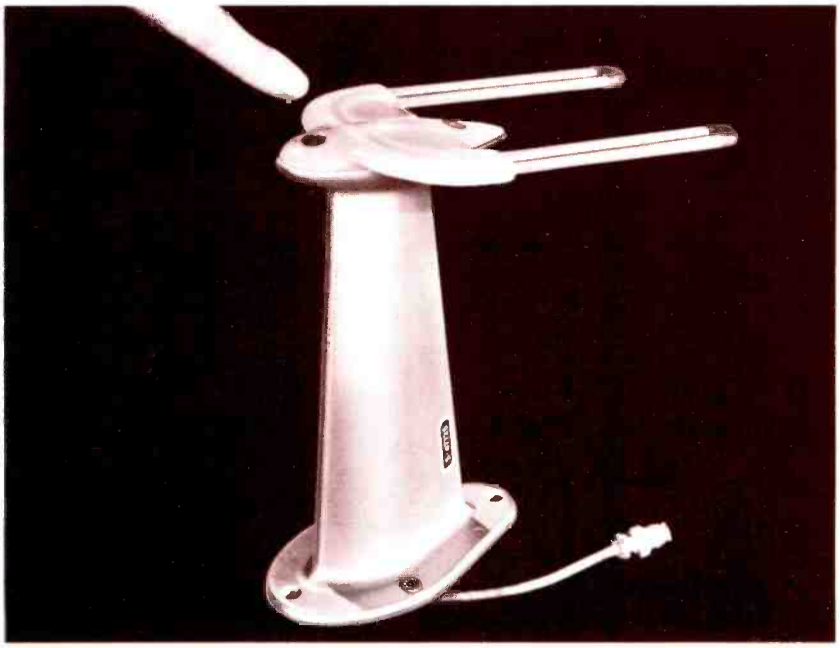
Aircraft Antenna Molded in Kel-F® to Cut Cavitation and Corrosion... Prevent Leaks at High Altitudes!

A casing of "Kel-F" trifluorochloroethylene polymer plastic, on this glide-path antennae "takes" operating conditions prohibitive to other materials. Exposed to ice abrasion, thermal cycling and corrosive gases, it maintains top performance in RF communication.

High dielectric strength through thermal cycling, and under high humidity prevents signal dissipation at ground level or at high altitudes. High impact, compressive strength prevents damage from wind loads or airborne solids.

The new antennae is injection molded of "Kel-F" trifluorochloroethylene polymer by Auburn Button Works, Inc., Auburn, N. Y., for the Technical Appliance Corporation, Sherburne, N. Y. It was specified by the Boeing Airplane Company.

For further information ask for Application Report E-121



Molders & Fabricators of the Month

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

Chicago Gasket Company
Chicago, Ill.
Compression & Transfer Molding
Rod Sheet & Tube

Cortland Industries, Inc.
Chicago, Ill.
Machining Production
Sealing of Film

Electronic Wave Products, Inc.
New York, New York
Sealing of Film
Forming
Gaskets Container Liners

Perma-Line Rubber Products, Corp.
Chicago, Ill.
Corrosion Control
Dispersion Application

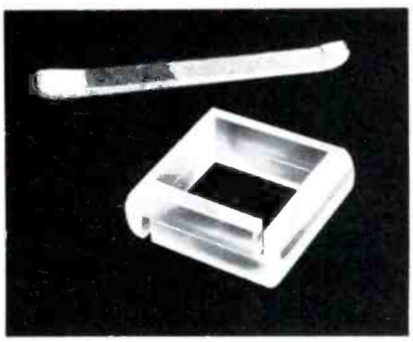
The Rex Corporation
West Acton, Mass.
Extrusion
Extruded Rod Tube & Spaghetti
Insulated Wire

Reusable "Chases" Keep Portable Receiver Crystals "on the beam"

RF crystal "chases" or frames of "Kel-F" extend the effective life and improve operating characteristics of portable, fixed-frequency military radios. Excellent dielectric strength insulates against leakage of RF pulses, unbreakable frames prevent damage and permit re-use.

The ¾" x ¾" "chases" are injection molded from unplasticized "Kel-F" by Electronic Mechanics, Inc., Clifton, N.J.

For further information ask for Application Report No. E-119



Be sure you have the new BUYERS GUIDE for Kel-F parts and services!

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

Technical Service

CHEMICAL MANUFACTURING DIVISION

THE M. W. KELLOGG COMPANY

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

KELLOGG MW — SUBSIDIARY OF PULLMAN INCORPORATED

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Check these:

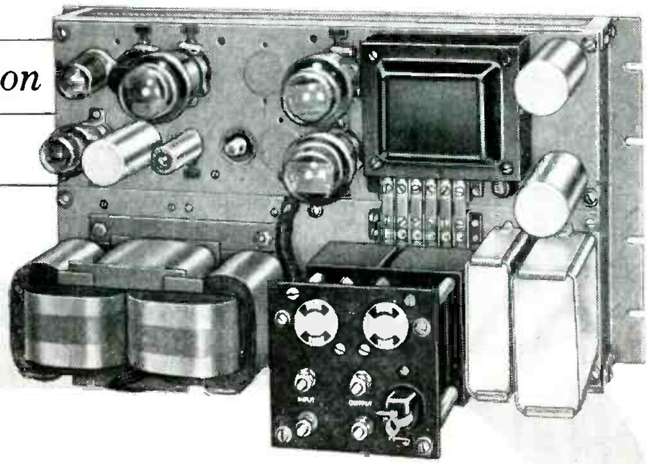
Stabilizing and Regulating Ability

Correction Speed

Waveform Distortion

Input Range

Output Range



and you will specify

STABILINE TYPE IE

Instantaneous Electronic

AUTOMATIC VOLTAGE REGULATORS

Here's how the Stabiline type IE measures up:

Stabilizing and regulating ability — For all conditions maximum variation less than ±.25 of 1%. For input voltage changes, variation less than ±0.1 of 1%. Load current change or power factor change from lagging .5 to leading .9 will vary output voltage less than ±.15 of 1%.

Correction speed — Comparatively instantaneous — 3 to 10 cycles.

Waveform distortion — Never exceeds 3%. Is generally under 2%.

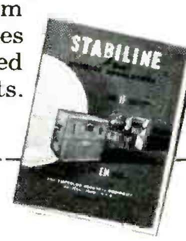
Input Range — For nominal 115 volts output, input range is 95 to 135 volts. For nominal 230 volts output, input range is 195 to 255 volts.

Output Range — Output voltage on 115 volt units can be adjusted from 110 to 120 volts; on 230 volt units from 220 to 240 volts.

Furthermore, the Stabiline type IE has a circuit simplicity and mechanical ruggedness that minimizes maintenance.

Check all these characteristics against all other automatic voltage regulators and you will find Stabiline type IE is *superior* in design, construction and performance.

Stabiline automatic voltage regulators type IE are available in ratings from .25 to 5.0 KVA. Special types will be application engineered to meet specific requirements.



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zero to

70,000 cycles per second

...recorded on one tape recorder, the Ampex Model 311

This versatile Ampex recorder is a combination of a wide-range direct recorder for high frequency phenomena and an fm-carrier recorder for highly transient or extremely low frequency phenomena requiring excellent amplitude accuracy. It provides a means for recording nearly every type of data encountered in laboratories and in industry.

The Ampex 311 uses two parallel channels on quarter-inch tape. The direct recording channel handles frequencies from 300 to 70,000 cycles per second. The fm-carrier channel has high transient accuracy in the range from 0 to 5,000 cps.

The Ampex 311 can record diverse types of data signals with a common time base. For instance, the fm channel might record high transient phenomena or low frequency signals while the direct channel records wide-band multiplexed signals or other high frequency information.

Even where serving only one need, the Ampex 311 is effectively a two-channel recorder, since the channel not being used to record data can be used for time signals. Thus, it can serve the same purposes in many cases as either a two-channel direct recorder or a two-channel fm-carrier recorder.

AMPEX Model 311 Combination Recorder
Two parallel channels cover a wide range of data situations:

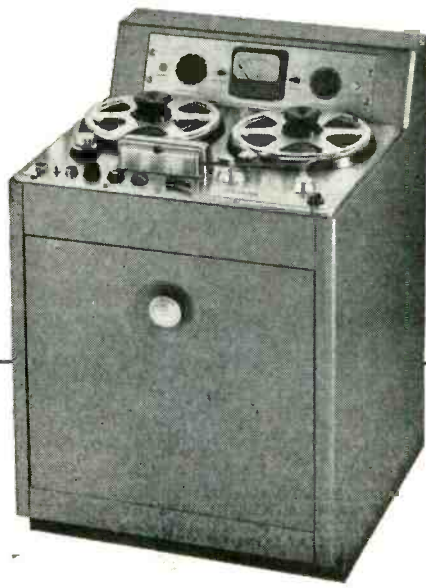
The fm channel

- Frequency response, 0 to 5,000 cps. ± 1 db.
- Transient accuracy independent of minor tape flaws and irregularities.

The direct channel

- Frequency response, 300 to 70,000 cps. ± 3 db.
- Wide band multiplexed or fm-carrier data
- High frequency phenomena

For further information write to Dept. E-1370R-B



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NEW LOW PRICES FOR G-E ALUMINIZED TUBES

Help You In The Black-and-White TV Market!

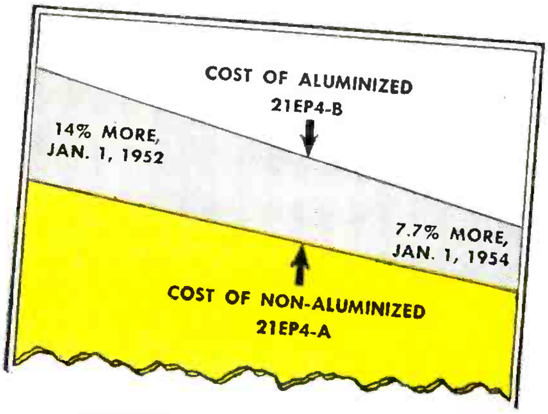
EXTRA COST IS HALVED.
NOW YOU CAN FEATURE TOP PICTURE QUALITY IN EVERY SET YOU BUILD!

G.E. LOWERS PRICES for aluminized tubes, to strengthen your position in the 1954 volume black-and-white market. The cost differential on many types has been cut in half. Now you can design into *all* TV sets the greater brightness and contrast which aluminized tubes give. You can use a tinted safety glass with no sacrifice of picture brightness. You can offer topnotch video at moderate voltages.

G-E SERVICE to TV builders on aluminized tubes follows a pattern that started with basic development of the product. Later, G.E. pioneered process after process of manufacture . . . finally, through scientific quantity production, achieved savings that now are being passed on to the whole television industry.

GET THE FIGURES! Phone, wire, or write for latest prices on G-E Aluminized Tubes! Learn how little more it will cost to provide pictures up to 100% brighter—*your* answer to today's stiff TV competition! *Tube Department, General Electric Company, Schenectady 5, N. Y.*

How the cost differential on one popular 21" tube—aluminized vs. non-aluminized—has been cut by General Electric large-scale production economies. Both tubes have come down in price, with the aluminized type leading.



WIDEST RANGE OF TYPES!
A dozen G-E Aluminized Picture Tubes are available for your design requirements, sizes 5" to 27". They include the following:

5TP4 (projection type)

10FP4-A	*17BP4-B	*21ZP4-B
12KP4-A	*21EP4-B	*21ACP4-A
16KP4-A	*21YP4-A	*24CP4-A
27EP4	*27RP4	

*Recommended types

GENERAL ELECTRIC

162-1A1

That's for Me for TV!

insl-x
INSULATING SPRAY

Higher dielectric strength than any other insulating spray on the market! Proven by twenty years of use by leading component parts manufacturers— Now packaged in easy-to-use Spra-tainer especially for you!

Contract service calls cost money. Spray every TV installation with Insl-x E-16 and eliminate return calls. The extremely high dielectric strength of Insl-x E-16 assures positive insulation. Insl-x dries to a hard but extremely flexible finish of unusual thickness.

Use Insl-x, the material that was designed to do one specific job—INSULATE.

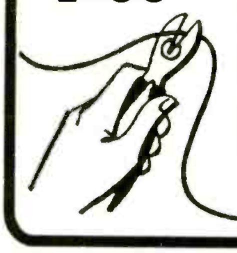
Specify Insl-x E-26 for complete insulation of electrical equipment and wiring.

Insulate everything in TV set except moving parts and tubes! Spray antenna and all connections. Prevent corona, arcing. Keep out moisture, rust.

TECHNICAL DATA

Dielectric strength, 800 to 1200 v/m • Drying time, 3 to 5 minutes • Hard, yet retains great flexibility. Adhesion excellent to all conventional assembly surfaces including ceramic, anodized aluminum and phenolic • Highly resistant to chemicals and moisture.

insl-x E-33



For Safely Handling "Hot" Wires

Do away with the uncertain protection of taped tool handles. Insl-x E-33, the material used by major utility companies for insulating linesmen's tools, is now available to you!

Just dip tool handles—Insl-x E-33 dries to a tough, smooth coating that provides absolute protection. In bright red for quick, positive tool identification.

See your jobber, or write for complete technical data, Dept. 402

INSL-X SALES COMPANY, 26 Rittenhouse Place, Ardmore, Pennsylvania

Insl-x Products are available in bulk for spray, dip, and brush application.

MICROWAVE SIGNAL GENERATORS

Complete coverage of the range 950-10,800 mcs/sec.

with Polarad single dial operation

Four new Microwave Signal Generators covering the range 950-10,800 mcs/sec. All with famous **Polarad single dial operation**. Each provides the maximum working range possible in one compact signal generator. And, additional Polarad Signal Generators are available to cover 12.8 to 39.7 kmc.

These features on all MSG units assure fast and simple operation: direct reading, single dial frequency control that tracks reflector voltages automatically . . . direct reading attenuator dial . . . conveniently placed controls, in logical sequence . . . high visibility on the face of each instrument.

Polarad Signal Generators are built to the same high standards required for military equipment. They are practical for the factory assembly line—engineered ventilation assures continuous and stable operation of all instrument functions. Components are readily accessible for easy maintenance. And laboratory accuracy is guaranteed under the most rigorous operating conditions.

Write directly to Polarad or your nearest Polarad representative for details.

	MSG-1	MSG-2	MSG-3	MSG-4*
Frequency Range	950-2400 MCS/sec.	2150-4600 MCS/sec.	4450-8000 MCS/sec.	6950-10,800 MCS/sec.
	(Frequency set by means of a single directly calibrated control)			
Frequency Accuracy	±1%	±1%	±1%	±1%
Power Output	1 MW	1 MW	.2 MW	.2 MW
Attenuator Range	120 db	120 db	120 db	120 db
Attenuator Accuracy	±2 db	±2 db	±2 db	±2 db
Output Impedance	50 ohms	50 ohms	50 ohms	50 ohms
Input Power	115V±10% 60 cps	115V±10% 60 cps	115V±10% 50-1000 cps	115V±10% 50-1000 cps
Internal Pulse Modulation:				
Pulse Width	0.5 to 10 microseconds			
Delay	3 to 300 microseconds			
Rate	40 to 4000 pulses per second			
Synchronization	Internal or external, sine wave or pulse			
Internal FM:				
Type	Linear sawtooth			
Rate	40 to 4000 cps			
Synchronization	Internal or external, sine wave or pulse			
Frequency Deviation	±2.5 MCS	±2.5 MCS	±6 MCS	±6 MCS
External Pulse Modulation:				
Polarity	Positive or Negative			
Rate	40 to 4000 pulses per second			
Pulse width	0.5 to 2500 microseconds			
Pulse separation	(For multiple pulses) 1 to 2500 microseconds			
Output Synchronizing Pulses:				
Polarity	Positive, delayed & undelayed			
Rate	40 to 4000 pps			
Voltage	Greater than 25 volts			
Rise time	Less than 1 microsecond			
Size | Approx. weight	17" long x 13¼" high x 15½" deep | 60 lbs.		17" long x 15" high x 19½" deep | 100 lbs.	

*Also available—MSG 4A: 6,950—11,500 MCS/sec.

"THE FINEST SIGNAL GENERATORS OF THEIR KIND" **Polarad** ELECTRONICS CORPORATION 100 METROPOLITAN AVENUE, BROOKLYN 11, NEW YORK

REPRESENTATIVES Albuquerque • Arnprior, Canada • Atlanta • Boston • Chicago • Cleveland • Fort Worth • Kansas City • Los Angeles • New York • Philadelphia • San Francisco • Seattle • St. Paul • Syracuse • Washington, D. C.

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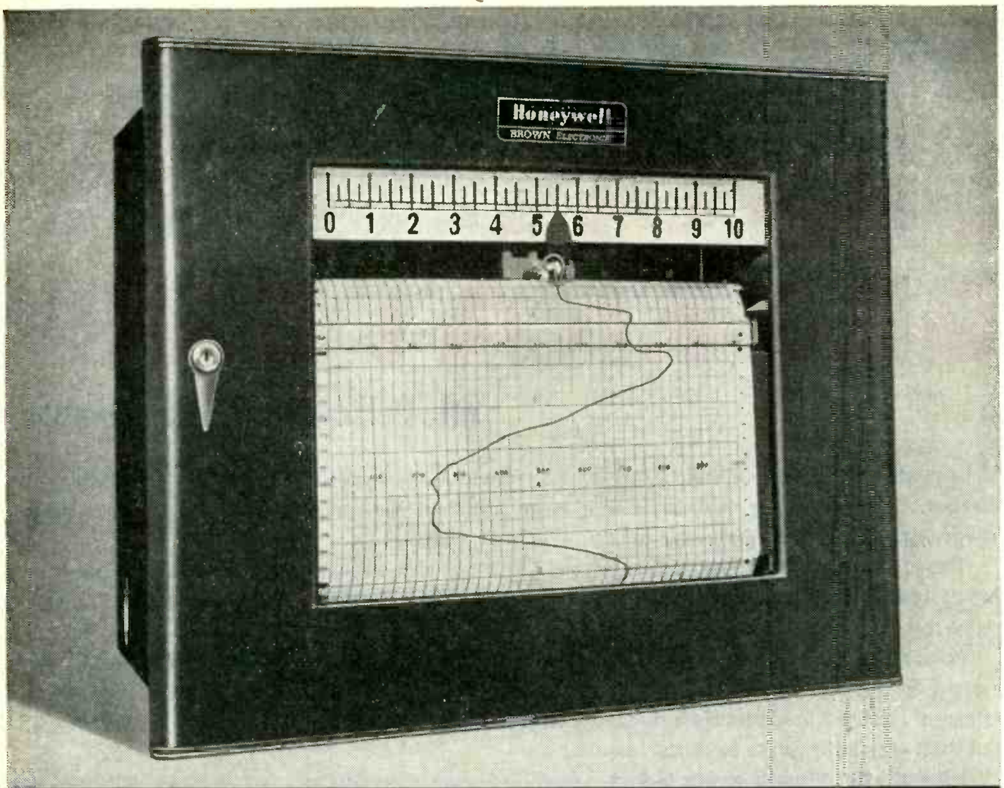


approximate maximum sensitivities

AMPLIFIER	SPAN	VOLTAGE SENSITIVITY	CURRENT SENSITIVITY
3x	2mv	1×10^{-6} volts	3×10^{-12} amp
1x	10mv	3×10^{-6} volts	2.5×10^{-11} amp

New *ElectroniK* recorder *for high impedance circuits*

A NEW MODEL of the *ElectroniK* instrument now makes it possible to record data from high impedance sources without resorting to external pre-amplifiers. It can measure voltages originating in sources with impedances ranging from 0 to 50,000 ohms without appreciable change in sensitivity, damping or speed.

Because of its high input impedance, the instrument can be applied to voltage measurements with negligible loading effect on the source. It is also applicable to current measurements in conjunction with photocells, spectographs and similar devices.

The recorder is supplied with pen speed of 24, 12, 4½ or 2 seconds, for spans down to 2 mv. The amplifier can be used separately in many high impedance servo systems.

Excellent stray rejection, meeting the most stringent specifications, is incorporated in the new circuit. Stray a-c voltages, equal to full scale span for the 2-second model and up to 10 times the span for the 24-second model, are rejected with no appreciable loss in instrument sensitivity.

Your nearby Honeywell sales engineer will be glad to discuss your applications . . . and he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Aves., Philadelphia 44, Pa.

● **REFERENCE DATA:** Write for Instrumentation Data Sheet No. 10.0-14.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

First in Controls

Every plate in Bradley rectifiers is manufactured as an individual unit. It is a precision product and not a stamping from selenium coated material. That is why Bradley rectifiers give you superior stability, efficiency at high temperatures and long life.

Vacuum-Processed Bradley Rectifiers

laboratory quality at production line cost

Multiple layers of selenium are purified and bonded to each plate, under vacuum. Impurities cannot introduce variables in rectifier performance.	Phenolic insulating pad is applied to minimize counter-electrode pressure on selenium when plates are assembled under spring tension. Efficiency of rectifier is protected.	Counter-electrode is masked away from edge of plate. Periphery of counter-electrode won't chip or dig into selenium when plates are assembled. Counter-electrode shorting is eliminated.

Edge shorting of the counter-electrode under vibration is a performance hazard you can't foresee. Routine tests may or may not disclose its existence. Like any flaw, if it is slight, you won't know about it until the customer complains.

A sure way to eliminate counter-electrode shorting as a threat to your circuit's operation is to specify Bradley rectifiers. They are made to prevent shorting. Does this mean you pay a premium price for Bradley rectifiers? It does not. You get laboratory quality, but you pay production line costs. Try us and see. Specify Bradley as a source when you next consider rectifiers. Special problems are welcomed.

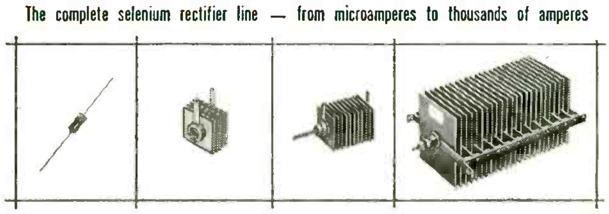
SELENIUM AND COPPER OXIDE RECTIFIERS

VACUUM PROCESSED for PERFORMANCE AS RATED

SELF-GENERATING PHOTOELECTRIC CELLS

Bradley
LABORATORIES, INC.

The complete selenium rectifier line — from microamperes to thousands of amperes



BRADLEY LABORATORIES, INC., 168E Columbus Avenue, New Haven 11, Conn.

Want more information? Use post card on last page.

NEW! FOR PRINTED

COMPLETE LINE

1 **FOR AUTOMATION: EXCLUSIVE NEW** Self-Supporting Snap-in Bracket Mounting. (See Type YGC-B45.)

2 **NEW** Twist-ear Mounting. (See Types XP45 and UPM45.)

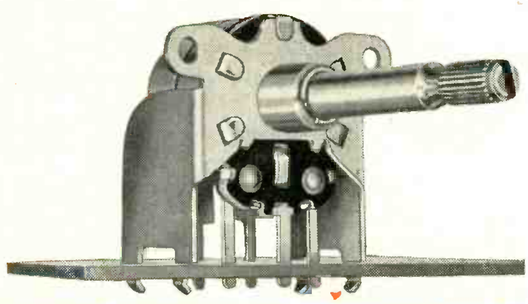
3 **PLUG-IN BLADE-TYPE TERMINALS** for vertical or horizontal mounting of control to printed circuit panel. (See all photos.)

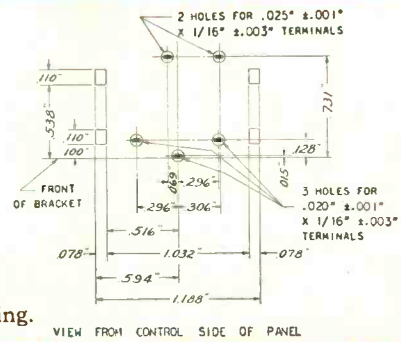
4 Threaded Bushing Mounting. (See Types XGC-45, GC-U45 and *miniaturized* U70.)

Consultation without obligation available on variable resistors for your printed circuit applications. Write today.

VERTICALLY MOUNTED to Printed Circuit Panel. Shaft above panel. (Types YGC-B45, XP45 and XGC-45.)

- NO shaft protection needed during soldering.
- PARALLEL terminals permit *small* round connecting holes instead of *large* elongated slots necessary for fan shaped terminals.
- Terminals available in 7/8" or 1-1/32" lengths from control's center.

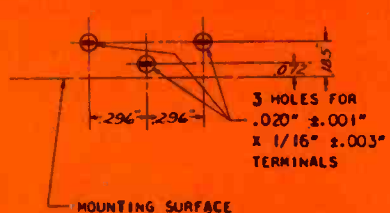




Suggested panel piercing.

Type YGC-B45 FOR AUTOMATION: *EXCLUSIVE NEW Self-Supporting Snap-in Bracket*

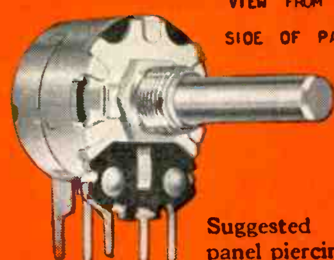
- Snaps instantly into place.
- Stays firmly put during soldering. Solder permanently anchors control to circuit panel.
- Terminal connections cannot loosen; bracket prevents mounting or operating strain on control or switch terminals.
- No mounting hardware, no separate supporting panel needed.
- No strain on printed circuit panel. Anchor tabs attach bracket to cabinet.
- Adequate clearance for circuit paths provided by ample spacing between terminals and by design of mounting lugs on bracket.

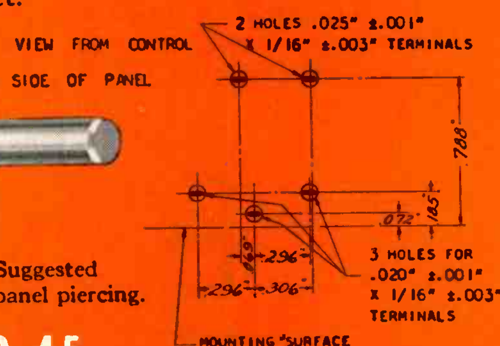


Suggested panel piercing.

Type XP45

For TV preset control applications using a mounting chassis to support printed circuit panel. Twisting 2 ears holds control rigidly to mounting chassis. Available in finger adjusted shaft lengths of 1/2", 5/8", 11/16", 7/8" and 1" from control's mounting surface. Also available with recessed screw driver slotted shaft (Type XPM45).





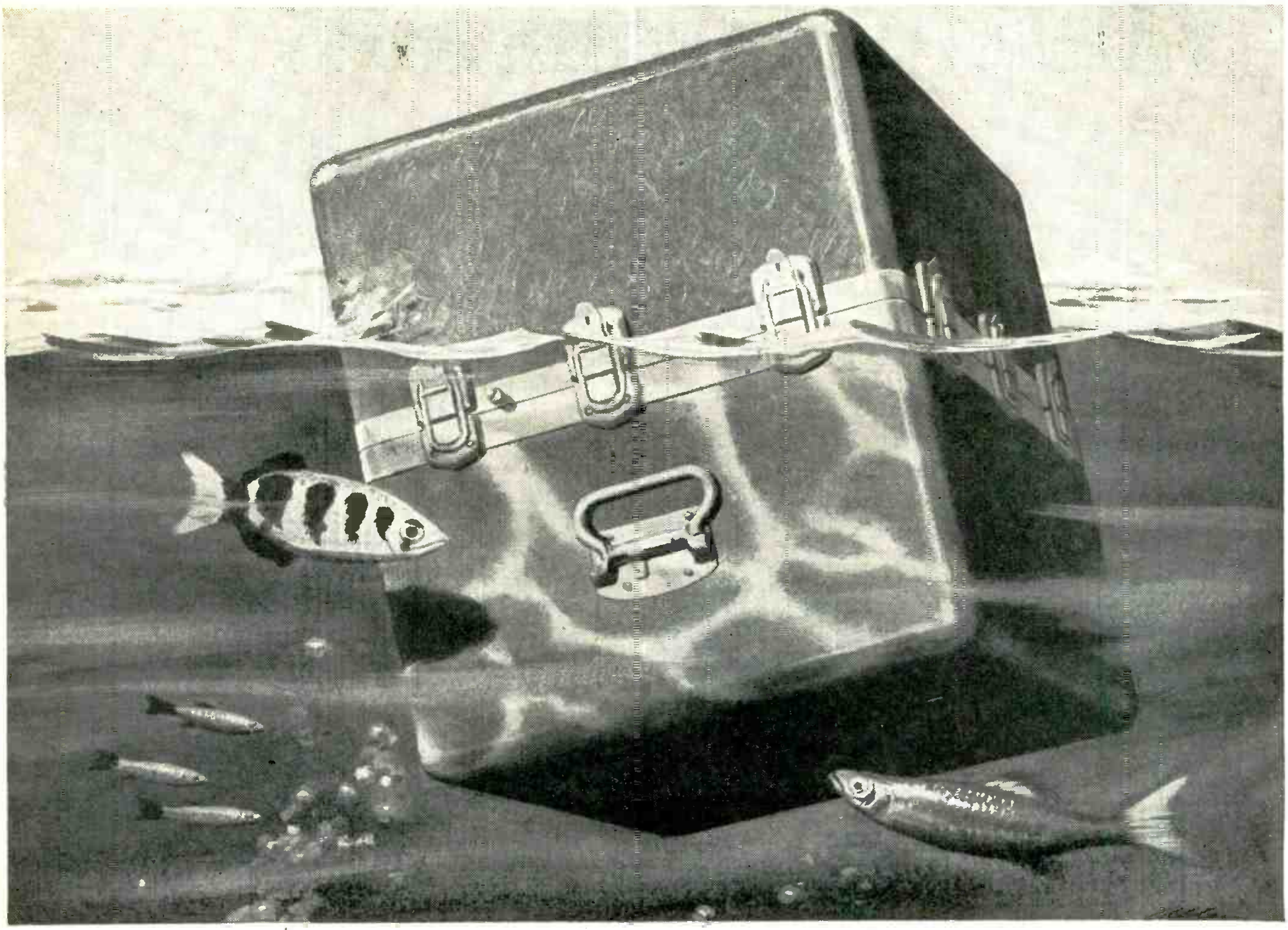
Suggested panel piercing.

Type XGC-45

For applications using a mounting chassis to support printed circuit panel. Threaded bushing mounting

All controls illustrated actual size.

KOCH *Pioneer in Fiberglas reinforced plastics*



Can your shipping cases pass this test?

To protect costly aerial cameras and other precision instruments, the U. S. Air Force has developed a special Fiberglas case, now being manufactured in quantity by Koch of California. (Specification MILC 4150 A-USAF).

In one test, this special case was submerged in 43 feet of water without leaking. In another, the case was dropped by parachute from a plane flying 250 miles an hour at 600 feet altitude (equivalent to a free fall of 25 feet). Both case and contents were undamaged.

Koch Fiberglas cases double as shipping cases, carrying cases and storage cases. No crating or other outer protection is necessary for overseas shipment. Vapor and moisture transmission rate is zero. The cases are fungus and mildew proof. They won't dent—are actually lighter than steel, yet much stronger.

If you manufacture a valuable product that needs this kind of protection, it may pay you to investigate our facilities and experience.

Originator of Koch Fiberglas Luggage— unconditionally guaranteed against breakage on any airline, railroad or steamship, anywhere in the world.

H. KOCH & SONS

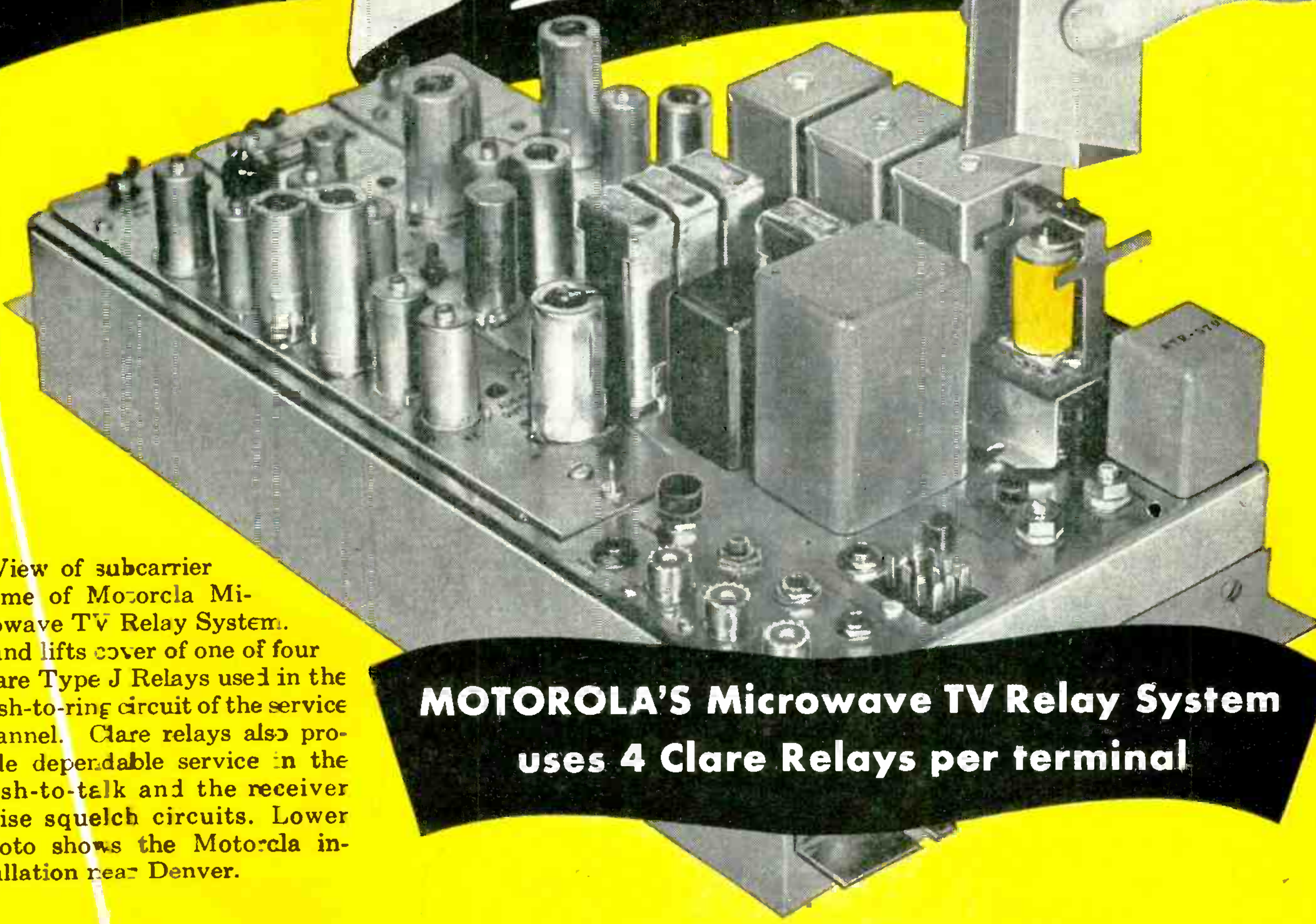
Pioneer in Fiberglas reinforced plastics

73 BEALE STREET, SAN FRANCISCO

Where ordinary relays won't do...

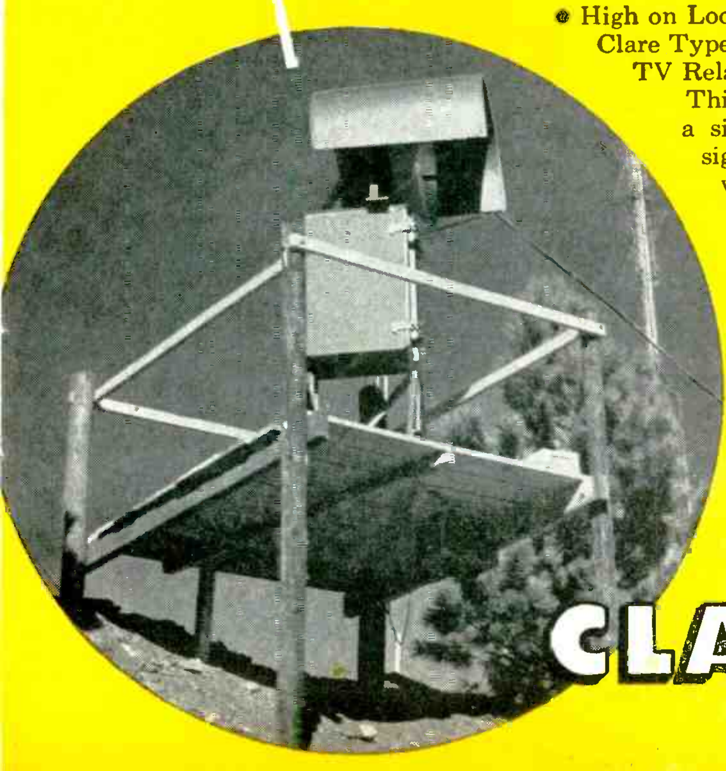
...that's where you find

CLARE RELAYS



• View of subcarrier frame of Motorola Microwave TV Relay System. Hand lifts cover of one of four Clare Type J Relays used in the push-to-ring circuit of the service channel. Clare relays also provide dependable service in the push-to-talk and the receiver noise squelch circuits. Lower photo shows the Motorola installation near Denver.

MOTOROLA'S Microwave TV Relay System uses 4 Clare Relays per terminal



• High on Lookout Mountain, 3000 feet above the city of Denver, four Clare Type J Relays are in 24-hour service in Motorola's Microwave TV Relay System.

This Motorola Microwave TV Relay System is unique in that a single RF channel is used for a broadcast-quality video signal, a high fidelity audio program channel and a two-way service channel for orders and cuing.

The four Clare relays are mounted under the metallic covers on the subcarrier frame. They were chosen because of the need for maximum reliability of performance and long-life dependability.

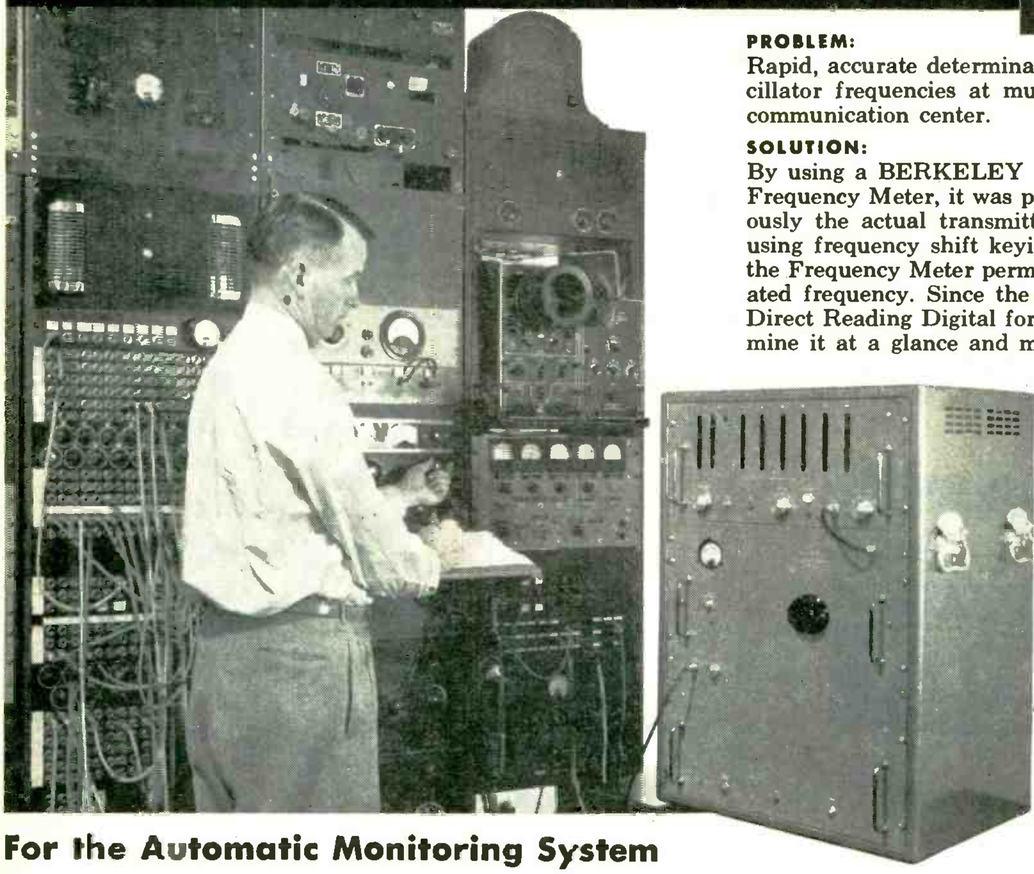
This choice is typical of the confidence placed in Clare relays by engineers in every phase of industry. Clare sales engineers are located in principal cities to consult with you on your specific relay problems. Call the nearest Clare office or write: C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable Address: CLARELAY.

***FIRST* IN THE INDUSTRIAL FIELD**

CLARE RELAYS

HOW Berkeley EQUIPMENT HELPED SOLVE A PROBLEM FOR RCA Communications, Inc.

Bolinas, California



PROBLEM:
Rapid, accurate determination of transmitter and oscillator frequencies at multiple-transmitter overseas communication center.

SOLUTION:
By using a BERKELEY Model 5570 direct reading Frequency Meter, it was possible to monitor continuously the actual transmitted frequency. Even when using frequency shift keying, the averaging effect of the Frequency Meter permitted measurement of radiated frequency. Since the frequency is presented in Direct Reading Digital form, the operator can determine it at a glance and make necessary corrections.

RESULTS:
Using the BERKELEY Model 5570, frequency determination to an accuracy of 1 part in 10^7 ± 1 cycle with a new measurement every 4 seconds is now a simple routine. Previous method required 10 to 15 minutes.

For the Automatic Monitoring System

Additional equipment provides automatic recording of the last 6 digits of the measured frequency on standard adding machine tape. This is accomplished by use of the R-6 Digital Recorder in conjunction with the Frequency Meter, Model 5570.

40 to 510 Megacycles

VHF and UHF converter units are available for use with the Model 5570 (0 to 42 megacycles) Frequency Meter.

Model 5575 extends range of Model 5570 to 150 megacycles. Model 5580 covers one 30 megacycle band width from 150 to 510 megacycles when used with Model 5570. Plug-in units select the 30 megacycle band width over which the Model 5580 is to operate. Reading is made in digital form as sum of base frequency of plug-in unit and direct indication on Model 5570.

May we help solve your problem?

If it involves faster, more accurate, easier and simpler ways to measure frequency, flow, pressure, velocity, r.p.m., time intervals, viscosity, — or high speed counting and counting plus pre-set control — chances are that BERKELEY can help you solve it. Complete data sheets covering many applications in these fields are yours for the asking — check the handy coupon below and mail it NOW!

M-24

Berkeley *division*
BECKMAN INSTRUMENTS INC.
2200 WRIGHT AVE., RICHMOND, CALIF.

Dept. G-2, 2200 Wright Ave., Richmond, Calif.
Please send me application data sheets checked

Name ____________________
Title ____________________
Address ____________________
City ____________ State ____________

MEASUREMENT OF:
- ☐ Flow ☐ Velocity
- ☐ Pressure ☐ RPM
- ☐ Viscosity ☐ Operating Time
- ☐ Frequency of ____________

☐ **COUNTING OR PREDETERMINED COUNTING OF:**
____

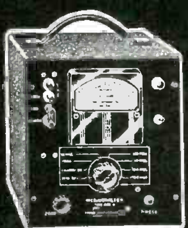
CONTROL OF:
- ☐ Cutting Stock to Length
- ☐ Packaging and Batching

Want more information? Use post card on last page.

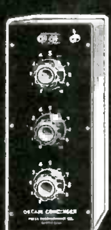
FREED *Instruments & Transformers*

Famous For **QUALITY • DEPENDABILITY • ACCURACY**

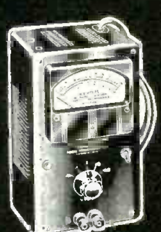
No. 1030
Low Frequency "Q" Indicator



No. 1020B
Megohmmeter



Decade Inductors



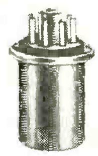
No. 1040
Vacuum Tube Voltmeter

FREED
MILITARY PULSE TRANSFORMERS
IN STOCK FOR IMMEDIATE DELIVERY

HERMETICALLY SEALED PULSE TRANSFORMERS for use in blocking oscillators, low level interstage coupling, and modulator outputs. Made in accordance with MIL-T-27 specifications. These pulse transformers are designed for maximum power, efficiency and optimum pulse performance. Balanced coil structures permit series or parallel connection of windings for turn ratios other than unity. Pulse characteristics, voltages and impedance levels will depend upon interconnections made.

DM–12

DM–18

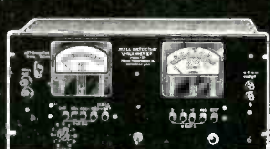


DM–8

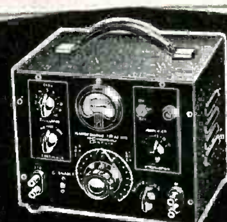
DM–01

CATALOG NUMBER	APPLICATION	PULSE VOLTAGE KILOVOLTS	PULSE DURATION MICRO-SECONDS	DUTY RATIO	TEST VOLTAGE KV., RMS	CHARAC-TERISTIC IMPEDANCE OHMS	CASE SIZE
MPT-1	Blocking oscillator or interstage coupling	0.25/0.25/0.25	0.2-1.0	.004	0.7	250	DM-12
MPT-2	Blocking oscillator or interstage coupling	0.25/0.25	0.2-1.0	.004	0.7	250	DM-12
MPT-3	Blocking oscillator or interstage coupling	0.5/0.5/0.5	0.2-1.5	.002	1.0	250	DM-18
MPT-4	Blocking oscillator or interstage coupling	0.5/0.5	0.2-1.5	.002	1.0	250	DM-18
MPT-5	Blocking oscillator or interstage coupling	0.5/0.5/0.5	0.5-2.0	.002	1.0	500	DM-12
MPT-6	Blocking oscillator or interstage coupling	0.5/0.5/0.5	0.5-2.0	.002	1.0	500	DM-12
MPT-7	Blocking oscillator, interstage coupling or low power output	0.7/0.7/0.7	0.5-1.5	.002	1.5	200	DM-18
MPT-8	Blocking oscillator, interstage coupling or low power output	0.7/0.7	0.5-1.5	.002	1.5	200	DM-18
MPT-9	Blocking oscillator, interstage coupling or low power output	1.0/1.0/1.0	0.7-3.5	.002	2.0	200	DM-18
MPT-10	Blocking oscillator, interstage coupling or low power output	1.0/1.0	0.7-3.5	.002	2.0	200	DM-18
MPT-11	Blocking oscillator, interstage coupling or low power output	1.0/1.0/1.0	1.0-5.0	.002	2.0	500	DM-01
MPT-12	Blocking oscillator, interstage coupling or low power output	0.15/0.15 0.3/0.3	0.2-1.0	.004	0.7	700	DM-8

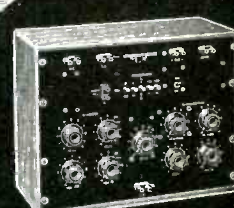
SEND FOR COMPLETE CATALOG OF
FREED INSTRUMENTS AND TRANSFORMERS



No. 1210
Null Detector & Vacuum Tube Voltmeter



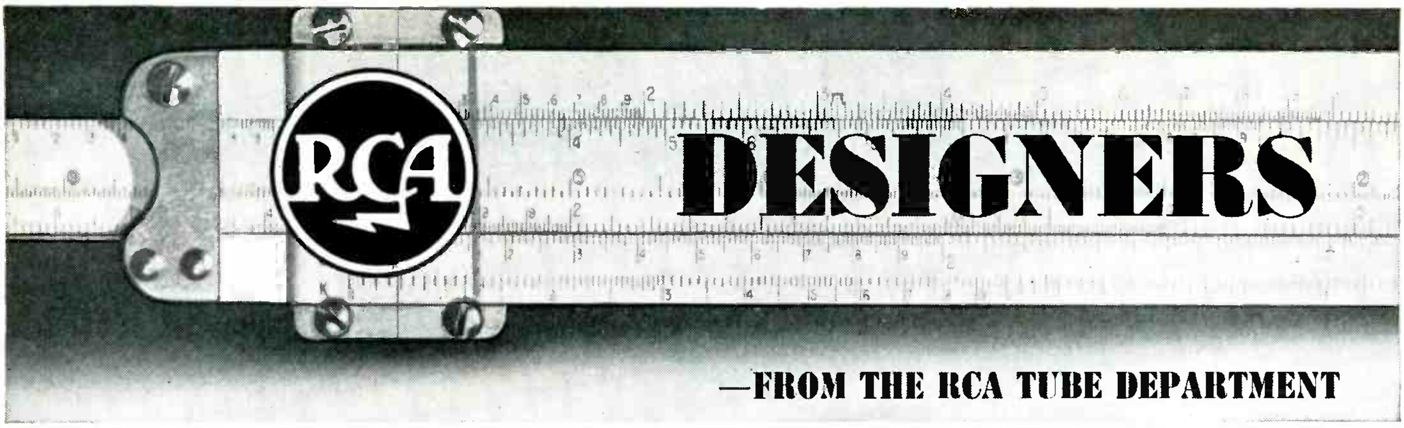
No. 1010
Comparison Bridge



No. 1110A
Incremental Inductance Bridge

FREED TRANSFORMER CO., INC.

1722 WEIRFIELD ST. (RIDGEWOOD) BROOKLYN 27, N.Y.



Cut equipment costs with RCA Preferred Tube Types

As a guide to cutting costs when choosing electron tubes for the design of new electronic equipment, RCA offers its current list of RCA Preferred Tube Types.

These key tube types—generally preferred for their performance in radio, television, and other widely used circuits—offer the *cost saving* advantages of *volume produced* types. Because they can be manufactured at a more uniform rate, Preferred Tube Types bring special benefits of year 'round availability, stocking economies, uniformly high quality, and initial lower cost which make for low equipment cost to designers, distributors, and consumers alike.

For standardization of your designs and simplification in the manufacture and maintenance of your equipment, consider the importance of Preferred Tube Types. Ask your RCA representative for details on how RCA Preferred Tube Types can actually reduce your manufacturing costs and increase your profit picture.

RCA PREFERRED TUBE TYPES for new Equipment Design

Types For AM and FM Receiver Applications

Amplifiers, Oscillators, & Mixers				
Triodes		Pentodes		
Twin	with Diodes	Sharp Cutoff	Remote Cutoff	with Diodes
12AU7◈	*6AV6* *12AV6*	*1U4* *6AU6* *6CB6*	*1T4* *6BA6* *12BA6*	*1U5*

Rectifiers and Diode Detectors	Converters	Output Amplifiers
5U4-G 5Y3-GT *6AL5* *6X4* *35W4*	1R5 *6BE6* *6X8* *12BE6*	*3S4* *3V4* *6AQ5* 6K6-GT 6V6-GT *35C5* *50C5*

Types For Television Receiver Applications

Amplifiers			
IF	Video	Audio	Deflection
6AU6 *6BQ7-A* *6CB6*	*6AU6* *6CL6*	*6AQ5* *6AV6* 6K6-GT 6V6-GT	*6S4* 6BQ6-GT 6CD6-G 6W6-GT

RF Tuner Tubes	Deflection Oscillators	Control Circuits#
*6AF4** *6BQ7-A** *6J6* *6X8*	6SN7-GT *12AU7*◈ *12BH7*◈	*6AU6* 6SN7-GT *12AU7*◈ *12BH7*◈

Rectifiers		Damper Tubes	Sound & Video Detector
High-Voltage	Low-Voltage		
1B3-GT	5U4-G	6AX4-GT 6W4-GT	*6AL5*

Miniature types are shown in italics   * For UHF   ◈ Tapped heater, for 6.3-volt or 12.6-volt operation   # Including synchronizing functions, AGC, etc.

SMALL TYPES FOR INDUSTRIAL AND COMMUNICATION SERVICES

Home Entertainment Types of Special Interest #		Vacuum Types For Critical Applications		Types For Regulator Service	Glow Discharge Triode
6AK6 *6AQ6* *6BJ6* *6C4*	6L6-G 6SC7 6SL7-GT *12AX7*	1620 5690 5691 5692 5693 5879	"Special Red" Types (5690–5693)	OA2 OB2 *5651* 6080	5823

Miniature types are shown in italics   * For UHF   ◈ Tapped heater, for 6.3-volt or 12.6-volt operation
Also see types for AM, FM, & TV Receivers

For Industrial equipment applications. In addition to the Preferred Tube Types listed above, RCA lists Preferred Tube Types in the following categories:

- Vacuum Types for RF and AF Power Applications
- Thyratons • Ignitrons • Rectifiers • Phototubes
- C-R Oscillograph Types • Camera and TV Studio Types

A complete listing of these types is yours for the asking.

For valuable assistance in choosing tube types for industrial applications, consult your RCA Field Engineer.

NEWS

(Actual height) 3 1/8"

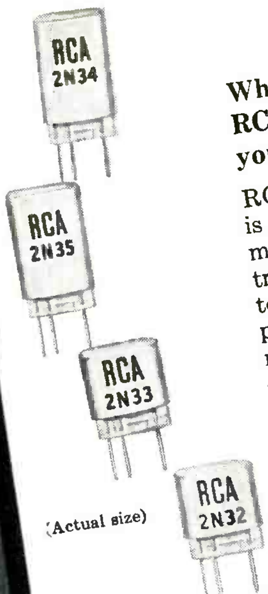
New Multiplier Phototube for Headlight Dimming Service

RCA-6328 is a short, 9-stage multiplier phototube. Instantaneous response of the tube meets the critical timing requirements of headlight-control service. RCA-6328 is capable of providing stable performance over long periods. High luminous sensitivity allows this tube to be used with an amplifier having relatively low-impedance input and fewer stages than required for a less-sensitive tube.

(Actual size)

RCA Germanium-Crystal Diodes are now available

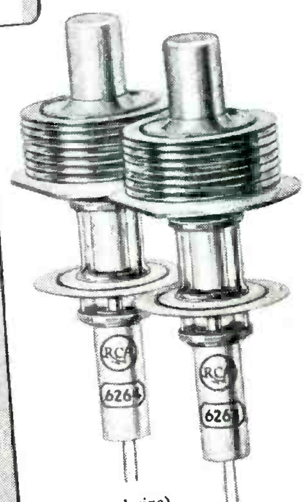
RCA Point-contact Germanium-Crystal Diodes are now available in quantity. Sealed in glass, they include RCA-IN34-A (general-purpose type); IN38-A, IN55-A, and IN58-A (large-signal types); IN54-A (high-back-resistance type); and the IN56-A (high-conduction type).



(Actual size)

Why you can count on RCA Transistors for your designs

RCA transistor production is geared to the progress made in developing new transistor manufacturing techniques and in improved production-control methods. That is why you can count on RCA for high-quality transistors. They are made in accordance with the best engineering practice known.



(Actual size)

UHF "Pencil" Triodes for Mobile and Aircraft Services

These new "Pencil" tubes—with external plate radiators—can be operated with full ratings at frequencies as high as 500 Mc—and at reduced input ratings up to 1700 Mc! ICAS plate dissipation is 13 watts. RCA-6263 is intended for rf power amplifier and oscillator services; RCA-6264 is designed for frequency-multiplier service.

RCA—"Headquarters" for

- Receiving Tubes
- Thyratrons
- Rectifier Tubes
- Voltage-Regulator Tubes
- Germanium Diodes
- Transistors
- TV Picture Tubes
- Portable Radio Batteries
- Cathode-Ray Tubes
- Vacuum-Gauge Tubes
- High-Power RF Tubes
- Phototubes
- TV Camera Tubes
- TV Components
- Speakers
- Laboratory Test Equipment

RCA

RADIO CORPORATION of AMERICA

TUBE DEPARTMENT HARRISON, N. J.

RCA Tube Department
Commercial Engineering, Section B19R Harrison, N. J.

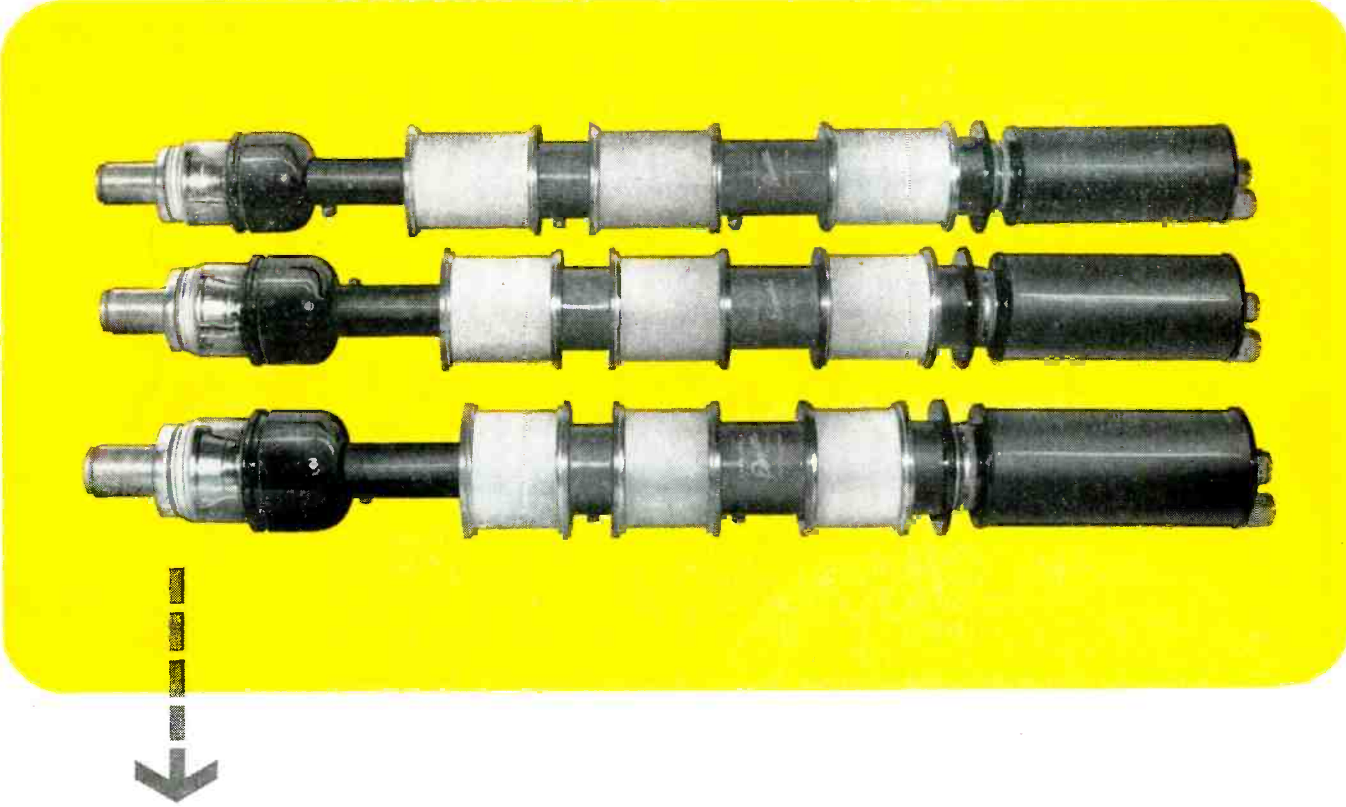
Please send me technical data on:

- ☐ RCA Preferred Tube List PTL-501D
- ☐ New Multiplier Phototube, RCA-6328
- ☐ RCA Germanium Diodes
- ☐ RCA Transistors
- UHF "Pencil" tubes: RCA-6263 ☐ RCA-6264 ☐

Name____________________

Firm____________________

City__________Zone______State______



all this and color too!
...with EIMAC UHF TV Klystrons

- **HIGH GAIN — SIMPLE TRANSMITTER.** Eimac klystrons are inherently ideal for the final linear amplifier in UHF color TV transmitters. There is no need for by-pass condensers, rf chokes or feedback loops, and through low driving power and high power gain, the preceding circuits are simplified, and the smallest number of rf stages is required.
- **LOW NOISE LEVEL.** Eimac klystrons operate below the noise level specified by the NTSC color television standards. The low noise level of these klystrons is amply demonstrated in UHF television transmitters now in daily operation.
- **NO TRANSIT TIME PHASE SHIFT EFFECTS.** Regardless of amplitude level, the transit time of electrons in klystrons is substantially constant, and, having excellent linearity, a klystron will provide the amplitude and phase responses necessary for faithful transmission of color values.
- **WIDE BANDWIDTH.** The rf resonant cavities are completed external to the tube, permitting the optimum arrangement of the rf circuits for bandwidths greater than six mc — more than enough for color TV.
- **RELIABLE — ECONOMICAL.** Because of the sheer simplicity of these klystrons, they are light weight, readily mass produced, and give long, reliable life.

Eimac Klystrons for UHF-TV

TYPE	CHANNELS	SATURATION POWER
3K20,000LA	14-32	6 kw
3K20,000LF	33-55	6 kw
3K20,000LK	56-83	6 kw
3K50,000LA	14-32	15 kw
3K50,000LF	33-55	15 kw
3K50,000LK	56-83	15 kw

For further information contact
our Application Engineering Department

Eimac TUBES

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

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Power Rheostats

NOW Available!

50 watt - 75 watt - 100 watt - 150 watt
(25 watt available shortly)

Special Features:

- ★ tapered windings
- ★ switch combinations
- ★ off positions
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delivery we guarantee immediate delivery regardless of quantity, value and sizes.

price we guarantee that our prices will always save you money.

quality we guarantee our engineering techniques and selection of materials will provide the finest products available.

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TRU-OHM VITREOUS ENAMELED RESISTORS — A complete line ready for shipment!

TRU-OHM RHEOSTATS and RESISTORS are approved by the foremost manufacturers for civilian and government applications.

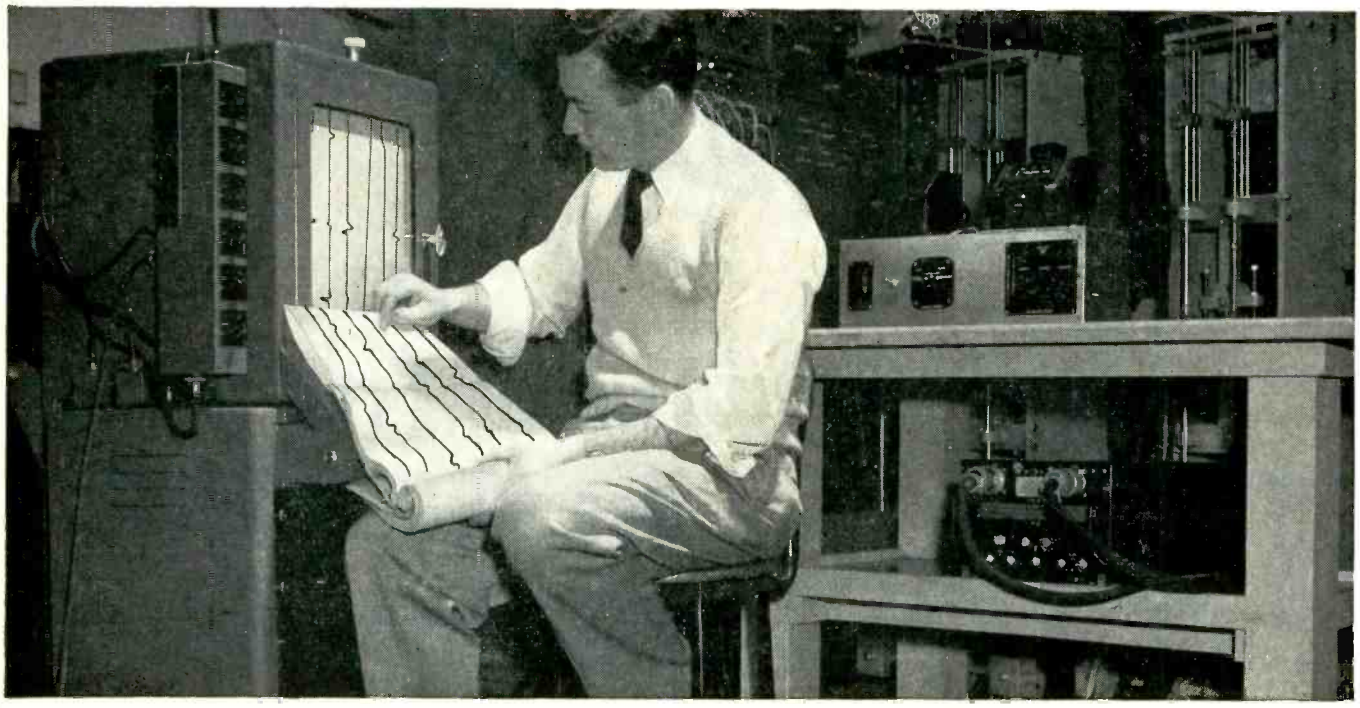
TRU·OHM PRODUCTS Division of Model Engineering & Mfg., Inc.

General Sales Office: 2800 N. Milwaukee Avenue, Chicago 18, Ill.
Factory: Huntington, Indiana

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

Want more information? Use post card on last page.

Brush six-channel magnetic oscillograph used to record output of an analog computer, which duplicates flight conditions for a jet plane. Photo courtesy Sperry Gyroscope Company.



MULTI-CHANNEL OSCILLOGRAPHS

Brush instruments reduce your engineering costs

Simultaneous recording of several electrical or mechanical phenomena with Brush multi-channel oscillographs *saves engineering time and simplifies your testing.* These precision instruments give you immediate answers in writing—stress, strain, torque, vibration, pressure, flow, electrical characteristics, and other variables.

For complete description of time-saving Brush instruments, ask your nearby Brush representative to call . . . or write for your copy of "Modern Measurements." Brush Electronics Company, Department K-2, 3405 Perkins Avenue, Cleveland 14, Ohio.

New portable six-channel oscillograph simplifies recording of phenomena in the shop or in the field. Instrument is lightweight, self-contained, and easy to use.

BRUSH ELECTRONICS COMPANY

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZO-ELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT
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SLIP RING AND COMMUTATOR ASSEMBLIES

This Instrument Corporation of America plant contains the most modern and complete facilities available anywhere in the world for the exclusive production of Miniature Slip-Ring and Commutator Assemblies to precision standards. It is now in full scale production to meet your requirements in the fastest possible time at the lowest possible cost.

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Our assemblies can be supplied at low cost. Quality is the highest in the industry. Dimensional accuracy and other characteristics are excellent and these units are highly recommended for instruments such as synchros, etc.

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Wherever extreme dimensional precision, accurate concentricity and high dielectric qualities are required, the electro-deposition method is recommended . . . the production of which is licensed under an exclusive arrangement with the Electro Tec Corporation.

TYPICAL SPECIFICATIONS

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Ring Hardness: 75 to 90 Brinell

Rotation Speeds: To Over 12000 RPM

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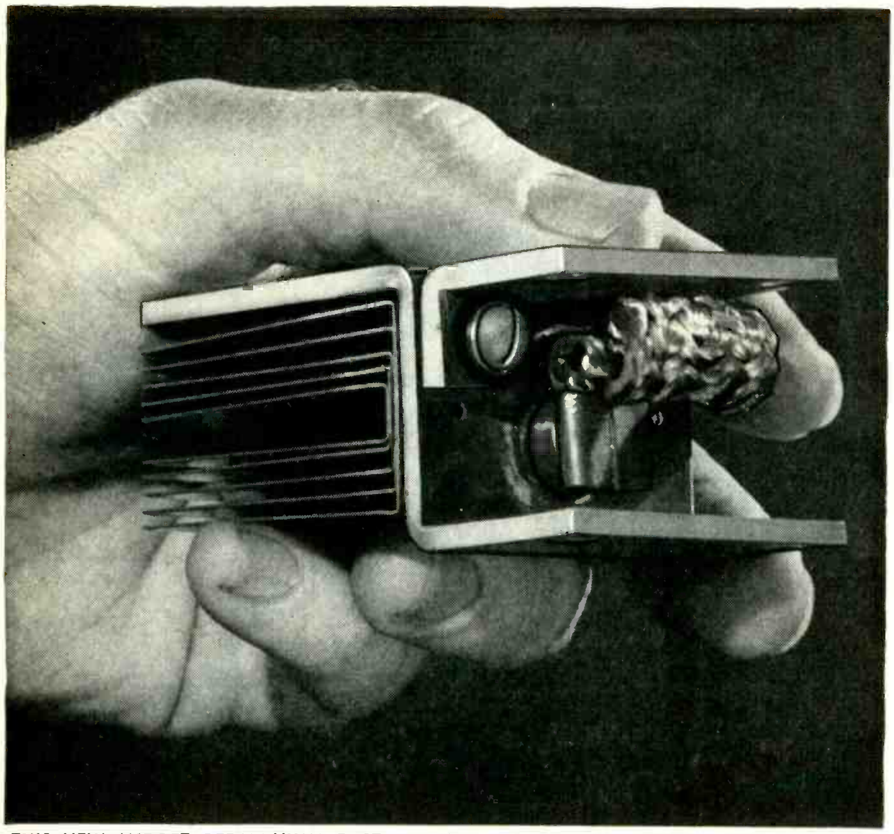


THIS NEW MIDGET GERMANIUM RECTIFIER HAS AN OUTPUT OF OVER TWO KILOWATTS

Get High Power and Save Space With G-E Germanium Rectifiers

Germanium is a material to stimulate the imagination, so endless are its possible applications. Germanium rectifiers, pioneered by General Electric, offer design engineers tremendous possibilities for product improvement. Combining extreme compactness with the highest efficiency of any metallic rectifier known, G-E germanium cells show practically no aging. D-C power supplies for welders, battery chargers, and electrochemical processes are just a few of the possible applications.

COMPACT—The compactness of germanium rectifiers makes possible real savings in space, volume, and weight. The dime-sized cell, pictured above with its heat exchanger, has a rating of two kilowatts with air cooling at a rate of 1000 fpm. Six of these tiny rectifiers connected in a three-phase bridge will deliver up to 65 volts d-c with a rated capacity of over 14 kw. To do a comparable job with selenium would take six stacks of 30 cells each, or a total of 180 selenium plates.

OTHER RATINGS—Besides the rectifier illustrated above, two other types are available. One is a sealed convection-cooled unit with a half-wave rating of 0.4 amperes d-c output with up to 125 r.m.s. volts a-c input. A second is the plate-mounted convection or fan-cooled rectifier with half-wave ratings of from 4 to 20 amperes d-c output. All assemblies can be used in doubler, center-tap, and full-wave bridge circuits with corresponding increases in ratings.

MORE INFORMATION is available from your nearest G-E Apparatus Sales Office, or write *Section 461-32, General Electric, Schenectady 5, N. Y.*

You can put your confidence in—

GENERAL ELECTRIC

METALLIC RECTIFIER FACTS FOR ENGINEERS

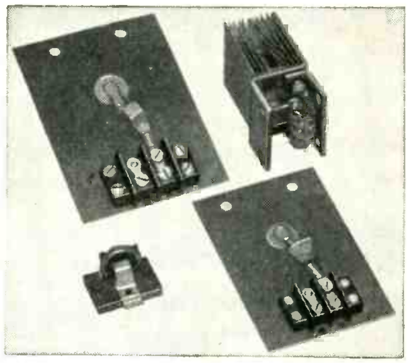
Germanium

The Rectifier of the Future by C. E. Hamann

Seldom if ever has the rectifier industry experienced such widespread interest in a new development as has occurred with germanium. While much is being written of the capabilities of germanium in the low current area of diodes and transistors, its possibilities in high-power applications are equally amazing.

Perhaps a simple comparison with selenium of the relative current densities will serve to illustrate its fantastic properties as a power rectifier. It is standard industry practice to operate selenium in a 3-phase bridge circuit at a current density of 75 milliamperes per square centimeter of cell area. With an adequate air-cooling system this current density may safely be doubled.

Germanium is presently being operated successfully at a current density of 75 amperes per square centimeter of cell area with every indication that



the top limit of capability has not yet been reached. Considering that germanium is also being operated at r.m.s. voltages per cell more than double that of the best available selenium, it will be seen that its power capabilities are at least 1000 times greater than selenium on a cell area basis.

The reason for this phenomenal ability lies in its inherently high efficiency which in turn means very little heat loss to be dissipated. The cell operating efficiency is in the range of 98 to 99 percent.

C. E. Hamann

General Electric Company

to follow the leader – precisely – specify

Doelcam

Synchros

PERFECTION of detail is the difference between a good performance and the very finest — like the coordinated attack and release of a brilliant string section. The precision with which DOELCAM Synchros transmit and receive electrical information is unsurpassed in a precision industry.

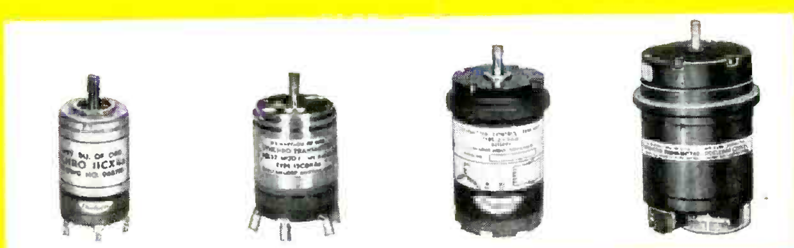
DOELCAM Synchros are tested and perfected standard military components for use in servomechanisms, computers, and automatic control systems. Many thousands have been delivered under Prime Government Contracts, which until recently absorbed our entire output. Now, the added facilities of our new plant enable us to make these outstandingly precise units available for general military and industrial usage. Your inquiry is invited.

Write for Bulletin S7

SIZES and Excitation	TYPES Control Transmitters	TYPES Control Transformers	TYPES Torque Transmitters	TYPES Torque Receivers
SIZE 11 1.062" O.D. 115v 400 Cycles	11CX4a	11CT4a		
SIZE 15 1.437" O.D. 115v 400 Cycles	15CX4a 15CDX4a	15CT4a	15TDX4a	15TR4a
SIZE 23* 2.25" O.D. 115v 60 & 400 Cycles	23CX4a 23CX6 23CDX4a	23CT4a 23CT6 23CT6a	23TX4a	23TR4a 23TR6 23TR6a
SIZE 31 3.10" O.D. 115v 60 Cycles			31TX6	

*All Type 23 Synchros are available with keyed or splined shafts.

Doelcam-designed Torque Receiver Error Tester has established an entirely new quality level for Type "TR" Synchros



SIZE 11
1.062" O.D.
Specification
MIL-S-16892 (BuOrd)

SIZE 15
1.437" O.D.
Specification
MIL-S-16892 (BuOrd)

SIZE 23
2.25" O.D.
MIL-S-12472 (ORD)
FXS-1066 (ORD)

SIZE 31
3.10" O.D.
Specification
MIL-S-12472 (ORD)

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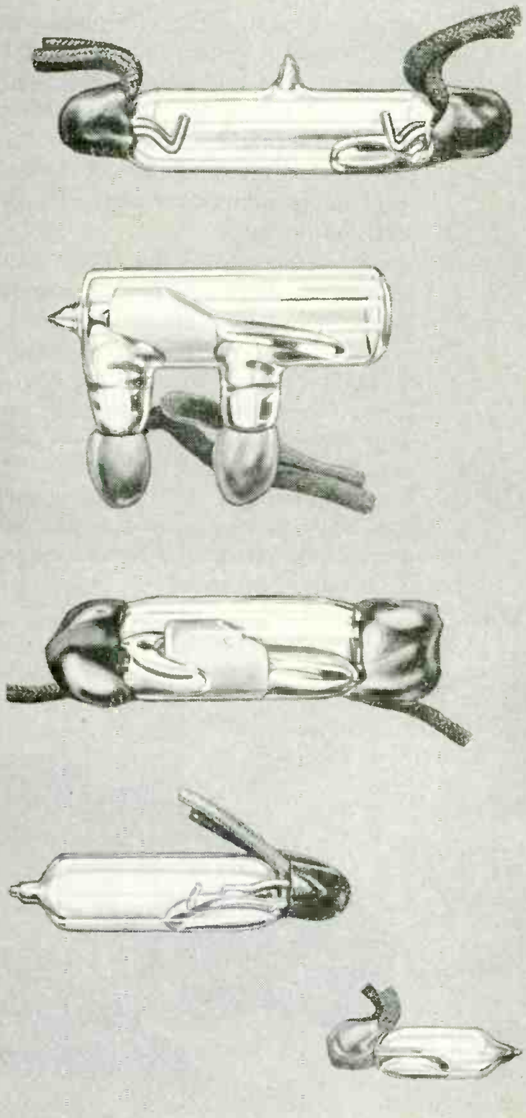
WHY

Honeywell Mercury Switches meet widest possible requirements



• HONEYWELL MERCURY SWITCHES are ideal electrical controls for applications which provide tilt motion and low force. Expert engineering cooperation can often indicate a means of tilt motion when it is not readily apparent.

While five basic types of Honeywell Mercury Switches are shown here, innumerable other designs are available which have met the demands of many types of automatic controls. These include a wide range of electrical ratings, sizes, shapes, mounting arrangements and circuitry.

When applications require resistance to severe shock and impact, as well as foreign elements, it is now possible to provide the high quality of glass-enclosed mercury switches in protective enclosures.

MICRO engineering service has assisted design engineers for many years in the solution of complex switching problems. This service is available to help you select the right Honeywell Mercury Switch to meet specific requirements. Call or write your nearest MICRO branch office. Write for Catalog 90.

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

FREEPORT, ILLINOIS

H HONEYWELL

MINIATURE ELECTRONIC COMPONENTS
BY FORTIPHONE LTD, ENGLAND

Component quality determines equipment performance!

NEW MIDGET TRANSFORMER, TYPE S

This new series of Fortiphone midget transformers, type S, has been specially designed for use with junction-type transistors when the size of the apparatus must be kept to a minimum. These new transformers are so tiny (0.375 x 0.375 x 0.250 in.) as to be smaller than the transistor itself!

Most requirements can be met from the range of Fortiphone type S transformers available. On receipt of details we will be glad to recommend suitable transformers from stock or, if necessary, make a specimen transformer specially for your purpose.

Every transformer is tested before final assembly for short-circuited turns, frequency response, and general efficiency.

Overall dimensions: 0.375 *x* 0.375 *x* 0.250 *in., or* 0.952 *x* 0.952 *x* 0.635 *cm. Weight:* 0.068 *oz. or* 1.92 *grams.*

TRANSFORMER, TYPE T

Designed for use in circuits employing sub-miniature valves or junction-type transistors, Fortiphone type T transformers are larger than Fortiphone type S transformers and are intended for use where smallness is not the first consideration. The connection contacts on these transformers are molded into the cheek of the bobbin.

Fortiphone type T transformers are available in over fifty different specifications. We will recommend suitable transformers, or if necessary make a specimen transformer specially suited to your purpose, on receipt of details of your requirements.

Every transformer is tested before final assembly for short-circuited turns, frequency response, and general efficiency.

Overall dimensions : 0.660 *x* 0.484 *x* 0.460 *in., or* 1.675 *x* 1.228 *x* 1.170 *cms. Weight* : 0.068 *oz. or* 1.92 *grams.*

MINIATURE RECEIVERS

Although so small, Fortiphone miniature electro-magnetic receivers are robust, highly efficient, and very reliable, and there is a wide range available. They can be supplied in a number of impedances from 30 ohms to 1,000 ohms, and with a variety of response curves; they can also be fitted with non-reversible receiver plugs and sockets for use in junction-type transistor circuits. Fortiphone miniature receivers will accept standard American earmolds.

Overall dimensions: Diameter, 0.82 *in. or* 2.08 *cm.; width (excl. nipple),* 0.38 *in. or* 0.97 *cm.; width (incl. nipple),* 0.47 *in. or* 1.20 *cm. Weight:* 0.3 *oz. or* 8.5 *grams.*

OTHER FORTIPHONE MINIATURE COMPONENTS AVAILABLE

MINIATURE FINGERTIP VOLUME CONTROLS: MINIATURE FINGERTIP VOLUME CONTROLS WITH COMBINED ON/OFF SWITCH
MINIATURE FINGERTIP SWITCHES: MICROPHONES: FLEXIBLE CONNECTORS: PLUGS: SOCKETS: DISC EARPHONES
HEARING AIDS: TELEPHONE PICK-UP COILS: HEADBANDS: ETC., ETC.

Cable or write for prices, further details, and samples. Please state probable quantities required

FORTIPHONE LIMITED

FORTIPHONE HOUSE, 247 REGENT STREET, LONDON, WI, ENGLAND

Established 1925 *Cables: Sonomax, Wesdo, London*

SPEEDY DELIVERY!

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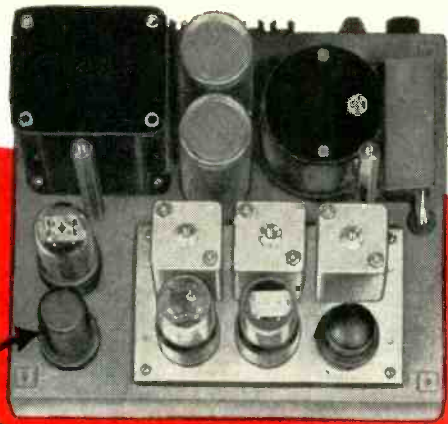
New WESTON Inductronic® D-C AMPLIFIER

Measures Millivolts to 0.1%!...



The new Weston Inductronic D-C Amplifier measures both millivolts and microamperes to an accuracy previously unheard of. A product of Weston Electrical Instrument Corp., Newark, N. J.

Its resistor network uses D-H ALLOY *to assure* *HIGH STABILITY and ACCURACY*

The Weston Resistance Network (Actual size) is wound with D-H Manganin wire to achieve a high degree of stability with extreme accuracy.

When it's millivolts or microamperes you are measuring, you talk in terms of accuracy in the order of 0.1%. Here is the most accurate measuring instrument yet developed — the Weston Inductronic D-C Amplifier. This amazing instrument makes potential measurements down to microvolts, current measurements to fractions of a microampere.

By using this 200 kc frequency shift amplifier in connection with thermocouples, radiation receivers, bolometers, strain gages, pressure transducers, resistance thermometers, photocells, ionization gages, etc., related physical quantities can be measured with speed and accuracy far superior to any other method previously known.

The amplifying system is essentially an automatic potentiometer, wherein an output current is maintained in balance against the input through a method of accurately adjusted resistors determining the balanced ratio of output to input. With a high gain in the amplification of error unbalance, the accuracy of amplification ratio is of course dependent almost entirely upon the *stability* and *precision* of the resistor network.

For this most exacting function Weston uses Driver-Harris MANGANIN, an alloy of such fixed stability that maximum change in resistance between 15°C. and 35°C. is less than *15 parts per million per degree Centigrade.*

If fixed stability and constant resistance under normally variable operating conditions are "musts" in *your* resistor designs, let us have your specifications. We'll gladly put at your disposal 50 years of alloy manufacturing experience to help solve your problem.

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

*Sole producers of world-famous Nichrome**

Driver-Harris Company

HARRISON, NEW JERSEY

BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco, Louisville

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

MAKERS OF THE MOST COMPLETE LINE OF ELECTRIC HEATING, RESISTANCE, AND ELECTRONIC ALLOYS IN THE WORLD

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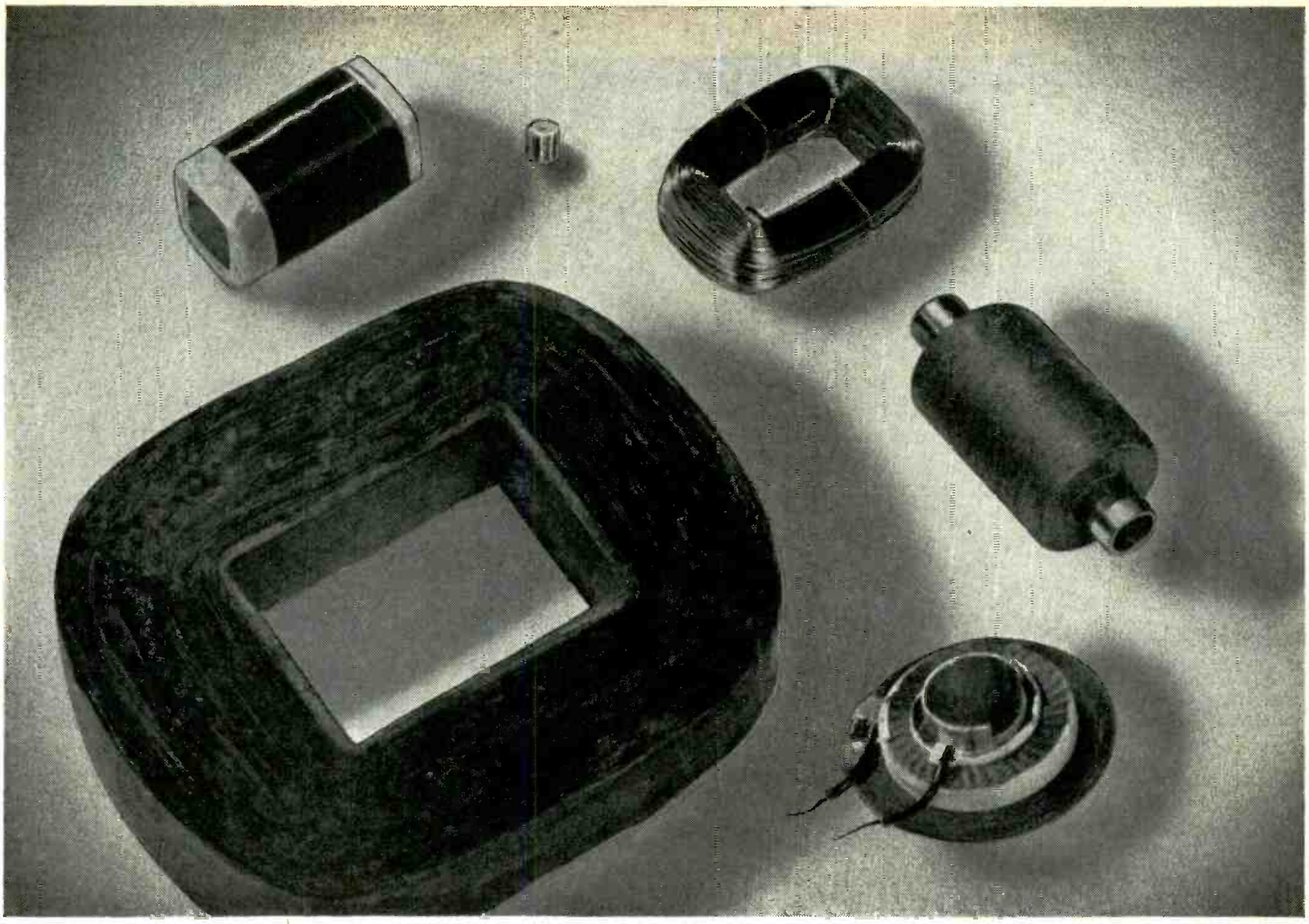

Want more per hour . . . or more accuracy . . . or less cost?

However you want your coil winding *improved* . . . there's likely to be a Universal Coil Winder that will do the job.

Higher-production machines. More versatile machines. Machines that will give you greater accuracy.

See for yourself by visiting the Universal Demonstration Room nearest you — in Cranston, R. I. or Chicago, Ill. Watch how coils are turned out at top speed, see how convenient the machines are for operators, observe how accurately the coils are wound.

Write us to set up a date for a visit. Address UNIVERSAL WINDING COMPANY, P.O.Box 1605, Providence 1, R. I., or 9 South Clinton St., Chicago, Ill.

And use the coupon to obtain information on latest developments in coil winding.

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FOR WINDING COILS IN QUANTITY . . . ACCURATELY . . . AUTOMATICALLY . . . USE UNIVERSAL WINDING MACHINES

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Please send me

☐ Condensed Catalog of Universal Winders

☐ Information on Universal Winders for coil types that meet my particular needs. I enclose specifications and production requirements.

Name. . . . . *Title*. . . . .

Company. . . . .

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"SCOTCHCAST"

seals R-B-M coils for extra-long life

"Scotchcast" is an epoxy-type electrical embedment resin that gives dependable insulation and protects against oil, moisture, chemicals and weather. The R-B-M Division of Essex Wire Corp. finds it ideal for industrial controller coils.

"Scotchcast" is a cold pouring resin that is supplied as a liquid. After liquid hardener is added, it cures and acquires long-lasting protective and insulating properties.

"Scotchcast" can be mixed with suitable filler to give better electrical properties, lower coefficient of expansion, higher heat dissipation.

For complete data, write Minnesota Mining and Manufacturing Co., Dept. ES-254, St. Paul 6, Minn.

1 AFTER WINDING, coils are fitted into plastic cases

2 SEALING COILS in "Scotchcast" Resin

"SCOTCHCAST" Electrical Embedment Resins

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No Room for Industrial Complacency

Do you believe that American industry is equipped with remarkably up-to-date and efficient machinery? If you do, you are mistaken. The fact is that a large share of American industry's equipment is ancient, of obsolete design and incapable of attaining the efficiency that is made possible by modern production techniques.

This fact is documented by the Seventh Inventory of Metalworking Equipment, just completed by AMERICAN MACHINIST, a McGraw-Hill publication. In brief, AMERICAN MACHINIST shows that:

1. More than half (56%) of American industry's most basic production equipment—machine tools and metal-forming units—is overage, and much of it is so old that it has very limited usefulness.

2. Since Korea, the situation has become dangerously worse.

Facts vs. Plausible Theory

These conclusions contradict the widely-held impression that America's industrial equipment is in better physical shape than ever before. The prevalence of this impression is not surprising. We, as a nation, have spent about $125 billion for new industrial plant and equipment since World War II. That is more than in any previous period in our history. During 1953, American industry invested $21 billion in new plant and equipment, an all-time high. From this, it would be reasonable to infer that our industrial plant and equipment must be in fine condition.

But the facts do not support that inference with respect to the machine tools and other metalworking equipment that are so crucial to our economy in war and peace. Here are the key findings of the AMERICAN MACHINIST Inventory:

(1) More than one million machine tools—out of a total of less than two million in the metalworking industries—are at least ten years old. Many of these, after day and night operation

during the war years and the recent rush to rearm, are actually much older production-wise than their age in years indicates. In most cases, these machines are unable to produce goods as efficiently as modern equipment can, thus needlessly increasing costs.

(2) Almost one out of five machine tools is more than twenty years old. Most of these machines are so outdated by modern standards that they have little more than scrap value. And an even larger portion of our metal-forming equipment (presses, brakes and shears, bending and straightening machines) has passed the 20-year mark and is beyond normal retirement age.

(3) Two out of three machine tools are of designs predating World War II, though many of them have been built since the war. Thus, two-thirds of our machine tools fail to incorporate the many major postwar improvements in design and operating methods.

(4) Never before has outmoded high-cost equipment been so widely diffused throughout American industry. In every one of fifteen major divisions of metalworking production, more than 45% of the machine tools are at least ten years old.

(5) Not since the depression days of the 1930's has the average age of machine tools risen so rapidly as it has in the past four years. Today, 55% are ten years old or older, compared with 43% just before Korea.

Quality vs. Quantity

Why has the condition of our metalworking equipment been steadily deteriorating since the end of World War II? Part of the explanation lies in the fact that, in the immediate postwar years, production of metalworking equipment lagged behind the production of industrial equipment generally. The larger part of the explanation, however, lies in the tremendous postwar expansion of the American economy. This expansion, which has more than doubled our total industrial capacity, has imposed requirements for metalworking machinery that have been met only by more extensive use of old and obsolete tools. In the critically important field of metalworking, the job of providing up-to-date tools is bigger than it ever has been.

There are those who argue that the time has come to cut back investment in new industrial plant and equipment and divert more of the national income into current consumption. They cite both the great increase in the nation's total industrial capacity since World War II and the fact that some industries now have more than ample producing capacity to meet their needs. But this type of calculation leaves out the *efficiency* of that producing capacity.

The AMERICAN MACHINIST Inventory makes it manifest that in the key field of metalworking we are alarmingly short of first-rate, low-cost producing capacity. If we fail to remedy this situation by speeding the replacement of obsolete tools, it will be at the peril of our prosperity, at the peril of a sustained increase in our standard of living and of our national security.

McGraw-Hill Publishing Company, Inc.

KARP METAL PRODUCTS CO.

featured in "Special Report to Industry" by AMERICAN MACHINIST MAGAZINE

America's leading metalworking magazine, in its Special Report No. 350, describes and illustrates methods, facilities and skills which make Karp Metal Products Co. the leading fabricator of sheet metal cabinets, chassis, housings and enclosures for the electronics industry.

Here's what the editors of American Machinist said: *"The important factor in the Karp plant is how a minimum of special tooling and a maximum of experience and personal initiative on the shop floor combine to produce special-purpose enclosures at reasonable cost."*

The report highlights:

- **Karp's vault of 3000 stock dies**—how it minimizes or eliminates total tooling costs in production of cabinets, chassis, housings and enclosures...

- **Karp's presses, press brakes and other equipment**—and how they have been modified to maintain highest quality and keep production time and costs to a minimum...

- **Karp's spot, gas, arc, and heliarc welding facilities**—and how they are set up for economical, thoroughly dependable welding of ferrous and non-ferrous materials...

Shows how you can save...In summarizing Karp's 29 years of specialized sheet metal fabricating experience, the report shows you positive ways to save in designing and specifying your next enclosure.

You will want to order copies of this article—use the Reader Service card on the last page of this magazine or write to:

KARP METAL PRODUCTS CO.
Division of H & B American Machine Company
215 63rd Street · Brooklyn 20, New York

KARP *enclosures reflect the skills within*

MOST COMPLETE FACILITIES FOR ENGINEERED SHEET METAL FABRICATION

FACILITIES FOR ENGINEERED SHEET METAL FABRICATIONS: in aluminum or steel • long run or short • spot, arc, gas or heliarc welding • any type finish

- Modern plant—3 city blocks long
- Thousands of dies available
- Most modern of sheet metal fabricating equipment
- U. S. Air Force Certified Welding Facilities
- Air-conditioned spray room ... complete baking facilities
- Complete sub-assembly facilities

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Come Again

Radio - Electronic Men!

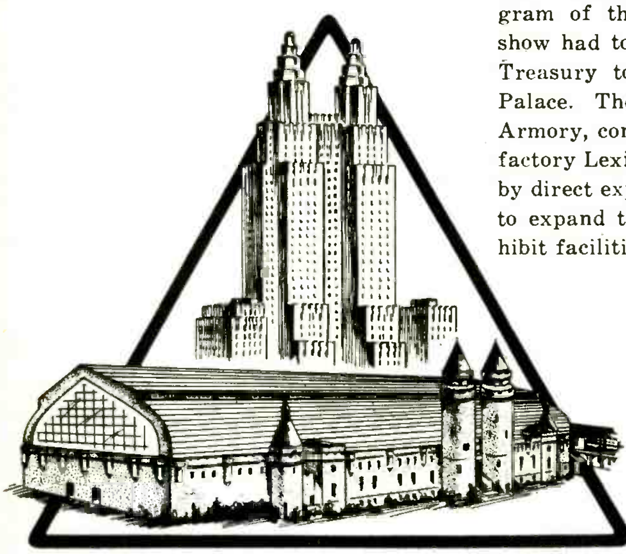
Just as you have been coming since 1945 to the IRE National Convention and Radio Engineering Show — coming by the thousands, 35,642 in '53 — so come again to see and hear all that is new in the engineering advances of your industry.

▲ Fifty-four in '54! — 243 scientific and engineering papers will be presented, skillfully grouped by related interests into 54 technical sessions. More than half these sessions are organized by IRE Professional Groups, thus making the IRE National a federation of 21 conferences in one. The whole provides a practical summary of radio-electronic progress.

▲ 600 Exhibitors "spotlight the new!" — A mile and a half of exhibits line the avenues of this show, intriguingly named for the elements of radio — such as "Instruments," "Components," "Airborne," "Radar," "Transistor," "Audio," "Microwave," etc., filling the four acres of the great Kingsbridge Armory to capacity. An expanding radio industry shows why it is growing by proving how engineering research pays out in new products. The exhibits themselves are an education, condensed to one place — reviewed in four days.

▲ Kingsbridge is the solution! Only the combined facilities of the Waldorf-Astoria Hotel, plus the three great halls in the Kingsbridge Armory, seating 906, 720, and 500 respectively, are able to keep pace with the increased technical papers program of the IRE Convention. The show had to move because the U. S. Treasury took over Grand Central Palace. The immense Kingsbridge Armory, connected to the very satisfactory Lexington Avenue Hotel area by direct express subway, serves well to expand the already outgrown exhibit facilities of the Palace and provide space for 200 new firms to exhibit, as well as seat greater audiences at the high-interest sessions. In addition to the subways, free busses leave the Waldorf every ten minutes in which you may travel in the congenial company of fellow engineers, direct to Kingsbridge.

▲ Admission by registration only! Registration serves for the four day period. It is $1. for IRE members, $3. for non-members, covering sessions and exhibits. Social events priced separately.



Waldorf-Astoria and Kingsbridge Armory

March 22-25, 1954

The IRE National Convention and

Radio Engineering Show

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if

you need absolute dependability . . .
you need ADLAKE Mercury Relays!

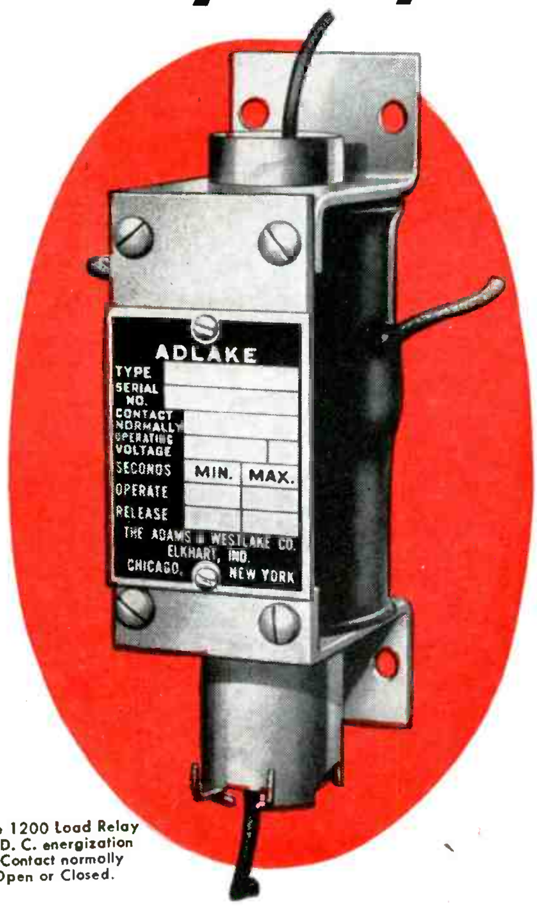
Because they're designed and built to meet the most exacting needs of industry...in jobs that conventional relays can do in an uncertain manner at best...ADLAKE Mercury Relays have won a reputation for *absolute* dependability! And no wonder, because each ADLAKE Relay offers:

Positive leak-proof sealing—assured by the use of properly selected metals and glass components with properly matched thermal expansion characteristics.

Liquid, mercury-to-mercury contacts—completely eliminate failures caused by low contact pressure, contact burning, pitting and sticking. And the inherent high surface tension of mercury imparts an ideal snap action to the contacts.

Arc-resisting ceramics—used to reduce any destructive effect caused by the arc.

Yes, as thousands of enthusiastic users in every branch of industry know, ADLAKE means dependability every way! Write for your free copy of the ADLAKE Relay catalog today. The Adams & Westlake Company, 1171 N. Michigan, Elkhart, Indiana. In Canada, write PowerLite Devices, Limited, of Toronto.



Type 1200 Load Relay for D. C. energization —Contact normally Open or Closed.

EVERY ADLAKE RELAY IS TESTED
—AND *GUARANTEED*
—TO MEET SPECIFICATIONS!

THE Adams & Westlake COMPANY

Adlake TRADE MARK — 97th year of serving the transportation and building industries

Established 1857 • ELKHART, INDIANA • Chicago • New York

Manufacturers of ADLAKE Hermetically Sealed Mercury Relays

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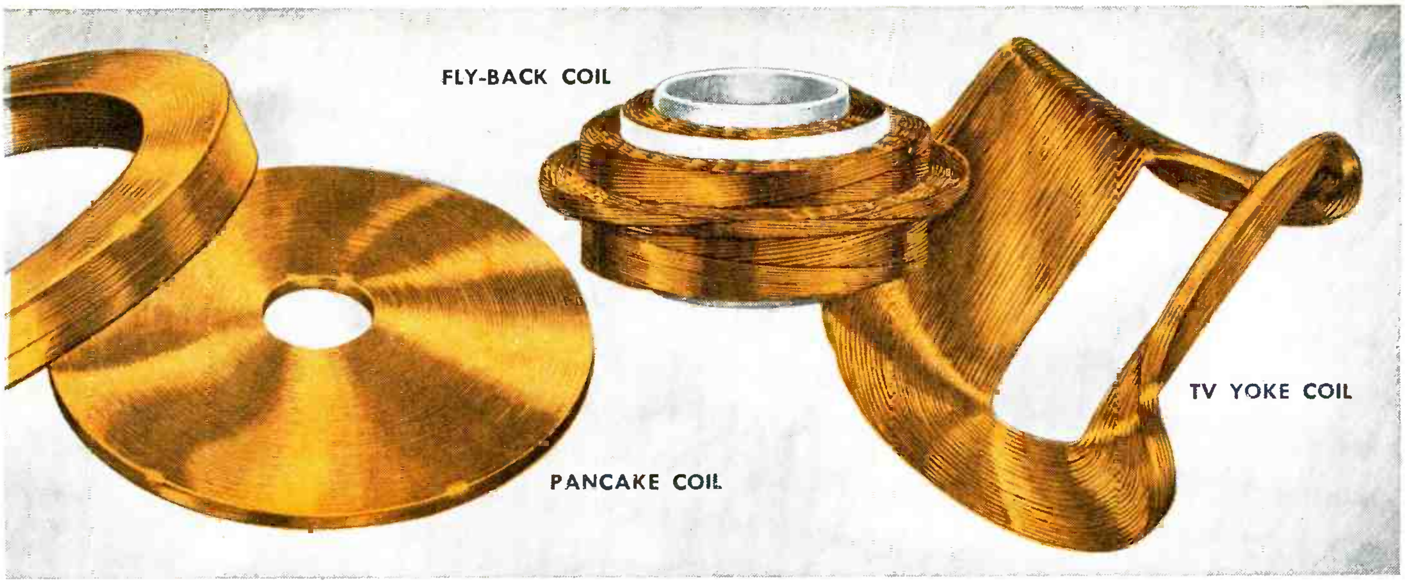
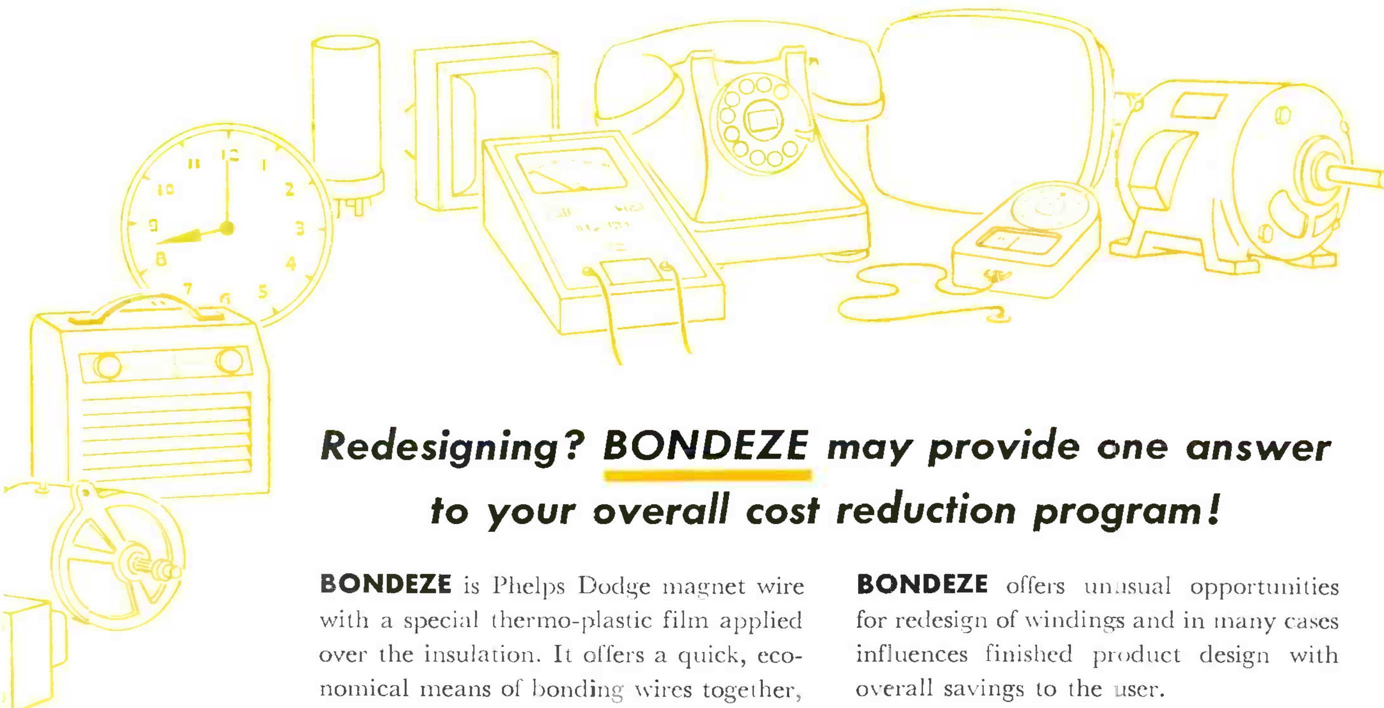


APPLICATIONS!



Redesigning? BONDEZE may provide one answer to your overall cost reduction program!

BONDEZE is Phelps Dodge magnet wire with a special thermo-plastic film applied over the insulation. It offers a quick, economical means of bonding wires together, turn to turn, through single application of heat or solvents.

BONDEZE offers unusual opportunities for redesign of windings and in many cases influences finished product design with overall savings to the user.

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

*BONDEZE is a Phelps Dodge Trademark

PHELPS DODGE COPPER PRODUCTS CORPORATION

INCA MANUFACTURING DIVISION

FORT WAYNE, INDIANA

NEW...

GOOD-ALL

Capacitors

★ **MIFILM** subminiature capacitors

★ With MYLAR* plastic dielectric. Metal enclosed, Hermetically sealed.

● GOOD-ALL production techniques make it possible for MIFILM capacitors to be available in sizes smaller than other miniaturized brands. Metal enclosed and hermetically sealed, MIFILM capacitors normally operate between −65°C and +150°C. Insulation resistance 10^{15} ohms. Power factor less than .5%. Sizes from .173" dia. x 21/32" long (.001 mfd, 600 VDC) to .750" dia. x 1⅞" long (1 mfd, 600 VDC). Slightly larger sizes to 1000 VDC. Your inquiries regarding this revolutionary advance in miniature capacitors are invited. We invite sample orders for your evaluation.

*DUPONT'S TRADEMARK FOR ITS POLYESTER FILM.

★ *Write for complete catalog covering GOOD-ALL MIFILM, MARBELITE and MIRACLE X long life capacitors.*

GOOD-ALL ELECTRIC MFG. CO.
114 W. FIRST ST. *Phone 112-113* OGALLALA, NEBR.
ROBERT A. GOODALL, *President* Cable Address, "GOODALLA"

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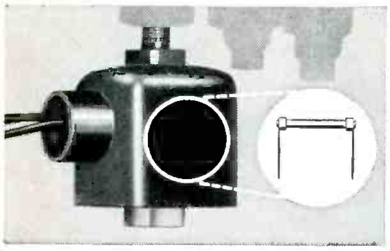
News About Created-Metals

Thermistors Provide Vital Time Delay

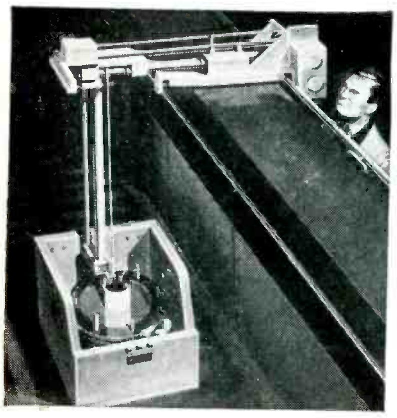


Smoky starts, puff-back and flutter in oil burners were checked by using a Carboloy Thermistor in the burner's electrical control.

The Thermistor delays the opening of a solenoid valve until the combustion chamber is ready to receive properly aerated oil. A mechanical timer is eliminated, and the cost of the unit reduced.

Thermistors are the most thermally sensitive resistor material known. Their resistance — unlike metals — changes negatively with temperature increases. They are ideal for temperature compensation, temperature detection, warning devices and controls. For more information, write: Carboloy Department of General Electric Company, 11139 E. 8 Mile Ave., Detroit 32, Michigan.

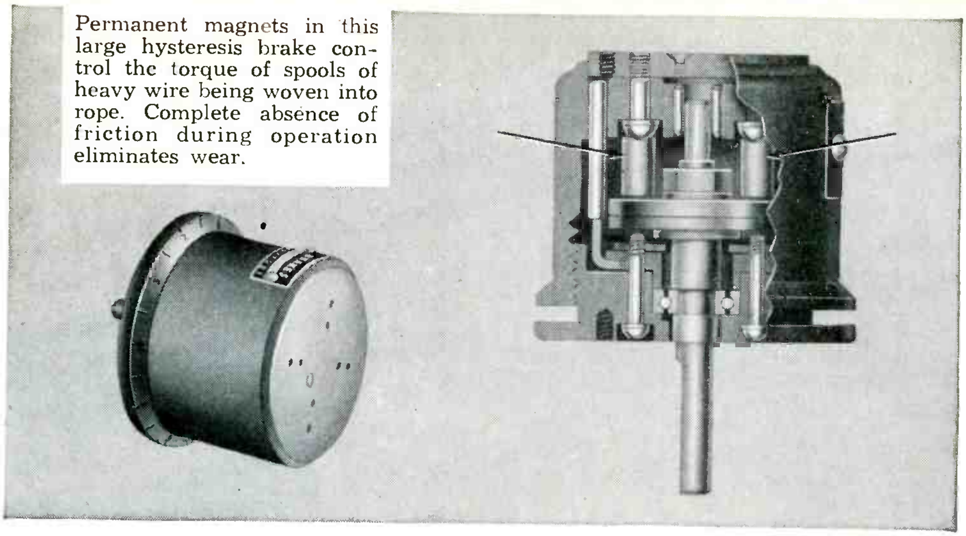
Hevimet Containers Stop "Hot Atoms"



Containers made of Carboloy Hevimet are making the job of handling and transporting radioactive materials easier and safer.

Because Hevimet is almost 50% heavier than lead, and provides 40% more gamma ray protection, these containers are smaller, less bulky . . . yet safer than lead.

Hevimet is an ideal material for all radioactive shielding. It is readily machinable, dimensionally stable and of high tensile strength. For more information, write: Carboloy Department of General Electric Company, 11139 E. 8 Mile Ave., Detroit 32, Michigan.



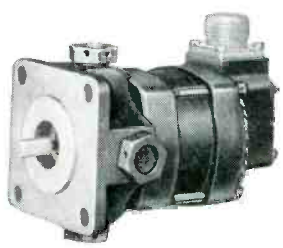
Permanent magnets in this large hysteresis brake control the torque of spools of heavy wire being woven into rope. Complete absence of friction during operation eliminates wear.

Control Torque

Basic functions of permanent magnets

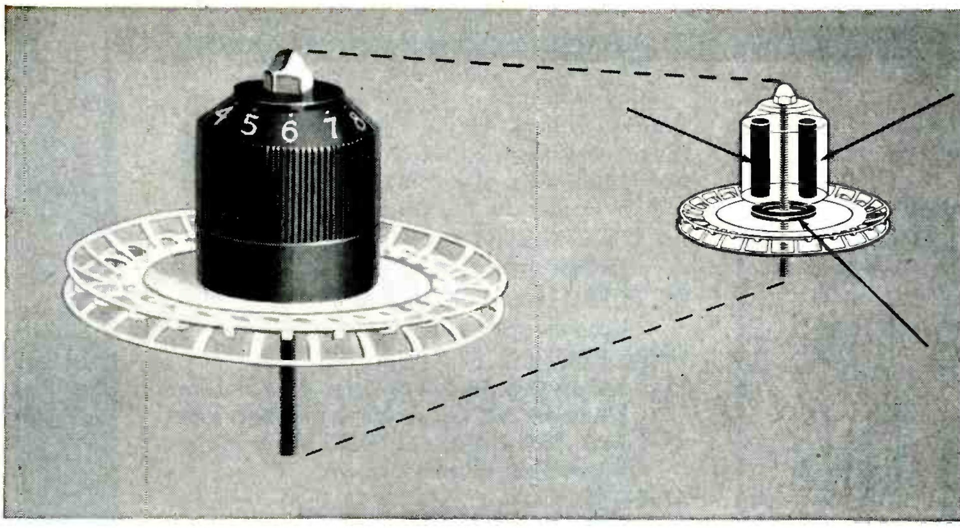
1	Change electrical energy to mechanical motion	Eddy current braking Motor action Instrument action
2	Change mechanical motion to electrical energy	Generator action Magneto action
3	Change mechanical energy to thermal energy	Control of torque
4	Mechanical holding	Snap action Separation Holding and lifting

Minneapolis-Honeywell Step Controller employs snap switch based on mechanical holding function of Carboloy Alnico permanent magnets. Magnets reduced weight, improved design, and increased performance.



G.E. jet tachometer generator had to be kept small and light. Engineers used permanent magnet's ability to change mechanical motion to electrical energy. Magnets eliminated coils and wires; provided powerful energy.

Rochester Liquid Level Gauge utilizes synchronous magnetic torque drive principle to operate pointer, keep gauge head pressure-tight. Magnets eliminate stuffing box and shaft — permit mounting gauge in any position without danger of leakage.



This tiny, permanent magnet hysteresis brake maintains constant pulley tension on delicate fibers. It reduces slippage and static electricity. Magnetic dial offers wide range of tensions and speeds.

with Permanent Magnets

In hysteresis brakes, permanent magnets convert mechanical energy to thermal energy. Other inherent properties make permanent magnets ideal for many electrical and mechanical applications.

Carboloy Alnico permanent magnets, in hysteresis brakes, provide smooth, frictionless torque control. Tension and torque are adjustable and constant.

The hysteresis brake is only one of the ways permanent magnets can control torque. And permanent magnets can be used to convert electrical energy to mechanical motion . . . or mechanical motion to electrical energy, or for mechanical holding.

Permanent magnets offer many production savings. They can eliminate parts, reduce costs, simplify design, save weight and improve performance. They retain their efficiency under varying conditions of temperature, shock, vibration. They resist the demagnetizing influence of stray magnetic fields . . . provide powerful, permanent energy sources. Available in all sizes and shapes, cast or sintered.

Perhaps Carboloy permanent magnets can improve your products or equipment. Specially trained engineers of the Carboloy Engineering Appraisal Service will work with you on permanent-magnet design and application. Send coupon, today, for free catalog or design manual.

CARBOLOY®
DEPARTMENT OF GENERAL ELECTRIC COMPANY
11139 E. 8 Mile Ave., Detroit 32, Michigan

Send me the following, without cost or obligation:

☐ Permanent Magnet Design Manual, PM-101

☐ Permanent Magnet Standard Stock Catalog, PM-100

Name________________ Position________________

Company________________

Address________________

City________________ Zone________ State________________

Want more information? Use post card on last page.

Get Longer Die Life With This Core Material

Here's a coil of Armco TRAN-COR DI-MAX, a hot-reduced electrical steel with a *cold-rolled finish*, that will give you flatter laminations and better die life. Besides,

THE COLD FINISHING MEANS:

- Excellent stacking factor

THE HOT-ROLLED STRUCTURE GIVES YOU:

- High permeability at all inductions

ARMCO PRACTICES BRING YOU:

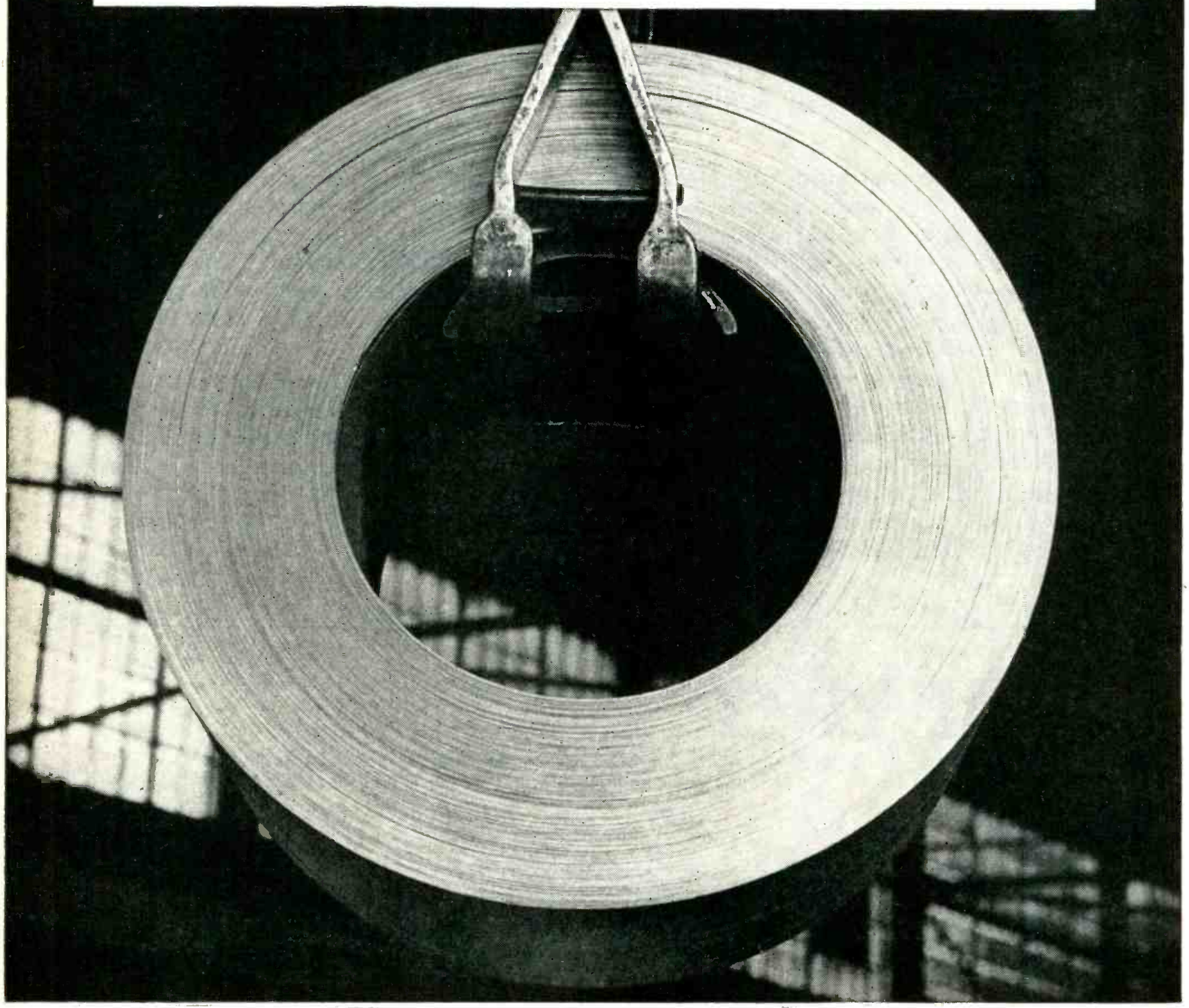
- Magnetic properties fully developed at the mill; long butt-welded coils that eliminate end-of-sheet scrap losses; No. 4 Insulation or CARLITE where extra interlamination resistance is required.

Armco TRAN-COR DI-MAX is available in coils in AISI Types M-19, -22, -27, -36 and -43. Let us show you what DI-MAX can do for you.

ARMCO STEEL CORPORATION

1384 Curtis Street, Middletown, Ohio
Export: The Armco International Corporation

ARMCO



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JFD Electronics

Division of
D MANUFACTURING COMPANY
Brooklyn 4, N. Y.

SERVES THESE GREAT NAMES

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IN THEIR REQUIREMENTS

BECAUSE OF THESE FEATURES

Approximately zero temperature coefficient (with quartz and invar construction).

Approximately ± 50 PPM per degree C. (with glass and INVAR construction).

One-piece spring loaded piston and screw prevent backlash.

Silver band fused to exterior of precision drawn quartz or glass tube serves as optimum stationary electrode.

"Q" as high as 7,000 at 1 mc.

Dielectric strength equals 1,000 volts DC at sea level pressure and 500 volts at 3.4 inches of mercury.

10,000 megohms insulation resistance minimum.

Operating temperatures -55 C. to $+125$ C. with glass dielectric. -55 C. to $+200$ C. with quartz dielectric.

Over 100 megohms moisture resistance after 24 hours exposure to 95% humidity of room temperature.

Piston dimensional accuracy is held to close tolerance maintaining minimum air gap between piston and cylinder wall.

NEW DEVELOPMENTS

- **Capacitance ranges in miniature size units from 1.0 to 200.0 mmf.**
- **Dust-proof metal caps with extruded lead-in.**
- **Baked-in water repellent plating.**

WITH THESE:

JFD piston type variable trimmer capacitor shown actual size (one inch).

MODEL	CAP. RANGE MMF.	COEF. OF CAP.	DIELECTRIC	ROTOR
VC-1G	0.7 to 7.0	± 50 PPM/°C. / $\pm 3.5 \times 10^{-4}$MMF./°C. At Max. Capacity	Glass	Invar
VC-3G	0.7 to 8.0	± 250 PPM/°C. / $\pm 2 \times 10^{-3}$MMF./°C. At Max. Capacity	Glass	Brass
VC-4G	1.0 to 18.0	± 250 PPM/°C. / $\pm 4.5 \times 10^{-3}$MMF./°C. At Max. Capacity	Glass	Brass
VC-11G	0.7 to 12.0	± 50 PPM/°C. / $\pm 6 \times 10^{-4}$MMF./°C. At Max. Capacity	Glass	Invar
VC-11GRB	0.7 to 10.0	± 250 PPM/°C. / $\pm 2.5 \times 10^{-3}$MMF./°C. At Max. Capacity	Glass	Brass
VC-11GRC	0.7 to 10.0	± 100 PPM/°C. / $\pm 1.0 \times 10^{-3}$MMF./°C. At Max. Capacity	Glass	Brass Invar
VC-5	0.5 to 5.0	Approx. Zero/°C.	Fused Quartz	Invar
VC-5F	0.7 to 5.0	Approx. Zero/°C.	Fused Quartz	Invar
VC-11	1.0 to 10.0	Approx. Zero/°C.	Fused Quartz	Invar

(Silver plating throughout is available at slight extra cost on every model for better performance on UHF and microwave frequencies.) JFD Piston type variable trimmer capacitors.

Call on JFD engineers for your piston capacitor requirements. Write for form 220 catalog of standard items available or send blueprints, specifications or details of application to *Piston Capacitor Department, JFD Electronics Division, JFD Manufacturing Company, Inc., Brooklyn 19, New York.*

FOR PISTON TYPE VARIABLE TRIMMER CAPACITORS

the new cae oscilloscope (type 104) performs the functions of several types

By using interchangeable D.C. Amplifier and Time Base Units, one CAE Oscilloscope performs the operations of several different types of oscilloscopes resulting in a considerable *saving in capital expenditure.*

Highly functional, it is constructed on the unitized principle and its unique system of controls makes it simple to operate with highly accurate results.

the cae Oscilloscope (TYPE 104)

INTERCHANGEABLE AMPLIFIERS provide suitable combinations of—

- wide band, from D.C. up to 10 MC/S
- rise time down to 0.05 micro-seconds
- voltage gain up to 500,000
- inherent noise as low as 1 micro-volt

INTERCHANGEABLE TIME BASE UNITS provide suitable combinations of—

- sweep velocity 10 cm/micro-seconds to 5 cm/seconds
- triggered or continuous sweeps
- automatic synchronization
- linearity 1%
- voltage, frequency and time calibration accuracy 2%

Ask for Bulletin No. SIE-30101

For complete details of CAE Oscilloscope, Type 104, call or write the CAE office nearest you.

Canadian Aviation Electronics, Ltd.

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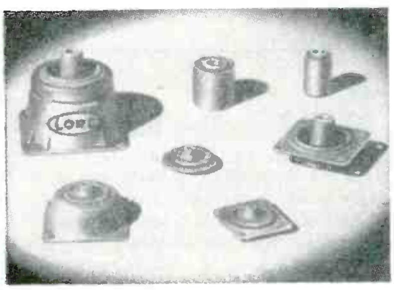
ADVERTISEMENT

Lord Vibration Control Mountings . . . The Most Effective Protection For Electronic Equipment

In the rapidly advancing field of electronics, the control of destructive vibration and isolation of damaging shock are prime factors in the consideration of design engineers. Lord, Headquarters for Vibration Control, is constantly working with electronics engineers to improve the methods for protecting sensitive mechanisms.

For instance, Varo Static Converters which change alternating to direct current for aircraft with less than 1% voltage ripple are protected against shock and vibration by Lord Mountings. High fidelity Audio frequency electronic equipment such as Collins Radio Company manufactures is protected from vibration and shock through the use of Lord Mountings. The 212A-1 Broadcast Station Speech Input Console by Collins requires 28 Lord square Plate Form Mountings to protect each amplifier stage individually. This prevents mechanical interaction between stages and lessens acoustical feed-back effects.



Again the Agnew Spark Plug Welder by Agnew Electric Company uses Lord Mountings to support the electronic weld timers to prolong the useful service life of Mercury Vapor Tubes.

Lord Mountings, which you see illustrated in the accompanying advertisement, are used in a wide diversity of applications to protect electronic equipment and sensitive instruments. Business machines and such sensitive mechanisms, the accuracy of which must be perfect, are improved in operation and protected from damaging vibration and shock by Lord Mountings.

The Lord Manufacturing Company, Erie, Pa., offers a vast reservoir of recorded experience in the solution of vibration and shock problems. Your request for help on your own problem is welcomed.

LORD MOUNTINGS PROTECT INSTRUMENTS *and* ELECTRONIC EQUIPMENT *from* VIBRATION *and* SHOCK DAMAGE • • •

VIBRATION and shock are natural enemies of electronic equipment and precision instruments . . . To control the damage which these enemies can do, Lord Vibration Control Mountings and Bonded Rubber Parts are used to very profitable advantage. More than a quarter century's experience in dealing with vibration and shock is yours when you take advantage of Lord engineering assistance. The result of such consultation is full protection for electronic units and sensitive instruments by correctly designed and precisely manufactured Lord Mountings and Bonded-Rubber parts.

BURBANK, CALIFORNIA 233 South Third Street	DALLAS, TEXAS 313 Fidelity Union Life Building	PHILADELPHIA 7, PENNSYLVANIA 725 Widener Building	DAYTON 2, OHIO 410 West First Street
DETROIT 2, MICHIGAN 311 Curtis Building	NEW YORK 16, NEW YORK 280 Madison Avenue	CHICAGO 11, ILLINOIS 520 N. Michigan Ave.	CLEVELAND 15, OHIO 811 Hanna Bldg.

LORD MANUFACTURING COMPANY • ERIE, PA.

LORD BONDED RUBBER

Headquarters for **VIBRATION CONTROL**

Sensitive Controls

The important components for your thermal, light, vaccum or R.F. actuated control systems are now immediately available at RELAY SALES.

ASSEMBLY PRODUCTS

Contact Meter-Relays

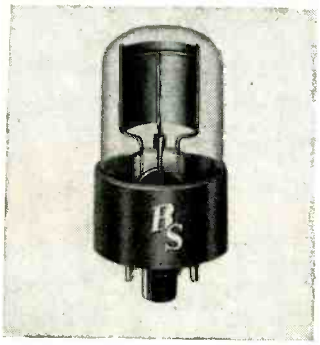
A highly sensitive locking relay for control of chemical processes and mechanical operations through either alarm, automatic shut-off or continuous on and off control. Contact Meters automatically maintain upper and lower limits (or both) of temperature, voltage, current, speed, light or liquid flow rate with extreme accuracy. Applications include their use in electronic circuits for quality control of piezo crystals and other components, switching of standby equipment in micro-wave communications, control of carbon feed in arc furnaces, as warning of bearing temperatures in turbines and generators, and a variety of speed controls for machines.

Contact Meter-Relays are current or voltage sensitive down to 2/10 microampere or 1/10 milliwatt. Contact ratings from 100 mils to 1 ampere. They are available in a wide selection of standard types. Special types engineered to your needs. Phone, write or wire Relay Sales for additional information.

TERADO

Miniature Micro Relay

A hermetically sealed sensitive relay, with particular application to airborne equipment, mounts in a standard 7-pin miniature tube socket. Its S.P.S.T. switch will operate on 60 milliwatts. Insulation: 500 Volts between any terminal and ground. Temperature range: +85°C. to −55°C. Shock 50G. Coil resistance, contact current and other specifications to your requirements. Send us your prints.



RS Phototubes

Phototubes, either gas filled or vacuum type, are available for all photo cell applications. RS Phototubes have superior operating characteristics in high output current, extreme sensitivity to small variations in light intensity, excellent response in infra-red regions, low dark current—all with notably longer tube life. Write for catalog.

CETRON

Grid Controlled Rectifiers

Due to the ever increasing demand for Grid Controlled Rectifiers, which are so closely allied to relay applications, RELAY SALES has arranged for the distribution of these special purpose tubes made by America's oldest and foremost manufacturer.

Write for New 1954 Relay Sales Catalog C-5

JUST OUT!

Immediate Delivery of Relays of all Types

You will receive 24 hour shipment on any material in our huge stock of practically any conceivable type of relay, contactor or motor control. Phone or wire your requirements.

Phone SEeley 8-4146

Relay Sales

4721 W. Madison St., Chicago 44, Ill.

Mr. Charles T. Button, Sales Mgr.
Holtzer-Cabot Motor Division.

"Put our Motor Experience to Work for You!"

"Here at Holtzer-Cabot, we have a superb team of motor specialists who can—and do—solve practically any motor problem that is given them.

"I've been connected with the motor business for nearly 30 years, yet every now and then our design and development engineers will come up with a motor innovation, adaptation or solution that makes me blink!

"Our sales representatives, too, are something to be proud of. They're men of long experience in motor application problems, they have a thorough knowledge of the business, and give customers sound advice and help.

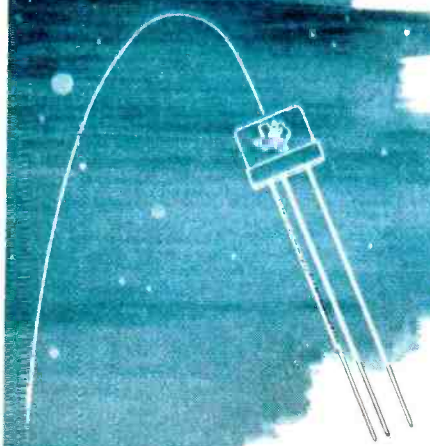
"If *you* have a problem in small-motor applications, take advantage of Holtzer-Cabot's organizational skill and depth of experience. The same engineering ingenuity and manufacturing excellence that have made Holtzer-Cabot the standard of high quality in motors and related electrical apparatus for 78 years are yours to command.

"Write, wire or phone. There is, of course, no obligation on your part by doing so. Your problem will get expert—and prompt—attention."

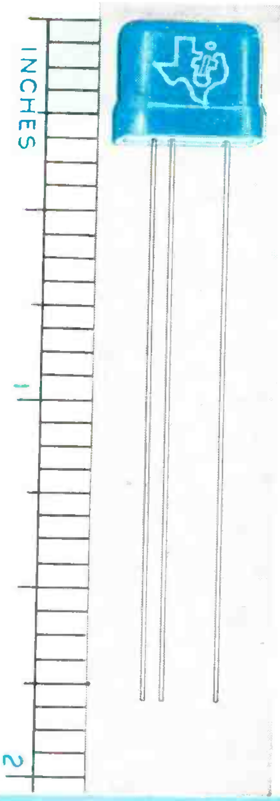
NATIONAL PNEUMATIC CO., INC. AND **HOLTZER-CABOT** DIVISIONS

125 Amory St., Boston 19, Mass.
PHILADELPHIA • CHICAGO • NEW YORK • CLEVELAND
Sales Service Representatives in Principal Cities throughout the Free World

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



TI transistors will FIT in Your Future!



FORTY PERCENT SIZE REDUCTION has been made in Texas Instruments junction transistor cases. With case length now less than a third of an inch, TI transistors offer you a major opportunity for equipment miniaturization.

This important size reduction was achieved without reducing the quality or changing the construction of the proven TI junction transistor. Transistor fabrication methods, materials, and moisture-proof glass-to-metal hermetic sealing remain the same.

Texas Instruments junction transistors undergo an exhaustive testing procedure to insure their close adherence to published specifications (see distribution curves below). And not only must all transistors pass more than 20 test procedures—in addition to continual visual checks—but also they are aged over 48 *hours* at rated output. They are then completely re-inspected, as a positive operating double-check.

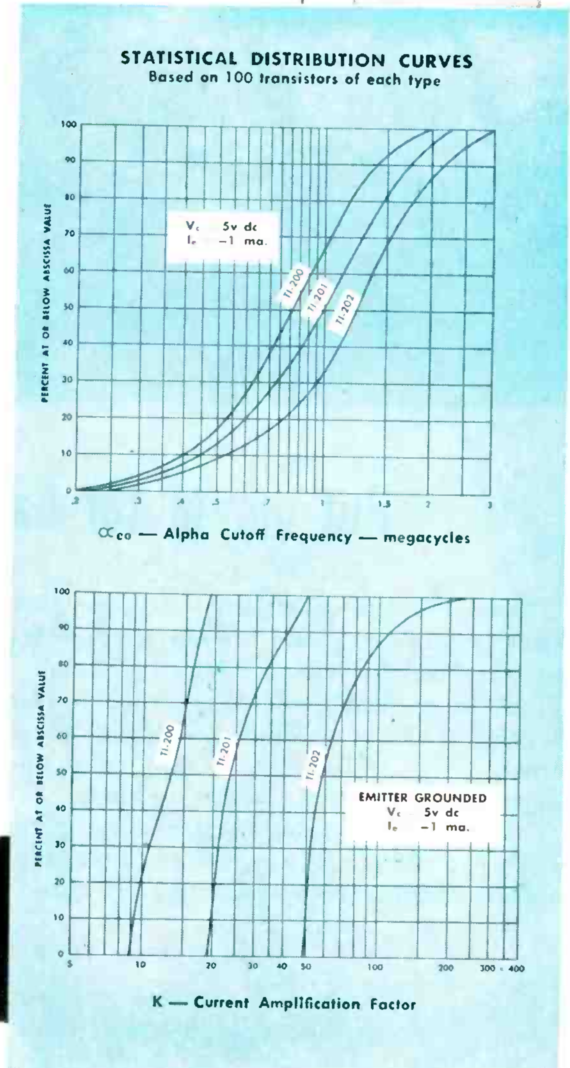
If *you* want transistors combining small size with high quality, they are now in production and available in five types from Texas Instruments Incorporated. Write for bulletins DL-S 310 (junction) and DL-S 312 (point-contact). Custom-built units also are available.

ELECTRICAL DATA:

	n-p-n junction transistors type 200	type 201	type 202	
RATINGS, RECOMMENDED MAXIMUM:				
Collector Voltage	30	30	30	volts
Collector Current	5	5	5	ma.
Collector Dissipation (at 25°C)	50	50	50	mw.
Ambient Temperature	50°C	50°C	50°C	
AVERAGE CHARACTERSTICS (AT 25°C.):				
Collector Voltage	5	5	5	volts
Emitter Current	−1	−1	−1	ma.
Collector Resistance (Minimum)	.4	.4	.4	megohms
Base Resistance	150	170	200	ohms
Emitter Resistance	22	22	35	ohms
Current Amplification Factor* (Minimum)	9	19	49	
Collector Cutoff Current (Maximum)	10	10	10	μa.
Collector Capacitance	15	17	19	$\mu\mu$fd.
Noise Factor** (V_c = 2.5 V., I_c = −.5 ma)	26	23	20	db
Frequency Cutoff** (α_{co})	.90	1.10	1.30	m.c.

*Emitter Grounded.

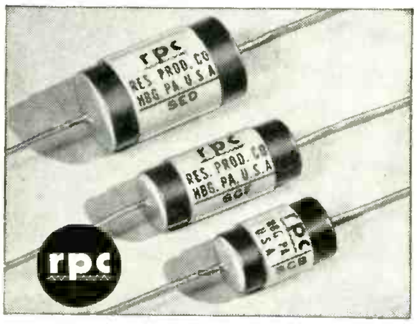
**Noise Factor and Frequency Cutoff are average and individual units may vary.



TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVENUE DALLAS 9, TEXAS

Want more information? Use post card on last page.

THESE *miniature* HERMETICALLY SEALED PRECISION RESISTORS *won't fail you!*



Submersion in boiling salt water, ice cold salt water; temperature or humidity cycling; sudden altitude changes; will not affect the performance of these resistors. They are specifically designed and engineered for the utmost in permanence and stability under severely adverse conditions.

RPC's miniature Hermetically Sealed Resistors are solder sealed, insuring a true, permanent seal. All parts are metal or steatite, eliminating shrinkage or deterioration. Not affected by time or unusual conditions. 100% vacuum tested under water.

Requirements of JAN-R-93 and proposed addition to MIL-R-93A are fully met. Available in resistance tolerances to 0.1%.

RPC makes a complete line of precision wire wound resistors. Test equipment and standards are on a level matched by only the outstanding laboratories. Advanced methods of production enable RPC to fill large or small orders promptly and at moderate cost.

Write for complete catalog.

ENGINEERING DATA

RPC TYPE	Govt. Spec.		Dimensions Inches		Resistance (Ohms)			Watts	
	JAN-R-93	MIL-R-93A	LENGTH	DIAM.	MIN.	MAX. with low T.C. Alloy .0015 DIA.	MAX. with low T.C. Alloy .001 DIA.	JAN or MIL	COMM.
SCB	....	....	9/16	11/32	2.0	20,000	0.15 Meg	......	.25
SCF	RB51A	RB52A*	13/16	11/32	1.0	50,000	0.40 Meg	.25	.5
SED	RB51A	RB52A*	13/16	15/32	0.5	.125 Meg	1.0 Meg	.25	.5

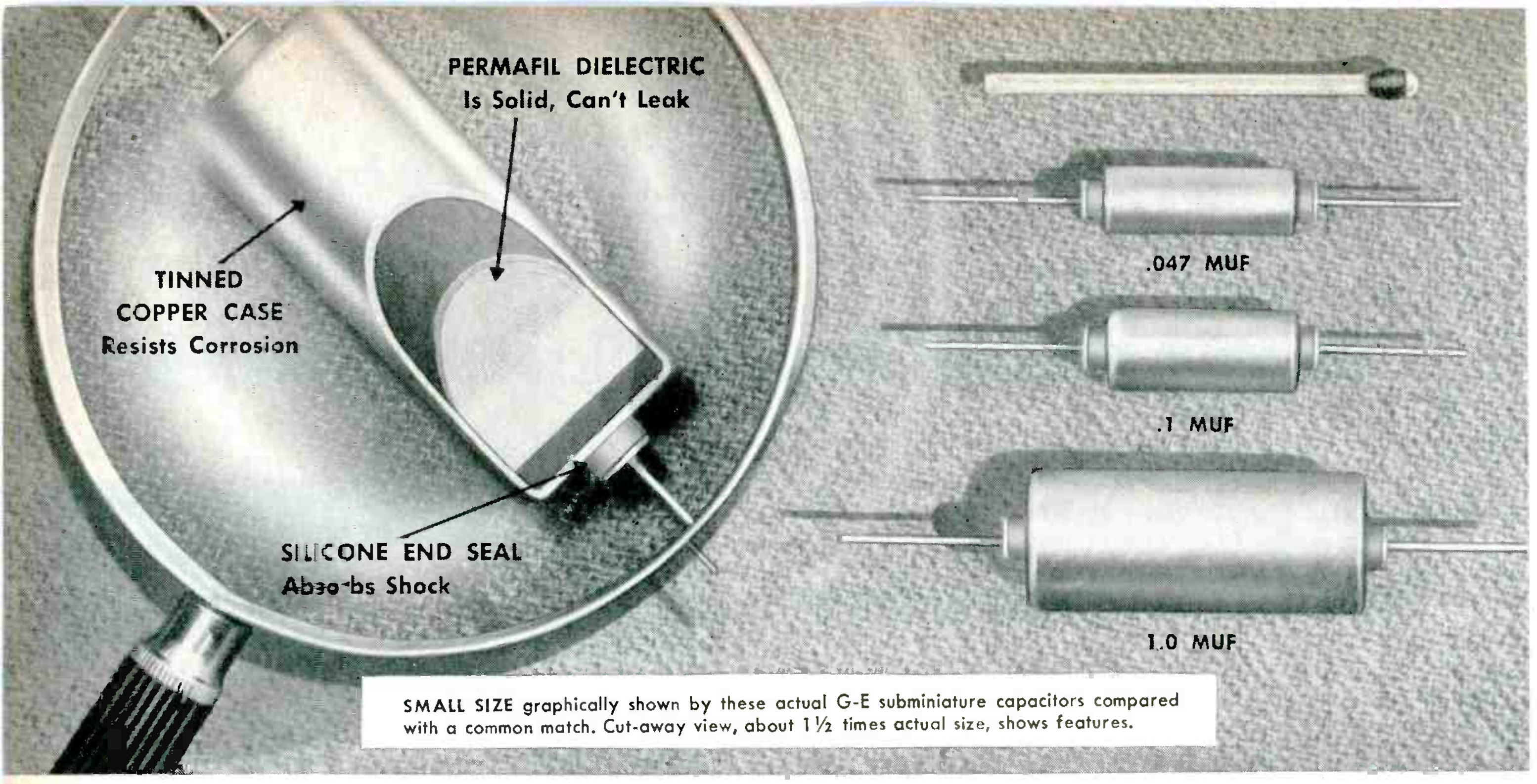
*Proposed

RESISTANCE PRODUCTS CO.

714 RACE ST. HARRISBURG, PENNA.

SPECIALIZING IN THE MANUFACTURE OF QUALITY RESISTORS IN ANY AMOUNT

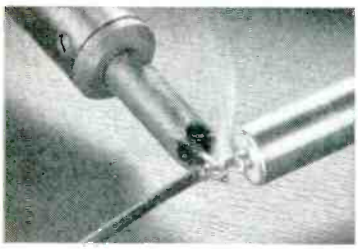
HIGH MEGOHM, HIGH VOLTAGE, HIGH FREQUENCY, WIRE WOUND PRECISION



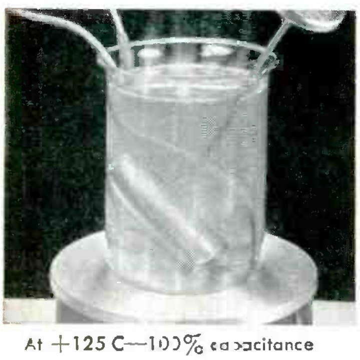
SMALL SIZE graphically shown by these actual G-E subminiature capacitors compared with a common match. Cut-away view, about 1½ times actual size, shows features.

New G-E subminiature metal-clad capacitor line features solid dielectric and silicone end seals

FOR OPERATION FROM −55 C TO +125 C WITHOUT DERATING



Solder right up to the bushing with G-E Silicone end seal—no danger of cracking glass.



At +125 C—100% capacitance

At −55 C—less than 7% loss

Designed specifically for electronic equipment, this new line of General Electric subminiature capacitors provides the utmost reliability under the most severe operating conditions combined with small size, no liquid leakage, and high insulation resistance. They will operate from −55 C to +125 C without derating and up to +150 C with proper derating.

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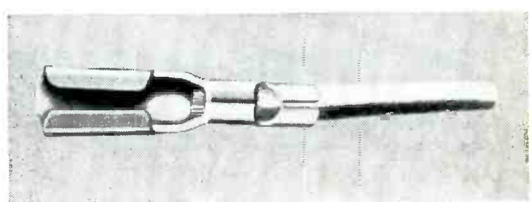

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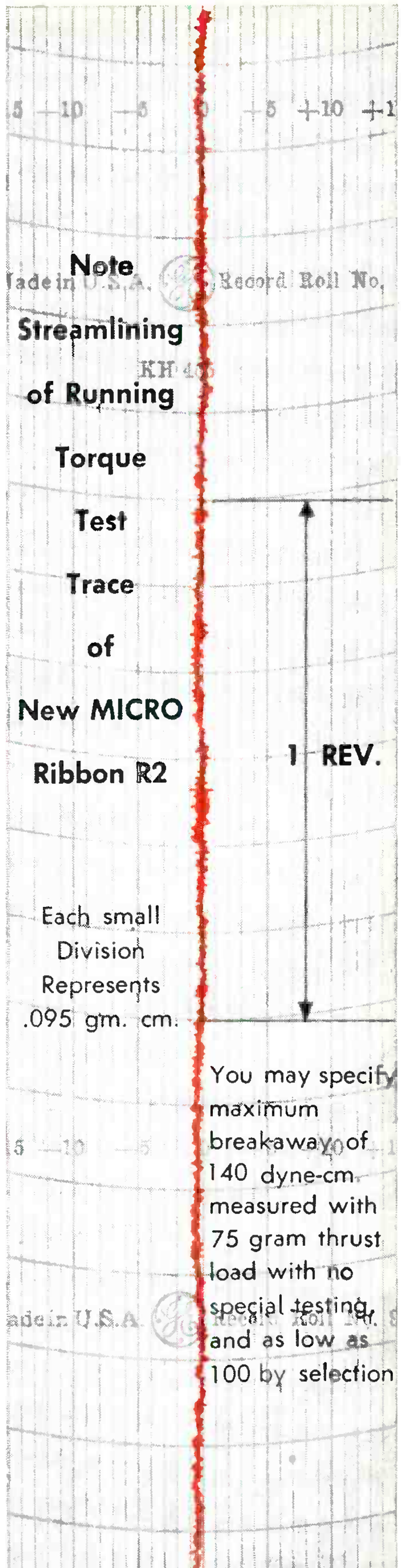

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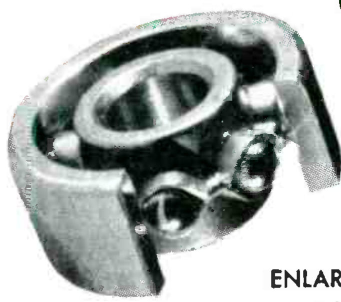

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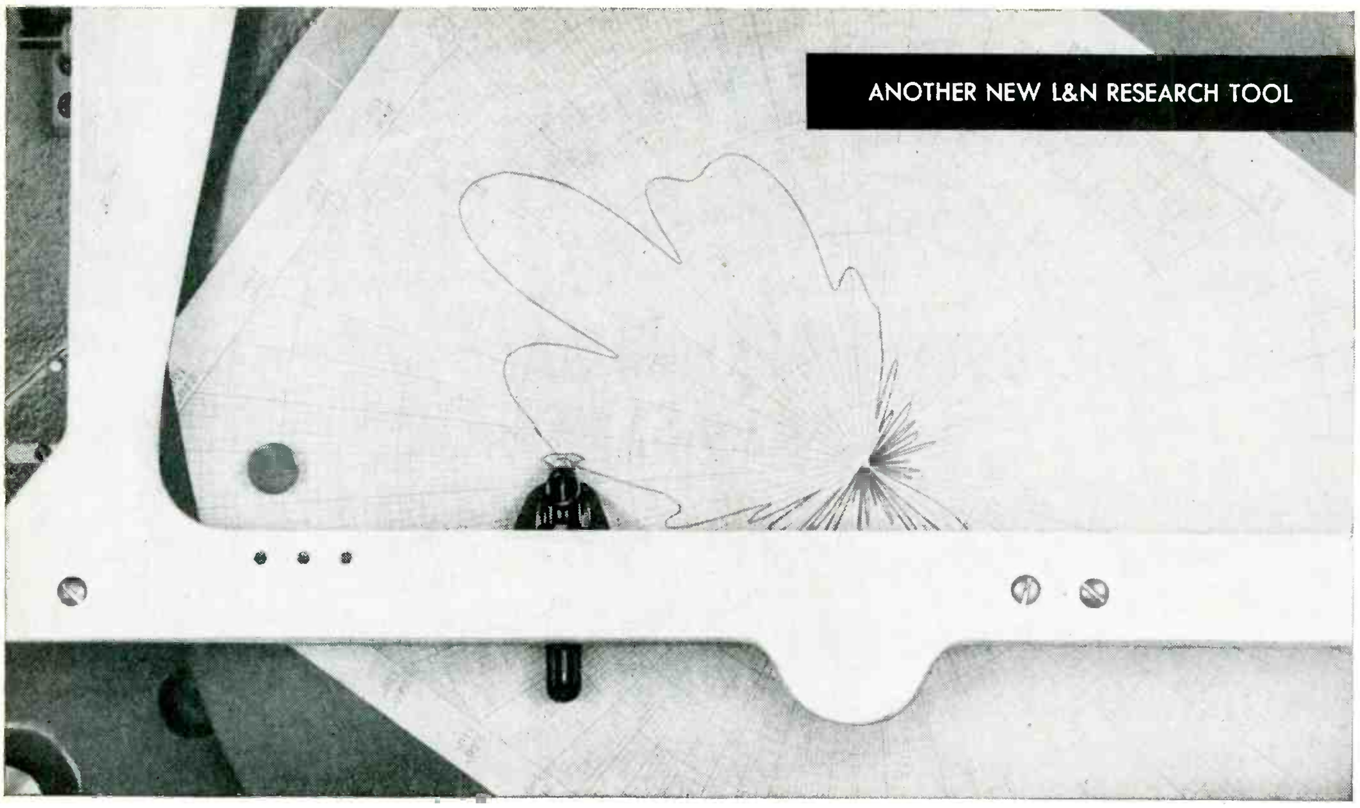

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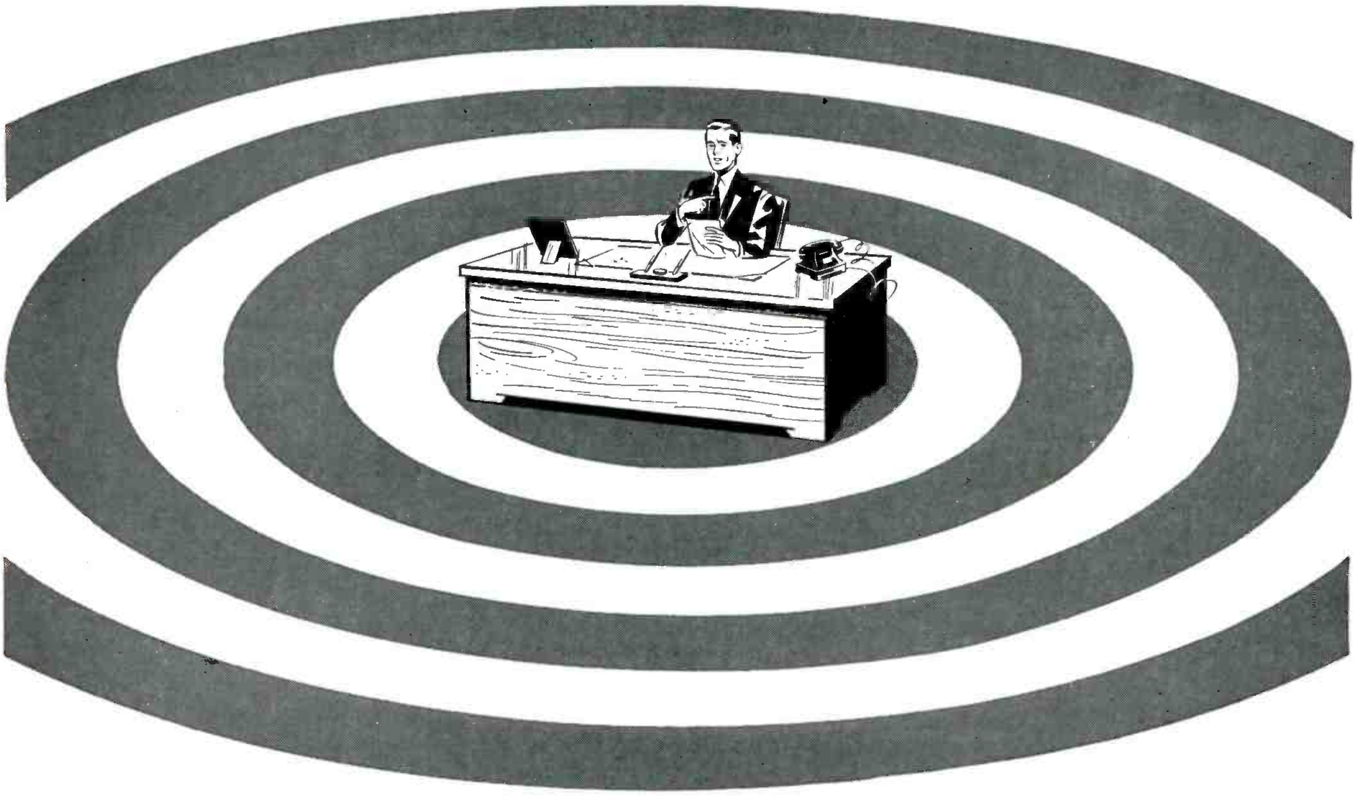

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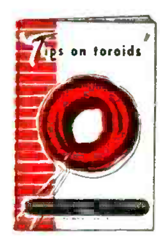

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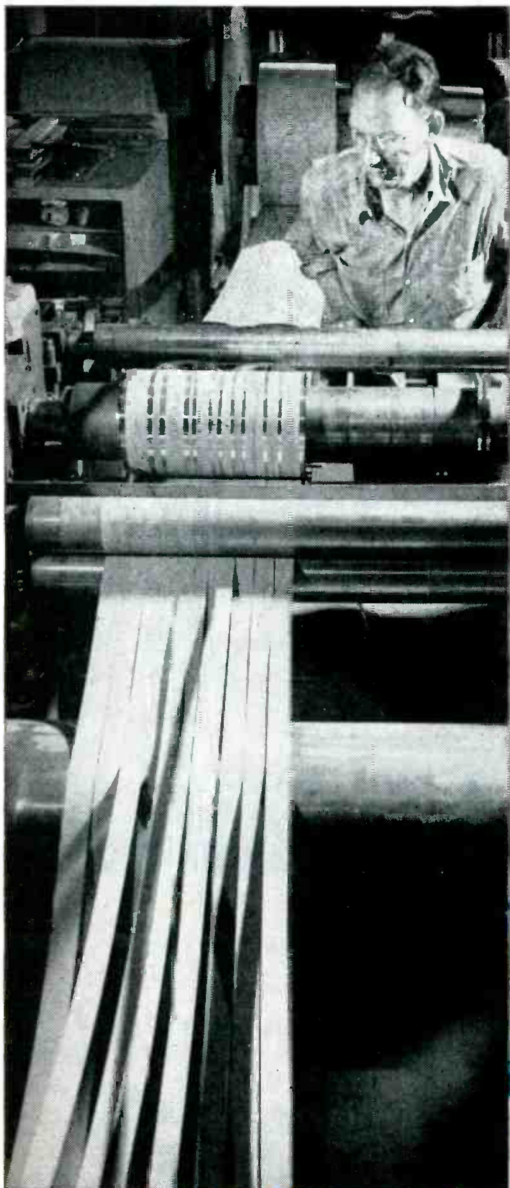

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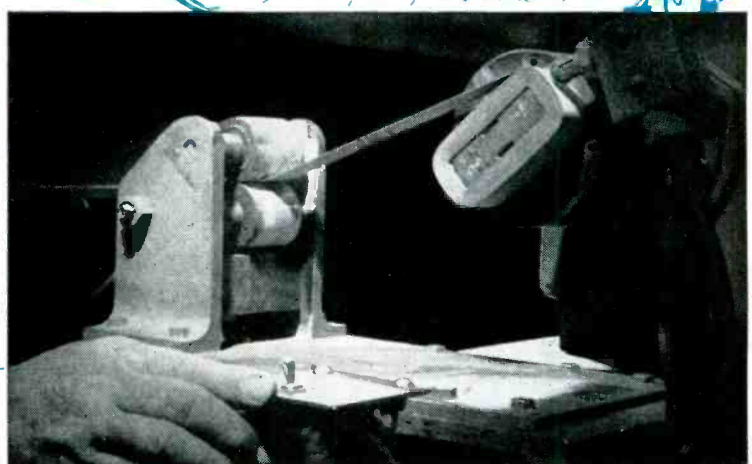

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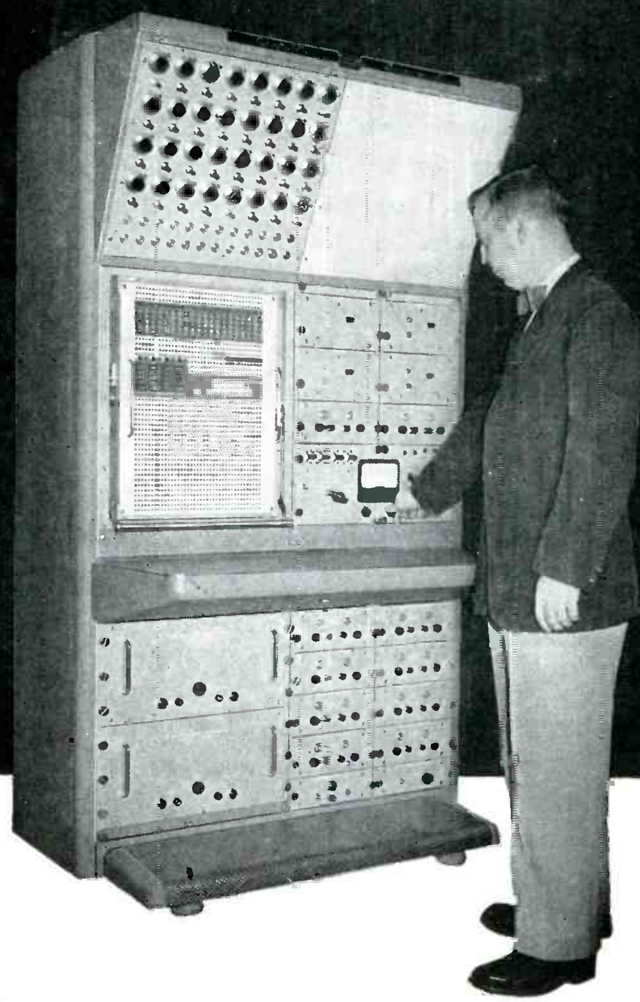

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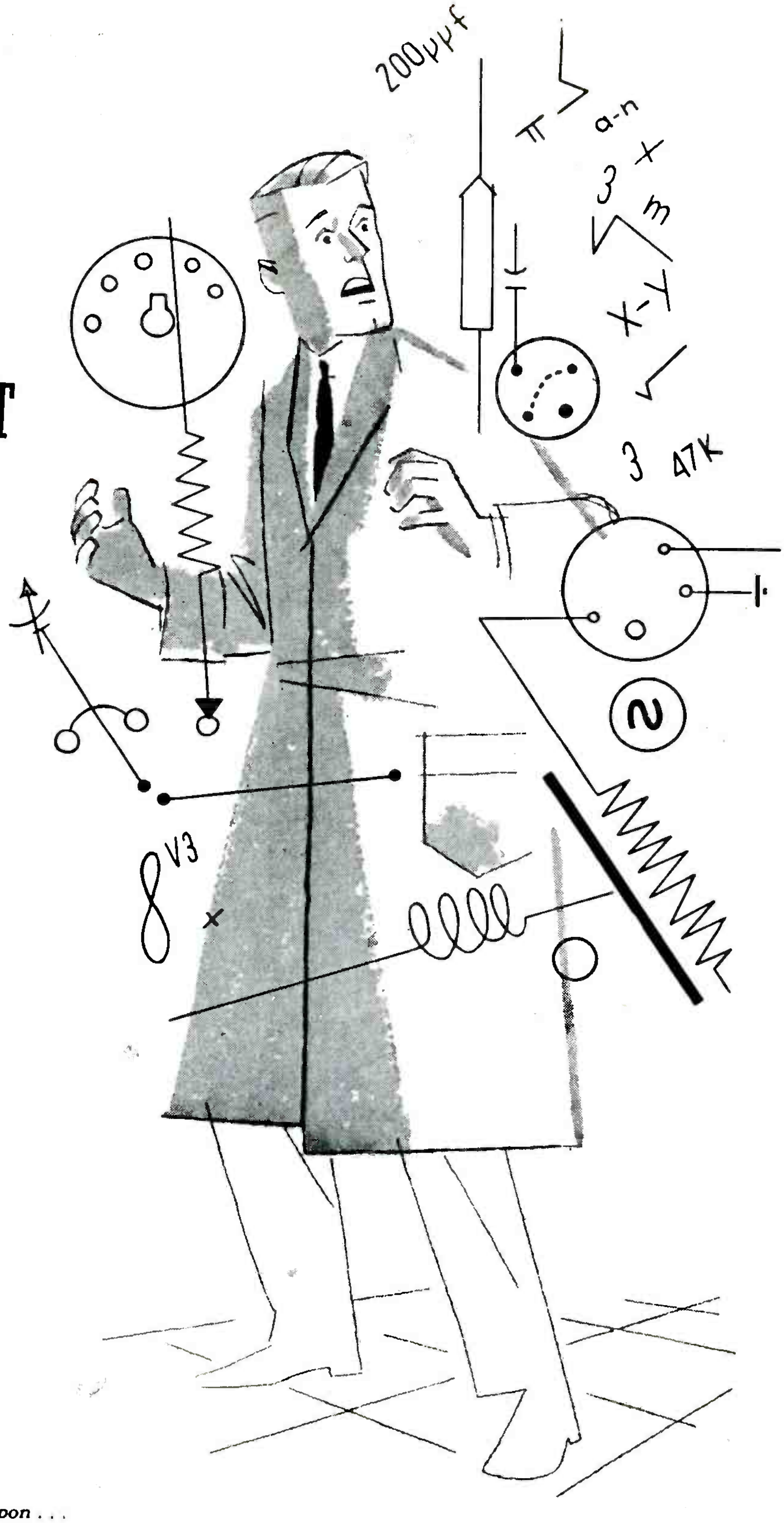

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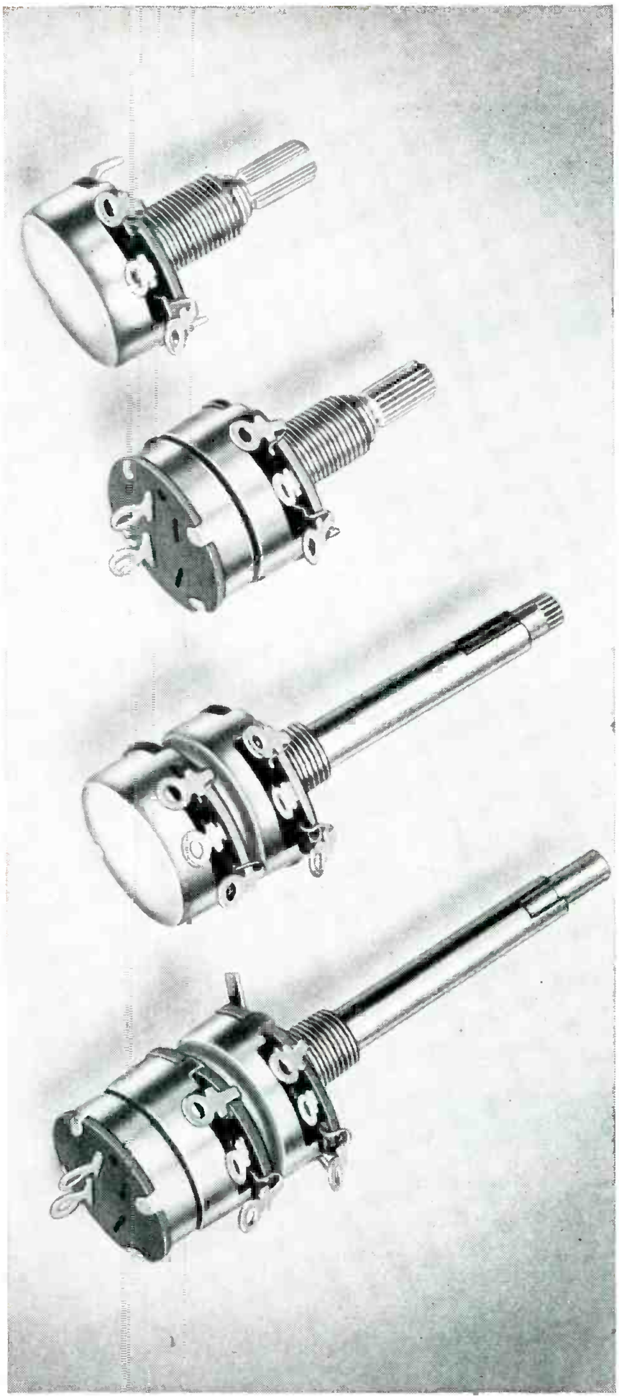

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CROSS TALK

▶ **COLOR** . . . Now that the FCC has established compatible color television standards two forces in temporary opposition will dictate the sales timetable. The consumer will want large color pictures at a low price. The industry will initially find it difficult to meet either of these requirements.

In the early stages color sets providing small pictures at a relatively high price will sell to people with money and those who somehow manage to be first in their neighborhood with something new. Monochrome sets will continue to be responsible for most of the volume, particularly in areas having new uhf stations, with still larger picture sizes or lower prices or both tipping the scale in their favor.

The sales crossover point between monochrome and color will not be reached in a rush. The transition will take several years to accomplish, and in this period there will be many market adjustments. We believe that overall television business will continue at a high level while these adjustments are being made.

▶ **EDUCATIONAL TV** . . . The idea that there should be special television stations to spread supplementary educational programs is neither dormant nor dead. Two groups in particular, the Joint Committee on Educational Television and the National Citizens Committee, are dispensing good advice to prospective operators.

Experience in programming can perhaps best be gained by initially using the facilities of existing commercial stations. It is becoming apparent, for example, that television may be particularly useful for pre-school teaching. Use during school hours may be of secondary importance. After-school tutoring appears to have possibilities. Adult education should not be discounted.

Financing the purchase of a station continues to be the chief stumbling block. It is suggested that a college might hurdle it by making provision for the expense in its regular budget (much as is done when, say, a new laboratory is planned), by soliciting public subscriptions or by enlisting the aid of an established foundation.

▶ **INSTRUMENTS** . . . No part of our business has grown faster, since the war, than the instrument division. The capacity to design and produce laboratory, test and service instruments has, in fact, been so expanded that additional markets are needed.

In all probability the key to further expansion of the instrument business is greater concentration on the design of devices that can become part of production machinery or production processes. This part of the market is farthest from saturation. And manufacturers of many kinds are currently preoccupied with the development of more automatic equipment. They are looking for help.

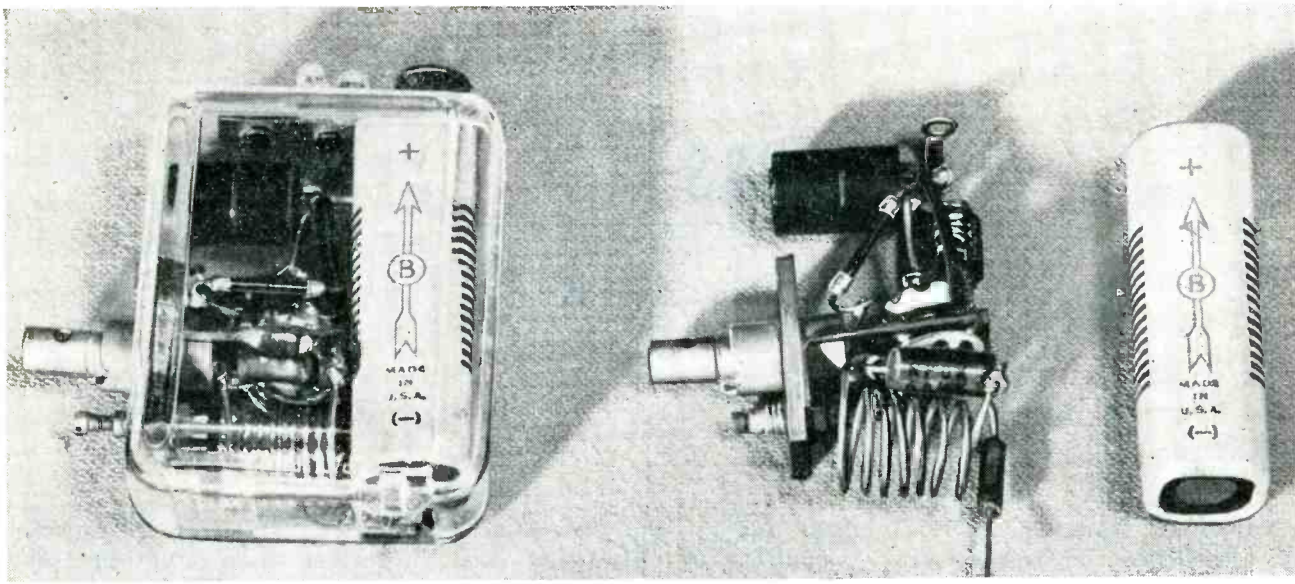
▶ **SOMETHING NEW** . . . Jim Lamb of Remington-Rand tells the story about a young engineer who was assigned the task of developing a more efficient relay. While experimenting with powdered-metal cores he noted an interesting phenomenon and became so enthused that he wrote a detailed report and submitted it to his supervisor.

"Joe," said the old timer seriously after studying the report, "let me offer my congratulations. You have invented the coherer."

▶ **INDEXES** . . . Batelle Institute's Clyde Williams says some authorities believe that as much as 25 percent of the time required to complete a research project may be needed to find, correlate and assimilate past knowledge.

This reminds us to remind you that ELECTRONICS publishes an annual index of its editorial material in each December issue, and that in our Buyers Guide issues published in mid-June of 1951 and 1952 we published in two bites a cumulative index covering our first 20 years in business (1930–1950).

Single-Transistor



Actual-size photograph of assembled transmitter is shown at left and transmitter and battery with case removed (right)

Nine noncritical components, including point-contact transistor, produce frequency-modulated signals in commercial f-m broadcast band. Modulation is produced by alpha-cutoff frequency-shift technique analyzed in text. Can be used as wireless microphone unit in public address systems

EXTENSION of point-contact transistor operation to the vhf region has resulted both from device development and circuit investigation.

The c-w oscillator, being a self-contained system that is suitable for accurate analysis, was chosen as a tool for studying the electrical characteristics of the transistor at vhf frequencies. The concept of frequency modulation by alpha-cutoff frequency shift originated as a result of this c-w oscillator circuit study.

The experimental single-transistor f-m transmitter to be described employs this principle to produce signals in the commercial f-m band. The circuit is Fig. 1.

The oscillator operates at a frequency well above the alpha cutoff frequency of the transistor. This is possible since transistors have potential gain at frequencies several times their alpha cutoff frequency.

The major problems present in the design of a vhf point-contact transistor c-w oscillator operating in the frequency cutoff region are the result of the transistor internal base resistance and the phase shift associated with alpha cutoff.

In considering the solution to these problems, it is convenient to consider only those elements of the transmitter which are important at radio frequencies. These are shown in the equivalent r-f circuit of Fig. 2A. The parasitic inter-element capacitances of the transistor itself are shown in dashed lines.

Feedback arising from the transistor internal base resistance causes the cutoff frequency[1] of the transistor as an amplifier to be lowered. This may result in a lowering of the maximum c-w oscillating frequency. This possibility is avoided by making the external emitter-to-base impedance at the oscillating frequency high compared to the emitter resistance by returning the emitter to r-f ground through a relatively high r-f resistance R_1.

Relaxation and blocking oscillations may occur. This is best understood from an examination of the effective circuit of the transmitter at radio frequencies well below the oscillating frequency, as shown in Fig. 2B. The circuit can become a relaxation oscillator if the emitter-to-ground capacitance

F-M Transmitter

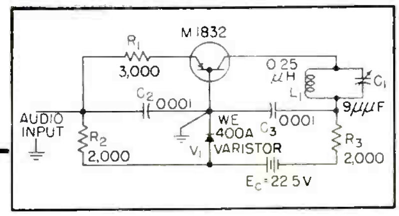


FIG. 1—Complete circuit diagram of vhf f-m transmitter capable of being picked up at several hundred feet when modulated with crystal phonograph pickup

By D. E. THOMAS
Bell Telephone Laboratories
Murray Hill, New Jersey

is sufficiently high. This possibility is also avoided by the use of the high r-f resistance R_1 to return the emitter to r-f ground. All emitter-to-ground capacitance other than the parasitic capacitances of the transistor itself is thereby eliminated, and these capacitances are sufficiently low to avoid the relaxation mode being considered.

Oscillator Circuit

The oscillator circuit is simplified as a result of the phase shift in alpha at the oscillating frequency. Because of this phase shift, the only feedback coupling required in the circuit is the inherent emitter-to-collector capacitance of the transistor itself. This may be shown by an analysis of the equivalent circuit of the oscillator (Fig. 2C) at frequencies in the vicinity of the oscillating frequency. No impedance appears directly between the emitter and base since this circuit is effectively opened at r-f by the resistance R_1. A resistance R_L now appears across the tank circuit to take care of tank-circuit losses and radiation resistance. The equations relating the voltages and currents of this circuit are

$$i_1 (r_e + r_c + Z_g - r_m) - i_2 r_c = 0$$
$$i_1 (r_m - r_c) + i_2 (r_c + r_b + Z_L) = 0 \quad (1)$$

The feedback loop gain $\mu\beta$ is given by[2]

$$\mu\beta = \frac{\Delta_o - \Delta}{\Delta_o} = \frac{\alpha}{1 + \frac{Z_g}{r_b + Z_L} + \frac{Z_g}{r_c}} \quad (2)$$

where Δ is the circuit determinant of Eq. 1, Δ_o is the circuit determinant when r_m is 0, $r_e << Z_g + r_c$, and α is substituted for r_m/r_c.

Although Eq. 2 is in convenient form for computing $\mu\beta$, an exactly equivalent expression which is more suitable for examining the phase of the feedback loop gain is given by

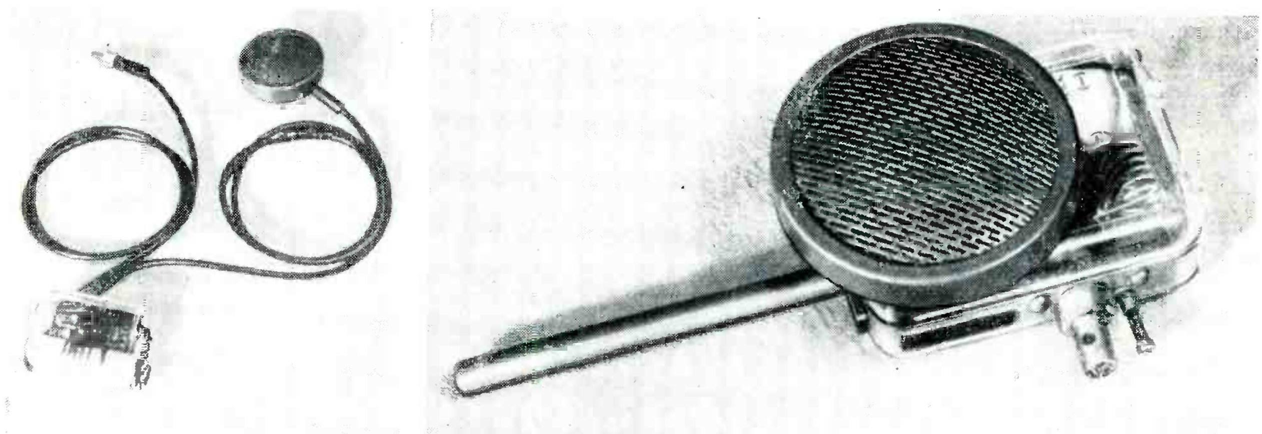
$$\mu\beta = \frac{\alpha Z_{CL}}{Z_g} \quad (3)$$

where Z_{CL} is the impedance of the combination of elements shown in Fig. 2C. This is the effective load impedance of the transistor in parallel with the collector impedance r_c. It closely approximates a moderately high-Q parallel-tuned circuit.

Oscillation Requirements

To maintain c-w oscillations, it is necessary for $\mu\beta$ to enclose the point (1,0) when plotted on polar coordinates.[3] For this particular circuit, this criterion is met if the magnitude of $\mu\beta$ exceeds unity when its phase is zero. In addition to the requirement for oscillation there is also the practical requirement that the frequency of oscillation be near the frequency of maximum magnitude of Z_{CL} if reasonably effective loading of the transistor is to be obtained.

At frequencies in the vicinity of maximum Z_{CL} the phase of Z_{CL} is small. Since the phase of Z_g is —90 degrees, the phase of alpha



Transmitter containing extra transister audio stage for use with crystal microphone. At left is lapel microphone model, and at right is hand microphone design in which microphone is mounted directly on transmitter housing

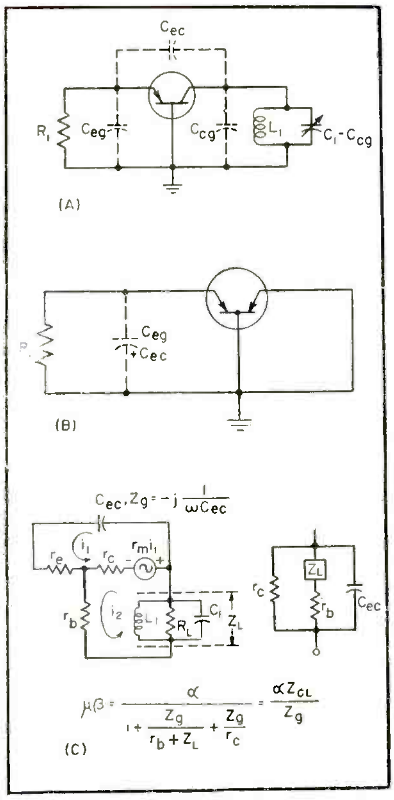


FIG. 2—High-frequency equivalent circuits of transistor oscillator

must be close to —90 degrees (Eq. 3) if the condition of zero phase for $\mu\beta$ required for oscillation is to be met.

If alpha were constant with frequency and therefore without phase shift, the circuit under consideration would not oscillate c-w at the desired frequency. However, alpha is not constant but falls off in magnitude above a certain frequency in a manner similar to the impedance of a parallel R-C circuit. Accompanying this change in magnitude of alpha, there is a corresponding phase shift. It has been found that the following expression for alpha closely approximates its magnitude and phase as a function of frequency

$$\alpha = |\alpha| \angle \theta = \frac{\alpha_o}{1 + jf/f_c} \tag{4}$$

where α_o is the low-frequency magnitude of α, and f_c is the frequency at which the magnitude of α is down by 3 db from its low-frequency value.

The magnitude and phase of alpha computed from Eq. 4 for a cutoff frequency of 40 mc is plotted in Fig 3. Forty megacycles is the order of magnitude of the cutoff frequency of the transistor used in the transmitter. In the vicinity of 105 mc (the desired oscillating frequency) the phase shift of alpha is approximately —70 degrees. It is therefore apparent that the phase of $\mu\beta$ will pass through zero if the phase of Z_{CL} is approximately —20 degrees, at which point the magnitude of Z_{CL} is still close to its maximum value.

The above discussion shows that the phase of the simple coupling circuit used is correct for c-w oscillation. However, it is also required that the amplitude of $\mu\beta$ be in excess of unity when the phase is zero. To determine whether this requirement is satisfied it is convenient to compute $\mu\beta$ from Eq. 2 above. This was done for a range of frequencies in the vicinity of the desired oscillating frequency. Circuit constants not already given are $\alpha_o = 2.4$, $f_c = 40$ mc, $r_c = 5{,}000$, $R_L = 10{,}000$, $r_b = 100$ and $C_{ec} = 1$ $\mu\mu$f.

The computed magnitude and phase of $\mu\beta$ are plotted on Fig. 4. In the vicinity of 105 mc, where the phase of $\mu\beta$ passes through zero, it is seen that the magnitude of $\mu\beta$ is in excess of unity. Thus the circuit oscillates near this frequency.

Low Frequencies

The effective circuit of the transmitter at d-c and audio frequencies is shown in Fig. 5. The varistor V_1 in the base circuit is a self-biasing element which makes possible efficient and d-c stable operation of the transistor with a single-battery power source.[4] Resistor R_2 provides a d-c path for the emitter current and is sufficiently high to avoid shunting the audio input.

Alpha cutoff frequency of the transistor is shifted by both emitter-current and collector-voltage changes. Since these changes are both proportional to the amplitude of the audio signal, the frequency of α cutoff is therefore also controlled by the audio signal amplitude. This shift in alpha-cutoff frequency produces frequency modulation of the oscillator.

Frequency Modulation

When the alpha-cutoff frequency is shifted, the entire phase characteristic of alpha as shown on Fig. 3 is also shifted in frequency. As a result, the frequency at which the phase of $\mu\beta$ passes through zero, and consequently the oscillator frequency, is also shifted.

Figure 6 gives expanded curves of the magnitude and phase of $\mu\beta$ plotted for a very narrow frequency range in the vicinity of the oscillating frequency and for a number of values of alpha-cutoff frequency. The frequency of zero phase and therefore the frequency of oscillation is seen to shift with the alpha cutoff frequency. The amplitude of $\mu\beta$ at the zero-phase-shift frequency varies only ± 0.5 db for a ± 75-kc frequency deviation. Therefore, the frequency modulation will not be accompanied by appreciable

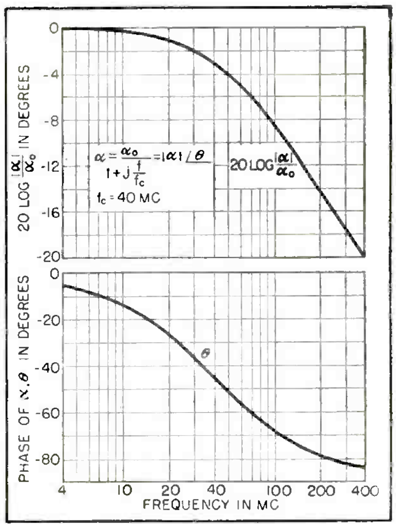


FIG. 3—Magnitude and phase of current amplification factor

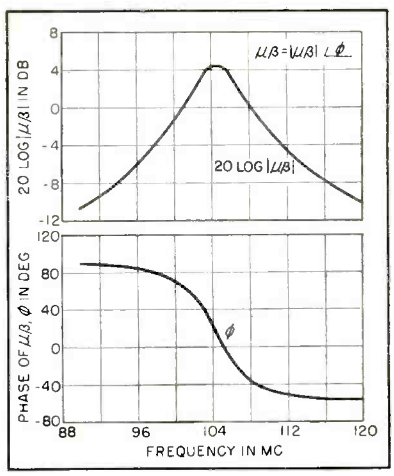


FIG. 4—Magnitude and phase of $\mu\beta$ in oscillating frequency region

amplitude modulation. No precise measurement has been made of the magnitude of the amplitude modulation of the actual transmitter. It is, however, believed to be less than ten percent.

To determine the degree of linearity of the circuit, the departure from linearity of the frequency deviation due to change in alpha-cutoff frequency was computed. This departure is plotted as a function of frequency deviation in Fig. 7. This curve shows that for a deviation of 75 kc, which is the standard maximum for commercial f-m broadcasting, the actual frequency deviation departs only a half of one percent from that which would be obtained if the relationship between alpha-cutoff frequency and oscillation frequency were absolutely linear. To determine the linearity of the relationship between oscillation frequency and audio signal amplitude, the relationship between audio signal amplitude and alpha-cutoff frequency must be known.

Preliminary measurements indicate that the departure from linearity for emitter currents in excess of 0.5 ma is of the order of six percent and in the opposite direction to that caused by the lack of linearity between alpha-cutoff frequency and oscillation frequency. The net nonlinearity in the region above 0.5 ma emitter current would therefore be of the order of twice that permitted for commercial f-m broadcasts. To get increased modulation sensitivity the transmitter described in this paper is operated at emitter currents less than 0.5 ma, where the linearity is slightly poorer. It is, however, sufficiently linear to provide good transmission of high-fidelity recordings.

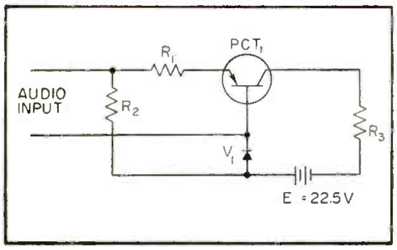


FIG. 5—Equivalent of oscillator circuit at d-c and audio frequencies

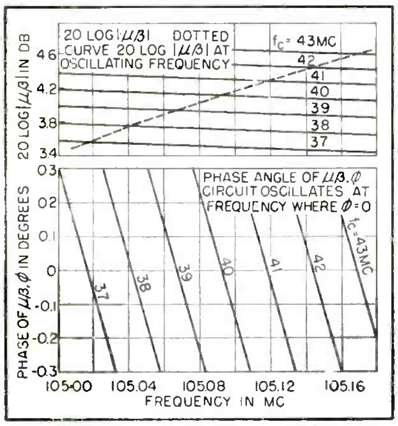


FIG. 6—Expanded section of Fig. 4 in vicinity of zero phase angle

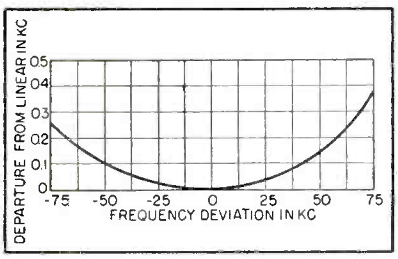


FIG. 7—Departure of frequency deviation from linear with alpha-cutoff

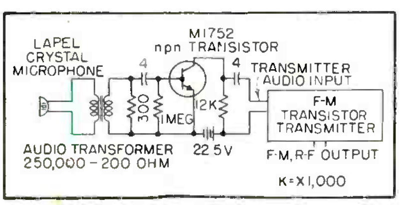


FIG. 8—Audio amplifier added to circuit of Fig. 1 for crystal microphone

Working Model

The transmitter shown in the photographs has been demonstrated by modulating it with the audio signal from a crystal phonograph pickup matched to the audio input of the transmitter with a suitable transformer. The f-m signal radiated from the transmitter is then received by a nearby standard commercial f-m receiver.

Since the output level of a crystal microphone is considerably lower than that of a crystal phonograph pickup, some additional audio amplification is necessary for public address work. This is provided with a single-stage *npn* transistor amplifier as shown in Fig. 8. The *npn* amplifier shown has no provision for stabilization of the d-c operating point. It is not therefore recommended for other than experimental use.

The experimental systems described and illustrated are limited in power to that necessary for transmission over a few hundred feet. Furthermore, variable tank capacitance is provided to permit adjustment of carrier frequency to be clear of local f-m stations.

The transmitter described has not been optimized electrically nor engineered mechanically. It was built only to demonstrate experimentally the vhf possibilities of point-contact transistors and the principle of frequency modulation by alpha-cutoff frequency shift. The carrier frequency range was chosen for convenience in using commercially available receivers for demonstration purposes. It does not represent the maximum frequency available with current developmental models of vhf point-contact transistors.

The fact that the transmitter represents only an experimental design is not intended to indicate that it cannot be duplicated. Circuit element values are not critical. Approximately a dozen of these transmitters have been constructed. All worked with no adjustment other than that of tank-circuit frequency and the value of R_3. Twenty different transistors functioned in one of the transmitters with no circuit adjustment required to compensate for the variation in transistor parameters between units.

Acknowledgement

The transistor used in the transmitter was developed as part of an engineering services contract sponsored by the Joint Services. The oscillator circuit analysis which led to the frequency-modulation technique used in the transmitter was performed as part of the same contract: Contract DA-36-039sc-5589.

The author wishes to thank Miss J. D. Goeltz of the Bell Telephone Laboratories for computing the data used in this paper.

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Audio Equipment for

Portable dual-channel preamplifier-mixer and monitor amplifier supplement standard control-room console. Response is flat within 1 db from 30 to 20,000 cps; harmonic distortion is less than 0.6 percent and noise level is 110 db down

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BROADCASTERS having both an a-m and f-m channel can easily provide their listeners with binaural or stereophonic sound rather than duplicated monaural reception. Station WQXR began its binaural broadcasting with demonstration programs during New York's 1952 Audio Fair. Listener interest and demand sustained a small but regular binaural transmission schedule. Now after one year, the entire live-music origination schedule of WQXR is broadcast binaurally.

Binaural Broadcasting

Binaural programs are originated by sampling the live-program source in the studio from two perspectives without degrading either channel monaurally. A balanced but completely separated transmission is maintained over each channel. The listener puts the two components together by using two receivers, an a-m set and an f-m set, thus adding depth and directivity to his radio listening.

The advantage of this method of binaural broadcasting is that existing equipment is used, both in the broadcast station and in the listener's home.

However, equipment in radio-station control rooms such as at WQXR was designed for monaural programming. Although a great number of hookups are possible with existing jack bays, the use of a monaural equipment installation for binaural transmission presents several awkward arrangements. These generally require additional manpower.

To overcome these handicaps, two portable units were constructed to complement equipment already installed in each control room. The first unit is a binaural preamplifier-mixer that provides for single-control monitoring of each pair of binaural microphones, with outputs fed to the existing control-room console. The control-room consoles already contain dual program channels complete with v-u meters. The second unit is a binaural monitor amplifier that takes the output of the console program channels at line level and feeds ten watts to each of two specially mounted binaural wall speakers. Figure 1 shows the binaural equipment setup.

Portable Units

Portability of the units enables a binaural equipment setup to be installed in any one of three control rooms from which live musical programs originate.

Studio designed selection need be based only upon considerations such as whether an audience attends, the esthetic needs of the performing artists in the selection of pianos or surroundings and the availability of studios.

The binaural preamplifier mixer shown in Fig. 2 is similar in design to the add-a-unit equipment fre-

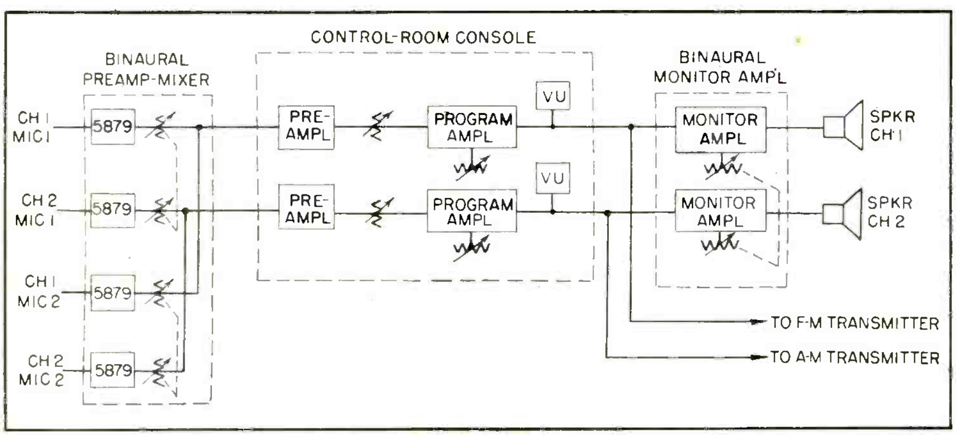

FIG. 1—Typical binaural broadcasting setup showing use of preamplifier-mixer and monitor

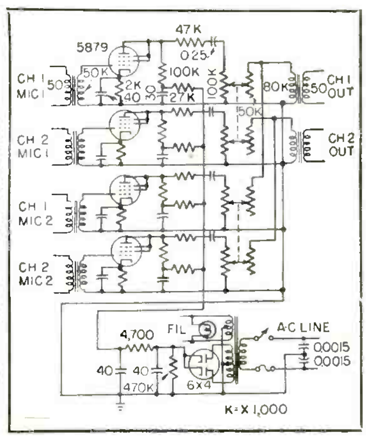

FIG. 2—Preamplifier-mixer unit

Binaural Broadcasts

Microphone arrangement for a binaural broadcast. Announcer's microphones are at right near control-room window

quently used to increase the number of microphone preamplifiers available to existing control-room consoles. The triode-connected 5879 provides a gain of approximately 14 db.

High-level mixing is accomplished with multisection carbon controls in which two mixing channels are ganged on a single shaft. Frequency response is within 1.0 db from 30 to 20,000 cps. Harmonic distortion is 0.6 percent or less over the frequency range of 30 to 20,000 cps. Noise level is approximately 110 db down at full gain.

The binaural monitor amplifier (Fig. 3) is provided with two 10,000-ohm bridging inputs feeding a dual control.

Cascade triode stages using the two halves of a 12AX7 feed a pair of miniature 6AQ5 beam-power amplifiers in push pull. Noise level is approximately 65 db down at 10 watts output.

Switching

A switch interlock system, operable from the control room, permits the engineer, on cue, to energize relays that line up the two channels for proper transmitter-line disposal.

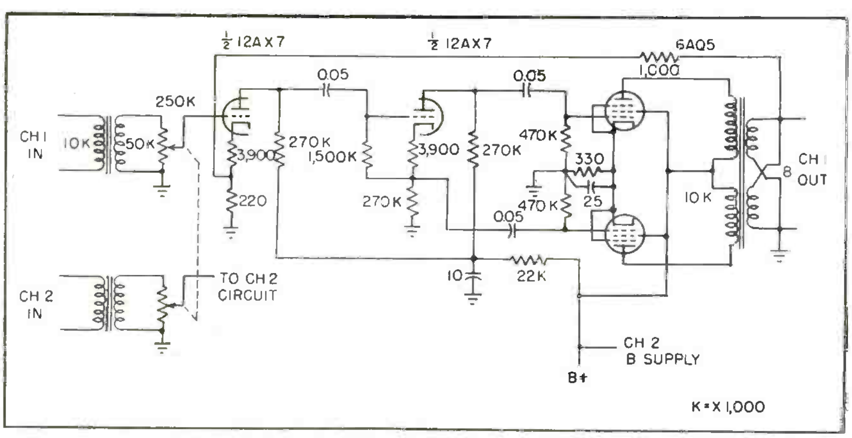

FIG. 3—Monitor amplifier furnishes 10 watts to each of two wall-mounted speakers

The engineer in the control room can check the functioning of the binaural-monitoring result by manipulating the console-channel line keys in balancing the program. As the two wall-mounted speakers operating from the binaural monitor amplifier are invariably used for the complete binaural program, a check for quality can be made with the conventional control-room monitor speaker, which can be switched to either console channel at will.

Aural Directivity

Station WQXR's live musical originations center almost wholly on small musical or chamber groups. In each case, announcements are also transmitted binaurally. For correct directivity, every binaural broadcast has left-hand microphones feeding the f-m channel and right-hand microphones feeding a-m. Thus the listener can be certain of the placement of his receivers to hear the violins on the left where they belong.

Credit must go to H. F. Kuch and Z. N. Masoomian of the WQXR engineering staff for their work on this project, also to Fred J. Sass for the photograph.

Design Techniques for

New circuit arrangements for reception of NTSC color television signals are discussed in detail and methods for optimizing their design are presented. Two actual designs typify ceiling-performance and economy receivers

CIRCUITRY required for reception of NTSC color transmissions includes the basic elements of the black-and-white tv receiver, plus those stages necessary to decode, synchronize and amplify the chrominance information. Additional circuitry is also required for convergence in the current type of tricolor picture tube.

Figure 1 shows a block diagram of the basic color receiver. The tuner and video i-f amplifier are of the conventional intercarrier type but considerably greater care must be taken in such design considerations as oscillator tuning range, bandpass, traps and sound takeoff.

Due to requirements of the chrominance signal, the pass band of the tuner and i-f system should be flat to about 4.0 mc. This is an increase of about 30 percent in i-f bandpass over present black-and-white receivers and attendant decrease in gain per stage of the i-f amplifier.

It is therefore good practice to use at least four, and preferably five stages of i-f amplification in the color receiver instead of three, as is commonly used in medium and low-cost monochrome designs. A variation of this approach is the use of a bandpass flat to about 3.6 mc, with compensating peaking obtained in the chrominance amplifier bandpass filter.

I-F Problems

Practical experience has shown that relatively small deviations from the ideal bandpass characteristic may produce noticeable picture degradation by introducing crosstalk between the quadrature components of the chrominance signal. This crosstalk is manifested as poor transient response in the color picture and is the result of improper utilization of the double-sideband chrominance transmission.

Another problem which necessitates special treatment relates to the 4.5-mc intercarrier sound component. It is necessary to provide high rejection of the sound carrier at the video detector so that the 4.5-mc component will not beat with the color carrier. Inadequate sound-carrier rejection produces a troublesome beat which may occur at the video detector or at the color demodulators. The possibility of this beat (920 kc) may be minimized by increased sound-carrier rejection in the video i-f stages. A 26-db video-sound carrier ratio at the video detector has been adequate in black-and-white receivers but a ratio of approximately 40 db or more appears necessary in color receivers. In order that the sensitivity and noise performance of the sound channel are not impaired with this increased rejection, a sound takeoff of the type shown in Fig. 2 is suggested.

These two requirements, relatively wide pass-band and high sound rejection, also limit the range of the fine tuning control. If the local oscillator frequency is varied over a range of about 200 kc, noticeable crosstalk, or considerable 920-kc sound-color carrier beat may result. Therefore it is desirable that the frequency range of the fine tuning be made as small as possible, consistent with long-term stability of the local oscillator.

Video System

The video system of the color receiver consists of monochrome video amplifiers, a chrominance bandpass amplifier, color demodulators and a matrix system that performs a function which is the inverse of that in the transmitter. Following the video detector, the

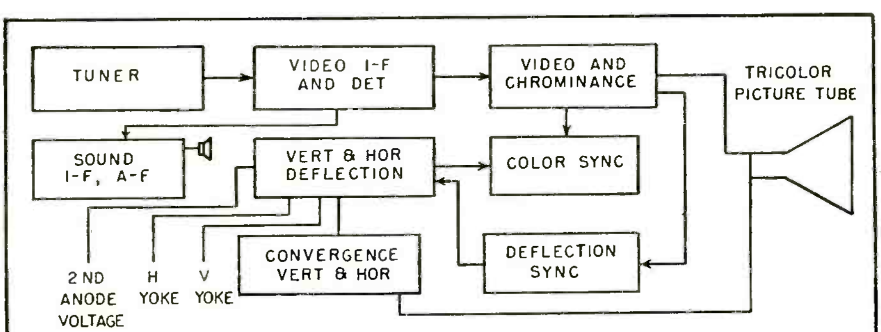

FIG. 1—Stages of basic receiver, emphasizing sections handling color signals

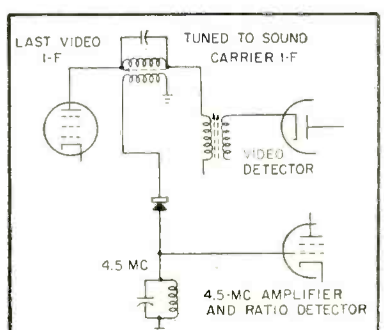

FIG. 2—Suggested sound takeoff

Color Television Receivers

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monochrome and chrominance signals are divided into two separate channels. The chrominance signal is fed through a bandpass amplifier to the color demodulators. The outputs of the color demodulators are matrixed in adders with the correct amplitude of monochrome signal E'_Y to produce the primary color signals E'_R, E'_G and E'_B.

To achieve correct color rendition, it is important that the relative gains of the chrominance and the monochrome channels be held constant regardless of video signal level. Since excellent linearity in the video system is required, it is considered good practice to design amplifier stages for at least 50-percent greater gain capability than is indicated by picture-tube drive requirements.

There are several ways in which the video system may be arranged to convert the composite color video signal (after detection) to its three primary color components E'_R, E'_G and E'_B. These color signals are the same signals that appear at the output of the gamma amplifiers in the transmitter, except that in some receiver circuits they may be modified to take into account variation in efficiency of the red, green and blue phosphors of present-day tricolor tubes.

Two types of color video systems will be described. The first uses demodulators which operate on the I-Q axes. The matrix system following the I-Q demodulators performs necessary additions, subtractions and amplifications to produce the desired E'_R, E'_G, E'_B color signals. This is a "ceiling performance" receiver and utilizes the full potentialities of the system.

A discussion of an "economy" receiver will also be given. In this system, the color demodulators operate on the $(E'_R - E'_Y)$ and $(E'_B - E'_Y)$ axes of the chrominance signal. In this circuit, the monochrome signal is bypassed to the grids of the picture tube, and the color difference signals are applied to the cathodes. The kinescope performs the necessary addition to produce the required color signal voltages. The color bandwidth of this economy receiver is approximately 0.5 mc. Several simplifications in circuitry accrue from use of this circuit.

The E'_I-E'_Q Video System

The block diagram of Fig. 3 shows a basic arrangement for a video system with I and Q color demodulators. The detected video signal contains both the monochrome and chrominance information, and may be described by:

$$E_M = E'_Y + [E'_Q \sin(\omega t + 33^\circ) + E'_I \cos(\omega t + 33^\circ)] \quad \text{(1A)}$$

For color-difference signal components below 0.5 mc, the video signal may also be described by:

$$E_M = E'_Y + \left[\frac{1}{2.03}(E'_B - E'_Y)\sin\omega t + \frac{1}{1.14}(E'_R - E'_Y)\cos\omega t\right] \quad \text{(1B)}$$

As shown in Fig. 3, this signal is amplified by a wide-band stage (video preamp) and then divided into separate channels, monochrome and chrominance. The monochrome channel is conventional up to the adder stages except that it contains a delay line. The E'_Y delay line is necessary so that the monochrome and chrominance components arrive in time coincidence at the adders.

To apply a suitable signal to the

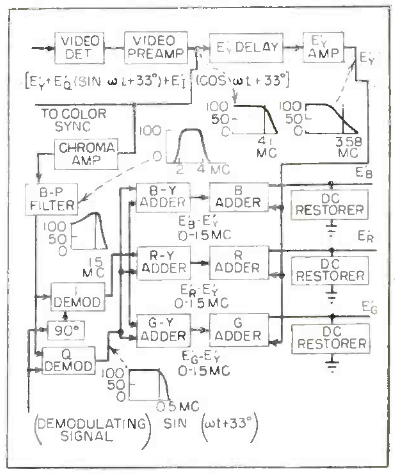


FIG. 3—Video system for ceiling-performance receiver

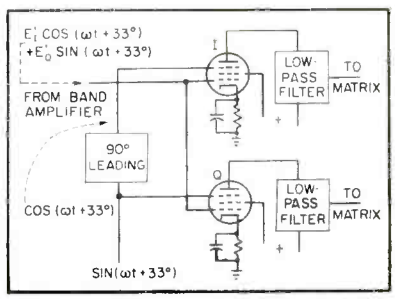


FIG. 4—Arrangement of the I-Q color demodulators in the receiver

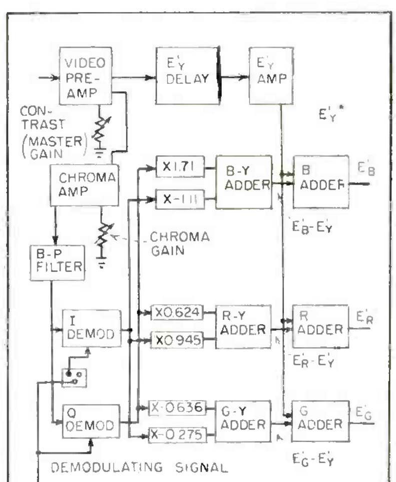


FIG. 5—Stages of the I-Q matrix

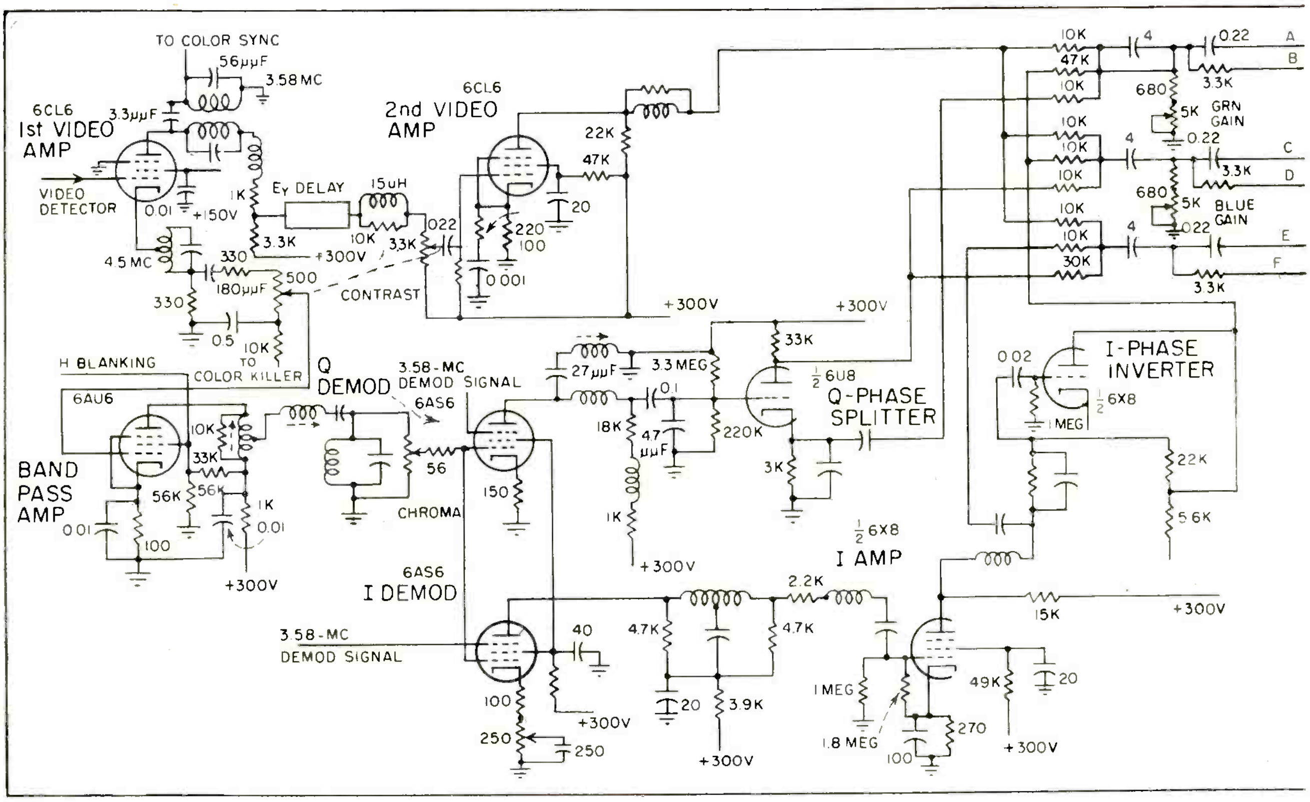


FIG. 6—The I-Q video system for a ceiling-performance receiver contains several new types of tubes

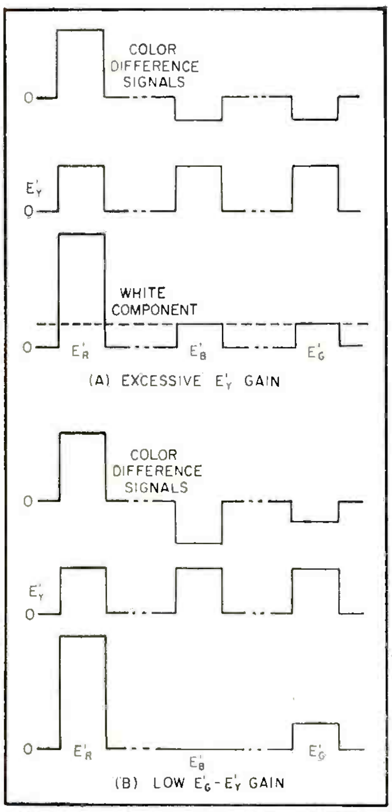


FIG. 7—Excessive E'_Y gain (A) results in desaturated red vertical bar. Low E'_G-E'_Y gain (B) adds green component

I-Q demodulators, the composite signal is amplified and its bandwidth restricted by a bandpass filter in the output of the chrominance amplifier.

The required E'_I and E'_Q components are obtained by product demodulation. A typical demodulator circuit is shown in Fig. 4. The outputs of the demodulators are the results of the products of the signals applied to their control grids.

In its simplest form, the output of the Q demodulator may be expressed as follows:

$$[E'_Q \sin(\omega t + 33^\circ) + E'_I \cos(\omega t + 33^\circ)]\,[\sin(\omega t + 33^\circ)] \times \text{Gain} =$$

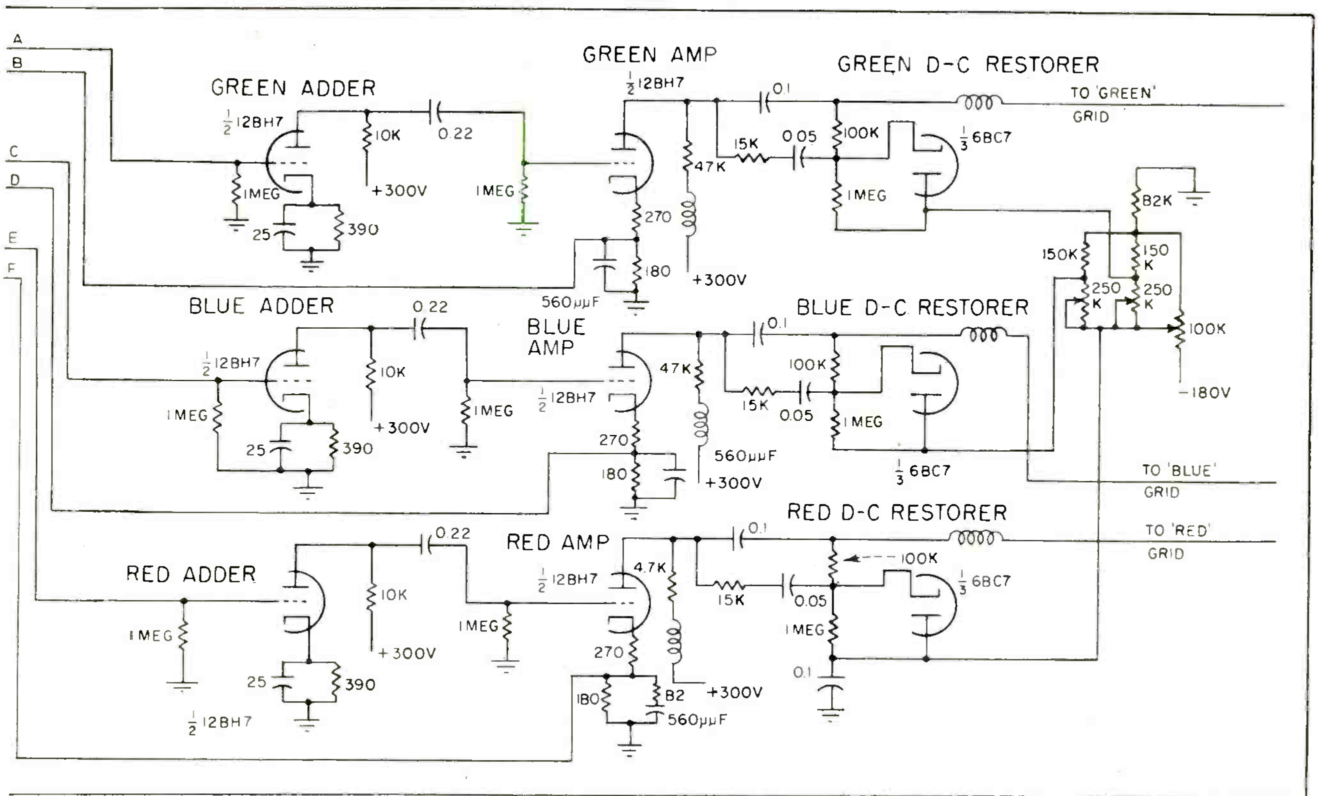
$$\left[\frac{E'_Q}{2} - \frac{E'_Q}{2}\cos 2(\omega t + 33^\circ) + \frac{E'_I}{2}\sin 2\,(\omega t + 33^\circ)\right] \times \text{Gain} \qquad (2)$$

With suitable filtering in the plate circuit of the demodulator, only the first term, or the E'_Q component, will appear at the output of the Q demodulator. Similarly, application of a demodulating signal to the I demodulator will result in the E'_I component only appearing at the output of the I demodulator.

The I demodulator output circuit is designed for a pass band of about 1.5 mc. However, since color signal components in the I band (0.5 mc to 1.5 mc) are essentially single-sideband transmissions as compared to the lower frequency double-sideband components, the I demodulator output should theoretically have a rising characteristic in this region. The Q demodulator load should be flat to about 0.5 mc. Figure 3 shows bandpass characteristics of the I and Q demodulators.

In designing the I and Q load circuits, consideration should be given to their relative delays. If both pass-bands were flat it would be possible to equalize their relative delays with suitable filter design. However since it is desirable to design the I channel filter with a rising characteristic, this will alter the delay in the I channel in the 0.5 to 1.5-mc region and so a compromise dictated by practical experience is required.

After extracting the E'_I and E'_Q color components from the composite video signal, the next step is to combine them in the proper proportions to form the three primary color-difference signals. The signal make-up, as produced by the transmitter matrix, may be described by the following equations:



$$E'_Y = 0.59E'_G + 0.30E'_R + 0.11E'_B \quad (3)$$
$$E'_I = 0.74(E'_R - E'_Y) - 0.27(E'_B - E'_Y) \quad (4)$$
$$E'_Q = 0.48(E'_R - E'_Y) + 0.41(E'_B - E'_Y) \quad (5)$$

From Eq. 4 and 5,

$$(E'_B - E'_Y) = -1.11E'_I + 1.71E'_Q \quad (6)$$
$$(E'_R - E'_Y) = 0.945E'_I + 0.624E'_Q \quad (7)$$

Rearranging Eq. 3,

$$(E'_G - E'_Y) = -0.186(E'_B - E'_Y) - 0.509(E'_R - E'_Y) \quad (8)$$

Substituting Eq. 6 and 7 in 8,

$$(E'_G - E'_Y) = -0.275E'_I - 0.636E'_Q \quad (9)$$

From Eq. 6, 7 and 9 the coefficients of E'_I and E'_Q may be used to form a matrix that produces the desired color-difference signals as shown in Fig. 5. The color-difference signals are then added to the monochrome component to produce the desired color signals.

The significance of the asterisk shown in Fig. 5 is that it is necessary to design for proper ratio of E'_Y to color difference signals. The overall gain of the E'_Y channel with respect to the gain of the color-difference channels, including the I-Q demodulators, must be correct for proper color rendition. To facilitate the adjustment of chrominance and/or monochrome gain, as well as to provide some flexibility in receiver operation, it is customary to provide both overall contrast and chrominance gain controls.

A schematic of a complete I-Q video system is shown in Fig. 6.

When the relative gains of the color-difference channels are correct, only saturation variations will result as the chrominance is independently varied. If however the relative color difference gains have not been properly adjusted, chrominance control variations will result in hue, as well as saturation, changes. Examples follow.

A saturated red bar transmission is received on (1) a receiver with correct color-difference gain adjustments but excessive luminance gain; and (2) with incorrect color difference gain adjustments. Waveforms at the kinescope are shown in Fig. 7.

In the first case, the addition of a white component results in desaturation of the received picture. The second case is that of insufficient gain in the green color-difference channel. The result is hue contamination of the red bar by the addition of a green component.

When properly designed, the action of the chrominance control is analogous to a tone control. This emphasizes the necessity for proper matrixing as well as excellent linearity in the video system.

Economy System

An economy color video system which utilizes only that chrominance information characterized by double-sideband transmission may be used instead of the I-Q system. One feature of this arrangement is in the use of the picture tube to perform the function of the color adders. This method of adding the E'_Y and the color-difference components to form E'_R, E'_G and E'_B color signals is optional, but is used in conjunction with the economy receiver as it may result in reduced complexity. However, kinescope adding may also be used in conjunction with the I-Q system if desired.

Since the receiver color bandwidth is restricted in its video section to 0.5 mc, only double-sideband color components are utilized. From Eq. 1B, the relative gains required for the red and blue color-difference channels are obtained. The equation for the green color-difference signal in terms of the red and blue color-difference signals has already been developed as Eq. 8. Information is available to set up a suitable video system in simple form.

Figures 8 and 9 show the economy video system. As compared to the I-Q system, there is a net reduction of two adder stages. Since the color demodulators have equal bandpass, there is no problem of equalizing their relative delays.

Further simplification of this type of video system might be affected by driving the kinescope cathodes directly from the color-difference demodulators and the green color-difference adder. This would result in the elimination of the three color-difference amplifiers. Until such time that suitable tubes are available, or tricolor kinescope gun sensitivities increased, it may be difficult to obtain sufficient drive with adequate linearity.

The action of the color demodulators in the economy receiver is the same as in the previously described system, except that the phasing of the locally derived demodulator signals are slightly different. Although the demodulator voltages are supplied in quadrature, as before, it is not necessary to shift them 33 degrees as in the I-Q system. This detail is of small consequence since it is a simple matter to control the phase of the demodulating voltages with respect to the reference burst by means of simple networks in the color sync section.

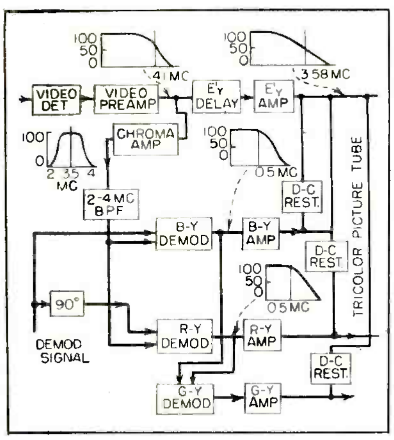


FIG. 8—Video system for an economy color television receiver design

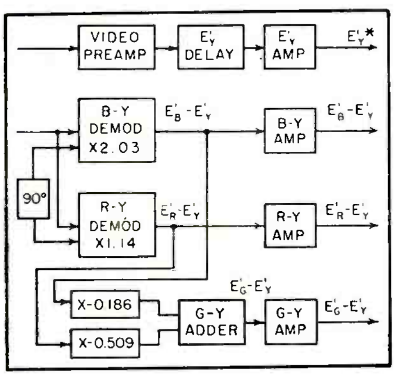


FIG. 9—The R-Y, B-Y matrix for economy color television receiver design

Color Balance

One of the problems encountered in designing and adjusting the color receiver is that of color balance. Although almost identical gun structures are used in present day three-gun picture tubes, phosphor efficiencies differ. That is, for equal second-anode currents, the blue, green and red phosphors will supply light energies in the approximate ratio 1:0.7:0.3, respectively. This means that the drive and supply voltage requirements of each gun must be altered accordingly so that the receiver will produce Illuminant C for monochrome signals regardless of video signal level.

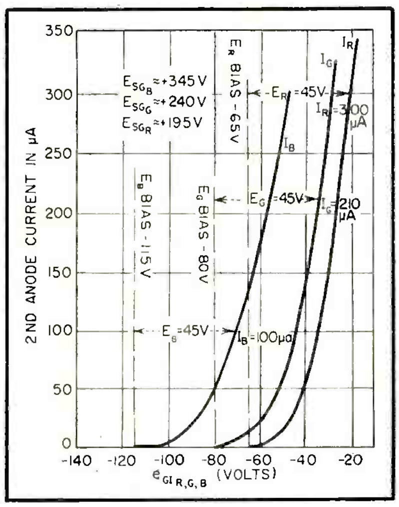


FIG. 10—Equal signal drive for color balance in one type of operation

A most exacting test of color balance may be made by use of a monochrome gamma-scale test pattern. With proper adjustment, the tricolor kinescope should produce only monochrome shades from black to white. Improper balance will be indicated by the predominance of some hue in the gray scale. Color unbalance will thus affect monochrome picture rendition and, if severe, will impair color fidelity. Pastel shades, such as flesh tones, are particularly affected.

It has been assumed that the desired output of the video matrix is E'_R, E'_G and E'_B. If equal signal drives are to be used, it is necessary that suitable e_{g2} and e_{g1} supply voltages of the tricolor kinescope be selected to compensate for unequal phosphor efficiencies. An approximately correct color balance may be obtained by this method.

Color balance using equal signal drive may be achieved by selection of e_{g1} and e_{g2} d-c supply voltages so that the red, green and blue gun currents (I_R, I_G and I_B) will have a constant ratio (approximately 1: 0.7: 0.3) from zero to maximum signal. To illustrate the method of setting up the tricolor kinescope, typical operating curves for balanced operation appear in Fig. 10.

The d-c supply values have been chosen so that I_R : I_G : I_B are in correct ratio at approximately the center of grid signal swing. These ratios will not remain precisely constant over the entire range. However, good balance may be obtained with this method although the adjustments are rather critical.

A more precise method of obtaining color balance involves the use of unequal signal grid drives and approximately equal e_{g2} and e_{g1} supply voltages. This method of setting up the tricolor kinescope is illustrated in Fig. 11.

Due to the curvature of the $I_p - E_g$ characteristic, the ratios of the drive voltages do not have to be as great as might be supposed from the relative phosphor efficiencies. For present tricolor kinescope designs, driving voltage ratios in the order of 1: 0.8 : 0.7 have been used. The color balance of the unequal drive method is theoretically not exact. However, experience has shown this method to be easier to adjust and somewhat superior to the equal drive system.

If the unequal drive system is to be used, it is necessary to alter the relative gains of the color adder stages in the I-Q system or the gains of the color amplifiers in the economy system. These adjustments are not critical since they may be compensated by variation of kinescope supply voltages.

D-C Restoration

The considerations for d-c restoration in the color receiver are the same as in the black-and-white receiver except that three color signals must be handled. Referring to Fig. 8, the d-c restorers are connected between the picture-tube grids and cathodes. It is not sufficient to restore the monochrome information alone. If only the monochrome information is d-c restored, color saturation will be a function of picture content.

A problem peculiar to color receiver d-c restoration arises from the fact that the reference burst, which is transmitted 180 degrees out of phase with the blue color-difference vector, is demodulated in the chrominance channel as color information. Although the burst occurs during the horizontal blanking period and should not normally be visible on the kinescope, it may cause small differences in the developed d-c of the restorer tubes.

This effect is due to a slightly different waveform in the blue color-difference channel where recovered burst information consists of a pulse of slightly less width and approximately the same amplitude as the horizontal sync pulse which exists in the monochrome channel as shown in Fig. 12.

If the waveforms are applied to a peak rectifier, as in the conventional restorer circuit, the blue restorer will develop a somewhat higher d-c potential than the red and green restorers. Setting up of the blue restorer on burst will upset the color balance, particularly at low video levels. This difficulty may be eliminated by supplying a suitably delayed and shaped blanking pulse (derived from the horizontal deflection circuits) to the chrominance amplifier, thus preventing the burst from reaching the color demodulators.

Color Synchronization

Accurate and stable phasing of the locally generated demodulation signal is necessary to decode the color signal correctly. The reference phase information is transmitted as a burst of approximately 9 cycles duration of 3.58 mc. This burst is situated on the back porch of the horizontal sync signal and its phase in relation to the color-difference vectors shown in Fig. 13.

The phasing information in this burst may be utilized in a number of ways for purposes of color synchronization. First it is necessary to separate the burst from the composite video signal. This is done in a gated amplifier which is keyed on during the burst period by means of a pulse usually derived from the horizontal deflection circuit. It is necessary to delay the gating pulse and shape it so that it will occur precisely coincident with the color sync burst.

Although the gating pulse may be derived from other points of the receiver, such as the sync clipper, it is advantageous to use a horizontal deflection pulse since then the gating pulse has the same degree of impulse noise immunity as the horizontal afc. Care must be taken to design the horizontal afc circuit so that the gating pulse phase will not vary greatly over the horizontal hold control range.

Considerations in the design of color sync systems are basically the same as in any synchronization system. Prime considerations are noise performance, pull-in time, pull-in range, and static phase accuracy.

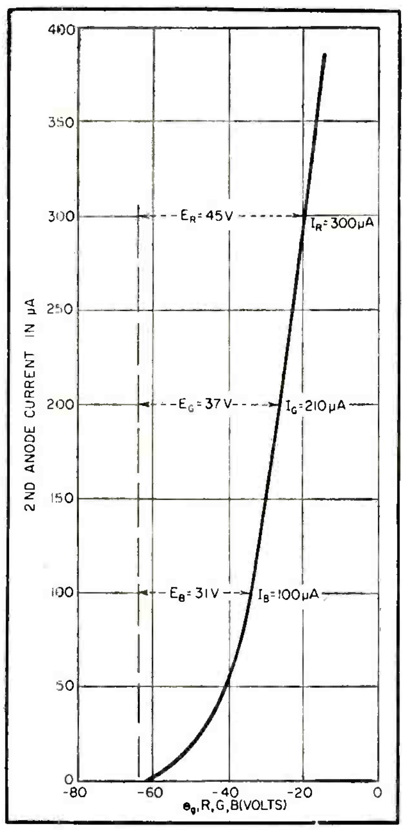


FIG. 11—Unequal signal drive takes advantage of tube curve

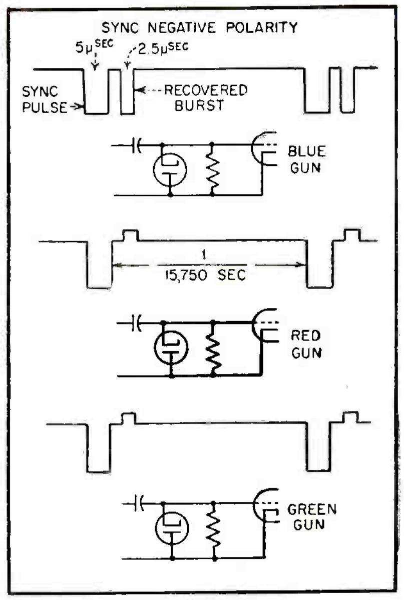


FIG. 12—Setting up of 'blue' d-c restorer on recovered burst

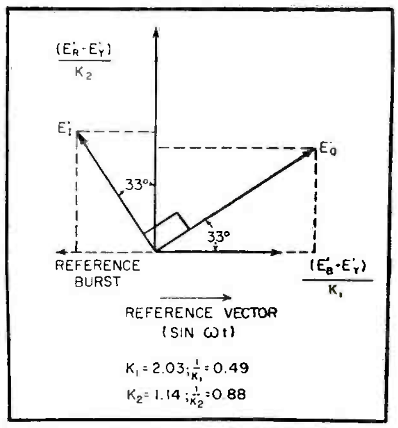


FIG. 13—Relationship between E'_I, E'_Q and color difference signals

Unlike deflection sync problems where impulse noise is an important factor in determining performance limitations, due to the frequency spectrum involved (region of 3.58 mc) thermal noise becomes of primary importance.

The noise performance of a color sync circuit may be expressed in terms of the probable phase error introduced into the color sync system at specified signal to thermal noise ratios. In a properly designed color sync system it is theoretically possible to hold color sync accurately (within ± 5 deg) at signal to noise ratios so low that video information is no longer usable. In practical circuits, however, the considerations mentioned, as well as economic factors, necessitate compromises in design.

Perhaps the simplest form of

color sync circuit is the crystal filter, or ringing circuit. In this system, shown in Fig. 14, the gated burst is passed through a narrow-band filter and lets through only the fundamental frequency component of the separated sync burst. Thus a c-w signal is generated which is amplified, phased and fed directly to the color demodulators. Noise immunity of this circuit depends upon the integrating effect of the filter. If the filter has a Q of about 500, integration is relatively short, and phasing information is utilized on a line-to-line basis.

The system when operating with such relatively low Q's is analogous to an impulse sync system such as is commonly used in vertical deflection, and in the presence of thermal noise is subject to relatively high phase error. For adequate noise performance much higher integration times (lower noise band-

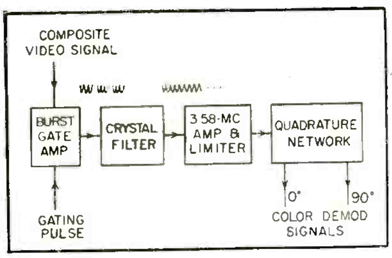


FIG. 14—Basic elements of crystal filter color sync circuit

widths) are required. High Q's of the order of 10,000 to 20,000 provide excellent noise immunity but transmitter frequency, tuning of the filter and the constants of the crystal become extremely critical.

If the filter, considered as a single parallel resonant circuit, is driven from a constant current source (during the burst interval) the static phase error of the system is given by

$$\Delta\phi = \tan^{-1} 2Q \frac{\Delta f}{f} \qquad (10)$$

Since it is desirable to use Q's in the order of 10,000 to 20,000 to attain good noise performance, the limitation on design of this circuit is due to static phase errors resulting from drift or mistuning of the filter elements, plus tolerance errors in the transmitter subcarrier frequency. For example, with filter Q's in the order of 10,000 to 20,000 (attainable with good crystal filters) excellent noise performance may be obtained, but with questionable static phase reliability unless a crystal with an unusually low temperature versus frequency coefficient is chosen, or it is housed in a temperature-stabilizing oven. Lower filter Q permits a lower cost crystal filter but with considerable compromise in weak-signal performance.

Another serious limitation in weak-signal performance of passive circuits arises from the fact that noise introduces amplitude as well as phase variations in the color sync signal. A high degree of limiting is therefore required to prevent these amplitude variations from reaching the color demodulators.

A complete crystal filter color sync circuit is shown in Fig. 15.

Automatic Phase Control

At present, conventional automatic phase control circuits have been applied to color synchronization with satisfactory results. The basic apc circuit is shown in Fig. 16.

The action of the integrator is analogous to that of the crystal filter in that it averages the phasing information over a period of time which is proportional to the reciprocal of its bandwidth. For equal degrees of noise immunity the apc integrator noise bandwidth is one-half that of the crystal filter circuit. For optimum performance under marginal signal to noise conditions, noise bandwidths of approximately 100 to 300 cps are desired.

There is considerable similarity between horizontal afc and color apc. In Fig. 16, the integrating network is charged by pulses, occurring at a line rate, whose amplitude is a function of the phase difference between local oscillator and burst.

The information fed to the integrating network is very much the same as in a horizontal afc system. Furthermore, the degree of required static phase accuracy is approximately the same in both systems. An error of ±5 degrees is considered as the maximum allowable shift in color reference phase for negligible effect upon color fidelity.

The main difference between the systems is in the free-running stability of the controlled oscillator. In horizontal systems, it is practical to design oscillators so that their free-running frequency will

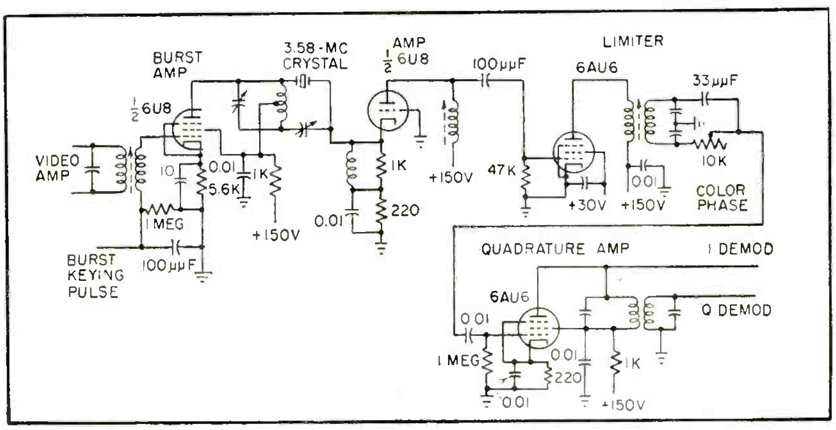


FIG. 15—Crystal filter and associated circuits for color sync

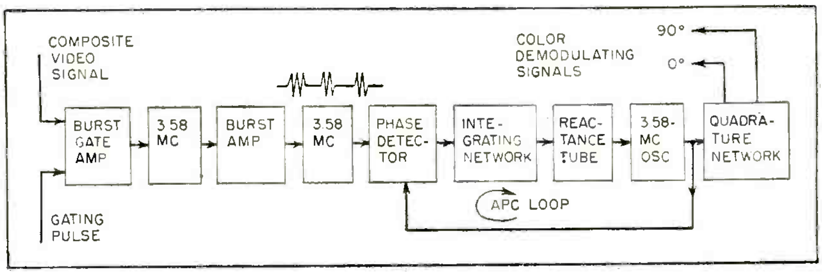


FIG. 16—Block diagram of automatic phase control circuit for color sync

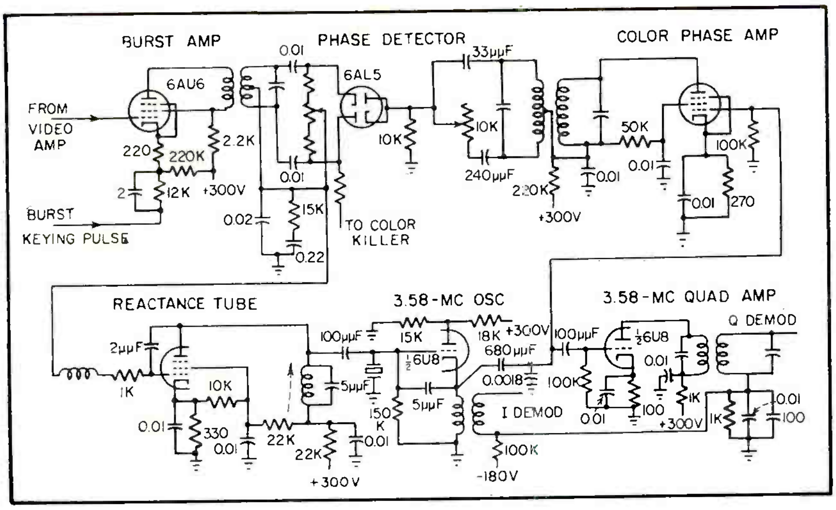


FIG. 17—The automatic phase control color sync circuit

remain within about 200 cps of the line frequency. This is a difficult requirement for an economical 3.58-mc oscillator.

The significance of this requirement is that the required pull-in time be as small as possible, a condition which is easily obtained in horizontal afc circuits. Since the pull-in time is approximately proportional to $(\Delta\ F)^2$, it becomes quite significant where the color oscillators may have to be pulled in from a difference frequency of perhaps 2 kc.

In a particular optimum design for an apc system using an integration time of about 1/200 second, approximately 2 seconds would be required for the system to stabilize from an initial signal-oscillator difference of 2 kc. Compromises in design, such as reduced integration (increased noise bandwidth) will reduce the required pull-in time. Use of a crystal-controlled oscillator, with free-running frequency stability of a few hundred cycles, simplifies the over-all problem.

A complete apc color sync circuit is shown in Fig. 17.

Interference

Due to the character of the most commonly encountered impulse noise interferences, very little of its energy is distributed within the color information bandpass. As a result, the chrominance circuits as well as the color apc system are relatively immune to the effect of impulse noise. The existence of an R-C time constant in the grid of the chrominance bandpass amplifier or the derivation of the color sync gating pulse from a source ahead of horizontal afc could cause the color section of the receiver to be upset by impulse noise. However, with suitable design it will be found that thermal noise in the chrominance section as well as in color apc provides the limit for weak signal performance.

The effect that thermal noise may have on the color information (in addition to that which it has on the monochrome information) may be shown by tracing noise interference through the system. The noise spectrum is limited by a bandpass amplifier to approximately 2.3 mc (Fig. 3).

Random phase and amplitude fluctuations due to thermal noise are demodulated in the color demodulators and thereby converted to 0 to 0.5-mc and 0 to 1.5-mc spectrums. This results in the appearance of rather coarse-grained color snow which is added to the usual snow experienced in weak monochrome pictures encountered in weak-signal areas.

This additional color noise component may be eliminated when the color receiver is used to receive monochrome pictures by the addition of a circuit known as the color killer. The function of this stage is to sense whether or not the burst is being transmitted and thus whether or not color information is being sent.

This information is converted to a bias component which cuts off the chrominance bandpass amplifier when the burst is absent. Thus the chrominance channel may be rendered inoperative during reception of monochrome pictures.

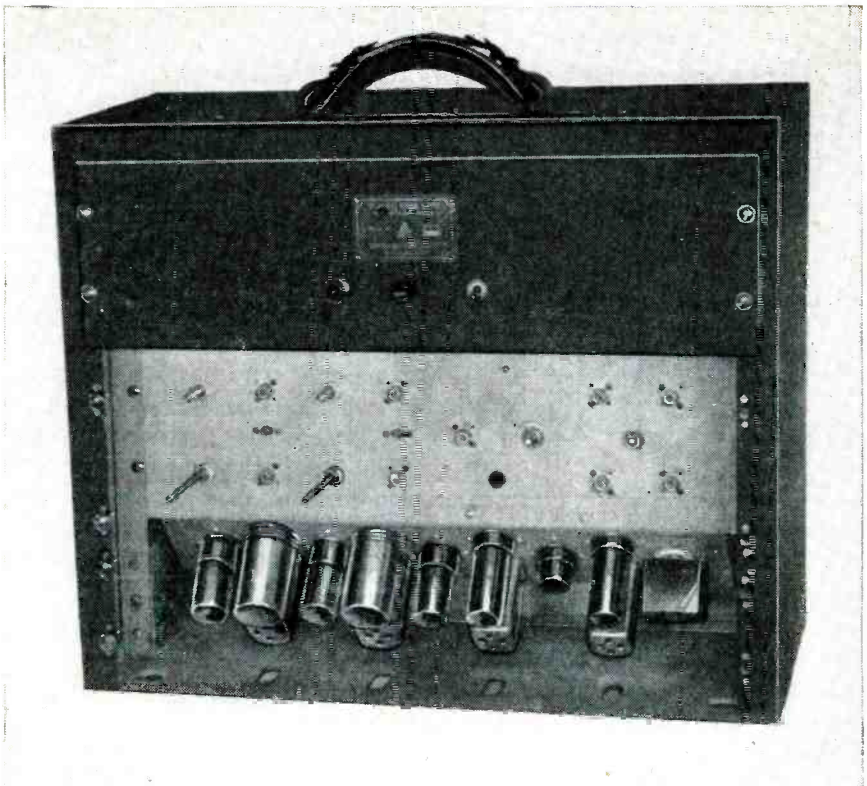
Other forms of interference to which the color receiver is peculiarly susceptible include sinewave interference to the color carrier. A strong carrier in the vicinity of the color carrier may result in a beat developed by the color demodulators. This beat, in the order of a few hundred kc, will result in an interference pattern, which would not exist on an ordinary monochrome receiver under the same conditions. Fortunately, due to the constant-luminance feature of the system, the effects of such interferences (as well as thermal noise) have been minimized.

Radiation

Extensive tests have shown that the color receiver is also capable of causing interference particularly in the 3.58-mc region and harmonics thereof. The receiver is capable, unless properly shielded, of radiating energy from its local 3.58-mc oscillator and also radiating video color information. The demodulators may be particularly efficient harmonic generators. The magnitude of such radiations has been found to be somewhat greater than sweep radiation, but may be eliminated effectively by relatively simple shielding and design procedures.

Other design considerations relate to the tricolor tube, its deflection convergence, and power supply requirements. The supply for the picture tube must receive special consideration since present tubes require at least 18 to 20 kv (regulated) and at least three times the second anode current required of black and white kinescopes. Suitable fly-back components for this application have been designed.

Circuits and procedures for convergence have been treated elsewhere and are available. Particular attention must be directed toward elimination of 60-cps hum components in the picture due to the asynchronous nature of the vertical deflection sync signal.



View of instantaneous multiplier with cover removed. Top section is power supply

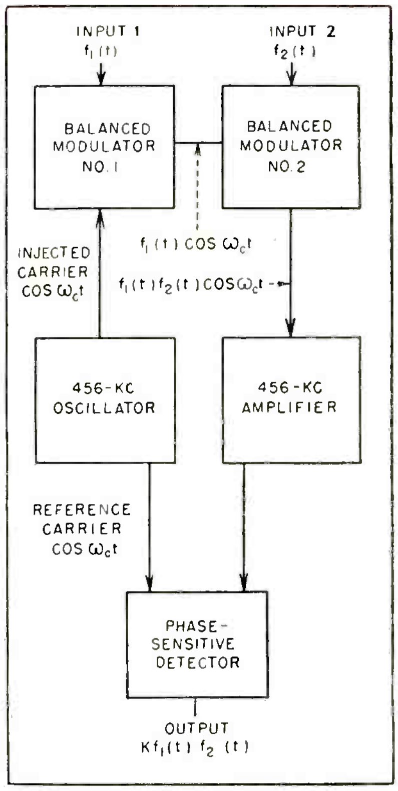


FIG. 1—Block diagram of multiplier

Instantaneous Multiplier

Cascaded curvature-type balanced modulators perform multiplication of two voltage functions of time and give direct indication of product whether positive or negative. Standard i-f coupling transformers and other available components are used

Instantaneous multiplication of two voltage functions of time is accomplished by the instrument shown in the photographs. As indicated in the block diagram of Fig. 1, the output is proportional to the product of the two inputs whether positive or negative.

The voltage input functions may contain components from 0 to 5,000 cps and the dynamic range of the output may be 50 to 1. When maximum peak amplitudes of the input functions (approximately 2 volts peak to zero of any polarity) are applied to both input channels concurrently the extraneous terms or errors in the output will have a combined peak amplitude less than 10 percent of the peak amplitude of true product terms.

Circuit Details

Referring to the complete circuit diagram, Fig. 2, a carrier voltage $E_c \cos \omega_c t$ is effectively applied in parallel to both sections of a balanced modulator through cathode follower V_1. The carrier voltage is supplied, as indicated, from crystal oscillator V_8. An additional function of V_1 is to furnish an essentially push-pull low-frequency input voltage function $f_1(t)$ to the balanced modulator when Input 1 consists of such a function. The input voltage function $f_1(t)$ is applied to one grid of the balanced modulator and also, through a voltage divider, to the grid of the cathode follower. The low-frequency voltage output of V_1 is one-half the amplitude of the input voltage function. The low-frequency inputs applied between each balanced modulator grid and the V_1 cathode are thus equal and of opposite polarity,

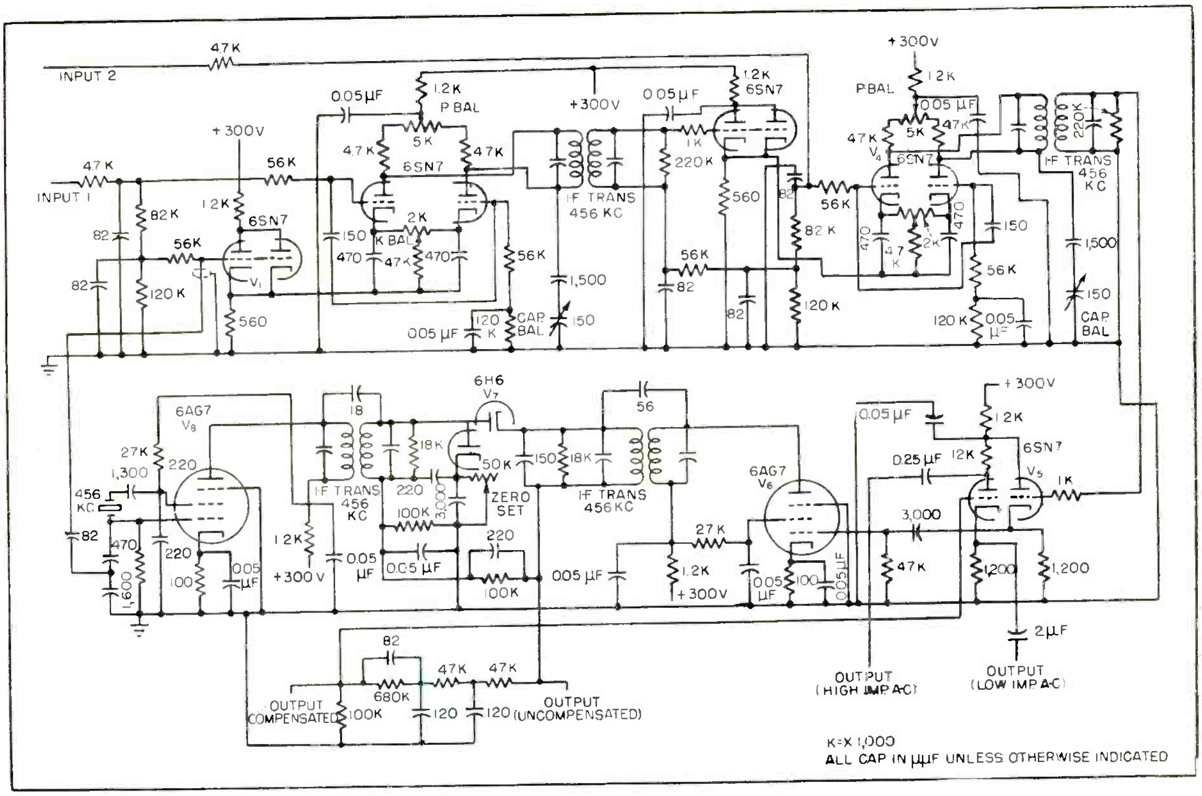


FIG. 2—Complete schematic of multiplier shows use of standard components

for Computers

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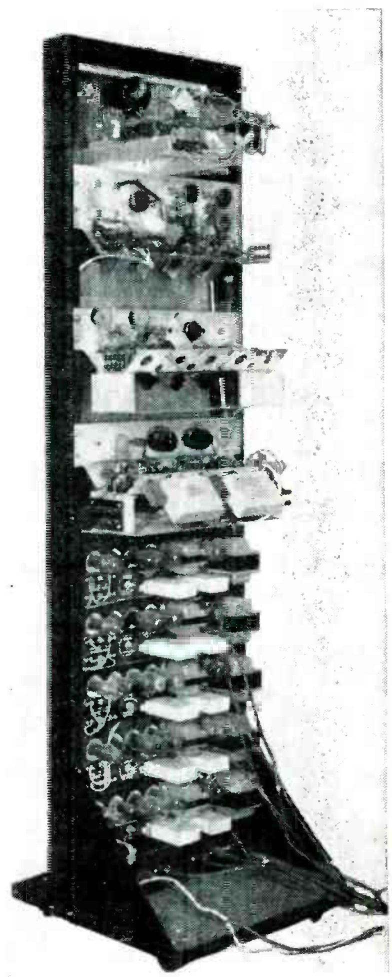
since one such voltage is $f_1(t) - f_1(t)/2$ while the other voltage, considering the cathode of V_1 as the reference point, is $-f_1(t)/2$.

If the low-frequency input voltage function $f_1(t)$ is of zero amplitude and if the characteristics of each section of the balanced modulator are identical, then the voltages at the carrier frequency measured from each balanced-modulator plate to ground will be of equal amplitude and like phase. Since a resonant filter consisting of coupled tuned circuits is connected between these two points and since no net voltage exists across the filter, the filter's voltage output will be zero. Each half of the balanced modulator is operated as a nonlinear device.

When the low-frequency input function $f_1\ (t)$ has some value other than zero, a voltage will appear at the output of the resonant filter. This voltage having the form $K_1 f_1(t) \cos \omega_c t$ is applied to the grid of the cathode follower in series with a part of Input 2, low-frequency input function $f_2(t)$. The operation of the second balanced modulator V_4 is essentially the same



Correlation computer. Top chassis is timer and integrator; second and third are instantaneous multipliers as that of the first modulator.

The voltage output from the secondary of the resonant filters in the plate circuit of V_4 is of the form $K\ f_1(t)f_2(t)\ \cos\ \omega_c t$ and is applied to cathode follower V_5. The output of V_5 is amplified by V_6 and applied as one input to a phase sensitive detector V_7. The other input to V_5, $A\ \cos\ \omega_c t$, is obtained from V_8.

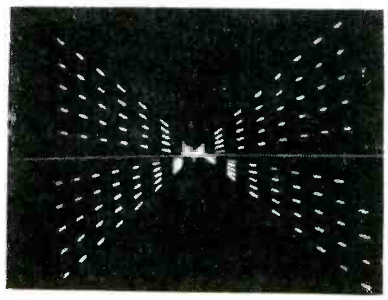
Multiplying Process

The reference carrier, $A\ \cos\ \omega_c t$, obtained from the plate circuit of crystal oscillator V_8 is larger than the peak value of the maximum signal input $K\ f_1\ (t)f_2(t)\ \cos\ \omega_c t$. Assuming that either $f_1(t)$ or $f_2(t)$ is zero, this reference carrier will produce zero-frequency voltage drops across the two diode load resistors R_1 and R_2 (See Fig. 3). These voltages will have opposing polarities as shown, and by adjusting R for balance the output voltage will be zero.

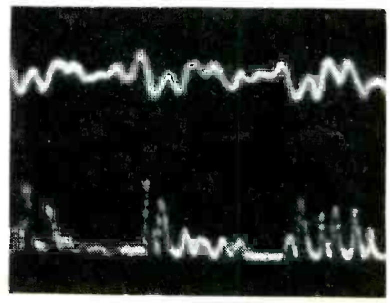
This is the method of subtracting out the direct voltage produced by the injected carrier. The voltage across R_1 is a constant d-c voltage approximately equal to the peak value of the reference carrier, while the voltage across R_2 is the result of rectifying the vector sum of the input signal and the reference carrier. The output voltage is equal to the voltage across R_2 minus the voltage across R_1.

For example, if the d-c voltages produced by the reference carrier are equal to A and if $f_1(t)$ and $f_2(t)$ are d-c voltages then the signal input will consist of a carrier frequency voltage $B\ \cos\ \omega_c t$. If this signal voltage is in phase with the reference voltage a d-c voltage whose magnitude is A plus B will appear across R_2 while a voltage A will appear across R_1. The output will be a d-c voltage of a value B. Since the product of two d-c voltages is a d-c voltage, it can be seen that the correct form of output voltage has been obtained.

If either $f_1(t)$ or $f_2(t)$ is reversed in polarity, the polarity of the output voltage will likewise reverse. These vector relationships are shown in Fig. 3. Because of vector addition in the detector circuit the carrier-frequency voltage output of amplifier V_6 must be either in phase or 180 degrees out of phase with the detector's reference carrier for the output to be linear with respect to the inputs. This necessary phase relationship is obtained by tuning the oscillator's resonant filters for optimum operation.



Product of sawtooth and different amplitudes of 500-cps square wave



Lower waveform is square of complex waveform shown above

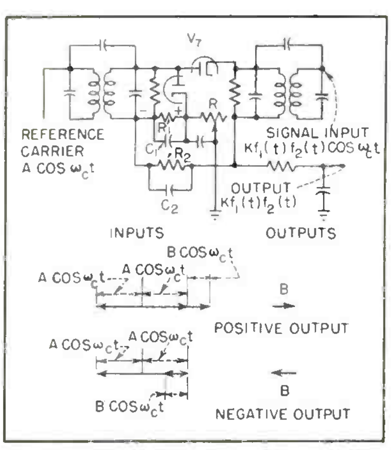


FIG. 3—Basic circuit of phase sensitive detector and output signal vectors

Adjustment

The potentiometers and variable capacitors in the balanced modulator cathode and plate circuits are for adjusting tube and circuit parameters to obtain proper operating conditions. These adjustments, while not critical are, unfortunately, interacting so that several adjustments and readjustments may be necessary. A typical alignment procedure is described in a later paragraph.

Crystal oscillator V_8 functions essentially as a Pierce oscillator with independent outputs taken from both the grid and plate circuits. This arrangement permits the plate output to be shorted, as required in one step of the alignment procedure, without substantially affecting the grid output.

The frequency components of the input functions which the balanced modulator multiplier may accommodate without excessive distortion are primarily limited by ability of the various tuned filters to pass the sidebands which are produced. By employing a carrier frequency of 456 kc and by moderately damping the tuned filters, an overall bandpass of from zero frequency to 5 kc may be achieved. Input functions with all their frequency components within this range may be multiplied without excessive distortions caused by bandpass restrictions.

The tuned filter in the second balanced modulator plate circuit will, in general, require wider bandwidth than the tuned filter in the first balanced modulator, if an instantaneous product is desired. The following equations will clarify this need. If $f_1(t) = \cos\ \omega_1 t$ and $f_2(t) = \cos\ \omega_2 t$, the output of the first balanced modulator will contain two sidebands, since $\cos\ \omega_1 t \times \cos\ \omega_c t \propto \cos\ (\omega_c \pm \omega_1)\,t$. The output of the second balanced modulator will contain four sidebands, since $\cos\ \omega_1 t \times \cos\ \omega_2 t \times \cos\ \omega_c t \propto \cos\ (\omega_c \pm \omega_1 \pm \omega_2)\,t$. Thus the first balanced modulator tuned filter requires a bandwidth of $2\omega_1$ while the second tuned filter, and subsequent filters, require a bandwidth of $2(\omega_1 + \omega_2)$.

If the product's d-c component alone is of interest, somewhat different requirements are placed on the respective bandwidths of the two balanced modulator tuned filters. A d-c component exists in the product only when a carrier-frequency component is produced at the output of the second balanced modulator. Such a component will exist only when $f_1(t)$ and $f_2(t)$ are of the same frequency or contain components of the same frequency. For example, if $f_1(t) = f_2(t) = \cos \omega t$ the output of the first balanced modulator will contain two sidebands, since $\cos \omega t \times \cos \omega_c t \propto \cos (\omega_c \pm \omega)t$. The corresponding output of the second balanced modulator will contain frequencies $\cos \omega_c t \times \cos \omega t \times \cos \omega t \propto \cos \omega_c t + \cos (\omega_c \pm 2\omega)t$. The required bandwidth of the first balanced modulator tuned filter is the same as in the previous case where an instantaneous product was desired. However, the bandwidth of the second balanced modulator tuned filter, and subsequent filters, need pass only the carrier-frequency component, when averaging multiplication alone is desired. Thus, such filters may be sharply tuned.

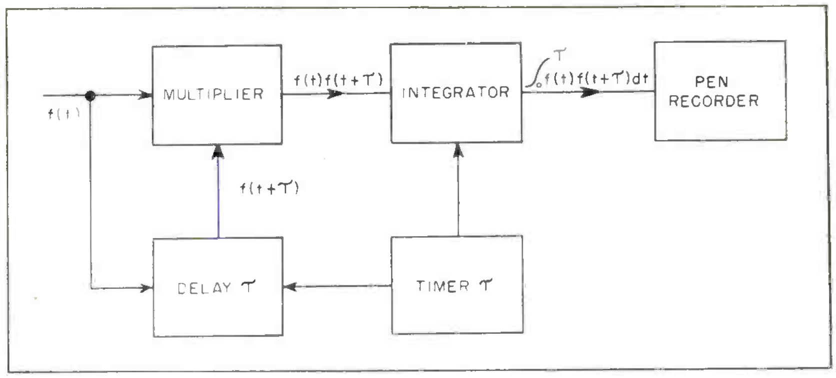
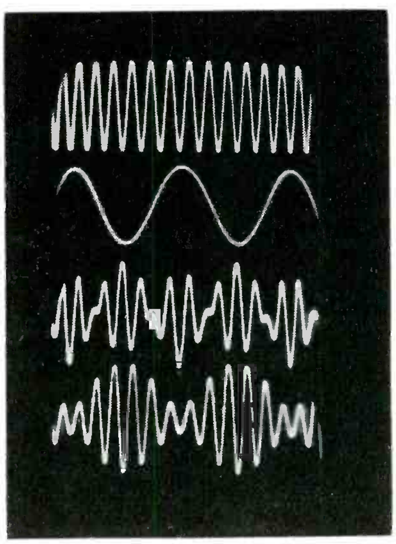
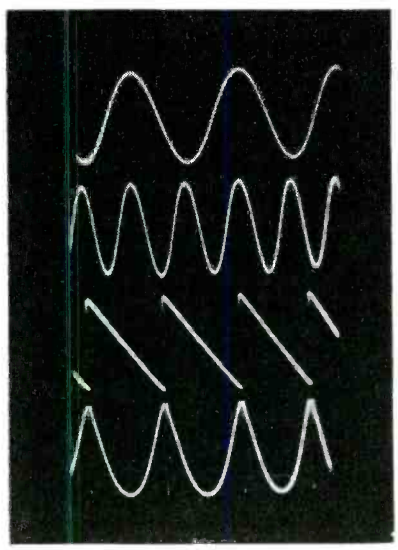


FIG. 4—Block diagram of circuit for obtaining autocorrelation of a function



Third line is product of first two. Fourth is product obtained by adding d-c to low-frequency input and multiplying this sum by higher frequency input



Sine wave (first line) applied to both inputs gives squared waveform (second line). Fourth line is squared version of sawtooth shown in third line

The present instantaneous multiplying device can obtain a product of two input functions whose frequency components may be as high as approximately 1 percent of the carrier frequency employed. By employing a much higher carrier frequency it should be possible to multiply input functions whose frequency components are in the order of several megacycles.

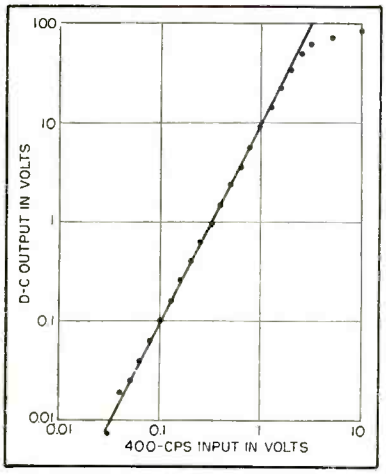
Alignment

The only instrument necessary to align the balanced modulator instantaneous multiplying device is a zero-center, vacuum-tube voltmeter; a 20,000 ohm-per-volt meter may be used but polarity reversing will be required. Two 1.5-volt batteries and a 0.01-μf capacitor or larger are also required.

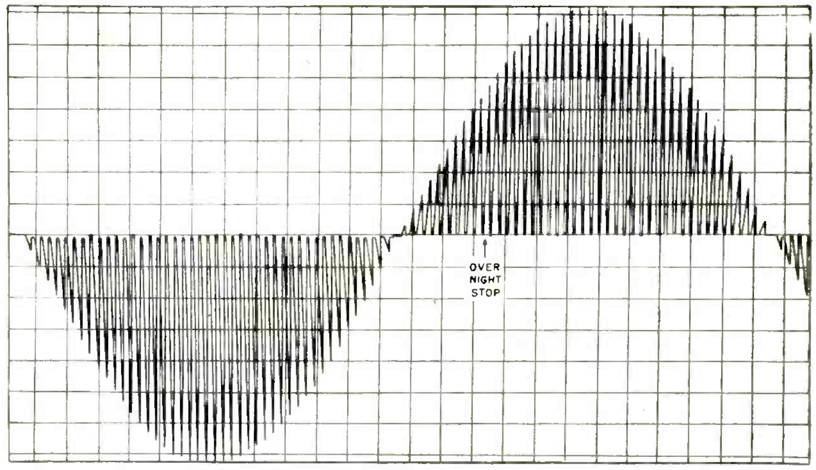
The vtvm is connected across the output of the multiplier while the capacitor is used to effectively short the plate output of crystal oscillator V_8. The batteries are connected to apply +1.5 volts to each multiplier input channel. The cathode and plate-balancing potentiometers and capacitors are set at approximately the center of their adjustable ranges. The secondary windings of the tuned filters in the balanced modulators and both primary and secondary windings of the tuned filter in the amplifier's plate circuit are then adjusted for maximum voltage reading on the vtvm.

The +1.5-volt battery input to the second balanced modulator is disconnected and the cathode-balance potentiometer of this stage is adjusted for minimum voltage reading on the vtvm. The plate-balance potentiometer and the primary tuning of this stage are then recurrently adjusted for zero reading on the vtvm. The battery is reconnected and the vtvm reading noted. The polarity of the battery is then reversed and the meter reading is again noted. These two meter readings should be approximately equal. If a difference between these readings exists, the cathode-balance potentiometer of this stage is adjusted until the difference between the readings is approximately doubled. The battery is then disconnected and the plate-balance potentiometer and capacitor adjusted for zero reading on the vtvm. The balance capacitor is a somewhat more convenient means for accomplishing an action similar to that of the balanced modulator's primary tuning. The battery is reconnected and the preceding checks and readjustments are made until there is no difference in the vtvm reading between a positive or negative 1.5-volt input.

A battery is connected to the second balanced modulator stage, and the battery input to the first stage disconnected. Adjustments similar



Amplitude range of input functions over which true product is obtained



Autocorrelation of sine wave. Stability of equipment is indicated by absence of discontinuity at point where machine was turned off for sixteen hours

to those described in the preceding paragraph are then made on the first balanced modulator stage.

With both batteries disconnected, the 0.01-μf shorting capacitor removed and the vtvm connected to the junction of the two 100-K resistors in the phase-detector circuit, the primary and secondary tuning capacitors in the crystal oscillator plate circuit are adjusted for maximum reading on the vtvm. With the vtvm again connected to the output of the multiplier, the phase detector's zero-set potentiometer is adjusted for zero reading on the vtvm.

With +1.5 volts connected to each input channel the tuning capacitors in the crystal oscillator plate circuit are now very slightly adjusted for maximum reading on the vtvm. Both a positive and a negative maximum may be obtained; the adjustments which provide the largest absolute maximum correspond to the desired operational settings. The voltage reading of the vtvm is noted and the polarity of one of the batteries reversed. The voltage reading of the vtvm should likewise reverse. Further slight readjustments in the tuning of the oscillator tuned circuits may be necessary to achieve equal and opposite vtvm voltage readings as the polarity of one of the batteries is reversed.

To obtain optimum operating conditions, the alignment procedure may be repeated using the preceding obtained control settings as initial adjustments.

The balanced-modulator instantaneous multiplying device may be employed as an element in an electronic computer. A typical example of such an application in a statistical computer is shown in Fig. 4, which indicates the interconnections required for obtaining the autocorrelation of a function.

The mathematical operation which a computer performs to obtain the autocorrelation of a function $f(t)$ may be expressed as

$$\varphi(\tau) = \int_0^T f(t)\, f(t+\tau)\, dt$$

where $\varphi(\tau)$ is the autocorrelation function of $f(t)$, τ is the time-delay parameter and T is a constant integrating time which is large compared to the period of the lowest frequency component of $f(t)$.

During any one integrating period T there is a fixed amount of delay. The multiplier forms the product $f(t)\ f(t+\tau)$ which, in general, consists of a d-c component and higher frequency components. If T is large compared to the period of the higher frequency components the integrator acts as an averaging or smoothing device.

For example, if the output of the multiplier is of the general form $E_{d-c} + A \sin \omega_1 t + B \sin \omega_2 t + \ldots$ the output of the integrator will be $\int_0^T (E_{d-c} + A \sin \omega_1 + B \sin \omega_2 t + \ldots)\, dt \propto E_{d-c}$.

During any one integrating period T the pen recorder will follow a linear voltage whose final value at time T is one point of the autocorrelation function corresponding to $\tau = \tau_1$. At the end of the integrating period the integrator timer dumps the integrator to zero output and a new value of delay $\tau = \tau_2$ is set in. This will result in a new final value (τ_2) for the pen recorder which is a second point of the autocorrelation function corresponding to $\tau = \tau_2$. After a sufficient number of delays have been set in, the final values on the pen recorder may be joined to form a curve which is the autocorrelation function of $f(t)$.

With signals whose frequency components are lower than may be accommodated by usual recording means, such as magnetic-tape recorder, the balanced-modulator multiplier may be employed to place the low-frequency information on a suitable audio-frequency carrier which is within the recorder's range. This modulation process may be accomplished by applying the low-frequency signal voltage functions $f(t)$ plus a d-c voltage E_{d-c} to one input of the multiplier and a suitable audio-frequency carrier voltage $E_c \sin \omega_c t$ to the other input. The output of the multiplier will be the audio-frequency carrier modulated by $f(t)$ since $E_{out} = K\, e_1 e_2 = K\, [E_{d-c} + f_1(t)]\, E_c \sin \omega_c t$.

The preceding equation is the mathematical relation involved in amplitude modulation. By adjusting E_{d-c}, the index of modulation may be controlled. Normally, E_{d-c} is made large compared to the peak value of $f(t)$ and a diode detector is employed at the output of the recorder to recover the low-frequency time function.

Crucible Heat Control

Photoelectric pyrometer setup measures temperature of small graphite crucible mounted between electrodes of electric furnace. Associated two-point electronic control holds temperature within 8 deg of 1,700 C by shorting out resistors in d-c circuit of reactor

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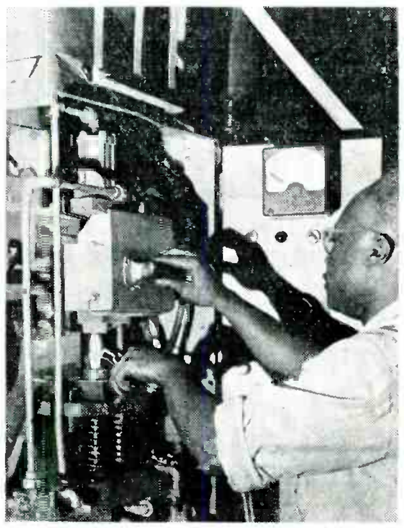
PRODUCTION of ignitors or starters for ignitrons involves placing the boron constituents and a graphite shank in a crucible for sintering at about 1,700 C. To maintain control of the quality and uniformity of the finished product, both temperature and time of the sintering operation must be controlled within close limits. This is accomplished with the automatic furnace control circuit shown in Fig. 1.

An optical system focuses radiant heat from the crucible onto the cathode of a gas phototube connected into the control-grid circuit of a 6J7 pentode. A suppressed-zero temperature-indicating milliammeter in the plate circuit of this tube is calibrated periodically with an optical pyrometer. Corrections are made by adjusting the phototube aperture disk and the range and sensitivity controls.

For sintering at 1,700 C, panel controls would be set so that thyratron V_1 fires at 1,600 C and pulls in its relay, thereby inserting R_1 in the d-c control circuit of the saturable reactor and decreasing power to the crucible. This decreases the rate of temperature rise, preventing overshooting. When the temperature reaches 1,708 C, thyratron V_2 fires and pulls in its relay, inserting R_2 and decreasing crucible power enough further so that the temperature starts dropping. When it drops to 1,692 C, V_2 blocks and its relay opens to short out R_2, increasing power and temperature. The temperature thus oscillates up and down about the control temperature.

A timer, started by an extra set of contacts on the relay of V_1, operates after 30 seconds and turns off the power. The equipment is then ready to begin another cycle as soon as a new crucible is placed between the electrodes.



Operator removes heated crucible with tongs after power has been shut off by 30-sec timer in control box of furnace

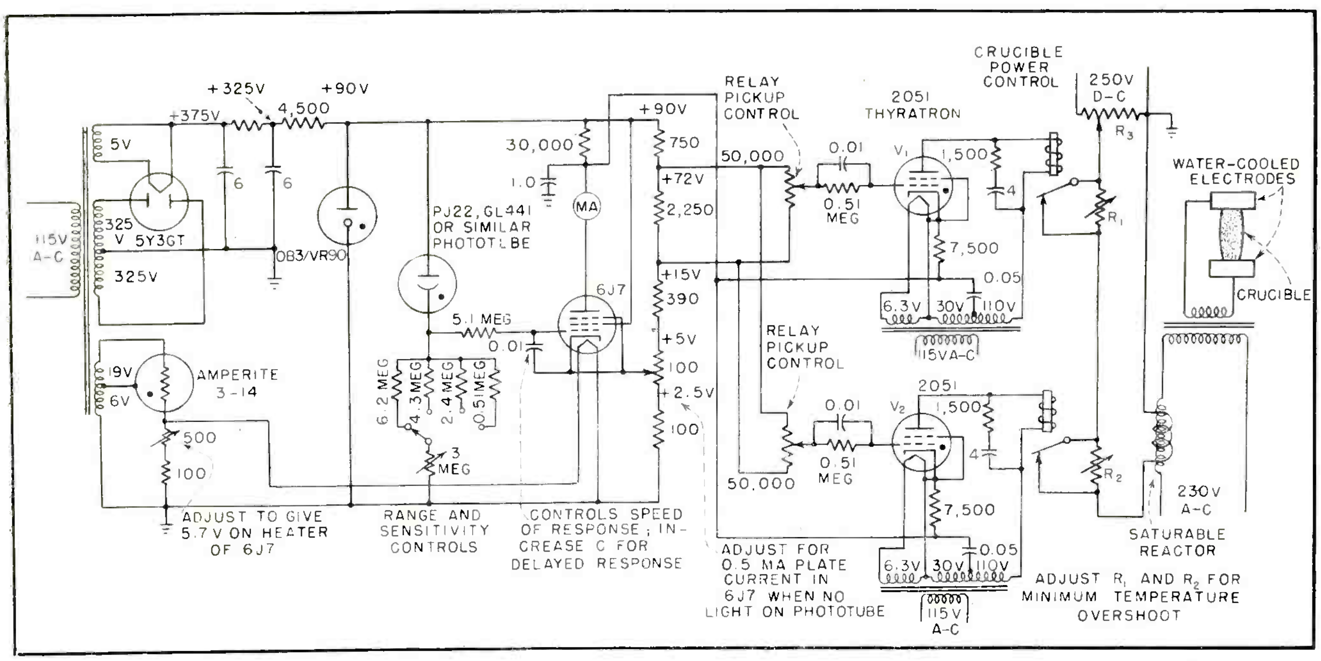


FIG. 1—Complete circuit of stabilized photoelectric amplifier as used for two-point control of temperature in graphite crucible

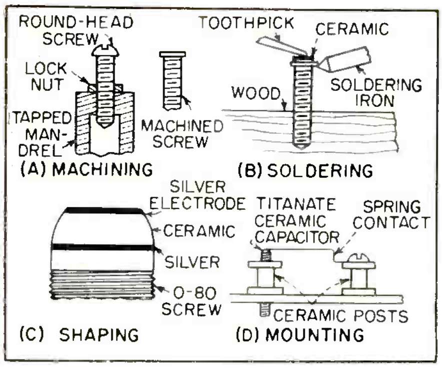


FIG. 1—Construction of variocap components

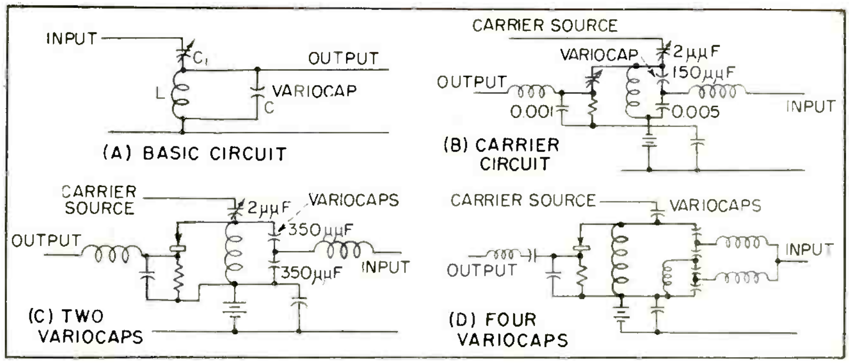


FIG. 2—Single-stage dielectric amplifier circuits using nonlinear variocaps in four ways

Building and Using Dielectric Amplifiers

Step-by-step instructions for constructing nonlinear barium-strontium-titanate capacitors giving power gain up to 10,000 per stage in dielectric amplifiers. Circuits include cascaded two-stage voltage amplifier and output stage capable of driving loudspeaker

By ABRAHAM SILVERSTEIN

*National Bureau of Standards Washington, D. C.**

NONLINEAR barium-strontium-titanate capacitors, designated variocaps for convenience showed early promise as dielectric amplifiers. Research involving various capacitor configurations and circuits confirmed this and showed stable operation to be entirely possible. Potential advantages over electron-tube amplifiers are compactness, sturdiness, freedom from microphonics and noise, low distortion, high power gain, wide frequency response, absence of heater supply and practically no heat production.

A variety of forms were considered and tried for fabrication of the small titanate capacitors. However, the final type is so superior to the others, in point of convenience and ease of production both for the smallest and larger sizes, that a detailed description of the process will be given.

Construction of Variocaps

The (Ba-Sr)TiO_3 capacitors are available in the form of small sheets up to 3 × 5 inches in surface area and from 5 to 20 mils thick. They will normally have a Curie point at room temperature. Unless bare ceramic is requested, the sheets are painted on both sides by the manufacturer with a special silver paint made of finely divided silver, plastic, thinner and constituents for a vitreous binder. After drying, the painted ceramic is fired at about 1,300 F. The plastic binder is driven off, while the silver and glass constituents form a combination having nearly the conductivity of silver but vitreous enough to adhere firmly to the titanate ceramic. In this form, the silver electrode will take solder, but if the molten solder is kept in contact with the electrode for more than a few seconds the silver is likely to go into solution with the lead and tin, leaving the ceramic bare.

There is available a plastic-cored solder consisting of lead and tin with about 4 percent of silver. The silver admixture appears to reduce the tendency to dissolve the electrode.

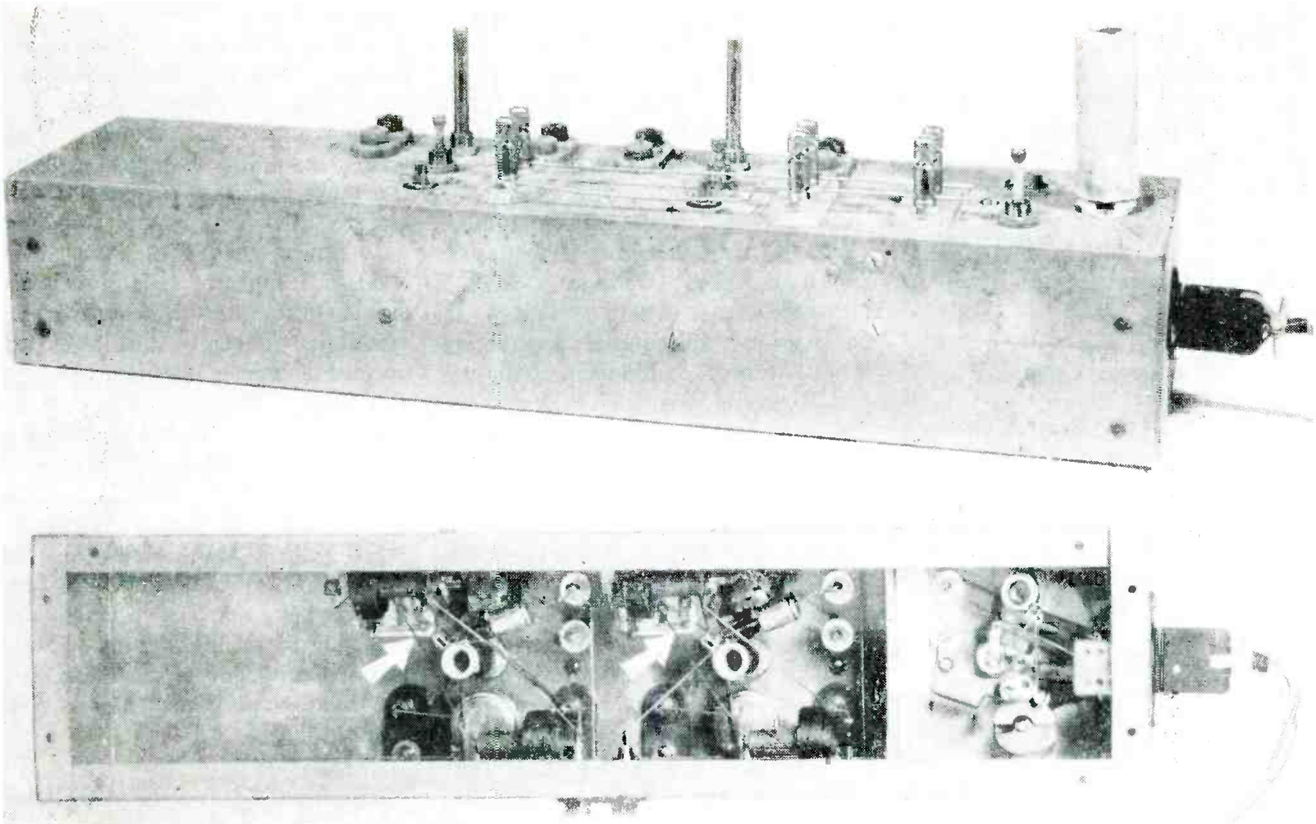
These are the raw materials. It remains to fabricate them into a useful form.

A round head 0-80 brass screw is fitted to a tapped mandrel, secured with a lock nut as in Fig. 1A and turned down in a lathe so that the slot is removed from the head and a flat plane is left, with no burrs.

The screw is placed in a body-size hole in a piece of Bakelite, wood or other poor conductor of heat. Then, using a small pointed iron, the flat surface is tinned lightly, taking care not to solder the thread below.

A silvered sheet of ceramic capacitor is placed on a flat, slightly yielding surface such as a few sheets of paper on a table. Then, by pressure with a backed single-edge razor blade, the sheet is cut into strips and then into 2-mm squares. A ceramic square is placed on the tinned screw top which has been swabbed with a

*Now with Naval Ordnance Laboratory.



Top and bottom views of cascaded two-stage dielectric amplifier, with 6AQ5 carrier-source oscillator at right end of chassis. Arrows point to the variocaps under the chassis. Extra input and output terminals and controls are provided here for experimental purposes

solution of rosin in alcohol. Now, placing a dry soldering iron under the screw top, a flat toothpick is placed on the ceramic as in Fig. 1B. When the solder melts, the ceramic square is worked to and fro on the screwhead until the silver has been thoroughly wetted by the solder and the square slides with friction against the brass. The square is then brought to the center of the screwhead and the iron is removed while pressure is maintained on the ceramic. When cooled, the ceramic is firmly attached to the brass. A toothpick is used because a good conductor of heat would shatter the ceramic.

The screw is again placed in the mandrel, secured with a locknut and the assembly is put into a lathe or fastened to a small motor shaft. (A drill press was used here.) Using a small flat file with smooth edges, the thickness of the brass head is reduced from below by placing the smooth edge of the file against the screw thread and pressing lightly with the cutting edge against the under side of the screwhead but stopping before the ceramic is reached. Then, with sandpaper (No. 2/0 at first) backed by a light slab of wood or plastic, the head and the capacitor itself are worn down at the sides by light strokes from the top down toward the mandrel until a shape as in Fig. 1C is achieved.

If the finest grade of abrasive paper is used to finish the shaping, the brass and ceramic look perfectly polished under a medium-power microscope. The brass-silver-ceramic junction shows no discontinuity and no evidence of the solder layer can be seen. This method of mounting appears to damp out all traces of piezoelectric resonances. The conduction of heat from the ceramic is better than through a soldered lead.

The essence of the technique is that light, yielding tools are applied to the metal-ceramic junction. A rigid grinder would seize the soft brass and shatter the ceramic.

Using a vertical drill press, mounted capacitors have been turned down in about 4 minutes. The actual soldering of silvered ceramic to brass takes about 5 seconds of working time.

In vhf applications, the capacitor screws are inserted in tapped posts of ceramic terminal strips. Contact to the upper electrode is made by spring tension from an adjacent post as in Fig. 1D. Arcing between the electrodes through air has been eliminated by putting a dab of vinyl carbazole plastic over the spring-screw junction.

Thin Capacitors

For use in the dielectric amplifier to be described, some extra-sensitive capacitors 2.5 mils thick were made in sizes up to several thousand micromicrofarads. The ceramic was ground down from thicker stock in equipment used to grind quartz crystal wafers to frequency. The mean sensitivity was ½ percent change in capacitance per volt. Special precautions were required in selecting and silvering the wafers, but the mounting procedure was much the same as for the thicker material except that rounding of the finished unit was omitted. This was done because of the larger values of capacitance required (over 2,000 $\mu\mu$f).

The basic variocap circuit, shown in Fig. 2A, involves using the variocap as part of a resonant tank circuit. Signal voltage applied to the variocap serves to shift the resonant frequency. The response of the tank circuit to a fixed-frequency carrier source then changes by a greater voltage than that of the signal.

Variocap Circuits

This circuit finds particular usefulness in applications where the source impedance is too large for high-Q series resonance and too low for parallel resonance. Capacitor C_1 is generally kept considerably smaller than C. When detuned slightly from the resonant frequency of LC, the inductive impedance is opposed by the capacitive impedance of C_1 and a voltage step-up is achieved across LC at approximately the frequency of the LC combination. The exact value of C_1 is a compromise between voltage step-up required and degree of decoupling from source desired.

The next development was the circuit of Fig. 2B, in which a single variocap is modulated in a resonant circuit. The carrier source was a simple tickler-coil oscillator using a 6AQ5. The output was tunable between 1 and 3 mc and output voltage was variable between 5 and 150 volts. The 2.5-mil variocap used had a mean sensitivity of ½-percent change in capacitance per volt over the useful range. The corresponding frequency change in a resonant circuit was therefore about ¼-percent per volt. The coil and capacitor in combination had a Q of 50.

Calculation shows that for a carrier level of 1 volt at resonance, a voltage gain of about 0.1 may be expected if the circuit is detuned to the steepest part of the resonance curve. Doubling the carrier should double the voltage gain and such was actually the case when the carrier was kept less than about 15 volts rms for the 2.5-mil variocaps. Beyond this value, the increase in carrier voltage yielded no increase in gain because the wide swings of carrier were running into the flatter portions of the capacitance-vs-bias curve and beyond the bias voltage. Also, the loss tangent probably increased with amplitude, thereby lowering the Q.

While the exact voltage gain varied with the particular variocap used, the usual peak gain was only about 1.5 for the circuit of Fig. 2B. The circuit modification of Fig. 2C was therefore tried next. Here the carrier voltage is divided between two equal variocaps in series and the signal applied to the parallel combination. The applied carrier can now be increased to twice that of the first case. A doubling of voltage gain is achieved.

In Fig. 2D, four variocaps are again in series to the carrier voltage but in parallel for the signal voltage. The principle cannot be extended indefinitely since the loss in the chokes or resistors used to separate the carrier from the signal would limit the gain.

Considering the direct voltage amplification, it might appear that the gain per stage is very moderate unless at least four thin variocaps are placed in series. A calculation of the power gain, however, shows that whether a single variocap is used or several are stacked, the power gain is high. For a 2.7-mc carrier frequency and a 100-cps signal frequency the gain is over 10,000. The power gain arises from the fact that the variocaps have a high impedance to the signal frequencies and a relatively low output impedance because of the much higher carrier frequency. For very low signal frequencies the power gain appears to increase without limit. Noise is very low, an advantange over the transistor.

Characteristics

A number of basic properties of the dielectric amplifier may be stated:

(1) The higher the carrier frequency for a given output impedance the greater the power gain, since the ratio of signal input impedance to r-f output impedance is increased. The input choke can be more efficient when the ratio of carrier to signal frequency is high.

(2) If the dielectric is subdivided into series elements for the carrier while the input signal is applied in parallel, the voltage gain will increase but the power gain is not changed since the input admittance is correspondingly increased.

(3) Thinness of variocaps is not an aid to gain since by applying the larger permissible carrier voltage to thick capacitors, the same gain can be realized as with sensitive, thin capacitors. However, the smaller the total thickness of the resonant variocap, the lower the optimum carrier voltage and carrier power consumption.

(4) For a power-output stage where the desired voltage swing is larger, the total dielectric thickness should be larger so that a carrier about three times the output signal may be used. Several thin variocaps in series are superior to a single thicker variocap of equivalent capacitance, since the heat conduction from the dielectric is greater.

Cascaded Dielectric Amplifier

After construction of the single-stage dielectric amplifier, the two-stage voltage amplifier of Fig. 3A was built using the same principles. For experimental reasons the bias, C and L were made variable. The resonant inductances were slug-tuned solenoids having 85 turns of No. 30 enameled silk-covered wire on a ½-inch ceramic coil form. This gave an inductance of between 0.030 and 0.045 mh with a Q of 150 at 5 mc with 30 $\mu\mu$f, and 105 at 2 mc with 150 $\mu\mu$f. Maximum gain was achieved with about 60 volts bias and a carrier of 40 volts rms across variocaps.

When compactness with good gain is most important, it would be best to use fixed universal wound coils in polyiron shells. Then if variocaps and coils are closely matched, the stages may be aligned with small bias adjustments at little cost in gain.

When the oscillator impedance was increased by decreasing the tank capacitance, the amplifier broke into oscillation at about 20 kc, which is the resonant frequency of the 35-mh chokes with the input capacitance of the second stage. This constituted a dielectric oscillator. Decreasing the oscillator impedance remedied the condition.

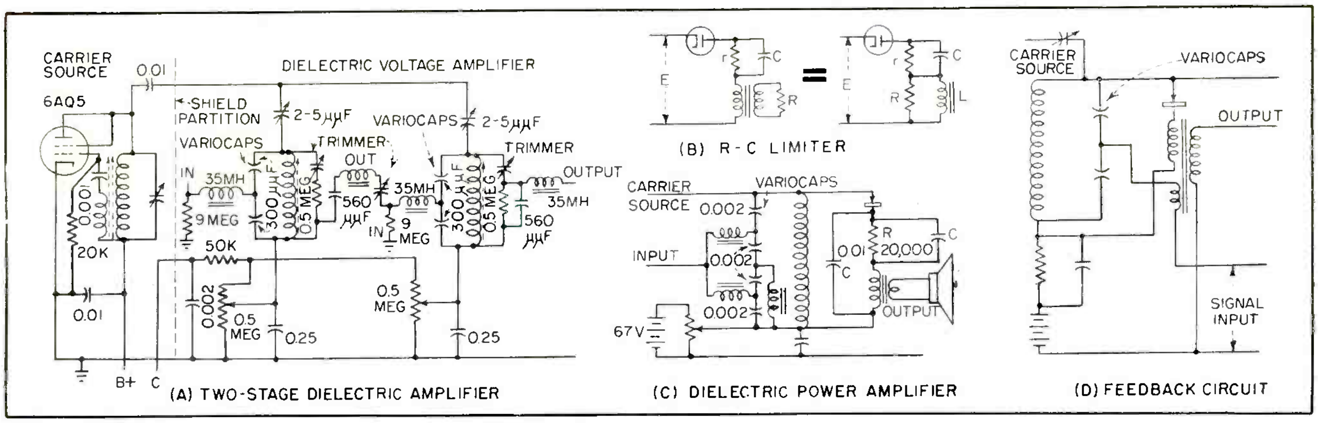


FIG. 3—Examples of dielectric voltage and power amplifier circuits using carrier sources. These circuit techniques are also adaptable to the small capacitance value used in vhf f-m oscillators. Mathematical derivations and further details are given in the original NBS reports by the author, 13.4-74R and 13.4-102R, available from the NBS Technical Reports Section

A dielectric power-output stage capable of driving a loudspeaker was constructed next. The circuits of Fig. 2 are not adapted to driving a loudspeaker because the output energy is dissipated in heating the load resistor. If a high-inductance transformer with resistive load were substituted for the resistor, the load would be determined by the resistor for audio frequencies, but for very low frequencies and direct current the transformer would be a short. Unlike vacuum-tube stages, this is not permissible in the dielectric amplifier since the energy lost in d-c flow would destroy the Q and hence the amplification of the stage. This condition can be avoided by using the R-C limiter for direct current, as shown in Fig. 3B.

Calculation shows an interesting property. If $L/C = r^2$ and $r = R$, then the combination will be indistinguishable at all frequencies from a resistor of value r, at least ideally. These proportions are attainable with $L = 10$ henrys, $C = 0.1$ μf and $r = 10{,}000$ ohms. In practice r may be increased up to the point where peak clipping begins, in order to limit d-c flow as much as possible.

These ideas were incorporated in the power stage of Fig. 3C, which has four thin variocaps stacked in series for better heat dissipation.

The optimum loading of a dielectric amplifier stage differs from most sources because the load drops not only the r-f output voltage but also the degree of modulation since this is dependent on Q. Calculation shows the optimum load resistance to be three times that of the source.

Feedback

Positive feedback may be achieved in a single stage of dielectric amplifier using only R-C components. With increase in β, the portion of output voltage fed back, there will be an increase in gain, at least for the peak frequency. When the feedback voltage equals the input the amplifier will oscillate at the peak frequency. However, because of the low voltage gain, feedback is more conveniently achieved with a transformer.

Negative feedback can be applied to any degree without oscillation, providing cumulative phase shifts do not reverse the phase of the output signal.

It would be an advantage if the dielectric amplifier had positive feedback for signal frequencies and negative feedback for very low frequencies and direct potentials. Figure 3D illustrates a circuit in which a transformer winding gives limited positive feedback in series with the signal input, while the entire voltage across the d-c limiter is used to provide negative feedback for counteracting drift.

Phase Considerations

The output phase of a dielectric amplifier stage is determined by three factors: (1) Whether the carrier is above or below resonance of the tank circuit; (2) The polarity of the rectifier used to detect the carrier modulation; (3) The polarity of the bias voltage on the variocaps. It follows that β will be reversed by a reversal of any of these factors.

The oscillations encountered in the circuit of Fig. 3A illustrate a different kind of feedback, in that no signal frequency component is fed back. If the first and second stages are tuned to opposite sides of resonance (the diode polarity is immaterial), positive feedback results across the common r-f impedance in the carrier source. A rise in carrier current due to a signal in the second stage will reinforce a corresponding drop in the output of the first. The degenerative rise in carrier voltage due to the drop in the first stage will not be so large as the first effect because of the lower amplitude.

A small capacitor may be placed in series with the oscillator output to increase the impedance.

The titanate dielectric used in all the amplifier work was Gulton No. 87-12, a $(Ba\text{-}Sr)TiO_3$ ceramic having a broad Curie point at room temperature. With no attempt at temperature stabilization, the amplifiers run for hours without requiring retuning.

A leveling of temperature response could be achieved by placing in parallel two variocaps, one with a Curie point above and the other below the intended temperature. Such a plan might be sufficient for some applications. Where larger variations are expected, an operating temperature could be chosen above the highest ambient temperature expected, and maintained with a heater-thermostat arrangement.

Magnetic Recording for

Tape transport mechanism and associated units mounted in truck. Voice channel is provided for commentary on changing road and test conditions, so that any section of resulting tape recording can be readily identified

Six crystal-pickup or bridge-type accelerometer channels plus voice and timing channels are recorded simultaneously on half-inch magnetic tape during performance tests of military vehicles on rough terrain. Use of f-m carrier recording system for data and ruggedized low-flutter tape transport make equipment immune to road shock

MECHANICAL RESEARCH and test work on the behavior of vehicles and of the electronic equipment installed in such vehicles during road tests can be greatly simplified, facilitated and economized by the use of suitable recording equipment. Such equipment should record the signals picked up by mechanical-electrical transducers, should be undisturbed by external shock and vibration and should be capable of faithfully reproducing the stored information many times.

Magnetic recording seems suitable for such applications. However, conventional audio recorders have several deficiencies for recording of stress, strain, shock and vibration. Few will record signals at a frequency as low as 20 cps and none will record zero cps. Faithful recording of complex waves is impossible because of appreciable phase shift. Amplitude variations are present in the reproduced signal which are due to imperfections in the tape coating. Finally, the recorders will not perform satisfactorily while being subjected to extreme shock and vibration.

The first three deficiencies can be eliminated by use of an f-m carrier recording system, and the fourth can be overcome by a ruggedized, low-flutter tape transport mechan-

Vehicular Research

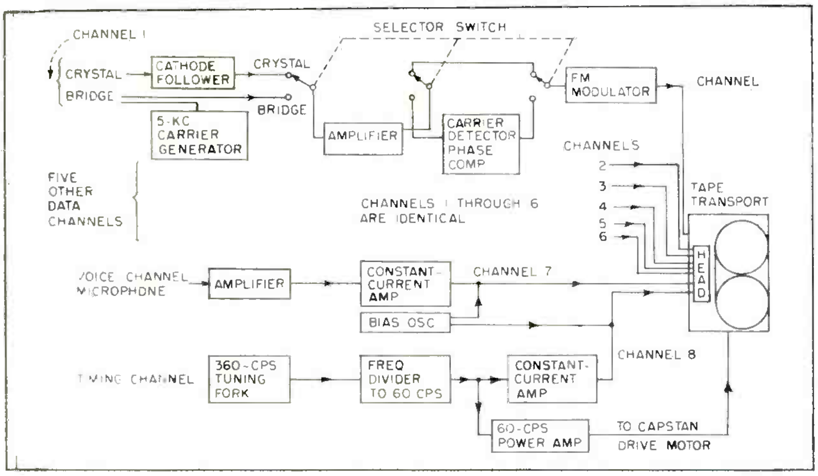


FIG. 1—Block diagram of eight-channel magnetic tape recorder

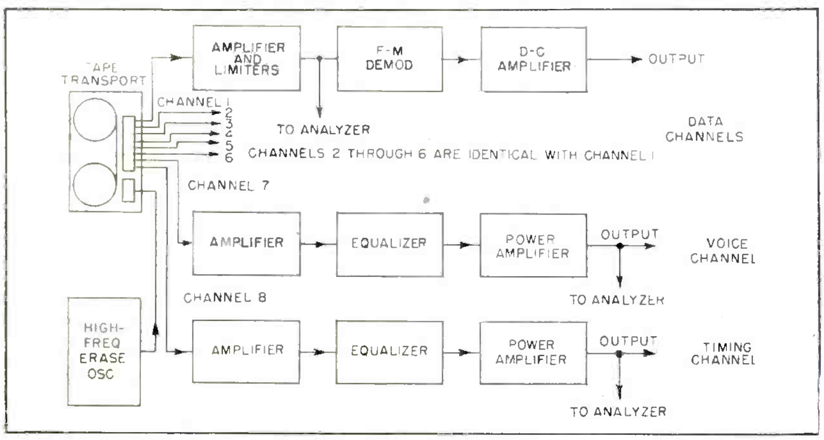


FIG. 2—Arrangement of reproducing equipment used at laboratory

By G. K. GUTTWEIN and J. M. LESLIE, Jr.

Signal Corps Engineering Laboratories
Fort Monmouth, New Jersey

Ampex Corporation
Redwood City, California

ism. Under these conditions magnetic tape recording becomes suitable for vehicular research and test work.

Since a need for such equipment existed at the Aberdeen Proving Ground and the Signal Corps Engineering Laboratories needed a multichannel recorder tailored to the requirements of vehicular research and test work, the development of such equipment was initiated. The development, design and construction work was carried out by Ampex Corp. under Signal Corps contract.

The recording portion of the equipment, shown in Fig. 1, uses multiple tracks on half-inch magnetic tape and is capable of recording eight channels simultaneously. Six data-recording channels utilize an f-m carrier system and have a frequency response from 0 to 1,000 cps. The seventh channel is a direct high-frequency bias recording channel with response from 100 to 10,000 cps for voice recording. The eighth channel records automatically a tuning-fork timing signal. The recorder provides up to 15 minutes of continuous recording at a tape speed of 30 inches per second.

Typical Data

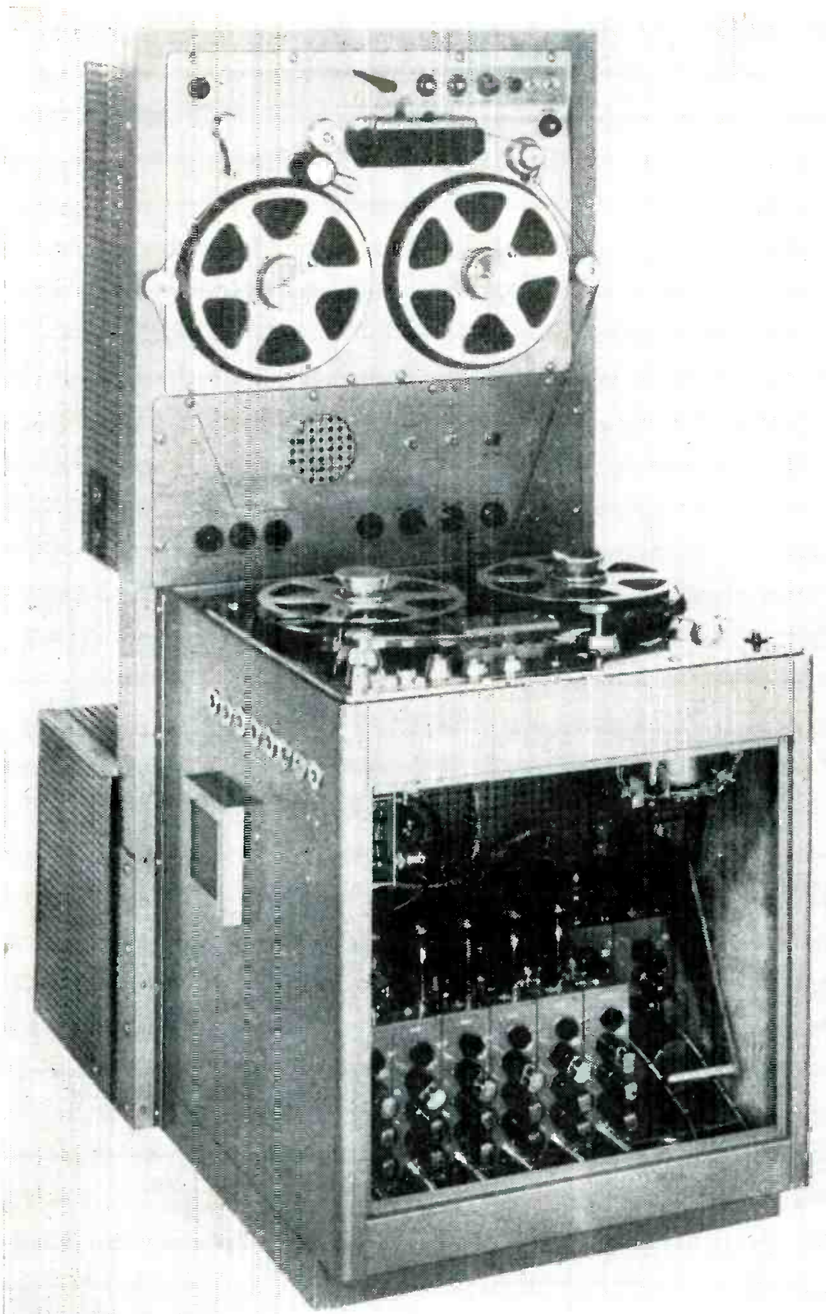
Each data-recording channel is designed to accommodate the two types of pickups most widely used as mechanical-electrical transducers: (1) high-impedance self-generating pickups, particularly piezoelectric accelerometers; (2) low-impedance, bridge-type transducers which require the supply of external carrier power, like wire strain gages, mutual inductance gages and accelerometers based on the strain-gage principle. The signal from each channel is amplified and fed to an f-m modulator. The carrier frequency modulated by the input signal is then coupled directly to the record head.

Channel 7 accommodates a high-impedance microphone or other similar pickup device.

Channel 8 is a timing channel which records automatically a 60-cps waveform on the tape. The same 60-cps source is amplified and used to drive the motor on the tape transport mechanism.

The eight record heads are arranged in two equal stacks, with the head cores interlaced so that channel 1 is at bottom right, channel 2 at bottom left—then finally, channel 7 at top right and channel 8 at top left. The head assembly records eight separate 0.044-inch tracks on half-inch tape simultaneously; the separation between tracks on the tape is 0.020 inch. The heads are interlaced so as to provide the additional space required for winding the coils about the head cores.

Two power supplies are available



Reproducing equipment, with analyzer mounted on vertical rack at rear

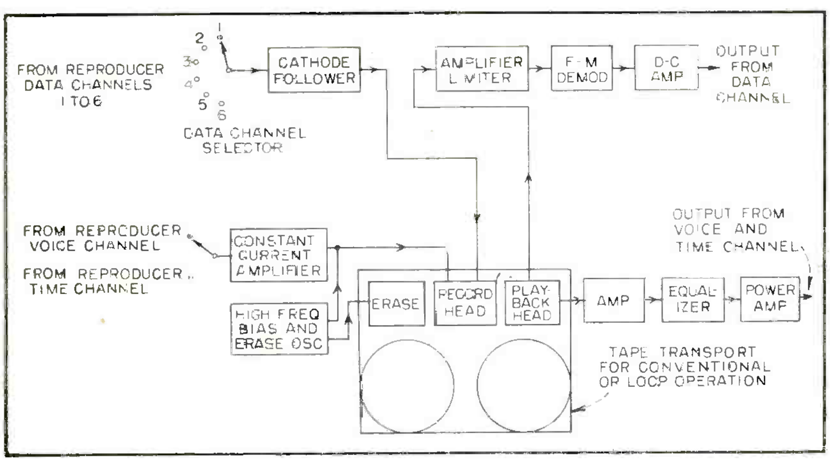


FIG. 3—Two-channel analyzer employed for detailed analysis of recording

for the recorder. One operates from 115 volts 60 cps and the other from 24 volts d-c. Size and weight of all recording units are kept as small as possible. One stringent requirement was imposed by the fact that all units must pass through the manhole in a tank.

Reproducing Equipment

The reproducer also uses a horizontally-mounted tape transport mechanism, along with eight separate data-extracting channels arranged as in Fig. 2.

The reproducer head assembly is basically identical to the record head assembly, except for the addition of a full-track erase head for erasing the signals from all channels simultaneously when desired.

For channels 1 through 6, the voltage from the playback head of each channel is fed through a series of amplifier-limiter stages to eliminate amplitude variations from the frequency-modulated carrier voltage. The carrier is then demodulated, filtered, amplified and fed to the output connector of the respective data channel.

Channels 7 and 8 have identical voltage amplifier, equalizer and power amplifier circuits.

The playback speed can be equal to one-third, or one-tenth that of the recorder. Therefore, recorded phenomena can be decreased in frequency by one-third or one-tenth if desired. In this manner, frequencies from 0 to 1,000 cps can be reproduced on a standard ink recorder.

Another means for facilitating the evaluation and analysis of the recorded data is the analyzer, shown in Fig. 3. This consists of a second tape transport mechanism having associated recording and playback amplifiers and handling ¼-inch wide tape. The analyzer can record and play back two channels simultaneously. The tape can be formed into a loop, if desired, to provide continuous repetition of a recorded interval of up to 3 seconds without cutting the original master tape. One of the two analyzer channels can record the signal from any one of the six reproducer data channels. The second analyzer channel can record either the voice or timing channel signal from the

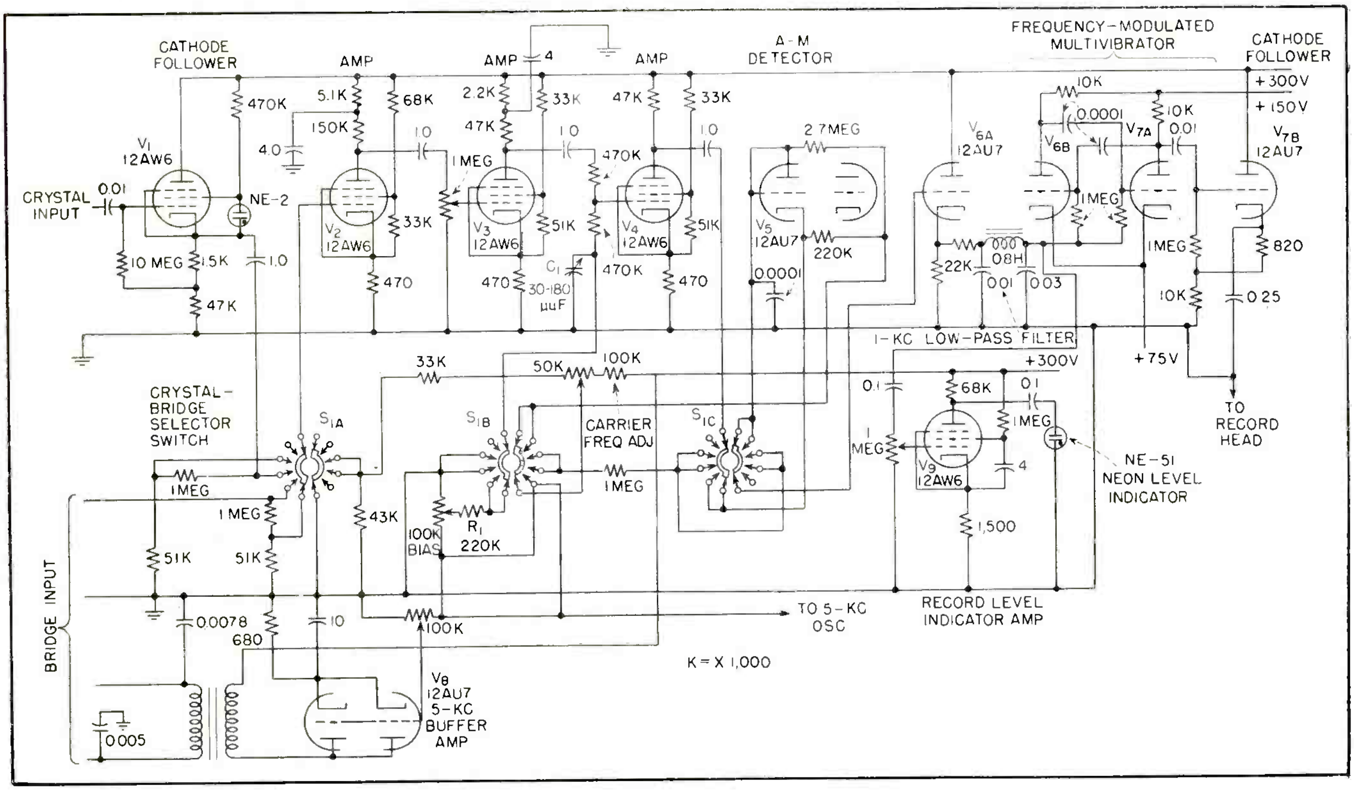


FIG. 4—Circuit used in each of the six f-m recording channels of vehicular research recording equipment shown in photographs

reproducer for purposes of the test.

Recording Circuits

The circuit used in each of the six data-recording channels is shown in Fig. 4, with the selector switch set for the bridge position for 0.1- to 2-volt input sensitivity. If the switch were rotated one position clockwise, the sensitivity would be increased so as to accommodate 0.001- to 0.1-volt input signals.

The circuit operation can best be described by starting at the multivibrator. This is of balanced design and would have a free-running frequency of approximately 3 kc if the grid resistors were returned directly to the cathodes. However, the grid resistors are connected to a point which is approximately 30 volts positive in respect to the cathodes; this raises the free-running frequency to 10 kc. If the biasing voltage is varied in amplitude from 0 to 60 volts, the frequency will increase linearly from 3 kc to 17 kc. A modulating signal of 30-volt peak amplitude superimposed upon a fixed 30-volt positive bias will cause a 70-percent peak deviation of the multivibrator carrier frequency, for example.

In practice, the multivibrator is operated at 35-percent peak deviation which is arbitrarily defined as 100-percent modulation; this is to allow an overload safety factor of 2. The neon level indicator flashes when the modulating signal reaches the 100-percent value.

In the bridge position shown, the amplitude-modulated carrier waveform from the pickup device is fed through the selector switch to amplifier stages V_2 and V_3. The signal at the plate of V_3 is a 5-kc carrier amplitude-modulated by the data signal; if the bridge-type transducer were perfectly balanced, a data signal of either polarity would cause an increase of the 5-kc voltage here, but of opposite phases for each of the two polarities. Advantage is taken of the phase of the 5-kc carrier coming from the transducer to obtain sensing as to polarity of the data signal.

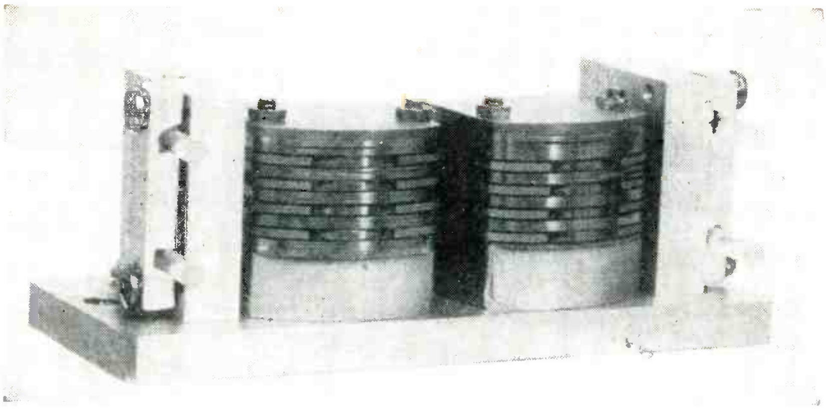
The signal from the plate of V_3 is mixed with an unmodulated 5-kc bias voltage at the input of V_4, hence this tube receives a signal which adds to or subtracts from the 5-kc bias voltage; C_1 and R_1 form a phase correction circuit.

The signal from V_4 is demodulated by half-wave rectifier V_5, whose output is coupled by cathode follower V_{6A} to a low-pass filter which passes only the desired data signal. The data signal then modulates the multivibrator.

In the crystal position, the shunting impedance across the pickup device is greater than 100 megohms by virtue of pentode cathode follower V_1. In this manner the low-frequency response of piezoelectric pickup devices is extended down to a few cycles per second. The signal from the cathode follower is amplified by V_2, V_3 and V_4, and then coupled to the multivibrator by cathode follower V_{6A}.

One of the major design considerations of this amplifier was maintaining flat response down to 2 cps. Both screen and cathode bypass capacitors were eliminated and resistor voltage dividers used in their place. In the case of V_1 the screen-to-cathode voltage was stabilized by use of a neon bulb.

The 5-kc master oscillator that feeds to each of the six f-m channels is a Wien bridge circuit having low distortion and constant output amplitude. Low output impedance



Recorder head assembly, showing staggered arrangement of the eight recording heads

is provided by a cathode follower.

The 60-cps timing signal, which also serves as the frequency used to drive the capstan drive motor on the tape transport mechanism, is generated and amplified in the circuit of Fig. 5. The tuning fork oscillator consists of a 360-cps tuning fork, with V_{1A} applying the necessary gain around the loop to sustain oscillations. Tube V_2, with the assistance of grid current flow of V_{1B}, limits the amplitude of oscillations to the proper value. The free-running frequency of multivibrator V_3 is slightly lower than 60 cps; it is locked at 60 cps by the tuning fork oscillator. The push-pull output of the multivibrator is amplified by V_4, V_5 and V_6.

Tape Transport Mechanism

The basic layout of the tape transport mechanism is conventional, in that the recording heads are located between a flywheel-loaded idler and the capstan shaft. A rubber-tired idler presses the tape against the capstan.

Since shock and vibration tend to affect the velocity of moving parts, careful design and precise mechanical work were necessary to minimize such interferences. A relatively high tape speed of 30 inches per second is used to provide high flywheel inertia with small flywheel mass. For the same reason, a high-speed motor is employed for driving the capstan. The number of rotating parts is kept to a minimum. The center of gravity of all flywheels is located near bearings to minimize the bending of the shafts. The main construction element is a rigid, cast aluminum top plate. The heads and all rotating parts are mounted to the top plate. Only one motor is employed, a hysteresis-type synchronous motor to which the capstan is directly attached. The takeup reel is driven by means of a friction clutch. This arrangement operates with a minimum of power. No facilities exist for rewinding the tape, since this can be done on the reproducer.

Reproducer

The top plate which carries the entire drive system is attached to the cabinet by means of vibration mounts which are located in the horizontal plane of the center of gravity of the top plate. Soft air-damped rubber mounts provide a high degree of vibration insulation and have satisfactory shock characteristics because of their damping action on rough terrain.

The reproducer tape transport mechanism is an Ampex model 300 in which a three-step pulley arrangement is incorporated between the capstan drive motor and the capstan shaft to give playback speeds of 30, 10 or 3 inches per second.

Due to the three-speed drive, the carrier frequency at the input of the playback amplifier circuit in Fig. 6 is either 10 kc (same as recorded), 3.3 kc or 1 kc.

Demodulator

The output voltage from the playback head is amplified and clipped severely in a series of amplifier-limiter stages extending from V_1 through V_{13}. The waveform at the junction of diodes V_{12} and V_{13} is a square wave having extremely fast rise and decay times and being frequency-modulated with the original pickup data. The waveform is then differentiated by C_1 and R_1. The differentiated output is fed through a split-load phase inverter V_{15}. Its push-pull output is rectified by a full-wave rectifier using diodes V_{14} and V_{16}. Across R_2 appears a series of identical positive pulses whose repetition rate varies in exact accordance with that of the modulation of the carrier. This waveform is coupled by cathode follower V_{15} to a low-pass filter which removes the carrier components.

This type of demodulator system has the advantage of being linear from 300 cps to over 20,000 cps.

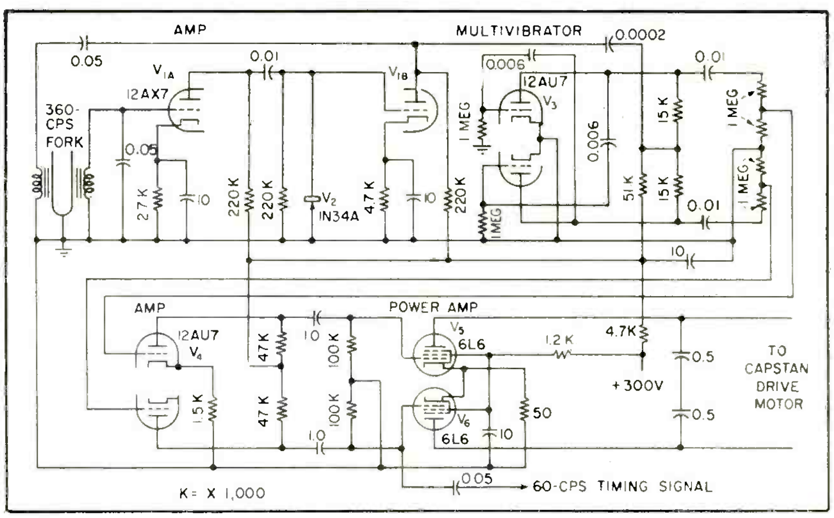


FIG. 5—Method of using tuning fork to generate precise 60-cps power for capstan drive motor and for timing purposes during analysis of the tape recordings

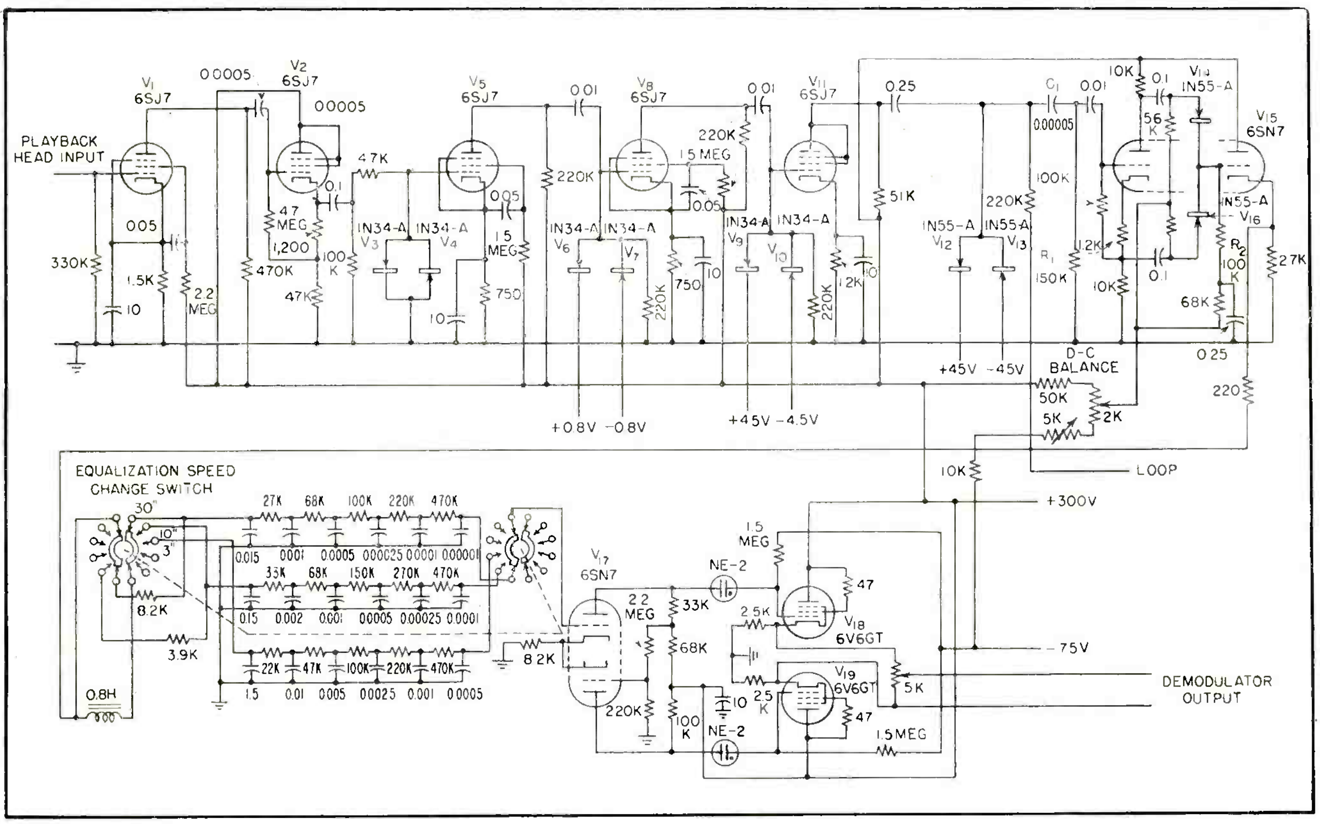


FIG. 6—Playback amplifier and demodulator for f-m channels. A separate channel amplifies voice and timing signals

Three filter cutoff frequencies are provided, one for each tape speed; the cutoff frequencies are 1,000 cps, 333 cps and 100 cps. The output of the filter is direct-coupled to phase inverter V_{17} which in turn is fed to the output connector through direct-coupled push-pull cathode followers V_{18} and V_{19}. A constant voltage drop is maintained between the plates of V_{17} and the respective grids of V_{18} and V_{19} with NE-2 neon bulbs. The push-pull output stage is capable of driving an ink recorder to full deflection.

The tape transport mechanism for the analyzer is standard except for a disabling switch for the rewind and takeup motors so that loop operation is quickly obtainable.

The analyzer provides two channels. One channel is similar to that of the recorder-reproducer voice track, except that the constant-current amplifier can receive a signal from either the reproducer voice or timing channel. The second analyzer channel is for f-m recording whereby the frequency-modulated carrier from any one of the six reproducer f-m channels can be recorded upon the tape by coupling to the analyzer record head with a cathode follower. The analyzer playback circuit for the f-m channel is the same as that shown in Fig. 6.

Applications

An example of the results obtained in using the equipment is shown in Fig. 7. This is a copy of an ink recorder chart pertaining to an investigation of electronic equipment mounted in a 2½ ton 6 x 6 truck. The accelerations encountered were recorded while the vehicle was running over a test course containing single corrugations. The peak accelerations can be obtained from the top graph, but considerably more information is rendered by a frequency analysis which shows the acceleration amplitudes at different frequencies. It is a tedious and time-consuming job to work out a graphical analysis based on the paper chart; the recording equipment enables the operator to perform this work much more quickly and economically by electrical means, since the information stored on the tape can be repeated over and over again. This is one of the most valuable features offered by the magnetic recording system.

To make this frequency analysis, the reproducer was connected to a bandpass filter which was followed by the ink recorder. The same section of the magnetic tape was repeatedly played back through the filter. The pass band was varied to desired limits and the output of the filter was recorded on a paper chart. The reproducer was operated at one-tenth of normal tape speed for this analysis.

The magnetic recorder equipment is easily adaptable to computing machinery and can also be employed for statistical evaluations, for which pulse counters in connection with amplitude discriminators have already been used successfully.

The equipment has been used so far in investigations pertaining to tanks, trucks, weapon carriers, railroad cars and guided missiles and has proven itself as a tool of great value.

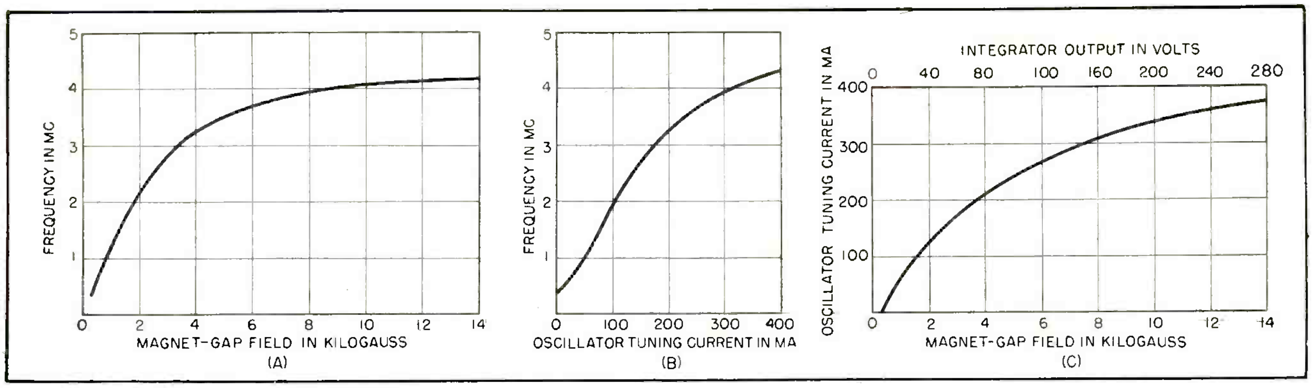
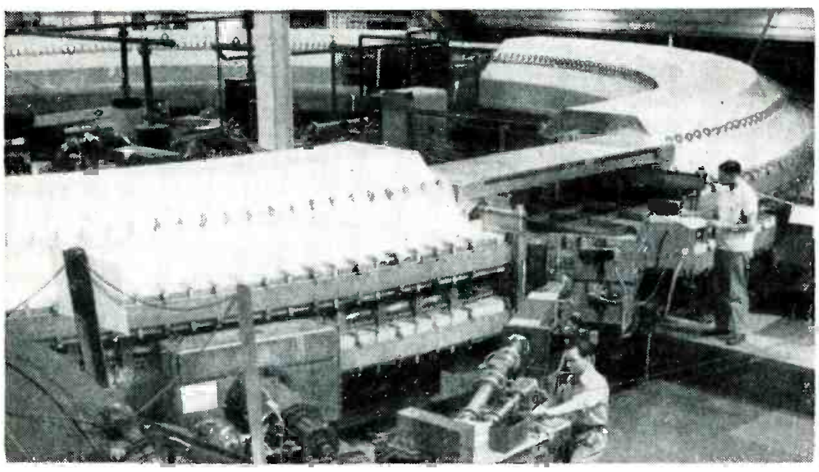


FIG. 1—How r-f generator frequency tracks cosmotron's magnetic field. Desired frequency vs field strength characteristic (A) is achieved by using voltage analog of magnetic field-strength variation to control oscillator tuning current

Generating R-F Power

PROTONS ARE ACCELERATED in the cosmotron to energy levels in the billion electron volt range by a radio-frequency voltage impressed across an insulated gap in the ferrite-loaded accelerating cavity of the vacuum chamber. To maintain a constant orbit radius as the beam is accelerated, the frequency of the accelerating voltage must increase from the initial value of 370 kc to 4,200 kc during the one-second magnet pulse. Over the entire 11-to-1 frequency range, a minimum gap voltage of 1,800 volts peak must be maintained. At every instant during the magnet pulse, the frequency of this voltage must be a predetermined function of the magnet field. Frequency errors greater than about 0.2 percent result in loss of beam due to excessive radius changes. Smaller frequency errors that recur at a rapid rate can excite undesirable phase oscillations in the beam. As little as 0.005-percent frequency modulation can result in total beam loss if it recurs at a rapid rate.



HOW THE COSMOTRON WORKS

Positive atomic particles—protons—from the Van de Graaff generator in the foreground, enter the cosmotron at energy levels above three million electron volts. The magnetic field of the cosmotron forces the protons to travel in a circular orbit around the doughnut-shaped vacuum chamber. During the one-second accelerating pulse, the protons make more than three million trips around the circle.

Each time the proton cloud passes the cosmotron's accelerating gap, it receives a kick from the r-f accelerating system that adds about 800 electron-volts to the energy of the protons. Since the speed of the protons increases with each trip around the circle, the frequency of the r-f generator must increase accordingly so that the kicks are delivered at the proper time.

When the protons have attained energy levels in the billion electron volt region, a target is rapidly inserted in the vacuum chamber. The atomic fragments that are produced when the high-energy protons collide with target atoms are studied for clues to the nuclear structure of the atom

Frequency-Control System

The correct frequency of the accelerating voltage in the cosmotron is given by

$$f = 4.034 \times 10^6 \times B\,(B^2 + 0.1171)^{-1/2}$$

where f is the frequency in mc and B is the field in the magnet gap in webers per sq meter. This function is plotted in Fig. 1A. Because the field in the cosmotron is not reproduced exactly from pulse to pulse, it is necessary to tailor the frequency sweep individually for each pulse.

The oscillator employs a version of the series-tuned Colpitts or Clapp circuit in which the usual air-core tank inductor is replaced by a coil wound on a saturable core made of manganese-zinc ferrite. Permeability tuning is accomplished by varying the current in a saturating winding on the core. The measured frequency-vs-current

Radio-frequency field accelerates proton beam to energy level of cosmic rays; r-f generator sweeps 11-to-1 frequency range during one-second magnet pulse while maintaining a minimum potential of 1,800 volts across ferrite-loaded gap

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for 3-BEV Accelerator

characteristic of the oscillator is shown in Fig. 1B.

Integrator Circuit

A pickup coil in the magnet gap delivers a voltage proportional to the rate of change of the magnetic field, dB/dt. Electronic integration of this signal yields a voltage that is proportional to the magnetic field B at any instant during the magnet pulse. The control-current function required in the oscillator-core saturating winding to produce the desired frequency-to-field relationship may be obtained graphically by eliminating the frequency parameter between Fig. 1A and 1B. The resulting curve, shown in Fig. 1C, gives the relationship between the output voltage of the integrator and the control current in the oscillator-core saturating winding.

A nonlinear resistance network, whose voltage-transfer characteristic is a close approximation to Fig. 1C, is connected to the output of the integrator. The output voltage of this network is therefore proportional to the required oscillator-core saturating current. This voltage drives an amplifier that has a large output-current to input-voltage feedback, producing a saturating current that is an accurate replica of the output voltage of the nonlinear network. The output frequency of the oscillator is thus controlled by the instantaneous value of the magnetic field during the entire one-second magnet pulse. Figure 2 is a block diagram of the frequency-control system.

The pickup coil in the cosmotron magnet has 12 turns per magnet quadrant, six turns on each pole face. The windings are of plastic-insulated wire contained within a copper tube that serves as a Faraday shield. A shielded-pair transmission line carries the Faraday shield and the ends of the pickup coil to the control room. The only external ground in the system is where this line is connected to the integrator input connector. Here

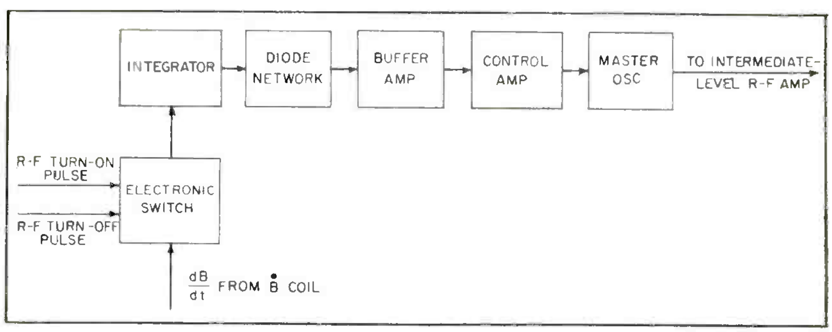

FIG. 2—Block diagram of frequency-control system illustrates how feedback from cosmotron magnet controls r-f generator frequency

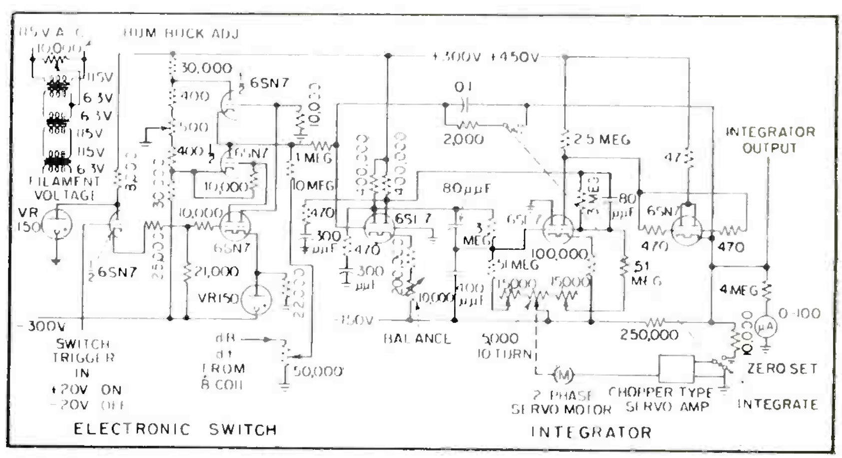

FIG. 3—Integrator and electronic switch provide voltage analog of magnetic field strength variation. Integrator uses Miller feedback circuit with d-c amplifier

the integrator chassis, the shield and the positive side of the shielded line are grounded. The output signal from the pickup coil has a value of about —300 volts during most of the magnet pulse. The voltage drops off somewhat toward the end of the pulse when the iron in the magnet begins to saturate.

The integrator and its associated electronic switch are shown schematically in Fig. 3. To obtain good linearity, the integrator time constant was made as long as practicable. Direct-current leakage considerations and the highest capacitance available in a polystyrene-film capacitor limit integrator resistance and capacitance to 11 megohms and 0.1 μf respectively. These components, used in a Miller feedback integrator circuit incorporating a d-c amplifier with a gain of 500, comprise an integrator with an effective time constant of 550 seconds.

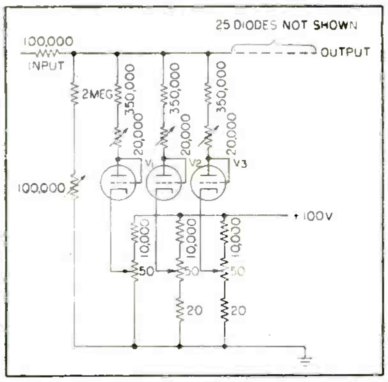

FIG. 4—Diode network converts voltage waveform from integrator to corresponding oscillator control signal

The integrator output signal reaches its peak value of +300 volts at the end of the magnet pulse. A pair of triodes connected in series with their junction tied to the tap between the 1-megohm and 10-megohm sections of the integrator resistor turn the integrator on and off. When the tubes are conducting, their plate resistance furnishes an effective short-circuit to ground for the 10-megohm driving-source impedance. A univibrator is triggered on by a peaking strip[1] in the stray field of the magnet and furnishes a gate pulse that biases the triodes off. This starts the integrator at the appropriate time. A timing-trigger at the end of the 1-second magnet pulse turns the univibrator off.

A second univibrator circuit operates a relay to discharge the integrating capacitor during the off period insuring that the integration starts at true zero. The second univibrator also switches a high-gain, chopper-type servo amplifier into the output circuit of the integrator during the off period. The accompanying two-phase servo motor adjusts a balancing potentiometer in the d-c amplifier to maintain the amplifier output voltage at zero while the input is grounded, thus compensating for drift in the d-c amplifier. The resistors are low-drift deposited-film units, while the capacitor is a polystyrene-film dielectric unit. This was the only type of capacitor that displayed sufficiently small soak effects to maintain required accuracy.

Diode Network

The nonlinear computer network consists of a voltage divider formed by a 100,000-ohm series resistor and 28 shunt resistors, each of which is connected in series with a biased diode. Three of the 28 sections are shown in Fig. 4.

Since the diode bias voltages increase progressively, the curve of Fig. 1C is approximated by 29 line segments of progressively decreasing slope. The transitional points may be changed by adjusting the diode bias voltages, while the slope of each segment is determined by the resistance in series with each diode. These parameters are variable over a small range to allow a precise curve fit despite Edison-effect voltages and individual resistance variations in the diodes.

A graphical construction indicated that the ideal characteristic could be approximated with a maximum error of about 0.1 percent by using 28 sections in the network. However, curvature in the diode characteristics smooths out transitions between individual line segments and an even better curve fit results.

Diode-connected 6SN7 triodes were found to possess better stability than conventional diodes. The filaments are operated from a voltage-regulated d-c supply for good stability and freedom from a-c pickup. At the end of the mag-

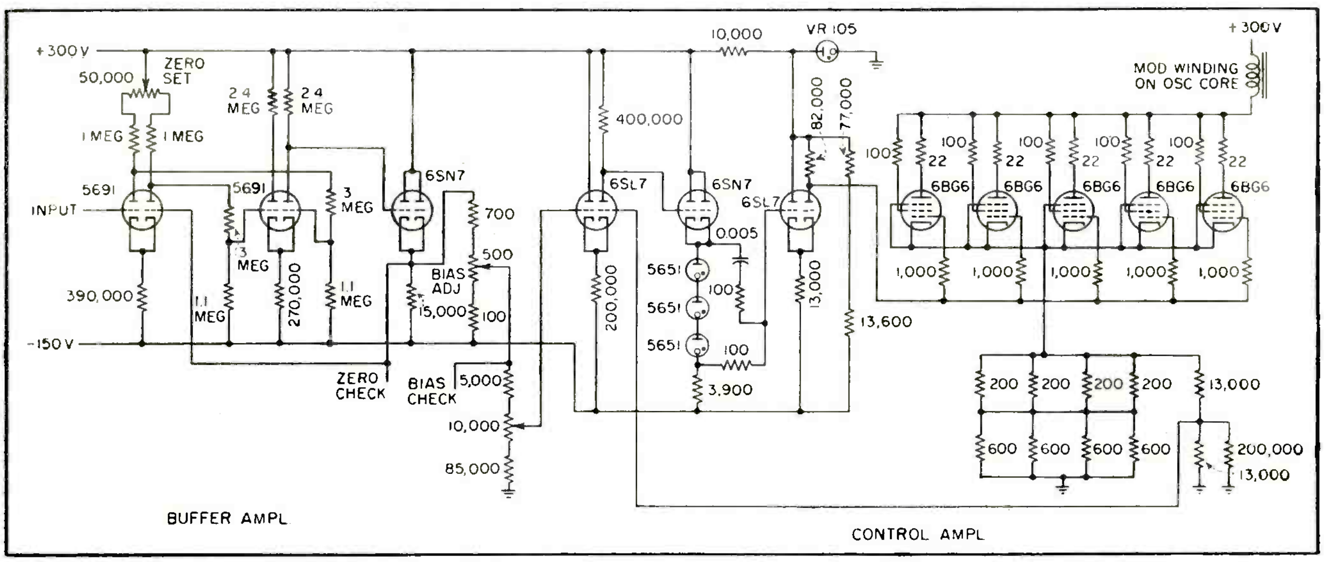

FIG. 5—Control amplifier delivers desired current waveform to control winding on oscillator tuning coil

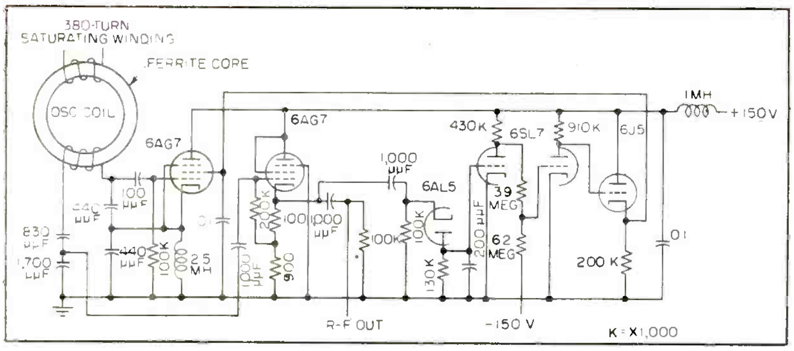

FIG. 6—Permeability-tuned master oscillator sweeps in frequency from 370 kc to 4.2 mc during the one-second cosmotron magnet pulse

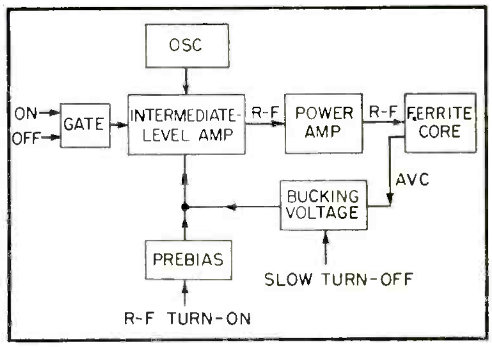

FIG. 7—Intermediate and high-level power amplifiers deliver 2,000-volt f-m signal

net pulse, the diode-network output signal reaches its peak value of +30 volts.

Control Amplifier

The high-impedance output-voltage signal of the diode network is converted to a proportional-current signal in the control amplifier. This consists of two sections, shown schematically in Fig. 5. The first section, called the buffer amplifier has a nominal voltage gain of one. It provides independent small adjustments of initial level and amplitude of the frequency-control signal. A large amount of feedback with a loop gain of 500 effectively stabilizes this amplifier against drifts in gain and output level.

The second section consists of a two-stage voltage amplifier with a gain of 500 driving five paralleled triode-connected 6BG6 beam power tubes with the oscillator core saturating coil in their plate circuit. Current feedback from the 6BG6 cathodes to the input grid circuit of the voltage amplifier provides an overall feedback factor of 1,500 at the peak output current of 400 ma. Since the mutual conductance of the 6BG6's falls off rapidly at currents below two ma per tube, the minimum output current must be held above 10 ma to insure sufficient loop gain for adequate stability. To allow a full frequency sweep, a bucking field is applied to the oscillator core by a current in an auxiliary winding, so that the net magnetomotive force in the core has an initial value of zero. At 10 ma output current, loop gain is still greater than 350, a value ample for the stability requirements. The 10-ma to 400-ma output current sweeps the oscillator frequency over the required range.

Although the acceleration of the beam is started at 370 kc, the initial frequency of the oscillator is set at 335 kc. This allows about 4 milliseconds for the frequency sweep to get under way before the r-f power amplifier is gated on, insuring that starting and switching transients will not appear in the beam-accelerating voltage.

The permeability-tuned oscillator in Fig. 6, which has been described in detail elsewhere,[2] delivers an output signal of 2.8 volts over the entire frequency range. This signal is applied to the r-f power amplifier through a 75-ohm transmission line driven by a cathode follower at the oscillator output.

Intermediate Amplifier

The input signal to the intermediate-level amplifier is approximately 2.8 volts rms. This must be amplified enough to develop 1,800 volts peak-to-peak across a ferrite-loaded cavity. In addition provisions must be made for avc, gating and slow turn-off. These functions will be described in detail. A block diagram is shown in Fig. 7.

The intermediate-level amplifier consists of four stages, a 6SK7, 6SJ7, 6AG7 and 829B. The 6SJ7 is used as the avc-control tube because of the large changes in the overall gain of the amplifiers due to the nonlinearities in the ferrite load. Early in the frequency cycle the control tube must be almost cut off. The two sections of the 829B are connected in parallel and operate as a cathode follower to drive a 75-ohm line terminated in a small transformer. This transformer is wound on a ferrite core of the type used in television horizontal-output transformers and serves to convert the single-ended signal on the line to a push-pull signal for the grids of the first stage of the power amplifier. All the stages in the intermediate amplifier are shunt peaked to obtain a bandwidth of 4.5 mc. The component values are adjusted to give an essentially flat response characteristic from the input to the secondary of the ferrite transformer. The maximum level at the grids of the first power-amplifier stage is about 20 volts rms.

Power Amplifier

The power amplifier is a four-stage push-pull unit. The first stage is operated class A and uses four 813's in push-pull parallel. The second stage uses four 833A's in push-pull parallel class B, the third stage has two 5917's operated class A_2, and the final stage uses two 5681's in class A_2. The choice of class of operation in each stage was made for maximum output to the ferrite core. A great deal of attention was paid to parasitic suppression since the tubes used in the final stages are of the ring-seal type capable of supporting oscillations up to 100 mc. Noninductive parasitic-suppression resistors were added at the plates and grids of all the stages except the final stage. The maximum signal d-c input to this stage is 150 kw. When parasitic oscillations occurred during the testing period several of the components were severely damaged or over heated.

To achieve the required bandwidth, shunt and series peaking elements are used in all stages. In addition, resonance peaking is used in the grid of the final stage to increase the drive at the high-frequency end of the band. It was found that increasing the grid impedance beyond a certain value would lead to parasitic oscillations at 44 mc. By putting in a low-Q circuit shunt resonant at 3.5 mc in series with the grid resistor, the grid impedance is raised for frequencies of 3 to 4 mc only.

Instead of trying to design each stage for a flat response, peaking circuits were chosen that tended to make overall response flat. In this respect only moderate success was achieved because of the extreme nonlinearity of the load characteristic. The ferrite-loaded cavity, shown in Fig. 8, contains 2,800 pounds of nickel-zinc ferrite surrounding the accelerating gap essentially as the core of an autotransformer. The equivalent circuit includes the tube and distributed capacitances C_d, the gap capacitance C_g, the leakage inductance L_L, the peaking inductance L_p and a series resonant circuit C_s-L_s-R_s. Figure 9 shows the reason for this circuit. Due to the shunt resonance at 1.2 mc, when the frequency passes through 400 kc the impedance of the load to the third harmonic is about 20 times the impedance to the fundamental. This leads to severe waveshape distortion.

With the series-resonant damping circuit the change in impedance at the low end of the band (370) kc) is practically eliminated. At the high end of the band (4.2 mc), however, a series resonance involving the leakage and peaking inductances and the gap capacitance occurs. Although the net impedance of the load at this time is essentially zero, the resonant voltage rise across the gap offsets the load-voltage drop.

For avc action, a portion of the gap voltage is rectified using a 1B3 diode, divided down, and fed back to the intermediate-level amplifier in series with a bucking voltage. The bucking voltage serves three purposes. First, by bucking out a portion of the rectified signal it increases avc sensitivity; second, it provides a convenient level control; third, it enables the r-f to be turned off slowly when cosmotron experiments so require. The last function is achieved by developing the bucking voltage across the cathode resistor in a cathode follower and gating off the grid through an R-C time constant. Originally, gating and avc were performed in separate stages of the intermediate amplifier. However, when the gate opened, the avc was wide open and a large turn-on transient spike occurred. To eliminate this, the gate is opened before r-f turn-on is required and a prebias voltage establishes a simulated avc voltage. When turn-on is needed, the prebias is gated off and the output voltage rises smoothly.

In addition to the avc diode at the accelerating gap, several other diodes and networks are also connected here. The additional diodes feed a voltmeter and an oscilloscope. The detector circuit for the oscilloscope diode has a short time constant to allow frequency transients, parasitics and fast level changes to be seen.

For examination of the r-f waveform across the gap, a frequency compensated voltage divider is used to feed directly the deflection plates of an oscilloscope. With a fast sweep and trigger pulses at any time during the cycle, the actual waveshape of the radio-frequency gap voltage can be observed.

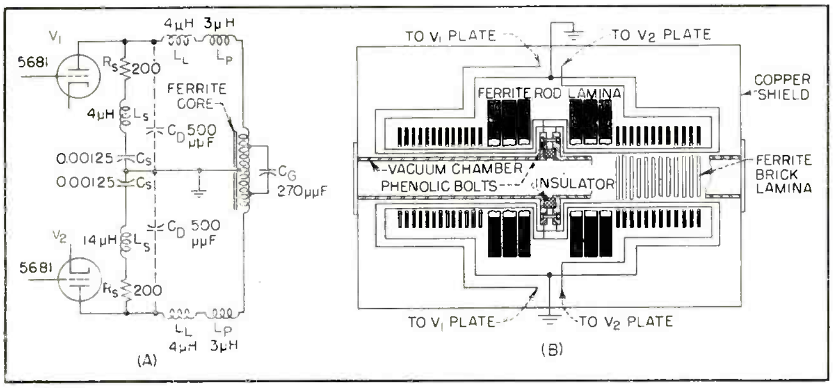

FIG. 8—Power-output system of r-f generator; push-pull 5681 triodes operating in class A_2 deliver 100 kilowatts to ferrite-loaded output loop

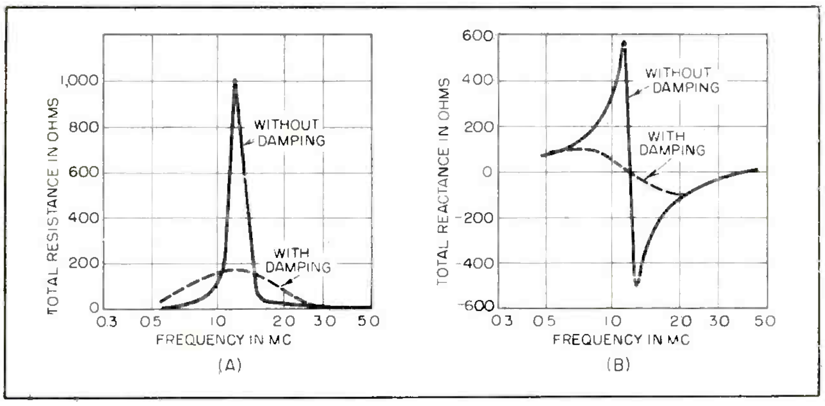

FIG. 9—Impedance of ferrite core with and without series resonant damping

Design of the r-f accelerating system includes the work of J. P. Blewett, S. Giordano, D. Griffin, J. Logue, A. I. Pressman and W. Surber. J. Rebman has performed a vital role in maintaining and operating the system as well as in constructing many of the components. Assistance of F. Janik in construction and testing the power-amplifier system is acknowledged, as well as the assistance of G. K. Green, H. S. Snyder and L. C. L. Yuan. The work described in this paper was performed under the auspices of the U. S. Atomic Energy Commission.

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(4) J. P. Blewett, M. Plotkin and E. J. Rogers, Cosmotron — Radio-Frequency System. Part IV—Accelerating Unit. *Rev Sci Inst*, 24, p 795, Sept. 1953.

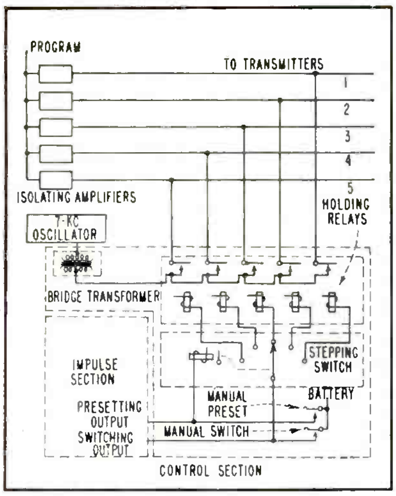
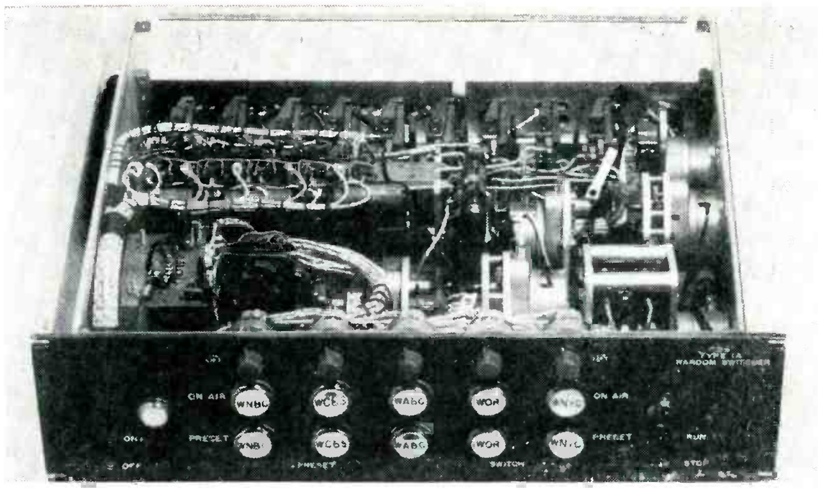


FIG. 1—Switching tone is superimposed upon one of five transmitter lines



Equipment in use at New York makes provision for control of five broadcast stations, but circuits can be modified for additional transmitters

Random Sequence Switching

Designed for automatic control of a cluster of radio broadcasting stations during Conelrad exercises, this five-channel device is arranged to permit fewer participating transmitters or can be modified to care for additional stations. No correlation exists between interval duration and the switching sequence

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Basis of FCC's Conelrad plan is to conceal the identity of radio broadcasting stations by shifting all operating transmitters to one or two frequencies, either 640 or 1,240 kc. Local civil defense headquarters provide a single source of program material that is fed to all transmitters in the area. Transmitter carriers are then switched on and off in a manner that will not interfere with reception of the program service by the general public, yet will result in confusion for an operator of direction-finding equipment. Maximum confusion to enemy attackers can be caused if this switching is accomplished in a random manner.

Several different modes of switching are specified in the FCC plan, depending upon the number of stations operating in the locality and whether intermittent or continuous broadcasting service is to be maintained. For continuous service in a large metropolitan area the sequential mode is employed. Co-operating stations are assigned to form a cluster for integrated operation on a single frequency. Clusters normally number from three to six stations.

In each cluster, transmitter carriers are so keyed that only one of the group radiates a signal at any given time. The maximum time interval for continuous radiation by one station is specified at forty seconds; the minimum is five seconds. Successive timing intervals vary in a random manner and the switching sequence among stations is noncyclic and likewise random in nature.

The unit described here is designed to satisfy these switching requirements for a maximum of five channels on a fully automatic and random basis. The principle may be applied, however, to requirements for more channels.

System Details

Keying circuits of the CBS random switcher are designed for use with a method of operation in which program material is continuously fed to all transmitter locations in the cluster. Each transmitter is equipped with a tone-operated relay so that power is applied only when a 7-kc tone is superimposed on the audio program line. A bridging coil constitutes a high-impedance source for superimposition of this tone on one line at a time. Individual line amplifiers are thus necessary for proper isolation, as shown in Fig. 1.

The circuits within the switching unit itself may be divided into two sections, each having a separate and distinct function. The random information is generated in the impulse section and supplied, in the form of short switching impulses, to the control section. The control section, which contains the transmitter keying circuits, is essentially a preset-type relay switching system that can be operated manually as well as automatically.

Control Section

A schematic diagram of the control section is shown in Fig. 2. The basic circuit is one in which presetting is accomplished by means of a stepping switch. Operation of the stepping switch (either by the manual PRESET pushbutton or by the impulse section) selects in rotating sequence one of five relay circuits. The relay thus preset can be energized either manually by the SWITCH pushbutton or automatically by the switching output of the impulse section.

The design of the control section (Fig. 2B), therefore, requires that the impulse section supply to it a short switching impulse at random time intervals varying from five to forty seconds. During the intervals between switching impulses, the stepping switch must receive a succession of impulses, numbering from one to four. By arranging for the number of these impulses during successive intervals to vary in a random manner, a random selection sequence is achieved.

To permit operation of the unit with less than five active channels, the control section also contains lift circuits that permit elimination of any keying circuit by causing the stepping switch to skip by the corresponding position and thus prevent presetting to that channel. In addition, a positive interlock is provided to prevent the stepping switch from stopping in a position corresponding to the most recently selected channel, so that an excessively long switching interval cannot be caused by consecutive selection of the same channel. The interlock circuits associated with the lift switches serve the purpose of preventing continuous operation of the stepping switch in the event of accidental closure of four or more lift switches.

Indicator lamps indicate the ON AIR and PRESET channels, either for automatic or manual operation.

Design Principles

In approaching this problem of random information generation, it has been assumed that the spirit of the FCC specifications requires a relatively smooth probability distribution of timing-interval durations and that no correlation should exist between interval duration and switching sequence.

There are numerous possible sources, both electrical and mechanical, of random information of normal distribution. The translation of such information, however, into timing intervals having discrete limits of duration, yet uniform probability distribution, is a problem of some magnitude. The approach, therefore, has been to devise a system that would have inherent randomness within the desired limits.

To maintain the desired duration limits with reasonable accuracy, the basic timing element to be used must have reliably consistent characteristics. For this reason, synchronous electrical timing motor assemblies are employed as a basic circuit component. A total of six motors is so used in four assemblies. These assemblies are interconnected with the necessary relays to obtain a continuous sequence operation that generates the required switching and presetting outputs.

To avoid recurring pattern effects, it is necessary to insert into the circuit a timing element of variable, nonconsistent characteristics. This is provided in the form of a thermal delay device, so connected that small variations in its random performance are greatly amplified in their effect upon the final timing intervals. The limits of duration of these intervals, however, retain the tolerance fixed by the accuracy of the timing motors.

The schematic diagram of the impulse section is shown in Fig. 2A. Motor M_2 with associated cams and snap-action switches is a five-second sequence timer that operates after each switching pulse.

Motor assemblies M_1 and M_3 are used, respectively, to time the basic switching interval and to determine the number of presetting pulses.

These assemblies are identically constructed, differing only in speed of operation. Their basic purpose is to create successively variable time delays. The time delay is in each case established by the *B* motor and then clocked off by the *A* motor.

Dual-Motor Switch

Each motor drives a shaft carrying a projecting arm. On the ends of each arm are mounted meeting electrical contacts. The direction of rotation of the *A* motor is such as to close the contacts, while rotation of the *B* motor opens them. Thus after the contacts have been closed by rotation of the *A* motor the *B* motor will move its contact away through an arc of variable size, determining the time interval for which the *A* motor must next operate to reclose the contacts. The *B* motor in each case operates at the higher speed, so that a long time delay is predetermined within the space of a shorter time.

Motor M_{1A} operates at 1 rpm and clocks off the basic timing interval. The assembly is reset during the 5-second timer sequence by motor M_{1B}, which operates its contact arm at 46⅔ rpm and has a maximum operating interval of ¾ second.

Assembly M_3 establishes the number of presetting pulses. Both stages of operation occur during the 5-second timer sequence. Motor M_{3A} (15 rpm) has a maximum operating interval of 4 seconds, during which the presetting pulses, generated at a rate of one per second by a cam on M_2 (the 5-second sequence timer), are per-

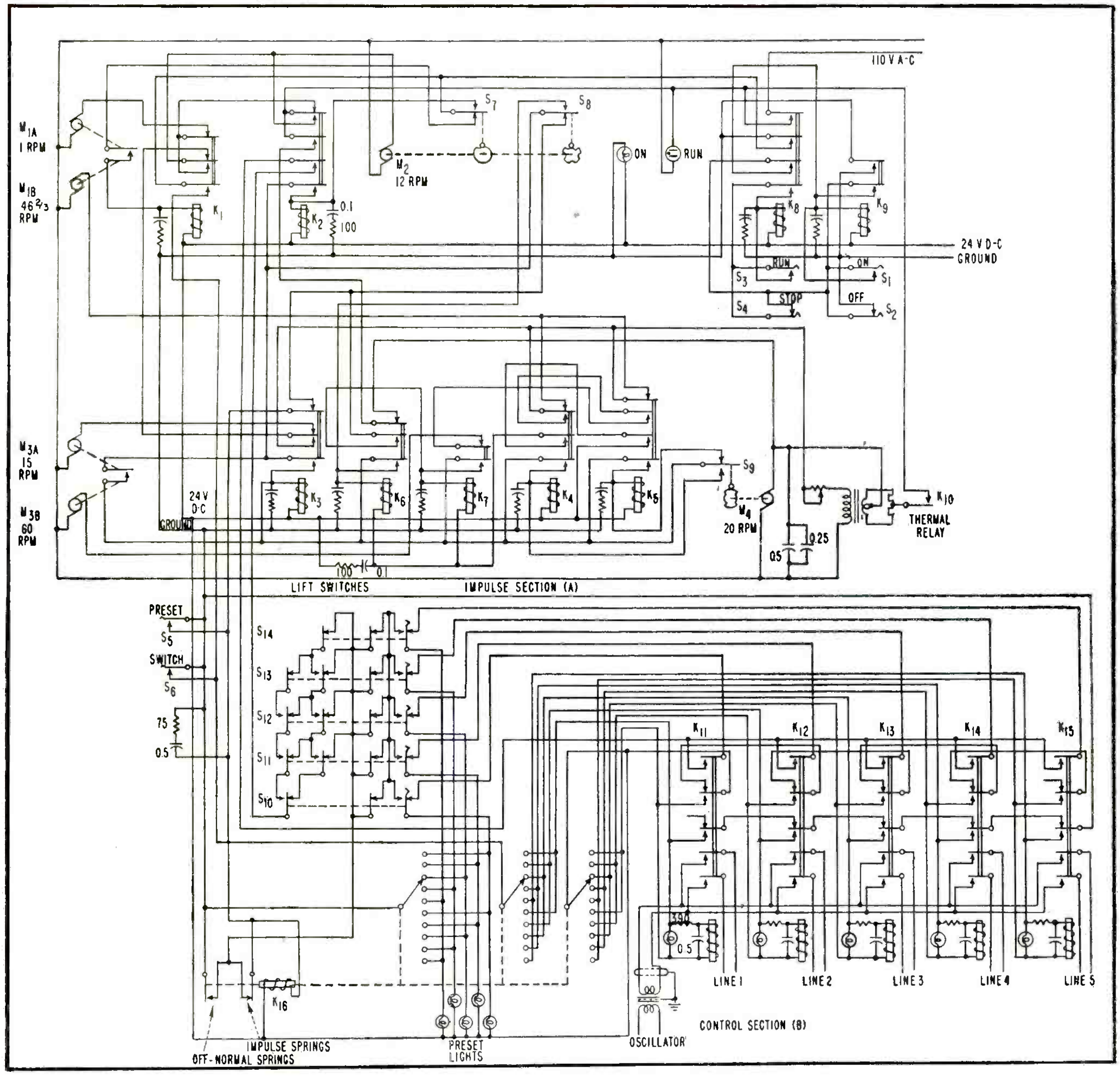


FIG. 2—Complete circuit of the impulse and control sections of the keyer. Synchronous motors provide pulses that are random because of thermal-delay relay. Relays are preset by stepping switch

mitted to go to the control section. Motor M_{3B} (60 rpm) resets the assembly with a maximum operating interval of 1 second.

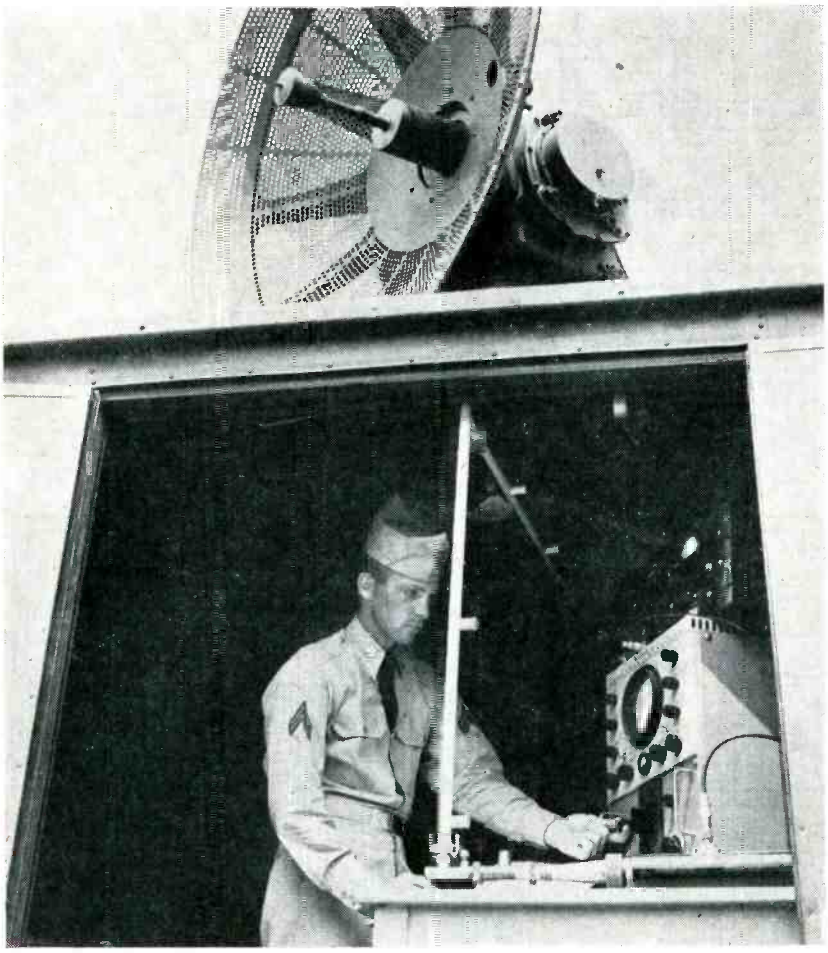
Motor M_4, which carries a cam that repeats a $\frac{3}{4}$-second on-off cycle, represents with the thermal delay element the ultimate source of the system's randomness. The phase position of this motor relative to the other timing events determines the resetting operating periods of the *B* motors. The thermal delay element is employed to scramble the phase position of this motor in such a complex, and in the long run, nonconsistent manner that, while no claim is made of purely random performance in the strict mathematical sense, little possibility exists that calculation or statistical analysis could predict any useful probabilities of future performance.

Removing Channels

Although the random switcher is constructed for five-channel operation, it is usable without modification for fewer channels by means of the lift feature provided. The principles of the design are readily adaptable to any requirement for a greater number of channels. In addition, the output circuits can be readily adapted for application to systems of transmitter keying other than the tone-operated relay method for which this unit is wired.

In spite of the large number of parts involved, the unit constitutes little more than an unconventional arrangement of conventional components. None of the mechanical assembly involves unorthodox designs whose stability might be open to question. Although the complete circuit has the appearance of complexity, inherent reliability is assured by the simplicity of the individual components.

How Long-Line Effect



Signal Corps installation showing van-mounted radar set with antenna on roof to permit a relatively short run of output line, but even this may be too long at higher microwave frequencies. To avoid frequency-jumping, X-band output line lengths must be less than 12 feet, and K-band lengths under 4 feet

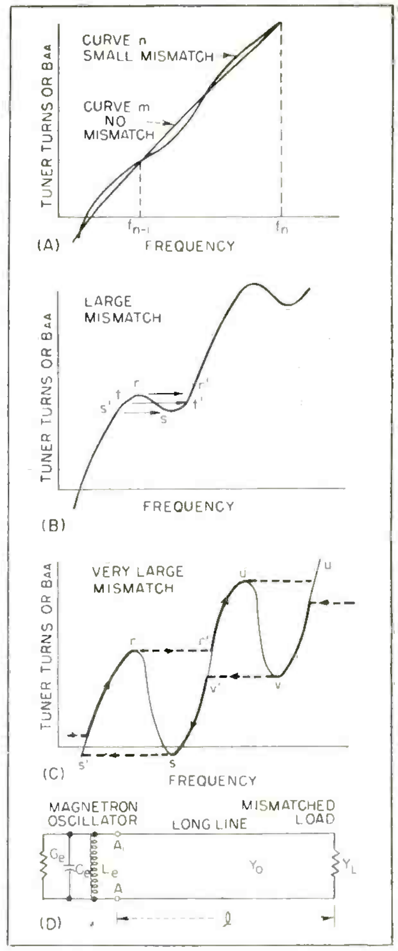


FIG. 1—Tuning curves of radar magnetron oscillator connected to long mismatched transmission line, and equivalent circuit for load mismatch

Analysis of conditions under which long mismatched output lines cause frequency-jumping in tunable pulsed or continuous-wave magnetrons of high-power radar sets. Equations and nomographs present practical engineering criteria for eliminating holes in tuning range when r-f generator cannot be mounted directly on antenna

With the advent of high-power microwave oscillator tubes in radar and other electronic devices during World War II, the problem of frequency instability due to long mismatched output lines was encountered and studied. The effect of such lines on the generated frequency and power has been called long-line effect, and is caused by the line acting as a resonant circuit. The result of long-line effect on the overall operation of conventional radar sets, for example, is to destroy the spectrum of the output signal whenever the antenna feed line is not of the proper length. The effect on tunable radar sets employing power oscillators is to leave periodically spaced holes in the tuning range. The necessity of elimi-

Impairs Tunable Radar

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nating these holes multiplies the problems of long-line effect, especially at microwave frequencies whenever the oscillator tube is not mounted directly on the antenna.

Long-Line Effect

Studies have been made of long-line effect on pulsed magnetrons[1] and on continuous-wave magnetrons.[2] It is the purpose of this paper to put the theory of long-line effect for both pulsed and c-w oscillator tubes on a useful quantitative engineering basis.

It should be pointed out that long-line effect is not confined to the magnetron, nor even to microwave tubes. Any self-excited oscillator whose frequency is affected by the output loading can experience frequency-jumping due to long-line effect if the vswr at the tube is sufficiently high and if the line is sufficiently long. A figure of merit which is a measure of the immunity of an oscillator tube to this effect is the effective external Q of the tube when oscillating. For most oscillator tubes using high-impedance tank circuits, such as the magnetrons, klystrons or tetrodes, this value is nearly equal to the cold external Q of the tank circuit.

Some of the more important manifestations of long-line effect are the alteration of the tuning curve of mechanically tunable oscillator tubes, the alteration of the modulation characteristics of f-m tubes and the alteration of the output spectrum of either f-m or a-m.

Curve m of Fig. 1A shows the tuning curve of a tunable oscillator tube whose output line, though several wavelengths long, is terminated in a matched output load. Curve n is the same except that a slight frequency-insensitive impedance mismatch exists at the load end of the line. The periodicity in frequency, with which the tuning rate is alternately greater and then less than that of the flat line tuning rate, is

$$f_n - f_{n-1} = \frac{f}{2N_g}\left(1 - \frac{f_c^2}{f^2}\right) \quad (1)$$

where N_g is the number of guide wavelengths on output line and f_c is cutoff frequency of guide.

If the mismatch at the end of the output line is increased, the tuning characteristic becomes that shown in Fig. 1B. For pulsed oscillator tubes, as the tuner setting is increased, the frequency increases smoothly until point t is reached, where the frequency jumps to t'; similarly, as the tuner setting is decreased the frequency jumps from t' to t. When the tuner setting of a pulsed tube is t' the tube pulses randomly at frequencies corresponding to t and t', with approximately equal division of pulses. When the tuner setting is deviated from t' the percentage of pulses rapidly increases to 100 percent on the side of the tuning curve which has the steepest slope. This is due to the fact that the effective Q of the overall system can be shown to be higher where the slope of the tuning curve is steeper, and the oscillator prefers to start in the mode with higher overall Q.

The tuning behavior of continuous-wave tubes with long output lines is considerably different from that of pulsed tubes because frequency hysteresis occurs. In Fig. 1B, as the setting is increased, the frequency increases smoothly until the point r is reached, when the frequency jumps to r'.

As the tuner setting is decreased, the frequency decreases smoothly until s is reached, when the frequency jumps to s'. Thus the frequency hysteresis permits operation in the frequency range s' to r only when the frequency is increased, and in the frequency range r' to s only when frequency is decreased. With no external circuit changes, the range from r to s can never be realized with stable oscillation.

If the vswr is still further increased, a tuning curve corresponding to Fig. 1C is obtained, where more than two possible frequencies can occur with one tuner setting. Pulsed tubes will usually start at the frequency corresponding to the steepest slope of the tuning curve; c-w tubes, when tuned continuously in one direction or the other, will follow the paths shown by heavy lines with arrows. (The dotted portions of these heavy lines correspond to frequency-jumping.)

Unstable Regions

The frequency regions from r to s and from u to v cannot be realized with stable oscillation. The frequency range from s to v' is covered only when tuning downward, and the range from r' to u is covered only when tuning upward. However, by special manipulation of the tuning knob every point in the tuning range can be realized except those in ranges corresponding to r to s and u to v.

Everything that has been said previously applies also to the voltage-versus-frequency characteristic of a frequency-modulated oscillator, provided the period of the modulation frequency is considerably greater than the transient time of the frequency-jumping phenomenon. The only alteration of a pure amplitude-modulation spectrum by long-line effect is that caused by the fact that the effective loaded Q of the tube for the various frequencies of the carrier and sidebands is greater or less than the loaded Q of the tube when operating into a flat line.

Frequency-Jumping Criteria

The most important relationship in the theory of long-line effect is the critical condition which determines the onset of frequency-jumping. This corresponds to the transition between the curves of Fig. 1A and 1B. The condition for this transition will now be derived. Figure 1D shows the equivalent circuit of an oscillator tube connected to a long line mismatched at the load. (Assume only one frequency-insensitive discontinuity in the transmission line located at the load.) The effective admittance of the electron cloud in the tube is included in C_e and G_e. The condition for stable oscillation is that the total admittance across AA is zero. The total susceptance B_{AA} is therefore

$$B_{AA} = \omega C_e - \frac{1}{\omega L_e} + \frac{(\rho_t^2 - 1) Y_o \tan \beta l}{\rho_t^2 + \tan^2 \beta l} = 0 \quad (2)$$

where ρ_t is vswr at the tube, C_e is effective capacitance of the equivalent circuit of the tube in farads, L_e is effective inductance of the equivalent circuit of the tube in henrys, Y_o is characteristic admittance of the output line in mhos, β is phase constant of the output line in radians per meter and l is line length in meters.

The value of ρ_t is expressed in terms of the vswr at the load by

$$\rho_t = \frac{\rho_L + \tanh \alpha l}{1 + \rho_L \tanh \alpha l} \quad (3)$$

where α is attenuation constant of the line in nepers per meter and ρ_L is vswr at the load.

For a nontunable tube, or with a given tuner setting of a tunable tube, the plot of B_{AA} versus frequency has the same shape as the tuning curves of Fig. 1. The condition for onset of frequency-jumping for a tunable tube is that the minimum slope of the B_{AA} curve is equal to zero. From this condition

$$\rho_{ct}^2 = 1 + \frac{Q_{xh}}{\pi N_g}\left(1 - \frac{f_c^2}{f^2}\right) \quad (4)$$

where ρ_{ct} is critical vswr at the tube for onset of frequency-jumping, N_g is the number of guide wavelengths on the line, f_c is the cutoff frequency of the line in mc and Q_{xh} is the effective external Q of the tube when the tube is oscillating.

The effective external Q for any oscillator tube is defined as Q_{xh} by

$$Q_{xh} = \frac{f}{2Y_o}\,\frac{d(B_o)}{df} \quad (5)$$

where B_o is susceptance of output line at the tube output terminals.

For conventional microwave oscillators such as magnetrons and klystrons the value of Q_{xh} is related to the pulling figure[2] by

$$Q_{xh} = \frac{5}{12}\,\frac{f}{\Delta f}\sec\theta \quad (5a)$$

where Δf is pulling figure of the tube and θ is angle between constant-frequency and constant-susceptance contours on a Rieke diagram. Typical values of sec θ for magnetrons lie between 1.0 and 1.1.

For microwave oscillators which use a high-impedance tank circuit, the value of Q_{xh} is essentially independent of the loading and the

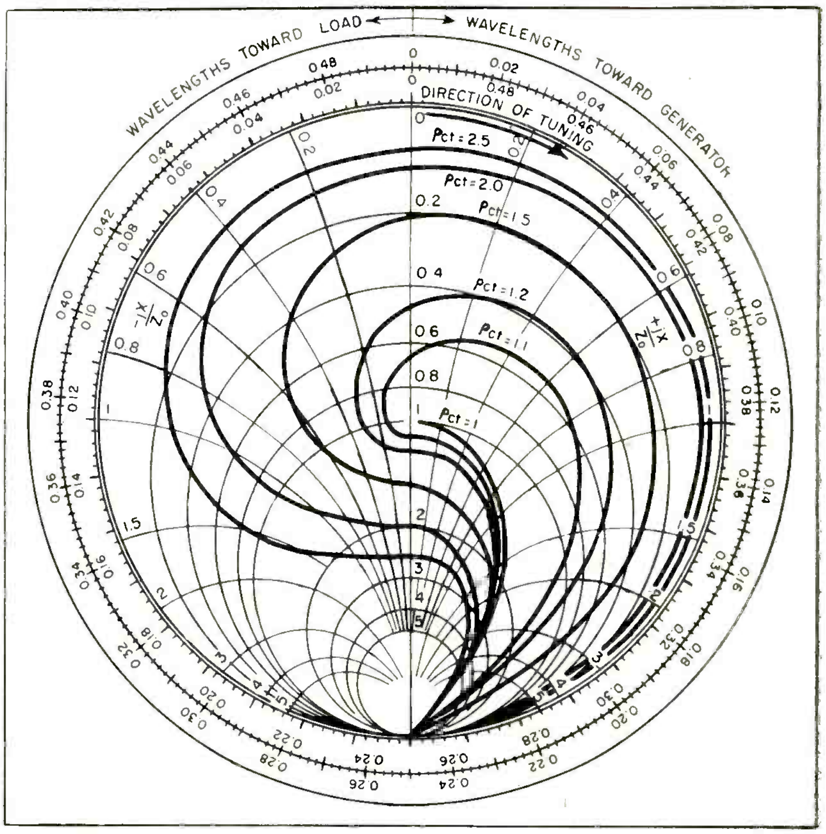

FIG. 2—Rieke diagram showing frequency-jumping contours for pulsed tube

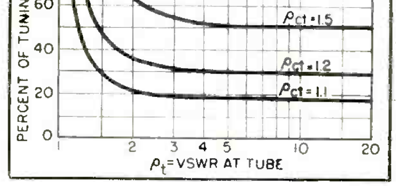

FIG. 3—Percent of tuning range accessible to pulsed magnetrons

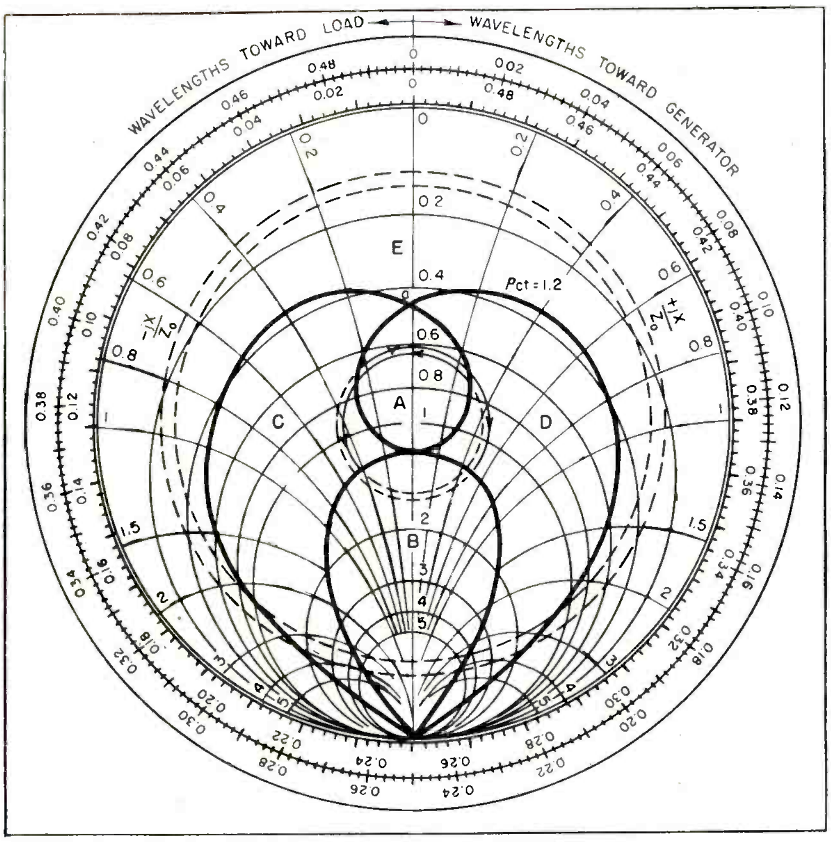

FIG. 4—Example of frequency-jumping behavior of a continuous-wave tube

power output of the tube, and differs from the cold external Q by only a few percent.

When the vswr at the tube is less than ρ_{ct}, no frequency-jumping occurs. As the vswr is increased and approaches ρ_{ct}, the tuning rate becomes periodically faster and slower than the normal tuning rate with a reflectionless line. The ratio of actual tuning rate to normal tuning rate is

$$\frac{R_{\text{actual}}}{R_{\text{normal}}} = \frac{1}{1+\left(\frac{\rho_t^2 - 1}{\rho_{ct}^2 - 1}\right)\frac{(\rho_t^2 \cos^2 \beta l - \sin^2 \beta l)}{(\rho_t^2 \cos^2 \beta l + \sin^2 \beta l)^2}} \quad (6)$$

The ratio of maximum tuning rate to normal tuning rate is

$$\frac{R_{\text{maximum}}}{R_{\text{normal}}} = \frac{\rho_{ct}^2 - 1}{\rho_{ct}^2 - \rho_t^2} \quad (7)$$

When ρ_t is less than $\sqrt{3}$ and less than ρ_{ct} the ratio of minimum tuning rate to normal tuning rate is

$$\frac{R_{\text{minimum}}}{R_{\text{normal}}} = \frac{\rho_{ct}^2 - 1}{\rho_{ct}^2 - \frac{1}{\rho_t^2}} \quad (8)$$

When ρ_t is greater than $\sqrt{3}$, the ratio of minimum tuning rate to normal tuning rate is

$$\frac{R_{\text{minimum}}}{R_{\text{normal}}} = \frac{1}{1 + \frac{(\rho_t^2 - 1)^3}{(\rho_{ct}^2 - 1)(\rho_t^2 + 1)\rho_t^2}} \quad (9)$$

Equations 6 through 9 represent also the factor by which the density of the slow-rate f-m spectrum of the tube is compressed or expanded by long-line effect. When the vswr at the tube is greater than ρ_{ct}, frequency-jumping occurs as the tube is tuned. Since the frequency-jumping behavior of pulsed tubes is considerably different from that of continuous-wave tubes, the following discussion is divided accordingly.

Frequency-Jumping of Pulsed Tubes

The two parameters ρ_t and ρ_{ct} determine the width of the frequency breaks as a fraction of the frequency spacing of the modes on the line, $(f/2N_g)\ (1 - f_c^2/f^2)$. Therefore, the single parameter ρ_{ct} completely characterizes the Smith chart presentation of the frequency-jumping behavior of a pulsed oscillator. For any given physical situation the value of ρ_{ct} may be determined from Q_{xh}, line length and frequency (Eq. 4). The frequency instability region boundaries, shown in Fig. 2, were determined graphically from plots of Eq. 2.

As a pulsed tube is tuned, the point on the Rieke diagram representing the line impedance at the tube moves around the Smith chart in a circle which is concentric with the center of the chart, with a radius corresponding to the vswr. (This assumes that the load is not frequency-sensitive.) When the impedance point reaches a frequency instability region boundary, the point jumps to the opposite side of the frequency instability region on the Smith chart. Practically speaking, however, when the impedance point is in the neighborhood of the frequency instability boundary, the tube fires randomly on either side of the region, so that the boundaries for stable operation are not very definite.

The transient that occurs during frequency-jumping is considerably longer than the ratio of twice the line length to the group velocity of the waves on the line. Therefore, when the line length is greater than 100 feet, the transient may not be completed during a one-microsecond pulse. If the line length is greater than that which is equivalent to 500 feet of air-dielectric coaxial line, the line will appear to be reflectionless for a one-microsecond pulse.

Figure 3 shows the percent of the tuning range accessible to pulsed tubes with long-line effect present.

Frequency-Jumping of C-W Tubes

The single parameter ρ_{ct} again characterizes the Smith chart presentation of the frequency-jumping behavior of a c-w oscillator, but in this case the behavior is complicated by hysteresis. Figure 4 shows the frequency instability regions (heavy lines) for a value of ρ_{ct} equal to 1.2. When the line impedance at the tube falls within region A, no frequency-jumping can occur, but only a nonuniformity

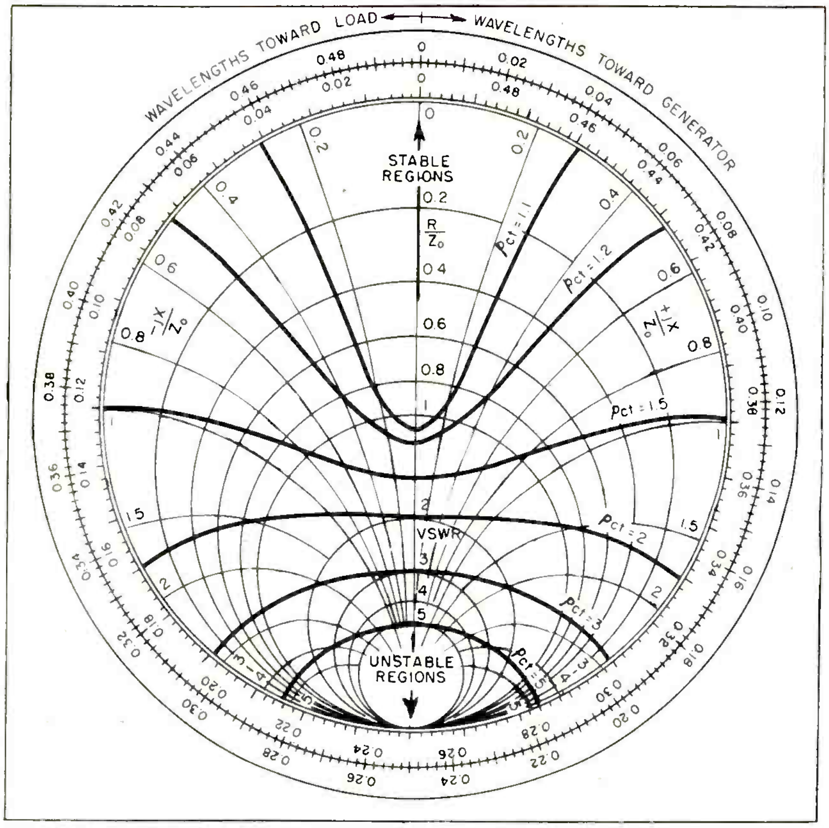

FIG. 5—Rieke diagram showing frequency-jumping contours for c-w tube

of the tuning rate exists.

Region *B* is unconditionally unstable for any manner of tuning, while region *E* is not accessible when tuning one way or the other. Region *C* is realizable only when tuning downward in frequency, while region *D* is realizable only when tuning upward. The two sets of concentric circles shown with light lines illustrate the frequency-jumping behavior for two different values of vswr and for both directions of tuning. The solid lines represent stable tuning, while the dotted lines represent the frequency-jumping transient.

Frequency-Jumping Contours

From Fig. 4 together with Eq. 1 all frequency-jumping information can be obtained for ρ_{ct} equal to 1.2. A family of curves similar to Fig. 4 could be plotted but would be rather complex, hence in Fig. 5 a family of half-curves is plotted, giving the complete story for tuning upward in frequency. A mirror reflection of the curves around the zero-reactance line completes the picture for downward tuning.

Figure 6 shows the percent of the frequency band accessible to c-w oscillators with long-line effect present as the tube is tuned both ways. For each curve the abrupt change in slope corresponds to point *a* in Fig. 4, where the two regions of frequency-jumping begin to overlap each other.

Critical VSWR Ratios

For vswr values greater than that corresponding to region *A* the only operable regions correspond to short frequency intervals, spaced $(f/2N_g)\ (1 - f_c^2/f^2)$ apart when tuning in one direction, and similar short frequency intervals spaced between the first set when tuning in the other direction.

Thus far in the discussion the emphasis has been placed on the vswr at the tube, whereas the vswr at the load is usually the known quantity. Therefore, in most practical problems Eq. 3 and 4 must both be solved. The nomograph in Fig. 7 simplifies the solution of these two relatively complex equations by giving the critical standing wave ratios ρ_{ct} and ρ_{cL} directly from the system constants.

The dashed lines on the nomograph illustrate its use for a specific problem, involving a 10-foot length of RG 48/U brass S-band waveguide. At 3,000 mc, attenuation per 100 feet is 1.2 db. Assume the external *Q* of the tube is 200. The cutoff wavelength is 14.42 mc, and at 3,000 mc the free-space wavelength is 10 cm. Now $1 - f_c^2/f^2 = 1 - \lambda^2/\lambda_c^2 = 0.519$ and $\lambda_g = \lambda/\sqrt{1 - \lambda^2/\lambda_c^2} = 0.139$ meter. Thus, $Q_{xh}\lambda_g(1 - f_c^2/f^2) = 14.42$.

Using this value and $l = 10$ feet on the right-hand side of the nomograph gives $\rho_{ct} = 1.58$. Transferring this value to the left-hand side of the nomograph and using with 0.12 db for total attenuation of 10 feet of line gives 1.6 for critical vswr ρ_{cL} at the load.

Alternatively, it is possible to eliminate ρ_{ct} and work in terms of ρ_{cL}. Eliminating ρ_{ct} between Eq. 2 and 3 and solving for ρ_{cL} gives

$$\rho_{cL} = \frac{\sqrt{1 + \frac{Q_{xh}}{\pi N_g}\left(1 - \frac{f_c^2}{f^2}\right)} - \tanh \alpha l}{1 - \sqrt{1 + \frac{Q_{xh}}{\pi N_g}\left(1 - \frac{f_c^2}{f^2}\right)}\ \tanh \alpha l} \qquad (10)$$

As the line length is increased, the value of ρ_{cL} decreases until a minimum is reached, after which it increases again and becomes infinite. At line lengths greater than that corresponding to $\rho_{cL} = \infty$, Eq. 10 is no longer valid; ρ_t is always less than ρ_{ct} for any ρ_{cL}. Plots of ρ_{cL} versus line length for S-band, X-band and K-band waveguides for various values of Q_{xh} are shown in Fig. 8. Since attenuation and guide wavelength vary over the frequency range of a given waveguide, the curves shift as the tube is tuned. The expressions for minimum crit-

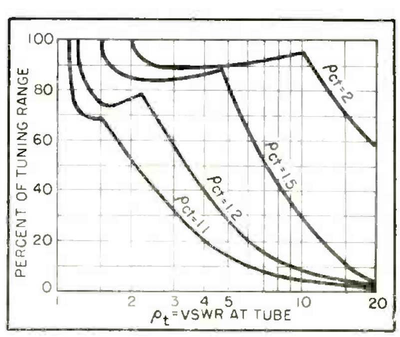

FIG. 6—Percent of tuning range accessible to continuous-wave oscillators when tube is tuned both ways

ical vswr at the load, and the line length at which this occurs, are given in Eq. 11 and 12.

$$\rho_{cL\text{-minimum}} = \frac{\sqrt{1 + \frac{2}{\zeta}\left(1 - \frac{f_c^2}{f^2}\right)} - \tanh \frac{\alpha \lambda_g Q_{xh} \zeta}{2\pi}}{1 - \sqrt{1 + \frac{2}{\zeta}\left(1 - \frac{f_c^2}{f^2}\right)} \tanh \frac{\alpha \lambda_g Q_{xh} \zeta}{2\pi}} \quad (11)$$

$$\text{For minimum } \rho_{cL},\ l = \frac{\lambda_g Q_{xh} \zeta}{2\pi} \quad (12)$$

$$\text{where } \zeta = \sqrt{1 + \left(\frac{\pi}{Q_{xh} \alpha \lambda_g}\right)^2} - 1$$

From Eq. 11 and 12, ρ_{cL} becomes a minimum at a line length corresponding to about 4 db attenuation, and ρ_{cL} becomes infinite for a line length corresponding to about 25 db for the usual range of values of Q_{xh}.

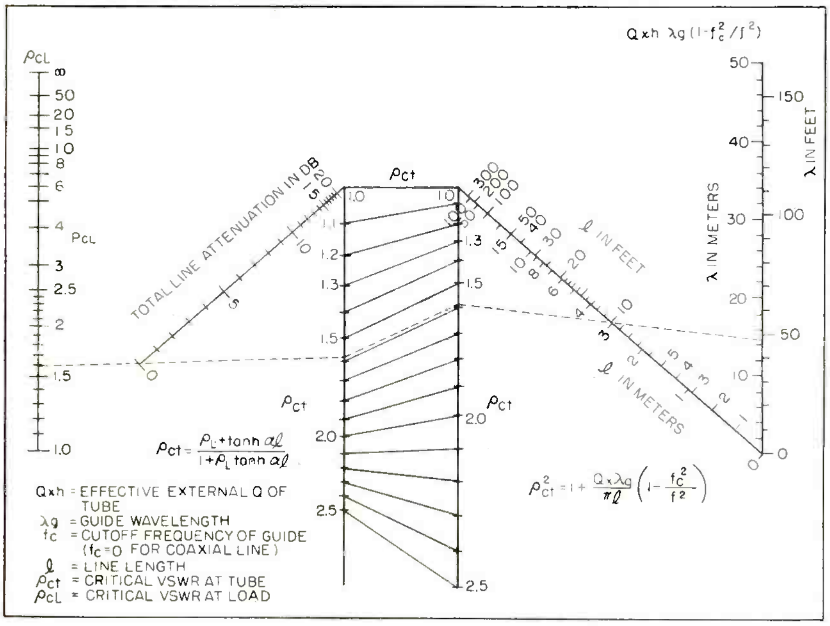

FIG. 7—Nomograph for calculation of the critical voltage standing-wave ratio at which frequency-jumping begins in the oscillator tube

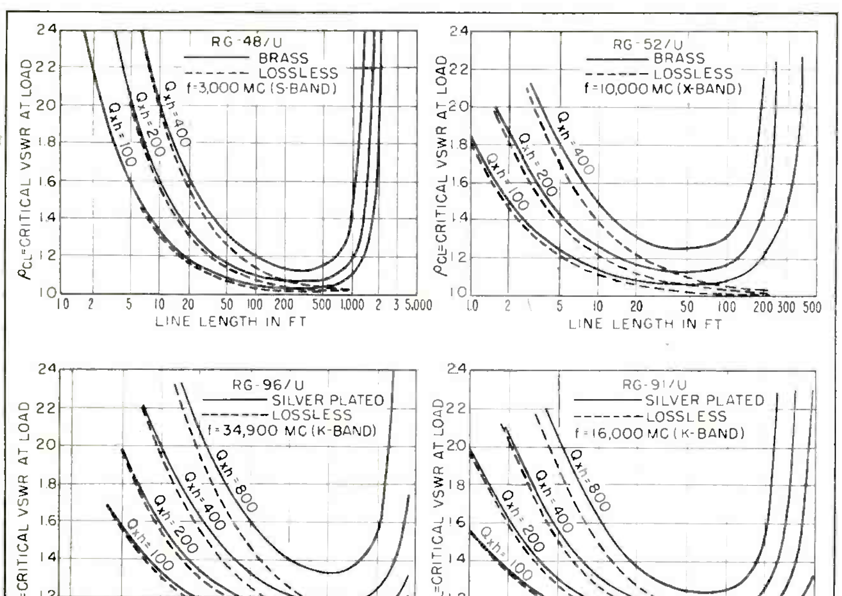

FIG. 8—Curves giving critical voltage standing-wave ratios at load as function of system constants. Curves shift as tube is tuned through the operating range

Conclusions

A nomograph, a set of curves and some simple equations have been evolved which simplify calculations of long-line effect. From these studies it may be seen that line lengths of the order of 75 guide wavelengths render ordinary microwave oscillator tubes useless for applications where smooth tuning is required when the line is terminated in standing-wave ratios presented by typical broadband antennas. This means, for example, that to avoid frequency-jumping, X-band line lengths must be less than 12 feet, and K-band line lengths must be less than 4 feet.

Elimination of frequency-jumping is most easily achieved by designing the system for a short line length. Another solution is to introduce sufficient attenuation, but this causes substantial power loss and is hence not suitable for high-power work.

Line stretchers may be employed whenever the application tolerates their use. No long-line frequency-jumping is experienced when the microwave generator is an amplifier driven by a well-buffered master oscillator. Ferrite gyrators[3] or other types of one-way transmission lines may solve the long-line problem when the peak power is low.

Carcinotron

A new type of oscillator tube, the carcinotron[4, 5] (backward-wave oscillator) employing basically new principles of operation, is presently in development and shows promise of having a much higher effective external Q than those ordinarily encountered. These tubes should be very insensitive to long-line effect.

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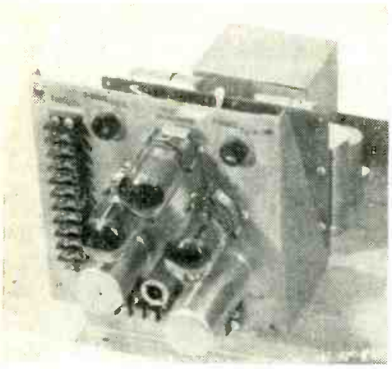
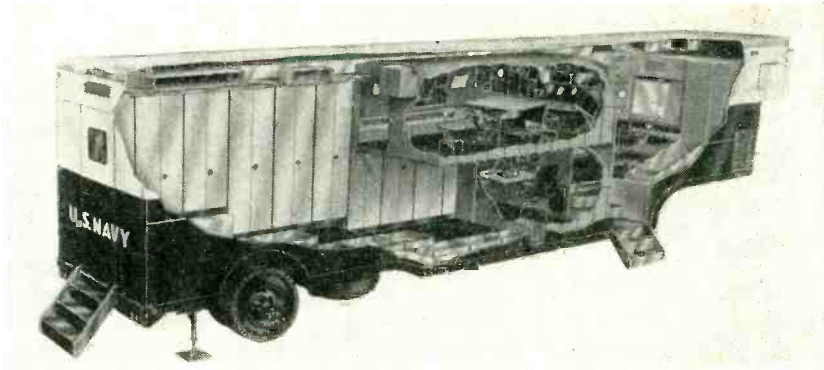


Electronic filter occupies one fiftieth the space required by equivalent L-C filter



Cutaway view of Navy tactics trainer using central d-c power supply with electronic filter to replace prohibitively bulky inductance-capacitance filter

Electronic Filter For

Economy of rack space and improved filtering action result from using electronic filter in central power supply for multi-unit analog computer. Typical filter described removes ripple from 300-volt 18-ampere d-c supply for Navy tactics trainer

By R. N. RIGGS and J. D. CRONIN

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CENTRAL power supplies for electronic computers are rapidly replacing the numerous isolated power supplies that existed in the past. They have the advantages of lower cost and less waste of expensive rack space.

These advantages, however, are accompanied by many severe problems which must be solved if the supply is to be suitable for analog computer applications. Such computer supplies must have low d-c regulation, low a-c output impedance from d-c through the audio range and low ripple within the pass band of the computer components. Failure to accomplish these objectives could cause severe noise and interaction between computer elements; in the extreme case, it could cause the system to break into oscillation.

Isolated power supplies do not usually present such interaction problems. Solution of the ripple and impedance problems by a simple L-C filter, for a typical 300-volt d-c 18-ampere 3-phase supply, would require an inductance occupying about two-thirds cubic foot and an oil-filled capacitor of about fifty cubic feet. These can be replaced by an error-actuated electronic filter occupying about one cubic foot, at a small fraction of the cost.

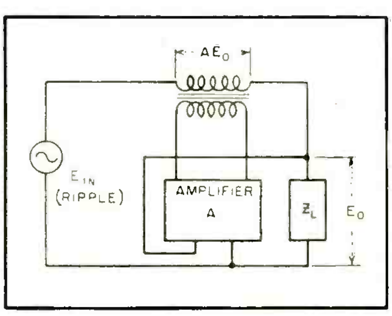


FIG. 1—Basic a-c equivalent circuit of electronic power supply filter

The a-c equivalent block diagram of such a filter is shown in Fig. 1. Taking each component of the a-c ripple individually, it can be shown that ripple reduction varies with the gain of the amplifier, while the power (volt-amperes) required for filtering is an inverse function of amplifier gain.

$$E_o = E_{IN} - AE_o$$

$$E_o\,(1 + A) = E_{IN}$$

$$E_o = E_{IN}/(1 + A) = E_{IN}/A \text{ for } A \gg 1$$

$$VA = AE_o\,\frac{E_o}{Z_L} = \frac{E_{IN}^2}{AZ_L}$$

The amplifier indicated in Fig. 1 is a two-stage unit with attenuation and phase-shift compensating networks. Nyquist's criteria for stability was applied with the stipu-

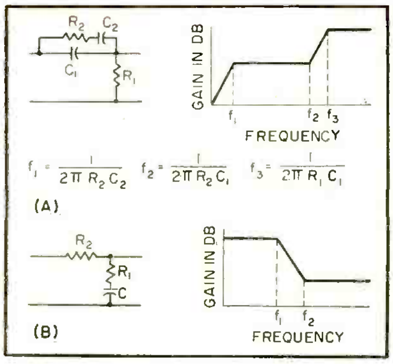


FIG. 2—Low-frequency (A) and high-frequency (B) networks and responses

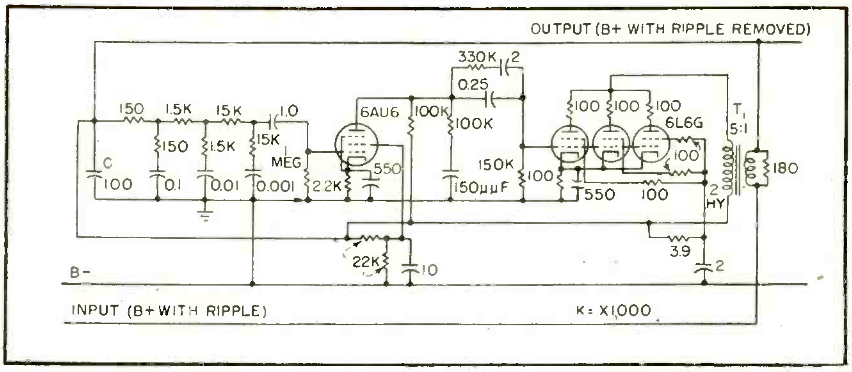


FIG. 3—Complete circuit diagram of electronic filter for 300-volt 18-ampere power supply. Equivalent L-C filter would require 50 cubic-foot capacitor

Central Power Supplies

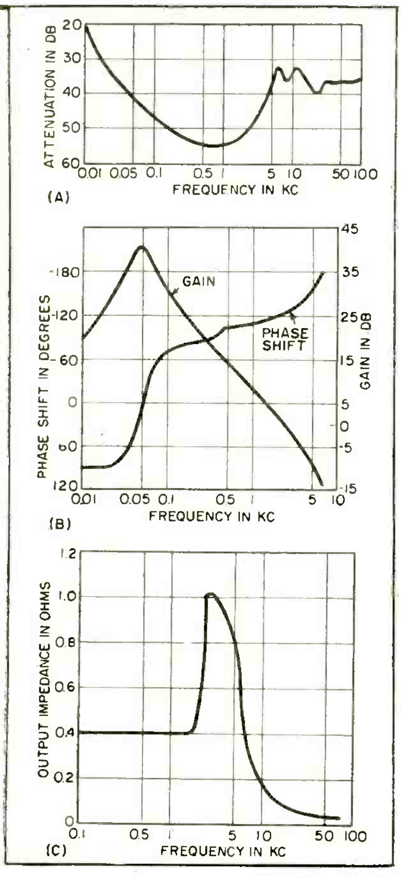


FIG. 4—Curves showing filter attenuation and amplifier gain and output impedance vs frequency

lated safety factor that the gain would not exceed 0 db when the phase shift reached 150 degrees, nor exceed —10 db when the phase shift reached 180 degrees.

Two types of attenuation and phase-shift networks are used; one is effective at low frequencies, the other at high frequencies. The low-frequency network is shown in Fig. 2A. The number of octaves between f_2 and f_3 can be controlled to give some attenuation without excessive phase shift. The attenuation is accomplished at 6 db per octave. The use of a coupling capacitor large enough to cause blocking is avoided, while the break frequency of f_1 nevertheless occurs at a very low frequency.

The high-frequency networks are of the type shown in Fig. 2B. Attenuation is accomplished at 6 db per octave per network. In the case of the interstage network the 6AU6 load resistor acts as the series arm. The complete amplifier employing these circuits is shown in Fig. 3.

The total ripple attenuation is the sum of that due to a conventional L-C (capacitor C and the secondary of T_1) filter network action and that due to the amplifier. The plot, in Fig. 4A, of ripple attenuation vs frequency shows the total attenuation due to both for one of the filter types developed. The curves of the amplifier open-loop characteristics (Fig. 4B), show the effects of the amplifier network alone as measured by the setup shown in Fig. 5. The curve of output impedance vs frequency, in Fig. 4C, was calculated by passing a known current from the simulated load impedance into the filter unit and measuring the voltage drop across it as shown below in Fig. 5.

Load Power Factor

Since the capacitive component of the load is not very predictable,

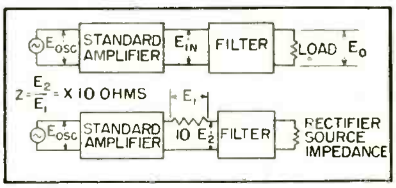
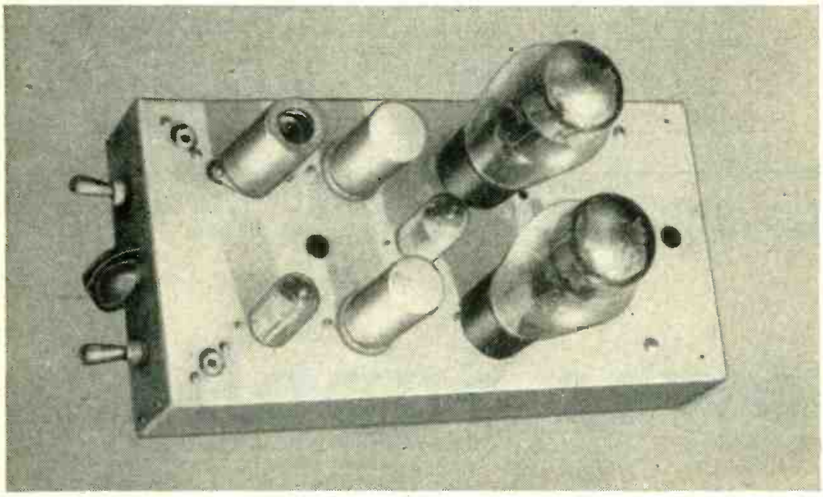


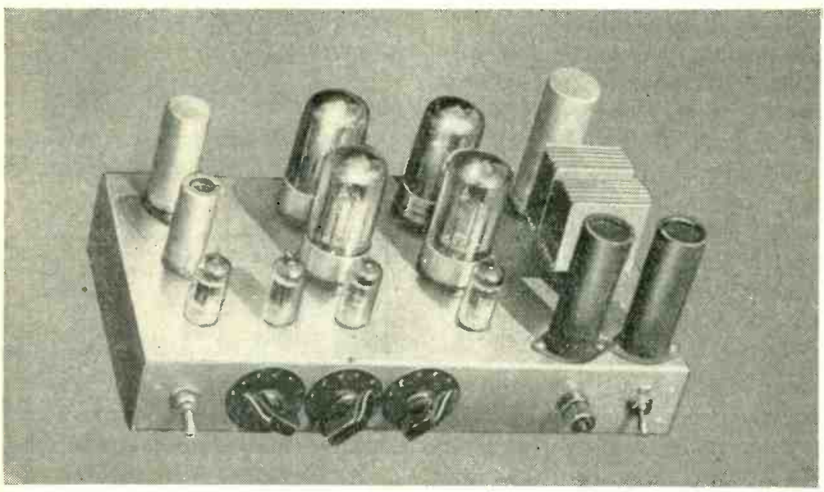
FIG. 5—Circuit arrangements for measuring filtering action

and output transformer phase and gain response is a function of the capacitance across its output terminals, it was necessary to parallel the load with a capacitor C such that any increased capacitance in the load would not cause increased phase shift which would endanger stability. The consequent amplifier gain reduction was compensated for by L-C filter action. The sum of these two effects is included in the total attenuation vs frequency plot of Fig. 4A. The stability criteria plot in Fig. 4B shows the gain of the amplifier, this being the inverse of the attenuation produced.

Audio Amplifier Matches



View of transformerless amplifier including preamplifier



Chassis of 18-watt amplifier includes preamplifier and power supply

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TRANSFORMERS are used in power amplifiers for impedance transformation to deliver maximum power to a given load with minimum distortion and to isolate the load from direct-current components in the circuit. An ideal transformer should perform these functions without introducing any distortion and power loss. However, a practical audio transformer is far from the ideal and it is the heaviest, bulkiest and most expensive item in an audio amplifier—including even the power supply transformer (on a watt per watt basis).

The equivalent circuit of an iron-core push-pull output transformer is shown in Fig. 1 and requires little comment other than that it now represents an impedance that varies both with frequency and operating level or excitation.

Amplitude distortion will be caused due to the nonlinearity of the B-H characteristics of the core material and will become worse at low frequencies as can be seen from the relation

$$E_p = 4.44\, fBAN \times 10^{-8} \text{ volt} \quad (1)$$

Investigation of nonlinear distortion caused by transformer core materials shows that the total harmonic distortion may run up to several percent.[1] Additional amplitude distortion will be generated due to mismatch between the load and the tubes as a result of transformer impedance variation particularly at low and high frequencies.

The amplitude falls off at low frequencies due to the finite value of the primary inductance and due to leakage inductance and winding capacitances at high frequencies. Resonance effects are also produced at certain frequencies.

Frequency distortion will be accompanied by phase distortion and this becomes an important consideration when feedback is applied around a loop including the output transformer. At certain frequencies the nature of feedback may exceed the stability requirements where a safety margin of 30 degrees and 15-db loss around the feedback loop must be allowed. This requires that the cutoff rate at both ends of the frequency response curve should not exceed 10 db per octave. Some feedback amplifiers which seem to be stable under steady conditions show poor transient response and instability when subjected to the tone burst method of testing.[2]

The efficiency of an audio output transformer is often overlooked. However there are commercial transformers in which the losses including the total core and copper losses may be as high as 50 percent. The core losses vary with both frequency and flux density according to the well known relation

$$P = k_h f B_m^n + k_e f^2 B_m^2 \text{ watts} \quad (2)$$

Voice-Coil Impedance

Balanced transformerless amplifier is characterized by low distortion, wide frequency range and good transient response. Typical amplifier produces 18 watts of audio and weighs only 4 pounds including preamplifier and power supply

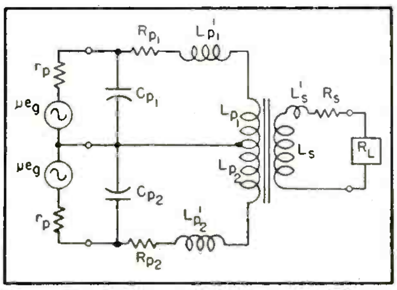

FIG. 1—Equivalent circuit of a typical output transformer illustrates its frequency dependence

As a result of this, the frequency response of an amplifier will look quite different at various power levels.

Furthermore with push-pull output transformers, there is the problem of symmetry and coupling between each half of the primary as well as the secondary windings; and unless a coupling factor of one is realized, the flux due to the d-c components cannot be completely cancelled out while maintaining a-c symmetry. This is of particular importance in class-B audio amplifiers.

Thus, the performance of an audio amplifier is intimately linked with the quality of the output transformer. It is by no means an easy task to design a good audio output transformer even if cost, weight and size are of no consideration. Hence, many attempts have been made to eliminate the output transformer.[3,4,5]

Some objectives may be prescribed for a transformerless amplifier. The circuit should be symmetrical with no d-c through the load and it should not be necessary to use large electrolytic capacitors to block the d-c components. The tubes should be easily driven in the right phases, without using transformers; but in-phase components, such as hum, should not appear in the load. The output impedance should be as low as possible and no taps should be used in the loudspeaker voice coil. Inverse feedback should be easily applied without using complicated circuits.

Transformerless Amplifier

Figure 2 shows the circuit of a power amplifier consisting of four tubes connected in a balanced bridge circuit and so driven that each tube delivers equal power to the load. The tubes are properly biased to establish normal operating plate voltages and currents. The lower tubes in the bridge are biased with the total plate currents flowing through R_k. The upper tubes are positively biased by the bleeder network R_1, R_2 and R_3, so that the correct negative bias is established between their grids and cathodes. The bias voltage should be equal in all tubes.

The loudspeaker or load is connected between points 5 and 6 and no current should flow through it in the absence of a signal. A d-c balancing control R_3 is provided to zero adjust the circuit if necessary. However, due to the nature of the circuit, out-of-balance current with tube replacement is very small, even without this control.

A push-pull voltage amplifier drives the output tubes in the proper phase and amplitude. Since less drive is required for the lower tubes, taps are provided in the plate load resistors of this amplifier. The drive may be termed diagonal phasing, since the tubes on the same diagonal are driven in phase whereas the tubes on the other diagonal are 180 degrees out of phase. The drive voltage e_i for the upper tubes depends on the value

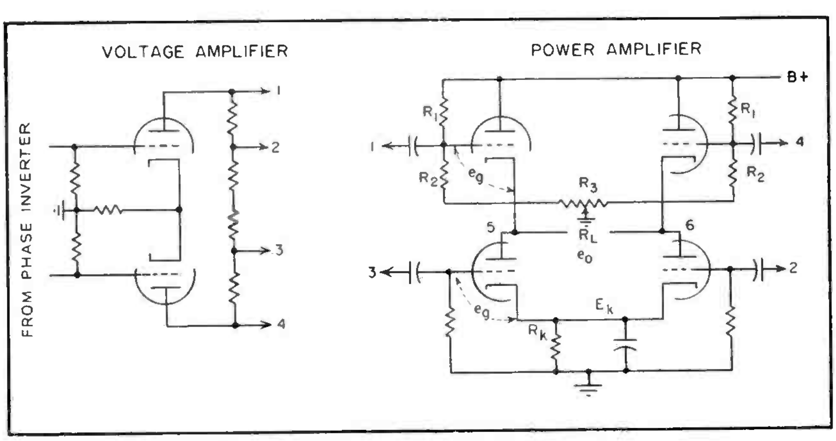

FIG. 2—Basic circuit diagram of transformerless amplifier

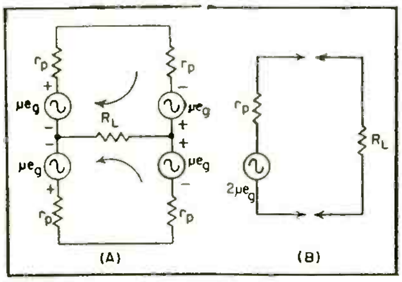

FIG. 3—Equivalent circuit of amplifier

of the load resistance and is given approximately by the expression

$$e_i = e_g + \frac{e_o}{2} \qquad (3)$$

where e_o is the output voltage.

The equivalent a-c circuit of the power amplifier stage is shown in Fig. 3A and may be represented by a generator of voltage $2\mu e_g$ in series with the plate resistance r_p (Fig. 3B). Thus the total power is 4 times that of a single tube. It should be noted that e_g is the net a-c driving voltage between grid and cathode.

Circuit Variations

Several varieties of this circuit are possible. For instance, the grids of the upper tubes may be directly connected to the plates of the voltage amplifier as shown in Fig. 4. In this way the coupling capacitors and the biasing resistors are eliminated. Then the d-c balancing of the power amplifier is adjusted by potentiometer R in the voltage amplifier cathode circuit. An audio amplifier using this variation was built and used for sometime with good results. Furthermore the tubes may be biased for class-AB or class-B operation for higher plate efficiencies. With the direct-coupled circuit, however, the filaments of the push-pull amplifier cannot be placed in the cathode lead.

Feedback can be connected between either point 5 or 6 and a suitable point in the early stages of the amplifier virtually to eliminate amplitude distortion. It can also be applied in push-pull from both points in the output. Poorly filtered d-c plate supply voltage can be used with no audible hum in the output. In this case feedback must be applied in push-pull.

A complete audio amplifier using this circuit in the output stage is shown in Fig. 5. A see-saw type of phase inverter is used although other types are equally satisfactory. The filaments of the voltage amplifier and the phase inverter tubes are placed in the common cathode circuit of the power output stage. In this way filament hum is eliminated and some saving both in power and parts realized.

Audio Characteristics

Overall negative feedback of about 15 db is applied from the correct output terminal to the cathode of the input tube. With a total plate current of 215 ma at 270 volts and using a load of 400 ohms the output power is 9 watts with an intermodulation distortion of only 0.7 percent. Plate efficiency under these conditions (class-A operation) is 20 percent. Power output versus load impedance is shown in Fig. 6A. Intermodulation distortion versus power output with and without feedback are shown in Fig. 6B.

No special comments are necessary for the frequency response of this amplifier; since the only limiting factors are the tube and stray capacitances at high frequencies and the size of the coupling capacitors at low frequencies. It is flat within the audible range and the response is the same at all levels of operation. This is not true for transformer amplifiers. An input voltage of 0.3 volts rms is required for full power output.

One criticism which may be directed against this transformerless amplifier is the fact that a comparatively high impedance loudspeaker is required for full power output. However, even with a 4-ohm loudspeaker, sufficient volume without noticeable distortion can be obtained in an average-size room.

18-Watt Amplifier

With the object of increasing the power output and at the same time reducing the load impedance, another amplifier was built using four type 6082 tubes. These tubes are industrial versions of the well-known 6AS7G and require 26.5 volts for the filaments. Hence it is possible to connect all the tubes in series across the power line without using a filament transformer.

As seen from Fig. 6 the ideal loudspeaker for use with the amplifier described should have a voice-coil impedance of 400 ohms. However, satisfactory results are also obtained with a 16-ohm loudspeaker. Several speakers may be connected in series to obtain an approximate match to the amplifier; for example, four 50-ohm five-inch intercom speakers mounted in a suitable enclosure make an ideal system.

One of the best speakers tried with the system is a special DeLuxe 12 Bakers loudspeaker having a voice-coil impedance of 250 ohms. This unit has a power rating of 15 watts and its frequency range is 18 to 17,000 cps.

The cone is suspended with a cloth ring and has a fundamental resonant frequency of about 35 cps.

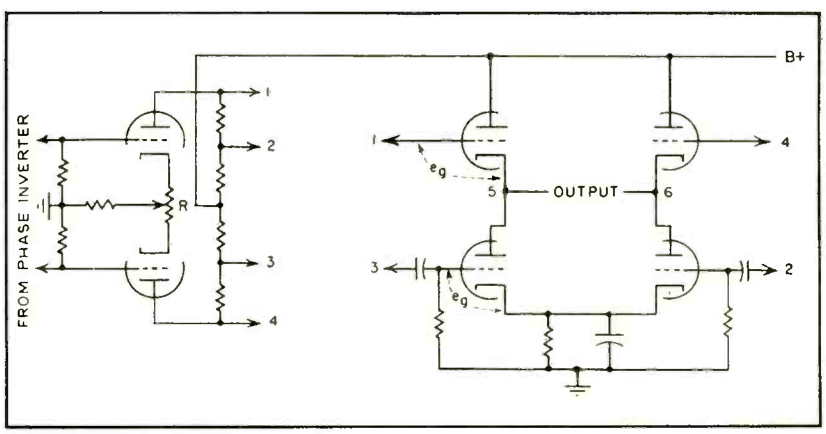

FIG. 4—Basic circuit of transformerless amplifier using direct coupling

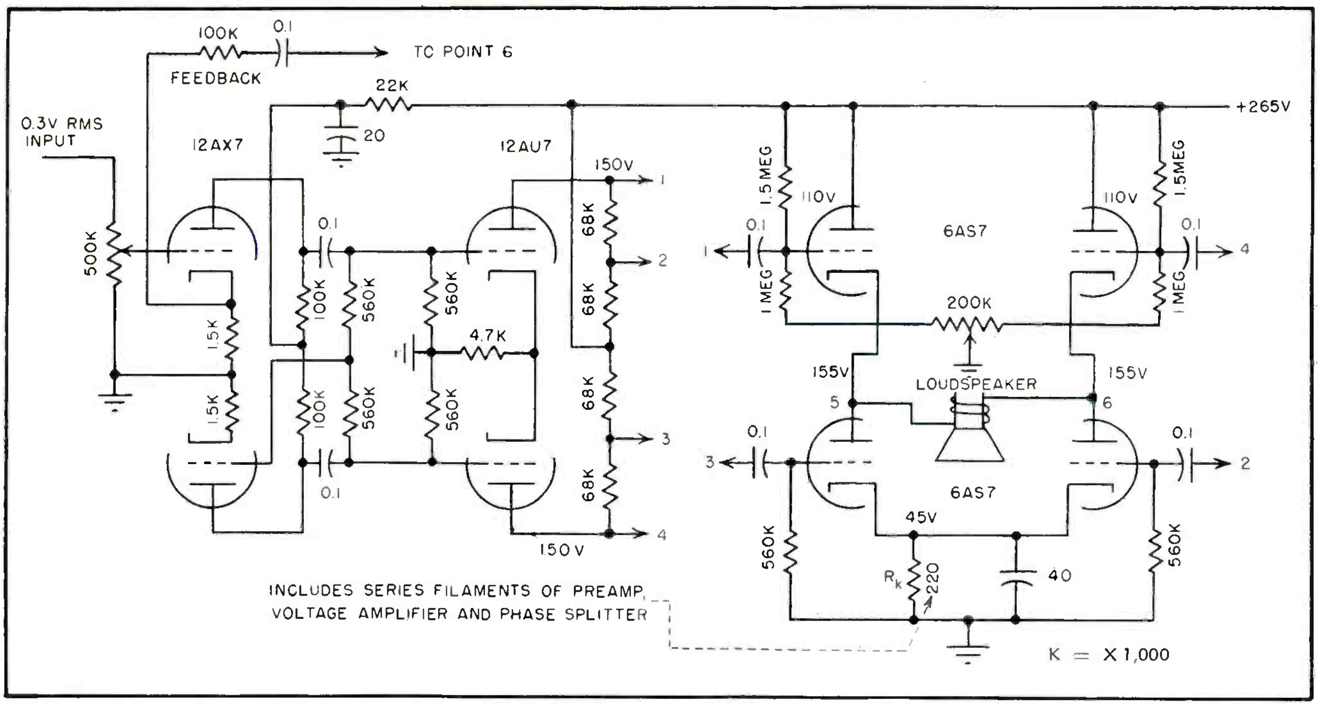

FIG. 5—Complete transformerless amplifier capable of outputs of 8 watts. Bridge-type ouptut circuit matches voice-coil impedance

If desired, an output transformer can be used with advantage, since the requirements imposed on the transformer would be far less than a conventional push-pull audio output transformer. This can be of simple construction, with only two windings and having a small turns ratio. Such a transformer will be comparatively free from the troubles outlined in the beginning of this paper and will cost far less. In fact, an ordinary filament transformer has been used successfully with large amounts of negative feedback applied over the secondary winding.

Applications

The amplifier circuit described above is not restricted to the circuits, tubes and mode of operation described. Other tubes, such as the 12B4 and the 6SN7 may be used, but with some sacrifice in power output. Also the total plate current may be reduced to 150 ma or to 300 ma to simplify the cathode load circuit and provide heater current for the voltage amplifiers. Several varieties using the basic idea may be used. Furthermore, several applications of this amplifier circuit are possible, besides its use as a straight audio amplifier. It can be used with advantage in recording amplifiers, in ultrasonics, in wide-band amplifiers, in aircraft, in commercial, military and other equipment where reduction of weight, and compactness are the objectives.

Cathode-Ray Circuits

This transformerless amplifier circuit is particularly suitable for magnetic deflection of cathode-ray tubes in television, radar and other applications. The linearity of the forward trace will be greatly improved due to the wide frequency response and no high transient voltages will be produced during the return trace other than across the yoke inductance. A damper diode may be connected across the output to reduce these transient voltages. Furthermore the efficiency of the system will be greatly improved, particularly in the line drive circuit where the frequency is high. In contrast to push-pull deflection systems, there will be no direct current through the yoke and no center tap is necessary. The linearity of the tubes may be improved by the application of negative feedback as discussed above.

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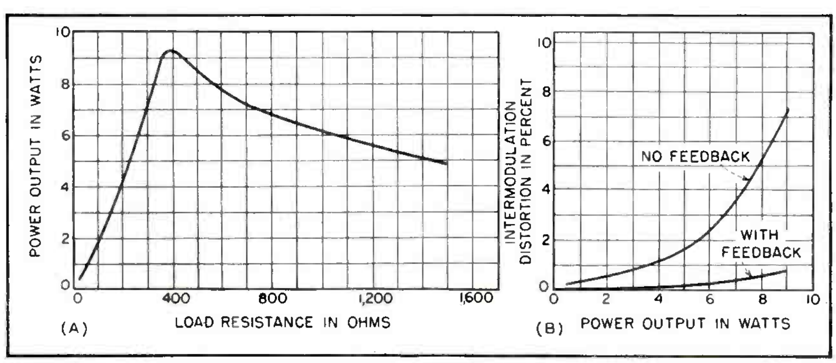

FIG. 6—Curves show output versus load (A) and distortion (B)

Multiexposure Flash

Hydrogen thyratrons triggered by ring counter provide ten one-microsecond flashes for series photography of rapidly occurring phenomena, and use in making Schlieren and shadowgraph pictures. Flash timing can be synchronized with camera operation

Microsecond flash equipment with high-speed camera at left. Pulse generator supplies triggering pulses for series of ten flashes

Thyratrons of pulser unit connect energy storage capacitors at bottom if picture across light source when triggered by counter circuit

SEQUENCE photography of phenomena such as projectile motion, explosive reactions, and rapid mechanical motions require a timed series of short-duration flashes. The system described in this article provides a group of ten one-microsecond pulses synchronized with camera operation.

The equipment consists of a timing-pulse source and driver, a pulser with energy storage and power supply, a light source and a photographic recorder.

The light source can be either a magnesium gap or a gas-filled strobe lamp and will dissipate 32 watt-seconds of energy for each pulse. Time interval between light flashes can be adjusted from 100 μsec upward.

A block diagram of the complete photographic system in shown in Fig. 1. The timing unit provides synchronization of the light impulses with camera operation.

When a high-speed movie camera is used, a magnetic pickup coil is aligned with the film-sprocket tooth, causing a pulsed signal to flash the light approximately at the center of each frame time. If a rotating-mirror camera is used the light flashes are controlled by a time-mark generator.

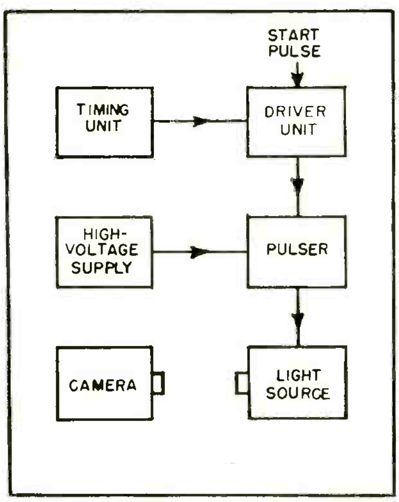

FIG. 1—Block diagram of flash system. Pulser connects series of charged capacitors across flashlamp

The driver, which contains a ten-stage gas-tube counter, shapes and counts the time marks for the pulser circuit. Driver action can be triggered by the phenomenon being observed.

The pulser consists of energy-storage capacitors and thyratron switching tubes. These tubes connect the stored energy into the light source as each successive pulse is received from the driver. An 18-kv power supply charges the storage capacitors for each cycle.

Driver

The driver unit, shown in Fig. 2, is composed of a pulse-shaping circuit, gate amplifier, control multivibrator, ten-stage thyratron counter and ten output circuits.

A two-stage limiting-type amplifier and a monostable multi-

This article is based on a paper presented at the National Electronics Conference, Chicago, 1953. The paper will appear in *Proc NEC*.

for High-Speed Cameras

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vibrator make up the pulse-shaping circuit. The timing signal is squared by the amplifier and this square-wave is differentiated to obtain a trigger signal for the multivibrator. Amplifier sensitivity is such that the multivibrator is triggered with a one-volt input signal.

For sine-wave input, sensitivity is somewhat dependent upon the frequency; at frequencies of 3.5 kc and higher, one volt rms is sufficient; at lower frequencies the amplitude must be increased slightly. With pulsed-signal inputs, repetition frequency is immaterial. Pulses having an amplitude slightly greater than one volt and a rise time of a few microseconds are satisfactory.

The output pulse of the shaper is obtained from the trailing edge of the multivibrator pulse. This pulse can be adjusted in width from about 10 to 85 μsec, and, hence, the timing pulses can be delayed by a controlled amount within this range. This delay is used for centering the light pulses in the frame exposure time.

A 6AS6 tube is used as a gate. Pulses from the shaper are applied to its control grid and its suppressor voltage is controlled by a bistable multivibrator. In its normal reset state, the multivibrator clamps the gate suppressor at a negative bias level and blocks the timing pulses. When a start pulse occurs, this bias is removed and the pulses pass through to the counter. The gate remains open until the counter has received ten pulses. At this time an end pulse is generated resetting the control multivibrator.

Pulses out of the gate are applied in parallel to the grids of all thyratrons in the counter. Since this requires more power than the

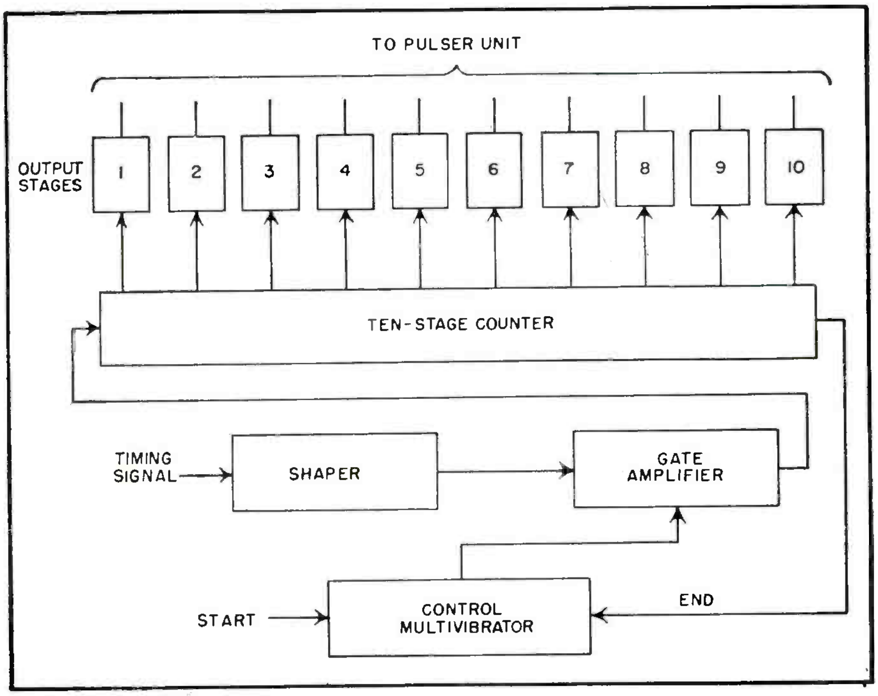

FIG. 2—Driver unit, shown in block form, supplies ten pulses to the pulser unit when triggered by signal from marker generator or magnetic pickup

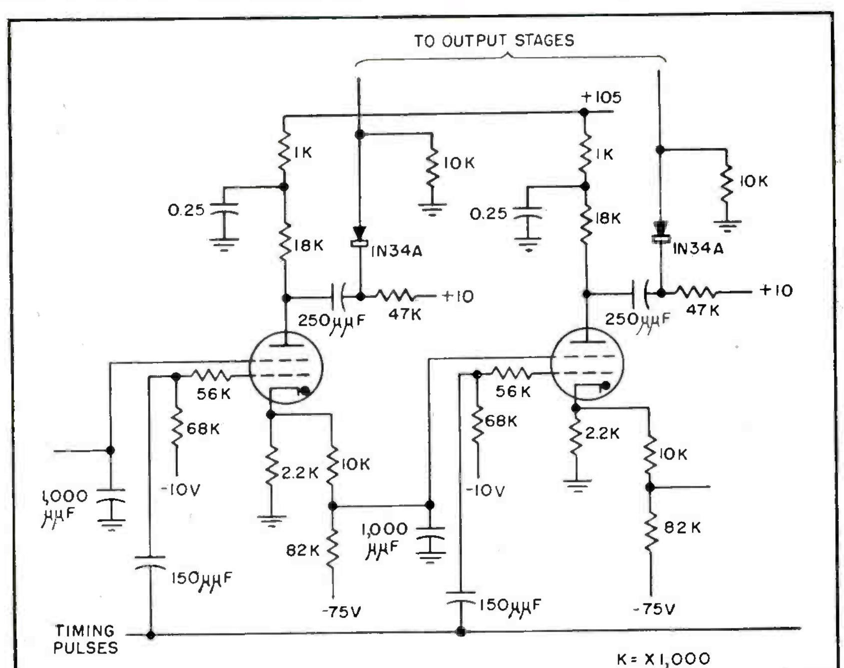

FIG. 3—Two of ten ring-counter stages. Circuit constants give a maximum count of 10,000 per second using component values indicated

6AS6 can deliver, the gate circuit is followed by an amplifier and cathode follower.

Counter

The counter is a version of a gas-tube ring counter in which the ring has been opened. A typical pair of counter stages is shown in Fig. 3. In the normal reset state, all thyratrons of the counter are nonconducting. The voltage-divider network in the cathode circuit of each stage places a negative bias on the screen of the succeeding stage. This bias is sufficient to prevent the thyratron from being fired by any pulses present at its grid. If the thyratron in the preceding stage conducts, the voltage drop across its cathode resistor decreases the screen bias to approximately zero. When the bias is removed, the stage will fire on the next pulse.

The screen of the thyratron in the first stage of the counter is clamped at zero bias voltage. Therefore, this stage will fire on the first pulse that is passed by the gate to the counter. A 1,000-$\mu\mu$f capacitor across the screen of each stage forms, in conjunction with the divider of the preceding stage, a slow-time-constant charging circuit. This R-C circuit prevents the screen voltage from changing so rapidly that two stages of the counter will fire on a single pulse. The plate load of each stage is such that conduction will continue after each stage is fired. This prevents the counter from counting through more than one cycle without being manually reset. For the circuit constants shown in Fig. 3, the counter is limited in counting speed to about 10,000 counts per second.

The large negative signal that occurs in each stage as it is fired is fed through a biased diode to an output stage. This clipping of the signal removes hash appearing at the thyratron plate during conduction.

Each output stage of the driver unit is composed of a triode inverter, one-half a 12AU7 and a 2D21 thyratron pulser. The cathode of the thyratron is cable-connected to the 25-ohm grid circuit of a hydrogen-thyratron discharge circuit in the pulser unit. A 150-volt pulse is developed across 25 ohms by this circuit arrangement.

It was found necessary, however, to place approximately 100-volt bias on the control grids of the 2D21 pulser circuits. This is to counteract the large negative pulse fed back through the cable from the pulser unit when the hydrogen thyratrons corresponding to other output circuits are discharged. This large pulse is due to the plate-grid capacitance of the 5C22 thyratrons.

Power for the driver unit is supplied by a conventional low-voltage supply. A series-type voltage regulator controls the voltage to the counter thyratrons. Other voltages are obtained by taps on a bleeder circuit or across glow-discharge regulator tubes.

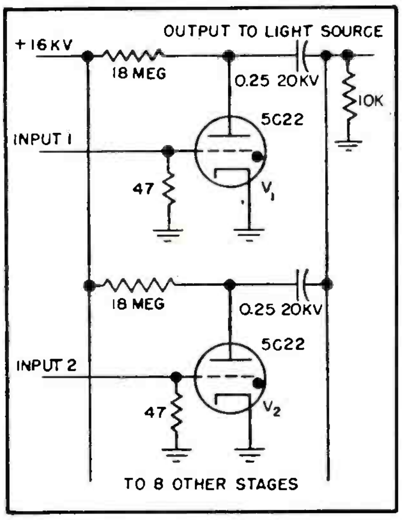

FIG. 4—Series of 5C22 thyratrons sequentially switches ten 0.25-μf energy-storage capacitors across flashlamp

Pulser

The light-source pulser consists of ten 5C22 thyratrons and sequentially switches ten energy-storage capacitors into the light source. A circuit diagram of this unit is shown in Fig. 4.

A negative excursion toward zero will occur for all thyratron anodes except the one firing, or those that have been previously fired. Due to capacitive coupling between the anodes and grids of the 5C22's, the grids are also driven negative and if the grid impedance is high enough the grids will be driven positive as the anodes return to full d-c level. Since this would result in the firing of all tubes simultaneously, a resistive grid impedance of 25-ohms has been chosen for proper operation of this pulser. Each grid receives its driving pulse through a 50-ohm coaxial cable from the driver unit.

In each pulser stage, a 0.25-μf energy-storage capacitor gives a one-microsecond light pulse when used with light-source impedances of four to five ohms. The capacitors are charged to 16 kv through 18-megohm resistors. This resistance was selected to isolate the individual pulse stages and to reduce the high-voltage power supply charging current following each operation cycle. The 5C22 thyratrons are in shunt across the high voltage, and the capacitors are connected from each anode to ground through the light source. A wire-wound resistor shunts the light source to provide a d-c charging path to the capacitors. Under pulse conditions this resistor has negligible effect, owing to its high inductive impedance.

The power supply is a conventional voltage-doubler system using 371B rectifiers and is capable of supplying up to 18 kv at 50 ma.

Surge fields inside the pulser cabinet are severe enough to disturb the reference amplifier in the low-voltage driver supply. For this reason the driver supply and driver are located in another cabinet external to the pulser.

Normally the 5C22 thyratron is not forced-air cooled, but with a compact array of 10 tubes whose heater consumption totals 650 watts, fan cooling is necessary.

The development described in this article was carried out under a contract with the Small Arms Branch, Research and Development Division, Office of Chief of Ordnance. The authors also wish to acknowledge with gratitude the assistance of Messrs. Goll, Williams, Rosine and Rendina of the Midwest Research Institute Staff.

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Gain-Stabilized Transistor Amplifier

Junction transistor amplifier uses unbypassed emitter resistor to obtain a predictable, stable gain and wide range of input impedances. Audio and instrumentation equipment are among possible circuit applications

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INHERENT low input impedance and wide variation in gain of transistor amplifiers often necessitate transformer coupling and wide-range amplitude control. The grounded-collector circuit has a high input impedance, but a gain of less than unity. The amplifier circuit described here possesses the high input impedance of the grounded-collector connection, the amplification possibilities of the grounded-emitter connection, and a predictable and stable gain.

Analogy between the grounded-emitter transistor amplifier and the grounded-cathode vacuum-tube amplifier indicates that gain stability may be obtained by an unbypassed resistor between emitter and ground. This produces negative current feedback, causing increased gain stability at the cost of lowered overall gain. In the case of the transistor, the increased input impedance obtained may compensate for the gain reduction.

Theoretical Basis

The transistor amplifier and its conventional low-frequency equivalent circuit are shown in Fig. 1. The symbols used are standard: e_i is the a-c input voltage, e_o the a-c collector voltage output, e_o' the a-c emitter voltage output, r_e, r_b, r_c and r_m, are the transistor parameters,[1] $I_e = -(I_1 + I_2)$ is the emitter current, $I_c = -I_2$ is the collector current, R_e is the external emitter resistor, R_c is the external collector resistor and E_{cc} is the collector bias voltage.

By straightforward analysis

$$R_{in} = \frac{e_i}{I_1} = r_b + r_e + R_e + \frac{(r_e + R_e)\,(r_m - r_e - R_e)}{R_c + r_c + R_e + r_e - r_m} \qquad (1)$$

$$A = \frac{e_o}{e_i} = \frac{-R_c\,(r_m - r_e - R_e)}{[r_b(R_c+r_c+R_e+r_e-r_m) + (R_e+r_e)\,(R_c+r_c)]} \qquad (2)$$

and

$$A' = \frac{e_o'}{e_i} = \frac{R_e\,(R_c + r_c)}{[r_b(R_c+r_c+R_e+r_e-r_m) + (R_e+r_e)\,(R_c+r_c)]} \qquad (3)$$

Since junction-type transistors are generally used in the grounded-emitter circuit, it may be assumed that r_m and r_c are much larger than R_e and R_c, which are in turn much larger than r_b and r_e (remembering that $r_m \approx \alpha r_c'$). Values used in calculations are, $r_c = 0.7$ meg, $r_b = 350$ ohms, $r_e = 20$ ohms and $\alpha = 0.975$.

Values of R_e and R_c will generally be between 1,000 and 50,000 ohms. Application of these assumptions to Eq. 1, 2 and 3 shows that

$$A \approx -\alpha \frac{R_c}{R_e} \qquad (4)$$

$$R_{in} \approx R_e + \frac{r_m R_e}{R_e + R_c + (1 - \alpha)\, r_c} \qquad (5)$$

$$A' \approx 1 \qquad (6)$$

If it is assumed further that α is very nearly unity, Eq. 4 and 5 reduce to

$$A \approx \frac{R_c}{R_e} \qquad (7)$$

$$R_{in} \approx R_e + \frac{r_c}{1 - A} \qquad (8)$$

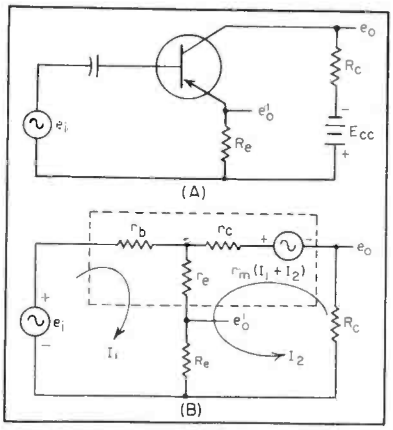

FIG. 1—Grounded-emitter transistor amplifier (A) and low-frequency equivalent circuit (B)

Equation 8 shows that this amplifier may possess high input impedances. While Eq. 7 and 8 are over-simplifications, they serve to indicate the magnitudes of the gains and input impedances which may be achieved.

The output impedance of this amplifier is essentially equal to R_c. This indicates that the smallest possible value of output impedance is determined by the maximum voltage swing desired. If a 10-volt peak-to-peak swing is desired from a transistor whose maximum practical collector current is 2 ma above cutoff current, the minimum output impedance is 5,000 ohms. Thus very low output impedances may be achieved in low-level stages where the maximum voltage output is small.

The condition where $R_e = R_c$ is the transistor equivalent of the vacuum-tube phase splitter. If α were unity the a-c collector and emitter currents would be equal, and the two a-c voltage outputs would be equal in magnitude and opposite in phase. In the junction transistor, balanced outputs can be achieved by making the ratio of the emitter resistor to the collector resistor equal to α. This means that R_c is about five percent larger than R_e.

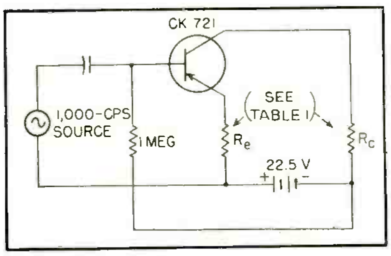

FIG. 2—Amplifier circuit used to obtain data given in Table I

For the CK721 transistors tested, the gain of a single amplifier was flat to about 20 kc, falling off 6 db at about 100 kc.

The gain obtained from cascaded stages, however, will fall off more rapidly due to decrease of input impedance with frequency. This will be discussed further as apparent input capacitance.

Measurements

The circuit of Fig. 2 was used to make gain and input impedance measurements. Bias applied at the base through a 1-megohm resistor increases the undistorted output of the amplifier by allowing the input to become somewhat positive before the emitter current is cut off. This biasing resistor is a direct shunt upon the input impedance of the amplifier, and its effect has been removed from the tabulated values of R_{in}.

The data of Table I, taken from the circuit of Fig. 2, have measured gain accuracies ranging from about 5 percent when R_e is zero to about 1 percent in the unity-gain condition.

The input-resistance measurements have approximately 5-percent accuracy. Computed values given in the table were obtained from Eq. 1, 2 and 3.

The data of Table I indicate the increased input impedance and gain stability produced by the emitter resistor. They also show that gain can be predicted quite accurately when an emitter resistor is present. Note that unit No. 1, whose gain without degeneration is much lower than any of the others, continues to have less gain in the presence of current feedback but by a much smaller percentage.

Calculations

The degree of correlation between computed and measured gain is at least as good as anticipated, since Eq. 4 has shown that the gain must vary at least as widely as α. For the CK721, this variation is about 5 percent.[2]

No great accuracy of prediction of input impedance is expected, since it is a function of r_c. Collector resistance varies widely between units and with voltage and current conditions for a given unit. The fact that the computed gain is high and the computed input resistance is low in the absence of degeneration could be explained by the r_e for all of the units being larger than usual. In this condition ($R_e = 0$), the gain and impedance of the amplifier reflect the variability of transistor parameters.

Thus the lack of correlation between computed and measured values is to be expected, indicating the value of the current-feedback method.

A relatively low frequency of measurement, 1,000 cps, was chosen to eliminate the effects of the apparent input capacitance of the amplifier. While gain is constant to about 20 kc, the input impedance is not.

Apparent Input Capacitance

The apparent input capacitance is so-called because it is felt that this is at least partially a transit-time effect. The large values of capacitance measured are not con-

Table I—Voltage Gain and Input Impedance Data from the Circuit of Fig. 2

	R_c = 10,000 ohms								
	R_e = 0		R_e = 1,050 ohms		R_e = 4,900 ohms		R_e = 10,500 ohms		
Transistor Unit No.	Gain collector output	R_{in} (ohms)	Gain collector output	R_{in} (ohms)	Gain collector output	R_{in} (ohms)	Gain collector output	Gain emitter output	R_{in} (ohms)
1	70	1,500	8.1	12,000	1.80	5,000	0.85	0.99	11,500
2	205	1,100	9.2	18,000	1.87	7,000	0.87	1.00	13,500
3	195	1,700	9.3	34,000	1.96	15,000	0.93	1.01	27,000
4	150	1,600	9.1	20,000	1.93	11,500	0.91	1.00	21,500
Computed	290	870	8.9	27,000	1.88	10,300	0.89	0.98	19,700

	R_c = 25,000 ohms								
	R_e = 0		R_e = 2,300 ohms		R_e = 10,500 ohms		R_e = 23,000 ohms		
Transistor Unit No.	Gain collector output	R_{in} (ohms)	Gain collector output	R_{in} (ohms)	Gain collector output	R_{in} (ohms)	Gain collector output	Gain emitter output	R_{in} (ohms)
1	180	1,300	9.4	20,000	2.08	105,000	0.93	1.00	195,000
2	310	900	10.0	40,000	2.16	145,000	0.96	1.01	255,000
3	330	1,700	10.4	48,000	2.25	205,000	1.01	1.01	420,000
4	280	1,600	10.2	45,000	2.24	185,000	1.01	1.01	355,000
Computed	580	690	10.0	35,000	2.15	145,000	0.98	0.99	255,000

firmed by the transistor manufacturer[3] or by bridge measurement, nor is it possible to obtain a marked peak of input impedance at one frequency when a high-Q coil of the proper magnitude is shunted across the input. It seems possible that the inherent transit time of the semiconductor could cause an effect analogous to input capacitance. That is, the current flowing through the emitter and collector in series, lags the current in the emitter-base circuit in much the same way as the current through the resistor of a parallel R-C combination lags the current through the capacitor. The phase of the output current is then not proper for current degeneration, lowering the input impedance just as the impedance of the parallel R-C is decreased due to the presence of the capacitor. The effect of transit time increases with frequency just as does the effect of a shunt capacitor.

Input Impedance

The circuit shown in Fig. 3 was used to measure the input impedance of the amplifier. If this input impedance is assumed to be a resistor R_{in}, shunted by a capacitor, C_{in}, then

$$\left(\frac{e_1}{e_2}\right)^2 = \left(1 + \frac{R}{R_{in}}\right)^2 + (2\pi f C_{in} R)^2 \quad (9)$$

Measurements indicated that C_{in} was about 100 μμf. Essentially the same result was obtained at several frequencies, indicating that the assumed form of input impedance gives usable results. As a further check, the loading effects of the amplifier on a 10,000-ohm square-wave source were observed and compared with results obtained by loading with a simple capacitor. The two effects were similar in all respects, showing the same deterioration of rise time.

A phenomenon similar to the Miller effect in the vacuum-tube amplifier was observed. Apparent input capacitance increased with amplifier gain according to the equation

$$C_{in} \approx C_1 + A\ C_2 \quad (10)$$

For the units tested, C_1 was of the order of 100 μμf and C_2 about 10 μμf. It seems possible that C_2 is the true base-to-collector capacitance, increasing in effect with gain exactly as does the grid-to-plate capacitance of the grounded-cathode vacuum-tube amplifier, while C_1 is primarily a transit-time effect.

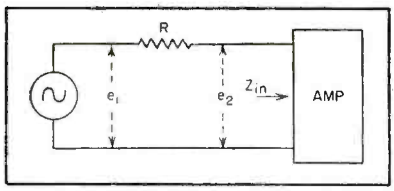

FIG. 3—Circuit used in measuring input impedance of transistor amplifier

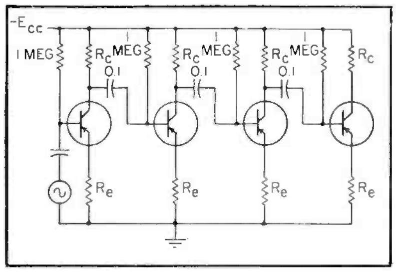

FIG. 4—Four-stage transistor amplifier using emitter degeneration to stabilize gain and raise input impedances. Values for R_c and R_e are given in text

Cascading of Stages

Since the gain of each stage decreases as its input impedance increases, the use of current degeneration does not produce increased overall gain of cascaded stages. If an amplifier having a gain of A and input resistance of $r_c/(1\text{-}A)$ is used to amplify the voltage from a source of output impedance R_o, the net gain, A_o, becomes

$$A_o = \frac{\frac{r_c}{1-A}(A)}{\frac{r_c}{1-A} + R_o} = \frac{A}{1 + (1-A)\frac{R_o}{r_c}} \quad (11)$$

Since A must always be negative, the largest value of A_o is obtained where A is very large and the input resistance very small.

There are, however, distinct advantages of this amplifier. It may be used to amplify the output of a high-impedance source without overloading the source. It also eliminates the large-range volume controls which are required without gain stabilization in order to allow unit interchangeability.

To illustrate that these amplifiers may be cascaded by simple capacitance coupling, the four units tested were placed in the circuit of Fig. 4. With $R_c = 10{,}000$ ohms and $R_e = 4{,}700$ ohms, the gain of each stage should be 2.015, the input-impedance 93,500 ohms (including the effect of the 1-megohm biasing resistor), and the output impedance about 10,000 ohms. Operating from a zero-impedance source into a very high impedance load, the gain should be

$$(2.015)^4 \left(\frac{93{,}000}{93{,}000 + 10{,}000}\right)^3 = 12.14.$$

Using 5-percent resistors, the measured gain was 12.

In the same circuit with R_e changed to 1,000 ohms, the computed total gain becomes 2,600 (including the attenuation due to the 0.1 μf coupling capacitors) and the measured gain was 2,000. The accuracy of prediction has been reduced with the decreased degeneration. It is, however, at least as good as the predictability of a single stage without degeneration. The total gain was down 3 db at 16 kc for four amplifiers in cascade.

Conclusions

High input impedance and gain stability may be obtained at the sacrifice of total gain for a transistor amplifier. The gain stability feature reduces the troublesome temperature variability of these devices.

Lower quality transistors will also produce satisfactory results in the circuit, but the results will be inferior since both α and r_c are smaller in magnitude.

The author acknowledges the aid of Rufus P. Turner in the solution of certain practical problems, in the taking of valuable data and in the wording of explanations.

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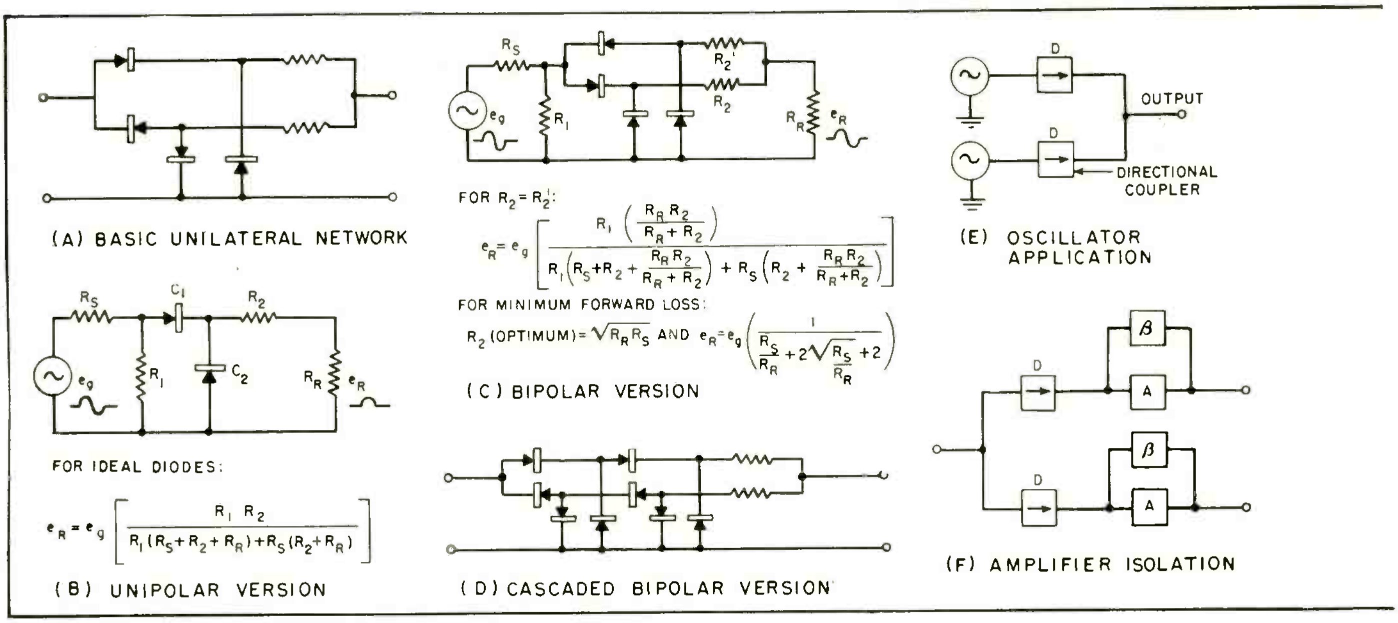


Unilateral Four-Terminal

Directional couplers made up from carbon resistors and germanium diodes reduce weight, size and power consumption of electronic equipment and improve reliability. Applications include isolation of subcarrier oscillators in control system to prevent pulling

CIRCUITS made up of four rectifying elements and two resistors may be made to provide unidirectional coupling over a band of frequencies limited only by the frequency response of the rectifiers. Such circuits may be used in place of isolation amplifiers to effect economies of weight, space, energy consumption and first cost, and to improve ruggedness and reliability.

When used to replace lossy isolation pads, unilateral networks achieve an effective gain in the direction of desired transmission without introducing added loss in the direction of undesired transmission. Applications include decoupling bridged inputs or outputs to reduce interaction, reduction of forward leakage in feedback circuits and, in general, reduction of reaction of the controlled on the controlling circuits.

The basic unilateral circuit of Fig. 1A (above) was built up from unselected 10 percent resistors and crystal diodes, to give forward-to-reverse transmission ratios at 1,000 cps of 28 db and a forward transmission loss of 3 db, with distortion less than 5 percent.

The circuit action may be illustrated by referring to the unipolar case in Fig. 1B. This circuit passes only positive-going waves from left to right. Values of R_1 and R_2 are not critical, but depend on the terminating impedances, the diodes and the maximum forward and minimum reverse attenuation allowed.

For ideal diodes, it is assumed that C_1 is shorted and C_2 open to obtain the equivalent circuit for the positive half-cycle, and vice versa for the negative half-cycle. Similarly, equivalent circuits can be deduced either with the diodes reversed or with generator and load interchanged.

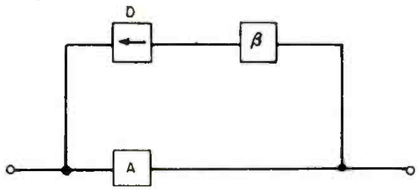
The composite bipolar circuit of Fig. 1C will transmit both half-cycles from left to right only. The equation for output voltage differs from that of Fig. 1B because of mutual loading of the two unipolar networks. Transmission in the reverse direction is zero for ideal diodes, in the equivalent circuit.

Design Criteria

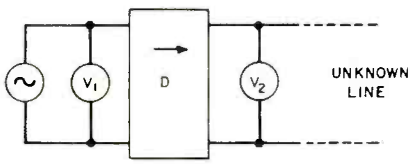
Although series resistor R_2 in Fig. 1C is not critical, there is an optimum value for minimum forward loss. Since the reverse transmission is zero in this ideal case, reverse transmission need not be a consideration in optimizing R_2.

If the source and receiving impedances can be adjusted so that an impedance match at the input and output of the unilateral circuit is obtained, R_2 becomes equal to 1.414 R_R or 0.707 R_S. The relationship between R_R and R_S which must hold for impedance matching is then $R_S / R_R = 2$.

Directional couplers have been



(G) FEEDBACK LEAKAGE CONTROL



(H) LINE MEASUREMENT

Circuits

By J. S. FOLEY
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built and tested under various conditions of frequency, forward and reverse signal strength, terminating impedances and d-c bias. An experimental model was made up using 1N54 crystals because they were readily available. In any application the choice of rectifier would be governed by signal level, terminating impedances, frequency and attenuation desired. The series resistance, determined experimentally for greatest forward-to-reverse transmission ratio, was 24,000 ohms. The equal terminating impedances, optimized on the same basis as the series resistance, were 7,500 ohms.

With these values and a 3-volt signal, the reverse insertion loss was 33.8 db and the forward insertion loss was 9.4 db, making the forward-to-reverse transmission ratio 24.4 db. These values were constant for a signal frequency ranging from 20 to 200,000 cps.

The input impedance of this directional coupler was measured with various terminating impedances. With a signal frequency of 1,000 cps and an input of 4 volts, the input impedance varied from 21,000 ohms to 39,000 ohms as the load impedance varied from short-circuit to open-circuit.

Performance Characteristics

This same directional coupler was also tested to determine the effect of the presence of a desired signal on the rejection of the undesired signal. The test was made with desired and undesired signals of equal levels but different frequencies. The rejection of the undesired signal was diminished 6 db; the transmission of the desired signal was not affected.

Another bipolar directional coupler was built up with the same diodes but with ganged variable series resistors. The input and output impedances were varied independently from 20,000 ohms to 560,000 ohms, and the series resistors were adjusted to obtain minimum forward loss for every terminal impedance setting. Observation of the forward-to-reverse transmission ratio showed degradation as either input or output impedance increased. The maximum degradation of forward-to-reverse transmission ratio occurred when input and output impedances were both maximum. The highest forward-to-reverse transmission ratio occurs when both the input and output impedances are minimum.

The forward insertion loss is highest for the case of maximum input and output impedances, as was true for forward-to-reverse transmission ratio. One important difference is that lowest forward insertion loss is obtained when the input impedance is large and the output impedance is small.

With the high-impedance terminations, distortion was most noticeable. This was corrected by individual adjustment of the series resistors.

Bias and Signal Level

The presence of a large d-c bias in the direction of maximum transmission causes the directional coupler to conduct signals in both directions. A d-c bias in the direction of maximum attenuation causes the directional coupler to block signals coming from either direction.

Tests were made to determine the dependence of the forward-to-reverse transmission ratio and the forward insertion loss on signal level. The tests showed serious degradation of these parameters as the signal level became comparatively small. For a change in level from 10 volts to 0.1 volt, the forward-to-reverse transmission ratio for one circuit dropped from 26 db to 2 db and the forward insertion loss rose from 8 db to 14 db. This points up the importance of choosing the most suitable diode for the application.

A pair of directional couplers was connected in cascade as shown in Fig. 1D. The forward-to-reverse transmission ratio for the pair was 6 db higher than for a single circuit, but the forward insertion loss increased only 0.5 db. The cascading might be extended with good effect.

Examples of Applications

When two or more oscillators must be connected together without the output of one pulling the other off frequency, directional couplers may be used as shown in Fig. 1E. More output can now be obtained from the oscillators than if lossy pads had been used to provide the necessary isolation. Circuit complications, energy consumption and other evils of buffer amplifiers are also avoided.

When the inputs of two feedback amplifiers must be connected together, couplers may be used as shown in Fig. 1F to prevent interaction.

Forward leakage in a feedback amplifier can be minimized as illustrated in Fig. 1G.

Finally, the directional coupler is suggested as an aid in making low-frequency measurements on transmission lines. A proposed circuit is shown in Fig. 1H. Here V_2 will read the sum of the transmitted wave (traveling from left to right) and the reflected wave (traveling from right to left), and V_1 will read only the transmitted wave since the directional coupler stops reflected waves coming from the right. These voltages may be used to find the reflection coefficient of the transmission line.

Phase-Selective Detectors

Half-wave, full-wave and electromechanical circuits for use in self-balancing bridges, phase discriminators and a-c null detectors. Applications include automatic machine control and operation, radar search-track and navigation systems

By CURTIS R. SCHAFER

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IN ALL DETECTOR applications it is desirable to operate at fairly high current and voltage levels to minimize errors due to unbalance in the circuit.

Input V_1 is the unknown signal, or carrier modulated by the unknown signal. The other input V_2 is a reference voltage of the same frequency and phase as the signal to be detected. Output is a pulsating d-c.

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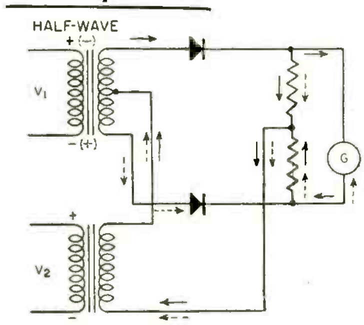
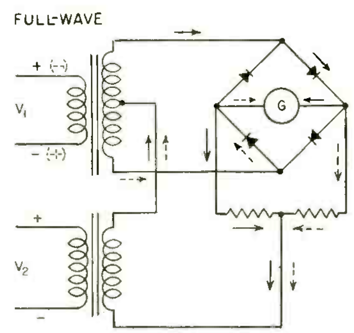
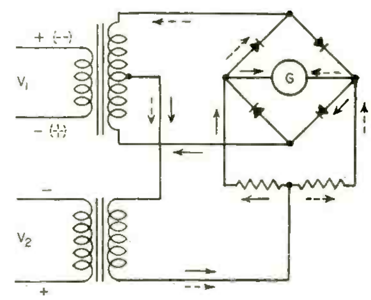
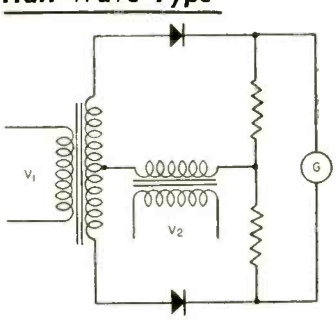
Basic Operation



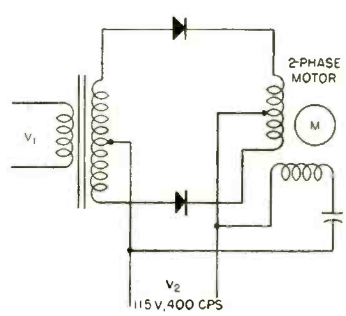




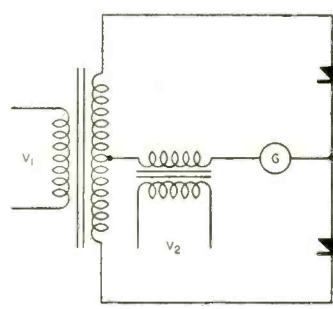
Half-Wave Type



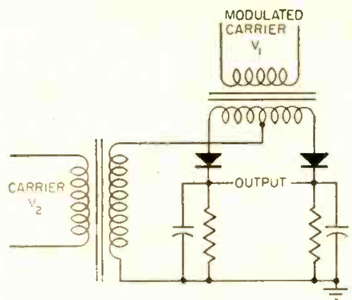
WALTER PHASE-SELECTIVE RECTIFIER[1,2]— Gives square-law response, with sensitivity decreasing near balance point. Meter reads zero if V_1 and V_2 are 90 deg out of phase



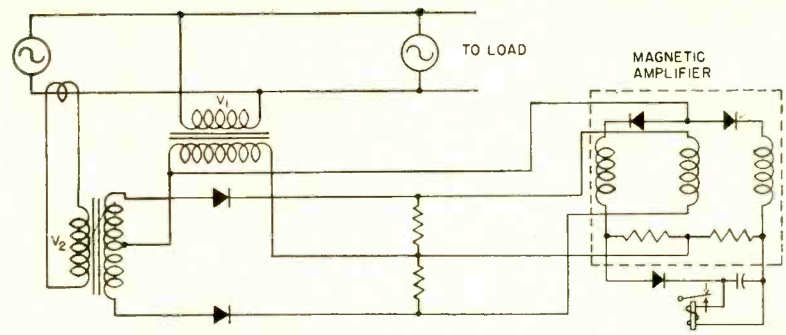
VARIATION OF WALTER CIRCUIT — Suitable for output stage of amplifier in self-balancing bridge. Germanium power rectifiers or diffused-junction diodes can be used



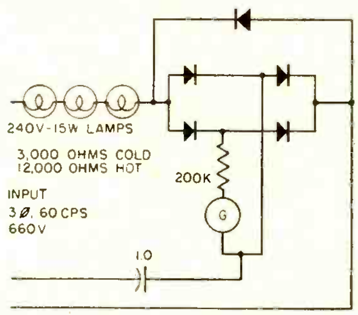
VHF RADIO-RANGE COMPARATOR[3]— Meter indicates zero when V_1 and V_2 are 90 degrees out of phase or when either or both voltages are zero. Used to demodulate 10-kc f-m subcarrier



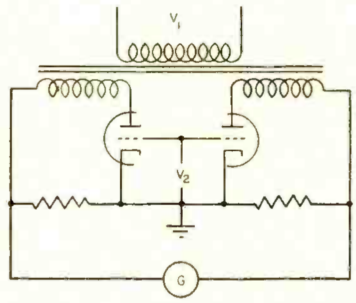
PHASE-SENSITIVE DEMODULATOR[4]— Has push-pull output. Input may be from balanced or single-ended carrier. Carrier signal is reference



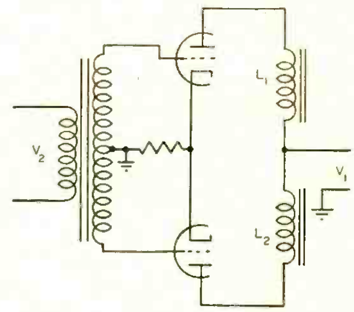
MAMON PHASE DISCRIMINATOR[5]— Uses balanced, polarized magnetic amplifier to boost output of phase-selective detector. Application shown is used to operate relay to disconnect alternator in case of field-excitation failure, loss of synchronization or drive failure



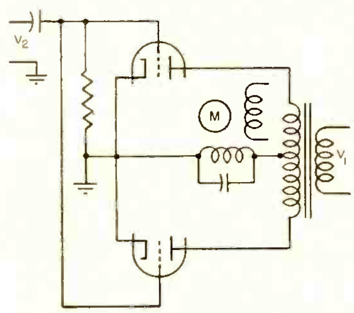
LIVINGSTONE PHASE-SEQUENCE INDICATOR[6]— A fifty-to-one voltage change will cause a four-to-one change in the meter indication



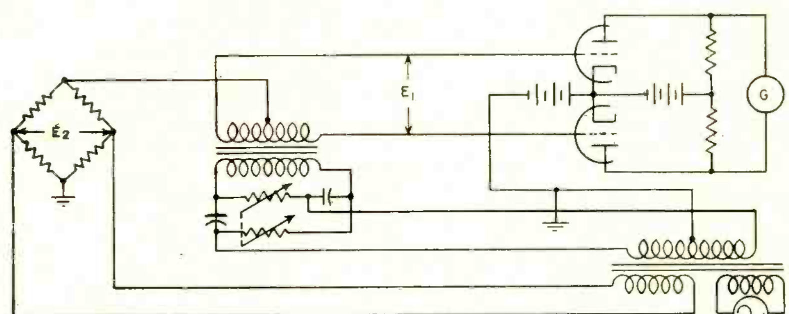
COSENS PHASE-SELECTIVE BRIDGE[7]— Triode amplification provides high sensitivity. Output proportional to phase angle divided by $V_1 V_2$



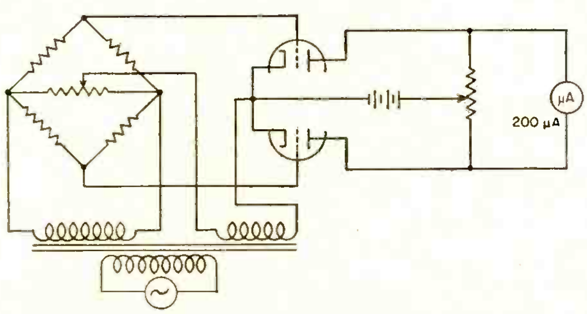
MODIFIED COSENS BRIDGE DETECTOR[8]— Applicable to servo control. Coils L_1 and L_2 are differential relay coils or fields of d-c servo motor



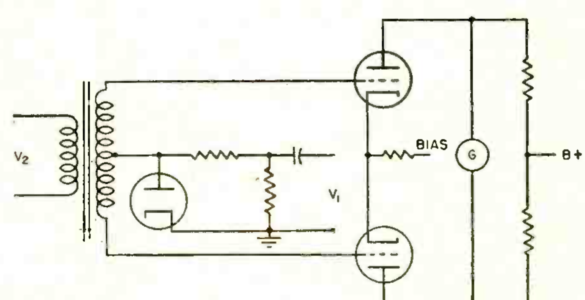
BROWN DISCRIMINATOR[9]— Basic circuit for electronic potentiometer. Modification of Cosens circuit for use with two-phase a-c servo motor



BRIDGE-BALANCE DETECTOR[10]— Current in meter is proportional to $E_1 E_2 \cos\theta$. By adjusting phase of E_1, output current can be made dependent on only the reactive or resistive component of either voltage. Phase is adjusted by dual potentiometer in phase shifting circuit



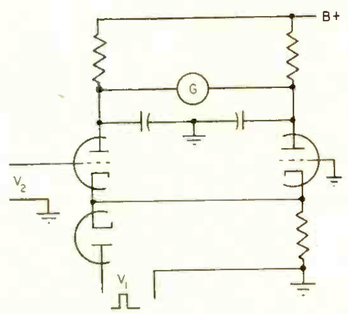
MACNAMARA PHASE BRIDGE[11]— Has accuracy of 0.1 percent with an input of 20 volts at frequencies up to 50 kc



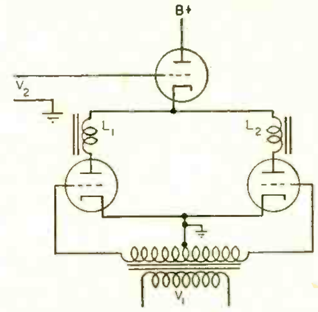
GATED-GRID DETECTOR[8]— Rectangular reference waveform produced from sinewave V_1 by diode and R-C circuit

(continued on p 190)

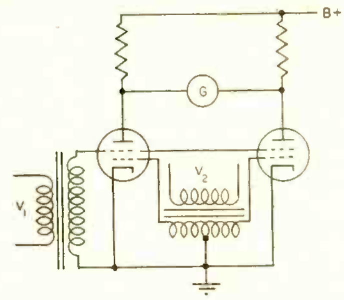
(continued from p 189)



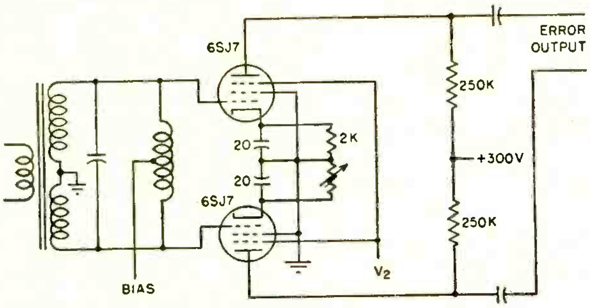
GATED-CATHODE DETECTOR[8]— Similar in operation to gated-grid circuit except that pulses are applied to cathodes. Common cathode resistor for all tubes provides nearly push-pull grid-cathode voltages



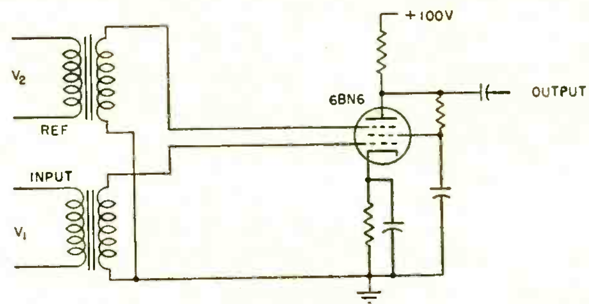
CATHODE-GATED DETECTOR WITH CURRENT OUTPUT[8]— Used with d-c servo motor. Coils L_1 and L_2 are split field of servo motor or differential relay. Provides differential current with low output impedance



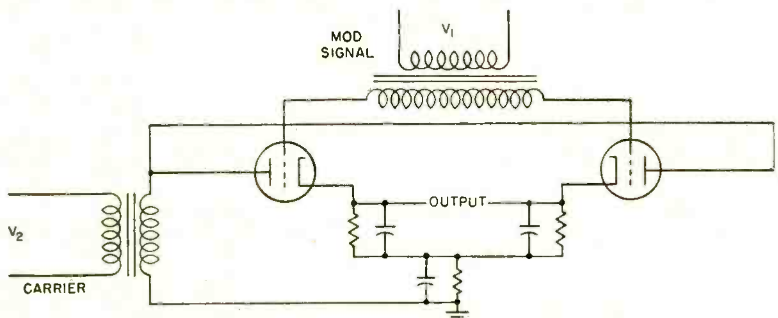
MORTON SCREEN-GRID PHASE DETECTOR[13]— Reference voltage V_2 is applied to control grids and variable voltage V_1 is applied to screens. System puts light load on power supply of variable phase



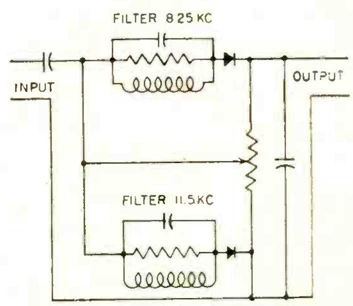
PENTODE PHASE DETECTOR[12]— Used in radar units. Has a gain of 70 using 6SJ7 tubes; with 6AS6 tubes gain is 120 with 40-volt, 2,000-cps reference voltage on V_2



GATED-BEAM PHASE DETECTOR[14]— Plate current is at maximum for in-phase operation, and at a minimum for 180-degree phase difference

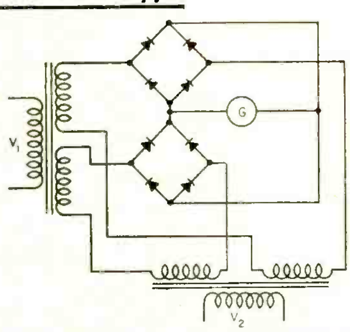


BALANCED-TRIODE DEMODULATOR[15]— Push-pull modulated signal is applied to grids. Unmodulated carrier is used as reference and to supply plate voltage. Output is push-pull error signal

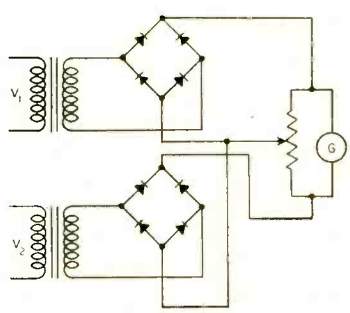


VHF OMNIRANGE DEMODULATOR — Recovers 60-cps modulating signal from 10-kc f-m subcarrier

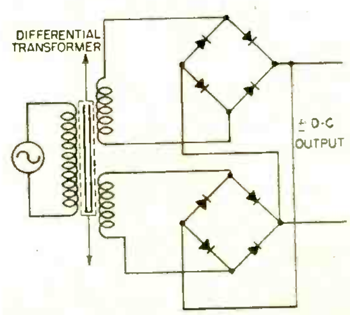
Full-Wave Type



PHASE-SELECTIVE DETECTOR FOR BRIDGES[17]— Double-bridge system for use at high frequencies



DOUBLE-BRIDGE PHASE DETECTOR — Used in CAA landing system as part of crossed-pointer indicator



DENSITROL RECTIFIER BRIDGE[18]— Core of differential transformer is actuated by float

(continued on p 192)

SOCKETS...

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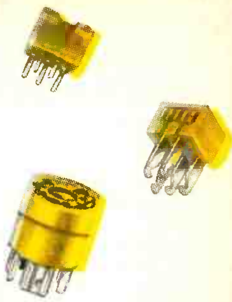

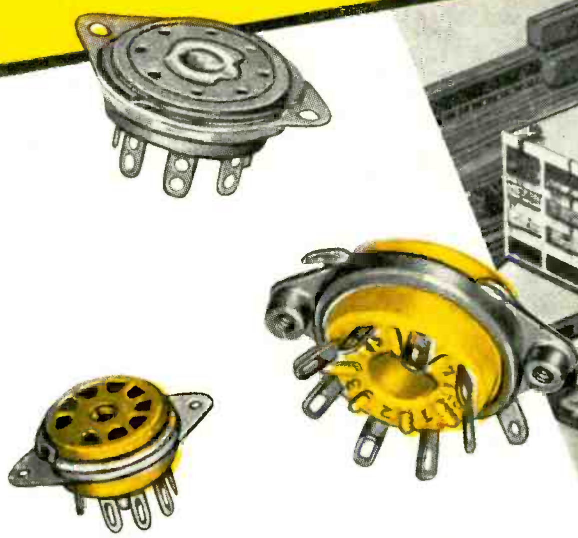

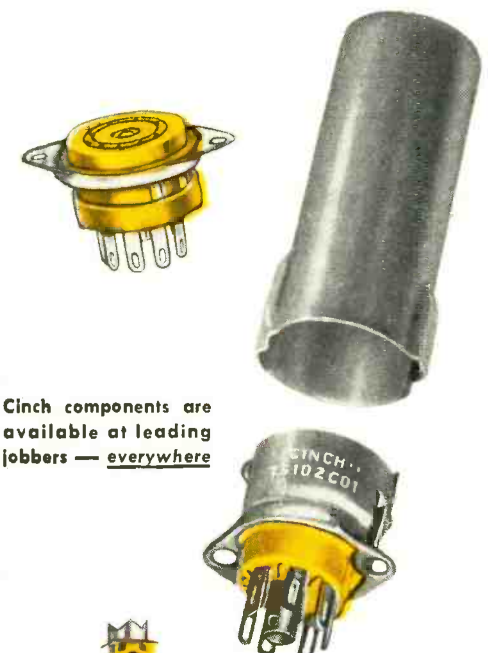

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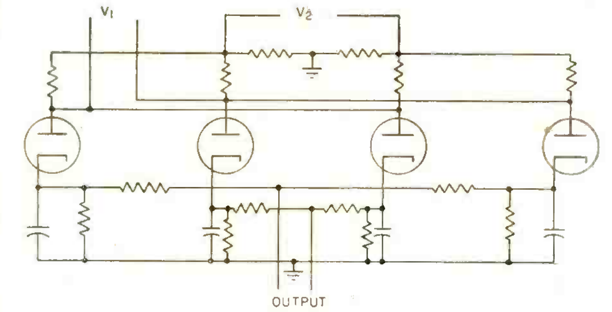
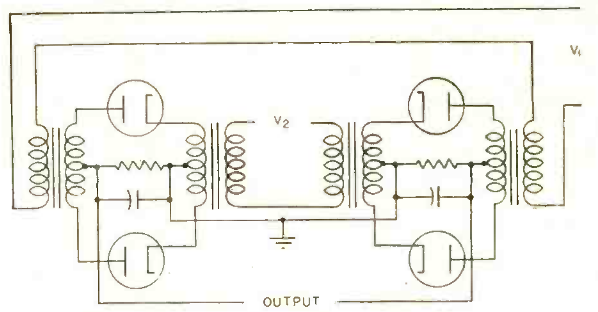
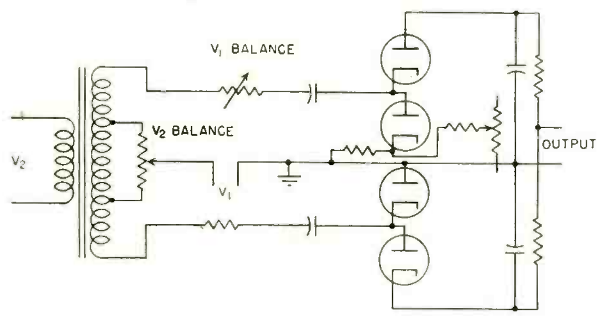
(continued from p 190)



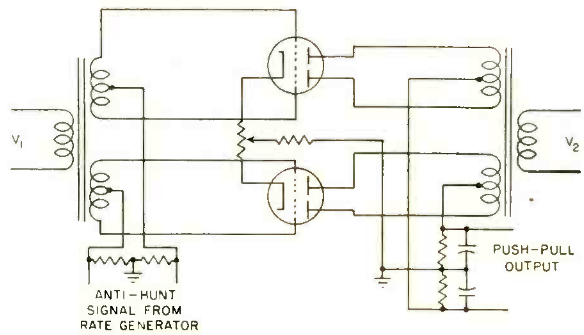
FULL-WAVE DEMODULATOR[15]— Push-pull inputs and output. Inputs are carrier-balanced. Signal V_1 is compared to unmodulated carrier signal V_2



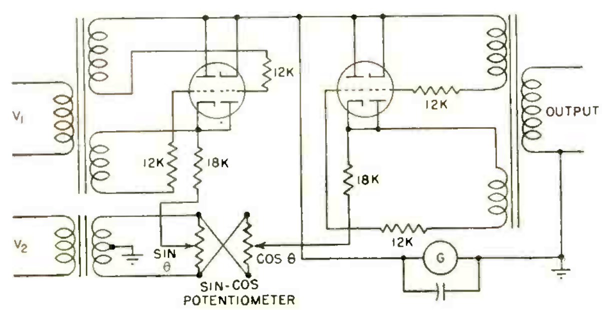
WARD-LEONARD SYSTEM DETECTOR[18]— Commercial variation of full-wave demodulator system. Output is used to control d-c motor through d-c amplifier



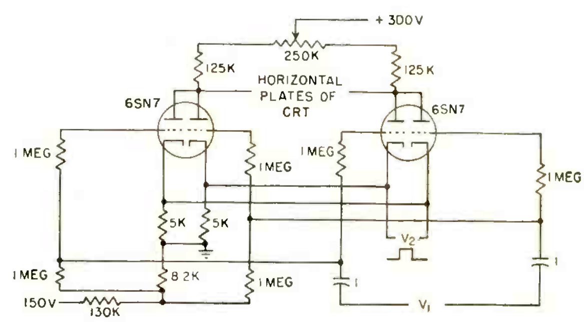
R. L. FRANK PHASE COMPARATOR[20]— Insensitive to the third and all even harmonics of both input voltages. Combines two 120-degree-conduction cascade doubler circuits



AMPLIDYNE SYSTEM PHASE DETECTOR[18] — Has provision for antihunt signal injection from rate generator. Circuit gives high power amplification

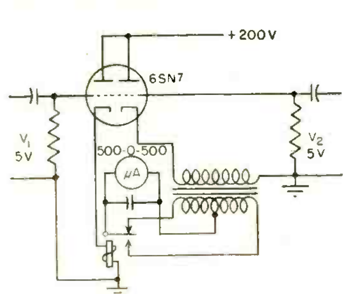


DOUBLE-CLAMP PHASE DETECTOR[20]—Used in British omnidirectional beacon. A 200-pps signal is applied to sine-cosine potentiometer as a reference signal. Output is indicated on a zero-center course meter

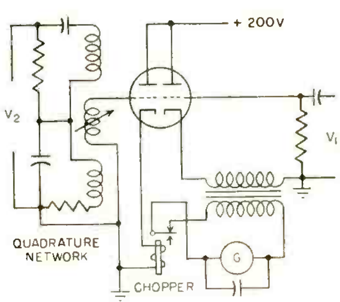


SCR-615 PHASE-SENSITIVE AMPLIFIER[16]— Radar application with cathode-ray tube display. Cathodes are gated by sine-wave generator. Reference voltage comes from two-phase generator synchrononized with antenna

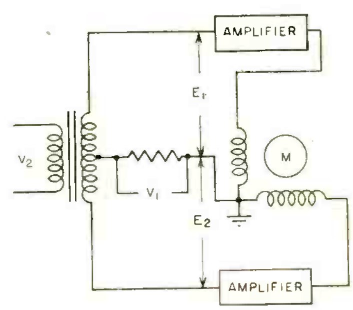
Electromechanical Type



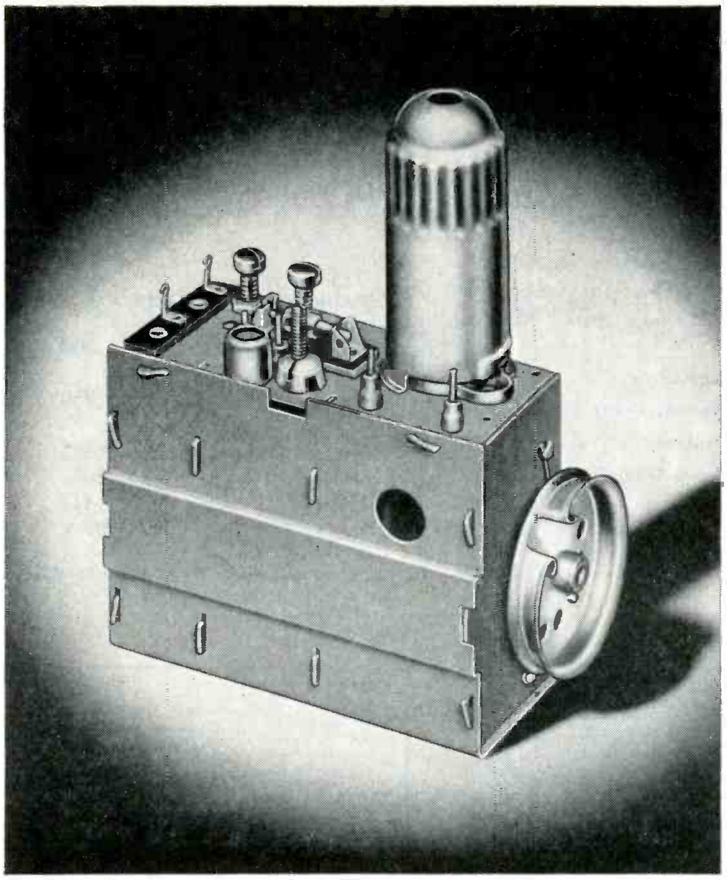
WALD PHASE INDICATOR[22]— Has high input impedance. Accuracy is ± 1 percent. Average output current $I_{max} \cos \theta/\pi$. Upper frequency limit is determined by chopper used



WALD REBALANCING PHASE INDICATOR[22]— Similar to Wald indicator, but higher precision. Resolver is rotated so meter indicates zero. Phase shift is indicated on resolver dial



SERVO MOTOR PHASE DETECTOR — Phase detection is accomplished in two-phase motor. Output is a mechanical torque of reversible polarity. $E_1 = V_1 + V_2$, $E_2 = V_1 - V_2$



New, Compact Front End Unit

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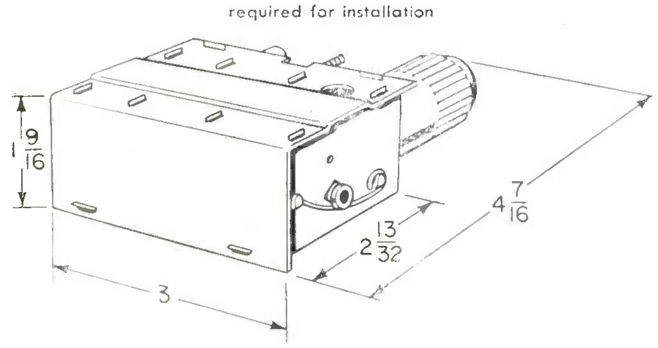
When you're designing receivers for the new TV bands, take a look at the new Mallory UHF Front-End Assembly. It's so compactly built that it fits readily into crowded chassis layouts. It comes as a complete unit that cuts assembly costs on your production line.

Figure 2. Dimensional drawing, indicating actual space required for installation



The circuit will tune continuously from 460 to 910 megacycles (channels 14 to 83) in 180° rotation of the single tuning shaft. It works into any IF amplifier that operates over the 41.25 to 45.75 band. The assembly consists of a double-tuned RF preselector, oscillator, crystal mixer and tuned IF coil.

Solder tab terminals are provided for connection to a 300-ohm balanced antenna feed, and to heater and "B+" power supply. Trimmer capacitances are readily accessible on the same side of the chassis as the tube. Output impedance is nominally 50 ohms. The tuning shaft rotation can be either clockwise or counterclockwise, as desired.

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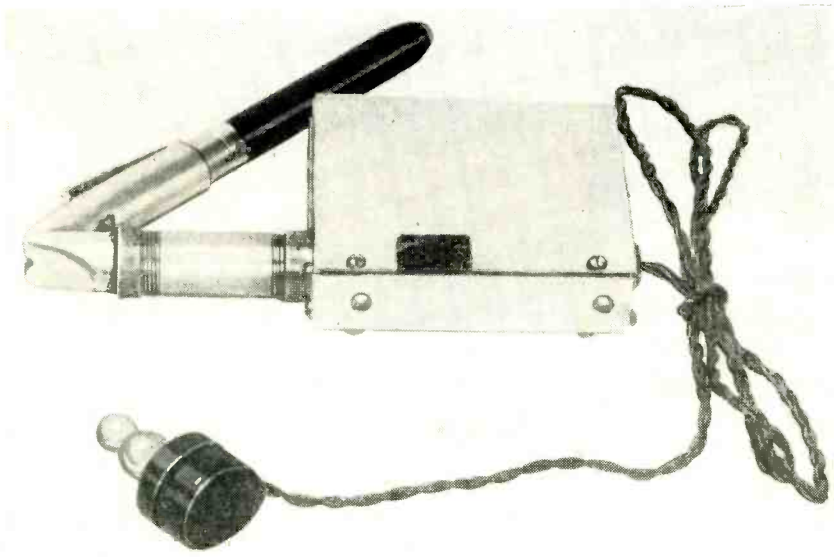
ELECTRONS AT WORK

Edited by ALEXANDER A. McKENZIE

OTHER DEPARTMENTS

featured in this issue:



Equipment for blind has battery drain of 30 μamp resulting in 700-hour life

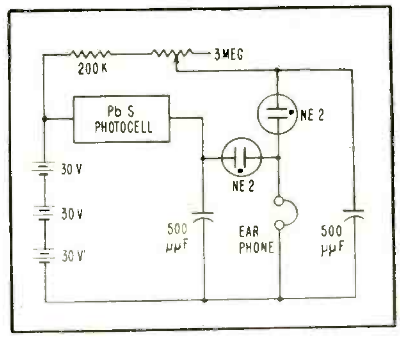


FIG. 1—Two neon-tube relaxation oscillators are initially tuned to same frequency so that discontinuity in reflected light shows up as beat frequency. Effect is caused when light variations produce small variations in cell resistance

Pointer and Line Locator Aids Blind

ABILITY TO LOCATE pointers under glass would allow the blind to engage in work involving the reading of meters and the like. A simple device has been developed for this purpose, based upon a similar principle already described (ELECTRONICS, p 80, June 1949).

Both circuit and equipment are much simpler than those of comparable devices considered in the past. As shown in Fig. 1, the circuit consists basically of two small 0.04-watt neon lamps connected as relaxation oscillators. A Photoswitch A4-116 lead sulfide photocell is used as resistance element in one oscillator and a small potentiometer is employed in the other.

Light from a penlight bulb in one section of the v-shaped tube, illustrated, emerges from its apex through a small hole and is reflected into the other side of the tube from whatever lies outside the hole.

Since variations in the reflected light will produce small variations in cell resistance, there will be small variations in the frequency of the oscillator. The second oscillator can be tuned to zero beat with the cell oscillator for any given light intensity. A slight change in light intensity will then produce a beat frequency.

The unit described is sensitive enough to detect most printing and locate meter pointer positions easily. In the latter service, the v-tube shown is replaced by one in which the apex is milled off to make the point of maximum sensitivity of the system about 0.312 inch beyond the common opening.

Developed by C. M. Witcher and L. Washington, Jr. at Research Laboratory of Electronics, MIT, the device will be the subject of a more complete report in future.

Binaural Broadcasts Use Multiplexed F-M

RECENTLY PUBLISHED results of experiments show that it is possible to transmit two different programs on the same f-m broadcast channel. A successful system described by E. H. Armstrong and J. H. Bose utilizes principles shown in Figure

1, wherein subcarrier modulation is introduced through an auxiliary phase-shift modulator following the main modulator. Serrasoid-type modulators are used in both cases.

Enhanced noise modulation resulting from frequency multiplication required with the phase-shift method makes use of a good modulator mandatory.

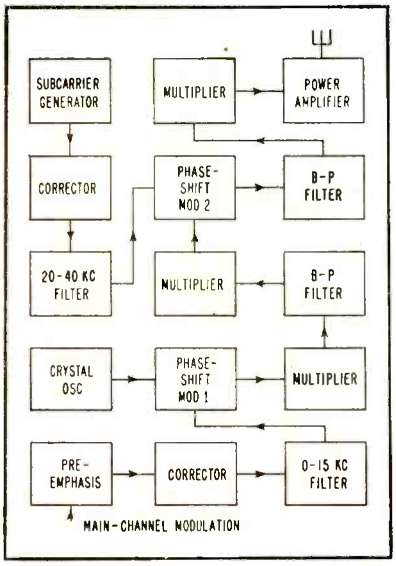


FIG. 1—Method of introducing subcarrier in multiplex f-m system

When the main-channel deviation is ±75 kc and the side-channel is ±20 kc, cross modulation into the second channel for full modulation on the main channel by the most troublesome frequencies can be held to better than —60 db. In experiments carried on by station KE2XCC at Alpine, N. J. a subcarrier frequency of 27.5 kc was used.

A workable auxiliary-channel section for receiving the subcarrier transmission is shown in Fig. 2. It comprises a 15-kc high-pass filter, resistance-coupled amplifier and band-pass filter. A frequency-sensitive network, followed by limiters, drives a 6BN6 detector. The 10-kc low-pass filter that prevents overload of the subcarrier audio amplifier is predicated upon the present maximum modulating frequency of 7.5 kc for that channel.

The main channel is presently capable of handling 30 to 15,000 cycles with a maximum deviation held to 50 kc. Binaural or two different programs can therefore be broadcast simultaneously in this system.

The information abstracted here has been taken from a paper published in *Proc Radio Club of Am*, 30, No. 2.

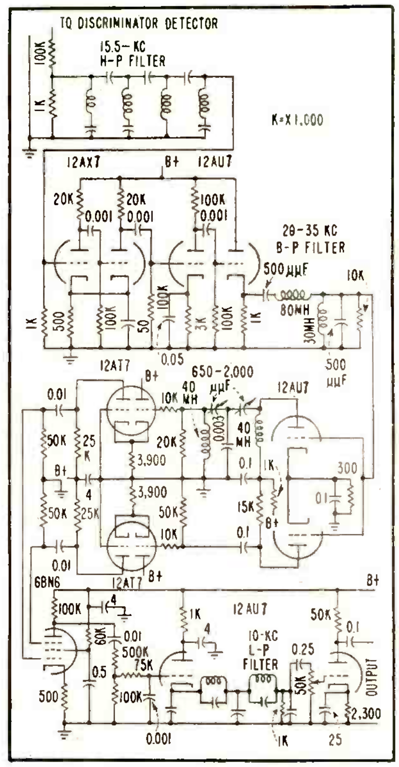


FIG. 2—Auxiliary channel section of multiplex broadcast receiver

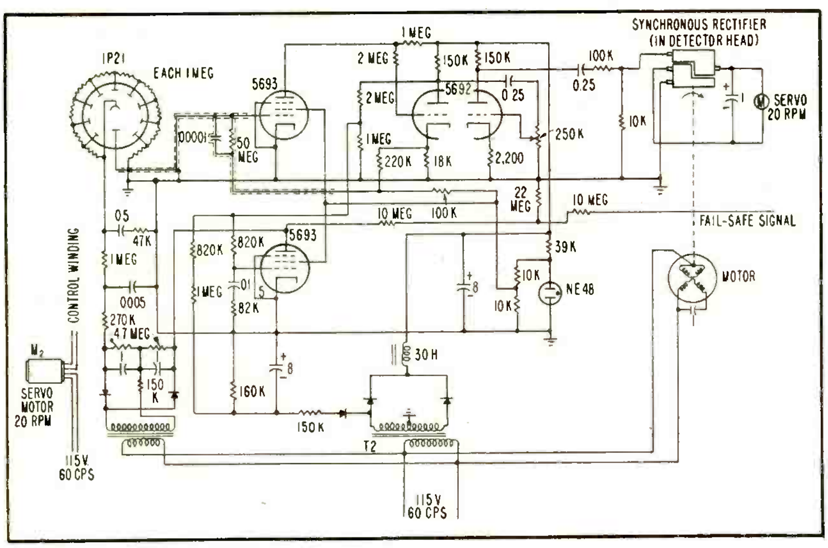
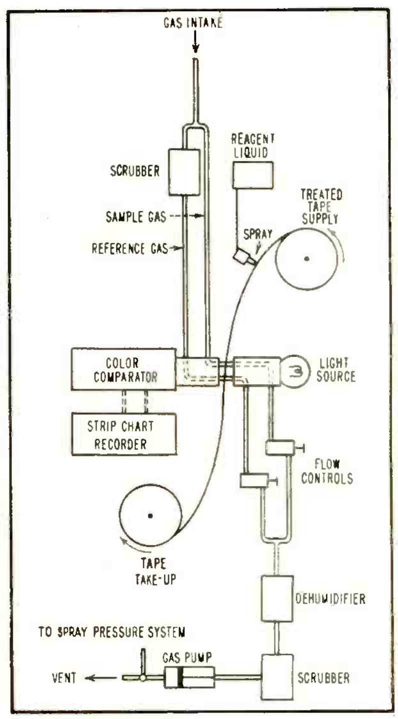


FIG. 1—Circuit diagram of the electronic colorimeter used in gas detector



Gas detector uses treated tape that reacts to gas. Tape color is detected by colorimeter. Information fed into servomotor provides direct process control

Optical Measurement Controls Gas Concentration

A VERSATILE GAS DETECTOR of sensitivity intermediate to that between conventional infrared instruments and mass spectrometers has been developed from the Colorede general-purpose optical measuring device (ELECTRONICS, p 102, Aug. 1951).

As shown in the drawing, the tristimulus colorimeter is actuated

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The first characteristic which the user has a right to expect in a precision potentiometer is accurate performance...and in precision potentiometers, performance depends upon the coil.

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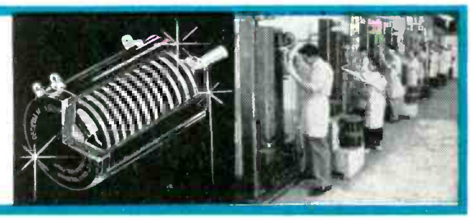

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first in precision potentiometers 221 by a paper tape treated with a chemical indicator reagent. A servo-slit system drives the instrument to balance to compensate for differences in transmittance of the paper in the two beams.

The gas sample is then directed as shown. One sample goes directly to the first beam area. A second sample, diverted through a scrubber for the gas under measurement, is applied to the second beam area. Operation is cyclic, allowing integration for several seconds or minutes. A number of gases may be thus surveyed in concentrations as low as a few parts in 10^8.

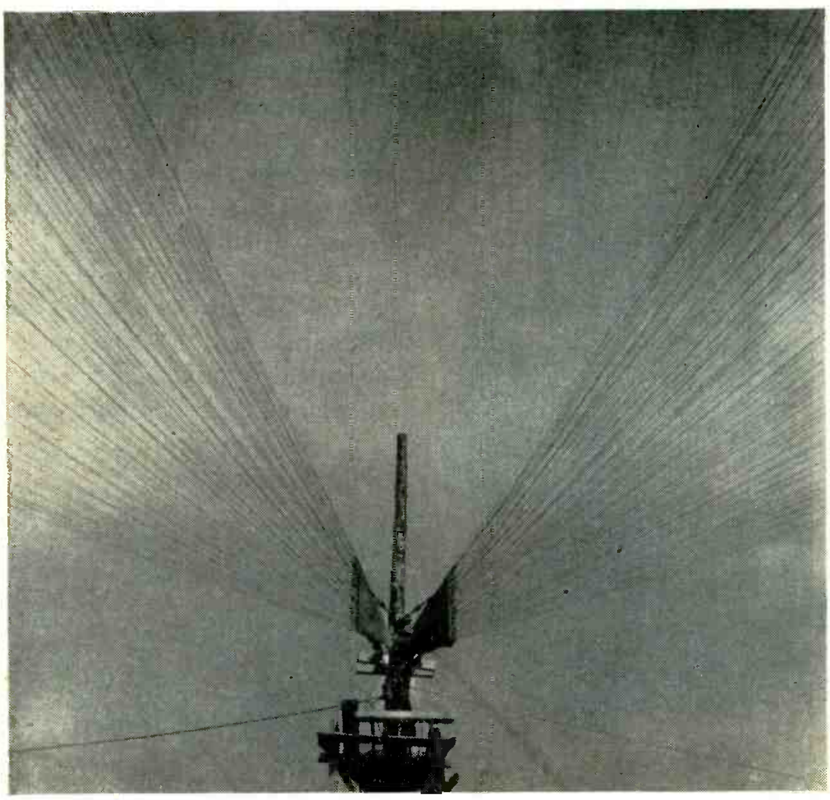
The so-called Microsensor developed by Vitro Corp. of America utilizes circuit details not found in the original description, including dry-disk rectifiers, ruggedized tubes and an output servomotor for direct process control.

The improved photoelectric control circuit is shown in Fig. 1. Output of the multiplier phototube is a combined direct and alternating current. The d-c component is a function of mean flux from sample and standard, while the a-c is a function of difference between the two.

The d-c signal is amplified and fed back to control the plate resistance of the regulator tube, thereby reducing effective multiplier plate supply as incident flux increases. The tightness of this loop is such that the mean multiplier anode current remains substantially constant for all practical ranges of incident energy.

Alternating-current signals thus become a direct measure of the brightness ratio of sample and standard. This signal is amplified and synchronously rectified by the flicker-motor commutator system so that a full-scale output of 1 volt d-c can be obtained into a 10,000-ohm load for a relative difference of as little as 1 percent for net transmission as low as 10^{-4}.

Information abstracted here is taken from a report by Phillip M. Engel and George P. Bentley of Instrument Development Laboratories, Inc.



TV Distributor's Pickup Uses Wire Horn

REMOTE PICKUP of television broadcasts for distribution over a wire system requires adequate signal strength. This is obtained in Vermont Television's Barre installation by means of a directive antenna. The horn shown, comprising three miles of wires, picks up Boston on channel 4 and Schenectady on channel 6.

Length of the horn is 120 feet and its opening is 65 feet. It is supported by poles 60 feet high. Gain of the horn antenna is 20 db.

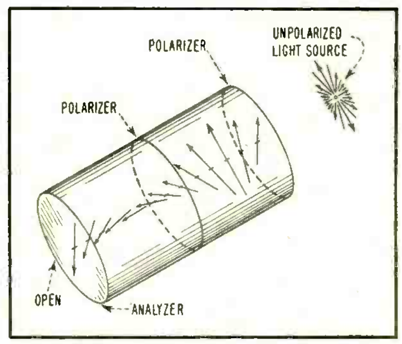


FIG. 1—Rotational effect of two polarizers and an analyzer

Faraday Shutter Freezes Transient

FAST-TRANSIENT, self-luminous subjects requiring exposures less than 100 microseconds are difficult to record on moving film. A part of the problem may often be solved by use of several single-exposure cameras, each having a high-speed shutter.

Of the several types of electro-optical shutters available, that employing the Faraday effect has recently been developed for the Atomic Energy Commission. Faraday found that the plane of polarization of light traversing a material in a magnetic field is rotated when the light is traveling in a direction parallel to the lines of force.

A practical shutter using this principle requires that crossed

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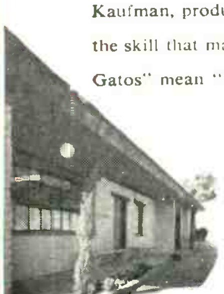

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polarizing elements be used, together with a light-transmitting medium free from mechanical strain. If perfect polarizers are used, the shutter will reject all light when it is in the crossed or closed condition. The quality of available polarizers and the accuracy to which two of them can be crossed does not produce perfect light rejection. However, a third polarizer behind a second shutter element can be added as shown in Fig. 1.

The Rapatronic camera produced by Edgerton, Germeshausen and Grier is a three-polarizer type that opens to 1/30 transmission and closes to 1/1,000,000,000. An open-to-closed transmission ratio of about 30,000,000 is needed to photograph such phenomena as nuclear explosions.

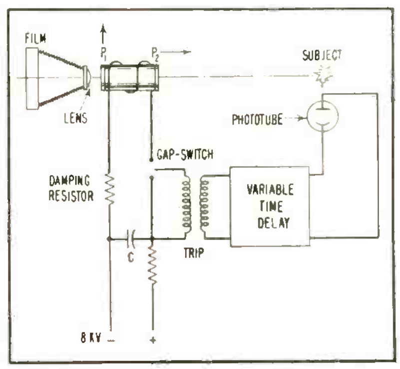

FIG. 2—Basis of a single-element magneto-optical shutter

Because commercially available polarizing material was not suitable, Polaroid Corp. developed HN-22 Polaroid to provide adequate attenuation. Best practical choice of the optical medium proved to be Faraday's original material, extra-dense flint glass. Having a high content of lead, this glass is used because it produces a considerable degree of magneto-optic rotation and can be manufactured with a controlled, low-strain quality.

Elements of the new camera are shown in Fig. 2. Crossed polarizers P_1 and P_2 provide adequate light attenuation. Electrical energy required to rotate the plane of polarization is stored in capacitor C. The shutter is triggered by a light pulse from the subject or from a separate flash unit to the phototube. An impulse passes through the variable

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Plain Pointers on Projection

MOST optical textbooks mention the French physicist Augustin Jean Fresnel in connection with his work in helping to establish the wave theory of light. However, Fresnel also contributed greatly to the design of optics used for lighthouses. His work in this field, which forms the basis upon which lighthouse opticians still work, has led to the coupling of his name with a distinctive "flat" lens type.

At first glance this might seem removed from the field of optical gaging and the use of contour projectors throughout industry. The truth of the matter is, however, just the opposite. In designing the Kodak Contour Projector, our optical engineers have included a Fresnel lens directly behind the instrument's ground-glass screen.

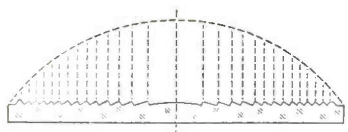

Fig. 1. Steps of the Fresnel lens duplicate the curvature of conventional condensers, making it possible to "collapse" a lens into a flat plane.

This flat plastic lens is illustrated schematically above (Fig. 1). In effect, a curved surface is collapsed into a series of minute steps which reduce the mass of the lens to a practical size. A conventional lens used for the same purpose, of diameter to equal the projector screen, would be more than 5″ thick, heavy, and not inexpensive.

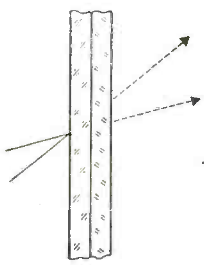

Fig. 2. Diffusing properties of ground-glass screen scatter oblique light away from viewer's eye.

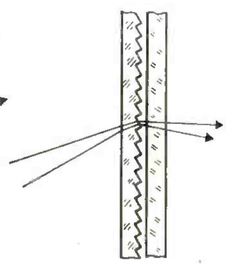

Fig. 3. Fresnel lens behind ground-glass screen directs oblique light towards viewer.

Use of the Fresnel lens in this manner serves a double purpose: 1) it effectively increases screen brilliance by directing the light on the screen directly at the operator's position; and 2) it provides even illumination over the entire screen area.

Because of this our projectors may be used under normal shop illumination without hoods or curtains—both of which sometimes tend to give a feeling of claustrophobia. In addition, the over-all screen brilliance makes possible easy reading of critical tolerances at any point on the projector screen. Together, these attributes tend to make your personnel more contented and efficient . . . help to make contour projection suited to mass inspection needs.

How rapid, accurate inspection on Kodak Contour Projectors keeps a production line moving

When you receive a great many precision parts from a great many suppliers, quality control checks can be a real production bottleneck.

At General Electric's jet engine plant at Cincinnati, Ohio, engineers have solved one such problem using Kodak Contour Projectors. Rotor blades arriving in lots of 2000 to 5000 are given a 4 per cent AQL check by the young ladies seated above. Eleven dimensions, including angles and radii, are checked on the dovetail contour, and 14 different dimensions checked on the rotor blade root—all at a rate of approximately 150 pieces per hour. Optical gaging has lightened the load, reduces inspection time, helps to keep the production line moving.

The Kodak Contour Projector is particularly suitable for such routine production inspection. It requires no hoods, curtains, or darkened room (the column at the left tells you why). Operators work rapidly and accurately in comfort—require little training. And, simply by changing chart-gages and staging fixtures, all sorts of complex parts, large and small, can be inspected.

To find out more about the Kodak Contour Projector and how it can work for you, send for our 12-page booklet. Or, write for details on a sound movie, "Optical Gaging."

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time-delay unit and triggers the capacitor-discharge circuit.

Energy surges through the coil and the resulting magnetic field causes rotation of the polarized beam as it passes through the glass, effectively opening the shutter. The damping resistor prevents oscillation that would cause the shutter to open several times. It is possible to open the shutter for as short a period as 1 microsecond.

Stain Counter Totals Droplets

By William L. Clink

Suffield Experimental Station
Defence Research Board
Ralston, Alberta
Canada

The stain counter is an instrument for the sizing and counting of the stains on a representative area of a droplet-stained card.

A spiral-shaped area of the card is scanned at a constant linear rate. The output of the scanner is an electrical pulse corresponding in length to the maximum chord of the individual stain scanned. The length of the pulse is transformed into a pulse of related amplitude by the pulse converter section. The pulse amplitude in turn governs which pulse sorter section shall trip a corresponding electromechanical counter. A block diagram of the stain counter is shown in Fig. 1.

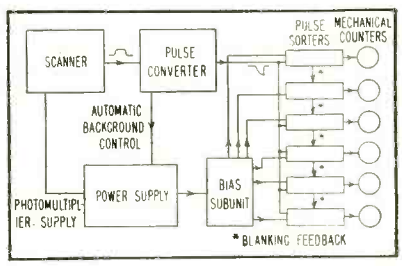

FIG. 1—Block diagram of the stain counter uses spiral scanner

The Scanner

The scanner consists of an optical system and a photomultiplier.

A positive multielement lens scans the rotating subject material and focuses the image on a narrow slit aperture placed in front of a photomultiplier tube. The slit is formed by two ground razor blade edges providing a slit accurate to $\pm 5\ \mu$. A slit width of 50 μ to 100 μ

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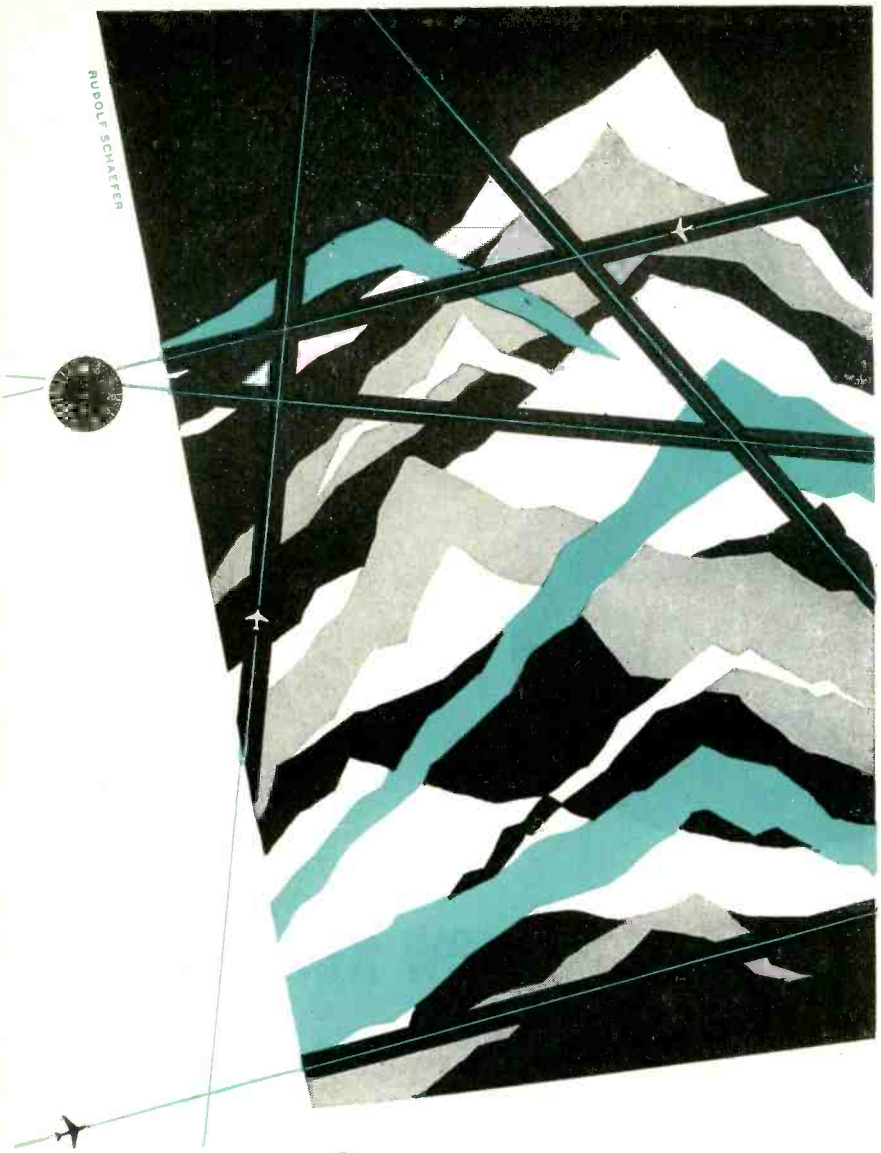

has been found best for general use. The output of the photomultiplier is coupled through a cathode-follower to the pulse converter.

Three 120-volt 7-watt bulbs fed in series from a regulated 400-volt d-c source provide even lighting of the scanned material.

Pulse Converter

The pulse converter provides a sharp output pulse whose amplitude is a unique function of the time width of the initiating pulse. A capacitor-charging circuit is used with a thyratron discharge of the

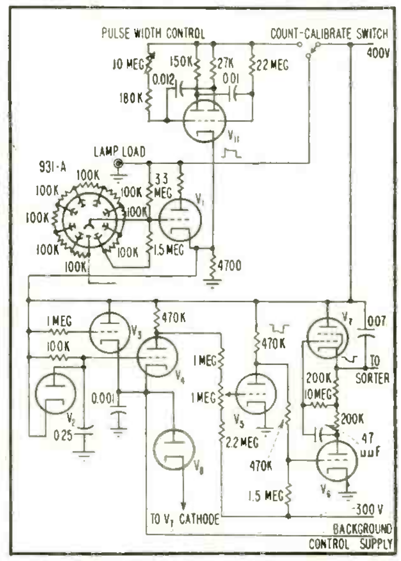

FIG. 2—Phototube, amplifier and pulse converter circuits used in counter

capacitor to provide a sharp positive output pulse. The input to the unit consists of wanted signals resembling half-wave sinusoidal forms of amplitudes up to 100 v and unwanted noise signals whose amplitude and time duration are largely dependent on the material being scanned. There is also an ambient base voltage level that is a function of the photomultiplier sensitivity, light level and scanned material reflectivity.

The base level of the input signal is determined by the diode V_2 clamping circuit that feeds the grid of the triode V_3. This tube acts as a cathode follower to supply approximately 35 volts to the regulator section of the photomultiplier power supply. The feedback circuit, thus provided, acts to maintain a constant input voltage base level of approximately 25 volts. The output of V_3 also provides a constant cathode bias of 11 volts to V_4 and

acts as a voltage reference to the diode clipper V_8.

The signal input is applied through a grid resistor to V_4. This stage has a fixed positive potential on the cathode corresponding closely to current cutoff. To a positive signal, V_4 acts as a quasilinear amplifier until zero bias is reached (with an 11 volt signal). A tap on the V_4 output resistor chain selects the portion of the input signal that is to operate V_6 through the intermediate d-c amplifier containing V_5. The signal required to completely operate V_6 represents only a small fraction of a volt of the input signal. However, the signal required before the voltage delay is overcome is variable between 2 and 10 volts by means of the 1-megohm potentiometer in the V_4 output resistor chain.

Signal Action

The highly amplified signal operates V_6 as a two-position valve, with either no conduction or with full conduction corresponding to an effective resistance of approximately 15,000 ohms. When the circuit is quiescent, V_6 is an open circuit, the output capacitor is discharged and thyratron V_7 is deionized. The receipt of a signal drives V_6 to saturation allowing the output capacitor to charge negatively towards ground potential through the series resistor (400,000 plus 15,000 plate resistance of V_6).

During conduction the plate potential of V_6 is always well below the thyratron cathode potential. One half of this difference is applied to the thyratron grid to prevent thyratron ionization. The thyratron grid is also coupled capacitively to the plate of V_6. Normally, long before the charging process can be completed, the end of the input signal cuts off the current flow through V_6. The plate potential of V_6 immediately returns to the thyratron cathode potential which places a strong positive signal on the thyratron grid resulting in the ionization of the thyratron. The output capacitor discharges through the thyratron producing a rapid positive pulse. The circuit returns to its quiescent state as the thyratron deionizes (approximately 50 μsec). This process produces a positive pulse whose voltage ampli-

tude is a unique, but not linear, function of the time duration of the input signal.

If the input signal were abnormally long it would be possible for the output capacitor to charge fully reducing the thyratron grid potential to a value that would permit the thyratron to ionize. The thyratron would subsequently deionize, the capacitor would charge again and the cycle would be repeated. To prevent this type of oscillation, a diode V_5 clipping stage prevents the capacitor from charging to lower than 35 volts above reference ground. At this point there is still sufficient bias on the thyratron grid to prevent ionization and the circuit remains in this state until the end of the signal.

As there exists a minimum potential below which a zero-biased thyratron will not fire, there exists a possible source of error in the output. The output capacitor may not be fully discharged at the beginning of a cycle due to the charge collected from one or more extremely small signal or noise pulses preceding the cycle. It is necessary to reduce this minimum to as low a value as possible and to determine its effect.

It was found that the thyratron used in this circuit required a minimum of 35 volts plate potential to produce ionization when all grids were zero biased. However, with the introduction of the capacitively coupled positive pulse to the thyratron grid as used in this circuit, the minimum plate potential for ionization by signals likely to be present was reduced to 14 volts. There exists in the output pulse of the converter, a possible error ranging up to −14 volts. The use of a nonlinear conversion relationship reduces the overall effect of this error.

Pulse Sorter

The pulse sorter consists of two stages, the thyratron discriminator stage, and the driver stage that operates a mechanical counter. The signal output of the converter unit is differentiated by an input R-C coupling network (having a time constant of 120 μsec). On the negative-going portion of the signal the maximum signal voltage at the grid of the thyratron is −1.7 volt. Thus

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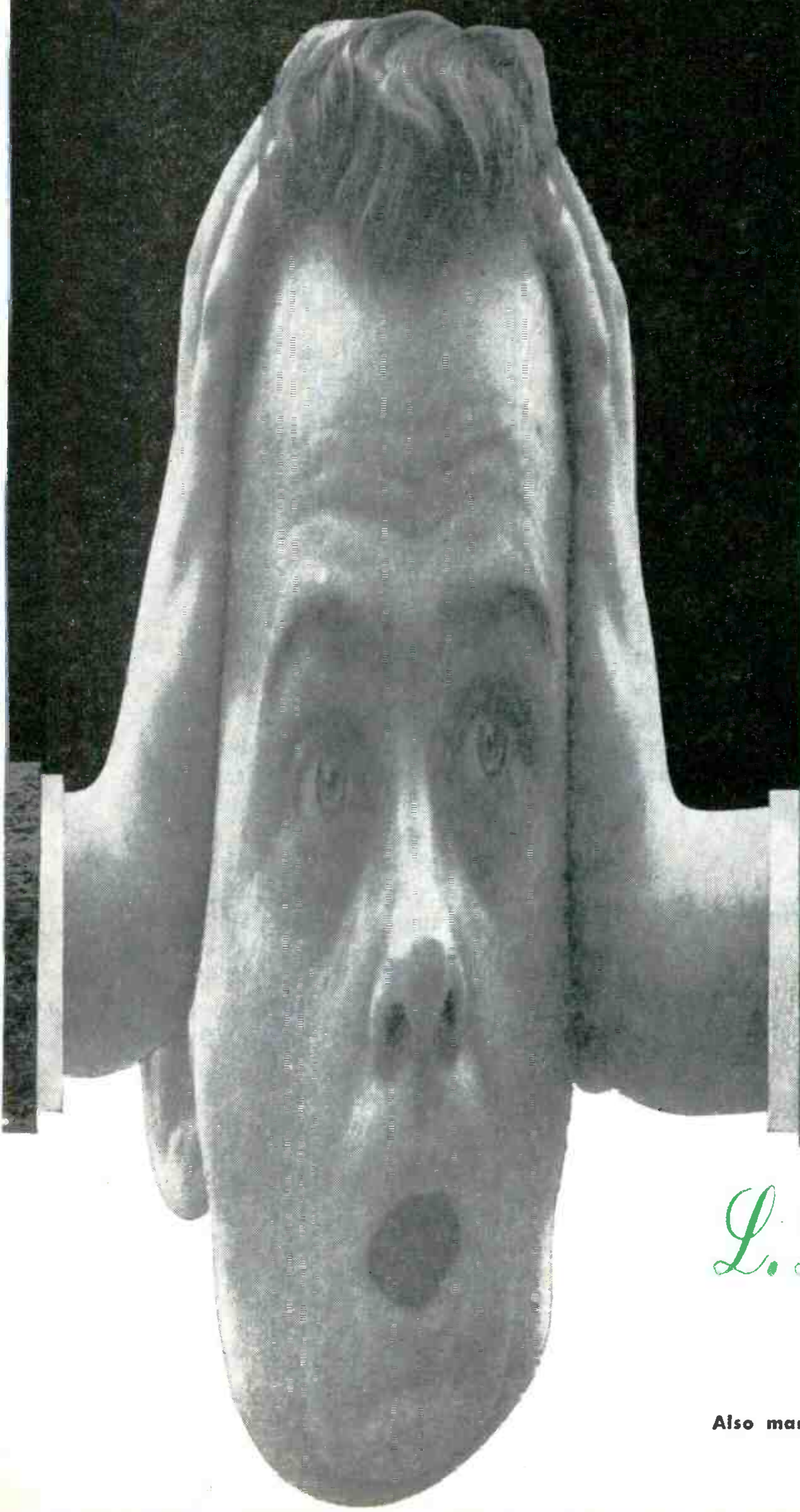

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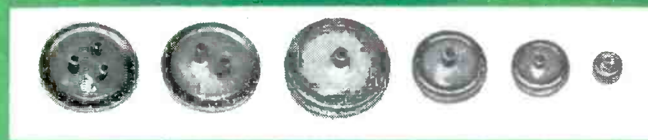

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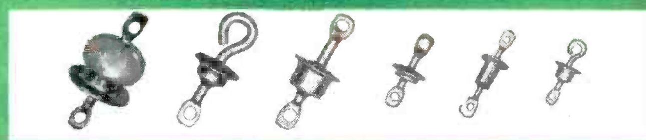

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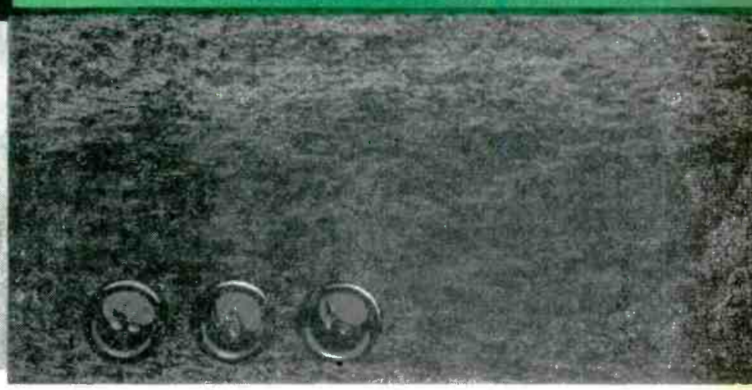

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practically all of the signal appears across the coupling capacitor. The instantaneous (0.5 μsec) positive pulse that follows is coupled directly to the grid through the 10,000-ohm grid stopper. If this pulse is sufficient to overcome the negative bias applied to the stage then the thyratron fires.

It was found that a delay of up to 6 μsec could occur before the thyratron would fire if the pulse was only slightly greater than bias. This made necessary the use of a rather

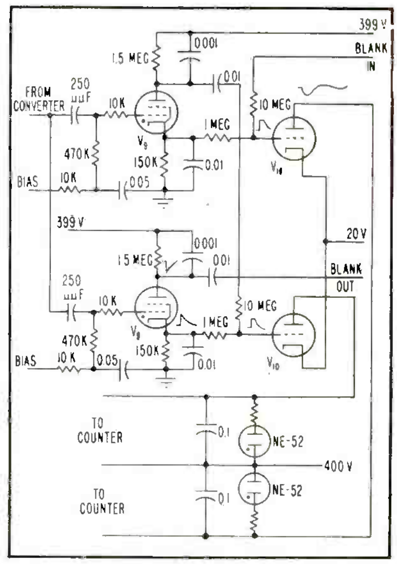

FIG. 3—Pulse sorter and counter outputs are handled in this stage by the thyratron circuits shown

long time constant (120 μsec) in the input network in order that no significant change in instantaneous grid voltage would take place in 6 μsec.

The plate and cathode loads of the thyratron are in impedance ratio of 10-to-1 and are composed of R-C networks with decay time constants of 1.5 milliseconds each. This ratio is important as it controls the blanking of lower units in the multiple sorter setup. A resistor divider network also in ratio of 10-to-1 connects, through a d-c blocking capacitor, the cathode of one stage to the plate of the next higher stage. If both stages are tripped then there can be no signal at the midpoint of the divider due to mutual cancellation. Thus, it can be said the higher unit has blanked the lower unit. If only the lower unit is tripped, a positive signal of 91 percent of the cathode

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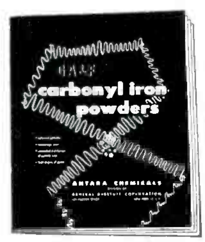

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signal appears at the divider midpoint.

A high-conductance triode is used to drive a high speed relay-operated counter. The output from the previous stage consists of a pulse of approximately 35-volt amplitude and with a decay time of 1.5 milliseconds. The triode is biased just beyond current cutoff by a positive fixed potential of 20 volts applied to the cathode. The input signal to the stage, due to the large resistive impedance of its source, is clipped by grid-current action to a square pulse of 20-volt amplitude and 1.5 millisecond duration. The length of the pulse is sufficient to charge a 0.1 μf capacitor to 300 volts through the fully conducting triode. The resulting discharge of the capacitor into the relay of the counter provides ample actuating force. The discharge is of a strongly damped oscillatory nature with a period of oscillation of approximately 15 milliseconds. A neon bulb in the output of each unit indicates visually the correct operation of the unit. A Cyclotron Specialities high-speed counter is used with each sorter unit.

The variable, regulated high-voltage negative supply for the photomultiplier uses a standard rectifier circuit. Regulation is achieved through a series regulator tube controlled by an output from the control section of the converter unit. The voltage range of the supply is zero to 1,000 volts.

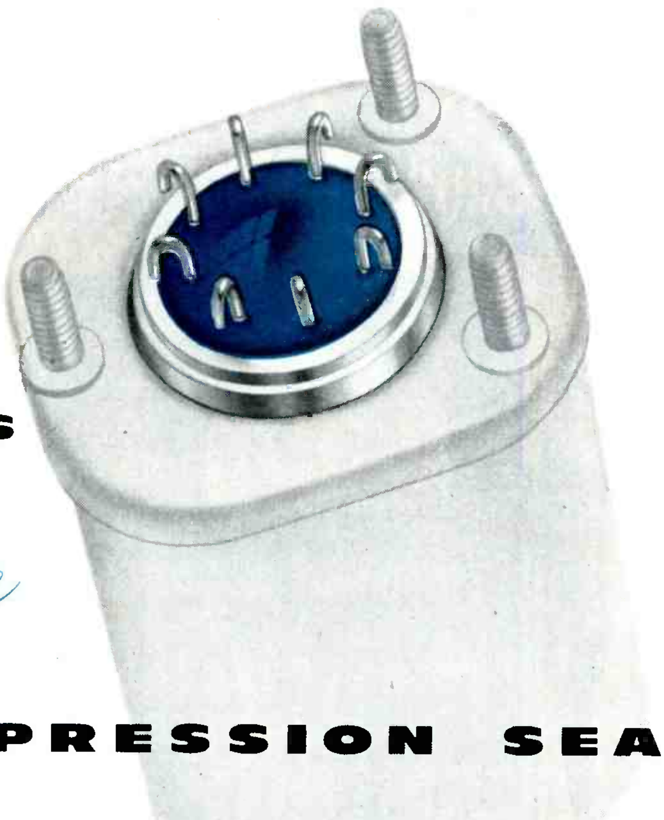
Acknowledgment is made to G. O. Langstroth and R. A. Kendall for their initiation of and early work on the problem of stain counting and sizing.

Germanium-Diode Push-Pull Voltmeter

By D. D. Davis,
General Electric Co.
Pittsfield, Mass.

A SIMPLE push-pull voltmeter circuit has been devised having advantages of low cost, good linearity and good frequency response. It is an average-reading type of a-c voltmeter and has full-scale sensitivity of 10 volts.

In the circuit shown in Fig. 1, two germanium diodes of opposite polarity rectify the alternate half-cycles of the input voltage. The re-



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sulting d-c voltages are of opposite polarity and are applied to the grids of the two cathode followers.

Voltage between the tube cathodes is filtered through an R-C

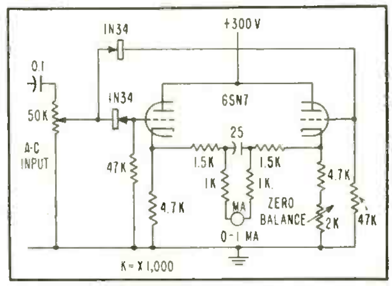

FIG. 1—Electronic voltmeter uses cathode followers to obtain push-pull output, high input impedance and good linearity at low cost in parts

network and applied to a milliammeter that reads average value. Since the cathode followers work in opposite directions, their individual nonlinearities tend to cancel and the circuit works in an essentially linear fashion.

Input impedance is 47,000 ohms permitting capacitance coupling to the output of an R-C amplifier. No d-c return path is needed in the input because a full-wave germanium-diode circuit is used. A low output impedance and high degree of linearity make possible the use of an

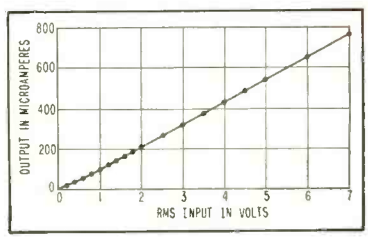

FIG. 2—Linearity of cathode-follower voltmeter circuit is shown in graph

inexpensive milliammeter. Linearity of the push-pull detector circuit is shown in Fig. 2. Accuracy is ±5.5 percent between 10 and 100 percent of full-scale reading. To maintain linearity over a wide range of voltages, attenuators or an amplifier should be used ahead of the input circuit.

Square-Wave Amplifier

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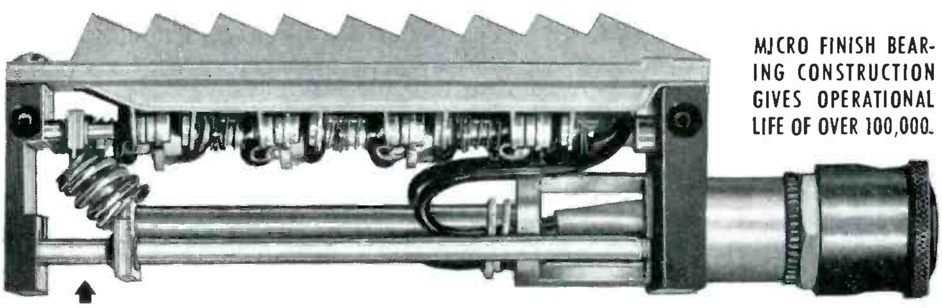

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and rectifying the combination voltage in such a way that the noise components are cancelled over a period of time that is long compared to the period of the reference voltage. In this way, the performance of a narrow-band amplifier having a bandwidth of perhaps a fraction of a cycle per second can be obtained, but without the serious problems of drift and detuning that may occur with a conventional amplifier. The practical necessity of having the signal and a reference voltage derived from the same source restricts the range of application of the lock-in amplifier.

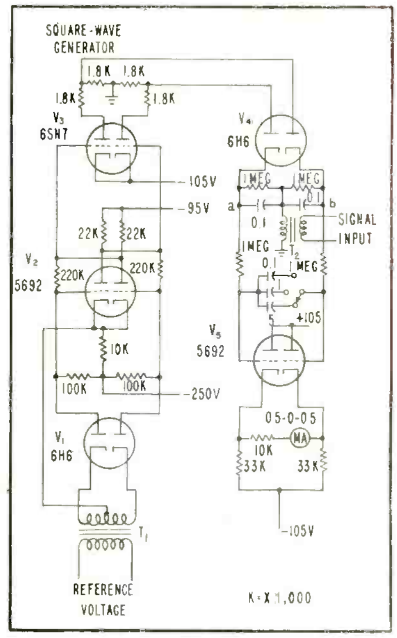
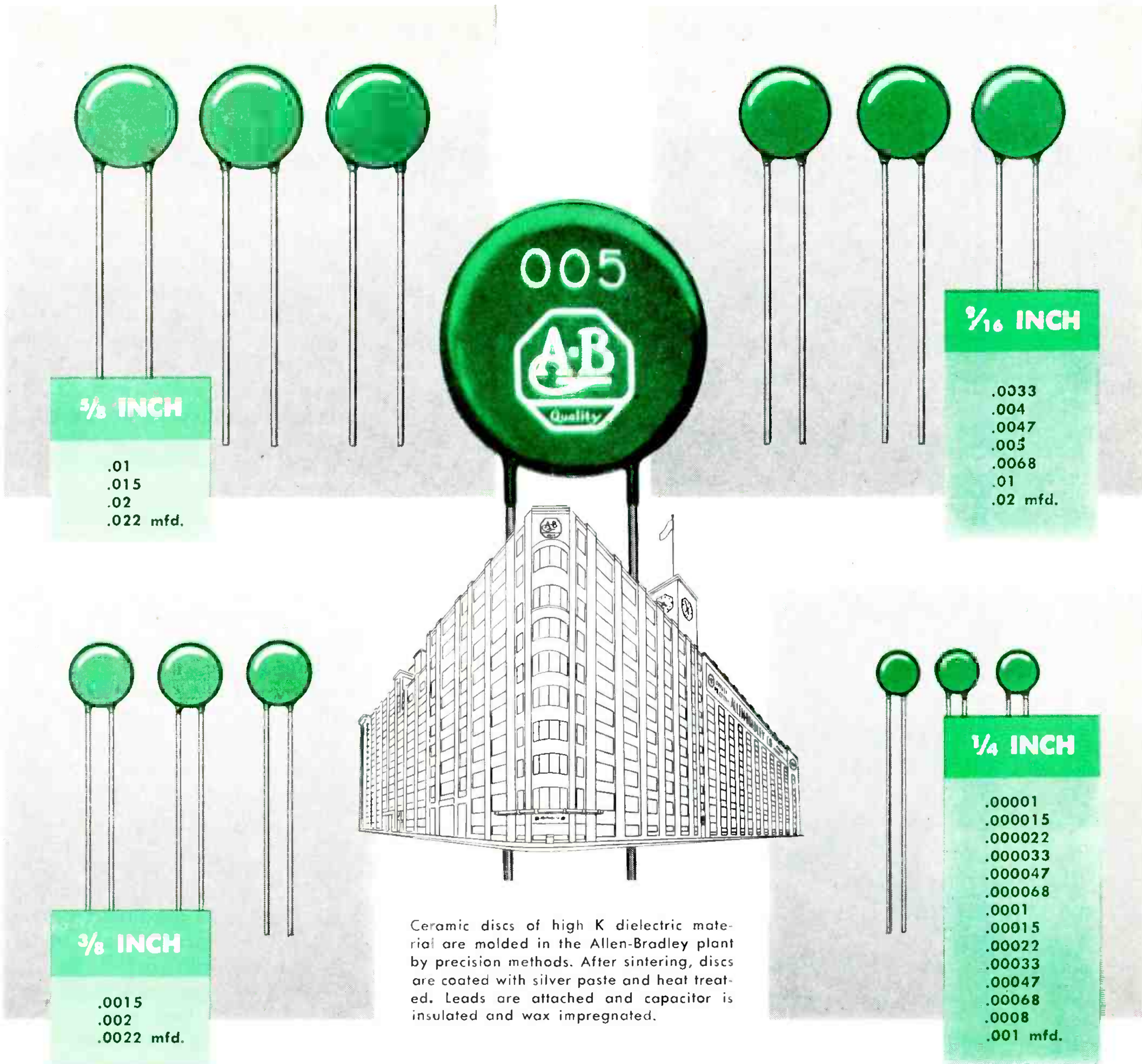


FIG. 1—Synchronous amplifier combines reference square wave with signal to obtain error voltage across filter circuit

The circuit shown in Fig. 1 was developed primarily as a result of attempts to minimize the number of balancing adjustments and to improve the linearity of response in a lock-in amplifier circuit.

A square-wave generator V_1, V_2 and V_3 impresses a grounded-based, negative square wave upon the plate of one of the diodes V_4, and it impresses a similar square wave of opposite phase upon the plate of the other diode. The combination of the square-wave generator and the diodes serves as a synchronous rectifier, charging the two filters, on alternate half-cycles of the reference voltage. The difference voltage between points *a* and *b* is proportional to the reference-frequency component of voltage ap-



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plied to the signal input multiplied by a phase-angle factor, provided the signal is smaller than the reference voltage. The voltage between *a* and *b* is observed on vacuum-tube voltmeter circuit V_5.

Since the output voltage from each terminal of the square-wave generator is used only to cut off the associated diode, it is not necessary that the two output voltages be equal. The only critical adjustment occurs in matching the two time constants R_1C_1 and R_2C_2. If these time constants are unequal, a low-frequency noise component will develop unequal voltages across the two filter sections. To balance the time constants, it is convenient to disconnect both plates from the square-wave generator and ground them. A variable-frequency audio oscillator is then connected to the signal-input terminals. As the oscillator frequency is reduced toward the lower end of the useful range, the meter deflection will usually be found to increase rapidly. One of the resistors should be adjusted for minimum frequency deviation.

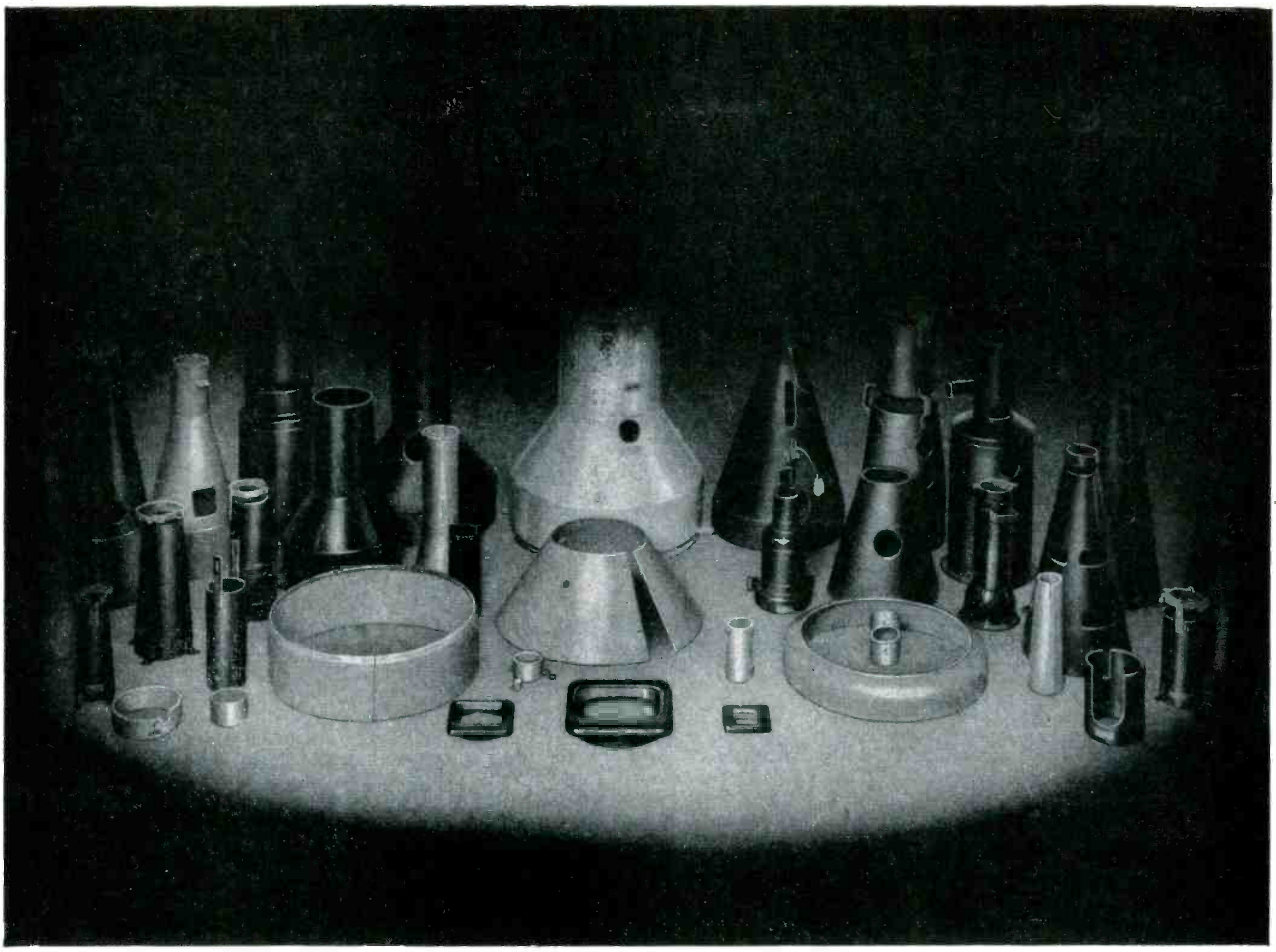
Reference Level

Although the two output voltages of the square-wave generator do not have to be balanced in magnitude, it is essential that the ratio of the two off periods be independent of the reference-voltage amplitude, if there is a possibility that the reference level may change.

Since the output of a lock-in amplifier depends upon the phase angle between the reference voltage and the signal voltage, a phase shifter should be included either in the signal path or in the reference voltage circuit.

The use of a square-wave switching voltage causes the lock-in amplifier to respond to noise components which are exactly odd harmonics of the reference frequency. This is not believed to be a serious disadvantage, however, for it is relatively easy in most applications to introduce a low-pass or band-pass filter having any desired attenuation at the third and higher harmonics of the signal frequency.

With the circuit values and components indicated in Fig. 1, the response is essentially uniform for a signal frequency between 10 cps



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and 500 cps. The range for 70 percent response is 7 cps to 2 kc. With a 1-ma recorder movement displaced mechanically to zero center, full-scale deflection occurs for approximately 10 volts at the signal input. The performance of this instrument is limited largely by the electrical characteristics of the two transformers, especially T_1 and there appears to be no reason why the frequency range should not be extended to around 100 kc, provided appropriate transformers are used or R-C coupling is employed instead of transformers.

This article has been abstracted from a paper "An Improved Lock-In Amplifier", by H. L. Cox, Jr., appearing in the April 1953 issue of *The Review of Scientific Instruments.*

Frequency Response in Four-Terminal Networks

By Robert L. Konigsberg
Research Associate, Radiation Laboratory, Johns Hopkins University, Baltimore, Md.

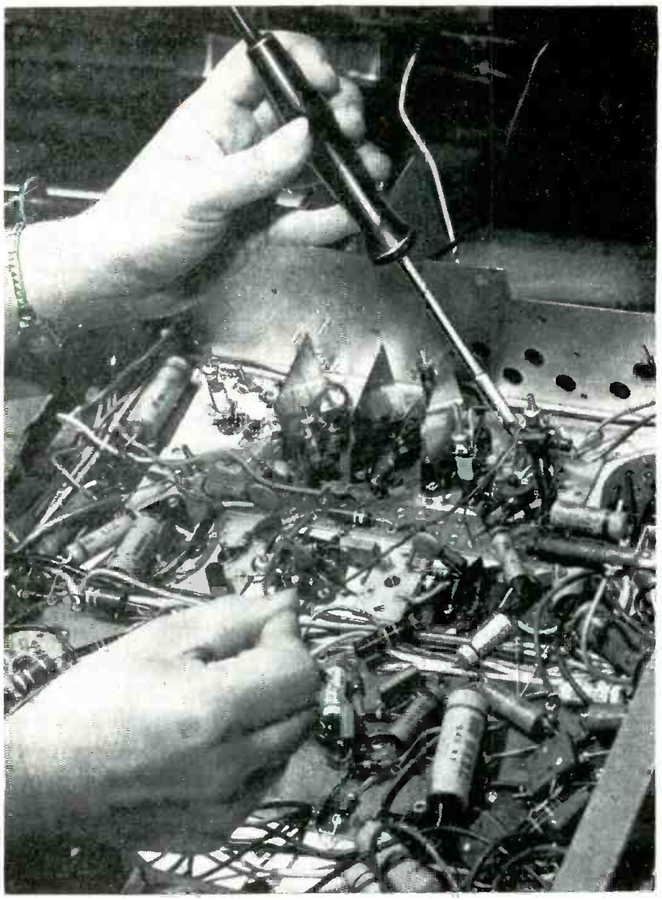
There are several methods of measuring the amplitude-frequency response of a four-terminal network driven by a constant-current source.

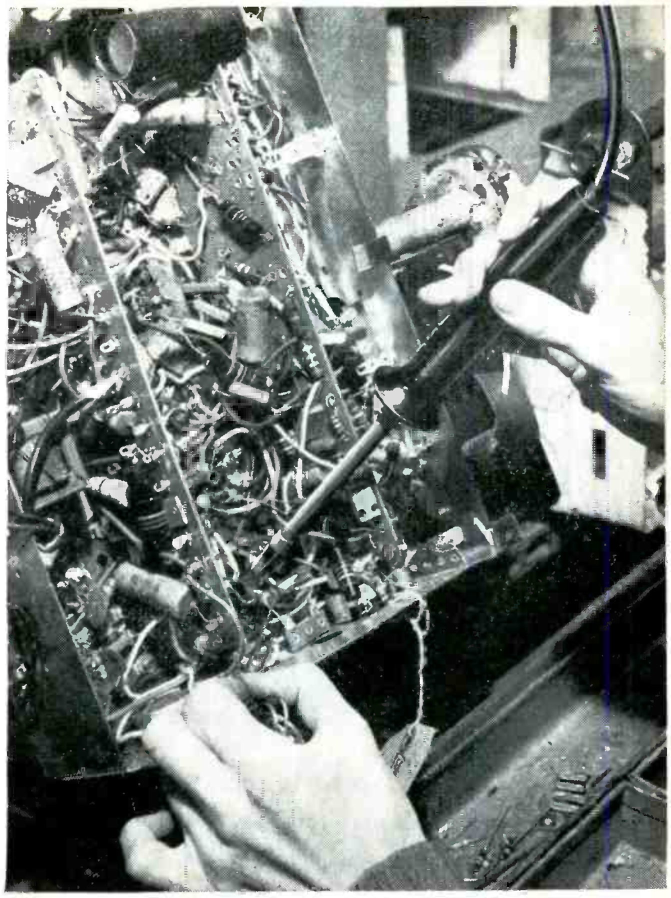
If the network were driven by a vacuum tube, the measurements would be fairly straightforward. The constant-current source, i, in Fig. 1 would be $i = g_m e_g$ where g_m is transconductance, and e_g grid voltage. If R_1 and C_1 are part of the input circuit of the network, these quantities should include the shunt effect of the plate resistance and plate-to-ground capacitance, respectively, of the tube. That is, the network would be designed so that R_1 and C_1 included these effects. Then, by definition, the network response G_n would be

$$G_n = \frac{e_o}{i} = \frac{1}{g_m}\left(\frac{e_o}{e_g}\right)$$

If g_m remains a constant in all measurements, measuring e_o and e_g, and forming their ratio will give the response at any one frequency. Repeating these measurements at other frequencies will give the required relative response data.

Now, suppose the driving source





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is a low-impedance device such as a crystal diode in a heterodyne mixer circuit, Fig. 2A. In this case, the network would be designed to pass the i-f currents generated by the nonlinear crystal. The equivalent

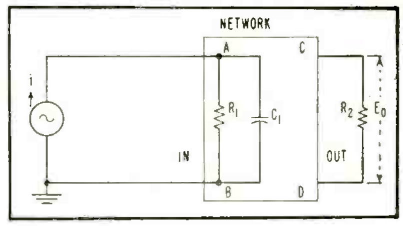

FIG. 1—Network driven by constant-current source

circuit for the crystal, r-f circuitry and network would be represented by Fig. 2B. The input circuit of the network must be designed to include the shunt-loading effect of the equivalent source admittance of the r-f and crystal-diode circuits at intermediate frequencies. These are represented by shunt elements R_F and C_F in Fig. 2B. In this case, the value of R_F will be of the order of 300 or 400 ohms since the equivalent shunt source resistance for the crystal and r-f circuits is of this order.

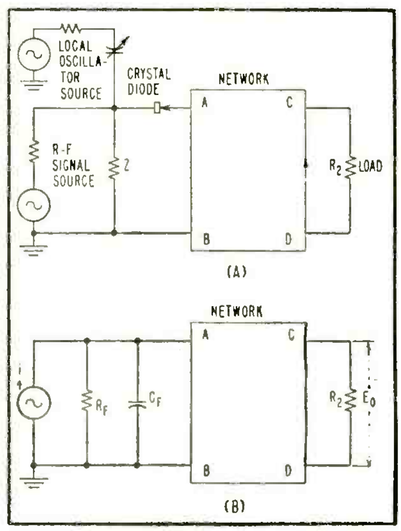

FIG. 2—Hetroydne mixer circuit (A) and its equivalent (B) at intermediate frequencies

Constant-current response of the network can be measured by replacing the crystal diode and r-f circuits by an admittance, with R and C shunt components, equal to the equivalent source admittance of these circuits. This admittance is connected across the input terminals of the network, making up the net R_1 and C_1 for which the network

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input circuit was designed, Fig. 3A. To create a constant-current source, insert a high resistance, R_3, in series with the network and feed the combination by a signal

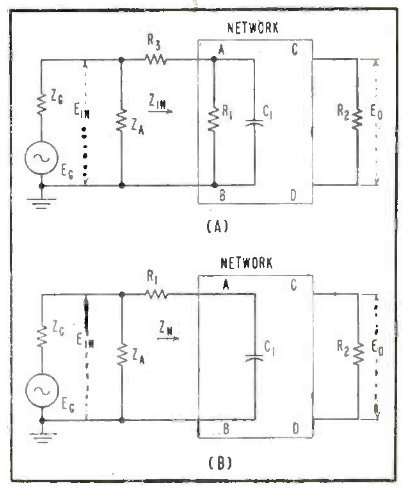

FIG. 3—Circuit for measuring frequency resp nse (A). Circuit (B) is used when resistance of R_1 may vary over test range

generator terminated in a low impedance, Z_a, as shown in Fig. 3A.

If, in Fig. 3A, $R_3 >> |Z_{IN}|$ where Z_{IN} is the input impedance of the network, then the ratio e_o/e_{IN} becomes a measure of the relative response of the network.

Using the Thevenin equivalent circuit it can be shown that the response of the network, G_n, is very nearly

$$G_n = \frac{e_o}{i} = \left(\frac{e_o}{e_{IN}}\right) R_3$$

If R_3 can be held fairly constant within the test-frequency band of interest, then the ratio e_o/e_{IN} becomes a measure of the relative response of the network.

In some cases, however, the test frequencies are high enough so that R_3 is influenced by its own distributed capacitance with the result that it cannot be considered constant over the test-frequency band. To circumvent errors introduced by this variation, another approach to the problem may be used.

In Fig. 3B, another method of connecting the network to the generator is shown. The network input damping resistance R_1 is now placed in series with the network rather than in shunt. If $|Z_a| << R_1$, e_o/e_{IN}

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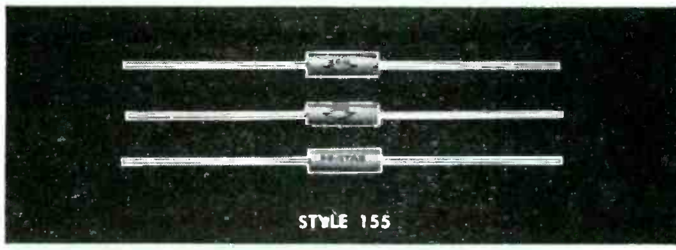

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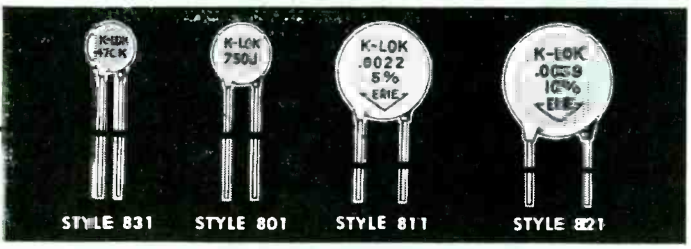

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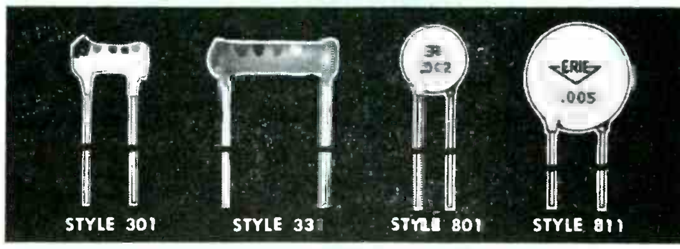

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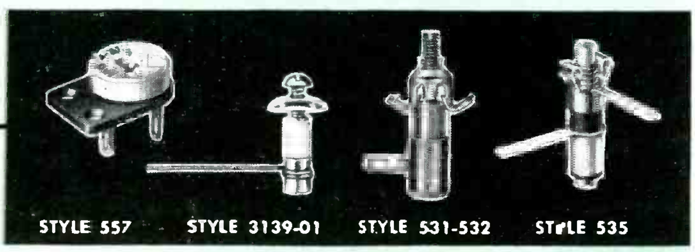

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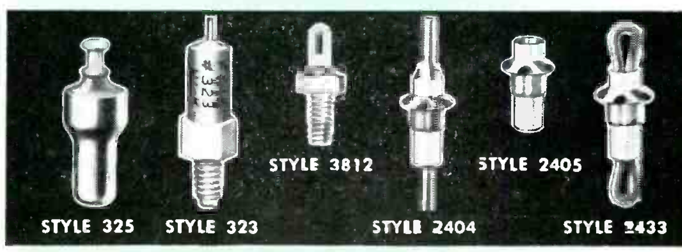

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In this case, using the Thevenin constant-current equivalent circuit, the response of the network can be shown to be very nearly

$$G_n = \frac{e_o}{i} = \left(\frac{e_o}{e_{IN}}\right) R_1$$

Now, if R_1 can be held fairly constant over the test frequency band, then the ratio of e_o/e_{IN} is a measure of the relative response of the network.

Values of e_o and e_{IN} may be measured indirectly by amplitude modulating the signal source at an audio-frequency rate. Then e_o and e_{IN} are measured in terms of the detected audio signals using a square-law detector of the germanium-crystal type. Associated with the detector output circuit may be a tuned audio amplifier with an output meter calibrated directly in db response. It is assumed that the detector has a high enough input impedance and will not affect the measured values. In many cases, Z_a can be made small enough so that the measurement of e_{IN} is unchanged by the presence of the detector. If R_2 is not small compared to the detector impedance, the value obtained for e_o may be in error. In broadband networks, R_2 is usually small enough so that this error can be made negligibly small, but in narrow-band networks it may be necessary to compensate the network output constants for the presence of the detector.

A precaution should be observed in making constant-current response measurements when the signal generator is terminated in a low impedance such as Z_a in Fig. 3B. Because the input voltage, e_{IN}, is developed across a low impedance, Z_a, a relatively large current is drawn by Z_a. If more than one chassis ground path exists, part of this current may pass through a chassis ground path common to the network.

At high frequencies, a significant voltage drop can be produced across the common ground path, the inductance of which is not insignificant. This voltage drop is then applied to the network and considerably alters the response characteristic. To eliminate this

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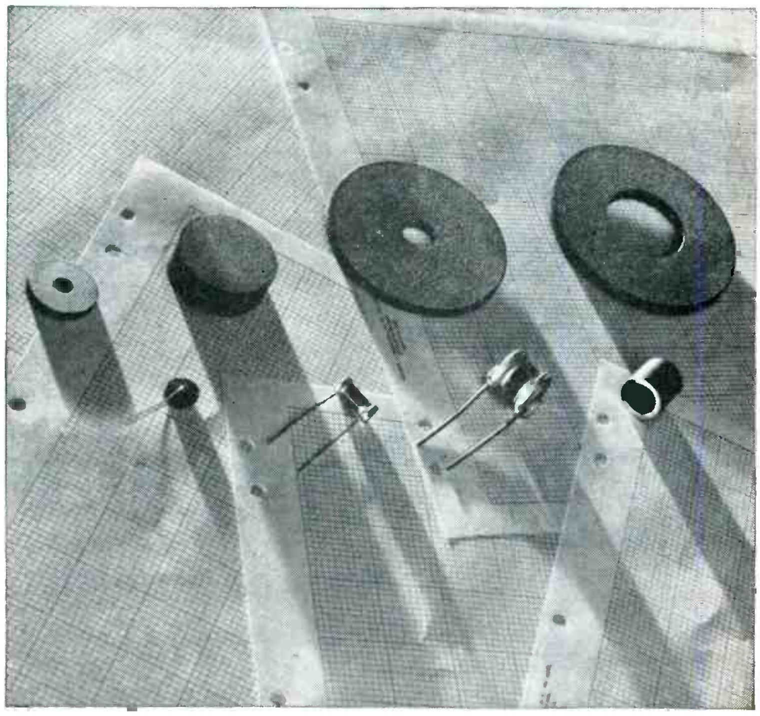

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source of error, it is necessary to insure that there are no network ground paths common to those through which the current drawn by Z_a is passing. This usually means that the test circuit should be grounded to the chassis at only one point.

Phototube Tester Checks Anode Current

BY MILTON ADELMAN, ROBERT W. BURKE AND REUBEN T. LEIBOWITZ
Phototube Unit
Naval Material Laboratory
Brooklyn, N. Y.

OF THE SEVERAL measurable phototube characteristics, anode current has been designated by military specifications as the sole criterion for determining the end of useful life for all vacuum and gas phototubes, except for photomultipliers, where the characteristic of amplification is measured. Anode current, however, is an important factor in determining amplification, and therefore furnishes a reliable indication of the end of useful photomultiplier tube life.

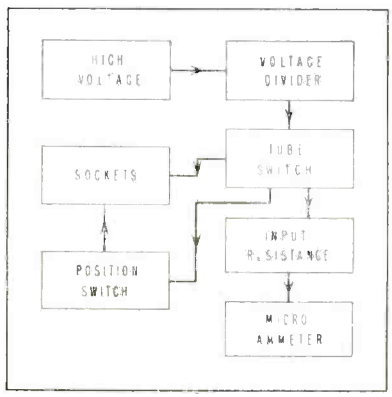
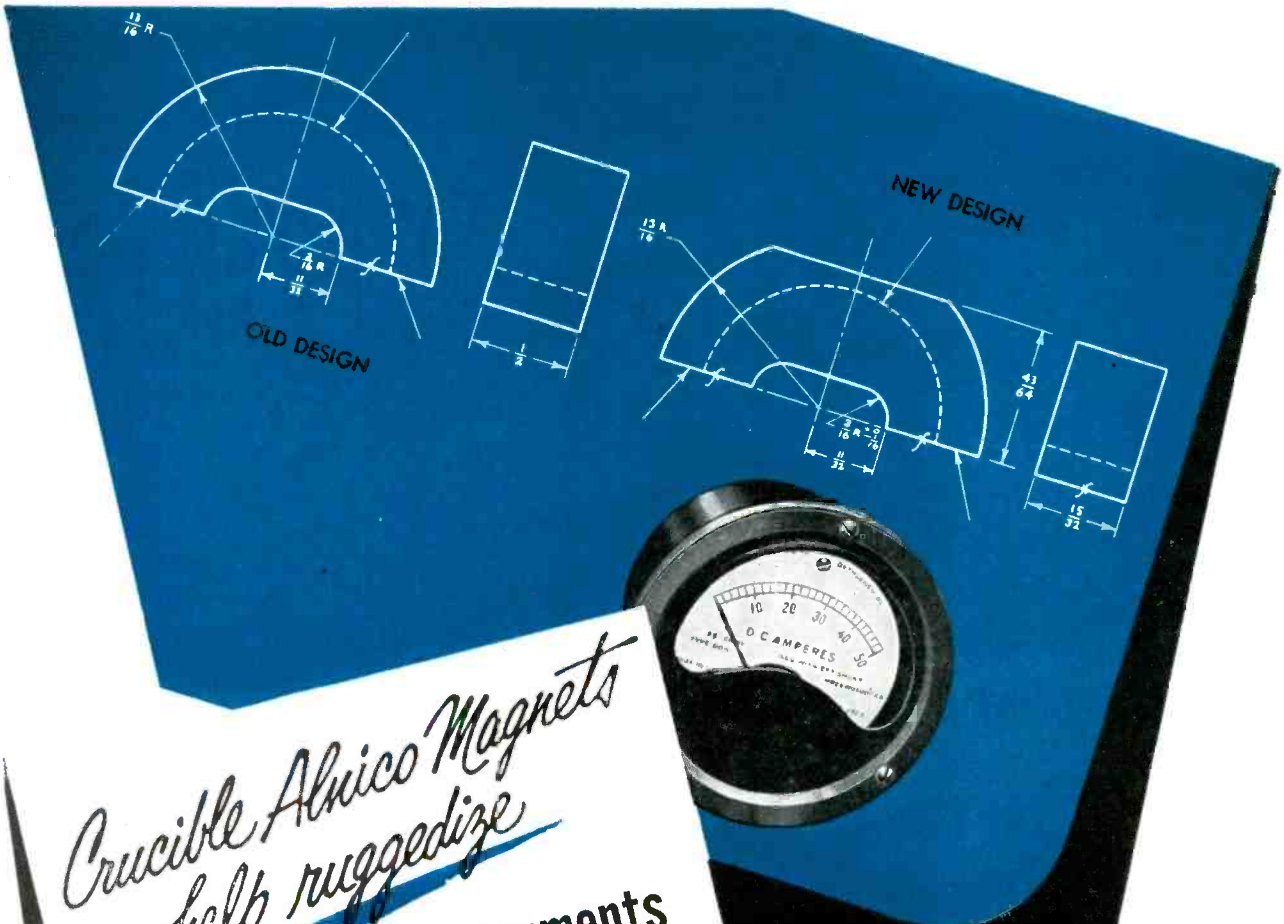


FIG. 1—A node current checker for phototubes used in Navy equipment

Apparently, shelf life causes no prohibitive increase in dark current of tubes that were within specification limits when originally stocked. The equipment described below was designed to test all the 97 diverse stock phototube types and constructed at the Material Laboratory of the New York Naval Shipyard in Brooklyn, N. Y.

Complete equipment shown in Fig. 1 includes an electronically regulated high-voltage d-c power supply adjustable from 700 to 1,600 v, with output of 10 ma. Ripple voltage of 0.3 v at any load current is too small to affect voltages from



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divider networks across the output. Voltages for the photomultiplier dynodes and other tube types are provided by two networks made up of precision resistors. Each network draws 5 ma.

Since the low anode current, ranging from 0.2 to 200 microamperes, cannot be directly measured by a meter, a d-c amplifier is required. This amplifier, operating push-pull, is calibrated to cause full-scale deflection at 1.5 v on a 200-microampere movement. The meter is marked and scaled so that the latter 3/5 is colored green and

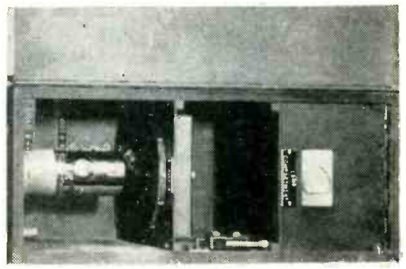

FIG. 2—Black box with end-on tube under test. Proper luminous flux is obtained by interposing different area apertures between light and photocathodes

marked to indicate good tubes.

The relatively low internal resistance of gas-filled, as compared to vacuum phototubes, is compensated by adjustment of input resistance.

Voltage supply for the standard exciting lamp comprises a small constant-voltage transformer feeding into an autotransformer that, in turn, controls the voltage to a low-voltage, high-current, step-down transformer. The resultant output voltage is constant within less than plus or minus 1 percent for total input variation of 30 percent. Available regulated d-c supplies for the current range were too expensive and bulky.

Frequency Synthesizer

An equipment has been developed in Britain to act as a source in which any individual frequency between 1 kc and 100 mc can be produced quickly and accurately.

The principle used is that of synthesis of frequencies, with static filters to select the wanted products in mixer outputs. The required output is arranged to have a small sideband component of

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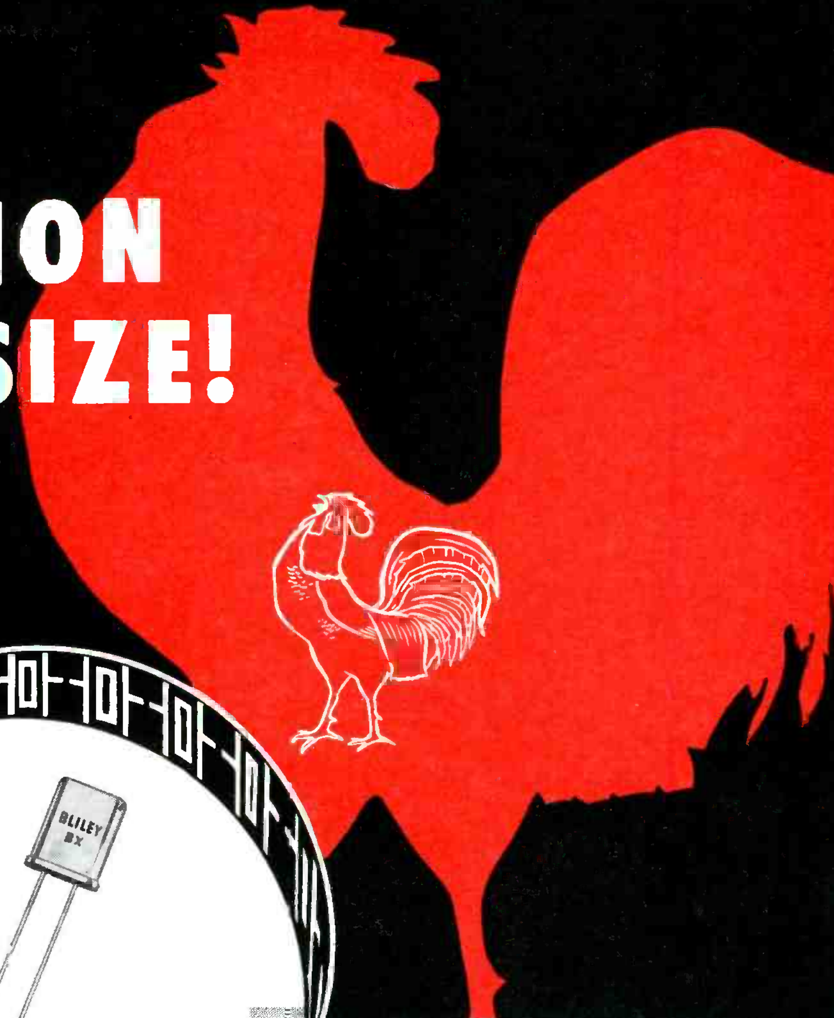
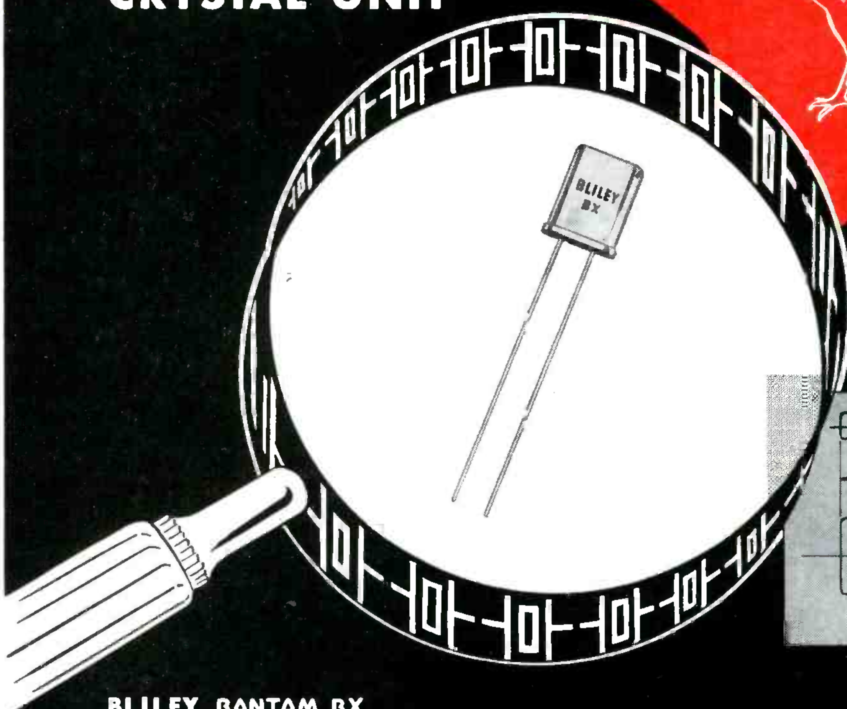
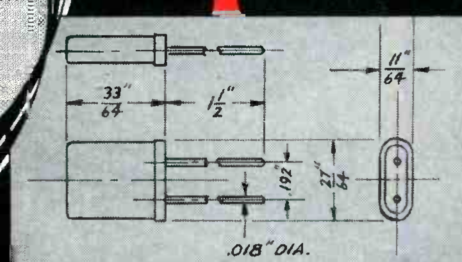
BANTAM BX

CRYSTAL UNIT





BLILEY BANTAM BX
FREQ: 15mc-100mc



ACTUAL SIZE

The new **BANTAM BX** has wire leads for mounting in a miniature selector switch or can be soldered to a printed circuit terminal board.

The new **BANTAM BX** does not sacrifice precision or dependability. It meets same performance and tolerance requirements as larger crystal units such as MIL types CR-23 or CR-32.

The new **BANTAM BX** is fully described in Bulletin 46. Now available for prototypes or in production quantities.

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about 0.05 percent. Selection of the necessary static filters is by means of a system of motor-driven Geneva mechanisms and switches and the entire selection routine is a simple manual operation.

A certainty of frequency division from the standard is guaranteed by use of harmonic selector circuits. Because the output is a sine wave, it is possible to establish the fundamental frequency of a complex input.

Extending Multivibrator Delay Time

By George Eliot Kaufer
Electronics Research Laboratories
Department of Electrical Engineering
Columbia University, New York, N. Y.

For a given multivibrator and trigger rate a definite limitation is imposed on the maximum obtainable delay interval. As the delay is increased, exponential decay of the waveform, as shown in Fig. 1, moves farther to the right. Eventually, a point A will be reached

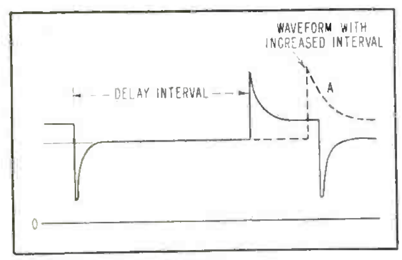

FIG. 1—Voltage between cathode and ground in monostable multivibrator showing effect of increasing delay time

where the next trigger occurs at an instant when the timing capacitor is not fully charged. The subsequent delay will not be constant. Delays of greater than 80 percent of the total period are usually difficult to obtain unless additional techniques are employed.

A remedy is to effect more rapid discharge of the timing capacitor. A simple method of accomplishing this is to shunt R_k with a biased diode as in Fig. 2. For best results, bias should be a volt or two above the value I_2R_k where I_2 is the full on current of V_2 and must be derived from a low-impedance source.

When V_2 conducts and C begins to charge through R_k, the diode short-circuits and presents a low-impedance path. Charging-time constant is thus reduced and the

delay may be stretched as much as 10 or even 15 percent further.

A capacitor in series with the diode shunts R_k at the instant an output pulse is being generated increasing gain, with a resultant rise in output delay pulse magnitude.

Addition of capacitor C_1 from the pulse-coupling transformer to ground, will cause the plate of V_2 to take a finite time (determined by the values of the plate resistor and capacitor) to reach the supply voltage.

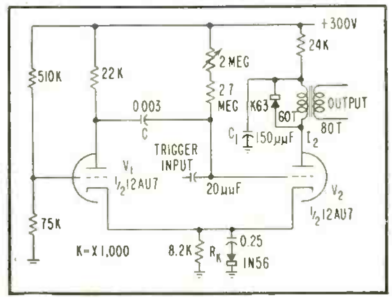

FIG. 2—Circuit of multivibrator cathode-shunt diode and plate-shunt capacitor to extend delay time

Minimum delay obtainable is not appreciably affected by the added capacitor since in all cases the value of capacitance will be small enough to allow for a short time constant. At the conclusion of the delay interval V_2 is turned on and its plate voltage falls.

The diode opposes current flow and acts as an open circuit, causing the changing current plus the discharge of C_1 to flow through the transformer primary. This additional capacitor current, which flows for a time equivalent to the output pulse duration (due to proper selection of the discharge time constant) increases the rate of change of transformer primary current and results in greater output voltage.

As it is desirable to discharge the plate capacitor rapidly, a low-resistance path is beneficial. Diode clipping in the cathode circuit is used further establishing the advantages of these components.

The value of the plate capacitor should be such that the discharge-time constant of C_1 and the internal tube resistance in parallel with the current-limiting resistor is equal to or greater than the output-pulse width. Its maximum value is limited by the trigger-pulse repeti-

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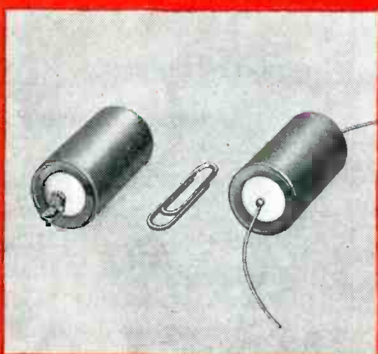

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Center Frequency	30 Mc.
Bandwidth	7 Mc.
Capacity	15 to 20 mmfds.
Pulse decay	1 to 1½ db. average

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DELAY LINE SPECIFICATIONS FOR 500 MICROSECOND STORAGE TYPE

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tion frequency, since the plate voltage of V_2 must fall to the full-on value before the appearance of the next trigger.

Microfilmed documents previously marked are read off by flying-spot scanner in new technique developed for computer input

FOSDIC Feeds Figures

A FILM OPTICAL sensing device for input to computers (FOSDIC) converts ordinary pencil marks appearing on microfilmed copies of documents into electrical pulses that are recorded on magnetic tape for data processing machines.

The device is designed to reduce the work now necessary to convert written records into a medium suitable for feeding computers. FOSDIC allows considerable freedom in design of documents and requires no special writing equipment.

Mark sensing is based upon the detection of specific blacked-in areas or ovals in a large field of possible answers arranged on a sheet of paper. A yes-no answer is given two ovals, while a numerical answer is supplied with a vertical column of 10 ovals for each decade.

Scanning is carried out frame by frame. Each frame is a microfilmed picture of one side of a sheet that may be as large as 14 by 16 inches. The film is placed in an optical assembly between a cathode-ray spot-scanning tube and a phototube that produces a varying electrical signal from the interrupted light beam as indicated in Fig. 1. Present maximum capacity is 2,800 marks a sheet. The individual film is scanned in 0.5 to 0.9 second. Average information rate is 2,000

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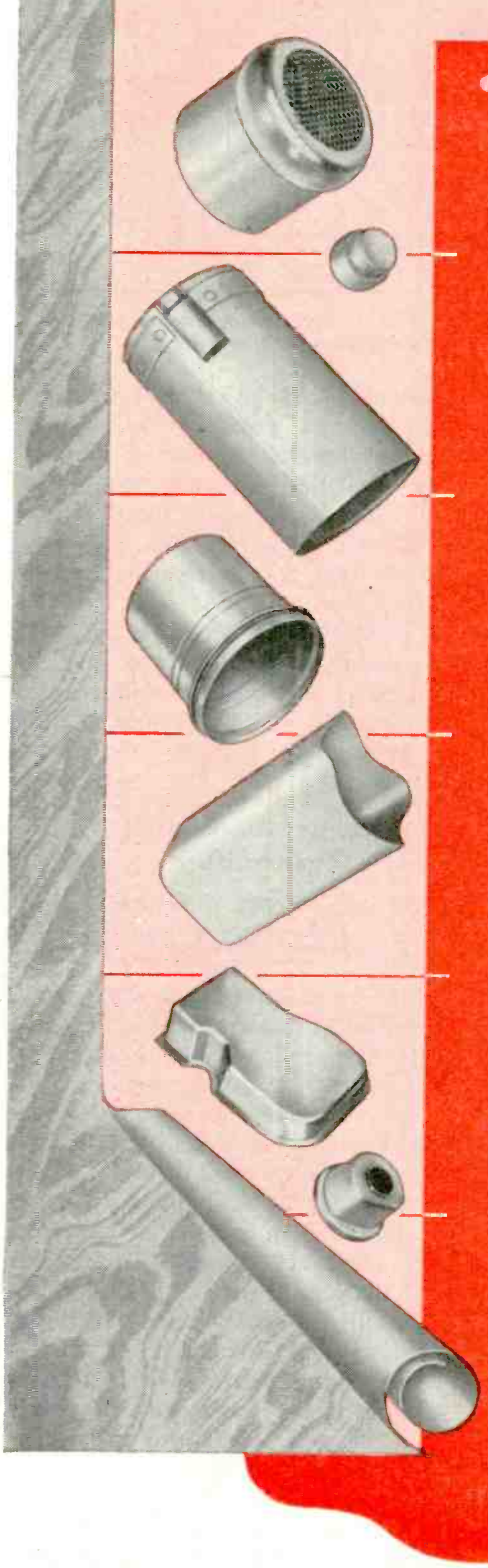

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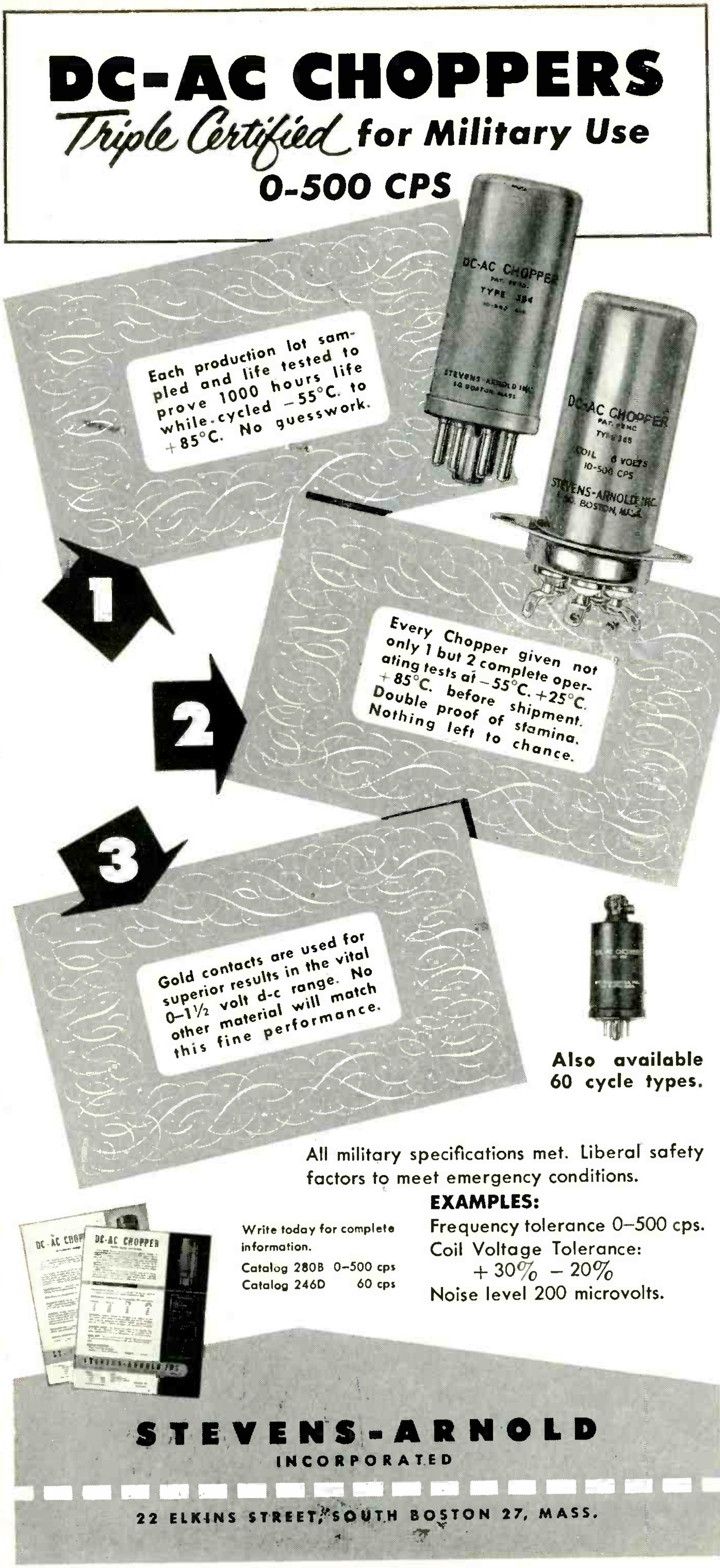

binary digits or 250 decimal digits a second.

An index recognition circuit determines when the scanning beam is at the top edge of a solid mark

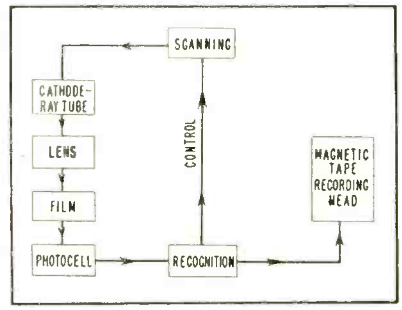

FIG. 1—Flying spot scanner and computer-input tape recorder

between 0.24 and 0.36 inch high. Means are provided to make a column count on each document. If a column is missed, owing to a film defect, a special signal on the magnetic tape informs the computer that the information may be unreliable.

FOSDIC was developed by M. L. Greenough, H. D. Cook and M. Martens of the National Bureau of Standards at the request of the Bureau of the Census.

Frequency-Modulated UHF Transmitter

HARRY W. GATES
Electronics Engineer
Capehart-Farnsworth Corp.
Fort Waye, Indiana

THE OSCILLATOR-TRANSMITTER described in this article was designed for frequency-modulated operation in the 400- to 500-mc region. Pencil-type uhf triodes are particularly well-suited for use in this range, and a power output of five to seven watts may be easily obtained using two tubes in a push-pull circuit. However, the planar construction of the pencil triode is basically better suited to coaxial and cavity circuits than to parallel lines. Therefore, it has been necessary to construct mechanical mounts to permit the use of pencil triodes in parallel-line circuits. Figure 1 is a sketch of one such mount.

This mount not only serves as a mechanical support for the tubes but is also the grid feedback loop. The dimensions given are for 400 to 450 mc with a six to seven-watt output. Since the length of this

Famous Kings in History

FERDINAND V, 1452-1516, was the Spanish King of Castile and Leon. As Ferdinand II he was also King of Aragon. His policies, though severe, founded Spain's imperial greatness. He married Isabella of Castile. King Ferdinand is best-known to Americans because he and the Queen aided Christopher Columbus in his famed voyages of discovery.

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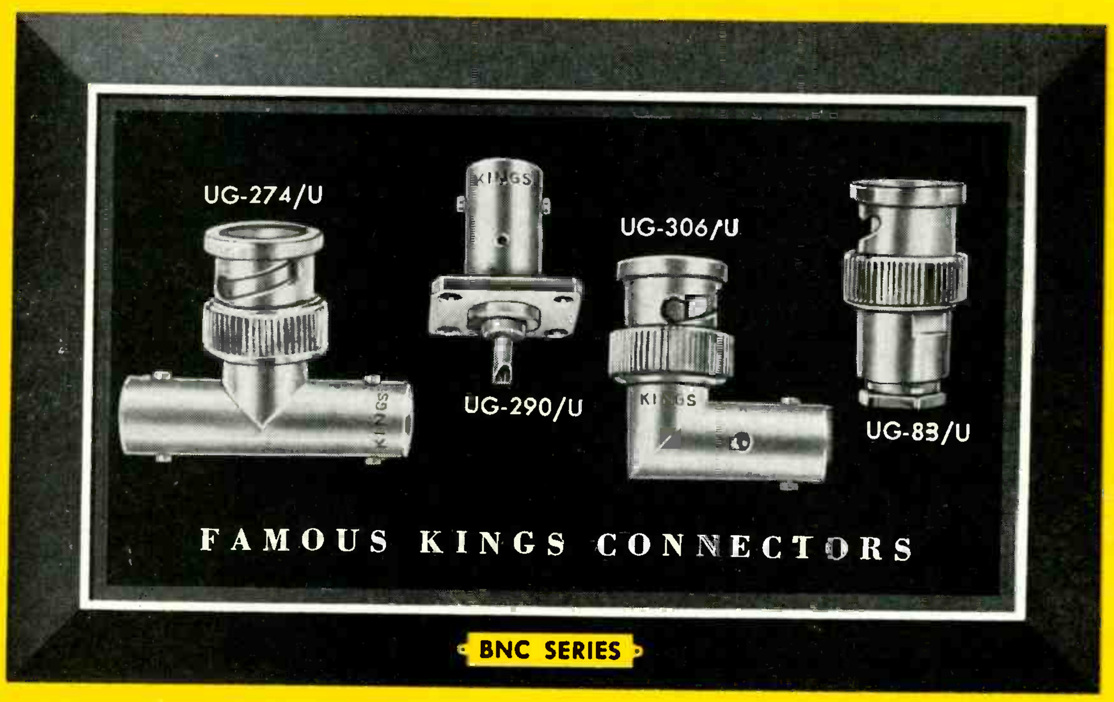

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loop determines primarily the amount of feedback and to a much lesser extent the frequency, the dimensions can be fixed at an op-

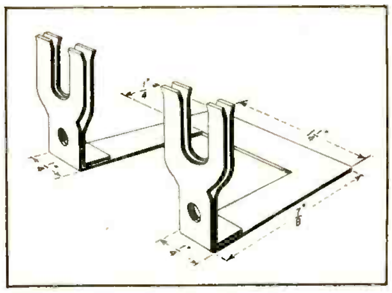
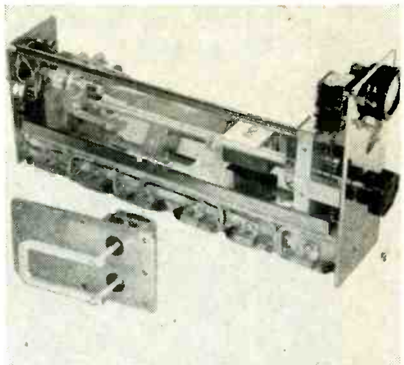


FIG. 1—Mounting bracket for two pencil triodes is grid-feed back loop

timum value of power output for over a greater than 10-percent range of frequency.

The block used to support the cathode clips and the grid clip is made of material having a low loss factor at 500 mc. Care should be taken to avoid placing supports near the plate lines since the power output may be reduced as much as 50-percent by leakage.



UHF frequency-modulated transmitter uses two pencil triodes in output

Tuning is accomplished by a shorting bar between the plate lines. A three or four-digit counter in conjunction with a gear train permits the sliding short to be reset to one one-thousandth of an inch, or at a nominal frequency of 400 mc. to the nearest 50 kc. A calibration chart is used to correlate dial settings with carrier frequency.

In the application for which the oscillator-transmitter was designed, the carrier is frequency-modulated with six different audio signals which can be applied either separately or in combinations up to all six at once. This means that the modulating signal can be a complex wave with frequencies as high

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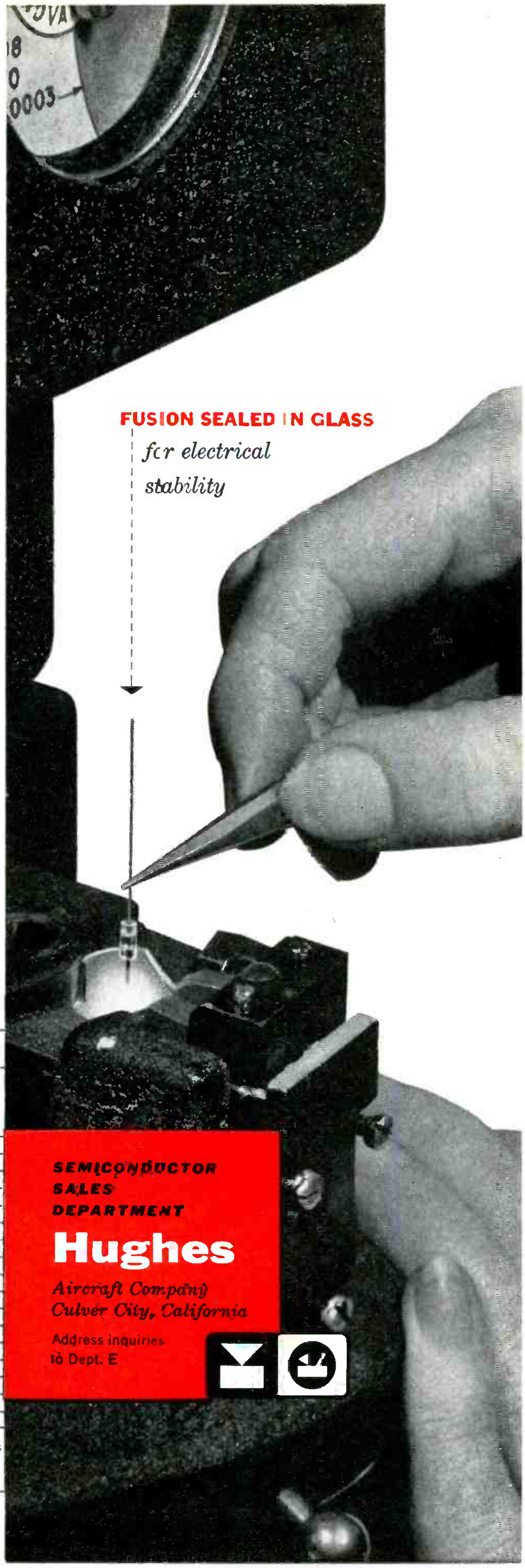
HUGHES GERMANIUM DIODE ELECTRICAL SPECIFICATIONS AT 25° C.

Description	RETMA 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.

HUGHES DIODES *are also supplied 100% factory-tested to a wide range of customer-specified characteristics, including high-temperature requirements.*



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as 120 kc. Assuming a deviation ratio of three it is necessary to allow for a frequency deviation of ±200 kc. For this, the modulator shown in Fig. 2 was developed.

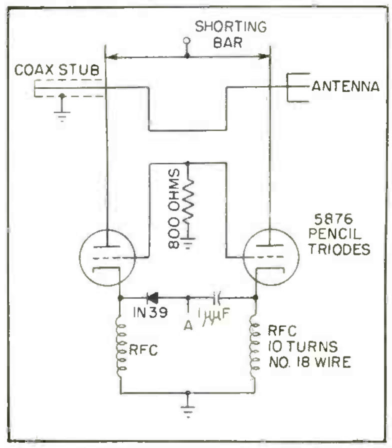

FIG. 2—Crystal in cathode circuit of f-m transmitter applies modulation

The modulator circuit applies the reactance-variation principle of a crystal, capacitor and loop combination to the push-pull circuit. Statically, replacing the crystal with various values of resistance will give a frequency deviation at 400 mc from zero to 400 kc. This, of course, is the same effect that would be obtained if the 1-μμf capacitor were varied. Passing from

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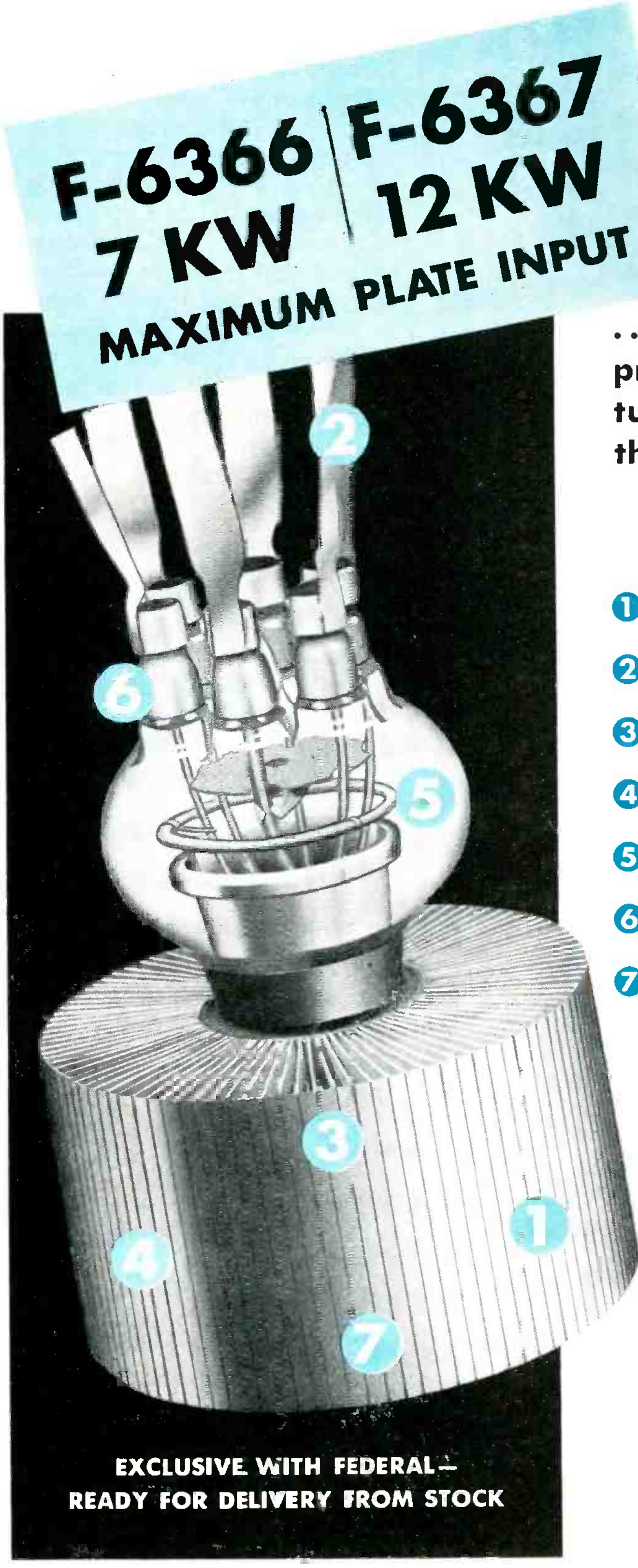
After an eight-year study, including analysis of 270 items, Naval Research Lab engineers conclude that 90 percent of the damages resulting from shock and vibration can be eliminated in future by proper choice of components and suitable mounting. Vibration has been found as damaging as shock. Good design inherent in equipment on testing machine, results from low-mounted transformers and aluminum mounting feet set in from bottom edge to permit greater deflection of bottom panel

DESIGNERS—Cut New-Equipment Costs



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5. **Internal Corona Ring** eliminates trouble with hot-spots and glass cracks.
6. **Kovar Terminal Cups** used throughout for ruggedness required in industrial service.
7. **Full Voltage** can be safely applied to the cold filament ... no step starting or high reactance transformers necessary.

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Both tubes not only provide *more* ruggedness, *longer* service life and *higher-quality* performance, but they actually cut costs for manufacturers ... saving as much as 80% on blower costs, while factory-attached grid and filament leads eliminate this expense.

Federal's new triodes feature simplified construction ... with fewer potential trouble spots. Wide element spacing gives better protection against filament-grid shorts. Rated filament voltage may be applied to cold filament, eliminating need for step starting or high reactance filament transformers. Both tubes are operable up to 30 Mc/SEC at full ratings ... anode up or anode down.

Equipment manufacturers now using the F-6366 and F-6367 in new designs report they are "extremely well pleased" with their stamina and performance. For prices and technical data, write to Federal, Dept. K-413.

Handbook of Tube Operation

Federal's 72-page booklet gives complete data on efficient operation of tubes in service. Mail your request to the department listed above.

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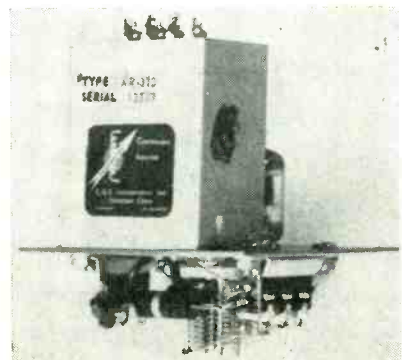
zero to 3 ma d-c through the 1N39 crystal at point *A* in Fig. 2 closely approximates this change in resistance and if a corresponding amount of a-c is applied it is possible to obtain ±200 kilocycles.

The output coupling consists of a conventional series tuner for use with 50-ohm coaxial cable. Variable matching may be used in the output coupling, but for simplicity a shorted quarter-wave section of coaxial cable will give an approximate match over a 10-percent tuning range at 400 mc.

The mechanical design and layout of this oscillator transmitter was done by Carl Hubartt of Capehart-Farnsworth Corp.



Inductor Control Gives AFC

SWEEP OSCILLATORS sometimes require automatic frequency control of center frequency. A high-Q, high-frequency saturable-reactor type device can be used for this purpose, particularly as applied to telemetering.

The circuit of a remotely controlled oscillator covering the range between 30 and 100 kc is shown in Fig. 1. Half a double triode serves as the oscillator. Part of the output is fed to a discriminator circuit comprising a 6AL5 operated as described below.

One diode is driven through an integrating circuit to provide response inversely proportional to frequency. The other diode is fed directly from the oscillator to give rectified output of opposite polarity across a potentiometer. The two rectified voltages are placed in series and the output taken from the tap of the potentiometer.

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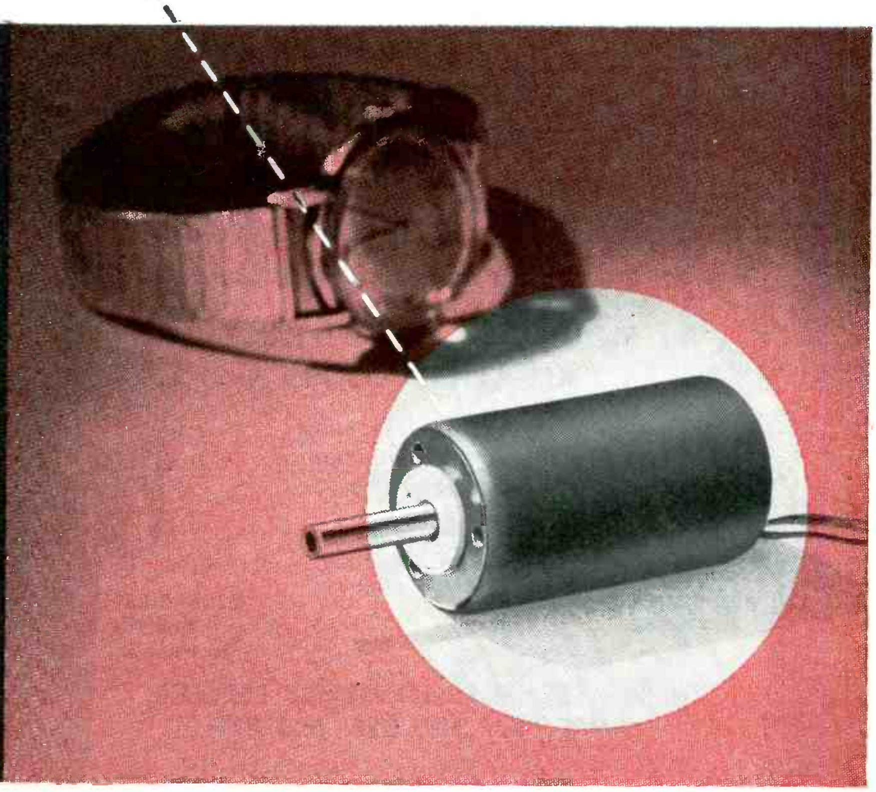
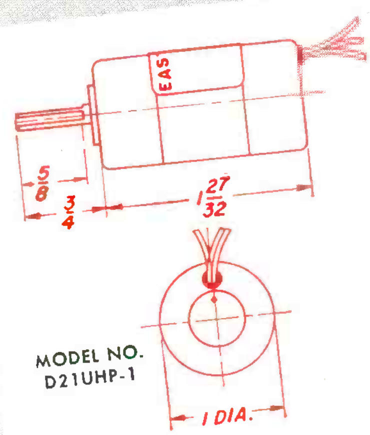


MODEL NO. D21UHP-1 (ACTUAL SIZE)



MODEL NO. D21UHP-1

SPECIFICATIONS

Capacitor run induction motor, 115 volts, 400 cycles, single phase, 11,000 R.P.M., .1 Amp., 1/300th H.P., .1 MFD.-220 V., 35% efficiency, weight—3½ oz.

APPLICATIONS

Fans, blowers, instruments, controls and low power drives.

Another outstanding EAD contribution to the miniaturization program is this extremely small, precision motor. Engineered for *long life and high efficiency*, it is especially designed for operation in confined areas where minimum size and weight is essential.

Units are available in this small frame size for 400 cycle or variable frequency operation, with 400 cycle power ratings ranging up to approximately 1/100 H.P. Modifications include high ambient and high altitude versions as well as servo, synchronous and gear motors.

400 CYCLE OPERATING CHARACTERISTICS

APPROXIMATE R.P.M.	7,000	10,500	21,000
PHASES	1,2	1,2,3	1,2,3
INPUT VOLTAGE (MAXIMUM)	115	115	115

EAD

EASTERN AIR DEVICES, INC.

15 WASHINGTON ST., DOVER, N. H.

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be obtained by adjustment of the potentiometer. The discriminator output is fed to a d-c amplifier comprising a pentode directly coupled to the other double-triode section.

The closed control loop forces the oscillator to generate a frequency close to that for which the discriminator output is zero. Oscillator frequency therefore depends primarily upon the potentiometer setting alone. Temperature drift, hysteresis effects and nonlinear control current are all reduced.

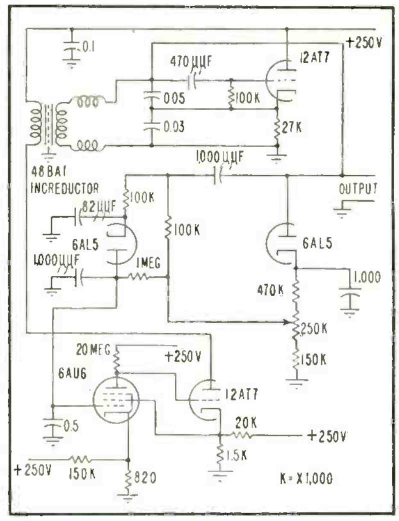

FIG. 1—Low-frequency closed-loop telemetering control uses inductor

By incorporating a limiter before the discriminator, the oscillator frequency can be controlled by an input voltage. Such an arrangement gives oscillator stabilities better than 1 percent and can be used effectively for telemetering.

Information on this frequency control has been abstracted from a report on applications of high-frequency saturable reactors by Carl G. Sontheimer of CGS Laboratories, Inc., Stamford, Conn.

PERTINENT PATENTS

THE STATEMENT, "there isn't anything you can't do with electronics" is nowhere better indicated than in the Electronic Egg Grader, which was granted U. S. Patent 2,636,925 for the invention of T. Gascoigne of Cloverdale, British Columbia, Canada.

The inventor applies a comparatively weak r-f field through an egg in a special pair of egg cups. Detecting the energy passing

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through the egg and rectifying the detected energy, the inventor claims he is able to determine the quality or hatchability of the egg.

The circuit of the invention is shown in Fig. 1. It consists of an

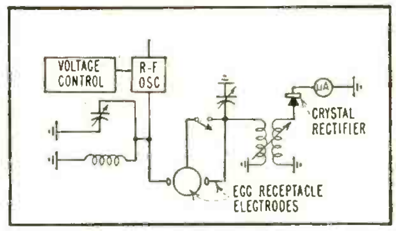


FIG. 1—Radio-frequency oscillator and detector system used for grading eggs

r-f oscillator operated from a regulated power supply, a resonant output circuit and a detector system delivering an output in microamperes or microvolts. The test assembly is shown in Fig. 2.

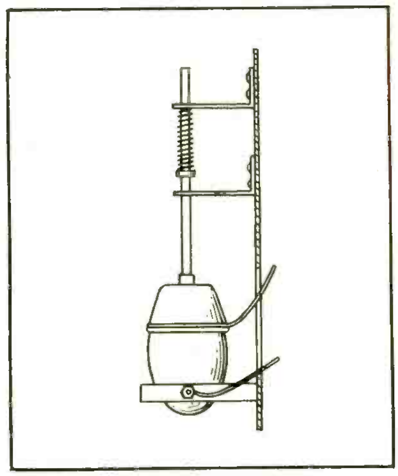


FIG. 2—Arrangement of electrodes in electronic egg grader

The condition of the egg would appear to be some function of the rectified r-f energy.

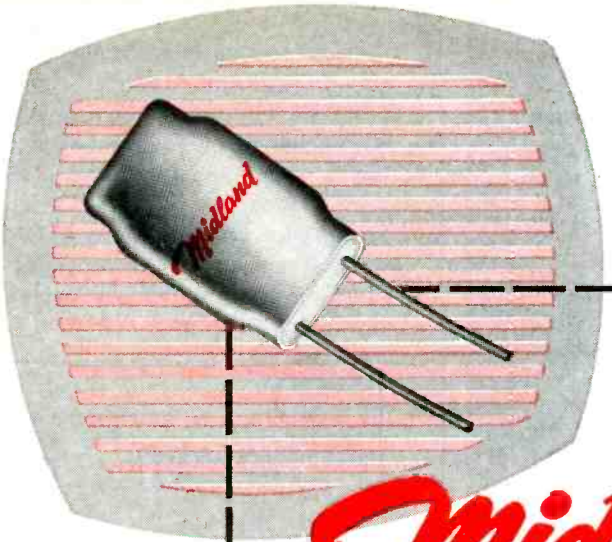
Current Integrator

Patent 2,638,491 has been issued to George K. Turner of Consolidated Engineering Corp., Pasadena, Calif. for a Microcoulometer. The patent is assigned to the company.

A microcoulometer is a meter arranged to measure the quantity of electricity passing through a conductor. The coulometer integrates the current for some period of time.

This device is particularly adaptable to the integration of very small currents.

It employs a vacuum-tube circuit for charging a capacitor in pro-



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portion to the magnitude of the current to be measured.

As shown in Fig. 3, a gaseous-discharge tube is connected across the capacitor and to an amplifier so the capacitor is discharged through the amplifier network when the voltage across the capacitor is equal to the breakdown potential of the gas tube.

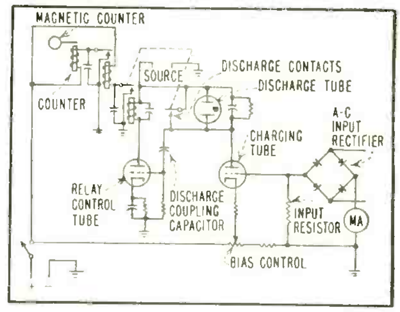

FIG. 3—Integrator circuit for small currents records counts

Because all gas tubes have a residual operating potential the capacitor would normally retain a charge equal to the operating voltage of the gas tube. In this invention each time the capacitor discharges, a pulse is applied to an amplifier tube that results in operation of a relay in its plate circuit.

The relay contacts completely discharge the capacitor. A resistor across the charging capacitor linearizes the charge that may start from substantially a zero value. A bias control in the charging-tube circuit sets the circuit either for some minimum operating value or variations in supply voltage.

For each operation of the relay circuit a counter is actuated.

If the input to the coulometer is a-c, a bridge rectifier is provided as shown in the figure. For a d-c input, the potential or current is applied across the input resistor directly.

Parallel Tube Control

In patent 2,646,472 recently issued to R. J. Rockwell of the Crosley Broadcasting Corporation, Cincinnati, Ohio, there is described an Amplifier Control System. The patent is assigned to the company.

As is known among broadcast engineers production of high power amplifier tubes doesn't keep up with the needs of the broadcasting industry and broadcasters are required as a result to parallel some

How To Gauge a Vacuum

From 1 to 1 x 10^{-3} mm Hg

NRC'S Model 516 Pirani Vacuum Gauge

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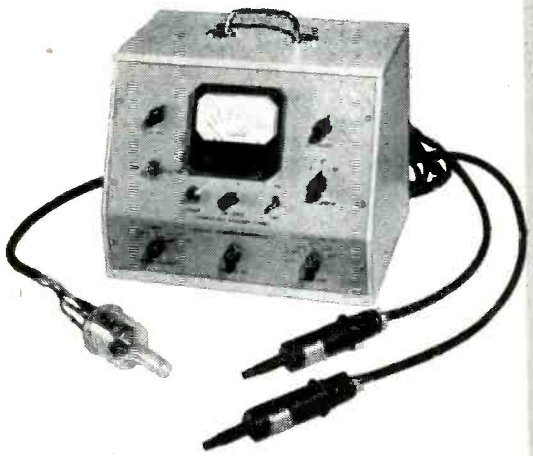

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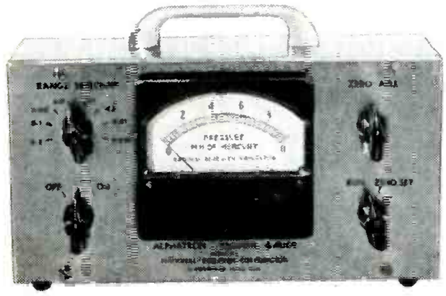

From 1000 to 1 x 10^{-4} mm Hg

NRC'S Model 511 Alphatron Gauge

This gauge is latest refinement of well-known radium source ionization principle. As there is no filament to burn out, the gauge cannot be damaged by exposure to air or gas at atmospheric pressure. Speed of response is essentially instantaneous. Readings are linear, accurate to ± 2% full scale. Maintains original factory calibration indefinitely.

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number of lower power types in order to operate transmitters at higher power.

Equalization of the load among the several tubes in parallel is a problem that these broadcast engineers have faced many times with great difficulty in finding a solution.

The solution defined in this patent is shown schematically in Fig. 4. The signal applied to a push-pull parallel power-output stage is divided among the parallel tubes of each side through parallel potentiometers so that the signal on each grid may be adjusted independently of the others.

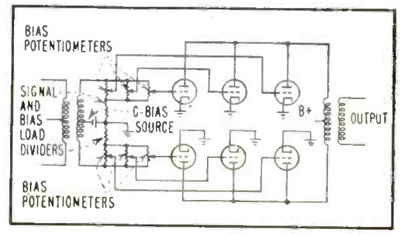


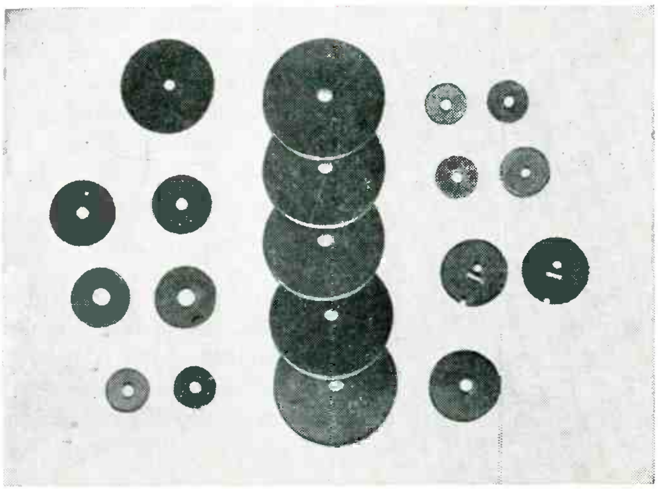
FIG. 4—Power tubes in push-pull parallel with bias adjustment

The adjustment is made to provide both a bias and signal adjustment simultaneously. In practice, the potentiometers are first adjusted to equalize the idle current of each tube in the absence of a signal. When this adjustment has been made there is always an equal division of plate-current flow among the tubes when signal is applied. There is a linear relationship between the signal amplitude and the bias voltage required to maintain similar plate-current excursions in the various parallel connected tubes.

Although the principle of load division by controlling the signal swing of parallel tubes has been known before, the inventor in this case has found that there is a particular relationship in this principle and he has taken advantage of it to reduce the necessary cut-and-try used in prior techniques.

If one of the tubes in the parallel group may be considered as the norm and the bias applied to its grid circuit as the standard, the percentage change in bias-voltage value applied to another tube with higher μ in the parallel grouping to make the other tube operate at the same idle current can be de-

Do you have any of these problems?



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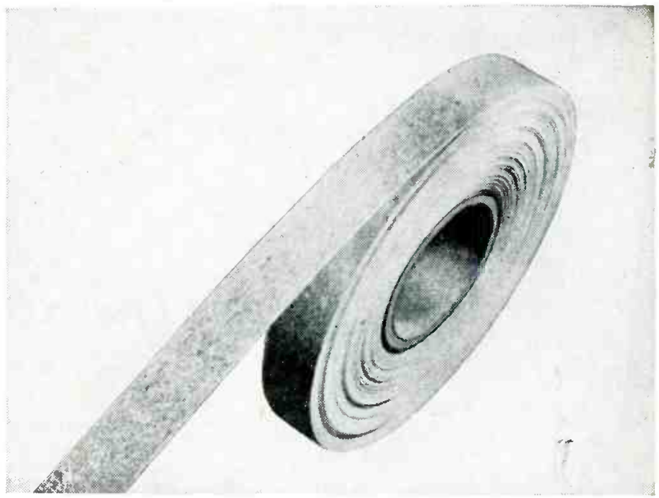

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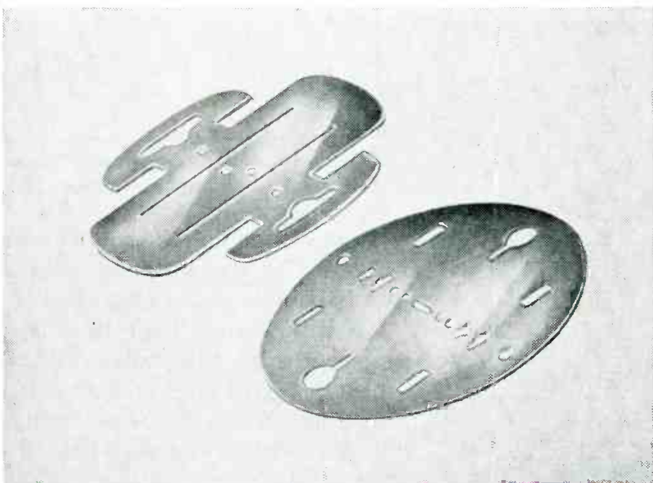

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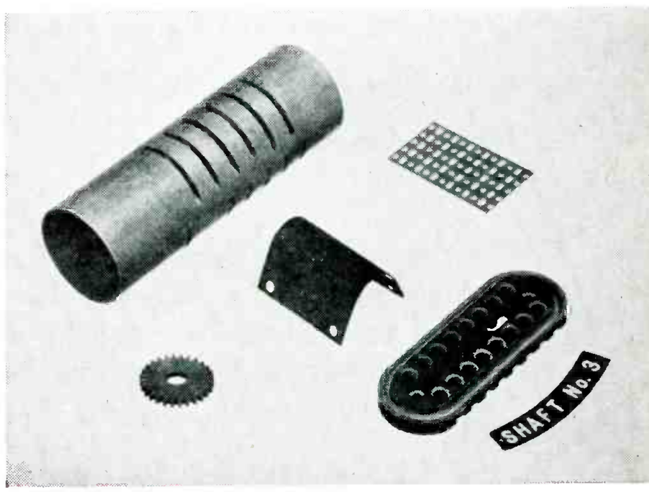

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termined. It is equal to the percentage by which the amplitude of the input signal to the higher μ tube must be changed with reference to the signal applied to the norm tube to make the plate-current swing of the second tube the same as that of the first. This is a linear relationship.

Bridge Amplifier

R. W. Bordewieck of Southboro, Mass, is the inventor of a novel bridge amplifier circuit described in patent 2,637,786. The patent is assigned to Moore Electronic Laboratories, Inc., of Worcester, Mass.

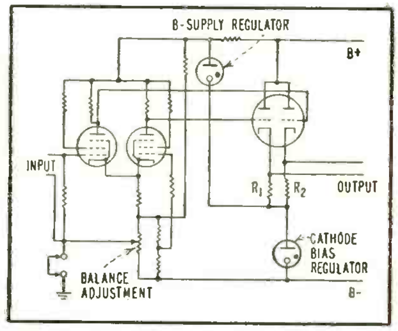


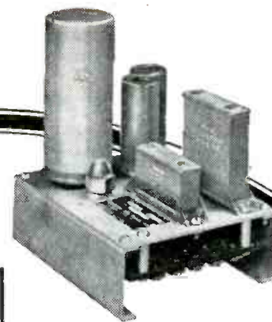
FIG. 5—Regulator tube is used in cathode-follower for bridge amplifier

The bridge amplifier is shown in Fig. 5. Its operation is described by the inventor as follows.

With no signal impressed on the input circuit the balance adjustment is varied until perfect balance is obtained in the plate voltages of the pentode input tubes. It is possible if desirable to so make this adjustment that there may be a plate voltage differential of some predetermined amount in either polarity.

By the addition of a cathode-bias regulator tube to the output cathode followers of the bridge circuit an extremely low-output impedance is effected without losing any of the advantages of the bridge amplifier.

Since the output cathode followers have such low impedance the driving tubes may use higher plate-load impedances whereas it is not possible to accomplish the same result if the driver tubes were required to drive the load directly. The inventor claims that his major element of novelty resides in the use of the cathode follower with voltage-regulated cathode circuits.



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

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

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Frequencies, 200 to 3000 cycles. Dividers and multipliers available for lower and higher frequencies. Output, 6 V.—JAN construction.

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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.

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Production Techniques

Edited by JOHN MARKUS

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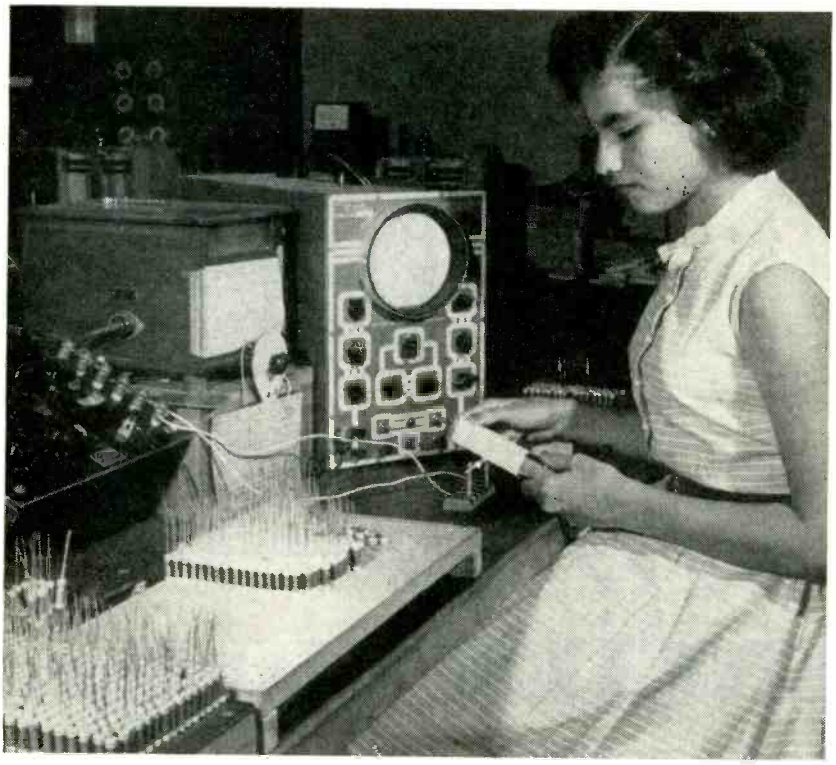
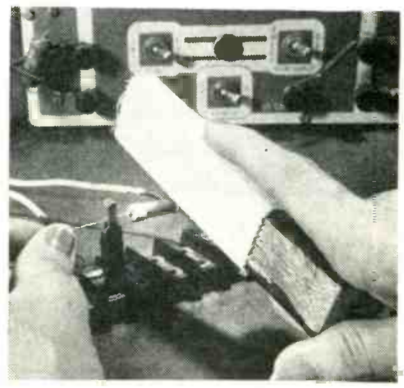
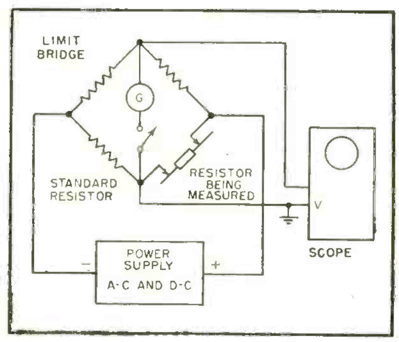






Canvas-Covered Rubbing Block Brings Carbon Resistors to Value

DEPOSITED carbon resistors are brought to within 1 percent of specified value by rubbing with a canvas-covered wood block while measuring the resistance with a setup employing an Eico push-pull oscilloscope and a Rubicon galvanometer as indicators in connection with a Shallcross model 617 percent limit bridge. Heavy spring clips mounted on a wood block maintain good contact while permitting rotation.

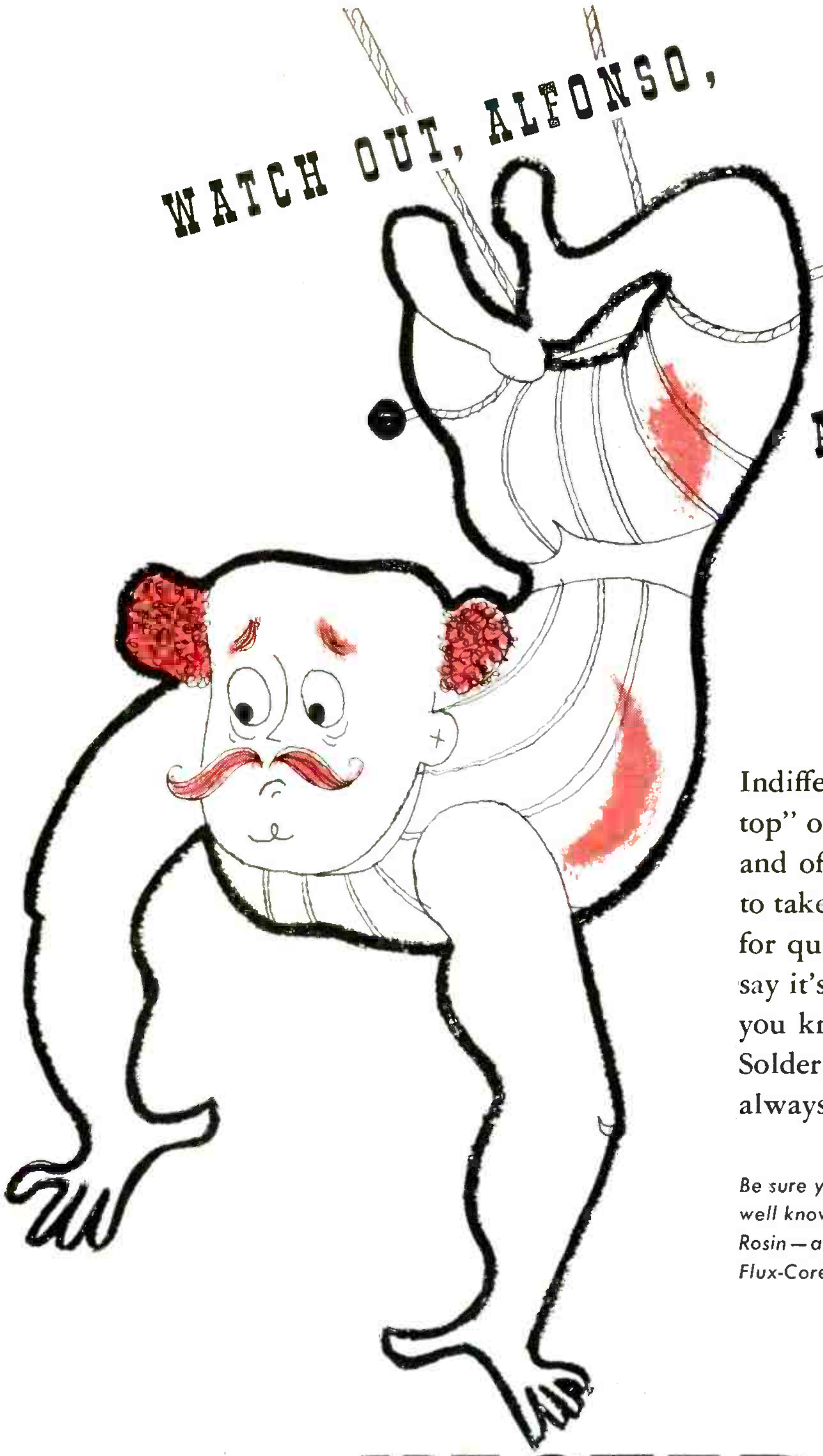
The operator drops the resistor between the test clips and rubs the carbon coating with the canvas while watching the oscilloscope pattern, to bring the resistor up in resistance to approximately the required value. She then switches over to the galvanometer and continues rubbing slowly until the galvanometer is zeroed. This indicates that the resistor is within 1 percent tolerance. A deflection of 1 cm on the galvanometer scale corresponds to a deviation of ¼ percent in value.

The horizontal input terminals of the scope are fed with a 60-cycle signal obtained from a Variac located in the power supply for the setup. This Variac is so connected that it varies the d-c voltage for the limit bridge along with the a-c voltage. The scope indicates a-c balance when the trace approximates an ellipse marked with red crayon on the screen.

After d-c balance is obtained by using the galvanometer as indicated, the operator switches back to the scope for a final check on a-c balance before passing the resistor.

After testing, the resistors are placed in self-counting tote trays made by drilling holes for the axial leads in a panel of quarter-inch

WATCH OUT, ALFONSO, ONE TUMBLE'S ALL IT TAKES...



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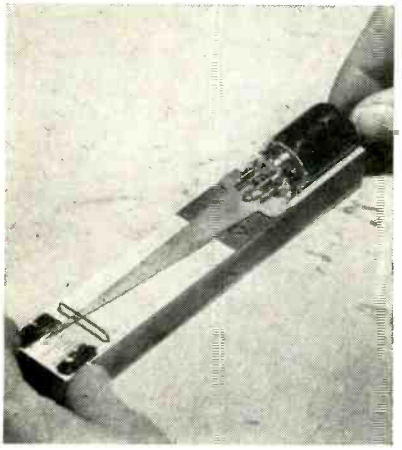
Pressdwood or one-inch white pine mounted on corner blocks. The blocks allow leads to project down without touching the bench.

The 120-cycle ripple of the a-c power supply proved essential for this setup; battery power for the limit bridge failed to give satisfactory repeatable measurements. This adjustment and test procedure is used in the plant of Radell Corp., San Juan, Puerto Rico.

Square-Bottom Test Gage for Glass Bases of Subminiature Tubes

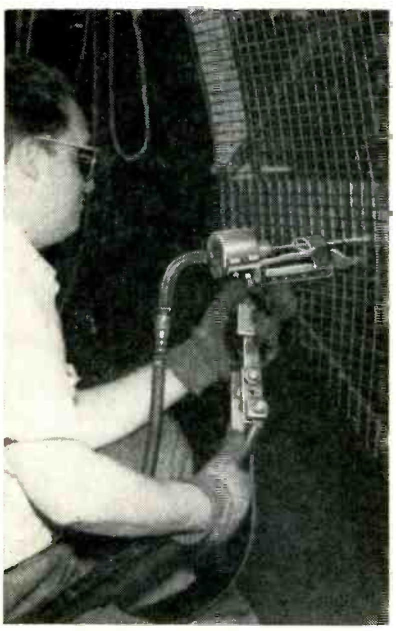


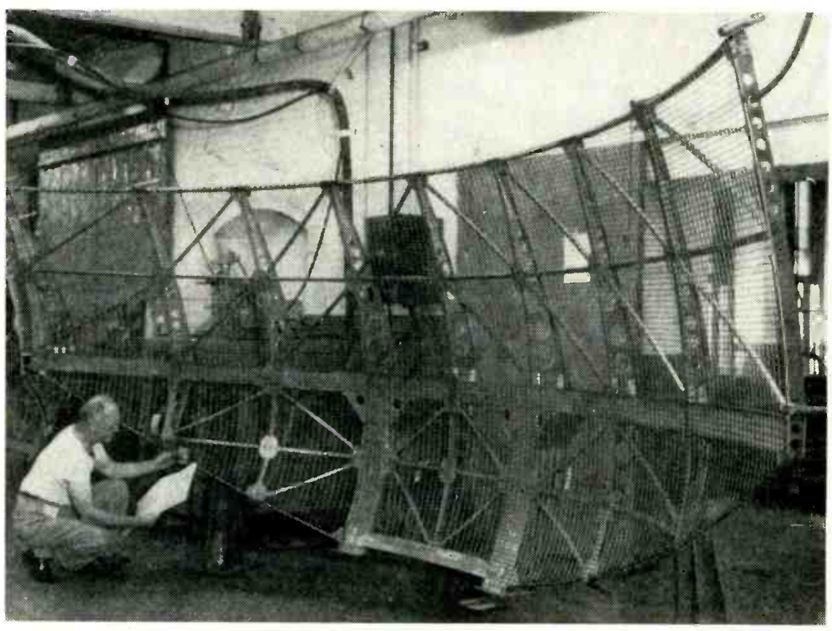
Square-bottom tester for subminiature tubes. Each tube must be turned several times in its V-shaped cradle to determine the greatest deviation from squareness. The tube is pulled back each time before rotating, to clear the pins

A V-BLOCK and a small pivoted indicator constitute a simple and efficient means of measuring the amount in degrees by which the bottom of a subminiature tube is off square from the plane of the tube. The tube is placed in the machined V of the metal block and pushed forward until the base of the pointer goes between the tube pins and rests in close contact with the bottom surface of the tube. If this surface is square, the pointer end of the indicator will read zero.

Normal tolerance is three degrees on each side of zero. The scale area beyond 3 on each side is darkened, so that the operator can easily tell when the pointer is in the bad area. This gage was developed by W. P. Koechel for use in the quality-control department of Tung-Sol's Bloomfield, N. J. plant.

Fabricating Tubular Frames for Large Shipboard Radar Screens





RADAR scanning screens for naval vessels are mounted high in the ship's superstructure. This imposes severe requirements for light weight, yet demands great strength to resist the winds, vibrations and pitching and tossing movements that occur in this high and exposed position. Also, though large, these screens must be accurately shaped and must retain this shape to preserve the operating characteristics of the radar.

To achieve all this, engineers of ITE Circuit Breaker Co. departed from the usual design approach of forming the screen's supporting frame entirely of girder sections. Instead, they formed the frame of vertical ribs, but connected these by tubular spanning members across the top and bottom.

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An assembly with 14 concentric, hard silver rings electro deposited into machined plastic blank. Dovetail locks rings in place. Machined blank insures accuracy. Diameter approx. 11", thickness approx. 5/16".

Cylindrical assembly with 25 rings. Three wide rings accommodate large contact area brushes for high current capacity. Length 14", O.D approx. 5¼".

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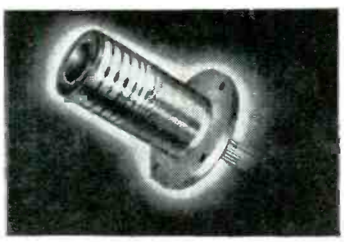

An assembly with 30 rings of various widths to accommodate various current requirements. Unit is approx. 4-5/16" long, designed for flange mounting.

Cylinder type assembly approx. 3¾" long with 24 hard silver rings. 1⅝" O.D. with wall thickness less than ¼".

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ELECTRO TEC LARGE SLIP RING Assemblies are widely used in Radar Equipment, Fire Control Systems, Test Tables and many other critical applications. Light weight combined with rugged durability recommends their use in airborne applications.

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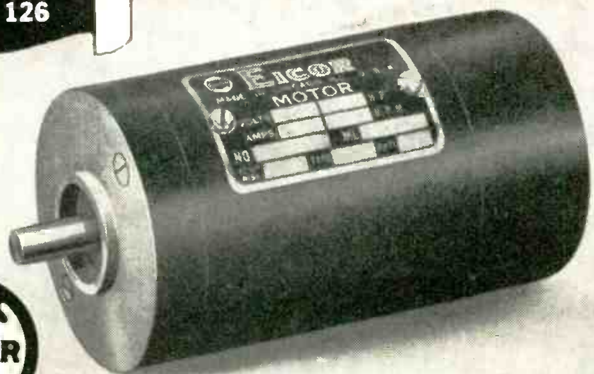

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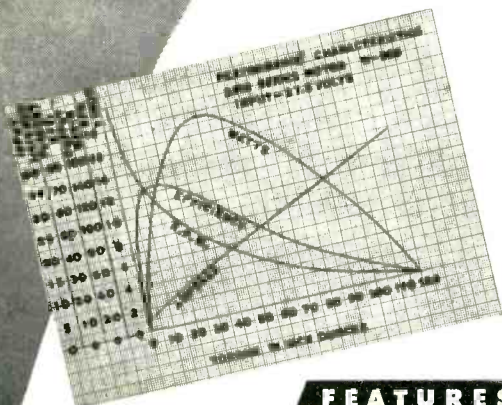
2300 FRAME MOTOR
1/5 HP at 3800 RPM



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- Segment-built commutator
- Permanent end play adjustment

2300 FRAME MOTORS		2318 Series	2310 Shunt
Watts Output, Int.	(max.)	160	50
Torque at 6000 RPM	(in. oz.)	40	10
Torque at 3800 RPM	(in. oz.)	57	—
Lock Torque	(in. oz.)	120	14
Volts Input	(min.)	5	5
Volts Input	(max.)	110	28
Temperature Rise	(int.)	50°C	50°C
Diameter		2 5/16″	2 5/16″
Length less shaft		4 5/32″	2 3/4″
Shaft Dia.	(max.)	.312″	.312″
Weight	(lbs.)	2.4	1.5

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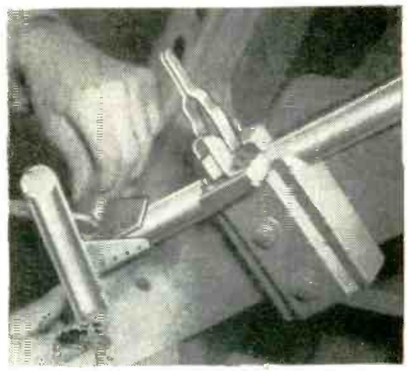
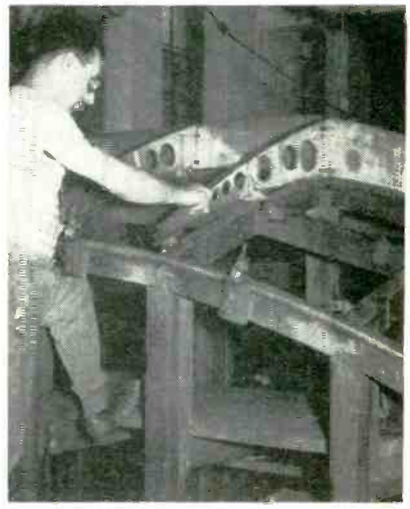
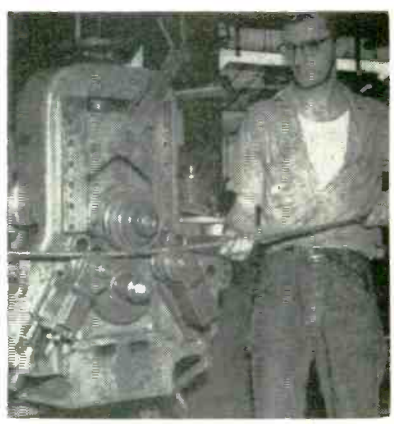


One end of tubing, showing how it is plug-welded to the corner braces



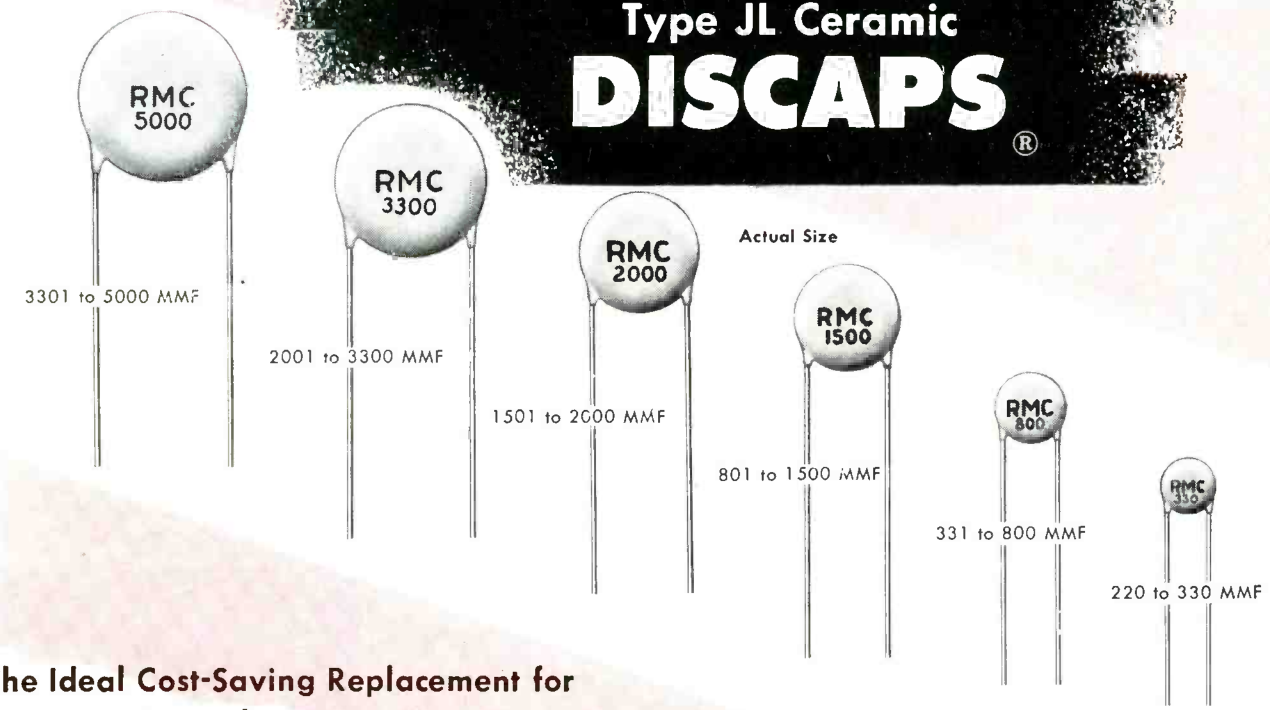
Setup for bending tubing to precise shape by hand without using mandrels inside tubing and without distorting the tubing cross-section. Three men are used for the shaping operation. Small lever-action clamps hold the tubing against the curved template. The operator is here positioning the structural back frame of the screen for subsequent welding to the tubing



Use of three special shaping rolls to give required parabolic shape to shorter lengths of half-inch tubing. Several passes are used, with the degree of arc increased for each pass. No mandrel is needed to prevent deformation

Another RMC *First*

Type JL Ceramic DISCAPS®



The Ideal Cost-Saving Replacement for Paper or General Purpose Mica Capacitors

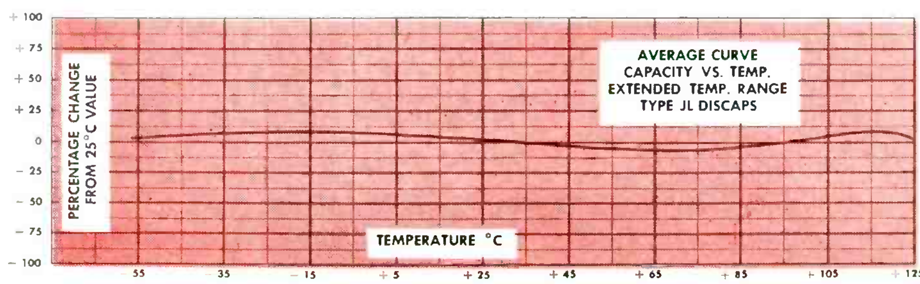
Type JL DISCAPS, the result of extensive research in the RMC Technical Ceramic Laboratories, afford exceptional stability throughout an extended temperature range. The maximum capacity change between −60° C and +125° C is only ±7.5% of capacity at 25° C. Type JL DISCAPS are available in tolerances of ±10% or ±20%. Standard working voltage is 1000 V.D.C.

Manufactured in a wide range of capacities, Type JL DISCAPS offer the advantages of longer life, dependability, and lower initial cost. Their smaller size and greater mechanical strength provide additional economies in assembly line operations.

It will pay you to investigate the advantages of using Type JL DISCAPS as replacements for paper or general purpose mica capacitors. Your inquiry is invited.

SPECIFICATIONS

POWER FACTOR: 1% max. @ 1 K C (initial)
POWER FACTOR: 2.5% max. @ 1 K C, after humidity
WORKING VOLTAGE: 1000 V.D.C.
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
AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms
CAPACITY TOLERANCE: ± 10% ± 20% at 25° C



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DISCAP CERAMIC CONDENSERS

RMC

RADIO MATERIALS CORPORATION
GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.
FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.
DISTRIBUTORS: Contact Jobbers Sales Co., 146 Broadway, Paterson 1, N. J.

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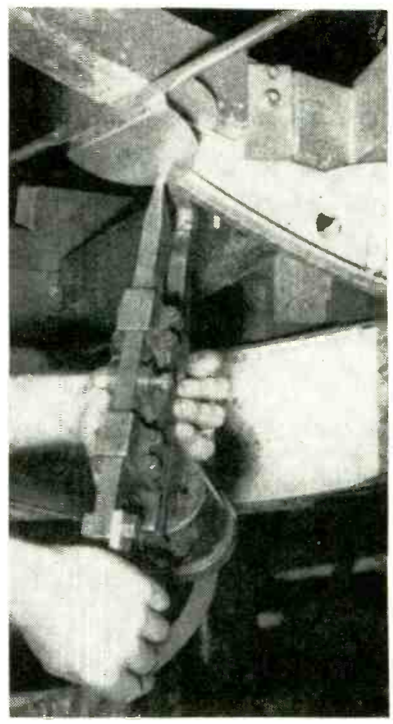
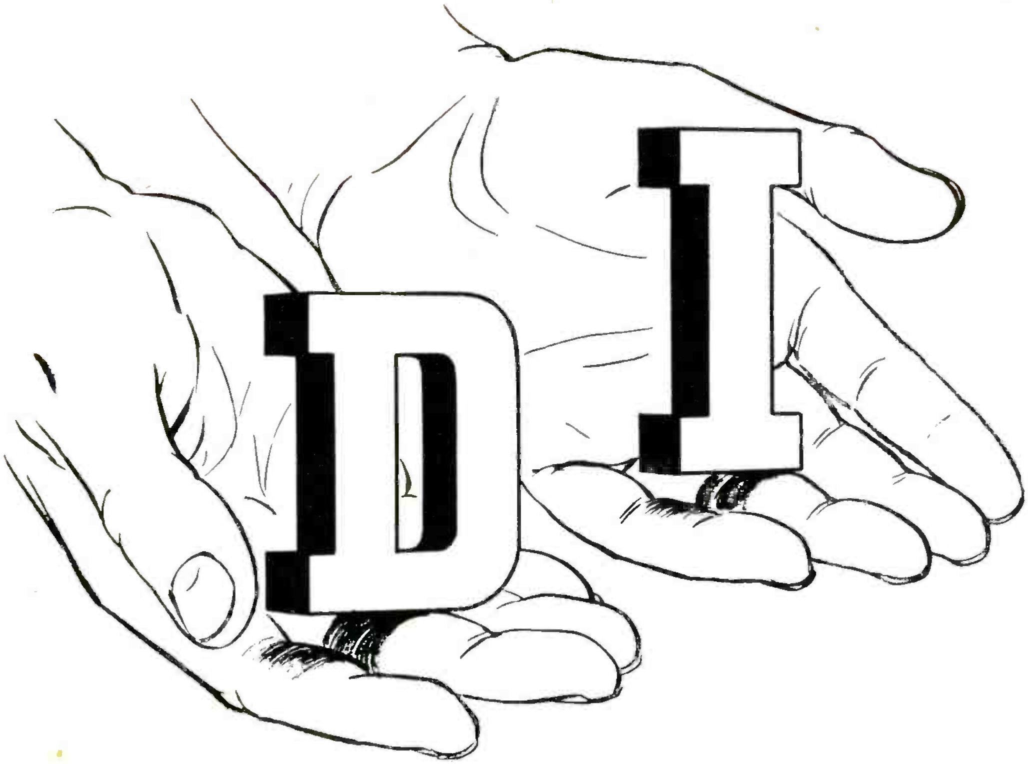
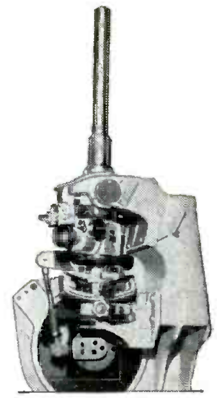
After the tubing has been shaped to the right curvature, a hydraulic press flattens it for easy joining to radar-screen rib ends. Rapid and uniform pressure of the press insures a perfectly flat joining surface without affecting the tube's parabolic shape, without distorting the sections along spans where rigidity is specified and without unduly stressing the metal at flattened areas

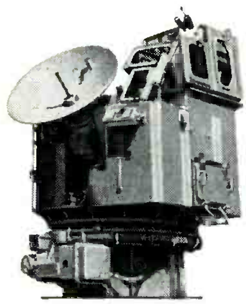


Using electric hand welding machine for welding preshaped tubing to stainless steel joint flanges which in turn are shot-welded to the vertical ribs of the radar screen. Welder is supported from ceiling on track carriage. Assembly is done on shaped wood forms having positioned brackets

bottom spanning members of the parabolic frame. This tubing in the 1.0-inch O.D. size was used for the top spanning member and the 0.50-inch size for the lower edge of the radar-screen frame. A simple







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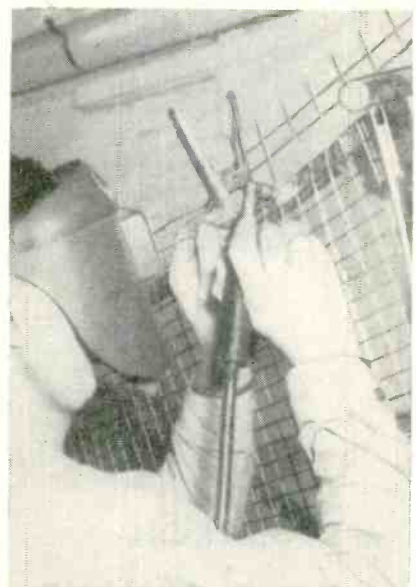
Final joining of half-inch tube members to the radar screen frame is accomplished by shot-welding the tacked joints. Lower assembly of the screen skeleton has been removed from wood shaping form and is now ready to be joined to upper assembly



Top and bottom edges are welded on face of screen. Excess screening is clipped one inch beyond tubing, rolled over and tacked along reverse side

fabricating procedure was developed by taking advantage of the bending and welding properties of this tubing. The net result of this new structural design and new fabricating technique is a radar screen of the required lightness, strength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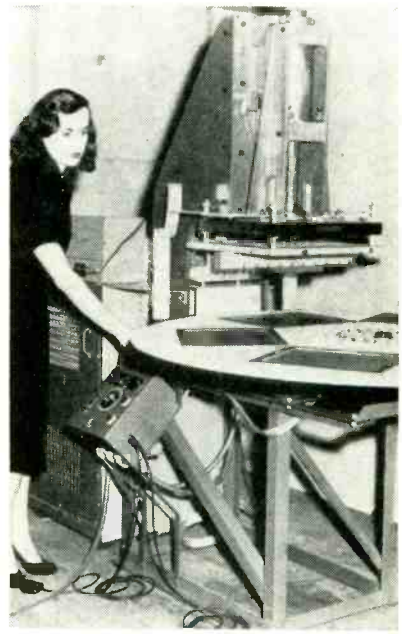
and shape, but produced faster, at lower cost, with less use of skilled labor and with less consumption of strategic materials than were formerly needed.

A step-by-step explanation of the fabricating procedure is given in the accompanying illustrations.



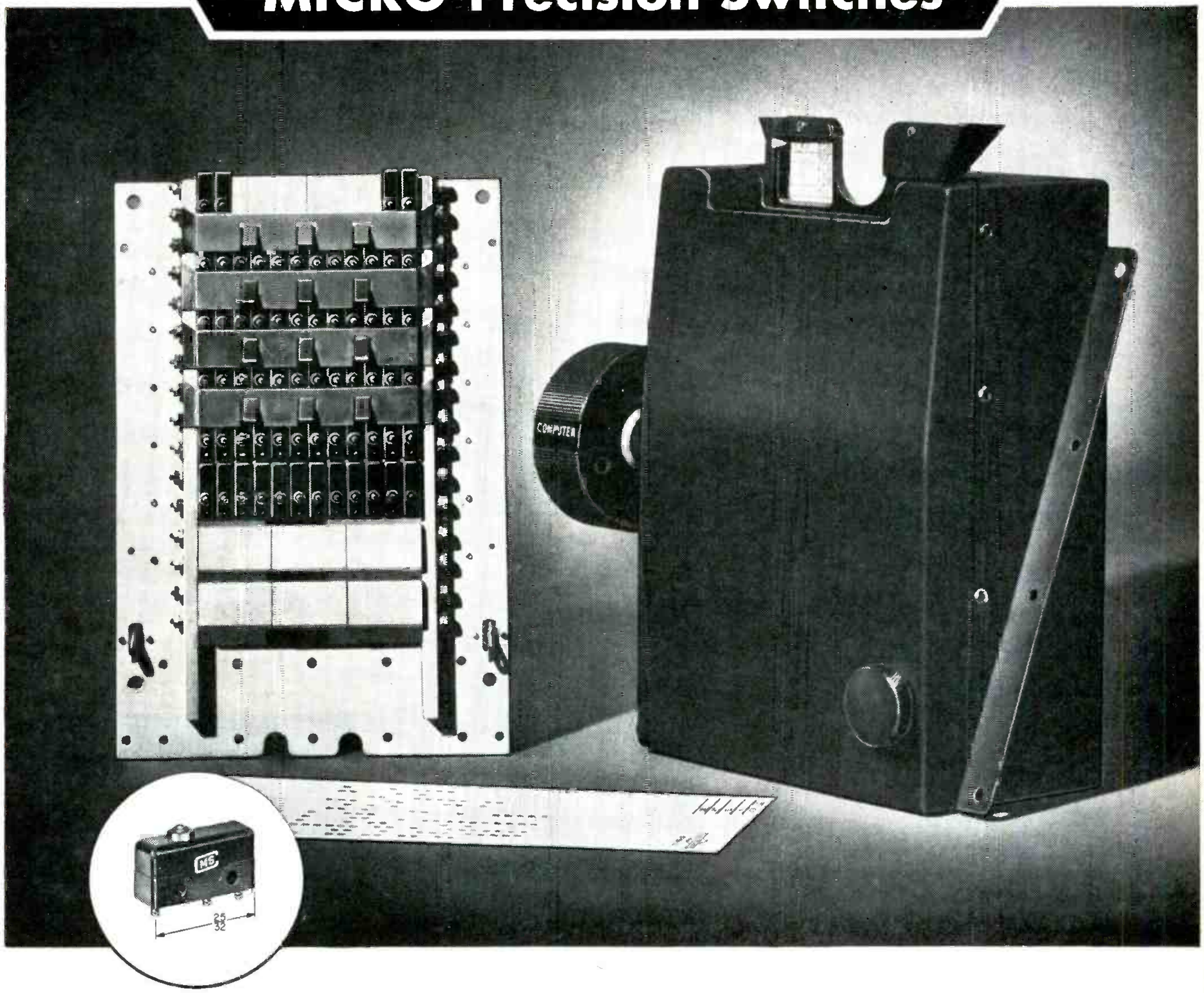
Automatic Turntable Speeds Plastic Sealing

A SELF-INDEXING turntable with a choice of 4, 6, 8, 12 and 24 stops per revolution makes possible automatic operation of any electronic heat-sealing generator and press for vinyl plastic components of electronic equipment.

Loading trays, or stations, are spaced around the outer edge. The items to be sealed are loaded into the trays by one or more operators. At the start of the cycle, the table rotates until the first tray is automatically indexed under the sealing electrode. The table stops, the press closes and remains closed until the seal is completed. This dwell is controlled by an electric timer. The press then opens and the turntable moves to the next position. This cycle is automatically repeated for each station, and speed can be set to the fastest operator's pace.

Safety factor is increased since

MICRO Precision Switches



Why 64 MICRO Subminiature Switches are used in Collins Radio airborne navigation system

• Engineers of Collins Radio Company chose MICRO subminiature switches for this sensational new navigation development because they combined small size with the utmost precision and reliability required in such delicately adjusted equipment.

These small, precision subminiature switches are mounted on the inside panel of the card reader of Collins Navigation System (Type NC 101).

The switches are actuated by the business machine-like punched holes in the navigation card, transferring information from the punched cards to the computer. This tunes the VHF receivers and gives the pilot a continuous fix measured in miles along his course line which tells him how far he is from and how to get to his destination.

Electronic engineers in every field of industry are finding MICRO switches peculiarly suitable for use in devices where small size must go hand in hand with precise action and reliable performance. MICRO field engineers are located in 16 branch offices. Consultation with them on difficult switch problems involves no obligation, can save you time and money.

There is a MICRO switch to meet every switch requirement. They are available in a wide variety of sizes, shapes, weights, housings, mountings, actuators and electrical characteristics.

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

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there is much less handling of the unit to be sealed. The automatic operation of the turntable and the easy feeding facilities leave the operator free to work faster and achieve a higher output.

The controls, mounted in a single box, consist of a cooling timer, indicator lights and a selector for manual, semiautomatic or fully automatic operation. Remote starting and stopping controls are also provided. The equipment is made by Thermatron Division, Radio Receptor Co., Inc., 251 West 19th St., New York, N. Y.

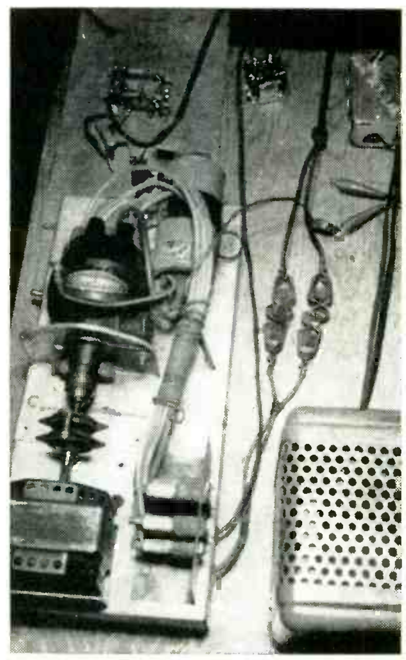
The unit is completely safety-interlocked. Power cannot go on until the press is down. The press cannot close unless a tray is properly indexed under the sealing electrode, nor can the turntable index unless the press is up.

Inspecting Tube Micas with Optical Comparator

To EXPEDITE and improve sampling inspection of tiny punched mica spacers for vacuum tubes, a transparent plastic overlay is used in connection with a Bausch and Lomb optical comparator in the quality-control department of Tung-Sol's

Bloomfield, N. J. radio tube plant.

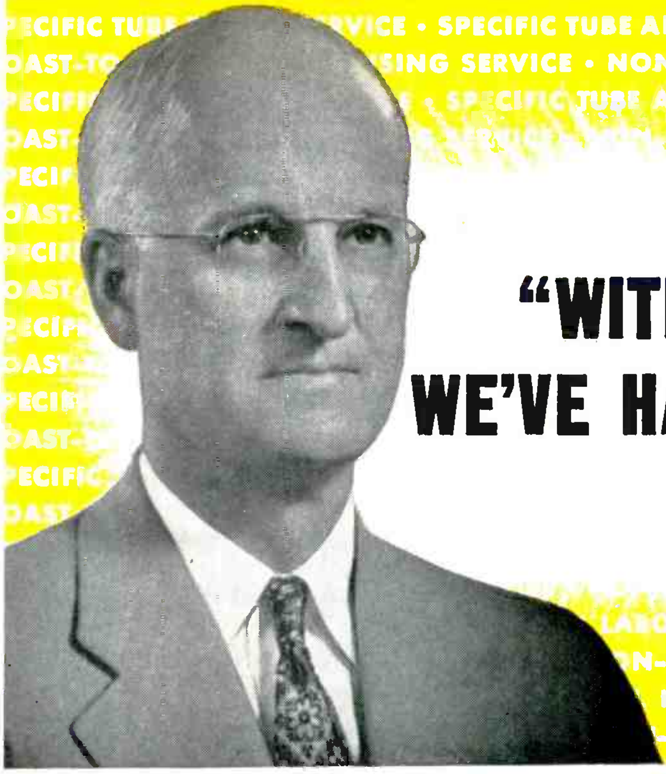
On the plastic overlay the correct outlines for the spacer are scratched with a steel stylus at 40 times normal size. Spring-steel strips hold the overlay over the viewing screen of the comparator. The operator places a mica spacer in the machine and adjusts its position until the projected outline coincides with that on the overlay. She can then readily check positions and sizes of critical holes visually to see if they are within tolerance.



Noise-Generating Cart

To PROVIDE a quick check of the ability of television and radio receivers to withstand different types of electrical interference, various types of noise generators are mounted on a rolling cart for use in the CBS-Columbia plant in Brooklyn, N. Y.

One unit simulates the ignition system of an automobile. Here an electric phonograph motor drives the distributor of a six-cylinder engine, the spark plugs for which are mounted on a metal bracket alongside. The ignition coil is bolted to the mounting board also. When the motor is plugged into an a-c line, the resulting spark display at the gaps in the plugs creates far more interference than would be



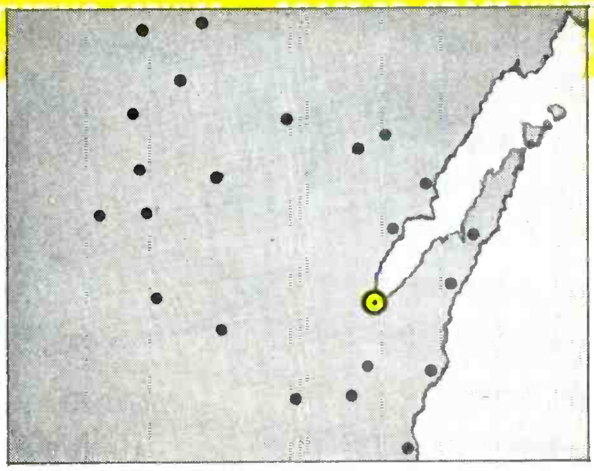
"WITH G-E 5-STAR TUBES WE'VE HAD ONLY 1.5% FAILURES!"

Says **L. P. WORKS, Distribution Engineer, Wisconsin Public Service Corp., Green Bay, Wis.**

"SOME of these tubes have served 7,500 hours—have been on the job 24 hours a day, 7 days a week, in the two-way radio stations we use to contact our trouble-shooting trucks. Many of the stations are remote-control, which puts a heavy load of responsibility on the tube complement. G-E 5-Star Tubes are everything we could ask for in reliability."

If *you* wish to build and sell communications equipment that will "take it"—will stand the gaff of hard, continuous service—specify 5-Star high-reliability tubes! Their amazingly low failure rate, shock-resistant characteristics, long service life, add up to minimum maintenance time and cost for your customers.

Practically all your receiving-tube needs can be met with G-E 5-Star types. Ask for complete facts. *Tube Department, General Electric Co., Schenectady 5, N. Y.*



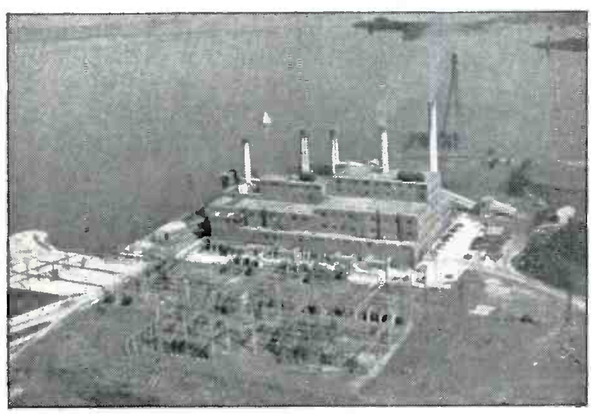
● General Electric 5-Star Tubes serve Wisconsin Public Service Corporation in 23 key locations! Fast, sure contact with trouble-shooting crews is maintained by radio transmitting-receiving stations in Green Bay and 22 other cities and towns. These in turn control 175 mobile service units.

G-E tube service helps you with new low 5-Star prices!

. . . **MANY CUT 50% AND MORE!** Large-scale production has brought about savings reflected in new *economy* prices for G-E 5-Star Tubes, many of them down more than half from the original figures.

G-E SERVICE INCLUDES DESIGN AND APPLICATION AID that concentrates on *your* tube problem and solves it, drawing on the extensive technical facilities of General Electric.

G-E SERVICE FEATURES FAST TUBE DELIVERIES from coast-to-coast warehouse stocks . . . alert handling of orders . . . local-laboratory help in checking your tube and circuit performance.



● Power demand from clients in northern Wisconsin taxes the output of several large generating plants like this 192,500-kw "J. P. Pulliam" station. The power is kept moving to all points by a wide-spread service organization on duty around the clock, and always in radio touch with headquarters.

GENERAL ELECTRIC

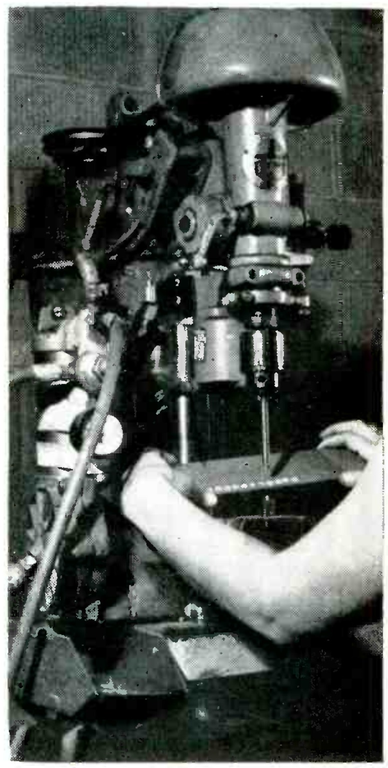
163-1A3

produced by an automobile.

A buzzer with worn and badly adjusted contact points provides another type of electrical noise. This buzzer is mounted in a BX box, with a switch on the top plate.

A relay is hooked up to an R-C circuit in such a way that it opens and closes continuously and automatically. Arcing at the contacts then produces pulses of interfering radiation.

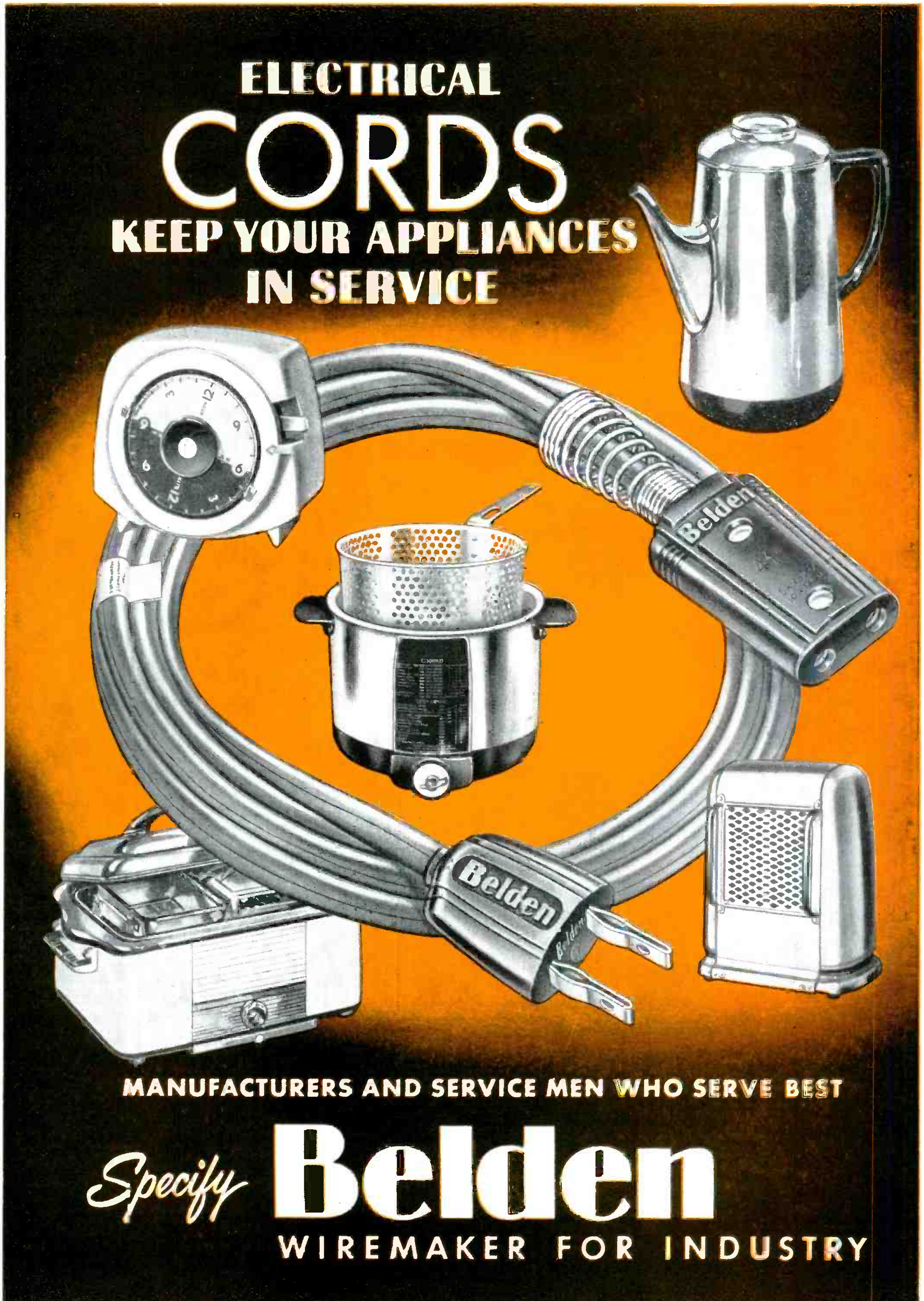
This noise-generating equipment could alternatively be operated from a storage battery located on the lower shelf of the cart to make it independent of power lines.



Air Cylinders Speed Terminal Spinning

WRAP-AROUND TERMINALS are quickly spun into position on long insulating terminal boards with the aid of two air cylinders mounted on a standard Walker-Turner drill press. This arrangement leaves both hands of the operator free for loading terminals and holding the work, in the military radar subassembly section of Caribe Aircraft Radio Corp. in Coamo, Puerto Rico.

On the bed of the press is mounted an air vise made by W. R.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WIREMAKER FOR INDUSTRY

Brown Corp. of Chicago, in which the operator inserts a terminal upside-down. The panel is now set over this terminal.

A single foot-operated air valve is used to initiate the action of both cylinders. This valve directly controls the Mead Specialties Co. air cylinder which brings down the drill chuck and spinning tool. This cylinder also serves to open an air switch that actuates the air vise so as to grip the terminal tightly just before the spinning operation starts. On the return movement of this air cylinder after spinning, the air vise is automatically released for moving out the work and inserting the next terminal.

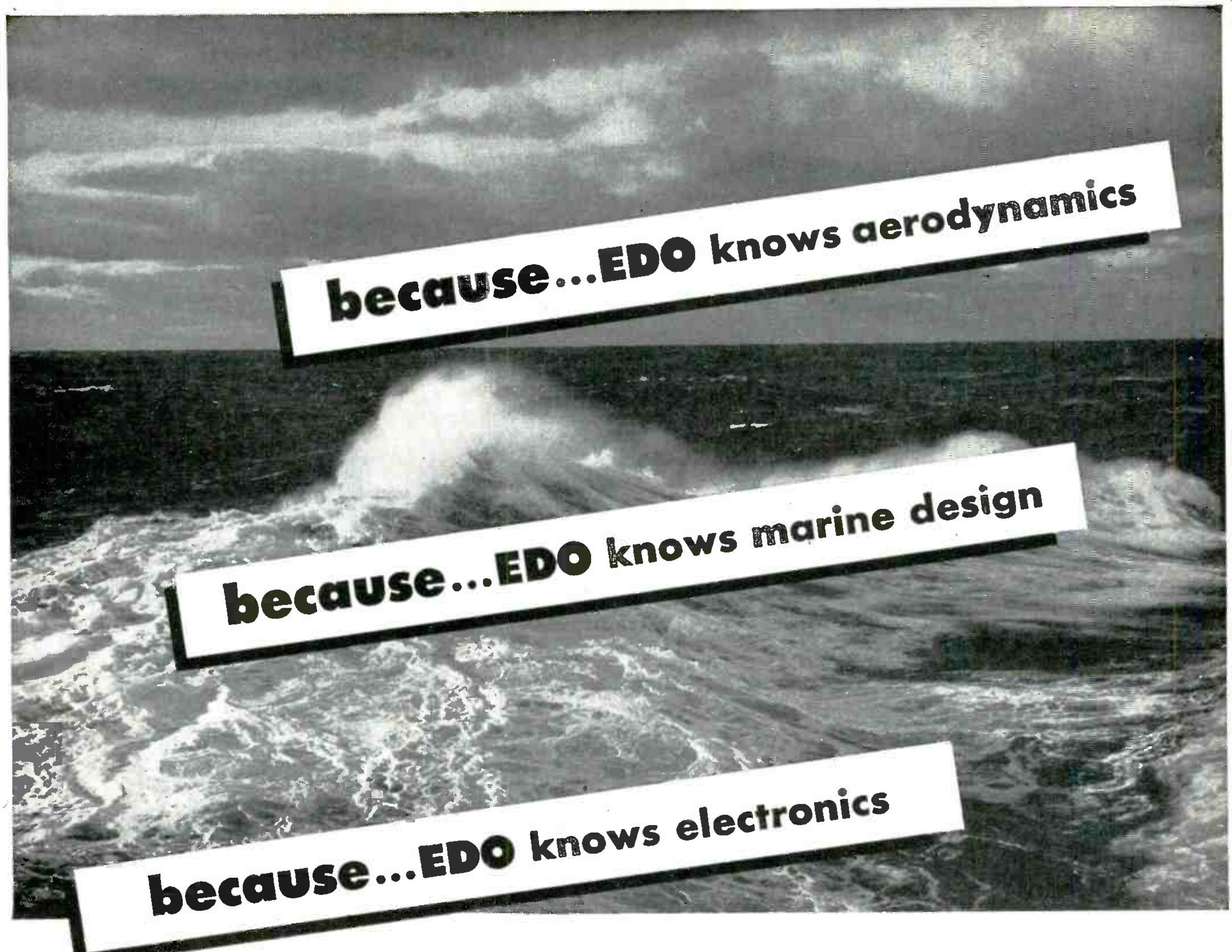
Dip Brazing of Microwave Components

By WILLIAM J. RUDOLPH

Brazing Engineer
Glenn L. Martin Co.
Baltimore, Md.

PROPER design and construction of fixtures for the dip brazing of aluminum microwave components is as important as the design of the waveguide units themselves. The unit can only hold the close tolerances demanded if the fixture is built within the same close tolerances. The function of the fixture is to hold the assembled parts together during the preheat and brazing operation.

During preheating and dip brazing, the unit is exposed to temperatures ranging from 1,000 F for preheating to 1,100 F for brazing. Since the expansion of alum-



let EDO house your electronic equipment

Housing intricate electronic equipment for airborne or shipboard use to withstand shocks and forces which might cause malfunction often presents problems as difficult as the design of electronic systems themselves.

Tackling such problems for electronic manufacturers, ship and aircraft builders is a specialty of the Edo Corporation. Whether your equipment must operate properly on jet aircraft or on board ship under battle conditions, its reliability is improved if mounted in Edo-designed and built cabinets or housings.

If you have a housing problem, why not talk it over with our versatile engineering staff whose three-fold experience in the marine, aviation and electronics fields is unique *and at your disposal.*

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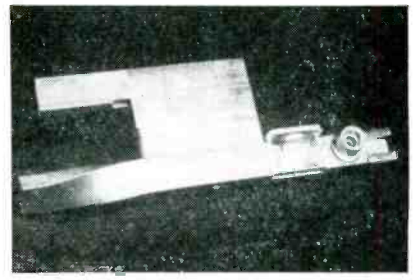
1. AIRBORNE HOUSING. A volume producer of airborne radar nacelles, Edo was asked to design a pressurized external store housing capable of being flown in the trans-sonic speed range. From wind tunnel tests to completed tooling and production, Edo relieved the electronics manufacturer and the aircraft builder of these design problems.

2. SEABORNE INSTALLATIONS. To house its own electronic equipment developed and manufactured for the Navy, Edo engineers have perfected a series of *standard* electronic cabinets admirably suited to naval electronic equipment. Capable of housing all standard electronic units, the Edo cabinets are vibration-proof and spray-proof.

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



Example of complicated microwave plumbing, containing flanges and several pieces of waveguide tubing, as produced by dip brazing

inum is greater than that of steel, distortion will take place in the aluminum components if held tight in a steel fixture. This is eliminated in two ways: (1) Stainless steel springs are used throughout the fixture with just enough pressure to hold the unit, but permitting it to expand without distortion during preheat and brazing; (2) tack welding of the aluminum parts will hold them in the proper position during brazing; however, this is recommended only for such parts as flanges and horns. On complicated units where flanges and several pieces of waveguide tubing are joined in one operation, it is essential to have a well designed fixture.

It is advisable to construct all fixtures from stainless steel or inconel metals. Springs should be made from stainless steel. Never use any copper or brass for holding or fixturing when the unit is to go into the salt bath.

Preparation of Materials

Deburring is the first step. Use files, wire brushes or any sharp instrument that will remove burrs. If burrs are not removed, they will tend to act as barriers, causing skips to appear in the fillet.

Either vapor or solvent degreasing comes next. This is done to remove all oily films that may restrict the fluxing action, causing incomplete wetting of the brazing surface. This would result in skips, porous fillets and incomplete fusion.

It is always necessary to remove surface oxides from the parts prior to dip brazing. This is called precleaning, and is accomplished by a 30-second immersion into caustic acid, followed by a cold water rinse. The parts are then immersed in a nitric-hydrofluoric acid solution for

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- **3B28 RECTIFIER**
  Rugged half-wave Xenon filled rectifier. Operates in any position. Ambient temperature range −75° to +90°C. Inverse peak anode voltage 10,000, average current .25 amps. Filament 2.5v., 5 amp.
- **4B32 RECTIFIER**
  Ruggedly built, half-wave Xenon filled rectifier. Ambient temperature range −75° to +90°C. Inverse peak anode voltage 10,000, average anode current 1.25 amp. Filament 5v., 7.5 amp.
- **VC-1258 MINIATURE HYDROGEN THYRATRON**
  for pulse generation. Handles 10 kw peak pulse power.
- **6336 TWIN TRIODE**
  for voltage regulation. Features high plate dissipation, hard glass envelope.
- **6394 TWIN TRIODE**
  Similar to 6336 except 26.5 volt heater instead of 6.3 volt heater.
- **5594 XENON THYRATRON**
  Operates over wide ambient temperature range −55°C to +90°C.

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Applying No. 718 flat brazing wire to joint area during assembly of flange to a waveguide prior to dip brazing

2 to 5 minutes, followed by a cold water rinse, or into a nitric acid bath for 5 to 8 minutes followed by a cold water rinse. The precleaning dip time is very important. If the parts are not immersed for a long enough period, the surface condition will not improve and poor brazing will result. If the immersion time is too long, it will impair the surface by formation of films and pitting which restrict the flowing of the brazing material.

Brazable Alloys

While many aluminum alloys are now available, only a few are suitable for dip brazing. The E.C., 2S and 3S are high-purity aluminum alloys with high melting ranges and are preferred for brazing; however, these cannot be machined with the ease of heat-treatable alloys and do not have the strength that is in some instances required. The alloy recommended is 61S, a heat-treatable aluminum alloy which can be machined with ease.

Where castings are found to be more practical, it is advisable to employ the A-612, C-612 or 40E alloys. Through repeated tests and experience, these are the alloys that

Now— an Irvington PLASTIC INSULATING TAPE with the heat- and oil-resistance of Temflex® 105 Tubing

Here is a new addition to the Irvington family of insulating tapes — Temflex 105 Plastic Tape, based on the *same* formula that has made Temflex 105 Tubing the leader where service calls for continuous operation in air at 105° C. — or in oil at 90° C.

Temflex 105 Tape is strong and flexible — possesses exceptional elongation. It can be easily hand wound over bus bars, coils, cables — even over very irregular surfaces — or can be used in taping heads. Temflex 105 Tape frequently offers substantial savings as compared with varnished cambric. Easily baked to a homogeneous mass, it also offers cost economies over pressure-sensitive tapes.

Made in thicknesses of .007", .010" and .012"; widths from ½" to 34". Dielectric strength as high as 1200 vpm *even at 100° C.* Tensile strengths up to 3100 psi — elongation 165% to 240%.

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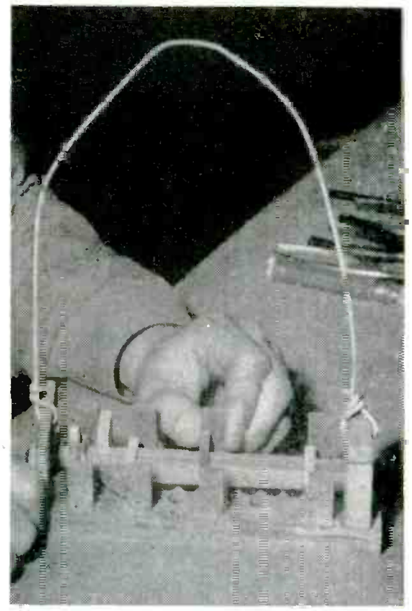
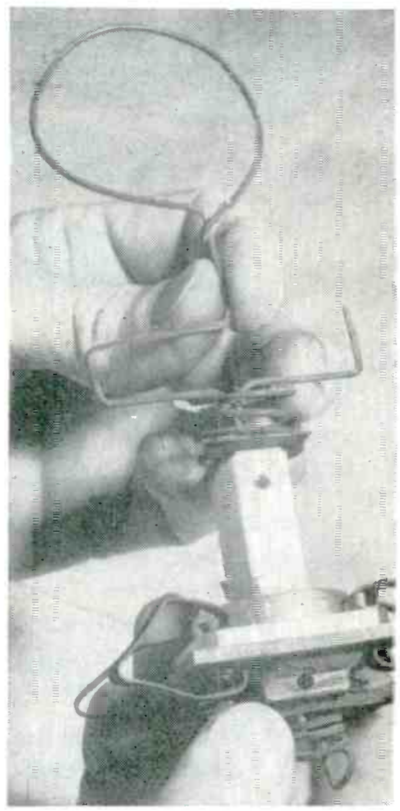


Fixture used to hold close tolerances on a small aluminum microwave antenna during dip brazing. Flat springs on fixture are made from stainless steel



Waveguide flange assembly fixture consisting chiefly of wire springs and stainless steel spring clamps. Wire loop at top serves for placing assembly in preheating furnace and later suspending it in dip pot

have been found the most satisfactory. These alloys are employed for irregular parts such as waveguide flanges. It has been found that investment castings employing

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Good dielectric strength • Low dielectric loss properties
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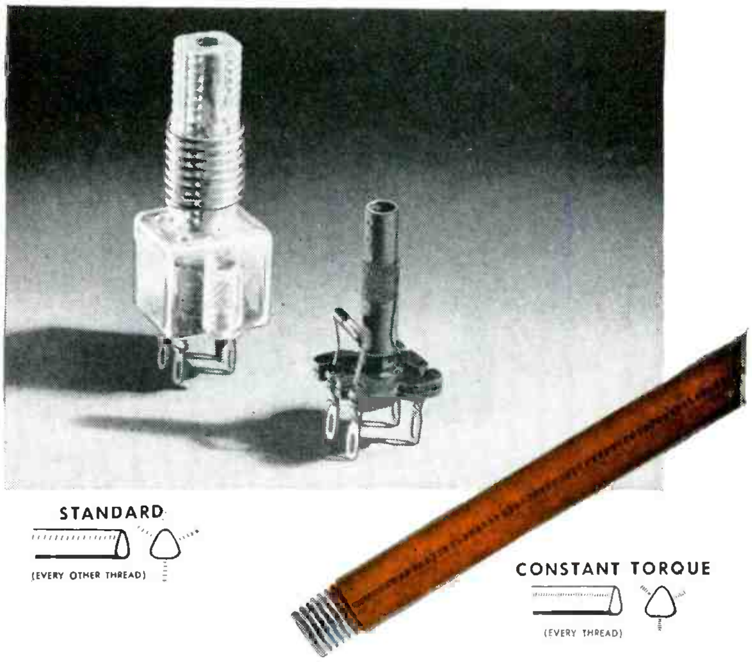

C-D-F is a dependable source of supply for all of your coil form spiral tubing needs. Uniform, high product quality is maintained by rigid standards of manufacture. C-D-F offers you fabricating skill, backed by exacting technical and inspection control. A recent C-D-F development is Grade 5 Constant Torque Tubing for use in coil forms. After the threaded iron tuning core is inserted and finally adjusted, you obtain the same stable torque rating.

Constant Torque features: exact internal threading . . . every thread engaged. 3-point contact with core prevents binding and permits positive tuning and re-tuning. Outer surface of tube has no weak spots, no external embossing to cause cement leakage. Available in lengths up to 14" to take .218" to .250" core with 28 threads per inch and also 6-32, 8-32 and 10-32 screw sizes. Write for samples.

Grade 5 Tubing is also custom-fabricated by C-D-F in conventional shapes to accommodate other sizes of tuning cores.

C-D-F produces spiral tubing in grades to meet most requirements. Use the Grade Selector Chart when requesting samples and additional information.

AVAILABLE GRADES

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- 1 General Electrical and Mechanical Grade. ○
- 1A Electrical and Mechanical Grade—Special Punching. ○
- 2 Mild Stapling, Riveting, and Post Forming Quality. ○
- 2A Intermediate Fabricating and Stapling Quality. ○
- 3 Severe Stapling, Riveting, and Post Forming Quality. ○
- 5 Constant Torque and Formed-to-Shape Coil Form Tubing.
- 6 Special for High Humidity Applications. ○
- 6A Extra Hard, High Strength Tubing. ○
- 7 Soft Varnished Kraft Tubing. ○ □
- 7A Hard, Rigid Rectangular Tubing. □
- 8 Varnished Diamond Insulation—Tubing. ○
- 9 "Deflection Coil" Tubing. ○
- 10 Larger Size, Heavy Wall Tubing for Mechanical Uses. ○

UNIMPREGNATED

- 20 Special Wound in Specified Combinations of kraft paper, fish paper, etc. ○ □
- 21 Plain Kraft Paper Tubing. ○ □
- 22 Plain Diamond Insulation Tubing. ○
- 23 Plain Chipboard Tubing. ○

○ Round
Formed (fluted shape)
□ Formed and Notched Square, Rectangular

SELECTION OF THE PROPER GRADE

While the differences between some of the grades are not great, they are quite distinct when specific requirements are considered. For most uses, the proper grade can be selected from the descriptions, size range, and properties tables in our catalog. If this should prove difficult in some cases, it is desirable for our C-D-F sales engineer to have as much information as possible about the application, especially fabricating requirements, in order that we may make suggestions. Your blueprint is usually sufficient if it carries some indication as to the quality desired. In other cases, the following check list will be found to be helpful:

Type of Application.

Properties required or the customer's specification for the material.

Fabricating quality desired. This is important where stapling, riveting, punching, or forming operations are to be performed by the customer.

Any unusual conditions which may affect the suitability of the material for the job. For tubing that is to accommodate tuning cores, actual samples of the cores are essential along with torque requirements (if known).

Get all the facts. Write for 8-page Technical Folder ST-53 describing standard grades of C-D-F Spiral Tubing, their properties, sizes and tolerances, and how to select the proper grade for your application. Free test samples are available upon request. Call your C-D-F Sales Engineer (offices in principal cities). He's a good man to know!

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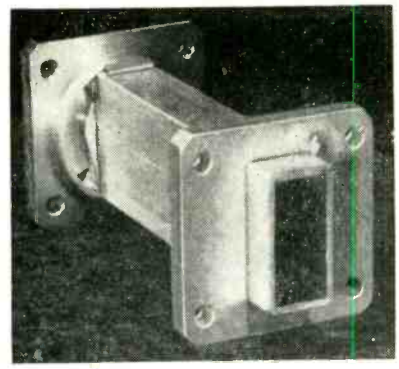

Method of placing flat brazing material in joints of aluminum waveguide in preparation for preheating

the 2S aluminum alloy are very good for detailed parts involving close tolerances.

Brazing Materials

Through repeated tests it was found No. 718 aluminum brazing wire is most satisfactory for a general-purpose filler material. This material's flow range is from 1,070 F to 1080 F and will give very sound fillers when brazed in a range from 1,085 F to 1,130 F.

The brazing material is in the form of round or flat wire. The round wire ranges from $\frac{1}{16}$" to $\frac{1}{4}$" in diameter, while the flat wire ranges from 0.003" thick to 0.020" thick. For dip brazing of microwave components the flat wire ranging from 0.003" to 0.006" in thickness is the most satisfactory in maintaining close tolerances.

Another important brazing material is brazing sheet. This is a material that has a core (J-51S or 3S material) clad with a brazing material of a lower melting point than that of the core.

Design of Brazing Joints

Proper joint design is one of the most important factors in the brazing of microwave components. Due to the very close tolerances that must be held, it is essential to design all joints or as many as possible to be self-locating. A self-locating assembly will lower the cost and time of building elaborate fixtures and will reduce the assembly time considerably.

The joint should also be designed without tight or pressed fits. Clearance between the parts is necessary to guarantee complete fillets and

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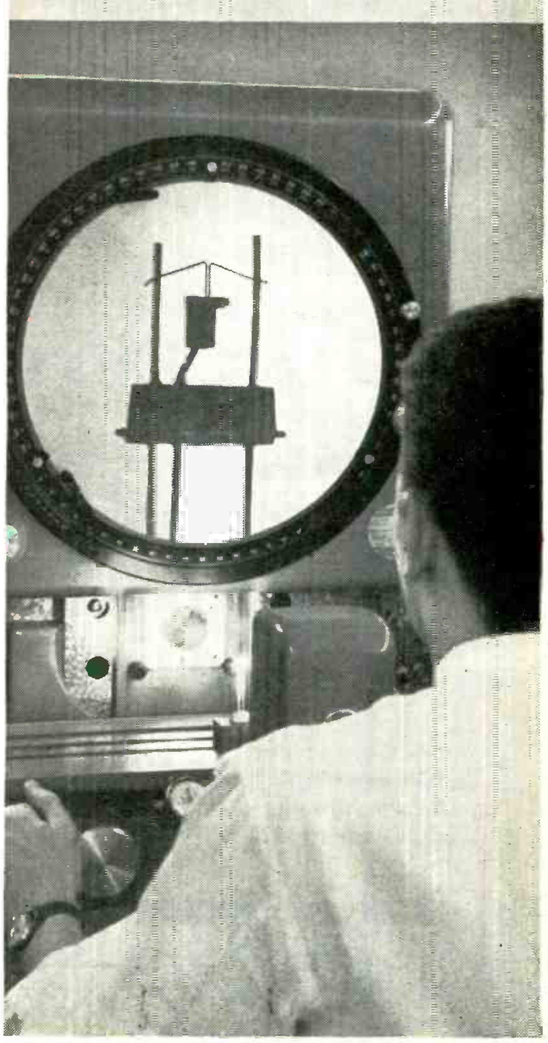

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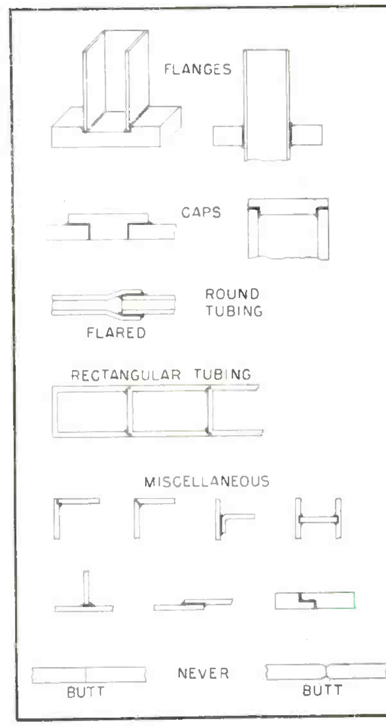
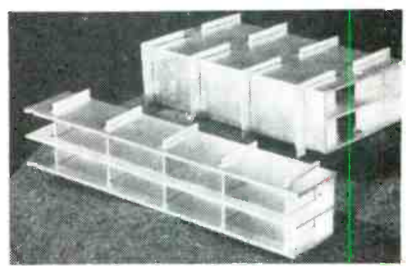
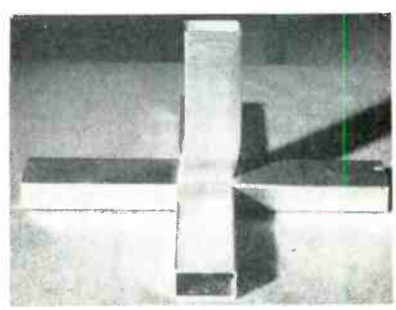


Typical joint designs used with dip brazing of microwave plumbing



Complicated microwave component produced with high accuracy by dip brazing of stainless steel pieces



Completed waveguide junction, showing small fillets achieved through proper design for dip brazing

good flow of the brazing material. This flow depends chiefly on capillary action. When a joint is designed, enough clearance should be permitted between the joining surfaces to allow for the brazing material.

The design of the joint should permit complete drainage of the

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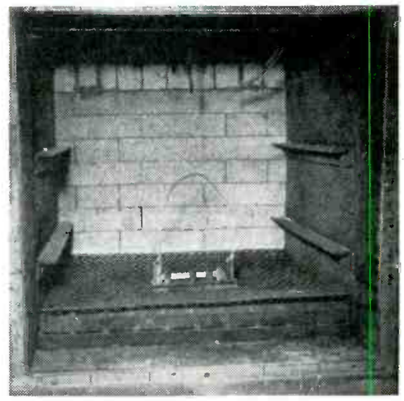

Assembly in preheating furnace

flux. Trouble occurs where flux is entrapped so hot water and an acid neutralizer cannot remove it.

Filler Specifications

Inner fillets should be small. This can only be accomplished by using a small-diameter filler wire or flat wire. A flat wire 0.003″ thick is recommended to keep these fillets small, neat and uniform with maximum strength.

A good example for filler materials for microwave components is three times the thickness of the parts up to $\frac{3}{32}$″ in thickness. For example, $\frac{1}{16}$″-thick plate to be brazed would require a $\frac{3}{16}$″ wide 0.003″ thick strip of filler material. This would result in a 0.010″-radius fillet in the joint. Dip brazed parts should be designed so that alignment during brazing is obtained by the fit of the parts rather than by forces exerted by jigs or fixtures.

Assembly and Preheating

After cleaning, the filler material is added to the joint areas of the parts to be brazed. These parts are then assembled and placed in the holding fixture. They should then be checked for proper seating in the fixture, proper spring loading and proper location of the parts.

The unit is placed in a preheating furnace at 950 F to 1,030 F for from 5 to 15 minutes depending upon the mass of material to be preheated. This operation is essential because it removes all moisture, prevents local freezing of the molten fluxes when the unit is immersed in the dip pot and eliminates distortion.

The preheat furnace can be either gas-fired or electric, but

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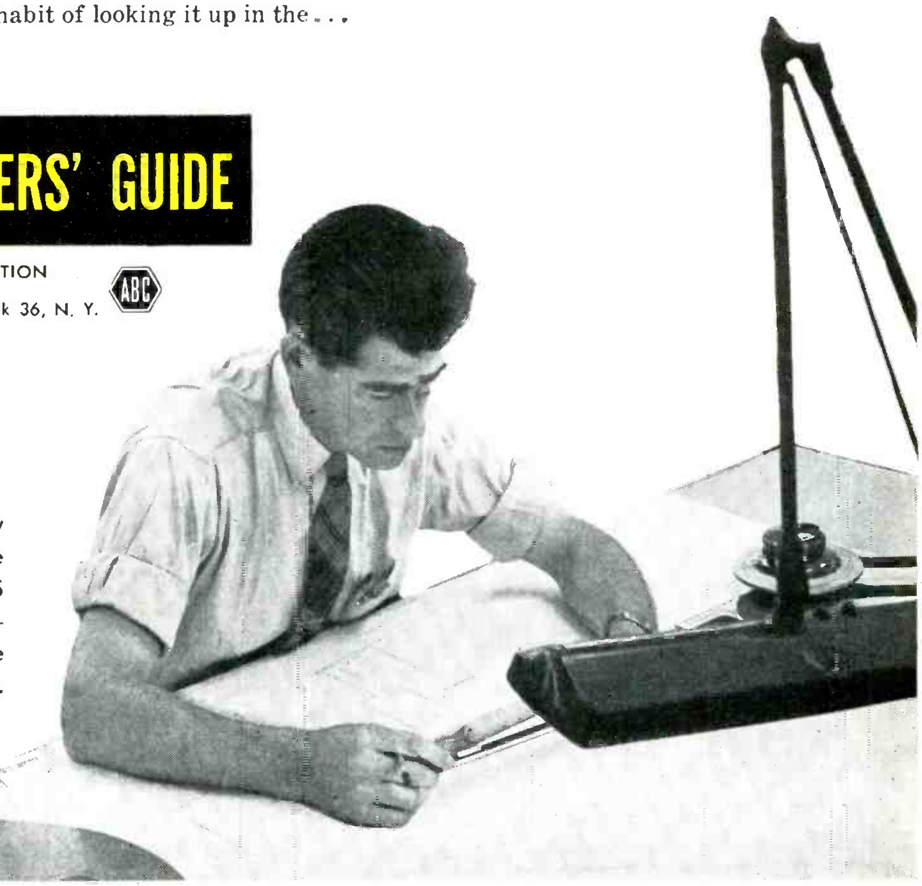

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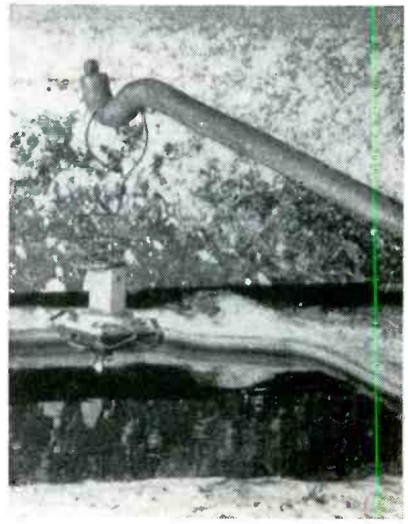
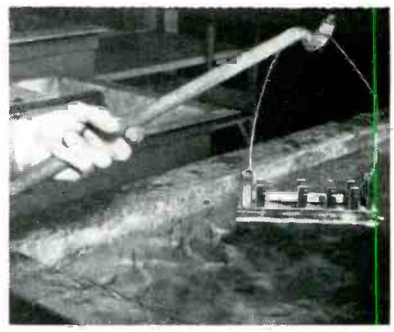


Removing another type of component from flux used for heating to 1,110 F



Lowering dip-brazed part into cold water quench, for heat-treatment

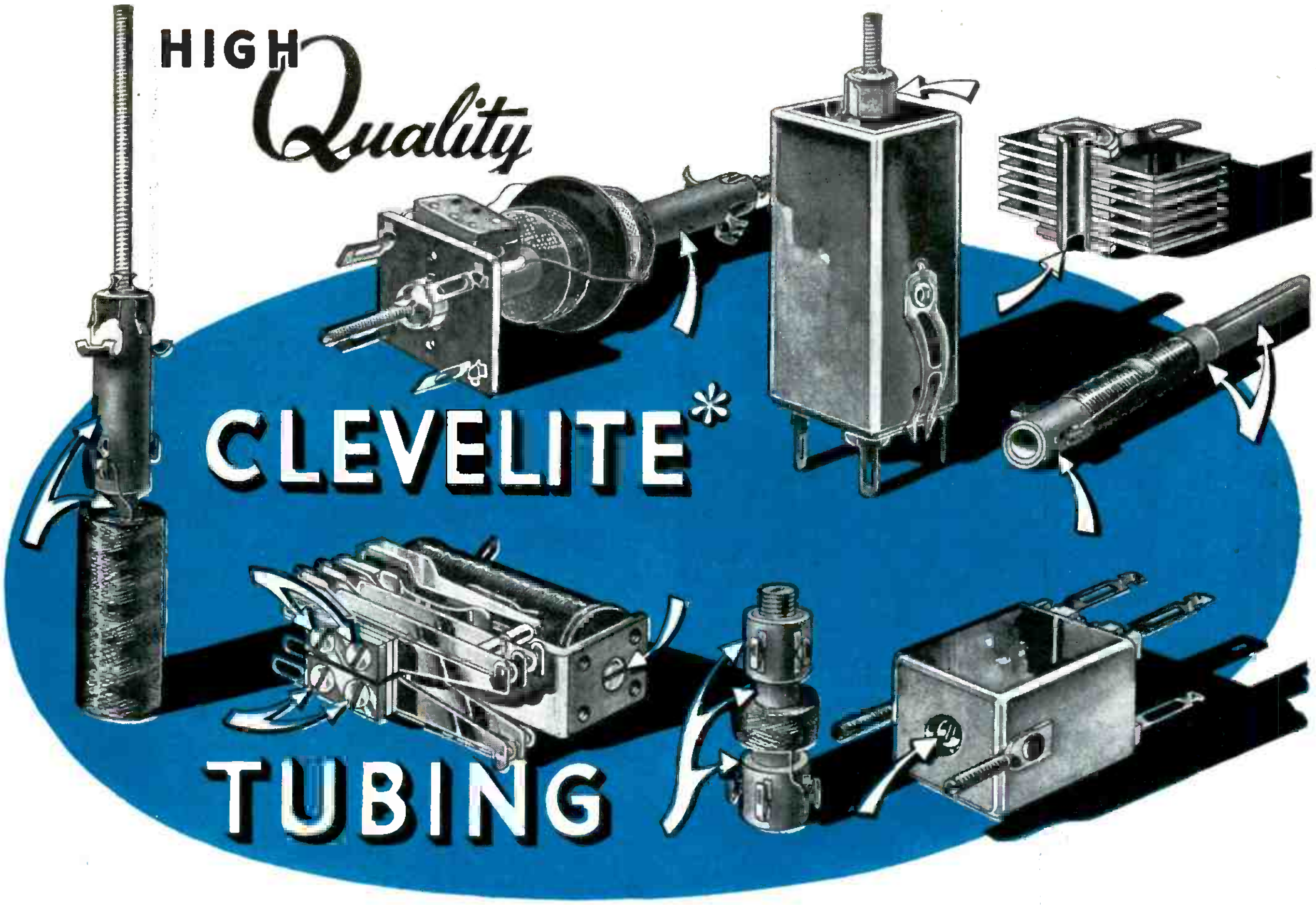
should be an air-circulating type controlled to within 10 degrees F.

Dip Brazing

After preheating, the assembled parts are removed from the furnace and lowered slowly into molten No. 34 brazing flux, which is held at the proper temperature to melt the filler material and produce its flow into the joint (1,090 F to 1,110 F) for from 1 to 3 minutes.

Ceramic-lined pots are suitable for dip brazing. Electric resistance heating of the molten flux is the most satisfactory, with temperature control within 5 F of brazing temperature. The capacity of the pot should be such that sufficient flux can be melted so that the chilling effect from dipping the parts to be brazed does not drop the temperature below the lower limit. It is important that the flux be held in a container which will not cause contamination.

It is always necessary to clean



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the part after a dip-brazing operation. Parts should be immersed in hot water (190-200 F) to remove the major portion of the flux. This is followed by a dip in concentrated nitric acid for 5 to 15 minutes, depending on the design of the parts. The acid is removed by a water rinse.

Plastic Sleeving Dispensers

By RONALD L. IVES
Williamsville, New York

CONSTRUCTION of experimental, prototype and custom-built electronic devices commonly requires use of plastic insulating sleeving in a wide variety of sizes and colors. Because of its springiness, this sleeving cannot be satisfactorily stored in, or dispensed from, a conventional wire rack, and usually will not stay wound on the spools on which it is supplied.

Larger spools of sleeving can be supported on a vertical surface by use of a hinged wire bail made from a dime-store toilet-paper holder, as in the diagram. This is limited to one spool per holder, as a second spool will rotate along with the first, with resultant tangling.

A self-rereeling holder, incorporating a window-shade spring mechanism, is theoretically useful. It permits the end of the sleeving to be pulled to the working position, and the requisite amount cut off, after which the rest of the sleeving is released and automatically rewinds. Experiments with a holder of this type show that it is unsatisfactory, as the free end of the sleeving whips around in a hazardous fashion when released.

The most convenient holder for

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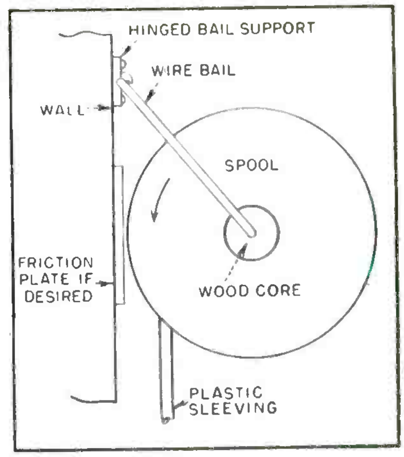

Suspension system of dispenser

medium-sized and small spools of sleeving is a trough, which supplies adequate friction and support. A miniature wooden hog-trough is quite satisfactory here, but a metal trough, assembled from case parts of a Fairchild K-8 gunsight control unit (previously gutted for parts) is more suitable. The base of this trough is the center reinforcing member of the control unit case. The trough proper is cut from the bottom of the case. Rubber feet prevent slippage of the trough, and eliminate scuffing of shelf surfaces; cap nuts on holding screws at both ends reduce droppage when the trough is moved. Because the quality of the workmanship of assembled devices tends to reflect the quality of the equipment used during assembly, the entire device was given a coat of black crackle enamel.

Construction time, including painting, is about one hour, and this is apparently recovered, as time saved by eliminating tangling, each 50 working hours.

Green Conveyor Belt Reduces Eye Fatigue

An abrasion-resistant green conveyor belt has been developed for use on assembly and inspection lines where a great deal of visual concentration is necessary.

Extensive tests have shown that eye fatigue is substantially reduced when a green belt is used for assembling or inspecting such objects as radio chassis, tubes and small parts assemblies. While the color has no effect on belt performance, a

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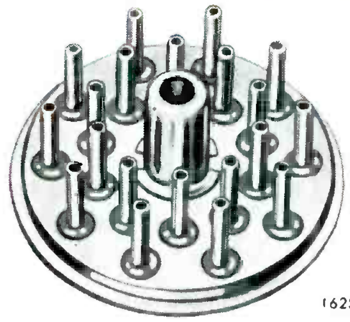

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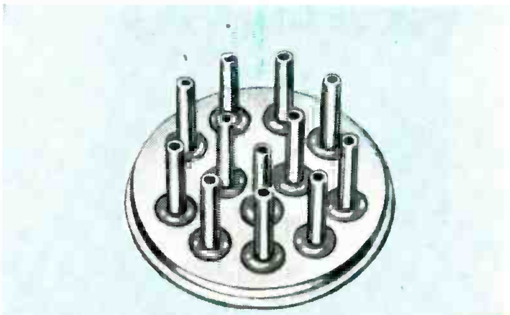

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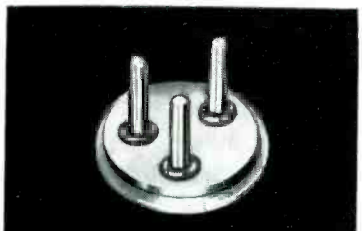

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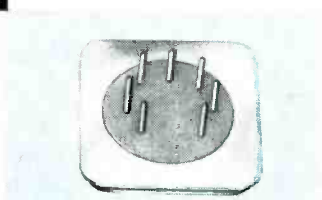

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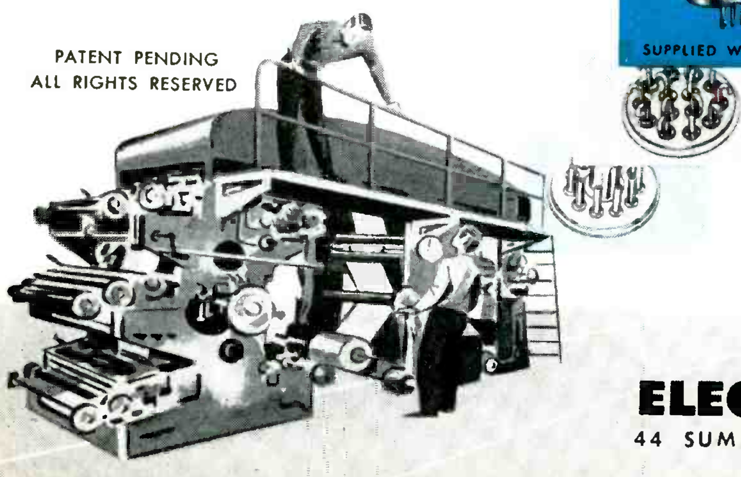

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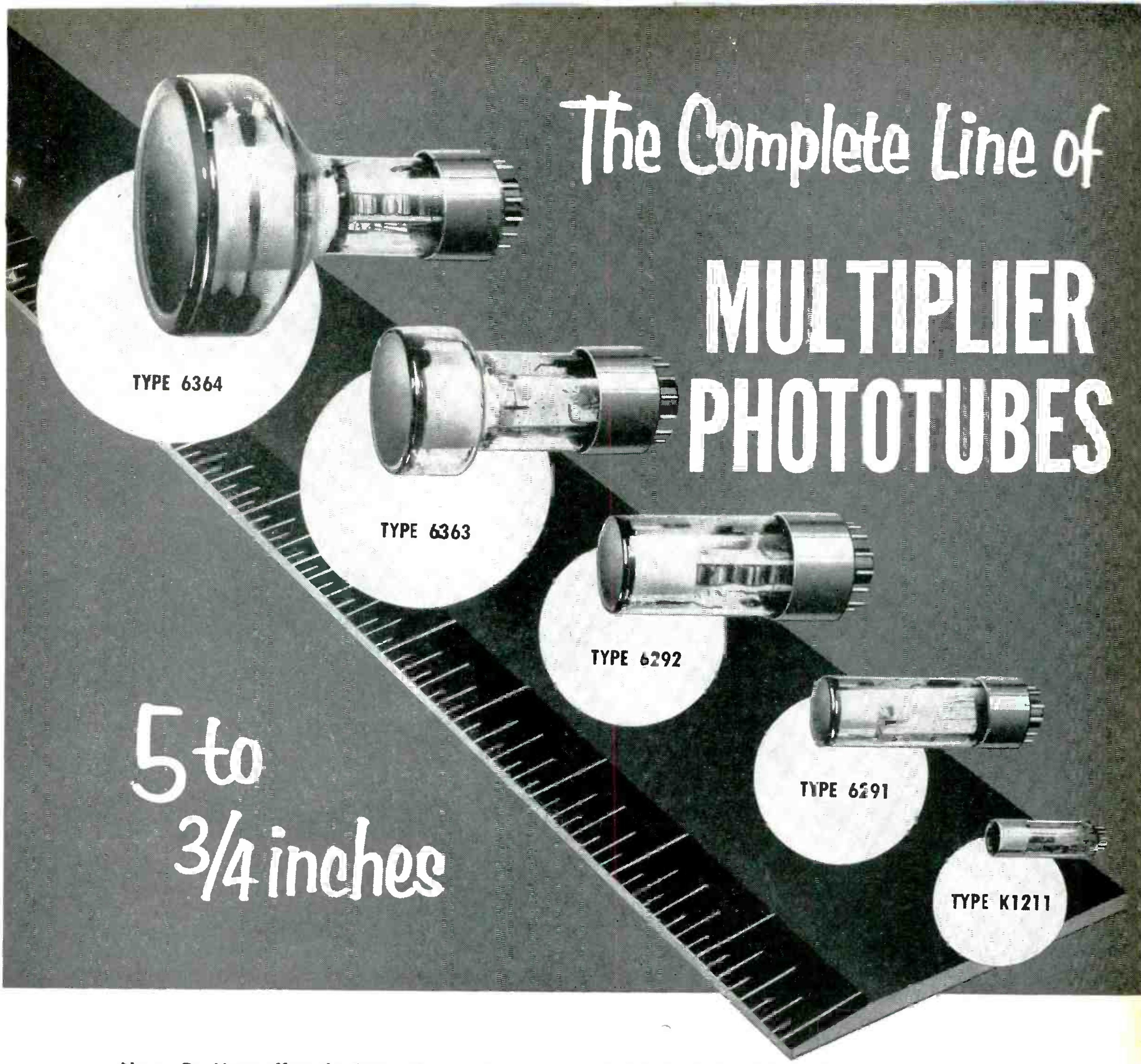
Demonstrating Efficiency of Sampling Techniques

WOOD paddles and a jar of colored beads have proved more effective for in-plant demonstration of the laws of probability and sampling than hours of explanation or pages of reports. As one example, a foreman in the test department of an electronic-tube plant might measure ten tubes as a sample from a batch. If all are good, he optimistically assumed that the rest of the tubes in the batch are likewise good. With this jar of beads, it is easily and dramatically demonstrated the zero defects in samples of ten come up quite often even when five percent of the tubes in the batch are bad.

In the demonstration system developed by W. P. Koechel, director of quality-control for Tung-Sol Electric Inc., Bloomfield, N. J., the jar contains 4,000 beads. Of these, ½ percent are brown, 1 percent are



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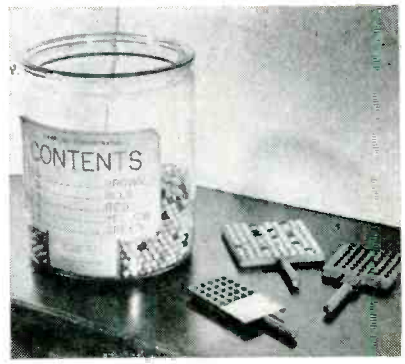
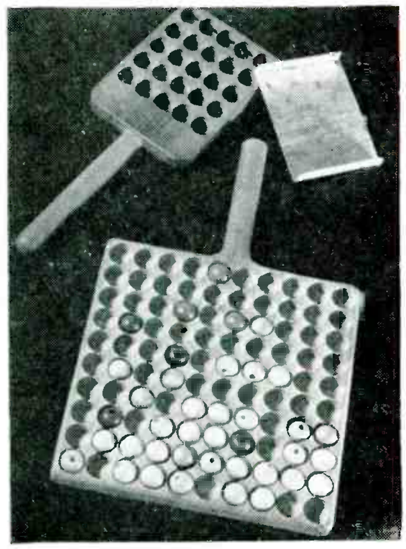


Glass jar, paddles and beads used as sampling simulator



Closeup of paddles used in sampling simulator, with metal slide for covering rows of holes not wanted

blue, 2 percent are red, 5 percent are yellow and 10 percent are green; the balance are white, representing good items. The colored beads represent defective items. If, for example, a 1-percent defective population is to be simulated, only blue beads would be counted as defective. If a 6-percent defective population is to be simulated, both blue and yellow beads are counted as defective. This arrangement permits having up to 18½ percent defects without changing the contents of the jar.

Wood paddles are provided which permit scooping out any desired size of sample ranging from 5 up to 100. This is achieved by using three sizes of paddles in conjunction with a sliding metal cover for the smallest paddle. The paddles have drilled holes to accommodate 25, 50 and 100 beads respectively. The metal slide for the smallest paddle permits covering rows of

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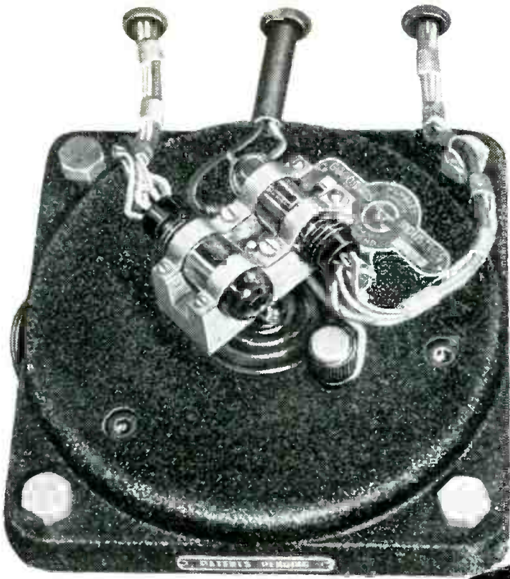

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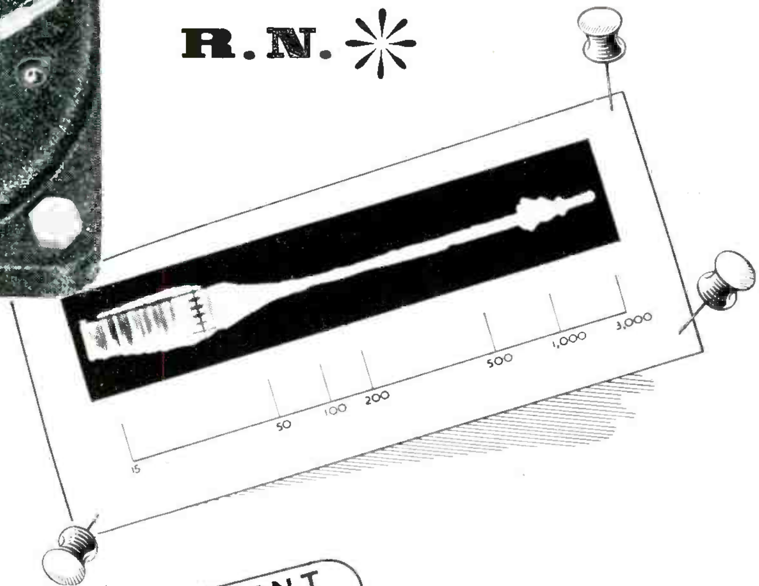
Pin down

R.N. *



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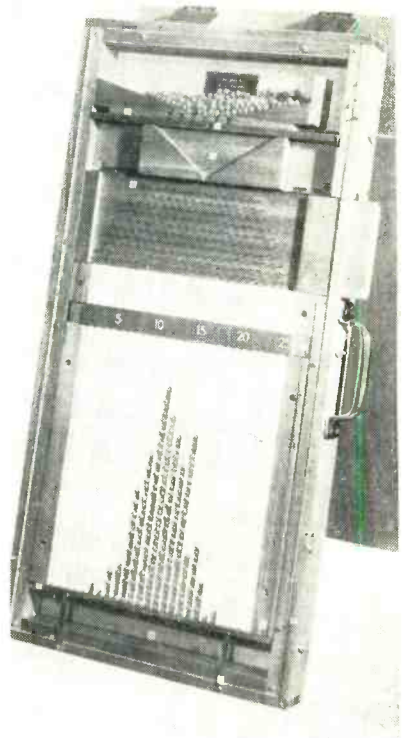

Quality control distribution pattern demonstrator. Nails must be somewhat irregular and balls should vary slightly to get most effective demonstration. Poor results would be obtained by using steel ball-bearings and precisely driven phonograph needles as pegs

beads to reduce in units of five the number picked up by this paddle.

Use of the glass jar permits a clear view of the beads inside and at the same time minimizes spilling and loss of beads.

Another bead device developed by W. P. Koechel is a pinball-type slide for demonstrating the typical distribution pattern obtained when checking quality of normal production runs. Wood beads at the top of the slide drop through a maze of nails when the release lever at the side is operated. The nails cause the beads to scatter and distribute themselves among 25 vertical channels. Most of the beads enter the central channels, with fewer and fewer spreading out to the sides. The result is a bead pattern which approximates the standard curve shown in the diagram.

Metal strips at the bottom of the slide point to the bead columns that represent the upper and lower specification limits; beads falling outside of these strips therefore represent shrinkage due to rejects. After

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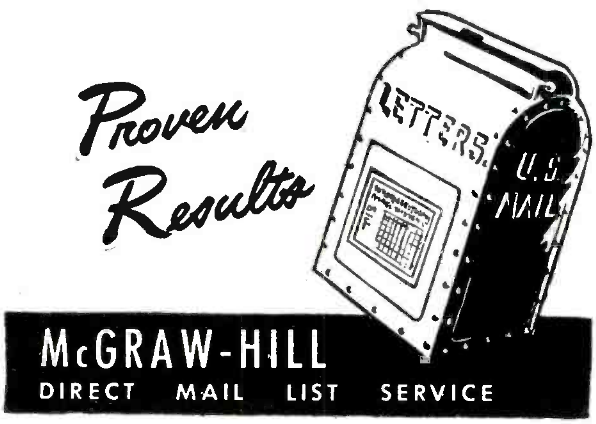
The world-wide reputation McGraw-Hill has earned as builders of the finest mailing lists was born of constant research in our office and in the field—constantly adding new names . . . developing new markets, new avenues of revenue for direct mail list users.

McGraw-Hill Mailing Lists are built—and constantly maintained—to provide, as accurately as humanly possible, complete rosters of the industries we serve.

Investigate their tremendous possibilities in relation to your own product or service. Your specifications are our guide in recommending the particular McGraw-Hill lists that best cover your market. When planning your industrial advertising and sales promotional activities, ask for more facts or, better still, write today. No obligation, of course.



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a demonstration, another push rod releases beads to the bottom. The slide is then turned over to get the beads all back at the top again in readiness for another demonstration.

The wood board containing the nails is mounted loosely and held in position by a flat spring. Pulling this board partly back alters the distribution of the beads to simulate production that has gone out of control.

The nails on the sliding board are staggered, so as to give each ball a 50–50 choice of dropping to one side or the other each time it hits a nail. Nails can readily be removed to simulate a particular condition or problem. A six-notch slide located between the exit hole and the source of the beads at the top is used to obtain normal distribution. Each traverse of this slide from one side to the other releases five beads. A wood funnel just below the release hole can be shifted to one side or the other by means of a rack-and-gear arrangement controlled by a knob at the rear. The slides are made from $\frac{1}{16}$-inch Lucite strips, and a glass or Lucite cover is used to prevent beads from falling out during a demonstration. The device is technically called a quincunx demonstrator.

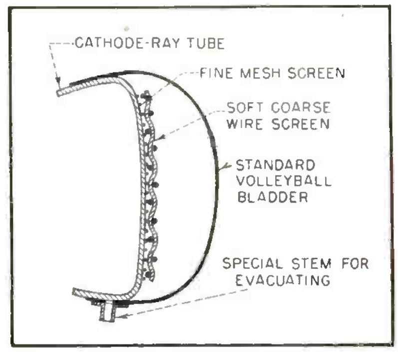
Cementing Metal Screens to Cathode-Ray Tubes

By R. W. HOLMES
Mechanical Engineer
Argonne National Laboratory
Lemont, Illinois

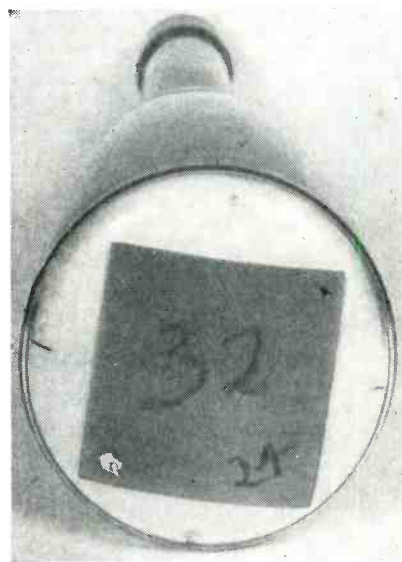
THE CEMENTING of fine mesh screens to the faces of 5-inch cathode-ray tubes was an important operation in the construction of the memory unit of Argonne National Laboratory's new electronic digital computer (AVIDAC). The cementing was accomplished efficiently and at low cost by use of a variation of the vacuum bag molding technique, developed by Elwin Yoder and Frank Newcom of the Laboratory's Central Shops.

A basic requirement was that the screens be in even contact with the entire face surfaces. The screens are 100 x 100 square-mesh wire cloth made of 0.004-inch diameter

 Want more information? Use post card on last page



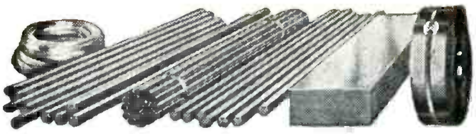
Technique used for cementing fine mesh screen to face of cathode-ray tube



Tube with screen in position on face. Connection to associated amplifier is soldered to lower left corner of screen

copper wire and annealed in a hydrogen-atmosphere furnace. Conventional approaches to the problem, such as use of rubber pressure pads backed up with formed blocks or use of inflated bags held in close contact with the face, proved to be impractical due to nonuniformity of the tube faces and because of the excessive drying time resulting from the prevention of normal air circulation. With the vacuum bag molding technique developed for the purpose, the possibility of tube breakage is reduced to a minimum because there is no increase in pressure on the face of the tube.

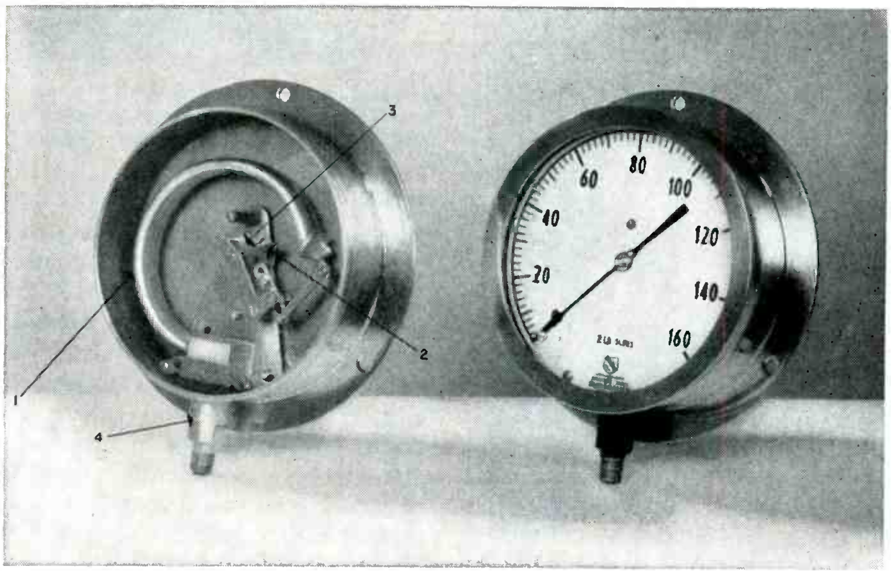
A round hole about 3 inches in diameter was cut into a standard volleyball bladder. The tube face was coated with a solvent-type cement (GE No. 1202 Glyptal varnish mixed with three parts of Glyptal No. 1500 thinner) and the fine mesh screen was affixed. A soft coarse



BRIDGEPORT BRASS COMPANY

COPPER ALLOY BULLETIN

Bridgeport Brass Co. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL



Interior of Ashcroft Duragauge at left shows where copper-base alloys are widely used because of their dependability and corrosion resistance. Brass and Bronze are especially important at the following key points: (1) Bourdon Tube, (2) Gear Segment, (3) Rotary Geared Movement, (4) Socket. Courtesy of Manning, Maxwell & Moore, Inc., Stratford, Conn.

Quality Gauges Rely on Copper Alloys

How many of us realize the importance of dependable gauges which are so vital to modern living. Wherever there's a need for accurate measurement, you'll find gauges. In fact, there are applications beyond number where gauges automatically safeguard lives, equipment, and uniformity of product.

Just as gauges are essential to the making of many things, copper-base alloys are vital to the accuracy and dependable performance of their sensitive yet rugged components.

Quality gauges designed for air, water, steam, oil and other media use high corrosion-resistant copper alloys because accurate readings are imperative in spite of constant surges, fluctuations, pulsations, vibrations, and corrosive attack encountered in service.

In the pressure gauge illustrated, one of the most important parts is the curved Bourdon tube whose elliptical shape and the accuracy of the tube-wall curvature, as well as the physical properties of the metal, are all very critical.

As pressure is applied inside the Bourdon tube, it tends to straighten out, resulting in deflection of the free end of the tube. This end of the Bourdon tube is linked to the gear segment in mesh with the pinion gear that moves the pivot shaft to which the pointer is attached. The amount of motion is transmitted to the pointer which moves over a calibrated scale and indicates the applied pressure.

The temper and spring characteristics of the metal in the Bourdon tube prevent it from becoming "set" after repeated flexing. Any change in its physical characteristics or corrosive attack would affect the accuracy of the gauge. Consequently, copper-base alloys are widely used in gauge construction, which comprises the rotary geared movement that is actuated by the Bourdon tube, the socket, plates, segment, columns, pivot shafts, pinion gear, hair spring, bushings, link and link screws, and closing end for the tube and the case.

Phosphor Bronze Widely Used in Rotary Geared Movement

Phosphor Bronze, Grade A, long known for its excellent spring properties, its fine resistance toward fatigue and corrosion is generally used for Bourdon tubing for pressure gauges designed for medium and low pressures and vacuum measurements. This alloy contains about 95% copper, and 5% tin.

In some instances, Alloy 21, which contains approximately 81% copper, 1.1% tin and balance zinc, is used for making Bourdon tubing for low pressure steam gauges.

Phosphor Bronze, Grade A, is also used for the hair spring, which takes the back lash out of the rack and pinion assembly.

The gear segment bushing and link screws are also made from Phosphor Bronze on the higher quality instruments, although leaded brass is very often used for these applications.

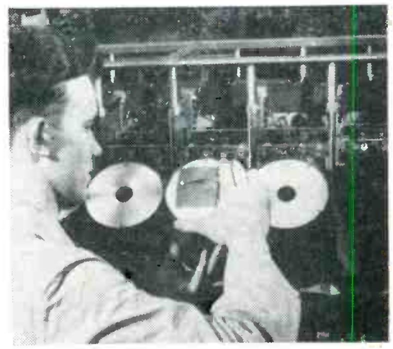
Leaded Brass for Ease of Machining

The plates, blanked, pierced, drilled, reamed and tapped, are made of clock brass for clean, sharp blanking and free machinability. This contains about 62% copper, 2% lead, and balance zinc. The socket, into which the Bourdon tube is mounted and on which the movement is attached, whose end is threaded for pipe connection, is square free-machining brass rod, Alloy 6—copper about 61%, lead 3.4%, zinc remainder. Drilling, turning, milling, threading and tapping are done at great speeds on this high-leaded alloy.

Laboratory Service Available

The selection of the correct material for all types of products can be simplified by contacting our nearest district office for information. Machining, corrosion and other problems are discussed in our "Technical Handbook," a copy of which will be sent to you on your request. Be sure to write for your copy on your company stationery.

(1290)



Inserting screen-faced cathode-ray tube into memory frame of computer capable of storing 1,024 twelve-digit numbers

wire screen (approximately 50 x 50 mesh brass wire cloth, annealed) was then placed on top of the mesh screen and the entire tube face assembly inserted into the bladder opening. An evacuating stem was connected to a vacuum pump and all air in the bladder was exhausted. There was no need to wet the bladder to obtain adhesion, as it snapped down onto the glass face like a rubber band as soon as the vacuum pump was started. An ordinary laboratory vacuum pump capable of pulling down to about 28 inches of mercury proved satisfactory.

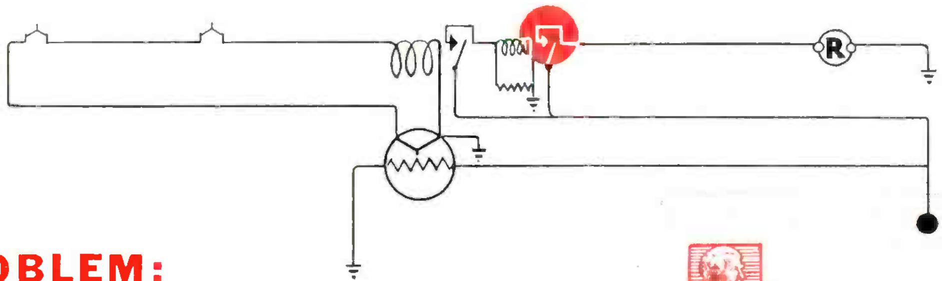
By use of this method, very close contact over the entire face of the tube was achieved. The coarse wire screen, which was removed from the completed unit, prevented air entrapment and the evacuated space effectively accelerated the rate of solvent evaporation.

The cathode-ray tube is the heart of the Williams memory circuit. The screen is analogous to one of the plates of a capacitor, and is used to read off the information as to whether a charge is stored there or not.

Pin and Tip Gage for Miniature Tubes

CHECKING of pin length and glass-tip length are important quality-control steps in connection with tube production, up to now quite difficult to measure. A simple combination gage built around a micrometer dial indicator was developed by W. P. Koechel of Tung-Sol as a successful solution to this

HOW WOULD YOU SOLVE THIS PROBLEM?



PROBLEM:

In the control panel of the Edison Aircraft Fire Detection System the sensitive relay which picks up the current generated by a thermocouple immersed in flame is not designed to carry the warning load. The problem is to design a slave relay rugged and dependable enough for aircraft service, yet moderately priced. The slave relay will carry the current load to actuate the pilot alarm system . . . it must stand up under conditions ranging from the heat of the equator to the cold of the Arctic.

SOLUTION:

Engineers at Price Electric Corporation, realizing that cost was an important factor, decided to experiment with an open-style relay rather than hermetically sealed units. Finally, they were able to solve the customer's problem with a modification of a standard midget-type open relay. Customer comments:

1. The relay is simply made, compact and rugged enough for aircraft use.

2. The Price relay saves considerable labor cost in production because of its simplicity. In other words, it is extremely easy to make connections to this relay, and unusual dexterity is not required.

3. The use of Cantilever Contact Springs instead of the usual tail spring eliminates unnecessary parts which might cause service difficulties.

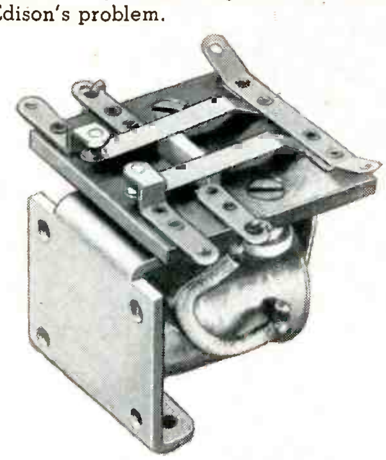
RECOMMENDATION:

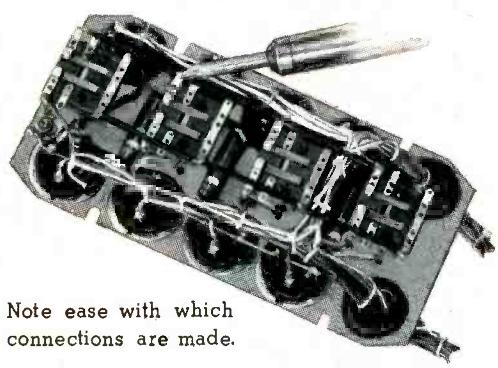
Let Price Engineers have a look at your relay problems and needs. You'll find that their abilities can save time, labor and money!

The EDISON Fire Detection System

The Edison system is used on the B36, the F86 Sabre, the B29 and a long list of other military aircraft as well as being standard equipment on every major airline in the United States, and on every commercial transport except the Lockheed Constellation. It is manufactured by the Instrument Division of Thomas A. Edison, Inc., West Orange, N. J.

The Husky Series 1100 relay . . . modified by Price Engineers to solve Edison's problem.





Note ease with which connections are made.

Send for this valuable file folder showing 42 types of relays. Write *today* for your free copy.

See us at booth No. 793
I.R.E. Show, New York

Price Electric
CORPORATION
5300 Church Street Frederick, Maryland

PRICE ELECTRIC CORP., FREDERICK, MD.
HUSKY RELAYS and CONTROLS

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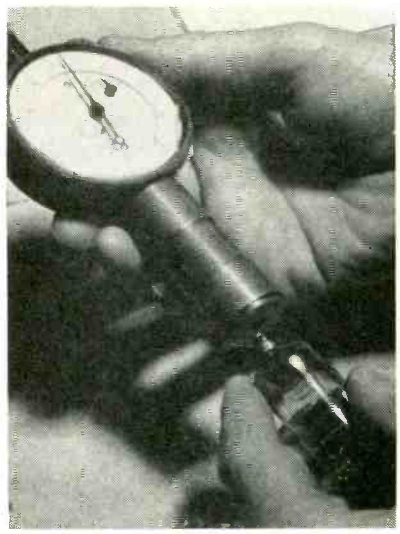
Method of inserting tube in gage to measure length of longest pin



Use of gage with cap over sleeve for measuring tip length

problem in tube production.

An extension sleeve was fastened to the sleeve of the micrometer indictor, and a small extension stem was fastened to the indicator stem. The added parts are so related that zero indication is obtained when the sleeve and stem extensions line up. When the pin end of a miniature tube is pushed in, the dial pointer gives the exact length of the longest pin.

By slipping a cap over the stem, the same gage can be used to measure tip length. This cap has a hole just enough larger than the tip so that gage rests against the tube envelope when the tip is inserted.

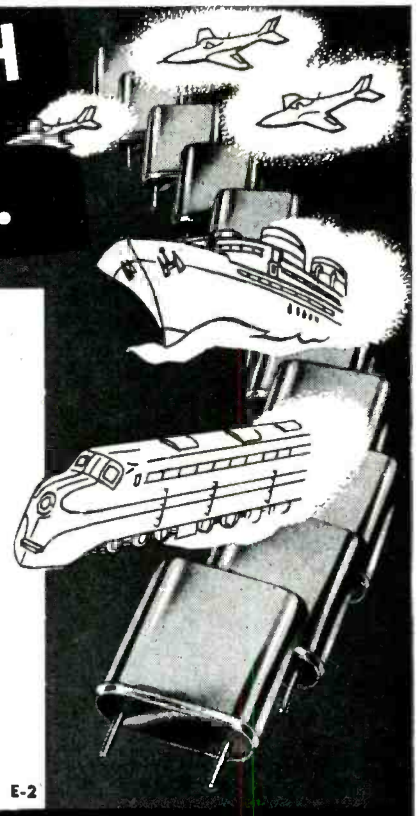
AEROCOM MEANS TROUBLE-FREE SERVICE!
From Ground To Air or Point to Point

The model 12GLX-M, 1KW Beacon Transmitter illustrated, operates on a single frequency in the range 200-415 Kcs. Oscillator coil can be supplied crystal-controlled or self-excited. Tone oscillator provides 30% high level modulation for identification when keyed with Aerocom's model AK-3B automatic keyer. The unit can also be voice modulated. Power supply . . . any stable voltage in the range 200-240 volts, 50/60 cycles, single phase. Overall dimensions in CM, 56W x 62D x 177H. Net weight 286 kilos.

AER-O-COM

3090 DOUGLAS ROAD MIAMI 33, FLA.

WHEN SO MUCH depends on SO LITTLE . . .



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Literature on request to Dept. E-2

NEW! COLOR TV CRYSTALS
Now Available! Write for Information.

KEYSTONE ELECTRONICS COMPANY
114 Manhattan Street Stamford, Connecticut

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there's a BIRTCHER CLAMP for *almost* every purpose!

NEW SUB-MINIATURE TUBE CLAMPS

The Birtcher KOOL KLAMPS were developed for use under conditions of extreme heat and severe vibration and shock. Made from a heat treatable silver alloy of high thermal conductivity, reducing bulb temperatures by as much as 40° C, KOOL KLAMPS are improving the reliability of miniaturized electronic equipment.

The Birtcher Corporation, world's largest producer of electro-surgical devices, maintains a separate division for the manufacture and sale of tube and component clamps.

The BIRTCHER CORPORATION
4371 Valley Blvd.
Los Angeles 32, California

Please send catalog and samples by *return mail.*

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NEW PRODUCTS

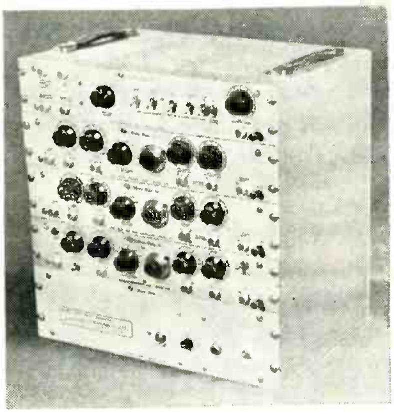
Edited by WILLIAM P. O'BRIEN

Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered . . . Thirty-Three Trade Bulletins Reviewed

OTHER DEPARTMENTS: featured in this issue:

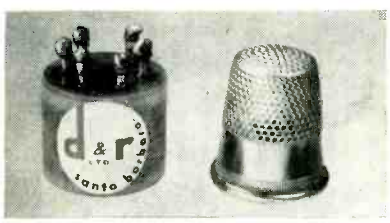
PULSE GENERATOR
is block-unit constructed

ELECTRO-PULSE, INC., 11811 Major St., Culver City, Calif. Model 2120A pulse generator, constructed on the block-unitized principle, generates a positive or negative main pulse whose width, amplitude and delay from trigger are continuously variable over a wide range. Using no gas tubes in pulse-forming circuits, operation from either internal or external frequency sources at repetition rates up to 100,000 cycles is provided, along with single pulse and gated operation. Amplitude of the main pulse is 80 v maximum across an internal 93 ohm resistor and may be continuously varied within 10-db steps. Pulse width is variable from 0.1 μsec to 1,000 μsec in four ranges and flatness of the pulse top may be adjusted to within 2.0 percent on all ranges. Block-unitized circuitry and construction allows use of the instrument as an independent frequency source and cascaded or parallel time-delay generator, among other applications.

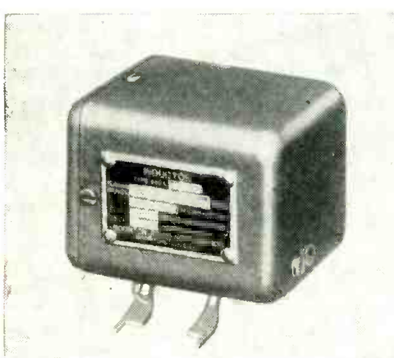


SUPPLY TRANSFORMER
is subminiaturized unit

D & R, LTD., Santa Barbara, Calif., is producing subminiaturized supply transformers with extremely high performance characteristics in relation to their size and weight. Produced on special order in conformance with individual requirements and specifications, the compact transformers can withstand severe shock, wide temperature ranges and vibration. The model illustrated, DR-T 107, developed primarily for printed-circuit applications, delivers up to 5 w at 400 cps and is designed to feed a pair of synchro control transformers. Weighing only $\frac{2}{3}$ oz, it is $\frac{5}{8}$ in. high and $\frac{3}{4}$ in. in diameter.



INDUCTORS
are available in six different types



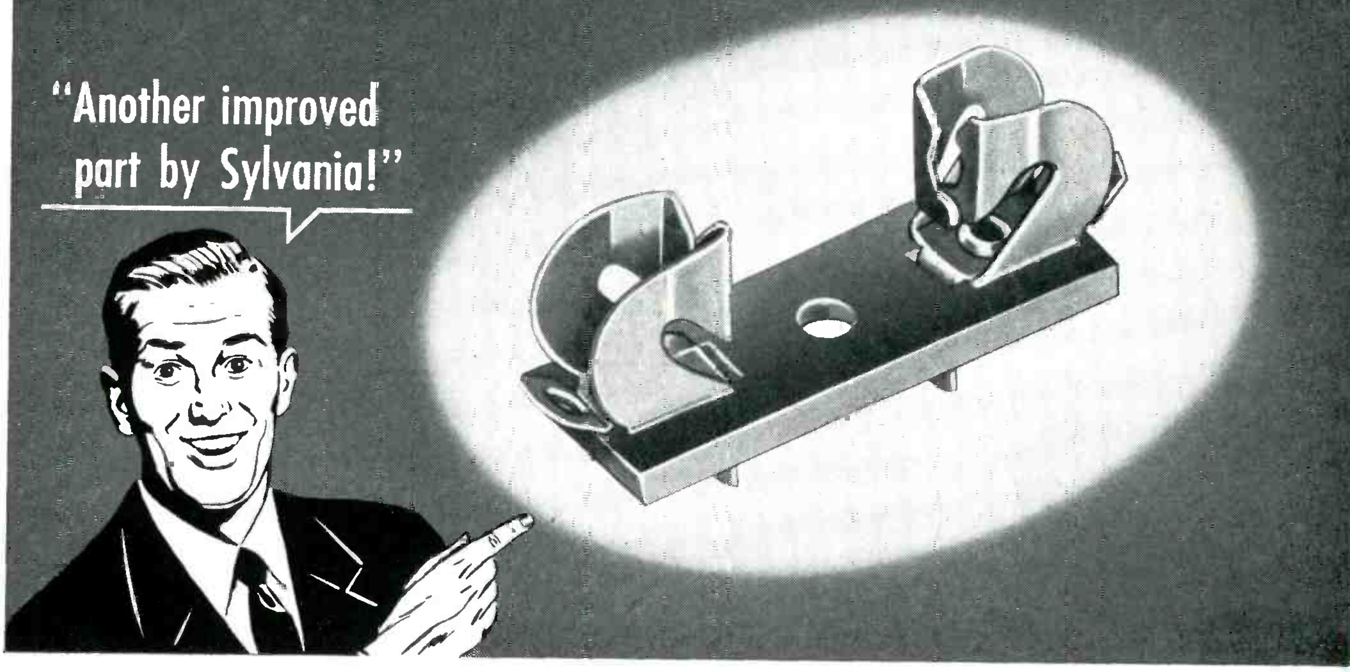
BOONTON RADIO CORP., Boonton, N. J. Type 590-A line of inductors is designed for use in the Q circuit of the company's Q meters types 170-A and 190-A. The new inductors, available in 6 types, are useful for measuring the r-f characteristics of capacitors, resistors and insulating materials over a frequency range of 20 to 230 mc. Each inductor consists of a high-Q coil mounted in a shield and is provided with spade lugs for connection to the coil terminals of the Q meters. The shield is connected to the lugs which connect to the low coil terminal in order to minimize any changes in characteristics caused by stray coupling to elements or to ground.

ELECTROSTATIC GUN
improves beam focus

WESTINGHOUSE ELECTRIC CORP., 401 Liberty Ave., Box 2278, Pittsburgh

A new, efficient crystal diode holder

Sturdy Sylvania Holder Contacts Provide High Retention for Diodes



Here's a brand new, extremely efficient Crystal Diode Holder designed for you by Sylvania.

The contacts retain diodes with terminal leads ranging from .078 to .125 diameter, with ease of insertion and withdrawal. The center-line of retention is specially located at sufficient distance from the surface of the mounting plate to allow installation of large diameter Crystal Diodes. Mounting plate is made of laminated phenolic and the contacts can be furnished in either phosphor bronze or brass with silver plating. Eyelets are made of nickel-plated brass.

For detailed specification sheets concerning this improved diode holder or any other Sylvania part write to Sylvania today!

SYLVANIA

Sylvania Electric Products Inc., Dept. 4A-1602, 1740 Broadway, New York 19, N. Y.

In Canada: Sylvania Electric (Canada) Ltd., University Tower Bldg., St. Catherine St., Montreal, P. Q.

LIGHTING • RADIO • ELECTRONICS • TELEVISION

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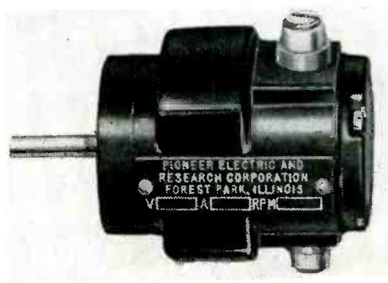
30, Pa., has developed a new electrostatic gun that improves beam focus in electrostatic tv picture tubes. The smaller spot size produced by the new gun gives greater resolution and finer definition. Tubes using the gun show more detail in highlights while diminishing snow particles. Sharper focus also means the tube is a better performer in fringe areas. The gun is less affected by variation in anode and screen-grid voltages, permitting the tube to maintain better focus over a wide voltage range.

TINY P-M MOTOR

conforms to JAN specifications

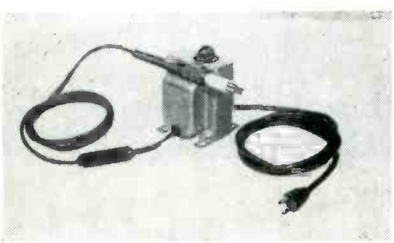
PIONEER ELECTRIC & RESEARCH CORP., Forest Park, Ill., has introduced a miniature permanent-magnet motor that is smaller than a standard pack of cigarettes. It offers h-p rating from 0.004 to 0.0165, speeds from 2,000 to 20,000 rpm, with total weights from 3.5 to 9 oz. The new motor is made with its magnetic structure cast into an aluminum housing. The lineup indices are accurately ma-



chined to fit directly into the field structure bore so a uniform air gap between field and armature is assured. Stainless steel shaft, rotor and commutator diameters are precision ground to maintain perfect concentricity. In its basic construction, the motor fully conforms to JAN specifications for minimum weight, low current consumption and high efficiency. Voltage range is 6 to 110 d-c. Commutator is 14 bar, with 35-bar type available for special applications. Used as a generator, the tiny motor at 6,000 rpm offers an output range from 1.5 to 8 w.

SOLDERING TOOL

for subminiature work

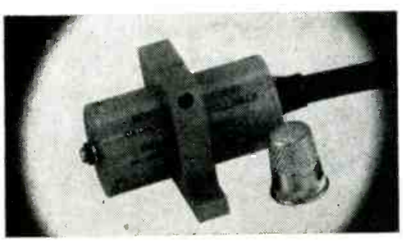


IDEAL INDUSTRIES, INC., 1055 Park Ave., Sycamore, Ill., has introduced the Thermo-Tip soldering tool for miniature and subminiature work, featuring extremely rapid heating light weight and small size. Consisting of a step-down transformer connected to a small soldering pencil, it utilizes the principle of resistance heating with the soldered part becoming a part of the electrical circuit. Passage of high current at low voltage through the part causes rapid heating. Solder is flowed by this heat and cold-flow joints are entirely eliminated. Soldered joints can be made in ½ sec. The soldering pencil weighs only 3 oz.

CATHODE FOLLOWER

uses latest design techniques

ENDEVCO CORP., 180 E. California St., Pasadena 1, Calif. The new subminiature cathode follower for impedance transformation now permits vibration and shock area location of the electronic equipment associated with high impedance instruments. The cathode follower

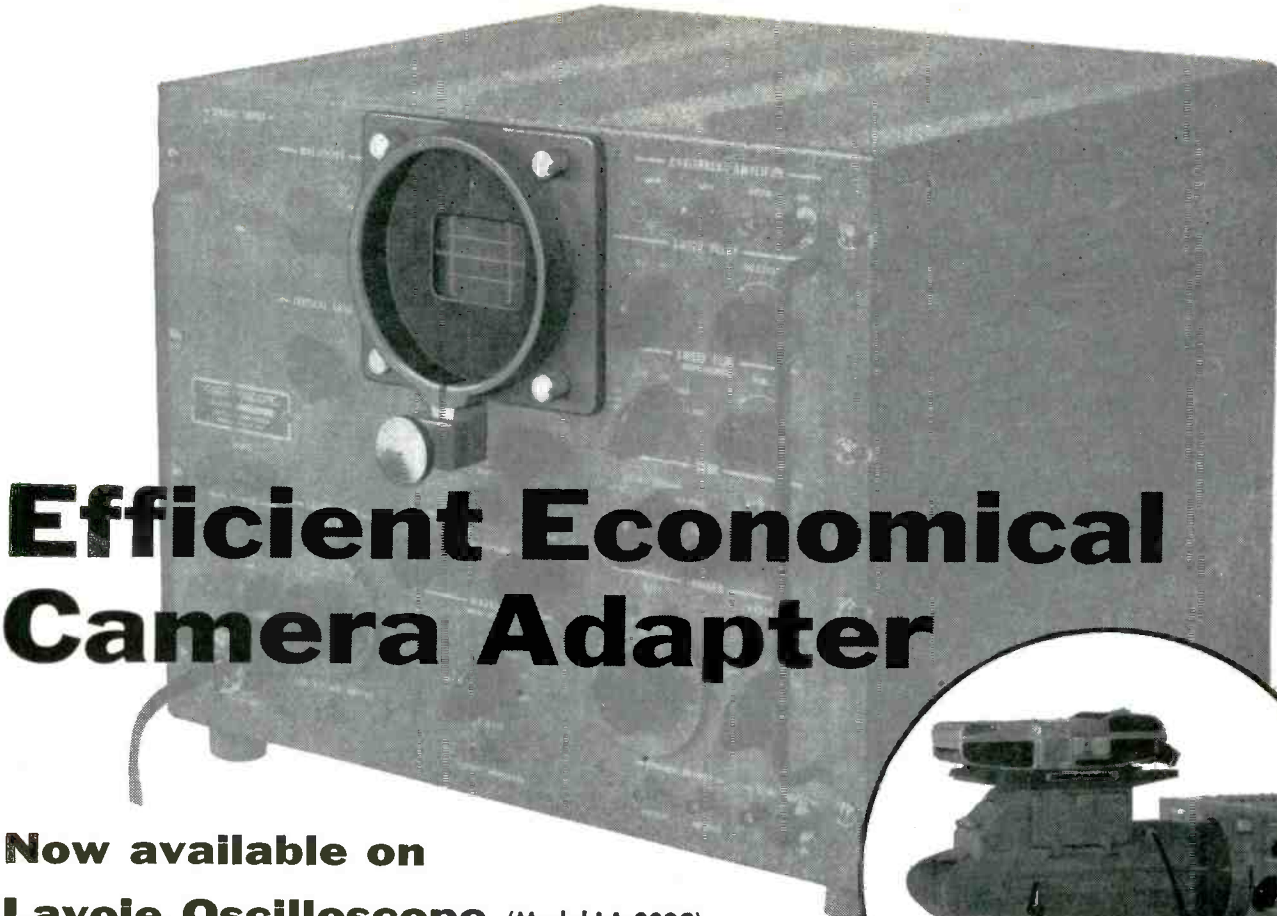


satisfies the needs of piezoelectric accelerometers, force gages and pressure pickups. Model 2608 cathode follower is internally shock-mounted and uses the latest of design techniques, including etched wiring, subminiature shock resistant tubes and tantalytic capacitors. The small size permits installation in cramped quarters. Input impedance is over 100 megohms.

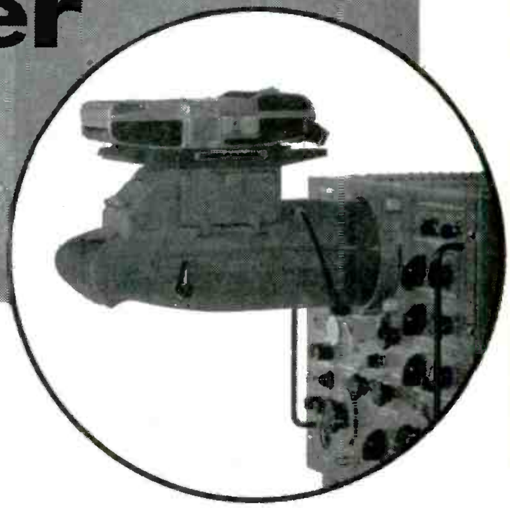
PHOSPHOR BRONZE

in ultra-thin gages

INDUSTRIAL DIVISION, AMERICAN SILVER CO., INC., 36-07 Prince St., Flushing 54, N. Y., has available phosphor-bronze strip, precision-rolled to very close tolerances and to thin gages and foils, for use in the manufacture of electrical, electronic, communications and instrumentation equipment components. The metal possesses high tensile and yield strength, good ductility, resiliency, high fatigue strength, wear resistance and good bearing qualities. It is rolled in strip up to 6 in. wide and down to 0.005 in., to tolerances as close as ±0.0001 in. The strip is available in any quantity from 1 lb to thousands of pounds. Typical uses include: bellows and diaphragms; high strength springs and brushes; fuse



Efficient Economical Camera Adapter



Now available on

Lavoie Oscilloscope (Model LA-239C)

The popular Lavoie Oscilloscope LA-239C has had a new plus feature added: The ability to mount the Lavoie Camera Adapter quickly and without modification. The Camera Adapter may be readily installed by removing the bezel, and securing the Adapter with four knurled nuts supplied on the panel. Already widely used in the development of radar and guided missiles, this new feature makes the LA-239C Oscilloscope a more valuable tool than ever.

NOTE: When ordering the LA-239C Oscilloscope primarily for photographic use, a P-11 Screen CRT is recommended. Specify type of phosphor desired.

- **Long persistence trace (P-2 phosphor)**
- **medium persistence trace (P-1 phosphor)**
- **blue photographic trace (P-11 phosphor) available.**

CAMERA ADAPTER DATA: Calibrated illuminated scale—1/50, 1/25, 1/2, 1, 5 secs. at f2.8
32 pictures per roll @ 5 cents each—a saving of 50 cents per roll.

OSCILLOSCOPE DATA

Wider Bandwidth: Complex waves from 5 cycles to 15 megacycles. Sine waves from 3 cycles to 20 megacycles.

Extended Sweep Frequencies: Linear from 10 cycles to 20 megacycles internally synchronized. Triggered sweep, from a single impulse to irregular pulse-intervals up to as high as 6 megacycles.

Square Wave Response: Rise time 0.022 microseconds, only 5% droop on flat-topped pulses as long as 30,000 microseconds duration.

Greater Stability: Electronically regulated power supplies throughout to maintain accuracy and constant operation under varying line conditions or line surges. Surges on the line from which Model LA-239C is being powered can be displayed without distortion.

Higher Signal Sensitivity: Maximum sensitivity without Probe: 10.4 millivolts. With Probe: 100 millivolts. (Maximum signals, 125 V. Peak and 450 V. Peak respectively.)

Timing Markers: Interval: Markers of 0.2, 1, 5, 20, 100, 500 or 2,000 microseconds may be superimposed on the trace for the accurate measurement of the time base.

Voltage Calibration: Signal amplitude is referenced to a 1,000 cycle square wave (generated internally) the amplitude of which is controlled by a step-and-slide attenuator calibrated in peak volts. (A jack is provided to deliver 30 V. Peak for use in calibrating other instruments.)

Sweep Delay: Any portion of the sweep longer than a 5 microsecond section may be expanded by 10:1 for detailed study of that portion of the signal.

Power Source: 110 to 130 V. AC from 50 to 1,000 cycles. 295 Watts. (Fused at 4 amperes.)

Dimensions: In Bench Cabinets: 19½ in. wide, 15¼ in. high, 16¾ in. deep. In Rack Mounting (with cabinet removed to fit standard relay rack): 19½ in. wide, 14 in. high.

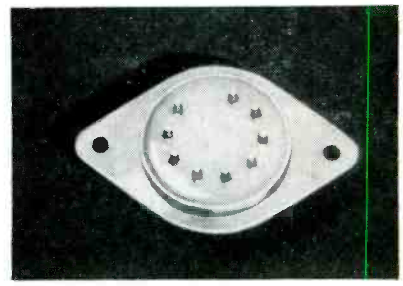
Lavoie Laboratories, Inc.

MORGANVILLE, NEW JERSEY

Designers and Manufacturers of Electronic Equipment

Want more information? Use post card on last page.

clips, sleeve bushings, lockwashers and fasteners; snap switches, socket and plug contacts; printed circuits; bourdon tubes; and clutch discs.

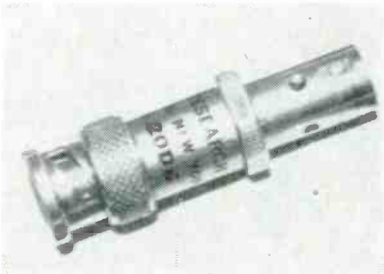


SADDLE HEADER
with glass-to-metal seal

SCIENTIFIC ELECTRONIC LABORATORIES, INC., 866 Bergen St., Newark 8, N. J., has available a miniature saddle header featuring a glass-to-metal compression seal. This miniaturized, vacuum-tight header permits locking to standard saddle socket. This is a new addition to the line of standard hermetic seals available from stock. Special designs are also available.

POWER OSCILLATOR
provides 400 or 1,000 cps

THE INDUSTRIAL TEST EQUIPMENT Co., 55 E. 11th St., New York 3, N. Y. Model 1040 power oscillator provides a frequency of either 400 or 1,000 cps at the flick of a switch. Three watts of undistorted power (less than 1 percent) are provided at various output impedance levels. A control on the front panel allows for a continuously variable output from 0 to 120 v. Frequencies are factory set to 0.25 percent and are maintained with high stability even with line voltage variations. It is extremely useful as a power source for all types of bridges and test setups. An isolated output transformer permits its use in modulation applications, and its high stability makes it a good frequency standard.



ATTENUATORS
for 0 to 1,000 mc

APPLIED RESEARCH INC., 163-07 Depot Road, Flushing, N. Y., has introduced the HFA-50 and HFA-75 inexpensive fixed pad attenuators for the 0 to 1,000 mc frequency ranges. The HFA-50 has an impedance of 52.5 ohms; the HFA-75, an impedance of 75 ohms. They have a maximum vswr of 1.2 up to 1,000 mc. BNC connectors are used so that the pads can be incorporated in most equipment and test setups without the need for auxiliary adapters. Accuracy of the pads is better than 0.5 db. Nominal attenuation is 3, 6, 10 or 20 db.

H-V PEAK UNIT
in shielded brass container

SENSITIVE RESEARCH INSTRUMENT CORP., 9 Elm Ave., Mount Vernon, N. Y. Model VPA high-voltage peak unit has the following electrical characteristics: maximum in-

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verse peak voltage—30,000 v; charging time constant—10 μsec; discharging time constant—5 seconds; and frequency range—60 cps to 10 mc. Mechanical dimensions are 6 in. in diameter and 8 in. high. Weight is 5 lb.

INSTRUMENT STAND
saves bench space

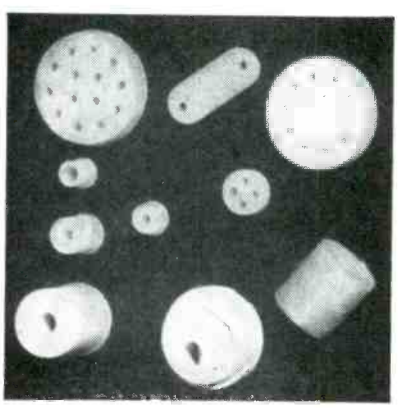
SHASTA DIVISION, Beckman Instruments Inc., P. O. Box 296, Sta. A, Richmond, Calif. Model 901 Tek-Stand brings a technique long familiar to the chemical laboratory to the electronics field. Specially constructed arms are clamped to the upright member and are firmly attached to the backs of the instrument cabinets, allowing adjustment to any position or angle. Up to three "A" size cabinets may be mounted on a single stand. Use of the Tek-Stand minimizes the bench space necessary for the instruments and facilitates their use by making them easier to attach, read and adjust. Multiple a-c outlets are provided in the base for the power cords of the instruments.

PICTURE TUBE
with aluminized screen

CBS-HYTRON, Danvers, Mass., has announced the 21FP4C Mirror-Back picture tube. This aluminized tube features low-voltage, electrostatic focus. Electromagnetically deflected, it incorporates an all-glass, rectangular bulb, and a gray-glass cylindrical face plate that provides greater contrast and a reflection-free viewing surface. The aluminum-backed screen reinforces light output and provides brighter, sharper pictures, without additional demands on the other components of the set. The tube has an electron gun designed for use with a single-field, external ion-trap magnet. It also has an outer conductive coating which, when grounded, serves as a high-voltage filter capacitor.

LABORATORY DOLLY has 8 power outlets

TECHNICAL SERVICE CORP., 1404 W. Market St., Louisville 3, Ky. The lab dolly illustrated has 2 shelves for instruments and a pan for miscellaneous test leads, books and the like. It has a plug mold strip with 8 power outlets rated at 115 v a-c, 1,500 w, and a 10-ft extension cord. The dolly moves on rubber-tired casters and is made of aluminum. It can be used to move equipment for testing in the lab or on the production line. It is 31½ in. high, 18¾ in. wide and 27 in. long.



MOLDED POWDERS for hermetic seals

ELECTRONIC CERAMICS CO., 868 Bergen St., Newark 8, N. J., are now manufacturing molded powders including powdered glass of all types for iron and kovar hermetic seals. Close tolerance work is maintained on a full line of cold-mold plastics and sintered powders. Deliveries are immediate.

VACUUM GAGE
operates from 1 to 0.001 mm Hg

NATIONAL RESEARCH CORP., 70 Memorial Drive, Cambridge 42, Mass. Designed to operate in the pressure range between 1.0 and 0.001 mm Hg, (1,000 to 1 microns) the model 516 Pirani vacuum gage has several unique features: (1) a low-impedance power rectifier that eliminates the need for voltage adjustments during operation; (2) one meter that is used for both voltage adjustment and pressure reading; and (3) a compensating element mounted inside the cabinet facilitating installation and transportation of the gage.

LAB INSTRUMENT
has 88 ranges

SENSITIVE RESEARCH INSTRUMENT CORP., 9-11 Elm Ave., Mount Vernon, N. Y. The Universal a-c, d-c Polyranger illustrated has 88 internal ranges in current and voltage. The ranges overlap each other so that all readings can be taken on the upper half of the scale. The unit has automatic temperature compensation on both d-c and a-c. Accuracy is 0.5 percent on d-c and 0.75 percent on a-c. Current measurements for d-c range from 0.0002 ampere to 1.5 amperes; for a-c, 0.01 ampere to 1.5 amperes. The d-c voltage measurements range from 0.02 v to 300 v by volt range selector switch; a-c voltage measurements, from 0.05 to 500 v.

SSB ADAPTERS
use toroidal coil filters

Crosby Laboratories, Inc., Box 233, Hicksville, L. I., N. Y. Type 76 single-sideband adapter incorporates the new Burnell toroidal-coil filters in place of the crystal filters used in the type 51 adapters. This makes for reduction in cost, smaller size and a saving in weight and chassis space. The unit is more suitable for field use where equipment may be subject to shock and vibration conditions. Since the type 76 has none of the multiple crystal and L-C network circuits, alignment procedures are substantially eliminated.

THERMISTOR KIT
is inexpensive package

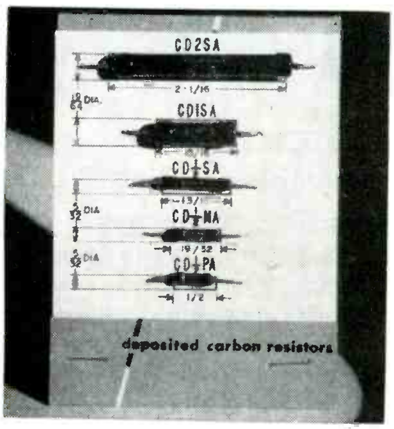
Victory Engineering Corp., Springfield Road, Union, N. J. Model 168 experimental thermistor-varistor package is an inexpensive kit for use in research work. It contains 2 plain thermistor washers, 2 thermistor discs, 2 thermistor beads and 1 varistor washer—plus a technical information sheet of simple circuitry and electrical characteristics of these units. The kit will aid manufacturers in simplifying circuitry, and designing for compactness and increased sensitivity.

VACUUM RECTIFIER
for industry and aircraft

RADIO CORP. OF AMERICA, Harrison, N. J. Type 5690 is a "Special Red" vacuum rectifier tube especially designed for industrial and aircraft applications where rigid requirements for dependability, stability and long tube life are of prime importance. The tube has two separate diode units of the indirectly heated cathode type. It is conservatively rated to withstand a maximum peak inverse plate voltage of 1,120 v, a maximum peak plate current per plate of 375 ma, and a maximum d-c output current per plate of 75 ma. Minimum life is 10,000 hours when it is operated within maximum ratings. It can withstand continuous vibration of 2.5 g at a frequency of approximately 25 cps for hundreds of hours at maximum rated voltage.

PANEL METERS
are side indicating type

INTERNATIONAL INSTRUMENTS, INC., P. O. Box 2954, New Haven 15, Conn. Developed to obtain greater legibility for complex instrument panels, these side-indicating panel meters provide maximum scale length with minimum panel area. Available in a wide variety of ranges with flanges for single and back-to-back mounting, these self-contained units can be grouped in both horizontal and vertical arrangements implementing at-a-glance comparative readings while reducing the size and weight of equipment. They have an accuracy of ±3 percent of full-scale deflection on d-c and ±5 percent on a-c.

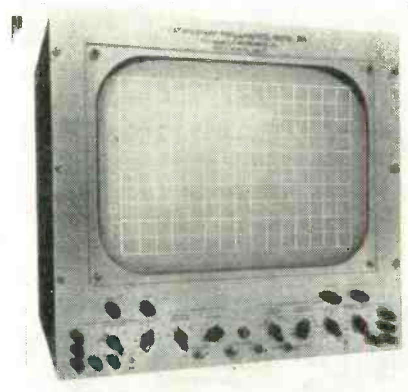


RESISTORS
for industrial application

THE RADELL CORP., 7900 Pendleton Pike, Indianapolis 26, Ind., has announced a new line of deposited-carbon resistors for industrial and instrument applications. They feature stability and long service life. A tough, resilient outer coating seals the precisely adjusted element and protects it from physical abuse without the addition of protective sleeving. The line includes three sizes of ½-watt rating as well as a 1-watt and a 2-watt unit. The designations, in order of size, are CD⅛PA, CD¼MA, CD½SA, CD1SA and CD2SA.

PLASTIC WAFER
guides tubes into sockets

S/C LABORATORIES, INC. 37 George St., Newark, N. J. The Guide-A-Tube is a low loss plastic wafer designed to assure quick, safe and simple insertion of miniature tubes into their sockets. The wafer is simply slipped over the tube pins and then the tube can be inserted into the socket with the ease of an octal. Another important feature of the device is that it reduces microphonics and prevents tube breakage.

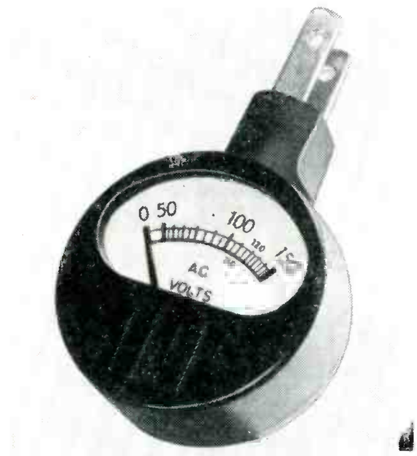


C-R OSCILLOSCOPE is l-f precision calibrated

TECHNOMATIC INSTRUMENT CO., 2316 Pico Blvd., Santa Monica, Calif., has introduced a low-frequency precision calibrated c-r oscilloscope, using a 21-in. rectangular direct-view tube, for classroom demonstrations and more accurate laboratory measurements. Model 21A oscilloscope is particularly suitable for large audiences in that waveforms and oscilloscope patterns in classroom and lecture hall are possible without the use of projection systems, it provides a clear image and does not require a darkened room. Maximum deflection sensitivity is 10 mv peak-to-peak per in. Extreme stability of vertical and horizontal amplifiers and a regulated power supply make it possible to calibrate the gain controls directly in volts for accurate voltage measurements.

PHENOLIC LAMINATES in 49-in. x 49-in. sheets

TAYLOR FIBRE CO., Norristown, Pa., has announced two new families of paper-base phenolic laminated plastics. For application where high insulation resistance is a critical factor, type XXXP-300 meets the most rigorous punching and staking requirements. It punches perfectly at 135C. The XP-400 series offer a solution to the need for a true cold punching laminate having good electrical characteristics. They punch cleanly and evenly at room temperature. Both types offer low water absorption and high flame retardance. They are available in 49 in. × 49 in. sheets.



VOLTMETER
has no wires

ELECTRO MECHANICAL INSTRUMENT Co., 813 Chestnut St., Perkasie, Pa., has available a voltmeter for testing voltage right at the electric receptacle. It has no wires and needs no assembly. It is equipped with prongs and can be readily plugged into any standard 110-v receptacle. The prongs have a swivel arrangement permitting the meter to be read easily from any position. It is precision built with a damped meter movement. The dial is colorfast and calibrated from 0 to 150 v. Accuracy is ±5 percent.

POWER OSCILLATOR
for uhf wide-band use

THE W. L. MAXSON CORP., 460 W. 34th St., New York 1, N. Y., has developed a uhf wide-band oscillator for precision test and power meas-

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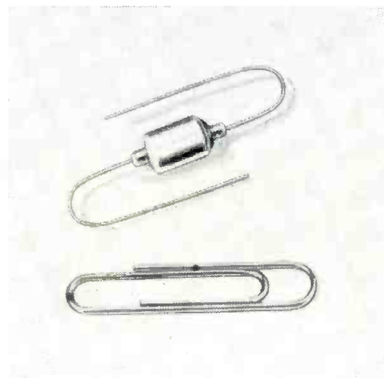
urement. Useful in antenna radiation, field strength, wave filter, noise and interference measurements, it can be used also as a general-purpose, low-power, portable transmitter and in production testing and measurement of uhf equipment. Frequency range is 200 mc to 2,500 mc with one simple band changeover. Varying power output depending on frequency is 50 w at 200 to 400 mc, 25 w at 400 to 1,000 mc, 10 w at 1,000 to 2,500 mc. The unit has a 50-ohm output impedance.



TINY CAPACITOR
of the electrolytic type

P. R. MALLORY & Co., INC., 3029 E. Washington St., Indianapolis 6, Ind., has available a subminiature electrolytic capacitor for hearing aids, miniaturized radios, personal page radios, and other transistor applications requiring high capacitance in a small container at low voltage. The Silverlytic capacitor is available in ratings of 0.1, 0.2, 0.3, 0.5 and 1.0 μf at 10 v d-c, and 2.0 μf at 5 v d-c and 4.0 μf at 4 v d-c. Its operating temperature range is —30 C to +65 C. Maximum leakage current measured in lab tests was 2 μa after 5 minutes application of rated voltage. The capacitor measures $\frac{3}{8}$ in. long × $\frac{7}{32}$ in. diameter. It may be mounted by its own leads, each of which is $1\frac{1}{2}$ in. long No. 26 bare, tinned copper.

COMPACT BRIDGE
measures pulse impedance

CLEGG LABORATORIES, INC., 142 So. Livingston Ave., Livingston, N. J. The PIB-100 is a compact, portable laboratory instrument for accurate measurements of impedance, and impedance-vs-time characteristics of networks, transformers, transducers, transmission lines and delay networks. The unit is direct reading with an accuracy of better than 1 percent in the range from 1 to 1,000 ohms. Characteristics of pulse components can be examined over the range from 0.1 to 100 μsec. The unit is particularly useful for measuring rate of change of impedance. Slopes as high as 10 ohms per μsec can be accurately evaluated. Provisions are included for independent use of the bridge section or the pulse generator section.

L-F OSCILLATOR
for 0.35 to 52,000 cps

KROHN-HITE INSTRUMENT CO., 580 Massachusetts Ave., Cambridge 39, Mass. Model 420-C low-frequency oscillator is designed for applications requiring a source of sine-wave and square-wave voltage in the range from 0.35 to 52,000 cps. Special circuits have been installed to eliminate transients after tuning or band-switching. Maximum output is 30 v peak to peak across a 1,000-ohm load. Features are low hum and distortion and good amplitude constancy. The wide frequency range makes the unit useful for servomechanism, geophysical and seismological work, for vibration checks and medical research, and for work with a-f circuits.

TOROIDAL COILS
in a wide range of sizes

F. W. SICKLES DIVISION OF GENERAL INSTRUMENT CORP., 829 Newark Ave., Elizabeth 3, N. J., offers a new line of toroidal coils in a wide range of sizes varying in

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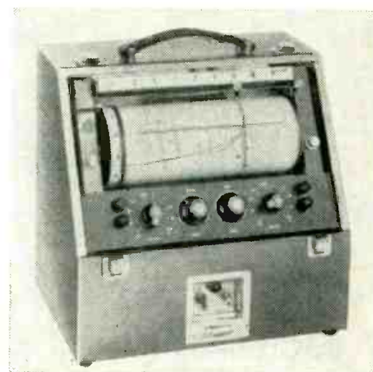
finished coil dimensions having a hole size of $\frac{1}{16}$ in. to coils with an 8-in. hole size using cores of small cross section. One of the outstanding features is the close electrical tolerances that can be held in production. Units can be wound to ±5-percent inductance, matched to a standard to 0.1-percent inductance or ±1 turn. The finished coils are available as uncased units, hermetically sealed or embedded to meet applicable MIL specifications. If desired, the coil can be incorporated in complete wave filters or networks designed to performance specifications or to the customer's own design.

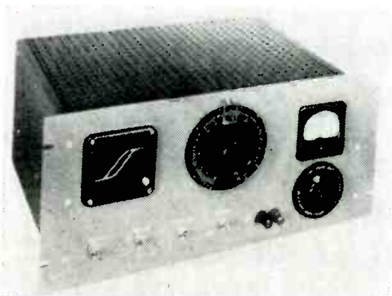


CURVE FOLLOWER plots Y = f(*X*) automatically

F. L. MOSELEY CO., 409 N. Fair Oaks Ave., Pasadena 3, Calif., has available the Autograf, a general purpose portable precision 2-axis graphic recording instrument. It generates, as a potentiometer setting, the function Y from a graph of the relationship Y = f(X). When used as a recorder, it plots instantly Y = f(X) through two independent rebalancing servo-actuated recording axes from data reduced to electrical form. The resulting cartesian coordinate graph is drawn in pen and ink on $8\frac{1}{2}$-in. × 11-in. graph paper. When used as a curve follower, the pen is replaced with a pickup stylus. Writing or reproducing rate is 10 ips.

VHF TV TETRODE has 25-kw power output

GENERAL ELECTRIC CO., Schenectady, N. Y., is now producing the GL-6251, a vhf tv tetrode with a gain in excess of 10 and a power output of 25 kw. Maximum ratings apply up to 220 mc. Since only 5 kw are needed to drive a pair of the tubes, low-power stations now on the air can increase signal strength to top levels at moderate cost by adding two of them in an amplifier stage. New transmitters may incorporate the tubes for a maximum antenna input power of 50 kw. Because of its ratings the tube also is well adapted to use in dielectric heating equipment. It has a metal-and-ceramic envelope, and employs water and forced-air cooling.



INDUCTANCE BRIDGE
includes a crt indicator

WATERS MFG., INC., 4 Gordon St., Waltham, Mass. Type 1002-A incremental inductance bridge is completely self-contained, including a crt indicator. No accessories are required. The instrument is ready for operation when connected to the power line. To operate, the adjustment of only one balance control is necessary. The range of values obtainable is 1 to 200 henries at ±3-percent accuracy. The operator can select d-c values of 1 to 500 ma. The unit has application for such uses as testing filter chokes, transformers, magnetic amplifiers and other iron-cored inductors in development laboratories, production lines and incoming inspection.

ALNICO ALLOY
has high energy product

THOMAS & SKINNER STEEL PRODUCTS CO., INC., Indianapolis, Ind., announces a new Alnico alloy offering an energy product of 5.70 x 10^6

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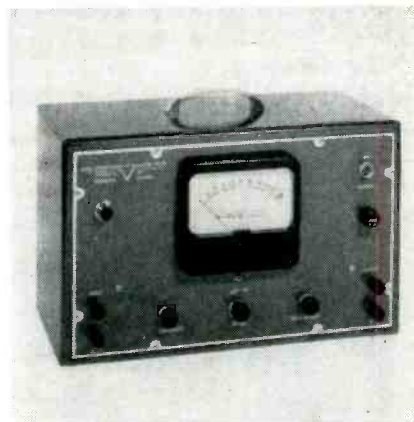
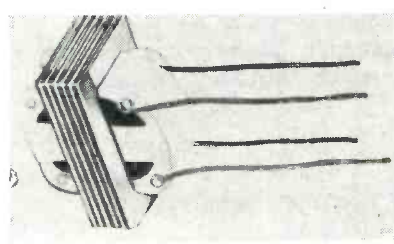
BdHd. Designated Alnico 5Cb, this alloy offers the highest energy product of any Alnico. It is similar in physical characteristics to Alnico 5, but offers considerably higher external energy and residual reduction. The new product is designed for electrical, electronic and industrial applications and opens new possibilities for weight and space reductions in product design.



NULL DETECTOR
has high input impedance

DELTRON INC., P. O. Box 192, Glenside, Pa. Model 200A null detector is a sensitive, wide-band, quasi-logarithmic voltmeter used as a balance indicator for a-c measuring bridges and as a signal-tracing voltmeter of large dynamic range. An on-scale range of 120 db (1,000,000 to 1) in addition to the logarithmic relationship between the meter reading and input voltage prevents overload for large bridge unbalance. The approach to null is never obscured. A single-page bulletin gives an illustrated description, along with chief features, technical specifications and price.



TINY TRANSFORMERS
for transistor circuitry

MICROTRAN CO., 84-11 Rockaway Beach Blvd., Rockaway Beach,

N. Y., has introduced a line of extremely miniature transformers designed for use in transistorized circuitry, such as hearing aids and radio paging units. They are available for input, interstage, output and choke applications. Size is $\frac{7}{16}$ in. x $\frac{1}{2}$ in. x $\frac{7}{16}$ in. Frequency response is flat from 300 to 10,000 cycles. Special units can be constructed upon receipt of customer's specifications.

BEAM POWER AMPLIFIER
is 7-pin miniature type

RADIO CORP. OF AMERICA, Harrison, N. J. The 12AQ5 is a beam-power amplifier of the 7-pin miniature type intended primarily for use in the output amplifier of automobile radio receivers operating from a 12-v storage battery. The application of directed electron beam principles in its design makes it capable of producing relatively high-power output with high sensitivity. For example, a single 12AQ5 operated with a plate and screen voltage of 250 v can deliver a maximum-signal power output of 4.5 w with a peak driving voltage of only about 12 v. These features, together with the relatively low plate-current drain, make the 12AQ5 especially suitable for use in the output stage of automobile receivers.

BRAZING POWDER
melts at about 3,450 F

AMERICAN ELECTRO METAL CORP., Yonkers, N. Y., has developed Mo-Braze for the brazing of Molybdenum and tungsten parts. Mo-

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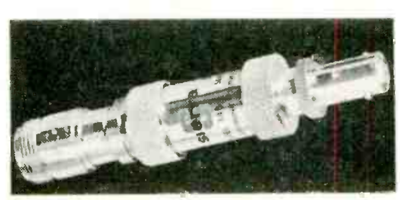
Braze melts at a temperature of about 3,450 F and forms a continuous and very strong braze upon solidifying. The brazed joint is formed quite rapidly, usually without oxidation of the part. Mo-Braze will not volatilize to any detectable extent at useful temperatures, whether in hydrogen or high vacuum. Tests for 1,000 hr and more in 10^{-6} mm mercury vacuum did not indicate any poisoning of the vacuum.

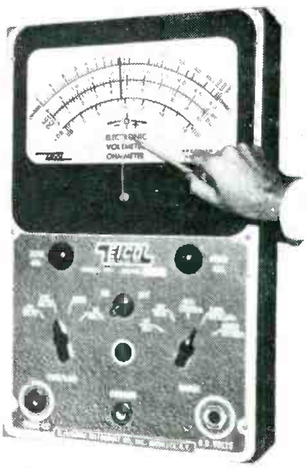
FREQUENCY CHANGERS are hermetically sealed

D&R, LTD., 402 E. Gutierrez St., Santa Barbara, Calif., is producing power frequency multipliers that change the frequency of line power without the use of rectifiers. Units are hermetically sealed and operate directly from a 400-cycle, 3-phase power line, delivering 2,000-cycles single-phase output at a conversion efficiency of approximately 75 percent. Model F-10 illustrated delivers 5 watts at 2,000 cycles with good regulation and with a harmonic content less than 7 percent.



CRYSTAL DETECTOR features sensitive readout

SIERRA ELECTRONIC CORP., 1050 Brittan Ave., San Carlos 2, Calif. Model 148 crystal detector makes available sensitive readout from vhf-uhf directional couplers. Typical sensitivity realizable with the instrument when used with a 50-μa, 1,140-ohm meter is at least 30 μa of rectified d-c output for an r-f input of 140 mv rms. It is designed for use with 50-ohm transmission lines operating at frequencies from 30 to 1,500 mc. The instrument includes a 1N21B crystal and a built-in low-pass output filter.

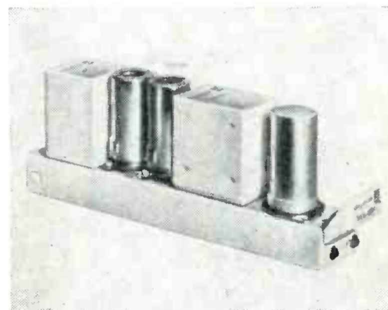


DEMONSTRATOR
for instruction in vtvm's

ELECTRONIC INSTRUMENT CO., INC., 84 Withers St., Brooklyn 11, N. Y., has available a dynamic demonstrator which is a special giant replica of the model 221 vtvm. Its actual size is 14¾ x 23 x 3⅛ in. It features movable function and range switches, and a settable dial pointer . . . thus enabling the instructor to explain easily and graphically to a large group how readings are taken with the instrument, and to test students on same.

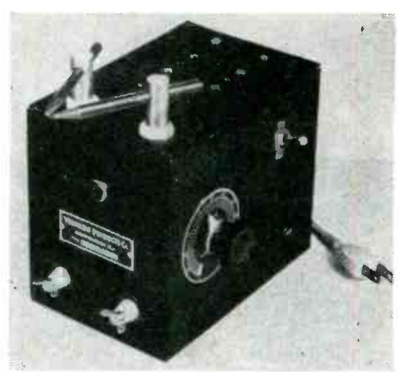
SHIFT REGISTER
is space-saving unit

RAYTHEON MFG. CO., 148 California St., Newton 58, Mass. This single-stage 100-kc magnetic shift register is an extremely compact unit designed, miniaturized and packaged for space saving, reliability and ease of installation. All long-life components are sealed in a plastic case except the diode which is readily removable. It runs at a power level less than ¼ w per stage at maximum frequency of 100 kc. It has a 16-v output with one-zero ratio of 5 to 1. Minimum load impedance is 7,500 ohms. Wide margins of operation provide exceptional circuit stability.



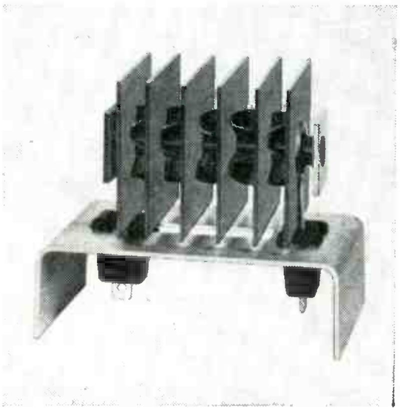
TINY PREAMPLIFIER
features plug-in design

LANGEVIN MFG. CORP., 37 W. 65th St., New York 23, N. Y. Model 5116 is a miniature plug-in two-stage, low-noise preamplifier or booster amplifier. It is ideal for installation in consoles and equipment racks. A new catalog now available from the company discusses amplifiers, power supplies and transformers for radio and tv broadcast, recording studios and sound systems.



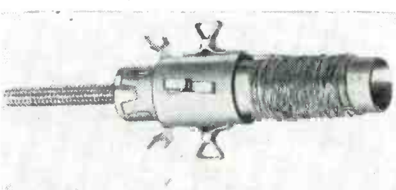
SOLDERING UNIT
adaptable for a-m connectors

VEMALINE PRODUCTS CO., P.O. Box 222, Hawthorne, N. J. Model J-5 Glo-Point soldering unit, with adjustable heat control, is very adaptable for soldering a-m connectors, terminals, subassemblies, butt soldering and terminal boards. Timing attachments and ground plates are also available for the unit. Binding posts for the use of the H-1 or H-2 electrode holders can be used to make the unit more practical. A single-page bulletin illustrates and describes this unit as well as the model J-4, and also gives a complete price listing.



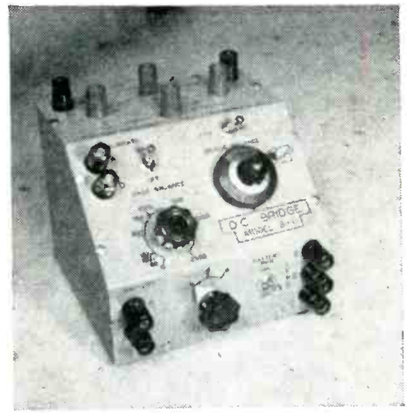
SELENIUM RECTIFIER
is plug-in type

CINCH MFG. CO., Chicago, Ill. This recent development in the selenium rectifier field facilitates field replacement of selenium rectifiers, particularly the types commonly used in radio and tv receivers. The rectifier lugs are polarized for proper circuit connection and are so designed that vibration or shock will not cause the rectifiers to fall out of the socket. It is possible to mount the plug-in rectifier in a conventional manner and solder to the lugs.



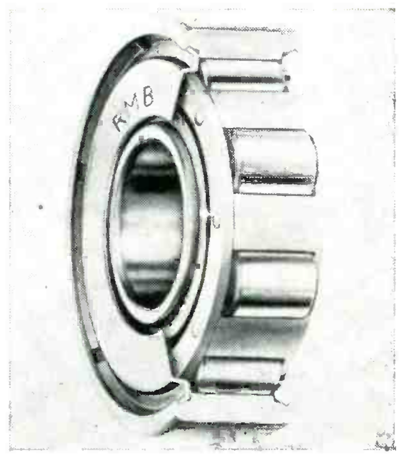
COLOR TV COMPONENTS
for lab and prototype use

CREST LABORATORIES, INC., Rockaway Beach, N. Y., has introduced a line of variable inductances suitable for use with the latest color-tv circuitry, as shown in the NTSC published schematics. These variable inductances are designed for both laboratory and prototype usage. Additional information will be furnished upon request.



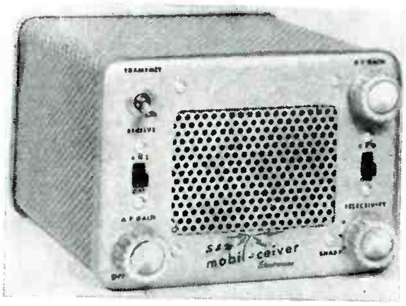
D-C BRIDGE
is a general-purpose unit

ALLEGANY INSTRUMENT Co., 1,000 Oldtown Rd., Cumberland, Md. The model B-1 d-c bridge was designed as a general-purpose unit for wire strain gages and transducers. Balance is effected by a 10-turn potentiometer for all gage resistances in the range of 60 to 2,000 ohms. Input is for 1, 2 and 4-arm gages and transducers.



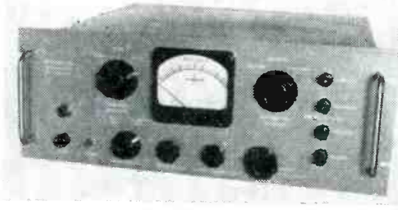
ROLLER BEARINGS
in seven tiny sizes

LANDIS & GYR, INC., 45 W. 45th St., New York 36, N. Y., announces miniature roller bearings in 3 types and 7 sizes from 0.4724 in. to 1.0236 in. o.d. Identified as RMB types N, NU and NP, they are especially suitable for use in all kinds of apparatus, machines and motors where shafts are subjected to heavy radial loads. The roller assembly is retained by a snap-ring on the inner race and a section of the shield at the outer race. This eliminates necessity of a lip on either raceway and permits production of a perfectly cylindrical race, and a superfine finish on the latter's rolling surface. In type NP (illustrated) the outer and inner races are permanently assembled. This bearing permits location of the shaft axially, provided the axial stresses are slight.



MOBILE RECEIVER
for use with converters

S & W ELECTRONICS, 3418 W. Pico Blvd., Los Angeles 19, Calif. The Mobile-Ceiver is a compact fixed-tuned receiver designed for use with mobile converters. When used with a converter it becomes a double-conversion superhet. It has variable selectivity of 5, 10 or 16 kc. The stable oscillator can be adjusted for any input frequency between 1,400 and 1,600 kc. No crystal is required, thus the frequency may be shifted when necessary to avoid troublesome beats with local broadcast stations with resultant heterodynes.



NOISE GENERATOR
for test and studies

STATISTICAL INSTRUMENT CO., P.O. Box 552, Church St. Station, New

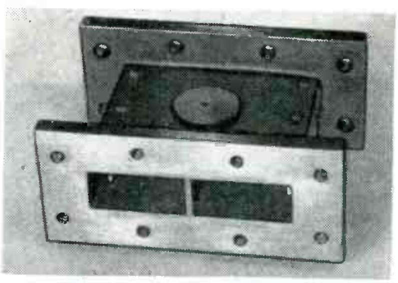
York 8, N. Y. Model RUG-1-10 low-frequency noise generator makes available for simulation studies and test purposes a random voltage source of controlled frequency spectrum and probability distribution. Examples of its use are: a study of random air-load effects in airframe design, noise problems in missile guidance, study of the statistical properties of ground electromagnetic reflection, and low-frequency phenomena including chemical and thermal processes and certain bio-electrical effects. Frequency coverage is from 0 to 10 cps in three steps for the Guassian, Rayleigh and uniform distributions. The unit will deliver approximately 5 v rms at the wide bandwidth and 1 v at the narrow setting and is continuously variable to 0.1 v accuracy.

HEAVY-DUTY RELAY for control applications

LEACH RELAY Co., 5915 Avalon Blvd., Los Angeles 3, Calif. Part No. 9191 heavy-duty relay is designed for electrical and electronic commercial and industrial control applications. This compact, lightweight, rugged relay is capable of handling heavy contact loads with low coil-power requirements. Its double-break contacts provide a large gap to extinguish the arcing associated with heavy loads. Insulation and spacing meet UL requirements for industrial control equipment. Contact life exceeds requirements for UL temperature indicating and regulating equipment. Multiple mounting holes in the bracket allow the relay to be mounted from above or below mounting surface as required. Contacts are spst—normally open, double break.

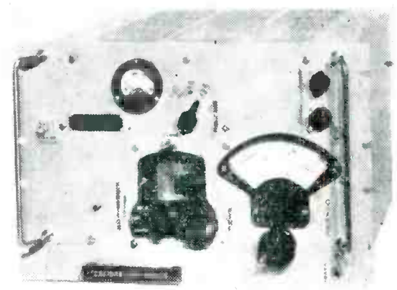
D-C POWER SUPPLY
occupies small space

Allied Engineering Div., Allied International Inc., Connecticut & Richards Aves., South Norwalk, Conn. Model 302 power supply furnishes precise regulation with low ripple and minimum magnetic radiation. Designed to conserve bench space, its dimensions are 8 in. x 5 in. x 5½ in. Two outputs are available: (1) From 150 to 350 v at 0 to 80 ma, with either positive or negative grounded to chassis. Regulation is more than ±0.05 percent against line and load variations within specifications. (2) From 0 to 150 v at 0 to 5 ma, with positive internally connected to the negative of output No. 1. Regulation is better than ±1.0 percent against line variations only. Ripple is less than 3 mv. Ambient temperature range is 0 to 40 C.



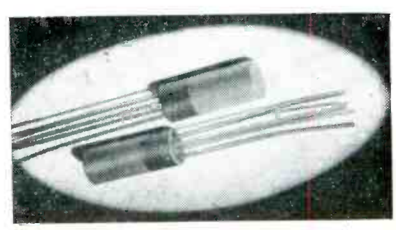
SHORT-SLOT HYBRID
for radar applications

Airtron, Inc., Linden, N. J., have available a complete series of fabricated short-slot hybrids for modern radar applications. Their application in connection with mixers, power splitters, directional couplers, phase shifters and duplexers make for compact mechanical layout and simplicity. These components, with miniaturized dual-contact flanges, are adaptations of the proposed RETMA contact-flange types designed for unpressurized service. Without sacrificing electrical performance, these flanges make it possible to adapt any arrangement of components. Adapters and accessories are available for use with these short-slot hybrids. Engineering Report RR585 may be obtained upon request.



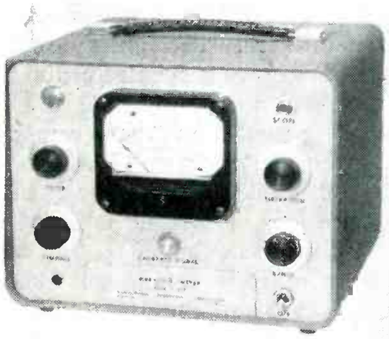
FREQUENCY METERS cover from 10 to 2,000 mc

LAVOIE LABORATORIES, INC., Morganville, N. J., has introduced three new precision frequency meters accurate to 0.001 percent, which cover ranges from 10 to 2,000 mc. Model LA-5 provides frequency measurements at 10 to 100 mc; model LA-6, at 100 to 500 mc and model LA-61 at 500 to 2,000 mc. All units are extremely rugged and compact, being only two cu ft in volume. Each operates under both field and laboratory conditions.



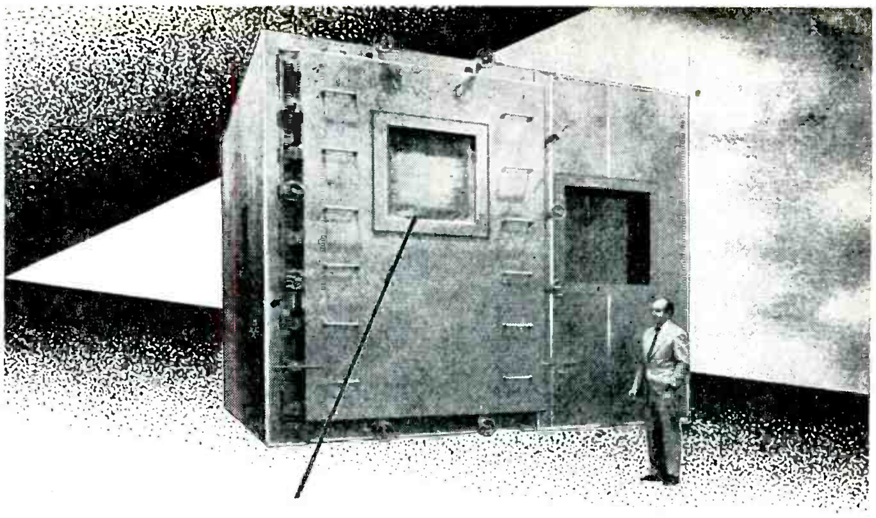
COIL CORE for printed circuitry

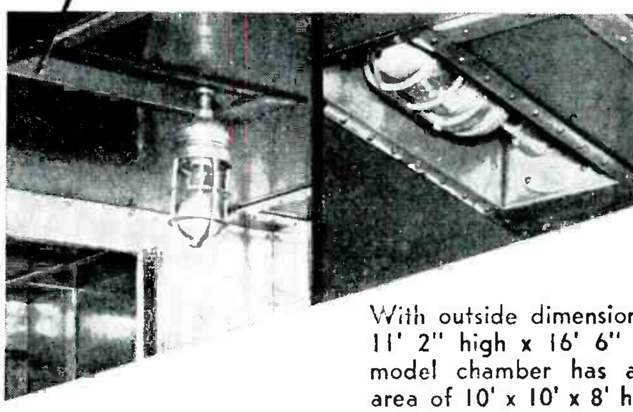
HENRY L. CROWLEY & CO., INC., One Central Ave., West Orange, N. J., has announced a new h-f powdered iron core designed for use with printed circuits. It lends itself to the dip-soldering process used in many radio and tv receivers, as well as component printed circuits. The core consists of an upper section of powdered iron available in any of the many types suitable for practically any frequency application. Bonded to the iron core and of the same diameter is a phenolic insulator base. Four wire leads, imbedded in the phenolic section serve as leads for the two coil windings and allow quick and easy mounting of the unit when used on a phenolic base in printed wiring.



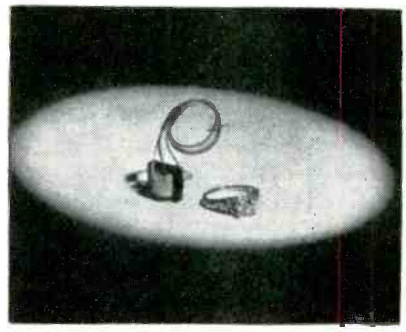
VIBRATION METER
for critical testing

CONSOLIDATED ENGINEERING CORP., 300 N. Sierra Madre Villa, Pasadena 8, Calif. Type 1-117 vibration meter may be used for on-the-spot field tests, trouble shooting, in the laboratory, or as a go-no-go gage for production quality-control testing. The meter weighs only 25 lb with three accessory filters installed and can be used wherever standard 115-v, 50, 60 or 400-cycle power is available. Suitably matched self-generating pickups are the only external items required for its operation. Dimensions are 8¼ in. high, 10½ in. wide and 9½ in. deep. Where unwanted low-frequency signals interfere with the desired frequency, three accessory high-pass filters may be used to cut off sharply at 30, 70 or 110 cps. These filters plug into the case and add nothing to its external dimensions. Measured values of both linear and torsional velocity of motion and peak-to-peak



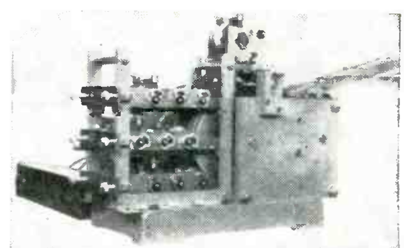


displacement are indicated on a direct-reading scale.



TINY TRANSFORMERS measure ½ in. x 7/16 in.

THE WHEELER INSULATED WIRE CO., INC., Waterbury, Conn., has produced an entirely new series of extremely compact demi-miniature transformers. The units are designed to meet requirements for transistor audio uses, and the increasing need for extreme compactness in printed-circuit systems for control, guided missile and similar applications. Assembly is based on nickel alloy laminated cores, with fine wire coils wound on molded nylon bobbins. Special techniques are employed in terminating windings to insure maximum protection to leads. Transformers are varnish-treated with 3-in. color-coded leads. They can be supplied in metal shells, hermetically sealed, and with No. 22 tinned leads soldered to header terminals, to facilitate printed circuit assemblies.

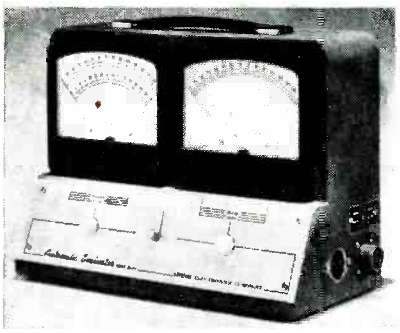


MARKING MACHINES are fully automatic

POPPER & SONS, INC., 300 Fourth Ave., New York, N. Y., now offer the latest addition to their line of Rejafix marking machines—a new, fully automatic machine that prints color bands around resistors, fuses and similar components in up to 8 colors, at a production rate of up to 9,000 pieces per hr, depending on the size and shape of the article. One of the color bands can be replaced by printing matter such as letters, numerals and trademarks.

TRANSFORMER TESTER
detects shorted turns

RADIO CITY PRODUCTS CO., 152 W. 25th St., New York, N. Y. Model 123 Flybacker is a new instrument for testing the condition of flyback transformers and yokes in the horizontal-output circuit of tv receivers. It detects shorted turns and shows up short-circuited windings. A large clear front meter indicates on a good-bad scale conditions which could not be detected through an ohmmeter continuity test.

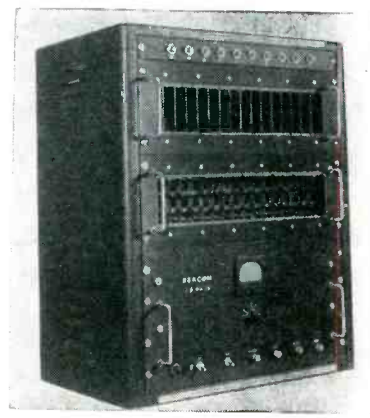


AUTOMATIC EVALUATOR
is easy-to-use accessory

BRUSH ELECTRONICS CO., 3405 Perkins Ave., Cleveland 14, Ohio. Model

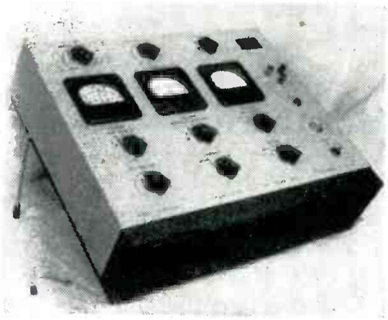
Want more information? Use post card on last page.

BL-814 automatic evaluator is a direct-reading accessory for use with the company's uniformity analyzer, an instrument that accurately measures and permanently records on paper the variations in weight per unit length of yarn, roving and sliver. It is a portable, easy-to-read device that indicates the same average peak-to-peak readings that otherwise would be obtained from chart calculations. This accessory enables an operator to obtain complete nonuniformity data from a 1,000-ft sample of yarn in 3½ minutes and practically eliminates the need for time-consuming chart calculations.



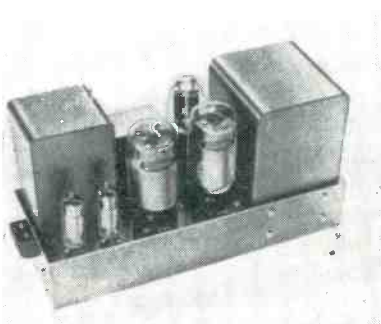
DATA CONVERTER
for automatic industry use

J. B. Rea Co., 1723 Cloverfield Blvd., Santa Monica, Calif., has announced an automatic high-speed, analog-to-digital converter for industrial firms and governmental agencies with instrument data handling problems. Built for continuous duty, it requires 115 v, 60 cycle, single-phase power. The Reacon operates with inputs directly from strain gages, thermocouples, resistance thermometers, and other devices producing low-level d-c voltages. A digital output count proportional to the input voltage is recorded on either a magnetic drum memory, a storage-type magnetic tape recorder, or on other recording media, depending on the application. The digital output can be recorded on magnetic tape at the rate of 8,000 pieces of information per sec from a continuous channel or at the rate of 640 pieces of information per sec from a number of pickups being sampled in sequence. Information can be taken at intervals selected manually or at preselected intervals from an intervalometer.



TRANSISTOR TESTER
is self-contained unit

OWEN LABORATORIES, 412 Woodward Blvd., Pasadena 10, Calif. Type 210 transistor test set is a completely self-contained instrument intended for use in the circuit laboratory, inspection department, and on the production line. It measures the equivalent circuit parameters of both junction and point-contact units over a wide range of d-c conditions. No accessory equipment is necessary, and operation is simple and straightforward. The unit is designed to be of maximum value in the design and development of transistor circuits, giving quickly and directly the most useful and easily applied information.



AUDIO AMPLIFIERS
for monitoring purposes

BEAM INSTRUMENTS CORP., 350 Fifth Ave., New York, N. Y., has available the new Acoustical QUAD II amplifiers for monitoring use by broadcast operators. They feature 1 to 4 v input for 15-w output,

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20 to 20,000 cps inclusive within 0.2 db; a 14-section output transformer and balanced feedback with complete stability; low noise level —minus 80 db at 15 w. Total distortion with 25-percent tube mismatch is less than 0.25 percent. Weight is 18½ lb. Size is 13 in. × 4¾ × 6½ in.

Literature

Unit Amplifier. General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass. Volume 28 No. 6 of the Experimenter illustrates and describes type 1206-B unit amplifier designed for general laboratory use. Complete circuit diagram, operating characteristics, uses and specifications are given. Also included in the bulletin are an article on oscillator considerations and one on electrolytic capacitor testing at 120 cycles.

Chemo-Carbon Resistors. Arnhold Ceramics, Inc., 1 E. 57th St., New York 22, N. Y. A single-sheet bulletin illustrates and describes Stemag Chemo-Carbon subminiature and miniature resistors. Tabular information gives dimensions and resistance (dependent on rating and tolerance). Included are diagrams showing styles, full technical data, and a listing of the various types of Chemo-Carbon resistors available.

Deposited Carbon Resistors. Arnhold Ceramics, Inc., 1 E. 57th St., New York 22. N. Y., is distributing a single-page bulletin illustrating and describing Radiac high-stability deposited-carbon resistors. The resistors discussed are available in wattages from ⅛ to 4 w and come in tolerances of ±1, ±2, ±5, ±10 and ±20 percent. All types described are provided with a molded insulation which completely covers the resistor element and guarantees a good protection against mechanical damages.

Test Equipment. Heath Co., Benton Harbor, Mich., has published its 1954 catalog covering a line of electronic equipment for testing amplifiers, receivers and amateur radio. Fifty-two different instruments available in kit form are indexed and illustrated. Chief features, design information, specifications and applications are given. Prices are included.

Microwave Test Equipment. NARDA-Nassau Research & Development Associates Inc., 66 Main St., Mineola, N. Y. An 8-page catalog presents the company's line of microwave test equipment for general laboratory use. Descriptions, illustrations and specifications are included. A price list covering all items is attached to each catalog.

Molded Boron-Carbon Resistors. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. Catalog bulletin B-8 deals with molded Boron-carbon resistors (type MBC). Comprehensive data on characteristics, applications, tolerance, windings, terminations, dimensions, insulation, charts and graphs are given.

UHF TV Transmission-Line Equipment. Radio Corp. of America, Camden 2, N. J. A 28-page catalog describes new low-loss coax transmission lines and fittings for uhf tv broadcasting stations. The illustrated booklet (Form B. 767) provides important information on $3\frac{1}{8}$ and $6\frac{1}{8}$-in. transmission lines, fittings and accessories with complete tables of efficiencies for channels 2 to 83, inclusive, for distances ranging from 100 to 1,600 ft. In addition to complete technical specifications, the brochure provides important information on layouts and installation.

Magnetic Impulse Counter. Kellogg Switchboard and Supply Co., 79 W. Monroe St., Chicago 3, Ill., has issued a 4-page folder illustrating and describing its magnetic impulse counter. The countless applications of the unit described include computer design, industrial control, selective signalling, simplified circuitry, and vhf radio and microphone.

Curve Follower. Goodyear Aircraft Corp., Akron 15, Ohio. A 4-page folder discusses the T1 GEDA

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that combines a function generator (input unit) and a function plotter (output unit) in a single compact instrument. A radical departure from conventional input units, the T1 illustrated and described generates functions from continuous pencilled graphs, including curves having small step discontinuities, into proportional voltages for direct introduction to differential analyzers. Complete specifications are given for function generator and function plotter.

Power-Line Carrier. Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa. The complete line of power-line carrier equipment (type FD) is described in the 12-page booklet B-5873. Some features of the equipment described are improved receiver selectivity, operation from station batteries, filament-current regulation and accessibility of assemblies. Use of carrier for relaying, telemetering, supervisory control and voice communications is discussed.

R-F Noise Suppression Filters. Aerovox Corp., New Bedford, Mass. High reliability r-f noise suppression filters of high current ratings and high attenuation, compactly housed in hermetically-sealed metal cases are dealt with in the bulletin "Aerovox R-F Noise Suppression Filters." The bulletin lists seven filter types, together with their dimensions and drawings, electrical factors, attenuation curves and approximate weights.

Uniformity Analyzer. Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio. A 4-page folder tells how quality control of yarn, roving and sliver is provided by the company's uniformity analyzer. The electronic instrument described and illustrated consists of an amplifier, measuring heads, a direct-writing oscillograph, a material drive unit and the necessary material handling equipment.

Photoelectric Relays. General Electric Co., Schenectady, N. Y. Two 4-page bulletins discuss a line of photoelectric relays. Bulletin GEA-5920 covers the CR7505-K201 and K202 types designed for up to

450 operations per minute. Bulletin GEA-5921 deals with types CR-7505-N210 and 211 units meant for use at up to 600 operations per minute and featuring high sensitivity and high speed. Both bulletins are well illustrated contain chief features of the units, accessory information and application data.

Inaugurating Color TV. Telechrome Inc., 88 Merrick Road, Amityville, L. I., N. Y., has published a brochure entitled "Color TV—How to Inaugurate It With Minimum Investment." Included are block diagrams and descriptions of three packages of NTSC color signal generating, testing, analyzing and monitoring equipment.

Bimetal Disk Thermostats. Stevens Mfg. Co., Inc., 69 S. Walnut St., Mansfield, Ohio, announces a bulletin describing the company's line of type-M bimetal disk thermostats for appliances, electronic devices and apparatus. Hermetically sealed and open types are discussed. Punched for insertion in standard 3-ring binders, bulletin F-2009 describes the operating principle and illustrates it with a schematic diagram. Ratings, typical performance curve, dimensions, construction, and various available terminal arrangements are shown in diagrams, tabular data and photographs.

I-F Transformer and TV Coils. Electrometric, Inc., Woodstock, Ill., has issued a new catalog page. One side gives detailed information on type TX100 miniature i-f transformer for any application requiring a ¾-in. i-f transformer. Clearly illustrated is the single-end tuning whereby both coils can be tuned from the same end, either from the top or from the bottom. The other side describes a complete line of tv coils, including 40-mc i-f coils, trap coils, sound-takeoff coils and ratio-detector coils. Illustrated in the catalog are six standardized coils available for immediate delivery.

VTVM and Tube Testers. The Hickok Electrical Instrument Co., 10527 Dupont Ave., Cleveland 8, Ohio. Form 209A2 (a 4-page bulletin), lists technical specifications and uses of the multipurpose model-209A capacitance tester and

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v-t volt-ohm-milliammeter. A 4-page form TT5A1 describes ten dynamic mutual conductance tube testers including those for the radio and tv technicians as well as the highly accurate design lab and final manufacturing inspection line models. Graphic explanation is included.

Radio Compass Control Panel. North American Philips Co., Inc., 750 S. Fulton Ave., Mt. Vernon, N. Y., has available a bulletin giving technical information on a miniaturized radio-compass control panel. Dimension drawings and circuit diagrams are included in the bulletin for the ED-100 and ED-200 models which provide for complete control of a receiver ARN-6 from a remote location by electrical or mechanical coupling. The bulletin covers a new control panel which is exactly half standard control size. It measures 5¾ in. × 4½ in. × 4 in.; weighs 2.8 lb; is designed for console or rack mounting, and conforms to latest MIL specifications.

Twin Magnetic Receiver. Telex, Inc., Telex Park, St. Paul, Minn., has issued a two-color, 8½ x 11-in. catalog sheet on its Twinset. The twin magnetic receiver described weighs only 1.6 oz and it operates through two receivers resting on the temples (not on the ears) piping the sound through a slender, tubular sound arm directly into the ear. The catalog sheet lists the specifications and advantages of the Twinset and explains its many professional, business and technical uses from stenography to aviation.

Subminiature Capacitors. Dumont-Airplane & Marine Instruments, Inc., 15 William St., New York 5, N. Y. Catalog No. 53 is a 20-page booklet illustrating and describing a line of Milcaps (glass-to-metal hermetically sealed subminiature capacitors). Included are an identification guide, catalog numbering system, application data, temperature characteristics, construction notes, styles and engineering data.

High-Performance Plastics. Flek Corp., 2252 E. 37th St., Los Angeles 58, Calif., offers a new illustrated brochure describing the company's services and facilities for precision molding and extrusion of Kel-F, Teflon and Nylon. Applications for each of the plastics are given.

Accelerometer. Gulton Mfg. Corp., Metuchen, N. J. A single-page bulletin covers the model-105 accelerometer designed for high impact shock measurements. The unit described and illustrated is useful to 5,000 g and is extremely rugged. It features excellent sensitivity and high accuracy. Characteristics are given.

TV Picture Tube Chart. Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y., has released a revised version of its tv picture tube comparison chart. Over 160 different picture tube types are listed. Added informational features in the chart include ion-trap listings and base diagrams. Face, body, focus, deflection angles, basings and length in inches on all tubes are also given.

Rotary Electric and Electronic Equipment. Mission-Western Engineers, Inc., 132 West Colorado Blvd., Pasadena 1, Calif., has prepared a new bulletin of essential data and information on rotary electric and electronic equipment, as an aid to engineers, designers and users of electric equipment. Write on your company letterhead for bulletin No. 153.

Magnetic Tape Splicing. Minnesota Mining and Mfg. Co., 900 Fauquier St., St. Paul 6, Minn. Splicing techniques for magnetic tape are covered in Sound Talk bulletin No. 26. The 3-page technical bulletin discusses general considerations in magnetic tape splicing including the solutions to such problems as splice weakness, loss of recorded signal due to poor head contact and adhesive transfer causing sticky layers. Detailed instructions for splicing magnetic tape for audio recording are given, as well as information on splicing critical recordings used in computer work and instrumentation.

Nondestructive Testing Instruments. J. W. Dice Co., 1 Engle St., Englewood, N. J. Bulletin 32 pictures a line of unusual nondestruc-

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tive and physical testing and measuring instruments for quality control. Included are metal-testing instruments, tramp metal detectors, electronic micrometers, power-equipment testers and pressure-measuring equipment.

Test Set. Gulton Mfg. Corp., Metuchen, N. J. Bulletin KA-1A covers the Glennite KA-1 test set, a unit designed specifically to meet rigid Signal Corps requirements. The accelerometers included in the unit illustrated and described have been made extremely rugged by the use of stainless steel housings. Also announced in the bulletin is the company's series of aluminum accelerometers for use with the same units. Technical specifications are given.

Synchronizing Generator. Dage Electronics Corp., 69 N. Second St., Beech Grove, Ind. Bulletin 400-A-1 illustrates and describes a sync generator of ultra-portable design for field or studio use. Output of the unit discussed is 4 v negative peak-to-peak at 75-ohm impedance. The generator described measures 14 in. $\times$ 9⅜ in. $\times$ 4⅝ in. and weighs less than 20 lb. Power required for operation is approximately 100 w.

Kits and Instruments. Electronic Instrument Co., Inc., 84 Withers St., Brooklyn 11, N. Y., has released its 1954 catalog listing and illustrating the complete EICO line of 30 kits and 33 factory-wired instruments. Features, specifications and applications are given for each instrument. The catalog also describes the company's engineering laboratories, quality control department and other facilities.

Cord Sets. Whitney Blake Co., New Haven 14, Conn., has available bulletin CS-1, a 12-page design guide for custom-built cord sets. Developed primarily for design engineers, the bulletin illustrates the standard molded parts available, including male plugs, female connectors, strain reliefs and junction boxes, and the types of flexible cord on which they can be molded by this company. In addition, one section of the bulletin shows what information must be supplied by the customer when ordering a cord set and, if there are no unusual features, allows him to sketch the cord set he desires by tracing the illustrated components without the necessity for having a blue-print made.

Module Cabinets. Hudson Bay Division, Refrigeration Systems, Inc., 646 W. Washington Blvd., Chicago 6, Ill., has published a 2-page bulletin dealing with a line of module cabinets for operation at temperatures down to —100 F. Each of the three models of the 0.8 cu-ft mechanically refrigerated unit described is available for operation in a different temperature range. The bulletin covers the application of the unit in the cloud-and-pour testing of petroleum products as well as for general laboratory testing and processing. The side-by-side module arrangement of cabinets according to the user's requirements is also illustrated.

Pneumatic Time Delay Relays. Elastic Stop Nut Corp. of America, 1027 Newark Ave., Elizabeth, N. J. Bulletin SR-3 covers a complete line of solenoid-actuated, pneumatically-controlled time delay relays. The 4-page illustrated catalog describes two basic types of Agastat relays: one with time delay beginning when the coil is energized; and one with time delay beginning when the coil is deenergized. The catalog includes mounting dimensions and wiring diagrams. Typical applications, from elevator and traffic controls to jet plane ignition systems, are listed.

Service Replacement Capacitors. Cornell-Dubilier Electric Corp., South Plainfield, N. J. All the data for any of the 134 types of C-D replacement capacitors is presented in clear, concise form in a new 36-page catalog. The items listed have been selected for broad coverage in each class, yet are streamlined to cover the practical day-to-day requirements of the radio, tv, electrical and electronic service industry. Many of the capacitors listed will also be of interest to industrial and experimental users. Information includes specifications, diagrams, photographs and prices

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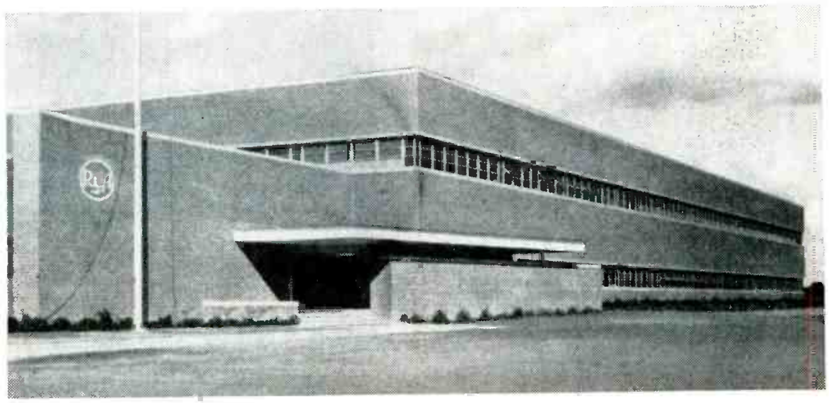
PLANTS AND PEOPLE

Edited by WILLIAM G. ARNOLD

Electronic manufacturers continue plant expansions . . . Associations and universities announce new activities . . . Engineers and management executives are promoted . . .



New Military Radar Engineering and Development Plant Opened by RCA Victor

A TRANSISTORIZED transmitter was used by L. W. Teegarden, executive vice-president of RCA, to raise a flag at the dedication ceremony of the firm's new radar plant in Moorestown, N. J.

The plant was established to handle expanded government study and production projects in radar engineering. Its projects will include the conception, development and design of all types of ground and marine radar equipment, according to W. Walter Watts, vice-president in charge of technical products. Projects range from basic studies of possible new developments to final production design of complete equipments, it was stated, and are undertaken for virtually all branches of the military service.

The plant buildings, containing more than 145,000 sq ft of floor space, occupy a portion of a 420-acre tract acquired by the company in Morrestown, N. J. The additional acreage was required to provide the necessary separation of terminals for transmission of test signals, but the unused land between transmission points is being rented to local farmers for cultivation.

The plant already employs about 600 men and women. Separate laboratories are provided for general engineering of various radar activities. The heavy equipment laboratory is four stories high and equipped with a five-ton crane to handle massive units of equipment. Outside the antenna test lab, housed in its own building a mile away from the main structure, is a two-story hoist on a track for use in raising heavy antennas to the roof for performance measurements. The model shop is fitted with the newest machines and other equipment for turning out accurate developmental prototypes of appara- from engineering designs. A self-service stockroom contains, in indexed bins, more than 64,000 different items.

RCA Victor also started construction on a group of buildings to serve as administration and laboratory headquarters for its Home Instrument and Service Company activities.

The project, which was almost a year in planning, will contain five inter-connected buildings and will be located on a 58-acre tract in the suburban Cherry Hill section of Camden. It is scheduled for completion in the fall of 1954.

About 1,400 persons will be housed in the buildings, including the engineering and administrative staffs of the RCA Victor Home Instrument Department, which have been located at their present site in Camden since 1898.

The project will also accommodate the main laboratory and office facilities of the RCA Service Co., now located in Gloucester, N. J.

The buildings, which will provide 325,000 sq ft of office and laboratory space, have been designed in line with the modern trend toward landscaped business structures.

California Polytechnic Surveys Its Graduates

RECENT graduates of the electronics engineering department of California State Polytechnic college are finding it much easier to find good paying jobs than their predecessors did.

Statistics recently compiled by a

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department survey show that the growth of the electronics industry in California has made it unnecessary for electronic engineering graduates to go east for employment. However, employment in the east still has an attraction because of the extended training programs offered by some of the large companies, according to Clarence Radius, department head.

The survey shows: Salaries for engineers began their upward trend in 1950. Average starting salaries received by engineers from Cal Poly during 1953 compared favorably with those received by graduates of engineering of other schools. New York University reports $345, Illinois Institute of Technology $362 and Cal Poly $355.

Cal Poly electronic engineering graduates seem to prefer to remain in California to ply their trade. Only 19 percent of the graduates have elected to work elsewhere. More than 25 percent of the graduates work in aircraft electronics. More than 21 percent work for electronic equipment manufacturers.

Homer R. Oldfield

Walter Hausz

A. Donald Arsem

General Electric Appoints Three Laboratory Engineering Managers

HOMER R. OLDFIELD, JR. was appointed manager of plans and product applications in the newly formed laboratories department of GE's Electronics Division. He had been manager of the GE advanced electronics center at Cornell University.

Walter Hausz was appointed manager of the advanced electronics center at Cornell University. He had been manager of development engineering in the GE electronics laboratory at Syracuse.

A. Donald Arsem was appointed manager of advanced products development engineering in the GE electronics laboratory in Syracuse. He has served in the laboratory on electronics applications for guided missiles and had been section engineer on magnetic materials since November, 1952.

Oldfield was a research associate and instructor at MIT prior to World War II and was in charge of the instrument laboratory. From 1941 to 1945 he held key posts as chief of the electronics section of the Anti-aircraft Artillery Board and was in charge of the Air Force program for developing airborne fire control radar systems. He joined GE in 1945 as manager of Electronics Division sales to the Air Force. He became manager of the advanced electronics center at Cornell when it was created in January, 1952.

Hausz joined the electronics laboratory at Schenectady in 1945 and specialized in guided missile work until 1948. He has held positions as section engineer, assistant to the manager and sections head. He became manager of development engineering in 1952.

Arsem joined GE's electronics laboratory in 1948 after service with the National Bureau of Standards and with the Radio Corporation of America.

Los Angeles WCEMA Elects Officers

THE West Coast Electronic Manufacturers' Association, Los Angeles Council, selected E. P. Gertsch of Gertsch Products as chairman for 1954.

R. G. Leitner of Packard-Bell was named vice-chairman of the group and Gramer Yarbrough of American Microphone became secretary-treasurer. New directors are: Ed Grigsby of Altec-Lansing; Don Duncan of Helipot; W. V. Phillips of Hoffman and Thomas J. Walker of Triad Transformer.

The WCEMA organization has a total of over 160 member companies throughout the West. There are two councils, the other being in San Francisco.

Environmental Equipment Group Elects Officers

THE INSTITUTE of Environmental Equipment Manufacturers elected the following officers: Monroe Seligman of Tenney Engineering, president; C. M. Shelburn of Webber Manufacturing, executive vice-president; R. S. Jamison of Sub-Zero Products, vice-president of the

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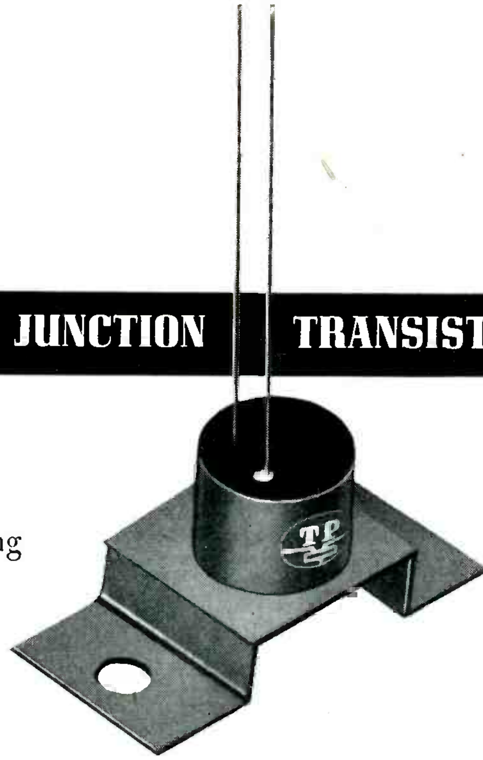

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Input impedance (base-base) approximately	10 ohms
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low temperature division; Albert J. Deeb of International Radiant, vice-president of the high altitude division; David H. Leatherman of Bemco, vice-president of the special equipment division.

IRE Group On Component Parts Formed

A COMPONENT parts professional group has been organized in the Institute of Radio Engineers for the purpose of promoting continued improvement of electronic components and providing channels for exchanging both functional and environmental test information on component parts among research, development and production organizations. Membership is open to all IRE members.

Floyd A. Paul of Northrop Aircraft has been elected chairman of this group whose field of interest includes the characteristics, limitations, applications, development, performance and reliability of component parts.

The group, with the cooperation of AIEE, RETMA, WCEMA, the U. S. Department of Defense and the National Bureau of Standards, will sponsor the Electronic Components Symposium scheduled to be held in the auditorium of the Department of Interior in Washington, D. C., on May 4, 5, 6, 1954. Session topics to be presented are as follows: First session: The Executive Views Components; Second: Relationship of Materials Developments to Component Progress; Third: Automation-Its Impact on Components; Fourth: Solid State Devices and Companion Components; Fifth: New Frontiers In Component Development; Sixth: Component Requirements For Computers, Color TV, Guided Missiles

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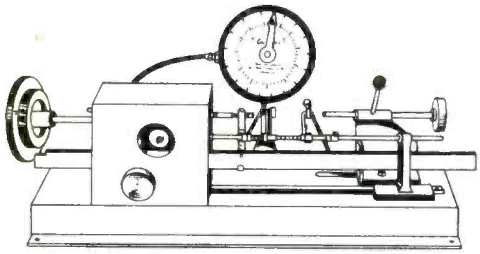

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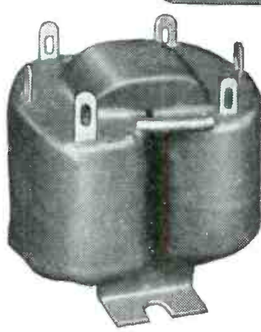

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and Other New Applications.

The technical committee, under A. W. Rogers of the Signal Corps, is introducing a new concept into the electronic symposium field. The program of the forthcoming meeting is designed to emphasize quality and reliability of components in electronic systems as distinguished from the former emphasis on individual components. The committee is carrying the problem a step further in concerning itself with the development, fabrication and application of component parts into electronic systems.

National Union Radio Makes New Moves

As 1953 CLOSED, National Union Radio Corp. delivered its first color tv tube to a major set manufacturer and announced that it would be in quantity production as soon as it can obtain bulbs and other materials from suppliers.

The firm also created two new positions to tie National Union's expanding research activities more closely to manufacturing to meet the competitive challenge of color tv and other industry developments.

A. Melvin Skellett, head of the research division, was promoted to the newly created position of vice-president in charge of manufacturing and engineering. Lawrence L. Hardin, Jr., was named director of the research division.

"National Union is prepared to meet aggressively the competitive challenge of 1954 with new and better products while carrying on its work in established fields," top company officers said in a joint state-

A. Melvin Skellett

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Lawrence L. Hardin, Jr.

ment. "Despite the feverish race for leadership in the field of chromatic television, it will be our continued policy in 1954 to give all of our customers what they need. Although some companies are shutting down assembly lines, we are presently continuing our production of black and white television tubes at 50 percent of our normal output in belief that the opening of stations in new areas, impatient consumers who will not wait for color, and replacements will create continued demand."

Skellett spent 15 years with Bell Telephone Laboratories before joining National Union in 1944 as head of research.

Hardin, who will be in charge of the company's Orange, New Jersey, custom research work under Skellett's supervision, served with the Army Signal Corps and with RCA before joining the company in 1945.

Emerson Establishes Research Laboratories

THE Emerson Research Laboratories will be established in Washington, D. C., operating as a division of Emerson Radio for research and advance development work, it was announced by Benjamin Abrams, president.

Activities of the new research center will be directed primarily toward research and development in the field of electronics. It will also engage in other research and development projects. Several research projects have been scheduled to start immediately after the opening of the center in January, 1954.

The research operation will be

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conducted under the active supervision of Harold Goldberg as director and Donald P. Burcham as assistant director. A substantial number of scientists and engineers will be engaged to participate in the activities of the labs.

The center will supplement the research and development activities engaged in by the company. Emerson will also continue to expand its program of laboratory work in engineering and manufacturing techniques.

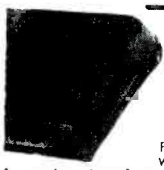
"This new research center for our company", Abrams said, "is an integral part of Emerson's expansion plans which include a recently-completed 3-story addition to our Jersey City plant and the purchase of a ten-story building in New York City which will house our administrative and engineering division."

Both Goldberg and Burcham, for the past six years, have directed the Ordnance Division of the National Bureau of Standards, the activities of which have centered on guided missiles. Goldberg has done research in the fields of microwave radar, air navigation systems and tv.

Burcham has done work for the Navy on underwater defense, magnetics and acoustics. He also has done research on magnetic torpedo exploders.

Heising Awarded Armstrong Medal

RAYMOND A. HEISING was presented the Armstrong Medal by the Radio Club of America at its 44th annual banquet, in recognition of his many notable contributions. He was an



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ELECTRONIC MEASUREMENTS

Covers measurement fundamentals in many fields beyond conventional radio, including television, radar, and other pulsed systems, microwave techniques, and techniques of value to engineers in other areas who use electronics in their instrumentation. Treats circuit constants and lumped circuits; wave-form, phase, and time interval measurements; receiver and antenna measurements; generators of special wave-forms; attenuators and signal generators, etc. By F. E. Terman, Dean, School of Eng., and J. M. Pettit, Assoc. Prof. of Elec. Eng. Stanford Univ. 2nd Ed., 683 pp., 450 illus., $10.00

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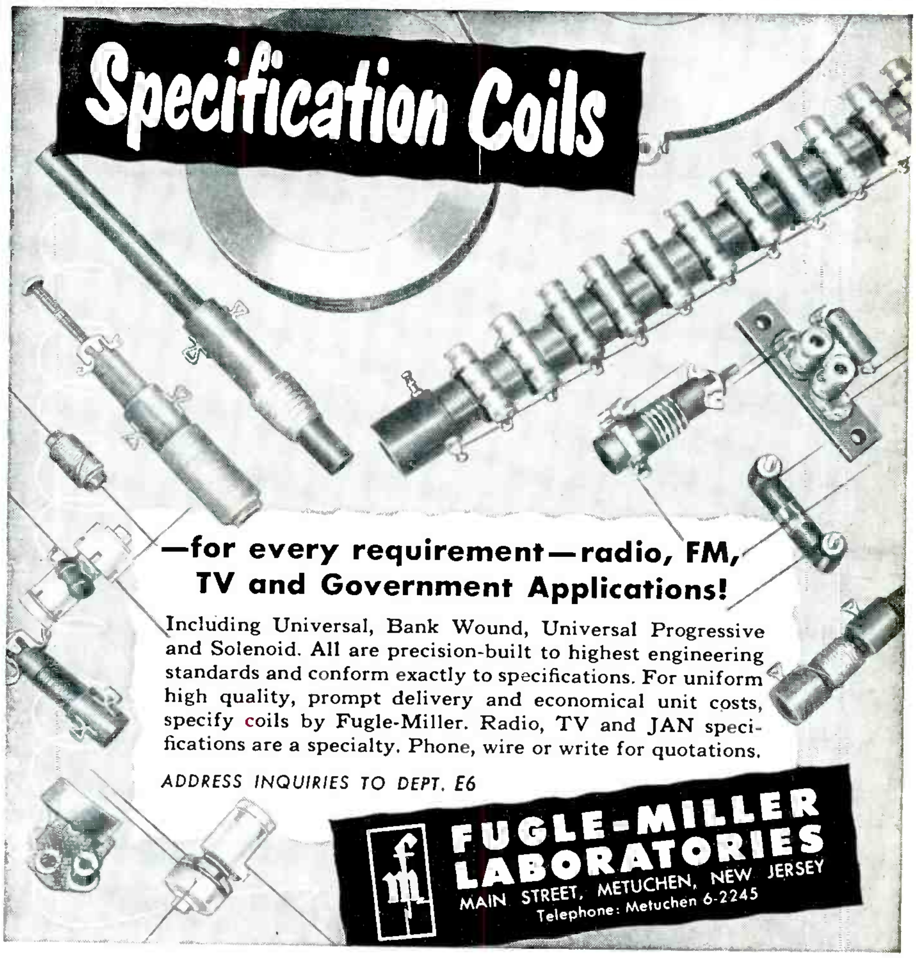

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Executives Change At Bell Laboratories

WILLIAM H. MARTIN, Bell Telephone Laboratories vice-president in charge of station apparatus and outside plant development, quality assurance and design engineering has resigned to become Deputy Assistant Secretary of Defense (Applications Engineering). He will

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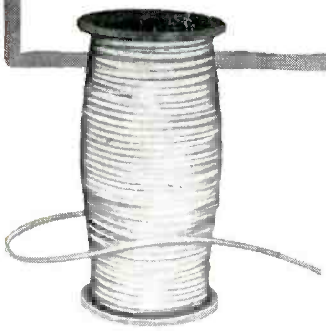

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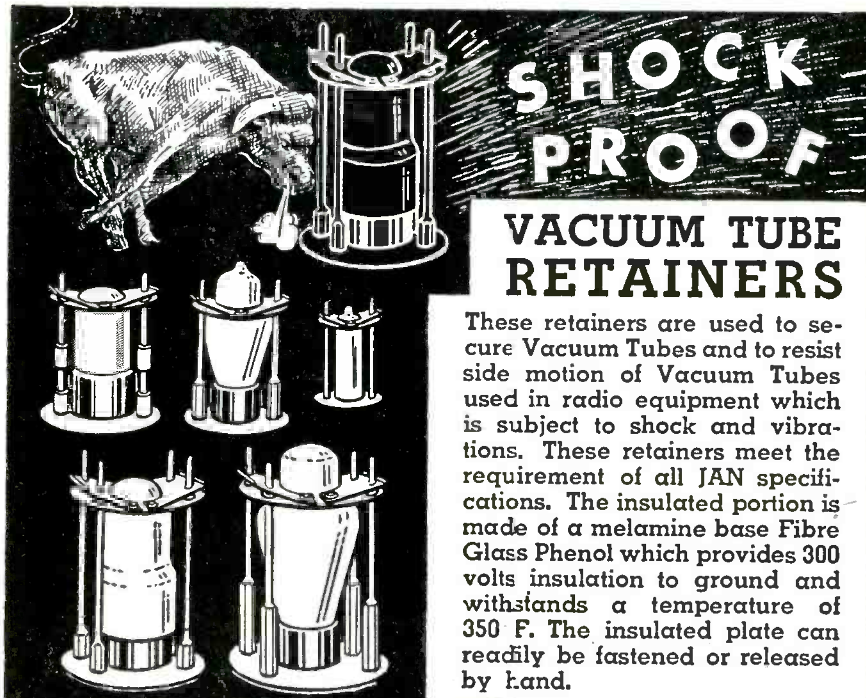

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be succeeded by Morris H. Cook who has been elected a vice-president of the laboratories.

IRE Organizes Group On Management

INSTITUTE OF RADIO ENGINEERS has organized a professional group on engineering management in electronics.

The group is sponsoring a course, through March 5, 1954, on "Engineering Management in the Electronics Industry" and meets regularly in Los Angeles. A new series is planned for shortly after March 5 because of the interest shown in the course by IRE members.

Twenty-seven companies in the Southern California electronics field are represented in the discussion group. T. W. Jarmie, division engineer of the L. A. division of the Electronic Engineering Co. of California, is chairman of the group.

Fielden Instrument Appoints Maltby

FREDERICK L. MALTBY was appointed technical director in charge of all research, development and design facilities at the Fielden Instrument Division of Robertshaw-Fulton Controls Co.

Previous to joining the company, he served in various capacities from senior development engineer to technical director of the Bristol Co. of Waterbury, Conn. from 1944 to

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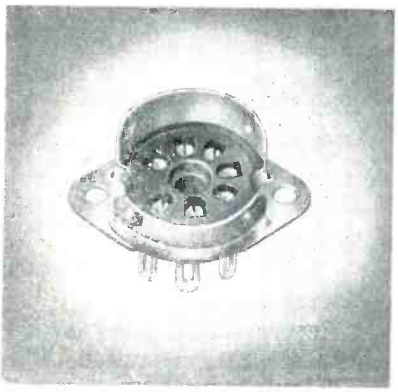

Again, there is much that is new and much that is news from Elco Corporation. This time, it is the introduction of Elco's UHF tube-socket — the critical link in the UHF chain. And, as with all other Elco products, the UHF socket you see illustrated here has been developed and produced with highest-efficiency as its goal. With its use, electrical and mechanical stability is assured. The low-loss phenolic body has been designed for strength and low capacitance. Contacts provide good retention of the tube; and short contact-path greatly reduces contact resistance. All metal parts are cadmium plated for durability and resistance to wear, thereby insuring high quality performance characteristic of Elco products. Upon your request, we will forward complete technical data to you. Full information is also available concerning Elco Corporation's complete quality line of miniature and sub-miniature tube-sockets, shields and Varicons — the sensational miniature connector now available with covers, brackets and handles.

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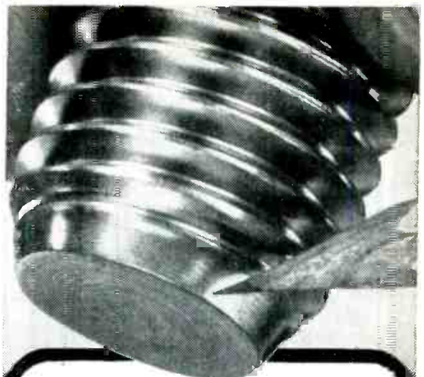

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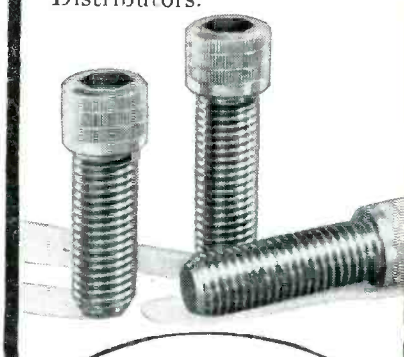

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1952. Prior to that, he was an electrical engineer at Wurlitzer and taught physics and communications at the University of Buffalo.

Blonder-Tongue Names Rogers

DONALD H. ROGERS has been appointed chief engineer of Blonder-Tongue Laboratories of Westfield, N. J. He is enlarging the staff of the engineering department and will accelerate the firm's research and development programs.

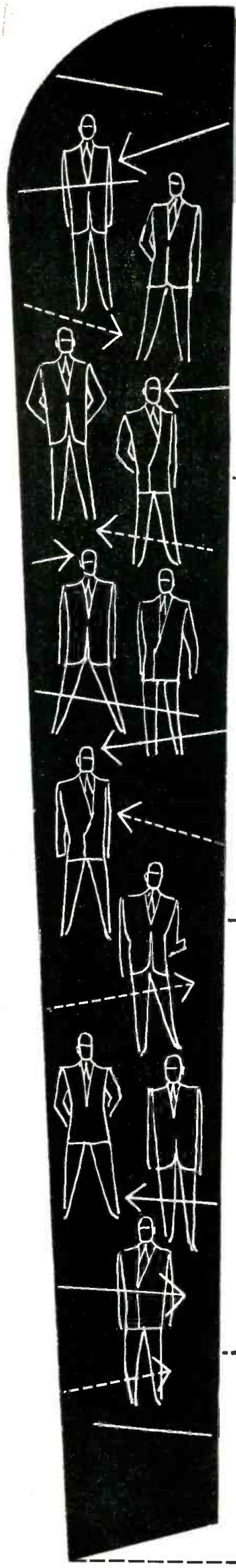
Rogers, who has been associated with Blonder-Tongue for over one year, previously supervised electronic development work for Western Electric and Utility Electronics Corp.

NBC Elects President And Vice-President

SYLVESTER L. WEAVER, JR. was elected president of the National Broadcasting Company and Robert W. Sarnoff was named executive vice-president.

Weaver joined NBC in 1949 as head of its tv operations after 23 years in the broadcasting and advertising business, including service as vice-president in charge of broadcasting for Young & Rubicam and advertising manager for the American Tobacco Co. He was put in charge of both radio and television networks for NBC in the summer of 1952 and became vice-chairman of the board in December of that year.

Sarnoff, son of Brig. General David Sarnoff, joined NBC in 1948



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THREE OPENINGS

SENIOR RADAR INDICATOR SYSTEMS ENGINEER

DUTIES: Systems planning, studying, proposing, carrying on applied research, development and design of advanced radar indicator systems for all types of radar systems including search, fire control and missle guidance. Coordination of 5 to 10 subordinates.

REQUIREMENTS: B.S. degree in E.E. or in Physics and 5 to 10 years design experience in the radar field with emphasis on indicators and analog devices.

FOUR OPENINGS

SENIOR RADAR ENGINEER

DUTIES: Applied research, development and design of advanced radar, fire control and missle guidance equipment. Openings exist in the fields of pulsed circuits, video, simulators, preamplifiers, linear and logarithmic post amplifiers and MTI and in analysis and synthesis of complex radar systems.

REQUIREMENTS: B.S. degree in E.E. or Physics and 3 or more years design experience.

THREE OPENINGS

TECHNICAL WRITERS

DUTIES: Preparation and editing of technical reports and instruction manuals for communications, radar and missle guidance equipment.

REQUIREMENTS: B.S. degree in E.E. or Physics and 3 years technical writing experience.

Or, if you have experience in fields of antennas and waveguides, high frequency heating applications, servo mechanisms, magnetic amplifiers, magnetic deflection yokes, magnetic materials, transformers, or components, send resume at once!

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where he served in a variety of executive capacities and launched "Victory at Sea", the NBC-Navy documentary, for which he received the Navy's Distinguished Public Service Award. He was elected a vice-president in 1951, named head of the NBC film division a year later, became Weaver's executive officer last September, and was elected to the board of directors in October of 1953.

Motorola Appoints Tansey Service Head

JOHN P. TANSEY, formerly service contract manager, was named national service manager of Motorola's Communications and Electronics division. He succeeds Fred Schnell who has been designated staff assistant to Daniel E. Noble, vice-president in charge of the division.

Motorola now has over 700 authorized service stations, which are privately owned, located throughout the U. S. to handle service for two-way radio users.

Standard Engineers Society Elects Officers

THE Standards Engineers Society announced the reelection of William L. Healy of GE as president for 1954. Others elected include: Madhu S. Gokhale of RCA Victor, reelected as vice-president; Harold J. Nugent, manufacturers' representative, treasurer and Fred M. Oberlander of RCA Victor, secretary.

Reelected to the board of directors are: Herbert G. Arlt of Bell Laboratories; W. G. Baird of IBM and

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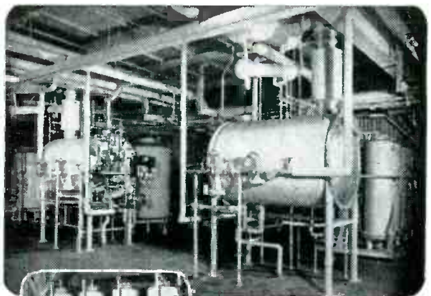
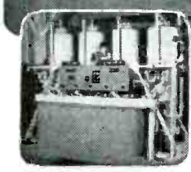
HOW Barnstead PURE WATER HELPS RCA





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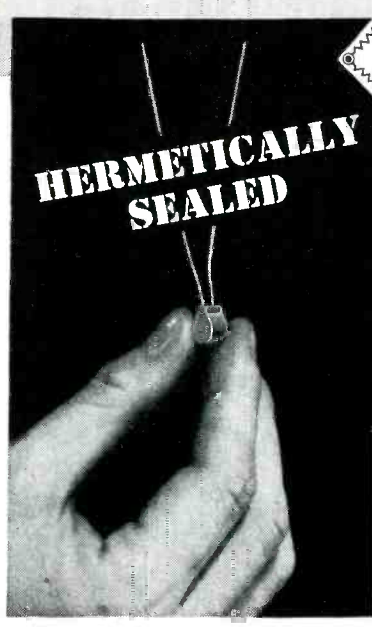

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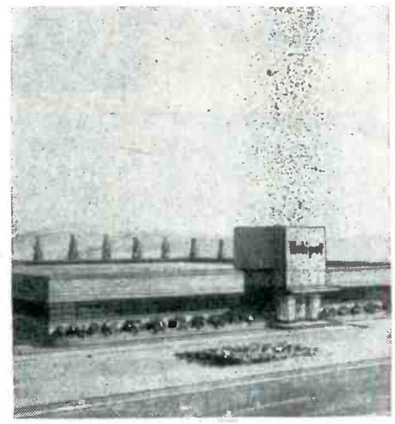
Victor S. Gittens of Philco.

Jerome L. Steen of Sylvania and John Gaillard of the American Standards Association have become new members-at-large on the board of directors.



Helipot's New Plant Officially Open

HELIPOT CORP., a division of Beckman Instruments, officially opened its new eastern plant in Mountainside, N. J.

The new plant provides 14,000 sq ft of space in which many models of the company's line of precision potentiometers and turns-counting Duodials will be made.

An additional 6,000 sq ft in the new plant will be occupied by the eastern regional offices and showrooms of the Beckman division of the company.

David C. McNeely, formerly sales manager of the Philadelphia Gear Works, has been appointed national sales manager of Helipot Corp., according to D. C. Duncan, vice-president and general manager.

Educational TV Group Names Braum

CYRIL M. BRAUM, former chief of the television facilities division of FCC, joined the consultant staff of the Joint Committee on Educational Television.

"Braum will provide general engineering assistance to educational channel applicants", explained Ralph Steetle, JCET's executive director. "He will also be available to consult with engineers employed by educators to prepare station applications. He will keep the educa-

Cyril M. Braum

tors informed about important technical tv developments through participation in conferences and written reports," Steetle said.

A registered professional engineer in the District of Columbia, Braum has been with FCC since 1937.

As chief of the tv facilities division he has had responsibility for processing both educational and commercial tv applications.

According to Steetle, Braum will also be available as engineering consultant for the National Citizens Committee for Educational Television.

McMillan Laboratory Appoints Overholt

EDWARD B. MCMILLAN, president of McMillan Laboratory of Ipswich, Mass., announced the appointment of Ray Overholt, formerly director of the laminated plastics and metals Palmer Laboratory of the United

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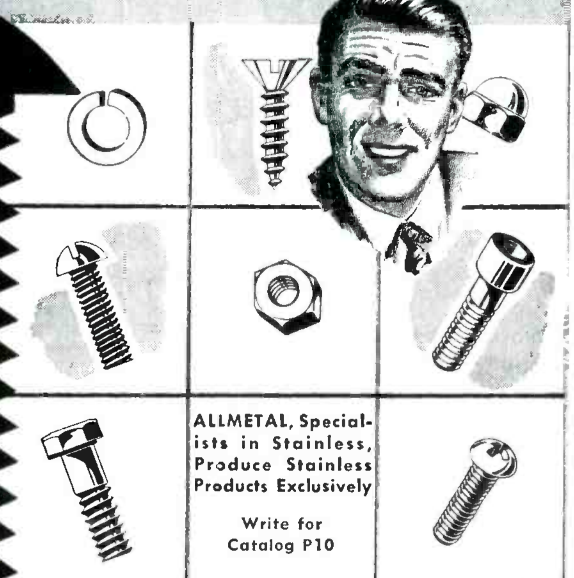

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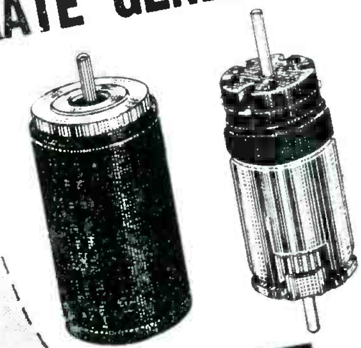

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States Plywood Corp., as technical director of the manufacturing division.

During the past 16 years, he has been associated with the chemical field while with Du Pont and later, with electronics in radome engineering and production while associated with United States Plywood.

He will continue his work on the advancement of radome manufacturing techniques which he has been doing since the first stages of World War II.

Hill Named Pentron Research Director

LESLIE HILL was appointed director of research for the Pentron Corp. of Chicago. He joined Pentron in November of 1953. Formerly, he developed electronic and mechanical devices for the British and Egyptian governments.

Johns Hopkins Names Henry Porter

HENRY H. PORTER, supervisor of the Johns Hopkins University applied physics laboratory's Bumblebee guided missile program since 1948, was named as an assistant director of the laboratory for planning. He will be chiefly concerned with laboratory planning, policy and objectives.

The laboratory, established in 1942 to continue development of the proximity fuze, is now engaged in guided missile research and development for the Navy.

During World War II, Porter worked on the development of

Want more information? Use post card on last page.

a proximity fuze for use in guns, naval gun directors and guided missiles. During the Korean war, he was assigned to the Far East as a representative of the operations evaluation group of the Department of Defense.

CBS-Columbia Appoints Maken And Petrany

GUY MAKEN has been named manager and Joseph Petrany, assistant manager of the material control department for CBS-Columbia, it was announced by Charles J. Kayko, administrative vice-president.

Maken has been connected with electrical manufacturing organizations since 1928. Prior to coming to CBS-Columbia last August, he was manager of material control for Emerson Radio for five years. Prior to that, he held a similar position at Olympic Radio.

Jacobs of GE Wins Award

JOHN E. JACOBS has been selected as one of the nation's outstanding young electrical engineers by Eta Kappa Nu and will receive an honorable mention award.

The 33-year old scientist developed the x-ray-sensitive cadmium sulfide crystal detector which is known for its application in automatically assuring full and accurate levels of beer and other liquids in cans at unprecedented speeds.

Dr. Jacobs first became associated with GE as a shipping clerk at the company's Kansas City office. He received GE's highest honor to em-

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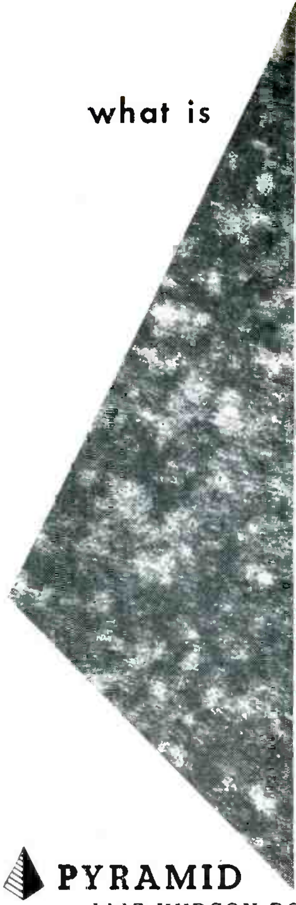

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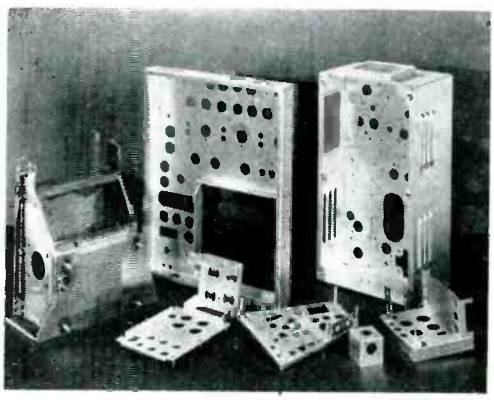

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ployees, the Charles A. Coffin Award, given for major contributions to science and company welfare.

Sylvania Names Gunn General Sales Manager

D. W. GUNN has been appointed general sales manager of electronic products, for Sylvania succeeding Harold P. Gilpin, who has retired.

He will be responsible for the sales of products of the radio tube division, the tv picture tube division and the electronics division.

Gunn, who has been a member of Sylvania since 1931, started as a factory engineer with the company. He was appointed equipment sales manager in 1951, and until his new appointment, has been assistant general sales manager of the electronics product sales division.

Representatives In Los Angeles Elect Officers

THE LOS ANGELES chapter of Representatives installed its 1954 officers. George Davis, chapter vice-president, was elected president. A. J. Rissi, secretary-treasurer, became vice-president and Frank A. Emmet was elected secretary-treasurer.

John J. Hill, retiring president, became chairman of the five-man board of directors which includes: John B. Tubergen, E. V. Roberts, H. A. Kittleson and Gerald B. Miller.

Ralph L. Power is executive secretary-treasurer.

The organization, formed originally as the Radio Boosters Club and later affiliated with the national

body as a local chapter, was formed 20 years ago and currently has a roster of 60 seniors and associates.

Standard Coil Appoints Adams

STANLEY ADAMS was named general manager of the Chicago plants of Standard Coil Products Co., it was announced by Glen E. Swanson, president. Associated with the radio and tv industry since 1939, Adams, for the past seven years, has been manager of Standard Coil's plant at Bangor, Michigan.

Standard Coil operates four plants in the Chicago area, having about 200,000 sq ft of combined production space. Other plants are located in Los Angeles, Aurora, Ill. and North Dighton, Mass.

Nunan Named President Of Consolidated Vacuum

ELECTION of J. Kneeland Nunan as president of Consolidated Vacuum Corp. of Rochester, N. Y., a subsidiary of Consolidated Engineering Corp. of Pasadena, Calif., was announced by Philip S. Fogg, president of the parent company and board chairman of Consolidated Vacuum.

Nunan, who was named executive vice-president of the Rochester firm in early 1953, succeeds Fogg as president. Fogg will continue as chairman of the board.

Consolidated Vacuum, which was formerly the vacuum equipment department of Distillation Products Industries, a division of Eastman

Kodak, was acquired by Consolidated Engineering in December, 1952. Year-end sales figures for the subsidiary are expected to exceed $4.5 million.

Prior to becoming associated with Consolidated Engineering in 1952 as vice-president in charge of sales, Nunan was employed by Howard Hughes. Before joining Hughes, he served as general manager of the motion picture department of the

J. Kneeland Nunan

Ansco Division of General Aniline and Film Corp. and introduced the Ansco color process to the motion picture industry in 1946.

He was formerly assistant dean of engineering and assistant professor of electrical engineering at the University of Southern California.

Clevite Makes Personnel Changes

DOUGLAS C. LYNCH has been promoted to executive vice-president of Brush Electronics, one of the units of the Clevite Corp. He has been vice-president of sales and, along with his new duties, will continue to direct the sales division. He joined the company in 1952, previously having been assistant general manager for Westinghouse International.

C. J. Mayers, who has been treasurer and controller, advanced to vice-president and treasurer. He has been with Brush since 1943.

B. H. Van Houten becomes a vice-president and will continue as director of employee relations.

Arthur D. Schwope joined the

Brush Laboratories Division of Clevite as director of metalurgical research. He was previously division chief of mechanical metallurgy at Battelle Memorial Institute. In his new post he will direct immediate and long-range basic and applied research projects in metals for Clevite.

Harry W. Dodds has been appointed vice-president of engineering services for Brush laboratories. He will continue as director of engineering services and pilot plants. Dodds has been with the company for three years and was previously associated with Brush Beryllium.

Circuit Research Lab Formed

ESTABLISHMENT of Circuit Research Laboratory in New York City was announced by the company. Its activities will be devoted to research and development work in radio, tv, audio and electronics including design and development of experimental and production models and special test equipment.

According to the firm, a new f-m receiver, free from multi-path interference, and an audio amplifier using no transformers have been developed.

Kerim Onder is the engineer-in-charge of the laboratory. He has had 15 years experience on the staffs of several companys, including Marconi in England and RCA Laboratories in Princeton, N. J.

Westinghouse Names Tube Sales Manager

JOHN A. CURTIS has been appointed general sales manager of the Westinghouse Electronic Tube Division succeeding Harold G. Cheney, who has been named assistant to E. W. Ritter, vice-president in charge of the division.

From 1938 to 1941, Curtis worked on the development of railway radio-telephone communications systems. From 1942 to 1945 he was vice-president of the Halstead Traffic Communications Corp.

Later, he became manager of the mobile communications division of Farnsworth and directed its development of the first train-wide passenger entertainment system in-

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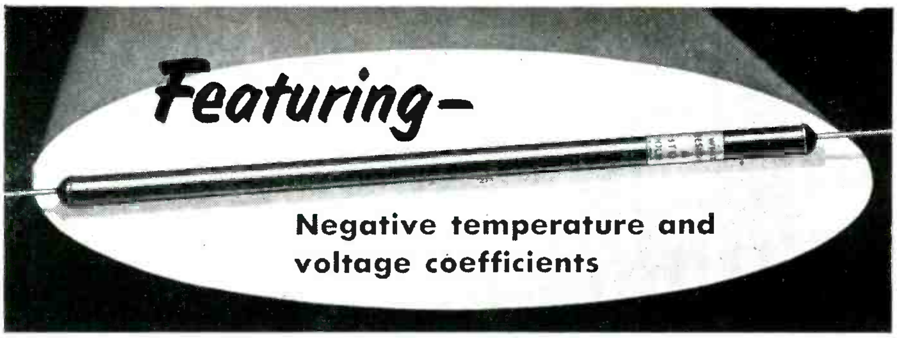

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troduced on the Santa Fe's Superchief in 1949.

Before joining Westinghouse, Curtis was manager of the track equipment department of the Pullman-Standard Car Manufacturing Co., responsible for the development and sale of railway track maintenance machinery.

Hopkins Joins CBS-Columbia

DAVID J. HOPKINS has been named director of sales for CBS-Columbia, it was announced by Harry Schecter, vice-president in charge of sales.

In making the announcement, Schecter said that Hopkins' appointment is in line with the firm's program of reorganization and expansion of its national sales force.

Hopkins resigned as director of sales and advertising for Emerson Radio, with whom he has been associated for 9 years, to accept his present post.

Minneapolis-Honeywell Elects New Officers

HAROLD W. SWEATT, president of Minneapolis-Honeywell Regulator Co. since 1934, was elected chairman of the board, succeeding Mark C. Honeywell, who was named honorary chairman.

Paul B. Wishart, vice-president and general manager of the company, was elected to succeed Sweatt as president.

At the same time, two other

officers of the company were elected directors, enlarging the board's membership to 10. The new directors are Tom McDonald, vice-president in charge of sales and A. W. Wilson, vice-president in charge of the firm's aeronautical division.

Changes in Honeywell management came with the retirement of five officials under the company's executive retirement plan established in 1943.

The retiring officials include, in addition to Honeywell, W. L. Huff, director, executive vice-president and former treasurer; R. P. Brown, vice-president and chairman of the board of the company's industrial division; George A. DuToit, vice-president in charge of manufacturing and L. Morton Morley, vice-president and formerly in charge of sales for the industrial division.

Honeywell, Huff and Brown will continue as directors.

When Sweatt became president of the company in 1934, it had 1,000 employees and annual sales of about $5 million. Honeywell now employs 24,000 persons in factories and sales offices in both the U. S. and foreign countries and has annual sales approaching $200 million.

Link Radio Plans Reorganization

LINK RADIO CORP. of New York, manufacturers of mobile radio equipment, announced the transfer of stockholding interests to Murray Platt, who was elected president.

A complete reorganization is planned to extend the company's activities in the mobile communications field, both domestically and

Murray Platt

Want more information? Use post card on last page.

internationally.

Platt is also president of Platt Manufacturing of New York which is engaged in the manufacture of a new line of mobile radio equipment as well as U. S. defense production. The entire engineering and production facilities of Link and Platt will be combined for greater output and economy.

Associated with Platt will be James B. Ferguson, chief engineer and Larry Straw, sales manager, formerly of Bendix.

Radio City Appoints Chief Engineer

ROBERT E. RICKETTS has been appointed chief engineer of Radio City Products.

He was formerly associated with DuMont Laboratories and with GE after having been a manufacturer of laboratory test equipment and wired music electronic systems.

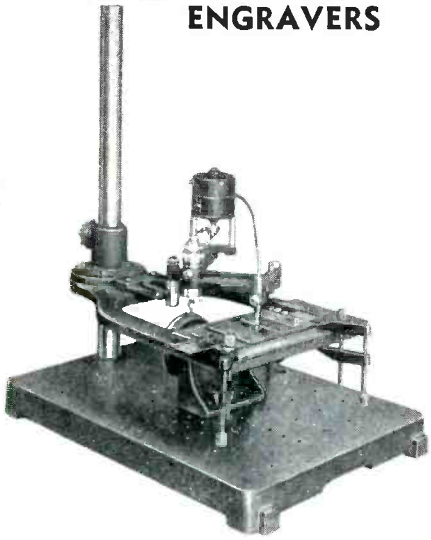
Stanford Research Names Duvall And LeMay

Two research physicists, George E. Duvall and Charlotte Z. LeMay, have joined the staff of Stanford Research Institute.

Duvall, formerly with GE, will work as a theoretical physicist in high explosives with SRI's department of physics. From 1946 to 1948 he was a research associate in the research laboratory of electronics at MIT. Earlier, he worked five years with the University of California's division of war research.

LeMay, formerly in the transistor program at Texas Instruments of Dallas, will undertake a research

MICO ENGRAVERS



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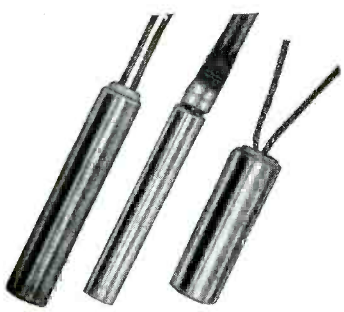

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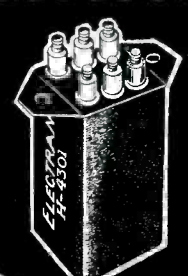

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George E. Duvall

SRI's engineering division. She was an instructor in physics at Mt. Holyoke College and at Louisiana State University. At Monsanto Chemical Co., during the war, she did research on the dielectric properties of plastics.

Dage Appoints Chief Engineer

DAGE LABORATORIES, which handles design and development for Dage Electronics, announced the appointment of H. E. Crow as chief engineer.

He has served as chief engineer of WHEN in Syracuse and WBKB in Chicago. He has also been connected with RCA, Zenith and the Thorgeson Manufacturing Co. He served as a radio technician with the Navy training program and has had experience in broadcast equipment design in which he is presently engaged.

Appointment of Clifford Bruhn as production manager was announced by Dage Electronics. He was formerly associated with AC Spark Plug.

CBS-Columbia Promotes Schoenbrun

MAURICE SCHOENBRUN has been promoted to director of cabinet engineering for CBS-Columbia. He previously was assistant product design manager for the firm. He has had more than six years product design experience in the radio-tv field. Prior to that, he was an aircraft designer, working on experimental airframe structures.

Gramer Transformer Acquires Company

FOUR executives of the Gramer Transformer Corp. of Chicago have acquired controlling interest in Johnson Electronics of Orlando, Fla., manufacturers of coils and component parts.

Production facilities of Johnson Electronics in Orlando will be expanded and Gramer Transformer will serve as its exclusive national sales agency.

The Johnson plant consists of more than 10,000 sq ft of space and employs more than 100 people.

James M. Blacklidge, president of Gramer, will serve as board chairman and treasurer of Johnson. Other new principals from Gramer include Burt Anderson, general sales manager; Ralph L. Weber, secretary and Fred R. Cooper, chief engineer.

E. S. Johnson, president of Johnson, will continue in that position. Charles Edwards of Orlando is vice-president of manufacturing in the new organization.

IRE Aviation Group Sets Sessions

"AVIATION ELECTRONICS DAYS," sponsored by the Institute of Radio Engineers' professional group on Aeronautical and Navigational Electronics to commemorate the 50th anniversary of powered flight, has been scheduled for March 22-23 during the national IRE convention in New York City. The event will include three consecutive technical sessions and a luncheon, on March 23, at the Hotel Shelton. The Institute of the Aeronautical Sciences is also participating in the program.

British IRE Sets Convention Theme

THE THEME of the 1954 convention of the British Institution of Radio Engineers, to be held at Christ Church, Oxford, from July 9 to 12, is "Electronic Aids to Production."

The subject has not been covered in previous post-war conventions and is expected to give opportunity for demonstrating the contribution of the radio and electronics engineer towards improving industrial production.

It is anticipated that the subject will attract wide attention because of its interest to many engineers engaged in other branches of industry.

Lynch Carrier Names Noller

WALTER E. NOLLER joined the engineering department of Lynch Carrier Systems in an executive capacity.

He was previously with Bell Laboratories where he was engaged in the design and development of voice operated devices and fire control radar equipment. He received the Naval Ordinance Development Award as a result of this work. He subsequently held the position of senior engineer with the Pacific Telephone and Telegraph Co. working on toll transmission, inductive coordination, protection and toll plant extension engineering.

Insuline Buys Plant In New England

TO SUPPLEMENT its present manufacturing operations in Long Island City, N. Y., the Insuline Corp. of America has purchased a four-story factory in Manchester, N. H. The building has 281,000 sq ft of space.

The facilities afforded by this new plant will permit Insuline to implement a long-planned expansion program, according to S. J. Spector, president. The firm expects to turn out ten times as many tv antennas and three times as many auto antennas as it is now making.

Automatic and conveyorized machinery for spraying, baking, plating and finishing is being installed in the plant. The company will continue to maintain its New York production facilities and administrative staff.

Western Electric Names F. B. Smith

FRED B. SMITH, personnel director and treasurer of Sandia Corp. in Albuquerque, N. M., for the past four years, has been appointed

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comptroller of Western Electric's Hawthorne Works in Chicago.

Succeeding Smith at Sandia Corp. as treasurer will be Philip D. Wesson, who will also continue to serve as the general attorney.

Smith started as a test equipment repairman at the Hawthorne Works in 1928. He held a succession of inspection, test equipment and manufacturing assignments and was in charge of Hawthorne's vacuum tube production during World War II. In 1948 he was placed in charge of Western Electric's plant at Lincoln, Nebr. He left there in 1949 to accept his position at Sandia.

Crescent Industries Elects Officers

HENRY H. GEFVERT, formerly president of Crescent Industries, was elected chairman of the board of directors and J. Russell Duncan, formerly president of Electric Sprayit and Moe Bridges of Sheboygan, Wisc., was elected president and general manager of Crescent. Nelson Lenberg will continue as vice-president and Donald E. Heinisch will continue as secretary and treasurer.

The change in executive responsibilities was made in accordance with plans for strengthening the business which now employs 1,300 people.

Webcor To Establish New Branch Plant

WEBSTER-CHICAGO CORP. will establish a branch assembly plant at New Ulm, Minn., early in 1954, according to R. F. Blash, president. The building will be constructed by the city of New Ulm and leased to Webcor.

While the building is under construction, Webcor will lease an existing building nearby. Several items in the company's line will be assembled at New Ulm.

FCC Names Barr Broadcast Chief

FCC ANNOUNCED the consolidation of the aural facilities division and the television facilities division of its Broadcast Bureau and has designated James E. Barr to be chief of the new Broadcast Facilities Division.

Stromberg Makes New Appointments

R. C. TAIT, president of Stromberg-Carlson, announced the promotions of Arthur F. Gibson, formerly general manager of the firm's telephone division, as corporate secretary of the company, and John H. Voss, formerly chief telephone engineer, as general manager of the telephone division.

Harry M. Bruckart and Robert R. Dobbin have been appointed chief engineer and assistant chief engineer, respectively, of the division.

Bruckart, formerly in charge of systems engineering for the telephone division, has been with the company since 1946.

Dobbin was formerly in charge of telephone apparatus design and also joined the firm in 1946.

General Ceramics Sets Technical Agreement

THE GENERAL CERAMICS AND STEATITE CORP. of Keasbey, N. J. has established an agreement with Techno Ceramica, S.A., to supply technical knowledge for the manufacture of high frequency insulators in Techno's plant at Sao Paulo, Brazil.

Techno Ceramica, producer of high tension porcelain insulators, sees growing requirements for high frequency insulators in the territory it serves.

Wilson Moves To West Virginia

G. C. WILSON & Co., designers and manufacturers of electronic timers, moved its offices and plant from Chatham, N. J. to Huntington, W. Va. The move was made, according to G. C. Wilson, president, to provide increased facilities for production and service.

Jerrold Names Two Executives

CAYWOOD C. COOLEY has been appointed vice-president and general manager of Jerrold Service Corp.,

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according to Milton J. Shapp, president of Jerrold Electronics. Cooley was formerly assistant to the president, engineering, and recently completed supervising the installation of the first Jerrold five-channel community antenna system at Mahanoy City, Pa.

Robert J. Tarlton, who formerly headed the Jerrold Service Corp., became manager of Jerrold's community operations division. In his new capacity, Tarlton will be responsible for the installation and organization of community antenna companies where Jerrold has management responsibilities. Tarlton has been active in the community antenna system industry since the time of the establishment of the first antenna company in Lansford, Pa.

Minnesota Mining Promotes Brown

PROMOTION of Erwin W. Brown to the position of division engineer for its electrical products group was announced by Minnesota Mining & Manufacturing.

He joined the firm in 1947, was transferred to 3M's engineering department as a chemical engineer in 1948 and became a member of the new products engineering staff in 1950. He became division engineer for sound recording tape in 1951 and last year was given the additional responsibilities of division engineer for 3M's staff laboratories.

The company also announced the appointment of Daniel J. MacDonald as assistant division engineer for the electrical products group. MacDonald has been a project engineer for staff laboratories for the past four years.

New London Instrument Acquires Atlantic

SAMUEL GUBIN, partner in the New London Instrument Co. of New London, Conn., announced the acquisition of the Atlantic Transformer Corp., formerly A.J.F. Industries, in Brooklyn, N. Y.

The equipment and facilities of Atlantic have been moved to new and expanded quarters in Groton, Conn.

The company has retained the

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services of key engineering and production personnel of Atlantic and will continue to manufacture custom-built transformers.

Solar Manufacturing Names Das Gupta

ASRU K. DAS GUPTA, who came to the U. S. from India in 1946, has been promoted to director of engineering of Solar Manufacturing Corp.

He has been associated with several industries engaged in the manufacture of electrical ceramics. He received his Ph.D in 1949 from Ohio State University with a major in ceramic engineering.

He joined the Solar organization in 1950 as director of ceramic operations, a position he held until his present appointment.

Hogan Named By Harvard University

CLARENCE L. HOGAN, formerly of Bell Laboratories, has been appointed associate professor of applied physics at Harvard University. He has served as lecturer on applied science during the past fall term.

Dr. Hogan successfully constructed the microwave gyrator which, in principle, permits the simultaneous transmission and reception of a single frequency from the same antenna.

He was employed as engineer for Anaconda Copper in 1942-43. During the war he served with the U. S. Navy and worked on establishing and maintaining the acoustical torpedo shop at Pearl Harbor. Since 1950 he has been in the physical research department of Bell Laboratories. In addition to his work on the gyrator there, he also participated in the development of borocarbon resistors.

Broadcasters Attend RCA Color Clinics

A TOTAL of 210 broadcasters have had training in theory and operation of color tv equipment at three clinics held by RCA Victor in Camden. The company plans to continue the program in 1954.

Complete technical information on RCA's color tv broadcast equipment was presented by means of lectures, demonstrations and a laboratory tour conducted by color tv specialists and design engineers of the company's Engineering Products Department.

Instrument Engineering Changes Its Name

ROBERT D. RICHARDSON, director of engineering, announced a change of name for his organization. Formerly the Instrument Engineering Service, of Michigan City, Indiana, the firm is now known as the Thermaco Laboratories.

Burlingame Elects New President

A. B. BOGIN has been elected president of Burlingame Associates. He has been associated with the firm for four years as legal counsel and general manager.

His election follows the recent death of past president and founder of the company, Bruce Burlingame.

Weston Plans Plant In Puerto Rico

WESTON ELECTRIC Co. of New Jersey plans to establish a plant at Ponce, Puerto Rico, to manufacture photo-meters. It expects to employ about 200 operators with an annual payroll of approximately $100,000.

With the aid of the industrial promotion division of the Puerto Rico Industrial Development Co., Weston expects to start a training program for workers in order to prepare enough personnel to begin operations early in 1954.

The manufacture of precision instruments and parts is tax exempted on the island in accordance with the provision of the tax holiday act of Puerto Rico.

Holzman Joins JFD As Field Engineer

THE JFD Manufacturing Co. of Brooklyn appointed Simon Holzman to the new post of field engineer. His duties will include field testing antennas and other electrical tv accessories in tv areas throughout the country and speaking at dealer antenna clinics. He was formerly associated with Federal Radio and Engineering Corp. where he did research work on U. S. projects involving uhf equipment.

Miller Instruments Makes Changes

SEVERAL major changes in the management set-up of William Miller Instruments of Pasadena, Calif. have been announced by E. E. Goskins, recently elected president.

New appointees include: George W. Downs, vice-president and chief engineer; Edwin M. Graham, vice-president and treasurer; Charles T. Munger, secretary; Rex Welch, general sales manager and Paul Ashway, production manager. Completing the management staff are Raymond C. Olesen, senior development engineer; John F. Kalbach, development engineer; Paul A.

Want more information? Use post card on last page.

Dennis, research engineer and Donald F. Hydrick, industrial engineer.

Radio Sales Acquires Two Companies

RADIO MERCHANDISING SALES of New York has acquired the controlling interests in the Ames Mfg. Corp., manufacturers of wire products, and in the JEB Sales Corp., producers of the JEB rotator.

The sales program for all three companies will be handled by Martin Bettan, present sales manager of RMS.

Edison Named By RCA Victor

EDWARD EDISON was appointed broadcast field sales representative in RCA Victor's western region.

He joined the RCA Service Co. in 1942 as a field engineer and served with it for nine years, five of which he was manager of consumer products branch offices. In 1951 he joined KLAC-TV in Hollywood as assistant chief engineer and in 1952 transferred to NBC in Hollywood as tv engineer assigned to development work on audio and video engineering problems.

National Company Names Three

GEORGE R. LOUX was appointed vice-president in charge of manufacturing and Thomas D. Walsh was named vice-president and controller of the National Company, it was announced by Raymond C. Cosgrove, chairman of the board.

Loux was formerly works manager of the radio and tv division of Federal Telephone & Radio Co., works manager of General Instrument, plant manager of Sylvania and an industrial engineer with RCA.

Walsh has been with the company since 1946, serving previously as assistant treasurer and controller. He was formerly assistant to the treasurer of the American Marine Hull Insurance and with a New York firm of CPA's.

E. MacDonald Nyhen, former chief of the products branch, electrical division of the National Production Authority, was appointed industrial contracts sales manager of the company.

Federal Radio Appoints McDevitt

J. J. McDEVITT, JR., former manager of mobile radio for Federal Telephone and Radio, has been appointed government sales manager for the company. He succeeds J. A. Frabutt, recently named general sales manager.

McDevitt has been associated with Federal since 1949, serving as manager of the mobile radio division since February, 1952. Prior to that time, he occupied posts of sales manager for mobile radio and service manager of the Telephone and Radio Divisions.

Molloy And Runge Promoted By Vitro

THE West Orange, N. J. laboratory of Vitro Corp. of America has announced the promotion of Charles T. Molloy to manager of the newly created department of physics research. He was formerly analysis group leader of the physical research and development department.

Arnold W. Runge was made manager of the department of fabrication services. He was formerly group leader of product fabrication.

Arthur R. Soffel remains as manager of development engineering, formerly the product development department.

National Fibre Plans Expansion

A PLAN for the enlargement of manufacturing facilities and product development activities at National Vulcanized Fibre of Wilmington, Del. has been announced by E. R. Perry, president.

Part of the plan involves organization of a new development and research department devoted to improving company products, solving chemical problems and developing new materials for manufacturing. The program also includes plans for a half-million dollar building and facilities expansion at the company's Phenolite plant in Pa.

H. H. Street has been appointed

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plant manager of the company's Yorklyn, Del., plant. He formerly was assistant plant manager.

Workshop Associates Changes Its Name

WORKSHOP ASSOCIATES Division of The Gabriel Company of Norwood, Mass. is now known as the Gabriel Electronics Division. The change, according to the company, is required by the broadened scope of operations and is in line with current plans for further expansion during 1954.

Workshop Associates, which developed, at the outbreak of World War II, from a small group of home workshop hobbyists, was acquired by the Gabriel Company of Cleveland early in 1951. Shortly afterward it outgrew its plant facilities at Needham, Mass., and now occupies six buildings with over 100,000 sq ft at its Norwood site.

Majestic Radio Adds Another Plant

MAJESTIC Radio & Television acquired an additional manufacturing plant near their main Brooklyn plant as part of an expansion program for increased production of tv sets. The new structure adds 50,000 sq ft of floor space and includes two new production lines for final assembly and additional warehousing facilities to serve the main plant.

Leonard Ashbach, president, explained that the plant will relieve congestion in the main plant, eventually resulting in a reduced overhead.

Phen-O-Tron Names Schotter And Bayha

APPOINTMENT of Richard D. Schotter as vice-president and Jack Bayha as chief engineer of Phen-O-Tron's new printed circuit plant was announced by Robert L. Coryell, president.

Schotter brings years of experience in the fabrication of phenolic and allied materials.

Bayha was senior engineer of Emerson Radio prior to his association with Phen-O-Tron. He developed the "Autobrader", an

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automatic resistor abrading device developed at Emerson.

New Antenna Company Established In Iowa

WELCO MANUFACTURING CO. of Burlington, Iowa is a new tv antenna manufacturing firm which has been established and is owned and managed by John R. Wells. The new plant is in operation at its recently acquired building in Burlington.

Wells has been associated for several years in the sale and manufacture of tv equipment, most recently as a partner in Wells & Winegard, tv accessory manufacturers.

Bell Heads Toledo Scale Electronics Research

ROBERT E. BELL has been appointed manager of the electronics research engineering department at Toledo Scale Co. in Toledo, Ohio. The organization of this separate department has been necessitated by the rapid expansion of the company's activities in the field of industrial electronics, according to R. O. Bradley, director of engineering.

Bell has previously held positions as electronic design section head and assistant to the chief engineer at Lear.

Lansing Sound Moves Into New Plant

JAMES B. LANSING SOUND of Los Angeles, makers of speakers, units and systems, has moved into its new 12,000 sq ft building adjoining its main building. The main building is now used entirely for production.

The move doubles the number of factory and office employees. The new building contains offices, a cabinet and paint shop, a research and development laboratory, warehouse facilities and limited production space.

Besides its manufactured line for the electronics field, the company has added a new department for theater system components under the direction of George F. Halkides, production manager.

California Chassis Moves To New Plant

CALIFORNIA CHASSIS has moved its plant from South Gate, Calif. to its new one-story building with 10,000 sq ft of floor space in Lynwood, Calif. An additional two acres was purchased next to the site for future expansion.

The new facilities include quarters for its fabrication department, baking and spraying rooms and complete production and administrative areas.

Magnecord Names Bixler Vice-President

OTTO C. BIXLER, director of engineering and research at Magnecord of Chicago, has been elected vice-president by the board of directors.

He joined Magnecord in 1951 as chief engineer. From 1949 to 1951 he had been a development engineer for AiResearch Manufacturing Co. in Los Angeles.

Before that, he worked eight years for Western Electric in both New York and Hollywood. He was successively field engineer, senior engineer and systems engineer.

Edwards Joins Cinema-Aerovox

GORDON EDWARDS, formerly chief engineer with Cole Instrument Co. of Los Angeles, became sales engineer with Cinema Engineering Co., a division of Aerovox, according to James L. Fouch, general manager of Cinema.

Vic Lees, formerly production manager with Cole Instrument, joined Cinema in a similar capacity.

NEW BOOKS

Television Engineering

BY S. W. AMOS AND D. C. BIRKINSHAW. *Iliffe and Sons, Ltd., London, Vol. I,* 302 *pages,* 1953, 30 *shillings* ($6.75 *USA*).

THIS excellent volume is the first on television in the well-known series of Engineering Training Manuals of the British Broadcasting Corporation. Since the BBC has a technical staff preeminent among broadcasting organizations, it comes as no surprise that the book is technically above reproach. The treatment is refreshingly free from mathematical symbolism, as is appropriate in a textbook intended for operations and maintenance staffs. Mathematical derivations are confined to eight appendices; even here simple algebra, trigonometry and plane geometry suffice.

The elementary tone of the book is in a sense deceptive, because the so-called expert will find in it much information not conveniently gathered in one place heretofore. "Part II: Television Camera Tubes" is the most comprehensive treatment of the subject now in print. The BBC uses more kinds of camera tubes than do American broadcasters and it is necessary that the BCC staff know the nature of the several beasts. So we find not only the image orthicon and the iconoscope (the American stable) described in adequate detail, but also the image iconoscope, the orthicon, the C.P.S. emitron and the vidicon. This section, written by men who evidently have lived with the camera tubes long enough to regard them with intimacy, if not affection, is in itself worth the cost of the book.

"Part I: Fundamentals" represents a well-chosen selection of topics essential to the television broadcast engineer. It deals with scanning, synchronization and the video waveform. The latter is based on the BBC standards, but the time is past when the numerical differences between British, American and European standards are a source of confusion. Non-British readers will find this section a concise and informative statement of the technical basis of the British tv

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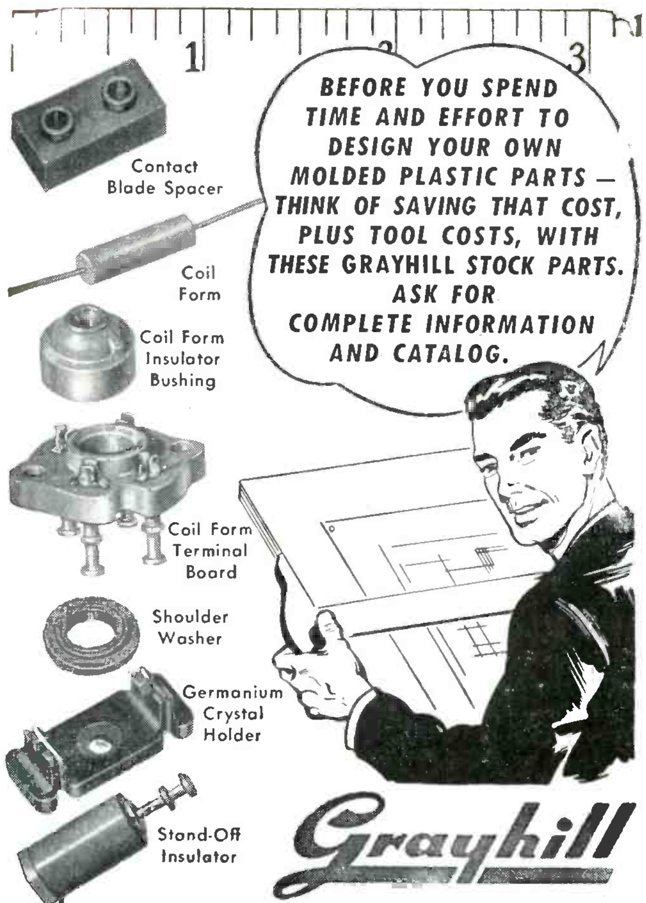

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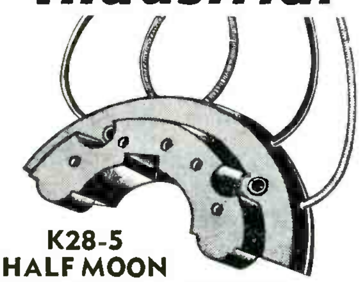

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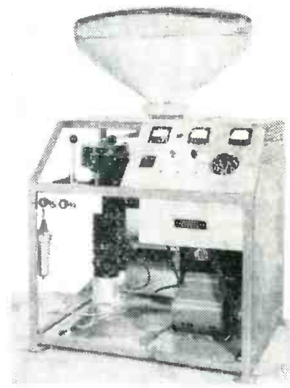

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"Part III: Television and Electron Optics" deals, first, with the input to the camera tube, light and manipulation of light by mirrors and lenses and, second, with the elements of electron optics as they apply to the beam focussing and deflection systems. These go as far as the intended reader has need, and no farther. The treatment of light is disappointing in one respect; it deals exclusively with luminous quantities. The fact that camera tubes can respond to radiations outside the luminous limits is not given proper emphasis. Since tube designers have conspired to keep infrared and ultra-violet sensitivity within bounds, this omission is not serious from the operations point of view.

The book concludes with appendices on aperture distortion, units of illumination and brightness, derivation of useful formulas in geometric optics, and electron forces in magnetic fields.

This first volume in the series treats but a small part of the field; it can be confidently expected that the succeeding volumes will cover the remaining topics with equal clarity and simplicity.—DONALD G. FINK, *Philco Corp., Philadelphia.*

Television Fundamentals

BY KENNETH FOWLER AND HAROLD B. LIPPERT, *McGraw-Hill Book Co., Inc., New York*, 1953, 524 p. $7.00.

THE BASIC material in this book, having appeared in lesson material previously, has weathered its "trial by fire" during many a "service clinic" conducted by the book's authors or their representatives.

The writing of this book spans practically the entire life of commercial television service as we know it today. Therein lies some of the virtues of the book as well as some of its faults.

Let's dispose of its faults first, so we can dwell on the many features of the book that make it worthy of study by a technician or student desiring to increase his knowledge and skill.

Essentially, the shortcomings of the book can be summed up by stating simply that the advancement of the art ran too far ahead of the authors' revisions.

We note by the copyright that parts of the material were written in 1948. While no doubt there were many revisions and additions made during the years, the important fact to keep in mind is that the book is issued now—in 1953. It must be so judged.

The radio technician or student for whom this book was written has every right to be disappointed when he finds that this book ignores uhf as though it hardly existed. There is no mention of uhf tuners, converters, antennas or the additional care required in installing uhf receivers.

When one considers that uhf is currently playing such a large part in current service problems, this omission in a current book is serious.

Other developments that receive no mention from the authors, probably because of the difficulty in completely revising the material previously written, are the cascode-type front end, the turret tuner and self-focus picture tubes.

These errors, if we want to call them errors, are errors of omission rather than commission. The material that *is* found in the book, however, is excellent.

It is difficult to evaluate the real worth of *good*, basic knowledge, clearly explained, in terms of money—but certainly the 40-page chapter on "Automatic Frequency Control of Horizontal Sweep Generators" is alone worth the price of the book. It is the most complete and clearest description of this difficult subject this reviewer has seen in current literature.

The authors' objective is to provide "a course of study and a reference volume for radio technicians and students who may eventually have the responsibility for installing and servicing television receivers". Except for students in uhf areas, like Scranton for instance, where four uhf stations are received, the book can be said to fulfill its objective completely.

The book's 524 pages shine with good practical information. The major sections of a modern receiver are described fully and in logical order. An example of the thoroughness of the authors can be gleaned from the subheadings in the chapter on video i-f circuitry: Requirements of Video I-F, Receiver Compensation for Vestigial Side Band Reception, Need for Adjacent Channel Sound Trap, Obtaining Wide-Band Characteristics, Video I-F Transformer Features, I-F Wave Trap Features, Contrast Control Circuits, Input Capacity of Video I-F Tubes, Over-all Video I-F circuit, and Tracking of Sound with Picture.

The material is amply illustrated with photos and drawings. The layout and type selection encourage easy reading, thus aiding student concentration. The 51-page pictorial presentation of receiver troubles, together with an analysis of possible causes, is a helpful innovation in books of this type.

Summing up, for a currently issued book on television service there are serious omissions, but the material that is presented is done well enough to warrant a serious student's attention.—HAROLD J. SCHULMAN, Director of Service, *Allen B. Du Mont Labs., Inc.*

Basic Electronic Test Instruments

BY RUFUS P. TURNER. *Rinehart Books, Inc., New York, N. Y.*, 1953, 254 *pages*, $4.00.

INCREASED use of electronic techniques requires understanding and maintenance by nonengineers or engineers from other fields. Despite the number of good electronics texts at all levels, there are still wide gaps in the printed word for those primarily concerned with instrumentation in its most practical forms.

The author has made a large contribution towards plugging these gaps by providing information for the technician. Engineers from outside the electronics field will likewise find the expositions of basic principles helpful.

Specifically, the book covers operation and use of electrical and electronic instruments from simple voltmeters through inductance checkers, audio test oscillators and r-f signal tracers to a discussion of

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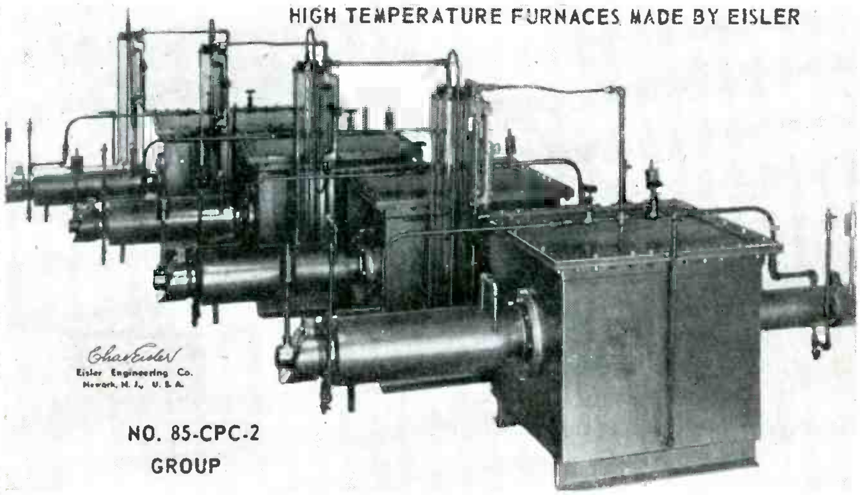

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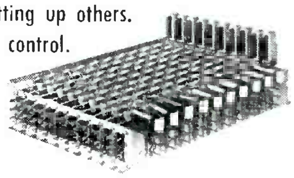

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tube characteristics and tube testers.

While he has had to give relatively scant coverage for important topics such as the cathode-ray oscilloscope (27 pages), the author has managed quite well to hit the high spots of particular interest to the serviceman who represents a major market for the volume. A brief but adequate series of references points the way to more specialized information for every chapter.

As a self-help, or for use by schools, there are likewise review questions summarizing what the reader should have learned from each chapter.

Of particular interest is the author's apparent preoccupation with kits that can be assembled into various pieces of test equipment. As he says in his preface, "... instrument kits have become established in the electronic market, have received wide acceptance, and have for the most part rendered uneconomical the design and construction of shop-built equipment unless the latter serves some special purpose."—A. A. McK.

Principles and Practices of Telecasting Operations

BY HAROLD E. ENNES. *Howard W. Sams and Co., Inc., Indianapolis* 5, *Indiana*, 1953, 596 *pages*, $7.95.

THIS book is specifically intended for engineers engaged in the field of television operations as distinguished from those involved in television research or design work. Video control engineers, cameramen, station engineers and those concerned with the technical phases of telecasting will find it a useful compilation of operating techniques and procedures as they prevailed circa 1953.

The first five chapters are devoted to a summary of elementary television theory as it affects camera chains, control rooms, studios and transmission systems. Chapters 6, 7, and 8 deal with studio operating practices and 9 and 10 with field operations. In Chapters 11 and 12 the operation and maintenance of transmitters are discussed.

Since television operators are always most concerned with the particular pieces of equipment they use, the author has dipped deeply into the manufacturers' technical literature. Specific equipments discussed in detail are the RCA TS-10A switching system, the Dumont 5098-A camera, the RCA TG-1A sync generator, the RCA TM-5-A master monitor, the Dumont 5056-A remote sync phasing unit, the GE synchro-lite projection system, the GE TT-6D transmitter, the RCA TT-5A transmitter, the RCA TK 30A camera, the GE TV-16B stabilizing amplifier, the Dumont 5130-C 16-mm projector, the Eastman television recording camera, the RCA 77-D microphone, the RCA microwave equipment, the GE TT-10A transmitter and the General Radio 1183-T station monitor.

The technical accuracy of the book is generally adequate for the level intended. The author, however, overstresses the superiority of the cathode follower (p 15) as compared to the plate-loaded amplifier in video amplifier output stages. Quite often, the choice of either circuit will be based on output signal polarity considerations alone, and newer developments in feedback video amplifier circuits bid fair to obsolete entirely the use of the follower circuit for coaxial cable feeds.

The diagram of the diplexer shown on p 39 is incomplete. No power will be developed in the radiators by the aural transmitter in the circuit shown.

It should be noted that the modulation bandwidth of the television aural transmitter is not simply twice 25 kc as indicated on p 33.

Certain of the faults as well as the virtues of negative modulation should have been mentioned on p 38, including the difficulty of obtaining a linear modulating characteristic down to the maximum white point which represents zero power output. The British system of positive modulation has much to recommend it on this score.

The studio layouts shown on p 96 are not necessarily representative of current practice. A view of the studio floor from the control room is no longer considered essential.

Not all stations use the technical director system of crew control as described on p 333 et seq.

In Chapter 10, which is devoted

to the technical production of field events, it is recommended (p 457) that in covering baseball play on an infield hit, number-2 cameraman should be preinstructed to "always take close-up of likely culmination of play." This technique should require a considerable amount of preinstruction, particularly if the Dodgers are being televised!

Certain of the definitions in the Glossary (Appendix 2) are loosely worded. In the description of the field strengths required for Grades A and B tv station service (p 588) no mention is made of the fact that the values shown are median fields. Also, it should be noted that the maximum ERP permitted tv stations is a function of antenna height as well as the channel of operation.

No mention is made in this volume of the NTSC color system, which is as it should be, since such color equipment is not yet in wide operational use. This book, in future years, will serve as an excellent memorial of the halcyon days of monochrome television when life was relatively simple and carefree.—FREDERICK W. SMITH, *National Broadcasting Co.*

Good Listening

BY R. D. DARRELL. *Alfred A. Knopf, New York, N. Y.,* 206 *pages,* 1953, $2.75.

AN EXCELLENT book for the LP record enthusiast.

Although it is slightly high-brow (musically) for the average listener it is interesting how much one can get out of this book and how many times one will return to it and how long one will stay with it once the covers are opened.

There are three major divisions and 26 chapters, all dealing with the philosophical aspects of good music, some history, much description and comparison of individual composers and their works—operas, symphonies, ballets, concertos, oratorios, quartettes.

Finally, there is a combined index and recommended list of recordings which gives the author's personal preferences and which makes the whole book worth its price, even

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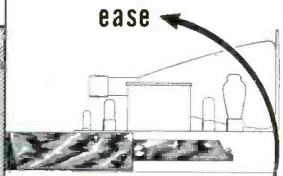

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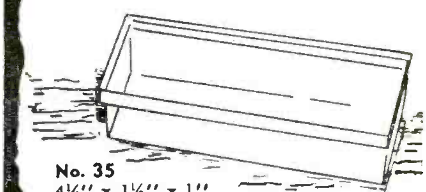

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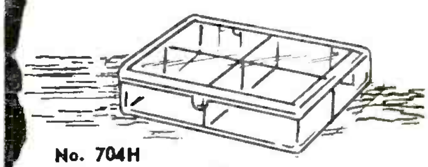

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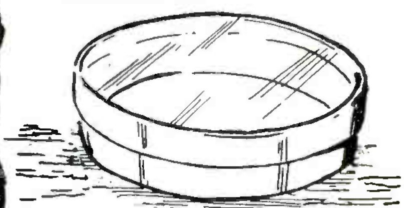

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if the reader isn't completely up to all of the text.—K.H.

Automatic Control of Heating and Air Conditioning

By John E. Haines, *Minneapolis-Honeywell Regulator Co. McGraw-Hill Book Co., Inc., New York,* 370 pages, $6.75, 1953.

While there is nothing electronic in this book, it covers a phase of industrial and domestic life which concerns virtually every engineer in the country. The emphasis is on the controls themselves and only secondarily upon the necessity or desirability of the control. All manner of controls are described with text, diagrams and drawings. It is simple and non-mathematical and could be used for a first course on automatic control by electric or pneumatic devices. Chapters are devoted to domestic heating control. commercial heating and cooling systems, commercial refrigeration control and, finally, the problems of radiant-panel heating.—K. H.

THUMBNAIL REVIEWS

Simultaneous Linear Equations and Determination of Eigenvalues. NBS Applied Mathematics Series 29; U. S. Government Printing Office, Washington, D. C., 126 pages, 1953, $1.50. Symposium of 19 papers presented at a Los Angeles meeting sponsored by NBS Institute for Numerical Analysis. Useful to physicists, chemists and aerodynamics engineers.

Introduction a L'Electronique. By P. Grau. Dunod, 92 rue Bonaparte (VI) Paris, 212 pages, 1953, 1,650 francs. An elementary and thoroughly readable book on the bases of electronic circuits and applications to communication, to industrial operations and to general measuring techniques. In French.

Selenium Rectifier Handbook. Federal Telephone and Radio Co., Clifton, N. J., 80 pages, 1953, $.50. Second edition. Listing of rectifier types, dimensions, circuits and design data for engineers.

Statistical Methods in Electrical Engineering. By D. A. Bell. Chapman & Hall, Ltd., London, 175 pages, 1953, 25 shillings. Probability theory, frequency distributions, curve fitting, data reliability, quality control principles, fluctuations, entropy and information. Rather severely technical but much of it is readable by those with limited mathematical backgrounds.

BACKTALK

Heat Rise

DEAR SIRS:

YOU have no doubt had news of the recent fire in the 10-kc Network Analyzer recently put in service at the University of Illinois. A large portion of the functions in this analyzer are performed electronically, and the construction follows the electronics pattern with standard racks and panels. In some manner a hot fire (not a "roast out") started at the bottom of one of the racks, containing the generators. The fire was sufficiently hot to melt aluminum chassis and completely destroy Micarta terminal boards. The cause has not been determined.

It does not seem possible that the combustible material in a single tray could furnish enough heat to touch off the trays above and cause destruction of all the equipment in one rack and badly destroy equipment in adjacent racks, but that appears to be the case.

Apparently the analyzer did not go quite far enough in duplicating the power systems it was designed to simulate.

F. D. WHITE
Springfield, Illinois

Low-Frequency Resonators

DEAR SIRS:

I WAS very interested to read the article entitled "Vibrating Wire High-Q Resonators" by A. W. Dickson and W. P. Murden in the September issue of ELECTRONICS (p 164). However, I must question a statement made in the first paragraph. It is stated that there is a gap on available resonators between 5 and 50 kc, given as the highest frequency for forks and the lowest for crystals. I am not aware of the range of crystals available in the United States, but here in England we have commercially-available units from 400 cps upwards. Such crystals can be obtained with frequency adjusted to ± 0.005 percent accuracy at stated temperature and maximum deviation over the range -10 to $+70$ deg C or 0.02 percent.

These crystals are, of course, not

cheap. We recently required a special unit of 1,667 cps for a gated counter and the price was approximately 65 dollars. Therefore it is possible that the tungsten wire unit may be competitive in price.

It is necessary to know the frequency stability, both as regards time and temperature. Unfortunately no data on this point are given. I would be glad if the authors could furnish this information and also some idea of cost, if in commercial production, of a 2,000-cps resonator.

J. G. G. HEMPSON
Ricardo & Co.
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Shoreham-by-Sea
Sussex, England

Interference

DEAR SIRS:

IN CONNECTION with the CONELRAD program, has any consideration been given the effect of stacking the oscillator radiations from hundreds of receivers into a small segment of the spectrum?

Speaking of local oscillators, some uhf-tv tuners are playing havoc with the 2-meter amateur band in areas served by channels 14 through 17, 42 through 45 and 69 through 74. Two-meter operation in Peoria, Illinois, has ceased due to this condition. Local dx-tvi record is held by W9EHX who put an identified signal into Bloomington, a distance of approximately 15 miles. At the same time, a receiver of another make was unaffected while operating in the room adjacent to the 200 watt 2-meter transmitter.

Trouble seems to be confined to certain types of tuners, especially outboard converters.

F. D. WHITE
Springfield, Illinois

Correspondent

DEAR SIRS:

I WOULD like to correspond with a New York gentleman working in electronics. My purpose is to increase my English knowledge and to talk about our common interests and by exchanging letters to become friends. I am 26 years old and an electrician by profession.

PAUL CSABAI
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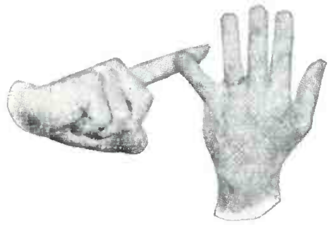

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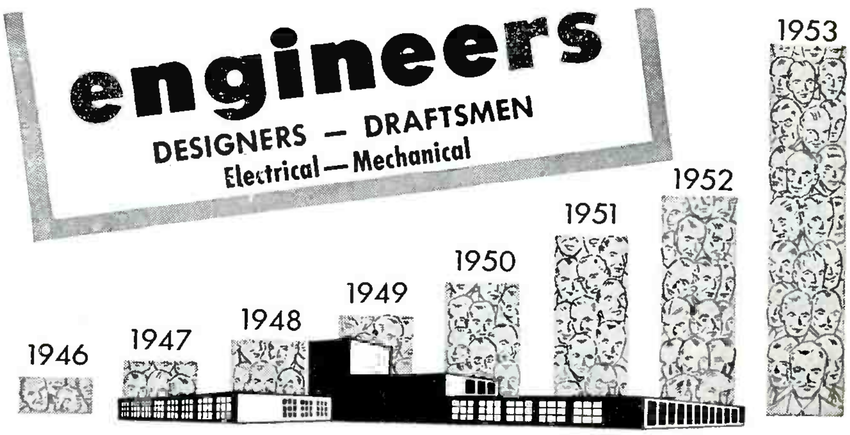

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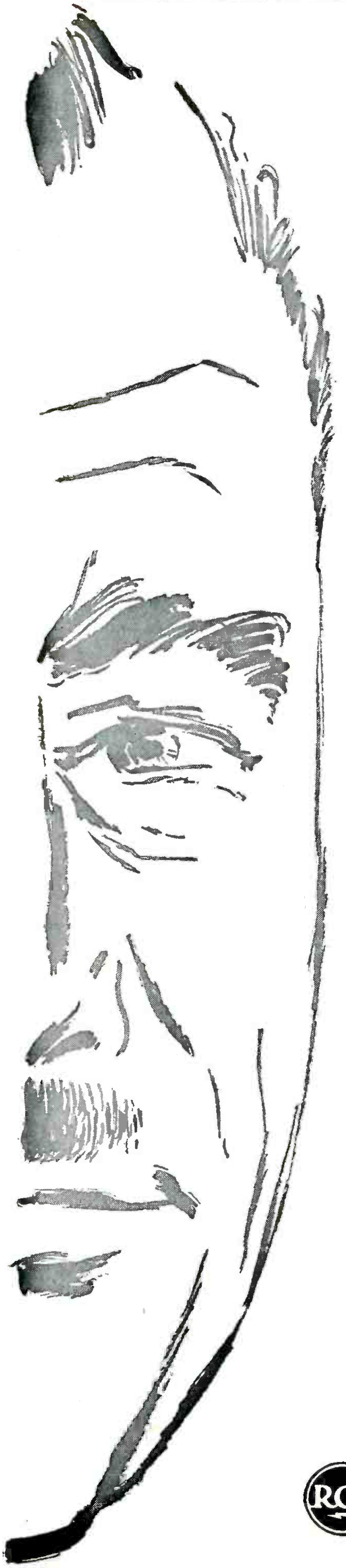

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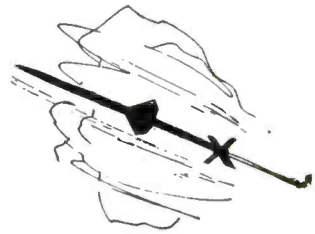

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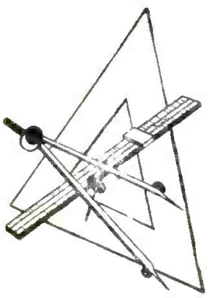

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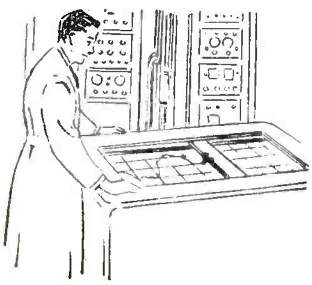

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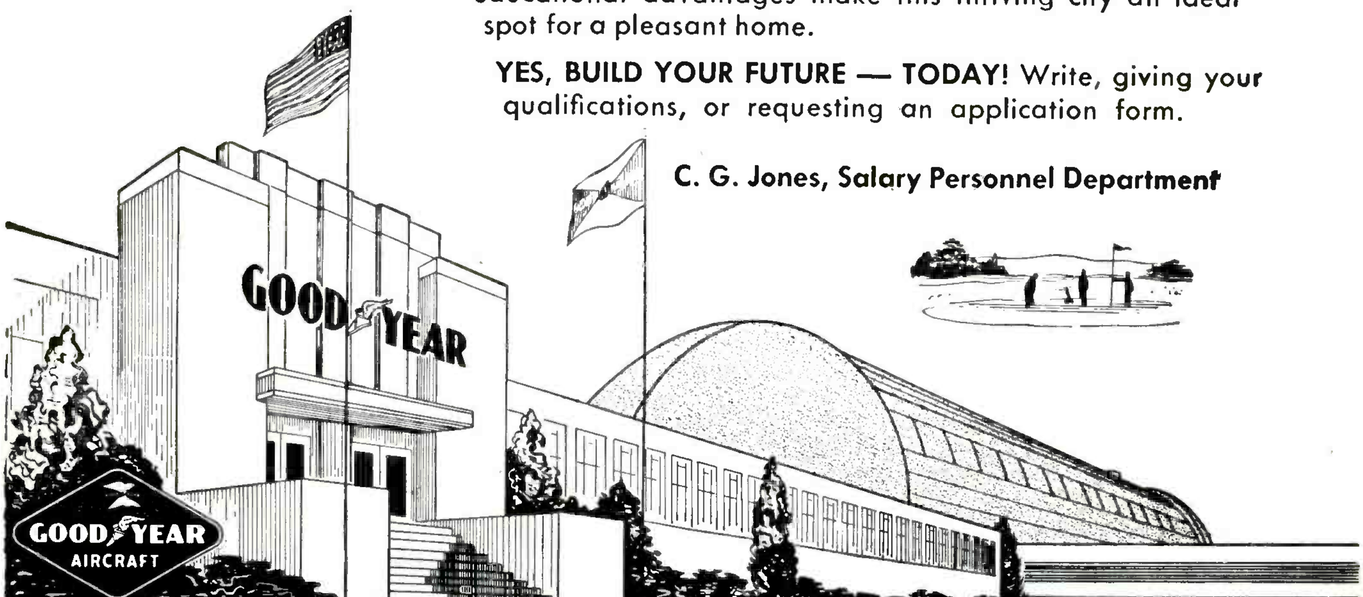

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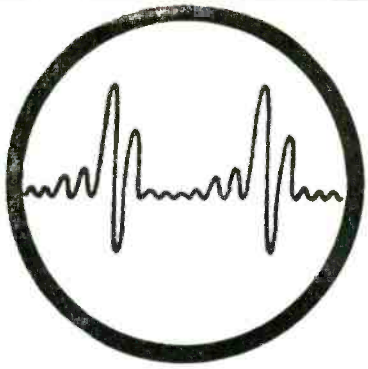

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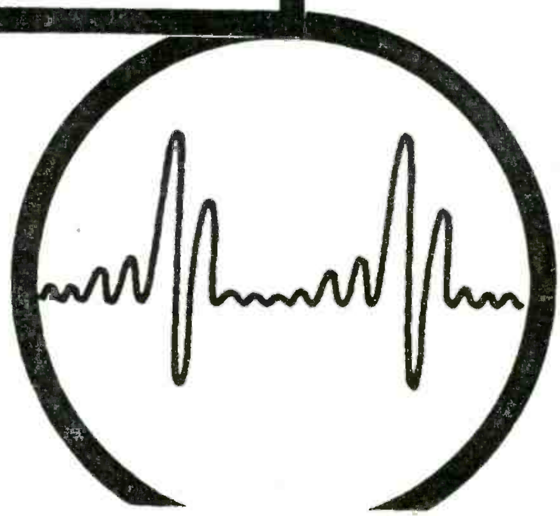

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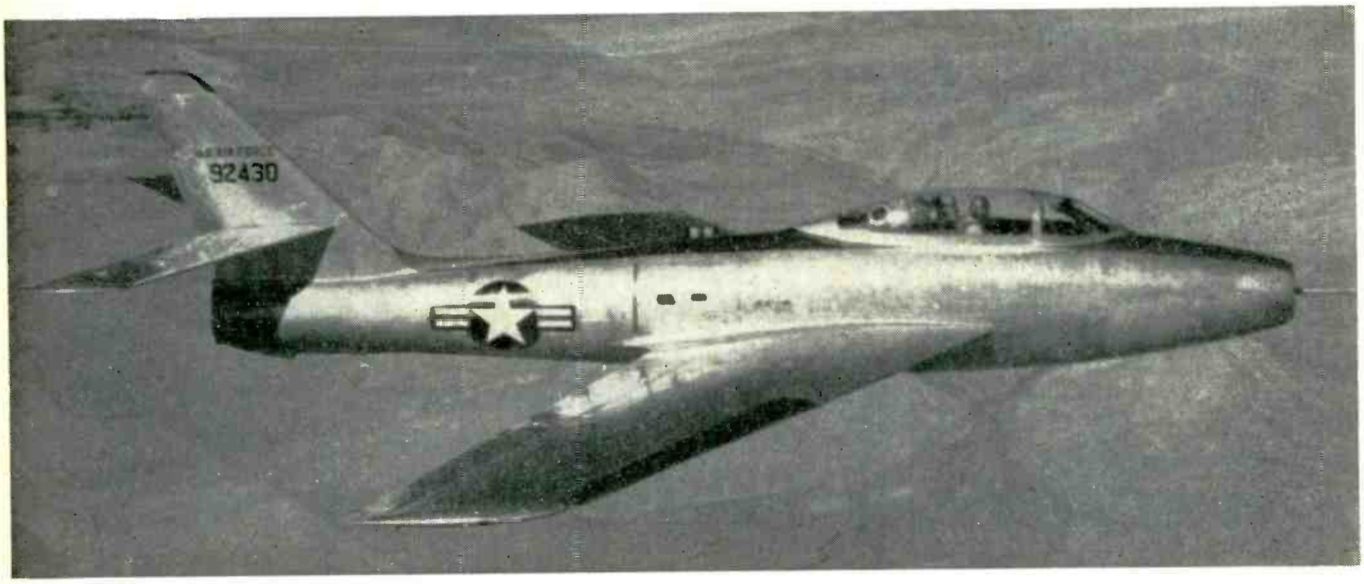

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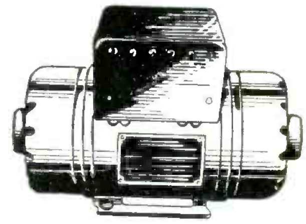

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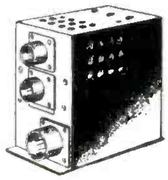

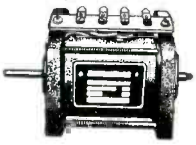

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Instrument Associates highly skilled instrument technicians combined with extensive laboratory facilities results in rapid and exacting workmanship. Unusual problems requiring know-how and ability find their solution in our Engineering and Development Department. Whatever your requirements in avionic instruments and their component units look to Instrument Associates for their fulfillment.

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Ask for Mr. Greenberg or Mr. Herzog

We have a large variety of standard types of relays and solenoids for a multiplicity of uses which for various reasons are not listed in our advertising. When inquiring concerning your needs give as much information as possible. Catalog numbers are not sufficient. Give coil voltage; specify AC or DC; give current or resistance; contact current and arrangement.

PRODUCTION QUANTITIES OF MOST ITEMS AVAILABLE

ALL MERCHANDISE IS GUARANTEED AND MAY BE RETURNED FOR FULL CREDIT

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, 8 ma DC, 3 makes (3As) #R276 ... $4.25

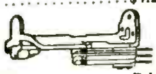
CLARE K101, 6500 ohm, SPDT, 2 ma DC. Fast Action R588 ... $4.25

A18258 BENDIX (Cook 102) 8-12 VDC, Copper Slug. Slow Release. SPDT, 200 ohm. Part of SCR 522. #365 ... $2.49

R5229AI AUTOMATIC 6VDC, 3PST n.o. (3As), 75 ohms. Slow Release. #412 ... $2.50

R5021AI AUTOMATIC 1300 ohm, 20 ma DC, SPST n.c. (1B). #413 ... $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	F108	1B, 1A, 1C	2.00
F102	2A	1.50	F131	1B, 9A, 1C	4.00
F103	3A	1.75	F107	2B, 1A	1.75
F104	4A	2.00	F142	2B, 2A	2.00
F138	5A	2.25	F112	2B, 2A, 2C	3.00
F139	10A	3.50	F129	2B, 2A, 6C	5.00
F128	12A	4.00	F140	3B, 1A	2.00
F106	1A, 1B	1.50	F121	5B, 1C	2.75
F107	1A, 2B	1.75	F122	1C	1.50
F140	1A, 3B	2.00	F123	2C	2.00
F108	1A, 1B, 1C	2.00	F145	3C	2.50
F109	1A, 1C	1.75	F124	4C	3.00
F141	1A, 3C	2.75	F146	6C	4.00
F111	2A, 1B	1.75	F109	1C, 1A	1.75
F142	2A, 2B	2.00	F137	1C, 2A	2.00
F137	2A, 1C	2.00	F117	1C, 5A	2.75
F142	2A, 2C	2.50	F133	1C, 1B	1.75
F112	2A, 2B, 2C	3.00	F108	1C, 1A, 1B	2.00
F129	2A, 2B, 6C	5.00	F121	1C, 5B	2.75
F114	3A, 1B	2.00	F131	1C, 9A, 1B	4.00
F115	3A, 2C	2.75	F142	2C, 2A	2.50
F117	5A, 1C	2.75	F112	2C, 2A, 2B	3.00
F143	6A, 4C	4.50	F115	2C, 3A	2.75
F131	9A, 1B, 1C	4.00	F141	3C, 1A	2.75
F147	1A, 2D	2.75	F144	4C, 1B	3.24
F148	2A, 1D	2.25	F143	4C, 6A	4.50
F120	1B	1.25	F129	6C, 2A, 2B	5.00
F132	2B	1.50	F149	1C, 1D	2.25
F134	3B	1.75	F150	3C, 1D	3.25
F106	1B, 1A	1.50	F151	1D	1.75
F111	1B, 2A	1.75	F148	1D, 2A	2.25
F114	1B, 3A	2.00	F149	1D, 1C	2.25
F133	1B, 1C	1.75	F150	1D, 3C	3.25
F144	1B, 4C	3.24	F147	2D, 1A	2.75

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

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To open a normally closed circuit. Ten holes — capacity: 1-10 impulses. Has 3 shunt springs, arranged to make when dial is moved off normal. #D101 ... $4.95
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AUTOMATIC ELECTRIC TYPE 13

25 Position: Self Interrupter Springs; Norm. Oper Volts: 25 VDC; Max 30 VDC; 0.6 Amps; 30 Ohm. Three Levels Auto. Elect. RA92; #R900 ... $17.75

WESTERN ELECTRIC 22 Position; Make & Break Interrupter Springs; Normal Operating Voltage 6VDC; Max 8VDC 4 ohm; Five Levels #R926 ... $19.75

WESTERN ELECTRIC 44 Position; Make & Break Interrupter Springs; Normal Operating Voltage 6VDC; Max 8VDC; 4 ohm; Two Circuit Levels #R927 ... $22.50

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	K107	750	1.50
K131	5.0	1.25	K135	800	1.75
K102	12	1.25	K109	1000	1.75
K156	50	1.25	K111	1300	1.75
K157	70	1.25	K158	1400	2.00
K132	175	1.25	K112	2000	2.25
K153	300	1.50	K159	2250	2.50
K154	400	1.50	K155	2500	2.50
K104	450	1.50	K113	3000	2.50
K105	500	1.50	K116	6500	2.75
K133	600	1.50	K118	40,000	3.25
K134	700	1.50			

SLOW-ACTION COILS

SLOW-MAKE			SLOW-RELEASE		
Stock No.	Ohms	Price each	Stock No.	Ohms	Price each
K160	20	1.50	K161	30	1.50
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

DUAL COILS

Stock No.	Ohms	Price each	Stock No.	Ohms	Price each
K162	20/400	2.25	K106	500/1100	2.00
K163	25/200	2.25	K144	500/1800	2.50
K141	50/2000	2.25	K165	550/550	2.25
K166	125/125	2.25	K143	1000/200	2.00
K142	125/1300	2.25	K106	1100/500	2.00
K164	200/200	2.25	K142	1300/125	2.25
K163	200/25	2.25	K144	1800/500	2.50
K143	200/1000	2.00	K141	2000/50	2.25
K162	400/20	2.25			

A = Normally open; B = Normally closed;
C = Double throw; D = Make before break

ACCESSORIES FOR TELEPHONE TYPE RELAYS

Clare	CR1	Molded Bakelite Cover 2⅛" x 2⅜" x 4¼" overall	#CR1	.90
Clare	CR3	Steel Cover 2⅛" x 1⅛" x 4⅜" overall	#CR3	.95
Clare	CR5	Steel Cover 2¾" x 1⅛" x 4⅜" overall	#CR5	.95
Clare	BR2	Long Relay Bracket	#BR2	.20
Clare	BR4	Short Relay Bracket	#BR4	.15

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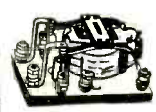
ALLIED—Most numbers



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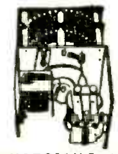
MINIATURE AIRCRAFT



GUARDIAN Series 110, 120, 125, 155, 165, 405, 415 and Series R Steppers

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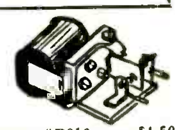
D 171584; SPDT; 1 coil of 4500 ohms plus 24V Heater; High pressure sealed octal plug base. Operating current 6.6 ma; release current 5.2 ma. Overall length — 3¼"; overall diameter — 1-316". #R1021 ... $6.95 each
10 for $65 100 for $625

D.C. SENSITIVE PLATE CIRCUIT RELAYS



Allied FID; 8 ma; 1A; 3000 ohm; #R916 ... $1.50
Allied BO6D40; 30 ma; DPDT; 2380 ohm; #R303 ... $4.95
Allied BO6D42; 20 ma; DPDT; 5000 ohm; #R304 ... $5.25
RBM 23024; 6 ma; 4PST n.o. (4A's); 6500 ohm; #R802 ... $2.95
RBM 452-1041; 4 ma; 12000 ohm; DPDT; Telephone Type; #R685 ... $4.95
W. E. (Whelock) KS9665; 9 ma; 1A, 1B, 1C; 2000 ohm; #R426 ... $4.95
Clare Type J (K102); 6 ma; SPDT; 3500 ohm; #R30 ... $3.50
Clare B 11613 (K101); 2 ma; SPDT; 6500 ohm; #R588 ... $4.25
Clare A11996; 12 ma; 3A; 2000 ohm; #R94 ... $1.75
Clare Type G; 4 ma; DPDT; 20,000 ohm; #R302 ... $3.50
Clare 5036; 15 ma; 2A, 1C; 2450 ohm; Hermetically Sealed; #R440 ... $6.95
Cooke Type C; 4 ms; 1A; 6500 ohm; #R596 ... $3.50
Leach P3; 3 ma; SPDT; 1280 ohm; #R941 ... $1.25
Leach 1028-434; 20 ma; 1A, 2B; 1550 ohm; #R301 ... $2.95
Leach 1037; 10 ma; DPDT; 10,000 ohm; #R540 $4.50
Leach 1421; 2.5 ma; 1A, double break; 4200 ohm; U. H. F. Insulation; High Voltage, High Current; #R306 ... $5.25
Sigma 4F8000S; 1 am; SPDT; 8000 ohm; #R287 ... $5.95
Sigma 41FS7; 2 ma; SPDT; 10,000 ohm; #R914 ... $2.95
Sigma 41F8000S; 2.5 ma; SPDT; 8000 ohm; #R1002 ... $2.95
Sigma 4AH; 4 ma pull-in, 2.5 ma hold; SPDT; 2000 ohm; Air Tight Seal; RTMA 5 prong Plug Base; #R444 ... $4.25
Sigma 5RJ2000G; 2.3 ma; SPDT; 2000 ohm; Hermetically Sealed; #R1005 ... $7.50
Sigma 5RJ5000G; 1.4 ma; pull-in; 0.4 ma hold; SPDT; Hermetically Sealed; #R281 ... $6.95
Kurman or Ward Leonard BK35; 0.4 ma; SPDT; 11,000 ohm; #R277 ... $5.95
G. M. Lab. 12917-1; 8 ma; 1B; 2200 ohm; #R305 ... $2.00
Advance K1604; 12½ ma; DPDT; 6500 ohm; #R532 ... $2.95
Advance 1713A; 30 ma; 4 PDT; 1000 ohm; #R533 ... $4.95
Advance 455; 20 ma; DPST (2A); 1800 ohm; #R535 ... $2.95

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6 Amps.	4.75	9.00	13.50	33.00
10 Amps.	6.75	12.75	20.00	44.95
12 Amps.	8.50	16.25	20.50	49.00
20 Amps.	13.25	25.50	38.00	87.50
24 Amps.	16.25	32.50	45.00	95.00
30 Amps.	20.00	38.50	.....	.....
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Pri: 115 V., 60 cycles in.
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12 Amps......16.75
24 Amps......35.75
30 Amps......45.00
50 Amps......59.75

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24 Amps.—.004 Hy.—.025 ohm....................$29.95

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Capacity	W. Voltage	Ea.
500 MFO.	50 V.	.85
1000 MFD.	15 V.	.35
6000 MFD.	15 V.	1.50

VICTOREEN VXR-130

Subminiature Voltage Regulator. Brand new in cellophane bag. Used as stabilizer in battery R. F. supplies; for voltage reference & limiting circuits; for D.C. Amplifier Coupling. Nominal volts; 130 . . . Max. DC Starting Voltage: 200 Regulation: 1 to 2.5 Ma. ± 1½%. You will find many uses for these units. Regular price is........................$4.79
Barry Price.......only $.75 Ten for.....$7.00

• New Erco 4 Channel Ship-to-Shore Marine Transmitter — Receiver — F.C.C. Approved, Brand New. Complete, less xtals @..$179.50
Write for Full Details

WESTERN ELECTRIC CHOKES
NEW—HERMETICALLY SEALED

SMOOTHING 8 Henries @ 300 MA. 75 Ohms 4¾" x 5¼" x 5". W.E. # KS 9476....$4.75
SWINGING, from 4 to 7 Henries. 200 to 700 MA, 42 Ohms. 5" x 5½" x 5". W.E. KS13063. $4.75

W.E. HERM. SEALED POWER TRANSFORMER

Type D175847, Primary 115 AC. 60 Cy. Secondary 1000 VCT @ 500 MA. 5 V @ 5 Amps. (20 KV Insul) 5¼" x 5¼" x 6½". Brand new........$8.50

FLUXMETER

Used to calibrate field strength of magnets from 500 to 4000 gauss and indicate polarity. Probe has gap of 1¼". Beautifully built in hardwood case with hinged cover. Instructions for operation on under side of cover. Size 12¾ x 9 x 6 in. Ideal for lab and school use. New. An exceptional value at...$19.95

FULLY GUARANTEED — # TUBE SPECIALS — **STANDARD BRANDS ONLY**

Type	Price
OA2	$ .87
OA3/VR75	1.03
OB2	.85
OB3/VR90	.90
OC3/VR105	.91
OD3/VR150	.89
OZ4	.50
1AE4	.85
1A3	.70
1A7GT	.66
1AX2	1.05
1B3GT	.85
1B22	1.20
1B23	5.75
1B24	7.15
1B26	2.20
1B27	11.50
1B32	1.45
1B35	8.00
1B42	8.25
1B46	1.85
1B63	39.50
1C6	.45
1G6GT	.60
1H4G	.60
1J6G	.55
1L4	.45
1L6	1.10
1LN5	.73
1N21-B	1.90
1N23A	1.95
1N23B	2.20
1N31	7.25
1N34A	.78
1N38	1.20
1N38A	.95
1N44/400B	1.50
1N45/400C	.90
1N48	.50
1N54	.85
1N64	.68
1N69	.65
1P23	2.50
1P28	9.00
1P40	1.55
1P42	5.00
1Q6	.75
1R4	.67
1R5	.75
1S4	.70
1S5	.70
1T4	.75
1U4	.50
1U5	.70
1V	.65
1V2	.69
1X2A	.85
1Z2	3.20
2AP1	5.70
2B22	2.25
2C21	1.05
2C22	.40
2C33	4.50
2C39(JAN)	22.50
2C39A(JAN)	19.50
2C40	6.00
2C43	14.95
2C44	.98
2C51	3.85
2C52	3.75
2D21	1.17
2E24	3.30
2E26	3.40
2E30	2.25
2J21/2J21A	6.50
2J22	5.00
2J26	13.00
2J27	9.70
2J31	20.00
2J32	22.00
2J34	18.50
2J37	12.00
2J39	6.95
2J40	32.00
2J50	18.35
2J54	62.95
2J54B	95.00
2J55	62.50
2J61	29.50
2J62	25.00
2K22	19.50
2K23	11.40
2K25	20.20
2K28	25.00
2K29	23.00
2K30/410R	320.00
2K33	175.00
2K33A	180.00
2K34	139.50
2X2	.33
3A4	.59
3A5	.85
3AP1	5.00
3B7/1291	.39
3B22	2.45
3B24	3.95
3B25	3.50
3B26	2.75
3B28	4.95
3B29	10.50
3BP1	3.65
3BP11	7.75
3C23	6.75
3C24/24G	.90
3C27	3.50
3C31/C1B	2.50
3C33	8.75
3C45	11.75
3CP1	2.00
3D6	.40
3DP1	2.75
3DP1A	6.50
3DP1-S2	3.75
3FP7	1.75
3GP1	2.70
3HP14	6.60
3J30	95.00
3J31	75.00
3L4	.90
3Q4	.60
3Q5GT	.84
3RP1	7.50
3S4	.65
3V4	.68
3X2500A3 (JAN)	135.00
4A1	1.15
4B22	7.50
4B25/EL6CF	7.95
4B28/CE225	3.95
4C27	12.75
4C35	19.25
4-65A	20.00
4-125A	30.25
4-400A	60.50
4D22	18.50
4E27	14.00
4E27A	35.75
4J32	220.00
4J36	140.00
4J37	195.00
4J63	195.00
4PR60A	90.00
4X150A	48.00
C5B	3.50
5AW4	1.50
5A6	2.75
5BP1	3.35
5BP4	3.35
5C22	37.50
5D21	11.98
4-250A	41.25
5FP7	1.25
5GP1	3.35
5J29	11.50
5J30	29.50
5JP2	19.75
5JP7	22.75
5LP5	17.00
5R4GY	1.45
5R4WGY	1.60
5TP4(RCA)	35.00
5T4	1.40
5U4G	.56
5V4G	.92
5W4	.80
5X4G	.75
5Y3GT	.44
5Y4G	.56
5Z3	.60
5Z4	1.05
6A3	1.12
EL6CF	7.95
C6J	7.25
6C21(JAN)	24.95
6-4/6-4B	.39
6AB4	.65
6AB7	.90
6AC7	1.04
6AF4	1.20
6AG5	.71
6AG7	1.10
6AH4GT	.80
6AH6	1.88
6AJ5	1.30
6AJ6	1.95
6AK5	.79
6AK5W	1.50
6AK6	.90
6AL5	.55
6AN4	1.50
6AQ5	.55
6AQ6	.65
6AR5	.75
6AR6	2.70
6AS5	.70
6AS6	2.15
6AS7G	3.45
6AT6	.48
6AU5GT	1.00
6AU6	.59
6AV6	.48
6AX4GT	.72
6AX5	.72
6B4G	1.15
6B8	.75
6BA6	.60
6BC5	.69
6BE6	.63
6BG6G	1.79
6BG7	1.65
6BH6	.80
6BJ6	.70
6BK7	1.10
6BL7GT	1.00
6BN6	1.20
6BQ6GT	1.17
6BQ7A	1.23
6BX7GT	1.50
6BY5G	1.98
6BZ7	1.28
6C4	.50
6C5	.59
6C6	.65
6C36	.65
6CD6G	1.80
6CL6	1.10
6CS6/5915	1.10
6CU6	1.95
6F4	3.50
6F5	.68
6F6M	.65
6F8G	.90
6G12	.90
6H6	.52
6J4	4.95
6J5M	.50
6J5GT	.52
6J6	.75
6J7M	.70
6K4/6K4A	2.75
6K6GT	.59
6K7	.60
6L5G	.90
6L6G	1.05
6L6GA	1.05
6L6M	1.39
6L7M	.85
6N7	.75
6P5G	.85
6S4	.58
6S4M	.95
6SD7GT	.80
6SA7GT	.64
6SA7M	.64
6SC7	.79
6SG7	.60
6SH7	.65
6SJ7	.58
6SK7M	.61
6SK7GT	.61
6SL7GT	.64
6SN7GT	.73
6SQ7	.58
6SR7	.59
6SS7	.83
6T8	.89
6U5/6G5	.75
6U8	.90
6V3	1.15
6V6-GT	.61
6V6M	1.35
6W4GT	.59
6W6GT	.75
6X4	.50
6X5GT	.50
7A4	.70
7A7	.74
7A8	.67
7B7	.76
7B8	.75
7C4	.29
7C5	.69
7C6	.69
7C30	85.00
7E5	.39
7E6	.55
7F7	.80
7H7	.70
9LP7	3.50
10 (Special)	.95
10T1	.75
12A/112	.75
12A5	1.25
12A6	.75
12AL5	.70
12AT6	.50
12AT7	.89
12AU7	.79
12AV6	.50
12AV7	.90
12AW6	.88
12AX4GT	.90
12AX7	.70
12AY7	1.75
12AZ7	.90
12BA6	.65
12BE6	.64
12BH7	.85
12BY7	1.05
12BZ7	1.10
12GP7	15.25
12SA7	.64
12SC7	.85
12SG7	.78
12SH7	.63
12SJ7	.56
12SK7	.61
12SN7GT	.75
12SQ7	.55
15-R	.50
19BG6G	2.05
19T8	.90
20-4	1.20
KY21A	13.95
RY21A	9.00
22	.99
23D4	.85
24-A	.55
25AV5	1.20
25A6	1.15
25BQ6GT	1.25
25L6GT	.62
25Z6GT	.59
26	.55
27	.55
28D7	1.55
35A5	.62
35B5	.60
35C5	.62
35L6GT	.65
35TG	16.00
35W4	.45
35Y4	.55
35Z5GT	.48
41	.75
42	.70
45 (Special)	.40
47	.80
50A5	.75
50B5	.65
50C5	.65
50L6GT	.65
50Y6	.73
50T	3.95
53A	4.95
RK59	1.20
WL-SK60	5.15
QK-60	60.00
QK-61	60.00
VR-65	1.50
70L7GT	2.40
QK-72	250.00
RKR-72	.90
RKK-73	.90
75	.65
76	.50
77	.70
78	.75
80	.64
81	.95
82	.85
83	1.11
83-V	1.00
84/6Z4	.61
98R	5.50
C-100E	2.50
100-TH (JAN)	5.95
101-F(WE)	2.25
101L(WE)	2.10
102-F(WE)	2.25
104-D(WE)	3.10
FG-105	17.50
VU-111	.88
HY-114B	.50
117L7GT	2.65
117Z3	.75
117Z4GT	1.55
C-120	9.90
121-A	8.00
VXR130	.75
WL-172	51.00
CV-172	25.00
183(TS)	2.50
211/VT4C	.88
RX215	7.75
215-A	.24
CE225	3.95
227/227A	3.75
231-D	2.00
RX232	3.20
RX233A	3.35
245A	2.25
QK249	120.00
250-TH	33.00
HK-257B	14.00
271-A	6.30
FG 271/5551	55.00
275-A(WE)	5.95
HF-300	17.50
304-TH (JAN)	7.75
304-TL (JAN)	8.75
305A	4.50
306-A	3.95
310-A (WE)	3.75
311-A (WE)	5.95
316-A	.85
TR317	14.75
328-A	4.05
332-A	25.50
350-A	4.90
359-A (WE)	4.00
371-B	.68
373-A (WE)	3.75
374-A (WE)	3.30
387-A (WE)	2.75
388-A	1.25
393-A (WE)	7.75
394-A	2.50
403-B (WE)	5.00
404-A (WE)	12.95
407-A (WE)	4.95
408-A (WE)	3.00
416-A	12.95
417-A (Kly.)	12.95
417-A (WE)	7.50
418-A	12.00
421-A	5.95
422-A	5.95
GL-434-A	14.75
GL-446A	1.10
WL-450-TH	77.00
GL-451	3.00
464-A	9.50
GL-471-A	2.20
WL-481A	4.30
CK-501LX	1.25
WL-502A	1.65
WL-530	13.00
WL-531	5.00
WL-532	3.50
GL-559	1.15
GL-562	75.00
575-A	13.95
WL-579B	14.70
WL-KU610	21.50
WL-KU627	19.80
WL-629	11.70
WL-632B	26.00
635	11.00
651	65.00
ZP-653	195.00
WL-672-A	34.25
WL-KU676	52.25
WL-677	52.25
WL-678	46.00
701A	6.50
700-A	19.95
700-B	19.95
700-D	19.95
703-A	4.50
704-A	.85
705-A	.98
706B/or C	18.50
706EY	27.50
707-A	5.00
708-A	3.50
709-A	2.00
CK-710	.95
713A	.90
714-AY	9.95
715A	3.00
715B	4.00
719-A	16.00
721-A	1.95
722A	1.50
724-A	1.70
724-B	1.90
725-A	4.75
726-A	8.75
726-C	59.50
728 AY, BY, CY, DY, EY or FY Quantities	Write for Price
730-A	19.50
801-A	.35
803	3.25
805	3.20
807	1.55
808	1.50
WL-810	15.95
811	2.95
811-A	2.90
812	2.65
812-A	3.50
WL-813	17.75
813	10.25
814	3.50
816	1.40
822	19.50
826	.95
827-R	53.00
828	9.50
829-B	14.50
WL-833-A	49.00
834	8.00
836	3.00
837	.95
838	2.90
841	.40
WL-845	13.50
849	29.00
860	2.25
861	15.00
865	.95
866-A (JAN)	1.25
866-A (CBS)	1.75
874	.95
884	1.50
885	1.65
WL-889-RA	289.10
WL-891	218.54
892-R	195.00
902	5.00
902P1	9.00
918	2.20
921	1.85
922	1.60
924	2.60
927	1.65
954	.35
955	.45
956	.45
957	.45
959	1.75
968	1.50
991/NE-16	.50
1000T	137.50
FM1000	1.40
CK1005	.65
CK1006	1.50
CK1027	2.75
1201/1201A	.65
1203A	.45
1299A	.55
1608	4.95
1612	2.00
1613	.80
1616	.85
1619	.35
1622 (6L6M)	1.95
1624	1.50
1625	.30
1626	.20
1629	.25
1630	.90
1632	.45
1636	2.75
1638A	.50
1655	1.75
1665	1.75
1960	.60
2050	1.40
2051	1.00
5516	7.65
WL-5550/681	49.00
WL-5552/651	120.00
WL-5553/665	251.50
WL-5554/679	180.55
WL-5557/17	8.40
WL-5558/32	14.40
WL-5559/57	21.90
5636	5.75
5637	3.00
5643	8.00
5645	7.75
5646	7.75
5654	1.75
5670	3.25
5676	1.15
WL-5683	9.24
WL-5685	31.27
5687	2.75
5693	6.20
5694	2.50
5702	2.85
5702-WA	4.50
5703	1.20
5703-WA	3.50
5718	6.00
5719	5.50
5725	4.10
5726	1.50
5732	3.95
WL-5736	156.80
5733	2.25
5749	1.90
5751	2.95
5763	1.30
5780(WE)	350.00
5787	4.25
5795 (WE)	350.50
5814	1.85
5829	2.75
5838	3.00
5840/SN1039A	7.75
5844	2.00
WL-5846	126.40
5881	2.50
5886	3.00
5948/1764	395.00
5964	1.45
5991	3.95
5910	.75
WL-5934	14.70
WL-5996	25.00

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BARRY ELECTRONICS CORP.

136-C LIBERTY ST. N. Y. 6, N. Y.

NEW YORK'S RADIO TUBE EXCHANGE

TYPE	PRICE
OA2	$1.00
OA3	1.10
OB2	.99
OB3	1.10
OC3	.96
OD3	.89
C1B	2.95
1B21	1.50
1B22	1.50
1B23	6.95
1B24	12.00
1B26	1.75
1B27	12.50
1B32	2.95
1B38	35.00
142	7.50
1B50	23.00
1B51	7.50
1B56	35.00
1B60	35.00
1N21	1.25
1N21A	1.75
1N21B	2.75
1N21C	19.50
1N22	1.00
1N23	1.95
1N23A	2.75
1N23B	2.75
1N23C	7.50
1N25	4.50
1N26	6.75
1N27	3.50
1N34A	.79
1N43	2.25
2B4	1.25
2B22	1.75
2C34	.15
2C40	9.00
2C42	12.00
2C43	14.50
2C44	.60

TYPE	PRICE
2C46	7.50
2E22	2.25
2J21A	12.00
2J22	9.00
2J26	15.00
2J27	15.00
2J31	24.00
2J32	29.00
2J33	32.00
2J34	36.00
2J36	90.00
2J38	8.95
2J39	8.95
2J40	29.00
2J42	135.00
2J49	60.00
2J50	55.00
2J55	150.00
2J56	110.00
2J61	35.00
2J62	35.00
2K22	15.00
2K23	15.00
2K25	27.50
2K26	68.00
2K28	35.00
2K29	35.00
2K33A	95.00
2K39	140.00
2K41	135.00
2K45	80.00
2K50	175.00
2K54	125.00
2K55	125.00
2K56	72.00
3AP1A	10.00
3BP1	7.20
EL3C	5.50
3C22	99.00
3C24	1.50
3C31	2.95
3DP1	7.50
3DP1A	10.00

TYPE	PRICE
3DP1A-52	10.00
3EP1	5.00
3E29	15.50
3FP7	5.00
3HP7	5.00
4A21	2.75
3GP1	5.00
4B26	5.40
4C27	22.50
4C28	35.00
4E27	16.00

TYPE	PRICE
5BP1	3.95
5BP2A	12.00
5BP4	3.95
5CP1	7.50
5CP7	6.95
5CP7A	14.00
5D21	18.00
5FP7	1.95
5JP1	27.50
5JP2	19.50
5JP4	27.50

TYPE	PRICE
FG105	20.00
122A	1.75
203A	7.50
211	.95
217C	12.00
242C	10.00
244A	9.50
249C	4.25
250TH	19.95
250TL	12.00
274B	2.75

TYPE	PRICE
434A	15.00
446A	1.95
446B	3.95
450TL	45.00
464A	7.50
471A	1.25
527	18.00
WL530	3.00
WL531	22.50
WL532	1.75
WL533	15.00

TERRIFIC SLASHES in PRICE
up to 70%
FROM PREVIOUS LOW PRICES

4J25	150.00
4J26	150.00
4J27	150.00
4J28	150.00
4J29	150.00
5J30	150.00
4J31	150.00
4J32	150.00
4J33	150.00
4J34	100.00
4J35	150.00
4J36	150.00
4J37	150.00
4J38	150.00
4J39	150.00
4J40	150.00
4J41	150.00
4J42	190.00
4J51	190.00
4J52	225.00
4J53	225.00
C5B	250.00

C6A	11.00
C6J	7.50
7BP7	5.00
7DP4	9.00
12AP4	50.00
12DP7	24.00
LM15	225.00
15E	1.75
15R	.75
NE16	.59
KY21A	8.25
HK24G	1.50
35T	2.95
45 Special	.35
RK39	2.75
HF50	1.75
VT52	.35
HK54	4.50
RK72	1.00
RK73	1.00
FG95	19.95
100TH	7.95

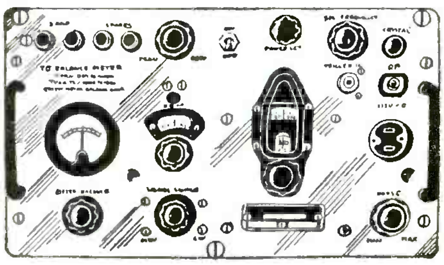
304TH	10.00
304TL	10.00
307A	3.50
310A	4.50
310B	4.95
311A	65.00
312A	3.50
323A	15.00
327A	3.75
328A	6.75
350A	10.00
350B	5.95
352A	3.00
357A	15.00
368AS	4.95
371B	1.50
385A	4.50
388A	1.80
393A	7.50
394A	3.95
MX408U	.50
417A	15.00

700A/D	10.00
701A	4.50
703A	3.95
704A	1.95
705A	1.75
706AY/FY	25.00
707A	9.75
707B	15.00
714AY	18.00
715A	4,50
715B	9.00
715C	22.50
717A	1.50
718AY/EY	30.00
719A	22.50
720AY/GY	150.00
721A	3.50
722A	3.50
723A/B	18.00
724A	1.95
724B	2.25
725A	9.00

TYPE	PRICE
726A	18.00
726B	45.00
726C	45.00
728AY/GY	15.00
730A	22.50
801A	.90
802	3.95
803	5.95
805	4.95
807	1.50
808	1.95
809	2.95
810	10.50
811A	3.75
812A	3.95
813	13.75
814	3.75
815	6.25
816	1.45
829	11.00
829A	12.00
829B	15.00
830B	2.00
832A	9.95
833A	45.00
834	7.50
836	3.95
837	2.75
838	5.95
849	35.00
860	3.50
861	25.00
866A	1.50
869B	67.50
869BX	50.00
872A	3.50
878	1.50
879	.50
880	250.00
884	1.50
885	1.50
914A	75.00
931A	5.00

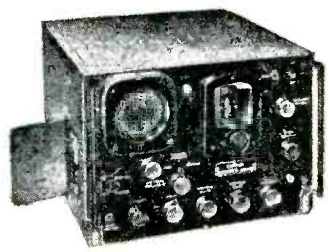
TYPE	PRICE
954	.35
955	.50
956	.75
957	.25
958A	.60
959	2.25
E114A	.25
1280	.95
1603	5.00
1612	1.50
1613	1.25
1616	1.25
1619	.45
1622	1.50
1624	1.75
1625	.35
1626	.25
1851	1.80
2050	1.80
2051	1.00
Various 5000 and 6000 series of new production	
8012	2.00
8012A	2.50
8013	3.00
8013A	3.50
8019	1.75
8020	1.80
8025	3.75
PD8365	96.00
9001	1.25
9002	.90
9003	1.25
9004	.35
9005	2.75
9006	.25

Thousands of other tubes



TS-147 C/UP TEST SET
Hard-to-get
X-Band SIGNAL GENERATOR
Now Available

Test Set TS 147 C/UP is a portable Microwave Signal Generator designed for testing and adjusting beacon equipment and radar systems which operate within the frequency range of 8500 MC to 9600 MC.



MICROWAVE TEST EQUIPMENT
TS148/UP
SPECTRUM ANALYZER

Field type X Band Spectrum Analyzer, Band 8430-9580 Megacycles.

Will Check Frequency and Operation of various X Band equipment such as Radar Magnetrons, Klystrons, TR Boxes. It will also measure pulse width, c-w spectrum width and Q or resonant cavities. Will also check frequency of signal generators in the X band. Can also be used as frequency modulated Signal Generator etc. Available new complete with all accessories, in carrying case.

Other test equipment, used checked out, surplus

TSK1/SE K Band Spectrum Analyzer
TS3A/AP Frequency and power meter S Band
RF4A/AP Phantom Target S Band
TS12/AP VSWR Test Set for X Band
TS13/AP X Band Signal Generator
TS14/AP Signal Generator
TS33/AP X Band Power and Frequency Meter
TS34/AP Western El Synchroscope
T35/AP X Band Signal Generator
TS36/AP X Band Power Meter
1-96A Signal Generator
TS45 X Band Signal Generator
TS47/APR 40-400 MC Signal Generator
TS69/AP Frequency Meter 400-1000MC
TS100 Scope
TS102A/AP Range Calibrator
TS108 Power Load
TS110/AP S Band Echo Box
TS125/AP S Band Power Meter
TS126/AP Synchroscope
TS147 X Band Signal Generator
TS270 S Band Echo Box
TS174/AP Signal Generator
TS175/AP Signal Generator
TS226 Power Meter
TS239A Synchroscope
TS239C Synchroscope

SURPLUS EQUIPMENT

APA10 Oscilloscope and panoramic receiver
APA38 Panoramic Receiver
APS 3 and APS 4 Radar
APR4 Receiver
APR5A Microwave Receiver
APT2 Radar Jamming Transmitter
APT5 Radar JammingTransmitter

MINIMUM ORDER
25 Dollars

YOU CAN REACH US ON TWX NY1-3235

Cables:
TELSERSUP

SPECIAL

Wide Band S Band Signal Generator 2700/3400MC using 2K41 or PD 8365 Klystron, Internal Cavity Attenuator, Precision individually calibrated Frequency measuring Cavity. CW or Pulse Modulated, externally or internally.

Large quantities of quartz crystals mounted and unmounted.
Crystal Holders: FT243, FT171B others.
Quartz Crystal Comparators.
North American Philips Fluoroscopes Type 80.
Large quantity of Polystyrene beaded coaxial Cable.

LIBERTY ELECTRONICS, INC.
135 LIBERTY STREET NEW YORK 6, N. Y.

Want more information? Use post card on last page.

COMPASS COMMUNICATIONS CO.

A Division of COMPASS ELECTRONICS CORP.

A WELL-INTEGRATED ORGANIZATION WITH FACILITIES AND TRAINED PERSONNEL FOR—

- DESIGN, MODIFICATION, PRODUCTION, AND TESTING OF COMMUNICATIONS AND RADAR EQUIPMENT
- SUPPLY AND DSTRIBUTION OF ALL TYPES OF EQUIPMENT AND TUBES

WE MAINTAIN OUR OWN FULLY EQUIPPED TESTING LABORATORY TO TEST AND GUARANTEE ANYTHING WE SELL

FIELD TRANSMITTERS

SCR-284—The famous mobile and ground equipment station for field use, complete with all accessories. Range 3.8—5.8 mcs; 20 watts cw, 5 watts phone.

SCR-510—Mobile, portable **FM** radio station. Operates from 6, 12, or 24 volt dc supply. Frequency range: 20.0 to 27.9 mcs.

SCR-610—Same as SCR-510, but with built-in speaker and range of 27.0-38.9 mcs.

SCR-508, 528—Mobile **FM** radio station, operates from 12 or 24 volt dc. Frequency range: 20.0-27.9 mcs.

SCR-608, 628—Same as SCR-528, but with range: 27.0 to 38.9 mcs.

SC-325—400 watts c.w., 100 watts MCW or phone operates from 110 or 220 volts ac. Freq. range: 1.5-18.0 mcs. Master oscillator or crystal control. 5 channel.

We Have Hundreds of These Transmitters in Stock

MARINE TRANSMITTERS and RADIO TELEPHONES

TCS—Collins mfd. Navy radiotelephones for shipboard and mobile use, complete with all accessories for operation from 12, 24, 110, 230 volts d.c. and 110 or 220 volts a.c. **40 watts.**

TDE—Navy or commercial marine transmitters, complete 110 & 220 volts d.c. and a.c. **125 watts.**

TBK—Navy high frequency transmitter, 2-20 mcs; **500 watts** output. Supplied complete with m/g and starter for d.c. or a.c. operation.

TBM—same transmitter but with speech input equipment to give **350 watts phone.**

TBL—Navy all-wave transmitter; **350 watts** output; CW and phone. Suplied complete with m/g and starter for d.c. or a.c. operation.

TAJ—Navy intermediate freq. transmitter, 175-550 kcs; **500 watts** output. Supplied complete with m/g and starter for a.c. or d.c. operation.

TBN—200-3,000 kcs, complete with 220/440 volt, 3 ph. 50-60c power supply — conservatively rated at **1 kw.** output.

ET-8012 — RADIOMARINE (RCA) —**75w output,** 2000-3000 kcs, 2-3 mcs—10 channels.

224-B—WESTERN ELECTRIC — **125w output,** 2-3 mcs, 10 channels, telephone dial selection, with selective ringer.

TCS—COLLINS—Navy radiotelephones for shipboard and mobile use, complete with all accessories for operation from 12, 24, 110, 230 volts d.c. and 110 or 220 volts a.c.—4 channels—**40 watts** cw, **20 watts phone**—1.5-12.0 mcs.

14C—WESTERN ELECTRIC—**800 watts** output - **400 watts phone**—10 channel automatic dial selection—2.0-22.0 mcs, with 220 volt 1 ph, 50-60 cycle power supply.

ET-8010 — RADIOMARINE (RCA) —Commercial and Coast Guard type transmitter—350-500 kcs, **200 watts** cw, mcw.

ET-8019 — RADIOMARINE (RCA) —Commercial and Coast Guard type h.f. transmitter — **200 watt** cw, 170 watts mcw—2.0 to 22.1 mcs in 4 bands.

ET-8023 — RADIOMARINE (RCA) —Commercial and Coast Guard type **h.f.** transmitter — **200 watts cw &** mcw—2.0 to 22.1 mcs—similar to ET-8019, but in larger console.

FT-102 (or 167BY) — FEDERAL (Mackay) — Commercial and Coast Guard type h.f. transmitter 2.0 to 22.0 mcs, **200 watts cw** and **mcw.**

SPECIAL PURPOSE and TRANSMITTING TUBES

This Is A Sample Listing • Write for Other Items & Unlisted Prices

Tube#	Selling Price				
		2K54	150.00	720	write
		2K55	100.00	720DY	90.00
1A	Owrite	3B24	5.40	721A	3.75
OC3	$1.60	3B27	10.00	723A/B	25.00
OD3	1.50	3B28	5.00	724B	6.50
C1A	6.00	3C31	5.75	725A	write
C1B	7.00	3E29	14.00	730A	45.00
C5B	2.95	4C27	25.00	803	7.00
C6A	write	4C28	35.00	807	1.65
C6F	12.50	4D32	22.50	813	9.00
C6J	write	4E27	17.50	829A	12.00
10Y	.90	4J25	175.00	832A	10.00
VR-92	.49	4J26	175.00	833A	39.50
1B22	3.95	4J28	175.00	836	3.95
1B23	10.00	4J29	175.00	837	1.45
1B24	write	4J30	write	843	.50
1N23B	2.50	4J31	175.00	849	27.50
2B22	4.95	4J33	190.00	851	45.00
2B26	3.75	4J34	195.00	860	5.00
2C40	18.00	4J42	225.00	861	25.00
2C44	1.20	4J51	300.00	865	1.25
2C43	25.00	4J52	235.00	872A	3.85
2D21	1.70	5J23	write	874	1.50
2D29					
2E22	3.75	5J26	125.00	889R	195.00
2J21	17.50	5J29	write	891R	210.00
2J22	17.50	6C21	29.50	892	150.00
2J26	27.50	100TH	9.00	892R	250.00
2J27	27.50	204A	60.00	2X2879	1.05
2J31	27.50	211	1.00	1616	2.75
2J32	27.50	250TH	30.00	1619	.75
2J33	35.00	250TL	30.00	1624	2.00
2J34	write	304TH	9.75	1625	.65
2J36	100.00	304TL	9.75	1626	.75
2J38	49.50	307A	5.00	1629	.65
2J39	49.50	339A	35.00	1636	1.50
2J42	75.00	371B	2.50	1642	3.50
2J49	65.00	388A	2.75	2050	2.00
2J50	75.00	415GL	37.50	5611	100.00
2J55	62.50	446A	2.00	8012	4.25
2J56	145.00	446B	3.75	8014A	55.00
2J61	55.00	450TH	45.00	8020	3.50
2J62	55.00	450TL	45.00	8025	7.00
2K22	write	464A	9.50	9001	1.20
2K25	26.00	705A	3.25	9002	1.00
2K26	100.00	706A-GY	45.00	9003	1.20
2K29	35.00	707B	12.50	9004	.50
2K36	write	715B	17.50	9005	1.90
2K45	100.00	717A	1.50	9006	.50

ALL TUBES GUARANTEED • ALL PRICES ARE FOB OUR WAREHOUSE AND SUBJECT TO CHANGE WITHOUT NOTICE

MOTOR GENERATORS • CONVERTERS • INVERTERS • DYNAMOTORS

We Have One of the Largest Stocks of Electical Conversion Eqpt in the East, including All Types of Rotating Machinery and a Variety of DC and AC Magnetic Starters and Controllers from 100 Watts to 100 Kilowatts

ESCO ROTARY CONVERTERS — Mounted in Steel Drip-Proof Boxes —Type R-1-41. Filtered. **Input** 110 volts, 2.5 amps, 3600 rpm. **Output** 110/1/60 @ 1.8 amps, 200 watts **$45.00**

ESCO MOTOR GENERATORS — Dual unit (a) **Input** 32 v d.c. @ 8 amps. **Output** 110/1/60 @ 1.5 amps, 165 va 150w, 1800 rpm. (b) **Input** 32 volts d.c. @ 16 amps. **Output** 260 volts, 1500 cycles @ 4 amps. Rating 1.05 kva, 3,000 rpm. Filtered.
These two units are mtd. together on bed plate, comp. with ctrl. panel containing switch & 0-50 v dc meter. **$32.50** ea. part.

MOTOR - GENERATOR - ALTERNATOR—Mfgr.—Quality Electric Co. Ltd. **Input** 115/1/60 ac @ 22.5 amps, 1800 rpm. **Outputs:** #1. d.c. 500/1000 v, 0.25/0.3 amp., 0.125/0.3 kw. #2 d.c. 150 v, 0.667 amp., 0.1 kw. #3. ac. 115 v, 0.87 amp., 3000 cycles, 0.1 kva. P.F.-1 .... **$245.00**

ESCO CONVERTER — **Input** 110 volts dc. **Output** 110 volts ac @ 1.2 amps. Brand new . . **$45.00**

ALLIS CHALMERS CONVERTER 110 volts dc to 110 volts ac @ 1.25 kva output **$165.00**

PINCOR ROTARY CONVERTER — **Input** 110 volts dc. **Output** 220/1/60 0.300 kva; .90 pf; 3000 rpm; cont. duty; 40°C. Filtered for Radio use **$60.00**

CONTINENTAL MOTOR-GENERATOR—350 watts. Type CC-21991 —Wt. 148 lbs. **Input** 115 volts dc @ 5.7 amps, 0.625 hp. **Output** 115 volts ac, 1 ph., 60 cycles @ 3.04 amps, 1800 rpm, 0.85 pf, 40°C temp. rise, sep. excited. Filtered **$95.00**

WESTINGHOUSE ELECTRIC GENERATOR—10 KVA—AC. **Output** 115/1/60 @ 108.5 amps; .80 pf; 50°C; cont. duty 1800 rpm, sep. excited, 125 dc. DC generator **Output** 125 volts dc @ 8 amps. This generator is mounted on bed plate with room for motor mounting. It can be driven by any mechanically coupled motor, dc or ac or other drive **$495.00**

MOTOR GENERATOR 800-1D— **Input** 24-28 volts dc. **Output** 115 v, 800 cycles at 10.5 amps. Small and compact **$29.50**

M-209—Holtzer-Cabot — Filtered. **Input** 115/1/60. **Output** 115 volts, 3ϕ, 233 cycles; at 0.4 amps and **24 volts dc** at 6.5 amps. 3500 rpm **$125.00**

MG-149—Holtzer-Cabot Inverter. **$49.50**

2J1F1 SELSYN—115-57.5v. 400 cycles **$4.45**

OUR EXPORT DEPARTMENT AVAILABLE FOR SPECIAL SERVICE TO OVERSEAS CUSTOMERS

393 GREENWICH STREET NEW YORK 13, N. Y.

***All phones:* BEEKMAN 3-6509 *Cable Address:* COMPRADIO, N. Y.**

TEST SETS	RECEIVERS
	ARB
TS-3A/AP	ARC-1
TS-10A and B	ARC-3
TS-12/AP	ARC-4
TS-13/AP	ARC-5
TS-16/AP	AR-88
TS-35/AP	CR-91
TS-36/AP	SLR
TS-62/AP	RAK
TS-69A	RAL
TS-74/UPM	RAO
TS-89/AP	RBB
TS-100/AP	RBO
TS-101/AP	RBG
TS-125/AP	RBL
TI-173/UR	RBA
TS-278	REM
TS-323	RCH
OAA	BC-224
OAP	BC-312
OBU	BC-314
LAE	BC-344
LM	BC-348
LU	
IE-19	
I-46	
I-56	
I-208	
I-222	
SCR-211	
and others	

AIRBORNE RADAR	MARINE RADAR	
	SA	SG
	SC	SJ
	SD	SK
APS-2	SF	SL
APS-3	SN	
APS-4	SO-1, 8, 13	
APS-6	SQ	YJ
APS-10	VG	BG
APS-13	VJ	BM
APS-15	YG	BN
SCR-717		
SCR-720		

and SPARE PARTS for

MANY OF THESE SETS, COMPLETE AND NEW IN ORIGINAL CASES

5F, 5G—SYNCHRO—115 v, 60 cycles **$30.00**

POWER UNIT TYPE 23—Rotary transformer, filtered. **Input** 24 vdc. **Output** 6.3 volts at 2 amps and 200 volts at 30 ma. . **$19.50**

And, of course, PE-73, PE-94, PE-98, DM-25, -28, -32, -33, etc.

This Month's SPECIAL OFFERS

SN—RADAR—10 cm — Compact, light and portable, ranges of 5 and 20 miles. Uses 5 CPI scope operation from 115 volts, 60 cycle, but we can supply converter for dc operation..... **$850.00** ea

ANTENNA ASSEMBLY—Reflector is a lightweight parabolic cylinder, Ass'y has both manual and motor drive. Ideal unit for labs, classroom demonstration, small craft, etc. .... **$99.50** ea.

AFR-4—38—4000 mcs. precision receiver, complete w/5 tuning units. Operates on 115/1/60... **$1700.00** ea

MAG—10cm. remarkable link radar, portable, operated from 6 volt battery, uses folding antenna and tripod. A pair at. . **$1750.00**

APS-3—3 cm - Airborne radar for search and homing, 5-in. scope. 10 brand new sets at . **$750.00 ea.**

APQ-13 Very late model airborne radar set, complete and new. One only at..... **$2,950.00**

SCR-545—Complete radar set, less vehicle, antenna and power plant, pretty fair condition, sold as-is at **$1,375.00**

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WRITE FOR OUR FREE BULLETIN — MORE GOOD ITEMS

GUARANTEED BRAND NEW

LECTRONIC RESEARCH TUBE SPECIALS

STANDARD BRANDS ONLY

WRITE FOR OUR FREE BULLETIN — MORE GOOD ITEMS

Receiving Tubes

Type No.	Price
OOA	$1.50
O1A	.67
OZ4	.59
OZ4A	.63
1A3	.71
1A5GT	.72
1A7GT	.79
1AB5	1.30
1B3GT	.99
1B4P	.79
1B5	.74
1C5GT	.69
1C6	.69
1C7G	.69
1D5GP	.69
1D8GT	.99
1E5GP	.71
1F4	.69
1F5G	.69
1F6	.71
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
1Q6	.99
1R4	.69
1R5	.79
1S4	.71
1S5	.69
1T4	.71
1T5GT	.71
1U4	.71
1U5	.77
1V	.65
1X2A	.93
2A3	1.28
2A5	.79
2B7	.79
2E5	.94
2X2	.50
2X2A	1.85
3A4	.65
3A5	.95
3A8GT	1.50
3B7	.57
3C6	1.15
3D6	.77
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
6A3	1.28
6A6	.82
6A7	1.05
6A8	.95
6AB4	.83
6AB7	.98
6AC5GT	1.19

Type No.	Price
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	.69
6AQ7GT	1.26
6AR5	.79
6AS5	.99
6AS6	2.25
6AS7G	4.25
6AT6	.63
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	.75
6BG6G	1.89
6BH6	.95
6BJ6	.95
6BK7	1.60
6BL7GT	1.45
6BN6	1.59
6BQ6GT	1.26
6C4	.55
6C5	.70
6C6	.70
6C8G	.96
6CD6G	2.21
6CL6	1.50
6D6	.88
6D8G	.88
6E5	1.10
6F5GT	.83
6F6	.99
6F6G	.87
6F7	1.05
6F8G	.91
6G6G	.99
6H6	.66
6H6GT	.66
6J5	.59
6J5G	.61
6J5GT	.55
6J6	.55
6J6W	1.75
6J7	.99
6J7GT	.79
6J8G	1.28
6K5GT	.89
6K6GT	.65
6K7	.79
6K7G	.86
6L5G	1.06
6L6	1.87
6L6G	1.49
6L6GA	1.39
6L7	.99
6L7G	.85
6N7	.99
6N7GT	.89
6P5GT	.96
6Q7	.89
6R7	.79
6S4	.72
6S7	1.06

Type No.	Price
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	.65
6SK7	.72
6SK7GT	.72
6SL7GT	.81
6SN7GT	.73
6SN7 WGT	2.10
6SQ7	.65
6SQ7GT	.65
6SR7	.65
6SS7	.63
6ST7	1.05
6T7G	1.23
6T8	.98
6U5	.98
6U7G	.65
6V6	1.49
6V6G	.89
6V6GT	.67
6W4GT	.64
6W6GT	.88
6X4	.59
6X5GT	.59
6Y6G	.89
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
7C7	.79
7E5	.79
7E6	.58
7E7	.83
7F7	.89
7F8	1.35
7G7	.85
7H7	.79
7J7	1.10
7K7	1.10
7L7	.97
7N7	.97
7Q7	.79
7R7	.79
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	.95
12AU6	.71
12AU7	.86
12AV6	.54
12AV7	.99
12AW6	1.20
12AX7	.99
12BA6	.69
12BA7	.95
12BD6	.99

Type No.	Price
12BE6	.66
12C8	.65
12F5GT	.79
12H6	.69
12J5GT	.65
12K8	.70
12Q7GT	.67
12SA7	.69
12SA7GT	.69
12SC7	.90
12SF5	.79
12SF5GT	.79
12SF7	.85
12SG7	.85
12SH7	.73
12SJ7	.71
12SJ7GT	.65
12SK7	.69
12SL7GT	.93
12SN7GT	.89
12SQ7	.89
12SQ7GT	.68
12SR7	.79
12SR7GT	.79
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
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	.87
33	.69
34	.69
35/51	.59
35A5	.72
35B5	.72
35L6GT	.67
35W4	.55
35Y4	.72
35Z4GT	.69
35Z5GT	.58
36	.69
37	.69
38	.69
39/44	.59
41	.72
42	.79
43	.79
45	.79
45Z5GT	.89
46	.81
47	.99
50	1.09
50A5	.89
50B5	.69
50C5	.69
50L6GT	.69
50Y6GT	.92
55	.89
L55B	.32
56	.69
57	.69
58	.69
59	1.24
70L7GT	1.29
71A	.79

Type No.	Price
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
117P7GT	1.89
117Z3	.65
117Z6GT	.97
FM-1000	1.59

Trans-mitting 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
1B24 West.	12.95
1B24 Sylv.	18.95
1B24A	39.50
1B26	3.73
1B27	14.95
1B29	2.75
1B32	3.75
1B35	11.00
1B36	12.50
1B37	14.70
1B38	32.50
1B40	4.95
1B41	51.94
1B42	9.80
1B49	50.33
1H20	.88
1P21	35.00
1P23	4.10
1P24	1.27
1P28	10.00
1P29	2.89
1P30	2.85
1Q23	122.50
1S21	9.50
1Z2	2.75
2A4G	1.22
2AP1	8.95
2AP5	8.95
2B4	2.10
2B22	2.10
2C21	.65
2C22	.45
2C26	.39
2C26A	.49
2C33A	4.95
2C34	.49
2C39	22.00
2C39A	29.00
2C40	12.00
2C42	12.75
2C43	17.75
2C44	1.20
2C46	21.50
2C51	5.75
2C52	31.75
2C53	11.75
2D21	1.55
2E22	1.85
2E24	4.10
2E26	3.79
2J21	8.75
2J22	8.95
2J26	24.75
2J27	22.95
2J31	27.00

Type No.	Price
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	78.50
2K28	29.50
2K29	27.50
2K33	185.00
2K33A	135.00
2K39	135.00
2K45	129.50
2K55	135.00
3AP1	8.95
3AP4	10.25
3B22/ EL-1C	2.60
3B24	5.20
3B24W	7.50
3B25	4.50
3B26	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	37.50
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
4-250A/ 5D22	35.00
4A1	1.18
4AP10	4.40
4B22/ EL-5B	8.95
4B24	5.75
4B25/ EL-6CF	8.95
4B32	10.50
4C27	17.50
4C35	27.00
4E27	21.50
4J36	150.00
4J38	120.00
4J52	275.00
4X150A	36.00
4X500A	118.50
4X 1000A	129.36
5AP1	5.95
5AP4	4.75
EL-C5B	3.95
5BP1	3.50
5BP4	5.50
5C22	47.75
5CP1	4.95
5CP7	9.50
5D21	19.50
5D22/ 4-250A	35.00
5FP7	1.95
5HP1	5.50
5HP4	5.75
5J26	325.00
5J29	18.50
5JP1	26.50

Type No.	Price
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
C6L/ 5528	12.50
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
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
RK-19	1.85
21-2	.65
RK-21	1.65
REL-21	1.95
23D4	1.15
24G	1.85
RK-25	3.82
FG-27A	8.25
FG32/ 5558	6.75
FG33	22.54
RK34	.49
35T	4.95
35T ION gauge	5.95
35TG	4.95
REL 36	.45
T-40	3.75
FG-41	122.50
RK-47	4.92
CE-48	1.90
EF-50	.79
VT-52	.45
53A	5.60
RK59	2.44
QK-60	65.00
SK-60	6.62
QK-61	65.00
QK-62	65.00
VT-62 Br	1.15
RK-63	22.50
FG-67	14.80
VT-67	.45
RK-69	2.25
72	1.32
73	1.32
RK-75	4.25
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

Type No.	Price
FG-105	19.50
VR-105	1.10
VU-111S	1.60
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
217C	8.95
WE- 220B	155.00
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	4.50
WE-2489	4.50
250R	17.50
250TH	22.50
250TL	22.50
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-294A	5.75
304TH	8.75
304TL	8.75
307A	.45
WE-310A	6.25
312A	3.95
WE-313C	4.15
316A	.89
TR-317	18.50
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
368A	6.25
371A	.95
371B	.95
388A	2.95
393A	8.60
394A	4.50
WE-399A	4.70
410R	185.00
414	118.60
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	140.25
481A	4.31
502A	1.67
503AX	1.25
506AX	1.25
507AX	1.47
527	17.50
530	22.00
531	7.50
532A	3.75
WL-533	19.50
559	2.20
561	3.50
575A	20.58
579B	14.70
KU610	21.56
HY615	.49
616	213.75
KU-623	39.50
624	47.00
KU-627	19.80
KU-628	22.50
KU-629	11.70
631P1	5.00
WL- 632B	26.10
KX642	11.34
WL-652/ 5551	62.50
WL-654/ 659	82.00
WL-670A	8.70
WL-672	22.00
KU-6[illegible]	34.30
KU-676	52.25
677	52.25
678	46.06
WL-681/ 5550	49.00
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
706EY	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
715A	6.25
715B	8.95
715C	19.50
717A	1.47
718AY	45.00
718BY	45.00
702DY	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
[illegible]	1.40
800	1.75
801A	.45
802	3.30
803	4.95
805	4.50
806	33.50
807	1.65
808	2.65
809	3.60
810	10.95
811	3.60
811A	4.25

Type No.	Price
812A	3.50
813	10.50
814	3.95
815	5.25
816	1.45
826	1.25
828	9.60
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
845W	6.75
849	29.50
851	67.00
852	19.50
857B	204.78
858	498.00
860	4.95
861	22.50
864	.35
865	1.28
866A	1.48
866A Jr./ 2B26	1.25
868	1.74
869B	125.40
872A	3.95
874	1.35
876	1.60
878	1.85
880	460.00
884	1.75
885	1.75
886	2.60
889A	179.00
889RA	289.10
891	218.54
892	218.54
892R	355.76
893A	617.40
893AR	1127.00
895	931.00
895R	1274.00
902P1	9.95
905	3.50
913	11.25
917	3.43
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	.63
CK-1005	.69
CK-1006	3.30
CK-1013/ 5517	2.25
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	3.99
1624	1.90
1625	.39

Type No.	Price
1626	.30
1629	.30
1630	.95
1631	1.38
1632	.75
1633	1.00
1636	3.10
1642	.65
1644	.95
1655	1.90
1656	6.50
1665	1.80
1904	14.80
1960	.70
2002	4.85
2050	1.70
2051	1.10
5516	7.70
5517/CK- 1013	2.25
5518	514.59
5528/ C6L	12.50
5549	362.00
5550	49.00
5551	62.50
5552	94.50
5553	251.70
5554	180.55
5555	314.00
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	529.20
5610	2.10
5611	115.09
5619	382.20
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	9.24
5665	55.64
5670	4.10
5671	1225.00
5674	85.75
5675	16.95
5683	9.24
5685	31.27
5686	3.68
5687	4.80
5691	8.55
5692	8.55
5693	6.95
5696	1.87
5713	173.48
5718	9.33
5719	8.33
5720	22.54
575	4.16
5726	1.72
5727	3.43
5734	17.63
5736	156.80
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

Type No.	Price
5794	16.43
5796	13.47
5814	3.43
5822	140.14
5826	1274.00
5830	196.00
5840	10.54
5846	126.40
5855	75.46
5876	18.38
5879	1.72
5890	25.48
5893	19.20
5896	7.10
5899	10.53
5902	10.78
5515	1.18
5934	14.70
5936	1078.00
5939WA	47.04
5974	215.60
6005	3.68
6012	4.41
6026	2.89
6072	5.39
6082	5.19
6095	1.45
6096	1.65
6099	3.95
6101	2.95
6135	2.69
6136	3.19
6137	2.45
6159	4.80
620	5.39
UX6653	.65
7193	.45
8000	10.15
8003	13.72
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	2.45
1N27	1.79
1N31	7.90
1N34	.66
1N34A	.90
1N38	1.50
1N38A	2.55
1N39	6.10
1N41	9.85
1N42	18.00
1N43	1.65
1N45	.94
1N52	1.05
1N55	3.05
1N60	.55

SYNCHROS—ARMY—NAVY—COMMERCIAL: All Types—All sizes-1-3-5-6-7. Immediate Delivery from Largest Stocks! Prices on Request—FREE!! 165 page Navy Synchro Manual with each order.

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UTAH OA-18 X-124T 9262 9278 9280 9318 9340 9341 9350

G.E.—K2464; K2468; K2469; K2744B; 68G627; 68G828; 68G929G1; 80G13; 80G152

WESTINGHOUSE—132AW2; 139DW2F; 166AW2F; 176AW2F; 187AW2F.

RAYTHEON—UX-7350; UX-10066.

PHILCO—352-7071; 352-7149; 352-7150; 352-7178; 352-7190; 352-7224.

W.E.—D-161310; D-163247; D-163325; D-164661.

REVERSIBLE GEAR HEAD MOTORS

G.E. 5BA10AJ65—27.5 VDC .66A 2.35 RPM 8 oz-ft Torque $27.50
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G.E. 5BA10FJ19—24 VDC .51A 56 RPM 12 oz-in Torque $22.50
G.E. 5BA10AJ41—PM 24 VDC 55A 140 RPM 10 oz-in Torque $22.50
G.E. 5BA10AJ52—27 VDC .7A 145 RPM 14 oz-in Torque $19.50
Delco 5069230—PM 27VDC 145 RPM $19.50
Delco 5068750—27 VDC 160 RPM $22.50
G.E. 5BA10AJ51—27 VDC 160 RPM .65A 8 oz-in Torque $19.50
Delco 5069600—PM 27 VDC 250 RPM $22.50
G.E. 5BA10AJ8—27 VDC 250 RPM .72A 8 oz-in Torque $19.50
Delco 5067127—PM 27.5 VDC 250 RPM $22.50
Delco 5068820—PM 27 VDC 250 RPM $22.50
G.E. 5BA10AJ37B—27 VDC 250 RPM .8A 8 oz-in Torque $19.50

TACHOMETER GENERATOR

Elinco type PM-1M, DC Tachometer Generator—New $27.50

OIL FILLED CONDENSERS

MFD	VDC		Price	MFD	VDC		Price
2	400		$ .55	.5	3000		$2.40
5-5	400		1.65	1	3000		3.40
1	600		.55	2	3000		5.85
2	600		.69	3 x .2	4000		2.95
2-2	600	R'd	1.65	2	4000		7.95
3	600		.95	1	5000		5.75
4	600		1.65	2	5000		12.50
4	600	R'd	1.65	5	5000		29.50
5	600		1.75	.01-03	6KV		1.65
6	600		1.85	1	6000		9.95
8	600	R'd	1.85	.1	7000	R'd	1.79
4-4-4	600		2.50	.1-.1	7000		5.95
4 x 3	600		2.50	.1	7500		2.85
10	600		3.25	.5	7500		7.95
50	600		7.95	1-1	7500		26.50
1	1000		.65	.075-.075	8 KV		6.50
2	1000		.90	1	10KV		29.50
2	1000	R'd	.95	.1	12KV		8.95
.3.5-5	1000		1.85	1	15KV		47.50
4	1000		1.95	.25	20KV		19.95
6	1000		2.50	1	20KV		54.00
8	1000		3.25	1	25KV		85.00
1	1200		.85	.001	50KV		24.50
1-1-1	1200		1.85	.005	50KV		34.50
.1	1500		.69	.025	50KV		37.50
3	1500		2.50	.2	50KV		67.50
4	1500		2.95	.25	50KV		70.00
.1-.5	2000		.95	7.5	220VAC		1.95
.25	2000		1.50	20	236VAC		3.95
.3	2000		1.30	1-3	330VAC		1.95
1	2000		1.95	12.75	330VAC		4.10
12	2000		8.95	15	330VAC		4.50
1	2500		2.75	5	440VAC		3.10
1-1	2500		3.85	2.9	660VAC		3.50
30	2500		14.75	7	660VAC		4.25
32	2500		15.80	8	660VAC		4.50

OILMITES

MFD	V.	TYPE	Price
.02	600	OM-6002	$.45
.05	600	OM-6005	.49
.1	600	OM-610	.51
.25	600	OM-625	.55
.5	600	OM-650	.69
1.0	600	OM-601	.85

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

Minn. Honeywell type—115V 60 cy. 13.5W—Brown Instr. 76750-1 162 RPM; 76750-2 54 RPM; 76750-3 27 RPM. Any Type .... $19.50 ea.

COAXIAL CONNECTORS

83-1AC	$ .42	83-1RTY	$ .65	83-22J	$1.40
83-1AP	.30	83-1SP	.45	83-22R	.68
83-1F	1.10	83-1SPN	.50	83-22SP	.80
83-1H	.12	83-1T	1.30	83-22T	1.95
83-1HP	.22	83-2AP	1.95	83-168	.12
83-1J	.73	83-22AP	1.40	83-185	.12
83-1R	.40	83-22F	2.10	86-765	.24
				83-776	.65

UG-7/AP	$6.30	UG-58/U	$ .70	UG-185/U	$ .95
UG-12/U	.95	UG-58A/U	.90	UG-191/AP	.80
UG-15/U	1.25	UG-59A/U	2.15	MX-195/U	.75
UG-18/U	1.25	UG-60A/U	1.75	UG-197/U	2.80
UG-18B/U	1.05	UG-61A/U	2.10	UG-201/U	1.95
UG-19/U	1.60	UG-83/U	1.75	UG-203/U	.65
UG-20B/U	1.60	UG-85/U	1.60	UG-206/U	1.80
UG-21/U	.85	UG-86/U	2.25	UG-224/U	1.15
UG-21A/U	1.50	UG-87/U	1.40	UG-236/U	3.85
UG-21B/U	1.00	UG-88/U	.90	UG-245/U	2.25
UG-21C/U	1.05	UG-89/U	1.10	UG-246/U	2.35
UG-22/U	1.30	UG-90/U	1.15	UG-254/U	2.75
UG-22B/U	1.20	UG-98/U	1.85	UG-255/U	1.95
UG-22C/U	1.20	UG-102/U	.80	UG-260/U	.85
UG-23/U	1.20	UG-103/U	.68	UG-261/U	1.10
UG-23B/U	1.50	UG-104/U	1.40	UG-262/U	1.10
UG-23C/U	1.10	UG-106/U	.12	UG-273/U	1.45
UG-24/U	1.30	UG-107B/U	2.75	UG-274/U	2.30
UG-25/U	1.35	UG-108/U	2.00	UG-275/U	5.50
UG-27/U	1.25	UG-109/U	2.60	UG-276/U	2.75
UG-27A/U	2.25	CW-123A/U	.45	UG-290/U	.90
UG-28A/U	2.95	UG-146/U	1.95	UG-291/U	.95
UG-29/U	.95	CW-159/U	.60	UG-306/U	2.65
UG-29A/U	1.85	UG-166/U	32.50	UG-349/U	2.65
UG-29B/U	1.75	UG-167/U	3.75	MX-367/U	.85
UG-30/U	2.30	UG-171/U	2.25	UG-414/U	1.95
UG-34/U	9.75	UG-173/U	.35	UG-498/U	1.80
UG-36/U	12.50	UG-175/U	.12	UG-536/U	1.65
UG-37/U	17.50	UG-176/U	.12	UG-625/U	1.35
UG-57B/U	1.85	UG-177/U	.24		

Full line of JAN Approved coaxial connectors in stock UHF-N-BN-BNC-pulse—Prices on request.

COAXIAL CABLE

Type	Price Per M Ft.	Type	Price Per M 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	330.00	RG-34/U	300.00
RG-10/U	240.00	RG-35/U	900.00
RG-11/U	100.00	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	60.00
RG-20/U	1450.00	RG-62/U	75.00
RG-21/U	220.00	RG-77/U	100.00

ADD 25% TO PRICES SHOWN FOR QUANTITIES UNDER 500 FT.

Terms 25% cash with order, bal. COD unless rated. All prices net F. O. B. warehouse. Phila., Penna., subject to change without notice.

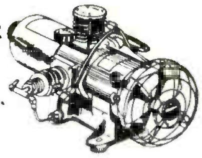
CABLE ADDRESS "LECTRONIC PHILADELPHIA"

LECTRONIC RESEARCH LABORATORIES

715-19 ARCH ST. PHILA. 6, PA.

Telephones - MARKET 7-6771-2-3

AIR COMPRESSOR



Mfg. Cornelius; Model 32-R-200 High Output three stage compressor for charging up to 1500 PSI; driven by 27 VDC Motor; 20 amps. Measures 12½" x 10½" $69.95

G. E. GENERATORS

General Electric Type 5-ASB-31JJ3; 400 cycles out at 115 volts; 7.2 amps; 8,000 rpm.; size 6" long x 6" dia.
$89.50 ea.

SINE-COSINE GENERATORS

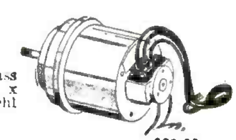
(Resolvers)

Diehl Type FJE43-9 (Single Phase Rotor). Two stator windings 90° apart, provides two output sequel to the sine and cosine of the angular rotor displacement. Input voltage 115 volts, 400 cycle........... $30.00 ea.
Diehl Type FPE-43-1 same as FJE-43-9 except it supplies maximum stator voltage of 220 volts with 115 volts applied to rotor.................... $25.00 ea.

VOLTAGE GENERATORS (RATE)

ALNICO MIDGET D.C. VOLTAGE GENERATOR Type B-35-D $17.50
ALNICO MIDGET D.C. VOLTAGE GENERATOR Type B-44-D $17.50
A.C. GENERATOR: 67 V., 20 Cyc., 2-Phase, .015 Amps. Type PM-1, 1200 R.P.M.............. $15.00

SYNCHRONOUS SELSYNS



110 volt, 60 cycle, brass cased, approx. 4" dia. x 6" long. Mfg. by Diehl and Bendix.
Quantities Available.
REPEATERS .... $20.00 ea.
TRANSMITTERS .... $20.00 ea.

AUTOSYN MOTOR TYPE 1

115 VAC; 60 cycle; 1-phase; DR. # 4279 Foot mounted; Mfg. Bendix Aviation Corp........... $15.00 ea.

SELSYN GENERATORS

General Electric MOD. 2J15M1; 115-57.5 Volts 400 Cycle .... $22.50 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
MICROSYN UNIT. Type 1C-006-A............ $35.00
1F Special Repeater (115V-400 Cy.)....... $15.00 ea.
2JIF 3 Generator (115-400 cyc.)............ $10.00 ea.
5CT Control Transformer: 90-50 Volt; 60 Cy.. $45 00
5F Motor (115/90 Volt—60 cyc.)............ $45.00
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 V., 60 Cy........... $5.00
5N MOTOR (115 Volts/60 Cycle)............ $22.50
REPEATER, BENDIX C-78410: 115 Volt, 60 Cycle .... $37.50 ea.
REPEATER, AC synchronous 115 V., 60 cycle. C-78863 .... $15.00 ea.
REPEATER, DIEHL MFG. No. FJE 22-2; 115 Volt; 400 Cy.; Secondary 90 V.................... $27.50
5G GENERATOR (115/90) 60 cycles.......... $45.00
7G Synchro Generator (115/90 volt; 60 cycle).. $75.00
6G Synchro Generator (115/90 volt; 60 cycle).. $60.00
60G Synchro Differential Generator (90/90 volt; 60 cycle) $50.00
2-JF5-J Selsyn Control Transformer: 105-55 Volts; 60 Cycle $50.00
5ID5HAI Selsyn Generator: 115-105 Volts; 60 cycle $50.00
2JIFI GENERATOR: 115—57.5 Volt; 400 cycle.
$12.50 ea.
2JIHI DIFFERENTIAL GENERATOR: 57.5—57.5 Volt; 400 cycle.......................... $12.50 ea.
2JIGI CONTROL TRANSFORMER: 57.5—57.5 Volt; 400 cycle .... $7.50 ea.

PIONEER TORQUE UNITS

TYPE 12604-3-A: Same as 12606-1-A except it has a 30:1 ratio between output shaft and follow-up Autosyn .... $10.00 ea.
TYPE 12602-1-A: Same as 12606-1-A except it has base mounting type cover for motor and gear train
$70.00 ea.
TYPE 12606-1-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.

Immediate Delivery

ALL EQUIPMENT FULLY GUARANTEED

All prices net FOB Pasadena, Calif.

INVERTERS

10563 LELAND ELECTRIC

Output: 115 VAC; 400 cycle; 3-phase, 115 VA; 75 PF. **Input:** 28.5 VDC; 12 amp....... $59.50

PIONEER 12117

OUTPUT: 26 volts; 400 cycles; 6 volt amperes, 1-Phase. **INPUT:** 24 VDC; 1 amp........... $25.00 ea.

ALTERNATOR, CARTER

Mfg. Carter Motor Co.; OUTPUT: 7 VAC; 9.7 amp.; 650 cycles, and 295 VDC. 200 amps. INPUT: 26.5 VDC; 10.5 amps; 6500 rpm................ $49.50 ea.

PE 218 LELAND ELECTRIC

Output: 115 VAC: Single Phase; PF 90; 380/500 cycle; 1500 VA. **INPUT:** 25-28 VDC; 92 amps; 8000 RPM; Exc. Volts, 27.5
BRANO NEW .... $39.95 ea.

PE 109 LELAND ELECTRIC

Output: 115 VAC, 400 cyc; single phase; 1.53 amp.; 8000 RPM. **Input:** 13.5 VDC; 29 amp......... $65.00

MG 153 HOLTZER-CABOT

Input: 24 V. DC. 52 amps; **Output:** 115 volts—400 cycles, 3-phase, 750 VA. and 26 Volt—400 cycle, 250 VA. Voltage and frequency regulated....... $95.00 ea.

PIONEER 12130-3-B

Output: 125.5 VAC; 1.15 amps. 400 cycle single phase, 141 VA. **Input:** 20-30 VDC, 18-12 amps. Voltage and frequency regulated $75.00

12116-2-A PIONEER

Output: 115 VAC; 400 cyc.; single phase; 45 amp. **Input:** 24 VDC 5 amp........................ $65.00

10285 LELAND ELECTRIC

Output: 115 Volts AC, 750 V.A., 3 phase, 400 cycle, .90 PF. and 26 volts, 50 amps, single phase, 400 cycle, .40 PF. **Input:** 27.5 VDC, 60 amps. cont. duty, 6000 RPM. Voltage and Frequency regulated...... $95.00

10486 LELAND ELECTRIC

Output: 115 VAC; 400 Cycle; 3-phase; 175 VA; .80 PF. **Input:** 27.5 DC; 12.5 amp; Cont. Duty.
$90.00 ea.

PIONEER 10042-1-A

DC INPUT 14 Volts; **OUTPUT:** 110 Volts; 400 Cycle 1-Phase; 50 Watt $75.00

94-32270-A LELAND ELECTRIC

Output: 115 Volts; 190 VA; Single Phase; 400 Cycle; .90 PF. and 26 Volts; 60 VA; 400 Cycle, .40 PF. **Input:** 27.5 Volts DC 18 amps cont. duty, voltage and freq. regulated $95.00

PIONEER 12147-1-B

OUTPUT: 115 VAC 400 cycle; Single phase. **INPUT:** 24-30 VDC; 8 amps.......................... $79.50

MG 149F HOLTZER-CABOT

OUTPUT: 26 VAC @ 250 VA; 115V @ 500VA; Single Phase; 400 cycle. **INPUT:** 24 VDC @ 36 amps.
$69.50

EICOR CLASS "A" NO. 1-3012/08-7

OUTPUT: 125 VAC; 400 cycle; single phase; 100 VA. **INPUT:** 24-30 VDC; 11 amps; Duty int. Voltage and Frequency Regulator $99.50

POWER RHEOSTATS

Standard Brands: 5 Ohms; 100 Watt; 4.48 amps 100 Ohms; 100 Watt; 1.0 amp.
Boxed. Brand New with Knob $2.50 each—or—$25.00 per Doz.

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.
AY-38D . . . 26 Volt, 400 cycle . . . double shaft . $9.95
AY14D $10.00
AY34 .... $20.00
AY20—26 Volt—400 cyc.................. $12.50 ea.
Midget Type NT-6 WILLARD STORAGE BATTERIES
$2.49 ea.

ALNICO FIELD MOTORS

(Approx. size overall . . . 3¾" x 1¼" diameter)
DELCO TYPE #5069600: 27.5 volts DC; 250 RPM........ $12.50
DELCO #5069230: 27.5 VDC; 145 rpm......... $12.50
PM Motors Delco Type #5069371: 27.5 volts; DC Alnico Field; 10,000 R.P.M.; dimensions 1" x 1" x 2" long; shaft extension ½" diameter 0.125"..... $15.00

PIONEER GYRO FLUX GATE AMPLIFIER
Type 12076-1-A, complete with tubes........... $22.50

AC CONTROL MOTOR

A. C. SYNCHRONOUS MOTOR Type RBC 2505; Volts 115; Cycles 60; RPM 2; Mfg. HOLTZER CABOT ELECT. Approx. size: 2⅝" x 2⅝" x 2⅝"..$15.00 ea.

400 CYCLE MOTORS

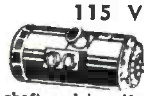
EASTERN AIR DEVICES # J33 Synchronous Motor 115 Volt; 400 cycle............................. $17.50
PIONEER: TYPE CK5 2 Phase; 400 cycles. $25.00 ea.
EASTERN AIR DEVICES TYPE J49A: 115 V; 0.1A; 7000 r.p.m. Single phase 400 cycle........ $17.50 ea.
AIRESEARCH: 115V; 400 CPS; Single phase 6500 RPM; 1.4 amp; Torque 4.6 in. oz.; HP .03.
$10.00 ea.
EASTERN AIR DEVICES TYPE JM6B: 200 VAC; 1 amp; 3 phase; 400 cycles, 6000 RPM.... $12.50 ea.
EASTERN AIR DEVICES, TYPE J31B: 115 V. 400-1200 Cycle. Single Phase.................. $12.50 ea.
AIRESEARCH: AC induction, 200 V; 3 Phase, 400 Cycle, 2 H.P.; 11,000 RPM; 8 amps....... $79.50 ea.
AIRESEARCH: AC Induction, 200 V; 3 Phase, 400 Cycle, 12 H.P. 6500 RPM; 1.5 amps.......... $25.00
Electric Motor: PNT—1400—A1—1A Serial No. 207, 208 V., 400 Cycles, 3 Phase Kearfott Co., Inc.
$17.50 ea.

SERVO MOTOR 10047-2-A; 2 Phase; 400 Cycle, with 40-1 Reduction Gear $17.50

SMALL DC MOTORS

GENERAL ELECTRIC # 5BA10AJ18 . . . 27 VDC; RPM 110; 1 oz. FT............................ $12.50
DELCO #5069625 . . . 27 VDC; 120 RPM; Governer controlled $22.50
EMERSON #175: 12 Volt DC; 1/6th HP; 10 amp; 3800 RPM; Approx. size: 2½" x 5".......... $9.95 ea.
DELCO #5072000: 27.5 VDC; 11.75 rpm..... $15.00
DELCO #5068750: 27 VDC; 160 RPM; built-in reduction gears .... $12.50 ea.
J. OSTER: series reversible motor; 1/50th H.P.; 10,000 RPM; 27½ VDC; 2 amps; **SPERRY** #806069: approx. size 1⅝" x 3½"...................... $7.00 ea.
General Electric Type 5AB10AJ37: 27 volts, DC; 5 amps. 8 oz. inches torque; 250 RPM, shunt wound; 4 leads: reversible $12.50
General Electric, Mod. 5BA10FJ33: 12 oz. inches torque. 12 DC, 56 RPM, 1.02 amp........ $15.00 ea.
General Electric Type 5BA10AJ52C: 27 volts DC; 5 amps. 8 oz. inches torque; 145 RPM; shunt wound; 4 leads; reversible $12.50
GENERAL ELECTRIC DC MOTOR Mod. 5BA10AJ-64. 160 r.p.m.; 65 amp; 12 oz.-in. torque 27V DC.
$12.50
2¼ **H.P. MOTOR**—Mfg. LEECE-NEVILLE Co; Type 1454-MO; 24VDC; 4000 RPM; 100 amp......... $35.00

115 VOLT GENERATORS



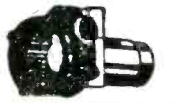
Brand new Eclipse generators; 115 VAC; 9.4 amp; 1000 watts; single phase; 800 cycles, 2400-4200 rpm. DC output is 30 volts at 25 amp. Unit has spline drive shaft and is self-excited $29.95

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.

BLOWER

Eastern Air Devices, Type J31B: 115 volt; 400-1200 Cycle; single phase; variable frequency; continuous duty; L. & R. #2 blower; approx. 22 cu. ft./min.
$15.00



BLOWER: Mfg. John Oster; Type C2A-1B; 27 VDC; .63 amps; 1/100 H.P.; 7000 RPM; Series Wound ...... $9.95 ea.

BLOWER ASSEMBLY

115 Volt, 400 Cycle. Westinghouse Type FL. 17CFM. complete with capacitor. New............ $12.50 ea.

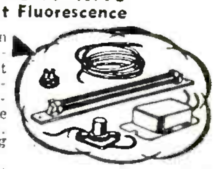
SENSITIVE ALTIMETER

Pioneer Sensitive altimeters, 0-35,000 ft. range . . . calibrated in 100's of feet. Barometric setting adjustment. No hook-up required.
$12.95 ea.

BLACK LIGHT KITS

Ultra-Violet Fluorescence

Now . . . build your own black light lamp equipment at a new low cost with these easy-to-assemble components. Kit contains: Ultra-Violet tube brackets, ballast, starter, wire, plug and wiring diagram.



4-Watt Kit—(5½" tube)........................ $3.50
8-Watt Kit—(12" tube)........................ $4.50

C and H Sales Company

BOX 356-X EAST PASADENA STATION • PASADENA 8, CALIFORNIA

COMMUNICATIONS EQUIPMENT CO.

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. Broad-band type "N" Coupling, 20 db. with std. flanges, Navy #CABV47AAN-2 (as shown) $37.50
LHTR. LIGHTHOUSE ASSEMBLY. Parts of RT39 APG 5 & APG 15. Receiver and Trans. Cavities w/assoc Tr. Cavity and Type N CPLG, To Recvr. Uses 2C40, 2C43, 1B27, Tunable APX 2400-2700 MCS. Silver Plated......$32.50
BEACON LIGHTHOUSE cavity p/o UPN-2 Beacon 10 cm. Mfg. Bernard Rice, each......$32.50
MAGNETRON TO WAVEGUIDE Coupler with 721-A Duplexer Cavity, gold plated......$45.00
721A TR BOX complete with tube and tuning plungers......$12.50
McNALLY KLYSTRON CAVITIES for 707B or 2K28......$4.00
WAVEGUIDE TO ⅞" RIGID COAX "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
HOLMDELL-TO-TYPE "N" Male Adapters, W. E. #D167284......$2.75
I.F. AMP. STRIP: 30 MC. 30 d.b. gain, 4 MC Band width, 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" PLANE BENDS, 90 deg. less flanges......$7.50

X Band— RG 52/U WAVEGUIDE

HORN FEED. Mounted at end of 1' run. Designed to be used with dish reflector......$15.00
VSWR Measuring Section. Consisting of 6" straight section, with 2 pick-up, Type "N" Output Jacks. Mounted ½ Wave apart......$8.50
1" x ½" 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 20db..$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
90 degree elbows. "E" plane 2½" radius......$12.50
Microwave Receiver, 3 CM. Sensitivity: 10-13µ Watts. Complete with L.O. and AFC Mixer and Waveguide Input Circuits, 6 I.F. Stages give approximately 120 DV gain at a bandwidth of 1.7 MC. Video Bandwidth: 2 MC. Uses latest type AFC circuit. Complete with all tubes, including 723A/B Local Oscillator......$175.00
ADAPTER, waveguide to type "N", UG 81/U, p/o TS 12, TS-13, Etc......$27.50
ADAPTER, UG-163/U round cover to special btl. Flange for TS-45, etc......$2.50 ea.

1¼" x ⅝" WAVEGUIDE

VSWR SECTION, 6"L, with 2-type "N" pickups mounted ½ wave apart......$7.50
GG 98B/APQ 13 12" Flex. Sect. 1¼" x ⅝" OD.$10.00
X Band Wave GD 1¼" x ⅝" O.D. 1/16" wall aluminum......per ft. 75¢
Slug Tuner Attenuator W.E. guide, gold plated.$6.50
Bi-Directional Coupler. Type "N" Takeoff 25 db. coupling......$27.95
Bi-Directional Coupler. UG-52. Takeoff 25 db. coupling......$24.95
Waveguide-to-Type "N" Adapter. Broadband..$22.50

K Band—½" x ¼" W.G. 1.25 CM.

APS-34 Rotating Joint......$49.50
Right Angle Bend E or H Plane, specify combination of couplings desired......$12.00
45° Bend E or H Plane, choke to cover......$12.00
Mitered Elbow, cover to cover......$4.00
TR-ATR-Section. Choke to cover......$4.00
Flexible Section 1" choke to choke......$5.00
"S" Curve Choke to cover......$4.50
Adapter, round to square cover......$5.00
Feedback to Parabola Horn with pressurized window......$27.50
90° Twist......$10.00

MAGNETRONS

Type	Freq. Range (MC)	Peak Power Out (KW)	Duty Ratio	Price
2J21A	9345-9405	50		$8.75
2J22	3267-3333	265		7.50
2J27	2965-2992	275	.002	19.95
2J31	2820-2860	285	.002	24.50
2J32	2780-2820	285	.002	28.50
2J38*	3249-3263	5		16.50
2J39*	3267-3333	8.7		24.50
2J48	9310-9320	50	.001	24.50
2J49	9000-9160	50	.001	59.50
2J56*	9215-9275	50	.001	132.50
2J61†	3000-3100	35	.002	34.50
2J62†	2914-3010	35	.002	34.50
700B	690-700	40	.002	22.50
700D	710-720	40	.002	39.75
706EY	3038-3069	200	.001	32.50
706CY	2976-3007	200	.001	32.50
725-A	9345-9405	50	.001	Write
730-A	9345-9405	50	.001	24.50
4J38	3550-3600	750	.001	169.45

*—Packaged with magnet.
†—Tunable over indicated range.

5J23 ...$49 | QK-253 ..$249
4J34 ...$125 | 3J31 ...$85

C.W. MAGNETRONS*

QK-60....2800-3025 MC. QK-62....3150-3375 MC.
QK-61....2975-3200 MC. PRICE......$85 Ea.

*TUNABLE, AND PACKAGED WITH MAGNET.

—IN STOCK—

AIA	ASH	SO-8
APA-9	BG	SG-1
APA-10	DAS†	SJ-1
APN-3	DBS†	TAJ
APN-7	APT-2	TBK
APN-9*	APT-4	TBL
APS-2	MKIV	SCR520*
APS-3	MKX	SCR521
APS-4	RC145	SCR518
APS-6	RC148	
ASD	SO-1	

* COMPONENTS. † LORAN EQUIPMENT

—TEST SETS—

TS-10	TS-12	TS-159
TS-36	TS-56	TS-268
TS-47	TS-34	TS-270

I. F. AMPLIFIER STRIPS

MODEL SO: 30 Mc Gain figure is 120 db. Bandwidth: 2Mc. Uses 6 stages of 6AC7 Plus one video detector. Less Tubes......$24.50
Model 15: 30 Mc center frequency, Bandwidth 2.5 Mc, gain figure: 65 db. Uses 5 stages of 6AC7's. Has D. C. Restorer and Video Detector. A.F.C. Strip included. Input impedance: 50 Ohms. Less tubes......$27.50
Model APS-4: Miniature IF strip, using 6AK5's 60 Mc center Freq. Gain: 95db at Bandwidth of 2.7 Mc. Less tubes......$45.00

BC 1203 MODULATOR

Provides 200-4,000 PPS. Sweeptime: 100 to 2,500 microsec. in 4 steps fixed mod. pulse, suppression pulse, sliding modulating pulse, blanking voltage, marker pulse, sweep voltages, calibration voltages, fil. voltages. Operates 115 vac. 50-60 cy. Provides various type of voltage pulse outputs for the modulation of a signal generator such as General Radio #804B or #804C used in depot bench testing of SCR 695, SCR 595, and SCR 535......$150

MICROWAVE ANTENNAS

AT49/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
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: 24,000-27000 MC......$22.50
SCR 584, Dishes Perforated, Metal Construction $185.00

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

PULSE NETWORKS

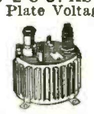
15A—1,400-50: 15 KV, "A" CKT, 1 microsec. 400 PPS, 50 ohms imp......$37.50
G.E. #3E (3-84-810) (8-2.24-405) 50P4T; 3KV "E" CKT Dual Unit: Unit 1, 3 sections, 0.84 Microsec. 810 PPS, 50 ohms imp.; Unit 2, 8 Sections, 2.24 microsec. 405 PPS 50 ohms imp......$6.50
7-5E3-1-200-67P. 7.5 KV "E" Circuit, 1 microsec. 200 PPS 67 ohms impedance 3 sections......$7.50
7-5E4-16-60, 67P, 7.5 KV "E" Circuit, 4 sections 16 microsec. 60 PPS. 67 ohms impedance......$15.00
7-5E3-3-200-67P. 7.5 KV. "E" Circuit, 3 microsec. 200 PPS. ohms imp. 3 sections......$12.50
KS8865 CHARGING CHOKE: 115-150 H @ .02A. 32-4011 @ .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
SPRAGUE H-615 "E" Circuit 10KV, 0.85 microsec pulse at 750 PPS-50 ohms......$27.50
SPRAGUE H-616, "E" Circuit, 10KV 2.2 microsec. pulse at 3.755 PPS—50 ohms......$27.50

PULSE EQUIPMENT

MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp). Duty Ratio: .001 max. Pulse duration: 5, 1.0, 2.0 microsec. Input voltage: 115 v. 400 to 2400 cps. Uses: 1-715B, 1-829B, 3-'72's, 1-'73. New......Less Cover $135
APQ-13 PULSE MODULATOR. Pulse Width .5 to 1.1 Micro Sec. Rep. rate 624 to 1348 Pps. Pk pwr. out 35 KW Energy 0.018 Joules......$49.00
TPS-3 PULSE MODULATOR. Pk. power 50 amp. 24 KW (1200 KW pk): pulse rate 200 PPS. 1.5 microsec. pulse line impedance 50 ohms. Circuit series charging version of DC Resonance type. Uses two 705-A's as rectifiers, 115 v. 400 cycle input. New with all tubes......$49.50

PULSE TRANSFORMERS

RAYTHEON WX 4298E: Primary 4KV., 1.0 USEC. SEC: 16KV-16 AMP DUTY RATIO: .001 400 CYCLE FIL. TRANS. "BUILT-IN"......$42.50
W E C O: KS 9948: Primary 700 ohms; Sec: 50 ohms. Plate Voltage: 18 KV. Part of APQ-13......$12.50



GE #K-2449A. Primary: 9.33 KV. 50 ohms Imp. Secondary: 28 KV, 450 ohms. Pulse length: 1.0/5 usec @ 635/120 PPS. Pk Power Out: 1.740 KW. Bifilar: 1.5 amps (as shown) $62.50
GE #K-2748-A. 0.5 usec @ 2000 Pps. Pk. Pwr. out is 32 KW impedance 40:100 ohm output. Pri. volts 2.3 KV Pk. Sec. volts 11.5 KV Pk. Bifilar rated at 1.3 Amp. Fitted with magnetron well......$39.50
K-2745. Primary: 3.1/2.8 KV, 50 ohms Z. Secondary: 14/12.6 KV 1025 ohms Z. Pulse Length: 0.25/1.0 usec @ 600/600 PPS. Pk. Power 200/150 KW. Bifilar: 1.3 Amp. Has "built-in" magnetron well......$42.50
K-2461-A. Primary: 3.1/2.6 KV—50 ohms (line). Secondary 14/11.5 KV—1000 ohms Z. Pulse Length: 1 usec @ 600 PPS. Pk. Power Out: 200/130 KW. Bifilar: 1.3 Amp. Fitted with magnetron well......$39.75
UTAH X-151T-1: Dual Transformer, 2 Wdgs. per section 1:1 Ratio per sec 13 MH inductance 30 ohms DCR......$7.50
UTAH X-150T-1: Two sections. 3 Wdgs. per section. 1:1:1 Ratio. 3 MH, 6 ohms DCR per Wdg....$7.50
68G711: Ratio: 4:1 Pri: 200V. Sec. 53V. 1.0 usec Pulse @ 2000 PPS. 0.016 KVA......$4.50
TR1049 Ratio: 2:1 Pri. 220 MH, 50 Ohms, sec. 0.75 H. DCR 100 Ohms......$6.75
K-904695-501: Ratio 1:1, Pri. Imp. 40 Ohm, Sec. Imp. 40 Ohms. Passes pulse 0.6 usec with 0.05 usec rise $8.95
Ray UX 7896—Pulse Output Pri. 5v sec. 41v...$7.50
Ray UX 8442—Pulse inversion—40v + 40v......$7.50
PHILCO 352-7250, 352-7251, 352-7287
RAYTHEON: UX8693, UX5986......$5 ea.
W.E.: D-166310, D-166638, KS9800, KS9948.
UTAH #9262, with Cracked Beads, but will operate at full rated capacity......$5.00
UX 8693 (SCS #2Z9627-54): 3 Wdgs. 32 turns #18 wire. DCR is: 362/.372/.4 ohms. Total voltage 2500 vdc......$5.00

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-2 Chas. Rosen Phone: Digby 9-4124

COMMUNICATIONS EQUIPMENT CO.

POWER TRANSFORMERS

Comb. Transformers 115V/50-60 cps inpue

CT-129	550-0-550V @ 150 MA, 6.3V/4A, 2.5VCT/5A	$5.79
CT-013	450-0-450V @ 200 MA, 10V/1.5A, 2.5V/3.5A 5V/3A	6.95
CT-341	1050 10MA,—625V @ 5MA, 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-071	110V .200A 33/.200, 5V/10, 2.5/10	4.95
CT-367	580VCT .050A 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 80 MA 6.3V/1.3A, 5V/3A	3.45
CT-442	525VCT 75 MA 5V/2A, 1 CT/2A, 50V/200 MA	3.85
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-140	5VCT @ 10A 25KV Test	$22.50
FT-157	4V/16A, 2.5V/2.75A	2.95
FT-101	6V/.25A	.79
FT-924	5.25A/21A, 2x7.75V/6.5A	14.95
FT-824	2x26V/2.5A, 16V/1A, 7.2V/7A, 6.4V/10A 6.4V/2A	8.95
FT-463	6.3VCT/1A, 5VCT/3A, 5VCT/3A	5.49
FT-55-2	7.2V/21.5A, 6.5V/6.85A, 5V/6A, 5V/3A	8.95
FT-38A	6.3/2.5A, 2x2.5V/7A	2.79

Plate Transformers, 115V 60Cy Input

PT 175	550-0-550VAC (400VDC) @ 150MA	$6.30
PT 157	660-0-660 VAC (500VDC) or 550-0-550 VAC (400VDC) at 250 MADC	8.70
PT 158	1080-0-1080V (1000VDC) at 125MA Plus 500-0-500 VAC (400VDC) at 150MADC Simult. Ratings	10.80
PT 159	900-0-900 VAC (750VDC) or 800-0-800 VAC (600VDC) at 225 MADC	10.35
PT 167	1400-0-1400 VAC (300MADC) or 1175-0-1175 VAC (1000VDC) at 300MADC	25.80
PT 168	2100-0-2100 VAC (1750VDC) or 1800-0-1800 VAC (1500VDC) at 300MADC	33.00
PT 062	2900-0-2900 VAC (2500VDC) or 2385-0-2385 VAC (2000VDC) at 300MA	48.00

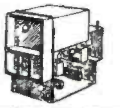
10 KW TRANSMITTER KIT

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...... **$630**

400 CYCLE TRANSFORMERS

(All Primaries 115V. 400 Cycles)

Stock	Ratings	Price
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 1D-39/APG-13	4.95
352-7039	640VCT @ 380MA, 6.3V/.9A, 6.3V6A 5V/6A	5.49
702724	9800/8600 @ 32MA	8.95
K59584	5000V/290MA, 5V/10A	22.50
KS9607	734VCT/.177A, 1710VCT/.177A	6.79
352-7273	700VCT/350MA, 6.3VO.9A, 6.3V 25.A 6.3V/.08A, 5V/CA	6.95
352-7070	2x2.5V/2.5A (2KV TEST) 6.3V/2.25A, 1200/100/750V. @ .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	2.5/1.75A, 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/6MA, 300, VCT, 135MA	5.95
KS 9336	1100V/50MA TAPPED 625V 2.5V/5A	3.95
M-7474319	6.3V/2.7A, 63.V/.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, 2.5/3.5A	4.85
KS 9445	592VCT/118MA, 6.3V/8.1A, 5V/2A	5.39
KS 9685	6.4/7.5A, 6.4V/3.8A, 6.4/2.5A	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., 22Kv Test	5.95
352-7096	2.5V1.79A, 5V/3A, 6.5V/6A, 6.5V/1.2A, D/O BC800	
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



INTERPHONE AMPLIFIER

Easily converted to an ideal Inter-Communications set for office, home, or factory. Original. New w/conversion. Diagram .. **$4.75**

HI-POWER COMPONENTS

Plate Trans. Primary: 115 V, 50-60 Cy. Sec. 17-600 V/144 MA. Has "Bilt-in" Filter Choke. Oil Immersed $115
Plate Trans. Pri: 198/220/240 V, 60 Cy. 1 Ph. Sec: 3650 V/16.7 KVA, 30 KV Insulation. Oil-Immersed, Less Oil Gauge $335
Plate Trans. Amertran #31133. Pri: 110/115/120 V/60 Cy/1 Phase. Sec: 3140/1570 V, 2.36 KVA $105
Fil. Trans. Pri: 220 V/60 Cy/1 Phase. Sec: 5 VCT/10A/30 KV Test $37.50
Plate Trans. Raytheon UX6801. Pri: 115 V/60 Cy./1 Ph. Sec: 22,000 V/234 MA/5.35 KVA. Lo-Cap. "Donut" Construction $135
Reactor: Raytheon U-11533: 13.5H @ 1.0 Amp., 13.5 KV Test $29.95
Reactor, Modulation: 50 H/3 A/80 Ohms DCR. Response: .03 Cy—10 KC. Level: plus 63db. 40 KV Test. Nominal Circuit Impedance: 3000 Ohms $350
Swing Reactor: 9-60 HY/.05—400 MA, 10,000 V. Test—Kenyon $14.95
Transtat: Type TH45BG: Input 130/260 V. 50-60 Cy. 1 Ph. Output Range: 0-260 V, 45 A. 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 115 A. Break time adjustable from instant. to 10 minute. Break amperes adjustable from 115 A to 1000% overload. Brand New $15.00
Alternator: Louis-Allis Co. Type "AL", 198-C. Output 110/220 V.—1 Ph. 60 Cy. .9 P.F. 1200 RPM, completely self-regulating with built-in exciter. Brand new, original crates $795.00
PE-94C Power Supply, Brand New ... $6.95
Plate Trans: #218521—Pri: 115V/1PH./60 Cy. Sec. 7500V/.06A (Half-Wave) SCS #2Z9612.41 .... $85.00
Plate Trans. Amertran #26579; Pri: 105/110/120V, 1 ph./60 Cy. Sec. 3100-0-3100V at 2 KVA. Insulated for 15 KV. Center-Tap Grounded to Case ... $135.00

FILTER CHOKES

Stock	Description	Price
CH-187	Swing. 4-16H, 150MA, 210 ohms, 3KV Test	$3.90
CH-189	Swing. 4-16H, 250MA, 125 ohms, 3KV Test	6.60
CH-190	Swing. 3-14H, 300MA, 80 ohms, 3KV Test	6.90
CH-CEC117:	9-60H/.05-400MA, 10KV Test	14.95
CH-366	20H/.3A	6.95
CH-322	.35H/350MA—10 Ohms DCR	2.75
CH-141	Dual 7H/75 MA, 11H/60 MA 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
CH-43A	10HY/15MA—850 ohms DCR	1.75
CH-366	20H/300MA	6.95
CH-999	15HY/15MA—400 ohms DCR	1.95
CH-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	29.95

ARTILLERY MICROPHONES

Microphone, Type T-21, condenser type, used to detect sound of Artillery fire or shell detonation.

A number of these units are placed in the ground at various field locations in Geometric patterns at intervals up to 2000 yds. Mike unit comprises a condenser head, acoustic chambers, and a 2-stage Audio Amplifier.

Requires 6 flashlite Batteries and 1-"C" Battery—Sold less tubes $32.50

DYNAMOTORS

TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT AMPS	PRICE
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.	
PE 73 CM	28	19	1000	.350	22.50
BD 69‡	14	2.8	220	.081	12.95
D-402†	13.5	12.2	300	.200	
			8.8VAC		12.50
SP 175	18	3.2	450	.06	4.49
DM 25†	12	2.3	250	.05	6.95

‡ Less Filter * Replacement for PE 94.
† Used, Excellent
PE 94-C, Brand New 6.95

INVERTERS

PE-218-H: Input: 25/28 vdc, 92 amp. Output: 115v. 350/500 cy 1500 volt-amperes. NEW $37.50
PE-206: Input: 28 vdc, 36 amps. Output: 80 v 800 cy, 500 volt-amps. Dim: 13" x 5½" x 10½". New $22.50
NAVY CDR-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

RECTIFIER TRANSFORMERS

Pri: 115V, 60 Cy. Sec: 28V/3.1A, 26V/8.4A 7.3V/14A $12.95
Pri: 210/215/220/225/230/235/240V, 60 Cy., 1 Phase Sec: 11/10/7.5/5VCT @ 35A $19.50
Pri: 115V 60 Cy: Sec: 8.1V @ 1.5A $1.39
Pri: 115V 60 Cy: Sec. 18.5V @ 5A $2.79

12-14V SUPPLY KIT

Delivers 12-14VDC at 3.5A from 115V, 60 cy., Kit contains 1—Transformer Rated 18.5V, 4A, 1—Selenium Rectifier F. W. Bridge **$6.35**

SPECIAL GEAR

MK-12 Pressurizing Unit, with DEHYDRATOR. Hand-Operated **$32.50**
2CV3A1 Servo-Amplifier (APG-2) New, Complete With Tubes **$75.00**
T-26 APT-2 Jamming Transmitter 450-710 MC. 7 MC. Bandwidth Output Power 8 Watts **$75.00**
T-75/APT-4 Jamming Transmitter: 165-780 MC Noise Modulated. Uses 5J30 Magnetron. Input: 115 V, 400 CY, 1500 Watts and 28VDC New, with Tubes **$450.00**

BARRYMOUNTS

C-2045
C-2060
C-2070
C-2090

45¢ each **$35/100**

UPRIGHT OIL CONDENSERS

CAP.	PRICE
220VAC/600VDC	
6.2	$1.29
15	3.49
330VAC/1000VDC	
15	$3.79
6	1.25
1000 VDC	
.5	$.69
.5-.5	1.19
1	1.49
4-1.5	2.19
1.5	1.39
1500 WVDC	
4	$1.95
1.5	1.59
2	1.79
2000 WVDC	
1	$1.79
2500 WVDC	
.5	$2.98
4000 WVDC	
.15	$6.95

CAP.	PRICE
4800 WVDC	
.1-.1	$4.79
6000 WVDC	
.1	$3.69
115-.15	3.89
1.5	10.98
7000 WVDC	
.1-.1	$3.79
1	9.95
8000 WVDC	
.075-.075	$3.79
10K VDC	
.1	$8.95
15K VDC	
.0016	$7.95
16K VDC	
.015	$9.50
20K VDC	
.25	$17.50
25K VDC	
1	$85.00
.5	65.00

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OR
6 Volt Input: 300 V @ 90 MA; 160 V @ 110 MA

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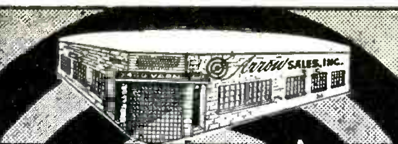

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G.E. 25F774	.1X .1	7 KV	8.00
G.E. 25F450	.1	7 5 KV	7.50
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Intereen	.25	15 KV	19.95
G.E. 14F91	1.0	15 KV	39.50
Intereen	.5	25 KV	49.50
Intereen	1.0	25 KV	69.50
Fast A6734	1.0	25 KV	89.50
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8x8x8mfd, 500WVDC Special $2.69
Many other types of oil filled condensers in stock. Write for quotation on your requirements.

HIGH CURRENT MICA CONDENSERS

Ceramic cased, Sangamo type G1 or similar

Mfd	WVDC	Amp @ 1 mc	
.04	1 KV	25	7.50
08	1.5 KV	35	12.50
09	1.5 KV	40	15.00
.02	3 KV	21 (600 Kc)	15.00
.00035	6 KV	5	12.50
.00075	6 KV	7	14.50
.0005	6 KV	5	14.00

Type G-2 or Similar

.0012	5 KV	8	17.50
.003	7 KV	15	19.00
.0002	10 KV		19.50
.00025	10 KV	3	19.50
.0003	10 KV	5	19.50
.0005	10 KV	6	19.50
.00057	10 KV	8	19.50
.00065	10 KV	6	19.50

Type G-3 or Similar

.05	3KV	50	45.00
.005	5.5 KV	25	45.00
.00015	20 KV	5	36.00
.0012	20 KV	15	36.00

Sangamo type F-2, C-D type 6, or similar
$5.20 each

Mfd	VDC	Amps @ 1 Mc.	Mfd	VDD	Amps @ 1 Md.
.00005	5 KV	.8	.001	5 KV	4
.00009	5 KV	.8	.0012	5 KV	4.5
.0001	5 KV	1	.0015	5 KV	5
.00015	5 KV	1.5	.002	5 KV	5
.0002	5 KV	1.7	.002	6 KV	6.5
.00025	5 KV	2.5	.002	6 KV	6.5
.0003	5 KV	2	.0025	5 KV	6
.00035	5 KV	2	.003	2 KV	6
.000375	5 KV	2	.003	3 KV	6
.00039	5 KV	2.7	.004	3 KV	6
.0004	5 KV	2.5	.005	3 KV	5
.0005	5 KV	2.5	.005	5 KV	11
.0005	7.5 KV	3	.01	2 KV	8
.0006	2.5 KV	1.5	.02	2 KV	12
.0006	5 KV	3	.03	2 KV	12
.00072	5 KV	3.5	.07	1 KV	13
.0008	5 KV	4	.12	.5 KV	18
.0008	6 KV	4			

Sangamo type F-1, C-D type 15L or similar
$3.75 each

.00005	3 KV	.6	.0008	3 KV	2.5
.00009	3 KV	.8	.001	3 KV	3
.0001	3 KV	.08	.0012	2 KV	3
.00015	3 KV	1	.00125	2 KV	3
.000175	3 KV	1	.0015	3 KV	3.5
.0002	3 KV	2	.0016	2.5 KV	3.5
.0003	2 KV	8	.002	3 KV	4
.0003	3 KV	2	.0025	2 KV	4.5
.0004	8 KV	4	.003	2 KV	5
.0005	3 KV	2	.004	2 KV	6
.0006	2.5 KV	2	.005	2.5 KV	6.5
.0006	3 KV	2	.006	2 KV	5.5
.000625	3 KV	2.5	.008	1.5 KV	8
.0007	3 KV	2.5	.01	2 KV	14
.00075	3 KV	2.5	.1	1 KV	12

Sangamo type A, C-D type 9 or similar

	2500WVDC		5000TVDC		
mfd	price	mfd	price	mfd	price
.00001	.57	.0003	.64	.002	1.27
.000025	.57	.00035	.64	.0025	1.38
.00005	.57	.0004	.64	.003	1.53
.00006	.57	.0005	.76	.004	1.69
.0001	.57	.00051	.76	.005	1.86
.00015	.57	.00063	.76	.01	2.19
.0002	.60	.001	.87	.015	2.41
.00025	.64	.0015	.87	.02	2.68

1200WVDC 2500TVDC

.00005	.48	.001	.57	.008	1.23
.0001	.48	.002	.75	.01	1.41
.00015	.48	.0025	.84	.015	1.74
.0002	.48	.003	.88	.02	2.11
.00025	.48	.004	.93	.025	2.37
.0004	.48	.005	.99	.03	2.43
.0005	.48	.006	1.03		

600WVDC 1200TVDC

.00005	.43	.001	.43	.01	.84
.0001	.43	.002	.49	.015	.91
.00015	.43	.0025	.51	.02	1.06
.0002	.43	.003	.55	.025	1.30
.00025	.43	.004	.60	.03	1.36
.0003	.43	.005	.63	.04	1.75
.0004	.43	.006	.66	.05	2.13
.0005	.43	.008	.73	.06	2.41

LIQUIDATION SALE

We are overstocked on the following items and are liquidating them at far below current surplus prices.

3C23

Grid controlled rectifier tubes. Normal operation 100 to 500 VDC at 1.5 amps. Peak anode 1000V at 6 amps. Unused, guaranteed perfect........ $3.95

Selsyn Motors

Type I-4, C-79331 transmitters. 115V, 60 cy Diehl & Bendix size 6, brass. Unused priced at less than ½ market........ $9.75 ea

DYNAMOTORS

The dynamotors listed below are either NEW or fully overhauled. Guaranteed.

TYPE	INPUT	OUTPUT	Mils	
DM-34	12V	220V	80	$12.50
DM-35	12V	625V	225	24.50
DM-36	24V	220V	80	12.50
DM-37	24V	625V	225	17.50
DM-64	12V	275V	150	11.50
DM-65	12V	400V	440	22.50
BD-77	12V	1000V	350	25.00
TCS Rcvr.	12V	225V	100	12.50
TCS Xmtr.	12V	400V	180	22.50

TCS Complete power supply, 12VDC input........ 68.50

MC-203A T coupling New. AAF source inspected @ $12.50

The dynamotors listed below are NOT overhauled. Guaranteed to operate.

type	input	output	mils	price
DM-32A	28	250	60	2.95
CBY-21531	28	250	60	1.95
DY2-ARR2	28	250	60	1.95
PE-86	28	250	60	2.95
D-101	27	285	60	1.45
......	28	230	100	2.95
DM-416	28	330	170	3.50
SP-22	28	330	170	3.50
DM-33A	25	575	160	2.50
SS-2669	18	450	60	2.50
BD-83	14	375	150	7.50
DM-414	14	220	80	4.95
DM-416	14	330	170	7.50
......	12	400	180	9.50
	12	220	100	5.50
AD7-377	14	425	163	9.50

HEADSETS
New, guaranteed to pass AAF inspection
HS-23 .... 5.75
HS-33 .... 5.95
MC-162A extra ear cushions new manufacture, per pair ...... .50

SOUND POWERED HANDSETS
New .... each $9.95

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12604-3-A Contains CK5 motor & AY43D autosyn Gear ratio, motor to shaft 125:1, Gear ratio shaft to follow-up Autosyn 15-1........ $70.00
12606-1-A Same as above except Gear ratio shaft to follow-up autosyn 30:1. 70.00
12602-1-A Same as 12606-1-A except has base mounting cover for motor & gears........ 70.00

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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

27 VDC—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

2800 RPM Reversible Motor—Size: 5-¼" x 3-½". Shaft Size: 1" x ¼". Emerson No. 186-0412—Price $5.95

GEAR HEAD for above motor. Ball Bearing Geared Shaft, 10 to 1 reduction. Price....................$5.95

COMBINATION: Motor & Reduction Gear....$10.00

21 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

A.C. INDUCTION MOTOR—115 Volts 60 cycle 1.9 RPM—Torque Oz. In. 75; Watts—9; with variable Multiple Disc Coder Wheel and Micro Switch mounted on Bracket Assy. Holtzer Cabot Motor Type RWC 2505 ....$14.95

GEARED HEAD MOTOR—Heavy Duty, 24 VDC 8 Amp. 2-½ lb. Torque; 100/200 RPM. Shaft size: 5/16" x 1". Right Angle Drive....................$8.95

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RG-8/U (SPECIAL) 51.5 ohm. Same size as RG-8/U. Prices: 1 to 100 ft. @ 8¢ per ft.—100 to 500 ft. @ 7½¢ per ft.—500 to 1000 ft. @ 7¢ per ft.—1000 ft. Rolls (or more) @ 6½¢ per ft.
RG-34/U—71 ohm, 145 ft. length..........$15.00
PL-259—Plug ea. end & 32"—RG-54/U—58 ohm.50¢
UG-21/U—Plug ea. end & 32"—RG-11/U75 ohm.50¢
UG-22/U—with 4" Coaxial Cable..........50¢

TRANSFORMERS —110 V. 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. Winding—gives 12 V. 8 A. or 24 V. 4 A....................$5.95
Sec. 24 V. ½ A....$1.50 Sec. 24 V. 1 A....$1.95
Sec. 24 Volt 6 Amps....................$5.95
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NAVY TYPE—No Batteries required. Ideal for TV Antenna installations, and many other uses. 20 Ft. Cord. Used—Tested ....Each: $5.95
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RECTIFIER POWER SUPPLY—Input 105—125 Volts 60 Cycle; output 24 VDC 3 Amp. 200 Watts. Size: 16-¼" x 15" x 9-⅛". Used—Tested $19.95

DYNAMOTORS:

INPUT VOLTS	OUTPUT: VOLTS	MA.	STOCK NO.	USED	NEW
14	330	150	BD-87	$6.95	$8.95
14	250	50	DM-25	6.95	8.95
14	1000	350	BD-77	22.50	39.95
28	230	100	DA-1A	3.95	5.95
24	250	60	DM-32	2.95	6.95
24	575	160	DM-33	2.95	
28	210	125	DY-22	7.95	
24	220	80	DM-53	3.95	
28	1000	350	PE-73	8.95	
28	300	260	PE-94-	5.95	10.95
	150	010	A, B, CM		
	13	3.9A.	"		
14	172	138	DM-40	6.95	8.95
28	250	60	PE-86	2.75	8.95
12 or 24	500	50	USA/0515		4.95
12 or 24	275	110	USA/0516		4.95
13 or 26	400	135			
	800	025	PE-101C	3.95	4.95
12	150	100	DM-310X	4.95	7.95
6 or 12	500	160	PE-103	29.95	39.95
12	230	90	PE-133	6.95	8.95
18	450	60	SP-175	3.00	4.95

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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.
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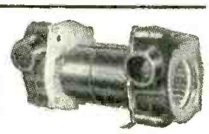

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PE-115 or **PE-206**—Input 28 VDC 36 A; output 80 Volts 800 cycle 7.2 Amps..........Like New: $12.95
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2C44	1.00	4J35	125.00	FG-190	9.50	F-375A	12.50	724B	1.75	861	13.50
2D21	1.00	5BP1	3.00	HF-200	13.50	393A	7.50	725A	4.00	866A	1.00
2E22	1.75	5BP4	3.00	C-202	12.50	394A	2.50	726A	7.50	869B	55.00
2J21A	6.50	5CP1	3.75	204A	25.00	417A	7.50	726B	40.00	872A	2.50
2J26	12.50	5D21	11.00	205B	1.00	GL-434A	12.00	726C	45.00	878	1.25
2J27	9.25	5FP7	1.00	F-207	100.00	446A	1.00	728CY-GY	35.00	884	1.25
2J31	19.00	5FP14	15.00	217A	3.50	446B	3.00	802	3.00	885	1.50
2J32	20.00	5JP1	13.00	WL-218	25.00	450TL	37.50	803	3.00	892R	250.00
2J33	20.00	5JP4	13.00	250R	5.00	WL-460	12.00	805	3.00	902-PP1	7.50
2J34	18.00	5JP11	35.00	251A	150.00	464A	7.00	807	1.25	913	10.00
2J36	75.00	5J30	23.50	253A	6.00	WL-468	20.00	808	1.50	918	2.00
2J38	12.50	5J32	60.00	267B	7.00	527	15.00	809	2.50	923	1.00
2J56	75.00	5R4GY	1.00	271A	5.75	WL-530	10.00	810	9.75	931A	4.25
2J61	28.50	C6A	7.50	274B	2.00	WL-531	4.75	811	2.50	959	1.50
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3BP1	3.00	6BM6	60.00	283A	3.75	700A-D	13.50	814	2.50	1624	1.25
3B22	2.25	6C21	15.00	286A	6.50	701A	5.25	815	4.50	2050	1.25
3B24	3.75	6G4	4.75	304TH	6.75	702A	1.50	822	17.50	ZB-3200	125.00
3B24W	7.50	6J4	4.75	304TL	5.00	702B	2.50	826	1.00	8002R	85.00
3B25	3.50	7BP7	3.00	307A	3.00	705A	1.00	828	9.00	8012	1.75
3B26	2.75	9GP7	7.50	310A	3.00	706AY-GY	35.00	829A	6.00	8013	2.00
3B28	4.00	9LP7	3.00	311A	5.25	707A	5.00	829B	8.00	8020	1.00
3C23	6.75	12DP7	12.50	313C	3.00	707B	8.75	830B	2.00	8025	4.00
3C24/24G	1.00	12GP7	13.50	323B	9.75	708A	2.50	832	6.50	PD8365	50.00

- *Prices do not include transportation*
- *Usual terms apply*

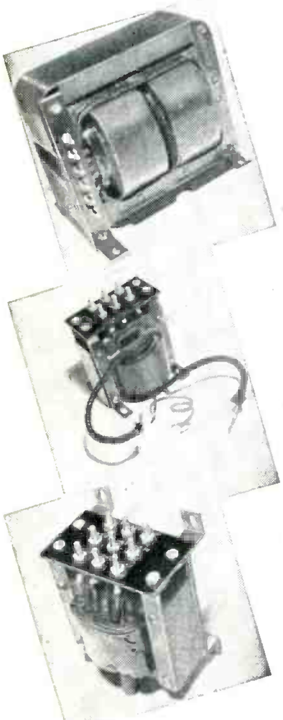
western engineers

ELK GROVE, CALIFORNIA

GEORGE WHITING, OWNER

- *Unconditional guarantee extended*
- *Subject to prior disposition*

3 OUTSTANDING TRANSFORMER VALUES!



. . . . Acme Induction Heating or Transmitter Plate Supply

3100 Volts Each Side of Center at 500 M.A. Primary tapped for 98, 104, 110, 116, 123 Volts, 60 cycle A.C. Conservatively rated. 15 KV. impregnated mica insulation. Balanced secondary windings. Special high silicon low loss core. Size: 9" L. x 8" H. x 7½" W. Shipping wt: 60 lbs. Priced extremely low at **$34.50.**

. . . . Acme Rectifier Filament Transformer

2.5 Volts (C.T.) at 10 amps. 10 KV. insulation. Primary tapped as above. Excellent design and construction for continuous operation. Limited quantity. Only **$2.75 each.**

. . . . Acme Filament Transformer

10 Volts (C.T.) at 10 amps. 5 KV. insulation. Primary tapped as above. Absolutely top quality. A highly useful type for many applications. Be sure to order spares at this low price: **$3.25 each.**

NEW AND GUARANTEED

Prices shown apply to present limited stock only.

Order today.

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833 W. Chicago Ave., Chicago 22, Ill.

RESISTORS*

- **ALL MAKES**
- **ALL OHMAGES**
- **ALL TOLERANCES**

½ WATT—1 WATT—2 WATT

AMERICA'S BEST

EB ½ W 10%	.03 each	
GB 1 W 10%	.06 each	
HB 2 W 10%	.09 each	

For 5% add 100%

Minimum per Item — $2.00

Minimum per Order — $10.00

LEGRI S COMPANY

158 West 99 Street, New York, N. Y.

WANTED

ARC-1, 3, ART-13, BC-342, 348, APS10, 15, TS-13, 35, 146, 147, 148, 174, 175, 263 ETC. All SCR, BC, AN, TS. ALL TUBES.

MOBILE RADIO SCR-508

10 Channel FM Receiver and Transmitter. Frequency Range 20-27.9mc. Receiver is manually tuned, transmitter is crystal controlled. Consists of 2 BC-603 Receivers, BC-604 Transmitter, FT-237 mount, Box 80 xtals BC-606 Control, A-62 Phantom Ant., Headsets, mike, and antenna. Input 12v DC. SCR-608 also avail. ....POR

SCR-291A

1.5-30mc automatic direction finder. This equipment used to take bearings on transmitters within its freq. range. Complete equipments available comprising the following: BC-1147A Rec., PN 31, Power Panel, BC-1159, automatic bearing goniometer, RC-223 antennae system consisting of 5 masts with legs, MC-412, MC-413 phase inverters calibrating transmitter, cables, 115v 60 cyc gasoline generator. Complete equipment overhauled and guaranteed ....POR

VE REMOTE PPI INDICATOR

This is a remote PPI indicator "7 in." screen for use with any Radar for remote viewing. Contains all indicating circuits and is driven by the main Radar. Input 115v 60 cyc. POR

AN/APN-3 SHORAN EQUIPMENT

This equipment is used for navigation, surveying, and automatic blind bombing. Operates in conjunction with AN/CPN-2 ground-beacons. Operating frequency of this equipment is 290mc. The accuracy is plus or minus 10 feet up to its range of 300 miles. We can supply bombing computers, if desired we can supply APN-3 spares. AN-CPN-2 ground-beacons also available..................POR

SO-8 S-BAND MARINE RADAR

This equipment operates in the 10 centimeter FCC approved marine band. Consists of transmitter-receiver, indicator, motor generator, antennae, voltage regulator, etc. Input 115v DC. ....POR

RADALAB

87-17 124th STREET
Richmond Hill 18, New York
Phone Virginia 9-8181-2-3

AN-GSQ/1A SPEECH SCRAMBLER

This is a very compact unit designed to be attached to either a radio or telephone circuit to scramble speech or code. This equipment utilizes coded cards in each terminal equipment. Unless the properly numbered card is inserted on the receiving end the speech can not be unscrambled. This provides an excellent privacy system. Complete equipment available consisting of: scrambler, code card set, cables, etc. This equipment can be used with any field or airborne communications equipment.
Mfg. Western Electric..................POR

SCR-506A

Mobile radio transmitter-receiver covering 2-4.5mc phone and CW. 1090 watts output 5 channel operation. 12 or 24 volt input. Consisting of: BC653, BC652, Rack, dynamotors, microphone headset, antenna and mounts.

AN/ARN-7

Automatic direction finder covering 100-1750 kc. Comprising Receiver, Loop, Control boxes, Plugs, Mounts, etc. ....POR

SCR-522

Airborne Transceiver, Freq. 100-156 Mc. This unit is crystal controlled 4 channel. Power output approx. 10 watts. Consists of: BC-624 Receiver, BC-625 Transmitter, FT-244 mount, BC-602 control box, PE-94 dynamotor, antenna, plugs $137.50

TS-102 A/AP

This crystal controlled pulse generator produces a square-topped, 50 volt synchronizing pulse of .8 microseconds at a prf of 400, 800, 1600 or 2000 cps. and a triangular marker pulse of 0.4 microseconds duration at a prf corresponding to a pulse-echo distance of 1500 ft. The phase between the marker and sync. pulses is continuously variable from —180 to +180 degrees. AN/APR-4..............POR

38-4000 mc precision receiver consists of receiver and five tuning units to cover the full range. Each tuning unit is calibrated directly in mc. Input 115v 60 cyc..............POR

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.

RF-3A/AP X-BAND FREQUENCY SWEPT MANUALLY TUNED ECHO BOX

Frequency range 8500-9600mc. This equipment consists of an echo box with a motor mounted on one end which provides a frequency swept response from the echo box enabling it to be easily observed on the Radar indicator. Input 28v DC .5 amps. Can be supplied in 110v 60 cyc AC...........POR

AN/ART-13 AUTO-TUNE AIRCRAFT TRANSMITTER

This equipment covers the frequency range of 2-18mc. and is automatically tuned 10 channel. Power output is 75 watts CW. 60 watts phone. This equipment consists of T-47 or T47A transmitter, dynamotor power supply, control box, racks, antennae loading unit, etc. ....POR

AN/PPN-1 REBECCA GROUND BEACON

This equipment operates on 215 mc and is used in conjunction with AN/APN-2 or SCR-729. Provides a signal enabling the aircraft carrying the APN-2 to home on it. This equipment is completely portable and operates from a 12 volt battery. Complete installations avail. ....POR
AN/APN-2 and SCR-729 equip. avail.
BC-348R CAA and Military approved model. POR
AN/APT-5 300-1200 mc transmitter 30 watts output..................................$169.50
AN/APR-5 1000-3100 mc receiver
BC-639 100-156 mc.....................POR
AN/APS-10 3cm airborne Radar........POR
AN/UPN-4 3cm portable Radar beacon..POR
TS-13AP 3cm sig. generator
TS-89 Voltage divider
TS-148 3cm spectrum analyzer
TS-62/AP X-Band Echo Box
TS-117/GP S-Band wavemeter

TUBES

2J41	2C43	2K50
4C27	814	7C22

SPECIAL VALUES

783 Output Power Meter General Radio. Like New $225.00
3200-3370 mc. ....Like New 400.00
LR-1 Signal Generator 160-30,000 KC. 115VAC, 60 cy. with xtal calibration.Exc..1,000.00
Model 228X Hickok Universal crystal controlled Signal Generator......Like New 125.00
Model 200C Hewlett Packard Audio Generator ....Exc. 100.00
Kay Electric Mega-Sweep..............Exc. 250.00
Kay Electric Mega-Pipper..............Exc. 100.00
R65/APN9 Receiver-Indicator ....PUR*
Du Mont 208B Oscilloscope...........Exc. 125.00
Boonton Q-Meter 160A 50KC. to 75Mc..Exc. 400.00
Model 230 Clough Brengle AC Cap. & Res. Turns Ratio Bridge ....Evc. 45.00
Type 726A General Radio Vacuum Tube Voltmeter ....Exc. 125.00
804C Federal or General Radio Signal Gen. 8-330 mc. ....Exc. 300.00
BC-221 or LM Freq. Meter............Exc. 99.50
BC-221AK with modulation ....Exc. 150.00
General Electric Dual Regulated Power Supply Type ST9A ....New 300.00
Type 724A Precision Wavemeter General Radio, 16 KC. to 50 mc.............Exc. 175.00
A LARGE STOCK OF ARC-1, ARC-3, ART-13, APN4A, APN4B, APR4, ARB, BC-312, BC-342, BC-348, BC433G, BC-611, BC-1306, CRT-3, 196A, I222,IE-19A, IE-35A, IE-36A, SCR-284, SCR-522, SCR-578, SCR-625, TCS, T19/APQ5, TS-34/AP, TS-100/AP, TS-184/AP, 14C, Plugs and Sel syns ....PUR*
*PUR—Price upon request.

WANTED

All types of radio and electronic surplus. We especially need: APA10, APN9, APR4, ARN4, ARC1, ARC3, ART13, ATC, BC221, BC342, BC348, BC611, BC721, DY12, DY17, I100, LM10 to LM18, MG149F, MG149H, PU14, R5/ARN7, R5A/ARN7, SCR718C, TCS, TN16, TN17, TN19, TN54, TS3, TS13/AP, TS33, TS35, TS45, TS75, TS76, TS102, TS147/UP, TS148/UP, TS173, TS174, TS175, TS250, TS251, TS323, (1CT, 1F, 1G, 5CT, 5DG, 5F, 5G, 6DG, 6G, 115V, 60 c.p.s. Selsyns), and all types of Hewlett Packard, General Radio Co., Measurements Corp., Boonton Radio, Ferris, Leeds & Northrup, and other test equipment.
Please state accurate description, condition, and your lowest price. Explain modification, if any. We pay freight charges.

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Industrial, Special-Purpose, Receiving Tubes, Give-Away Prices!

FEB. SPECIAL FG-27A $4.90

0C3/VR-105	$0.79
0D3/VR-150	.69
1A3	.78
1A5GT	.62
1B22	1.11
1B24	7.95
1B27	9.95
1B32/532A	1.75
1N21	.69
1N22	.95
1N27	.95
1P23	1.95
1R4	.39
1T4	.49
2A3	.75
2AP1	7.50
2B22	1.50
2C33	2.75
2C40	9.95
2E22	1.50
2J21	4.95
2J21A	5.95
2J22	6.50
2J27	8.95
2J34	19.95
2J50	49.50
2J55	65.00
2X2	.59
2X2A	1.10
3A4	.69
3B7/1291	.62
3C23	8.50
3C24	1.95
3DP1	2.50
3D6/1299	.62
3EP1	3.50
3FP7	1.69
3GP1	2.50
3JP12	7.95

4B22/EL5B	5.50
4B25/EL6CF	5.50
EL/C5B	5.50
EL/C6A	5.50
4J36	95.00
4J37	95.00
5BP1	4.69
5D21	11.50
5FP7	1.65
5JP2	12.50
6AC7	.79
6AG7	.79
6AJ5	.95
6AJ6	.79
6B6G	.55
6C6	.55
6C8G	.55
6H6	.49
6K7	.45
6SC7	.75
6SH7GT	.59
6SH7	.59
7C4/1203A	.55
7E5/1201	.69
7E6	.45
10Y	.79
12A6	.69
12C8	.59
12J5GT	.40
12SF7	.40
12SJ7GT	.40
14H7	.49
14J7	.49
15R	.55
CE22	.69
RK-25	2.10
23D4	.45
FG-27A	4.90
30SP	.39
45SP	.35
53A	1.00
QK-59	50.00
QK-60	50.00
QK-61	50.00
71A	.45
QK-72	50.00
RK-72/ CRP72	.85

FG-90	2.50
100TH	7.50
VR-105	.79
112A	.39
VT-127A	1.50
VR-150	.69
211/VT4C	.79
227A	3.50
274B	1.95
EL-302.5	1.00
304TH	9.95
GL-316A	1.69
350A	2.95
371A	1.95
388A	1.95
394A	2.50
WL-417A	12.50
GL-434A	12.50
GL-446A	1.50
464A	3.95
CK-501X	.59
532A	1.95
GL-605	35.00
WL-653B	45.00
ZP-653	35.00
705A	1.50
706AB	12.50
706AY	16.50
707A	6.50
721A	1.50
723AB	14.95
724A	1.25
724B	1.50
725A	5.50
726A	9.95
801	.75

803	3.10
804	8.50
805	2.50
807	1.35
810	9.95
811	2.10
813	8.95
814	2.25
815	3.00
816	1.10
826	.90
830B	1.95
832	6.95
832A	7.95
838	2.50
866A	1.00
872A	1.95
884	1.00
902P1	4.50
954	.29
CK-1089	.45
957	.29
1616	.75
1619	.49
1624	1.00
1625	.49
1629	.55
1655/6SC7	.75
1846	50.00
2051	.79
8005	4.25
9001	.95
9002	.85
9003	.99
9004	.39
9006	.34

FREE! New 1954 electronic parts mail-order catalog! Better than ever!

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New "SEARCHLIGHT" Advertisements
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Classified Advertising Division
ELECTRONICS
330 West 42nd St. New York 36, N. Y.

A S S O C I A T E D   I N D U S T R I E S

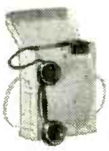
SAVE 85%

Boonton 120-A Q METER

A double frequency coil set consisting of two 120-A Boonton Q meters and two magic eye indicators built into a single unit. For checking resonance, coil inductance, and capacitance. Magic eye tube shows whether circuit under test is tuned to each of the oscillator frequencies.

Power: 115V - 60 cycle
Frequencies: 24 - 54 mc, 70 - 160 mc, 130 - 210 mc

When ordering specify frequency preferred. Limited Qty **$59.95**



FIELD TELEPHONE

EE-8 Portable Telephones complete with magnetoringer handset, and carrying case. Each set has been **Tested and Guaranteed.** As many as six phones can be used on one line. **Excellent** condition. NEW wire at 1c per ft.

Govt. cost $65.00 each
NOW ONLY - **$19.95**

NEVER BEFORE At This Low Price BC-453 Range Receiver

190-550KC - 28V and 250V. One RF and two IF stages. Beat frequency oscillator. Automatic vol. control **$19.95**

ANTENNA and BATTERY SWITCHES

Square D

with 2½" porcelain standoffs
SPST - NEW 98c
DPDT $15.00 value . . $2.98
10 Assorted Toggle Switches SPDT, SPST, DPDT, DPST $1.99

CRYSTALS 19c

We recently purchased over THREE MILLION crystals from the U. S. Govt. in various type holders and an unlimited range of frequencies. Send for complete inventory and price list.

FLUORESCENT UTILITY LIGHTS

Heavy Duty steel stand mounted on removable rubber casters. Folds into a unit measuring 18"x 55". Extends as high as 11'7". **Adjustable** 6 tube fixture. Ideal for shop, photography, industrial, advertising, etc.

Single fixture with bracket	12.95
Heavy duty 11'7" stand	12.95
Complete stand & three fixtures	39.95

SYNCHROS

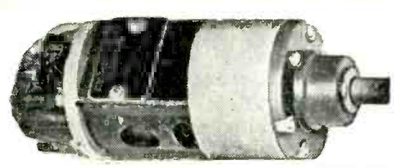
115V-60 cycle. Brand New
Delco . 8.95

We maintain an extensive stock of all types of synchros. Send for our latest descriptive bulletin.

ASSOCIATED INDUSTRIES
CABLE ADDRESS *Arule* LOS ANGELES
6855 TUJUNGA AVENUE
NORTH HOLLYWOOD, CALIF.

REVERSIBLE GEARED-MOTOR

Delco-PM-Permanent Magnet Alnico Field Motor

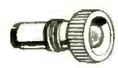


#5071895 ¼" SHAFT or 11/16 GEAR... $17.50
#5069600 .... $18.50
Clamps to hold motor: $1.50 ea.

GRAIN OF CORN LAMPS

28 VOLTS
#328 #321
10 for $3.00 100 for $25.00

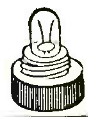
#318 3V AMBER OR CLEAR, 18 Amp.



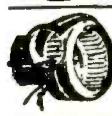
10 for $1.80
100 for $15.00

LM32 10 for $4.50
Bausch & Lomb 10 for $6.50

EXTENSION SOCKET ON CORD & TRANSFORMER FOR LM 32 $3.50



#326 2½ Volts 10 for $3.00



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Ford Spark Coil by Delco-Remy ½" $2.75
SMALL BLOWER OR AGITATOR FOR COOLING T.V. ETC. $4.50
A Miracle Switch that will not leave you in the Dark. Delayed Action Light Switch $1.95

3" Round Elapsed Time Meter $13.75

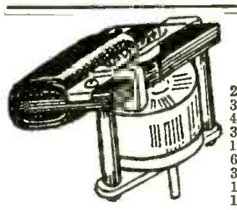
MARKTIME 5 HOUR SWITCH

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



Genuine TELECHRON Motors

2 RPM	$2.90
3 RPM	3.90
4 RPM	2.90
3.6 RPM	3.15
1 RPM	3.95
60 RPM	4.30
3 R.P. Hr.	2.85
1 R.P. 2 HP...	2.80
1 R.P. 12 Hr..	3.25

Laboratory Special 1 of Each Above. .$25.00

HAYDON SYNCHRONOUS TIMING MOTOR

110 v. 60 cycle 30 RPM..	$2.60
110 v. 60 cycle 1 RPM...	$2.85
230 V. 1 RPM	$1.00
60 cycle 2 RPM.......	$1.00

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Check your needs on this list of specially-priced aircraft and electronics equipment. Complete stocks—write for FREE CATALOG!

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TS-11	$45.00	TS-268	37.50
TS-34	300.00	1E-19	$200.00
TS-47/APR	225.00	I-139A	12.50
TS-50/u	14.95	I-183A Frequency Meter	17.50
TS-89	32.50		
TS-100	85.00	I-185A Oscillator	24.50
TS-126	75.00		
TS-153 (I-95)	47.50		
TS-184	45.00	BC-221 Meter	89.50
TS-251	650.00	BC-1287A (S Band)	125.00
(compl. with tubes, crystal, cables)		LM	85.00

√√ RADAR EQUIPMENT

APS-4 Complete Radar Set with Modulators	$550.00
SN complete	400.00
MD-12/APQ-13 with tubes	25.00
T25/TPS-2	75.00
R65/APN-9	700.00
AN/PPN-1 (Eureka)	50.00
AN/PPN-2 (Eureka)	75.00

T116/APT5A UHF Transmitter
Freq. Range 300–1500 mc.
20 w. output — band width 2.5–3 mc.
Complete with tubes and 110 v. 60 cy. fil. transf. New $175

CERAMIC CONDENSERS.... $1 ppd.
Kit of 100 asstd. Brand new, standard brands. $10 value.
MICRO SWITCHES, new . 4 for $1.00
SCOPE TRANSFORMERS $2.95
Prim. 110 v. 60 cyc. Sec. 3500 v. 25 ma. 10 KV ins.
Shipping wt. 15 lbs.
POWER TRANSFORMERS— Brand new .... 79c.
110 v. 60 cy. prim.
150 v. 30 ma. sec.
6.3-1 Amp. Fil.
FB for grid dip kits, test equip., etc.

√ TRANSMITTERS AND RECEIVERS

1D60/APA-10	$125.00
ARC-3 complete, certified	850.00
BC-640 and BC-639, RA-42	750.00
AN/TRT-1 Mine trans.	100.00
ART-13	350.00
BC-797 ground stas.	900.00
SCR-284	100.00
BC-1333 Marker Recvrs., certif.	75.00
BC-733D CAATC	35.00
DZ-1 Compass, new	20.00

METERS

3-inch Black Dialface 0-750 ma	$4.50
500-0-500 micro	6.50
2-inch Round 0-1 ma	3.45

FILTERS

FL 30	8.50
T123/ART-22	150.00
T179/ART-26	125.00
compl. with tubes	

HAZELTINE MODEL 1017 PULSE GENERATOR $150.00

√√ POWER SUPPLIES INVERTERS

MG-149F Rotary converters, certif	$49.50
RA-34 Hi-voltage for BC-191, etc.	149.50
RA-62 Hi-voltage for SCR-522	125.00
Pincor 1K11X Rotary conv (110DC in—110AC out)	17.95

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FEBRUARY, 1954

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(Classified Advertising)
H. E. Hilty, Mgr.

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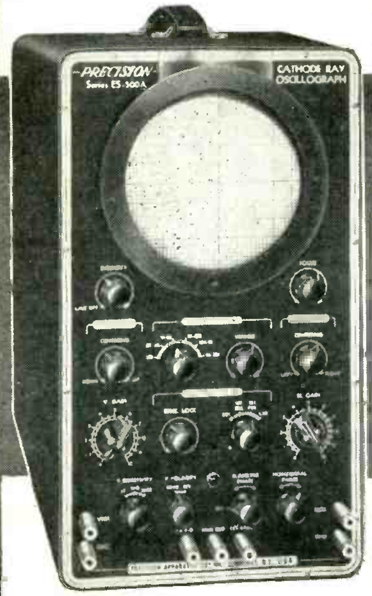

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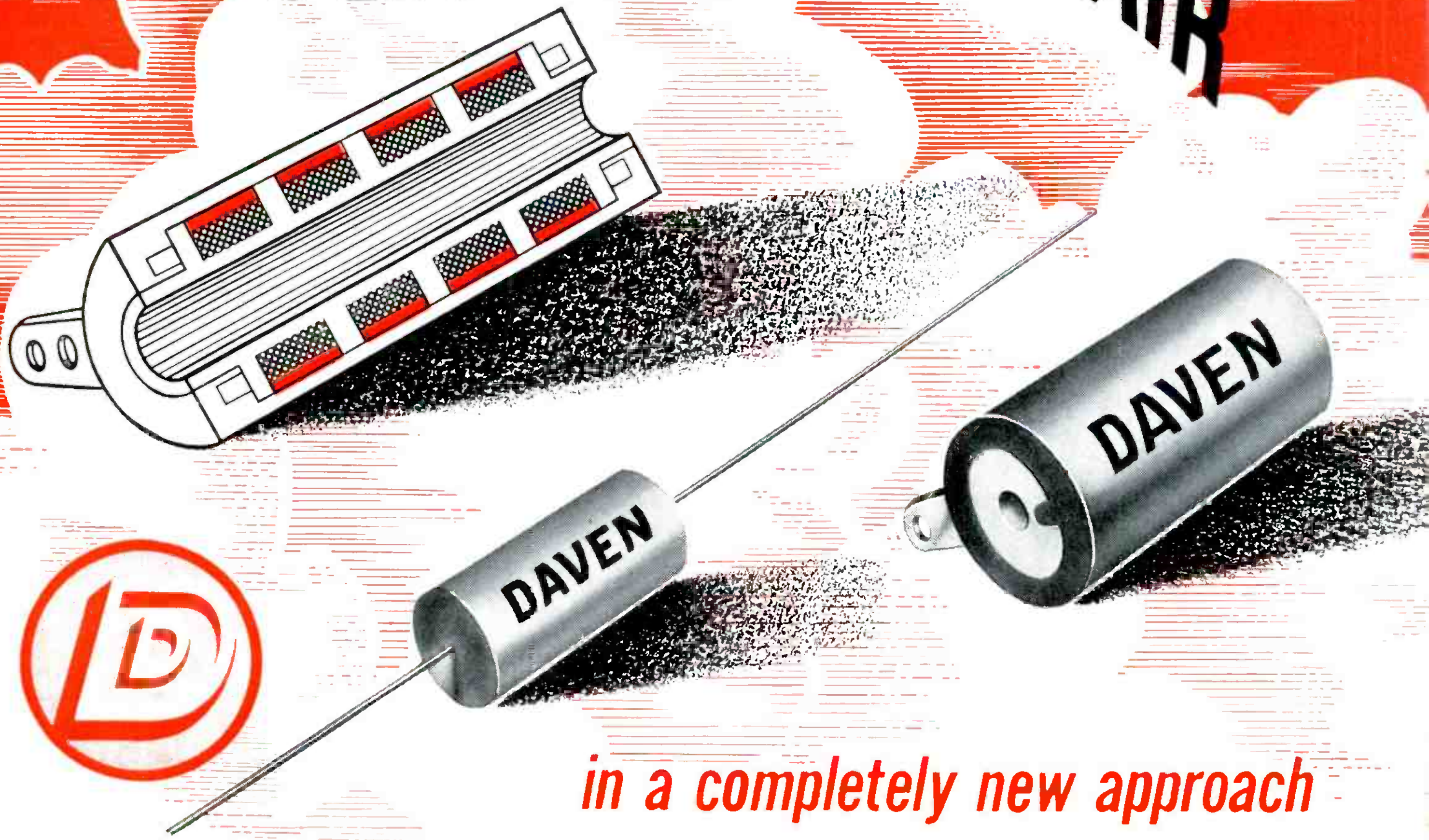
DAVEN TURNS TO AIR



in a completely new approach

to the production of Encapsulated Seald-Ohm Wire Wound Resistors

***Only* DAVEN** turns to air to keep the molding material absolutely separated from the resistance wire in its new line of Super Davohm Encapsulated Seald-Ohm Resistors. The wire is maintained in a slot filled with dry air . . . no external pressures are applied to it. These air pockets, between the wire and the plastic coating, guarantee absolute stability . . . eliminate shorted turns.

***Only* DAVEN** matches the temperature coefficient of expansion of the molding compound with the ceramic bobbin, the resistance wire and the metal terminals. This removes the possibility of cracks or strains on the wire during cycling.

Because of the special construction used, Daven can furnish Encapsulated Wire Wound Resistors with temperature coefficients below ±20 P.PM/°C. when required, and with accuracies to ±.05%.

These exclusive Daven precision, wire wound resistors are completely hermetically sealed . . . yet are no larger than standard lug-type resistors.

In addition, these units are made in accordance with MIL-R-93A specifications, and are substantially more rugged than conventional resistors. They will withstand the JAN-R-93, characteristic A, salt-water immersion test, and, in addition, temperature cycling from −65°C. to +125°C. The strong molding material will resist pressures equivalent to 75,000 ft. altitude, and will not cold flow at temperatures up to 150°C.

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